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FLORISTIC, VEGETATION AND CLIMATE ASSESSMENT OF THE EARLY/MIDDLE MIOCENE PARSCHLUG FLORA INDICATES A DISTINCTLY SEASONAL CLIMATE

Zlatko, our teacher, colleague and friend, left us suddenly and much too soon in October 2020. We hope to make a worthy contribution to his legacy by completing this piece of work.

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Abstract: The late Early/early Middle Miocene flora from Parschlug (Styria, Austria) is famous for its numerous specimens and high diversity. Some taxa previously described are revised here and 42 new angiosperm leaf morphotypes/taxa are described. The Climate Leaf Analysis Multivariate Program (CLAMP) is applied to assess the palaeoclimate. An update of the tool to assess the most suitable modern climate CLAMP calibration dataset is introduced. The Integrated Plant Record (IPR) vegetation analysis, assessing the most likely major vegetation type represented by a fossil flora, and similarity approaches Drudges 1 and 2, indicating the most similar modern vegetation proxies, had been previously applied to data from Parschlug. Both are again applied here on the enlarged floristic spectrum. The results indicate "sclerophyllous subhumid forest" as the most likely major zonal vegetation type for Parschlug and European vegetation, namely "Thermophilous mixed deciduous broadleaved forests", distributed today in southern and southeastern Europe, as the most similar modern vegetation. The climate for Parschlug, inferred from CLAMP and the climate in the region of the modern vegetation proxies, indicates distinct seasonality in precipitation and temperature.

Key words: leaf flora, CLAMP, IPR vegetation analysis, Drudges, modern vegetation and palaeoclimate proxies, Neogene, Austria

Introduction

The Early/Middle Miocene plant assemblage of Parschlug has been the focus of research since the middle of the 19th century. It comprises mainly fossil leaves and to a lesser extent remains of infructescences and inflorescences. Certainly, it is among the most sampled Miocene sites of Europe and fossil plant material from Parschlug is housed in many collections, scattered all over the world but especially concentrated in Europe (Kovar-Eder et al. 2004). The most extensive collections are housed in Vienna (Natural History Museum, Geological Survey) and in Graz (Universalmuseum, the former Landesmuseum Joanneum).

The very first investigations of the Parschlug flora date back to Unger's studies in Chloris protogaea (1841–1847). Unger also summarised the geology and provided the first list of the flora in his preliminary paper (Unger 1848). During the following decades Unger, as well as Ettingshausen, published results from Parschlug, mostly together with those from other sites, e.g., Unger (1852, 1860, 1864, 1866), Ettingshausen (1878). The flora of Parschlug was not treated systematically in any monograph until Kovar-Eder et al.'s (2004) revison which included a summary of the geological context and a complete survey of the earlier literature. These authors focussed on recognizing taxonomic affinities in order

to classify the flora in the context of work on other European Neogene floras. As cuticles are very rarely preserved, the work relied largely on analysis of gross morphology. The plant-bearing sediments at Parschlug are estimated to be of late Burdigalian to early Langhian age (Karpatian/early Badenian – Central Paratethys stages) (Kovar-Eder et al. 2004). Unfortunately, a more precise dating is not available.

The study by Kovar-Eder et al. (2004) also shed light on the fact that the Parschlug assemblage is distinctive for several reasons: (1) A very small number of taxa are extremely abundant. These taxa are all azonal implying swamp vegetation and gallery forests masking the true character of zonal vegetation. (2) The majority of fossil-species are, however, represented by a limited number of specimens or single specimens only. (3) The number of such taxa is extraordinarily high. (4) Based on the empirical analysis of autecology, Kovar-Eder et al. (2004) concluded that subhumid forests with sclerophyllous oaks were the most likely zonal vegetation type.

Later the Integrated Plant Record (IPR) vegetation analysis (Kovar-Eder and Kvaček 2003, 2007, Teodoridis et al. 2011a) was applied to assess the major zonal vegetation type for Parschlug. This approach indicated subhumid sclerophyllous forests as the most likely zonal vegetation type (Kovar-Eder et al. 2008, Kovar-Eder and Teodoridis 2018). Most recently, modern vegetation analogues were inferred by similarity approaches involving the use of two tools, "Drudges 1 and 2", which are based on the IPR vegetation analysis (Teodoridis et al. 2020, Kovar-Eder et al. 2021; see section Material and methods). Those results highlighted "Thermophilous mixed deciduous broadleaved forests" of Europe, which are distributed today in southern and southeastern regions of Europe (Formation G; Bohn et al. 2004: map 13; http://www.floraweb.de/vegetation/dnld_eurovegmap.html), as the most relevant modern analogue for the flora of Parschlug. Furthermore, Parschlug is one of several late Early to Middle Miocene Central European floras which signal a higher diversity of modern analogue vegetation proxies than do earlier and later Neogene time intervals (Kovar-Eder et al. 2021: fig. 3). Finally, Parschlug is indicative of the divergence of the IPR-Similarity (reflecting mainly leaf physiognomy) and the Taxonomic Similarity (TS), the former pointing towards strong similarity to Europe while the latter consistently points towards an East Asian relationship (Teodoridis et al. 2020, Kovar-Eder et al. 2021).

Though the flora of Parschlug provides an important signal regarding Miocene vegetation change in Europe implying stronger seasonality in precipitation than in earlier and later time intervals (Kovar-Eder and Teodoridis 2018, Kovar-Eder et al. 2021), a palaeoclimate assessment based on quantitative techniques has not yet been performed. Such an assessment is important and may serve to support or refute the results of the palaeovegetation reconstruction. Moreover, Kovar-Eder et al. (2004) suggested that probably several morphotaxa might have been missed because of the huge number of specimens housed in several collections. To fill in these gaps, a new study was initiated. In 2005 ZK and MEC screened the collections of the Natural History Museum (NHMW) and the Geological Survey (GBA) both in Vienna and the collection of the Karl-Franzens-University in Graz (IBUG, now part of the collection of the NHMW) for

previously poorly documented or unidentified angiosperm leaf morphotypes with the objective to create a solid basis for the application of the Climate Leaf Analysis Multivariate Program (CLAMP). All such specimens were documented by photographs. Between 2005 and 2008 the morphology of all identified angiosperm leaf morpho-species from Parschlug (both previously published and unpublished) were briefly described by ZK and JKE. Unfortunately, this study remained incomplete at that time.

Here we present an additional 42 leaf morphotypes and taxa not included in the previous study by Kovar-Eder et al. (2004). It was also necessary to revise some taxa from that previous study which resulted in the overall number of angiosperm leaf taxa and morphotypes for Parschlug being increased by 50 %, from 83 to 123. Therefore, we have broadened the original objective to assess the climatic signal by including a taxonomical section with short diagnoses of all angiosperm leaf morphotypes and taxa documented from Parschlug. This decision was also made because the descriptions, even for the already published morphotypes (or taxa) from Parschlug, were somewhat incomplete. The climate signal is assessed by applying CLAMP. The IPR vegetation analysis is reapplied to test to what extent the newly discovered morphotypes and taxa affect the results for the most likely zonal vegetation type. Finally, the similarity approaches are repeated by applying Drudges 1 and 2 (Teodoridis et al. 2020, Kovar-Eder et al. 2021) to test the extent to which the assessment of similar modern vegetation proxies is affected by the enrichment of the floristic spectrum.

Material and methods

Fossil material

The resources used for this study are the Parschlug collections housed at the Natural History Museum in Vienna (NHMW) including the collection of the Institute of Botany at the Karl-Franzens-University in Graz (IBUG), which was transferred to the NHMW in 2019, the collection of the Austrian Geological Survey (GBA) in Vienna and the collection of the Naturkundemuseum (UMJGP, formerly Landesmuseum Joanneum Graz, LMJ, which is now part of the Universalmuseum Joanneum in Styria).

This study focuses on (i) refining the morphological characteristics of the taxa already described by Kovar-Eder et al. (2004) and (ii) identifying the as yet undescribed morphotypes and taxa. Short diagnoses are provided for all angiosperm taxa in the section "Descriptions of angiosperm leaf morphotypes and taxa".

The terminology of the morphological descriptions is based on the Manual of leaf architecture (Ellis et al. 2009). In the diagnoses, length (l) and width (w) of the lamina are provided as l × w and the ratio l/w is calculated. Incompletely preserved leaves were mentally reconstructed to enable a reasonable size estimation. Angles of secondary veins are classified as narrow (prevailingly <45°), moderate (prevailingly 30–60°) or wide (prevailingly >50°).

The ten plates are restricted to morphotaxa which are described here for the first time and to taxa for which the range

of morphological variability is extended based on newly recognised specimens. For those using an online version of Kovar-Eder et al. (2004) to obtain sizes for previously described taxa it should be noted that magnifications not scale bars were used in those plates. The magnifications will be correct if viewed at the published size of the area containing the images which is 135 mm (left to right) and 196 mm (top to bottom).

Comparison with the Parschlug flora is restricted to the flora from the Mecsek area (Hably 2020) because of the obvious closer floristic relationship compared to other plant assemblages of similar age. Those relationships may be relevant for future palaeobiogeographic considerations. Tectonically the Mecsek region is situated on the Tisza-Dacia megaunit which was probably distinctly further south during the depositional phase than it is today (Hably 2020). Erdei et al. (2007) briefly summarised the tectonic history of the Pannonian region and noted a distinct floristic change for Magyaregregy (part of the flora from the Mecsek area) compared to older and younger fossil assemblages from Hungary.

Integrated Plant Record (IPR) vegetation analysis

Principally the IPR vegetation analysis is a semi-quantitative approach based on leaf physiognomy and autecology of taxa to assess major zonal vegetation types for Paleogene and Neogene plant assemblages. Zonal vegetation types are defined by their proportions of major (key) zonal components (Kovar-Eder and Kvaček 2003, 2007, Kovar-Eder et al. 2008, Teodoridis et al. 2011a). All taxa and morphotypes from a fossil assemblage are assigned to components. In this context, the essential zonal components are: BLD (broad-leaved deciduous), BLE (broad-leaved evergreen), SCL + LEG (sclerophyllous and legume-like), DRY and MESO HERBS (dry and mesophytic herbs). The most recent descriptions of these components are accessible at http://www.iprdatabase.eu/components-character (Teodoridis et al. 2011–2021).

In the case of taxonomically unassignable angiosperm leaf morphotypes, the assignment has to be largely restricted to leaf physiognomical criteria. The majority of morphotypes from Parschlug are documented by only a few specimens and therefore are assigned to zonal components and not to azonal ones. For some morphotypes assignment possibilities are variable. To take this fact into account, three variants of assignment have been tested to assess to what extent the results are affected (Tab. 1, App. I).

Similarity approaches (tools Drudge 1 and 2)

The similarity approaches serve to identify the most similar modern vegetation proxies for Paleogene and Neogene plant assemblages out of a currently available set of 503 modern vegetation units from Asia and Europe (see Teodoridis et al. 2020: appendix 7). The similarity approaches are easily carried out using the tools Drudge 1 and 2 (Teodoridis et al. 2020, Kovar-Eder et al. 2021, Teodoridis et al. 2021). Based on the IPR vegetation analysis, Drudges 1 and 2 automatically calculate the similarity of the proportions of major zonal angiosperm components (IPR Similarity) and the Taxonomical Similarity (TS) at the genus level by cluster

analysis (Ward's method, Euclidian distance) between a given fossil assemblage and the reference set of modern vegetation. Furthermore, the Results Mix is calculated in which the major zonal angiosperm components of the IPR Similarity and the TS results are weighted equally. The results display the number of similarity hits for the fossil and modern plant assemblages. The five best fit modern vegetation proxies for each of the IPR Similarity, the TS and the Results Mix, are shown in Table 2, Appendix II and are visualised in Text-fig. 1.

Drudge 1 extracts the highest level of correspondence of the proportions of woody angiosperms (BLD, BLE and SCL + LEG) while Drudge 2 includes DRY and MESO HERBS (the zonal herb components) to more clearly distinguish more open vegetation types from closed ones (Teodoridis et al. 2020, Kovar-Eder et al. 2021).

The results of the IPR vegetation analysis for Parschlug, i.e., variants 1–3 (Tab. 1, App. I), also served as the basis for applying the Drudges 1 and 2.

Climate Leaf Analysis Multivariate Program (CLAMP)

Climate Leaf Analysis Multivariate Program (CLAMP) is a multivariate statistical technique for quantitative determination of a range of palaeoclimate parameters based on foliar physiognomy of woody dicotyledonous angiosperms. CLAMP was first introduced by Wolfe (1993) and subsequently this technique has been refined (Wolfe and Spicer 1999, Spicer 2000, 2007, Spicer et al. 2004), methodologically modified (e.g., Teodoridis et al. 2011b, 2012, Yang et al. 2011, 2015, Teodoridis and Mazouch 2017, Zolina et al. 2020) and updated using gridded meteorological data (Spicer et al. 2009, 2020) and new CLAMP calibration data (e.g., Jacques et al. 2011, Khan et al. 2014, Yang et al. 2015).

CLAMP employs 31 different foliar physiognomic characteristics to estimate 11 climatic parameters, i.e., MAT (Mean Annual Temperature), WMMT (Warmest Month Mean Temperature), CMMT (Coldest Month Mean Temperature), GROWSEAS (Length of the Growing Season), GSP (Growing Season Precipitation), MMGSP (Mean Monthly Growing Season Precipitation), 3-WET (Precipitation mean during 3 Consecutive Wettest Months), 3-DRY (Precipitation mean during 3 Consecutive Driest Months), RH (Relative Humidity), SH (Specific Humidity) and ENTHAL (Enthalpy). Mathematically, this method is based on Canonical Correspondence Analysis (CCA) – see Ter Braak (1986). The CLAMP analyses were performed on the CLAMP web site (Spicer 2011–2021) using various calibration datasets available there. The new calibration dataset used in Spicer et al. (2020) is not yet available on the web site so could not be utilised in this study.

CLAMP may produce different results depending on which modern calibration dataset is used. A statistical tool developed by Teodoridis et al. (2011b, 2012) can be used to determine the most appropriate calibration dataset. This tool was based on the similarities (i.e., minimum difference MIN DIFFi) of the fossil (studied) and modern (calibration) leaf physiognomic characteristics from the 144 (Physg3br), 173 (Physg3ar) and 189 (PhysgAsia1) modern calibration sets (from Spicer et al. 2009, Jacques et

al. 2011). An updated version of this tool is presented here in Appendix IV, including additional calibration datasets, namely Asia 2 (177, PhysgAsia2 – Khan et al. 2014) and Global (378, PhysgGlobal – Yang et al. 2015). Appendix V includes this updated version as a "copy & paste" Excel application.

CLAMP can be used with meteorological or gridded meteorological calibration data. Spicer et al. (2009) introduced the GRIDMET3ar/br data sets to standardize CLAMP climate data, which are based on the New et al. (1999, 2002) global gridded data sets, which interpolated MAT parameters from over 12,000 meteorological stations (records for the period 1961–1990) distributed worldwide. Climate stations were not uniformly distributed, and so regional 'tiling' was used to standardize the data to uniform grids. By taking data from as many stations as possible for the same 30-year period, some of the 'noise' in the MET3ar/br files (i.e., 173 and 144 calibration data) is removed. However, other uncertainties are introduced, e.g., instrumentation and the quality of data differences are larger on a global scale than over the more restricted regional scales of the MET3ar/br datasets (Spicer et al. 2009).

An important (palaeo) climatic parameter is Mean Annual Precipitation (MAP), which cannot be simply estimated by CLAMP. Based on original CLAMP estimations for Parschlug, we have calculated MAP as follows: 3-WET + 3-DRY + (MMGSP × 6) or 3-WET + 3-DRY + [(GSP – 3-WET)/5.3] × 6.

Regarding Parschlug, the results of the CLAMP analysis are summarised in Table 3.

In addition to already published climate parameters in regions of modern proxies, climate has been assessed using the tool "Earth Systems Modelling Results" available at BRIDGE (2021).

Mitigating sources of uncertainty and possible bias

Depositional setting and taphonomy

The Parschlug Basin is one of a group of three (Leoben, Aflenz and Parschlug) relatively small and shallow basins developed along the eastern part of the Mur-Mürz fault system of the Noric Depression in the Eastern Alps during the Miocene (Sachsenhofer et al. 2003). The rapidly subsiding basins in the Noric Depression were filled, from bottom to top, with fluvial sediments, a single thick coal seam (sometimes splitting towards the East and Northwest; Sachsenhofer et al. 2001) and lacustrine sediments, in places overlain by shallowing upwards deltaic sediments (Sachsenhofer et al. 2003, Reischenbacher and Sachsenhofer 2013).

Based on the palaeogeographic interpretation by Sachsenhofer et al. (2003: fig. 21), and on proximity to the Aflenz Basin, it is unlikely that the Parschlug Basin was affected by any marine influence. This is supported by the presence of freshwater gastropods (*Gyraulus* sp. formerly as *Planorbis applanatus* Thomä, 1845) in an interbed of the lower coal bench in the Parschlug Basin (Petraschek 1924, Sachsenhofer et al. 2001, Ebner et al. 2002). The nearby Leoben Basin contains a freshwater fish fauna in sediments

above the main coal layer (Gruber and Sachsenhofer 2001: section 5.1.4). Assuming similar basin fill as that in the larger Fohnsdorf Basin, where lacustrine sediments span the full N-S width of the basin (Sachsenhofer et al. 2000: fig. 10), and using the geological map in Sachsenhofer et al. (2003: fig. 1) to estimate the size of the Parschlug Basin to be about one third of the area of the Fohnsdorf Basin (120 km²), then the lake at Parschlug can be estimated at 40 km².

The limited data that is known regarding the sedimentological context of the Parschlug flora was summarised by Kovar-Eder et al. (2004) who also (their fig. 3) provided a sketch and translation of the geological column from Unger (1848). The leaf fossils were recovered in the southwestern part of the basin from sediments overlying the main coals, specifically from clays and marls with up to 10 cm thick marlstone-ironstone intercalations (Kovar-Eder et al. 2004). Based on the nearby Aflenz and Leoben Basins (Gruber and Sachsenhofer 2001, Sachsenhofer et al. 2003) the sediments overlying the coal in the Parschlug Basin are here interpreted as lacustrine sediments. The nearby Leoben Basin was subjected to volcanic ash fall (Gruber and Sachsenhofer 2001, Sachsenhofer et al. 2010) and tuffs are present across the Noric Depression (Reischenbacher and Sachsenhofer 2013: fig. 15), so volcanic activity may also have affected the area of the Parschlug Basin. The portion of the Parschlug Basin containing leaves as recorded by Ettingshausen (Kovar-Eder et al. 2004: fig. 3, about 23 m of section) shows only fine-grained sediments (supported by the leaf-bearing sediment blocks studied here) as does the Groisenbach Member in the nearby Aflenz Basin (Sachsenhofer et al. 2003: fig. 14, about 200 metres of section). Tuffs are not mentioned in those sections. Boreholes in the Parschlug Basin also show that the sediments in the lower portion of the succession overlying the coals are fine-grained (Ebner et al. 2002). By contrast there is evidence of coarser grained sediments indicating deltaic systems inputting to the lakes in the deeper and much larger Fohnsdorf Basin in the southwest of the Noric Depression (Sachsenhofer et al. 2003).

The limited evidence suggests that volcanic activity was relatively infrequent and hence was unlikely to have resulted in a vegetation not in equilibrium with the regional climate. From the available information it seems likely that many of the leaves in the Parschlug flora, especially of abundant morphotypes, were likely to have been derived from plants living in fairly close proximity to an inland lake, i.e., close enough to fall in, be blown in, or possibly be transported in by low energy runoff and inflow. The leaf physiognomic climate signal from such fossil floras may appear cooler and drier than the regional climate due to a bias towards canopy sun leaves, smaller leaves from taller species, and more coriaceous leaves which are more easily preserved (Spicer 2000). However, the estimated size of the lake in the Parschlug Basin indicates quite a large catchment area for leaf input and there are more than 50 rare angiosperm taxa and morphotypes (i.e., represented by less than 5 specimens) included in our analyses, which may have been derived from more regional vegetation or below upper canopy contexts. Furthermore, there are a large number of taxa and morphotypes (123 of which 92 are angiosperm leaves) included in this study, far more than the recommended

minimum of 20 taxa for a CLAMP analysis. These factors help to minimise the impact of any biases.

Collecting and sampling

New collecting by the authors would be preferable for a leaf physiognomic study in order to account for any original collecting bias (such as collection of only well-preserved complete specimens or sampling from only one bed or a very small area). Unfortunately, new collecting is impossible for the Parschlug flora. Coal exploitation in the basin, which had provided the opportunity to collect the flora, ceased operation in 1959 (Kovar-Eder et al. 2004). Nevertheless, the fact that this is the most species diverse Neogene flora in Austria containing a number of endemic taxa (Kovar-Eder et al. 2004) plus an unusually high proportion of smaller entire-margined or minutely toothed leaves, means it is well worthy of a leaf-physiognomic study.

The following factors serve to indicate that previous collecting biases are unlikely to have resulted in any significant bias on the vegetation and climate interpretations made in this study. Firstly, the original collections were made by different people over long periods. Unger (1848) referred to two beds with leaves whilst the Ettingshausen catalogue refers to three sampling levels (for further details see Kovar-Eder et al. 2004). Furthermore, Ettingshausen (1878) commented, that since the year 1850 he had paid full attention to the various places where fossil plants were found near Parschlug, indicating that specimens were derived from a wider area. Secondly, large collections in three (formerly four) institutions (GBA, NHMW including the collection IBUG, and UMJGP) have been viewed during the course of this study (several thousand specimens). Thirdly, fragments and poorly preserved specimens are included in those collections. Fourthly, considerable emphasis has been placed on including all specimens in this study. For example, ZK and MEC together studied the collection IBUG (about 2,000 slabs, many of them with more than a single leaf fragment) and ensured that fragments and poorly preserved material and specimens on the reverse sides of blocks etc., were all included. In total several thousand slabs were viewed during this study.

Morphotyping and taxonomy

Inappropriate lumping or splitting of morphotypes (or taxa), or failure to include fossil leaf fragments, have the potential to bias climatic interpretation from a leaf physiognomic study. In this study the morphotype and taxon list was produced by two authors (JKE and ZK) both of whom have extensive experience studying Neogene fossil leaf floras including the previous monograph on the Parschlug flora (Kovar-Eder et al. 2004). ZK and JKE co-authored an earlier version of the diagnoses (2005–2008). In 2021 JKE overhauled all short descriptions, revisited the collections in Vienna to check a few specimens again and assembled the plates.

All specimens have been re-examined for this study and the morphotypes and taxonomic assignments have been revised where necessary (see "Descriptions of angiosperm leaf morphotypes and taxa"). "Material" and "Additional material" is restricted to collection numbers not provided by Kovar-Eder et al. (2004). There remain "ambiguous specimens" where identification to morphotype or taxon (or both) is uncertain. These fall into two categories. Firstly, specimens that may belong to one of two morphotypes/taxa but it is not clear to which (Appendix VI, "Ambiguous specimens"). This has no effect on the vegetation or climate interpretations as both the possible morphotypes or taxa have been included. Secondly, specimens which cannot be assigned to a morphotype or taxon due to the lack of sufficient features (Appendix VI, "Unidentified specimens"). In the analyses to assess vegetation and climate these unidentified specimens have not been included.

Descriptions of angiosperm leaf morphotypes and taxa

"*Acacia*" *parschlugiana* Unger

2004   "*Acacia*" *parschlugiana* Unger; Kovar-Eder et al., p. 75, pl. 9, fig. 12.

A d d i t i o n a l   m a t e r i a l . IBUG 2362 (counterpart to the neotype (NHMW 1878/6/9117) selected in Kovar-Eder et al. 2004: pl. 9, fig. 12), IBUG 2455, NHMW 1878/6/2098.

D e s c r i p t i o n . Pinnately compound leaves, preserved as fragments and isolated leaflets; leaflets "mimosoid", narrow oblong, slightly curved, l × w about (4) 6–7 × 0.9–2 mm, ratio l/w about 3–4.1, sessile, base convex to rounded, slightly asymmetrical, apex rounded, asymmetrically mucronulate; margin entire; venation very indistinct, only the midvein sometimes recognisable.

R e m a r k s . Similar foliage occurs in mimosoid legumes, such as *Acacia*, *Albizzia* and many others (see also Herendeen 1992: fig. 323).

Acer integrilobum C.O.Weber sensu Walther 1972

2004   *Acer integrilobum* C.O.Weber sensu Walther 1972, forma A; Kovar-Eder et al., p. 78, pl. 10, figs 1–4 (non *A. integrilobum*, forma B).

D e s c r i p t i o n . Long-petiolate leaves; lamina trilobate, lamina l × w about 45–50 × 40–60 mm, base rounded (to subcordate), medial lobe broad, narrowing abruptly into an acuminate apex; lateral lobes almost of the same length or slightly shorter, acuminate to acute, at moderately wide to narrow angles to the medial lobe, sinus rounded and wide; margin entire or with one or a few small rounded teeth; venation palmate, with three primaries arising at the base and a few delicate eucamptodromous – craspedodromous secondaries.

Differing from *Acer pseudomonspessulanum* by a steeper divergence of the lateral lobes.

Differing from *Dicotylophyllum* sp. L (previously assigned to *Acer integrilobum* forma B sensu Ströbitzer-Hermann in Kovar-Eder et al. 2004) in lower ratio of length of central lobe to basal lateral lobes. In *Dicotylophyllum* sp. L the central lobe is also distinctly broader than the basal lateral lobes giving the lamina a broadly triangular shape.

Differing from terminal leaflets of *Toxicodendron melaenum* by the larger size, broader shape and the basally palmate venation.

Acer pseudomonspessulanum Unger emend. Ströbitzer-Hermann 2002
Pl. 1, Fig. 1

2004 *Acer pseudomonspessulanum* Unger emend. Ströbitzer-Hermann 2002; Kovar-Eder et al., p. 77, pl. 10, figs 7–9.

M a t e r i a l . cf. GBA 2005/0004/112.

D e s c r i p t i o n . Long-petiolate leaves; lamina trilobate, l × w about 23–35 × 35–50 mm, ratio l/w about 0.7–1, base rounded, lobes narrow, nearly of the same length, narrowing to the acute apex, lateral lobes at wide angles to the median, sinus narrow rounded; margin entire or with single inconspicuous teeth; venation palmate, with three primaries and a few thin eucamptodromous – craspedodromous secondaries which are rarely preserved.

Differing from *Acer integrilobum* see that taxon.

Acer tricuspidatum A.Braun in Bronn 1838
Pl. 1, Figs 2–3

2004 *Acer tricuspidatum* A.Braun in Bronn 1838; Kovar-Eder et al., p. 77, pl. 10, figs 10–12.

A d d i t i o n a l m a t e r i a l . GBA 1848/0001/0075, cf. GBA 2005/0004/0122.

D e s c r i p t i o n . Long-petiolate leaves; lamina trilobate, l × w about 50 to at least 70 × 30–80 mm, base rounded, medial lobe broad, narrowing into an acute to acuminate apex, lateral lobes usually shorter and narrower, sinus between lobes narrow to medium rounded; margin irregularly double serrate; venation palmate, three primaries arising from the base, lateral ones at moderately acute angles from the central one; secondaries craspedodromous, rarely eucamptodromous, numerous, regularly spaced, distinct; tertiaries percurrent.

Ailanthus pythii (Unger) Kovar-Eder et Kvaček
Pl. 1, Figs 4–9

2004 *Ailanthus pythii* (Unger) Kovar-Eder et Kvaček; Kovar-Eder et al., p. 81, pl. 14, figs 2–5.
2004 "*Evonymus*" *latoniae* Unger; Kovar-Eder et al., p. 85, pl. 12, fig. 4.

A d d i t i o n a l m a t e r i a l . GBA 1848/0001/0038, GBA 2005/0004/0044, ? 0062, ? 0099, 0124, IBUG 1587, 1588, 1598, 12010, NHMW 1852/1/1910, NHMW 1878/6/2837 (counterpart of 1878/6/2063; Kovar-Eder et al. 2004: pl. 12, fig. 4), 8481.

D e s c r i p t i o n . Long-petiolate compound leaves; leaflets petiolate, petiolules variable in length, often long (see Kovar-Eder et al. 2004: pl. 14, fig. 2); leaflets sub-opposite, lamina asymmetric, ovate/oblong, l × w about (40) 55–90 (> 160) × (14) 20–33 (42) mm, ratio l/w about 2.4–3.6 (4), base asymmetric acute/cuneate/convex/rounded, apex acute; margin irregularly, simply, bluntly toothed to almost entire; midvein curved in the lower half of blade or (more rarely) straight; secondaries semicraspedodromous to eucamptodromous to brochidodromous, interspaced with one or more intersecondaries, secondaries and intersecondaries originating at wide angles, angles different on either side of midvein due to asymmetric shape, course rather straight except for marginal area where they are curved.

Differing from *Dicotylophyllum* sp. H by broader shape (lower length/width ratio), irregular, less dense dentation and larger size of teeth.

Differing from *Dicotylophyllum* sp. J by lower length/width ratio, distinctly asymmetric base and less steep secondaries and intersecondaries.

Differing from *Dicotylophyllum* sp. FF by asymmetry, blunt teeth, and absence of proximally bent (concave) secondaries.

Differing from *Dicotylophyllum* sp. GG by blunt teeth and less dense venation.

Differing from *Dicotylophyllum* sp. JJ by dentate margin, rather straight secondaries, absence of basal secondaries closely paralleling margin.

Differing from leaflets of *Engelhardia orsbergensis* by mostly larger and broader blades (lower length/width ratio), stronger asymmetry of base and blunt and mostly larger teeth.

Differing from *Fraxinus* sp. by presence of petiolule, irregularly spaced, larger and blunt teeth, midvein bent in lower part of lamina, and more numerous intersecondaries.

Differing from lateral leaflets of *Toxicodendron melaenum* by usually larger size, more densely spaced secondaries interspaced with one or more intersecondaries.

Alnus gaudinii (Heer) Erw.Knobloch et Kvaček

2004 *Alnus gaudinii* (Heer) Erw.Knobloch et Kvaček; Kovar-Eder et al., p. 60, pl. 3, fig. 5.

D e s c r i p t i o n . Leaf lacking base; lamina slender elliptic, l × w when complete about 95 × 28 mm, apex acute; margin finely indistinctly double serrate, teeth moderately dense, sharp and slender, midvein slender, straight; secondaries craspedodromous, moderately dense and regularly spaced, extremely rarely forked, sub-parallel, almost straight; tertiaries dense, percurrent, oblique to midvein, tertiaries reticulate.

Alnus julianiformis (Sternb.) Kvaček et Holý

2004 *Alnus julianiformis* (Sternb.) Kvaček et Holý; Kovar-Eder et al., p. 59, pl. 3, fig. 6.

D e s c r i p t i o n . Leaf fragmentary, base and petiole not preserved; lamina (?) ovate or elliptic, l × w about 60 × 30 mm, ratio l/w about 2, apex acuminate; margin finely double serrate, teeth sharp; midvein strong, straight; secondaries craspedodromous, at acute angles, straight, forked near the margin, resulting in an admedial branch sub-parallel to margin; tertiaries not preserved.

Differing from *Betula* sp. in the (?) ovate or elliptical, not sub-triangular/deltoidal lamina.

Berberis (?) notata Doweld

2004 *Berberis* (?) *ambigua* (Unger) Kovar-Eder et Kvaček; Kovar-Eder et al., p. 56, pl. 2, fig. 11.

D e s c r i p t i o n . Leaf (?) sub-sessile; lamina obovate, l × w about 27 × 10 mm, ratio l/w = 2.7, base narrow cuneate, apex (?) rounded; margin simply spiny toothed; midvein straight; secondaries semicraspedodromous, widely spaced, looping well within the lamina.

R e m a r k s . Doweld (2018b) recognised *Berberis ambigua* as an illegitimate homonym of the extant species *Berberis ambigua* AHRENDT.

Differing from *Berberis teutonica* by slender lamina and long and sharp marginal teeth.

Berberis teutonica (UNGER) KOVAR-EDER et KVAČEK

2004 *Berberis teutonica* (UNGER) KOVAR-EDER et KVAČEK; Kovar-Eder et al., p. 56, pl. 2, figs 9, 10.

D e s c r i p t i o n . Leaves very shortly petiolate to sub-sessile; lamina obovate to elliptic, l × w = 30–35 × 15–20 mm, base cuneate, apex rounded to bluntly acute; margin widely indistinctly toothed; midvein straight; secondaries semicraspedodromous, widely spaced, arising from the base to the apex at sharp to moderately wide angles, looping well within the lamina, forming loops of several orders along the margin; tertiaries partly percurrent, partly forming large meshes; higher order veins reticulate.

Differing from *Berberis* (?) *notata* see that taxon.

Berchemia multinervis (A.BRAUN) HEER
Pl. 1, Figs 14, 15

2004 *Berchemia multinervis* (A.BRAUN) HEER; Kovar-Eder et al., p. 77, pl. 11, figs 4, 5.

A d d i t i o n a l   m a t e r i a l . NHMW 1878/6/2071, 9108.

D e s c r i p t i o n . Leaves incomplete, petiolate; lamina ovate to elliptic, l × w about 45–52 × 20–36 mm, ratio l/w about 1.4–2.4, base rounded, apex missing; margin entire; midvein straight, slender; secondaries eucamptodromous, slender, rather dense, regularly spaced, parallel to sub-parallel, bent, more strongly bent near the margin, arising at moderately acute to wide angles near the base, angles narrowing towards apex; tertiaries delicate, very densely spaced, parallel, percurrent to forked-percurrent, rather straight to slightly sinuous, obtuse to almost perpendicular to midvein; higher order veins not preserved.

Betula sp.
Pl. 2, Figs 1–3

M a t e r i a l . GBA 2005/0004/0031, IBUG 1542, 1543, NHMW 1878/6/2028a.

D e s c r i p t i o n . Leaves long-petiolate; lamina ovate to deltoidal, l × w about 25–59 × 19–36 mm, ratio l/w about 1.1–2.3, base widely rounded to almost truncate, apex acute to (?) acuminate; margin finely sharply serrate, teeth slightly unequal in size, triangular, narrow, shape variable, partly exmedially pointed; midvein straight; secondaries craspedodromous to semicraspedodromous, delicate, widely spaced but somewhat denser and at very wide angles near base, steeper towards apex, ending in tooth apices, near margin giving rise to exmedial veinlets which partly loop or end in tooth apices; tertiaries very thin, percurrent, partly sinuous, fourth order veins reticulate; higher order veins reticulate.

Differing from *Alnus julianiformis* see that taxon.

Differing from *Betula* vel *Alnus* sp. by ovate to deltoidal shape and widely rounded to truncate base.

Differing from Betulaceae gen. et sp. indet. by the deltoidal to triangular lamina, smaller teeth and higher length/width ratio.

Betula vel *Alnus* sp.

M a t e r i a l . IBUG 726, 734.

D e s c r i p t i o n . Leaves fragmentary, lacking petioles; lamina ovate to (?) elliptic, l × w about 36–56 × 16–29 mm, ratio l/w about 1.9–2.2, base convex, apex not preserved; margin serrate, poorly preserved; midvein straight, slender; secondaries (?) craspedodromous, delicate, medium densely, regularly spaced, medium steep, at first paralleling midvein (IBUG 734); tertiaries delicate, percurrent, almost perpendicular to secondaries.

Differing from *Betula* sp. see that taxon.

Betulaceae gen. et sp. indet.
Pl. 2, Figs 6–8

2004 *Betula* vel *Alnus* sp.; Kovar-Eder et al., p. 59, pl. 3, figs 3, 4.

A d d i t i o n a l   m a t e r i a l . IBUG 729, 738, NHMW 1878/6/2348 (part + counterpart), 2490.

D e s c r i p t i o n . Leaves probably short-petiolate; lamina broadly ovate to slightly obovate, l × w about 40–57 × 29–42 mm, ratio l/w about 1.3–1.6, base rounded to slightly cordate, apex acuminate; margin distinctly regularly double serrate, teeth variable in shape, often pointing exmedially; midvein straight, strong; secondaries craspedodromous, slightly curved and somewhat denser at base, widely spaced, angle of origin wider near base than near apex, exmedial side veins running into marginal teeth; no intersecondaries; tertiaries percurrent/forked-percurrent almost perpendicular to secondaries.

Differing from *Betula* sp. see that taxon.

Betulaceae vel Ulmaceae gen. et sp. indet.
Pl. 2, Figs 4, 5, Pl. 10, Fig. 16

M a t e r i a l . NHMW Ett. 497, Ett. 730, NHMW 1878/6/9678.

D e s c r i p t i o n . Incomplete leaves, petiole not preserved; lamina ovate, l × w about 60– ?80 × 24– at least 26 mm, ratio l/w about 2.5, base incomplete, convex, slightly (?) asymmetrical, apex (?) acute; margin double serrate, sinus and apex acute, basal and apical side convex to straight; midvein slender, straight; secondaries craspedodromous, moderately widely spaced, originating alternately, at first converging midvein, then straight, near margin curved upwards running into apices of larger teeth; tertiaries hardly visible, (?) percurrent.

Buxus cf. *egeriana* BŮŽEK, HOLÝ et KVAČEK
Pl. 2, Figs 9–15

2004 *Buxus* cf. *egeriana* BŮŽEK, HOLÝ et KVAČEK; Kovar-Eder et al., p. 71, pl. 8, fig. 16.
2004 ? *Buxus* cf. *egeriana* BŮŽEK, HOLÝ et KVAČEK; Kovar-Eder et al., p. 71, pl. 8, fig. 17 (non fig. 15).

A d d i t i o n a l   m a t e r i a l . GBA 1848/0001/0079, GBA 2002/0001/0014, GBA 2005/0004/0056, 0063, 0118 +

0119 (part + counterpart) IBUG 2005, 12006, NHMW 1878/6/6465 (part and counterpart).

D e s c r i p t i o n . Leaves shortly petiolate; lamina (narrow) elliptical to lanceolate, sometimes slightly ovate or obovate, l × w about (18) 24–50 × (7) 10–23 mm, ratio l/w about 1.9–2.9 (3.9), base cuneate to somewhat decurrent, apex bluntly acute, tip sometimes slightly emarginate; margin entire, thickened; midvein thick, straight, secondaries brochidodromous, very dense and numerous, at moderately acute angles, rather straight to sometimes slightly exmedially bent (concave), joining the margin; intersecondaries composite, numerous, with tertiaries forming narrow elongate meshes parallel to secondaries.

R e m a r k s . Differing from legumes in the characteristic dense venation and thickened margin. Specimen LMJ 76502 assigned to *Buxus* with doubts by Kovar-Eder et al. (2004: pl. 8, fig. 15) is excluded and assigned instead to ? *Dicotylophyllum* sp. B.

Cedrelospermum ulmifolium (UNGER) KOVAR-EDER et KVAČEK
Pl. 2, Figs 16–18

2004 *Cedrelospermum ulmifolium* (UNGER) KOVAR-EDER et KVAČEK; Kovar-Eder et al., p. 68, pl. 8, figs 1–5.

A d d i t i o n a l m a t e r i a l . GBA 2005/0004/0096, 0097, IBUG 835, 2806a, NHMW 1878/6/7617.

D e s c r i p t i o n . Leaves petiolate; lamina narrow slender ovate, elliptic to oblong, l × w about 23–66 × 5–18 mm, ratio l/w about 2.8–5.6, base usually asymmetrical, uneven, the narrower side straight, the wider side convex, apex long acute to acuminate; margin simple, regularly bluntly serrate, proximal and distal sides of teeth often convex, sinus angular to rounded; midvein straight to slightly bent or S-shaped; secondaries craspedodromous, ending in tooth apices, in number largely corresponding to the number of teeth, sometimes forked, course curved, descending at moderate angles; tertiaries and higher order veins reticulate.

Differing from *Ulmus plurinervia* UNGER by more slender, narrow ovate and smaller lamina, less numerous teeth and less dense venation.

Differing from *Zelkova zelkovifolia* (UNGER) BŮŽEK et KOTL. by more slender, usually smaller and stronger asymmetrical lamina, long acute apex, and higher number of teeth and secondaries.

"Celastrus" europaea UNGER
Pl. 1, Figs 10–12

2004 *"Celastrus" europaea* UNGER; Kovar-Eder et al., p. 84, pl. 12, figs 1–2.
2004 *"Euonymus" latoniae* UNGER; Kovar-Eder et al., p. 85, pl. 12, figs 3, 5 (non fig. 4).

A d d i t i o n a l m a t e r i a l . IBUG 1988, NHMW 1878/6/cf. 2740 + 2741 (part + counterpart), 2742.

D e s c r i p t i o n . Leaves (?) short-petiolate; lamina elliptic, l × w about 31–46 × 17–21 mm, ratio l/w = 1.8–2.7, base cuneate/decurrent, apex bluntly acute, tip rounded; margin basally entire, in the upper part almost entire/

slightly undulate to toothed with very few and more or less distinct blunt teeth; midvein straight; secondaries (?) eucamptodromous to semicraspedodromous, widely spaced, arising at acute angles, rather straight; intersecondaries occasionally present; tertiaries reticulate.

R e m a r k s . After studying more material, we merged both morphospecies because we are unable to differentiate them. Hably (2020) included the leaves published as *"Euonymus" latoniae* by Kovar-Eder et al. (2004) into synonymy with cf. *Gleditsia* sp. The leaves from Parschlug differ, however, from cf. *Gleditsia* sp. by their symmetrical shape, the presence of a petiole and blunt teeth. Only specimen NHMW 1878/6/2063 (Kovar-Eder et al. 2004: pl. 12, fig. 4), transferred here to *Ailanthus pythii*, resembles the specimen figured by Hably (2020) on pl. 17, fig. 4 in shape and the widely, irregularly spaced, blunt teeth.

Differing from *Dicotylophyllum* sp. B by non-entire margin, more widely and regularly spaced, steeper secondaries and short petiole.

Differing from *Dicotylophyllum* sp. X by non-entire margin.

Differing from *Dicotylophyllum* sp. HH by toothed margin and absence of a long petiole.

Differing from *Toxicodendron melaenum* by symmetrical shape and smaller, often indistinct teeth.

"Cornus" ferox UNGER

2004 *"Cornus" ferox* UNGER; Kovar-Eder et al., p. 84, pl. 12, figs 6, 7.

D e s c r i p t i o n . Leaf (?) sessile; lamina broadly obovate, l × w = 53 × 40 mm, base subcordate, apex rounded – (?) mucronate; margin entire; venation subpalmate, midvein stout, straight, basal lateral primaries 2 (–4, outermost very thin) arising from lamina base, forking; secondaries brochidodromous, delicate, very widely spaced, arising at very narrow angles, at first converging towards midvein, then distinctly turning towards the margin and bent towards it proximally (concave), forking once to several times near margin; intersecondaries present, forming elongated meshes; higher order venation not preserved.

Cotinus (?) *aizoon* (UNGER) KOVAR-EDER et KVAČEK
Pl. 3, Figs 1–8

2004 *Cotinus* (?) *aizoon* (UNGER) KOVAR-EDER et KVAČEK; Kovar-Eder et al., p. 80, pl. 11, figs 6, 8–10.

A d d i t i o n a l m a t e r i a l . GBA 2005/0004/0010 + 0011, 0012, 0014, 0071, 0075, 0086A + B (part and counterpart), IBUG 2018.

D e s c r i p t i o n . Leaves long-petiolate; lamina broadly obovate, l × w about 19–45 × 13–31 mm, ratio l/w about 1.2–1.5 (2), base cuneate, apex rounded, mucronate or slightly emarginate; margin entire; midvein straight, medium thick; secondaries brochidodromous/eucamptodromous, sometimes deeply forked, relatively dense; intersecondaries occasionally developed; tertiaries forming a polygonal network.

R e m a r k s . Hably (2020) noted that *Cotinus* sp. from the flora of the Mecsek region differs by a thicker petiole.

The material described here from Parschlug also includes such a specimen (Pl. 3, Fig. 4). However, the specimen from Mecsek area differs from the Parschlug material by its larger size.

Differing from *Dicotylophyllum* sp. A by the reticulate (not percurrent) tertiaries.

Differing from *Dicotylophyllum* sp. B by the obovate shape, lower l/w ratio, denser and occasionally deeply forked secondaries.

Differing from *Leguminophyllum* sp. E by smaller blade, long petiole, obovate shape, denser and steeper secondaries.

Daphnogene polymorpha (A.Braun) Ettingsh.
Pl. 1, Fig. 13

2004   *Daphnogene polymorpha* (A.Braun) Ettingsh; Kovar-Eder et al., p. 55, pl. 2, fig. 8.

Additional material. IBUG 1284 + 2827 (part + counterpart), 1285.

Description. Leaves petiolate; lamina (broad) elliptic, l × w about 31–52 × 17–32 mm, ratio l/w about 1.5–1.8, base wide cuneate/convex, apex not preserved; margin entire; venation acrodromous; midvein straight to slightly bent, lateral primaries suprabasal, reaching well above the middle of the lamina, giving rise to numerous exmedial veinlets; lateral primaries looping with secondaries; secondaries brochidodromous, few, restricted to upper part of lamina, at wide angles; tertiaries thin, arising from midvein at almost right angle to wide angle, tertiaries between secondaries percurrent, higher order veins fine reticulate.

Differing from *Dicotylophyllum* sp. X by thicker primaries originating suprabasally and reaching the upper third of the lamina.

Dicotylophyllum sp. 1
Pl. 2, Fig. 19

2004   *Dicotylophyllum* sp. 1; Kovar-Eder et al., p. 88, pl. 15, fig. 1.

Additional material. cf. GBA 2005/0004/0024.

Description. Leaves alternate, shortly petiolate; lamina narrow elliptic to obovate, l × w up to 62 (inferred) × 18 mm, ratio l/w about 3–3.4, base narrow cuneate to decurrent, apex incomplete, emarginate (GBA 2005/0004/0024); margin entire near base, upper two thirds widely simply serrate, teeth triangular, sinus acute to rounded, apex bluntly acute to rounded; midvein straight or bent: secondaries delicate, semicraspedodromous, densely spaced, at moderate angles, rather straight, looping near margin; veinlets entering teeth; higher order veins not preserved.

Remarks. The apex is only preserved in specimen GBA 2005/0004/0024. Whether the emarginate apex resulted from damage is uncertain.

Differing from *Dicotylophyllum* sp. G by the secondary veins which are not diverging towards the leaf margin.

Differing from *Dicotylophyllum* sp. M by the straight course of the secondaries.

Differing from *Dicotylophyllum* sp. T by elliptic shape, entire margin near base and less sharp teeth.

Differing from leaflets of *Engelhardia orsbergensis* by symmetry, cuneate base, broader shape and broader teeth.

Dicotylophyllum sp. 2

2004   *Dicotylophyllum* sp. 2; Kovar-Eder et al., p. 88, pl. 15, figs 2, 3.

This material is considered to be synonymous with *Ternstroemites pereger* (Unger) Kovar-Eder et Kvaček (see that chapter).

Dicotylophyllum sp. 3
Pl. 2, Figs 20–24

2004   *Dicotylophyllum* sp. 3; Kovar-Eder et al., p. 88, pl. 15, figs 9, 10.

Additional material. GBA 1848/0001/0027, 0028, IBUG 81a.

Description. Leaves mostly shortly petiolate; lamina obovate, l × w about 26–36 × 10–22 mm, ratio l/w about 1.5–2.7, base cuneate, decurrent, apex broadly rounded; margin entire near base, in the apical part shallow crenulate to irregularly toothed; midvein straight; secondaries basally eucamptodromous, in the crenulate part (semi)craspedodromous, densely spaced, in the basal part at moderately narrow angles, angles increasing apically, course rather straight, sometimes forked; simple intersecondaries occasionally present; tertiaries dense, usually forked, wavy, strongly oblique to secondaries and almost perpendicular to midvein.

Differing from *Dicotylophyllum* sp. C by wider lamina (lower length/width ratio) and apically crenulate margin.

Differing from *Dicotylophyllum* sp. D by more slender shape and crenulate margin.

Differing from *Dicotylophyllum* sp. E by inconspicuous secondary and tertiary venation, more densely spaced and rather straight course of secondaries as well as coarser crenate margin.

Differing from *Dicotylophyllum* sp. Y by obovate shape, cuneate-decurrent base and apically coarser crenulate margin.

Differing from *Dicotylophyllum* sp. II by distinctly obovate shape, apically coarser crenulate margin and inconspicuous secondary and tertiary venation.

Dicotylophyllum sp. 4

2004   *Dicotylophyllum* sp. 4; Kovar-Eder et al., p. 89, pl. 15, fig. 11.

Description. Leaf fragmentary; lamina broadly elliptic, l (inferred) × w about 96 × 70 mm, base (?) rounded, apex missing; margin simply partly double serrate, teeth coarse, regularly spaced, second order teeth distinctly smaller than first order teeth, tooth apices and sinuses sharp, coarse, proximal and distal sides rather straight; venation acrodromous, midvein straight, lateral primaries steep, rather straight, reaching well over two thirds the length of the lamina, sending side veins into teeth as do secondaries in the upper part of lamina, from side veins sometimes further veinlets run into secondary teeth; secondaries craspedodromous; tertiaries (forked) percurrent.

Dicotylophyllum sp. 5

2004 *Dicotylophyllum* sp. 5; Kovar-Eder et al., p. 89, pl. 15, fig. 12.

A d d i t i o n a l   m a t e r i a l . NHMW 1878/6/7408 (counterpart of NHMW 1878/6/7507; Kovar-Eder et al. 2004: pl. 15, fig. 12).

D e s c r i p t i o n . Leaf fragmentary; lamina elongate, l × w >120 × 33 mm, ratio l/w at least 3.4, base missing, apex attenuate; margin simple serrate, apically almost crenate, teeth widely, regularly spaced, small, sometimes sharp, spine-like; midvein straight, strong; secondaries crapsedodromous to semicraspedodromous, widely spaced, steep, straight, partly forked at variable distances from the midvein, with branches either directly entering teeth or looping and sending exmedial veinlets into teeth; tertiaries percurrent, very dense, in the middle of lamina at an obtuse angle to midvein, towards margin angle somewhat decreasing.

Differing from *Fraxinus* sp. by widely spaced, straight and steeper secondaries, tooth shape and percurrent tertiaries.

Differing from *Quercus drymeja* Unger and *Q. zoroastri* Unger by larger size, less dense marginal teeth and secondaries, and steeper secondaries.

Dicotylophyllum sp. 6
Pl. 3, Figs 9, 10

2004 *Dicotylophyllum* sp. 6; Kovar-Eder et al., p. 89, pl. 15, figs 4, 5.

A d d i t i o n a l   m a t e r i a l . IBUG 614.

D e s c r i p t i o n . Leaves fragmentary; apical part of lamina narrow lanceolate-oblong, 60 mm long but incomplete, width about 10–15 mm, ratio l/w ?, base not preserved, apex long attenuate; margin regularly simply toothed, teeth broad, bluntly acute or rounded at tip, sinuses narrow rounded to acute, proximal side convex, distal side convex to rather straight; midvein slightly bent; secondaries craspedodromous, at moderate angles, very regularly spaced, occasionally forked, largely corresponding to the number of teeth; intersecondaries occasionally present; tertiaries (?) percurrent.

Differing from *Myrica lignitum* (Unger) Saporta by the deeper incision of the margin recalling *Comptonia*, and differing from *Myrica oehningensis* (A.Braun) Heer by steep and less numerous secondaries.

Dicotylophyllum sp. A
Pl. 2, Figs 25, 26

M a t e r i a l . GBA 2005/0004/0002, 0006.

D e s c r i p t i o n . Leaves without petiole, petiole not preserved (?); lamina broadly elliptic to slightly obovate, l × w about 43–44 × 28–31 mm, ratio l/w = 1.4–1.5, base broadly cuneate, apex rounded; margin entire, venation eucamptodromous, midvein strong, straight; secondaries dense, rather regularly spaced, medium steep, curved apically (convex); occasional simple intersecondaries; tertiaries (forked)-percurrent, dense, almost perpendicular to midvein, further venation fine reticulate.

Differing from *Cotinus* (?) *aizoon* see that taxon.

Differing from *Leguminophyllum* sp. J by denser, more numerous and regular secondaries and denser spaced tertiaries perpendicular to midvein.

Dicotylophyllum sp. B
Pl. 3, Figs 11–15

M a t e r i a l . GBA 6704b, GBA 2005/0004/0009A, 0013, 0076b, IBUG sine numero, (?) LMJ 76502 (Kovar-Eder et al. 2004: pl. 8, fig. 15).

D e s c r i p t i o n . Long-petiolate leaves, petiole up to 14 mm long, straight to slightly bent only; lamina slender elliptic to oblong, 29–45 × 15–18 mm, ratio l/w = 1.8–2.5, base cuneate to somewhat convex, apex rounded to widely bluntly acute; margin entire; midvein straight; secondary venation eucamptodromous to brochidodromous, secondaries regularly spaced, almost straight, medium steep; tertiaries and higher order venation forming a polygonal network.

Differing from "*Celastrus*" *europaea* see that taxon.

Differing from *Cotinus* (?) *aizoon* see that taxon.

Differing from *Dicotylophyllum* sp. HH by more densely spaced secondaries.

Dicotylophyllum sp. C
Pl. 3, Figs 17–24

2020 "*Daphne*" *oeningensis* A.Braun emend. Weyland; Hably, p. 86, pl. 17, figs 6, 8–10 (non 7).

M a t e r i a l . GBA 6704a, GBA 2005/0004/0017A, 0018-0023, 0025-0027, IBUG 480, 796, ? NHMW 1878/6/5395, NHMW Ett. 6296.

D e s c r i p t i o n . Leaves petiolate, (short-)petiolate, petiole often bent; lamina spatulate, narrow, l × w about (5) 17–36 (50) × (1) 3–12 (20) mm, ratio l/w about (2.2) 2.6–4.3 (5.5), base narrow decurrent, sometimes bent, apex rounded to emarginate; margin entire; midvein strong, almost straight; secondaries probably eucamptodromous, medium steep, but rarely preserved.

R e m a r k s . Hably (2020) described similar foliage as "*Daphne oeningensis* (A.Braun) emend. Weyland". The specimen figured on pl. 17, fig. 7 by Hably (2020) appears, however, distantly dentate and should be excluded from *D. oeningensis*.

Differing from *Dicotylophyllum* sp. 3 see that taxon.

Differing from *Dicotylophyllum* sp. F by spatulate lamina with narrow decurrent base and higher l/w ratio.

Differing from *Dicotylophyllum* sp. O by smaller and more slender lamina (higher ratio l/w).

Dicotylophyllum sp. D
Pl. 3, Fig. 29

M a t e r i a l . GBA 2005/0004/0029A.

D e s c r i p t i o n . Leaf lacking petiole (? not preserved); lamina broad obovate, l × w = 21 × 13 mm, ratio l/w = 1.6, base cuneate, apex rounded, margin entire; midvein straight; secondaries (?) eucamptodromous, delicate, faintly visible, at wide angles.

Differing from *Dicotylophyllum* sp. 3 see that taxon.

Dicotylophyllum sp. E
Pl. 3, Fig. 16

M a t e r i a l . IBUG 1777.

D e s c r i p t i o n . Leaf incomplete at base; lamina elliptic or slightly obovate, l × w about 21 × 15 mm, ratio l/w about 1.4, apex rounded; margin basally entire, finely crenulate in the apical part; midvein straight, strong; secondary and tertiary venation also strong and distinct; secondaries brochidodromous to semicraspedodromous in the crenulate part, secondaries at wide to medium wide angles, angles decreasing towards apex, curved, looping within the lamina, their branches looping further near the margin; intersecondaries partly compound; tertiaries percurrent almost straight to sinuous, obtuse angle to midvein in basal part and almost perpendicular in apical part of lamina.

Differing from *Dicotylophyllum* sp. 3 see that taxon.

Differing from *Dicotylophyllum* sp. II by regular pattern of percurrent tertiaries.

Dicotylophyllum sp. F
Pl. 3, Figs 25–28

M a t e r i a l . GBA 2005/0004/0033, 0035-0037, NHMW 1878/6/8360.

D e s c r i p t i o n . Leaves lacking petiole, (?) sessile; lamina broad elliptic to roundish, l × w about (7) 12–22 × (4) 6–14 mm, ratio l/w = 1.2–1.8, base rounded to convex, apex rounded; margin entire; midvein almost straight; secondaries (?) eucamptodromous or (?) brochidodromous, rarely visible, rather straight to slightly curved, widely spaced.

Differing from *Dicotylophyllum* sp. C see that taxon.

Differing from *Dicotylophyllum* sp. Y by entire margin, rounded apex and lower length/width ratio.

Differing from *Dicotylophyllum* sp. II by the elliptic to roundish shape, entire margin and indistinct secondaries and tertiaries.

Dicotylophyllum sp. G
Pl. 4, Figs 2, 3

1864   *Ilex simularis* Unger; Unger, p. 13, pl. 3, fig. 14.

M a t e r i a l . GBA 6703 (orig. *Ilex simularis* Unger 1864: pl. 3, fig. 14), NHMW 1878/6/2498 + 7415 (part + counterpart).

D e s c r i p t i o n . Leaves incomplete at base, petiole not preserved, lamina (broad) obovate, l × w about 45–85 × 17–52 mm, ratio l/w about 1.6–2.6, apex incomplete, (?) acute, base cuneate, margin (sharply) toothed, teeth tiny, narrow, acute, widely spaced; midvein straight, secondaries semicraspedodromous, widely spaced, rather straight, medium steep, in apical part somewhat exmedially diverging, tertiaries faint, dense, percurrent, angle obtuse to mid vein.

Differing from *Dicotylophyllum* sp. 1 see that taxon.

Differing from *Dicotylophyllum* sp. M by broader obovate shape, tooth shape and straight secondaries.

Differing from *Fagus* sp. by distinctly obovate shape, distinctly cuneate base and less dense, i.e., less numerous secondaries.

Dicotylophyllum sp. H
Pl. 4, Fig. 1

1860   *Sapindus pythii* Unger; Unger, p. 33, pl. 14, figs 6–8.

M a t e r i a l . GBA 1848/0001/0078, Unger (1860: 33, pl. 14, fig. 8).

D e s c r i p t i o n . Leaflet shortly petiolulate; lamina narrow oblong, l × w = 148 × 28 mm, ratio l/w = 5.4, base distinctly asymmetrically cuneate-convex, apex acute-acuminate, margin regularly densely serrate, teeth blunt, (?) glandular; midvein strong, gently bent; secondaries semicraspedodromous, quite densely spaced, rather straight, arising at moderate angles, near the asymmetrical base at wider angles on one side than on the other, looping near margin; (?) short simple intersecondaries; tertiaries irregular, forming meshes.

Differing from *Ailanthus pythii* see that taxon.

Differing from *Dicotylophyllum* sp. GG by regularly spaced and blunt, possibly glandular teeth, long and slender lamina and less dense venation.

Differing from *Fraxinus* sp. by the strongly asymmetric base, slender shape, regularly, more densely spaced and larger teeth and straight course of secondaries.

Differing from *Ternstroemites pereger* by larger size, short petiole, distinctly asymmetrical base, basally bent midvein, teeth present near the base.

Dicotylophyllum sp. I
Pl. 4, Fig. 15

M a t e r i a l . NHMW 1878/6/9176.

D e s c r i p t i o n . Probably petiolate leaf, petiole not preserved; lamina broadly ovate, l × w = 41 × 30 mm, ratio l/w = 1.4, base broad cuneate, apex (?) bluntly acute; margin entire except for few, widely spaced, tiny blunt teeth in apical part of lamina; midvein straight, distinctly decreasing in thickness towards apex; secondaries brochidodromous to semicraspedodromous in apical part, arising at steep angles near base, higher up at moderate angles, basal pair almost paralleling margin; secondaries near base slightly converging towards midvein before running rather straight towards margin, near margin curved towards apex; secondaries forked, forkings increasing in number towards margin; higher order venation not visible.

R e m a r k s . Leaf shape and major veins are reminiscent of *Hedera*.

Differing from *Dicotylophyllum* sp. Q by more numerous and forking secondaries arising at steeper angles, absence of intersecondaries, cuneate base and tiny, blunt marginal teeth in apical part.

Dicotylophyllum sp. J
Pl. 4, Fig. 8

M a t e r i a l . GBA 2005/0004/0039a.

D e s c r i p t i o n . (?) Leaflet; shortly petiolulate, petiolule thick; lamina slender elliptic, l × w = 67 × 14 mm,

ratio l/w = 4.8, base cuneate, slightly asymmetrical, apex long acuminate; margin entire; somewhat undulate; midvein slightly bent in lower part of lamina; secondaries (?) eucamptodromous, very fine and dense, straight, at medium steep angles already in the lower part of the lamina; dense, (?) composite intersecondaries.

Differing from *Ailanthus pythii* see that taxon.

Differing from *Dicotylophyllum* sp. JJ by the thick petiole/petiolule more slender lamina, cuneate, only slightly asymmetrical base, dense and straight secondaries and intersecondaries, no basal secondaries closely paralleling leaf margin.

Dicotylophyllum sp. K
Pl. 4, Figs 4–7

M a t e r i a l . GBA 2005/0004/0040 (part + counterpart), IBUG 871b, 2053, NHMW 1878/6/8639.

D e s c r i p t i o n . Leaves fragmentary, neither base nor apex preserved; lamina broad elliptic, l × w (?) about 70 × 34–47 mm, ratio l/w (?) about 1.8–2.1; margin regularly, coarsely, densely simple serrate, tooth apices blunt, sinuses sharp; midvein strong, straight; secondaries distinctly semicraspedodromous, secondaries widely and not very regularly spaced, curved, looping at some distance from margin, giving rise to exmedial veinlets which form further loops; veinlets entering teeth; simple short intersecondaries sometimes present; tertiaries percurrent, widely and irregularly spaced, obtuse to midvein; further veins reticulate.

Differing from *Dicotylophyllum* sp. CC by blunt teeth, less densely spaced secondaries and tertiaries, and percurrent course of tertiaries.

Dicotylophyllum sp. L
Pl. 4, Figs 9–11, Pl. 7, Fig. 18B

2004 *Acer integrilobum* C.O.WEBER sensu Walther 1972 forma B; Kovar-Eder et al., p. 78, pl. 10, figs 5, 6.

A d d i t i o n a l m a t e r i a l . GBA 2005/0004/0041, 0113, IBUG 1259, NHMW 1878/6/2417a.

D e s c r i p t i o n . Leaves without petiole, (?) subsessile; lamina broadly ovate to triangular palmate, l × w (20) 28–56 × (14) 20–40 mm, ratio l/w = 1.4–1.5, base rounded, apex long acuminate; margin widely shallowly lobate-toothed, basal pair of teeth larger than more distal ones, resembling very short lobes, teeth solitary, apices bluntly acute, sinus widely rounded; midvein straight to slightly bent, basal secondaries originating at base (i.e., venation acrodromous), further secondaries craspedodromous, widely spaced, arising at wide angles, course somewhat curved, ending in tooth apices, intersecondaries weakly developed, tertiaries almost not visible.

R e m a r k s . For the origin of slab GBA 2005/0004/0113 see section *Fagus* sp.

Differing from *Acer integrilobum* see that taxon.

Differing from terminal leaflets of *Toxicodendron melaenum* by the basal pair of lateral veins originating directly at base.

Dicotylophyllum sp. M
Pl. 4, Figs 12, 13

M a t e r i a l . NHMW 1878/6/5397, 8717.

D e s c r i p t i o n . Petiolate leaves; lamina elliptic, l × w about 50–58 × 17–23 mm, ratio l/w = 2.5–2.9, base cuneate to slightly convex, apex probably bluntly acute; margin basally entire, in the upper part coarsely serrate, teeth blunt, sinus (?) acute or rounded; midvein straight, strong; secondaries delicate, brochidodromous/eucamptodromous in the basal part, semicraspedodromous higher up, rather widely spaced, originating at moderate angles, curved; intersecondaries present; further venation indistinct.

Differing from *Dicotylophyllum* sp. 1 and *Dicotylophyllum* sp. G see those taxa.

Differing from *Myrica lignitum* by the elliptic shape, blunt teeth, less dense and steeper secondaries.

Differing from *Quercus drymeja* and *Q. zoroastri* by blunt teeth and indistinct, curved secondaries.

Dicotylophyllum sp. N
Pl. 5, Figs 1–4

M a t e r i a l . GBA 2005/0004/0102, 0104, 0106, IBUG 2806b.

D e s c r i p t i o n . Long-petiolate leaves, petiole up to 18 mm long, straight to slightly bent; lamina slender ovate to almost elliptic, l × w = 35–50 × 19–24 mm, ratio l/w = 1.8–2.3, base rounded, slightly asymmetrical, apex acute to acuminate; margin dentate, teeth small, blunt, not very dense; midvein straight; secondaries (?) semicraspedodromous, delicate, straight, originating at moderate angles, moderately spaced; further venation not visible.

Dicotylophyllum sp. O
Pl. 5, Figs 5–8

M a t e r i a l . GBA 2005/0004/0077, 0079A, 0079B, 0085.

D e s c r i p t i o n . Petiolate leaves; lamina obovate, coriaceous, l × w about 37–53 × 20–29 mm, ratio l/w = 1.5–2.1, base cuneate, apex emarginate; margin entire; midvein straight; secondaries eucamptodromous, widely spaced, straight, at wide angles, (?) composite intersecondaries present; tertiaries reticulate forming large meshes (GBA 2005/0004/0085).

Differing from *Dicotylophyllum* sp. C see that taxon.

Dicotylophyllum sp. P
Pl. 5, Figs 9, 10

2004 *Celtis japetii* UNGER; Kovar-Eder et al. p. 70, pl. 8, fig. 7.

M a t e r i a l . NHMW 1878/6/7654, Kovar-Eder et al. (2004: pl. 8, fig. 7) and counterpart Ett. 5652, NHMW 1878/6/7691.

D e s c r i p t i o n . Incomplete three-veined leaves; lamina elliptic to slightly obovate, somewhat asymmetrical, l × w about 23–45 × 10–20 mm, ratio l/w about 2.2, base incomplete asymmetrical convex, apex acuminate; margin entire, apically faintly (?) crenulate; venation acrodromous;

midvein straight, medium thick, lateral main veins at acute angles, slightly curved towards apically (convex), steeply ascending into apical third of lamina; secondaries brochidodromous, very sparse, alternate, at moderate angles first one arising at about half the length of lamina; lateral primaries and secondaries giving rise to exmedial veinlets, regularly looping along margin; tertiaries and higher order veins reticulate.

R e m a r k s . In Kovar-Eder et al. (2004) the description of *Celtis japeti* UNGER was based on specimen NHMW 1878/6/7654 which is less complete than specimen NHMW 1878/6/7691. The reinvestigation of the specimens did not confirm the presence of teeth. Therefore, the taxonomic assignment proposed by Kovar-Eder at al. (2004) has been revised.

Dicotylophyllum sp. Q
Pl. 5, Figs 18–20

M a t e r i a l . GBA 2005/0004/0046, IBUG 12009, NHMW 1878/6/8805.

D e s c r i p t i o n . Leaves or (?) leaflets, no petiole preserved, (?) sessile; lamina broadly ovate to elliptic, l × w about 46–54 × 30–36 mm, l/w = 1.3–1.7, base rounded/decurrent, apex acute; margin undulate except the very base and apex; midvein straight, secondaries eucamptodromous/brochidodromous, widely spaced, arising at wide to almost right angles, straight to slightly exmedially bent (slightly concave), near margin turning towards apex, intersecondaries present but indistinct; tertiaries forming polygonal meshes with higher order venation.

Differing from *Dicotylophyllum* sp. I see that taxon.

Dicotylophyllum sp. R
Pl. 4, Fig. 14

M a t e r i a l . NHMW Ett. 5445.

D e s c r i p t i o n . Leaf, (?) long-petiolate, petiole straight; lamina elliptical to somewhat asymmetrical, l × w = 36 × 16 mm, ratio l/w = 2.2, base asymmetrical broadly cuneate to slightly convex, apex bluntly acute; margin densely minutely serrate; midvein almost straight; secondaries few, widely and irregularly spaced, slender, arising at moderate angles, course slightly curved; basal secondaries sending numerous rather parallel exmedial veinlets towards margin.

Dicotylophyllum sp. S
Pl. 5, Figs 13, 14

M a t e r i a l . NHMW 1878/6/2093, Ett. 6364.

D e s c r i p t i o n . Leaves or leaflets, (?) subsessile; lamina incomplete, apical part missing, elliptic, l × w about 70–110 × 20–42 mm, base cuneate, slightly convex, minimally asymmetrical; margin entire near base, then simply toothed, teeth tiny, acute, widely spaced; midvein strong, straight; secondaries brochidodromous in untoothed part, semicraspedodromous in toothed area; secondaries much thinner than midvein, widely, regularly spaced, alternate, at medium wide angles, smoothly curved, looping

near margin, occasionally forked; exmedial veinlets of secondaries looping along margin, fine branches entering teeth; intersecondaries rare, tertiaries (forked)-percurrent, almost perpendicular to secondaries; higher order veins reticulate.

Differing from *Dicotylophyllum* sp. T by bigger and broader lamina, smaller and less distinct teeth, and bent secondaries.

Differing from *Dicotylophyllum* sp. V by the elliptic laminar shape and slightly asymmetrical base.

Dicotylophyllum sp. T
Pl. 5, Fig. 12

M a t e r i a l . NHMW 1878/6/2052 and NHMW 2021/0109/0002 part + counterpart.

D e s c r i p t i o n . Leaf incomplete at base; lamina narrow elliptic, l × w about 52 × 14 mm, ratio l/w about 3.7, base cuneate, apex acute/acuminate; margin serrate, teeth widely spaced near base, towards apex denser, sharp, triangular; midvein strong, straight; secondaries delicate, semicraspedodromous, widely spaced, medium steep, near base rather straight, in apical part bent.

Differing from *Dicotylophyllum* sp. 1 and *Dicotylophyllum* sp. S see those taxa.

Dicotylophyllum sp. U
Pl. 5, Fig. 11

M a t e r i a l . NHMW 1878/6/8151.

D e s c r i p t i o n . Leaf long petiolate, petiole 10 mm long, bent; lamina narrow ovate, l × w = 37 × 10 mm, ratio l/w = 3.5, base convex, apex long attenuate, margin entire; midvein slightly S-shaped; secondaries brochidodromous, distinct, alternate, widely spaced, at medium wide angles; occasionally simple short intersecondaries present, almost perpendicular to midvein; tertiaries probably percurrent, almost perpendicular to secondaries, forming irregular large meshes.

Dicotylophyllum sp. V
Pl. 5, Figs 15–17

M a t e r i a l . IBUG cf.1136 + 1137 (part + counterpart), cf. 2819a, NHMW 1878/6/2701 + 2702 (part + counterpart), 2800 + 2801 (part + counterpart), 7806.

D e s c r i p t i o n . Leaves lacking petiole; lamina obovate, l × w about 70–132 × 20–43, l/w = 2.2–4.7, base cuneate, apex widely acute to short acuminate; margin entire to sub-entire, teeth tiny, sparse, mainly in upper part of lamina, exceptionally also in lower part (NHMW 1878/6/2701 + 2702); midvein straight, strong; secondaries eucamptodromous to semicraspedodromous, much thinner than midvein, widely spaced, curved towards apically (convex), somewhat steeper in lower part than in apical part; simple intersecondaries present, paralleling secondaries.

R e m a r k s . Specimens IBUG 1136 + 1137 and IBUG 2819a are assigned as cf. because the length/width ratio is about 2.2 to 2.3 and thus lower than in the other specimens.

Differing from *Dicotylophyllum* sp. S see that taxon.

Differing from cf. *Gordonia* (?) *oberdorfensis* Kovar-Eder by lower vein density, course of secondaries and minutely toothed margin.

Dicotylophyllum sp. W
Pl. 6, Fig. 1

M a t e r i a l . NHMW 1878/6/2346a + 9529 (part + counterpart).

D e s c r i p t i o n . Leaflet (?), probably sub-sessile; lamina oblong, basally slightly asymmetrical, l × w = 68 × 19 mm, ratio l × w = 3.5, base slightly (?) convex or (?) cuneate, apex acute; margin densely, regularly crenate to serrate, sinus and apex rounded; midvein slightly bent; secondaries semicraspedodromous, dense, arising at wide angles, rather straight, only minimally curved towards apex (convex), interspaced with intersecondaries, appearing rather irregular; secondaries and intersecondaries looping at variable distance from margin; exmedial veinlets further looping close to margin, veinlets running towards margin and into teeth; tertiaries reticulate.

R e m a r k s . This specimen, especially its leaf margin, is reminiscent of "*Arbutus*" *serra* Unger.

Differing from *Fraxinus* sp. by the dense and irregular venation and densely spaced teeth with rounded sinus and apex.

Differing from *Leguminophyllum* sp. I by the crenate to serrate margin and irregular pattern of secondary and higher order venation.

Differing from *Prinsepia serra* (Unger) Kovar-Eder et Kvaček by rounded and regular teeth.

Differing from *Ternstroemites pereger* by more crenulate than serrate margin, absence of glands on teeth, wider angles of secondaries, irregular pattern of secondaries and intersecondaries, and marginal venation pattern.

Dicotylophyllum sp. X
Pl. 6, Figs 2, 3

M a t e r i a l . IBUG 1271 + 1272 (part + counterpart), NHMW 1878/6/7787.

D e s c r i p t i o n . Leaves petiolate; lamina elliptic, l × w about 30–34 × 14–18 mm, ratio l/w about 1.7–2.4, base convex to cuneate, apex not preserved; margin entire; venation almost basally acrodromous; midvein and secondaries rather thin; midvein straight; lateral primaries reaching only to about middle of lamina, looping with secondaries near margin; secondaries widely spaced, the first pair originating at a wide distance from lateral primaries; composite intersecondaries thin and short; tertiaries and higher order veins forming polygonal meshes.

Differing from "*Celastrus*" *europaea* and *Daphnogene polymorpha* see those taxa.

Dicotylophyllum sp. Y
Pl. 6, Fig. 4

M a t e r i a l . IBUG 1410 + 1411 (part + counterpart).

D e s c r i p t i o n . Leaf lacking petiole; lamina elliptic, l × w = 19 × 9 mm, ratio l/w = 2.1, base widely cuneate, apex acute; margin entire basally, indistinctly crenulate-serrate apically, teeth blunt, probably glanduliferous; midvein straight; secondaries hardly visible.

R e m a r k s . This specimen is reminiscent of small-leaved Vaccinioideae.

Differing from *Dicotylophyllum* sp. 3 and *Dicotylophyllum* sp. F see those taxa.

Differing from *Dicotylophyllum* sp. II by indistinct secondaries and tertiaries.

Dicotylophyllum sp. Z
Pl. 6, Fig. 5

M a t e r i a l . IBUG 1471 + 1472 (part + counterpart).

D e s c r i p t i o n . Leaf without petiole, (?) sessile; lamina ovate, l × w = 24 × 13 mm, ratio l/w = 1.9, base subcordate, apex acute/acuminate; margin entire; midvein strong, straight; secondaries eucamptodromous, much thinner than midvein, widely spaced, arch-like, at base arising at wider angles than towards apex; tertiaries percurrent.

Dicotylophyllum sp. CC
Pl. 6, Fig. 7

M a t e r i a l . IBUG 2052b.

D e s c r i p t i o n . Incomplete leaf or leaflet; lamina elliptic, l × w about 55 × 26 mm, ratio l/w about 2.1, base convex, apex incomplete, (?) acute; margin densely serrate, teeth small, varying slightly in size, rather regularly spaced, tip and sinus acute; midvein straight; secondaries semicraspedodromous, near leaf base slightly S-shaped, otherwise arch-like curved towards apex (convex), widely, not very regularly spaced, partly forked, branches looping at some distance from margin; exmedial veinlets looping further or running into teeth; intersecondaries occasionally present; tertiaries oblique to midvein, (forked) percurrent to reticulate; further venation reticulate.

R e m a r k s . This specimen resembles *Fraxinus* leaves but the tertiary venation, which is in between percurrent and reticulate, precludes that assignment.

Differing from *Dicotylophyllum* sp. K see that taxon.

Differing from *Dicotylophyllum* sp. FF by broader shape, more dense and less sharp marginal teeth, more widely spaced, convex secondaries and percurrent to reticulate tertiaries.

Differing from *Fraxinus* sp. by more narrow angle of secondaries and (forked) percurrent tertiaries.

Dicotylophyllum sp. FF
Pl. 6, Fig. 9

M a t e r i a l . IBUG 742.

D e s c r i p t i o n . Shortly petiolate leaf; lamina oblong, l × w = about 64 × 17 mm, ratio l/w about 3.9, probably coriaceous, base cuneate, apex not preserved; margin sparsely serrate, teeth tiny, narrow, sharp, sinus and apex acute; midvein prominent, straight; secondaries brochidodromous /semicraspedodromous, medium densely spaced, delicate, originating at wide angles, basally somewhat steeper than apically, bent towards proximally (concave) to straight,

looping at different distances from margin; intersecondaries composite, densely spaced, together with tertiaries forming elongate meshes sub-parallel to secondaries.

Differing from *Ailanthus pythii* and *Dicotylophyllum* sp. CC see those taxa.

Differing from *Dicotylophyllum* sp. GG by symmetric base, concave secondaries and tertiaries which are not admedially ramified.

Differing from *Fraxinus* sp. by sharp teeth, proximally (concave) bent secondaries, and elongated meshes of higher order venation.

Dicotylophyllum sp. GG
Pl. 6, Figs 10–14

M a t e r i a l . GBA 1848/0001/0101a + b (part + counterpart), GBA 2005/0004/0083a, IBUG 1577, 1599, 1993b.

D e s c r i p t i o n . Leaflets, short-petiolate; lamina asymmetric, obliquely oblong to slender ovate/elliptic, l × w = about 33–83 × 11–26 mm, ratio l/w about 3–3.6, base asymmetrical, cuneate to slightly convex, apex bluntly acute; margin serrate, with widely spaced, small, sharp teeth; midvein straight to slightly bent; secondaries brochidodromous, partly semicraspedodromous, densely spaced, partly steeply forked, arising at (medium) wide angles; intersecondaries simple to composite; tertiaries and higher order veins admedially ramified (Pl. 6, Fig. 11b).

R e m a r k s . Admedially ramified higher order venation occurs, e.g., in Anacardiaceae.

Differing from *Ailanthus pythii*, and *Dictylophyllum* sp. H, M and FF see those taxa.

Differing from *Fraxinus* sp. by widely spaced, sharp teeth, very dense secondaries and intersecondaries, admedially ramified tertiaries and higher order veins.

Dicotylophyllum sp. HH
Pl. 6, Fig. 6

M a t e r i a l . GBA 2005/0004/0015.

D e s c r i p t i o n . Leaf long-petiolate, petiole straight, 7 mm long; lamina elliptic, l × w = 39 × 16 mm, ratio l/w = 2.4, base cuneate, apex rounded, at tip slightly emarginate; margin entire; midvein straight; secondaries eucamptodromous, widely spaced, originating at moderately steep angles; no intersecondaries; tertiaries hardly visible, probably not prominent.

Differing from "*Celastrus*" *europaea* and *Dicotylophyllum* sp. B see those taxa.

Dicotylophyllum sp. II
Pl. 6, Fig. 8

M a t e r i a l . IBUG 1737.

D e s c r i p t i o n . Leaf lacking petiole; lamina slightly obovate, l × w = 28 × 16 mm, ratio l/w = 1.8, base cuneate, apex rounded, slightly emarginate at very tip; margin minutely crenulate-serrate in apical part; midvein thick, straight; secondaries and tertiaries strong; secondaries brochidodromous to semicraspedodromous in toothed part,

at wide to medium wide angles, looping well within lamina, their distal branches forming additional narrow elongated loops towards margin; tertiaries branched, forming coarse meshes between secondaries.

Differing from *Dicotylophyllum* sp. 3, *Dicotylophyllum* sp. E, F and Y see those taxa.

Dicotylophyllum sp. JJ
Pl. 6, Fig. 15

M a t e r i a l . IBUG 1645.

D e s c r i p t i o n . Leaflet, (?) subsessile, asymmetrical; lamina slender elliptic, l × w = 69 × 24 mm, base strongly asymmetrical, convex, apex (?) acute; margin entire, shallow undulate; midvein almost strong and straight; secondaries eucamptodromous to brochidodromous, delicate, arising at moderately wide angles, irregularly spaced, interspaced with simple intersecondaries; course of secondaries and intersecondaries somewhat curved, slightly zigzag; secondaries and higher order veinlets running and looping close to margin; lowermost pair of secondaries running closely along margin; tertiaries (forked) percurrent, obliquely connecting secondaries and intersecondaries.

Differing from *Ailanthus pythii* and *Dicotylophyllum* sp. J see those taxa.

Engelhardia orsbergensis (P.Wessel et C.O.Weber) Jähnichen, Mai et H.Walther
Pl. 6, Figs 21–23

2004 *Engelhardia orsbergensis* (P.Wessel et C.O.Weber) Jähnichen, Mai et H.Walther; Kovar-Eder et al., p. 65, pl. 6, figs 10–12.

A d d i t i o n a l m a t e r i a l . GBA 2005/0004/0064, NHMW 1878/6/2053a.

D e s c r i p t i o n . Leaflets sessile; lamina narrow oblong, l × w = 50–95 × 12–14 mm, ratio l/w about 4.1–6.2 (7.5) mm, base asymmetrical, cuneate to slightly convex, apex acute to acuminate; margin simple serrate, except for entire base, teeth widely spaced, sometimes indistinct (GBA 2005/0004/0064), narrow, sharp, sinuses widely rounded, distal side mostly concave, proximal side variable; midvein often slightly bent; secondaries semicraspedodromous to eucamptodromous, fine, dense, originating at wide to moderate angles; intersecondaries partly composite, parallel with the secondaries.

Differing from *Ailanthus pythii* and *Dicotylophyllum* sp. 1 see those taxa.

Fagus sp.
Pl. 7, Figs 17, 18A

2004 *Fagus* sp.; Kovar-Eder et al., p. 60, pl. 3, figs 7–9.
2004 *Fagus* vel *Alnus* sp.; Kovar-Eder et al., p. 61, pl. 3, fig. 2.

A d d i t i o n a l m a t e r i a l . GBA 2005/0004/0113.

D e s c r i p t i o n . Leaves petiolate; lamina elliptical to slightly obovate, l × w about 75– >100 × 29–55 mm, ratio l/w about 1.9–2.6, base convex, apex acute-acuminate; margin more or less distinctly simple serrate, number of teeth corresponding to secondaries, exceptionally only

between secondaries ("*Fagus* vel *Alnus* sp." sensu Kovar-Eder et al. 2004: 61); teeth blunt, sinus rounded, proximal and distal sides mainly straight to slightly concave, distal side also sometimes slightly convex; midrib straight, slender; secondaries craspedodromous, slender, moderately dense, regularly spaced, originating at medium steep angles, near base commonly converging towards midvein, then running straight and sub-parallel into tooth apices; tertiaries forked percurrent, in strength almost equal to reticulate higher order veins.

R e m a r k s . Specimen GBA 2005/0004/0113 (Pl. 7, Fig. 18A) is by far the best preserved *Fagus* leaf from Parschlug. The lithology of this slab differs, however, from that of the majority of specimens which derive from hard marlstone-ironstone layers. In the collection of GBA, the orignal label of this specimen is missing. The presence of *Dicotylophyllum* sp. L, which has not been recorded elsewhere, on the same slab indicates Parschlug as the correct locality.

Differing from *Dicotylophyllum* sp. G see that taxon.

Fraxinus sp.
Pl. 7, Figs 6–8

M a t e r i a l . IBUG 1580, 1617, 1946.

D e s c r i p t i o n . Leaflets sessile; lamina oblong to narrow elliptic or ovate, mostly asymmetrical, occasionally symmetrical, l × w = 43– ~77 × 11–22 mm, ratio l/w = 2.3–3.9, base convex to cuneate, apex acute; margin more or less regularly serrate, teeth tiny, indistinct, not dense; midvein slightly bent; secondaries semicraspedodromous to eucamptodromous, regularly, rather densely spaced, originating at wide to almost right angles; simple intersecondaries rather regularly positioned, tertiaries reticulate, indistinct.

Differing from *Ailanthus pythii*, *Dicotylophyllum* sp. 5, H, W, CC, FF, and GG see those taxa.

Differing from leaflets of *Juglans* sp. by smaller leaflet size, wider angles of secondaries, more numerous intersecondaries and no indication of percurrent tertiaries.

cf. *Gordonia* (?) *oberdorfensis* Kovar-Eder

2004   cf. *Gordonia* (?) *oberdorfensis* Kovar-Eder; Kovar-Eder et al., p. 63, pl. 5, figs 5–8.

D e s c r i p t i o n . Short-petiolate large leaves; lamina elongate oblong, l × w about 100– (?) 200 × 20–47 mm, ratio l/w about 4–5, base (narrow) cuneate to decurrent, apex missing; margin entire; midvein prominent, straight; secondaries very fine, very dense, arising steeply from midvein, at first converging midvein, then diverging towards margin, course slightly irregular, often steeply forked; tertiaries rather thin, sub-parallel with the secondaries.

Differing from *Dicotylophyllum* sp. V see that taxon.

"*Juglans*" *parschlugiana* Unger
Pl. 6, Figs 16–20; Pl. 10, Figs 17, 18

2004   "*Juglans*" *parschlugiana* Unger; Kovar-Eder et al., p. 75, pl. 9, figs 15, 16.

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0055, 0058, 0092, NHMW 1878/6/7698, 8618, 8631.

D e s c r i p t i o n . Leaflets, sub-sessile; lamina probably coriaceous, broad elliptic to broad ovate, slightly asymmetrical, l × w about (27) 48–86 × 17–32 mm, ratio l/w about 1.6–2.6, base rounded, asymmetrical, apex bluntly acute to somewhat acuminate; margin entire, faintly undulate, very rarely with isolated blunt teeth; midvein moderately strong, straight; secondaries brochidodromous, regularly spaced, distinct, originating at right to wide angles; depending on asymmetry of lamina angles somewhat steeper in narrower half; course at first almost straight, towards margin bent and looping close to margin; intersecondaries occasionally interspaced with secondaries; tertiaries percurrent, often nearly perpendicular to secondaries.

Differing from leaflets of *Juglans* sp. by broad elliptic to ovate and stronger asymmetrical shape as well as probably more coriaceous lamina.

Differing from *Phaseolites securidacus* Unger by larger lamina, shape, and conspicuous secondaries.

Juglans sp.
Pl. 7, Figs 1–5

M a t e r i a l .   GBA   1848/0001/0099A,   GBA 2005/0004/0087, 0089, 0094, 0120, NHMW 1878/6/8467.

D e s c r i p t i o n . Leaflets, (?) sessile; lamina elongate, symmetrical to slightly asymmetrical, oblong, l × w = 65– ~110 × 22–39 mm, ratio l/w = 2.5–3, base convex to rounded, apex acute; margin entire; midvein straight; secondaries brochidodromous, medium dense, regular, arising at wide angles, course curved; intersecondaries occasionally present; tertiaries percurrent; higher order veins reticulate.

Differing from *Fraxinus* sp. and "*Juglans*" *parschlugiana* see those taxa.

Laurophyllum sp.
Pl. 7, Figs 10, 11

M a t e r i a l . IBUG 1484c, 2347, 2949.

D e s c r i p t i o n . Leaves petiolate (?); lamina lanceolate to narrow oblong, l × w about 56 × >85 × 11–20 mm, ratio l/w about 4.5–5.1, base (narrow) cuneate, apex narrow acute to slightly acuminate; margin entire; midvein straight; secondaries brochidodromous, regularly, widely spaced, curved; intersecondaries rare, short; tertiaries and higher order veins polygonal reticulate.

Differing from *Leguminophyllum* sp. A by symmetrical and more narrow shape.

Leguminophyllum sp. A
Pl. 8, Fig. 1

M a t e r i a l . GBA 2005/0004/0052a.

D e s c r i p t i o n . Short-petiolate leaf or leaflet; lamina elliptic, l × w = 53 × 18 mm, ratio l/w = 2.9, base asymmetric, convex, apex acute; margin entire; midvein straight; secondaries eucamptodromous, distinct, widely spaced, originating alternately at moderate angles, course moderately curved; single intersecondaries present, almost as long as secondaries; tertiaries not visible.

Differing from *Laurophyllum* sp. see that taxon.

Leguminophyllum sp. B
Pl. 8, Figs 2, 3

M a t e r i a l . IBUG 2207, NHMW 1878/6/8794.

D e s c r i p t i o n . Leaflets, (?) sessile; lamina roundish, more or less asymmetrical, l × w about 18–22 × 18–19 mm, ratio l/w about 1–1.2, base broadly convex to roundish, asymmetrical, apex roundish to minimal mucronate; margin entire; midvein straight; secondaries eucamptodromous, very few, widely spaced, originating at wide angles, on more narrow side of lamina somewhat steeper, course curved; faint intersecondaries present.

Leguminophyllum sp. C
Pl. 8, Fig. 4

M a t e r i a l . GBA 2005/0004/0050.

D e s c r i p t i o n . Probably leaflet, sessile; lamina elliptic, l × w = 42 × 20 mm, ratio l/w = 2.1, base convex to rounded, asymmetrical, apex widely and bluntly acute; margin entire; midvein straight, secondaries eucamptodromous, delicate, densely and regularly spaced, arising at medium to wide angles, straight, parallel; fine and dense intersecondaries present.

Differing from *Leguminophyllum* sp. E by smaller size, more slender shape, denser, faint and straight secondaries and intersecondaries.

Differing from *Phaseolites securidacus* by dense and straight secondaries.

Leguminophyllum sp. D
Pl. 8, Fig. 5

M a t e r i a l . GBA 1848/0001/0040, ? IBUG 804.

D e s c r i p t i o n . Shortly petiolulate leaflets; lamina slightly elliptical to oblong, symmetrical to slightly asymmetrical, coriaceous, l × w about 24–29 × 8–12 mm, ratio l/w about 2.4–3, apex rounded to slightly emarginate; margin entire, thickened; midvein very thick, prominent, slightly bent to straight; secondaries brochidodromous, very delicate, dense, at wide angles, smoothly curved, interspaced with intersecondaries.

R e m a r k s . Specimen IBUG 804 lacks details of secondary venation and the midvein is less prominent.

Leguminophyllum sp. E
Pl. 8, Figs 6, 7

M a t e r i a l . GBA 2005/0004/0004, IBUG 2132.

D e s c r i p t i o n . Probably leaflets, sessile; lamina broad elliptic, l × w about 70 × 38–46 mm, ratio l/w about 1.5–1.8, base widely rounded, apex (?) rounded or blunt; margin entire; venation brochidodromous, secondaries fine, at wide angles, smoothly curved upwards, short intersecondaries present.

Differing from *Cotinus* (?) *aizoon* and *Leguminophyllum* sp. C see those taxa.

Leguminophyllum sp. H
Pl. 8, Fig. 8

M a t e r i a l . IBUG 1948.

D e s c r i p t i o n . Leaflet lacking base; lamina slender ovate to elliptic, asymmetrical, l × w about 50 × 16 mm, ratio l/w about 3.1, base convex, apex long acute; margin undulate to minutely toothed; midvein straight not very distinct; secondaries hardly visible, rather dense, at moderate acute angles.

R e m a r k s . Although this leaflet is reminiscent of *Gleditsia*, e.g., *G. parajaponica* Shuang X.Guo et Z.K.Zhou (Guo and Zhou 1992) we prefer to refrain from this assignment.

Leguminophyllum sp. I
Pl. 8, Fig. 9

M a t e r i a l . IBUG 2311.

D e s c r i p t i o n . Leaflet incomplete at base; lamina slender ovate, l × w about 48 × 11 mm, ratio l/w about 4.5, base rounded or convex, slightly (?) asymmetrical, apex long acute to acuminate; margin sub-entire; midvein straight; secondaries craspedodromous to semicraspedodromous, rather densely and regularly spaced, at wide angles, once or twice forked near margin, branches partly looping, partly joining margin; intersecondaries occasional, thin, short.

Differing from *Dicotylophyllum* sp. W see that taxon.

Leguminophyllum sp. J
Pl. 8, Figs 10–12

M a t e r i a l . GBA 2005/0004/0005, 0007, cf. 0045.

D e s c r i p t i o n . Probably leaflets, subsessile to shortly petiolulate; lamina broad elliptic to somewhat ovate, l × w about (28) 50–60 × (15) 32–39 mm, ratio l/w = 1.6–1.9, base widely cuneate to convex, apex bluntly acute to rounded; margin entire; midvein strong; secondaries brochidodromous, strong, widely spaced, at moderately wide angles, bent, looping near the margin; intersecondaries occasionally present; tertiaries percurrent, partly forked, unevenly bent, moderately admedially oblique to secondaries to almost perpendicular to midvein, widely spaced (GBA 2005/0004/0007).

Differing from *Dicotylophyllum* sp. A see that taxon.

Liquidambar europaea A.Braun

2004 *Liquidambar europaea* A.Braun; Kovar-Eder et al., p. 58, pl. 2, figs 1–5.

A d d i t i o n a l   m a t e r i a l . GBA 1848/0001/0050, GBA 2002/0001/0094a, GBA 2005/0004/0090, 0109, 0114A, IBUG 1185, NHMW 1878/6/2336.

D e s c r i p t i o n . Leaves long petiolate; trilobate to double quinquelobate; base shape lobate; l (central lobe) × w (widest distance between lobe tips) up to at least 90 × 138 mm; medial and inner lateral lobes ovate to often obovate or slender elongated, rarely with additional two to four smaller lobes (form often designated as *Liquidambar parschlugiana* Unger); outermost lateral lobes smaller, narrow triangular; lobe apices attenuate to bluntly acute, sinuses between lobes acute; margin regularly, finely glandular serrate; venation palmate; midvein strong, straight; 2–4 lateral primaries arising from the base, straight to slightly

bent towards base; secondaries semicraspedodromous (and craspedodromous in double lobed leaves), widely regularly spaced, curved towards apex (convex); tertiaries irregular, forming elongated meshes oblique to the secondaries.

Mahonia (?) sphenophylla (Unger) Doweld
Pl. 7, Figs 12–16

2004 *Mahonia* (?) *aspera* (Unger) Kovar-Eder et Kvaček; Kovar-Eder et al., p. 57, pl. 13, figs 1–8.

A d d i t i o n a l   m a t e r i a l . GBA 1848/0001/0086, GBA 2005/0004/cf. 0001, 0034, cf. 0051, NHMW 1878/6/2031, 2381, 2406a, 9497, Ett. 642c.

D e s c r i p t i o n . Leaflets sessile or shortly petiolulate; lamina coriaceous, shape roundish to obovate, l × w about 12–48 (85) × 8–20 (30) mm, ratio l/w about 1–2.4, base subcordate to convex, sometimes slightly asymmetric, apex rounded; margin irregularly widely simple dentate to entire, teeth spine-like; venation acrodromous; midvein thick, straight; lateral primaries basal or shortly suprabasal, gently bent, reaching to about half of the lamina length; secondaries semicraspedodromous in 2–3 pairs, looping with lateral primaries, in dentate forms sending side veinlets into teeth; intersecondaries occasionally present; in the lower part tertiaries connecting midvein with lateral primaries percurrent, otherwise tertiaries reticulate, forming polygonal irregular meshes, rarely visible due to coriaceous texture of leaves.

R e m a r k s . Doweld (2018a) recognised that the combination *Quercus aspera* had been invalidly published by Unger (1847). Therefore, the oldest available name for this taxon is *Ilex sphenophylla* also published by Unger (1847) (see also synonymy for *Mahonia* (?) *aspera* in Kovar-Eder et al. 2004).

Myrica lignitum (Unger) Saporta

2004 *Myrica lignitum* (Unger) Saporta; Kovar-Eder et al., p. 64, pl. 7, figs 1–6, 8, 9.

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0091, IBUG 509a, 12002, NHMW 1878/6/2348b, 2405, 6444.

D e s c r i p t i o n . Leaves very variable in shape and size, long petiolate; lamina lanceolate, l × w about 45–180 × 4–32 mm, ratio l/w about 3.2–11, base narrow decurrent to cuneate, apex long, narrow acute/acuminate; margin entire to widely simple toothed, rarely double toothed, mostly in the upper half of lamina, teeth widely spaced, blunt to acute, often hook-shaped, sometimes s-shaped, sinuses acute to rounded; midvein strong, straight or bent; secondaries brochidodromous to camptodromous in entire-margined parts of leaves, semi-craspedodromous in the toothed part of the lamina; secondaries at wide angles, regularly spaced, looping along margin or entering teeth; intersecondaries sometimes present; tertiaries and higher order venation reticulate (for foliage variation see also Kovar 1982).

Differing from *Dicotylophyllum* sp. 6 and *Dicotylophyllum* sp. M see those taxa.

Differing from *Quercus drymeja* by the decurrent base, higher length/width ratio of lamina, brochido- to camptodromous secondaries and blunt to acute, partly hook-shaped teeth.

Myrica oehningensis (A.Braun) Heer
Pl. 7, Fig. 9

2004 *Myrica oehningensis* (A.Braun) Heer; Kovar-Eder et al., p. 65, pl. 7, fig. 7.

A d d i t i o n a l   m a t e r i a l . NHMW 1878/6/9348.

D e s c r i p t i o n . Leaves lanceolate, base not preserved; lamina 30 to more than 80 mm long, 8–15 mm wide, apex bluntly acute; margin irregularly dissected ranging from deeply lobed to coarsely crenate-toothed, teeth asymmetrical, rounded, directed apically, sinuses sharp; midvein straight to slightly bent, thin; secondaries semicraspedodromous-camptodromous, at moderate to almost right angles, partly looping partly entering teeth; tertiaries hardly visible.

Differing from *Dicotylophyllum* sp. 6 see that taxon.

Nerium sp.

2004 *Nerium* sp.; Kovar-Eder et al., p. 82, pl. 11, figs 17, 18.

D e s c r i p t i o n . Leaves petiolate, petiole stout, straight; lamina lanceolate, coriaceous, length incomplete, max. 70 mm, 10–25 mm wide, base cuneate, decurrent, leaf apex missing; margin entire at the base, in the upper parts slightly wavy; midvein stout, straight; secondaries brochidodromous, very densely, regularly spaced, thin, of almost the same thickness, originating at wide angles, running parallel, looping with each other near the margin; intersecondaries parallel to secondaries, forming narrow meshes with tertiaries.

R e m a r k s . In the specimens figured by Hably (2020: pl. 24, figs 2–4) the secondaries are less densely spaced.

Paliurus tiliifolius (Unger) Bůžek
Pl. 8, Figs 13–15

2004 *Paliurus tiliifolius* (Unger) Bůžek; Kovar-Eder et al., p. 76, pl. 11, fig. 1.
2004 *Cercidiphyllum crenatum* (Unger) R.W.Br.; Kovar-Eder et al., p. 57, pl. 2, fig. 7.

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0095A, 0095B, IBUG 1208, 239 + 1843 (part + counterpart), 1844, 1847, NHMW 1878/6/6510 (*Cercidiphyllum crenatum* sensu Kovar-Eder et al. 2004).

D e s c r i p t i o n . Petiolate leaves, petiole 6–8 mm long; lamina subcircular to widely oval, l × w about 20–42 × 15–33 mm, ratio l/w about 0.9–1.3 (1.7), base cordate to rounded, often slightly asymmetrical, apex rounded to acute (acuminate); margin entire to finely indistinctly crenulate; venation acrodromous; midvein straight, thin, lateral primaries sometimes diverging from the petiole below the lamina base, at moderate angles, running into the apical third of the lamina; higher secondaries delicate, widely spaced, looping with lateral primaries, higher order venation indistinct.

R e m a r k s . Foliage of *Ziziphus* closely resembles that of *Paliurus* (Bůžek 1971). Our assignment is supported by the record of fruits of *P. favonii* Unger from Parschlug (Kovar-Eder et al. 2004). Although *P. favonii* sporadically also occurs in the Mecsek area, Hably (2020) assigned similar but larger leaves to *Ziziphus paradisiaca* (Unger)

HEER. *P. tiliifolius* differs from *Cercidiphyllum crenatum* (UNGER) R.W.BR. by the almost entire margin and primaries often arising from below the lamina base.

Phaseolites securidacus UNGER
Pl. 9, Figs 1–4

2004   *Phaseolites securidacus* UNGER; Kovar-Eder et al., p. 75, pl. 9, figs 13, 14.

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0048B, 0054, cf. 0057, 0059, 0082, 0123, IBUG 1530, 2084, 2307, 2309, 2315, NHMW 1878/6/2291.

D e s c r i p t i o n . Leaflets sessile to shortly petiolulate; lamina broadly elliptic to elliptic, l × w about 40–77 × 14–30 mm, ratio l/w about 2–3.4, base widely acute, rounded or cuneate, often asymmetric, apex bluntly acute to acuminate; margin entire; midvein thick, often distinctly impressed, rather straight; secondaries delicate, faintly visible, moderately spaced, curved, densely interspaced with fine intersecondaries.

Differing from "*Juglans*" *parschlugiana* and *Legumino-phyllum* sp. C see those taxa.

Platanus leucophylla (UNGER) ERW.KNOBLOCH

2004   *Platanus leucophylla* (UNGER) ERW.KNOBLOCH; Kovar-Eder et al., p. 58, pl. 3, fig. 10, pl. 4, fig. 17.

A d d i t i o n a l   m a t e r i a l . NHMW 1878/6/7714 (counterpart of NHMW 1878/6/7713; Kovar-Eder et al. 2004: pl. 4, fig. 17).

D e s c r i p t i o n . Long-petiolate leaf; lamina palmately trilobate, transversely broadly oval, preserved fragment l × w about 65 × 80 mm, ratio l/w about 0.8, main lobe very wide, lateral lobes at moderate angles, short, sinuses rounded; margin irregularly coarsely dentate, teeth sharp, straight, directed apically, somewhat hook-shaped, sinuses rounded; venation palinactinodromous; midvein straight; lateral primaries originating at the very base, almost straight, at moderate wide angles of (about 40–50°), giving off exmedially straight, regularly spaced and subparallel side veins terminating in teeth; secondaries widely spaced, in about 3–5 pairs, also ending in tooth apices; tertiaries thin, percurrent, obtuse to midvein, almost straight to somewhat sinus-shaped, regularly, widely spaced.

Podocarpium podocarpum (A.BRAUN) HERENDEEN
Pl. 7, Figs 19, 20

2004   *Podocarpium podocarpum* (A.BRAUN) HERENDEEN; Kovar-Eder et al., p. 74, pl. 9, figs 10, 11.

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0047, 0060, 0061, 0080, 0117.

D e s c r i p t i o n . Leaflets subsessile; lamina narrow elliptic to oblong, l × w about 16–30 × 6–7 mm, ratio l/w about 3–5.4, base cuneate, slightly asymmetrical, apex acute to rounded, apex tip sometimes slightly mucronate; margin entire; midvein straight; secondaries brochidodromous, very thin, dense, at moderate angles, with a characteristic, more prominent steep basal vein on one side; tertiaries fine, rarely preserved.

Populus latior A.BRAUN
Pl. 8, Figs 16, 17

2004   *Populus populina* (BRONGN.) ERW.KNOBLOCH; Kovar-Eder et al., p. 70, pl. 8, fig. 18; pl. 14, fig. 1, nom. illeg., see Doweld (2017).

A d d i t i o n a l   m a t e r i a l . GBA 2002/0001/0078, GBA 2005/0004/0084, 0125, IBUG 1233, NHMW 1878/6/7762, 7767, 7792, 9083.

D e s c r i p t i o n . Long-petiolate leaves; rather variable in shape, broadly oval to rounded to deltoidal, l × w about 13–77 × 15–77 mm, ratio l/w about 0.7–1, base truncate to widely cuneate, apex bluntly acute to acuminate; margin crenate-serrate, near the base often entire, teeth sometimes irregular, sinus rounded, apex blunt, indistinctly glandular; midvein straight; secondaries semicraspedodromous to craspedodromous, basal pair running at wide angles upwards towards margin, looping with higher secondaries or their branches near margin, sending regularly exmedial side veins towards basal margin; further secondaries at wide to moderate angles, in broader specimens curved, in deltoidal forms rather straight; tertiaries dense, (forked-)percurrent, more or less obtuse to midvein depending on position within lamina; quarternaries and higher order veins polygonal reticulate.

R e m a r k s . Doweld (2017) reidentified *Populus latior* A.BRAUN as the correct name instead of *P. populina* (BRONGN.) ERW.KNOBLOCH, which is an illegitimate homonym.

Prinsepia serra (UNGER) KOVAR-EDER et KVAČEK
Pl. 8, Figs 20–24, Pl. 10, Fig. 15

2004   *Prinsepia serra* (UNGER) KOVAR-EDER et KVAČEK; Kovar-Eder et al., p. 72, pl. 13, figs 9–17.

A d d i t i o n a l   m a t e r i a l . IBUG 2059, NHMW 1878/6/7500, cf. 9119, cf. 9440, 9530, NHMW Ett. No. 660.

D e s c r i p t i o n . Long-petiolate leaves, petiole up to at least 18 mm; lamina rather variable in shape, elongated to roundish, l × w about (13) 20–90 × 12 to nearly 40 mm, ratio l/w about 0.9–3.6, leaf base cuneate to convex, often somewhat asymmetric, apex rarely preserved, narrow to broadly acute or emarginate; margin densely, but irregularly, serrate almost along whole leaf length, teeth irregularly sized, narrow triangular and sharp (narrow acute), sinuses acute or rounded; midvein stout, straight; secondaries semicraspedodromous, delicate, densely spaced, at moderate to wide angles, looping with sub-parallel intersecondaries, forming narrow elongated meshes near the leaf margin; side-veinlets arising from loops, some of them running into tooth apices; tertiaries and higher order venation reticulate.

R e m a r k s . The tertiary and higher order venation is reticulate (Pl. 10, Fig. 15); it is not exmedially ramified as suspected by Kovar-Eder et al. (2004). Specimen NHMW 1878/6/9119 is a rather large leaf and its margin is incompletely preserved. The venation is indicative of *P. serra*.

Differing from *Dicotylophyllum* sp. W see that taxon.

Differing from *Ternstroemites pereger* by the very variable, laminar shape, the usually larger size and lower l/w ratio, the dense, differently sized, triangular and sharp (narrow acute) marginal teeth lacking apical glands.

"*Quercus*" *daphnes* UNGER
Pl. 9, Figs 22–25, Pl. 10, Fig. 19

2004 "*Quercus*" *daphnes* UNGER; Kovar-Eder et al., p. 85, pl. 12, figs 10–15 .

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0069A, IBUG 779,? 803, ? 1641 + 1642 (part + counterpart).

D e s c r i p t i o n . Long-petiolate leaves; lamina oblong to slender elliptic, coriaceous, l × w about 55 to at least 120 × 14–29 mm, ratio l/w about 2.6–5.5, base cuneate to slightly convex, apex bluntly acute, rounded to minimally emarginate; margin entire; midvein strong and straight; secondaries brochidodromous, dense, at wide angles, slightly curved near midvein, stronger near the margin, densely interspaced with partly composite intersecondaries; tertiaries reticulate forming narrow meshes together with intersecondaries.

Quercus drymeja UNGER
Pl. 9, Figs 17–21

2004 *Quercus drymeja* UNGER; Kovar-Eder et al., p. 61, pl. 4, figs 1–7.

A d d i t i o n a l   m a t e r i a l . GBA 1841/0001/0036 (bis), GBA 2005/0004/0065, 0066, ? 0067, 0093, IBUG 874 + 875 (part and counterpart), ? 12001.

D e s c r i p t i o n . Leaves long petiolate; lamina lanceolate, rarely somewhat ovate to obovate, l × w about 18–>80 × 5–20 (30) mm wide, ratio l/w about (2.5) 3–5.3, base wide to narrow cuneate to convex, non-decurrent, apex narrow acute to long acuminate; margin often entire in the lowermost part of the lamina, then regularly, sharply toothed; teeth slender, spine-like, partly s-shaped, in broader leaves shorter, sinuses rounded to narrow rounded; midvein stout, straight or slightly bent; secondaries craspedodromous, regularly spaced, in number corresponding with that of marginal teeth, originating at moderate to acute angles, running rather straight into the tooth apices, rarely forked; tertiaries very thin, percurrent, almost perpendicular to secondaries.

R e m a r k s . The assignment of the specimens figured on Pl. 9, Figs 17 and 18 remains ambiguous.
Differing from *Dicotylophyllum* sp. 5, *Dicotylophyllum* sp. M and *Myrica lignitum* see those taxa.
Differing from *Quercus zoroastri* by the more slender shape of the lamina and more densely toothed leaf margin.

Quercus mediterranea UNGER
Pl. 9, Figs 12–16

2004 *Quercus mediterranea* UNGER; Kovar-Eder et al., p. 62, pl. 4, figs 8–16.

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0032, 0070, IBUG 920, 948a, 2806c, NHMW 1878/6/9358, 9421, NHMW 2021/0109/0001.

D e s c r i p t i o n . Leaves short-petiolate; lamina very variable in shape, obovate, elliptic to widely ovate to sub-circular, l × w about 18–55 × 8–30 mm, ratio l/w = 1.8–2.8 (3.6), base convex to widely cuneate, sometimes almost subcordate, apex rounded to bluntly acute; margin

irregularly simple toothed, teeth partly spine-like to blunt and indistinct, lower part of lamina often entire; midvein stout; secondaries craspedodromous and eucamptodromous, widely and irregularly spaced, sometimes forked, straight to slightly bent, at variable angles; tertiaries (forked) percurrent, obtuse to midvein.

Quercus zoroastri UNGER
Pl. 9, Figs 8–11

2004 *Quercus zoroastri* UNGER; Kovar-Eder et al., p. 62, pl. 5, figs 1–4.

A d d i t i o n a l   m a t e r i a l . GBA 1841/0001/0036 (bis), GBA 2005/0004/0098, IBUG 914, IBUG 2859a.

D e s c r i p t i o n . Leaves long petiolate, coriaceous; lamina broad elliptic to ovate, l × w about 45–65 × 18–32 mm, ratio l/w about 1.9–2.7, base rounded to cuneate, apex acute-acuminate; margin coarsely simple toothed except the entire base, occasionally with smaller teeth in between, teeth sharp, regular, ± closely spaced, apically directed, sinuses rounded; midvein straight; secondaries craspedodromous, at base eucamptodromous, straight to slightly bent, originating at moderately to wide angles, in number usually corresponding with the number of teeth, usually unforked, sometimes forked or sending exmedial side veins into teeth, secondaries or their branches/side veins terminating in tooth apices; tertiaries delicate, percurrent, almost perpendicular to secondaries.

Differing from *Dicotylophyllum* sp. 5, *Dicotylophyllum* sp. M and *Quercus drymeja* see those taxa.

Quercus sp.
Pl. 9, Figs 5–7

M a t e r i a l . GBA 2005/0004/0100, 0101, 0105.

D e s c r i p t i o n . Leaf fragments, apical parts of lamina only, lamina ? elliptic, l × w up to at least 100 × 40 mm, apex (narrow) acute; margin simple serrate, teeth slender, sharp, widely spaced, in number corresponding with secondaries; midvein straight; secondaries craspedodromous, widely spaced, straight to slightly curved.

cf. *Rosa* sp.
Pl. 8, Figs 18, 19

2004 cf. *Rosa* sp.; Kovar-Eder et al., p. 71, pl. 8, fig. 14.

A d d i t i o n a l   m a t e r i a l . GBA 2005/0004/0108A, 0111, NHMW 1878/6/2156 l.

D e s c r i p t i o n . Leaflets sessile or minutely petiolulate; lamina broadly ovate to elliptic to slightly obovate, symmetrical or asymmetrical, l × w about 7–35 × 8–24 mm, ratio l/w about 0.9–1.9, base rounded, convex to widely cuneate, apex rounded to bluntly acute; margin simple crenulate, teeth partly indistinct, sinuses sharp; midvein straight, distinct, secondaries fine and indistinct, rather dense; ? intersecondaries present; higher order venation not preserved.

Smilax sagittifera HEER emend. Hantke 1954

2004 *Smilax sagittifera* HEER; Kovar-Eder et al., p. 83, pl. 11, figs 19, 20.

Description. Leaves lacking petiole; lamina ovate, l × w about 50–60 × 28–46 mm, ratio l/w about 1.2–1.8, base auriculate or convex, apex incomplete; margin entire; venation actinodromous, at least 7 primaries radiating from the base, midvein straight, basal (outer) lateral primaries looping along margin, inner ones possibly reaching the apex; tertiaries forming distinct, relatively large meshes variable in form according to position within the lamina.

Ternstroemites pereger (UNGER) KOVAR-EDER et KVAČEK
Pl. 10, Figs 10–14

2004   *Ternstroemites pereger* (UNGER) KOVAR-EDER et KVAČEK; Kovar-Eder et al., p. 63, pl. 6, figs 1–7.
2004   *Dicotylophyllum* sp. 2; Kovar-Eder et al., p. 88, pl. 15, figs 2, 3.

Additional material. GBA 2005/0004/0107, 0121; NHMW Pb 2391a (counterpart of NHMW 1878/6/6555; Kovar-Eder et al. 2004: pl. 15, fig. 3), NHMW 1878/6/9507.

Description. Long-petiolate leaves; oblong to slender elliptic, length of petiole about 10 mm, l × w about 28–60 (75) × 8–16 (22) mm, ratio l/w about (2.6) 3.1–3.9 (4.4), base cuneate to convex, apex acute; margin serrate-crenulate, except at the very base, teeth directed towards apex, rounded, occasionally somewhat hook-shaped, with more or less distinct apical glands; midvein straight, strong; secondary veins semicraspedodromous, delicate, faintly visible, originating at moderate angles, regularly spaced, looping at margin; higher order veins not visible.

Differing from *Dicotylophyllum* sp. H, W and *Prinsepia serra* see those taxa.

Differing from *Ulmus plurinervia* by more symmetrical laminar shape, rounded shape of the glandular teeth and less distinct semicraspedodromous secondaries.

Toxicodendron melaenum (UNGER) DOWELD
Pl. 10, Figs 3–9

2004   *Toxicodendron herthae* (UNGER) KVAČEK et H.WALTHER; Kovar-Eder et al., p. 80, pl. 9, figs 17–19.

Additional material. GBA 2005/0004/0038, 0042, IBUG 1808 + 1809 (part + counterpart), 1942, cf. 2041, 2042, 2988 + 2989 (part + counterpart), NHMW 1878/6/2028.

Description. Probable leaflets of quite variable shape; presumably terminal leaflets sometimes long petiolulate, rather symmetric, ovate to subtrilobed, base rounded to acute, apex bluntly acute to bluntly acuminate; lateral leaflets sessile, asymmetric oblong to elliptic to ovate or slightly obovate, l × w about (15) 20–50 (> 80) × 12–30 mm, ratio l/w about (1) 1.3–2.2 (2.8), base acute/convex/cuneate to decurrent/rounded, apex (broadly) acute to rounded; margin with coarse teeth of different size to rather regularly toothed, teeth blunt; in terminal leaflets the first basal tooth of rather large size, the others as in lateral leaflets; midvein straight; secondary venation eucamptodromous to craspedodromous, in apical leaflets the basal secondaries arising above base, entering basal teeth more prominently than in lateral leaflets; tertiaries forming a network of coarse meshes.

Remarks. Statements about this species by Doweld (2018a) require some reconsideration and correction. Unger's study of the flora of Swoszowice is very likely to have been published already in 1849 as printed on the available preprints (see ICN 31.1. for date of effective publication) and not in 1850 as stated by Doweld (2018a). Unger (1850: 473) stated "In schisto margaceo ad Parschlug Stiriae, nec non ad Swoszowice Galiciae" which indicates that it was already known in 1850 that *Rhus herthae* (as defined by Unger taxonomically) did not occur at Swoszowice. This could only be known if the work on the Swoszowice flora had already been completed. Doweld (2018a) also argued that material from both Swoszowice and Parschlug served Unger (1850) for the protologue of *R. herthae*. This is not correct for Unger (1850) but it is for Unger (1849), because, although Unger (1849: 126) stated that the protologue-diagnosis was based exclusively on a specimen from Parschlug, which material from Swoszowice closely resembled he chose a specimen from Swoszowice to be figured and therefore to be a part of the protologue (see protologue definition in ICN glossary "Everything associated with a name at its valid publication, e.g. description, diagnosis, illustrations, references, synonymy, geographical data, citation of specimens, discussion, and comments"). Therefore, the selection of a lectotype for *R. herthae* from Swoszowice by Iljinskaja (1964) was very unfortunate, but valid (see ICN 9.19. and Note 7).

For differentiation from *Acer integrilobum*, *Ailanthus pythii*, "*Celastrus*" *europaea* and *Dicotylophyllum* sp. L see those taxa.

Ulmus plurinervia UNGER

2004   *Ulmus plurinervia* UNGER; Kovar-Eder et al., p. 66, pl. 6, figs 18–22.

Description. Leaves long-petiolate, petiole slender, often slightly curved; lamina ovate to slender elliptic, asymmetrical, l × w about 38–50 × 15–20 mm, ratio l/w about 2.3–3, base asymmetrically convex on the broader side, rather straight on the smaller side, apex (bluntly) acute; margin simple serrate, teeth dense, directed towards apex, sinus sharp, apex blunt; midvein straight or slightly bent; secondary venation craspedodromous, secondaries regularly spaced, dense, rarely forked, at moderate angles, steeper on the narrower side, mostly corresponding in number to number of teeth (more than 12) except when single secondaries are forked; tertiaries finely and densely polygonate reticulate, hardly distinguishable from higher order veins.

Differing from *Cedrelospermum ulmifolium* and *Ternstroemites pereger* see those taxa.

Differing from *Zelkova zelkovifolia* by long petiole, higher number of smaller and more dense teeth and thus secondaries, and by distinctly asymmetrical base which is convex on the broader side but straight on the narrower side.

Zelkova zelkovifolia (UNGER) BŮŽEK et KOTL.

2004   *Zelkova zelkovifolia* (UNGER) BŮŽEK et KOTL.; Kovar-Eder et al., p. 69, pl. 8, figs 8–11.

Additional material. GBA 1848/0001/0045, 2005/0004/0068A, B (part and counterpart), 2005/0004/0110, IBUG 75, NHMW 1878/6/9578.

D e s c r i p t i o n . Leaves either isolated or on deciduous branchlets, short petiolate; lamina ovate to elliptic, l × w about (5) 20–72 (85) × (3) 10–30 mm, ratio l/w about (0.9) 2–2.8, base shape convex to rounded, rarely nearly subcordate, not or only slightly asymmetrical, apex bluntly acute; margin simple regularly serrate, in leaves on branchlets teeth less distinct, regularly spaced, number according to pairs of secondaries and their side branches (7–12), blunt triangular, directed towards apex, sinuses sharp; midvein slender; secondaries craspedodromous, moderately to widely spaced (depending on number of teeth), smoothly curved, very rarely forked; tertiaries thin, hardly discernible, reticulate (NHMW 1987/57; Kovar et al. 2004: pl. 8, fig. 9).

Differing from *Cedrelospermum ulmifolium* and *Ulmus plurinervia* see those taxa.

Results

Key taxonomic and nomenclatural changes

Forty-two morphotypes and taxa were identified during this study in addition to those already recognised by Kovar-Eder et al. (2004). Most of them are documented by very few or single specimens only. The total number of taxa has increased from 83 to 123 increasing the floristic spectrum by around 50 % compared to the previous study. Some taxa from the previous study had to be revised. Taxonomic changes concern *Acer integrilobum* C.O.Weber sensu Walther 1972 forma B which is assigned to *Dicotylophyllum* sp. L, *Cercidiphyllum crenatum* (Unger) R.W.Br. recognised as *Paliurus tiliifolius* (Unger) Bůžek, *Celtis japeti* Unger assigned here to *Dicotylophyllum* sp. P, *Dicotylophyllum* sp. 2 which is reidentified as *Ternstroemites pereger* (Unger) Kovar-Eder et Kvaček, and "*Euonymus*" *latoniae* Unger has been merged with "*Celastrus*" *europaea* Unger. Nomenclatural changes concern *Berberis* (?) *notata* Doweld formerly *Berberis* (?) *ambigua* (Unger) Kovar-Eder et Kvaček, *Mahonia* (?) *sphenophylla* (Unger) Doweld instead of *Mahonia* (?) *aspera* (Unger) Kovar-Eder et Kvaček, *Populus latior* A.Braun formerly *P. populina* (Brongn.) Erw.Knobloch, and *Toxicodendron melaenum* (Unger) Doweld instead of *T. herthae* (Unger) Kvaček et H.Walther. The updated floristic spectrum of all taxa and morphotypes was used for the IPR vegetation analysis and the similarity approaches whilst all angiosperm leaf taxa and morphotypes were used for CLAMP analyses (App. I).

IPR vegetation analysis

Table 1 shows the results based on the floristic spectrum published by Kovar-Eder et al. (2004) and those derived from the assignment variants 1 to 3 of the updated spectrum from this study. The proportions of the key angiosperm components BLD, BLE, SCL + LEG are fairly similar between variants 1 to 3 (this study) and the values of the variants do not differ considerably from those published by Kovar-Eder and Teodoridis (2018), Teodoridis et al. (2020), and Kovar-Eder et al. (2021). The proportions of the BLD and BLE components published by Kovar-Eder et al. (2008) differ slightly from the other results owing to the later refinement of the components' spectrum of the IPR

vegetation analysis by Teodoridis et al. (2011a). All results indicate "subhumid sclerophyllous forests" as the most likely zonal vegetation type for Parschlug.

Similarity approaches (tools Drudge 1 and 2)

The results of all attempts (variants 1–3 and that previously published – Kovar-Eder et al. 2021) are very similar (Text-fig. 1, Tab. 2, App. II). The results for the TS are identical because the floristic spectrum of Parschlug has been enlarged mainly by morphotypes not assignable taxonomically. The IPR similarity, which is based on leaf physiognomy and autecology, points unambiguously towards a European relationship while the TS, which is based on the correspondence of the genera between the fossil assemblage and modern vegetation units, clearly indicates an East Asian relationship. On the higher level of East Asian vegetation types and European vegetation formations, the diversity of modern proxies for Parschlug is remarkably high (see Kovar-Eder et al. 2021: fig. 3 Overall score).

On the level of vegetation units Broad-leaved Deciduous Forest – The Mixed Northern Hardwood Forest (Heilongjiang, Jilin, Liaoning) (unit China 68) and Caucasian pine forests, partly alternating with birch forests, and spruce forests (D064) received the highest number of similarity hits followed by Northeast Iberian supra-Mediterranean *Quercus faginea*-forests (G072) (Tab. 4A, App. II: "Proxies delivered").

In all analyses the European Vegetation Formation G – Thermophilous mixed deciduous broadleaved forests achieved the highest number of similarity hits followed by Formation D – Mesophytic and hygromesophytic coniferous and mixed broad-leaved-coniferous forests and the vegetation type Meili Snow Mt. high altitude SCL and BLF, China (Text-fig. 1, App. II: "Proxy summary Text-fig. 1").

Furthermore, within these formations and vegetation types the units Thracian downy oak-bitter oak forests (G032), North and central Iberian supra-Mediterranean *Quercus faginea*-forests (G071), North European open pine forests with *Betula nana*, lichens, mosses and dwarf shrubs (D042), and Meili Snow Mt. – Sclerophyllous and Broad-leaved forest zone (2,580–3,650 m alt. – Form. 2 *Quercus aquifolioides* – 1. community *Q. aquifolioides* and *Pinus armandii* (China 12), – 2. community *Q. aquifolioides* (China 13), and – 3. community *Q. aquifolioides* and *Populus davidiana* (China 14) received the next highest number of similarity hits (Tab. 4B, App. II, "Proxies delivered").

Quantitative palaeoclimate predictions

The CLAMP climate predictions for Parschlug are presented in Table 3 derived from the 144, 173, 177, 189 and 378 calibration datasets. Applying the updated version of the statistical tool for determination of the most suitable calibration dataset based on the physiognomic similarity (see App. V), the Global 378 calibration dataset was shown to be the best fit. The climate predictions derived from the Global 378 calibration dataset are as follows: MAT 12.3 °C, WMMT 22.8 °C, CMMT 1.7 °C, GROWSEAS 8.3 months, GSP 987.8 mm, MMGSP 96.3 mm, 3-WET 534.9 mm, 3-DRY 94.7 mm. MAP 1,100–1,200 mm was calculated based on CLAMP estimates for 3-WET, 3-DRY, GSP and

MMGSP for Parschlug (see section Material and methods, Climate Leaf Analysis Multivariate Program).

Discussion

Floristic, palaeogeographical and age comparisons

With 123 taxa and morphospecies the flora of Parschlug is extremely diverse. In addition to taxa which were widely distributed in Europe during the Paleogene and Neogene such as *Acer tricuspidatum*, *Cedrelospermum*, *Engelhardia*, *Glyptostrobus europaeus*, *Liquidambar europaea*, *Platanus leucophylla*, *Populus latior*, and others, there are numerous taxa which currently cannot be assigned taxonomically and which may be endemic, e.g., *Dicotylophyllum* sp. B, H, L, W, GG or *Leguminophyllum* sp. E or "*Quercus*" *daphnes* to mention just a few of them. This fact, which had already been recognised by Kovar-Eder et al. (2004), is quite unusual for a Miocene plant assemblage from Central Europe. Moreover, Lauraceae are extremely rare in Parschlug (Kovar-Eder et al. 2004), even *Daphnogene*, the most common laurel in Paleogene and Neogene European floras, is documented by less than a handful of specimens among many thousands of viewed specimens.

Along the eastern part of the Mur-Mürz fault system of the Noric Depression and the Styrian Basin further plant-bearing deposits are known (see section Depositional setting and taphonomy), among which the floras of Leoben (Leoben Basin; Ettingshausen 1888) and Schönegg (Styrian Basin; Ettingshausen 1890) are the most famous. Floristically, these plant assemblages are comparable to Parschlug regarding azonal taxa such as *Glyptostrobus*, *Myrica* or *Acer* species. Beyond that, the comparison of presumably zonal taxa, which are decisive for estimating mesophytic vegetation of the hinterland and climate, would require revisions of those floras which have not yet been undertaken.

Although the age of the Parschlug flora is estimated to be late Burdigalian to early Langhian (see Introduction), it is very different (especially in the floristic spectrum) from the so-called Younger Mastixioid floras sensu Mai (1964) which are often considered to represent the Miocene Climate Optimum (MCO) (not least based on their floristic spectrum), e.g., Wiesa near Kamenz, Saxony (Mai 2000), Wackersdorf in Bavaria (Knobloch and Kvaček 1976), Hrádek nad Nisou (Kristina Mine, North Bohemia; Holý et al. 2012). Parschlug yields a high number of enigmatic taxa not known from elsewhere, which limits floristic comparisons with other sites. However, the overall leaf physiognomy, expressed in the proportions of key components in the IPR vegetation analysis, is definitely closer to plant assemblages assigned to the (late Early and) Middle Miocene (see Kovar-Eder and Teodoridis 2018) than to Younger Mastixioid floras. The latter are characterised by high proportions of broad-leaved evergreen taxa. Although this may imply that Parschlug is younger than Early Miocene, we refrain from this conclusion because precise cross-regional stratigraphic correlation by independent means (i.e., other than floristic composition) is rarely possible.

In this context, the florule of Znojmo in southern Moravia is also worth mentioning. That florule contains mainly small-sized, entire-margined or minutely toothed and legume-like taxa, many of them difficult to assign taxonomically, while deciduous taxa such as *Acer*, Betulaceae, Juglandaceae or Ulmaceae are absent (Knobloch 1969a, b). Knobloch (1969a, b) regarded this florule as late Burdigalian/early Helvetian (now Burdigalian) in age and interpreted it as "thermophilous, xerophilous flora". Unfortunately, the photographs of specimens from Znojmo do not allow for close comparison with Parschlug and the age correlation also remains unclear.

Although the mechanisms of biogeographic distribution of aquatic gastropods and land plants certainly differ, it is noteworthy that the early Middle Miocene mollusc fauna of lake Groisenbach, from the nearby Aflenz Basin, is

Table 1. IPR vegetation analysis results for Parschlug. The results from previous publications (based on the floristic spectrum published by Kovar-Eder et al. 2004) differ slightly from the results based on the enlarged floristic spectrum herein. Some morphotypes and taxa can be assigned differently, therefore three variants of assignments of taxa were used (variants 1–3; see Appendix I for full details). The differences between variants in the proportions of the zonal woody angiosperm components BLD (broad-leaved deciduous), BLE (broad-leaved evergreen), and sclerophyllous and legume-like (SCL + LEG) are minor. Following the definitions of major vegetation types (Teodoridis et al. 2011a), all results indicate "subhumid sclerophyllous forest" as the most likely zonal vegetation type for Parschlug because the proportion of the components SCL + LEG exceeds 20 %.

| Localities | IPR-vegetation analysis results | | | | | | | | | | | | |
| | Zonal components | | | | | | Azonal components | | | | | | |
	% of BLD component	% of BLE component	% of SCL + LEG component	% of DRY HERB component	% of MESO HERB component	% of zonal herbaceous component	Azonal woody component	Azonal non-woody component	Aquatic component	Problematic taxa	Number of zonal taxa	Number of zonal woody angiosperms	Total number of taxa
Parschlug – variant 1 (this study)	43.01	20.86	36.13	0.00	1.00	1.00	6.66	3.00	1.00	4.00	100.00	94.00	114.00
Parschlug – variant 2 (this study)	44.08	21.39	34.53	0.00	1.00	1.00	6.66	3.00	1.00	4.00	100.00	94.00	114.00
Parschlug – variant 3 (this study)	44.97	22.99	32.04	0.00	1.00	1.00	6.66	3.00	1.00	4.00	100.00	94.00	114.00
Parschlug – Kovar-Eder et al. (2008)	53.00	16.00	31.00	0.00	0.00	0.00	8.33	2.00	1.00	1.00	52.00	47.00	66.00
Parschlug – Kovar-Eder and Teodoridis (2018), Teodoridis et al. (2020), Kovar-Eder et al. (2021)	48.32	17.89	33.78	0.00	1.67	1.67	6.49	3.00	1.00	4.00	60.00	54.00	74.00

Modern vegetation proxies
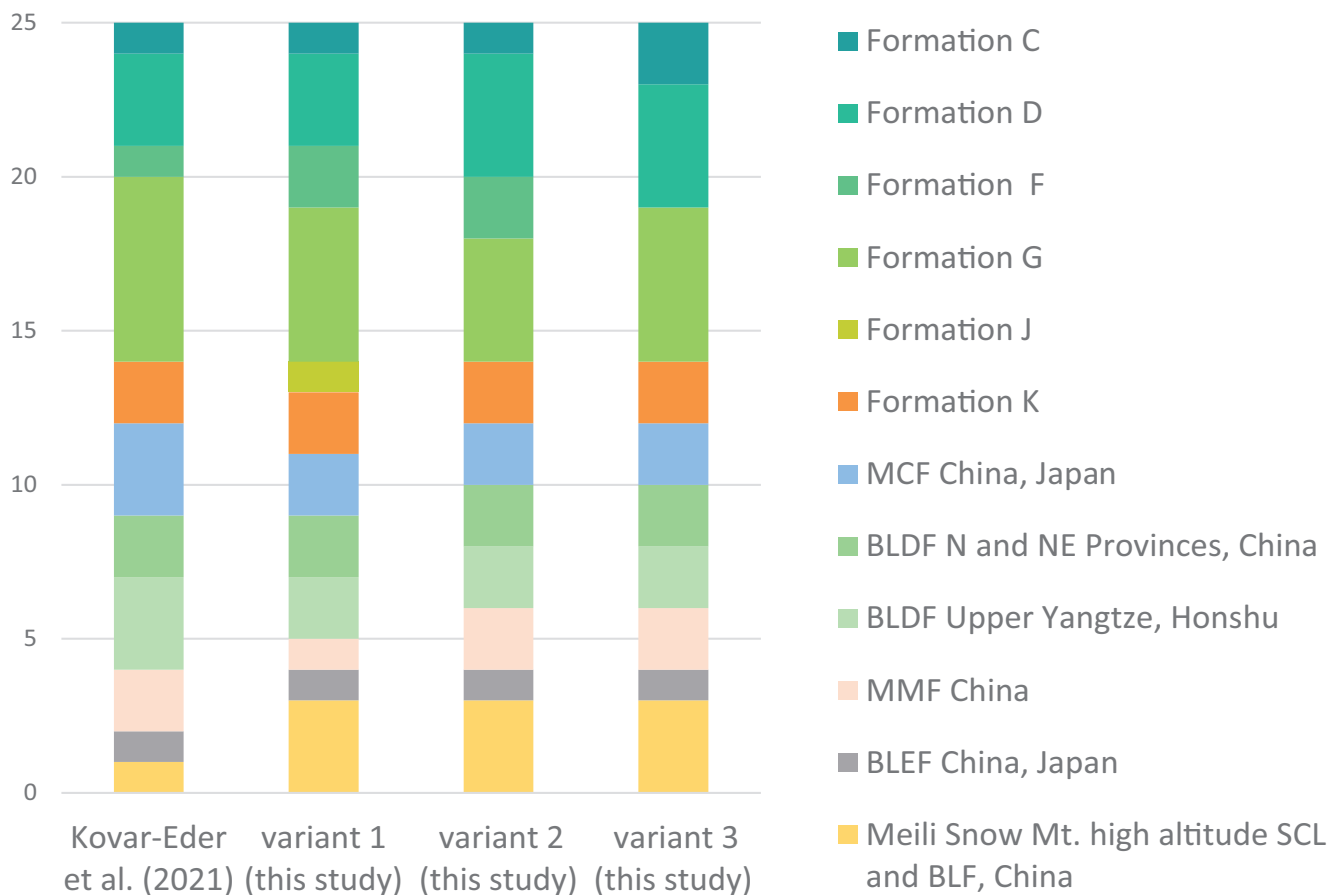
Text-fig. 1. Modern vegetation proxies as delivered by the Drudge 1 and 2 tools for Parschlug. Left column results from Kovar-Eder et al. (2021) based on the floristic spectrum published by Kovar-Eder et al. (2004). The other three columns result from three variants using the enlarged floristic spectrum herein. Differences between variants 1–3 from this study are caused by differences in assignment of some taxa and morphotypes (see Appendix 1). European vegetation formations: Formation C – Subarctic, boreal and nemoral-montane open woodlands as well as subalpine and oro-Mediterranean vegetation; Formation D – Mesophytic and hygromesophytic coniferous and mixed broad-leaved-coniferous forests; Formation F – Mesophytic broadleaved deciduous and mixed broadleaved/conifer forests; Formation G – Thermophilous mixed deciduous broadleaved forests; Formation J – Mediterranean sclerophyllous forests and scrub; Formation K – Xerophytic coniferous forests, coniferous woodland and scrub. East Asian vegetation types: MCF China, Japan – Montane Coniferous Forests China, Honshu, Yakushima; BLDF N and NE Provinces, China – Broad-leaved Deciduous Forests of the Northern and Northeastern Provinces (China); BLDF Upper Yangtze, Honshu – Broad-leaved Deciduous Forest, Upper Yangtze Provinces, Mt. Emei, and Honshu; MMF China – Mixed Mesophytic Forest, Lower Yangtze Provinces; BLEF China, Japan – Broad-leaved Evergreen Forests, China, Japan; Meili Snow Mt. high altitude SCL and BLF, China – Meili Snow Mt., Sclerophyllous and broad-leaved forest zone (2,580-3,650 m alt.). (Designations of European vegetation formations follow Bohn et al. (2004) and Asian ones follow Kovar-Eder et al. (2021).

characterised not only by a high rate of endemism but also by the occurrence of the genus *Bulinus*, which has not been recorded elsewhere in the Central European Neogene (Harzhauser et al. 2012). This gastropod occurs from southwestern Europe and southern Mediterranean islands to Arabia, the Middle East and Africa today (Harzhauser et al. 2012). Furthermore, there is evidence that the flora of the Mecsek region (Hungary), which shows a closer relationship to Parschlug than other European sites (see below), may have been deposited considerably further south than the present position of this region (Hably 2020). Evidence of a similar tectonic scenario for Parschlug is not available (pers. comm. M. Harzhauser), but could explain the distinctive floristic spectrum of the Parschlug flora.

Parschlug and Mecsek area floras compared

The flora of the Mecsek area (Early Miocene, Karpatian – Central Paratethys stage) has been compared to Parschlug in a preliminary way by Kovar-Eder et al. (2004) and later by Hably (2020). Both studies pointed out the close relationship between those fossil assemblages due to numerous shared species and genera. Beyond that, other distinctive characteristics are shared by both fossil floras or distinguish between them. Betulaceae are unusually scarce at both sites. *Ostrya* (fruits and leaves) is documented only from the Mecsek area while *Betula* and *Alnus* appear restricted to Parschlug (rare specimens). At both sites Fagaceae are well represented by *Fagus* (few specimens in Parschlug and Mecsek area) and different species of *Quercus*. Remarkably *Q. mediterranea*, common at Parschlug, is absent in the Mecsek flora. Though

Table 2. Results of the similarity approaches obtained by applying the Drudges 1 and 2 tools to assess the most similar modern zonal vegetation proxies. The five best fitting results are listed (modern vegetation units) for the IPR Similarity, Taxonomic Similarity (TS) and Results Mix which are delivered by the Drudges tools as proxies. For modern vegetation unit designations see Teodoridis et al. (2020: appendix 7). At the upper level of European vegetation formations and vegetation types in Asia these results are visualised in Text-fig. 1. For more details see Appendix II.

Drudge 1								
Site/results		Parschlug (Kovar-Eder et al. 2021)		Parschlug variant 1 (this study)		Parschlug variant 2 (this study)		Parschlug variant 3 (this study)	
Site/results		Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference	Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference	Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference	Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference
Results – IPR Similarity	1	G043	2.2	F025	1.4	F025	1.5	K015	3.1
	2	F098	2.6	C039	2.5	C039	1.6	K022	3.7
	3	K022	2.7	F098	4.2	K022	3.2	C039	4.1
	4	G074	3.4	K027	4.3	F098	3.5	C020	4.1
	5	K015	4.0	K022	4.7	K015	4.4	G074	4.2
Results – Taxonomic Similarity	1	China 68	32.8%	China 68	21.2%	China 68	21.2%	China 68	21.2%
	2	China 81	31.3%	China 81	20.2%	China 81	20.2%	China 81	20.2%
	3	Japan 05	29.7%	Japan 05	18.3%	Japan 05	18.3%	Japan 05	18.3%
	4	Japan 06	29.7%	Japan 06	18.3%	Japan 06	18.3%	Japan 06	18.3%
	5	China 60	29.7%	China 60	18.3%	China 60	18.3%	China 60	18.3%
Results – Mix	1	China 13	79.2	G072	88.2	G072	88.3	G072	88.6
	2	D052	79.3	China 12	90.0	China 12	89.7	China 12	89.4
	3	G072	80.2	China 14	90.4	China 13	90.1	China 13	89.8
	4	Japan 01	80.8	China 13	90.5	China 14	90.2	China 14	90.2
	5	C046	82.0	G063	91.1	D016	90.9	D016	90.4

Drudge 2								
Site/results		Parschlug (Kovar-Eder et al. 2021)		Parschlug variant 1 (this study)		Parschlug variant 2 (this study)		Parschlug variant 3 (this study)	
Site/results		Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference	Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference	Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference	Modern vegetation units	Mathematical difference/ Taxonomic Similarity /Total difference
Results – IPR Similarity	1	G032	17.1	G032	19.1	G032	19.7	G032	21.7
	2	G071	21.5	D042	23.9	D042	23.5	D042	22.6
	3	D064	22.5	G071	25.6	G071	25.0	D064	24.8
	4	D042	24.2	D064	26.4	D064	25.5	G071	24.9
	5	G030	24.3	J009	26.5	G030	26.3	G030	26.2
Results – Taxonomic Similarity	1	China 68	32.8%	China 68	21.2%	China 68	21.2%	China 68	21.2%
	2	China 81	31.3%	China 81	20.2%	China 81	20.2%	China 81	20.2%
	3	Japan 05	29.7%	Japan 05	18.3%	Japan 05	18.3%	Japan 05	18.3%
	4	Japan 06	29.7%	Japan 06	18.3%	Japan 06	18.3%	Japan 06	18.3%
	5	China 60	29.7%	China 60	18.3%	China 60	18.3%	China 60	18.3%
Results – Mix	1	China 68	81.2	China 38	91.3	China 38	90.6	China 38	89.6
	2	China 38	81.6	D064	93.2	China 67	92.6	China 67	91.6
	3	China 81	82.5	China 67	93.4	D064	93.0	China 68	92.4
	4	China 60	82.5	China 68	93.6	China 68	93.0	D064	92.8
	5	China 67	83.0	G072	94.2	China 59	93.8	China 59	92.9

Table 3. Palaeoclimate estimates derived from CLAMP for the Parschlug flora. For Parschlug, the Global 378 calibration dataset was determined to be the best suited using the "Copy & Paste" Excel application of the updated statistical tool for the selection of the best-suited modern vegetation CLAMP calibration dataset (App. V). Abbreviations: MAT (Mean Annual Temperature), WMMT (Warmest Month Mean Temperature), CMMT (Coldest Month Mean Temperature), GROWSEAS (Length of the Growing Season), GSP (Growing Season Precipitation), MMGSP (Mean Monthly Growing Season Precipitation), 3-WET (Precipitation during 3 Consecutive Wettest Months), 3-DRY (Precipitation during 3 Consecutive Driest Months), RH (Relative Humidity), SH (Specific Humidity) and ENTHAL (Enthalpy), MAP (Mean Annual Precipitation). MAP has been derived by a simple calculation based on 3-WET, 3-DRY, GSP and MMGSP, see section Material and methods, Climate Leaf Analysis Multivariate Program (CLAMP).

(Palaeo)climatic parameters/Calibration datasets	CLAMP estimates – Parschlug				
	378 (PhysgGlobal378 / HiResGRIDMetGlobal378)	144 (Physg3br / GRIDMet3brcAZ)	173 (Physg3ar / GRIDMet3arcAZ)	177 (PhysgAsia2 / HiResGRIDMetAsia2)	189 (PhysgAsia1 / GRIDMetAsia1)
MAT [°C]	12.33	13.82	12.84	17.06	14.12
WMMT [°C]	22.78	24.07	23.96	27.10	24.13
CMMT [°C]	1.74	4.53	2.00	6.38	5.59
GROWSEAS [months]	8.30	7.79	7.37	9.73	7.96
GSP [mm]	987.8	1,457.7	1,493.1	1,776.7	1,331.9
MMGSP [mm]	96.3	182.0	185.3	175.7	143.4
3-WET [mm]	534.9	848.7	686.4	765.9	753.7
3-DRY [mm]	94.7	153.5	153.1	272.5	208.3
RH [%]	68.93	63.37	56.74	69.62	65.54
SH [g/kg]	6.47	6.42	6.06	9.23	6.65
ENTHAL 0.1 [kJ/kg]	31.10	31.21	30.97	32.67	31.33

Ulmaceae are represented by *Cedrelospermum*, *Ulmus*, and *Zelkova* at both sites, the distinctive foliage of *Ulmus plurinervia* has not been recorded in the Mecsek flora. The scarcity of Lauraceae foliage including *Daphnogene* is a pecularity of the Parschlug flora. In the flora of the Mescek area there are common or even abundant Lauraceae, *Engelhardia*, *Ailanthus confucii* UNGER, *Antholithes stiriacus* KOVAR-EDER et KVAČEK , and *Nerium*, which are less common at Parschlug. *Paliurus* is documented at both sites by several fruits. At Parschlug leaves have also been assigned to *Paliurus*. In the Mecsek flora similar but larger leaves assigned to *Ziziphus paradisiaca* are abundant. The differentiation of foliage of both genera of the Rhamnaceae family based only on gross morphology is challenging even in modern material. Therefore, it cannot be excluded that such leaves from Mecsek area and Parschlug are congeneric or even conspecific. Palms are documented from the Mecsek area, although only by a single specimen, but, among the several thousand specimens viewed from Parschlug, no palms have been recorded. Characteristic but cryptic taxa regarding botanical affinity such as "*Quercus*" *daphnes*, "*Juglans*" *parschlugiana* and *Phaseolites securidacus* known from Parschlug have not been recorded from the Mecsek flora and Parschlug differs generally by the high number of cryptic morphospecies. *Ternstroemites pereger* (Theaceae) and *Prinsepia serra* (Rosaceae) were originally regarded as endemic to Parschlug (Kovar-Eder et al. 2004) but both have now been recorded from the Mecsek area though the latter species as cf. *Prinsepia serra* (Hably 2020). Also noteworthy is the high diversity of taxa represented by winged fruits, infructescences or inflorescences probably transported by wind into the deposits at both sites. Many of these taxa occur at both sites, e.g., *Acer*, *Ailanthus*, *Antholithes stiriacus*, *Cedrelospermum*, *Craigia*, *Engelhardia*, *Fraxinus*, *Paliurus*, *Pinus*, and *Tilia*. Some are restricted to Parschlug such

as *Betula*, *Chaneya*, and *Saportaspermum* while *Abies*, *Mecsekispermum* (Theaceae; Erdei and Hably 2021), *Ostrya*, *Tetraclinis*, and *Carpolithes* sp. 3 and 6 occur only in the flora from the Mecsek area.

Zonal vegetation

Based on the floristic composition, abundance of fossil taxa and their probable autecology, Kovar-Eder et al. (2004) reconstructed the landscape with gallery forests along streams discharging into the Parschlug Basin. Taxa which are very abundant in the Parschlug assemblage such as *Glyptostrobus europaeus*, *Myrica lignitum*, and *Liquidambar europaea* probably grew in those forests. Zonal forests were reconstructed as subhumid forests with sclerophyllous oaks in the canopy with only small, more humid patches depending on exposure and soil. Taxa such as *Betula*, *Fagus*, *Fraxinus*, *Daphnogene* and others, which are extremely rare in Parschlug, may have grown there (Kovar-Eder et al. 2004). The results of the IPR vegetation analysis, aiming to assess semi-quantitatively the major zonal vegetation type for a fossil assemblage, are in agreement with the empirically derived assessment, and indicate "subhumid sclerophyllous forests" as defined by the SCL + LEG (sclerophyllous and legume-like) components, comprising ≥20 % of the zonal woody angiosperm components (Teodoridis et al. 2011a). In Parschlug, the percentage of these components varies from 32 to 36 % (Tab. 1, App. I: variants 1 to 3). Note, that a differentiation within the major zonal vegetation type, as is possible using the empirical approach, is not possible when using a quantitative technique such as the IPR vegetation analysis.

Modern proxy vegetation for Parschlug

The assessment of the most similar modern vegetation proxies for Parschlug using the similarity approaches

Table 4. Comparison of climate proxies for Parschlug and climate data in regions of likely modern vegetation proxies. A – Climate proxies for Parschlug and climate parameters of modern vegetation units which achieved the highest number of hits in all similarity approaches (variants 1–3 and those published by Teodoridis et al. 2020 and Kovar-Eder et al. 2021), B – Amongst European vegetation formations and East Asian vegetation types, three achieved the highest number of similarity hits overall, namely the Formations G and D and "Meili Snow Mt. high altitude SCL and BLF" (China 12–14). Here the climate parameters for the vegetation units are given within those formations/types that achieved the highest number of similarity hits there (if not already listed in A). See Appendix II, Proxies delivered. Abbreviated designations of vegetation units are based on Bohn et al. (2004) and the list in Teodoridis et al. (2020: appendix 7). * based on Traiser and Mosbrugger (2004) see Kovar-Eder et al. (2021: appendix 11). In addition to already published climate parameters in regions of modern proxies, climate has been assessed using the tool "Earth Systems Modelling Results" available at BRIDGE (2021).

A

Number of hits in the similarity approaches (all variants)	ID of vegetation unit / site	Designation of vegetation unit	MAT [°C]	WMMT [°C]	CMMT [°C]	MAP [mm]	3-WET [mm]	3-DRY [mm]	Climate data derived by
n.a.	Parschlug	n.a.	12.33	22.78	1.74	1,100–1,200	534.9	94.7	this study
6	China 68	Broad-leaved Deciduous Forest – The Mixed Northern Hardwood Forest (Heilongjiang, Jilin, Liaoning)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Teodoridis et al. (2020)
	Changbai Mts. (region of China 68)		3.3	20.4	-17.2	768	476	27	BRIDGE (2021)
6	D064	Caucasian pine forests. partly alternating with birch forests and spruce forests	2.5–9	13–19	-9 to -3.5	700–1,400	n.a.	n.a.	Teodoridis et al. (2011–2021)
	Krachajevsk (region of D064)		0.7–8.2	11.5–18.9	-10.3 to -3.1	997	342	191	BRIDGE (2021)
	Tylarga (region of D064)		3.4–10.4	16.9–24.3	-10.3 to -3.9	997	403	160	
4	G072	Northeast Iberian supra-Mediterranean Quercus faginea-forests	10–13	19–22	2–5	500–800	n.a.	n.a.	Bohn et al. (2004)
			8–13*	17–24*	-1 to 5*	500–1,000 (>1,600)*	n.a.	n.a.	Kovar-Eder et al. (2021)
	Teruel (region of G072)		14.9	25.0	7.1	545.2	166.1	111.1	BRIDGE (2021)
	Pamplena (region of G072)		12.7	20.7	5.4	830.5	252.0	139.4	
	Huesca (region of G072)		14.0	23.7	5.4	568.6	168.6	113.2	
	Manrea (region of G072)		13.6	21.8	6.7	630.5	197.5	110.7	

B

Number of hits in the similarity approaches (all variants)	ID of vegetation unit	Name of vegetation unit	MAT [°C]	WMMT [°C]	CMMT [°C]	MAP [mm]	3-WET [mm]	3-DRY [mm]	Climate data derived by
3	China 12	Meili Snow Mt. – Sclerophyllous and Broad leaved forest zone (2,580–3,650 m alt. – Form. 2 Quercus aquifolioides - 1. comm Q. aquifolioides and Pinus armandii)							
	China 13	Meili Snow Mt. – Sclerophyllous and Broad leaved forest zone (2,580–3,650 m alt. – Form. 2 Quercus aquifolioides - 2. comm Q. aquifolioides)	10.5	16.7	2.9	976	n.a.	n.a.	Teodoridis et al. (2011)
	China 14	Meili Snow Mt. – Sclerophyllous and Broad leaved forest zone (2,580–3,650 m alt. – Form. 2 Quercus aquifolioides - 3. comm Q. aquifolioides and Populus davidiana)							
	Meili Snow Mountain National Park Scenic Area (region of China 12–14)	Meili Snow Mt. – Sclerophyllous and Broad leaved forest zone	5.3–11.4	12.3–17.9	-2.5 to 3.2	710	363	36	BRIDGE (2021)

Table 4. part B continued

			12–13.5	20.4–20.7	1–3.5	700–850			
3	G032		(8) 10–13 (15)*	17–24*	2–6*	500–800	n.a.	n.a.	Bohn et al. (2004)
	Thracian downy oak-bitter oak forests		14.0	24.3	3.0	588	201.6	86.2	Kovar-Eder et al. (2021)
	Edime (region of G032)		14.0	23.1	4.6	597	247.1	70.4	BRIDGE (2021)
	Corlu (region of G032)		8–13	18–19	2–4	600–1,600	n.a.	n.a.	
3	G071		8–13*	17–24*	–1 to 5*	500–1,000 (>1,600)*	n.a.	n.a.	Bohn et al. (2004)
	North and central Iberian supra-Mediterranean *Quercus faginea*-forests		12.5	21.0	5.1	597	179.6	95.7	Kovar-Eder et al. (2021)
	Burgos (region of G071)		13.1	22.0	5.5	416	123.0	66.8	BRIDGE (2021)
	Palencia (region of G071)		13.4	22.7	5.4	404	128.5	56.6	
	Valladolid (region of G071)		–4 to 1	12–16	<–10	400–600	n.a.	n.a.	
3	D042		0.1	13.9	–12.7	515	185	77	Bohn et al. (2004)
	Sidorov Island (region of D042)	North European open pine forests with *Betula nana*, lichens, mosses and dwarf shrubs	0.4	15.3	–14.9	551	183	84	BRIDGE (2021)
	Archangelsk (region of D042)		–2.9 to –1.7	11.9–13.0	–16.2 to –15.0	435	169	67	
	Kevo (region of D042)		–0.7	11.1	–12.3	684	247	104	
	Stormorvallen (region of D042)								

(Drudge 1 and 2 tools), based on the enlarged floristic spectrum for Parschlug presented here, differs only to a minor degree from those presented by Teodoridis et al. (2020) and Kovar-Eder et al. (2021). The European Vegetation Formation G – Thermophilous mixed deciduous broadleaved forests – received the highest number of similarity hits. It occurs from Spain to southeast Europe in a variable broad to interrupted belt between mesophilous, mixed broadleaved deciduous forests (Formation F) in the north, forest steppes and steppes in the southeast (Formations L, M) and Mediterranean evergreen, sclerophyllous broadleaved forests and scrublands (Formation J) in the south. Climatically, forests of Formation G occupy regions between temperate Central Europe and the Mediterranean and Pontic region. Thermophilous and drought resistant deciduous and evergreen tree species (mainly oaks) characterise the tree layer of these forests (Bohn et al. 2004). Formation D – Mesophytic and hygromesophytic coniferous and mixed broad-leaved-coniferous forests, next in order based on the number of similarity hits, thrive in the boreal to nemoral zones and at higher altitudes of the temperate and submeridional zones in Europe (Bohn et al. 2004). The vegetation type Meili Snow Mt. high altitude SCL and BLF, China occurs between 2,580 to 3,650 m altitude on Meili Snow Mt. and is characterised by sclerophyllous oaks (Teodoridis et al. 2011a).

The divergence between IPR Similarity and Taxonomic Similarity (TS), the former pointing towards a European relationship, the latter towards an East Asian link, was first recognised by Teodoridis et al. (2020) for Parschlug and later also for other Miocene European floras (Kovar-Eder et al. 2021). This divergence indicates that the European plant record underwent a change in overall leaf physiognomy of woody taxa from the Paleogene to the Neogene resulting in a closer relationship to modern European vegetation than to East Asian vegetation (Kovar-Eder et al. 2021). Considering the TS, the continuity of a close relationship with East Asia is likely to be the result of the pauperisation of the European flora due to the climatic oscillations during the Quaternary Ice Age (Kovar-Eder et al. 2021). In other words, this recently discovered divergent development of the Neogene flora in Europe may be interpreted in terms of the climate change that Europe experienced a climatic development different from that indicated by its floristic similarity.

The results of the similarity approaches for Parschlug also indicate a relatively high diversity of East Asian vegetation types and European vegetation formations compared to older and younger European plant assemblages. This high diversity is evident especially in the IPR Similarity but also in the Taxonomic Similarity and the Results Mix (Tab. 2). Similar high variability of vegetation proxies has been recorded for other Early and early Middle Miocene assemblages such as the Mecsek area (Hungary; Hably 2020), Randeck Maar (Germany; Rasser et al. 2013), and Holy Cross Mountains (Poland; Zastawniak 1980). This high variability distinguishes these assemblages from those of older and younger Neogene time intervals in Central Europe and may be interpreted as a signal of climate change (see Kovar-Eder et al. 2021: fig. 3 Overall score).

Climate proxies for Parschlug and other floras relevant for comparison

The palaeoclimate for Parschlug was previously inferred from the taxonomic composition and the physiognomic character of the zonal plant elements (Kovar-Eder et al. 2004). The relatively high number of presumably evergreen sclerophyllous and small-leaved taxa suggested subtropical but relatively dry climatic conditions. The results of the quantitative climate assessment by CLAMP largely conform to those inferences but provide more precise estimates and indicate distinct seasonality both in temperature (WMMT 22.8 °C, CMMT 1.7 °C) and precipitation (3-WET 534.9 mm, 3-DRY 94.7 mm). This contrasts with the humid, probably frost free, subtropical/warm temperate conditions documented for example from the nearby site of Oberdorf, a flora of the Younger Mastixioid type, at the northwestern margin of the Styrian Basin (Burdigalian, Ottnangian – Central Paratethys stage; Bruch and Kovar-Eder 2003). It also contrasts with the warm and humid climate documented from another nearby site, Mataschen (Eastern Styrian Basin, i.e., westernmost extension of the Pannonian Basin, lower Tortonian, i.e., early Pannonian – Central Paratethys stage; Kovar-Eder and Hably 2006) and the Early to Middle Miocene Younger Mastixioid floras from the regions of Bohemia, Bavaria and Saxony, e.g., Hrádek nad Nisou (Mine Kristina; Holý et al. 2012), Wiesa near Kamenz (Mai 2000) and Wackersdorf (Knobloch and Kvaček 1976). Detailed climate estimates of those sites can be found in Holý et al. (2012).

The CMMT of 1.7 °C is relatively low, implying that the Parschlug flora may have experienced occasional frost. As far as the floristic spectrum allowed for systematic assignment, temperatures below 0 °C are not precluded. Moreover, the near absence of warm-temperate to subtropical taxa, characteristic of Younger Mastixioid floras, may even support the possibility of frost.

It is worth noting that the largest uncertainties in climate estimates are associated with precipitation measurements (Spicer 2011–2021), in part because of small-scale variations that are not captured by the spatial distribution of the meteorological stations (including biases towards easily accessible lowland sites). Moreover, to correct for altitude at specific sites further spatial interpolations and altitude corrections are made. These are difficult to quantify because appropriate station data are missing. Yang et al. (2011) published comparisons between the ungridded and gridded data and while MAT shows a good agreement, understandably precipitation measures do not.

For Parschlug, the value of MAP may be estimated around 1,100–1,200 mm when applying a simple calculation based on CLAMP estimates for 3-WET, 3-DRY, GSP and MMGSP (see section Material and methods, Climate Leaf Analysis Multivariate Program CLAMP). This range is close to the estimates for Younger Mastixioid floras such as Oberdorf (MAP 1,187–1,322 mm; Bruch and Kovar-Eder 2003), Hrádek nad Nisou (MAP 1,146–1,146 mm; Holý et al. 2012), Wiesa near Kamenz (MAP 1,146–1,355 mm; Mosbrugger et al. 2005) and Wackersdorf (MAP 1,096–1,187 mm; Teodoridis and Kvaček 2015). It is also close to the lowermost limit of the estimates for Mataschen (MAP 1,280–1,950 mm; Kovar-Eder and Hably 2006).

However, the MAT predictions for those sites are higher than for Parschlug: Oberdorf MAT 15.7–17.6 °C (Bruch and Kovar-Eder 2003), Hrádek nad Nisou MAT 14.2 °C (CLAMP)/17–18 °C (CA) (Holý et al. 2012), Wiesa near Kamenz MAT 20–23 °C (Mai 2000), MAT 17.7–18 °C/17.2–18 °C (both CA) (Mosbrugger et al. 2005, Grein et al. 2013), Wackersdorf MAT 17.4 °C (CLAMP)/15.7–16.6 °C (CA) (Teodoridis et al. 2011b, Teodoridis and Kvaček 2015), Mataschen MAT 15–19 °C (Kovar-Eder and Hably 2006), Parschlug MAT 12.3 °C (this paper). Taking into account evaporation increasing with temperature, this may appear surprising. However, we regard seasonality both in temperature and precipitation as major drivers of floristic and hence vegetational changes.

Comparison of climate proxies for Parschlug and climate in regions of most similar modern vegetation proxies

Comparing the climate estimates for Parschlug with known climate records in regions with the most similar modern vegetation proxies (Tab. 4, App. VII), the climate similarity is closer in the regions of Formation G – Thermophilous mixed deciduous broadleaved forests in Europe (G072 – Northeast Iberian supra-Mediterranean *Quercus faginea*-forests, G071 – North and central Iberian supra-Mediterranean *Quercus faginea*-forests, G032 – Thracian downy oak-bitter oak forests) than it is in regions with Formation D – Mesophytic and hygromesophytic coniferous and mixed broad-leaved-coniferous forests (D064 – Caucasian pine forests, partly alternating with birch forests and spruce forests, D042 – North European open pine forests with *Betula nana*, lichens, mosses and dwarf shrubs) or East Asian vegetation of Meili Snow Mt. high altitude SCL and BLF (China 12–14), or Broad-leaved Deciduous Forest – The Mixed Northern Hardwood Forest (Heilongjiang, Jilin, Liaoning) (China 68). The climate estimates for Parschlug differ, however, from those of the proxy units of the European Vegetation Formation G in the higher MAP and distinctly higher 3-WET values. The difference between 3-WET and 3-DRY indicates even stronger seasonality in rainfall for Parschlug than for the regions of G072, G071 and G032. The climate of Caucasian pine forests, partly alternating with birch forests, and spruce forests (D064), differs considerably from Parschlug, especially in the lower MAT and CMMT values probably due to the montane altitude but also by lower estimates for 3-WET. The least comparable climate is that of the North European open pine forests with *Betula nana*, lichens, mosses and dwarf shrubs (D042). The Sclerophyllous and Broad-leaved forests from Meili Snow Mt. at high altitudes (China 12–14), which are comparable to sclerophyllous forests in the Mediterranean region (Ou et al. 2006), grow under temperate to cool-temperate climate with lower values of MAT, WMMT and drier conditions (lower values of 3-WET, 3-DRY and MAP) compared to Parschlug. Generally, the estimated palaeoclimate of Parschlug corresponds more closely to modern hot/warm-summer Mediterranean climate (Csa, Csb) – see, e.g., Peel et al. (2007), Beck et al. (2018), but the specific combination of temperature and precipitation parameters inferred from CLAMP for Parschlug is not represented in the climates of the relevant modern sampled vegetation indicated by the similarity approaches.

Climate evidence from nearby localities of similar age

More precise age constraints than late Burdigalian to early Langhian (Karpatian/early Badenian Central Paratethy stages) are not available for the Parschlug flora. Nevertheless, it is likely that its deposition occurred during the Miocene Climate Optimum (MCO), which is dated to approximately 16.9 to 14.7 Ma (Holbourn et al. 2015), i.e., approximately late Burdigalian to Langhian. Therefore, records from the Central Paratethys region during this time interval are relevant here.

Stable isotopes ($\delta^{18}O$) have been studied from shells of the bivalve *Macrochlamys* from lower Langhian sediments (Lower Badenian – Central Paratethys stage) of the Styrian Basin (Bojar et al. 2004). Those results indicate a warm climate and pronounced seasonality. From the Vienna Basin and surroundings, stable isotope data ($\delta^{13}C$ and $\delta^{18}O$) derived from shells of estuarine oysters (*Crassostrea gryphoides*) dated to 16.2 Ma (± 0.1) and 15.3 Ma (± 0.3) also indicate a distinct seasonal rhythm of warm-wet and cool-dry seasons for the MCO (Harzhauser et al. 2011).

Seasonality has also been inferred from the onset of the MCO (late Burdigalian/Karpatian – Central Paratethys stage) based on the pollen record from Stetten (Lower Austria) (Kern et al. 2011) using the Coexistence Approach (CA; Mosbrugger and Utescher 1997). The authors studied an approximately 21-kyr-long transgressive and regressive episode, most likely predating the flora of Parschlug. The rhythmic variability in the pollen record was interpreted as a result of seasonality in precipitation and temperature, in which warm and humid summer seasons (wettest month about 204–236 mm) and relatively cool and dry winters (driest month 9–24 mm) alternated. The temperature estimates were MAT 15.7–20.8 °C, WMMT 24.7–27.9 °C, and CMMT 9.6–13.3 °C. These temperature values are considerably above those for Parschlug derived from CLAMP.

In addition, based on the CA, the pollen record from marine strata in the northwestern part of the Central Paratethys (Vienna Basin and surroundings of Brno), dated to the late Burdigalian, Langhian and Serravalian, was interpreted in terms of climate change (Doláková et al. 2020). Overall, declining trends both for MAT and MAP were reconstructed for this time interval. The data from the late Burdigalian strata (Karpatian – Central Paratethys stage; see Doláková et al. 2020: fig. 3) were interpreted as representing a very warm and equable climate. However, seasonality in precipitation is indicated there by the mean precipitation of the wettest and the driest months (MPwet 180–270 mm and MPdry 8–40 mm). The numerical climate estimates are similar to those predicted for Stetten (see previous paragraph, Kern et al. 2011).

The differences in climate estimations (mainly temperature) between Parschlug and the pollen records from the northwestern Paratethys may be caused by the different proxies (the leaf record from Parschlug versus pollen records from the northwestern Paratethys region). Moreover, methodological differences between the Coexistence Approach and CLAMP, the former being based on autecology of "nearest living relatives" or more precisely most similar living relatives, the latter exclusively evaluating leaf physiognomy of dicotyledonous angiosperms, may

also result in diverging predictions (see, e.g., Utescher et al. 2014). Providing impressive examples, Kvaček (2007) arrived at the conclusion that "nearest living relatives" may be "false friends" because their autecology does not necessarily reflect that of fossil-species. That author further argued that leaf physiognomy should be considered more suitable for realistic climate predictions. The results of the similarity approaches for Parschlug (Tab. 2) and those for many other Neogene European sites in which the IPR Similarity points towards Europe but the Taxonomic Similarity (TS) points towards East Asia, strongly support this argument (see Kovar-Eder et al. 2021: tab. 2, fig. 2 – IPR Similarity Drudge 1, IPR Similarity Drudge 2, fig. 3 – Taxonomic Similarity).

Finally, the possibility must also be considered that the flora from Parschlug, indicating not only distinct seasonality in both temperature and precipitation but also lower MAT, WMMT and especially CMMT than the record from the northwestern Paratethys region (Kern et al. 2011, Doláková et al. 2020), may represent a time window around the late Burdigalian/early Langhian which is not represented in those pollen records.

Conclusions

In this study, the floristic spectrum of the plant assemblage from Parschlug has been enlarged by 42 leaf morphotypes and taxa of woody angiosperms increasing the number of taxa by around 50 % from 83 to 123. Based on that enriched floristic spectrum, IPR vegetation analysis, to determine the most likely major vegetation type, and similarity approaches (tools Drudge 1 and 2), to determine the most similar modern vegetation, were applied again. The new results from both methods confirm those presented by Kovar-Eder and Teodoridis (2018), Teodoridis et al. (2020) and Kovar-Eder et al. (2021) indicating the robustness of the results. Based on the high abundance of evergreen, sclerophyllous and small-leaved taxa, i.e., broad-leaved evergreen (BLE) and sclerophyllous and legume-like (SCL + LEG) components, the most likely major vegetation type is "subhumid sclerophyllous forest". The earlier reported divergence between IPR Similarity (based on leaf physiognomy and probable autecology) and Taxonomic Similarity (TS) (correspondence at the generic level), the former pointing towards an European relationship, the latter indicating a closer East Asian relationship (Teodoridis et al. 2020, Kovar-Eder et al. 2021), is confirmed. This implies different climatic development in Europe while floristic similarity to East Asia persisted. At the level of East Asian vegetation types and European vegetation formations, the diversity of modern vegetation proxies for Parschlug is remarkably high. Similar high diversity has been recorded for other Early and early Middle Miocene assemblages such as the Mecsek area (Hungary), Randeck Maar (Germany), and Holy Cross Mountains (Poland) (Kovar-Eder et al. 2021). The most similar modern vegetation is "Thermophilous mixed deciduous broadleaved forests" of Europe (Formation G sensu Bohn et al. 2004) and more specifically in this formation "Northeast Iberian supra-Mediterranean *Quercus faginea*-forests" (G072), "North and central Iberian supra-

Mediterranean *Quercus faginea*-forests" (G071) and "Thracian downy oak-bitter oak forests" (G032).

For the first time, CLAMP was used to estimate important climatic parameters for Parschlug. In this context, an updated version of the statistical tool to determine the most suitable calibration dataset based on physiognomic similarity is presented. Using this tool, the Global 378 calibration dataset has been identified as the most appropriate for Parschlug. Results derived from this calibration dataset indicate distinct seasonality in temperature (WMMT 22.8 °C, CMMT 1.7 °C) and precipitation (3-WET 534.9 mm, 3-DRY 94.7 mm). The estimate for MAT is 12.3 °C and MAP is 1,100–1,200 mm extrapolated from the CLAMP results.

In the regions of the modern vegetation proxies the climate parameters are similar to those for Parschlug as regards MAT, WMMT and CMMT and MAP indicating distinct seasonality both in temperature and precipitation (3-WET/3-DRY). There is, however, a remarkable discrepancy in the precipitation amounts of the 3 wettest months (3-WET) for which the estimate for Parschlug distinctly exceeds those of the modern vegetation proxies. Therefore, the specific combination of temperature and precipitation parameters inferred for Parschlug using CLAMP is not represented in the climates of the relevant modern vegetation proxies indicated by the similarity approaches based on the Drudge tools.

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Explanations of the plates

PLATE 1

1. *Acer* cf. *pseudomonspessulanum* Unger, GBA2005/0004/0112.
2. *Acer* cf. *tricuspidatum* Bronn, GBA 2005/0004/0122.
3. *Acer tricuspidatum* Bronn, GBA 1848/0001/0075.
4.–9. *Ailanthus pythii* (Unger) Kovar-Eder et Kvaček, 4: GBA 2002/0001/0009; 5: GBA2005/0004/0124; 6: GBA2005/0004/0044; 7: GBA1848/0001/0038; 8: NHMW 1878/6/8481; 9: NHMW 1852/1/1910.
10., 12. "*Celastrus*" *europaea* Unger, 10: IBUG 1988; 12: NHMW 1878/6/2742.
11. cf. "*Celastrus*" *europaea* Unger, NHMW 1878/6/2740.
13. *Daphnogene polymorpha* (A.Braun) Ettingsh., IBUG1284.
14., 15. *Berchemia multinervis* (A.Braun) Heer, 14: NHMW1878/6/9108; 15: NHMW 1878/6/2071.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 2

1.–3. *Betula* sp., 1: NHMW 1878/6/2028a; 2: IBUG 1543; 3a, b: IBUG 1542, b: detail of margin and venation.
4., 5. Betulaceae vel Ulmaceae gen. et sp. indet., 4: NHMW Ett. 497; 5: NHMW Ett. 730.
6.–8. Betulaceae gen. et sp. indet., 6: NHMW 2001/B0017/0004, as *Betula* vel *Alnus* sp. in Kovar-Eder et al. (2004: pl. 3, fig. 4); 7: IBUG 738; 8: NHMW 1878/6/2348.
9.–15. *Buxus* cf. *egeriana* Bůžek, Holý et Kvaček, 9: NHMW 1878/6/6465; 10: IBUG 2005; 11: GBA 2005/0004/0056; 12: GBA 2005/0004/0063; 13: IBUG 12006; 14: GBA 2002/0001/0014; 15: GBA 1848/0001/0079.
16.–18. *Cedrelospermum ulmifolium* (Unger) Kovar-Eder et Kvaček, 16: NHMW 1878/6/7617; 17: GBA 2005/0004/0097; 18: IBUG 835.
19. cf. *Dicotylophyllum* sp. 1, GBA 2005/0004/24.
20.–24. *Dicotylophyllum* sp. 3, 20: GBA 1848/0001/0027; 21: IBUG 81a; 22: GBA 2002/0001/0020, refigured from Kovar-Eder et al. (2004: pl. 15, fig. 9); 23: GBA 2005/0004/0028; 24: NHMW 1878/6/8571, refigured from Kovar-Eder et al. (2004: pl. 15, fig. 10).
25., 26. *Dicotylophyllum* sp. A, 25: GBA 2005/0004/0002; 26: GBA 2005/0004/0006.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 3

1.–8. *Cotinus* (?) *aizoon* Kovar-Eder et Kvaček, 1: GBA 2005/0004/12; 2: GBA 2005/0004/0011; 3: GBA 2005/0004/0010; 4: GBA 2005/0004/0086A, counterpart to Fig. 7; 5: IBUG 2018; 6: GBA 2005/0004/0014; 7: GBA 2005/0004/0086B, counterpart to Fig. 4; 8: GBA 2005/0004/0071.
9., 10. *Dicotylophyllum* sp. 6, 9: IBUG 1083, refigured from Kovar-Eder et al. (2004: pl. 15, fig. 4); 10a, b: IBUG 614, b: detail.
11.–15. *Dicotylophyllum* sp. B, 11: GBA 6704b; 12: GBA 2005/0004/0013; 13: GBA 2005/0004/0009A; 14: IBUG sine numero; 15: GBA 2005/0004/0076b.
16. *Dicotylophyllum* sp. E, IBUG 1777.
17.–24. *Dicotylophyllum* sp. C, 17: GBA 2005/0004/0018; 18: GBA 2005/0004/0017A; 19: GBA 2005/0004/0020; 20: GBA 2005/0004/0027; 21: GBA 2005/0004/0019; 22: GBA 2005/0004/0023; 23: GBA 2005/0004/0025; 24: GBA 2005/0004/0022.
25.–28. *Dicotylophyllum* sp. F, 25: GBA 2005/0004/0037; 26: GBA 2005/0004/0036; 27: GBA 2005/0004/0035; 28: GBA 2005/0004/0033.
29. *Dicotylophyllum* sp. D, GBA 2005/0004/0029A.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 4

1. *Dicotylophyllum* sp. H, GBA 1848/0001/0078, b: detail.
2.–3. *Dicotylophyllum* sp. G, 2a, b: NHMW 1878/6/7415, b: detail; 3: GBA 6703, orig./type *Ilex simularis* Unger (Unger 1864: pl. 3, fig. 14).
4.–7. *Dicotylophyllum* sp. K, 4a, b: IBUG 871b, b: detail; 5: IBUG 2053; 6: NHMW 1878/6/8639; 7: GBA 2005/0004/0040.
8. *Dicotylophyllum* sp. J, GBA 2005/0004/0039a.
9.–11. *Dicotylophyllum* sp. L, 9: NHMW 1878/6/6594, *Acer integrilobum* C.O.Weber sensu Walther 1972 forma B in Kovar-Eder et al. (2004: pl. 10, fig. 5), refigured; 10: NHMW 1878/6/2417a; 11: IBUG 1259.
12., 13. *Dicotylophyllum* sp. M, 12: NHMW 1878/6/5397; 13: NHMW 1878/6/8717.
14. *Dicotylophyllum* sp. R, NHMW Ett. 5445.
15. *Dicotylophyllum* sp. I, NHMW 1878/6/9176.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 5

1.–4. *Dicotylophyllum* sp. N, 1: GBA 2005/0004/0104; 2: IBUG 2806b; 3: GBA 2005/0004/0102; 4: GBA 2005/0004/0106.

5.–8. *Dicotylophyllum* sp. O, 5: GBA2005/0004/0077; 6: GBA 2005/0004/0085; 7: GBA2005/0004/0079B; 8: GBA 2005/0004/0079A.

9., 10. *Dicotylophyllum* sp. P, 9a: NHMW 1878/6/7654, neotype of *Celtis japeti* Unger, refigured from Kovar-Eder et al. (2004: pl. 8, fig. 7), 9b: NHMW Ett. 5652, counterpart of NHMW1878/6/7654; 10: NHMW 1878/6/7691.

11. *Dicotylophyllum* sp. U, NHMW 1878/6/8151.

12. *Dicotylophyllum* sp. T, NHMW 2021/0109/0002, b: detail.

13., 14. *Dicotylophyllum* sp. S, 13: NHMW Ett. 6364; 14a, b: NHMW 1878/6/2093, b: detail.

15.–17. *Dicotylophyllum* sp. V, 15: NHMW 1878/6/2702; 16a: NHMW 1878/6/2801, 16b: NHMW 1878/6/2800, part + counterpart; 17: NHMW 1878/6/7806.

18.–20. *Dicotylophyllum* sp. Q, 18: GBA 2005/0004/0046; 19: IBUG 12009; 20: NHMW 1878/6/8805.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 6

1. *Dicotylophyllum* sp. W, a and b are part and counterpart, a: NHMW 1878/6/2346a, b: NHMW 1878/6/9529.

2., 3. *Dicotylophyllum* sp. X, 2: IBUG 1271; 3: NHMW 1878/6/7787.

4. *Dicotylophyllum* sp. Y, IBUG 1410.

5. *Dicotylophyllum* sp. Z, IBUG 1471.

6. *Dicotylophyllum* sp. HH, GBA 2005/0004/0015.

7. *Dicotylophyllum* sp. CC, IBUG2052b, b: detail.

8. *Dicotylophyllum* sp. II, IBUG 1737.

9. *Dicotylophyllum* sp. FF, IBUG 742, b: detail.

10.–14. *Dicotylophyllum* sp. GG, 10a, b: IBUG 1577, b: detail; 11a, b: GBA 2005/0004/0083a, b: detail; 12: GBA 1848/0001/0101a; 13: IBUG 1993b; 14: IBUG 1599.

15. *Dicotylophyllum* sp. JJ, IBUG 1645.

16.–20. "*Juglans*" *parschlugiana* Unger, 16: GBA 2005/0004/0055; 17: GBA 2005/0004/0058; 18: NHMW 1878/6/8631; 19: GBA 2005/0004/0092; 20: GBA 2002/0001/0002.

21.–23. *Engelhardia orsbergensis* (P.Wessel et C.O.Weber) Jähnichen, Mai et H.Walther, 21: GBA 2002/0001/0100A; 22: NHMW 1878/6/2053a; 23: GBA 2005/0004/0064.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 7

1.–5. *Juglans* sp., 1: GBA 2005/0004/0089; 2: GBA 2005/0004/0087; 3: NHMW 1878/6/8467; 4: GBA 2005/0004/0094; 5: GBA 1848/0001/0099A.

6.–8. *Fraxinus* sp., 6: IBUG 1580; 7: IBUG 1617; 8: IBUG 1946.

9. *Myrica oehningensis* (A.Braun) Heer, NHMW 1878/6/9348, b: apical part of the same leaf.

10., 11. *Laurophyllum* sp., 10: IBUG 1484c; 11: IBUG 2347.

12.–16. *Mahonia* (?) *sphenophylla* (Unger) Doweld, 12: NHMW 1878/6/2381; 13: NHMW 1878/6/2031; 14: NHMW 1878/6/9497; 15: NHMW Ett. 642c; 16: GBA 1848/0001/0086.

17., 18. *Fagus* sp., 17a, b: NHMW 1878/6/2492 counterpart of Kovar-Eder et al. (2004: pl. 3. fig. 8), b: detail; 18: A *Fagus* sp., B *Dicotylophyllum* sp. L, GBA 2005/0004/0113.

19., 20. *Podocarpium podocarpum* (A.Braun) Herendeen, 19: GBA 2005/0004/0060; 20: GBA 2005/0004/0080.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 8

1. *Leguminophyllum* sp. A, GBA 2005/0004/0052a.

2., 3. *Leguminophyllum* sp. B, 2: IBUG 2207; 3: NHMW 1878/6/8794.

4. *Leguminophyllum* sp. C, GBA 2005/0004/0050.

5. *Leguminophyllum* sp. D, GBA 1848/0001/0040.

6., 7. *Leguminophyllum* sp. E, 6: IBUG 2132; 7: GBA 2005/0004/0004.

8. *Leguminophyllum* sp. H, IBUG 1948.

9. *Leguminophyllum* sp. I, IBUG 2311.

10., 12. *Leguminophyllum* sp. J, 10: GBA 2005/0004/0007; 12: GBA 2005/0004/0005.

11. cf. *Leguminophyllum* sp. J, GBA 2005/0004/00045.

13.–15. *Paliurus tiliifolius* (Unger) Bůžek, 13: GBA 2005/0004/0095B; 14: GBA 2005/0004/0095A; 15: IBUG 1843.

16., 17. *Populus latior* A.Braun, 16: NHMW 1878/6/9083; 17: NHMW 1878/6/7762.

18., 19. cf. *Rosa* sp., 18: NHMW 1878/6/2156; 19: GBA 2005/0004/0108A.

20.–22. *Prinsepia serra* (Unger) Kovar-Eder et Kvaček, 20: NHMW 1878/6/7500; 21: NHMW Ett. 660; 22: IBUG 2059.

23., 24. cf. *Prinsepia serra* (Unger) Kovar-Eder et Kvaček, 23: NHMW 1878/6/9119; 24: NHMW 1878/6/9440.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 9

1.–4. *Phaseolites securidacus* Unger, 1: IBUG 2307; 2: IBUG 1530; 3: GBA 2005/0004/0123; 4: GBA 2005/0004/0059.

5.–7. *Quercus* sp., 5: GBA 2005/0004/0100; 6: GBA 2005/0004/0101; 7: GBA 2005/0004/0105.

8.–11. *Quercus zoroastri* Unger, 8: IBUG 914; 9: IBUG 2859a; 10: GBA 1848/0001/0036 (bis); 11: GBA 2005/0004/0098.

12.–16. *Quercus mediterranea* Unger, 12: GBA 2005/0004/0032; 13: NHMW 2021/0109/0001; 14: IBUG 948a; 15: NHMW 1878/6/9421; 16: IBUG 920.

17., 18. ? *Quercus drymeja* Unger, 17: IBUG 12001; 18: GBA 2005/0004/0067.

19.–21. *Quercus drymeja* Unger, 19: GBA 2005/0004/0066; 20: GBA 1848/0001/0036 (bis); 21: IBUG 875.

22.–25. "*Quercus*" *daphnes* Unger, 22: NHMW 1878/6/8234; 23: NHMW 1845/39; 24: GBA 1847/0003/0010, cf. Unger (1847: pl. 31, fig. 4); 25: IBUG 779.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 10

1. *Toxicodendron melaenum* (Unger) Doweld vel *Ailanthus pythii* (Unger) Kovar-Eder et Kvaček, NHMW 1878/6/2029.

2. *Toxicodendron melaenum* (Unger) Doweld vel "*Celastrus*" *europaea* Unger, NHMW 1878/6/8160.

3.–9. *Toxicodendron melaenum* (Unger) Doweld, 3: cf. IBUG 2041; 4: IBUG 2989; 5: IBUG 1809; 6: GBA 2005/0004/0038; 7: GBA 2005/0004/0042; 8: IBUG 1942; 9: IBUG 2042.

10.–14. *Ternstroemites pereger* (Unger) Kovar-Eder et Kvaček, 10: NHMW 1878/6/9507; 11: GBA 2002/0001/0112; 12: NHMW Pb 2391a, counterpart of NHMW 1878/6/6555 figured by Kovar-Eder et al. (2004: pl. 15, fig. 3); 13: GBA 2005/0004/0121; 14: GBA 2002/0001/0109, figured as *Dicotylophyllum* sp. 2 by Kovar-Eder et al. (2004: pl. 15, fig. 2).

15. *Prinsepia serra* (Unger) Kovar-Eder et Kvaček, a: NHMW 1878/6/9528 (counterpart of NHMW 1878/6/7538 figured in Kovar-Eder et al. (2004: pl. 13, fig. 13), b: detail of NHMW 1878/6/7538, refigured for venation details from Kovar-Eder et al. (2004: pl. 13, fig. 13b).

16. Betulaceae vel Ulmaceae gen et sp. indet., NHMW 1878/6/9678.

17., 18. "*Juglans*" *parschlugiana* Unger, 17: NHMW 1878/6/7698; 18: NHMW 1878/6/8618.

19. "*Quercus*" *daphnes* Unger, IBUG 1641, b: detail.

For all figures the scale at bottom right of the plate is 10 mm except for figures with an embedded scale of 5 mm.

PLATE 1

PLATE 2

PLATE 3

PLATE 4
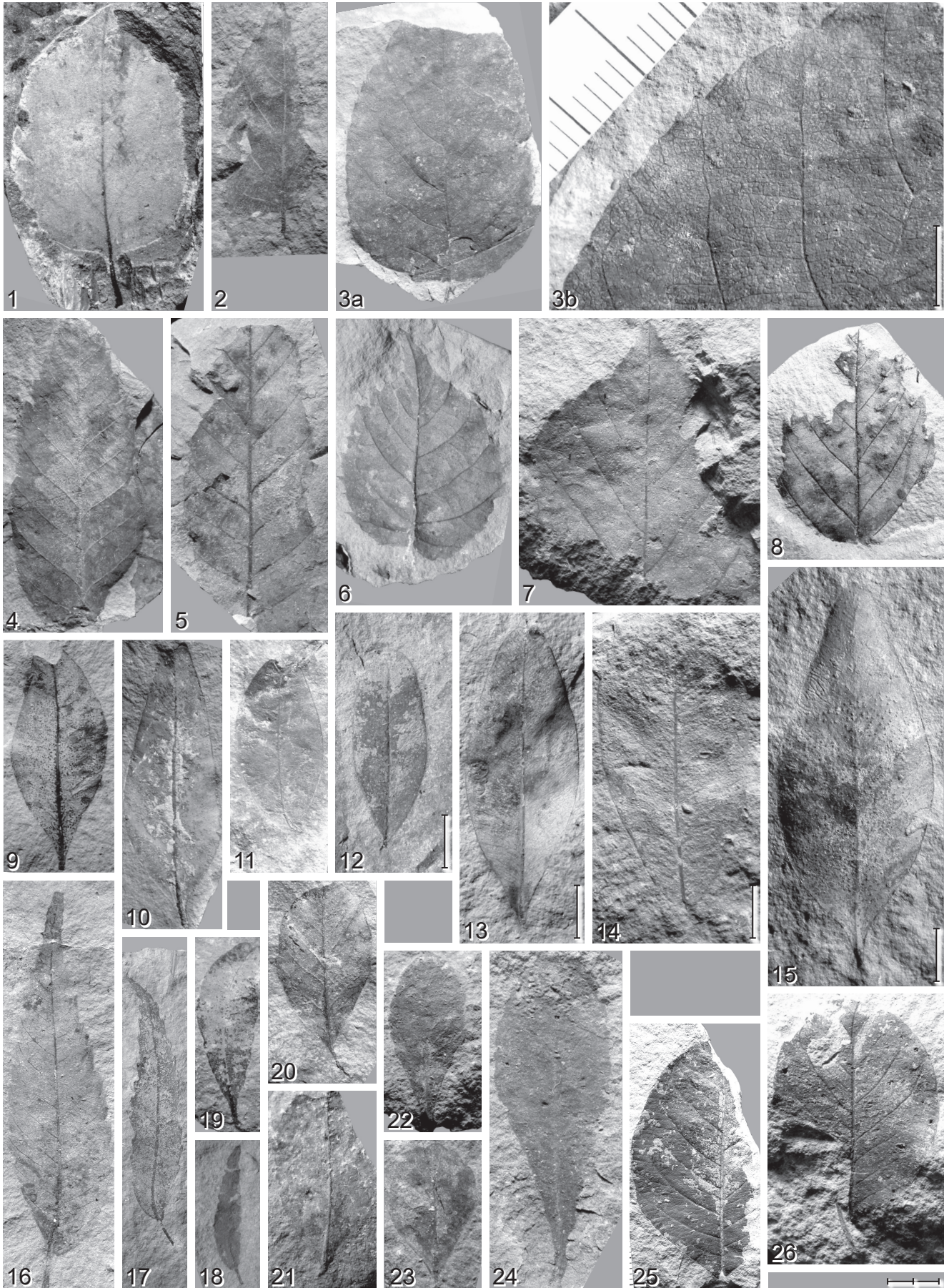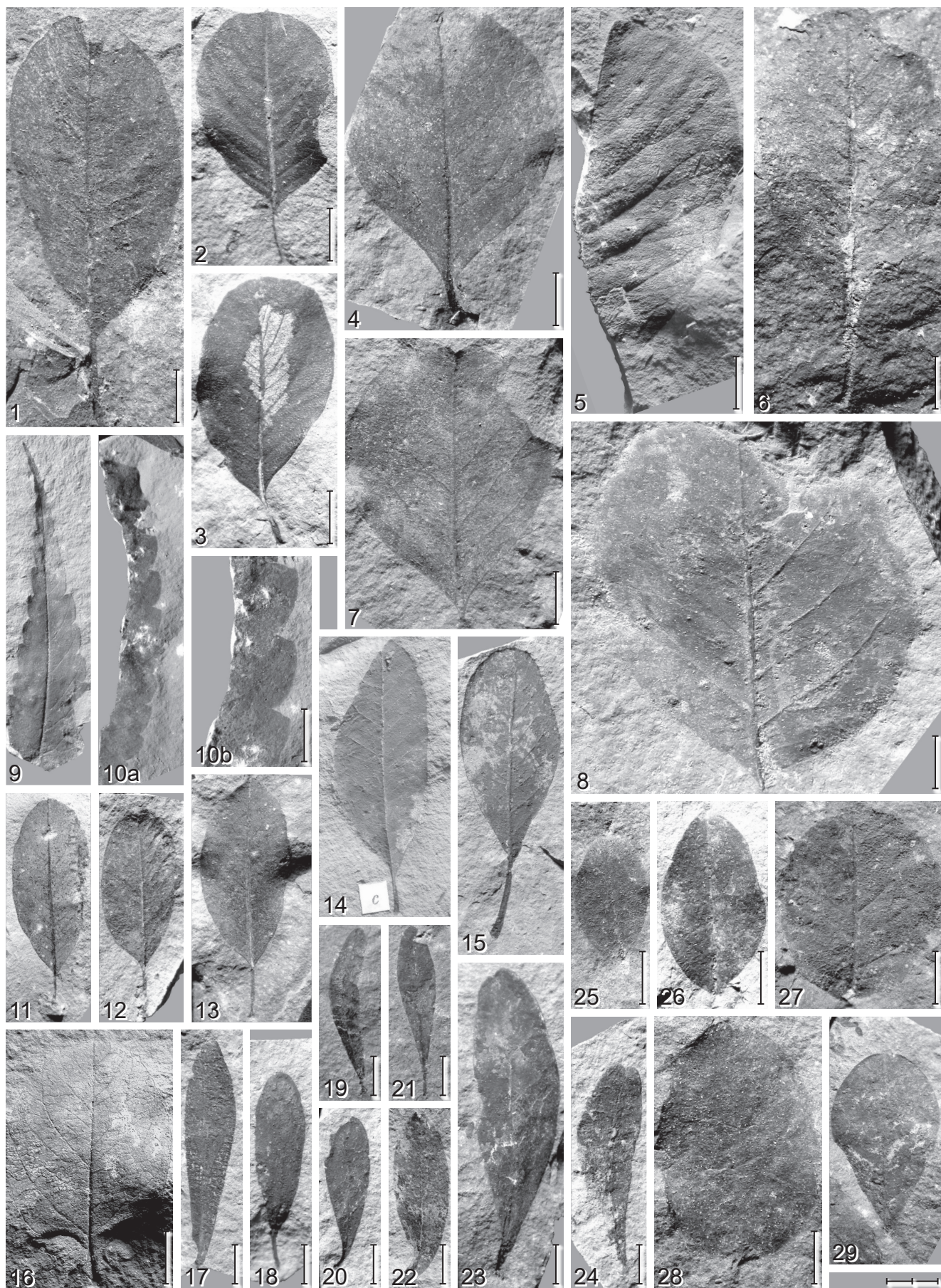
PLATE 5
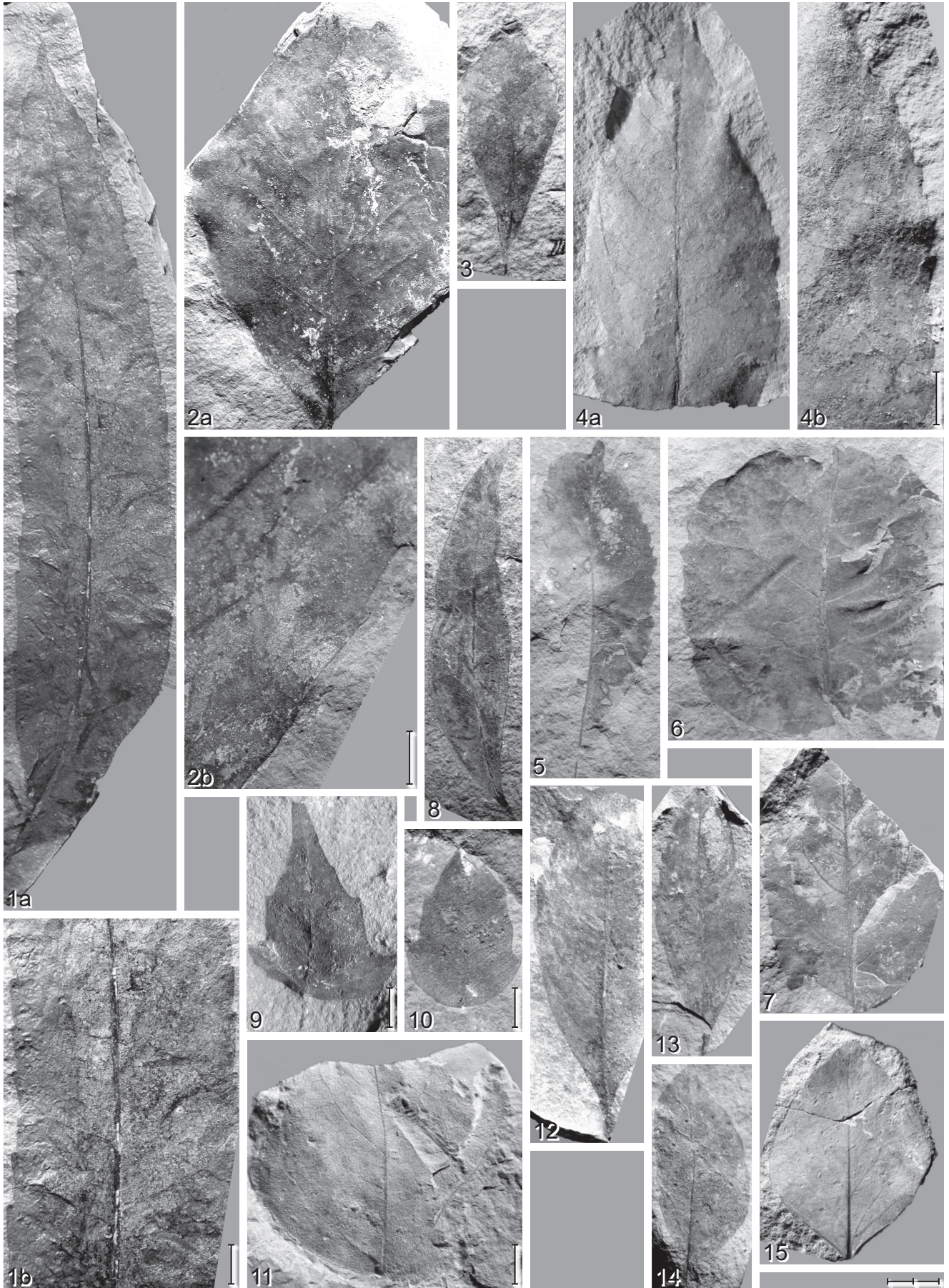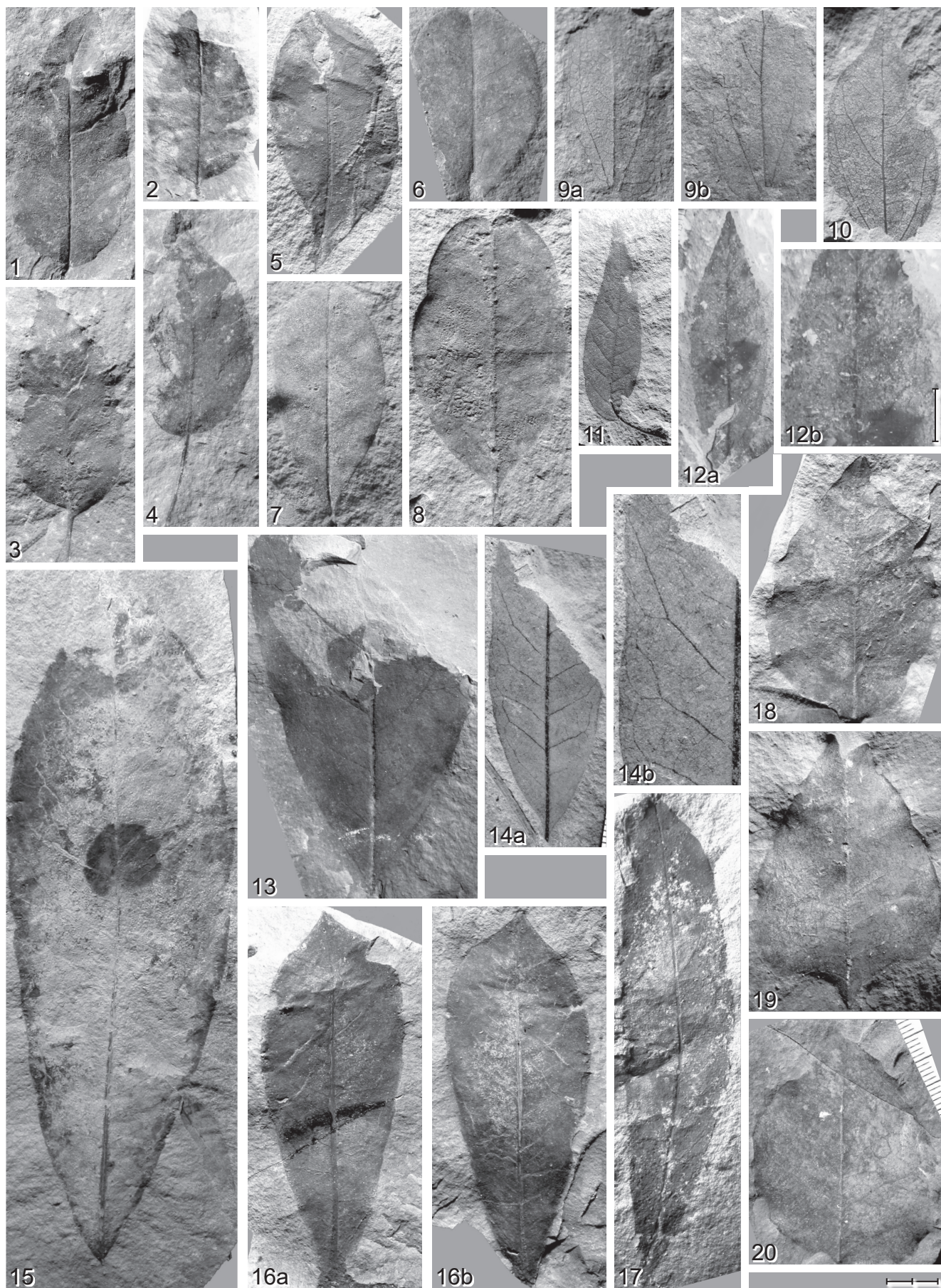
PLATE 6
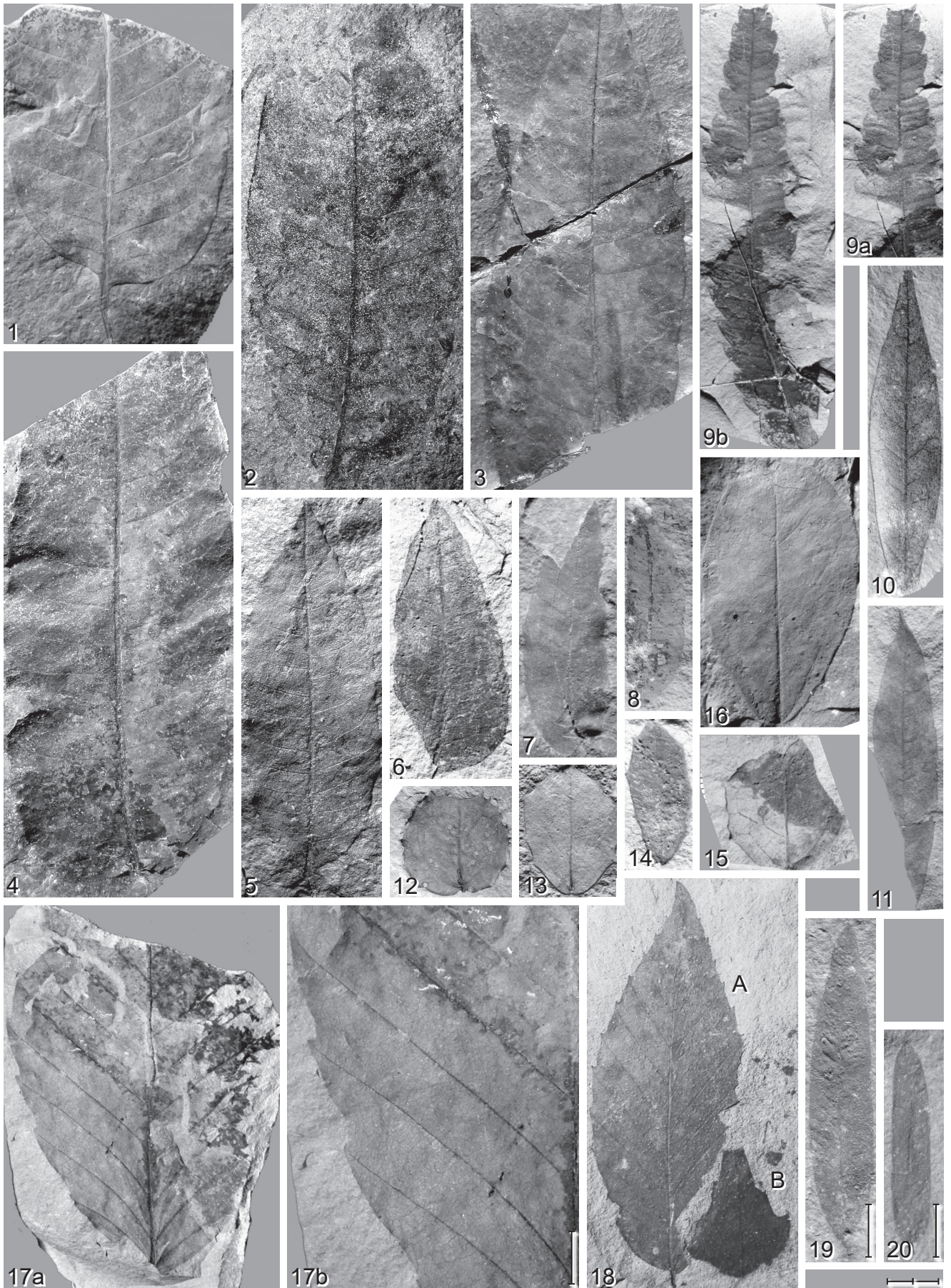
PLATE 7
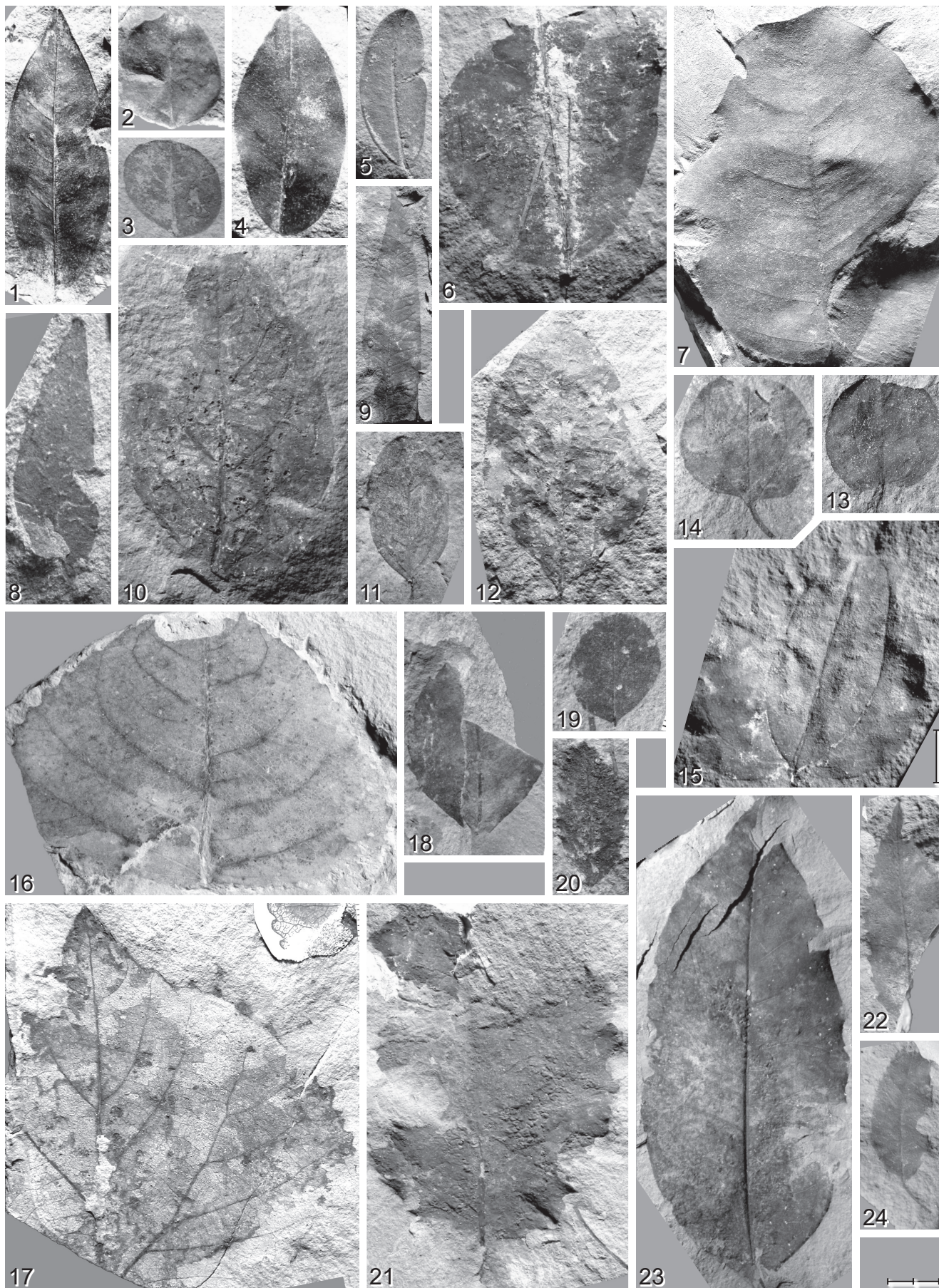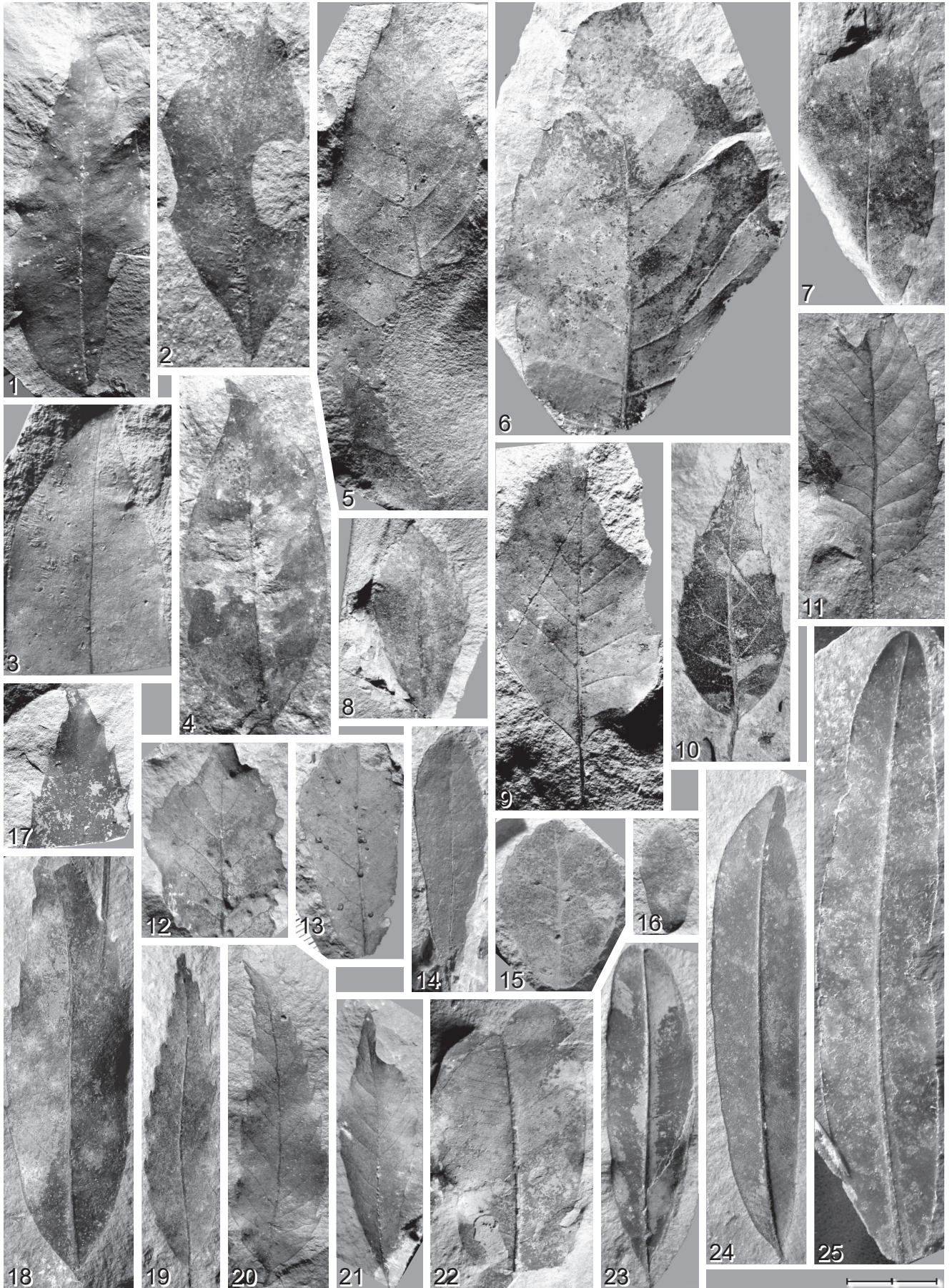
PLATE 8

PLATE 9

PLATE 10
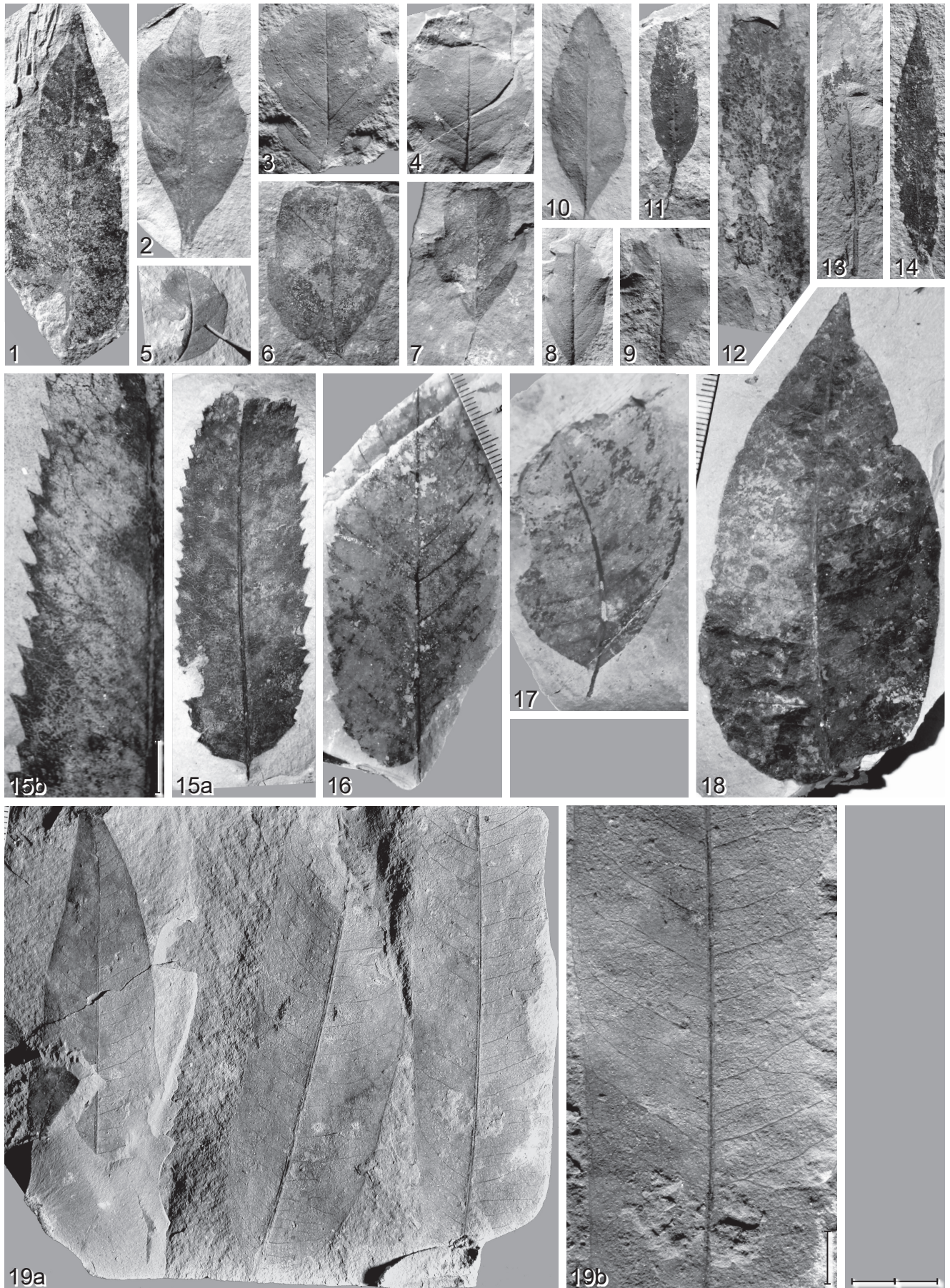
Appendix I

Integrated Plant Record (IPR) vegetation analysis assignments to components and results for Parschlug. Some morphotypes and taxa can be scored differently. "Variant 1 – this study" to "Variant 3 – this study" of scoring have been applied. There are only small differences in the results (see Table 1 for comparison) and all indicate "subhumid sclerophyllous forest" as the most likely zonal vegetation type suggesting robustness of that interpretation. The components are split into zonal and azonal categories. Zonal components are CONIFER, BLD (broad-leaved deciduous), BLE (broad-leaved evergreen), SCL (sclerophyllous), LEG (legume-like), ZONPALM (zonal palms), ARBFERN (arborescent ferns), DRY HERB (dry herbaceous), and MESO HERB (mesophytic herbaceous). Azonal components are AZONAL WOODY, AZONAL NON-WOODY, and AQUATIC. Taxa or morphotypes unassignable are scored as PROBLEMATIC TAXA.

Variant 1 – this study

Taxa	CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC	PROBLEMATIC TAXA	
"Acacia" parschlugiana					1.00									1.00
"Celastrus" europaea			0.50	0.50										1.00
"Cornus" ferox		1.00												1.00
"Juglans" parschlugiana			0.50		0.50									1.00
"Quercus" daphnes			1.00											1.00
? Cathaya sp.	1.00													1.00
? Chaneya sp.												1.00		1.00
? Cupressus sp.	1.00													1.00
? Gordonia oberdorfensis			1.00											1.00
Acer integrilobum		1.00												1.00
Acer pseudomonspessulanum		0.50		0.50										1.00
Acer tricuspidatum		0.25								0.75				1.00
Adiantum renatum							1.00							1.00
Ailanthus pythii / A. confucii		1.00												1.00
Alnus gaudinii		1.00												1.00
Alnus julianiformis		1.00												1.00
Antholithes stiriacus												1.00		1.00
Berberis ? notata				1.00										1.00
Berberis teutonica		0.25		0.75										1.00
Berchemia multinervis		1.00												1.00
Betula cf. dryadum		0.50								0.50				1.00
Betula vel Alnus sp.		1.00												1.00
Betulaceae gen. et sp. indet.		1.00												1.00
Betulaceae vel Ulmaceae gen. et sp. indet.		1.00												1.00
Buxus cf. egeriana			0.50	0.50										1.00
Cedrelospermum ulmifolium / C. stiriacum		0.50		0.50										1.00
Cotinus ? aizoon		0.33	0.33	0.33										0.99
Craigia bronnii		1.00												1.00
Cypselites sp.												1.00		1.00
Daphnogene polymorpha			1.00											1.00
Dicotylophyllum sp. 1		1.00												1.00
Dicotylophyllum sp. 3			0.33	0.33	0.33									0.99
Dicotylophyllum sp. 4		1.00												1.00
Dicotylophyllum sp. 5		1.00												1.00
Dicotylophyllum sp. 6		1.00												1.00

Name of fossil site	Parschlug													
		TAXONOMIC-PHYSIOGNOMIC COMPONENTS / GROUPS												
		ZONAL								AZONAL			PROBLEMATIC TAXA	
Taxa		CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC		
Dicotylophyllum sp. A			0.50	0.50											1.00
Dicotylophyllum sp. B			0.33	0.33	0.33										0.99
Dicotylophyllum sp. C				0.25	0.25	0.25					0.25				1.00
Dicotylophyllum sp. D				0.33	0.33	0.33									0.99
Dicotylophyllum sp. E				0.33	0.33	0.33									0.99
Dicotylophyllum sp. F				0.33	0.33	0.33									0.99
Dicotylophyllum sp. G			1.00												1.00
Dicotylophyllum sp. H			0.50			0.50									1.00
Dicotylophyllum sp. I			0.50	0.50											1.00
Dicotylophyllum sp. J				1.00											1.00
Dicotylophyllum sp. K			1.00												1.00
Dicotylophyllum sp. L			0.33	0.33	0.33										0.99
Dicotylophyllum sp. M			1.00												1.00
Dicotylophyllum sp. N			1.00												1.00
Dicotylophyllum sp. O				0.50	0.50										1.00
Dicotylophyllum sp. P			0.50		0.50										1.00
Dicotylophyllum sp. Q				1.00											1.00
Dicotylophyllum sp. R			1.00												1.00
Dicotylophyllum sp. S			0.50	0.50											1.00
Dicotylophyllum sp. T			0.50	0.50											1.00
Dicotylophyllum sp. U			0.50	0.50											1.00
Dicotylophyllum sp. V			0.50	0.50											1.00
Dicotylophyllum sp. W			1.00												1.00
Dicotylophyllum sp. X			1.00												1.00
Dicotylophyllum sp. Y				0.50		0.50									1.00
Dicotylophyllum sp. Z				0.50	0.50										1.00
Dicotylophyllum sp. CC			1.00												1.00
Dicotylophyllum sp. FF				0.33	0.33	0.33									0.99
Dicotylophyllum sp. GG					0.50	0.50									1.00
Dicotylophyllum sp. HH			0.50	0.50											1.00
Dicotylophyllum sp. II					0.50	0.50									1.00
Dicotylophyllum sp. JJ			0.50	0.50											1.00
Engelhardia orsbergensis / E. macroptera			0.50	0.50											1.00
Fagus sp. leaf / Fagus sp. cupule			1.00												1.00
Fraxinus sp. leaf / F. primigenia			0.50								0.50				1.00
Glyptostrobus europeaus											1.00				1.00
Juglans sp.			0.75								0.25				1.00
Laurophyllum sp.				1.00											1.00
Leguminophyllum sp. A						1.00									1.00
Leguminophyllum sp. B						1.00									1.00
Leguminophyllum sp. C						1.00									1.00
Leguminophyllum sp. D						1.00									1.00
Leguminophyllum sp. E						1.00									1.00
Leguminophyllum sp. H						1.00									1.00
Leguminophyllum sp. I						1.00									1.00
Leguminophyllum sp. J				0.50		0.50									1.00

Name of fossil site	Parschlug													
		TAXONOMIC-PHYSIOGNOMIC COMPONENTS / GROUPS												
		ZONAL								AZONAL				
Taxa	CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC	PROBLEMATIC TAXA	
Leguminosites dionysi					1,00									1,00
Leguminosites hesperidum					1,00									1,00
Leguminosites palaeogaeus					1.00									1.00
Leguminosites parschlugianus					1.00									1.00
Liquidambar europaea / Liquidambar sp.		0.75								0.75				1.50
Mahonia ? sphenophylla				1.00										1.00
Monocotyledoneae gen. et sp. indet.											1.00			1.00
Myrica lignitum										1.00				1.00
Myrica oehningensis / Myrica sp. fructus		1.00												1.00
Nerium sp.			0.50	0.50										1.00
Osmunda parschlugiana											1.00			1.00
Paliurus tiliifolius / Paliurus favonii		0.50		0.50										1.00
Phaseolites securidacus			0.50		0.50									1.00
Pinus sp. 1	1.00													1.00
Pinus sp. 2	1.00													1.00
Pinus sp. 3	1.00													1.00
Platanus leucophylla		1.00												1.00
Podocarpium podocarpum					1.00									1.00
Populus latior		0.50								0.50				1.00
Populus sp. fructus		0.00								0.00				0.00
Prinsepia serra / Prinsepia sp.		0.50		0.50										1.00
Pronephrium stiriacum											1.00			1.00
Quercus drymeja		0.33	0.33	0.33										0.99
Quercus mediterranea				1.00										1.00
Quercus zoroastri		0.33	0.33	0.33										0.99
cf. *Rosa* sp.		0.33		0.33						0.33				0.99
Salvinia cf. *mildeana*												1.00		1.00
Saportaspermum sp.													1.00	1.00
Smilax sagittifera			1.00											1.00
Ternstroemites pereger			0.50	0.50										1.00
Tilia longebracteata		1.00												1.00
Toxicodendron melaenum		1.00												1.00
Ulmus parschlugiana / U. plurinervia				0.50						0.50				1.00
Zelkova zelkovifolia		0.33		0.33						0.33				0.99
														114.38
Sum of taxa	5.00	40.31	19.55	14.96	18.90	0.00	0.00	0.00	1.00	6.66	3.00	1.00	4.00	114.38
Sum zonal taxa														99.72
Percentage of zonal taxa	5.01	40.42	19.60	15.00	18.95	0.00	0.00	0.00	1.00					100.00
Sum zonal woody angiosperms														93.72
percentage of zonal woody angiosperms		43.01	20.86	15.96	20.17	0.00								100.00
Sum of % SCL+ LEG	36.13													
Sum of % DRY HERB + MESO HERB (ZONAL HERB)	1.00													

Variant 2 – this study

Name of fossil site	Parschlug	TAXONOMIC-PHYSIOGNOMIC COMPONENTS / GROUPS												
		ZONAL								AZONAL			PROBLEMATIC TAXA	
Taxa		CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC		
"Acacia" parschlugiana						1.00									1.00
"Celastrus" europaea				0.50	0.50										1.00
"Cornus" ferox			1.00												1.00
"Juglans" parschlugiana				0.50		0.50									1.00
"Quercus" daphnes				1.00											1.00
? Cathaya sp.		1.00													1.00
? Chaneya sp.														1.00	1.00
? Cupressus sp.		1.00													1.00
? Gordonia oberdorfensis				1.00											1.00
Acer integrilobum			1.00												1.00
Acer pseudomonspessulanum			0.50		0.50										1.00
Acer tricuspidatum			0.25								0.75				1.00
Adiantum renatum										1.00					1.00
Ailanthus pythii / A. confucii			1.00												1.00
Alnus gaudinii			1.00												1.00
Alnus julianiformis			1.00												1.00
Antholithes stiriacus														1.00	1.00
Berberis ? ambigua					1.00										1.00
Berberis teutonica			0.25		0.75										1.00
Berchemia multinervis			1.00												1.00
Betula cf. dryadum			0.50								0.50				1.00
Betula vel Alnus sp.			1.00												1.00
Betulaceae gen. et sp. indet.			1.00												1.00
Betulaceae vel Ulmaceae gen. et sp. indet.			1.00												1.00
Buxus cf. egeriana				0.50	0.50										1.00
Cedrelospermum ulmifolium / C. stiriacum			0.50		0.50										1.00
Cotinus ? aizoon			0.33	0.33	0.33										0.99
Craigia bronnii			1.00												1.00
Cypselites sp.														1.00	1.00
Daphnogene polymorpha				1.00											1.00
Dicotylophyllum sp. 1			1.00												1.00
Dicotylophyllum sp. 3				0.33	0.33	0.33									0.99
Dicotylophyllum sp. 4			1.00												1.00
Dicotylophyllum sp. 5			1.00												1.00
Dicotylophyllum sp. 6			1.00												1.00
Dicotylophyllum sp. A			0.50	0.50											1.00
Dicotylophyllum sp. B			0.33	0.33	0.33										0.99
Dicotylophyllum sp. C				0.25	0.25	0.25					0.25				1.00
Dicotylophyllum sp. D				0.33	0.33	0.33									0.99
Dicotylophyllum sp. E				0.33	0.33	0.33									0.99
Dicotylophyllum sp. F				0.33	0.33	0.33									0.99
Dicotylophyllum sp. G			1.00												1.00
Dicotylophyllum sp. H			0.50			0.50									1.00
Dicotylophyllum sp. I			0.50	0.50											1.00

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Name of fossil site	Parschlug													
		TAXONOMIC-PHYSIOGNOMIC COMPONENTS / GROUPS												
		ZONAL								AZONAL			PROBLEMATIC TAXA	
Taxa		CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC	
Dicotylophyllum sp. J				1.00											1.00
Dicotylophyllum sp. K			1.00												1.00
Dicotylophyllum sp. L			0.33	0.33	0.33										0.99
Dicotylophyllum sp. M			1.00												1.00
Dicotylophyllum sp. N			1.00												1.00
Dicotylophyllum sp. O				0.50	0.50										1.00
Dicotylophyllum sp. P			0.50		0.50										1.00
Dicotylophyllum sp. Q				1.00											1.00
Dicotylophyllum sp. R			1.00												1.00
Dicotylophyllum sp. S			0.50	0.50											1.00
Dicotylophyllum sp. T			0.50	0.50											1.00
Dicotylophyllum sp. U			0.50	0.50											1.00
Dicotylophyllum sp. V			0.50	0.50											1.00
Dicotylophyllum sp. W			1.00												1.00
Dicotylophyllum sp. X			1.00												1.00
Dicotylophyllum sp. Y				0.50		0.50									1.00
Dicotylophyllum sp. Z				0.50	0.50										1.00
Dicotylophyllum sp. CC			1.00												1.00
Dicotylophyllum sp. FF				0.33	0.33	0.33									0.99
Dicotylophyllum sp. GG					0.50	0.50									1.00
Dicotylophyllum sp. HH			0.50	0.50											1.00
Dicotylophyllum sp. II					0.50	0.50									1.00
Dicotylophyllum sp. JJ			0.50	0.50											1.00
Engelhardia orsbergensis / *E. macroptera*			0.50	0.50											1.00
Fagus sp. leaf / *Fagus* sp. cupule			1.00												1.00
Fraxinus sp. leaf / *F. primigenia*			0.50								0.50				1.00
Glyptostrobus europeaus											1.00				1.00
Juglans sp.			0.75								0.25				1.00
Laurophyllum sp.				1.00											1.00
Leguminophyllum sp. A						1.00									1.00
Leguminophyllum sp. B						1.00									1.00
Leguminophyllum sp. C						1.00									1.00
Leguminophyllum sp. D						1.00									1.00
Leguminophyllum sp. E						1.00									1.00
Leguminophyllum sp. H			0.50			0.50									1.00
Leguminophyllum sp. I			0.50			0.50									1.00
Leguminophyllum sp. J				0.50		0.50									1.00
Leguminosites dionysi						1.00									1.00
Leguminosites hesperidum						1.00									1.00
Leguminosites palaeogaeus						1.00									1.00
Leguminosites parschlugianus						1.00									1.00
Liquidambar europaea / *Liquidambar* sp.			0.75								0.75				1.50

Taxa	CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC	PROBLEMATIC TAXA	
														Parschlug
Mahonia ? sphenophylla				1.00										1.00
Monocotyledoneae gen. et sp. indet.											1.00			1.00
Myrica lignitum										1.00				1.00
Myrica oehningensis / Myrica sp. fructus		1.00												1.00
Nerium sp.			0.50	0.50										1.00
Osmunda parschlugiana											1.00			1.00
Paliurus tiliifolius / Paliurus favonii		0.50		0.50										1.00
Phaseolites securidacus			0.50		0.50									1.00
Pinus sp. 1	1.00													1.00
Pinus sp. 2	1.00													1.00
Pinus sp. 3	1.00													1.00
Platanus leucophylla		1.00												1.00
Podocarpium podocarpum					1.00									1.00
Populus latior		0.50								0.50				1.00
Populus sp. fructus		0.00								0.00				0.00
Prinsepia serra / Prinsepia sp.		0.50		0.50										1.00
Pronephrium stiriacum											1.00			1.00
Quercus drymeja		0.33	0.33	0.33										0.99
Quercus mediterranea				1.00										1.00
Quercus zoroastri		0.33	0.33	0.33										0.99
cf. *Rosa* sp.		0.33		0.33						0.33				0.99
Salvinia cf. *mildeana*												1.00		1.00
Saportaspermum sp.													1.00	1.00
Smilax sagittifera			1.00											1.00
Ternstroemites pereger			0.50	0.50										1.00
Tilia longebracteata		1.00												1.00
Toxicodendron melaenum		1.00												1.00
Ulmus parschlugiana / U. plurinervia				0.50						0.50				1.00
Zelkova zelkovifolia		0.33		0.33						0.33				0.99
														114.38
Sum of taxa	5.00	41.31	20.05	14.96	17.40	0.00	0.00	0.00	1.00	6.66	3.00	1.00	4.00	114.38
Sum zonal taxa														99.72
Percentage of zonal taxa	5.01	41.43	20.11	15.00	17.45	0.00	0.00	0.00	1.00					100.00
Sum zonal woody angiosperms														93.72
percentage of zonal woody angiosperms		44.08	21.39	15.96	18.57	0.00								100.00
Sum of % SCL+ LEG	34.53													
Sum of % DRY HERB + MESO HERB (ZONAL HERB)	1.00													

Variant 3 – this study

Name of fossil site	Parschlug													
		TAXONOMIC-PHYSIOGNOMIC COMPONENTS / GROUPS												
		ZONAL									AZONAL			
Taxa	CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC	PROBLEMATIC TAXA	
"Acacia" parschlugiana					1.00									1.00
"Celastrus" europaea			0.50	0.50										1.00
"Cornus" ferox		1.00												1.00
"Juglans" parschlugiana			0.50		0.50									1.00
"Quercus" daphnes			1.00											1.00
? Cathaya sp.	1.00													1.00
? Chaneya sp.													1.00	1.00
? Cupressus sp.	1.00													1.00
? Gordonia oberdorfensis			1.00											1.00
Acer integrilobum		1.00												1.00
Acer pseudomonspessulanum		0.50		0.50										1.00
Acer tricuspidatum		0.25								0.75				1.00
Adiantum renatum									1.00					1.00
Ailanthus pythii / A. confucii		1.00												1.00
Alnus gaudinii		1.00												1.00
Alnus julianiformis		1.00												1.00
Antholithes stiriacus												1.00		1.00
Berberis ? ambigua				1.00										1.00
Berberis teutonica		0.25		0.75										1.00
Berchemia multinervis		1.00												1.00
Betula cf. dryadum		0.50								0.50				1.00
Betula vel Alnus sp.		1.00												1.00
Betulaceae gen. et sp. indet.		1.00												1.00
Betulaceae vel Ulmaceae gen. et sp. indet.		1.00												1.00
Buxus cf. egeriana			0.50	0.50										1.00
Cedrelospermum ulmifolium / C. stiriacum		0.50		0.50										1.00
Cotinus ? aizoon		0.33	0.33	0.33										0.99
Craigia bronnii		1.00												1.00
Cypselites sp.												1.00		1.00
Daphnogene polymorpha			1.00											1.00
Dicotylophyllum sp. 1		1.00												1.00
Dicotylophyllum sp. 3			0.33	0.33	0.33									0.99
Dicotylophyllum sp. 4		1.00												1.00
Dicotylophyllum sp. 5		1.00												1.00
Dicotylophyllum sp. 6		1.00												1.00
Dicotylophyllum sp. A		0.33	0.33	0.33										0.99
Dicotylophyllum sp. B		0.33	0.33	0.33										0.99
Dicotylophyllum sp. C			0.25	0.25	0.25					0.25				1.00
Dicotylophyllum sp. D			0.33	0.33	0.33									0.99
Dicotylophyllum sp. E			0.33	0.33	0.33									0.99
Dicotylophyllum sp. F			0.33	0.33	0.33									0.99
Dicotylophyllum sp. G		1.00												1.00
Dicotylophyllum sp. H		0.50			0.50									1.00
Dicotylophyllum sp. I		0.33	0.33	0.33										0.99
Dicotylophyllum sp. J		0.50	0.50											1.00

Name of fossil site	Parschlug												
		TAXONOMIC-PHYSIOGNOMIC COMPONENTS / GROUPS											
		ZONAL								AZONAL			
Taxa	CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC	PROBLEMATIC TAXA
Dicotylophyllum sp. K		1.00											1.00
Dicotylophyllum sp. L		0.33	0.33	0.33									0.99
Dicotylophyllum sp. M		0.50	0.50										1.00
Dicotylophyllum sp. N		1.00											1.00
Dicotylophyllum sp. O			0.50	0.50									1.00
Dicotylophyllum sp. P		0.50		0.50									1.00
Dicotylophyllum sp. Q		0.50	0.50										1.00
Dicotylophyllum sp. R		1.00											1.00
Dicotylophyllum sp. S		0.50	0.50										1.00
Dicotylophyllum sp. T		0.50	0.50										1.00
Dicotylophyllum sp. U		0.50	0.50										1.00
Dicotylophyllum sp. V		0.50	0.50										1.00
Dicotylophyllum sp. W		1.00											1.00
Dicotylophyllum sp. X		1.00											1.00
Dicotylophyllum sp. Y			0.50		0.50								1.00
Dicotylophyllum sp. Z		0.33	0.33	0.33									0.99
Dicotylophyllum sp. CC		1.00											1.00
Dicotylophyllum sp. FF			0.50	0.50									1.00
Dicotylophyllum sp. GG			0.50	0.50									1.00
Dicotylophyllum sp. HH		0.50	0.50										1.00
Dicotylophyllum sp. II			0.50	0.50									1.00
Dicotylophyllum sp. JJ		0.50	0.50										1.00
Engelhardia orsbergensis / E. macroptera		0.50	0.50										1.00
Fagus sp. leaf / *Fagus* sp. cupule		1.00											1.00
Fraxinus sp. leaf / *F. primigenia*		0.50								0.50			1.00
Glyptostrobus europeaus										1.00			1.00
Juglans sp.		0.75								0.25			1.00
Laurophyllum sp.			1.00										1.00
Leguminophyllum sp. A			0.50		0.50								1.00
Leguminophyllum sp. B					1.00								1.00
Leguminophyllum sp. C			0.50		0.50								1.00
Leguminophyllum sp. D				0.50	0.50								1.00
Leguminophyllum sp. E		0.50			0.50								1.00
Leguminophyllum sp. H		0.50			0.50								1.00
Leguminophyllum sp. I		0.33	0.33		0.33								0.99
Leguminophyllum sp. J			0.50		0.50								1.00
Leguminosites dionysi					1.00								1.00
Leguminosites hesperidum					1.00								1.00
Leguminosites palaeogaeus					1.00								1.00
Leguminosites parschlugianus					1.00								1.00
Liquidambar europaea / Liquidambar sp.		0.75								0.75			1.50
Mahonia ? sphenophylla				1.00									1.00

Taxa	Parschlug CONIFER	BLD	BLE	SCL	LEG	ZONPALM	ARBFERN	DRY HERB	MESO HERB	AZONAL WOODY	AZONAL NON-WOODY	AQUATIC	PROBLEMATIC TAXA	
Monocotyledoneae gen. et sp. indet.											1.00			1.00
Myrica lignitum										1.00				1.00
Myrica oehningensis / Myrica sp. fructus		1.00												1.00
Nerium sp.			0.50	0.50										1.00
Osmunda parschlugiana											1.00			1.00
Paliurus tiliifolius / Paliurus favonii		0.50		0.50										1.00
Phaseolites securidacus			0.50		0.50									1.00
Pinus sp. 1	1.00													1.00
Pinus sp. 2	1.00													1.00
Pinus sp. 3	1.00													1.00
Platanus leucophylla		1.00												1.00
Podocarpium podocarpum					1.00									1.00
Populus latior		0.50								0.50				1.00
Populus sp. fructus		0.00								0.00				0.00
Prinsepia serra / Prinsepia sp.		0.50		0.50										1.00
Pronephrium stiriacum											1.00			1.00
Quercus drymeja		0.33	0.33	0.33										0.99
Quercus mediterranea				1.00										1.00
Quercus zoroastri		0.33	0.33	0.33										0.99
cf. *Rosa* sp.		0.33		0.33						0.33				0.99
Salvinia cf. *mildeana*												1.00		1.00
Saportaspermum sp.													1.00	1.00
Smilax sagittifera		1.00												1.00
Ternstroemites pereger			0.50	0.50										1.00
Tilia longebracteata		1.00												1.00
Toxicodendron melaenum		1.00												1.00
Ulmus parschlugiana / U. plurinervia				0.50						0.50				1.00
Zelkova zelkovifolia		0.33		0.33						0.33				0.99
														114.35
Sum of taxa	5.00	42.13	21.54	16.12	13.90	0.00	0.00	0.00	1.00	6.66	3.00	1.00	4.00	114.35
Sum zonal taxa														99.69
Percentage of zonal taxa	5.02	42.26	21.61	16.17	13.94	0.00	0.00	0.00	1.00					100.00
Sum zonal woody angiosperms														93.69
percentage of zonal woody angiosperms		44.97	22.99	17.21	14.84	0.00								100.00
Sum of % SCL+ LEG	32.04													
Sum of % DRY HERB + MESO HERB (ZONAL HERB)	1.00													

Appendix II

Modern vegetation proxies as delivered by the similarity approaches based on applying the Drudges 1 and 2 tools. "Proxies delivered" shows the total number of hits for each vegetation unit within a given European vegetation formation or East Asian vegetation type in each approach. (Only the units which received similarity hits are listed.) In "Proxy Summary Text-fig. 1" the proxy units are summarised at the level of European vegetation formations and Asian vegetation types. For methodological details see Teodoridis et al. (2020) and Kovar-Eder et al. (2021).

Proxies delivered

European vegetation formation/East Asian vegetation type	Unit	Parschlug (Kovar-Eder et al. 2021)	Variant 1 (this study)	Variant 2 (this study)	Variant 3 (this study)	Sum variants 1–3 (this study)
Meili Snow Mt. high altitude SCL and BLF, China	China 12	0	1	1	1	3
	China 13	1	1	1	1	3
	China 14	0	1	1	1	3
	sum	**1**	**3**	**3**	**3**	**9**
BLEF China, Japan	China 38	1	1	1	1	3
	sum	**1**	**1**	**1**	**1**	**3**
MMF China	China 59	0	0	1	1	2
	China 60	2	1	1	1	3
	sum	**2**	**1**	**2**	**2**	**5**
BLDF Upper Yangtze, Honshu	China 67	1	1	1	1	3
	Japan 01	1	0	0	0	0
	Japan 05	1	1	1	1	3
	sum	**3**	**2**	**2**	**2**	**6**
BLDF N and NE Provinces, China	China 68	2	2	2	2	6
	sum	**2**	**2**	**2**	**2**	**6**
MCF China, Japan	China 81	2	1	1	1	3
	Japan 06	1	1	1	1	3
	sum	**3**	**2**	**2**	**2**	**6**
Formation K	K015	1	0	1	1	2
	K022	1	1	1	1	3
	K027	0	1	0	0	1
	sum	**2**	**2**	**2**	**2**	**6**
Formation J	J009	0	1	0	0	1
	sum	**0**	**1**	**0**	**0**	**1**
Formation G	G030	1	0	1	1	2
	G032	1	1	1	1	3
	G043	1	0	0	0	0
	G063	0	1	0	0	1
	G071	1	1	1	1	3
	G072	1	2	1	1	4
	G074	1	0	0	1	1
	sum	**6**	**5**	**4**	**5**	**14**
Formation F	F025	0	1	1	0	2
	F098	1	1	1	0	2
	sum	**1**	**2**	**2**	**0**	**4**
Formation D	D016	0	0	1	1	2
	D042	1	1	1	1	3
	D052	1	0	0	0	0
	D064	1	2	2	2	6
	sum	**3**	**3**	**4**	**4**	**11**
Formation C	C020	0	0	0	1	1
	C039	0	1	1	1	3
	C046	1	0	0	0	0
	sum	**1**	**1**	**1**	**2**	**4**

Proxy summary Text-fig. 1

European vegetation formation/East Asian vegetation type	Kovar-Eder et al. (2021)	Variant 1 (this study)	Variant 2 (this study)	Variant 3 (this study)
Meili Snow Mt. high altitude SCL and BLF, China	1	3	3	3
BLEF China, Japan	1	1	1	1
MMF China	2	1	2	2
BLDF Upper Yangtze, Honshu	3	2	2	2
BLDF N and NE Provinces, China	2	2	2	2
MCF China, Japan	3	2	2	2
Formation K	2	2	2	2
Formation J	0	1	0	0
Formation G	6	5	4	5
Formation F	1	2	2	0
Formation D	3	3	4	4
Formation C	1	1	1	2

Appendix III

Percentage scores for the foliar physiognomic characters of Parschlug derived from CLAMP character scoring.

Foliar Physiognomic Characters [%]		Parschlug
Margin Character States	Lobed	5.75
	No Teeth	52.87
	Teeth Regular	44.25
	Teeth Close	20.40
	Teeth Round	17.30
	Teeth Acute	29.25
	Teeth Compound	0.29
Size Character States	Nanophyll	0.57
	Leptophyll I	0.57
	Leptophyll II	1.49
	Microphyll I	20.29
	Microphyll II	40.86
	Microphyll III	29.66
	Mesophyll I	5.40
	Mesophyll II	1.15
	Mesophyll III	0.00
Apex Character States	Apex Emarginate	3.33
	Apex Round	31.38
	Apex Acute	44.54
	Apex Attenuate	20.75
Base Character States	Base Cordate	5.52
	Base Round	28.16
	Base Acute	66.32
Length to Width Character States	L:W < 1:1	5.75
	L:W 1-2:1	20.06
	L:W 2-3:1	26.90
	L:W 3-4:1	36.72
	L:W > 4:1	10.57
Shape Character States	Obovate	13.68
	Elliptic	49.54
	Ovate	36.78

Appendix IV

An updated version of the statistical tool determining the most appropriate calibration dataset based on the similarities (i.e., minimum difference MIN DIFFi) of the fossil (studied) and modern (calibration) leaf physiognomic characteristics, i.e., 144 (Physg3br), 173 (Physg3ar), 189 (PhysgAsia1), Asia 2 (177, PhysgAsia2) and Global (378, PhysgGlobal) modern calibration sets (Spicer et al. 2009, Jacques et al. 2011, Khan et al. 2014, Yang et al. 2015).

For the updated "copy & paste" Excel application see Appendix V.

The following text explains the details of the updated version of the statistical tool to determine the most appropriate calibration dataset based on the similarities (i.e., minimum difference MIN DIFFi) of the fossil (studied) and modern (calibration) leaf physiognomic characteristics from the 144 (Physg3br), 173 (Physg3ar), 189 (PhysgAsia1), Asia 2 (177, PhysgAsia2) and Global (378, PhysgGlobal) modern calibration sets (Spicer et al. 2009, Jacques et al. 2011, Khan et al. 2014, Yang et al. 2015). The process to determine the most appropriate calibration dataset is as follows:

(A) Calculate means for all foliar physiognomic characteristics for the 144 modern sites (MEAN144) in the 144 calibration dataset. Those 144 sites are also included in the calibration datasets of 173, 189 (Asia 1), 177 (Asia 2) and 378 (Global) sites.

(B) Calculate means for the remaining 29 modern sites (MEAN 29), i.e., difference between 173 and 144 calibration datasets.

(C) Calculate means for the remaining 45 modern sites (MEAN 45), i.e., difference between 189 (Asia1) and 144 calibration datasets.

(D) Calculate means for the remaining 33 modern sites (MEAN 33), i.e., difference between 177 (Asia2) and 144 calibration datasets.

(E) Calculate means for the remaining 234 modern sites (MEAN 234), i.e., difference between 378 (Global) and 144 calibration datasets.

(F) Take the values for the foliar physiognomic characteristics of the studied fossils (OUR) – see Appendix III.

(G) Find maximal difference between foliar physiognomic characteristics of studied fossils (OUR – step (F) above) and mean of modern sites (MEAN 144, MEAN 29, MEAN 45, MEAN 33 and MEAN 234 from steps (A)-(E) above) in absolute value:

$$\text{MAX}=\text{MAX}(\text{ABS}(\text{OUR-MEAN 144}),\text{ABS}(\text{OUR-MEAN 29})),\text{ABS}(\text{OUR-MEAN 45}),\text{ABS}(\text{OUR-MEAN 33}),\text{ABS}(\text{OUR-MEAN 234}))$$

For each foliar physiognomic characteristic:

(a) $DIFF144_i = \dfrac{\text{ABS(OUR-MEAN 144)}}{\text{MAX}}$,

(b) $DIFF29_i = \dfrac{\text{ABS(OUR-MEAN 29)}}{\text{MAX}}$,

(c) $DIFF45_i = \dfrac{\text{ABS(OUR-MEAN 45)}}{\text{MAX}}$,

(d) $DIFF33_i = \dfrac{\text{ABS(OUR-MEAN 33)}}{\text{MAX}}$,

(e) $DIFF234_i = \dfrac{\text{ABS(OUR-MEAN 234)}}{\text{MAX}}$,

where i=1 to 31 is a foliar physiognomic characteristic and MAX is maximal difference between foliar physiognomic characteristic of studied fossils and the mean of the modern sites (step (G) above).

If MIN($\sum($ DIFF144$_i$),$\sum($ DIFF29$_i$), $\sum($ DIFF45$_i$), $\sum($ DIFF33$_i$), $\sum($ DIFF234$_i$)) = $\sum($ DIFF144$_i$) then OUR site is closer to the mean calculated from 144 sites and the 144 dataset should be used;

If MIN($\sum($ DIFF144$_i$),$\sum($ DIFF29$_i$), $\sum($ DIFF45$_i$), $\sum($ DIFF33$_i$), $\sum($ DIFF234$_i$)) = $\sum($ DIFF29$_i$) then OUR site is closer to the mean calculated from 173 sites and the 173 dataset should be used;

If MIN($\sum($ DIFF144$_i$),$\sum($ DIFF29$_i$), $\sum($ DIFF45$_i$), $\sum($ DIFF33$_i$), $\sum($ DIFF234$_i$)) = $\sum($ DIFF45$_i$) then OUR site is closer to the mean calculated from 189 sites and the 189 (ASIA 1) dataset should be used;

If MIN($\sum($ DIFF144$_i$),$\sum($ DIFF29$_i$), $\sum($ DIFF45$_i$), $\sum($ DIFF33$_i$), $\sum($ DIFF234$_i$)) = $\sum($ DIFF33$_i$) then OUR site is closer to the mean calculated from 177 sites and the 177 (ASIA 2) dataset should be used;

If MIN($\sum($ DIFF144$_i$),$\sum($ DIFF29$_i$), $\sum($ DIFF45$_i$), $\sum($ DIFF33$_i$), $\sum($ DIFF234$_i$)) = $\sum($ DIFF234$_i$) then OUR site is closer to the mean calculated from 378 sites and the 378 (GLOBAL) dataset should be used.

Appendix V

Results of the "Copy & Paste" Excel application of the updated statistical tool for the selection of the best-suited modern vegetation CLAMP calibration dataset from the 144 (Physg3br), 173 (Physg3ar), 189 (PhysgAsia1), 177 (PhysgAsia2) and 378 (PhysgGlobal) datasets for Parschlug. To apply this tool use the on-line version (https://doi.org/10.37520/fi.2022.005) and to view the formulae click on the name of the working sheet (bottom of the page) there using the right mouse-button, choose "Show" or "Unhide" and the "Working area" sheet appears.

	Foliar Physiognomic Characters [%]																														
Locality	Margin Character States							Size Character States									Apex Character States				Base Character States			Length to Width Character States					Shape Character States		
	Lobed	No Teeth	Regular teeth	Close teeth	Round teeth	Acute teeth	Compound teeth	Nanophyll	Leptophyll 1	Leptophyll 2	Microphyll 1	Microphyll 2	Microphyll 3	Mesophyll 1	Mesophyll 2	Mesophyll 3	Emarginate apex	Round apex	Acute apex	Attenuate apex	Cordate base	Round base	Acute base	L:W <1:1	L:W 1-2:1	L:W 2-3:1	L:W 3-4:1	L:W >4:1	Obovate	Elliptic	Ovate
Parschlug	5.75	52.87	44.25	20.40	17.30	29.25	0.29	0.57	0.57	1.49	20.29	40.86	29.66	5.40	1.15	0.00	3.33	31.38	44.54	20.75	5.52	28.16	66.32	5.75	20.06	26.90	36.72	10.57	13.68	49.54	36.78

Insert physiognomic data of a fossil flora (OUR), e.g., Parschlug

RESULTS	
Locality	Selected relevant CLAMP physiognomic datasets
Parschlug	Global_Physg (378)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)
0	Asia 2 (177)

Appendix VI

"Ambiguous specimens": List of ambiguous specimens not assignable to a single taxon or morphotype. "Unidentified specimens": Specimens unassignable to described taxa or morphotypes owing to lacking sufficient details for adequate description.

Ambiguous specimens

Identification	Collection	Number
Acer integrilobum C.O.WEBER sensu Walther 1972 vel *A. pseudomonspessulanum* UNGER emend. Ströbitzer-Hermann 2002	GBA	2002/0001/0048
Ailanthus pythii (UNGER) KOVAR-EDER et KVAČEK vel *Engelhardia orsbergensis* (P.WESSEL et C.O.WEBER) JÄHNICHEN, MAI et H.WALTHER	NHMW	1878/6/8165
Ailanthus pythii (Unger) KOVAR-EDER et KVAČEK vel *Fraxinus* sp.	IBUG	1595
Betula vel *Alnus* sp.	IBUG	726
Betula vel *Alnus* sp.	IBUG	734
Betulaceae vel Ulmaceae gen. et sp. indet.	NHMW	497
Betulaceae vel Ulmaceae gen. et sp. indet.	NHMW	730
Quercus drymeja UNGER vel *Quercus zoroastri* UNGER	GBA	2005/0004/0103b
Ternstroemites pereger (UNGER) KOVAR-EDER et KVAČEK vel *Prinsepia serra* (UNGER) KOVAR-EDER et KVAČEK	IBUG	185
Ternstroemites pereger (UNGER) KOVAR-EDER et KVAČEK vel *Prinsepia serra* (UNGER) KOVAR-EDER et KVAČEK	IBUG	1945
Toxicodendron melaenum (UNGER) DOWELD vel *Ailanthus pythii* (UNGER) KOVAR-EDER et KVAČEK	NHMW	1878/6/2029
Toxicodendron melaenum (UNGER) DOWELD vel *"Celastrus" europaea* UNGER	NHMW	1878/6/8160

Unidentified specimens

Identification	Collection	Number
Dicotylophyllum sp. indet.	GBA	2005/0004/0003
Dicotylophyllum sp. indet.	GBA	2005/0004/0030a
Dicotylophyllum sp. indet.	GBA	1848/0001/0040 bis
Dicotylophyllum sp. indet.	GBA	2005/0004/0016a
Dicotylophyllum sp. indet.	GBA	2005/0004/0043A
Dicotylophyllum sp. indet.	GBA	2005/0004/0049
Dicotylophyllum sp. indet.	GBA	2005/0004/0052b
Dicotylophyllum sp. indet.	GBA	2005/0004/0072
Dicotylophyllum sp. indet.	GBA	2005/0004/0073
Dicotylophyllum sp. indet.	GBA	2005/0004/0074
Dicotylophyllum sp. indet.	GBA	2005/0004/0077B
Dicotylophyllum sp. indet.	GBA	2005/0004/0078
Dicotylophyllum sp. indet.	GBA	2005/0004/008A
Dicotylophyllum sp. indet.	IBUG	578
Dicotylophyllum sp. indet.	IBUG	942
Dicotylophyllum sp. indet.	IBUG	1023
Dicotylophyllum sp. indet.	IBUG	1206
Dicotylophyllum sp. indet.	IBUG	1286
Dicotylophyllum sp. indet.	IBUG	1434
Dicotylophyllum sp. indet.	IBUG	1475
Dicotylophyllum sp. indet.	IBUG	1485
Dicotylophyllum sp. indet.	IBUG	1533
Dicotylophyllum sp. indet.	IBUG	1547
Dicotylophyllum sp. indet.	IBUG	1686
Dicotylophyllum sp. indet.	IBUG	1769
Dicotylophyllum sp. indet.	IBUG	1811
Dicotylophyllum sp. indet.	IBUG	1866
Dicotylophyllum sp. indet.	IBUG	1939
Dicotylophyllum sp. indet.	IBUG	2310
Dicotylophyllum sp. indet.	IBUG	2312
Dicotylophyllum sp. indet.	IBUG	2952
Dicotylophyllum sp. indet.	IBUG	870b
Dicotylophyllum sp. indet.	NHMW	1878/6/2034
Dicotylophyllum sp. indet.	NHMW	1878/6/2621
Dicotylophyllum sp. indet.	NHMW	1878/6/6486
Dicotylophyllum sp. indet.	NHMW	1878/6/8212

Appendix VII

Climate estimates for the regions of the modern vegetation proxies. The climate was assessed using the tool "Earth Systems Modelling Results" (BRIDGE 2021; accessed June 2021).

Modern vegetation	Close cities	GPS coordinates	Resolution of input data	Mean Annual Temperature (in °C)	Warm Month Mean (in °C)	Cold Month Mean (in °C)	Mean Annual Range of Temperature (in °C)	Growing Season Length (in months)	Mean Annual Precipitation (in cm)	Growing Season Precipitation (in cm)	Mean Monthly Growing Season Precipitation (in cm)	Three Consecutive Wettest Months (in cm)	Three Consecutive Driest Months (in cm)	Annual Mean Relative Humidity (in %)	Annual Mean Specific Humidity (in g/kg)	DJF Vapour Pressure Deficit (in hPa)	MAM Vapour Pressure Deficit (in hPa)	JJA Vapour Pressure Deficit (in hPa)	SON Vapour Pressure Deficit (in hPa)	ANN Vapour Pressure Deficit (in hPa)	Enthalpy (in 0.1 kJ/kg)	Latitude (in degrees)	Longitude (in degrees)	Elevation of CLAMP Site (in m)	Elevation of UEA data (before climate data is corrected for elevation) (in m)
G32	Edime	41.65885206357994, 26.538485285974286, alt. 0 m	0.166x0.166 (New et al. 2002)	13.99	24.26	2.97	21.29	7.60	58.82	31.38	4.13	20.16	8.62	67.52	6.99	1.93	5.25	12.41	5.74	6.33	31.47	41.66	26.54	0.00	36.55
	Edime	41.65885206357994, 26.538485285974286, alt. 600 m	0.166x0.166 (New et al. 2002)	10.37	20.60	-0.50	21.09	6.13	58.82	23.26	3.79	20.16	8.62	85.67	6.99	0.12	1.75	6.60	2.20	2.67	31.10	41.66	26.54	600.00	36.55
	Corlu	41.1559993554643, 27.811861512950228, alt. 0 m	0.166x0.166 (New et al. 2002)	13.97	23.06	4.64	18.43	7.81	59.73	30.79	3.94	24.71	7.04	73.00	7.61	1.95	4.07	9.06	4.79	4.97	31.70	41.16	27.81	0.00	71.67
	Corlu	41.1559993554643, 27.811861512950228, alt. 600 m	0.166x0.166 (New et al. 2002)	10.30	19.38	1.13	18.25	6.08	59.73	20.35	3.35	24.71	7.04	92.73	7.61	0.01	0.73	3.52	1.10	1.34	31.32	41.16	27.81	600.00	71.67
G71	Burgos	42.34368059686249, -3.696924761151518985, alt. 500 m	0.166x0.166 (New et al. 2002)	12.47	21.03	5.11	15.93	6.85	59.65	30.77	4.49	17.96	9.57	67.54	6.21	2.17	4.56	9.57	5.11	5.35	31.03	42.34	356.30	500.00	912.82
	Burgos	42.34368059686249, -3.696924761151518985, alt. 1.300 m	0.166x0.166 (New et al. 2002)	7.71	16.09	0.59	15.50	4.48	59.65	16.94	3.78	17.96	9.57	91.14	6.21	0.00	0.86	3.40	1.01	1.32	30.53	42.34	356.30	1300.00	912.82
	Palencia	42.00728413238103, -4.537612287031858, alt. 500 m	0.166x0.166 (New et al. 2002)	13.13	22.04	5.52	16.52	7.27	41.55	23.59	3.24	12.30	6.68	66.58	6.35	2.12	4.89	10.95	5.55	5.88	31.14	42.01	355.46	500.00	786.98
	Palencia	42.00728413238103, -4.537612287031858, alt. 1.300 m	0.166x0.166 (New et al. 2002)	8.36	17.07	1.00	16.07	4.83	41.55	13.78	2.86	12.30	6.68	89.33	6.35	0.00	1.04	4.42	1.28	1.68	30.65	42.01	355.46	1300.00	786.98
	Valladolid	41.65098933386302, -4.729187946292924005, alt. 500 m	0.166x0.166 (New et al. 2002)	13.42	22.74	5.44	17.30	7.41	40.44	22.71	3.06	12.85	5.66	62.82	6.00	2.15	5.67	13.25	6.22	6.82	31.04	41.65	355.27	500.00	705.70
	Valladolid	41.65098933386302, -4.729187946292924005, alt. 1.300 m	0.166x0.166 (New et al. 2002)	8.63	17.70	0.92	16.79	4.94	40.44	12.96	2.62	12.85	5.66	84.21	6.00	0.04	1.72	6.42	1.86	2.51	30.55	41.65	355.27	1300.00	705.70

Modern vegetation	Close cities	GPS coordinates	Resolution of input data	Mean Annual Temperature (in °C)	Warm Month Mean (in °C)	Cold Month Means (in °C)	Mean Annual Range of Temperature (in °C)	Growing Season Length (in months)	Mean Annual Precipitation (in cm)	Growing Season Precipitation (in cm)	Mean Monthly Growing Season Precipitation (in cm)	Three Consecutive Wettest Months (in cm)	Three Consecutive Driest Months (in cm)	Annual Mean Relative Humidity (in %)	Annual Mean Specific Humidity (in g/kg)	DJF Vapour Pressure Deficit (in hPa)	MAM Vapour Pressure Deficit (in hPa)	JJA Vapour Pressure Deficit (in hPa)	SON Vapour Pressure Deficit (in hPa)	ANN Vapour Pressure Deficit (in hPa)	Enthalpy (in 0.1 kJ/kg)	Latitude (in degrees)	Longitude (in degrees)	Elevation of CLAMP Site (in m)	Elevation of UEA data (before climate data is corrected for elevation) (in m)
G72	Teruel	40.33768120969677, -1.134181440874749979, alt. 400 m	0.166x0.166 (New et al. 2002)	14.93	25.01	7.09	17.93	8.29	54.52	40.12	4.84	16.61	11.11	52.98	5.73	4.11	7.50	16.23	8.21	9.01	31.10	40.34	358.87	400.00	1076.29
	Teruel	40.33768120969677, -1.134181440874749979, alt. 1,300 m	0.166x0.166 (New et al. 2002)	9.29	19.00	1.71	17.29	5.16	54.52	23.95	4.64	16.61	11.11	76.78	5.73	0.85	2.64	7.32	2.74	3.39	30.52	40.34	358.87	1300.00	1076.29
	Pamplena	42.81186099275458, -1.646073501378780452, alt. 400 m	0.166x0.166 (New et al. 2002)	12.71	20.74	5.38	15.36	7.08	83.05	44.98	6.35	25.20	13.94	68.50	6.42	2.26	4.40	8.77	5.24	5.17	31.13	42.81	358.35	400.00	560.04
	Pamplena	42.81186099275458, -1.646073501378780452, alt. 1,300 m	0.166x0.166 (New et al. 2002)	7.32	15.16	0.22	14.94	4.31	83.05	22.17	5.13	25.20	13.94	95.16	6.42	0.00	0.25	2.00	0.64	0.72	30.57	42.81	358.35	1300.00	560.04
	Huesca	42.133646465084084, -0.4099253861742503, alt. 400 m	0.166x0.166 (New et al. 2002)	13.99	23.66	5.43	18.23	7.76	56.86	37.70	4.86	16.86	11.32	66.66	6.73	2.03	5.51	12.39	5.43	6.34	31.38	42.13	359.59	400.00	450.04
	Huesca	42.133646465084084, -0.4099253861742503, alt. 1,300 m	0.166x0.166 (New et al. 2002)	8.58	18.05	0.23	17.82	5.03	56.86	22.47	4.46	16.86	11.32	90.94	6.73	0.00	0.92	4.54	0.69	1.54	30.82	42.13	359.59	1300.00	450.04
	Manrea	41.729509309936753, 1.830265413947509, alt. 400 m	0.166x0.166 (New et al. 2002)	13.58	21.76	6.74	15.02	7.64	63.05	44.98	5.89	19.75	11.07	73.15	7.37	2.46	3.86	7.64	4.20	4.54	31.57	41.73	1.83	400.00	407.30
	Manrea	41.729509309936753, 1.830265413947509, alt. 1,300 m	0.166x0.166 (New et al. 2002)	8.13	16.10	1.51	14.58	4.64	63.05	26.66	5.75	19.75	11.07	99.33	7.37	0.00	0.00	0.48	0.00	0.12	31.01	41.73	1.83	1300.00	407.30
D042	Sidorov Island	66.34021859359123, 33.82494242016525, alt. 100 m	0.166x0.166 (New et al. 2002)	0.1	13.9	-12.7	26.6	2.5	51.5	15.0	6.0	18.5	7.7	87.3	3.8	0.0	1.2	3.3	0.8	1.3	28.9	66.3	33.8	100.0	39.1
	Archangelsk	64.56228967580792, 40.72462656159144, alt. 100 m	0.166x0.166 (New et al. 2002)	0.4	15.3	-14.9	30.2	3.0	55.1	17.8	6.0	18.3	8.4	86.6	3.9	0.0	1.6	3.9	0.7	1.5	29.0	64.6	40.7	100.0	13.7
	Kevo	69.74522993957365, 26.907668591583319, alt. 100 m	0.166x0.166 (New et al. 2002)	-1.7	13.0	-15.0	28.0	2.1	43.5	12.2	5.9	16.9	6.7	77.1	3.1	0.4	1.5	3.8	1.0	1.7	28.4	69.7	26.9	100.0	214.9
	Kevo	69.74522993957365, 26.907668591583319, alt. 300 m	0.166x0.166 (New et al. 2002)	-2.9	11.9	-16.2	28.1	1.4	43.5	8.5	6.2	16.9	6.7	84.3	3.1	0.2	1.0	2.8	0.6	1.2	28.3	69.7	26.9	300.0	214.9

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Modern vegetation	Close cities	GPS coordinates	Resolution of input data	Mean Annual Temperature (in °C)	Warm Month Mean (in °C)	Cold Month Means (in °C)	Mean Annual Range of Temperature (in °C)	Growing Season Length (in months)	Mean Annual Precipitation (in cm)	Growing Season Precipitation (in cm)	Mean Monthly Growing Season Precipitation (in cm)	Three Consecutive Wettest Months (in cm)	Three Consecutive Driest Months (in cm)	Annual Mean Relative Humidity (in %)	Annual Mean Specific Humidity (in g/kg)	DJF Vapour Pressure Deficit (in hPa)	MAM Vapour Pressure Deficit (in hPa)	JJA Vapour Pressure Deficit (in hPa)	SON Vapour Pressure Deficit (in hPa)	ANN Vapour Pressure Deficit (in hPa)	Enthalpy (in 0.1 kJ/kg)	Latitude (in degrees)	Longitude (in degrees)	Elevation of CLAMP Site (in m)	Elevation of UEA data (before climate data is corrected for elevation) (in m)
	Stormorvallen	61.61018786539175, 12.772402209925541, alt. 800 m	0.166x0.166 (New et al. 2002)	-0.7	11.1	-12.3	23.5	1.7	68.4	14.2	8.5	24.7	10.4	87.8	3.5	0.0	1.2	2.9	0.6	1.2	28.7	61.6	12.8	800.0	809.4
	Krachajevsk	43.79979520829013, 41.80305822357027, alt. 1,000 m	0.166x0.166 (New et al. 2002)	8.2	18.9	-3.1	22.0	5.4	99.7	54.4	10.0	34.2	19.1	77.4	5.7	0.8	2.7	5.5	2.8	3.0	30.4	43.8	41.8	1000.0	1035.0
D064	Krachajevsk	43.79979520829013, 41.80305822357027, alt. 2,200 m	0.166x0.166 (New et al. 2002)	0.7	11.5	-10.3	21.8	1.8	99.7	18.5	10.2	34.2	19.1	101.2	5.7	0.0	-0.1	-0.4	-0.1	-0.1	29.6	43.8	41.8	2200.0	1035.0
	Tylarga	42.47563933582496, 46.31476025311010144, alt. 1,000 m	0.166x0.166 (New et al. 2002)	10.4	24.3	-3.9	28.2	6.3	102.8	67.4	10.7	40.3	16.0	45.9	3.9	2.2	7.4	17.6	8.1	8.8	30.0	42.5	46.3	1000.0	2564.8
	Tylarga	42.47563933582496, 46.31476025311010144, alt. 2,200 m	0.166x0.166 (New et al. 2002)	3.4	16.9	-10.3	27.2	3.9	102.8	42.2	10.8	40.3	16.0	74.0	3.9	0.3	2.2	7.1	2.8	3.1	29.3	42.5	46.3	2200.0	2564.8
China 12–14	Meili Snow Mountain National Park Scenic Area	28.467467170620086, 98.819155163565865, alt. 2,580 m	0.166x0.166 (New et al. 2002)	11.4	17.9	3.2	14.8	7.0	71.1	60.3	8.6	36.3	3.6	53.5	5.1	4.8	7.5	6.0	5.9	6.1	30.5	28.5	98.8	2580.0	3914.4
	Meili Snow Mountain National Park Scenic Area	28.467467170620086, 98.819155163565865, alt. 3,650 m	0.166x0.166 (New et al. 2002)	5.3	12.3	-2.5	14.8	3.6	71.1	40.6	11.2	36.3	3.6	79.6	5.1	2.0	2.4	0.2	1.1	1.4	29.9	28.5	98.8	3650.0	3914.4
China 68	Changbai Mts.	41.733, 128.067, alt. 750 m	0.166x0.166 (New et al. 2002)	3.3	20.4	-17.2	37.6	4.8	76.8	60.3	12.6	47.6	2.7	58.5	4.2	0.9	4.7	6.3	3.7	3.9	29.4	41.7	128.1	750.0	1397.3