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New and rare species of the genus *Orobanche* (Broomrapes) in the flora of the Republic of North Macedonia

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Abstract
In the present paper, one new and four rare species of the genus *Orobanche*, in the flora of the Republic of North Macedonia, are presented. *O. flava* is a new species, the other that are rare, are with only one (*O. pubescens, O. hederae*) or two literature data (*O. serbica*). There are also two literature data for *O. cumana,* but one is with certain location while the other is just a name on a list of weeds with major economic impact on agriculture in the Republic of Macedonia. Descriptions of the plants from the alleged locations are given. Photos of all species are also taken. Literature and new data are given in the distribution maps.

Key words: *Orobanche*, flora, host plant, Republic of North Macedonia.

Introduction

The genus *Orobanche* (incl. *Phelipanche* Pomel) is the largest genus of the family Orobanchaceae with 150 (Kreutz, 1995) to 170 species (Uhlich & al., 1995). The most of the Broomrape taxa grow in the temperate and warm regions of Europe, in some parts of western and eastern Asia and in northern Africa (Kreuz, 1995). In Europe, the Mediterranean countries are the richest with *Orobanche* taxa. Some of the species of this genus, encountered in America, eastern Africa, Australia and New Zealand, are supposed to be introduced by human activities (Kreutz, 1995).

The genus *Orobanche* consists of only obligate root parasites. The lack of chlorophyll and well-developed root system made the species of this genus completely dependent on water and nutrients of the host plants. Instead of root, a system of haustoria is developed.

The holoparasitic way of life, that led *Orobanche* taxa to lack or strong reduction of leaves and absence of roots, accompanied with intraspecific variation of corolla's color and corolla's dorsal line as well as the color of the stigma, make the taxonomy of *Orobanche* species extremely difficult.

So far, systematic researches of the genus *Orobanche*, on the territory of the Republic of North Macedonia, are not carried out. Only sporadic data, for different species of this genus, appeared in some floristic or vegetation works that concerned parts of this territory like Grisebach (1844), Grecescu (1899), Dimitrov (1909), Vandas (1909), Stojanov (1921, 1928), Jurišić (1923), Urumov (1923), Bornmüller (1928), Beck (1930), Soška (1937; 1938/39a; 1953), Petrović (1941), Černjavski (1943), Rudski (1943), Micevski (=Micev, 1952), Grupče (1958), Matvejeva (1965; 1968); Drenkovski (1969), Teofilovski (2011).

The work on the project "Taxonomy and chorology of the genus *Orobanche* in the Republic of Macedonia", conducted between 2011 and 2013, made an important contribution to the knowledge of this genus, in the flora of the Republic of North Macedonia.

According to the available literature data, the genus *Orobanche*, in the flora of the Republic of North Macedonia, is represented with 23 species. *Orobanche picridis* F.W. Schultz and *Orobanche loricata* Rchb. are given as separate species on the basis of the alleged literature data.

Materials and methods

Voucher specimens are deposited in the Herbarium of the Natural History Museum of the Republic of

North Macedonia. Relevant and reliable literature sources were used for determination of the material: Beck (1890;1930), Hayek (1929), Chater & Webb (1972), Parabućski (1974), Gilli (1982), Buia (1985), Delipavlov (1995), Kreutz (1995), Uhlich & al. (1995), Pujadas Salva & Velasco (2000), Pujadas Salva, A.J. (2003), Pusch & Günther (2009), Piwowarczyk (2014). Photos of all species, from their natural habitats, were taken. Literature and new data for the species are given on the distribution maps.

Results and discussion

1. *Orobanche cumana* Wallr. (Or. Gen.: 58. 1925).

(Syn. *O. cernua* var. *cumana*, Beck, Bibl. Bothanica, 19:143. 1890; O. *cernua* subsp. *cumana* (Wallr.) Soó, Fedes Repert., 83:187. 1972).

Literature data

Mt. Galičica (Černjavski, 1943).

New data

Kumanovo (village Romanovce): along the black road that leads from the highway to the locality "Krasta", sunflower crops, 300 m a.s.l., 26.06.2017 (Leg./Det. Z. Nikolov).

Fig.1. *Orobanche cumana* Wallr. - Habitus, with the host plant *Helianthus annuus* L.

Description

Stem erect, 25-58 cm, simple. Inflorescence lax, 12-39 cm. Calyx up to 8 mm long, deeply bifid, the segments entire. The bracts up to 10 mm long, oval-lanceolate, deflexed at the apex. Corolla 14-17 mm long, yellowish-white at the base and somewhat blue-violet toward the apex of the upper lip, curved at the first third forward, then in the middle almost straight, and again light curved downward at the apex of the upper lip. Stamens inserted at approximately 5 mm from the corolla base. The style, in the upper part, with rare glandular hairs. The two spherical lobes of the stigma are whitish.

The taxonomic status of *Orobanche cumana* (Fig. 1, 2) is still uncertain. This species, described by Wallroth (1845) had been, for a long time, in the works of various authors, taxonomically different evaluated: as variety of *Orobanche cernua* Loefl. (Beck, 1890, 1930; Hayek, 1929), sub-species of *O. cernua* (Soó, 1972), conspecific species with *O. cernua* (Chater & Webb, 1972; Pusch, 2009) or synonym of *O. cernua* (Pignanti, 1982). Contrary to these allegations, in the papers of other authors, these two taxa are given as separate species (Kreutz, 1995; Uhlich & al., 1995; Pujadas-Salva & Velasco, 2000). Delipavlov (1995), for Bulgaria, and Parabućski (1974), for Serbia, recorded *O. cumana* with *O. cernua*, as its synonym.

This discrepancy, in the taxonomical evaluation of *O. cumana*, exists even to nowadays. In one of the most relevant sources: Euro+Med Plantbase (Domina & Raab-Straube, 2010+), *O. cumana* and *O. cernua* are accepted as separate species. But, in another also relevant source - the Plantlist, *O. cumana* is recorded as synonym of *O. cernua*.

Although *O. cernua* and *O. cumana* are closely related species yet, there are certain morphological, ecological and biochemical differences that make clear distinction between them and justify their species level. That is, in the best way, confirmed in the work of Pujadas-Salva & Velasco (2000), for the Iberian Peninsula. *O. cumana* is taller, the inflorescence is laxer and longer. There are also deviations in the bending of the dorsal line as well as of the color and the length of the corolla. Markedly longer and more curved-down are the flowers by *O. cumana.* Differences also appear in the view of habitats as well as in the seed oil content and fatty acid composition.

Fig. 2. *Orobanche cumana* Wallr. - Inflorescence

The flowering period doesn't overlap, for *O. cernua* takes part from March to June, for *O. cumana*, from June to August.

The distribution area of *O. cumana* spans from the entire Mediterranean region of Europe to China, Asia Minor and Central Asia, also northern Africa and Australia, while *O. cernua* inhabits mainly western Mediterranean region of Europe, then through Bulgaria, Asia Minor and central Asia, to China, also in eastern India, northern Africa and Australia (Kreutz, 1995).

The only data, for the presence of *O. cumana*, on the territory of the Republic of Macedonia, we find in Černjavski (1943), for the Mt. Galičica (Suvopolje: Poljce). The data by Kostov & Pacanoski (2007) is only a name on a list of weeds with major economic impact on agriculture in the R. of Macedonia. The new finding is along the black road that leads from the highway to the locality "Krasta" (village Romanovce, town Kumanovo), at altitude of approximately 300 m a.s.l. (Fig. 3).

The plants of our population match the description given by Kreutz (1995), Uhlich & al. (1995) and Pujadas-Salva & Velasco (2000). The only deviation concerns the length of the corolla. By our plants, the corolla length (14-17 mm) is almost the same with the one, given by Kreutz [(1994) (15-18 mm)] and Uhlich & al. [(1995) (15 -18 mm], but shorter, in average, in compare to the length, recorded by Pujadas-Salva & Velasco [(2000) (16)19-22 mm].

Despite to the allegations of Kreutz (1995), Pujadas-Salva & Velasco (2000), Parker (2013), that *O. cumana*

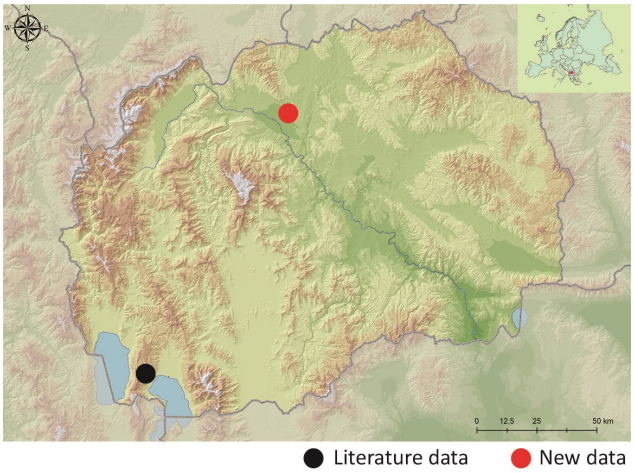

Fig. 3. *Orobanche cumana* Wallr.

parasitizes exclusively on sunflower (*Helianthus annuus* L.), while *O. cernua* mainly on *Artemisia* species or on Solanaceae crops, another authors (Buia, 1985; Uhlich & al., 1995; Pineda-Markos & al., 2014) recorded, beyond the sunflower, other species of Asteraceae and Solanaceae, as host plants for *O. cumana*.

O. cumama, in the alleged locality, in an immense number, parasitizes on sunflower crops (Fig. 1).

2. *Orobanche hederae* Duby (Bot. Gall., ed. 2, 1:350. 1828).

Literature data

Mt. Belasica: village Banjsko (Rudski, 1943).

New data

1. Matka (Skopje): in the vicinity of the dam "Matka", along the narrow path that leads to the caves, 343 m a.s.l., 10.06.2011 (N: 42º 00' 37.8''; E: 021º 30' 46.9'') (Leg./Det.: Z. Nikolov),

2. Debar (village Modrič): in the valley of the river Crn Drim, 594 m.a.s.l., 22.06.2012 (Leg./Det.: Z. Nikolov).

Description

Stem erect, (13)16-34(41) cm, simple, yellowish to yellowish-brown or even brown, with long, glandular hairs. Inflorescence lax, many-flowered (4)6-15(25) cm. The bracts with the same length as the corolla or even longer, oval-lanceolate, with glandular hairs, deflexed at the apex. Calyx segments with glandular hairs, entire or unequally bidentate, connate at the base. Corolla 14 -20 mm long, yellowish to yellowish-brown, with glandular hairs. The dorsal line of the corolla is nearly curved from the base, then almost straight (even) and

Figure 4. *Orobanche hederae* Duby
a) Habitus b) *O. hederae* parasitic on *Hedera helix* L. c) inflorescence detail

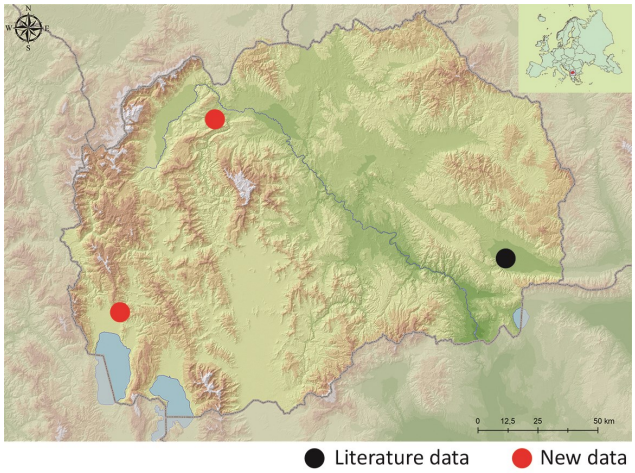

Fig. 5. *Orobanche hederae* Duby

somewhat raised at the upper lip. Stamens inserted at 3-4 mm from the corolla base. The style glabrous or with rare glandular hairs. The stigma consisted of two elongated, globular lobes, yellowish.

The distribution area of *O. hederae* extends from southern Europe (especially the Mediterranean region) to Asia Minor (Turkey), Caucasus countries and Iran, also in western, central and rarely, in eastern Europa (Crimea) and countries from North Africa - Morocco, Algeria (Uhlich & al., 1995; Kreutz, 1995; Pusch & Günther, 2009; Domina & Raab-Straube, 2010+).

The only data, for the presence of *O. hederae*, in the flora of the Republic of North Macedonia, comes from Rudski (1943), for village Banjsko (Mt. Belasica). New findings (Fig. 5.), revealed during the work on the project "Taxonomy and horology of the genus *Orobanche* in the flora of the Republic of Macedonia" (2011-2013), are Matka (dam in the gorge of the river Treska, city of Skopje) and the valley of the river Crn Drim (village Modrič, town Debar).

O. hederae parasitizes mostly on the root of *Hedera helix* L. (Fig. 4 a, b), rarely on other *Hedera*-species. Also, other Araliaceae are possible host plants for *O. hederae* (Pusch & Günther, 2009) as well as *Pelargonium* and other ornamental plants (Kreutz, 1995).

The population at the locality "Matka" is developed on the edge of the dam, on moist and shady site (Fig. 4, a,b). Along the road, in the valley of the river Crn Drim, occurs another population of *O. hederae*.

3. *Orobanche pubescens* D'Urv. (Enum. Pl. Ins. Eux. 76. 1822)

(Syn. *O. versicolor* F.W. Schultz in Flora (Regensburg) 26:129. 1843.)

Literature data

Beck (1930): Mazedonien: "bei Lundzi, naechste Gjevgjeli" (Dimonie).

New data

Matka (Skopje): in the vicinity of the church "Sv. Nedela", 757 m a.s.l., 10.06.2011 (Leg./Det.: Z. Nikolov).

Description

Stem 35 cm, simple, reddish, with long, white glandular hairs, bellow rich, upper scare scale-leafy. Inflorescence 16 cm, cylindrical, upper dense-flowered, bellow rather lax, villous. Scale leaves up to 16 mm, linear-lanceolate, with white- glandular-villous base. The bracts reach the corolla length, lanceolate, white- glandular-villous. Calyx-segments evenly bidentate, teeth

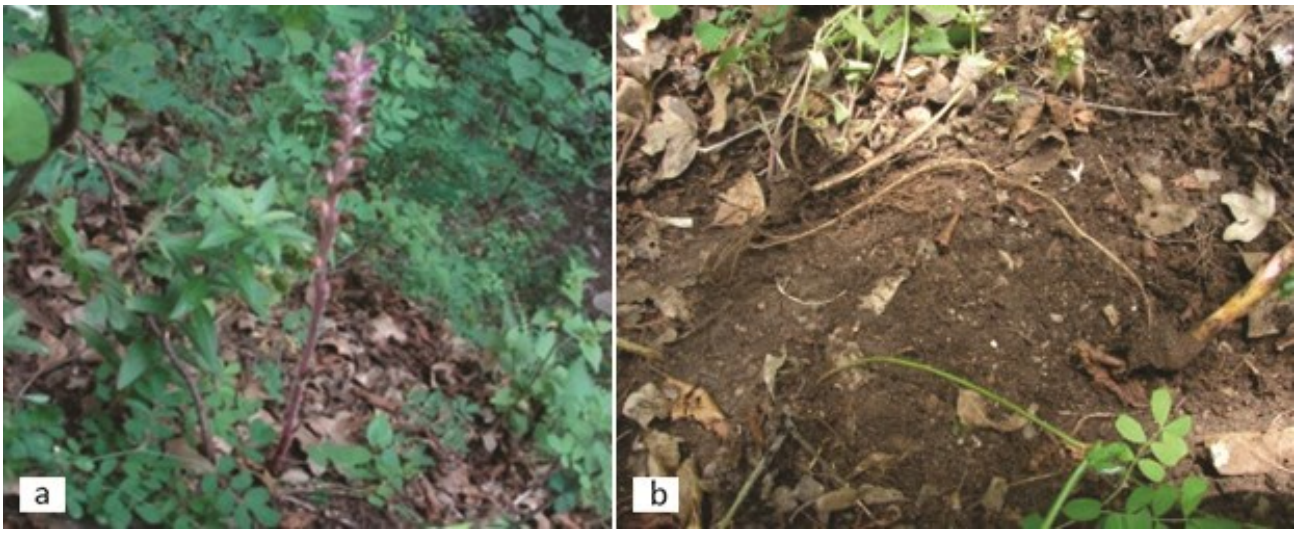

Figure 6. *Orobanche pubescens* D'Urv.
a) Habitus b) *O. pubescens* with the host plant *Lamium maculatum* L.

Figure 7. *Orobanche pubescens* D'Urv. - Inflorescence

long-acuminate, white-glandular-villous. Corolla 16 mm, tubular, yellowish-white at the basis, reddish to the lips, long lanate-pilose outside, mostly on the upper lip; the dorsal line, from the curved base, almost straight. Stamens inserted et 3-4 mm from the base of the corolla. Stigma 2-lobed, reddish.

O. pubescens (Fig. 6, 7) belongs to the Mediterranean elements spread from Spain, France, Italy, Balkans to Crimea and Transcaucasia, also in N.W. Africa (Gilli, 1982; Kreutz, 1995; Uhlich & al., 1995; Domina & Raab-Straube, 2010+).

The only data, for the presence of *O. pubescens,* on the territory of the Republic of North Macedonia, comes from the comprehensive monograph of Beck

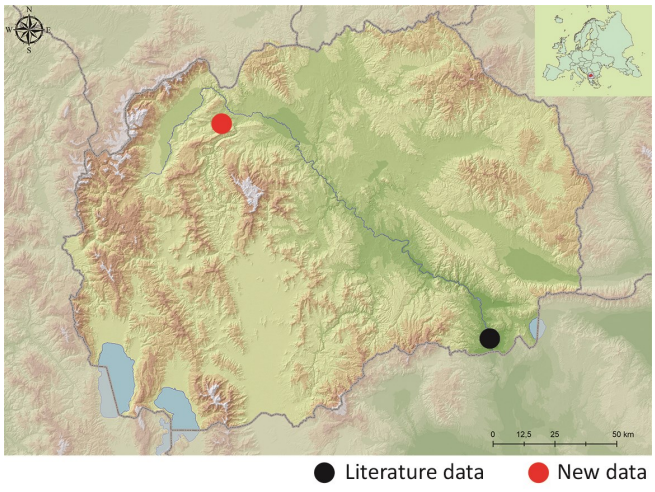

Fig. 8. *Orobanche pubescens* D'Urv.

(1930), for the surrounding of the town Gjevgjelia. On the locality "Matka" (Skopje valley), not far from the dam (Fig. 8), in the vicinity of the church "Sv. Nedela", only one plant of this species that parasitizes on *Lamium maculatum* L. (Fig. 6, b), was found. Although *L. maculatum* is so far unknown to be host plant for this or any other *Orobanche*, another one, of the same genus *Lamium* – *L. garganicum* L. subsp. *striatum* (Sm.) Hayek (Syn. *L. striatum* Sm.) is already known to be host plant, for *O. pubescens* (sec. Bornmüller, in Beck, 1930; Uhlich & al., 1995). Otherwise, *O. pubescens* is parasitic on various species, mostly of Asteraceae, Umbelliferae and Fabaceae, rarely on Lamiaceae and Geraniaceae (Uhlich & al., 1995).

4. *Orobanche flava* F.W. Schultz

Literature data

So far, there are no data for the presence of this species, in the flora of the Republic of North Macedonia.

New data

Jablanica (village Gorna Belica): nearby the village, along the road and Belička river, 1200 m a.s.l., 19.07.2006 (Leg./Det.: Z. Nikolov).

Description

Plants usually in groups, stem (15)23-39 cm, orange-yellowish, glandular-pubescent; scale-leaves up to 20 mm, numerous in the lower, rare in the upper part of the stem; the lower triangular to lanceolate, the upper

Fig. 9. *Orobanche flava* F.W. Schultz

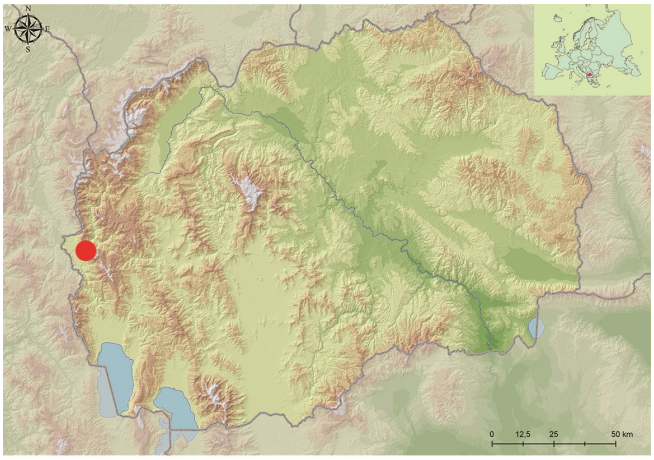

Fig. 10. *Orobanche flava* F.W. Schultz

scale-leaves lanceolate. Inflorescence (4)5-10 cm, many -flowered, dense at first, later, elongated and lax; bracteoles absent; calyx segments usually free, mostly unequally bidentate, rarely entire, glandular-pubescent; corolla up to 23 mm, yellowish, glandular-pubescent, relatively uniformly curved; the upper lip 2-lobbed, the lower 3-lobed, the middle one larger than the side lobes; stamens inserted 4-6 mm from the base of the corolla tube; stigma 2-lobed, yellow.

Orobanche flava (Fig. 9) grows in Central and Eastern Europe: France, Switzerland, Germany, Austria, Czech Republic, Slovakia, southern Poland, Hungary, Romania, Former Yugoslavia and northern Italy (Kreuz, 1995). Later, the presence of this species was confirmed for Spain (Pujadas Salva, 2003). Domina & Raab-Straube (2010), beyond the countries alleged by Kreuz (1995) and Pujadas-Salva (2003), extends the distribution area with Azerbaijan, Armenia, Georgia (A D G), Morocco, R(CS) and Ukraine.

O. flava is a mountain species that parasitizes mainly on species of the following genera of the fam. Asteraceae: *Adenostyles, Petasites, Senecio* and *Tussilago*, and probably on these species of the genus *Aconitum* (fam. Ranunculaceae*) – A. napellus* L. *and A. lycoctonum* L. (Kreutz, 1995; Uhlich & al., 1995; Pusch & Günther, 2009).

The habitat on the Mt. Jablanica (village Gorna Belica), where *O. flava* grows, completely matches the "preferred habitats" for this species, described by Piwowarczyk (2014). Namely, the plants occurred in the tall-herb stands of *Petasites* sp., on stony, wet place, sporadically flooded by the waters of Belička river, at approximately of 1200 m a.s.l. (Fig. 10).

Hitherto, *O. flava* hasn't been recorded for the territory of the Republic of North Macedonia.

5. *Orobanche serbica* Beck & Petrovic

(Syn. *Orobanche ozanonis* F.W. Schultz. ex G. Beck. Biblioth. Bot., 19:249. Stuttgart. 1890).

Literature data

Belasica: village Bansko (Stojanov, 1921); Mt. Galičica (Černjavski, 1943).

New data

Kozjak (village Nova Breznica, city of Skopje), 1107 m.a.s.l.; 03.07.2013. N: 41º 53' 40.6'' E: 021º 53' 28.6'' (Leg./Det.: Z. Nikolov).

Description

Stem (12)14-23(28) cm, swollen at the base, glandular-pubescent, yellowish, rarely purple. Scale-leaves ovate-lanceolate, 10-15(18) mm long, dense bellow, gradually rare up. Inflorescence rather dense, many flowered, 5-8 cm long. Bracts lanceolate, glandular-pubescent, slight shorter than the corolla. Calyx segments free, mostly unequally bidentate. Corolla 16-18 mm long, whitish with purplish nuance to the lips, glan-

Fig. 11. *Orobanche serbica* Beck & Petrović - Habitus of the plant, parasitic on *Artemisia campestris* L.

Fig. 12. *Orobanche serbica* Beck & Petrović - Inflorescence

dular-ciliate, curved at the base, straight in the middle and curved down to the lips; the upper lip subentire, the lower three-lobed, the lobes equal, glandular-ciliate at the margins. Filaments inserted at 4 mm from the corolla-base. Stigma 2-lobed, yellow.

Until recently, *Orobanche serbica* (Fig. 11, 12) was considered to be Balkan endemic species confined to Serbia (Beck, 1890), Serbia and Macedonia (Hayek, 1929), Serbia and Bulgaria (Beck, 1930, Uhlich & al., 1995), Bulgaria and former Yugoslavia (Chater & Webb, 1972), Serbia, Macedonia and Bulgaria (Parabućski, 1974; Delipavlov, 1995). But, as a result of the conclusion of Carlon & al. (2008) that *Orobanche ozanonis* F.W. Schultz is actually a synonym of *O. serbica*, the distribution area of the latest was widened to France and Spain. This solution was soon accepted by Domina & Raab-Straube (2010). In the distribution area of *O. serbica*, given by the later authors, the territory of the Republic of North Macedonia is not included.

In the locality "Kozjak" (village Nova Breznica, Fig. 13), where *O. serbica* grows "dominate rocky, dry grasslands on the calcareous bedrocks, rarely dry meadows and clearings in the oak belt or the rests of *Pinus nigra* forests" (Nikolov, 2019). The plants of this, not numerous population, match (without deviations) the descriptions given by Beck & Petrovic (1885), Beck (1890, 1930), Hayek (1929), Chater & Webb (1972), Parabućski (1974), Delipavlov (1995), Uhlich & al. (1995). The whitish corolla, with purplish nuance to the lips, the yellow, 2-lobed stigma and the ovate-

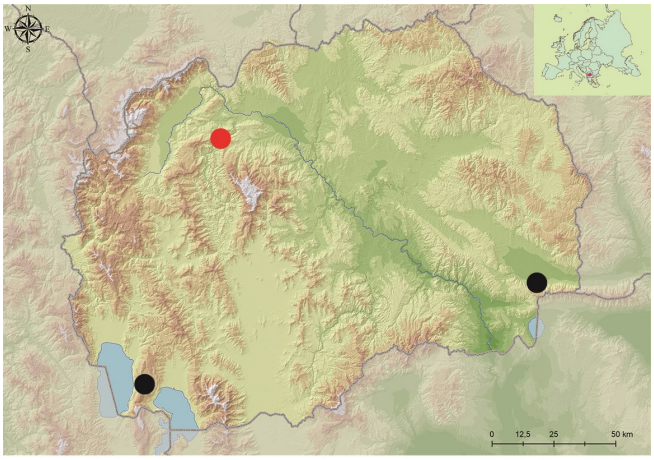

Fig. 13. *Orobanche serbica* Beck & Petrović

lanceolate scale-leaves make this species in the field easy recognizable.

O. serbica is parasitic only on species of the genus *Artemisia* (Beck & Petrovic, 1885; Beck, 1890, 1930; Chater & Webb, 1972; Parabućski, 1974; Uhlich et al., 1995; Carlon & al., 2005). In the locality "Kozjak" *O. serbica* parasitizes on the root of *A. campestris* (Fig. 11.), the same host species alleged by Parabućski (1974).

Conclusion

The result of the work on the material of the genus *Orobanche*, collected from 2006-2017, mostly from 2011-2013, is as following:

1. *Orobanche flava* – first record of the flora of the Republic of North Macedonia, new species, parasitic on *Petasites* sp., discovered on the Mt. Jablanica (village Gorna Belica),

2. *Orobanche cumana* - rare species, parasitic on *Helianthus annuus*, registered on a locality nearby the village Romanovce (town Kumanovo),

3. *Orobanche hederae* - rare species, parasitic on *Hedera helix*, encountered on the localities Matka (city of Skopje), valley of the river Crn Drim (village Modrič, town Debar),

4. *Orobanche pubescens* - rare species, parasitic on *Laminum maculatum*, found on the locality Matka (city of Skopje), and

5. *Orobanche serbica* - rare species, parasitic on *Artemisia campestris*, discovered on the locality Kozjak (village Nova Breznica, city of Skopje).

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