

## The genus *Pinguicula* (Lentibulariaceae) in Albania – a critical review

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*Summary:* Detailed morphological, palynological, karyological, and chorological investigations lead to the conclusion that in Albania the genus *Pinguicula* L. (Lentibulariaceae) is represented by only two species not related to each other: *P. hirtiflora* Ten. and *P. balcanica* Casper. They are sufficiently differentiated by the growth form type – *P. hirtiflora* does not develop winter buds, *P. balcanica* winters by buds –, by the flower colour – the corolla of *P. hirtiflora* is pink to pale blue, *P. balcanica* is dark blueviolet –, by the hair covering in the corolla – *P. hirtiflora* has three longitudinally directed hair stripes in the tube, in *P. balcanica* a similar structure is missing –, and by karyological data – *P. hirtiflora* has  $2n = 28$ , its var. *louisii*  $2n = 28, 56$ , *P. balcanica*  $2n = 32$  chromosomes. *P. louisii* Markgr. is ranked as *P. hirtiflora* var. *louisii* (Markgr.) A. Ernst. *P. balcanica* is represented by its type variety. *P. vulgaris* L. or *P. leptoceras* Rchb. often mentioned in the relevant literature do not occur. Morphological features as hair covering in the corolla (SEM analysis), pollen grains, and seeds are presented in detail. The distribution area of the taxa is listed and mapped (dot map). The taxonomical position of the two species in the genus and evolutionary aspects are discussed.

*Keywords:* taxonomy, distribution, karyology, evolution, Albania, *Pinguicula*, Lentibulariaceae

Albania is a small and relatively isolated mountainous country (28,748 km<sup>2</sup>) situated in the western part of the Balkan Peninsula. Climate, hydrology, soil and vegetation are determined by the broad exposition to the Adriatic and Ionian Sea. The geology is built up by formations like evaporates, serpentines, carbonates, flysch and molasses (KABO 1990: 40–45).

The geomorphology of Albania is characterised by its rich relief: it is mainly hilly and mountainous with an average altitude of ~708 m. The mountain chains mainly stretching from northwest to southeast (Albanian Alps) and running parallel to the coast from north (Albanian Alps) to south (Epirus mountains), respectively – with the highest summits Jezercës (2,692 m) in the northern alpine region, Korabi (Mali i Korabit 2,753 m) in the north east, and Maja e Dritës (Mali i Nëmërçkës; 2,485 m) in the south – are fragmented from east to west by many rivers and deep gorges.

Outside of the high mountains areas in the north, east and south with their temperate climatic conditions, the climatic type of Albania is mediterranean-subtropical with average annual temperatures up to 17.6°C in the south. Precipitation ranges between maximum ~2,500 mm in the north (Albanian Alps) and minimum ~750 mm in the south (Korça district) with an average of about ~1,430 mm.

Despite of its limited area, Albania is distinguished by a highly diverse flora. Conservative estimates run up to more than 3,200 species of higher plants (cf. PAPANISTO et al. 1988). Endemic species, i. e. such as *Wulfenia baldaccii* Degen and *Forsythia europaea* Degen et Bald., have attracted the attention of many foreign and native researchers. As a whole, the floristic exploration of the country is relatively young and by no means completed.

In our article we will give an overview of the genus *Pinguicula* in Albania. The country cannot be said to be an Eldorado for carnivorous plants: *Pinguicula* is represented by two species only. However, the specific climatic situation is reflected well by them: The *Pinguicula crystallina-hirtiflora* aggregate [*P. hirtiflora* Ten. including var. *louisii* (Markgr.) A. Ernst; CASPER 1970] which does not develop winterbuds, i. e., winters with an open leaf rosette even under snow and ice, corresponds to the Mediterranean subtropical climatic conditions of the hilly and mountainous regions, whereas *Pinguicula balcanica* Casper<sup>1</sup> is a typical member of the temperate growth form type adapted to the low temperatures and the thick snow cover in the high alpine regions by developing winterbuds. Their Albanian distribution, for the first time given in detail in our paper, is in good accordance with the environmental features.

## Material and methods

Our investigation is based on the extensive study of dried and living specimens of *Pinguicula hirtiflora* var. *hirtiflora*, *P. hirtiflora* var. *louisii*, and *P. balcanica*.

Between 2002 and 2006, living specimens have been collected in Albania at various sites (cf. appendix pp. 61–65), photographically documented, and cultivated in the Botanical Gardens of Jena (BGJ) and Tirana (BGT). The photographic documentary material (original photographs, photocopies) has been deposited in the photograph collections of Tirana (PS-TIR = photograph collection Shuka, Tirana) and Jena (PT-JE = photograph collection Jena, Institute of Systematic Botany). The cultivated plants (mostly listed with their sample numbers, i. e. BGJ 133; cf. tab. 1) were used for karyological, palynological and morphological (i. e. the SEM analysis of the corolla hair covering) studies.

Dried specimens have been studied from the following herbaria: Berlin (B), Brno (BRNU), Budapest (BPU), Genève (G), Göttingen (GOET), Jena (JE), Saint Petersburg (LE), Naples (NAP), Prague (PRC), Sarajevo (SARA), Stockholm (S), Tirana (TIR), and Vienna (W, WU).

Karyological studies were performed using the traditional 45% carmine acid dyeing technique (LA COUR 1947; modified after VON STOSCH 1952) followed by squeezing. Phase contrast was used, too. Microscopical studies were performed using Olympus SZX9 (stereomicroscopy), Zeiss-Jenalumar (LM), digital camera Olympus (microphotography).

## The historical background of *Pinguicula* study in Albania

The first report about the genus *Pinguicula* in Albania is from GRISEBACH<sup>2</sup> (1844: 9). He had collected a butterwort “in Albania boreali: in scaturiginosis muscosis distr. Ducajin [Dukagjin] pr. Chan X [Fushë-Arrës] sive Vlet [Flet] alt. 1000' (substr. jasp.). Juli–August.” [GRISEBACH 1841: 349/350; July 27<sup>th</sup>, 1839]<sup>3</sup>. GRISEBACH, who believed his plant to be a new species, named it *Pinguicula albanica*, added a brief diagnosis and a detailed description. He compared it with

1 *Pinguicula balcanica* subsp. *balcanica* var. *balcanica* (see p. 19).

2 August Heinrich Rudolf Grisebach (1814–1879), German botanist, 1841–1879 professor of botany at the University of Göttingen; published among other things his famous „Die Vegetation der Erde nach ihrer klimatischen Anordnung ...“ (1872; second edition 1884–1885).

3 Reporting on his journey Grisebach did not mention his *P. albanica*, but reported that he passed the watershed between Drin and Mat near Chan 10 and 11 on July 27, 1839, places situated in immediate neighbourhood of the locality written on the label added to his gathered specimens; cf. MARKGRAF (1932: 35).

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*P. lusitanica* and *P. crystallina* writing: “*Media inter P. lusitanicam L., calcare conico obtuso, et P. crystallinam Sibth., calcare apice obtuso et scapo basi glabro, dignoscenda*”. He did not refer to *P. hirtiflora* Ten. Obviously he was not aware of the existence of Tenore’s taxon from South Italy. It was BOISSIER (1879: 2) who put Grisebach’s *P. albanica* into the synonymy of *P. hirtiflora*.

About a hundred years later, BORNMÜLLER<sup>4</sup> (1933: 129) visiting the locus classicus was convinced – like SCHINDLER (1908: 61, 68), JÁVORKA (1926: 290), and MARKGRAF (1932: 107) – Grisebach’s *P. albanica* to be identical with Tenore’s *P. hirtiflora* which he knew from M<sup>te</sup> San Angelo near Castellammare (M<sup>ti</sup> Lattari, Italy; locus classicus).

On several botanical expeditions to Albania at the end of the 19<sup>th</sup> and at the beginning of the 20<sup>th</sup> century *Pinguicula hirtiflora* has been collected on various sites. Important collections and reports are from A. BALDACCIO (1892 [1894], 1900a; summary 1900b), I. DÖRFLER (1914, 1916, 1918 [the two latter in HAYEK 1924]), J. ROHLENA (1904, 1937, 1941/42) and S. JÁVORKA & J. B. KÜMMERLE (1918 [JÁVORKA 1926]) in E. CSIKI et al. 1926. They brought new insights into the distribution but only little new informations about the taxonomy of the species.

In 1924, FRIEDRICH MARKGRAF<sup>5</sup> started his studies on flora and vegetation of Albania which should last – with large interruptions – until 1942. The discussion about the taxonomical state of *P. hirtiflora* in Albania revived when he described *P. louisii* (1926: 430). In 1924, he had detected the allegedly delicate butterwort on his botanical journey across Central Albania at the water-trickled banks of the brook Lum i Ljanës [Lumi i Tiranës, Shkalla e Tujanit] NW of Linza near Tirana (CASPER 2004). He pointed out that his new species was distinguished by corolla lobes not emarginate but rounded at the apex, by the ± long straight spur and the delicate growth. Contrary to the indistinctly flesh to pink coloured corolla lobes of *P. hirtiflora*, his *Pinguicula* should be distinguished by its pale blue corolla lobes.

Unfortunately, the original material had been destroyed during World War II at Berlin-Dahlem (but see appendix on 1.2 *Pinguicula* var. *louisii*, Tirana, Lum i Ljanës). That is the reason why, for a long time, the true nature of *P. louisii* escaped botanists’ notice. Later on, MARKGRAF (1942: 665) reported about new sites of his *P. louisii* in the northern part of the ‘landscape Mat’ which he had visited in 1941<sup>6</sup> without giving any concrete localities. Additionally he annotated that “*Dr. Hoffmann had taken with him P. louisii from Thethi*”.

4 Joseph Friedrich Nicolaus Bornmüller (1862–1948), German botanist, Custos of the Herbarium Haussknecht Weimar (JE), undertook several successful plant gatherings in the Balkans, in Asia Minor, in Iran, on Madeira and the Canaries. He annotated (1933: 129): “*Distr. Mirdita, an der alten (Grisebachschen) Karawanenstraße zwischen Puke (Puka) and Han-i-Arsit, nahe Vlet (Flet = Han X). Hier nur an einer einzigen kleinen Stelle (links vom Saumpfad) auf abschlüssigem quelligem Terrain.*“ [Distr. Mirdita, along (Grisebach’s) old caravan route between Puke and Han-i-Arsit near Flet. Here only at a single small site (left of the mule-track) on sloping watery ground]. He emphasized: “*Dies ist ohne Zweifel der Fundort der P. Albanica!*” [This is without any doubt the place where *P. Albanica* has been found!].

5 Friedrich Markgraf (1879–1987), German botanist, professor of botany at the universities of Berlin (1939–1945), München (1948–1957), visiting professor Ankara (1957–1958) and Zürich (1958–1967). His studies on flora and vegetation of Albania culminated in his ‘Pflanzengeographie von Albanien’ (1932).

6 The journey has been undertaken by the ‘Reichsforschungsrat’ on behalf of the German and Italian military supreme command led by H. Stubbe from the Kaiser-Wilhelm-Institut für Biologie, Berlin-Dahlem (Germany). The said W. Hoffmann participated in the expedition and came from the Kaiser-Wilhelm-Institut für Züchtungsforschung, Müncheberg/Mark (Germany).

Largely unnoticed, BRUNO SCHÜTT (1936, 1945)<sup>7</sup> collected plants during several field campaigns in Albania in 1927, 1928, 1929, and 1933, nearly at the same time as Markgraf did. He completed them in 1935 by his journey across the landscape north of the river Drin and his tributary, the White Drin.

Between 1959 and 1961, Friedrich Karl Meyer<sup>8</sup> collected intensively throughout Albania. His *hortus siccus* comprises more than 3,500 collector's numbers which currently are in treatment, an important basis for taxonomical studies at all and especially on the *P. crystallina-hirtiflora* aggregate. In 1960, he succeeded in refinding the Markgraf taxon near the original site (W of Linza, brook Itimit [= Ltinit], F. K. Meyer 5555 – JE).

Between 2002 and 2006, many gathering campaigns were performed by Luëzim Shuka, Murat Xhulaj and Lefter Kashta. In 2004, M. Xhulaj and L. Kashta supplied the latter author with living plants from the place nearby (banks of brook Ltinit W of Linza). They were successfully cultivated in the Botanical Garden Jena (BGJ). The results of the investigation of living (cultivated) and dried specimens are laid down in CASPER (2004) and will be discussed below.

Not until 1926, *Pinguicula balcanica* Casper has been recorded from Albania under the name *P. leptoceras* Rchb. sensu Griseb. based on material collected in 1918 by J. B. Kümmerle from Mali i Korabit (Korab) in an altitude of 2,400 m (JÁVORKA 1926: 290).

GRISEBACH (1844: 9), who had given a brief but accurate description of the taxon he believed to be *P. leptoceras*, knew it only from “*regione alpina Macedoniae et Thraciae: rare ad nivem deliquescentem m. Peristeri alt. 6500' (substr. granit), in Rhodope pr. Carlova (Friv.) (Juni–Aug.)*”<sup>9</sup>. At least, following him, the nomen was accepted by BORNMÜLLER (1927: 10)<sup>10</sup> and HAYEK (1917: 183, 1924: 166, 1929: 209): the blueviolet *butterworts* from Bosnia, Hercegovina, Montenegro, and Albania should belong to Reichenbach's taxon. Indeed, the species in question are similar to each other but sufficiently different as CASPER (1962: 105–107) has shown.

*Pinguicula balcanica* is represented in Albania by its subsp. *balcanica* var. *balcanica* (CASPER 1970: 289–290). Its type (holotype) is the voucher collected by J. B. Kümmerle on July 25, 1918, ... “*Schneegipfel des Korab ... beim Dorfe Radomir ...*” [ ... snow summit of Korab mountain ... near the village Radomir ...] and deposited in BPU (CASPER 1962: 105–106). This view has been accepted by MILL (1978: 108–109) and STRID & KIT TAN (1991: 278).

What about *P. sempervivum* Janka? Janka had collected a *Pinguicula* “*in locis aquosis frigidis reg.*

7 Bruno Schütt (1876–1956), German botanist, teacher in Bremen, extensive field research in former Yugoslavia and Albania. His plant collection is deposited in the Übersee-Museum Bremen, Botanical Department, Herbarium of Bremen (BREM).

8 Friedrich Karl Meyer (\*1926), German botanist; in a position of responsibility (Curator of the Herbarium Haussknecht Jena – JE) from 1950 to 1991; brought together more than 3,500 herbarium specimens of Albanian provenance.

9 One single voucher collected by Grisebach in Albania exists in GOET, that means he must have seen the taxon in question.

10 BORNMÜLLER (1927: 10) remarked: “... *auch in Bulgarien und Albanien mehrfach beobachtet.*” [ ... also observed repeatedly in Bulgaria and Albania]. He added: “... *P. vulgaris aus dem Ochrida-Gebiet: im albanischen Grenzgebirge westlich von Struga (V.17, O. Rubitschung 28).*” [ ... *P. vulgaris* from Ochrida region: Albanian border mountains west of Struga (V.17, O. Rubitschung 28).] That means, he acknowledged *P. vulgaris* L. and *P. leptoceras* as inhabitants of Albania.

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*superioris m. Balkan prope Kalofer, Thraciae, 29. Junii 1871 Janka*” [with reference to the locality cf. the quotation above “*in Rhodope pr. Carlova (Friv.)*”] which he distributed in his exsiccate collection “*Janka iter turcicum a. 1871*” (for instance WU-Kerner). SCHINDLER (1907/08), who did not mention *P. sempervivum* in his ‘revision’, had studied the voucher and considered it “*P. vulgaris L. ad P. leptoceras Rchb. vergens*”. The two specimens represent *P. balcanica* Casper. To the WU-sheet a label is added “*Pinguicula sempervivum Janka 1872*”. As it becomes clear from JANKA (1873: 205), the new *Pinguicula* has not been validly described. Hence, the Janka nomen has no priority over the Casper nomen and did not come into use.

## Key to the species

- 1 Homoblastic (‘homophyllous’) rosette plant hibernating with an open leaf rosette, no winter buds developed; colour of distal parts of corolla lobes fleshy, pink to bright blue (var. *louisii*); corolla with a distinct palate-like yellow-greenish hairy crowd on the proximal part of the middle lobe of the lower lip; upper lip lobes much shorter than the lower ones, without a greenish-yellow spot, with a conspicuous net-like pattern of purple nerves on their proximal part; lobes of lower lip not or rarely overlapping, their distal margin retuse to emarginate, rarely rounded (var. *louisii*); tube ± cylindrical, its inside with three distinct separated longitudinal hair stripes on the ventral face; spur of different length, often longer (maximum 1½×) or ± as long as the rest of the corolla, straight (often in youth) deflected, yellowish-greenish; plant very variable in habit and flower structure. In Albania *P. hirtiflora* var. *hirtiflora* and var. *louisii* (= *P. louisii*) ..... 1. *P. hirtiflora*
- 1\* Heteroblastic (‘heterophyllous’) rosette plant hibernating by winter buds; flower colour deep violet-blue, with an extensive white densely hairy spot on the proximal part of the face of the lower corolla lip; corolla without a palate-like structure; lobes of the upper lip without hair covering, shorter than the lower ones, touching or overlapping, without a purple nerve pattern; lobes of the lower lip touching or overlapping, suborbicular; tube widely funnel-shaped, its inside without three distinct longitudinal hair stripes; spur short, maximum as long as ⅓–¼ of the whole corolla length, straight to slightly deflected. In Albania only subsp. *balcanica* var. *balcanica* ..... 2. *P. balcanica*

The Albanian taxa of *Pinguicula*1. *Pinguicula hirtiflora* Ten. (Pl. 1, 2)

Tenore, Fl. Napol. 1, Prodr.: VI. 1811; Fl. Napol. 3: 18. 1824.

Syn.: ≡ *P. crystallina* Sm. in Sibth. et Sm. subsp. *hirtiflora* (Ten.) Strid in Strid & Kit Tan, Mount. Fl. of Greece 2: 276 (1991).

Type: M.<sup>te</sup> della Cava, di Castellammare, all’acqua Santa, s.d., Ten. – NAP (Lectotype; designated by Peruzzi in PERUZZI et al. 2004).

Iconotype: Tenore, Fl. Napol. 5: pl. 201. fig. 2 (1835–1838).

= *P. albanica* Grisebach, Spic. Fl. Rumel. 2: 9 (1844).

= *P. laeta* Pantocsek, Österr. Bot. Z. 23: 80 (1873). – Verh. Vereins Natur-Heilk. Pressburg 1871–1872 (2): 74. 1874.



Plate 1: *Pinguicula hirtiflora* var. *hirtiflora*. – Fig. 1 habitat; Grabomi (Lumi i Cemit); fig. 2 population from Lumi i Zanaqishtit; fig. 3 population from Përroi i hijes; fig. 4 flowers, front view, population of Fusha e Rrosë (note in figs. 3 and 4 the purple veined not emarginate upper lip lobes distinctly smaller than the emarginate corolla lower lip lobes) . – Photographs: L. Shuka. – Magnification: figs. 2–3:  $\approx 2/3$ ; 4:  $\approx 2:1$ .

Perennial (holo-)rosette herb, wintering as a leaf rosette. Rhizome very short, erect, with numerous adventitious thread-like roots. Leaves 6–9(–12), 20–40(–80) mm long, (5–)10–30(–40) mm broad, broadly elliptical to obovate in outline, obtuse to emarginate at apex, barely rolled inwards

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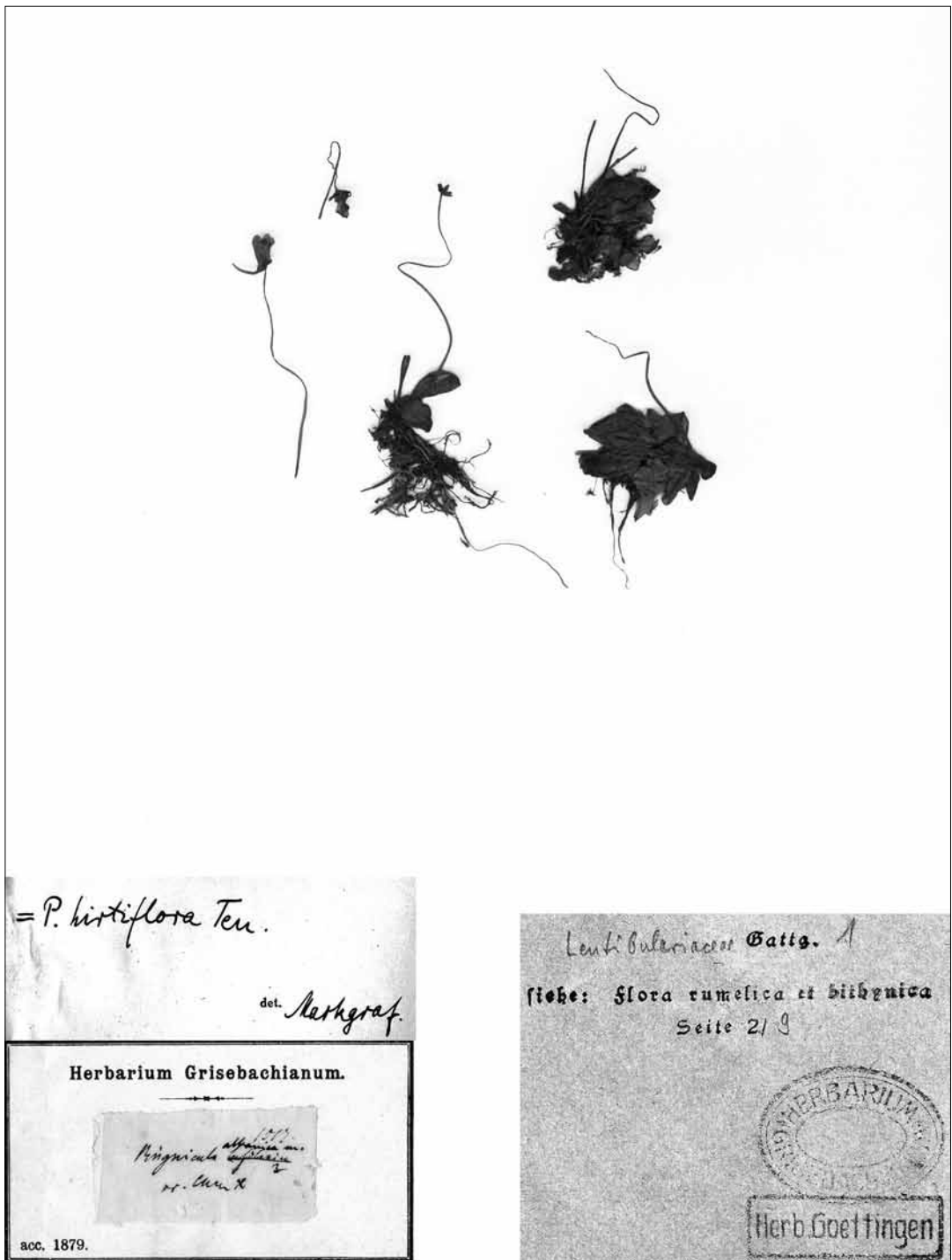


Plate 2: Grisebach's sheet 1017. *Pinguicula albanica* [*Pinguicula hirtiflora* Ten.], the first evidence of *Pinguicula* from Albania. – Photocopy GOET.

at margin; petiole flattened, short, deflected through an angle of  $\sim 90^\circ$  with the leaf blade. Scapes 1–5(–7), (35–)50–115 (–145) mm tall, spirally coiled when young, elongated and erect from anthesis to fruiting, slender, greenish,  $\pm$  glandular-pubescent. Calyx 2-lipped, bright green,

± glandular-pubescent externally; both lips ~2.5 mm long; upper lip 3-lobed, lobes elliptical-oblong to slightly spatulate, obtuse or truncate; lower lip truncate (sometimes nearly entire), emarginate or to 1/3 of its length 2-lobed. Corolla 2-lipped, (13–)16–25 (–32) mm long including spur, sparsely glandular pubescent externally; lips flesh-coloured, pale pink, lilac or bright to pale blue, sometimes whitish or white; palate-like zone, throat, and spur pale yellowish-green; upper lip 2-lobed, lobes obovate-obtuse, entire or rarely slightly emarginate at apex, with a net-shaped pattern of purple nerves; lower lip longer, deeply 3-lobed, the median lobe often longer than the lateral ones, with a distinct yellowish-greenish crowded palate-like zone on its proximal part, lobes obovate, 2 times longer than wide, emarginate or truncate at apex, rarely rounded; tube cylindrical to funnel-shaped, yellowish-greenish with longitudinal purple nerves, on the ventral outside with a longitudinal channel-like deepening which ends in an orbicular depression at the palate-like region; spur shorter than or as long as the rest of the corolla, (4–)7–10(–13) mm, cylindrical-subulate, straight or slightly deflected, yellowish-greenish. Stamens 2, pollen grains stephano- (6–)7–8(–9) colpate. Ovary subglobose, 1 mm diam., sparsely glandular pubescent, stigma 2-lipped, lower lip orbicular, fimbriate. Capsule globose, ~3 mm diam., overtopped by the persisting calyx. Seeds like sawdust, tiny, 0.5–1.0 mm long, 0.2–0.3 mm wide, regularly cylindrical to crescent (banana-like), exotesta (outer seed coat) honey-combed.

Chromosome number  $2n = 28$ .

Flowering from (February) April to October depending on altitude and exposure.

Gregarious on shady steep rocks with seeping water, around springs, along streams and brooks running through wet meadows or scree, ~150–1,650 m, on serpentine, limestone, marl, tufa, schist or conglomerate.

#### Key to the infraspecific taxa

1 Corolla lips pale blue; tips of lobes of calyx and corolla lower lip rounded, truncate or emarginate; spur mostly longer than rest of the corolla, straight to slightly deflected.

Endemic in Central Albania ..... *P. hirtiflora* var. *louisii*

1\* Corolla lips pink to pale blue; tips of lobes of calyx and corolla lower lip emarginate to truncate, rarely rounded; spur mostly shorter than or as long as the rest of the corolla, rarely longer, often distinctly deflected.

Widely distributed in Albania ..... *P. hirtiflora* var. *hirtiflora*

#### Annotations

As we have already stated above, the first report about a *Pinguicula* species from Albania is from Grisebach. The corresponding sheet is deposited in GOET (Herbarium Grisebachianum).<sup>11</sup> At first, he had called the specimens *P. lusitanica* but then he changed his opinion and replaced the Linnean nomen by *albanica* m [mihi]. It is a point in his favour that after the diagnosis he discussed a possible relationship to the atlantic *P. lusitanica* L. (and to *P. crystallina* Sm. from Cyprus) showing that he was aware of the specific taxonomical position of his taxon within the genus *Pinguicula*.

11 It shows a label with the handwritten remark: “1017. *Pinguicula lusitanica* pr. Chan X”; the epithet *lusitanica* is crossed out and corrected by *albanica* m. (pl. 2). GRISEBACH (1844: 9; cf. GRISEBACH 1841: 349–350) identified the place where he had found his taxon in the printed version as “pr. Chan X”.



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Plate 3: Figs. 1–12 *Pinguicula crystallina-hirtiflora* aggregate of Albania; variation of corolla lobes. – Figs. 1–2 *P. hirtiflora* var. *louisii*; fig. 1 from Linza (fig. 1.1 with lower lip lobes rounded at apex); fig. 2 from Dajti, with lower lip lobes not emarginate; fig. 3 Këlcyra; fig. 4 Përroi i hijes, upper lip lobes slightly emarginate; fig. 5 Librazhd (along road to Elbasan); fig. 6 Librazhd-Togëz (Lumi i Rrapunit); fig. 7 Librazhd (behind railway tunnel); fig. 8 Krorëz-Gjergjevica (note the broad double middle lobe); fig. 9 Moçali i madh; fig. 10 Shkalla e Rrapshës; fig. 11 Fusha e Rrosë (note in fig. 11.2 the broad double middle lobe); fig. 12 Lumi i Zanaqishtit. – Photographs: L. Shuka. – Magnification: figs. 6, 8 : ~1:1; figs. 1–5, 7, 9–12: ~2.5:1.

In literature differing views are held on the true nature of the Albanian *P. hirtiflora*. Nobody of the 19th century botanists seems to have been aware of the striking feature that the taxon does not form winter buds during its development, i. e. they did not know thermophilous behaviour. Winter buds are produced by all of the (microthermal) species dwelling in temperate habitats as for instance *P. vulgaris* L. and *P. alpina* L. Even for this reason it is impossible to unite *P. hirtiflora* or *P. crystallina* with *P. vulgaris*.

Markgraf did not realize the tropical-homophyllous growth form of *P. hirtiflora* and his *P. louisii*, too. Contrary, in his letter of November 5, 1959, quoted above, he wrote: "... Naturally, winter buds I have not seen because I didn't travel during autumn, but there is no reason that it didn't form such ones ..."<sup>12</sup>. So he did not realize the regular change in forming generative (flowering and fruiting) and vegetative (non flowering or fruiting) compact rosettes built of similar leaf generations without developing winter buds. He had not realized that both, *P. hirtiflora* as well as his *P. louisii* were thermophilous elements.

### Morphological features

#### Variation in size, shape, and colour of corolla lobes (pl. 3)

Our plate 3 shows corollas in front view selected from twelve different Albanian sites.

The outline of the corolla lobes can be broadly orbicular, rounded to truncate, not emarginate (figs. 1.1; 2), broadly rectangular, slightly emarginate (figs. 1.2, 12.1) or deeply emarginate (figs. 5, 9.1, 9.2), distinctly oblong to narrowly oblong, deeply emarginate at apex (figs. 3.1, 4.1, 11.1, 12.2, 9.3). Usually, the lobes of the upper lip are distinctly shorter than those of the lower lip and rarely emarginate at apex (figs. 4.2, 5, 11.2). They are usually 'ornamented' by a purple net-like nerve pattern.

Sometimes the lobes of the corolla lower lip touch or overlap (figs. 2, 4.2, 9.1). Occasionally, repeated division of the middle lobe occurs resulting in an increase in the number of lobe tips (three to four; cf. figs. 3.2, 8, 11.2). The flowers are widely open, the lobes of the upper and of the lower lip form with each other an angle of about (100°–)130°–160°(–180°).

The flower colour varies considerably. The distal sections of the corolla lobes are pink (figs. 1, 3, 5, 12) to blue (figs. 2, 4, 6, 8, 9, 11), the proximal ones white with a greenish-yellow hairy spot (the palate-like 'crowd') at the base around the throat. In figs. 9 and 10 the corolla lobes are whitish to white with a yellow hairy spot. In all of the flowers observed this yellow hairy spot ahead the throat is a significant characteristic. It is consistent and taxonomically more meaningful than the flower colour in all.

On the whole, variation in size, shape and colour of corolla lobes is evident, but without changes to the basic pattern and without a distinct geographical or ecological cline. Figs. 1 and 2 show the character state of the var. *louisii*-populations at Ltnit brook and of the neighbouring Dajti, respectively. We see that the Dajti-(Perroi i Llahingave-)population is fairly different from the Linza-(Perroi i Ltnit-)population regarding calyx and spur which resemble the corresponding characters in *P. hirtiflora* var. *hirtiflora* (cf. footnote 25, annotations to the *Pinguicula hirtiflora*-population at locus classicus).

<sup>12</sup> Original German version: "... Winterknospen habe ich natürlich nicht gesehen, weil ich nicht im Herbst gereist bin, aber es besteht kein Grund zu der Annahme, dass sie keine bildet ...".

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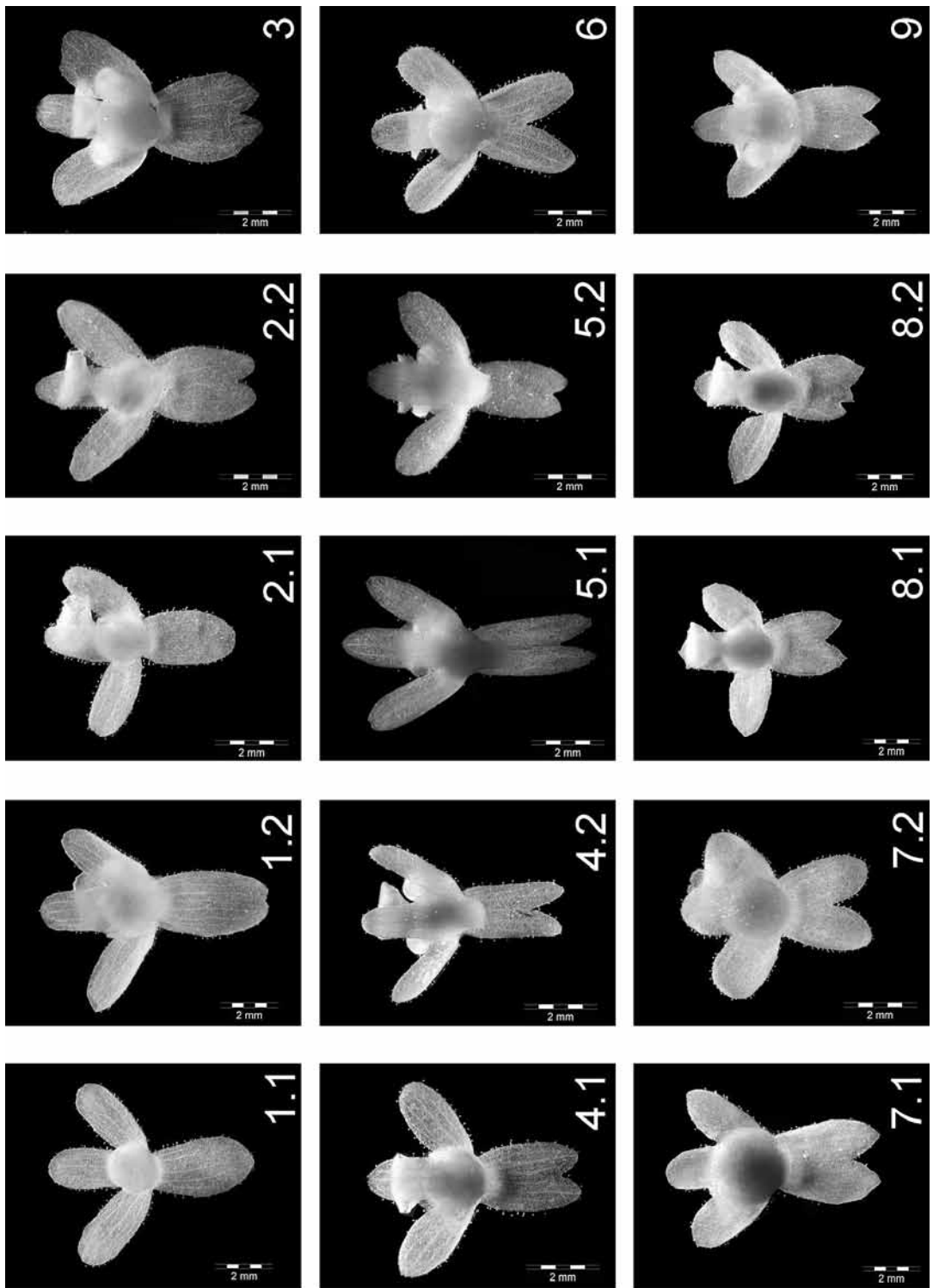


Plate 4: Figs. 1–9 *Pinguicula crystallina-hirtiflora* aggregate of Albania; variation in size and shape of calyx lobes. – Fig. 1 var. *louisii* from prr. i Ltinit (note in fig. 1.1 the undivided lower lip lobe); fig. 2 var. *louisii* from Dajti (note in fig. 2.1 the undivided lower lip lobe); fig. 3 Këlcyra; fig. 4 Librazhd (behind railway tunnel); fig. 5 Librazhd, Togëz (Lumi i Rrapunit); fig. 6 Floq; fig. 7 Rrapsha (spring); fig. 8 Shkalla e Rrapshës; fig. 9 Grabomi (Lumi i Cemit). – Preparation and photographs: Rosemarie Stimper.

## Variation in size and shape of calyx lobes (pl. 4)

The calyx is distinctly two-lipped. The upper lip consists of 3 oblong to nearly orbicular lobes, deeply (nearly to the base) divided at apex and never overlapping (figs. 1–9). The lower lip is characterized by 2 oblong to nearly orbicular lobes rounded or slightly pointed at apex, divided to  $\frac{1}{4}$ – $\frac{1}{3}$  (– $\frac{1}{2}$ ; fig. 6) of its length and never overlapping, but rarely really spreading (fig. 6). Sometimes, it is not divided (figs. 1.1 – var. *louisii* from the Ltinit brook population; 2.1– var. *louisii* from the Dajti population) or often slightly emarginate (fig. 1.2). In some cases we observed an increase in the number of lobes (figs. 3; 8.2). In figs. 4.2 and 5 the lobes are fairly narrow.

As in the corolla, variation of size and shape of calyx lobes is evident without changes to the basic pattern and without a distinct geographical or ecological cline. Comparing the Albanian specimens with those of Acqua Santa near Castellammare (locus classicus) there is no real difference: for instance the calyx lower lip is often not emarginate or divided into two lobes (cf. TENORE 1835–1838: pl. 201, fig. 1).

## The non-glandular hair covering (indument) in the corolla (pl. 5)

The glandless hair covering (the ‘Futterhaare’ of German literature) of the upper surface of corolla lobes, of throat and palate region, of the insides of tube and spur is a significant feature within *Pinguicula*. It is possible to group the species according to their non-glandular hair pattern and to the different forms of their hairs. ERNST (1961), CASPER (1962, 1966), and MIKELADSE (1996) have studied the aforementioned structure in detail.

In all of the specimens studied we have found, that the hairy region at the base of the middle (median) lobe of the corolla lower lip, at the palate, and at the tube entrance (throat), is strikingly greenish-yellow. A similar yellowish ‘patch’ is known in other European species, *Pinguicula alpina* and *P. lusitanica* (here much more complicated regarding its structure), too.

The numerous hairs of the ‘palate region’ at the base of the middle lobe or at the tube entrance, respectively, are densely packed like a crowd and directed to the front, i. e. to the distal part of the middle lobe. The crowd can appear as a single (fig. 11) or an indistinct two- to four-part accumulation of hairs (figs. 2, 3, 10, 12). These ‘palate hairs’ are  $\sim 300\ \mu\text{m}$  long, simple, multicellular uniseriate, consisting in the lower part above the foot cell of three longer bottle-like cells (figs. 13–16), in the upper part of five to eight shorter, more or less inflated cells forming a long thin uni- (figs. 13–14) or biseriate (fig. 15) ‘club’. The ‘club’ (head, capit, top) can be divided into two to four cells. At the base of the lateral lobes neither a hairy crowd nor palate like structures are developed.

Ahead of the densely hairy palate region at the bases of the middle lobe as well as on the lateral ones a small zone of scattered simple multicellular hairs is developed extending to  $\sim \frac{1}{3}$  of lobe length (figs. 1–4).

Behind the palate region a short ring-like zone of scattered irregularly oriented hairs occurs on the ventral and lateral inner surfaces of the throat (figs. 1–3, 5). The ventral and lateral sides of the tube are distinguished by a pronounced zone of three separated longitudinal ‘stripes’ of hairs extending to but not entering the spur (figs. 1–3, 5–6). The hairs are directed backwards, i. e. to the proximal end of the tube. They are formed like asparagus sticks and are  $\sim 500\ \mu\text{m}$  long. They consist of up to ten cylindrical cells tapering and getting smaller to the top, their top cell distinctly pointed. Similar hairs are absent on the upper lip lobes and in the spur.

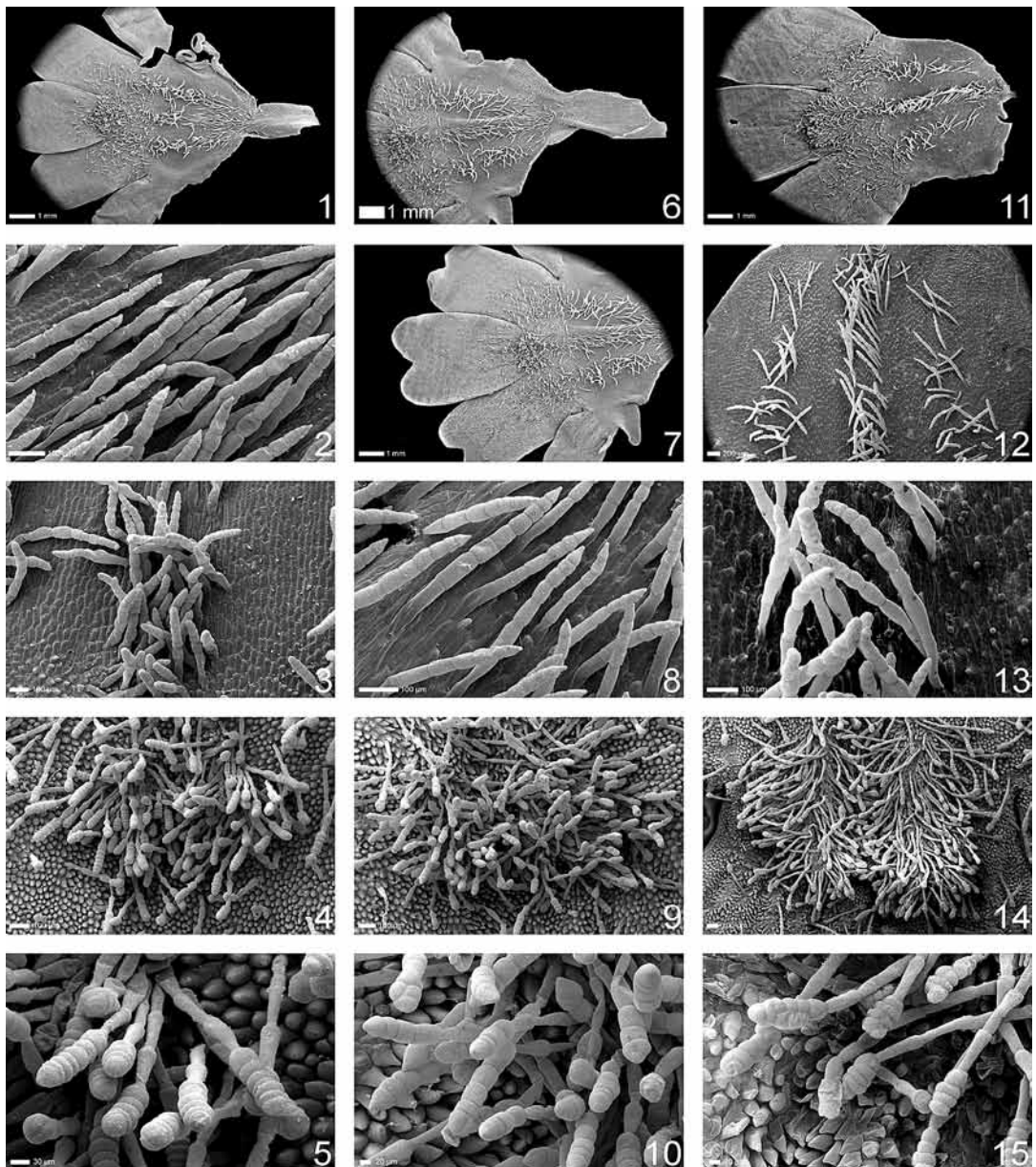
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Plate 5: Figs. 1–15 *Pinguicula crystallina-birtiflora* var. *birtiflora*, hair covering pattern and hair morphology (indument); SEM photographs. – Vertical row, to the left (figs. 1, 4, 7, 10, 13): Librazhd, behind the railway tunnel, BGJ 87.1; vertical row, in the middle (figs. 2, 5, 8, 11, 14): Floq, Qafa e Qarrit, BGJ 88; vertical row, to the right (figs. 3, 6, 9, 12, 15): Shkalla e Rrapshës, BGJ 133. – Figs. 1–3, 5 corolla, unfolded, showing the hair pattern; see the palate region at the throat and the three-striped hair pattern in the tube. – Figs. 4, 6–10 tube, zone of the three lengthways hairy stripes; note the asparagus like narrow pointed hairs directed to the distal part of tube. – Figs. 10–12: club-like (capitate) hairs in palate region. – Figs. 13–15 details of club-like (capitate) hairs. – Preparation: Ingemarie Stimper; SEM microphotographs: Ingemarie Herrmann.

Our SEM microphotographs (pl. 5) do not reflect the whole amplitude of variation. For example, the longitudinal stripes can be much shorter and in their distal part replaced by stripes with hairs directed forwards. The transition zone between tube and middle lobe can be developed regularly and extended to the lateral sides. But these modifications do not affect the basic pattern.

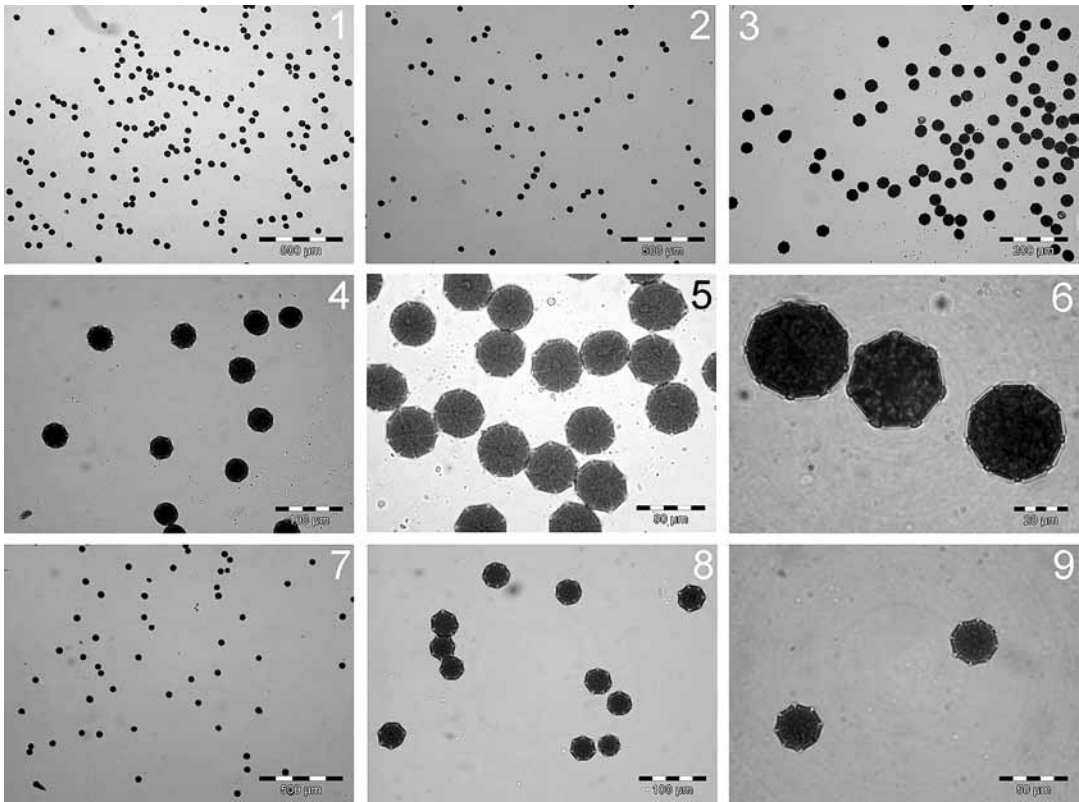


Plate 6: Figs. 1–9 *Pinguicula hirtiflora*, pollen grains taken from two flowers of different provenance. – Figs. 1–6 Shkalla e Rrapshës, BGJ 133; figs. 1–4 without any disorder; fig. 5 stephano- 7–9 colporate; fig. 6 stephano- 7–9 colporate. Figs. 7–9 Grabomi (Lumi i Cemit), BGJ 134; figs. 7–9 without any disorder; figs. 8–9 stephano- 7–8 colporate. – Preparation and microphotographs: Rosemarie Stimper.

#### Pollen grains (pl. 6, figs. 1–9; pl. 7, figs. 13–20)

From the embryological point of view no detailed information about *Pinguicula* from Albania is available. As far as we can see the development of pollen grains in the genus has only been studied by CASPER (1963: *P. crenatiloba* DC.) and ESPINOSA-MATÍAS et al. (2005: *P. agnata* Casper, *P. oblongiloba* DC., *P. crenatiloba* DC.). Meiotic divisions of the pollen mother cell by simultaneous cytokinesis lead to the formation of four microspores arranged in tetrads.

In specimens of *P. hirtiflora* var. *hirtiflora* from Albania no meiotic disorder has been observed.<sup>13</sup> The mature microspore, the pollen grain, has three nuclei. The infection of the pollen sac by *Ustilago* has not been observed (but see on *P. balcanica*). As in *Pinguicula* only two stamens are developed the number of pollen grains is relatively small. About 99% (estimated) of the pollen grains of two pollen sacs is more or less equal in size and form (pl. 6, figs. 1–9); aberrant pollen grains (nano- or gigas-pollen) have not been observed.<sup>14</sup>

13 Studying *P. hirtiflora*-pollen grains from M. Olimbos, Greece (Enipevs-Tal, unweit Hagios Dionysos; 1.6.1958, Casper – JE), KAHLEYS (1994: 51) deplored that most of the pollen grains had been heavily deformed, but she did not discuss the reason for the abnormality observed. MIKELADSE (1996: 65–66) did not report about any aberrant appearance in *P. hirtiflora*-pollen grains from Rossano, Italy (material provided by J. Steiger, Bern, Switzerland).

14 Additionally, we have studied air-dried pollen from Librazhd, Këlcyra, Shkalla e Rrapshës and Grabomi (Lumi i Cemit). – See pl. 6.

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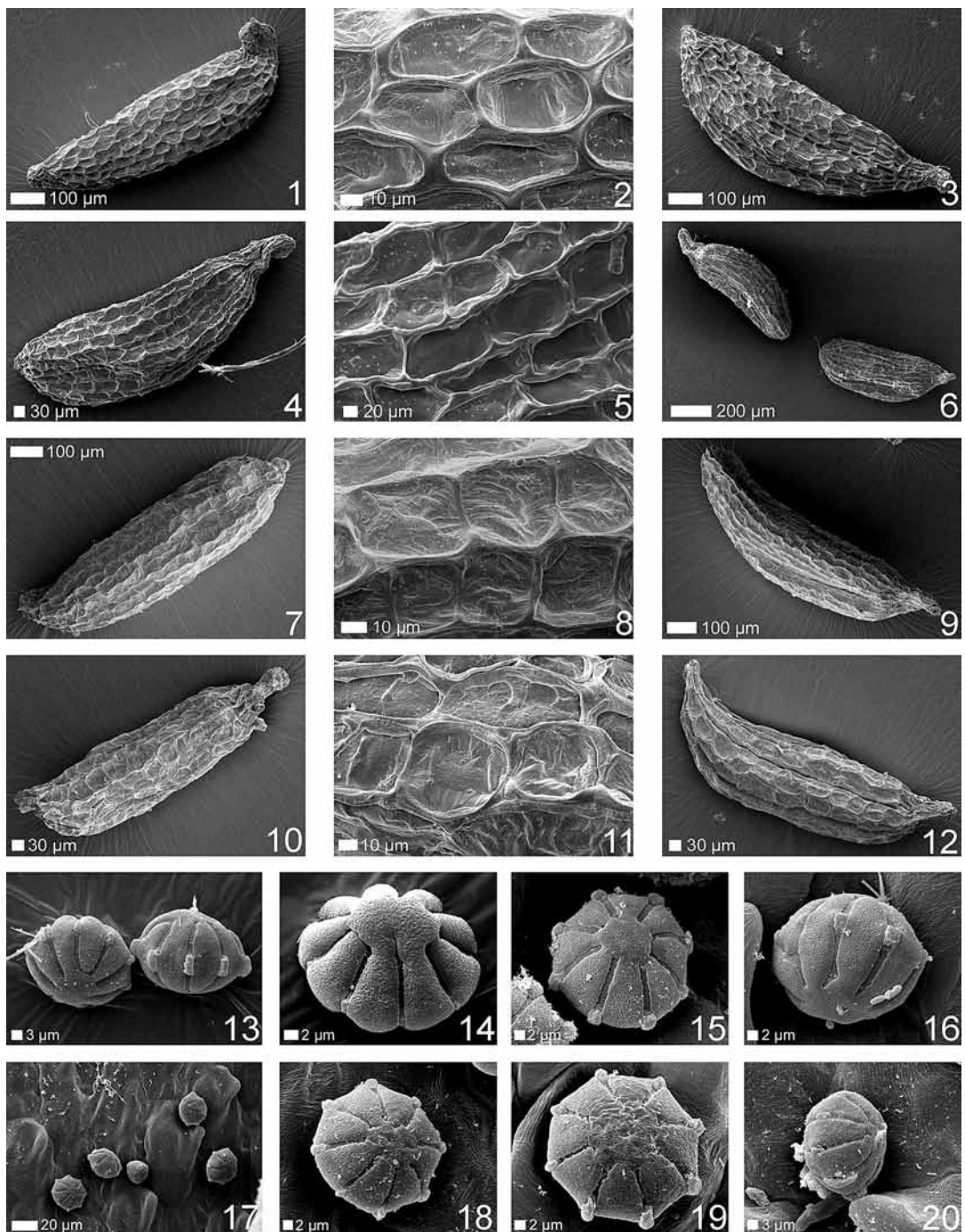


Plate 7: Figs. 1–20 *Pinguicula hirtiflora* var. *hirtiflora*, seeds and pollen, SEM microphotographs. – Figs. 1–12 seeds; figs. 1, 3–4, 6–7, 9–10, 12 general view; shape banana-like to cylindrical; – figs. 1, 3, 4, 6: right specimen, 9, 10 micropylar appendage at the right seed pole; – fig. 6: left specimen; figs. 7, 12 micropylar appendage at the left seed pole; – figs. 6 right specimen, 9 chalazal appendage absent. – Figs. 2, 5, 8, 11 details of exotesta surface. – Figs. 1–3 Librazhd-Togëz (Lumi i Rrapunit); 4–6 Pepellash, Qafa e Qarrit; 7–9, Uji i Frohtë, Këlcyra; 10–12 Dhërmi. – Figs. 13–20 pollen grains; figs. 13, 17 groups of pollen grains; figs. 14–15, 18–19 pollen grains in polar view; stephano-8–9 colporate; figs. 16, 20 pollen grain in equatorial view. – Figs. 13–14 Librazhd, railway tunnel; 15–16 Uji i Frohtë, Këlcyra; 17–18 Rrapsha; 19 Grabomi, Lumi i Cemit; 20 Shkalla e Rrapshës). – Preparations: Rosemarie Stimper; SEM microphotographs: Ingemarie Herrmann.

Table 1: Chromosome numbers in *Pinguicula* from some Albanian localities (b = flower buds; p = pollen grain mitosis; r = root tip tissue; \* estimated (tolerance  $2+ / 2-$ ); BGJ = Botanical Garden Jena).

Taxon	Sample-No	Source	Chromosome number
<i>P. balcanica</i> var. <i>balcanica</i>	135 (BGJ)	Shtegu i Dhenve	$2n = 32 - r$
<i>P. hirtiflora</i> var. <i>hirtiflora</i>	86.1 (BGJ)	Togëz	$2n = 28 - r$
<i>P. hirtiflora</i> var. <i>hirtiflora</i>	87.1 (BGJ)	Librazhd	$2n = 28 - r$
<i>P. hirtiflora</i> var. <i>hirtiflora</i>	88.1 (BGJ)	Floq (Qafa e Qarrit)	$2n = 28 - r$
<i>P. hirtiflora</i> var. <i>hirtiflora</i>	89.1 (BGJ)	Këlcyra	$n = 14 - p$ $2n = 28 - r$
<i>P. hirtiflora</i> var. <i>hirtiflora</i>	133 (BGJ)	Rrapsha, spring	$2n = 28 - r$
<i>P. hirtiflora</i> var. <i>hirtiflora</i>	134 (BGJ)	Grabomi (Lumi i Cemit)	$2n = 28 - r$
<i>P. hirtiflora</i> var. <i>louisii</i>	167 (BGJ)	Tirana, Dajti (lower population)	$2n = 56^* - b, r$
<i>P. hirtiflora</i> var. <i>louisii</i>	168 (BGJ)	Tirana, Dajti (upper population)	$2n = 56^* - r$
<i>P. hirtiflora</i> var. <i>louisii</i>	73.1; 166 (BGJ)	Tirana, Linza (pr. i Ltinit)	$n = 14 - p$ $2n = 28 - b$ $2n = 56^* - b, r$

Pollen grains stephano- 7–9(–10) colporate (pl. 6, figs. 4–6; figs. 8–9; pl. 7, figs. 14, 15, 18, 19), isopolar; in equatorial view oblate to spheroidal ( $P/E = -0.7-0.8^{15}$ ,  $P \sim 17-20 \mu\text{m}$ ;  $E \sim 22-25 \mu\text{m}$ ), in polar view circular (pl. 7, figs. 15–19). Colpi  $\sim 0.55 \mu\text{m}$  wide, emarginate; with trend to syncolpy of neighbouring colpi. Equatorial mesocolpi  $\sim 5.3-8.0 \mu\text{m}$  wide, strongly microreticulate. Poles (apocolpi) broadly ovate to circular,  $\sim 14.5 \mu\text{m}$  in diam., somewhat perforated.

#### Seeds (pl. 7, figs. 1–12)

The seeds are tiny, like saw dust;  $\sim 600-900 \mu\text{m}$  long,  $\sim 160-250 \mu\text{m}$  wide, with 7–9 longitudinal rows of exotesta cells. Their shape is variable: sometimes crescent- (banana-)like (figs. 1, 3–4, 6, 9, 12), i. e. ventrally slightly concave, dorsally convex, or  $\pm$  regularly cylindrical to ellipsoidal (figs. 7, 10); with a short chalazal (figs. 1, 3, 10: left seed pole; figs. 7, 12 right seed pole; sometimes absent or nearly absent, figs. 6, 9) appendage and a longer ( $\leq 1/6$  of total seed length) micropylar appendage (figs. 1, 3, 4, 6: right specimen, 9, 10 right seed pole; figs. 6: left specimen, 7, 12 right seed pole). The surface of the exotesta (outer seed-coat) is  $\pm$  concave (honey-combed), i. e. the exotesta cells are minutely pitted (foveolate) (figs. 2, 5, 8, 11), they are rectangular to polygonal-rounded and about  $1\frac{1}{2}$  times to twice longer than wide. The raised sharply angled outer parts of anticlinal walls of adjacent exotesta cells are thickened in the outer part only (revealed in cross sections; DEGTJAREVA et al. 2004: 442, 444, fig. 28) and almost completely united; no cracks were observed.<sup>16</sup>

#### Karyology (tab. 1; pl. 8)

The first report of chromosome numbers in Albanian *Pinguicula* taxa is found in CASPER & STIMPER (2004: 247, 248; pl. 2, fig. 4–6). The authors counted  $2n = 28$  in meristemic somatic cells of young leaves of var. *louisii* (in the publication quoted as *P. louisii*). The number is in exact agreement with their own counts in *P. hirtiflora* of Italy (Rossano) and in *P. crystallina* of Cyprus (Ayios Nicólaos).

15 P = pole; E = equator.

16 Different seed morphologies observed in different samples can be put down to a different degree of maturity of the seeds investigated.



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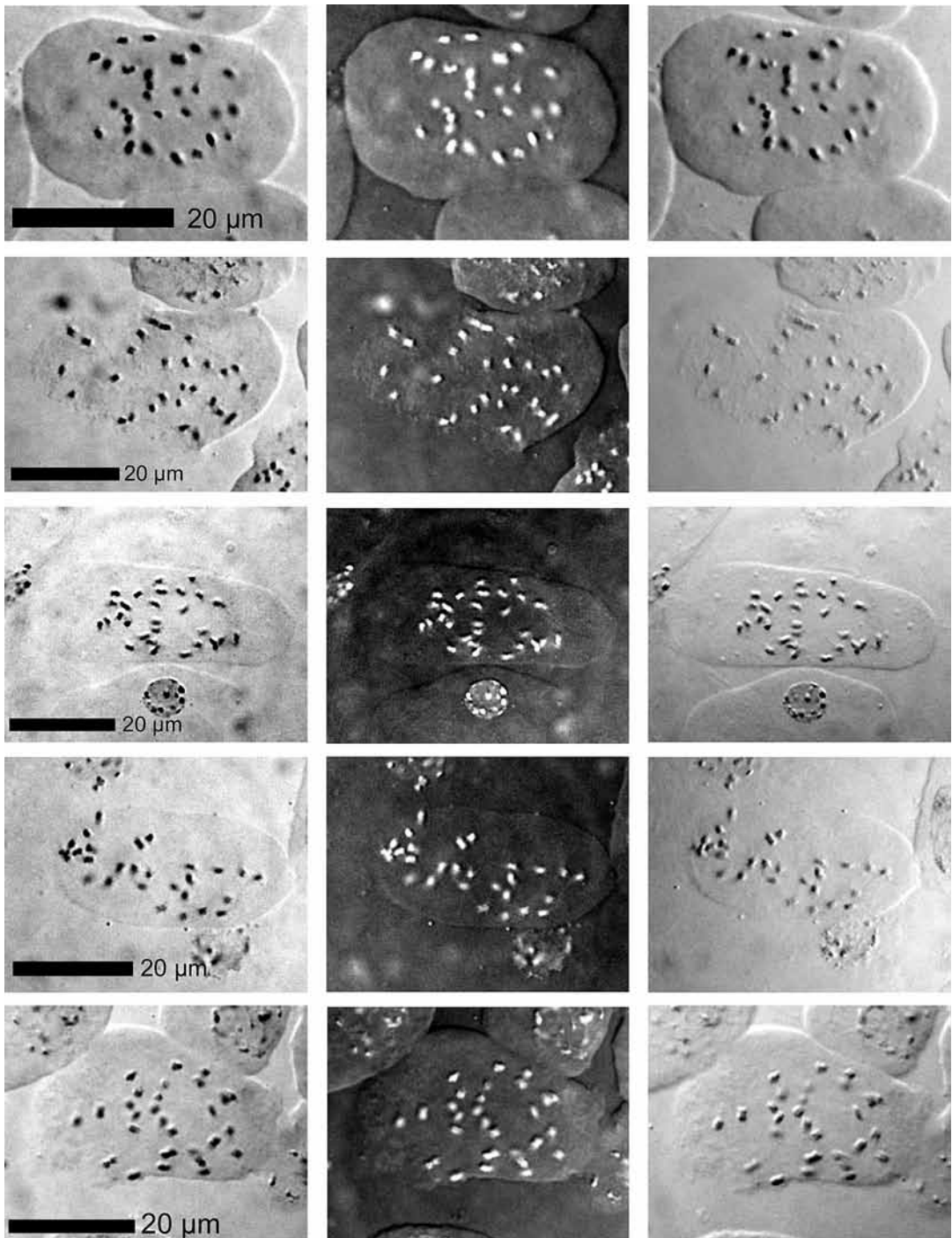


Plate 8: *Pinguicula hirtiflora* var. *hirtiflora*, Këlcyra, BGJ 89.1. Microphotographs (horizontally from left to right: black-white, white-black, DIC) of five different somatic metaphase plates from root tip tissue, with uniformly  $2n = 28$  chromosomes. – Preparation and microphotographs: Rosemarie Stimper.

Recently we have uniformly counted  $2n = 28$  chromosomes in root tip tissue of *P. hirtiflora* var. *hirtiflora* from six different Albanian sites (tab. 1; the unusual  $2n = 56$  in var. *louisii* will be discussed below). These findings match the former reports by MIKELADSE & CASPER (1997)

in the *crystallina-hirtiflora* aggregate but are in contrast to the counts by STRID & FRANZEN in LÖVE (1981:  $2n = 27$ , Greece; cf. GOLDBLATT 1984). PERUZZI et al. (2004, 71–72:  $2n = 27$  Italy, Rossano), and PERUZZI (2004, 105:  $2n = 27$ , Italy; cf. PERUZZI et al. 2004).<sup>17</sup> Much stronger are the differences with the reports of CONTANDRIOPOULOS & QUEZEL (1974) who found a ploidy row  $2n = 16, 24, 32, 48$  in *P. hirtiflora* s.l. of Greek provenance.

Neither STRID & FRANZEN (1981) nor PERUZZI (2004), PERUZZI et al. (2004) or CONTANDRIOPOULOS & QUEZEL (1974) studied material of Albanian provenance, but that cannot be the reason for the differing reports on chromosome numbers in the *P. crystallina-hirtiflora* aggregate. The apparently triploid number  $2n = 27$  did not make suspicious neither STRID & FRANZEN (1981) nor PERUZZI et al. (2004).<sup>18</sup>

Perhaps these authors had in their mind the well known phenomenon, that in most diploid species one seedling in every few hundred is a triploid. Triploids can arise from diploid parents through a failure of meiosis in the formation of the parental pollen grains or eggs. They are sexually sterile. The capacity to multiply vegetatively for instance by runners or tubers enable them to live side-by-side with their diploid progenitors without morphological variation (DARLINGTON 1956: 42). Perhaps the authors mentioned above believed the same in *Pinguicula crystallina* or *P. hirtiflora*, respectively. However, in our *Pinguicula* there is no side-by-side living of diploids and triploids without morphological variation. On the contrary, morphological variation is enormous (see the information about the amplitude of corolla and calyx variation; pls. 3, 4). Moreover, we have not any sign of sexual sterility. Meiosis (see pollen grains; pl. 6) and fertilisation do not fail; the formation of capsules with viable seeds is the rule in the populations throughout the whole distribution area of the taxon.

Obviously, the difference between  $2n = 27$  and  $2n = 28$  must be explained by faulty counts. Indeed, the small chromosomes of *Pinguicula* are tending towards lumping. But what is the exact number? The analysis of the haploid stages provides the correct answer. Studying pollen grain development in *P. hirtiflora* from Rossano (Italy; CASPER & STIMPER 2004: 248) as well as from Këlcyra (Albania; BGJ 89.1, tab. 1) we found the haploid chromosome number  $n = 14$ . That means, the exact somatic chromosome complement should be  $2n = 28$ .

We counted  $2n = 28$  and  $n = 14$  in var. *louisii* from Linza (Albania; CASPER & STIMPER 2006: tab. 1, pl. 9; cf. tab. 1, BGJ 73.1), too. With regard to the finding of  $2n = 56$  chromosomes in var. *louisii* see discussion on p. 38.

CONTANDRIOPOULOS & QUEZEL (1974) reported about a ploidy row  $2n = 16, 24, 32, 48$  in the *P. hirtiflora* 'complex' from Greece. Having observed an (allegedly) significant variation (in relation to chromosome number) in the populations studied, the authors separated from *P. hirtiflora* var. *hirtiflora* with  $2n = 16$  chromosomes (Smolikias) three varieties: var. *louisii* (extending its area

17 PERUZZI (2004) has given a synthesis of the karyological data in *Pinguicula*, which is incomplete and inaccurate. For instance in tab. 1 (p. 104) the source of *P. balcanica* material is wrongly quoted: the taxon does not occur in the USA; the paper of PERUZZI et al. did not come out in 2003 (tab. 1, p. 105) but in 2004. Apart from these ± printing errors the interpretation of literature reports is insufficient (i. e. *P. balcanica*, *P. bohemica*, *P. mundi*).

18 PERUZZI et al. (2004: 71) remark: "We think the chromosome numbers  $2n = 27, 28$  to be strictly correlated to triploids  $2n = 24$  by ascending aneuploidy phenomena (or perhaps occurrence of B chromosomes, although it is very difficult to establish it for the extreme homogeneity of the chromosome size)." In our opinion there is no hint to aneuploidy or B chromosomes. The possibility of count errors must be tested (see below).

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to Greece: Vardousia, Olymbos, Philippos, Falakron)<sup>19</sup> with  $2n=24$ , var. *gionae* (Giona) with  $2n=32$ , and var. *megaspilaea* (Chelmos: Styx) with  $2n=48$  chromosomes. *P. crystallina* from Southwest Turkey (Ala Dagħ) is said to have  $2n=24$  chromosomes like *P. 'louisii'*. Evidently, the striking differences in the chromosome numbers reported cannot be explained by count errors:  $2n=16, 24, 32$  and  $48$  are sufficiently different.

Polyploidy is known from many taxa; diploid plants can include some polyploid cells, that means, diploid species can include some polyploid individuals. To perpetuate themselves they depend on vegetative propagation and a specific local ecological situation. But in the *P. crystallina-hirtiflora* aggregate we find apparently polyploid populations with usual sexual reproduction. This requires the doubling of the chromosomes of a diploid hybrid. The process can result in an allo-tetraploid with true-breeding sexual fertility in nature (DARLINGTON 1956: 41).

To find out the reason for the discrepancies in the various chromosome reports we have studied many samples of one and the same population (see the somatic metaphase plates; tab. 1). As we said above, in the Albanian var. *hirtiflora* populations we counted consistently  $2n=28$  chromosomes (pl. 8).

The standard chromosome complement in the *crystallina-hirtiflora* aggregate seems to be based on the number  $x=14$  caused by a process of hybridisation of genetically different parents in the past. Hypothetically, a crossing of plants with basic chromosome sets of  $x=8$  and of those ones with  $x=6$  could have occurred. In *Pinguicula* the possibility for such a combination exists: in Europe sectio *Pinguicula* (the *vulgaris* group) and sectio *Micranthus* (the *alpina* group) are represented exclusively by species with the basic number  $x=8$ , whereas sectio *Isoloba* subsectio *Pumiliformis*, represented by the atlantic *P. lusitanica*, has  $x=6$  chromosomes.

The result would be an allo-diploid with  $2n=14$  chromosomes (not found in nature!) that will be replaced by an allo-tetraploid with  $2n=28$  chromosomes by doubling the chromosomes and sexual fertility. Today, it is represented by the (pseudo-) di- to tetraploid [ $2n=56$ ; (cleisto-) tetra- to octoploid] aggregate *P. crystallina-hirtiflora*.

The idea of the hybridogenous origin of the *crystallina-hirtiflora* aggregate is supported by the intermediate state of several characters that distinguish both ancestral sections and by the putative trend to polyploidy as well as by the variability in the group at all. Naturally, the hypothesis must be verified by modern karyological and genetical analyses in future.

#### The taxonomical state of the Albanian populations

Our studies on size and shape of calyx and corolla lobes in the Albanian *P. hirtiflora* var. *hirtiflora* populations have revealed high variation of characteristics. They confirm the results of former investigation of the *crystallina-hirtiflora* aggregate (including *P. crystallina* from Cyprus) by CASPER (1970: 285). He came to the conclusion that in the past (Pleistocene; see p. 55) the area of an ancestral single taxon, just the precursor of the *P. crystallina-hirtiflora* aggregate of today

19 CONTANDRIOPOULOS & QUEZEL (1974: 31, pl. 1, fig. 5) counted  $n=12$  chromosomes in a single metaphase plate of a single macrospore, perhaps from a sample collected in Greece on Vardousia, Falakron, Philippos or Olymbos (they gave no exact information about the provenance of the material studied). They believe the corresponding  $2n=24$  specimens to be *P. hirtiflora* var. *louisii*, which they consider as triploid. In our opinion that is impossible: if the  $n=12$  specimens are said to represent the haploid stage of the  $2n=24$  ones, they cannot be triploids. However, they can be diploids as we read in their tab. 1 (op. cit. p. 28).

– whose discontinuous chain-like area stretches from Alpi Marittimi (? Roia Valley) in the West across Central (Amalfitana) and South Italy (La Sila), Balkan Peninsula (Bosnia-Herzegovina, Montenegro, Serbia (Kosovo), Albania, Macedonia, Bulgaria, Greece), Southwest Turkey, Cyprus to the southeastern part of the Turkish coast (Antakya, Konacik; ADAMEC 1996, 1997) in the east –, has been split up into minor areas now inhabited by populations differing from each other by more or less significant features.

During a long-lasting diversification process (young in relation to the separation of the Aegean land bridge from the continent during Tortonian, 12.0 my ago, and the following formation of the Aegean archipelago during Pliocene), one ‘western’ Balkan-Italian taxon, *P. hirtiflora*, has been separated from one ‘eastern’ taxon, the Anatolian-Cypriot *P. crystallina*. *P. crystallina* tends to have smaller corollas with very small upper lip lobes, shorter spur, and angular rather than rounded heads of the hairs in the corolla palate region. The isolated population of Antakya, Konacik, Iskenderun Bay, said to be *P. crystallina* (ADAMEC 1996, 1997) is distinguished by a long narrow corolla lower lip, by a long subulate spur, and large broadly ovate to broadly obovate leaves. However, characters overlap to a considerable extent.

STRID & KIT TAN (1991) – who had no information about the existence of the Konacik-population – believed that it would be better to treat the two classical species as geographical races: *P. crystallina* subsp. *hirtiflora* and *P. crystallina* subsp. *crystallina*. They carried out what CASPER (1970: 285) had considered: “*The ... relatively minor morphological differences could suggest the view that the two taxa are nothing else than subspecies of a polytypic [read: polymorphic] aggregate species P. crystallina*”.<sup>20</sup> However, CASPER (1970: 285) hesitated to draw the taxonomical-nomenclatorial conclusions deploring the missing karyological data. He used the term *P. hirtiflora-crystallina* aggregate for all the taxa described close to *P. hirtiflora* and *P. crystallina*.<sup>21</sup>

In *P. hirtiflora*-populations of the Balkans, CONTANDRIOPOULOS & QUEZEL (1974: 30) distinguished three varieties based mainly on karyological data (they had found a series of chromosome numbers –  $2n = 16, 24, 32, 48$ ). Following their views we are able to distinguish four varieties (including the type variety<sup>22</sup>):

var. *hirtiflora* – diploid ( $2n = 16$ ), leaves up to 50 mm long, flower size 20–22 mm; peat bog plant, calcifuge;

var. *louisii* – triploid ( $2n = 24$ ), leaves up to 70 mm long, flower size 20–25 mm; rupicolous and peat bog plant,  $\pm$  substrate tolerant;

var. *gionae* – tetraploid ( $2n = 32$ ), leaves up to 80 mm, flower size 22–28 mm; rupicolous, calciphil;

var. *megaspilaea* – hexaploid ( $2n = 48$ ), leaves up to 120 mm, flower size 22–28 mm; rupicolous, calciphil.

20 Original German version: “*Die ... relativ geringen morphologisch fassbaren Unterschiede könnten auch eine Auffassung nahelegen, die in den beiden Sippen lediglich Unterarten einer polytypischen [read: polymorphen] Gesamtart P. crystallina sieht.*”

21 In our paper we use this working practice from case to case. In the near future we will get living specimens from Greece which will enable us to solve the taxonomical problems in the *P. crystallina-hirtiflora* aggregate.

22 *P. hirtiflora* Ten. var. *euboea* Beauverd et Topali, Bull. Soc. Bot. Genève sér 2, 28: 155 (1938), has been put into synonymy (CASPER 1962: 35). We do not consider the nomen because it has never been used for specimens of Albanian provenance.

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They assert a direct connection of ploidy level and morphological (and also palynological, ecological, and chorological) characteristics<sup>23</sup>. Apart from the fact that they did not study specimens or populations from Albania<sup>24</sup>, apart that they characterised the Albanian var. *louisii* (they had never seen!) by the insufficient and ambiguous descriptions of MARKGRAF (1926) and ERNST (1961) only, their conclusions are dubious.

As we have shown, the basic chromosome complement in *P. hirtiflora* is  $2n = 28$ , i.e. the taxon is a diploid. Additionally, we have found a tetraploid level with  $2n = 56$  chromosomes in populations of Giona and Megaspilaeon, but never in populations of Albanian provenance with the exception of *P. 'louisii'* from Linza (cf. tab. 1). This unexpected striking result contradicts heavily the reports by CONTANDRIOPOULOS & QUEZEL (1974: 30). They specifically say *P. hirtiflora* var. *hirtiflora* (counted from populations dwelling on ophiolite soils from Smolikas and Zygos which are similar to most of our Albanian populations!) to be a diploid with  $2n = 16$  chromosomes, whereas var. *louisii* is supposed to be a triploid with  $2n = 24$  chromosomes throughout its Greek distribution area.

Compared to var. *hirtiflora*, var. *louisii* sensu CONTANDRIOPOULOS & QUEZEL is supposed to be distinguished by “*foliis longioribus 40–80 mm, angustioribus, calycis labiis superis subemarginatis, inferis subaequalibus, corollis lobis superis integris, inferis obtusis, angustioribus*” (CONTANDRIOPOULOS & QUEZEL 1970: 30). They are showing var. *louisii* (in the caption to pl. II [sic] erroneously quoted on subsp. *louisii*; p. 31) on pl. 2 (figs. B1, corolla; B2, calyx). Description and drawings contradict each other: in the former we read that the corolla lower lobes of var. *louisii* are narrower than in var. *hirtiflora* (pl. 2, figs. A1, A2). But they are nearly of the same width. Compared with var. *gionae* (pl. 2, figs. C1, C2) or var. *megaspilaea* (pl. 2, figs. D1, D2) the corolla lower lobes are much broader. The unclear wording can be interpreted in a number of ways.

Not really familiar with the true nature of Markgraf's taxon, especially with its variability, possibly tempted and apparently justified in their taxonomical conclusions by Markgraf's unfortunate extension of its distribution area to the Greek Mount Olymbos, and induced by the (allegedly) triploidy of the Greek populations from Lithochoron, Vardousia, Falakron, and Philippos they created their ‘mysterious’ var. *louisii* not identical with the Markgraf taxon.

It is clear that the systematic and evolutionary consequences of the biological, karyological (including the suggested hybridogenous origin), ecological, and geographical peculiarities observed in the *P. crystallina-hirtiflora* aggregate must be evaluated by the study of the genetic diversity within the populations. Even then, it will be possible to interpret the phylogeny of the taxon.

23 CONTANDRIOPOULOS & QUEZEL (1974: 30): “*Les variations morphologiques, parallèles à l’augmentation progressive du nombre des chromosomes, sont certes perceptibles, mais restent cependant peu importantes, c’est la raison pour laquelle la distinction des simples variétés nous a paru seule possible. Ces variations vont d’ailleurs dans la même sens, puisque nous avons signalé plus haut sur le calice le raccourcissement et l’épaississement transversal des lobes, et sur la corolle, la disparition de la bilobation et l’allongement des lobes.*”

24 QUEZEL (1967: 138) claimed, that he would have studied an “association à *Aquilegia amaliae* et *Pinguicula louisii*” from Olymbos (Greece) and added: “*C’est à cette espèce considérée d’ailleurs par divers auteurs comme une simple sous-espèce de P. hirtiflora, que se rapportent en fait nos échantillons du Giona et de l’Olympe*” (op. cit. 138, footnote 1). However, in the paper mentioned QUEZEL (1964: 310–311) described an association “à *Aquilegia amaliae* et *Pinguicula hirtiflora*” from Giona (grotte dorée) and Olymbos (gorge en amont de Lithokoron). There is no mention of *P. louisii*! Moreover, when discussing the chromosome numbers (see above), CONTANDRIOPOULOS & QUEZEL (1974: 30) named the Giona specimens *P. hirtiflora* var. *gionae* and the Olymbos specimens *P. hirtiflora* var. *louisii*. That means, the authors had no clear idea of the true taxonomical status of the taxa of the *P. crystallina-hirtiflora* aggregate.

At the moment it will correspond best to the observations maintaining *P. hirtiflora* as a species of its own separated sufficiently from *P. crystallina* and divided into the two varieties var. *hirtiflora* and var. *louisii* in the Albanian part of its area.

*Pinguicula hirtiflora* var. *louisii* (Markgr.) A. Ernst (pl. 9)

Ernst, A., Bot. Jahrb. Syst. 80(2): 186. 1961.

Syn.: ≡ *P. Louisii* Markgr. in Ber. Deutsch. Bot. Ges. 44: 430 (1926); pl. 7/8, fig. 15 (black-and-white photograph) – Basionym.

Type: Mittel-Albanien: Tirana, überrieseltes, kalkreiches Lehmufer am Lum i Ljanës westlich Linsa, 150 m, blühend 23. Mai 1924 – n. 287, F. Markgraf – B (Holotype, (hic designatus); destroyed 1943 during World War II at Berlin-Dahlem), BPU [on “Lum i Ljanës, leg. F. Markgraf” – Syntype].<sup>25</sup>

Lecto- (Icono)-type (hic designatus): Markgr. in Ber. Deutsch. Bot. Ges. 44: 430 (1926), pl. 7/8, fig. 15 (black-and-white photograph).

= *P. hirtiflora* var. *decipiens* Bornm., Magyar Bot. Lapok Ungar. 32: 129. 1933, nom. nud.

Differs from *P. hirtiflora* by the ± elliptical-oblong leaves (up to ~80 mm long, ~25 mm broad) not notched at apex; by the corolla lobes bright to pale blue in the anterior half, the three lower lobes oblong to nearly orbicular, rounded, not shallowly notched, often slightly truncate at apex; by the median lobe broader than the lateral ones, rounded or at the most slightly truncate, not deeply notched at the tip; by the cylindrical slender or stout spur often longer than the rest of the corolla, (8–)13–20(–22) mm long straight or descending (deflected through an angle of nearly 90°–130° with the tube).

Chromosome number  $2n = 28, 56$ .

Flowering (February) April to October, depending from altitude and exposure.

Gregarious along brooks in more or less flat sites (meadows) and on steep seeping slopes; steno-endemic in Central Albania (NE of Tirana at the north and western slopes of Mali i Dajtit).

#### Annotations

The background of the creation of *P. louisii* has been discussed by CASPER (2004).

In his original publication, MARKGRAF (1926: 430)<sup>26</sup> added a commentary to his description: “At first glance the species is similar to *P. hirtiflora* Ten. but I found the latter only on serpentine about 1000 m asl, while the new species lives on soils rich in chalk in the Mittelmeerstufe [Mediterranean altitudinal zone]. With regard to its shape *P. hirtiflora* is distinguished by uniform calyx leaves, emarginate corolla lower lip lobes, a shorter, coarser spur and stronger growth”.

25 We have tried to get a clear idea about the locus classicus. Now we believe that Shalla e Tujanit is the locality where Markgraf collected his *P. louisii*. This assertion means that Markgraf has confused Lum i Ljanës and Lum i Tiranës.

26 Original German version: “Die Art ähnelt auf den ersten Blick *P. hirtiflora* Ten. Diese fand ich aber nur auf Serpentin in etwa 1000 m Meereshöhe, während die neue Art auf kalkreichem Boden der Mittelmeerstufe gedeiht. Gestaltlich unterscheidet sich *P. hirtiflora* durch gleiche Kelchblätter, ausgerandete Kronlappen der Unterlippe, einen kürzeren, derberen Sporn und im ganzen kräftigeren Wuchs.”

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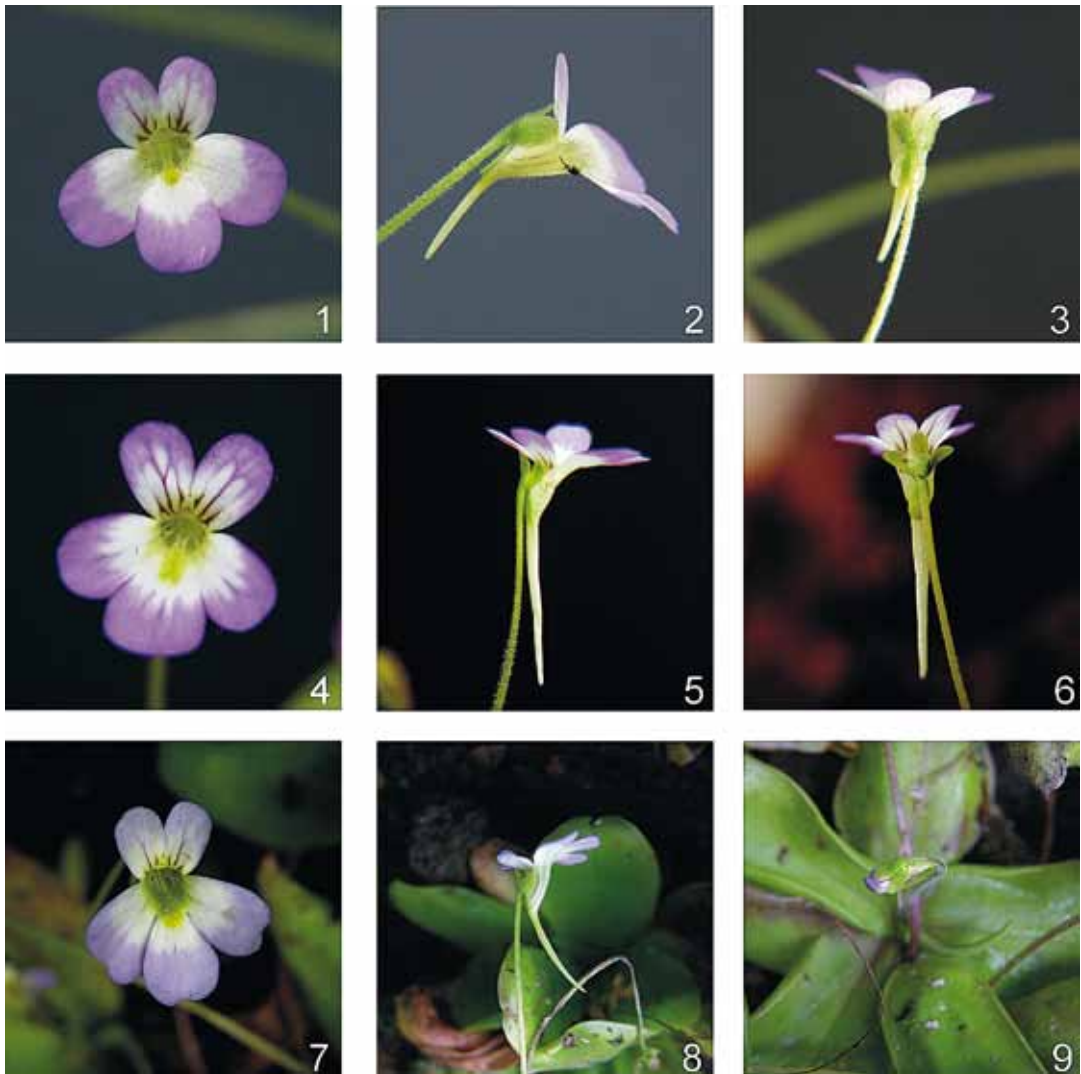


Plate 9: *Pinguicula hirtiflora* var. *lousii*. – Figs. 1–3 Linza, përroi i Ltinit; fig. 1 corolla, front view; fig. 2 corolla, side view, spur medium sized; fig. 3 corolla, dorsal view, spur medium sized. – Figs. 4–6 Linza; fig. 4 corolla, front view; fig. 5 corolla, side view, spur straight, extremely long; fig. 6 corolla, dorsal view, spur straight, extremely long; – Figs. 7–9 Linza, Shkalla e Tujanit; fig. 7 corolla, front view, lower lip lobes truncate; fig. 8 corolla, side view, spur long, curved; fig. 9 leaf rosette with flower bud. – Photographs: Rosemarie Stimper. – Magnification  $\times 2:1$ .

In his Latin description and in his German commentary any hints on the striking feature in the *P. crystallina-hirtiflora* aggregate – throat and base of corolla median lobe greenish-yellow, beset with long hairs – is missing. On the contrary, he wrote: “*Corolla coerulea, glabra, in fauce alba et longe pilosa*”. This is puzzling.

In several contributions MARKGRAF (1927: 129, 1932: 107) expressed repeatedly his position to his new species with slight modifications. He classified it as a lowland basic form (‘basic species’, ‘Stammart’) with one-sided habitat standards, i. e. with an extremely small distribution area. It should only be able to dwell on far-scattered, edaphically suited places. It shall be a ‘Macedonian’ species of the ‘Macchien’- or ‘Mittelmeerstufe’, a relict species of a formerly wider distribution (MARKGRAF 1927: 129, cf. his ‘Vegetationskarte von Mittelbanien’ at the end of the

book behind p. 217). On the contrary, he said the related *P. hirtiflora* to be an inhabitant of the mountainous ‘Wolkenwald- und Mattenstufe’, “eine griechisch-süditalische Art” [a Greek-South Italian species]<sup>27</sup> with (on this point he got really wrong) northern distribution border in North Albania (MARKGRAF 1927: 124).

If we are interpreting correctly the somewhat hazily phrases of MARKGRAF, he put forward the view that the wide-spread mountainous *P. hirtiflora* (in 1927 declared to be a Greek-South Italian species) comes from the endemic lowland taxon *P. louisii* (in 1932 declared to be a Greek-Italian basic species). Apparently he was carried away by his feelings caused by the detection of a new species to suggest the daring (in view of the limited facts) hypothesis *P. louisii* to be the ‘basic form’ of *P. hirtiflora* “for it has undivided corolla lobes” (1927: 129). We believe that later on he did not maintain his opinion about the basic state of *P. louisii*.

Admittedly, in 1959<sup>28</sup> he wrote (referring to his photograph figure 15 on pl. 7/8 in MARKGRAF 1926): “Dr. Ernst has incorporated the species into *P. hirtiflora* as a variety, however, that does not convince me, because the whole plant is much more delicate, its flower paler and its spur much finer, the leaves much shorter and blunter ...”. He added: “... I found it repeatedly namely in springs on marl, while I saw *P. hirtiflora* in Albania on many places but only in springs on serpentine ...”

But a year later, in 1960<sup>29</sup>, he said: “... *Pinguicula louisii* will be considered by Ernst in his treatment of the genus coming out soon only a variety of *P. hirtiflora*, probably quite rightly ... It has shorter, blunter leaves, more delicate pedicel, smaller flowers of somewhat deviating colour, and straight, fine spurs ...” He emphasized *P. hirtiflora* to be ‘serpentinhold’ [inclined to serpentine], while he believed *P. louisii* to be “vielleicht eine Kalkrasse” [perhaps a calcareous race] (cf. HAYEK 1929: 229).

Apart from the fact that the features mentioned above do not reflect the whole amplitude of variation of the taxon we have to ascertain that now Markgraf seemingly agrees with Ernst in considering *P. louisii* to be nothing else than a variety of *P. hirtiflora*. Moreover, as we can see from our karyological studies, *P. louisii* – regardless of what its taxonomical category will be – can no longer be considered as a ‘basic species’ in the sense of Markgraf. He extended (as we believe incorrectly) its distribution – originally restricted to Central Albania around Linza near Tirana and to Northeast Greece (Mount Olimbos) – from Tirana northwards across the ‘landscape Matja’ to Thethi (MARKGRAF 1942: 665) in the (North-) Albanian Alps.

#### Karyology (tab. 1; pl. 10)

In the *Pinguicula hirtiflora* var. *louisii* - population (BGJ 73.1; cf. tab. 1) from the brook of Ltinit (pr. i Ltinit) NW of Linza (now part of Tirana), we counted in meristemic tissue of a single

27 A subgroup of his ‘Greek species’ to which *Carex macrolepis*, *Saxifraga marginata* var. *eumarginata*, *Scabiosa crenata*, *Campanula foliosa*, and *Campanula versicolor* shall belong.

28 In his letter to S. J. Casper, November 5, 1959, he wrote (original German version): “... Herr Dr. Ernst hat die Art als Varietät zu *P. hirtiflora* gezogen, was mir allerdings nicht sehr einleuchtet, denn die ganze Pflanze ist viel zierlicher, ihre Blüte blasser und ihr Sporn viel feiner, auch die Blätter viel kürzer und stumpfer ... Ich fand sie wiederholt und zwar nur an Quellen im Mergel, während ich *P. hirtiflora* in Albanien an vielen Stellen, nur an Serpentin-Quellen sah”.

29 In his letter to F. K. Meyer, December 8, 1960, he wrote (original German version): “... *Pinguicula louisii* wird von ... Ernst in seiner demnächst erscheinenden Bearbeitung der Gattung nur als Varietät von *hirtiflora* bewertet, wohl mit Recht ... Sie hat kürzere, stumpfere Blätter, zartere Blütenstiele, kleinere Blüten von etwas abweichender Farbe und gerade, feine Sporne ...”



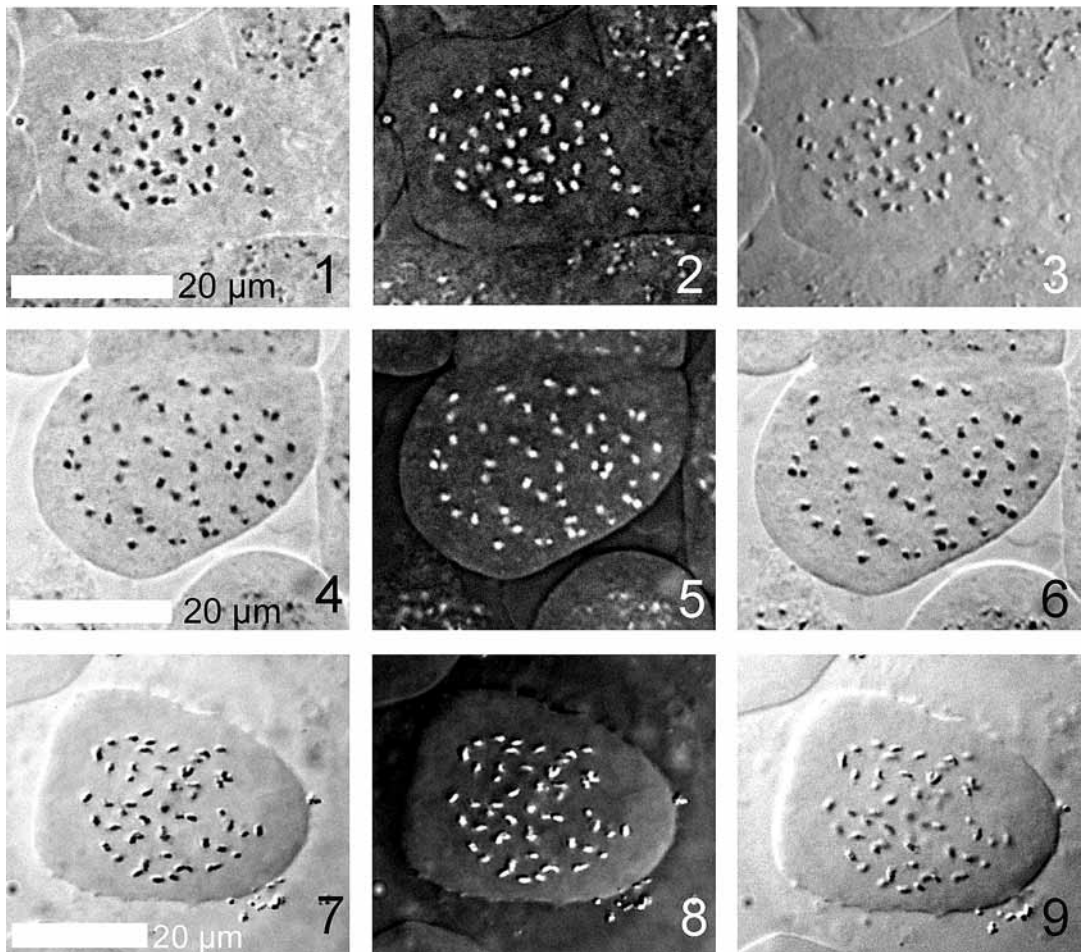
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Plate 10: Figs. 1–6 *Pinguicula hirtiflora* var. *louisii*, Linza, prr. i Ltinit, BGJ 73.1. Photocopies of two somatic metaphase plates; from left to right: black-white, white-black, DIC; root tip tissue,  $2n = 56$ . – Figs. 7–9 *P. hirtiflora* var. *louisii*, Dajti, lower population, BGJ 167. Photocopies of a single somatic metaphase plate; order as in figs. 1–6; root tip tissue,  $2n = 56$ . – Preparation and microphotographs: Rosemarie Stimper.

leaf of a young flower bud the expected  $2n = 28$  chromosomes and in pollen grain mitosis  $n = 14$ . Unexpectedly, we found in tissue of the root tip of the same population  $2n = 56$  chromosomes (pl. 10; figs. 1–6). However, it is not clear whether the different chromosome numbers come from the same specimen.

In all other metaphase plates from root tip tissue of Linza (BGJ 166; cf. tab. 1) and Dajti (BGJ 167; 168; cf. tab. 1) studied additionally we always counted the tetraploid chromosome number  $2n = 56$  (pl. 10, figs. 7–9).

Considering the tetraploid level ( $2n = 56$ ), our findings match the corresponding counts in our Greek *P. hirtiflora*-populations from Giona and Megaspilaeon (CASPER & STIMPER 2006) and in those of var. *louisii* sensu CONTANDRIOPOULOS & QUEZEL (1970: 28, 30). But as we have shown above our var. *louisii* (Markgr.) Ernst of Albania cannot be compared with the vaguely characterised var. *louisii* sensu CONTANDRIOPOULOS & QUEZEL. Apart from the different absolute numbers –  $2n = 28$  and  $2n = 56$ , respectively, in our Albanian var. *louisii*, against  $2n = 24$  in that of

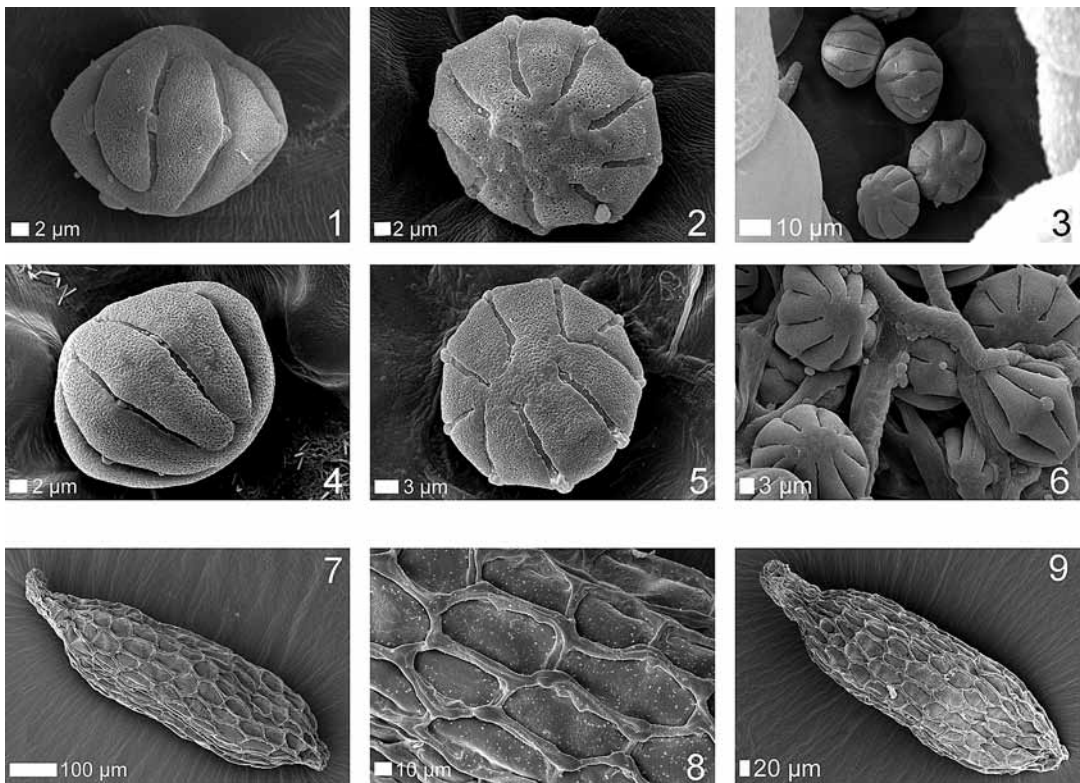


Plate 11: *Pinguicula hirtiflora* var. *lousii*, Linza, perr. i Ltnit; pollen grains (figs. 1–6) and seeds (figs. 7–9). – Figs. 1, 4: pollen grain, equatorial view, note syncolpy; figs. 2 pollen grain, polar view, note the nine colpi; fig. 3: pollen grain group; fig. 5 pollen grain, polar view, note syncolpy; fig. 6: pollen grain infected by hyphae of *Ustilago* (?). – Figs. 7, 9: seeds, general view; longer miropylar appendage at the left seed pole, shorter chalazal appendage at the right seed pole; fig. 8: seed, detail of exotesta (coat surface), cell walls distinctly thickened. – Preparation: Ingemarie Herrmann, Rosemarie Stimper. SEM microphotographs: Ingemarie Herrmann.

the ‘CONTANDRIOPOULOS & QUEZEL-Greek populations’ – the Albanian var. *lousii* seems to be partly a diploid, partly a tetraploid, whereas the Greek var. *lousii* sensu CONTANDRIOPOULOS & QUEZEL is (in our opinion wrongly) called a triploid. We cannot explain this difference up to now. We believe our findings (tab. 1; pls. 8, 10) with regard to the tetraploid level are unambiguous and based on sufficient studies.<sup>30</sup>

Our counts of the haploid chromosome complement  $n = 14$  in pollen grains comes from different samples (Linza, BGJ 73.1; Këlcyra, BGJ 89.1; cf. tab. 1) and are, we are convinced, not doubtful. Therefore, the counted diploid chromosome number  $2n = 28$  in one metaphase plate (leaf tissue of a flower bud; Linza, BGJ 73.1, tab. 1) matches these findings. However, we are not satisfied with our preparation. Further investigations are necessary to solve the case.

Nevertheless, from our karyological findings it becomes clear that Markgraf's *P. lousii* is no ‘basic’ taxon at all. Its polyploidy evidently shows its derived evolutionary state.

<sup>30</sup> The former (obviously incorrect) reports on chromosome numbers in *P. hirtiflora* by HONSELL (1959:  $2n = 16$ ) and CASPER (1962, 1966:  $2n = 32$ ) let expect a basic number of  $x = 8$  known from all the European species of sectio *Pinguicula*. The counts by CONTANDRIOPOULOS & QUEZEL (1974) match this assumption. Should we assume that the latter were tempted to follow uncritically the older reports and that they took over the (supposed)  $x = 8$  basic number of sectio *Pinguicula* as CASPER (1962) apparently wrongly did?

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## Pollen grains (pl. 11, figs. 1–6)

The pollen grains of *P. hirtiflora* var. *louisii* are very similar to those of *P. hirtiflora* var. *hirtiflora*. No significant differences have been found. Infection by fungi (*Ustilago* ?) has been observed (fig. 6).

Pollen grains stephano- 8–9(–10) colporate, spheroidal (figs. 1, 5), isoporate,  $P/E = -0,96^{31}$  ( $P = \sim 24 \mu\text{m}$ ;  $E = \sim 28 \mu\text{m}$ ), in equatorial view ellipsoidal, in polar view circular. Colpi  $\sim 22 \mu\text{m}$  long, syncolpy of neighbouring colpi observed (figs. 2–3). Equatorial mesocolpi 6–7  $\mu\text{m}$  wide, microreticulate to vermiculate. Poles (apocolpi) circular (fig. 3) to elliptical (fig. 2),  $\sim 7 \mu\text{m}$  in diameter.

## Seeds (pl. 11, figs. 7–9)

On the whole, the seed morphology is quite similar to that in *P. hirtiflora*.

The seeds are tiny like saw dust; at maturity they are  $\sim 600\text{--}800 \mu\text{m}$  long,  $\sim 200 \mu\text{m}$  wide ( $\sim 8\text{--}9$  longitudinal rows of exotesta cells). Their shape is cylindrical to ellipsoidal (figs. 7, 9); with two appendices: the longer micropylar ( $\leq 1/6$  of total seed length) appendage (figs. 7, 9 at the left seed pole) and the shorter chalazal appendage (figs. 7, 9 at the right seed pole). The exotesta cells are rectangular to polygonal, distinctly thickened, twice as long as wide, without anticlinal cracks. Their outer surface is uniformly concave (honey-combed; fig. 8), i. e. each cell forms a separate depression (a fovea, 'pit'). The outer parts of anticlinal walls of adjacent cells are almost completely united (fig. 8). In cross sections of seeds thickenings of anticlinal walls of exotesta cells are present in the outer part of the wall (DEGTJAREVA et al. 2004: 436–437, tab. 2).

## The non-glandular hair covering (indument) in the corolla (pl. 12, figs. 1–9)

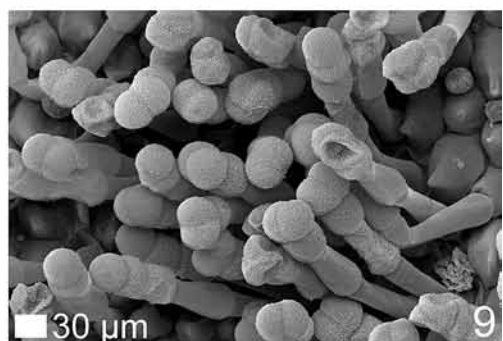
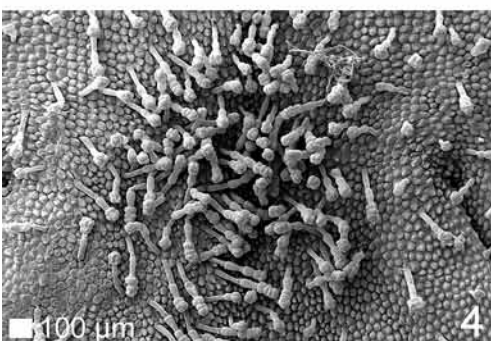
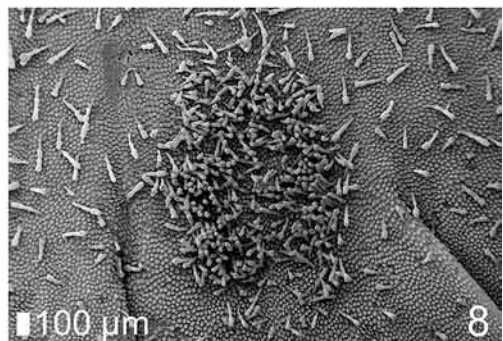
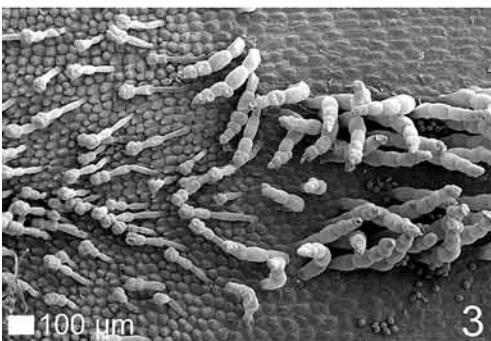
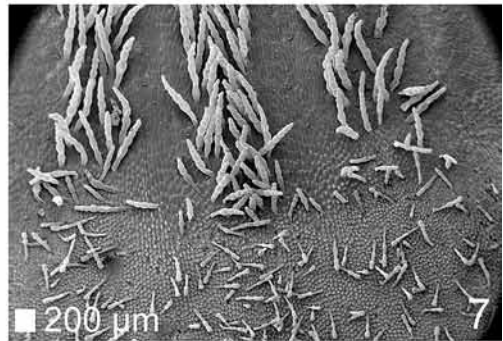
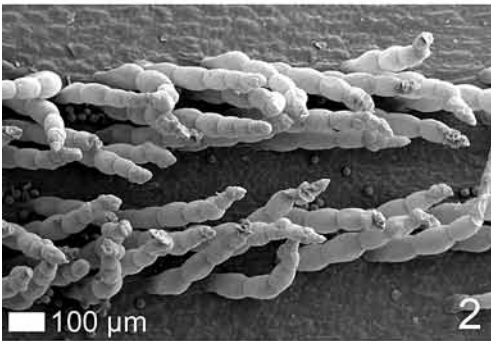
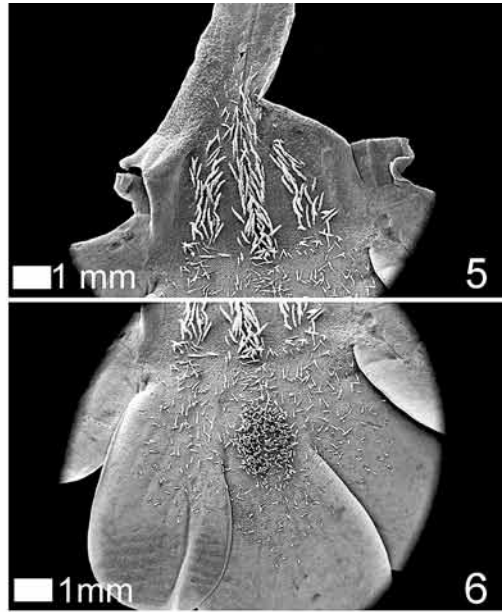
On the whole, the hair pattern is quite similar to that in *P. hirtiflora*. But, as it can be seen in figs. 1–2 and figs. 5–7, the 'three' lengthways 'stripes' of tube hairs can be developed as six stripes each composed of two distinctly separated double hair rows (figs. 1–2) or as three stripes (figs. 5–7). The capitate hairs are directed backwards to the spur, they are short ( $\sim 500 \mu\text{m}$  long) and compact. In the transition zone between the palate region and the three lengthways stripes short capitate (clavate) hairs ( $\sim 200 \mu\text{m}$  long) directed forwards are forming a more or less separate regular pattern (figs. 3, 7), that occupies the bases of the three lower lip lobes. The palate region is distinctly developed and shows a hair crowd forming a  $\pm$  two-part arrangement (figs. 4, 6, 8). The hairs are short and similar to those of the transition zone, they are capitate (club-shaped, to  $\sim 250 \mu\text{m}$  long) i. e. topped by multicellular  $\pm$  globular 'heads' (figs. 4, 9).

Ahead of the palate region on the middle lobe of the lower lip as well as on the basal (proximal) part of the two lateral lobes a sparse indument of short, capitate (club-shaped) hairs is developed extending to half the length of each lobe (figs. 1, 3, 5, 6, 7).

The little differences observed are within the basic pattern of the *P. crystallina-hirtiflora* aggregate. More investigations of material of Greece (Giona, Megaspilaeon) or Turkey (Ala Dağ, Antakya) are desirable.

As we have shown, the indument on the whole covers nearly half the length of the lower lip lobes. It is missing on the upper lip lobes. MIKELADSE (1996: 23–24) has pointed out that in

31 P = pole; E = equator.



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*P. crystallina* of Cyprus the hair covering would be developed much more heavily and extended to the basal part of corolla lobes. She believed that this feature would be suitable to separate taxonomically *P. hirtiflora* from *P. crystallina*. But she could not study *P. hirtiflora* outside Italy (her study material was from La Sila, Calabria), therefore she was unable to judge the amplitude of variation.

The taxonomical position of '*P. louisii*'

From our investigation we have learned that populations with features equal or similar to Markgraf's *P. louisii* occur in different places throughout the area. Character states such as the entire and rounded apex, non emarginate corolla and calyx lobes, respectively, which are dominant features in the Linza population, can be present in other Albanian populations, too. They are more or less intermingled with characteristics said to be typical of the *P. crystallina-hirtiflora* aggregate. In the Linza and Shkalla e Tujanit populations features such as emarginate or slightly divided corolla and calyx lower lip lobes occur at a lower frequency, too (see pl. 9, figs. 7–9).

The same is true with other features as for instance the delicate habit, by no means typical for *P. louisii* as MARKGRAF (1926) believed. There are delicate specimens (MARKGRAF 1926, photocopy pl. 8, fig. 15; Hrubý, Jirásek et Martinec PRC 82) as well as very stout ones (F. K. Meyer nr. 5555 – JE; L. Shuka – TIR, JE). The flower colour said to be bright blue varies to a high degree, too.

The feature 'calyx with unequal lobes' is common to both of the taxa (BORNMÜLLER 1933: 129). BORNMÜLLER added that HAYEK (1929: 229) was wrong when writing in the key "*corolla rosea*" instead of "*corolla rosea vel caerulea*" (in view of var. *louisii*) because in *P. louisii* the blue flowers would be the main differential characteristic to *P. hirtiflora*.<sup>32</sup>

With regard to the often quoted feature 'calyx lower lobe undivided' said to be typical for *P. louisii* we cannot stress enough its high variation: we can observe in one and the same population undivided lower lobes as well as divided ones. Moreover, in the *P. hirtiflora* - population of Acqua Santa near Castellammare (Italy), the type locality, calyx lower lobes with entire margins are very common.

At the moment *P. louisii* should be taken as a variety of *P. hirtiflora* in its distribution restricted to Central Albania, i. e. excluding the so-called var. *louisii* populations reported from Greece. Further karyological and genetical investigations of Albanian populations (i. e. gorge of Devoll) as well as of appropriate Greek ones (i. e. ravines of Giona and Styx near Megaspilaeon) are necessary to decide on the true taxonomical state of Markgraf's taxon.

32 Apparently BORNMÜLLER (1933) believed *P. louisii* to be a species of its own. This is somewhat puzzling because he knew Tenore's *P. hirtiflora* from the classical Amalfitana site M<sup>te</sup> San Angelo near Castellammare (Italy).

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Plate 12: Figs. 1–9 *Pinguicula hirtiflora* var. *louisii*, Linza, prr. i Ltinit: hair covering pattern and hair morphology (indument) of two flowers (flower 1, figs. 1–5; flower 2, figs. 6–10) – Figs. 1, 5–6: corollas, unfolded, note the three double-rowed lengthways hair stripes in the tube (fig. 1) and the palate region at the base of the median lobe (figs. 1, 6); fig. 2: tube, detail of the ventral double stripe of compact pointed hairs directed backwards; figs. 3, 7: transition zone between tube and corolla median lobe, note the short club-like hairs directed ± forwards to the palate region and the compact pointed hairs of the ventral stripe directed backwards to the spur; figs. 4, 8: short club-like hairs on the palate region (note the two-part palate region in fig. 8); fig 9: detail of the 'palate hairs' topped head-like. – SEM-microphotographs: Ingemarie Herrmann; preparation: Ingemarie Herrmann, Rosemarie Stimper.

2. *Pinguicula balcanica* Casper (pl. 13, 14)

Casper S. J., Feddes Repert. Spec. Nov. Regni Veg. 66: 105 (1962)

Type: Nordostalbanische Alpen, Schneegipfel des Korab, an überrieselten Felsen an Nordhängen oberhalb der höchsten Doline beim Dorfe Radomir, Kalkboden, 2400 m, leg. 25.7.1918, J. B. Kümmerle – BPU (Holotype).

= *P. leptoceras* Rchb. sensu Griseb., Spic. Fl. Rumel. 2: 9. 1844.

= *P. leptoceras* Rchb. sensu Hayek, Denkschr. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 99: 166. 1924; and Hayek in Repert. Spec. Nov. Regni Veg. Beih. 30(2): 209. 1929.

= *P. alpina* aut. monten. – non L.

= *P. alpina* L. sensu Baldacci, Malpighia 5: 77. 1891. (cf. his label on voucher nr. 266 – GOET)

= *P. alpina* L. sensu Halácsy, Consp. Fl. Graec. 3: 1. 1904.

= *P. vulgaris* L. sensu Boissier, Fl. Orient. 4: 2. 1879, p.p.

= *P. vulgaris* L. sensu Hayek in Repert. Spec. Nov. Regni Veg. Beih. 30(2): 209. 1929.

= *P. vulgaris* L. var. *alpicola* Rohlena, Sitzungsber. Königl. Böhm. Ges. Wiss. Prag, Math.-Naturwiss. Cl. 1904, 38: 79 – non Rchb.

= *P. sempervivum* Janka, Österr. Bot. Z. 23:205. 1873. – Nom. inval.

Heteroblastic ('heterophyllous') rosette herb, hibernating by winter buds; rosettes pressed down flat to the ground, their leaves undergoing a regular change in form and size: pre-floral (pre-anthetic; pre-generative; 'spring') rosette 35–50 mm in diam., composed of ~5 leaves, leaves in outline broad-ovate to broad-elliptical, (10–)20–25 × 15–20 mm, margins ~1 mm rolled inwards, shorter and broader than the summer leaves; post-floral (post-anthetic; post-generative; 'summer') rosette composed of 5 to 9 leaves; leaves elliptical-oblong, 20–50 × 10–20 mm. Winter buds bright green, wrapped into a short envelope of brownish dry scaly leaves at the base. Scapes 1(–5) dark green to dark purple, erect, (20–)40–80(–100) mm tall. Calyx greenish to dark purple, two-lipped; lobes of the upper lip 3, broadly triangular-ovate, nearly as long as wide, and often nearly orbicular; lobes of the lower lip 2, short, broadly ovate, to ~1/3 of its length divided, not spreading. Corolla (8–)14–19(–23) mm long (spur included), nearly as long as broad, dark blue-violet, two-lipped, widely open, i.e. the two lips forming with each other an angle of about 90°; the two lobes of the upper lip broadly ligulate to cuneate, rounded at the apex, ± overlapping; the three lobes of the lower lip broadly obovate to suborbicular, ± truncate to rounded at the apex, touching or overlapping, ahead of the throat extensively white patched, the middle lobe often saddle-shaped. Dense white hair covering on the bases of lower lip lobes and partly on throat. Tube short, widely funnel-shaped, the throat region partly reddish in colour, densely violet hairy; spur (2–)4–6(–7) mm long, as long as 1/3–1/4 of the rest of the corolla, straight,

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Plate 13: Figs. 1–6 *Pinguicula balcanica* from Maja e Bunit të Thores, limestone. – Fig. 1 Habitat; fig. 2 habitat, detail of population; fig. 3 habit, showing the before-in-bloom ('pre-anthetic', 'prefloral') leaf rosettes; fig. 4 flower, front view, showing the white patches on the lower lip lobes; fig. 5 flower, dorsal view, showing the calyx with its dark broad upper lip lobes; fig. 6 flower, side view, showing the short spur slightly curved downwards. – Photographs: figs. 1–3 L. Shuka; figs. 4–6 Rosemarie Stimper.

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L. SHUKA, M. XHULAJ, L. KASHTA & S. J. CASPER

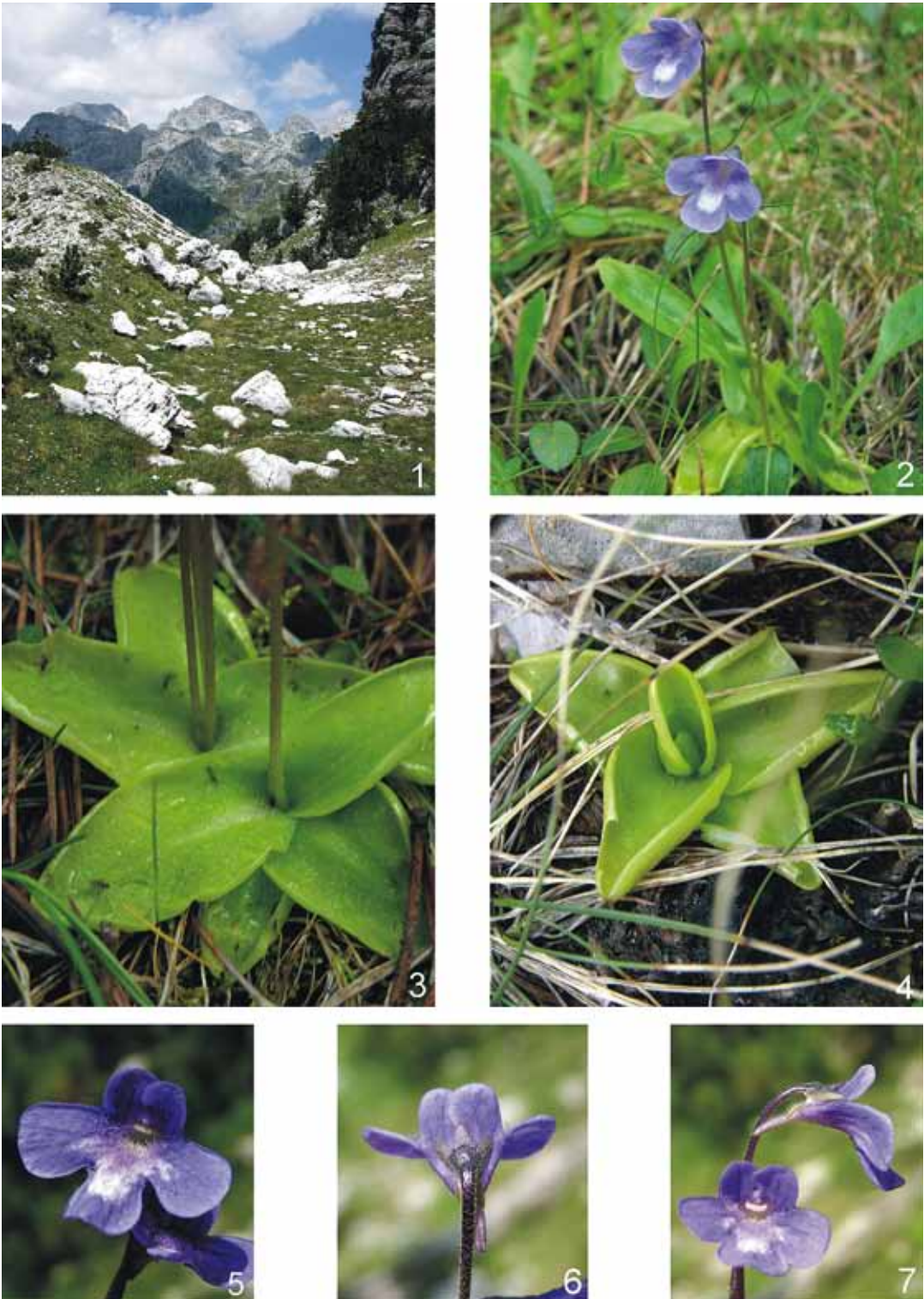


Plate 14: Figs. 1–7 *Pinguicula balcanica* from Shtegu i Dhenve near Qafa e Thores, limestone – Fig. 1 habitat, grassy places in scree; fig. 2 habit; figs. 3–4 before-in-bloom leaf rosettes; fig. 5 flower, front view; note the widely open corolla; fig. 6 flower, dorsal view; note the overlapping upper lip lobes; fig. 7 flowers, side and front view; note the white stigma. – Photographs: figs. 1–4 L. Shuka; figs. 5–7 Rosemarie Stimper.



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-obtuse. Stamens 2, pollen grains stephano- 6–7 colporate, prolate-spheroidal. Stigma white. Capsule ovoid to subglobose, overtopping the persisting calyx. Seeds like sawdust, cylindrical, ~800 × 300 µm.

Chromosome number  $2n = 32$ .

Flowering June–August.

Dwelling in marshy places near springs and brooks, 1,800–2,400 m, on various substrates (pl. 13, figs. 2–3, in limestone scree; pl. 14, figs. 1–3, in grassy places in serpentine scree).

## Annotations

The species has long been confused with *Pinguicula leptoceras* Rchb. and *P. vulgaris* L. (and even with *P. alpina* L.) from which it mainly differs by the broad calyx lobes rounded at the apex, the broadly obovate, contiguous or overlapping corolla lower lip lobes, the extensively white hairy throat patches, and the ovoid-subglobose capsule.

MARKGRAF (1931: 354) reported only *P. vulgaris* from Guri i Topit, Varri i Plakës. In 1932, in his 'Pflanzengeographie von Albanien', he ignored the taxon, a sign of his uncertainty about the taxonomical position of the 'alpine' *Pinguicula*.

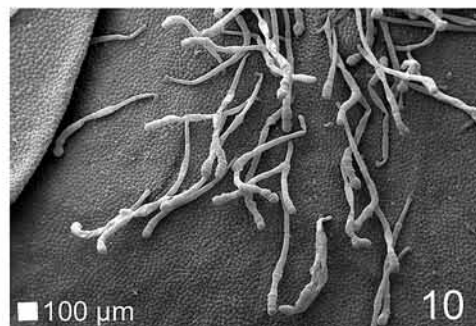
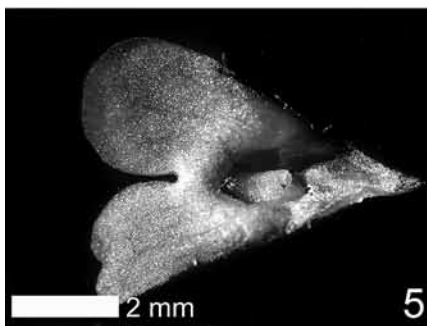
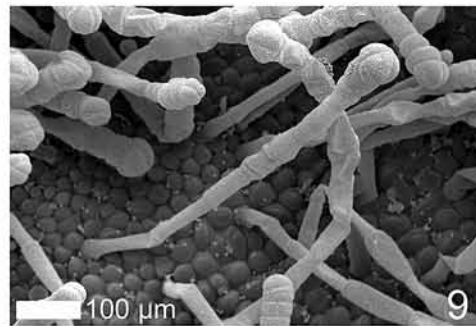
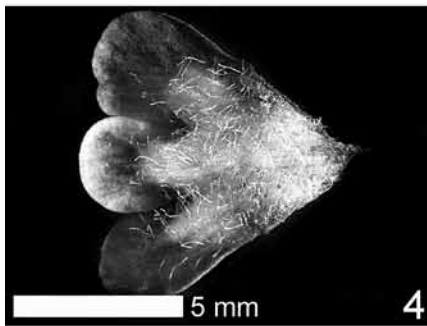
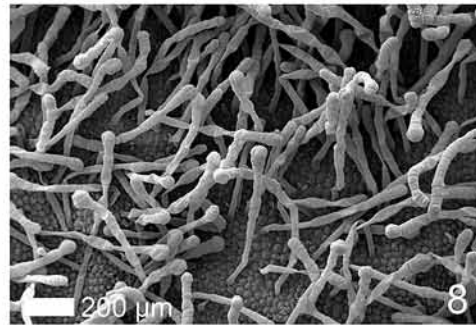
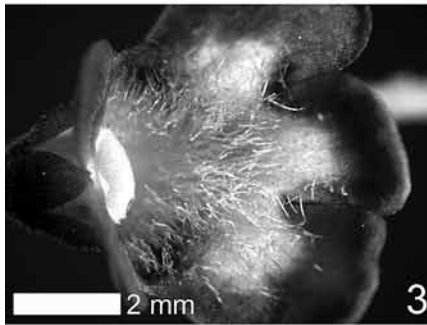
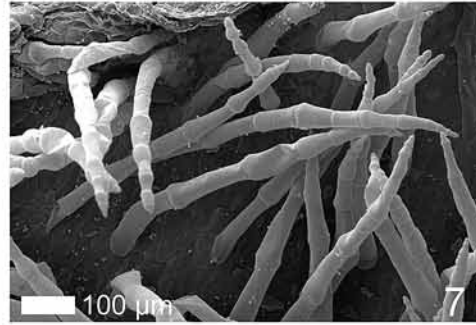
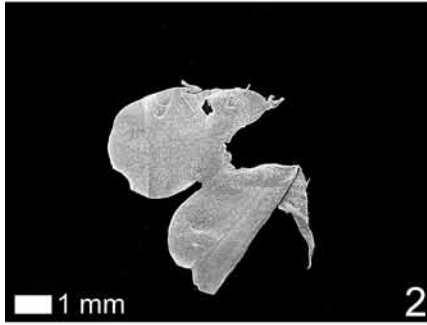
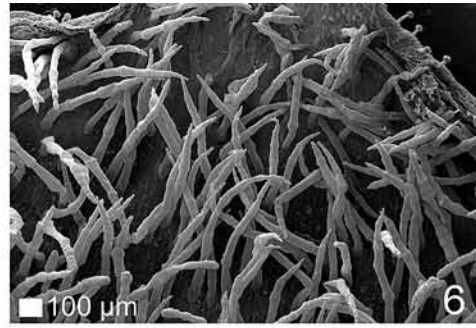
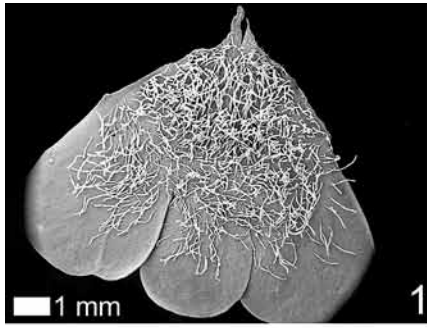
Like most of the European members of sectio *Pinguicula* the blue-violet flowering *Pinguicula* of the Balkans hibernates by winter buds ('hibernacula'), i. e. after the fruiting period during autumn the leaf rosette falls into decay and is replaced by a bulb-like bud which will be more or less covered by the substrate. This microthermal behaviour is quite different from the thermophilous *P. hirtiflora* which hibernates with an open leaf rosette developed after the decay of the 'summer' rosette.

The leaf rosette is said to be distinctly heteroblastic ('heterophyllous'): during the vegetation period the leaves undergo a regular change in size and form. In spring the winter buds are coming into leaf. The first four to five before-in-bloom ('pre-anthetic') leaves (pl. 13, fig. 3; pl. 14, figs. 3, 4) are forming a rosette more or less pressed down to the ground. In outline they are distinctly broad-ovate to suborbicular, nearly as long as wide, ~ (10–)20–25 mm long. From this 'spring' rosette the flowering scapes originate (pl. 14, figs. 3, 4). The spring rosette leaves (which are now the lower ones) are more or less covered by the after-bloom ('post-anthetic') leaves, the upper ones. The latter five to nine leaves are elliptical-oblong, i. e. distinctly longer than wide, at apex obtuse and on average about ~10–20 mm longer than the lower ones.

The corolla is about (8–)14–19(–23) mm long (spur included; pl. 13, fig. 6; pl. 14, fig. 7). Its appearance resembles to *P. leptoceras* in colour and in the touching or overlapping suborbicular lobes of the lower lip (pl. 13, fig. 4; pl. 14, fig. 2, 6), but it is on average smaller than in Reichenbach's taxon. Moreover, the lower lip of the calyx is divided just to  $\frac{1}{3}$  of its length into two lobes which usually are not spreading. The calyx colour is dark greenish to dark purple (pl. 13, fig. 5; pl. 14, fig. 6).

Non-glandular hair covering (indument) in the corolla (pl. 15)

The non-glandular hair pattern in the corolla of *P. balcanica* is quite different from that in the *P. crystallina-hirtiflora* aggregate. It is similar to the hair pattern in the *P. vulgaris*-group. The corolla lower lip is densely covered by long multicellular uniseriate hairs in the white patch zone which



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extends to  $\sim 2/3$  of the length of the lobes (pl. 15, figs. 1, 3–4). The hairs are directed more or less forwards, i. e. to the distal part of the corolla. They are  $\sim 800\text{--}900\ \mu\text{m}$  long and capitate, i. e. topped by three- to four-celled subglobose ‘heads’.

In the transition zone between throat and tube the hair covering is somewhat thinning; a palate or palate-like structure is not developed (pl. 15, fig. 4). On the ventral side of the tube the hair covering is especially dense (pl. 15, fig. 4), and the hairs seem to change their direction randomly (pl. 15, fig. 8; effect of preparation?!). In the proximal part of the short, widely funnel-shaped tube the hairs are directed backwards to the spur. They look like an asparagus stick, are narrow, multicellular, uniseriate,  $\sim 900\ \mu\text{m}$  long, and are tapering to the pointed head cell (figs. pl. 15, 6–7).

The lobes of the lower lip practically lack hair covering. A group of few simple hairs occurs at a very restricted area in the contact zone with the lateral lobes of the lower lip.

Pollen grains (pl. 16, figs. 1–9)

KAHLEYS (1994: 113) has grouped *P. balcanica* (material from Bulgaria, Pirin mountains, coll. 1960, Lepper & Lippold – JE) on reason of pollenmorphological features together with *P. corsica* Bern. et Gren., *P. vallisneriifolia* Webb, *P. nevadensis* (Lindb.) Casper, and *P. reichenbachiana* Schindl. in one and the same ‘pollen group’.

Pollen stephano- (5–)6–7(–8) colporate; prolate-spheroidal; P/E =  $\sim 1.13^{33}$  (P =  $\sim 26\ \mu\text{m}$ ; E =  $\sim 23\ \mu\text{m}$ ). Colpi  $\sim 20\ \mu\text{m}$  long, emarginate, at the end rounded; sometimes syncolpy of neighbouring colpi observed. Equatorial mesocolpi  $6.0\text{--}8.0\ \mu\text{m}$  wide, strongly microreticulate to vermiculate, muri arched, each other closely involved,  $0.41\text{--}0.58\ \mu\text{m}$  wide. Poles (apocolpi) circular,  $\sim 11.0\ \mu\text{m}$  in diameter.

Seeds (pl. 16, figs. 10–15)

The seeds are tiny like saw dust;  $\sim 650\text{--}800\ \mu\text{m}$  long,  $\sim 250\text{--}300\ \mu\text{m}$  thick ( $\sim 8\text{--}10$  longitudinal rows of exotesta cells; fig. 13) at maturity; their shape is mostly regular cylindrical to ellipsoidal (figs. 10, 13, 15); with one micropylar appendage ( $\leq 1/6$  of total seed length), in fig. 10, 13 at the left end, in figs. 12, 15 at the right end; chalazal appendage mostly absent, sometimes present (fig. 12). The testa (outer coat) is minutely pitted (honey-combed, foveolate), the exotesta cells are rectangular to polygonal-rounded, about  $1\frac{1}{2}$  times to twice longer than wide, without cracks in the outer periclinal cell walls (figs. 11, 14). The outer part of anticlinal walls of adjacent cells are  $\pm$  free, i. e. separated by a furrow. In cross sections of the seed coat the anticlinal cell walls are consistently thin, i. e. without any outgrowth or thickening (DEGTJAREVA et al. 2004: 441, fig. 13).

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33 P = pole; E = equator.

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Plate 15: Figs. 1–15 *Pinguicula balcanica*, pattern of hair covering and morphology of hairs. – Figs. 1–2 unfolded corolla lips, SEM; fig. 1 lower lip lobes, hairy; fig. 2 upper lip, hairless. – Figs. 3–5 unfolded corolla lips, LM; figs. 3–4 densely hairy lower lip lobes; fig. 5 upper lip lobes nearly hairless. – Figs. 6–7 multicellular pointed hairs directed backwards, in tube proximal to spur; SEM. – Figs. 8–9 multicellular capitate hairs in tube and throat; SEM. – Fig. 10 multicellular capitate hairs (with small heads), directed forwards; SEM. – Preparation: Rosemarie Stimper, Ingemar Herrmann; LM microphotographs: Rosemarie Stimper; SEM microphotographs: Ingemar Herrmann.

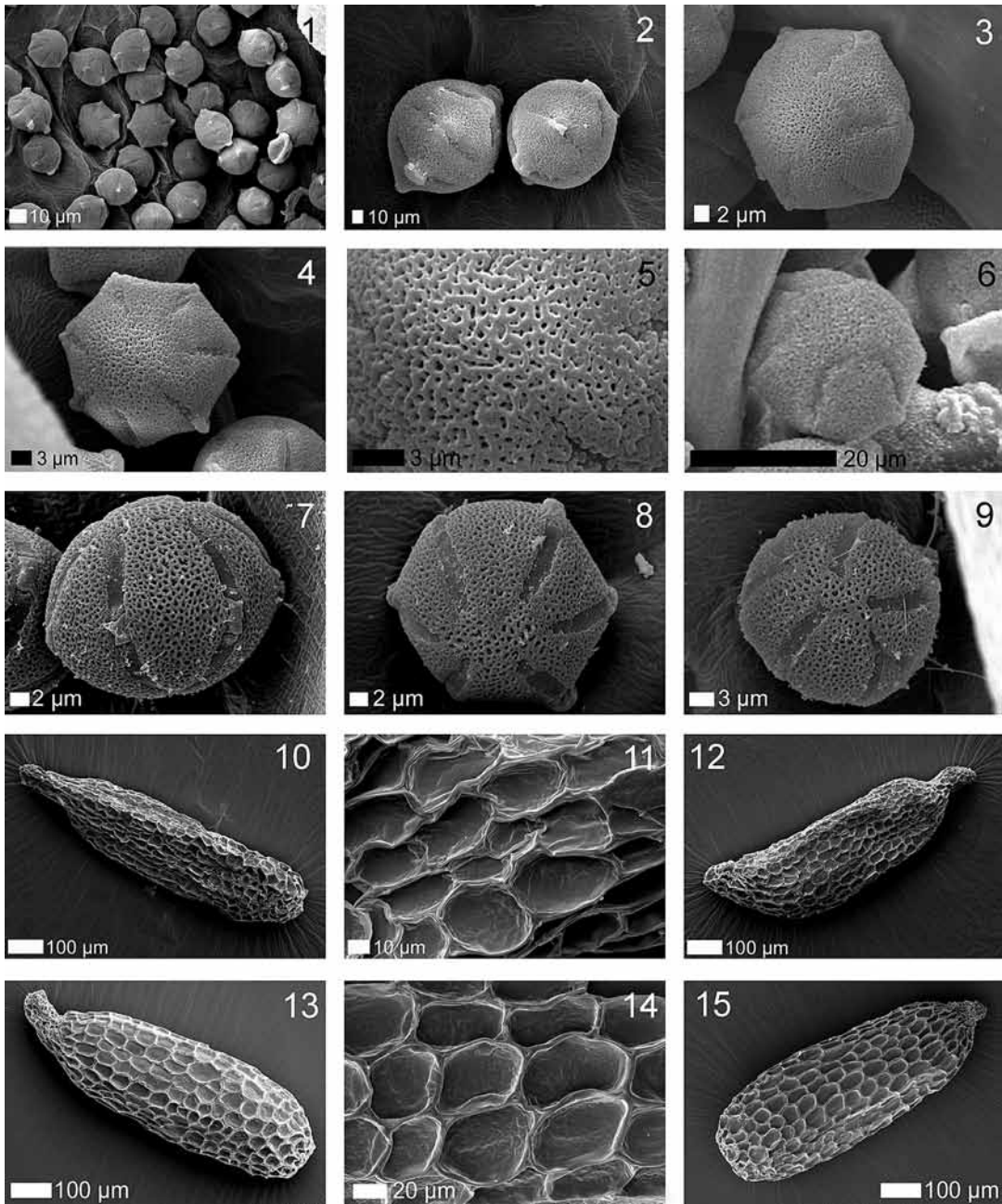


Plate 16: *Pinguicula balcanica*, pollen grains and seeds; figs. 1–15 SEM microphotographs. – Figs. 1–9 pollen grains; figs. 1–6 Albania, Stanet e Koprishtit, Lëpusha, BGJ 169; critical point drying; fig. 1 group of pollen grains; fig. 2 two pollen grains in equatorial view; figs. 3–4 pollen grain in polar view, stephano- 7 colporate; fig. 5 pollen grain, pole with microreticulate pattern; fig. 6 pollen grain showing syncolpy. – Figs. 7–9 Bulgaria, Pirin (Steiger 07), critical point drying; fig. 7 pollen grain in equatorial view; figs. 8–9 pollen grains in subpolar view; stephano- 6 colporate. – Figs. 10–12 seeds, Albania, Stanet e Koprishtit, Lëpusha (L. Kashta 2006); figs. 10, 12 seed, general view, shape regularly cylindrical; fig. 10 long micropylar appendage (left), chalazal appendage absent; fig. 12 long micropylar appendage (right), chalazal appendage shorter (left); fig. 11 seed, detail of seed coat. – Figs. 13–15 seeds, Bulgaria, Vitosa (Steiger S 30); figs. 13, 15 seed, general view; shape regularly cylindrical; fig. 13 long micropylar appendage (left), chalazal appendage absent; fig. 15 micropylar appendage (right), chalazal appendage absent; fig. 14 seed, detail of exotesta (seed coat). – Preparation: Rosemarie Stimper; SEM microphotographs Ingemarie Herrmann.

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## Karyology (tab. 1)

In Albanian *Pinguicula balcanica* we have found  $2n = 32$  chromosomes (tab. 1, BGJ 135). The counts correspond well to those of specimens of Bulgarian (Pirin) provenance (CASPER 1966: 32, 33 – haploid  $n = 16$ ; 168: diploid  $2n = 32$ , deduced, not counted). The chromosome complement is the same as in *P. leptoceras* Rchb. or *P. reichenbachiana* Schindl., both of them tetraploid members of sectio *Pinguicula* (CASPER 1966: 33) and said to be related to *P. balcanica*. The basic number in this group is  $x = 8$ . The hypothesis by CASPER (1970: 291) supposing the *P. balcanica*-populations from the Balkan peninsula and Asia Minor, respectively, to be tetraploids has found its confirmation.

Our report is the first about chromosome numbers in Albanian *P. balcanica*. From Greek (Pindos, Smolikas) specimens, chromosome reports exist (CONTANDRIOPOULOS & QUEZEL 1974: 28): “*Du point de vue caryologique, des fixations en provenance de 2 localités du Smolika ce sont toutes révélées triploides (2n = 24)*”. Again we wonder their statement *P. balcanica* to be a triploid. Moreover, the identity of *P. balcanica* and *P. hirtiflora* var. *louisii* with regard to the chromosome number is puzzling.

PERUZZI (2004: 103, 104) took over the numbers of CONTANDRIOPOULOS & QUEZEL ( $2n = 24$ ; 1974: 28) and of CASPER ( $2n = 32$ ; 1966: 168) not mentioning that the latter number is based on counts of the haploid stage:  $n = 16$ ; 1966: 32, 33). He concluded (op. cit. 103) “*this suggests an accurate systematic review of this species, aimed to clarify if this karyological variability is linked to some misidentification or to the union of more taxa under this species*”. However, there is no misidentification or union of different taxa. We have well-founded doubts about the exactness of the counts quoted. We believe there are simply count errors.

The plants we have studied were from Shtegu i Dhenve and Stanet e Koprishtit in the North Albanian Alps. The specimens had been heavily infected by *Ustilago*. The haploid level could not be established of because the whole male reproduction complex was full of fungal spores; no pollen grains had been developed. Perhaps the unsatisfactory results with regard to counts and microphotographs of metaphase plates of root tip tissue have been influenced by fungal contamination, too. Our diploid chromosome number  $2n = 32$  is not counted exactly; it is estimated (tolerance  $\sim 2+ / 2-$ ). That does not mean it is dubious as the comparison with our counts on Bulgarian material show.

Distribution and habitat features of *Pinguicula* in Albania (pl. 17)Distribution of *P. hirtiflora* var. *hirtiflora* (pl. 17)

*Pinguicula hirtiflora* var. *hirtiflora* mainly occurs in a north to south oriented belt in the eastern part of Albania. In the north, at the border to Montenegro, its area stretches westwards to the northern surroundings of Lake Shkodra there reaching its most western sites. A relatively continuous area extends from Qafa e Markofçës in the north southwards to Gërmenj-Shelegur in the southeast. In Central Albania, the density of sites decreases, but increases again in South Albania with a ‘focal point’ east of Ostrovica mountain range (Mali i Ostrovikës). In western Central Albania there are no sites. In South Albania two western sites more or less isolated from the main area have been reported: Dhërmi at the coast of the Ionian Sea, and Mali i Çikës above

Tërbaçi. In the north, east and south the Albanian area links up immediately to the neighbouring places in Hercegovina, Montenegro, Serbia (Kosovo), Macedonia, and Greece.<sup>34</sup>

On the whole, the area of *P. hirtiflora* var. *hirtiflora* in Albania can be characterized as the northwestern part of the Balkan-Italian area of the taxon (cf. GREUTER et al. 1989: 215).

#### Habitat features of *P. hirtiflora* var. *hirtiflora*

*Pinguicula hirtiflora* var. *hirtiflora* is a species of the mediterranean lowlands as MARKGRAF (1932) – with regard to the contrasting mountainous zone – says. This statement can be accepted remembering the subtropical growth form of the taxon. However, on suited places it reaches the subalpine zone of the mountains, on the whole growing between ~150 m and ~1,600 m (exceptionally up to maximum ~1,900 m). Summarizing it can be said that *P. hirtiflora* (var. *louisii* included) is living below the alpine *P. balcanica* with which it occupies neighbouring places.

It is dwelling on wet serpentine – MARKGRAF (1932: 87) says it would be (in the Albanian serpentine area) ‘serpentinster’ (that means confined to serpentine) – limestone, flysches, or marly substrates on rocks, around springs and along brooks of marshy meadows, in peat bogs from ~150 m up to ~1,600 m (~1,900 m). It prefers full sunny or shady places on rocks and at the margins of brooks. It is often accompanied by *Schoenus nigricans* L., *Juncus compressus* Jacq., *Potentilla erecta* L., *Brachypodium sylvaticum* (Huds.) P. Beauv., *Carex* spec., *Eriophorum angustifolium* Honck., *Veratrum album* L., *Ranunculus* spec. (in peat bogs), *Pinus nigra* J. F. Arnold, *Buxus sempervirens* L., *Arbutus unedo* L., *Juniperus oxycedrus* L., *Salix* spec., *Adiantum capillus-veneris* L., *Aquilegia vulgaris* L., *Gentiana asclepiadea* L. and *Festucopsis serpentini* (C. E. Hubb.) Melderis (the latter only on serpentine), *Cardamine raphanifolia* Pourr., and *Pyraacantha coccinea* M. Roem., along banks of streams or at marly places.

A place of growth rather exceptional for Albania and the whole Balkan Peninsula has been detected on June 1, 1924, by Markgraf. He found a *Carex distans*-*Schoenus nigricans* – Moorfleck [peat bog] on Mali i Shpatit near Gjinar, in an altitude of ~1,000 m, in a pine wood above serpentine at the banks of a brook. The two sedges form a black peat brightened up by the lilac flowers of *Pinguicula hirtiflora* (MARKGRAF 1927: 70). The following plant association has been established by him (sample 52; frequency in brackets):

*Carex distans* (3), *Pinguicula hirtiflora* (2), *Potentilla tormentilla* (2), *Juncus compressus* (1), *Schoenus nigricans* (1), *Sieglingia decumbens* (1), *Taraxacum* spec. (1), *Cirsium palustre* (1), *Bellis perennis* (1), *Ranunculus sardous* (1) and *Hieracium baubini* (1).

MARKGRAF (1927: 69) considered the occurrence of the small “Seggenmoor(es)” [sedge peat] on Mali i Shpatit a distinct sign for an approachment of the “Troockenwaldstufe” to the humid

<sup>34</sup> The question is allowed whether our list of specimens (see appendix) is representative. MARKGRAF (1927: 70) wrote: “In Albania, this butterwort (i. e. *P. hirtiflora*) can be found at each shaded stream about serpentine”. During our excursions between 2002 and 2006 we have detected a great many new localities. We believe that we have got a good idea of what the real distribution is. We consider that what we can see today of flora and vegetation is a complex mosaic of natural, semi-natural and man-made habitats; truly natural vegetation is confined to certain habitats in the mountains, habitats in which *Pinguicula* preferably lives. We know only a single place where *P. hirtiflora* is nearly extinct by human activities (road reconstruction): Shkumbin valley near Librazhd (see appendix). With regard to var. *louisii* we must register the (apparent) extinction of the Kruja site by water supply activities. The Linza site is endangered, too (closeness to Tirana city). The rare species *P. balcanica* seems to be not endangered because its alpine habitats are sparsely populated by man and nearly free from grazing.

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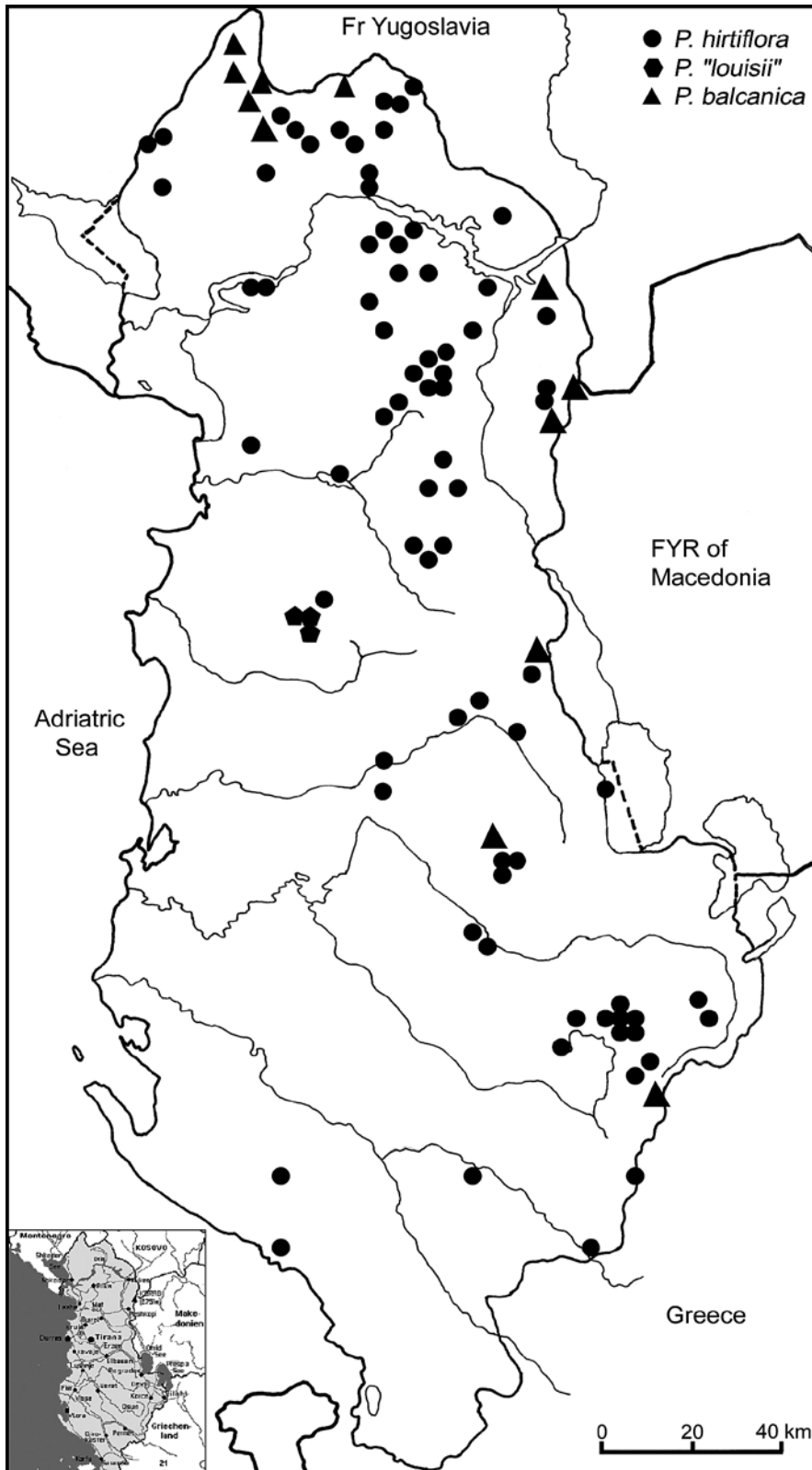


Plate 17: Distribution of the genus *Pinguicula* in Albania. – L. Shuka, Rosemarie Stimper, S.J. Casper.

mountains climate. Only here such rare 'peat bogs' are formed, and MARKGRAF (1932: 72) concluded that pure *Pinguicula hirtiflora* stands on trickled serpentine rocks would be the first steps into this direction (?).

In Greece, in the mountain ranges of Giona (grotte dorée) and Olymbos (gorge de Lithokoron), *P. hirtiflora* is said to occur in the association of *Aquilegia amaliae* and *Pinguicula hirtiflora* (class Adiantetea) among other things together with *Asplenium lepidum*, *Heliosperma pudibundum*, *Adiantum capillus-veneris*, and *Poa silvatica* (QUEZEL 1964: 310–311). The association is growing in altitudes between 1,300 m and 1,500 m on sites where the water trickles down steep calcareous rocks.

#### Distribution of *P. hirtiflora* var. *louisii* (pl. 17)

The dubious taxon *P. louisii* in the sense of Markgraf has been found in the northwestern slopes of Dajti mountains (Mali i Dajtit) in the neighbourhood of Brari and Linza (today annexed to Tirana), in the evergreen shrubby belt and in warm microhabitats (but in winter sometimes covered by snow and ice), at an altitude between ~150 m and ~700 (~900) m. It is said to occur to the north in the Mati district, too (MARKGRAF 1942). If this would be right, the taxon ought to be considered a local endemic taxon of northern Albania. MARKGRAF himself extended its area to the surroundings of Thethi in north Albania (MARKGRAF 1942) and to the Greek Mount Olimbos far to the south (MARKGRAF 1926: 430, 1927: 129).

Summarizing our observations and acknowledging the morphological circumscription of *P. louisii* by MARKGRAF (1926: 430) it can be said that its distribution is restricted to the western and northern slopes of Mali i Dajtit in the immediate neighbourhood of Tirana, i. e. it ought to be considered a steno-endemic taxon of Central Albania. Incorporating *P. louisii* into the *P. crystallina-hirtiflora* aggregate, however, its small area adjoins the large *P. hirtiflora* var. *hirtiflora* area as our dot map (pl. 17) clearly shows.

#### Habitat features of *P. hirtiflora* var. *louisii*

*Pinguicula hirtiflora* var. *louisii* is dwelling on soggy limestone, wet flysch substrate or marly grounds around springs and along brooks often accompanied by *Brachypodium sylvaticum* (Huds.) P. Beauv., *Carex* sp., *Adiantum capillus-veneris* L., *Arbutus unedo* L., and *Pyracantha coccinea* M. Roem.

#### Distribution of *P. balcanica* (pl. 17)

*Pinguicula balcanica* occurs in the upper mountainous zones in the western and central part of the Balkan Peninsula. Its area reaches from Bosnia-Herzegovina in the north across Montenegro, Albania, Serbia (Kosovo), Macedonia, Greece (North Pindos, North Central, with an isolated southern locality on Vardousia; cf. STRID & KIT TAN 1991: 278), to Bulgaria in the east (CASPER 1962: 110–112).

In Albania it is scattered in a narrow belt oriented from north to south with a distinct border to the west (pl. 17). Its area stretches from the western part of the north Albanian Alps (Vermoshi, Lëpusha, Thethi) across northeastern (Gjalica e Lumës, Mali i Korabit) and eastern Albania (Jablanica) to the southeast (Gur i Topit, Mali i Gramozit). In the north the localities join



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directly the sites in Montenegro (CASPER 1962: 110, 111, fig. 19, dot map),<sup>35</sup> for instances Kom Kučki, Vasojevići, and Plav; at the Mali i Gramozit-site in the south it goes over southwards to the neighbouring Greek localities in North Pindos (Gramoz, Smolikas).

Habitat features of *P. balcanica*

*Pinguicula balcanica* grows up in the subalpine and alpine zones in places often covered by snow until at the end of May. It goes up into altitudes between (~1,600–)1,800 and ~2,400(–2,600) m (Korabi i Madh ~2,500–2,600 m, F. K. MEYER 5039 – JE). It lives in different habitats, in shady places together with *Brachypodium sylvaticum* (Huds.), *Pinus leucodermis* Antoine (on limestone) and *Pinus nigra* J. F. Arnold, and in alpine meadows among shrubby and grassy plants, such as *Nardus stricta* L., *Veratrum album* L., *Dryas octopetala* L., *Salix retusa* L., *Gentiana verna* L. (on limestone), *Aquilegia amaliae* Heldr. ex Boiss. (= *A. ottonis* Orph. subsp. *amaliae* Strid), *Gentiana dinarica* Beck (on limestone), *Geum montanum* L., *Ranunculus carinthiacus* Hoppe, *Soldanella alpina* L. and *Viola calcarata* subsp. *zoysii* (Wulfen) Merxm. Preferred substrates are limestone (dolomite, marble), flysch, schist and serpentines.

From the phytosociological point of view, in Greece (Zygos mountain) QUEZEL (1967: 208–209; tableau 18, relève no. 1) has grouped *P. balcanica* together with *P. hirtiflora*, *Carex nigra*, *Eriophorum latifolium*, and *Soldanella pindicola* (“assoc. à *Pinguicula hirtiflora* et *Soldanella balkanica*“ [sic!]<sup>36</sup>). He reported that the association occurs in alpine ‘pozzines’ [wet meadows] on ophiolitic soils in the upper mountain zone of North Pindos (Zygos, Smolika) above 1,500 m.

It is difficult to arrange the distribution area of *P. albanica* in accordance with the floristic structure of Albania proposed by MARKGRAF (1932: 95–102). The significant western border matches to a certain degree the chorotype of the so-called ‘östlichen Arten’ (eastern species; listed by MARKGRAF op. cit.: 96). It is about those northeastern species for which the mountains at the Albanian-Macedonian boundary function like an assembly point.

Summary on the distribution of both the *Pinguicula* species in Albania and evolutionary aspects

From the interpretation of the distribution we learn that the two Albanian *Pinguicula* species occur in two closely neighbouring belt-like areas running parallel to each other from north to south or vice versa but do not live really sympatric (but see footnote 36).

*Pinguicula balcanica* represents the northern chorotype of the southeastern European floral element. Its area corresponds well to the Illyrian, Albanian, Balkanian and Macedonian-Thracean floral provinces (MEUSEL et al. 1965; cf. GREUTER et al. 1989: 214). From the historical point of view the area will be relatively old (~2.5 my; but phylogeographical data do not exist), it might be of Pleistocene origin (tetraploid chromosome level; possible relationship to the populations in Asia Minor). During ice age extensive ice caps were lacking; local glaciers in the higher zones of the mountains as well as refugia existed. Taxa like *P. balcanica* could survive.

35 Morphologically deviating populations occur in Bosnia-Herzegovina (*P. balcanica* var. *tenuilaciniata* Casper; cf. CASPER 1962: 112) and Asia Minor (*P. balcanica* subsp. *pontica* Casper; cf. CASPER 1970: 285–290; scattered in north and east Anatolia eastwards to Transcaucasia). They will not be discussed in this paper.

36 *Soldanella balkanica* – apparently a print error in the headline of tableau 18: in the list of species, in the description of the association (pp. 208, 209), and in the summary of the results (p. 228) we read *Soldanella pindicola*. The Zygos association shows a sympatric occurrence of *P. hirtiflora* and *P. balcanica*!

*Pinguicula hirtiflora* var. *hirtiflora*, however, belongs to the Balkan-(Greek-)Italian floral element including the southeastern part of the Centralmediterranean region, that crosses the Adriatic to South Italy (Magna Sila, Amalfitana) with a western outpost in the Alpi Marritimi (? Roia Valley).

The present shape of the area of *Pinguicula hirtiflora* (including var. *louisii*, but excluding *P. crystallina*) could be of Upper Pleistocene origin (~2,3 my ago), when the Adriatic and Aegean landbridges broke off and the Adriatic gap (street of Otranto) and the Aegean archipelago were formed. During this time the originally more or less continuous area of the *P. crystallina-hirtiflora* aggregate will have been fragmented by the repeated climate change during the ice age, i.e. by the alternating glacial and interglacial periods together with the marine transgressions and regressions resulting in always changing coastal lines (Adriatic Sea and Aegean Sea for instance have been much smaller during the colder periods). Our taxon will be much older, it will be of pre-Pleistocene origin (see the distribution gap of *Pinguicula* in the Aegean Archipelago).

Diversification led to the development of at least two different vicarious units: the western *P. hirtiflora* s. str., our Albanian unit, and the eastern *P. crystallina*, the oriental Anatolian-Cypriotic unit.

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**Appendix:** List of specimens (dried, living, and photographs) seen and evidence from literature (LIT)*Pinguicula hirtiflora* var. *hirtiflora* (pl. 17)

Specimens (dried and living) seen and evidence from literature:

**Malësia e Madhe:** Distr. Malcija, an überrieselten Felswänden an der Quelle in der Schlucht von Rapša, ~750 m, 13.5.1914, I. Dörfler, Reise in das albanisch-montenegrinische Grenzgebiet i.J. 1914 no. 108 – W, WU [fide DÖRFLER 1914: 462 - LIT]. — Distr. Klementi [Këlmendi], zwischen Moos an quelligen Orten bei Hani Grabom, ~160 m, 21.5.1914, I. Dörfler, Reise in das albanisch-montenegrinische Grenzgebiet i.J. 1914 no. 179 – LD, W, WU [fide DÖRFLER 1914: 462 - LIT]. — Distr. Klementi, Djevica (Broja) sub m. Kapa, A. Baldacci, Iter Albanicum septimum 144 – SARA. — Nikci, Hannibal & Antonio Baldacci – LE, SARA. — **Shkodra:** Nordalbanische Alpen (Prokletija), Thethi, Schlucht am Ende der Straße von Qafa e Thores, am Fluss Shal, 26.7.1959, F.K. Meyer 4320 – JE. — Lekaj dhe Theth, në rrugën Dukagjin-Theth në shkëmbinj gëlqerorë me lagështi, ~700–800 m, 29.7.1960, Balza & Dh. Shyqja – TIR. — Thethi, Okol, kiesiger Boden in der Nähe des Baches zwischen *Pinus Mughus* Scop. und *Juniperus nana* Willd. bei 800 m – fide B. SCHÜTT 1945: 52 - LIT. — Shkrel, Afër fshatit Ducaj, gëlqeror, vend me lagështi, ~700 m, 13.5.1977, K. Tartari & H. Voci – TIR, W. — **Tropoja:** Qaf e Markofçës, in kurzgrasigen subalpinen Wiesen unter Vorherrschaft von *Nardus stricta* L. an feuchten quelligen Orten – fide B. SCHÜTT 1936: 43 - LIT. – Nordalbanische Alpen (Prokletija), Vallbona, bei Selimaj, 28.7.1959, F.K. Meyer 4458 – JE. — Skelsen [Bach am Fuße des Berges Shkëlzeni], S. Jávorka – BPU [fide E. CSIKI et al. 1926 - LIT]. — Maj e Hekurave, steinige subalpine Zone unterhalb der Passhöhe – fide B. SCHÜTT 1945: 75 - LIT. — Qafa e Prushit, an feuchten Orten, (N. KOŠANIN, 1939). — **Kukës:** Bachufer bei Kruma, ~600–700 m, 1924, H. Zerny [fide A. HAYEK 1924: 166 - LIT]. — Längs des Flusses Sriča beim Dorfe Petka in Nordalbanien auf Serpentin, massenhaft, 4.6. & 19.6.1913, N. Košanin – BPU, W, WU. — Near the summit of Runa Mountain, on wet serpentine rocks, ~1,300–1,400 m – fide N. KOŠANIN 1939 - LIT). — Bjeshka e Tejës, në vënde serpentimore me lagështi, ~1,800 m, 24.6.1979, M. Xulaj & V. Tartari – TIR. — Shënmëri, në perëndim të Kukësit, nëpër shkëmbinj serpentimore me lagështi, ~250–900 m, 28.6.1955, K. Papparisto & Xh. Qosja – TIR. — **Puka:** An feuchten Felsen beim Stützpunkt Santa Maria (zwischen Pika und Kukës) [near Shenmëri along the road Pukë-Kukës], 15.6.1944 – sub *Pinguicula louisii* Mgf. fide F. HÖPFLINGER 1964: 99 – LIT (voucher not seen). — Nasser Felsen an der Straße bei Shenmeria, westlich Kukës, Serpentin, 18.5.1960, F.K. Meyer 5796, 5796a – JE. — Dukagjin (Puke), near Çam village, wet serpentine rocks, ~450 m, J.B. Kümmerle – BPU [fide E. CSIKI et al. 1926 - LIT]. — Dukagjin, M. Çam, B. Grünwald – BPU. — Pr. Chan X, s.d., A. Grisebach 1017 – GOET (Herbarium Grisebachianum; TYPE of *P. albanica* Griseb.). — Distr. Merdita, an der alten (Grisebachschen) Karawanenstraße zwischen Puke und Han-i-Arsit, nahe Vlet (Flet = 'Han X'), J. Bornmüller – ? [fide J. BORNMÜLLER 1933: 129 - LIT]. — **Peshkopi (Dibër):** Zwischen Ploshtan und Radomir, am Fuße des Korab, ~1,400 m, J.B. Kümmerle – BPU [fide E. CSIKI et al. 1926 - LIT]. — Korab, Radomir, Liqeni i Zi, ~1,800 m, leg. 5.8.1959, F.K. Meyer 4824 – JE. — Gjatë rrugës Fushë-Lurë Zall-Dardhë, në shkëmbinj serpentimore me lagështi, ~600–1,000 m, 27.5.1958, Xh. Qosja – TIR. — Dardha, s.d., s.n., P. Černjavski – W. — Lura, Kunora e Lurës, ~1,600 m, 2.8.1959, F.K. Meyer 4645 – JE. — **Bulqizë:** Në terrene serpentimore të lagëta, ~800 m, 3.6.1959, Xh. Qosja – TIR. — Në shkëmbinj serpentimore në një përrua në afërsi të Malit të Deshatit, ~1.200 m, 9.6.1978, V. Tartari – TIR. — **Mirdita:** Ostmerdita: Fani, Thera, Quellsumpf, Sandstein, ~900 m, bl., 1.8.1928, F. Markgraf n. 1963 – B [destroyed 1943; fide F. MARKGRAF 1931: 354 - LIT]. — **Mat:** Mali i Allamanit, afër majës në shkëmbinj serpentimore të lagët, ~1,700–1,800 m, 12.7.1976, J. Vangjeli – TIR. — Matja: zwischen Cëruj und Kurdarij, ~500 m, Serpentinsschwemmboden am Bach, bl., 27.5.1928, F.

Markgraf n. 1167 – B [destroyed 1943; fide F. MARKGRAF 1931: 354 - LIT] — Mali, Skenderbegut, Burrel, unter dem Qaf Shtam, ~1,000 m, 9.8.1959, F.K. Meyer 5086 – JE. — Skand.: Serpentinbach westlich Frenkth, ~600 m, bl., 28.5.1928, F. Markgraf n. 1134 – B [destroyed 1943; fide F. MARKGRAF 1931: 354 - LIT]. — **Lezhë:** Pranë fshatit Kashnjet, flysch, ~280 m, 24.5.1984, J. Vangjeli & V. Tartari – TIR. — **Kruja:** Mali i Skënderbeut afër Qafë Shtamës, serpentinë, ~1,000–1,150 m, 25.5.1976, V. Tartari – TIR. — Skand.: Shkreta, Bach im Schwarzkiefernwald, ~1,000 m, Serpentin, bl., 11.7.1928, F. Markgraf 1586 – B [destroyed 1943; fide F. MARKGRAF 1931: 354 - LIT]. — **Librazhd:** Elbasan, P. Černjavski – W. — Librazhd, 5 km W, an der Straße nach Elbasan, an überrieselten Serpentinfelsen, ~250 m, 4.7.1959, F.K. Meyer 3452 – JE. — Librazhd, 3 km NW on road to Togëz, just above the road on marly slopes, 16.6.2004, L. Shuka, S.J. Casper, M. Xhulaji, L. Kashta – JE; [living plants cult. BGJ 86.1]. — Librazhd, Shkumbini river valley, 3 km S of city on road to Pogradec, just above the railway tunnel, wet serpentine rocks, 16.6.2004, L. Shuka, S.J. Casper, M. Xhulaj, L. Kashta – JE; living plants cult. BGJ 87.1 [fide V. Rybka 1986 - LIT; information by I. Koudela 1997 - in litteris]. — Në afërsi të liqenit të fshatit Qarrishtë, serpentinë, ~1,200 m, 10.6.1962, M. Demiri & E. Palikuqi – TIR. — Shpat (Mal i Shpatit): Schoenusmoor bei Gjinar, ~1,000 m ü.d.M., Serpentin; blühend, 1.6.1924, F. Markgraf 419 – B [destroyed 1943; fide F. MARKGRAF 1927: 210 - LIT]. — **Pogradec:** Ohridasee: Bachrand bei Pishkupa, ~700 m ü.d.M., Serpentin, blühend. 21.6.1924, F. Markgraf 779 – B [destroyed 1943; fide F. MARKGRAF 1927: 210 - LIT]. — **Gramsh:** Gur i Topit: Wiesenbach nördlich Varr i Plakës, ~1,800 m, Serpentin, bl., 25.6.1928, F. Markgraf 1445 – B [destroyed 1943; fide F. MARKGRAF 1931: 354 - LIT]. — Guri i Topit-Varr i Plakës, në shkëmbinj serpentinorë përgjatë përrenjëve, ~1,400–1,900 m, 26.7.1976, J. Vangjeli & V. Tartari – TIR. — Guri i Topit-Guri i Nikës, në shkëmbinj të lagët serpentinorë, ~1,650 m, 26.7.1956, Xh. Qosja & M. Demiri – TIR. — Gur i Topit: Kurtigjontal bei Grabova Kr., Kalkbach, ~1,300 m, bl., 25.6. 1928, F. Markgraf 1450 – B [destroyed 1943; fide F. MARKGRAF 1931: 354 - LIT]. — Tomor (Mal i Tomorrit), Schlucht des Flusses von Sotir, unterhalb Dardha, Flysch, ~500 m, 22.9.1961, F.K. Meyer 6372 – JE. — Devoll-Tal, Gramshi, Devoll-Schlucht, südlich Kokol, im östlichen Seitental, ~400–500 m, 20.9.1961, F.K. Meyer 6272 – JE. — **Korça:** Korça, 15 km S von Qafa e Qarri, am Fuße des Pepellash (habitat in literature called 'Floq'), Quellhorizont nahe der Brücke, Serpentin, 17.6.2004, L. Shuka, S. J. Casper, L. Kashta, M. Xhulaj – JE [living specimens cult. BGJ 88.1]. — Voskopoja, A.H.G. Alston & N.Y. Sandwith – S (s. d., s. n.). — Ostrovica, zwischen Shtylla and Gjonbabas, ~1,100 m, 6.7.1959, F.K. Meyer 3580 – JE. — **Erseka:** Pranë fshatit Ballabanovë, 26.6.1961, E. Balza & Xh. Qosja – TIA. — Gërmenj-Shelegur, 5 km SE of Leskovik on road Ersekë-Leskovik, on wet serpentine ground along brooks, ~1,000 m, 17.6.2004, L. Shuka, S.J. Casper, M.Xhulaj, L. Kashta – JE [living specimens cult. BGJ]. — Shelegur, 2 km ahead of village, springy places above and below road, 17.6.1004, L. Shuka, S.J. Casper, L. Kashta, M. Xhulaj – JE. — **Përmet:** Çarshova, në veri të fshatit në përrua, flysh, 10.5.1963, Palikuqi & Zgjani – TIR. — Këlcyra, Vjosatal, Wasserfall 2 m über dem Wasserspiegel des Flusses, auf einem Kalkfelsen, 17.6.2004, L. Shuka, S.J. Casper, M. Xhulaj, L. Kashta – JE [living specimens cult. BGJ 89.1] [fide V. Rybka 1996 - LIT; information by I. Koudela 1997 – in litteris]. — **Vlorë:** Dhërmi, unmittelbar am Ortsausgang an der Straße nach Vlorë, auf lehmigen Grund oberhalb der Brücke über den Dhërmibach, ~150 m, 18.6.2004, L. Shuka, S.J. Casper, M. Xhulaj, L. Kashta – JE [living specimens cult. BGJ 90.1]. — M. Çika, sulle vergini rupi freschissimi intorno ai 700–800 metri dal livello del mare, 31.7.1892, A. Baldacci – [fide A. BALDACC I 1894 - LIT]. — Schlucht bei Rapsa, B. Schütt – G.

Photographs seen:

**Malësia e Madhe:** Rrapsha gorge, 1 km NE of Rrapsha, south side of road to Leqet e Hotit, on wet limestone rocks, 370–730 m, photo. 5.6.2005, L. Shuka – PS-TIR, PT-JE [fide B. SCHÜTT 1945: 42 -



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LIT]. — Cemit river valley, 1 km ahead of Grabomi village, along road to Tamara, on wet limestone rocks, ~350 m, photo. 6.6.2005, L. Shuka – PS-TIR [fide A. HAYEK 1917 - LIT]. — **Shkodra:** Nordalbanische Alpen, Bjeshkët e Nemuna, Thethi-Tal, an einem Wasserfall, Dolomit, photo. 17.7.2000, J. Winter – PT-JE. — Thethi-Okol, on limestone substrate, near cataract and water-mill, ~850–900 m, photo. 19.7.2005, L. Shuka – PS-TIR, PT-JE. — Near Karm, along road to Koman, on wet serpentine rocks at bank of brook, ~180 m, photo. 10.6.2005, L. Shuka – PS-TIR. — Near Shlinë, along road to Koman, on wet serpentine rocks at bank of brook, ~200 m, photo. 10.6.2005, L. Shuka – PS-TIR. — **Tropoja:** Valbona river valley, near Dragobi and Likaj, along road to Valbona, on wet limestone rocks, ~550–700 m, photo. 11.6.2005, L. Shuka – PS-TIR [fide E. CSIKI et al. 1926 - LIT]. — Grac-Biberaj, 10 m ahead of bridge across Valbona river, just above the road, on wet limestone substrate, ~450 m, photo. 11.6.2005, L. Shuka – PS-TIR. [fide E. CSIKI et al. 1926 - LIT]. — Gri Selimaj and Dushaj, 5 km E along road to Bajram Curri, on wet serpentine rocks at bank of stream, ~290 m, photo. 12.6.2005, L. Shuka – PS-TIR [cf. F.K. Meyer nr. 4458, 28.7.1959 – JE]. — **Kukës:** Kalimash, 1 km S of village, along road to Kukës, on wet serpentine rocks at bank of Kalimashi brook, ~350 m, photo. 27.7.2005, L. Shuka – PS-TIR. — **Peshkopi:** Fushë Lurë, 1 km W of the village, along road from Kurbneshi to Fushë-Lura, on wet serpentine rocks at bank of brook, ~800 m, photo. 25.7.2005, L. Shuka, M. Xhulaj – PS-TIR. — Fushë Lurë, on marshy meadows around the village, on serpentine substrate, ~1,000 m, photo. 25.7.2005, L. Shuka – PS-TIR. — Liqeni i Zi, on wet serpentine rocks, ~1,550 m, photo. 25.7.2005, L. Shuka – PS-TIR. — Kunora e Lurës, W-Seite des Tales des Schwarzen Drin, 100–150 m oberhalb Gurrë-Lura im Engtal des Pr. i Setës, Buchenmischwaldstufe, ~1,500 m, Quellgebiet, auf Serpentin, photo. 1999, M. Heime – PT-JE. — Kunora e Lurës, above Liqeni i madh, on wet serpentine ground, ~1,550–1,600 m, photo. 25.7.2005, L. Shuka – PS-TIR. — Flet, along road from Qafa e Malit to Dardha, just above the village, on wet serpentine substrate, ~700–800 m, photo. 12.6.2005, L. Shuka – PS-TIR. — Dardha village, along road from Qafa e Malit to Bajram Curri, 2 km ahead and 1 km behind the village, on wet serpentine rocks on bank of brook, ~400–700 m, photo. 12.6.2005, L. Shuka – PS-TIR. — **Puka:** Dardha Pass, along road from Qafa e Malit to Bajram Curri, 1 km ahead of Dardha and 3 km behind, on wet serpentine rocks at bank of brook, ~400–700 m, photo. 12.6.2005, L. Shuka – PS-TIR. — **Mirdita:** Gojan i Math, just behind the tunnel along road to Fushë-Arrës, on wet serpentine rocks, ~350 m, photo. 12.6.2005, L. Shuka – PS-TIR. — Kaçinar, near the village, along road to Fushë-Arrës, on wet serpentine rocks at bank of brook, ~350 m, photo. 12.6.2005, L. Shuka – PS-TIR. — **Mati:** Shkopet, along road to Burrel, on wet serpentine rocks, 1 km E of Shkopeti hydro-power station, ~400 m, photo. 22.3.2004, L. Shuka – PS-TIR. — **Kruja:** Near Cëlli, on wet limestone on road to Noja-Qafë Shtamë, ~450–600 m, photo. 13.05.2006, L. Shuka – PS-TIR, PT-JE. — Qafë Shtamë, near village on road from Noja to Qafë Shtamë, on wet serpentine rocks, 1,000–1,150 m, photo. 13.05.2006, L. Shuka – PS-TIR. — **Tirana:** Përroi i Llahingave at Dajti mountain [Mali Dajtit] slopes, wet limestone rocks and boggy sites, ~850–900 m, photo. 25.5.2005, L. Shuka – PS-TIR, PT-JE. — **Librazhd:** Librazhd, Shkumbini river valley, on wet serpentine rocks, on left side of road to Elbasan, 500 m S of the village, photo. 16.6.2004, L. Shuka – PS-TIR, PT-JE. [fide V. Rybka 1996 - LIT; inform. by I. Koudela 1997 - in litteris (site now nearly destroyed due to road reconstruction)]. — Librazhd, 3 km NW on road to Togëz, just above the road on marly slopes, photo. 16.6.2004, L. Shuka – PS-TIR, PT-JE. — Librazhd, Shkumbini river valley, 3 km S of city on the road to Pogradec, just above the railway tunnel, wet serpentine rocks, photo. 16.6.2004, L. Shuka – PS-TIR, PT-JE. — **Pogradec:** Piskupati, along road to Pogradec, on wet serpentine rocks, 30 m behind Piskupati, 10 m above Lake Ohrid and 2 m above railway, photo. 9.10.2004, L. Shuka – PS-TIR. — **Korça:** Mali i Moravës, on the path from Mborje to summit of Morava mountain, serpentine, along brook on W side of mountain, ~1,000 m, photo. 7.4.2006, L. Shuka – PS-TIR. — Along road to Dardha

, 2 km E of Boboshtica, on wet serpentine rocks at bank of brook, ~900–1,200 m, photo. 12.7.2005 & 14.8.2005, L. Shuka – PS-TIR. — Fushë e Rrosë, path Gjergjevicë to Dersniku, along ditchside of marshy meadows on serpentine, ~1,450 m, photo. 1.5.2005, L. Shuka – PS-TIR, PT-JE. — Gjergjevica, Kroi i Veliut, 1.5 km W, along road to Lekasi, on wet serpentine rock and boggy sites around the spring, 1,350 m, photo. 1.6.2004, L. Shuka – PS-TIR. — Gjergjevica, Krorëz, along road from Voskopoja to Gjergjevica, on *Sphagnum* bogs around the spring, ~1,400 m, photo. 1.6.2004, L. Shuka – PS-TIR. — Urë e Gurtë, along path from Gjergjevica to Vithkuqi, 5 km SE of Gjergjevica along ditchside of wet meadows and around springs, ~1,400–1,450 m, photo. 28.6.2004, L. Shuka – PS-TIR. — Moçali i madh, NE of Gjergjevica, 6 km SW of Voskopojë, along path from Voskopoja to Gjergjevica, along ditchside of wet marshy meadows on serpentine, ~1,450–1,500 m, photo. 27.5.2005, L. Shuka – PS-TIR, PT-JE — Përroi i Hijes, in deep gorge, E of Gjergjevica, on boggy sites and wet serpentine rocks at bank of stream, ~1,200–1,400 m, photo. 28.5.2005, L. Shuka – PS-TIR. — Përroi i Pyllës së Madhe, 3 km S of Gjergjevica, on marly ground, ~1,200–1,350 m, photo. 16.8.2004, L. Shuka – PS-TIR. — Përroi i Zanaqishtit, 4 km N of Gjergjevica, along brook on serpentine, ~900–1,400 m, photo. 28.5.2005, L. Shuka – PS-TIR, PT-JE. — Above Voskopoja, along brook, near reservoir ('Përroi i rezervuarit'), on wet serpentine rocks and at peaty banks of brooks, ~1,150–1,300 m, photo. 26.6.2004, L. Shuka – PS-TIR, PT-JE.— Korça, 4 km S, of both sides of Qarri pass on road Korça-Erseka, from bridge to the northern side of pass, along brook, on serpentine, ~900–1,050 m, photo. 17.6.2004, L. Shuka – PS-TIR, PT-JE. — Korça, 15 km S von Qafa e Qarri, am Fuße des Peterash (habitat in literature called 'Floq'), Quellhorizont nahe der Brücke, Serpentin, photo. 17.6.2004, L. Shuka, – PS-TIR. PT-JE. — **Erseka:** Shelegur, 2 km ahead village, springy places above and below the street, photo. 17.6.1004, L. Shuka – PS-TIR, PT-JE. — Gërmenj-Shelegur, 5 km SE of Leskovik on road Erseka-Leskoviku, on wet serpentine ground along brooks, ~1,000 m, photo. 17.6.2004, L. Shuka – PS-TIR, PT-JE. — **Përmeti:** Këlcyra, Vjosatal, Wasserfall, 2 m über dem Wasserspiegel des Flusses, auf einem Kalkfelsen, photo. 17.6.2004, L. Shuka – PS-TIR, PT-JE – [fide V. Rybka 1996 - LIT; information by I. Koudela 1997 – in litteris]. — Këlcyrë, Vjoses river valley by waterfall; photo. J. Steiger – cultivated plants, Bern (collected by V. Rybka). — **Vlora:** Dhërmi, unmittelbar am Ortsausgang an der Straße nach Vlorë, auf lehmigen Grund oberhalb der Brücke über den Dhërmibach, ~150 m, photo. 18.6.2004, L. Shuka – PS-TIR, PT-JE.

*Pinguicula hirtiflora* var. *louisii* (pl. 17)

Specimens (dried, living, and photographs) seen and evidence from literature:

**Tiranë:** Mittel-Albanien: Tirana: Lum i Ljanës w Linsa, kalkreiches, überrieseltes Lehmufer (Steilwand), 150 m ü.d.M.; blühend, 23.5.1924, F. Markgraf 287 – B [HOLOTYPE, destroyed 1943; fide F. MARKGRAF 1927: 210 - LIT. – The voucher “Lum i Ljanës, leg. Markgraf – BPU” noticed by CASPER (1958) on an index card could be a SYNTYPE. That means: a rest of the original material of Markgraf perhaps could exist!]. — Albania centralis, in declivibus meridionalibus montium Dajti prope Tirane, alt. ca. 200–300 m, 2.7.1934, K. Hrubý, V. Jirasek & T. Martinec – PRC. [fide J. ROHLENA 1937: 10: “*Ad latera mtis Dajti pr. Tirane, ca 200–300 m*” - LIT]. — Bach Itimit [pr. Ltinit], westlich Linza, ca. 250 m, 11.5.1960, F.K. Meyer 5555 – JE. — Linza, along prr. Ltinit, on limestone, February 2004, M. Xhulaj, L. Kashta [living specimens cult. in BGJ]; voucher prepared 31.03.2004, Rosemarie Stimper] – JE. — Linza, along prr. Ltinit, on flysch, ~150 m, leg. 19.6.2004, A. Miho, L. Shuka, M. Xhulaj, S.J. Casper – JE [living specimens cult. BGJ 91.1]; photo. L. Shuka – PS-TIA, PT-JE. — Linza, along prr. Ltinit, on different habitats (limestone or flysch substrate), ~150–350 m, photo. 7.7.2005, L. Shuka – PS-TIR, PT-JE. — Shkalla e Tujanit, on road to Zall-Bastari, 1 km E of Brari, along left side of Lumi i Tiranës [Tirana river], on marly soil,

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altitude 250–300 m, photo. 13.10.2005 & 14.5.2006, L. Kashta, L. Shuka, M. Xhulaj – TIR, PS-TIR, PT-JE. — Shkalla e Tunjanit, 250–300 m, limestone, 14.5.2006. L. Shuka – TIR, JE [same locality as just ahead]. — W slope of Dajti Mountain, on the upper part of Linza village, limestone, 400–700 m, 13.7.2006, L. Kashta.

[The reports by MARKGRAF (1942: 665) – landscape Matj, Thethi – have been ignored of because the lack of vouchers and the uncertainty of identification. – The report by HÖPFLINGER (1964: 99) has been listed on *P. hirtiflora* var. *hirtiflora*].

*Pinguicula balcanica* (pl. 17)

Specimens (dried, living, and photographs) seen:

**Shkodër:** Zwischen Vermoš und Širokar, ~1,750 m, 1914, I. Dörfler, Reise in das albanisch-montenegrinische Grenzgebiet i.J. 1914 no. 291 – WU [fide A. HAYEK 1917 - LIT]. — Vermosh-Tal, Seitental (Skrobotushë) bis zu den dort noch liegenden Schneefeldern, Matten über dem Buchenwald – fide B. SCHÜTT 1945: 87; sub *P. leptoceras* RCHB. - LIT — Zwischen Skrobotushë und Smutirogë, in der Nähe der Schneefelder, 20.6.1929 – fide B. SCHÜTT 1945: 89; sub *P. leptoceras* Rchb. - LIT. — Berizhdol-Koprisht, 4 km SE of Lëpusha, along the ditchside of wet meadows, on flysch substrate, ~1,800–2,000 m, photographs 23.7.2005 & 04.06.2006, L. Shuka – PS-TIR; PT-JE [living plants, leg. together with F. Hellwig, cultivated in BGJ]. — Prokletija, oberer See von Buni Jezerce, ~1,800 m, I. Dörfler, Reise in das albanisch-montenegrinische Grenzgebiet i.J. 1914 no. 524 – WU. — Nordalbanische Alpen (Prokletija), Thethi, am Maja e Radohimes, ~1,600–1,900 m, 25.7.1959, F.K. Meyer 4255, 4259 – JE. — Nordalbanische Alpen, Maja e Bunit të Thores, (oberhalb Thethi am Schnee unweit vom Pass Thores) ~1,683 m, N 42°23.034', E 19°45.141', photo. 9.6.2005, L. Shuka – PS-TIR, PT-JE [living plants leg. L. Shuka, cult. BGJ 135; dried specimens prepared 17.6.2005, Rosemarie Stimper – JE]. — Albanian Alps, Shtegu i Dhenve near Qafa e Thores, shadow places among grasses on limestone slopes and dolomite stone slopes (upper Triassic period), ~1,800–2,050 m, photo. 9.6.2005, L. Shuka – PS-TIR, PT-JE; leg. 18.7.2005 (together with K. Appenroth & L. Shuka) – TIR, JE – [cf. F.K. MEYER 4255, 4259]. — **Tropoja:** Qaf e Markofçës, zwischen Çerem und den Hirtenlagern Lugu kocet und Trokus, in der Region der alpinen Matten (*Nardus stricta*-Weiden), Schiefer, an feuchten, quelligen Orten – fide B. SCHÜTT 1945: 67, 1936: 43; on *P. leptoceras* Rchb. - LIT. — **Kukës:** An Wiesenbächen am Südabhang der Galica Lums, ~1,600–1,700 m, 1918, H. Zerny – W [on *P. leptoceras*; fide A. HAYEK 1924: 166 - LIT]. — **Peshkopi:** Zwischen Prizren und Debra, Schneegipfel des Korab, an überrieselten Felsen an Nordhängen oberhalb der höchsten Doline beim Dorfe Radomir, Kalkboden, ~2,400 m, 25.7.1918, J.B. Kümmerle – BPU. — Korab, an quelligen Stellen im Moose auf der Čafa Korabit, ~2,200 m, I. Dörfler, Reise in das albanisch-montenegrinische Grenzgebiet i.J. 1916 und 1918 no. 756 – WU, LD [fide A. HAYEK 1924: 166 - LIT]. — Korabgebirge, leg. Grebenschikow – BRNU. — Mbi Radomir-Liqeni i Zi dhe Razdoll-Valamare, pranë burimeve, ~1,800–2,300 m, 11.7.1962, Xh. Qosja & E. Palikuqi – TIR. — Korab, Radomir, am Presh Korabit, ~1,900 m, 8.8.1959, F.K. Meyer 4868 – JE. — Korab, Radomir, Korab i Madh, nördlicher Teil, ~2,500–2,600 m, 7.8. 1959, F.K. Meyer 5039 – JE. — **Librazhd:** Maja e zëzë në Malin e Jabllanicës, në vënde me lagështi, gëlqeror, ~ 2,200 m, 9.7.1975, J. Vangjeli & V. Tartari – TIR. — **Korça:** Guri i Topit: Wiesenbach nördlich Varri i Plakës, ~1,800 m, Serpentin, bl., 25.6.1928, F. Markgraf 1445 [on *P. vulgaris*; fide F. MARKGRAF 1931: 354 - LIT]. — **Erseka:** Mali i Gramozit mbi Varibob-Skorovot, flysch [above Varibob-Skorovot on flysch], ~1,900–2,200 m, 25.6.1971, Xh. Qosja & K. Papparisto – TIR [on *P. leptoceras*].



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