

## A taxonomic revision of the genus *Pastinaca* L. (Umbelliferae)

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### ABSTRACT

A taxonomic revision of the genus *Pastinaca* L. was carried out with respect to fruit macro- and micro-morphology, anatomy, palynology, and phytochemistry. The study covers the world distribution of the genus, confined to Europe and Asia, except for *Pastinaca sativa* L. subsp. *sativa* (parsnip) cultivated all over the world. Pollen studies showed that the pollen of the genus could be described as cerebroid. Three flavonoid compounds were detected in the genus. *Pastinaca* is represented with eight species and four subspecies in the world. *P. latifolia* DC. is regarded as a subspecies of *P. sativa*.

### INTRODUCTION

The name *Pastinaca* originated from the Latin word *pastus*, food, referring to the edible root which has been known for a long time. Tournefort (1694, 1700) gave a drawing of an Umbelliferae plant named *Pastinaca* which was adopted by Linneaus (1753). Miller (1731–1732) mentioned three names: *Pastinaca sativa latifolia*, *P. sylvestris latifolia*, and *P. sylvestris altissima*. These were changed to binomial names by Linneaus (1753): *Pastinaca sativa* var. *sylvestris*, *P. sativa* var. *sativa*, and *P. opopanax*, respectively. Adanson (1763) was the first to combine Umbelliferae (Umbellatae) with Araliaceae and recognized nine sections in the family, putting the genus in *Pastinacae*. Bieberstein (1808), Bernhard (1815), and De Candolle (1830) studied the genus. Boissier (1872) recognized three subsections in the genus using the habit, bract, bracteole, and petal characters, and introduced three new species. Calestani (1905) combined the genera *Pastinaca*, *Malabaila*, *Heracleum*, *Zosima*, *Lophotaenia*, *Ainsworthia*, *Wendiana*, and *Tordylium* under the genus name *Pastinaca*. He divided the genus into six sections. Koso-Poljansky (1916) slightly changed Calestani's work, recognizing two sections, seven subsections, and two groups. However, this taxo-

nomic treatment was not followed by any other taxonomist. Schischkin (1951), in *Flora of the USSR*, followed Boissier's treatment of 1872.

### MATERIALS AND METHODS

#### Morphology

Around 250 specimens were obtained on loan from the main herbaria in England and throughout Europe. Some species were examined in the field and also under cultivation in the University of Reading greenhouses. The specimens were examined and the measurements were made using a microscope and micrometer or ruler. Some characters (plant height, corolla color, and flowering time) were also taken from the literature (Gertsberger, 1995) or from labels on the herbarium sheets, whenever it was not possible to observe them directly from the specimens.

#### Palynology

The pollen grains were obtained from herbarium specimens. Several unopened buds (to make sure alien pollen grains were not present) were placed in a watch glass, a

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few drops of wetting agent added, and squashed. The acetolysis mixture was added with a bulb pipette to the dry pollen in the watch glass on the heating block. When the pollen grains darkened, they were allowed to cool for a few minutes and methylated spirit was added drop by drop to the center of the remaining acetolysis mixture. The acetolysis mixture formed a ring around the rim of the watchglass and was wiped away with a tissue. The pollen grains were transferred to copper stubs, which were already prepared with double-sided adhesive tape for SEM (Scanning Electron Microscopy) study. For preparing light microscope slides, the remaining pollen grains in the watch glasses were transferred to the slides using glycerine jelly with safranin stain added. When the glycerine jelly melted on the heating block, cover slips were added. For the SEM study, stubs were coated with gold for 5–6 minutes. The measurements were carried out using light microscopy. At least 20 pollen grains were measured from each slide.

### Phytochemistry

Two dried fruits from each sample were crushed and placed in a test tube, covered with 80% methanol, and placed in a heating block at 70 °C for about 20 min. Half of each extract was decanted into a watchglass in a fume cupboard and left to evaporate to dryness. The extracts were dissolved in a few drops of 80% methanol and spotted onto Whatman No. 1 chromatography paper (size approx. 22 × 22 cm) with rutin (quercetin 3-rutinoside) as a marker, in accordance with the method of Harborne (1998) and run in BAW (*n*-butanol: acetic acid: water) for five h. The papers were dried in a fume cupboard and trimmed, the rutin spot marked, and the paper refolded along the axis of the first separation run. The rutin marker was re-spotted on the origin of the original methanolic extract and the papers were re-run in 15% acetic acid for about 2 h and dried in a fume cupboard. The glycoside spots were examined in UV light and their position and color reactions recorded before and after fuming with ammonia.  $R_f$  values were recorded. The remaining methanolic extracts in the test tubes were hydrolyzed with 2 M HCl for 40 min in a water bath at 100 °C. After cooling, hydrolyzates were extracted with ethyl acetate and the ethyl acetate extracts evaporated to dryness in a fume cupboard overnight. The dried extracts were re-dissolved in 100% methanol and spotted onto TLC cellulose plates and run one-dimensionally in the following solvents:

1. BAW (*n*-butanol:acetic acid:water, 4:1:5).
2. CAW (chloroform:acetic acid:water, 30:15:2).
3. Forestral (acetic acid:water:conc. HCl, 30:15:2).
4. 50% acetic acid.

Quercetin, isorhamnetin, kaempferol, luteolin, and chrysoeriol were used as markers alongside the extracts, and the plates were run for 45–60 minutes depending on the solvent. The plates were sprayed with diphenylborinic acid ethanolamine ester (Naturstoffreagenz A) in methanol and re-examined. The color changes and  $R_f$  values helped in the identification of the aglycones.

Institutions visited or whose material we borrowed: B: Botanischer Garten Und Botanisches Museum Berlin-Dahlem (Berlin, Germany); BM: The Natural History Museum (London, UK); C: University of Copenhagen (Copenhagen, Denmark); E: Edinburgh Royal Botanic Garden (Edinburgh, UK); G: Ville de Genève, Conservatoire et Jardin botaniques (Geneva, Switzerland); GAZI: Gazi Üniversitesi, Fen-Edebiyat Fakültesi Herbariumu (Ankara, Turkey); GB: Göteborg University, Botanical Institute (Göteborg, Sweden); H: University of Helsinki (Helsinki, Finland); ISTE: Istanbul Üniversitesi Eczacılık Fakültesi Herbariumu (Istanbul Turkey); K: Kew Royal Botanical Garden (London, UK); L: Nationaal Herbarium Nederland (Leiden, Netherlands); RNG: The University of Reading (Reading, UK); SUNIV: Swedish Museum of Natural History (Stockholm, Sweden); W: Naturhistorisches Museum Wien (Vienna, Austria).

## MORPHOLOGY

### Longevity and seasonality

The genus consists of biennial and perennial herbs. All species have taproots. The flowering period generally starts in June and continues throughout October, except for *P. lucida*, which flowers in April.

### Stem and indumentum

The height of the plants varies from 25 cm to 200 (300) cm. The stem is erect and straight in all species, but in *Pastinaca zozimoides* it is angled. The stem surface is generally deeply sulcate if the shape is angled in cross section and striate or slightly sulcate when it is terete. Some species, such as *Pastinaca lucida* and *P. zozimoides*, produce a strong fibrous collar just above the root. The rest of the species very rarely produce a strong fibrous collar. The stem is hairy in all species except for *Pastinaca lucida*, which is glabrous.

### Leaves

The basal leaves are of taxonomic value, but heteromorphism in leaf form has caused problems in taxonomic descriptions and identification of the species. For example, the specimens of *Pastinaca lucida* grown in the glasshouse produced simple leaves in the first two years, but in their third year started to give 1-pinnate leaves. They also changed their shape from palmate to ovate-

triangular. The general tendency in *Pastinaca* is for leaves to be 1-pinnate, but *P. fleischmanni*, *P. zozimoides*, and sometimes *P. pimpinellifolia* are 2-pinnate. The leaves are alternate and have a distinct petiole. The bases of the petioles have sheaths with membranous margins. The outline leaf shape ranges from oblong to triangular. The size range is 35–400 × 13–200 mm. The primary leaf segment number is generally 3–7. The shape of the primary segments changes from oblong to triangular with serrate or lobed margin. The indumentum of the leaves is very similar to that of the stem, hairy on both side but glabrous in *P. lucida*.

### Umbels

In the genera examined, two types of compound umbels are seen: if three lateral umbels branch from the same node at the top of the plant, it is called here a complex compound umbel; if the lateral umbels are branched alternately (raceme), then it is called a simple compound umbel. The general tendency is to form a complex umbel type, although some plants do not always produce it. However, most of the specimens examined from *Pastinaca hirsuta*, *P. armena*, and *P. zozimoides* showed simple compound umbels.

The diameter of the umbels ranges from 20 mm to 150 mm, and species are generally equal or subequal and very rarely unequal, as in *Pastinaca fleischmanni* and *P. armena*. The number of the rays varies from 3 to 22.

### Bracts

Bracts are generally present in *Pastinaca hirsuta*, *P. pimpinellifolia*, and *P. armena*. They range from 1 to 6 in number and 3–17 mm in length. The shape is generally linear or linear-lanceolate, hairy with a ciliate margin, except for *Pastinaca pimpinellifolia* and *P. armena* which are sometimes glabrous.

### Bracteoles

Bracteoles are not present in *Pastinaca fleischmanni*, *P. lucida*, *P. sativa* subsp. *sativa*, *P. sativa* subsp. *urens*,

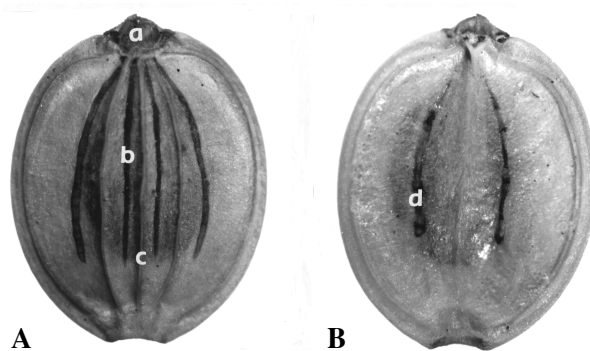


Fig. 1. A—dorsal surface of a mericarp of *Pastinaca sativa* subsp. *urens*. B—commissural surface of *P. sativa* subsp. *urens* (a, stylopodium; b, dorsal vitta; c, dorsal rib, d, commissural vitta). Magnification × 7.

*P. sativa* subsp. *sylvestris*, *P. divaricata*, and *P. zozimoides*. The length of the bracteoles ranges from 2 to 6 in number and 3–10 mm in length. The shape is generally linear or linear-lanceolate, and they are hairy with entire or ciliate margins.

### Sepals

Sepal teeth are absent or minute in all species.

### Petals

The petal is yellow to greenish-yellow, except for *P. zozimoides* in which it is pinkish, with or without brown veins. The corolla is actinomorphic and very small, ranging from 1.2 to 2.5 mm. The petal is generally glabrous, except for *P. hirsuta*, *P. pimpinellifolia*, *P. armena*, *P. divaricata*, and *P. zozimoides*.

### Fruit macro-morphology (Figs. 1,2)

The fruits are dorsally compressed, appearing to show a general tendency towards elliptic. The fruit length is between 3.5 and 7 mm. The style is curved in almost all species. It is generally glabrous except for *P. armena*. The apex of mericarp is not or only very slightly emarginate.

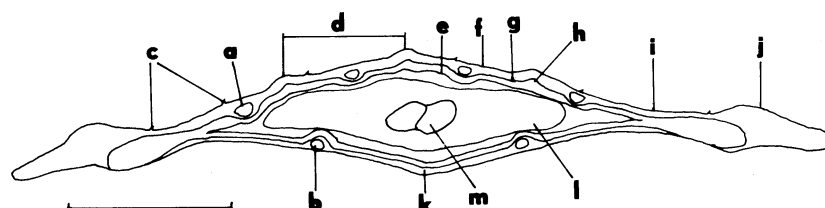


Fig. 2. Transverse section of a mericarp of *P. sativa* subsp. *urens* (a, dorsal vitta; b, commissural vitta; c, hairs; d, vallecular region (the distance between two ribs); e, endocarp; f, exocarp; g, mesocarp; h, dorsal vascular bundle; i, mericarp wing neck; j, mericarp wing margin; k, carpophore; l, endosperm; m, cotyledon). Scale bar = 1 mm.

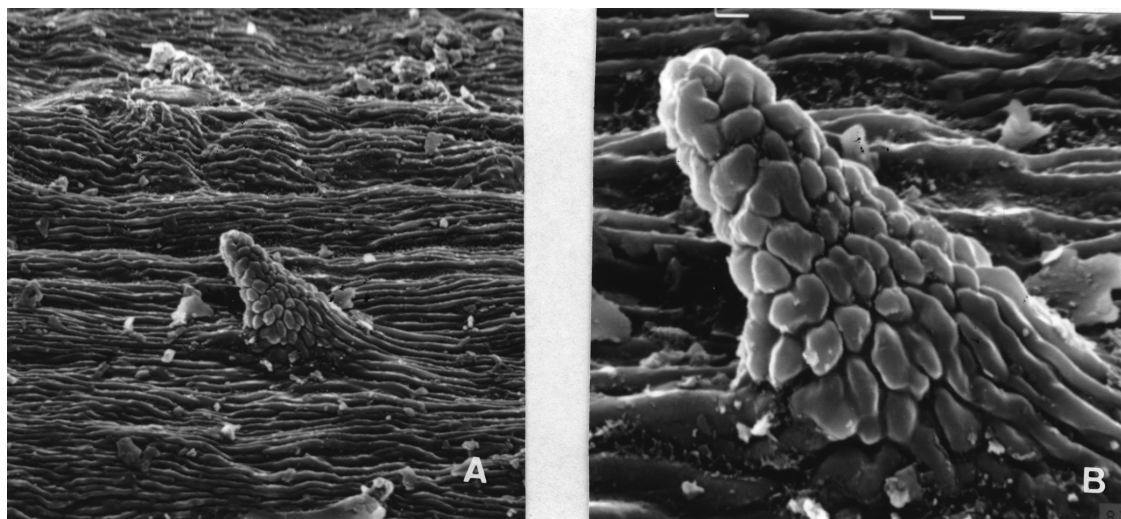


Fig. 3. A—striation in *Pastinaca sativa* subsp. *divaricata* between the two ribs on dorsal surface of a mericarp (Magnification  $\times 840$ ). B—very short triangular hair with papillose surface on dorsal surface of a mericarp in *P. sativa* subsp. *divaricata* (Magnification  $\times 3000$ ).

### Fruit micro-morphology (Fig. 3)

The SEM study shows that all cells on the dorsal surface are hexagonal and form a reticulate pattern. The surface between the two ribs in the species is striate. The margin of the mericarp surface is very similar to that of the surface between the two ribs. The dorsal surface in *Pastinaca armena* is glabrous. In the rest of the species it is hairy. Although *P. hirsuta*, *P. pimpinellifolia*, *P. lucida*, *P. sativa* subsp. *sativa*, *P. sativa* subsp. *urens*, and *P. sativa* subsp. *sylvestris* appeared to be glabrous under the dissection microscope, the SEM study showed that these plants have very short triangular hairs on the dorsal surface of the mericarp. The hairs have a papillose surface which is unique to the genus within the umbellifers. *P. zozimoides* is the only one with ribbon-type hairs which are papillose and with a vertical corrugated surface. The commissural surface in *P. divaricata* is waxy, and the remaining species are glabrous or subglabrous.

### ANATOMY OF MERICARP (Fig. 2)

The number of dorsal vittae in the genus *Pastinaca* is generally four. There is only one vitta between the two dorsal ribs. The number of commissural vittae is 2, very rarely 4–6 as in *P. sativa* subsp. *latifolia*. The shapes of vittae in cross section vary from rounded to elliptic, upside or downside crescent. There are 3 dorsal ribs and 2 lateral ones. They are all generally filiform on the upper surface. There is also one very distinct commissural rib (carpophore). All taxa have a lateral wing with a

neck. Exocarp layers range from one to five. The number of the mesocarp parenchyma cell layers varies from one to six. The genus has a very distinctive woody lignified endocarp layer which holds the red color of safranin when stained. This layer extends through the wings where it connects with the lateral rib bundles. The number of lignified endocarp layers is between one and four.

### PALYNOLOGY

The present study showed that the genus *Pastinaca* generally has oval pollen grains except for *P. hirsuta*, where they are slightly subrhomboid. There are three inner and outer contours which are generally different from each other. The three inner and outer contours are: straight, slightly or distinctly curved, and convex. The poles are generally rounded, but are slightly angled in *P. pimpinellifolia*. Polar, equatorial axes, nexine and sexine width, pore height, and colpi length were measured for at least 20 grains of each sample (see Table 1). The pollen surface is cerebroid in the genus (except for *P. sativa* subsp. *urens*).

### PHYTOCHEMISTRY

The fruit flavonoid patterns of 11 taxa were investigated (see Table 2). After acid hydrolysis of the crude methanolic extracts of the taxa surveyed, three flavonol aglycones (isorhamnetin, kaempferol, and quercetin) were found. The flavonol aglycone isorhamnetin was found to occur in all the taxa except *P. zozimoides*, which is the

Table 1  
Pollen grain measurements (in  $\mu\text{m}$ , mean  $\pm$  SD) in the genus *Pastinaca*

Species	P	E	P/E	N	S	N/S	Po	C	C/P
<i>Pastinaca hirsuta</i>	43.7 $\pm$ 1.9	21.7 $\pm$ 0.6	0.20	0.9 $\pm$ 0.1	1.1 $\pm$ 0.1	81.8	2.4 $\pm$ 0.2	24.3 $\pm$ 0.9	55.6
<i>P. pimpinellifolia</i>	48.9 $\pm$ 1.6	21.0 $\pm$ 1.2	0.23	0.9 $\pm$ 0.1	1.4 $\pm$ 0.1	64.3	2.7 $\pm$ 0.3	31.8 $\pm$ 1.1	65.0
<i>P. lucida</i>	35.3 $\pm$ 2.7	16.1 $\pm$ 1.0	0.22	1.0 $\pm$ 0.1	1.8 $\pm$ 0.2	55.6	2.6 $\pm$ 0.2	25.6 $\pm$ 2.7	72.5
<i>P. armena</i>	33.9 $\pm$ 2.1	19.5 $\pm$ 0.6	0.17	0.9 $\pm$ 0.1	1.4 $\pm$ 0.2	64.3	2.5 $\pm$ 0.2	23.1 $\pm$ 1.8	68.1
<i>P. sativa</i> subsp. <i>sativa</i>	37.3 $\pm$ 1.5	16.2 $\pm$ 0.7	0.23	1.1 $\pm$ 0.1	1.2 $\pm$ 0.1	91.7	2.6 $\pm$ 0.2	26.3 $\pm$ 0.8	70.5
<i>P. sativa</i> subsp. <i>urens</i>	32.4 $\pm$ 1.4	15.6 $\pm$ 1.2	0.21	1.0 $\pm$ 0.1	1.2 $\pm$ 0.2	83.3	2.5 $\pm$ 0.3	21.8 $\pm$ 3.3	67.3
<i>P. sativa</i> subsp. <i>sylvestris</i>	39.1 $\pm$ 2.7	17.7 $\pm$ 0.7	0.22	0.8 $\pm$ 0.1	0.9 $\pm$ 0.1	88.9	2.6 $\pm$ 0.2	24.0 $\pm$ 1.1	61.4
<i>P. zozimoides</i>	34.1 $\pm$ 1.8	19.3 $\pm$ 1.6	0.18	0.9 $\pm$ 0.1	1.6 $\pm$ 0.4	56.3	2.3 $\pm$ 0.3	17.6 $\pm$ 1.4	51.6

P—polar axis; E—equatorial axis; N—nexine; S—sexine; Po—pore; C—colpi.

Table 2  
Flavonol aglycone data obtained from the genus *Pastinaca*

Species	Isorhamnetin	Kaempferol	Quercetin
<i>Pastinaca fleischmanni</i>	+	—	+
<i>P. hirsuta</i>	+	—	+
<i>P. pimpinellifolia</i>	+	—	— (+)
<i>P. lucida</i>	+	—	—
<i>P. armena</i>	+	—	—
<i>P. sativa</i> subsp. <i>sativa</i>	+	—	—
<i>P. sativa</i> subsp. <i>urens</i>	+	—	— (+)
<i>P. sativa</i> subsp. <i>sylvestris</i>	+	—	—
<i>P. sativa</i> subsp. <i>latifolia</i>	+	—	+
<i>P. divaricata</i>	+	—	—
<i>P. zozimoides</i>	—	+	+

+, present; —, absent.

only species in the genus with kaempferol. The aglycone kaempferol had a scattered occurrence in the genus.

## DISCUSSION AND CONCLUSIONS

Although previous taxonomists treated *Pastinaca* in different ways, it was seen that the genus could be separated from other closely related genera in several ways using macro-morphology, micromorphology, anatomy, or palynology. The pollen study showed that the pollen surface is cerebroid in the genus *Pastinaca* (except for *P. sativa* subsp. *urens*). Micromorphology studies of the mericarp by SEM showed that the genus *Pastinaca* is also distinguished by very short triangular hairs (which are also papillose) on the dorsal surface of the mericarp. The flavonol aglycone isorhamnetin was found to occur in all the taxa, except *P. zozimoides* which is the only species in the genus with kaempferol. The genus is found to contain eight species and four subspecies. *Pastinaca latifolia* DC. is regarded as a subspecies of *P. sativa* (see *Taxonomic treatment* for synonyms). Boissier (1872) suggested that *P. glandulosa* Boiss. &

Hauskn. ex Boiss. belonged to *Pastinaca* on account of its smell and appearance, but obviously still had some doubt because he gave a question mark with the genus name. Unfortunately, the type specimen has no fruit and is incomplete and it is impossible to confirm this. *P. aurantiaca* (Alb.) Kolak. and *P. chrysanthia* (Alb.) K.-Pol. have no mature fruit on their type specimens, but look like *Malabaila dasyantha* (C. Koch) Grossh., var. *dasyantha* in their vegetative and floral features. Therefore, the taxonomic positions of these three specimens also cannot be determined.

## TAXONOMIC TREATMENT

*Pastinaca* L., *SP. PL.*: 262 (1753);

*Gen. Pl.* ed. 5: 126 (1754).

Biennial and perennial, 25–200 (–300) cm; tap rooted; strong fibrous collar generally absent, very rarely present. Stem glabrous, scabridous, pubescent, striate, or slightly or deeply sulcate, terete, or angled. Leaf generally 1-pinnate, rarely simple or 2-pinnate, 35–400  $\times$  13–200 mm, oblong, elliptic, ovate or triangular, generally hairy

on both sides. Leaf primary segments 3–7, oblong, ovate, triangular. Leaf secondary segments, if present, opposite or opposite and alternate, oblong, ovate or triangular, with serrate or lobed margins. Umbels generally complex compound, sometimes simple compound, 20–150 mm, rays 3–22, equal or unequal, glabrous or hairy. Bracts if present 1–6, 3–17 × 0.8–1.5 mm, linear or linear-lanceolate, glabrous or hairy with ciliate margins. Bracteoles, if present 2–6, 3–10 × 0.8–1.5 mm, linear-lanceolate, glabrous or hairy with ciliate margins. Sepals not conspicuous. Corolla actinomorphic; petals yellow to yellow-greenish, very rarely pinkish, with or without brown veins, glabrous or hairy on dorsal surface, 1.2–2.5 mm. Mericarp elliptic very rarely suborbicular, cordate-obovate, 3.5–7 × 3–8 mm, retuse, slightly cordate at base, margin entire; hairs present or absent. Styles curved not usually erect, glabrous or hairy. Apex of mericarp (slightly or not) or very rarely deeply emarginate, not making a sinus at top of mericarp. Dorsal vittae generally 4, equal or subequal, fusiform, oblong or sausage-shaped and reaching the middle sometimes not. Commisural surface glabrous or waxy; commisural vittae 2, very rarely 4–6, fusiform, oblong, or sausage-shaped, reaching the middle of mericarp, diverging (see key below).

**1. *P. fleischmanni* Hladnik ex W.D.J. Koch**

Syn. ed. 1: 307 (1837); & in W.D.J. Koch. Syn. ed. 2: 970 (1840)

**Type**

Slovenia: auf dem Schlossberge bei Laibach [Ljubljana], *Hladnik* s.n.

Biennial, (60)–81–(100) cm; tap rooted; strong fibrous collar absent or very rarely present. Stem scabridous, deeply sulcate and angled. Leaves 2-pinnate, (250)–327–(400) × (150)–171–(200) mm, ovate or triangular, hairy on both sides. Leaf primary segments

(4)–5.7–(7), oblong, ovate or triangular. Leaf secondary segments opposite and alternate, oblong, ovate or triangular, margin serrate. Umbels complex compound, (35)–48–(55) mm, rays (6)–6–(7), unequal, hairy. Bracts and bracteoles absent or very rare. Sepals not conspicuous. Corolla actinomorphic; petals yellow with brown veins, glabrous or subglabrous on dorsal surface, 1.6–2 mm. Mericarp elliptic, (4.5)–5.2–(6.5) × (4)–4.3–(5) mm, retuse, slightly cordate at base, margin entire. Hairs present. Style glabrous. Apex of mericarp slightly (or not) emarginate at top of mericarp. Dorsal vittae 4, fusiform and reaching the middle of mericarp. Commisural surface glabrous or with a little wax; commisural vittae 2, oblong, reaching the middle of mericarp, parallel.

**Specimens examined**

SLOVENIA: Auf dem Schlossberge in Laibach [Ljubljana] *Freyer* s.n. (W, BM). Laibach 1837 *Graft* s.n. (K). v.1839, *Welwitsch* s.n. (K). Carniolia, Spontanea in pratulis horti botanici Labacensis, *Paulin* s.n. (GB). Cornia, ix.1892, *Pichler* s.n. (GB, BM). Spontanea in pratulis horti botanici Labacensis, viii, *Paulin* s.n. (GB). Carniolia, *Mulley* s.n. (W).

**2. *P. hirsuta* Pančić**

*Fl. Princ. Serbiae*: 359 (1874)

**Type**

In pratis alpinis et subalpinis m Vrazja Glava, *Panč.* s.n. (Lectotype: ? BP).

Perennial, (60)–83–(100) cm; tap rooted; strong fibrous collar absent or very rarely present. Stem scabridous, deeply sulcate and angled. Leaves 1-pinnate, (120)–192–(240) × (45)–67–(85) mm, elliptic, hairy on both sides. Leaf primary segments (4)–5.6–(7), oblong, ovate or triangular, serrate and lobed and acute.

**Key for Type Species: *Pastinaca sativa* L.**

- 1a. Leaves simple and glabrous on both sides ..... **5. *P. lucida***
- 1b. Leaves pinnate and hairy on both sides ..... 2
- 2a. Petals pinkish ..... **8. *P. zozimoides***
- 2b. Petals yellow ..... 3
- 3a. Bracts and bracteoles present ..... 4
- 3b. Bracts and bracteoles absent ..... 6
- 4a. Petals glabrous or subglabrous on dorsal surface ..... **2. *P. hirsuta***
- 4b. Petals hairy ..... 5
- 5a. Leaves elliptic to ovate-triangular, mericarp elliptic to ovate, rays generally more than 10 ..... **3. *P. pimpinellifolia***
- 5b. Leaves oblong to elliptic, mericarp elliptic to orbicular, rays generally less than 10 ..... **4. *P. armena***
- 6a. Leaves 2-pinnate, rays unequal, brown veins absent ..... **1. *P. fleischmanni***
- 6b. Leaves 1-pinnate, rays equal or subequal, brown veins present ..... 7
- 7a. Petals hairy, mericarp ovate, commisural surface waxy ..... **7. *P. divaricata***
- 7b. Petals glabrous or subglabrous, mericarp elliptic, commisural surface glabrous very rarely waxy ..... **6. *P. sativa***

Umbels generally simple compound very rarely branching from the same nodes, (35)–51–(60) mm, rays (10)–13–(20), equal or subequal, hairy. Bracts present, 2–6, 5–11 × 0.8–3 mm, linear or linear-lanceolate, margins ciliate. Bracteoles 4–6, 6–10 × 0.8–1.2 mm, linear-lanceolate, margins ciliate. Sepals not conspicuous. Corolla actinomorphic; petals yellow with brown veins, glabrous on dorsal surface, 1.4–2.1 mm. Mericarp elliptic or cordate-obovate, (4.5)–5.3–(7) × (4)–4.1–(5) mm, retuse, slightly cordate at base, margin entire. Hairs present. Style glabrous. Apex of mericarp slightly (or not) emarginate at top of mericarp. Dorsal vittae 4, fusiform and reaching the middle of mericarp. Commisural surface glabrous or with a little wax; commisural vittae 2, fusiform, reaching the middle of mericarp, parallel.

### Specimens examined

BULGARIA: Petrohan, 1903, *Urumoff* s.n. (GB). In pratis prope bragalevce, 3.vi.1912, *Urumov* s.n. (GB). vii.1909 *Stribruny* s.n. (W). Rhodope, 21.vii.1930, *Ronniger* s.n. (W). Rhodope, 21.vii.1930, *Zerny* s.n. (W). M. Vitosa, in fruticetis ad 1423 m, 11.viii.1952, *Ahtarov & Vyhodcevski* s.n. (W). Rumeli, 1892, *Vagner* s.n. (W).

FEDERAL REPUBLIC OF YUGOSLAVIA: Serbia, vii.1897, *Adamovic* s.n. (W). Serbia, in pascuis subalp. Basara, 10.vii.1897, *Adamovic* s.n. (W).

**3. *P. pimpinellifolia* M. Bieb.,**  
Fl. Taur. Cauc. 1: 237 (1808)

### Synonymy

*M. pimpinellifolia* Hoffm., *Gen. Umb.*: 126 (1816); *Heracleum pimpinellifolium* (M.B.) Spreng. *Umb. Prodr.*: 12 (1813); *Pastinaca intermedia* Fisch. & Mey. *Fl. Or.*, 2: 1061 (1872).

### Type

Habitat in promontorio Causcassico ad flumium Terek; et circa Castellum Georgopolitanum, *Bieberstein* s.n. (Syntype specimen was cited in Leningrad by Schischkin (1951: 218 (156)).

Biennial, (50)–79–(100) cm; tap rooted; strong fibrous collar sometimes present. Stem pubescent, deeply sulcate and angled. Leaf 1-pinnate very rarely 2-pinnate, (80)–183–(250) × (40)–63–(80) mm, ovate or triangular, hairy on both sides. Leaf primary segments (4)–5.9–(7), oblong, serrate, lobbed and acute. Umbel complex compound, (40)–51–(60) mm, rays (7)–12–(20), equal or subequal, hairy. Bracts present, 1–4, 6–17 × 0.9–1.5 mm, linear or linear-lanceolate glabrous and hairy with ciliate margin. Bracteoles 2–5, 5–10 × 0.5–0.9 mm,

linear-lanceolate glabrous and hairy, margins ciliate. Sepals not conspicuous. Corolla actinomorphic; petals yellow with brown veins, hairy on dorsal surface, 1.2–1.9 mm. Mericarp elliptic to ovate, (4.5)–5.6–(6.6) × (4)–4.4–(5) mm, retuse and slightly cordate at base, margin entire. Hairs present. Style glabrous. Apex of mericarp slightly (or not) emarginate at top of mericarp. Dorsal vittae 4, fusiform and reaching the middle of mericarp. Commisural surface glabrous or with a little wax; commisural vittae 2, sausage-shaped, reaching middle of mericarp, parallel.

### Representative specimens examined

IRAN: Prope u. Schiras, v.1842, *Kotschy* s.n. (SUNIV).

GEORGIA: Distr., Razdan, in vicinitate pagi Verin Akhta, 6.vii.1975, *Vasak* s.n. (W). In virgultis et in locis herbidis prope col. Karass prov. Ciscaucas, vii.1843, *Hohenacker* s.n. (W). Distr., Tynnyauz, regio montis Elbrus, in declivibus ad ripam sinistram rivi Shelda, 27.vi.1984, *V. Vasak* s.n. (W). Distr., Baksan, 14 km ad septentriones versus a pago Bylyn, in valle fluminis Baksan, 27.vii.1981 *Vasak* s.n. (W). Carthalina, vi.1881, *A. H & V. F. Brothers* s.n. (SUNIV). Tiflis, *Steven* s.n. (W).

TURKEY: Armenien, Karakurt (Strasse Pasinler-Kagizman, im Aras-Tal), *Holzschuh* s.n. (W). A9 Kars, Umgebung von Ardahan, 30.vii.1982, *Sorger & Buchner* s.n. (W). B7 Erzincan, Kelkit-Erzincan, 32 km n Erzincan, 3.viii.1982, *Nydegger* s.n. (G). A7 Giresun, Alpweiden, Osthang ob Tamdere, 7.vii.1958, *Huber-Morath* s.n. (G). A9 Kars, 10 km from Sarikami? to Karakurt, 15.vii.1966, *Davis* s.n. (E).

**4. *P. armena* Fisch. & Mey.,**  
*Enum. Pl. Elisabethopol*: 225 (1833)

### Synonymy

*P. dentata* Freyn & Sint., *Ost. Bot. Zeitschr.* 44: 103 (1894); *P. armena* subsp: *dentata* (Freyn & Sint.). Chamberlain, *Fl. Turkey & E. Aegean Is.* 4: 482 (1972); *P. pimpinellifolia* M. B. var. *alpina* M. B., *Fl. Taur.-Cauc.* 1:237 (1808); *M. hispidula* Boiss. & Bal., *Fl. Or.*, 2: 1056 (1872); *P. hispidula* (Boiss. & Bal.) K.-Pol., *Bull. Soc. Imp. Nat. Moscou n. s.*, 29: 112 (1916).

### Type

Hab. In Montis Serial et Schuscha, *Hohenacker* (The type specimen was cited in Leningrad by Schischkin (1951: 221 (158)).

Biennial, (25)–62–(80) cm; tap rooted; strong fibrous collar absent. Stem scabridous, deeply sulcate and angled. Leaf 1-pinnate, (120)–172–(230) × (28)–44–

(70) mm, oblong, hairy on both sides. Leaf primary segments (4)–4.7–(6), oblong, ovate or triangular, serrate and lobbed, acute or obtuse. Umbel simple compound, (20)–49–(65) mm in diameter, rays (3)–5.1–(12), unequal, hairy. Bracts present, 2–6, 3–15 x 0.8–1.5 mm, linear or linear-lanceolate glabrous and hairy, margin ciliate. Bracteoles 4–6, 3–7 x 0.8–1.5 mm, linear-lanceolate glabrous and hairy, margin ciliate. Sepals not conspicuous. Corolla actinomorphic; petals yellow with brown veins, hairy on dorsal surface, 1.3–2 mm. Mericarp elliptic to orbicular or suborbicular, (4)–5.5–(6) x (4)–4.5–(5) mm, retuse and slightly cordate at base and margin entire. Hairs present. Style hairy. Apex slightly (or not) emarginate at top of mericarp. Dorsal vittae 4, fusiform and sausage-shaped and reaching the middle of mericarp. Commisural surface glabrous or with very little wax; commisural vittae 2 sometimes 3–4, sausage shaped, reaching middle of mericarp, parallel.

#### Representative specimens examined

ARMENIA: In pratis montium ditionis Elisabethopol et Karabach, prope Pasanur et in Caucas, prope Kaischaur, *Hohenacker* s.n. (W).

GEORGIA: Transcaucasia, Daghestania, prov. Tiflis, distr., Borzhom, in jugo Tzchra-Tzcharo, 16.vii.1925, *Kozlovsky* s.n. (K). Transcaucasicae, 14.vii.1930, *Polianska* s.n. (W).

TURKEY: Alpine de Djimil (Cimil), Lazistan, vii.1867, *Balansa* s.n. (K). B8 Erzurum, 29 km from Hınıs to Pasinler, 12 .vii.1966, *Davis* s.n. (K). B8 Erzurum, 28 km from Varto to Hınıs, 11.vii.1966, *Davis* s.n. (E, W, K). B9 Ağrı, SW Balıkgölü, beweidete Grassteppen, 4.viii.1983, *Fitz* s.n. (W).

**5. *P. lucida* L., Mant. 1: 58 (1767).**

#### Type

Habitat in Europa australi [(Obligate lectotype: LINN.!)] *P. lucida* has not had a type designated so far. There is a single original element, a Herb. Linn. Specimen No. 369.1. In my observations this specimen represents *P. lucida*, therefore, it is recognised as an obligate lectotype (S. Cafferty, personal communication).

Perennial, (25)–37–(50) cm; tap rooted; strong fibrous collar generally present. Stem glabrous, deeply sulcate and angled. Leaf simple, (80)–177–(300) x (65)–123–(150) mm, cordate or ovate or triangular, glabrous on both sides. Leaf primary segments absent, but very rarely 1–2. Umbels complex compound, (28)–41–(50) mm, rays (10)–12.9–(20), equal or subequal glabrous. Bract and bracteoles absent or very rare. Sepals not conspicuous. Corolla actinomorphic; petals yellow

with brown veins, glabrous or subglabrous on dorsal surface, 1–1.8 mm. Mericarp orbicular or suborbicular, (4.5)–5.5–(7) x (5)–5.5–(8) mm, retuse, slightly cordate at base, margin entire. Hairs present. Style glabrous. Apex of mericarp deeply emarginate but not making sinus at top of mericarp. Vittae on the dorsal surface 4, very rarely 5–6, oblong and sausage-shaped and reaching the middle of mericarp. Commisural surface glabrous or with a little wax; commisural vittae 2, very rarely 3–4, sausage-shaped, reaching the middle of mericarp, parallel.

#### Representative specimens examined

BALEARIC ISLANDS: vi.1885 *Porta & Rigo* s.n. (W). Mallorca, Barranch e ob Biniaraix (e Soller), Felsheiden (Kalk), 8.iv.1971, *Krendl* s.n. (W). Mallorca, Puig Major, Sudhang N von Soller, 29.v.1978, *Fitz* s.n. (W). Mallorca, vi.1869, *Bourgeau* s.n. (W). Mallorca, Salt de la Bella Donna (an der Strasse zwischen Monasterio de Lluch und Inca): Steile Kalkschutthalde, 12.iv.1971, *Krendl* s.n. (W). Mallorca, Puig Major, v.1899, *Gandoger* s.n. (W).

#### 6. *P. sativa* L., Sp. pl.: 263 (1753)

Biennial, 65–200 (–300) cm; tap rooted; strong fibrous collar absent or very rarely present. Stem glabrous to densely hairy, terete or angled, striate to deeply sulcate. Leaves 1-pinnate, 100–350 x 35–180 mm, elliptic, ovate or triangular, hairy on both sides. Leaf primary segments 3–7, oblong, ovate or triangular, serrate, apex acute or obtuse. Umbels generally complex compound, 25–55 mm, terminal umbel up to 150 mm broad, rays 3–9, equal or subequal, hairy. Bracts and bracteoles absent or very rare. Sepals not conspicuous. Corolla actinomorphic; petals yellow without brown veins, glabrous or subglabrous on dorsal surface, 1.1–2 mm. Mericarp elliptic, 5–6.5 x 4–5 mm, retuse, slightly cordate at base, margin entire. Hairs present. Style glabrous. Apex of mericarp slightly (or not) emarginate at top of mericarp. Dorsal vittae 4, fusiform and reaching the middle of mericarp. Commisural surface glabrous, very rarely waxy; commisural vittae 2, sausage-shaped, reaching the middle of mericarp, parallel.

- 1a. Stem angled in transverse section and deeply sulcate ... 2
- 1b. Stem in transverse section terete and striate ..... 3
- 2a. Leaves with short hairs, stem glabrous or very sparsely scabridous hairy ..... **a. subsp. *sativa***
- 2b. Leaves with soft long hairs, stem densely covered with hairs ..... **c. subsp. *sylvestris***
- 3a. Commisural vittae 2 ..... **b. subsp. *urens***
- 3b. Commisural vittae 3–6 ..... **d. subsp. *latifolia***



**A. subsp. *sativa*****Type**

In Europae australioris ruderalis et pascuis (Lectotype designated by Sell (1993) Herb. Cliff. 105 !).

Stem angled and deeply sulcate; leaves with short hairs, stem glabrous or very sparsely hairy. Umbel rays 6-22. Rays unequal.

Commonly cultivated for its edible roots throughout the Northern Hemisphere. However, few herbarium specimens exist.

**Specimens Examined**

ITALY: Lombardia, Sondrio, S. Pietro Berbenno, 30.viii.1979, *Steinberg* s.n. 9493 (RNG). Prov. Veneto, distr., Chioggia, 1 km N. W. of Chioggia between lagoon and main road S309, 16.x.1982, *Miles* s.n. (RNG).

POLAND: Kazimierza Wilka, pagus Slonowice, 12.vii.1972, *Palkowa & Tacik* s.n. (RNG).

**B. subsp. *urens* (Req. ex Godron) Çelak.,**

*Prodr. Fl. Böhmen.*: 574 (1875).

**Synonymy**

*P. umbrosa* Stev. ex DC., *Prodr.* 4: 189 (1830); *P. opaca* Bernh. ex Hornem. Hort. Hafn. 2: 961 (1815); *P. urens* Req. ex Godron, *Fl. Fr.* 1: 694 (1849); *P. teretiuscula* Boiss., *Fl. Or.*, 2: 1060 (1872); *P. latifolia* Ledeb. *Fl. Ross.* 2: 318 (1842), non DC. (1830); *P. sativa* subsp. *umbrosa* (Stev. ex DC.) Bondar. ex O. N. Korovina, *Byull. vses Ord. Lenina Inst. Rast. N. I. Vavilov* 81: 37 (1978).

**Type**

*Described from France.* Stem terete and striate, leaf elliptic, ovate or triangular. Primary leaf segments (3)–3.6–(4). Umbel rays 3–8; rays nearly equal in length.

**Representative specimens examined**

ALBANIA: Reisen in Nord Albanien, 5.viii.1916, *Dorfler* s.n. (GB).

AUSTRIA: Styriaca, Stiria superior, inter segetes prope pagum Kraubath, viii.1911, *Khek* s.n. (GB, W). Styriaca viii.1909 *Khek* s.n. (GB).

BULGARIA: Campora, viii.1907, *Stribruny* s.n. (GB). Kalofer Balkan, in monte Jumrukcal 2.vi.1907, *Schneider & Bergmann* s.n. (W).

CZECH REPUBLIC: Bohemia australis, distr., Blatna, ad marginem graminosum viae prope pagum Pastiky, 1.ix.1974, *Deylova* s.n. (W).

RUMANIA: Deliblat, Kinestari homokpuzta, ix.1911, *Janos* s.n. (GB). Banatica, Herculesbad, 1902, *Richter* s.n. (GB).

ITALY: Caromanica, 21.vii.1875, *Porta & Huteri* s.n. (GB). San Saverino Lucano (Lucania), 27.viii.1908, *Grande* s.n. (GB).

SWITZERLAND: Wallis, *Wolf* s.n. (GB).

TURKEY: Cappadocia, 1856, *Balansa* s.n. (W). Tauricum, ad Salgirum flumen prope pagum Mamut-Sultan, 26.vii.1900, *Callier* s.n. (GB). Sandschak, prope oppidum Ordu, 7.viii.1907, *Handel-Mazetti* s.n. (W). Ordu, E of Ordu, bridge of the River Turna on coastal road, 25.vii.1972, *Uotila* s.n. (H). Istanbul, Silivri to Tekirdag, 12.viii.1962, *Davis & Coode* s.n. (BM).

**C. subsp. *sylvestris* (Mill.) Rouy & Camus**

*Fl. Fr. Böhm.*: 574 (1875).

**Synonymy**

*P. sylvestris* Mill. *Gard. Dict.* ed. 8. n. 1 (1768).

**Type**

*Described from England.* Stem angled and deeply sulcate, Leaf very soft long hairy, stem densely covered with hair. Petals glabrous or subglabrous.

**Representative specimens examined**

ALBANIA: District of Moskopölë, W. of Korçë, near Gjonbabas, 6.vii.1933, *Alston & Sandwith* s.n. (BM).

FRANCE: Dept. Alpes de Haute-Provence, Limons, 25.vii.1982 *Geerinck-Coutrez* s.n. (BM).

GREAT BRITAIN: Badbury Rings, Dorset, chalk grassland of old Hill Fort, 7.vii.1972, *Jury* s.n. (RNG). Oxfordshire, Basington, 29.vii.1942, *Hubbard* s.n. (K).

HUNGARY: Helvetica, 27.vii.1904, *Besson* s.n. (BM). Prope Herkulesbad, xi.1907, *Schneider & Golopencza* s.n. (K).

ITALY: Prov. Trieste, M. Valerio, 20.viii.1964, *Poldini* s.n. (RNG).

MACEDONIA: Mavrovo valley, 5 km W. of reservoir dam, 19.vii.1970, *Edmonson* s.n. (RNG; BM).

SPAIN: Guadalajara, Siguenza, 12.vii.1963, *Galiano & Silvestre* s.n. (RNG). Almeria, Velez Blanco, roadside, 10 km W of village, 27.vii.1981, *M. F. & S. G. Gardner* s.n. (RNG; BM).

**D. subsp. *latifolia* (Duby) DC.,**

*Prodr.*, 4: 189 (1830).

**Type**

*Described from Corsica.* Fruits with 3–6 commisural vittae; commisural surface waxy.

**Specimens examined**

CORSICA: Bastia, 25 July 1868, *O. Debeaux* s.n. (W).

### 7. *P. divaricata* Desf.

*Cat. Hort. Par.* ed. 3: 405 (1829)

#### Synonymy

*P. sativa* var. *divaricata* (Desf.) Rouy & Camus, *Fl. Fr.* 7: 374 (1901).

#### Type

*Described from Corsica.* Biennial, (75)–83–(100) cm; tap rooted; strong fibrous collar absent or very rarely present. Stem scabridous, deeply sulcate and angled. Leaves 1-pinnate, (200)–287–(400) × (75)–97–(140) mm, elliptic or ovate or triangular, hairy on both sides. Leaf primary segments (3)–3.6–(4), ovate or triangular, serrate, obtuse. Umbels complex compound, (30)–44–(50) mm, rays (5)–8–(13), equal or subequal hairy. Bract and bracteoles absent or very rare. Sepals not conspicuous. Corolla actinomorphic; petals yellow without brown veins, hairy on dorsal surface, 1.5–2 mm. Mericarp ovate, (4.5)–4.8–(5.5) × (4)–4.3–(5) mm, retuse, slightly cordate at base, margin entire. Hairs present. Style glabrous. Apex of mericarp slightly (or not) emarginate at top of mericarp. Dorsal vittae 4, oblong and sausage-shaped and reaching the middle of mericarp. Commisural surface waxy; Commisural vittae 2, sausage-shaped and oblong, reaching the middle of mericarp, parallel.

#### Specimens examined

CORSICA: In saxosis, 15.viii.1912, *Spencer* s.n. (GB, W). In ruderalis, Bastia, 15.vi.1906, *Spencer* s.n. (GB). Ad silvarum margines in umbrosis, Bastia, 25.ix.1912 (GB). La Restonica, à Dragone, près de Corte, *Marbille* s.n. (W). Ruisseau de Toga, à Bastia, 5–21.vii.1865, *Debeaux & Mabille* s.n. (W; BM).

### 8. *P. zozimoides* Fenzl

*Tchihat. Asie Min. Bot.*, 1: 436 (1860).

#### Synonymy

*Zosima humilis* Fenzl, *Fl. Or.*, 2: 1062 (1872).

#### Type

Bulghar Dağı; arenosis dioriticis, m. Guzeltepe, 2730 m, 8 1853, *Kotschy* 118, 232c (Holotype: W!; Isotypes: SUNIV!, K!).

Perennial, (10)–17–(25) cm; tap rooted; strong fibrous collar present. Stem villose, striate or slightly sulcate and angled. Leaves 2-pinnate, (35)–43–(50) × (13)–18–(23) mm, oblong, ovate or triangular, hairy on both sides. Leaf primary segments (3)–3.4–(4), ovate or triangular. Leaf secondary segments opposite, oblong with lobed margins. Umbels simple compound, (20)–

31–(35) mm, rays (3)–4.8–(6), equal or subequal, hairy. Bract and bracteoles absent or very rare. Sepals not conspicuous. Corolla actinomorphic; petals pinkish with brown veins, hairy on dorsal surface, 1.6–2.5 mm. Mericarp cordate-obovate, (3.5)–3.9–(4.5) × (3)–3.1–(4) mm, retuse, slightly cordate at base, margin entire. Hairs present. Style glabrous. Apex of mericarp slightly (or not) emarginate at top of mericarp. Dorsal vittae 4, fusiform sometimes reaching the middle of mericarp. Commisural surface glabrous or with a little wax; commisural vittae 2, fusiform, reaching the middle of mericarp, parallel.

#### Specimens examined

TURKEY: Kizil-depe (Kiziltepe), viii.1895, *Siehe* s.n. (G). 1855 *Balansa* s.n. (G). Bulghar Dağı; arenosis dioriticis, m. Guzeltepe, viii.1853, *Kotschy* s.n. (W, SUNIV, K).

### SPECIES OF UNCERTAIN POSITION AND STATUS

#### 1. *P. glandulosa* Boiss. & Hausskn. ex Boiss.

*Fl. Or.*, 2: 1062 (1872)

#### Type

Hab. inter dumeta montis Berit Dağı, Cataonia, *Haussknecht* (Holotype: W!).

#### 2. *P. aurantiaca* (Alb.) Kolak.

*Fl. Abkhazia* 3: 243 (1948)

#### Synonymy

*Malabala aurantiaca* Alb., *Tr. Tifl. Bot. Sada* 1: 117 (1895).

#### Type

Transcaucasia, Circassia, Kyttsykh, 16.viii.1894, *Alboff* s.n. (Holotype: G!).

#### 3. *P. chrysantha* (Alb.) K.-Pol.

*Bull. Soc. Imp. Nat. Moscou n. s.*, 29: 112 (1916)

#### Synonymy

*Malabaila chrysantha* Alb. *Tr. Tifl. Bot. Sada* 1: 117 (1895).

#### Type

Abkhasie, 1 August 1894, *Alboff* s.n. (Holotype: G!).

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