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Leaves of Lauraceae in the Inden series (Miocene) from the Lower Rhenish basin, Germany (open pits Hambach and Frechen)

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Abstract

Eight species of fossil leaves from the family Lauraceae are described from the so-called Inden schichten of the lower Rhenish basin. Six of them are new for these Series: *Sassafras ferretianum* MASSALONGO*, Laurus abchasica* (KOLAKOVSKI) FERGUSON*, L. primigenia* UNGER, *Ocotea. hradekensis,* (Z. KVACEK et BUZEK) BUZEK, HOLY et Z. KVACEK, *Laurophyllum. pseudovillosum* Z. KVACEK*, and L. rugatum* Z. KVACEK et BUZEK.. Some remarks concerning the ecology are made.

Zusammenfassung

Es werden 8 Arten von Blättern aus der Familie der Lauraceen beschrieben, die aus den sog. Inden Schichten des niederrheinischen Beckens stammen. Sechs von ihnen sind neu für die Schichtfolge: *Sassafras ferretianum* MASSALONGO*, Laurus abchasica* (KOLAKOVSKI) FERGUSON*, L. primigenia* UNGER, *Ocotea. hradekensis,* (Z. KVACEK et BUZEK) BUZEK, HOLY et Z. KVACEK**,** *Laurophyllum. pseudovillosum* Z. KVACEK*, and L. rugatum* Z. KVACEK et BUZEK**.** Bemerkungen zur Ökologie werden akzessorisch erwähnt.

Key words: leaves, cuticles, Ecology, Tortonian, Europe

Schlüsselworte: Blätter, Kutikulen, Ökologie, Tortonium, Europa

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1 Introduction

During the last thirty year a great number of leaf impressions was collected in the browncoal quarries of the Rheinbraun Company, predominantly in the quarry Hambach near Düren. The majority of the species identified was already described by BELZ (1992), BELZ and MOSBRUGGER (1994) and by VAN STROE (1996). However, some Lauraceous leaves were collected, which were not known from these deposits. Therefore, it became appropriate to describe all lauraceous leaf impressions from the Inden series together.

2 Material and methods

The material used comprises a total of about 2000 leaf impressions from the Inden series hitherto collected in the browncoal quarries Hambach, Frechen, Fortuna Garsdorf and Inden. On a total of about 2000 leaf impressions, material of 8 Lauraceae species was found. *Daphnogene* was most numerous, followed by *Laurophyllum rugatum*. The oldest and still usable stratigraphic division of the Lower Rhine basin was made by SCHNEIDER and THIELE (1965). In their scheme the Inden Series is no. 7. It consists of a series of alternating sand and clay deposits, starting with a sandy deposit over the Main Browncoal. It is followed by the "Hauptkiesserie", which starts with rather coarse deposits of local clays and sands. Although some correlation with marine stratigraphy has been made (ZAGWIJN 1987), a precise correlation with the official stratigraphy of the Neogene cannot be made by lack of suitable marine deposits. However, the Hauptkiesserie starts with floras which contain some forms typical for the Messinian in e.g., Northern Greece (Z. KVACEK et al. 2002) The Upper part of the Main Browncoal is generally considered to be of Serravallian (Middle Miocene) age (HAGER 1981). The Inden series, therefore, represents the Tortonian. It is divided in 6 units, A-F, of which 7A, 7C, and 7E show a sandy development and the units 7B, 7D and 7F are more silty in composition. The latter three deposits contain clay beds with leaf-compressions.

If possible, cuticle preparations were made by coating a part of a compression with a glue (Collall allpurpose glue) and after that a film of collodium was applied. After drying, this, together with the leaf material was removed, treated with 40% HF for one hour and, after rinsing with water, it was treated with 30% HNO_3 for 30 minutes. Then the remnants of the mesophyll were dissolved with ammonia (NH_4OH). The films were processed into slides, embedded in glycerin jelly and afterwards sealed with "Pantserlak". The slides were examined using a Olympus microscope. All photographs were taken with a Samsung WB1000 camera. Photographs have not been manipulated other than enhancing contrast and brightness of the entire photograph.

3 Fossilium Catalogus

Below a description is given of the material from each species, using the terminology of DILCHER (1974). In some cases remarks concerning a possible ecological preference are made, based on the nature of the deposit in which the fossils are mainly found.

Daphnogene polymorpha (BRAUN) ETTINGSHAUSEN 1851

Plate 1, Figs. 1-4; Plate 3, Figs. 1-4

Material: Hambach specimens: U10442, U10994A, D, U11414, U11415, U11419, U11420A, U11422, U11426, U12967, U13143, U13358, U13422, U13442, U19527, U20418, U20420, U20459, U20660, U20678, U21033, U21176, U21363, U21642, U22417; cuticle preparations: 7237, 7263, 7264, 7276,

Description: (Plate 1, Figs. 1-4). The shape of the leaf is symmetrical, mostly elliptic, sometimes oblong or obovate. The base is acute or decurrent, the apex acute or acuminate. The margin is entire. The venation is pinnate, acrodromous, with two suprabasal inserted dominating secundaries. The tertiary venation is reticulate. The measures are very variable, from 3.5 to 9 cm in length and 1.5 to 4.2 cm in with. Per consequence the leaves are microphyllous to mesophyllous.

The cuticle is not very thick, mostly of reasonable to good quality. The upper cuticle shows a pattern of pentamerous cells with straight, rounded or undulate walls (Plate 3, Fig. 1). The lower cuticle is thinner, mostly consisting of imprints of pentamerous cells with rounded to undulate walls (Plate 3, Figs 2, 4). Trichome bases are not always present, they are radiate with a single small (3-4µm diameter) thick walled central cell (Plate 3, Fig. 3). The stomata are brachyparacytic. The length of the stomatal cells is 14-18 µm, the width is 12-15 µm. The stomatal pit is 8-10 µm long. The measurements of the stomatal complex as a whole are 15-20 x 25-45 µm.

Remarks: This material is comparable to that described by BELZ and MOSBRUGGER (1994) and VAN STROE (1996) from comparable deposits in the same area, and with the descriptions of several other authors, e.g., FERGUSON (1971) which described the species as his number XXVI from Kreuzau, which is in the same area but slightly older (Middle Miocene, FERGUSON 1971, PINGEN, 1992). Therefore, this material is also assigned to this species.

Ecology: The leaf is highly variable in size. In this respect it is worthwhile to mention that the smaller leaves are mostly found in light grey rather silty clays together with a clearly allochthonous flora, which is often rich in species. The larger ones are predominantly collected from coaly clays with a brown to dark grey colour. These clays are very fine in structure and the species composition is restricted. However, the number of smaller leaves in the silty light grey clays is comparable to that of the leaves in the dark grey coaly clays. So no preference for a humid environment can be found.

***Sassafras ferretianum* MASSALONGO 1858**

Plate 1, Figs. 5-6; Plate 3, Figs. 5-8.

Material: Hambach specimens: U12947A, U18817, U19422, U19482, U21631, U22692; cuticle preparations 6267, 7268.

Description: The shape of the leaf is incompletely to completely palmate, with two lobes (Plate I, Fig. 5); in one case only one lobe was developed (Plate I, Fig. 6). The base is acute, the apices of the lobes are also acute. The margin is entire. The venation is actinodromous, the secundaries are nearly

basally inserted and eucamptodromous, the tertiaries are reticulate. All six impressions are incomplete, but from the size of five of these specimens, a mesophyllous leaf can be inferred. The sixth impression is microphyllous.

The cuticle is thin and badly preserved. The upper cuticle contains impressions of pentamerous epidermis cells with straight to slightly rounded walls (Plate 3, fig 5). The much thinner lower cuticle shows impressions of pentamerous cells with slightly rounded to undulate walls (Plate 3, 6, 7) and radial trichome bases with a small thick-walled central cell (Plate 3, figs 8). The stomata are brachyparacytic, with a very variable length and width of the stomatal cells. They measure 10-18 µm in length and 6-15 µm in width. Together with the subsidiary cells they measure 12-25 µm (length) x 15-18 µm (width).

Remarks: The shape of the leaves is very characteristic and agrees fully with those of *Sassafras*. It is also comparable to the material of the fossil species *S. ferretianum* as described and illustrated by various authors (FERGUSON 1971, MAI & WALTHER 1988, Z.KVACEK et al. 2002, Z.KVACEK et al. 2008). The cuticle of the fossil species also agrees with the description and figure of the cuticle in Z.KVACEK et al. 2002. Therefore, our material is assigned to this species.

***Laurus abchasica* (KOLAKOVSKI) FERGUSON 1974**

Plate 1, Fig. 7; Plate 3, Figs. 9-10.

Material: Hambach specimen: U22579; cuticle preparation 7278.

Description: The leaf is microphyllous, symmetrical, length 6 cm and width 2 cm. The base is acute, the tip is acute, the margin is entire. The venation is pinnate, the primary is straight, the secondaries are eucamptodromous, the tertiary venation is reticulate (Plate I, Fig. 7).

The cuticle is well preserved. The upper cuticle is relatively thin, showing pentamerous cells with rounded to undulate type a walls (Plate 3, Fig. 9). The lower cuticle is thicker than the upper cuticle, showing tetra-pentamerous cells with undulate, type c, walls. The stomata are brachyparacytic. The length of the stomatal cells is 15µm, the width is 5µm. The subsidiary cells show rounded walls. The total stomatal complex measures about 15 µm (height) x 25 µm (width) (Plate 3, Fig. 10).

Remarks: This material is similar to material originally described as *Laurophyllum abchasicum* by Z. KVACEK (1971) and KNOBLOCH & Z. KVACEK (1976). FERGUSON (1974) assigned it to the genus *Laurus* based on a comparison of the structure with that of two species of *Laurus: L. nobilis* L. and *L. azorica* (SEUB) FRANCO. Also material described by UZUNOVA (1995) shows a strong resemblance. It is also assigned to this species.

***Laurus primigenia* UNGER 1850**

Plate 1, Fig. 8; Plate 3, Figs. 11, 12.

Material: Hambach specimen: U19410, cuticle preparation 7227.

Description: The leaf is symmetrical, oblong, microphyllous, length 5.2 cm. width 1.7 cm. The apex is missing, the base is acute, the margin is entire. The venation is pinnate, eucamptodromous; the tertiary venation could not be observed, due to the rather coriaceous nature of the compression (Plate 1, fig. 8).

The cuticle is well preserved. The upper cuticle is thick, the outline of the epidermis cells is pentamerous with straight walls (Plate 3, Fig. 11). The lower cuticle shows the outline of very variably shaped epidermis cells with rounded walls. The stomata are brachyparacytic. The stomatal cells are up to 22 µm long and up to 17 µm wide. The stomatal pit is rather short, only 7-8 µm. The subsidiary cells are in comparison rather large, bringing the total stomatal complex to 27 µm (length) and 45 µm (width) (Plate 3, Fig. 12).

Remarks: These characters are only found in *Laurus primigenia*; a very good description and figures are found in FERGUSON 1971 under no. XXIV. Our material is assigned to this species.

***Ocotea hradekensis* (Z. KVACEK et BUZEK) BUZEK, HOLY et Z. KVACEK 1996**

Plate 2, Figs. 1, 2; Plate 4, Figs. 1, 2.

Material: Hambach specimens: U21144, U21155, U21181; cuticle preparations: 4471, 4472, 4474.

Description: The shape of the leaf is symmetrical, ovate to narrowly elliptic with an acute base and acute apex. The margin is entire. The venation is pinnate and eucamptodromous. Due to the thick texture of the leaf-impression (pointing to a leathery leaf), no tertiary veins could be observed. The length of the leaf is 5 - 7 cm, the width is 1.5 - 2.2 cm; therefore, the leaves are microphyllous (Plate 2, Fig. 1, 2).

The cuticle is thick and well preserved. The upper cuticle shows pentamerous cells with straight to slightly rounded walls (Plate 4, Fig.1). The lower cuticle shows tetra- to pentamerous cells with rounded to undulate (type c, DILCHER 1974) walls. The stomata are numerous, brachyparacytic and rather large: the length of the stomatal cells is up to 27 µm and the width up to 15 µm. Together with the subsidiary cells they measure about 27 µm

(height) x 50 µm (width). The cuticle of the stomata and subsidiary cells is thinner than that of the normal epidermal cells (Plate 4, Fig. 2).

Remarks: The compressions and the cuticle structure of this material is in accordance with that of *Laurophyllum hradekense* as described by Z.KVACEK & BUZEK 1966, KNOBLOCH & Z. KVACEK 1971, 1976, PETERS 1963 (her Lauraceae II is included in the species by KNOBLOCH & Z. KVACEK (1976) and UZUNOVA (1995). This species was assigned to *Ocotea* by BUZEK et al.(1996) based on its co-occurrence with *Ocotea*-type seeds and a characteristic gland-like structure in the axils of the secondary veins in the leaves. Based on the agreement of the gross morphological and cuticular structures the above described material is assigned to this species.

***Ocotea pseudoprinceps* (WEYLAND et KILPPER) UZUNOVA et STOJANOVA 1999**

Plate 2, Figs. 3, 4 ; Plate 4, Figs. 3-6.

Material: Frechen specimen: U12193, Hambach: U 22101; cuticle preparations: 4750, 7276.

Description: The leaf is microphyllous, length c. 5 cm, width 2.3 cm, it is thick, coriaceous. The base is obtuse, the apex is acute, the margin is entire. The venation is pinnate, with a straight primary vein and eucamptodromous secundaries; the tertiaries could not be observed (Plate 2, Fig. 3, 4).

The cuticle is well preserved. The upper cuticle is thick, the cell pattern is tetra- to pentamerous; the walls are undulate type c, with knobs (plate 4, Fig. 3, 4). The lower cuticle is thinner than the upper

cuticle; the shape of the cells is variable, the walls are undulate type b-c, knobs are present, but not so strong as on the upper cuticle. The stomata are brachyparacytic, the length of the stomatal cells is 17-23 µm, the width is 10-15 µm. The stomatal pit is about 8 µm long, and about 3 µm wide (Plate 4, Fig. 5, 6) . The measurements together with the subsidiary cells are 17-23 µm (length) x 35-40 µm (width).

Remarks: Leaves with this appearance are described in the literature as *Laurophyllum pseudoprinceps* WEYLAND et KILPPER 1963. Material of this species is described from the Miocene of the lower Rhenish basin by WEYLAND & KILPPER in 1963. Subsequently it was also described from several Oligocene and Miocene localities by e.g., KILPPER (1968), JÄHNICHEN (1969), MAI & WALTHER (1978, 1991), OSCHKINIS & GREGOR 1992, UZUNOVA 1995, GREGOR & OSCHKINIS (2005), SCHNEIDER & GROSCHKE (2004). It was also mentioned for the Inden Series by BELZ (1992), BELZ & MOSBRUGGER (1994) and by VAN STROE (1996). FERGUSON (1971) described comparable material under his numbers XXI and XXII. UZUNOVA & STOJANOVA (1999) pointed out that this species shows many characters of *Ocotea* material and made the new combination *Ocotea pseudoprinceps*. They are followed here on the basis that this is at the moment the best known comparison with a recent genus.

***Laurophyllum pseudovillense* Z. KVACEK 1971**

Plate 2, Fig.5; Plate 4, Figs. 7-9.

Material: Frechen specimens: U12192, U12237, Hambach specimens: U18783, U22324, U22398; cuticle preparations: 4767, 4771, 4473, 7270, 7372.

Description: The leaves are microphyllous and symmetrical; the length is up to 10 cm, the width up to 2 cm. The shape is narrow elliptic to elliptic, the base is acute, the apex is acute to attenuate. The margin is entire. The lamina is coriaceous, pointing to a thick leathery leaf. The venation is pinnate with a straight primary and eucamptodromous secondary venation, the tertiary venation is reticulate (Plate 2, Fig.5).

The cuticle is not always well preserved. The upper cuticle is rather thick and shows pentamerous cells with straight walls. The lower cuticle is very thin. The outline of the epidermis cells is tetra to hexamerous with straight or rounded walls. Trichome bases with a thickened radial pattern and a þhickwalled central cel are present in both the upper (Plate 4, Fig. 7) and the lower cuticle, especially over the veins (Plate 4, Fig. 8). The stomata are brachyparacytic. The length of the stomatal cells is ca. 15 µm, the width ca. 10 µm. Together with the subsidiary cells they measure about 15 µm (length) x 25 µm (width) (Plate 4, fig. 9)..

Remarks: This material is comparable to material described by Z. KVACEK (1971, KNOBLOCH & Z. KVACEK 1976, NEMEJC et al. 2002 as *Laurophyllum pseudovillense* and is assigned to this species.

***Laurophyllum rugatum* Z. KVACEK et BUZEK 1966**

Plate 2, Figs. 6-8; Plate 4, Figs. 10-15.

Material: Hambach specimens, U19339, U20861, U20865, U21164, U21184, U21194, U21356, U21481, U22233, U22234; cuticle preparations: 4066, 4469, 7181, 7209, 7236, 7310, 7314, 7315, 7321, 7322.

Description: The leaves are mostly mesophyllous, with a length between 10 and 15 cm and a width of 3.5-5cm. Also 2 microphyllous specimens are present, with a width of approximately 2 cm and a length which did not exceed 7cm. The shape is symmetrical, narrowly elliptic; the base is cuneate, the apex is acute, the margin is entire. The venation is pinnate, eucamptodromous, the tertiary veins are reticulate. The compressions are thick, pointing to a thick leathery leaf (Plate 2, Figs 6-8).

The cuticle is well preserved , the upper cuticle is thick and shows the outlines of pentamerous epidermis cells with variable shaped walls: from straight to rounded to undulate (Plate 4 Figs 10,11). The lower cuticle is thin, showing pentamerous epidermis cells with rounded walls. The stomata are brachyparacytic. The height of the stomatal cells is c. 20 µm, their width is 3 µm. The subsidiary cells are wide and bring the total measures for the stomatal complex on 20 µm (height) x 25 µm (width) (Plate 4, Figs 12,13). The lower cuticle

bears very numerous unicellular thick-walled bases of single trichomes. The trichomes are up to 140 µm long) (Plate 4, Figs.14,15).

Remarks: These leaves agree with the descriptions of *Laurophyllum rugatum* by Z. KVACEK & BUZEK (1966) , KNOBLOCH & KVACEK (1971, 1976), MAI & WALTHER (1991), UZUNOVA (1995) BUZEK et al. (1996) and are assigned to this species.

Ecology: These leaves of *L. rugatum* all originate from collections in a river channel from which about 1200 leaf compressions were collected. The bulk of the deposit consisted of a silty light grey clay from which about 800 identified leaf compressions were collected, divided over 47 species. This silty clay grades upwards into a very fine yellow clay, which in its turn grades into a brown very coaly clay. The last remainder of the channel was filled with a pure brown coal, consisting of *Quasisequoia couttsiae* (PINGEN 1994) with an additional high number of *Nyssa ornithobroma*. Nearly all the specimens of *L. rugatum* were found in the coaly clay; only two of them were collected in the grey clay, both being microphyllous. On the whole the species is not very numerous, forming less the 1 % of the total of identified leaf compressions of this series (N= 1192). In the very fine coaly clay it formed 8% of the total of identified leaf-compressions (N=96). As in this coaly material the number of species is restricted to 17 and dominated by *Alnus menzelii* (28%), *Acer tricuspidatum* (14%), *Quasisequoia couttsiae* (14%) it is clear that in this deposit the local influence was rather strong. This points for *L. rugatum* to a preference for a very humid habitat, dominated by *Alnus, Acer* and in this case also *Quasisequoia*. This is also in agreement with the statement of MAI & WALTHER (1991) where it is said to be a plant characteristic for warm-humid climate and coaly deposits.

4 Discussion and conclusion

Material *of Daphnogene polymorpha* and *Laurophyllum rugatum* was collected mostly from coaly clay and very fine clay with crowded leafy layers. Both species have mesophyllous leaves and are partly or predominantly collected from dark coaly clays in which a more local influence is to be expected . For *Laurophyllum rugatum* a preference for a humid habitat can be deduced. In the case of *Daphnogene* this is not clear, due to the rather numerous fossils in the allochthonous leaf deposits. *Sassafras* is also predominantly mesophyllous, but from the occurrence in the silty clays with an allochthonous leaf composition it is clear that no conclusion or even indication to a special environment can be made. The majority of species this family, *Laurus abchasica, L. primigenia, Ocotea hradekensis, O. pseudoprinceps, Laurophyllum pseudovillense,* are microphyllous and exclusively found in the light grey silty clay. These species are allochthonous elements and are possibly adapted to a more severe environmental regime.

The species of Lauraceae found in the Tortonian Inden Series of the lower Rhenish basin are all known from other younger Miocene localities all over Europe. This makes it clear that during the Tortonian the composition of the flora of that region was comparable with all other lowland floras of that epoch.

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Plates

The material is stored in the collection of the Laboratory of Palaeobotany and Palynology under the mentioned inventory numbers.

Plate 1

Fig. 1. *Daphnogene polymorpha* (BRAUN) ETTINGSHAUSEN, complete leaf, U10994A.

Fig. 2. *Daphnogene polymorpha* (BRAUN) ETTINGSHAUSEN, incomplete leaf, U21642.

Fig. 3. *Daphnogene polymorpha* (BRAUN) ETTINGSHAUSEN, incomplete leaf, U20660.

Fig. 4. *Daphnogene polymorpha* (BRAUN) ETTINHGSHAUSEN, incomplete leaf, U20418.

Fig. 5. *Sassafras ferretianum* MASSALONGO, incomplete trilobate leaf, U12947a.

Fig. 6. *Sassafras ferretianum* MASSALONGO, incomplete bilobate leaf, U22692.

Fig. 7. *Laurus abchasica* (KOLAKOVSKI) FERGUSON, incomplete leaf, U22579.

Fig. 8. *Laurus primigenia* UNGER, incomplete leaf, U19410

Plate 1

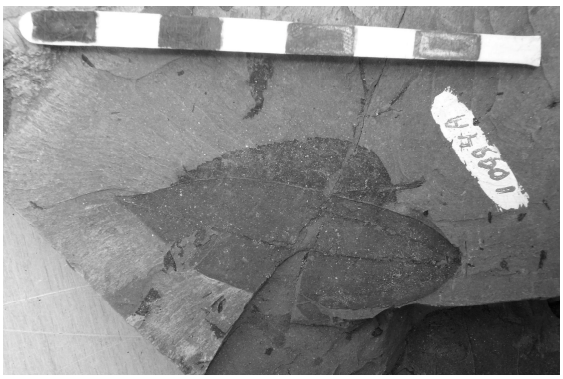

Fig. 1

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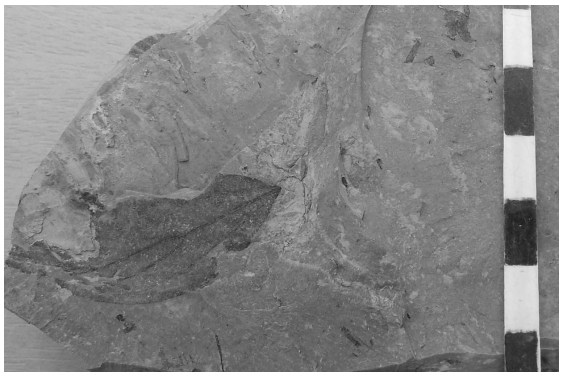
Fig. 3



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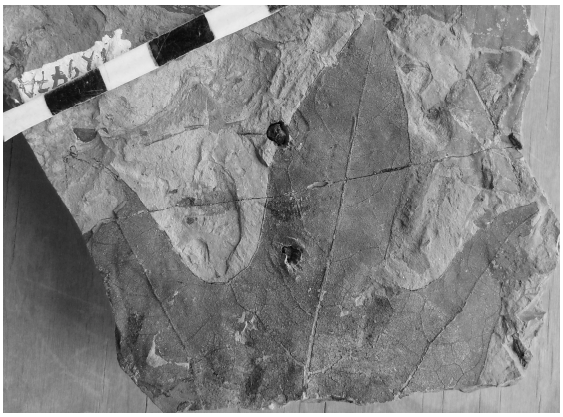

Fig. 5

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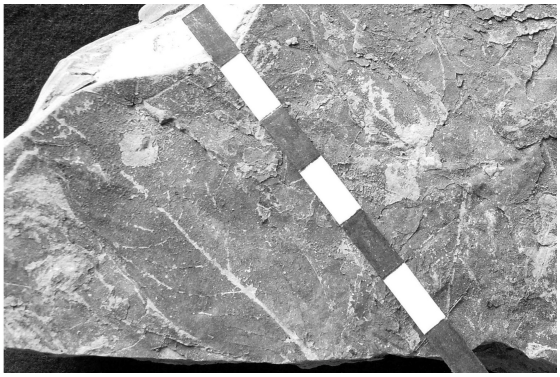


Fig. 7

Fig. 8

Plate 2

Fig.1. *Ocotea hradekensis* (Z. KVACEK et BUZEK) BUZEK et al., incomplete leaf, U21155.

Fig. 2. *Ocotea hradekensis* (Z.KVACEK et BUZEK), Buzek et al., piece and counterpiece of a complete leaf, U21144A,B.

Fig. 3. *Ocotea pseudoprinceps* (WEYLAND et KILPPER) UZUNOVA et STOJANOVA, incomplete leaf, U21101.

Fig. 4. *Ocotea pseudoprinceps* (WEYLAND et KILPPER) UZUNOVA et STOJANOVA, complete leaf, U22336.

Fig. 5. *Laurophyllum pseudovillense* Z. KVACEK, incomplete leaf, U12237.

Fig. 6. *Laurophyllum rugatum* Z. KVACEK et BUZEK, incomplete leaf, U21164.

Fig. 7. *Laurophyllum rugatum* Z, KVACEK et BUZEK, complete leaf, U22233B.

Fig. 8. *Laurophyllum rugatum* Z. KVACEK et BUZEK, incomplete leaf, U20861.

Plate 2

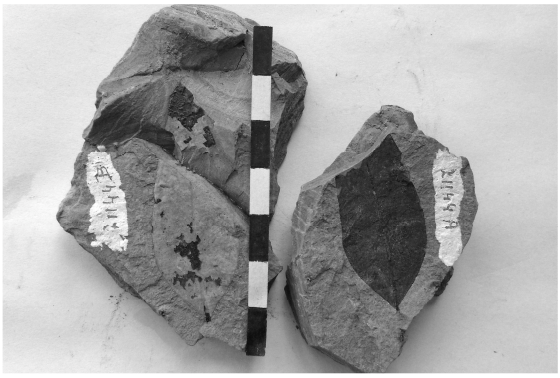
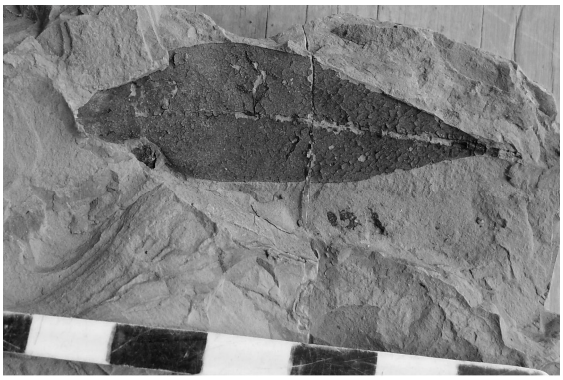


Fig. 1

Fig. 2



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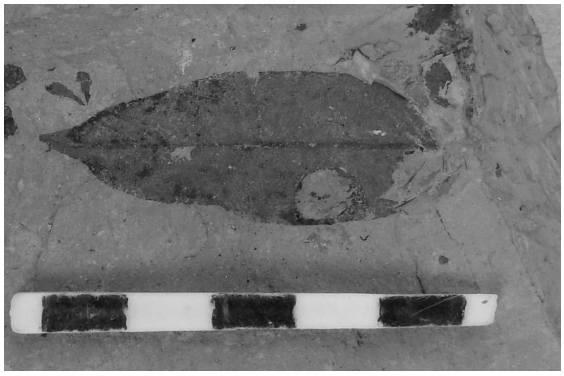

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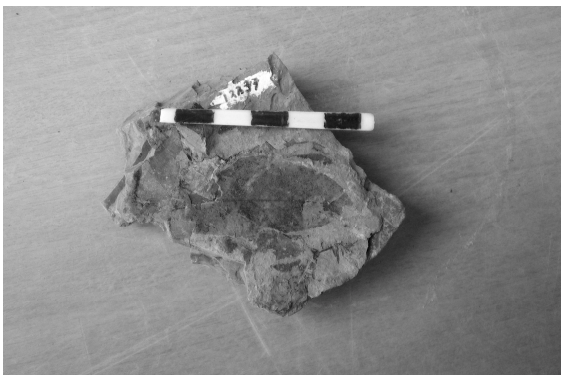


Fig. 5

Fig. 6

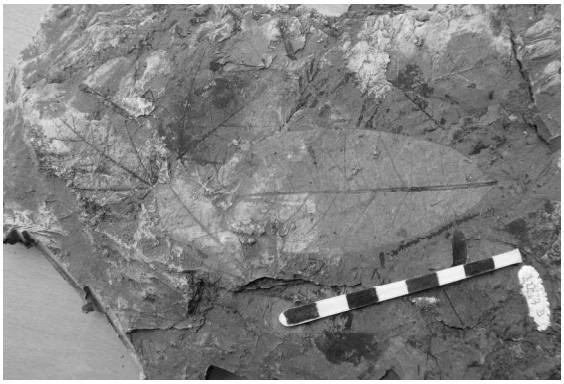


Fig. 7

Fig. 8

Plate 3

Fig. 1. *Daphnogene polymorpha* (BRAUN) ETTINGSHAUSEN, abaxial cuticle, U11420A, prep. 7263, x400.

Fig. 2. *Daphnogene polymorpha* (BRAUN) ETTINGSHAUSEN, adaxial cuticle, U11420A, prep. 7263, x 400.

Fig. 3. *Daphnogene polymorpha* (BRAUN) ETTINGSHAUSEN, adaxial cuticle, with stomata and hairbase, U11420A, prep 7263, x 400.

Fig. 4. *Daphnogene polymorpha* (BRAUN) ETTINGSHAUSEN, adaxial cuticle, undulate epidermis walls, U19586, prep. 7264, x 400.

Fig. 5. *Sassafras ferretianum* MASSALONGO, abaxial cuticle, U12497A, prep. 7268, x 400.

Fig. 6. *Sassafras ferretianum* MASSALONGO, adaxial cuticle, U12497A, prep. 7268, x 400.

Fig. 7. *Sassafras ferretianum* MASSALONGO, adaxial cuticle, stoma, U22692, prep., x 400.

Fig. 8. *Sassafras ferretianum* MASSALONGO, adaxial cuticle, hairbase, U12947A, prep. 7268, x 400.

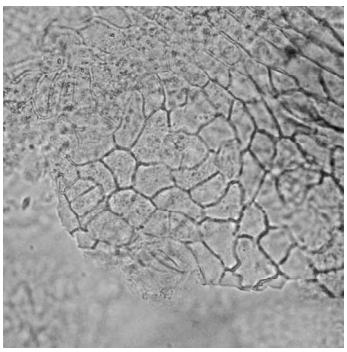
Fig. 9. *Laurus abchasica* (KOLAKOVSKI) FERGUSON, abaxial cuticle, U22579, prep. 7279, x 400.

Fig. 10. *Laurus abchasica* (KOLAKOVSKI) FERGUSON, adaxial cuticle, U22579, prep. 7279, x 400.

Fig. 11. *Laurus primigenia* UNGER, abaxial cuticle, U19410, prep. 7227, x 400.

Fig. 12. *Laurus primigenia* UNGER, adaxial cuticle, U19410, prep. 7227, x 400

Plate 3



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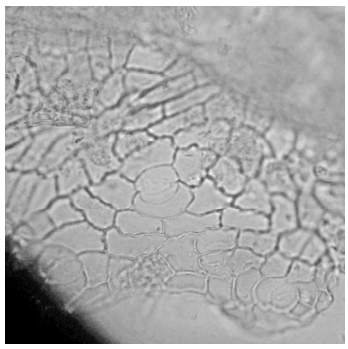

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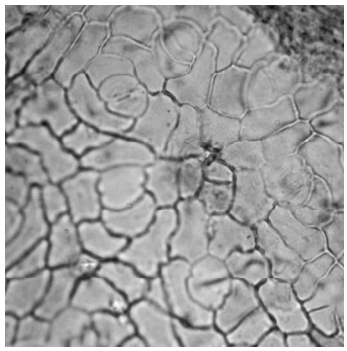

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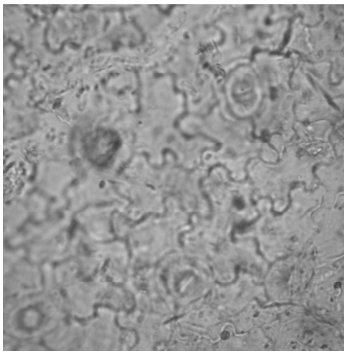

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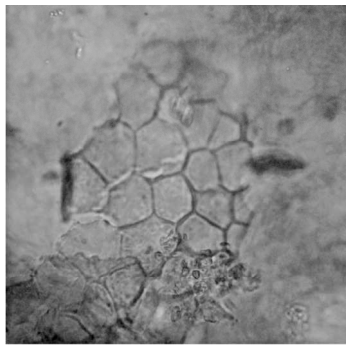

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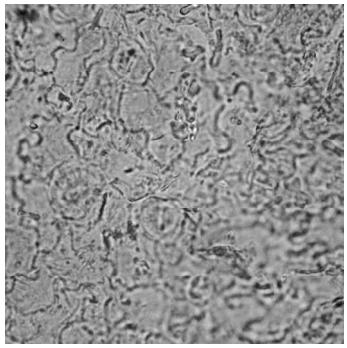

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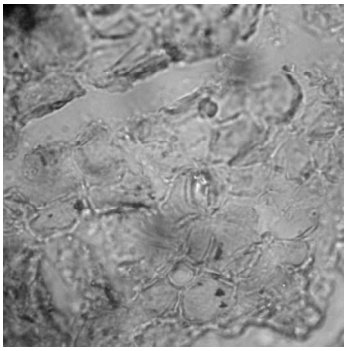

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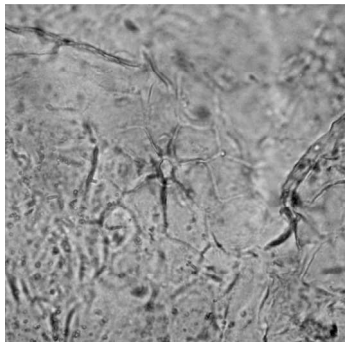

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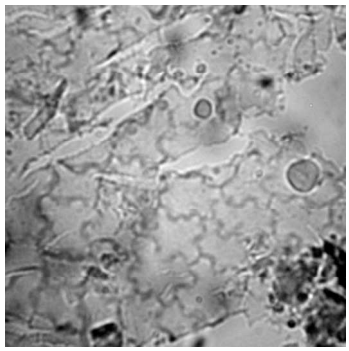

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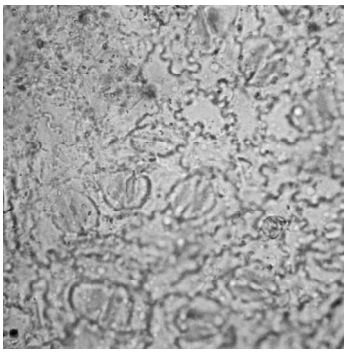

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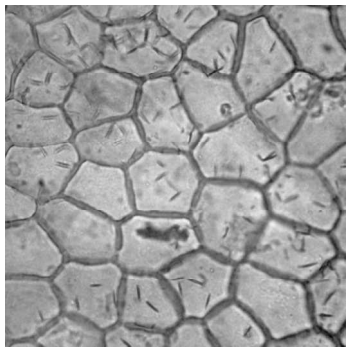


Fig. 11

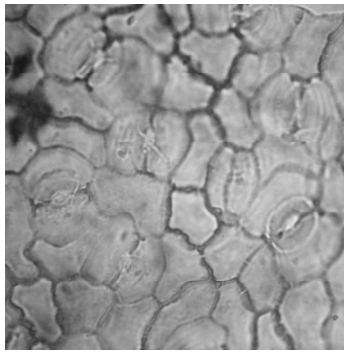


Fig. 12

Plate 4

Fig. 1. *Ocotea hradekensis* (Z. KVACEK et BUZEK) BUZEK et al., abaxial cuticle, U21181, prep. 4471, x 400.

Fig. 2. *Ocotea hradekensis* (Z. KVACEK et BUZEK) BUZEK et al., adaxial cuticle, U21181, prep. 4471, x 400.

Fig. 3. *Ocotea pseudoprinceps* (WEYLAND et KILPPER) UZUNOVA et STOJANOVA, abaxial cuticle, U22101, prep, 7276, x 400.

Fig. 4. *Ocotea pseudoprinceps* (WEYLAND et KILPPER) UZUNOVA et STOJANOVA, abaxial cuticle, U12193, prep. 4750, x 400.

Fig. 5. *Ocotea pseudoprinceps* (WEYLAND et KILPPER)UZUNOVA et STOJANOVA, adaxial cuticle, U22101, prep. 7276, x 400.

Fig. 6. *Ocotea pseudoprinceps* (WEYLAND et KILPPER)UZUNOVA et STOJANOVA, adaxial cuticle, U12193, prep. 4750, x 400.

Fig. 7. *Laurophyllum pseudovillense* Z. KVACEK, abaxial cuticle, hairbase, U22324, prep. 7270, x 400.

Fig. 8. *Laurophyllum pseudovillense* Z. KVACEK, adaxial cuticle, stomata and hairbases, U22324, prep. 7270, x 400.

Fig. 9. *Laurophyllum pseudovillense* Z. KVACEK, adaxial cuticle, stomata, U22398, prep. 7272, x 400.

Fig. 10, *Laurophyllum rugatum* Z. KVACEK et BUZEK, abaxial cuticle, U20865, prep. 7314, x 400.

Fig. 11. *Laurophyllum rugatum* Z. KVACEK et BUZEK, abaxial cuticle, U20861, prep. 7315, x 400.

Fig. 12. *Laurophyllum rugatum* Z. KVACEK et BUZEK, adaxial cuticle, hairbases and stomata, U 20865, prep 7314, x 400.

Fig. 13. *Laurophyllum rugatum* Z. KVACEK et BUZEK, adaxial cuticle, stoma and hairbases, U 21164, prep. 4464, x 400.

Fig. 14. *Laurophyllum rugatum* Z. KVACEK et BUZEK, adaxial cuticle, hair, U 21164, prep. 4464, x 400.

Fig. 15. *Laurophyllum rugatum* Z. KVACEK et BUZEK, adaxial cuticle, hairs, U 21164, prep. 4464, x 100.

Plate 4

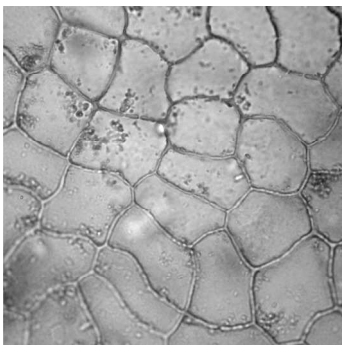


Fig. 1

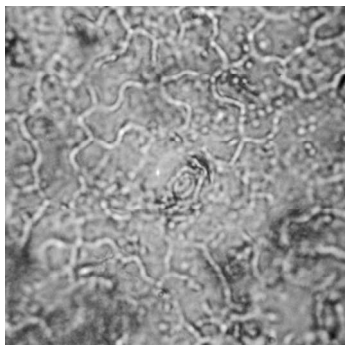
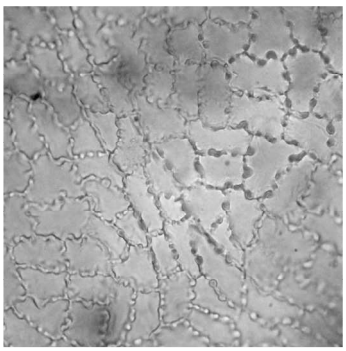


Fig. 2



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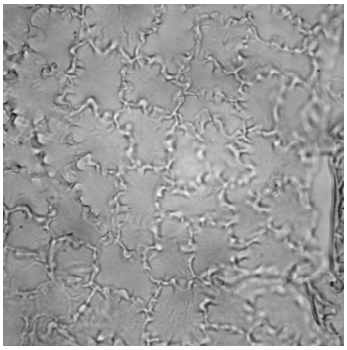

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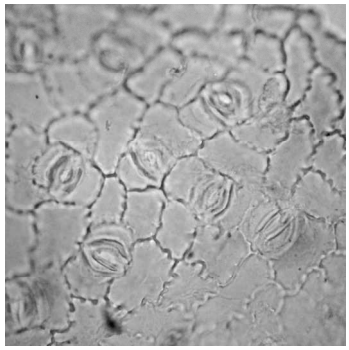

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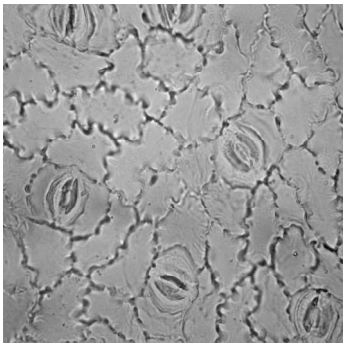

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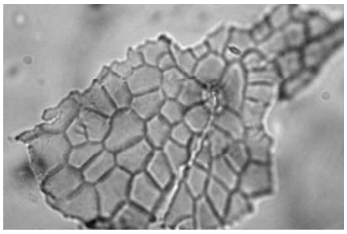

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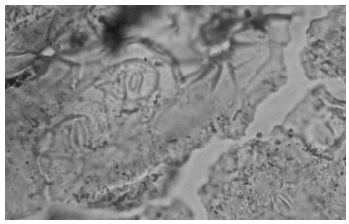

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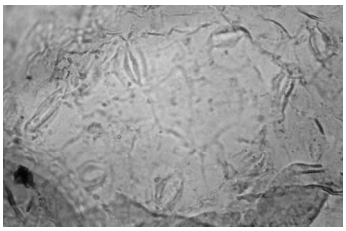

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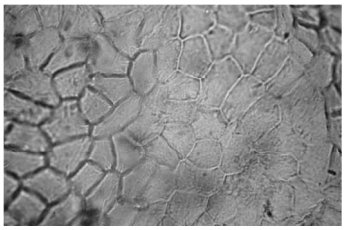

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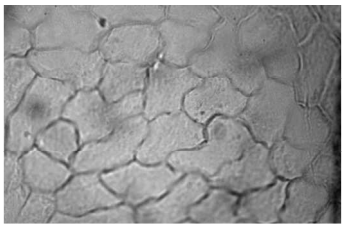

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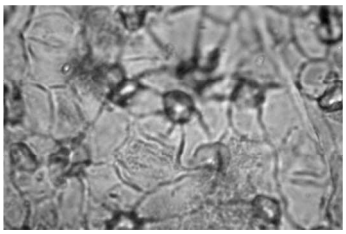

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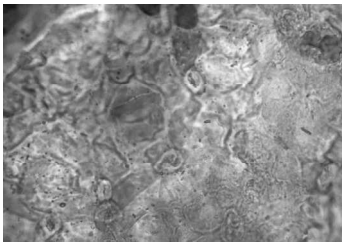

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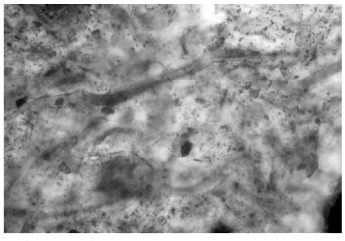

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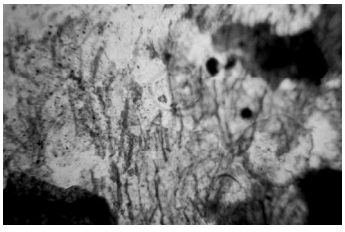

Fig. 15