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The genus *Erysimum* (Brassicaceae) in Bulgaria

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Abstract

The genus *Erysimum* is represented in the Bulgarian flora by 14 species. The present communication reviewes briefly the history of its systematic treatments between Flora Bulgarica and its Supplementum I (VELENOVSKÝ 1891, 1898) and Flora N. R. Bulgaria, vol. 4 (ASSENOV 1970). The results of our field and laboratory studies in the Bulgarian flora 1992 - 2005 are summarized. The synonymy, morphological descriptions, flowering times, chromosome numbers and distributions are provided. The species wrongly reported for Bulgaria are listed and commented. The ecological characteristics, reproductive biology, chromosome numbers and karyotypes, as well as polyploidy, distribution and supposed evolution of the *E. drenowskii* and *E. diffusum* polyploid complexes are discussed.

Key words: Brassicaceae, *Erysimum,* Bulgaria, systematic treatment, distribution, chromosome numbers and morphology, polyploid complexes, reproductive biology.

Zusammenfassung

Die Gattung *Erysimum* ist in Bulgarien mit 14 Arten vertreten. Die systematische Behandlung in früher publizierten Floren für Bulgarien wird kommentiert und mit der aktuellen Gliederung, die auf intensiven Feld- und Herbarstudien 1992 - 2005 basiert, verglichen. Synonymie, Morphologie, Blühzeiten, Chromosomenzahlen und Verbreitung werden ebenso wie die Ökologie der einzelnen Arten eingehend behandelt. Auf zwei in der bulgarischen Flora mit mehreren Arten vertretenen Polyploidkomplexe (*E. drenowskii* and *E. diffusum*) wird besonders hingewiesen.

Introduction

Erysimum comprises between 290 and 350 species of mostly perennial and biennial plants, distributed in Europe, the Mediterranean area, Near East, East Asia and North to Central America (POLATSCHEK & SNOGERUP 2002).

During history the genus *Erysimum* had different taxonomic content in the Bulgarian flora. The reason for that was the increase of knowledge for the different species and the description of new taxa, as well as the different views of the species limits and contents. VELENOVSKÝ (1891) in his Flora Bulgarica included 6 species of *Erysimum*: *E. repandum, E. canescens* (= *E. diffusum****), *E. odoratum*, *E. cuspidatum*, *E. strictum* and *E. crepidifolium* - the last two have not been confirmed later. In Flora Bulgarica, Supplementum I (VELENOVSKÝ 1898) along with *E. moesiacum* (= *E. crassistylum*) and *E. goniocaulon*

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*** For the adopted and synonymic names see the taxonomic treatment below.

var. *bulgaricum* (= *E. bulgaricum*), described from Bulgaria, VELENOVSKÝ for the first time reported *E. boryanum* var. *atticum* (= *E. pseudoatticum*), and confirmed *E. canescens* and *E. odoratum*.

STOJANOV & STEFANOV (1924) in the first edition of "Flora of Bulgaria" listed 12 species of *Erysimum*, including the taxa reported by VELENOVSKÝ (1891, 1898), as well as *E. helveticum* (= *E. pseudoatticum* p.p.), E. *comatum*, *E. sessiliflorum* (= *E. quadrangulum*) and *E. canescens* var. *welchevii* (= *E. welchevii*), taxa found later in or described from Bulgaria. In the next three editions of Flora of Bulgaria (1933, 1948, 1966) the number of the listed species had not been essentially altered, although *E. drenowskii* was described in this period (DEGEN 1934). ASSENOV (1970) in Flora N. R. Bulgaria accepted 10 species, treating *E. welchevii* and *E. moesiacum* as varieties of *E. diffusum,* and *E. drenowskii* as a variety of *E. helveticum*. Recently ANČEV & POLATSCHEK (1998, 2003) described new species from Bulgaria.

The aim of the present communication is to summarise the results of our field and laboratory studies in *Erysimum* in the Bulgarian flora in the period 1992 through 2005. Currently *Erysimum* is represented in Bulgaria by 13 species.

Material & Methods

The study is based on herbarium material deposited in B, BP, BR, BRA, BRNM, BRNU, C, FI, G, GJO, GOET, GZU, H, JE, K, LE, LI, LZ, M, MHA, PR, PRC, S, SO, SOA, SOM, W and WU*, in the herbarium in Brixen (Italy: Südtirol) and the private herbaria M. Ančev (Sofia) and M.A. Fischer (Wien), as well as on field studies and plants collected in Bul-garia in the years 1990 - 2005, and on plants cultivated in Sofia, Institute of Botany, and in Wien, Alpengarten Belvedere. All cited specimens have been seen. In the systematic treatment the synonyms are given as far as they are important for the Flora of Bulgaria.

The hair types and their relative abundance used in the morphological descriptions are presented in Table 6, and indicated in the following way: HT 2: 2-fid hairs predominant (more than 50%); HT 2: 2-fid hairs common (10 to 50 %); HT (2): 2-fid hairs uncommon (up to 10 %); HT ((2)): 2-fid hairs rare, scattered on the apex and lower surface of the leaves, or completely absent; HT 3: 3-fid hairs predominant, etc.

The pollen grains were studied after staining with 4% acetocarmine, carefully warming the material on flame. Measurements of the polar (P) and equatorial (E) pollen diameter were made on 150 grains.

The chromosome numbers counted by both authors and karyotypes were studied on mitotic metaphase plates obtained from seedling root-tips and flower buds, the later collected in the field and fixed in ethanol : acetic acid (3 : 1), stained immediately before squashing with acetocarmine. The root-tips were fixed in ethanol : acetic acid (3 : 1), hydrolized in 1N HCl at 60° for 10 min and stained with hematoxyline after Gomori (MELANDER & WINGSTRAND 1953, see also ANČEV & POLATSCHEK, 1998). The interphase nuclei, which in *Erysimum* are of the prochromosomal type, were also observed.

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* Abbreviations following Index Herbariorum: http://207.156.243.8/emu/ih/index.php

The investigation on interphase nuclei of diploid species gives additional information about the karyotypes, as the number of the interphase chromocentres most frequently corresponds to the somatic number of chromosomes. In polyploid species the number of chromocentres gives only an approximate notion about the ploidy level (ANČEV 1995). In the lists of examined specimens the karyologically studied populations are marked by one asterisk (*) for cytotypes investigated by A. Polatschek, and by two asterisks (**) for cytotypes studied by M. Ančev. Earlier published chromosome numbers are given with their reference, B-chromosomes are given if stated in that count. The voucher specimens have been deposited in SOM and W.

Systematic treatment

Erysimum L., Sp. pl.: 660 (1753).

Annual, biennial or perennial herbs, covered by medifixed bifid hairs, in some species mixed with 3 - 5 (- 7)-fid ones (see Table 6). Leaves entire or dentate to pinnatisect, mostly sessile. Inflorescence of one or several racemes. Sepals erect or slightly spreading, the inner (lateral) pair usually more or less saccate, outer (median) gibbous or horned near the apex. Petals yellow, rarely golden yellow, spathulate, with short blade and long claw, or cuneate. Filaments sometimes dilated at base; anthers oblong or linear. Nectaries present around the outer stamens and usually also outside the inner ones. Ovary sessile, multi-ovulate. Fruit compressed, a 4-angled or rarely terete siliqua; valves usually pubescent, often with prominent midvein. Style in most of the species short, with spherical or shallow bilobed, retuse or capitate stigma. Seeds in one, rarely in two alternating rows in each loculus, usually compressed, sometimes narrowly winged, when wet slightly mucilaginous or not; cotyledones incumbent. Perennial species and some biennials are predominantly autcrossing, allogamous, pollinated by insects; annual and most of the biennial with small flowers are predominantly self-pollinating, autogamous; all reproduce by seeds, some of the perennials also by underground rhizomes. Chromosome numbers: × = 6, 7, 8, 9, with series of polyploid numbers.

1 Indumentum with 4 - 7-fid hairs; annual or biennial plants (Tab. 1, Fig. 1) 2

1* Indumentum with 2 + 3 ((- 4))-fid hairs; annual and biennial or perennial plants (Tab. 1, Fig. 1) 5

2 Annual plants; stem base without cover of dry leaves or leaf remains; style more or less sessile; siliquae forming an angle of 40° - 60° with the axis; pedicels about 1/2 of the siliquae lenght ..... 14. *E. cheiranthoides*

2* Biennial plants; stem base with or without cover of dry leaves and leaf remains; style 1-7 mm 3

3 Pedicels 1-3 mm; style (3 -) 4 - 5 (- 7) mm; petals with (2) + 4 + (5)-fid hairs; flowers slightly to strongly fragrant ..... 11. *E. cuspidatum*

3* Pedicels longer than 3 mm; style almost sessile or not more than 3 mm; petals with 2 - 4-fid hairs; flowers fragrant or not fragrant 4

4 Stem with long petiolate, runcinate basal leaves with 2 - 5 (- 6)-fid hairs; sepals 5 - 6 (- 7) mm; petals 8 - 15 mm long, pale yellow; flowers not fragrant .... 9. *E. bulgaricum*

4* Stem with shortly petiolate sinuate-dentate basal leaves with 2 - 4 (- 5)-fid hairs; sepals (7 -) 8 - 10 mm; petals 13 - 16 (-20) mm long, yellow; flowers strongly fragrant ..... 10. *E. odoratum*

5 Petals glabrous; style longer than 2 mm; flowers with strong fragrance 6

5* Petals hairy; style shorter than 2 mm (in *E. pseudoatticum* up to 3 mm) 7

6 Perennial plants, stem 5 - 20 cm, mostly simple; siliquae with 2-fid hairs on the angles; style 2-4 mm ..... 3. *E. slavjankae*

6* Biennial plants, stem 30 - 80 cm, branched along the upper 2/3; siliquae with 4-fid stellate hairs on the angles; style (5 -) 7 - 8 (- 10) mm ..... 12. *E. quadrangulum*

7 Annual plants; siliquae forming an angle of 90° with the axis; style 0.5-1.5 mm .. .. 13. *E. repandum*

7* Biennial or perennial plants; siliquae forming an angle up to 70°Z with the axis 8

8 Perennial plants; petals always spathulate 9

8* Biennial plants; petals mostly cuneate 10

9 Stem with 1-7 branches; siliquae forming an angle of 60° - 70° with the axis; style c. 1 mm ..... 1. *E. drenowskii*

9* Stem simple; siliquae forming an angle of 50°; style 2 - 3 mm ..... 2. *E. pseudoatticum*

10 Stem base with thick tunic of dry leaves and leaf bases; petals 15-17 (-19) mm; flowers strongly fragrant ..... 11. *E. comatum*

10* Stem base without tunic, sometimes in flowering with dry leaves; petals up to 15 mm long; flowers not fragrant 11

11 Stem with 4 - 8 branches above the middle; leaves with 2-fid hairs, the margins usually with up to 0.3 mm long, distant teeth* (Fig. 6); fruit pedicel 2 - 5 mm .... 5. *E. pirinicum*

11* Stem with 1 - 7 branches above the middle; leaves with 2 + (3) + ((4))-fid hairs, the margins with 2 - 4 pairs of 0.1 mm long, distant teeth; fruit pedicel 5-11 (-14) mm 12

12 Lowest leaves with 3-4 pairs of fine teeth, stem leaves without or with 3-4 pairs of small distant teeth; siliquae forming an angle of 10° - 30° with the axis; fruit pedicel (6 -) 8 - 11 (- 14) mm; seed (- 1) 1.2 - 1.5 mm ..... 8. *E. welchevii*

12* Lowest leaves sometimes with 1 - 2 (- 4) pairs of very small teeth; siliquae forming an angle of 30° - 50° with the axis; fruit pedicel up to 5 - 6 (- 8) mm; seed 0.9 - 1.1 mm 13

13 The lowest leaves entire, sometimes with 1 - 2 (-4) pairs of teeth, stem leaves almost mucronate, 1- 3 (- 5) mm wide with 2 + (3) + ((4))-fid hairs; sepals mostly with 2 + (3)-fid hairs; anthers glabrous, sometimes with 2-fid and 3-fid hairs; silique with 2 + ((3))-fid hairs; style 0.3-0.5 (-1) mm, with 3 + (2) + ((4))-fid hairs ..... 7. *E. crassistylum*

13* The lowest leaves entire, very rarely with 1 - 2 pairs of short fine teeth; leaves more or less obtuse, 2 - 3 (- 7) mm wide, with 2+(3)-fid hairs; sepals with 2 + (3) + ((4))-fid hairs; anthers mostly with 2-fid hairs; silique with 2 + (3) + ((4))-fid hairs; style 1 (-1.5) mm, with 3 + (2)-fid hairs ..... 6. *E. diffusum*

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* The very small and often far distant teeth can be overlooked easily - it is sometimes necessary to check the specimen with 20× enlargement.

Table 1: Characters distinguishing annual, biennial and perennial species of *Erysimum*. All characters valid when the specimens are in full flowering.

	annual	biennial	perennial
Stem	not thickened at base	thickened at base	stem ± woody at base
Stem base	with no remainings of leaves between flowering and fruiting	with tunic of dry leaf-stalks or even with complete dry leaves	tunic of leaf bases in most cases existing
Additional branches in the inflorescense area	always several	always several	0 - 2, rarely up to 5 (in *E. drenowskii*)
Root	main root strongly developed additional lateral roots very thin or ± missing	main root strongly developed additional lateral roots mostly not well developed	main and lateral more or less equal developed
Pulling out	very easy	very easy	difficult, stem breaks near root neck

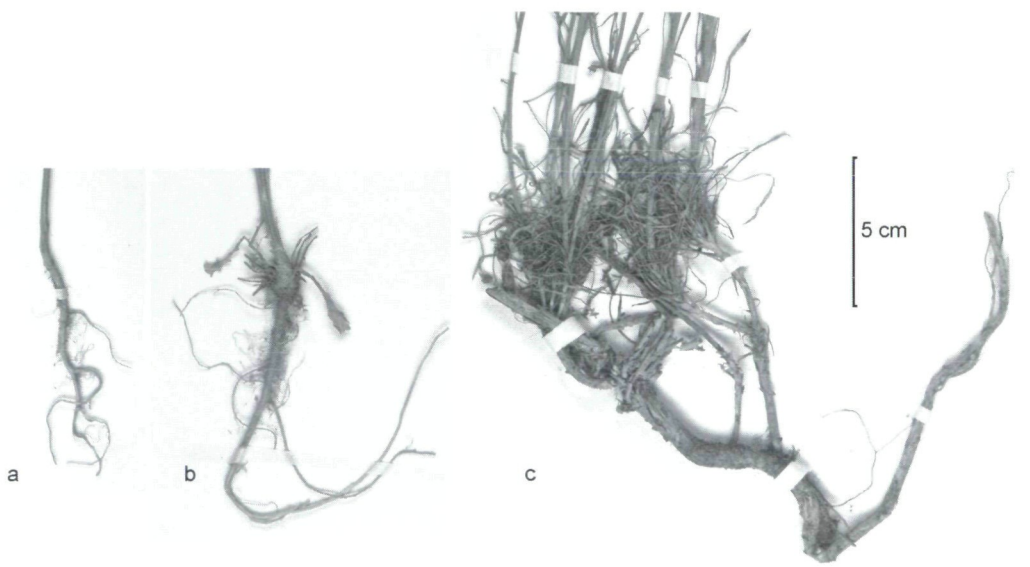

Fig. 1: Characteristic examples for life forms as described in Tab. 1, all pictures of flowering specimens: a) annual; b) biennial and c) perennial growth form.

Note: The large morphological variability and related taxonomic problems in *Erysimum* are mostly due to the morphological plasticity and active processes of differentiation in morphologically little differentiated groups of species. Closely related diploid and polyploid species form polyploid complexes such as the species groups of the perennial *E. drenowskii* (2x), *E. pseudoatticum* (6x) and *E. slavjankae* (12x), or the biennial *E. crassistylum* (2x), *E. diffusum* (4x), and *E. welchevii* (6x). Some of the species especially in the polyploid complexes are difficult to distinguish morphologically and for their identification specimens are needed with flowers, ripe fruits, and in *E. diffusum* group also seeds. Correct observation on life forms are important; perennial habit is indicated by

the presence of non-flowering rosettes and/or well developed lateral roots. Leaf fascicles (dwarf shoots) in the axils of the cauline leaves are not well developed until the plant is in full flower. The plants should not be dissected before pressing, as this may makes the study of some key characters difficult. Specimens with ripe fruits are necessary for observation of siliqua and style characters, direction of siliquae and presence/absence of vegetative short shoots. The pubescence and ultimate length of the style can be observed even before it emerges from the flower, as little or no elongation takes place during the development of the siliqua. Siliqua measurements exclude the style. The small teeth of leaves often need observation at a magnification of at least 25×. Damage of the main shoot, e.g. by grazing, may lead to abnormal growth forms, as such plants cannot be keyed out.

Good diagnostic characters are hair type and hair density, but several individuals should be examined. Hairs must be studied at a magnification of 50×. They are predominantly bifid (two-armed) in *E. drenowskii*, *E. pseudoatticum*, *E. slavjankae*, *E. comatum*, *E. pirinicum*, *E. crassistylum, E. diffusum* and *E. welchevii* with few 3-fid hairs and very few or single 4-fid ones mostly at the tip of the leaves and at the style base only. In the rest of the Bulgarian species, with an exception of *E. quadrangulum*, hairs on the leaves and fruits are 3-fid, 4-fid and 5-fid, mixed with 2-fid hairs, rarely with few or very few stellate 6-rayed to 7-rayed ones (Tab. 6). When several hair types occur the proportion of hairs with more numerous branches often increases toward the apex and on the lower surface of leaves.

For the biennial *E. comatum* a good diagnostic character is the thick tunic of old leaves and leaf remains at the stem base. A tunic is present also in *E. pirinicum*, but it is torn and not as well expressed. Lateraly compressed winged siliquae in *E. cuspidatum* and *E. quadrangulum* is characteristic for these species. Annual *E. repandum* differs very well in the morphology and position of the patent siliquae, forming an angle of c. 90° with the raceme axis.

1 - 3. *Erysimum drenowskii* group

Perennial, loosely to densely caespitose. Stem (2 -) 5 - 35 cm. Leaves entire. Inflorescence short simple raceme or with 1 - 3 (- 5) branches. Flowers morphologically protogynous, fragrant; petals spathulate. Siliqua densely covered by bifid hairs.

1. *Erysimum drenowskii* DEGEN

Magyar Bot. Lapok 33: 73 (1934); BALL, Fl. Eur. ed. 2, 1: 331 (1993); JALAS & SUOMINEN, Atlas. Fl. Eur. 10: 62 (1994). – Fig. 2.

≡ *E. comatum* var. *drenowskii* (DEGEN) STOJ., STEF. & KITAN., Fl. Balg. ed. 4, 1: 481 (1966), nom. illeg.

≡ *E. helveticum* var. *drenowskii* (DEGEN) ASSENOV, Fl. R. P. Bulg. 4: 354 (1970). Lectotype (POLATSCHEK & SNOGERUP 2002: 137): Auf Kalkfelsen, bei 1300 - 1500 m. Alibotusch-Gebirge, in bul. N-O Mazedonien. 20. V. - 21. VI. 1933, leg. A.K. Drenowski [SOM 33318].

= *E. helveticum* p. p., auct. bulg., non (JACQ.) DC.

Loosely caespitose perennial with a thick, branched taproot 10 - 15 cm long and woody stock branched only at apex, lacking non flowering rosettes and runners, with 1 - 5

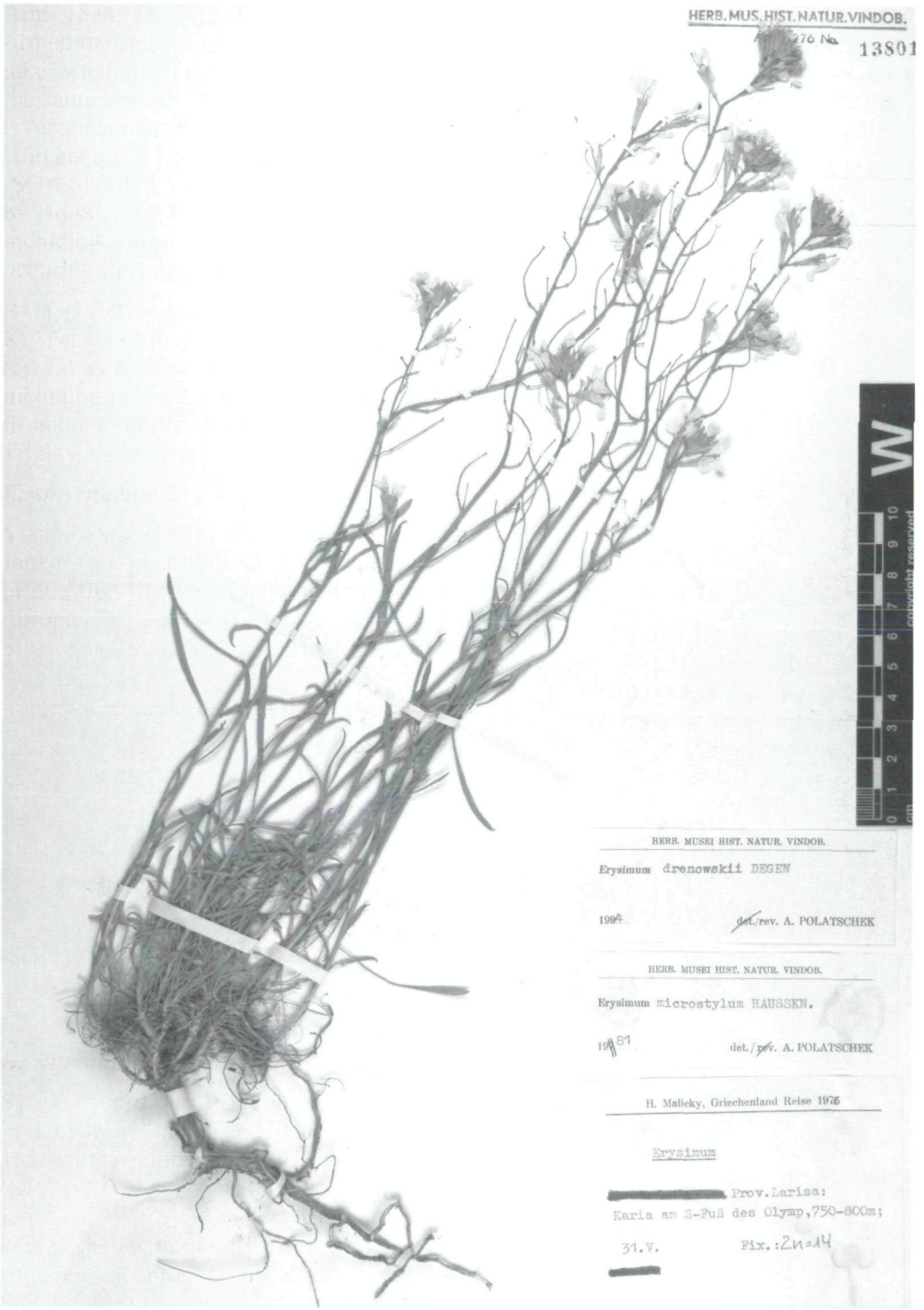

Fig. 2: *Erysimum drenowskii*, characteristic specimen from Greece [W 1976-13801].

stems, (7 -) 10 - 23 (- 27) cm high in flowering, elongated during fruting. Stem erect with shortly ascending base with often early withering basal rosette and usually 5 - 10 cauline leaves, simple, with vegetative short shoots in some of the upper leaf axils; tunic inconspicuous or absent, upper part of stem angled, with dense medifixed hairs only. Basal leaves petiolate, 20 - 80 × 1 - 8 mm narrowly oblanceolate to linear with 2 - 3 pairs of small teeth, obtuse. Cauline leaves sessile, 14 - 50 × 1 - 4 mm, linear, mostly entire, acute, with dense 2-fid and very few 3-fid hairs. Inflorescence a short simple raceme or with 1 - 3 (- 5) short branches, moderately elongating in fruit, racemes (5 -) 10 - 20-flowered, and up to 20 - 30 flowers on the main axis. Flowers slightly fragrant, protogynous. Flower pedicels 1.5 - 2.5 (- 3.5) mm, fruit pedicels (3 -) 4 - 6 mm; pedicel diameter about 2/3 of the siliqua diameter. Sepals (5 -) 7 - 8 (- 9) mm long, narrowly obovate-lanceolate, with dense 2-fid and few 3-fid hairs. Petals pale yellow to yellow, spathulate, pubescent outside with 2-fid and few 3-fid hairs, (10 -) 11 - 14 mm long, the blade 5 - 5.5 × (3 -) 3.5 - 4.5 (- 5) mm. Stamens glabrous, anthers pale yellow; lateral and median nectaries well developed. Siliquae 30 - 60 (- 75) mm, forming an angle of 60° - 70° to the axis, with dense medifixed and few 3-fid hairs, almost patent; style 1 - 1.5 mm, with 2-fid, 3-fid and sometimes with 4-fid hairs; stigma capitate, retuse. Seeds 0.9 - 1.2 × 0.5 - 0.7 mm, pale brown. Pollen grains: P = 19.7 - 20.5 µm, E = 18.1 - 19.1 µm. 2n = 14 + 0-2 B; x = 7.

Distribution and ecology

Central Stara Planina, Slavjanka, N Pirin Mt., Central Rhodope Mts. (Chernatitsa), from 900 up to 1900 m a.s.l. (Fig. 3); Balkan Peninsula (Greece).

Frequent in open mountainous south-facing stony and grassy slopes, glades and grazed meadows, in Central Stara Planina at lower altitude in patchy shrub communities dominated by *Carpinus orientalis*, *Fraxinus ornus* and *Colutea arborescens*, in the coniferous belt in Slavjanka Mt. and N. Pirin Mt. along forests of *Pinus heldreichii*, on shallow and eroded soils on limestone or marble ground.

Flowering mid-May to late July.

Examined specimens: Central Stara planina Mt.: Trojanski prohod, above Karnare, 1000 m, 20.VI.1989, M. Ančev A895 [W 1996-05635]*. – Trojanski prohod, above Karnare, 900 m, 12. VIII. 1984, M. Ančev A8495 [W 1996-05634]. – seeds of this coll., cult. Alpengarten Belvedere Wien, 1996/97, A. Polatschek [W 1997-08189]*. – Trojanska Planina, above Sopot, ca. 1300 m, 6.VIII.1994, M. Ančev, A94135 [SOM 3552, W 1996-05632], 2n = 14 + 0-2 B (ANČEV 1995)**. – Naroden Park, Karnare gegen Trojanski prohod, 900 m, 25.VI.1997, A. Polatschek [W1997-08217]*. – Zentrale Stara planina, 1300 m, 6.VI.1994, M. Ančev A9443 [W 1996-05632, Ančev]. – seeds of this coll., cult. Alpengarten Belvedere Wien, 1996/97, A. Polatschek [W 1997-08192]. – Pirin Mt.: Pirin-Gebirge: NE Mazedonien, 1450 m, 10.VII.1936, A. Drenowski [M]. – Slavjanka Mt.: In saxosis calcareis montis Ali Botuš, 1300-1500 m. VI-VII.1933, A. Drenowski. [SOM 33320]. – Graminosis et glareosis calcareis ad "Dolat" mt. Ali Botuš supra Paril, ca. 1300 m, 24.V.1934, B. Achtarov [PR].

2. *Erysimum pseudoatticum* ANČEV & POLATSCHEK

Ann. Naturhist. Mus. Wien, B, 100: 726 (1998).
Holotype: Bulgaria, Rila Mt., Levi Iskar River valley, 1200 m, 28.V.1994, M. Ančev, A9426 [SOM 3294, isotypes: SOM 3496, W 1996-05639].
Figures: ANČEV & POLATSCHEK 1998: 727.

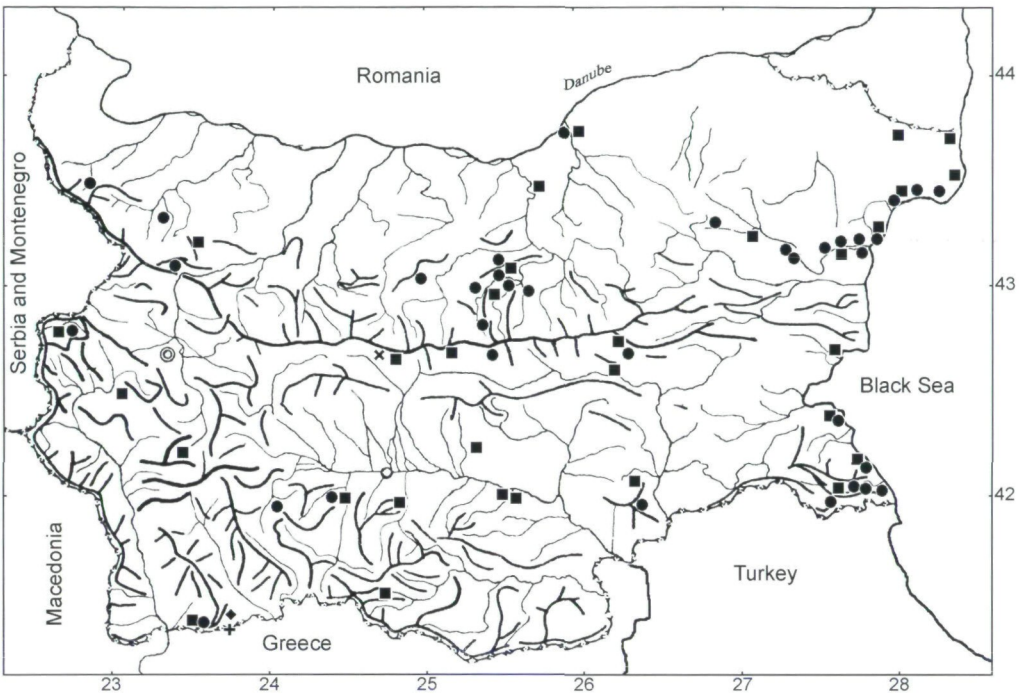

Fig. 3: Distribution of *Erysimum* in Bulgaria: *E. welchevii*, ● examined herbarium specimens; ■ populations studied for chromosome number 2n = 42. *E. drenowskii*, ◆ examined herbarium specimens; populations studied for chromosome number ✚ 2n = 14, ✖ 2n = 14 + 0-2 B.

= *E. pseudoatticum* ANČEV, Giorn. Bot. It. 129 (1): 95 (1995), nom. prov.

= *E. boryanum* var. *atticum* auct., non BOISS.: VELEN. Fl. Bulg. Suppl. I: 21 (1898).

= *E. pusillum* subsp. *parnassi* var. *atticum* auct. p. p., non BOISS.: HAYEK, Prodr. Fl. Penins. Balc. 1: 380 (1925).

= *E. parnassi* var. *atticum* auct., non BOISS.: STOJ. & STEF., Fl. Balg., ed. 3: 476 (1933).

= *E. pusillum* subsp. *parnassi* auct. p.p., non (BOISS. & HELDR.) HAYEK: ASSENOV, Fl. R. P. Bulg. 4: 357 (1970).

= *E. helveticum* p. p., auct. bulg. non (JACQ.) DC.

Loosely caespitose perennial, green to dark green, with few flowering shoots. Root 7 - 12 cm long, with well developed secondary roots, without runners. Stems, 1 - 5, ascending to erect, (6 -) 10 - 20 (- 25) cm in flowering, up to 35 cm in fruiting, elongated during fruting, rounded angular, 1 - 3 mm thick, simple; withered past year stems sometimes present at anthesis, mostly without sterile rosettes; the tunic absent or with few remnants of leaves. Basal leaves narrowly spathulate, 35 - 70 × 2 - 4 mm, pubescent, apiculate, distinctly petiolate, gradually narrowed into a long petiole; margins with 1 - 3 pairs of small teeth. Cauline leaves narrowly oblanceolate, pubescent, 20 - 35 (- 45) × 1 - 3.5 mm, apiculate or acute, with 1 - 3 pairs of minute teeth, shortly petiolate to almost

sessile, without fascicles of small leaves in the axils. Inflorescence a short simple apical raceme or with 1 (- 2) short branches, with up to 15 (- 16) flowers on the main axis and up to 6 - 8 flowers on each branch, moderately elongating during fruit development. Flowers slightly fragrant, protogynous. Flower pedicels (2 -) 3 - 5 mm, fruit pedicels 4 - 6 mm, pubescent; pedicel diameter about 2/3 of the siliqua diameter. Sepals pubescent on outer surface, (5 -) 7 - 8 (- 9) mm long, narrowly obovate-lanceolate. Petals lemon yellow, spathulate to shortly cuneate at the base, (14 -) 17 - 22 mm, the blade 6 - 8 × (3 -) 3.5 - 5 (- 5.5) mm. Stamens glabrous, anthers pale yellow; lateral and median nectaries well developed. Siliquae 60 - 90 mm long, 1.3 - 1.5 mm thick, 4-angled in cross-section, grey - greenish, densely covered with bifid hairs, edges glabrescent. Angle between the axis and the pedicel 50°-60°; siliqua diverging at 20° - 40°. Style 2 - 2.3 (- 3) mm, widening into a siliqua, with 3-fid and few 2-fid hairs; stigma capitate, retuse. Seeds 1.3 - 1.7 (1.8 -) × 0.6 - 0.7 mm, elliptical, pale brown - yellowish. Pollen grains: P = 22.5 - 25.0 (- 26.3) µm, E = 16.26 - 18.75 µm. 2n = 42; x = 7.

Distribution and ecology

Occurs in Western and Central Stara Planina, Znepole region (Mitrovitza, Strezimirovtzi), Rila Mt. and Central Rhodope Mts. (Fig. 4). Endemic.

On open slopes, on river banks and terraces, in high mountain grasslands, on skeletal and undeveloped soils with slightly alkaline reaction, on gneisses, granites or limestone substrate. The species localities are scattered from the mesophyllous and xeromesophyllous oak and hornbeam forest belt up to the alpine vegetation belt, from 700 up to 2600 m a.s.l. In W Stara Planina Mts. *E. pseudoatticum* grows on rocky and gravely terrains, on limestone at 700 - 750 m altitude in the periphery of shrub communities of *Carpinus orientalis, Quercus dalechampii, Acer campestre* and *Crataegus monogyna,* together with *Briza media, Dianthus petraeus, Campanula sibirica* and *Hieracium piloselloides.*

Flowering (mid-May -) June to July.

Note: VELENOVSKÝ (1898: 21-22) reported for Bulgaria *Erysimum boryanum* BOISS. & SPRUNER var. *atticum* (HELDR. & SART.)BOISS. from a locality above Samokov, most probably in Rila Mt.: "Supra Samokov a. 1894 legit am. Střibrný". Plant specimens from this collection have not been not found, neither in the Bulgarian [SO, SOA, SOM], nor in Czech [PR, PRC] herbariums. There is a specimen from a later collection of V. Střibrný in the same area, identified as *E. boryanum* BOISS. & SPRUN. (Rila, Kobilino branishte, VI. 1898 [SOA 25007]). The plants are with flowers and correspond to *E. pseudoatticum*. To the same species belong another 14 specimens, identified as *E. helveticum* or *E. helveticum* var. *comatum* (PANČIĆ) ACHT., collected in localities in Central Rila during the period of 1911 - 1990.

URUMOV (1904: 9) reported *E. boryanum* BOISS. & SPRUN. for Tikijska Mt. [Central Stara Planina] and later for Rila Mt. (URUMOV 1923: 113). STOJANOV AND STEFANOV (1924: 522) supported the distribution of *E. boryanum* var. *atticum* in Bulgaria, following VELENOVSKÝ (1.c.) and URUMOV (1.c.). In the second edition of Flora of Bulgaria (STOJANOV & STEFANOV 1933: 476) appeared the new combination "*E. parnassi* var. *atticum* (HELDR. & SART.) STOJ. & STEF.", which was maintained in the later two editions of the same flora (STOJANOV & STEFANOV 1948: 522; STOJANOV, STEFANOV &

Table 2: Characters distinguishing *Erysimum pseudoatticum* from *E. drenowskii*.

Characters	*Erysimum pseudoatticum*	*Erysimum drenowskii*
Sepals	(7 -) 9 - 10.5 × 1-1.7 mm	7 - 8 × 2 - 2.1 mm
Petals	(14 -) 17 - 22 mm	11 - 14 mm
Petal blade	6 - 8 × (3 -) 3.5 - 5 (- 5.5) mm	5 - 5.5 × (3 -) 3.5 - 4.5 (- 5) mm
Siliqua	60-90 mm	30-60 (-70) mm
Style	2 - 2.3 (- 3) mm	1 – 1.5 mm
Seeds	1.3 - 1.7 (- 1.8) mm	0.9 - 1.2 mm
2n	42	14 + 0-2 B

KITANOV 1966: 481). This taxon was indicated for Central and West Stara Planina, Rila, Ali-Botush (Slavjanka Mt.) and Pirin mountains.

ASSENOV (1970) accepted *E. pusillum* subsp. *parnassi* (BOISS. & HELDR.) HAYEK and listed *E. boryanum* var. *atticum* in its synonymy.

E. atticum BOISS. appeared in the literature and remained for long, wrongly indicated for Bulgaria - in reality this species is an endemic diploid species of the flora of Greece (POLATSCHEK 1983: 88; JALAS & SUOMINEN 1994: 61).

From our studies and the references reviewed above it is evident that the perennial caespitose plants occuring in C. & W. Stara Planina, Rila Mt. and W. Rhodope Mts., earlier connected with *E. atticum, E. boryanum, E. pusillum,* or *E. helveticum*, belong to *E. pseudoatticum,* a hexaploid member of the *E. drenowskii* polyploid complex (ANČEV 1995; ANČEV & POLATSCHEK 1998).

The morphology of *E. pseudoatticum* is similar to *E. drenowskii*. Their important differing characters are the height of the stem, size of the petals and sepals, the length of siliqua and style, and the chromosome number (Table 2).

Examined specimens: Stara planina Mt.: SE of vill. Milanovo, ca. 750 m, 2.VIII.1984, M. Ančev A8479 sub *E. sylvestre* [SOM 3551, W 1996-05637] (ANČEV & al. 1987)**. – Near Milanovo, ca. 800 m, 02.VIII.1984, M. Ančev A8482 [Ančev]. – seeds from this collection, cultivated in the Alpine Garden Belvedere Vienna 1996/1997, A. Polatschek, M. Ančev [W 1997-08215]*. – Under Milanovo, ca. 700 m, 21.VI.1997, A. Polatschek [W 1997-08185]*. – Between Pirdop and Anton, ca. 900 m, Gneis, 18.V.2000, A. Polatschek [W 2000-05839]*. – Karnare gegen Trojanski prohod, 1350 m, 25.VI. 1997, A. Polatschek [W1997-08215]*. – Oberhalb Karnare zum Trojan-Pass, Kalk, 29.VI.1988, P. Gutte [LZ]. – Znepole region: Strezimirovtzi, 900 m, Kalk, buschiger Hang mit *Syringa vulgaris* und *Fraxinus ornus*, 18.V.2002, A. Polatschek, M. Ančev [W 2002-13518, Ančev]*. – Rila Mt.: Kobilino branishte, VI.1898, V. Střibrný sub *E. Boryanum* BOISS. [SOA]. – Smradlivo ezero, VII.1921, N. Stojanov sub *E. helveticum* DC. [SOA]. – In m. Rilo, 1915, I. Urumov, [BP 20493]. – In pascuis saxosis Samokovski lag, 950 m, 10.V.1911, B. Davidov & B. Achtarov sub *E. helveticum* DC. [SOM 33299]. – In umbrosis saxosis mt. Malka Rila, Šišman vrah, versus Iskar, 1250 m, 27.VI.1911, B. Davidov & B. Achtarov, sub *E. helveticum* DC. [SOM 33293, 33296]. – In saxosis calcareis mt. Tzarska Rila, Sokolet, 1500 m, 30.V.1911, B. Davidov & B. Achtarov sub *E. helveticum* DC. [SOM 33292]. – Montes Rila, infra opp. Samokov, in valle alpestri Levi Iskar pr. Mala ‹erkva, 20-21.VI.1929, S. Javorka sub *E. helveticum* DC. [BP 454170]. – Rila-Gebirge, oberhalb Levi Iskar, 1200 m, VII. 1988, M. Ančev A86119 [W 1991-0931]. – In rupestribus mt. Bela Rila, Ivanovo ravnište, supra pag. Mala Čerkva, 1400 m, 12.V.1911, B. Davidov & B. Achtarov sub *E. helveticum* DC. var. *comatum* (PANČIĆ) ACHT. [SOM 33348, 33351]. – Sredonos, above Levi Iskar, 6.VI.1936, N.V. Tzar Boris III, sub *E. helveticum* var. *comatum* (PANČIĆ) ACHT. [SOM 33306]. – Džendema, Riletz, 2600 m, 5.VIII.1964, M. Simeonovsky, sub *E. helveticum* DC. [SO 29100]. – Josafitza, limestones, 5.VIII.1964, M. Simeonovsky,

sub *E. helveticum* DC. [SO 29099]. – Mramoretski circus, 2500 m, 10.VII.1990, V. Russakova sub *E. helveticum* DC. [SO 29097, SOM 150516]. – Mramoretski circus, the summit of Mermera, 2600 m, 12.VII.1995, M. Ančev, A95141 [SOM 153563 W 1996-05622] (ANČEV & POLATSCHEK 1998; ANČEV 2001)**. – Along the valley of Levi Iskar, 1200 m, VI. 1994, M. Ančev, A94175 [SOM 3507] (ANČEV & POLATSCHEK 1998; ANČEV 2001)**. – Beli Iskar river valley, 1300 m, 14.VI.1995, M. Ančev A95172 [SOM 3496] (ANČEV 1995; ANČEV & POLATSCHEK 1998)**. – Beli Iskar, 1200 m, 2.VII.1997, A. Polatschek & M. Ančev [SOM 153564, W 1997-08208]*. – The valley of Beli Iskar, 1100 m, 18.VI.1996, M. Ančev [SOM 153565]. – Rhodope Mts.: Trigrad, 18.VII.2002, Zh. Cherneva [SOM 159246]. – Vača valley near Devin, 800-1000 m, 10.VIII.1968, H. Merxmüller & B. Zollitsch [M 24390]. – seeds from this collection cultivated in the Alpine Garden Belvedere Vienna 1972/1974, A. Polatschek [W 1974-19600]*. – Bujnovska Valley, N Trigrad, 1200 m, 13.V.2002, A. Polatschek [W 2002-13522]*. – NW of Smolyan, 7 km NW of Shiroka Laka, 13.V.2002, A. Polatschek & M. Ančev [W 2002-13558]*. n = 21, 2n = 42.

3. *Erysimum slavjankae* ANČEV & POLATSCHEK

Ann. Naturahist. Mus. Wien, B, 100: 729 (1998).
Holotype: Bulgaria, Slavjanka Mt., Tsarev vrah, 2000 m, 13. VI. 1995, M. Ančev A9545 [SOM 3295, isotype: W 1996-05621].
Figures: ANČEV & POLATSCHEK 1998: 731.

= *E. slavjankae* ANČEV, Giorn. Bot. It. 129 (1): 96 (1995), nom. prov.

= *E. helveticum* p. p., auct. bulg. non (JACQ.) DC.

Densely caespitose, green, perennial with few flowering shoots. Root branched, 70 - 120 mm long, without runners. Stems (2-) 5 - 12 (- 20), ascending to erect, (5 -) 10 - 18 (- 20) cm in flowering, slightly elongated during fruiting, rounded angular, 1,5 - 3 mm thick, simple; withered past year stems present at anthesis; the tunic very dense, present at anthesis, formed by the broad leaf bases. Basal leaves linear oblanceolate, narrowly spathulate, (30 -) 40 - 50 (- 65) × 2 - 5 mm, pubescent, sometimes slightly succulent, acute, petiolate, gradually narrowed into sometimes pale liliac petioles; margins without or with 1 - 2 (- 3) pairs of minute teeth. Cauline leaves 7 - 10, without leaf fascicles in the axils, linear to linear oblanceolate, pubescent, 25 - 50 (- 60) × (1 -) 2 - 3 (- 4) mm, acute, entire, shortly petiolate to almost sessile. Inflorescence a short simple apical raceme with up to 12 (- 15) flowers, slightly elongating during fruit development. Flowers balmy fragrant, protogynous. Flower pedicels (1-) 3 - 5 mm, fruit pedicels 3.5 - 6 mm, pubescent; pedicel diameter about 2/3 of the siliqua diameter. Sepals ovate to lanceolate, pubescent on outer surface, 10 - 13 × (1.5 -) 2 -2.7 mm, the lateral saccate, in flower buds liliac on the tips. Petals dark yellow, spathulate, (16 -) 18 - 22 mm, the blade 7 - 8 × (4 -) 5 - 7 mm, glabrous. Stamens glabrous, anthers pale yellow; lateral and median nectaries well developed. Siliquae 55 - 70 mm long, 1.7 - 2 mm thick, 4-angled in cross-section, grey-greenish, densely covered with bifid hairs; edges pubescent, slightly liliac, covered with scattered hairs. Angle between the axis and the pedicel 40° - 60°; siliqua diverging at 20° - 40°. Style 3 - 4 mm, cleary set up on the siliqua, with 2-fid and 3-fid hairs; stigma deeply retuse. Seeds 1.7 - 2 (- 2.2) × 1.3 - 1.7 mm, elliptical, pale brown - yellowish. Pollen grains: P = 30.0 - 35.0 µm, E = 25.0 - 28.7 µm. 2n = 84 + 0-2 B; x = 7 (ANČEV & POLATSCHEK 1998).

Distribution and ecology

In the coniferous and subalpine forest belt of Slavjanka and Pirin Mts. (Orelek and Baba), from 1800 up to 2200 m a.s.l. (Fig. 4). Endemic (It could possibly occur in North Greece in Sarlinga or Falakron mountains.)

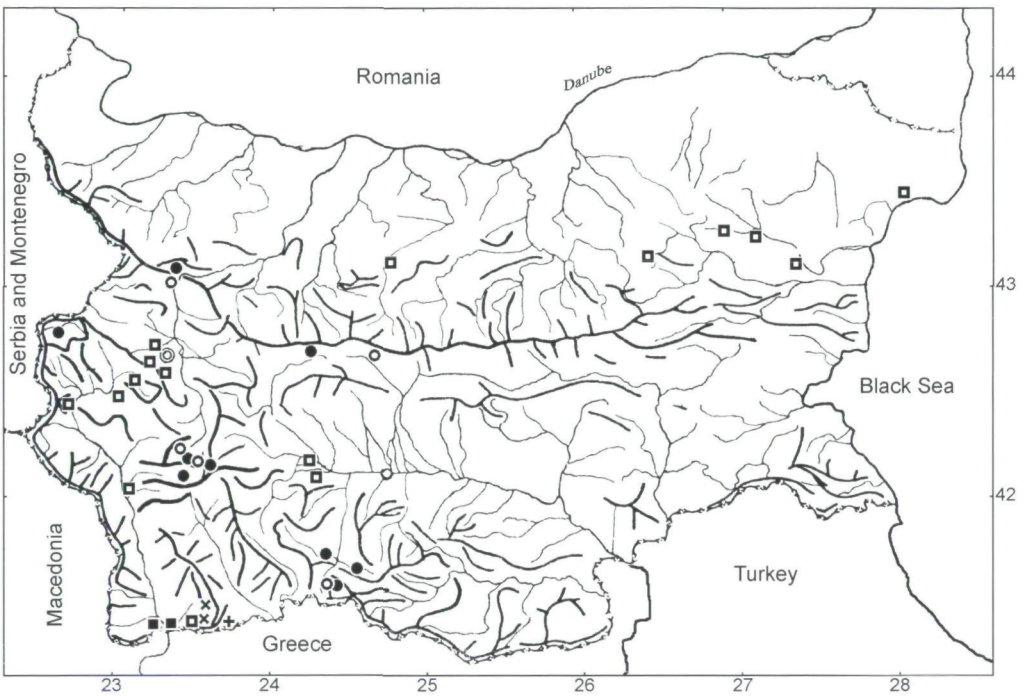

Fig. 4: Distribution of *Erysimum* in Bulgaria: *E. pseudoatticum*, ○ herbarium specimens; ● populations studied for chromosome number 2n = 42. *E. repandum*, □ herbarium specimens, ■ populations studied for chromosome number 2n = 16. *E. slavjankae*, ✚ herbarium specimens, ✕ populations studied for chromosome number 2n = 84 + 0-2 B.

On rocky and gravely marble terrains on open mountain slopes, grasslands and pastures, along edges of *Pinus heldreichii* forests, usually on slightly developed humus-carbonic soils. Above the timberline in plant communities of *Juniperus communis* subsp. *alpina*, *Chamaecytisus absinthioides*, *Peridiction sanctum* (= *Festucopsis sancta*), *Paronychia kapela*, *Iberis saxatilis* subsp. *saxatilis*, *Centaurea parilica*, on limestone rocky terrains together with *Saxifraga sempervivum*, *Androsacae villosa*, *Alyssum montanum* subsp. *ali-botushicum*, *Campanula orphanidea*.

Flowering June to July (- early August).

Note: Probably one of the first collections of *E. slavjankae* was that of N. Stojanov in Slavjanka Mt., identified as "*E. helveticum* DC": Ali-Botush,Tsarev vrah, 23.VI.1923 [SOA 4705]. Later "*E. helveticum* DC." has been reported for Rila, Pirin, Stara Planina (STOJANOV & STEFANOV 1924: 522) and Slavjanka (STOJANOV & STEFANOV 1933: 476). *E. helveticum* turned to be a rather confusing name, and caespitose perennial plants which belong to *E. slavjankae, E. drenowskii* or *E. pseudoatticum,* collected by different botanists at different time in the high mountains of Central & SW Bulgaria, were treated as "*E. helveticum*". *E. slavjankae* is densely caespitose plant with low stems and large, morphologically protogynous, balmy fragrant flowers. The species is dodekaploid and is morphologically well distinguished from both perennial *E. drenowskii* (2n = 14) and *E. pseudoatticum* (2n = 42). (Table 3).

Table 3: Characteristics distinguishing *Erysimum slavjankae* from *E. drenowskii*.

Characteristics	*Erysimum slavjankae*	*Erysimum drenowskii*
Habit	densely caespitose	loosely caespitose
Sepals	10-13 × (1.5 -) 2.5-2.7 mm	7 - 8 × 2 - 2.1 mm
Petals	(16) 18-22 mm	11 - 14 mm
Blade	7 - 8 × (4 -) 5 - 7 mm	5-5.5 × 4-4.5 mm
Siliqua	55 - 70 mm	30 - 60 (- 70) mm
Style	3 - 4 mm	1 - 1.5 mm
Stigma	deeply retuse	retuse
Seeds	1.7 - 2 (- 2.2) mm	0.9 -1.2 mm
2n	84 + 0-2 B	14

Examined specimens: Slavjanka Mt. (= Ali-Botush): In pascuis saxosis calcareis mt. Ali Botush, 1800 m, 2.VII.1932, B. Achtaroff, sub *E. helveticum* DC. [SOM 33355]. – Tzarev vrah, 23.VI.1923, N. Stojanov, sub *E. helveticum* DC. [SOA 4705]. – Ali Botusch-Gebirge: Gipfel des Tzarew, 2000 m, 9.VII.1961, J. Bisse & U. Schneider [JE 693]. – Gotzev vrah, 2200 m, 19.V.1994, D. Stojanov, sub *E. helveticum* (JACQ.) DC. [SO 92399]. – Near Tzarev vrah, ca. 2000 m, 18.X.1994, M. Ančev A94190 [SOM 153558, W 1996-05623], 2n = 84 + 0-2 B (ANČEV 1995, ANČEV & POLATSCHEK 1997)*, **. – Above G. Kojnarnik, 1850 m, 3.VI.1995, M. Ančev [SOM 153559]. – Ambar-dere, on rocky slope, 1700 m, 20.VII.1991, I. Pashaliev, sub *E. helveticum* DC. [SOM 151522]. – Goljam Tzarev vrah, rocki glades, 2180 m, 17.VI.2004, P. Stanimirova, det. M. Ančev [SOM 160597]. –Pirin Mt.: Baba, 1950 m, 9.VI.1988, D. Stojanov, sub *E. comatum* Pančić [SOM 147145, SO 94061]. – Orelek, 2000 m, 12.VIII.1995, V. Goranova & M. Ančev A95192 [SOM 15357]**. – seeds of this collection, cult. Alpengarten Belvedere, 1996/97, A. Polatschek [1997-08194]. – Near Orelek, 1980 m, 30.VI.1997, A. Polatschek & M. Ančev [SOM 153560, W 1997-08205], (ANČEV & POLATSCHEK 1998; ANČEV 2001)*, **.

4. *E. comatum* PANČIČ

Fl. Princ. Serb. (1874) 131; ASSENOV, Fl. R. P. Bulg. 4 (1970) 352; BALL, Fl. Eur. ed. 2, 1 (1993) 331; JALAS & SUOMINEN, Atlas. Fl. Eur. 10 (1994) 63. – Fig. 5.

≡ *E. helveticum* var. *comatum* (PANČIČ) ACHT., in STOJ. & STEF., Fl. Bulg. izd. 3 (1948) 523.

Lectotype (POLATSCHEK & SNOGERUP 2002: 151): [Serbia] "in rupestribus m. Malinik, Serb. austr.", Mai, Jun. 1872, Pančič s. n. [GOET - Herb. Grisebachianum].

Biennial, usually one-stemmed, 7 - 25 (- 35) cm tall in flower, up to 60 cm in fruit. Stem erect from a swollen and more or less woody base, simple; at the base first year's leaf rosette partly withered before anthesis, and the aggregated broad leaf bases form dense conspicuous tunic. Leaves 20 - 80 × 1 - 4 (- 8) mm, first basal ones petiolate, following ones sessile, entire or sometimes with 1 - 3 pairs of very small teeth, acute or the basal ones obtuse, all with 2-fid and very few 3-fid hairs. Inflorescence occupying 1/3 - 2/3 of the stem, simple or with 1 - 3 (- 6) branches, moderately elongating in fruit, raceme 10 - 30 (- 35) flowered. Flowers yellow, strongly fragrant. Flowering pedicels 2.5 - 3.5 mm, fruiting pedicels 4 - 7 (- 8.5) mm, almost as thick as the siliqua. Sepals 7 - 8 (- 10) × (1.2 -) 1.4 - 2 (- 2.2) mm, narrowly ovate-lanceolate, with dense 2-fid and few 3-fid hairs. Petals (16 -) 18 - 25 mm, spathulate, pubescent outside with 2-fid and very few 3-fid hairs, in high altitude specimens glabrous. Stamens glabrous, anthers yellow. Siliquae (60 -) 70 - 100 mm, patent, 4-angled in cross-section, grey to silvery greenish, densely covered with bifid hairs; edges pubescent, with scattered hairs; the angle

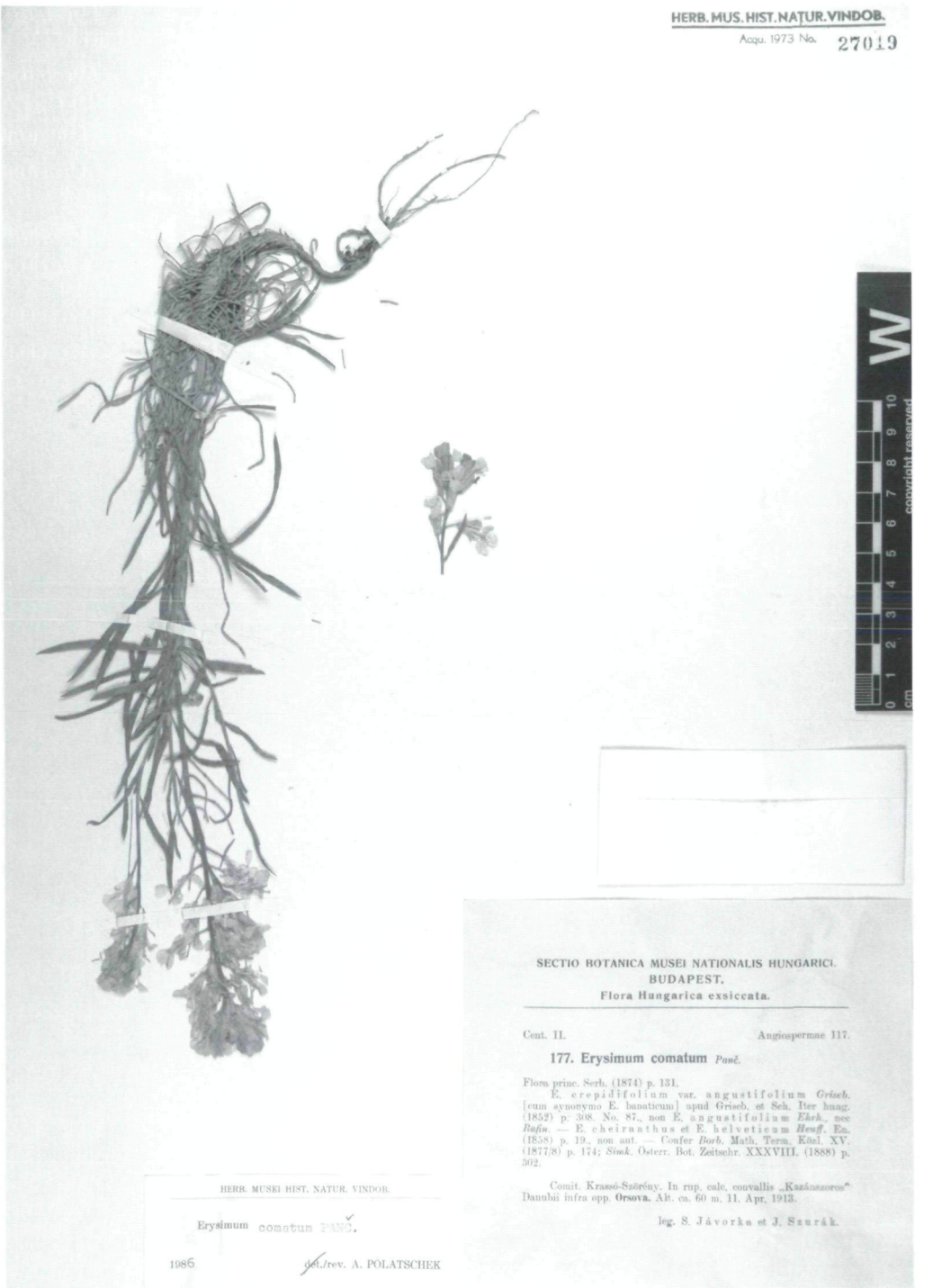

Fig. 5: *Erysimum comatum*, characteristic specimen from Romania [W 1973-27019].

between the axis of the raceme and the pedicel c. 30°, siliqua diverging at 40° - 50°, often arcuate; style (1 -) 1,3 - 2 mm; stigma capitate, slightly retuse. Seeds 1.3 - 1.5 (- 2.5) × 0.6 - 0.7 (- 1) mm, oblong ellipsoid light brown to brown. Pollen grains: P = 22.8 - 23.6 µm, E = 19.5 - 20.5 µm. 2n = 14 + 0-2 B; x = 7.

Distribution and ecology

Balkan foothill region (Vrachanska Planina Mt.), Znepole region (Dragomanski Chepan, Strazha, Paramunska Planina, Konjavska Planina), Slavjanka, from 450 up to 1750 m (Fig. 10). SE Europe: Balkan peninsula (without Albania and European Turkey), Romania.

On open limestone slopes and stony grasslands facing south, in foothills and mountains, on shallow and erosive humus-carbonate soils. It occurs in individual formations from the oak up to the coniferous belt and often together with *Aurinia saxatilis*, *Scutellaria orientalis*, *Micromeria cristata*, *Stipa pennata*, sometimes with typical calciphylous plants like *Asplenium rutamuraria* and *Campanula versicolor*.

Flowering: May - June (late July).

Examined specimens: Balkan foothill region: Vrachanska Planina, cretaceous rocks near Vratsa, V.1915, Stojanov & Stefanov [K]. – In fissuris rupium calcareum prope Vratsa, 10.V.1907, Urumov [BR 93]. – Vrachanska Mt., Vratzata, 520 m, 4.X.1989, M. Ančev, A89136 [SOM 3102], (Ančev 2001)**. – NW Vratza, Vratzata, limestone rocks, 17.V.2002, A. Polatschek & M. Ančev [W 2002-13524]. – Vratzata, 11.V.1986, M. Ančev [W 1996-5628]*. – Vrachanska Mt., Beglicka mogile-Gipfel, 25.VI.1995, D. Uzunov & M. Ančev [W 1996-5629]. – Vrachanska Mt., grassy places on the river bed of Leva reka east of Vratzata, 17.V.2002, M. Ančev & A. Polatschek [SOM 158397]. – The locality Vratzata, south of Vratza, 7.V.1976, J. Cherneva [SOM 132939]. – Znepole region: In saxosis aridis calcareis ad Ćarčalat prope Tran, 27.5.1906, I. Urumov [SOM 33302]. – Konjovska planina, Risa Mt., Shegava-Valley, 650 m, 21.V.2005, A. Polatschek [W 2005-10373]. – Konjavska Mt., the locality Shegava, 600 m, 19.VII.1985, M. Ančev A85103 [SOM 2641], (Ančev & al. 1987, Ančev 1995)**. – Slavjanka Mt.: Ambar dere, near vill. Paril, 1450 m, 27.IV.1990, I. Pashaliev [SOM 151521]. – Pirin planina, Slavjanka Mt., 1600 m, 13.VI.1995, M. Ančev A9533 [W 1996-5620]*. – Parilski dol, 1400 m, 29.VI.1980, B. Kuzmanov, det. M. Ančev [SOM 145245]. – The locality G. Kojnarnik, 1500 m, 3.VIII.1994, M. Ančev A94130 [Ančev], 2n = 14 + 0-2 B (Ančev 1995)**. – Zarev vrah, 1450-1800 m, 1.VII.1997, A. Polatschek [W 1997-8206]*.

5. *Erysimum pirinicum* Ančev & Polatschek

Ann. Naturhist. Mus. Wien, B, 100: 729 (1998). – Fig. 6.
Holotype: Bulgaria, Central Pirin Mt., on southeastern slopes of mount Orelek, at 1800 m a.s.l., 17.X.1994, M. Ančev A94183, [SOM 3296, isotype: W 1996-05640].
Figures: Ančev & Polatschek 1998: 734.

= *E. pirinicum*, Ančev, Giorn. Bot. It. 129 (1): 98 (1995), nom. prov.

= *E. comatum* auct. bulg. p. p. min., non Pančič.

Biennial, grey-green with 2-fid hairs, 3-fid hairs scattered on the lower surface of the leaves and on the style. Root 7-15 cm, tappering to fusiform, slightly branched, with filiform secondary roots. Stem simple or caudex branched, with 1 - 3 (- 5) erect stems, 20 - 45 (- 55) cm high in flowering, slightly elongating during fruiting, rounded angular to almost cylindrical, 1.5 - 3 mm thick near the base; the tunic with few petiole remains. Leaves oblanceolate, (25 -) 30 - 83 × 1 - 3.5 (- 6) mm, almost of the same size along the stem, pubescent, acute, the basal distinctly petiolate, the cauline shortly petiolate to sessile with fascicles of small leaves in the axils; the leaf margin distinctly denticulate with

Fig. 6: *Erysimum pirinicum*, characteristic specimen from Bulgaria. Note the rich additional branching of the biennial species. Enlarged the leaf to show the small dents [W 1997-08197].

Table 4: Characters distinguishing *Erysimum pirinicum* from *E. comatum.*

Characteristics	*Erysimum pirinicum*	*Erysimum comatum*
Sepals	6 - 8.5 × 1 - 1.8 mm	7 - 8 × 2 - 2.2 mm
Petals	11 - 15.5 (- 17) mm	(16 -) 18 - 25 mm
Blade	6 - 7.5 × 4 - 6.5 mm	6 - 6.5 × 5 mm
Siliqua	(30 -) 37 - 55 mm	(60 -) 70 - 100 mm
2n	28	14

small distant teeth. Inflorescence a simple raceme or above the middle with 2 - 6 (- 8) short lateral branches. Flowers yellow, few to numerous, slightly fragrant. Flower pedicels 2 - 3 (- 4) mm, fruit pedicels (2 -) 3.5 - 5 mm, pubescent. Sepals ovate-oblanceolate, pubescent on outer surface, 6 - 8.5 × 1 - 1.8, the lateral shallowly saccate. Petals cuneate, 11 - 15.5 (- 17) mm, blade 6 - 7.5 × 4 - 6.5 mm. Stamens glabrous, anthers pale yellow. Siliquae 30 - 37 (- 55) mm long, 1.5 - 1.8 mm thick, in cross-section tetrangular, grey - whitish, densely covered with bifid hairs, edges pubescent. Angle between the axis and the pedicel 40°-60°; siliqua diverging at 30° - 50°. Style (1 -) 1.7 - 2.3 mm, as thick as the siliqua, with 2-fid and few 3-fid; stigma capitate, retuse. Seeds (0.9) 1 - 1.2 × 0.6 - 0.7 mm, elliptical, pale brown-yellowish. Pollen grains: P = 21. 20 - 25.0 µm, E = 16.26 - 18.75 µm. 2n = 28; x =7 (ANČEV 1995).

Distribution and ecology

Occurs in the coniferous vegetation belt of Pirin Mt. (from Popski preslap to the area of mounts Orelek and Baba), and Slavjanka (Chengene-Kulen), from 1300 up to 2000 m a.s.l. (Fig. 7). Balkan Peninsula: NE Greece: Mt. Kozuf, Mt. Menikion, S Polytamos.

On open stony and gravely terrains, in mountain grasslands often in spots of burned-out Juniperous shrubs, on slopes with screes and embankments along mountain roads, sometimes with *Arabis sagittata*, *Cerastium alpinum* subsp. *lanata*, *Onobrychis montana* subsp. *scardica*, *Polygala comosa*, *Campanula patula* subsp. *epigea*, *Achillea millefolium*, *Erigeron alpinus* etc.

Flowering (late May -) June to July.

Note: *E. pirinicum* is a polyploid species, morphologically close to the diploid *E. comatum. E. pirinicum* easily differs from *E. comatum* by the smaller flowers, often branched raceme and shorter siliquas (Tab. 4).

The tetraploid plants (2n = 28) occuring in N. Pirin Mt. in the area of Djamdjievi skali and circus Dolen Kazan are morphologically more or less close to the diploid *E. drenowskii*. Here included in *E. pirinicum* they deserve additional studies (note by M. Ančev).

Examined specimens: **Bulgaria**. Pirin Mt.: Kamkatin Poljana, 2000-2400 m, 20.VII.1938, J. Ujhelji, sub *E. pusillum* var. *atticum* [BP]. – N Pirin planina, E und W Popovi Livadi-Pass, 1350 m, 19.V.2005, A. Polatschek [W 2005-10380]*. – Pass Popovi gegen Livadi, 1320 m und den Orelek-Gipfel-W-Hang, 1700 m, 29.VII.1993, H. Kalheber, sub *E. comatum* [M 93-1479]. – SE of Orelek, 1800 m, 17.X.1994, M. Ančev [SOM 153561]. – Glades south of Orelek, 1700 m, 12.VIII.1995, V. Goranova & M. Ančev [SOM 153562]. – Südteil des Pirin, zwischen dem Pass von Popovi Livadi, 1320 m, und dem Gipfel des Orelek, 2099 m, W-Hang, 1700 m, 29.VII.1993, H. Kalheber, as *E. comatum* Pančič [M]. – Southeast of Orelek, 1800 m, 17.X.1994, M. Ančev [SOM 153563] (ANČEV & al. 1987 sub *E. drenowskii*; ANČEV 1995; ANČEV & POLATSCHEK 1998)**. – Auffahrt zum Orelek, 1750-1850 m, 30.VI.1997, A. Polatschek [W 1997-08202]*.

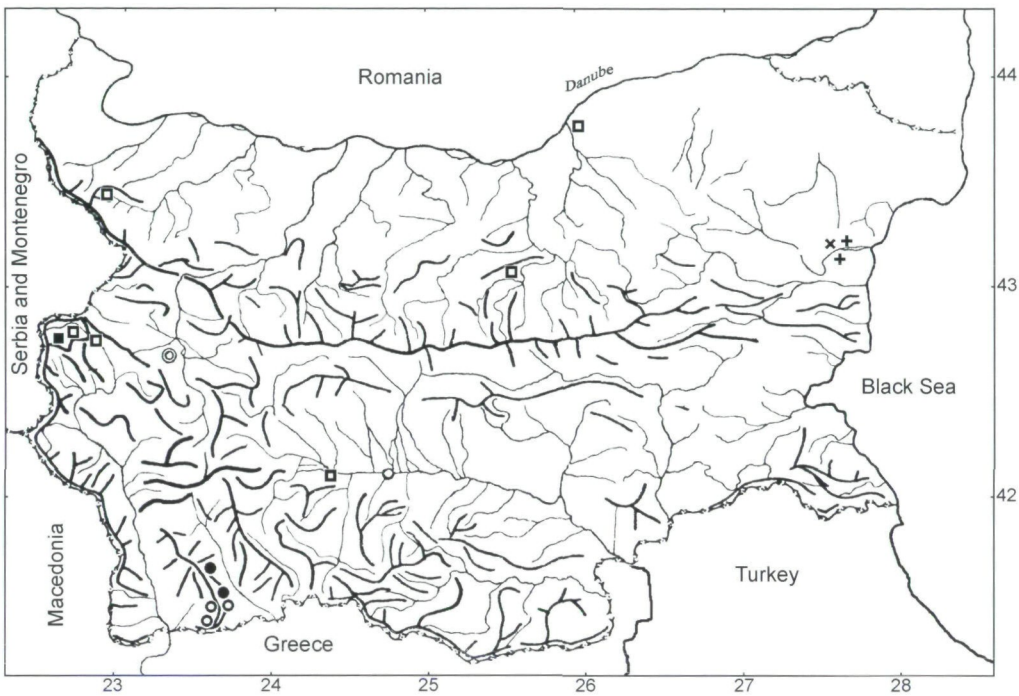

Fig. 7: Distribution of *Erysimum* in Bulgaria: *E. odoratum*, □ herbarium specimens; ■ population studied for chromosome number 2n = 32. *E. pirinicum*, ○ herbarium specimens, ● populations studied for chromosome number 2n = 28. *E. quadrangulum*, ✚ herbarium specimens; ✖ populations studied for chromosome number 2n = 28.

– Popski preslap, 1350 m, 3.VII.1988, M. Ančev A88190 [SOM 3498] (ANČEV 2001)**. – South of Orelek, 1850 m, 18.VI.2004, V. Goranova, M. Ančev [SOM 153562]. – Banderitsa house to Dzamdzievi skali, 1900-2000, 29.VI.1997, A. Polatschek [W 1997-08222]*. – Banderitsa house to Dolen Kazan, 1900-2000 m, 28.6.1997, A. Polatschek [W 1997-08211]*.

6 - 8. *Erysimum diffusum* group

Biennials with bifid hairs, single 3-fid hairs only on the leaf tip and style. Stems (20 -) 30 - 120 cm. Leaves entire to sinuate dentate. Inflorescence simple raceme or with 2 - 4 side branches. Flowers numerous, without scent; sepals 4.5 - 9 mm, petals 8 - 15 mm, with long claw. Style 0.5 - 2 mm.

6. *Erysimum diffusum* EHRH.

Beitr. Naturk. VII (1792) 157; HAYEK, Prodr. Fl. Penins. Balc. 1: 388 p. p. (1925); BALL, Fl. Eur. ed. 2, 1: 333 (1993); JALAS & SUOMINEN, Atlas Fl. Eur. 10: 68 (1994); ASSENOV, Fl. R. P. Bulg. 4: 357 (1970).

Lectotype (POLATSCHEK 1974): Ehrhart's Plantae selectae Europaeum nr. 8, 1792-93 [M, Isotypes: GOET, WU].

= *E. canescens* ROTH, Catal. Bot. 1: 76 (1797); VELEN., Fl. Bulg.: 32 (1891) et Suppl. I: 20 (1898).

Lectotype (hic designatus): E. canescens Roth nov. Plant. Spec., ab auctore ipso col. 1796, ex Herb. G.F. Meyer [GOET].

= *E. crepidifolium* auct. bulg., non REICHENB.

= *E. australe* auct. balcan., non GAY

Biennial, grey-green with 2-fid hairs, 3-fid hairs scattered on the lower surface of the leaves. Root 7-16 (- 18) cm, slightly branched, with filiform secondary roots. Stem simple, ascending to erect, 40 - 60 (- 75) cm high in flowering, elongating up to 120 cm during fruiting, rounded angular, 1 - 2 mm thick, with few petiole remains at the base. Leaves entire, sometimes with 1 - 2 pairs of very short distant teeth, lanceolate to narrow linear, 18 - 90 × 2 - 3.5 (- 7) mm, almost of the same size along the stem, pubescent, acute, the basal distinctly petiolate, middle and upper ones almost sessile, with fascicles of small leaves in the axils; Inflorescence branched in the upper third with (1) 3 - 6 ascending branches, conspicuously elongating in fruit. Flowers pale yellow, not fragrant; pedicels 2 - 4.5 (- 5) mm. Sepals 5.5 - 7 × 1.3 - 1.6 mm, ovate lanceolate with dense bifid, few 3-fid and very few 4-fid hairs. Petals 8 - 10 (-12) × 2.5 - 4.5 mm, cuneate, sparcely pubescent outside. Anthers pale yellow; filaments with few bifid hairs. Siliquae 30 - 55 (- 70) × 0.7 (- 1) mm, 4-angled in crossection; pedicel 5 - 6 (- 8) m, almost as thick as the siliquae, with dense bifid hairs. Angle between the axis of the raceme and the pedicel 30° - 50°; style 1 (- 1.5) mm. Seeds (0.8-) 0.9 - 1.2 × 0.6 - 0.7 mm. Pollen grains: P = 21.3 - 22,0 µm E = 16.8 - 17.7 µm. 2n = 28. x = 7.

Distribution and ecology

In scattered localities along the Black Sea Coast, in NE Bulgaria, Danube plane, Balkan foothill region, Stara Planina, Sofia region, Znepole region, Vitocha region, West Frontier mountains, Struma valley, Slavjanka Mt., Pirin Mt., Rila Mt., Sredna Gora Mt., Rhodope Mts., Thracian plane, Tundža hilly plane, Strandža Mt., from the sea level up to 900 (1350) m (Fig. 8). Central (scattered), E & SE Europe.

Dry, usually eroded limestone substrates, rarely on silicate stony and rocky terrains, more often in the oak belt, in xerophilous plant communities dominated by *Quercus pubescens*, *Carpinus orientalis*, *Paliurus spina-christi*, *Fraxinus ornus*, planes, foothills and mountains.

Flowering: (late April -) May to June.

Examined specimens: Black Sea coast: Near the vill. Balgarevo, 14.VI.1999, Ant. Petrova [SOM 158910]. – Varna, 16.V.1997, M. Ančev A975 [Ančev], (ANČEV & al. 1987)**. – NE Bulgaria: Pastures near vill. Nikolaevka, Varna distr., 15.VII.2004, Ant. Petrova [SOM 161233]. – The locality Markova mogila, northward of Cherven brjag, 400 m, 30.VII.1982, M. Ančev A8252 [SOM 3574], (ANČEV 2001)**. – N Mezdra, Varbeshnitsa river, 16.V.2002, A. Polatschek [W 2002-13556]*. – Danube plane: Ad Pleven, 1924, I. Urumov [BP 108]. – Balkan foothill region: Village Glavatzi, near to Vratza, 350 m, 14.VII.1986, M. Ančev A86155 [SOM 3271], (ANČEV 1995)**. – Vratza distr., Mezdra am Iskar, Varbeshnitza, VI.1928, J. Hruby 2168 [BRNU 2184, H]. – Stara planina Mt.: In fauce fluvii Iskar prope Lakatnik, 29.VII.1930, K.H. Rechinger 1699 [W 2006-00519]. – N Sofia, in collinis prope Svoge, 3.V.1902, I. Urumov [BP 587]. – Mezdra am Iskar, Vurbesnica, 1928, Hruby 2184 [H]. – N Sofia, S Svoge, 1890, I. Urumov [PR]. – Iskar Valley, gorge N Svoge, Gara Bov, 16.V.2002, A. Polatschek [W 2002-13557]*. – Prope Sliven, ad Sotirja; Porphyr, 25.VII.1907, C. Schneider 677 [W 1907-20900]. – Vitosha Mt.: In pascuis Mt. Plana planina, Prodanovski Rid, 1200 m, 6.V.1909, B. Davidoff [SOM 33225]. – Lozenska planina, pastures on the south slopes, VII.1959, I.G Ančev [SOM 162328]. – Znepole region:On the gravelly slopes above vill. Trun, 1050 m, 22.VII.1998, leg. D. Dimitrova, det. M. Ančev [SOM 153842]. – Roadside in Erma gorge, 700 m,

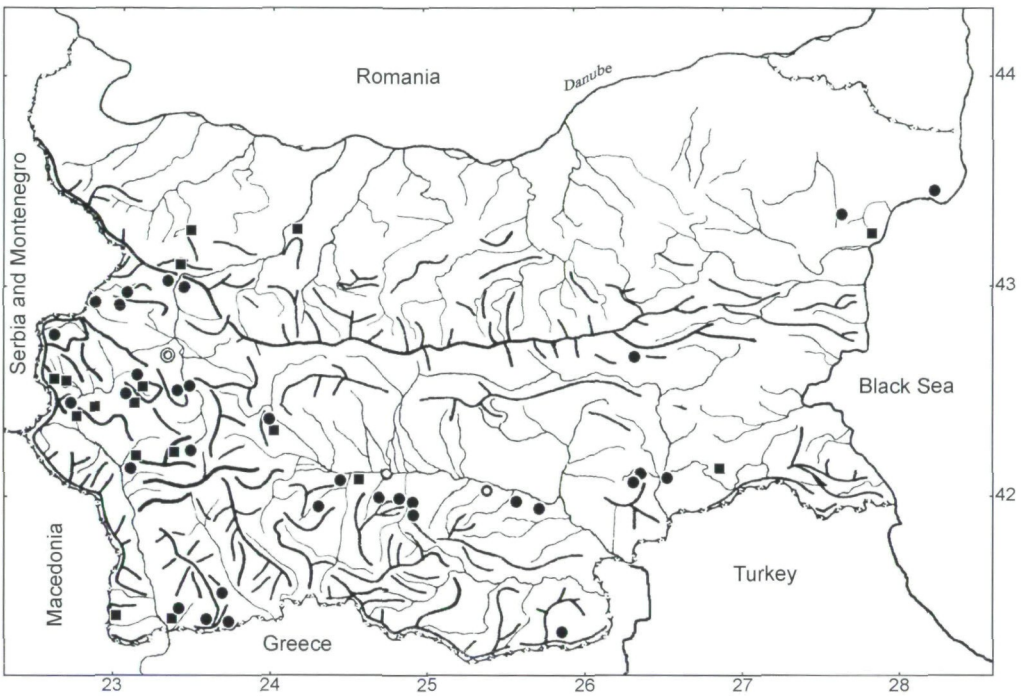

Fig. 8: Distribution of *Erysimum diffusum* in Bulgaria: ● examined herbarium specimens; ⊙ doubtful reference data; ■ populations studied for chromosome number 2n = 28.

29.VI.1998, V. Goranova, det. M. Ančev [SOM 154033]. – In pascuis inter dumetis mt. Golo Bardo ad hizha Golo Bardo, ca. 900 m, 14.V.1937, B. Achtarov [SOM 33176]. – Golo bardo, 700 m, 12.VIII.1984, M. Ančev A8491 [SOM 2659], (ANČEV 2001)**. – In pascuis saxosis calcareis mt. Rudina prope Trekljano, 26.V.1939, B. Achtarov [SOM 33200]. – In graminosis siccis intar pag. Dragoman et Tzaribrod, 18.VI.1907, I. Urumov [SOM 33184]. – NW Sofia, NE Dragoman, 18.V.2002, A. Polatschek [W 2002-13555]. – Dragoman, Mont. Golem Cepan, 31.VII.1930, K.H. Rechinger 1811 [W 2006-00520]. – In graminosis ad Zemen, distr. Kjustendil, 25.VI.1910, I. Urumov [SOM 33186]. – The village Zlogosh, 750 m, 7.V.1997, M. Ančev A9711 [Ančev], (ANČEV & al. 1987)**. – Konjavska Mt., Shegava, 750 m, 17.VII.1985, M. Ančev A85105 [Ančev], (ANČEV & al. 1987)**. – West frontier Mts., Ograzhden Mt., 900 m, 30.VII.1977, M. Ančev A7123 [Ančev], (ANČEV & al. 1987)**. – Struma valley: Südliches Struma-Tal, zwischen Melnik und Lozanica, 22.V.1974, H. Manitz & R. Marstaller [JE]. – Malak Kozhuh Mt., 30.VII.1977, M. Ančev A7130 [Ančev]. – town Kula, 24.VII.1983, M. Ančev A83122 [SOM 2665], (ANČEV, 2001)**. – Vill. Chuchuligovo, M. Ančev, A87120 [SOM 84120], (ANČEV, 2001)**. – Slavjanka Mt.: Parilski dol, 1300 m, 29.VI.1980, B. Kuzmanov, M. Ančev [SOM 145088]. – Pirin Mt.: In saxis silicosis ad pag. Toshevo, prope Nevrokop, 1000 m, 20.VII.1933, B. Achtarov [SOM 33183]. – Melnik, zwischen Melnik und Rozen Kloster, 13.VI.1971, F. & J. Meyer 10239 [JE]. – Rila Mt.: In collibus apricis, supra riv. Vlashka reka, 800 m, 10.VIII.1912, B. Davidov [SOM 33165]. – In arenosis fluviatilis agri Samokovensii, "Lago" ad urbem Samokov, 930 m, 1.VI.1911, B. Davidoff [SOM 33218]. – Oberhalb Rila gegen Rila Monaster, 750 m, 27.VI.1977, A. Polatschek [W 1997-8219]. – Zwischen Kostenets und Belovo, nahe Bahnhof Sestrimo, ca. 400 m, 11.V.1978, G. & M.A. Fischer [W 1979-16321]*. – Above Rila near Rila Monastir, 700 m, 27.VI.1997, A. Polatschek [W 1997-8220]*. – Rhodope Mts.: Assenovgrad, zwischen der Hütte Momina Salza und Kloster Bachkovo, 11.V.1980, P. Gutte 31723 [LZ]. – Entre Bachkovo et Assenovgrad, ca. 300 m, 12.VI.1973, H. Burdet & A. Charpin 10099 [G]. – Zwischen Bachkovo und Lukovice, 8.V.1974, R. Marstaller [JE]. – Supra monasterium Bachovski, distr. Plovdiv, 350-400 m, 12.VI.1973, W. Greuter 11169 [W 1974-10806]. – SSW Pestera, Kupena Reservat, 1000-1100

m, 13.V.1978, G. & M.A. Fischer [W 1979-16324]. – Plovdiv: ad p. Hisar, I. Urumov 100 [BP]. – Distr. Plovdiv, supra monasterium Bačkovski, 350-400 m, 12.VI.1973, W. Greuter 11169 [W 1974-806]. – Assenovgrad, zwischen Caja-Tal und Koru-dere, 9.VI.1971, F. & J. Meyer 10098 [JE]. – Assenovgrad, Koru-dere unterhalb der Abzweigung zur Hütte Bezovo, 28.VI.1972, R. Marstaller [JE]. – An Sufandere, 17.VII.1912, I. Urumov [SOM 33124]. – Near Bachkovo, 14.VI.1985, R. Hardalova, M. Ančev [SOM 144978]. – Bačkovo, beim Gebeinhaus, 10.VII.1970, F. Krendl [W 1974-7500]*. – Grassy places near Chernichevo, south of Kardzhali, 21.V.1995, Ant. Petrova [SOM 155694]. – In collibus apricis ad Sufandere, 15.7.1912, I. Urumov 136 [BP]. – In collibus prope Kričim, 20.VI.1917, I. Urumov 579 [BP]. – 5 km S Kričim, Vača valley, 11.V.2002, A. Polatschek [W 2002-13521]*. – Vill. Skrebatno, 1200 m, 5.X.1984, M. Ančev A84113 [Ančev]. – Jundola, 1350 m, 6.X.1984, M. Ančev, A84121 [Ančev], (ANČEV & al. 1987)**. – 5 km S Kričim, Vača valley, 11.V.2002, A. Polatschek [W 2002-13521]*. – Thracian plane: Inter Haskovo et Harmanli, 18.IV.1961, K.H. Rechinger 21775 [W 1996-6355]. – In saxosis ad cacum. Aida, distr. Haskovo, 1.V.1979, Zh. Cherneva, P. Gerginov [SOM 139921, W 1980-12808]. – Zwischen Popovica und Dimitrovgrad, 28.V.1966, F. Sorger [W 1996-5630]. – Tundzha hilly plane, 8 km NNE Topolovgrad, 11.VI.1998, D. Uzunov & E. Vitek 98-890 [W 2004-17761]. – Road from Elhovo to Topolovgrad, 3 km W Knyazhevo, 200 m, 11.VI.1998, D. Uzunov & E. Vitek 98-916 [W 2004-17762]. – Rumelia orientalis, Kavakly (Topolovgrad), 1900, J. Podpera [BRNU]. – Strandža Mt., road from Sredets to Bolyarovo, W crossroad to Kirovo and Valchanovo, c. 380 m, 11.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-886 [W 2003-8711]*.

7. *Erysimum crassistylum* C. PRESL

Fl. Sicula 1: 77 (1826).
Lectotype (POLATSCHEK 1974): [S Italy] "in apricis siccis collibus prope Messinam versus Tauromenium in Calabria", 2 Jul. 1817, Berger s.n. [PRC].

= *E. moesiacum* VELEN., Fl. Bulg. Suppl. I: 21 (1898); JALAS & SUOMINEN, Atlas Fl. Eur. 10: 71 (1994).

≡ *E. canescens* var. *moesiacum* (VELEN.) STOJ. & STEF., Fl. Bulg. ed. 1, 1: 523 (1924); ASSENOV, Fl. R. P. Bulg. 4: 358 (1970).
Lectotype (hic designatus): Bulgaria: ad Philippolin [= Sliven] in collibus, 1893, J. Velenovský [PRC].

= *E. diffusum* var. *australe* sensu HAYEK, Prodr. Fl. Penins. Balc. 1: 380 (1925), non *E. australe* GAY.

Biennial with 1 - 4 (- 7) stems, (20 -) 30 - 70 cm tall in flower, up to 85 cm in fruit. Basal rosettes of leaves usually withered before anthesis. Stem simple, with usually 10 - 20 leaves, the lower often withered at end of anthesis; basal tunic absent or of withered leaf bases only, leafy shoots present in the leaf axils of the lower 1/3, stem terrete, with dense bifid hairs only. Leaves 10 - 60 (- 100) × 1 - 3 (- 5) mm, lowest ones petiolate, very narrowly oblanceolate to linear, rarely with few small teeth, upper linear, entire, all sparsely pubescent with bifid and few 3- to 4-fid hairs. Inflorescence usually occupying 1/3 - 1/2 of the stem, simple or with up to six erecto-patent branches, conspicuously elongating in fruit, main raceme 10 - 20 (- 50)-flowered, siliquae forming an angle of 50 - 70 with the axis; pedicels 2 - 4 mm in flower, (3 -) 4 - 6 (- 8) mm in fruit, almost as thick as the siliquae, with dense bifid hairs only. Flowers pale yellow, not or slightly fragrant. Sepals (4.5 -) 5.5 - 7 (- 8) × 1.2 - 1.3 mm, lanceolate to ovate, with dense bifid and few3-fid hairs. Petals 8 - 12 (- 14) × (2 -) 2.3 - 3.5 mm, narrowly cuneate, pubescent outside. Stamens glabrous; anthers pale yellow. Silquae (30 -) 35 - 55 (- 74) × 0.9 - 1 mm; style 0.9 - 1 mm. Seeds 0.9 - 1 (- 1.1) × 0.5 - 0.6 mm. Pollen grains: P = 17.8 - 18.8 µm, E = 16.0 - 17.2 µm. 2n = 14; x = 7.

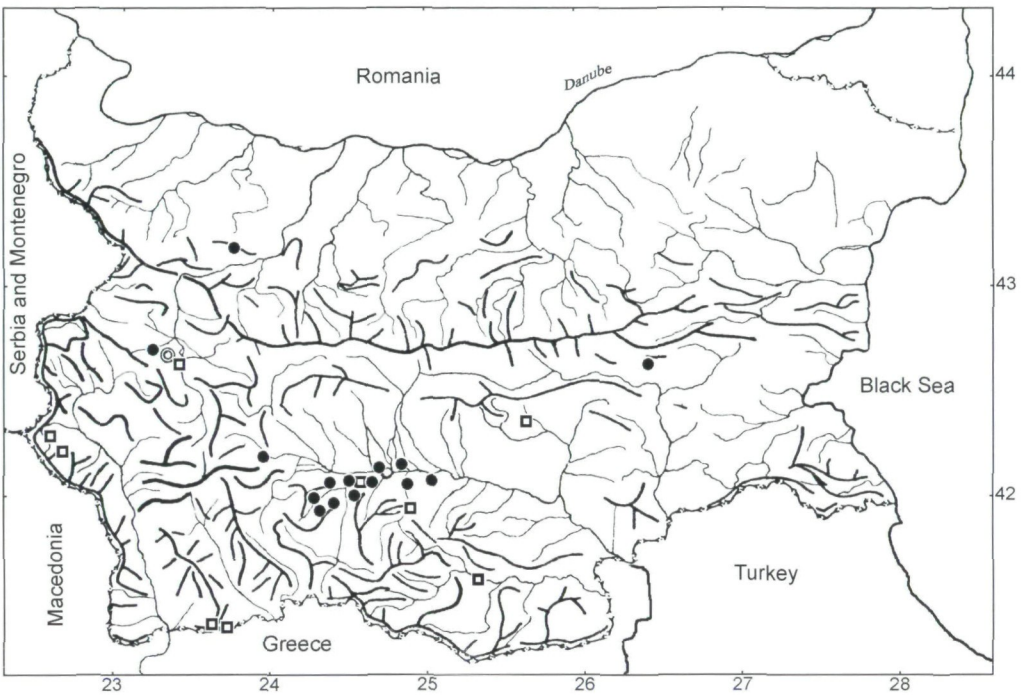

Fig. 9: Distribution of *Erysimum crassistylum* in Bulgaria: ● examined herbarium specimens, ◘ populations studied for chromosome numbers (2n = 14).

Distribution and ecology

Scattered localities, NE Bulgaria, Danube plane, Balkan foothill region, Stara Planina, Vitosha region (Ljulin Mt.), Znepole region, West Frontier mountains (Osogovska Mt.), Struma valley, Slavjanska Mts., Pirin Mt., Sredna gora Mt., Rhodope Mts., Thracian plane, from 100 up to 900 m. (Fig. 9). S. Europe (Italy, Balkan Peninsula: Serbia, NW Greece).

On open, dry, often eroded limestone substrates, rarely on silicate terrains, in the oak vegetation belt, in xerophilous plant communities, usually dominated by *Quercus pubescens*, *Carpinus orientalis*, *Fraxinus ornus*, *Syringa vulgaris*, *Paliurus spina-christi,* in planes (sparsely), foothills and mountains.

Flowering: (late April -) May to June.

Balkan Foothill region: The mount Vesletz near Varbeshnitza, 16.V.2002, A. Polatschek, M. Ančev [SOM 158407]. – Stara Planina Mt.: In collis siccis mt. Balkan orient, Kamcijska Planina, 1.V.1895, B. Davidov, sub *E. diffusum* EHRH. var. *moesiacum* (VELEN.) STOJ. & STEF. [SOM 33157]. – Lale-bair at vill. Sotir, Sliven distr., 15.VI.1990, M. Ančev, sub *E. moesiacum* VELEN. [SOM 153836]. – Sofia region, SE Sofia, S Pancharevo-reservoir, Schluchteingang, 19.V.2002, A. Polatschek [W 2002-13527]*. – Vitosha region: Montes Ljulin planina, ad Monastir Sv. Kral, 28.V.1929, S. Javorka, sub *E. diffusum* [BP]. – Struma-Valley, Kresnesci-Pass, 350 m, 20.V.2005, A. Polatschek [W 2005-10374]*. – West frontier Mts., Osogovska Mt., above Kjustendil, 600 m, 12.VII.1991, M. Ančev A9150 [SOM 2519], (ANČEV & al. 1987)**. – Above vill. Garljano, 900 m, 21.VII.1987, M. Ančev, A87156 [SOM 2993], (ANČEV, 1995)**. – Slavjanka Mt.: above vill. Paril, 1400 m, 22.VII.1988, M. Ančev A88162 [SOM 3107], (ANČEV 2001)**. – Sredna gora Mt.: vill.

Yagoda, near to Stara Zagora, 300 m, leg. R. Hardalova A86155 [SOM 3522], (ANČEV 1995)**. – Rhodope Mts: Zwischen Plovdiv und Pestera, zwischen Kurtovo Konare und Isperihovo, 300-400 m, 11.V.1978, G. & M.A. Fischer [Fischer]. – Martziganitza, along the path to Chervenata stena, 1.VIII.1998, S. Bancheva, det. M. Ančev [SOM 154024]. – Lazhene, 1912, I. Urumov, sub *E. diffusum* EHRH. var. *moesiacum* (VELEN.) STOJ. & STEF. [SOM 33197]. – In saxosis mt. Rhodope occident., Peshtera - Batak, 600 m, 18.VI.1926, B. Davidov, sub *E. diffusum* EHRH. var. *moesiacum* (VELEN.) STOJ. & STEF. [SOM 33185]. – Distr. Smolyan, an der Straße zur Hütte "Er-Kupria", 1100-1400 m, 9.VIII.1968, H. Merxmüller & B. Zollitsch 4366, sub *E. diffusum* [M]. – seeds of this collection, cult. Alpengarten Belvedere 1972/73, A. Polatschek [W 1974-19601]. – Straße nach Batak bei der Kreuzung nach Fotinovo, 12.VII.1970, F. Krendl [W 1974-07509]*. – Peshtera, 4.VIII.1985, M. Ančev A85125 [SOM 2644] (ANČEV 1995)**. – Vill. Bjaga, 500 m, 7.IX.1985, M. Ančev A85131 [Ančev], (ANČEV & al. 1987)**. – Graben vom Bačkovski manastir, SE gegen Červenata stena, ca. 900-950 m, 12.V.1978, G. & M.A. Fischer [W 1979-16319]*. – Thracian plane: Ad Philipopolin in siccis, 1893, J. Velenovský, sub *E. diffusum* [PRC]. – Nova Mahala, 15.V.1914, J. Mrkvicka, sub *E. diffusum* EHRH. var. *moesiacum* (VELEN.)STOJ. & STEF. [SOM 33241]. – Plovdiv, 10.VI.1927, G, Sirjaev 330 [BRNU]. – Plovdiv: in colle Dschendem tepe, 20.VII.1930, K.H. Rechinger 1162, sub *E. diffusum* var. *australe* [W 2006-00517,W 2006-00518]. – Ad pagum Kričim, distr. Plovdiv, 18.VI.1907, I. Urumov, sub *E. diffusum* var. *moesiacum* VELEN. [SO 33145]. – SW Plovdiv: 1 km W Kričim, 13.VII.1970, F. Krendl [W 1974-07498]*; N Kričim, 11.V.2002, A. Polatschek [W 2002-13526]*. – SE Pazardžik, 408 m, 14.VII.1970, F. Krendl [W 1974-07499]*. – Bessaparski ridove, 22.VIII.1974, M. Ančev A4135 [SOM 2615], (ANČEV 2001)**.

8. *Erysimum welchevii* URUMOV

Spis. Balg. Acad. Nauk. 17: 216 (1919); JALAS & SUOMINEN, Atlas. Fl. Eur. 10: 71 (1994).

≡ *E. canescens* var. *welchevii* (URUMOV) STOJ. & STEF., Fl. Bulg. ed. 1, 1: 523 (1924).

≡ *E. diffusum* var. *welchevii* (URUMOV) HAYEK, Prodr. Fl. Penins. Balc. 1: 380 (1925); ASSENOV, Fl. R. P. Bulg. 4: 358 (1970).

Lectotype (ANČEV 1995: 100): [Bulgaria] Ad monasterium Sv. Troica prope Tirnovo, VII.1898, I. Urumov [SOM 33212]

Biennial, forming one to few leaf rosettes in the first year, 1 - 6 (- 8) stems in the second year. Stem simple or with 1 - 3 side branches, with vegetative short shoots in the middle and upper leaf axils, in flower 30 - 70 cm tall, in fruit up to 70 (- 110) cm; basal rosette withered before anthesis, basal tunic of withered leaf bases inconspicuous, upper part of stem angular with conspicuous low wings, with dense bifid hairs. Leaves 15 - 70 × (1.2 -) 2 - 6 (- 9) mm, oblanceolate to lanceolate, obtuse, lower and middle ones conspicuously petiolate, entire with 3 - 4 pairs of very small teeth, upper ones sessile and entire, all with dense bifid, few 3-fid and very few 4-fid hairs. Inflorescence occupying upper half of the stem, simple or with up to six erect branches conspicuously elongating in fruit, branches with some short shoots, racemes 12 - 15 flowered. Flowers bright yellow, not fragrant or slightly fragrant. Sepals 6 - 8.5 × 1.3 - 1.7 mm, ovate lanceolate, with dense bifid and few 3-fid hairs. Petals (8 -) 10 - 15 mm, cuneate, outside pubescent; blade 4.5 - 8 × (2.5 -) 3 -6.5 mm. Stamens subglabrous, with few bifid hairs. Siliquae (50 -) 60 - 80 × 0.8 - 1 mm, densely covered with bifid hairs; style 1 - 1.5 (- 2) mm, almost as thick as siliqua, with 2-fid, 3-fid, and very few 4-fid hairs; stigma capitate, sometimes slightly retuse. Seeds (1 -) 1.2 - 1.5 × 0.5 - 0.6 mm, ellipsoid-lenticular, light brown. Pollen grains: P = 22.1 - 22.8 µm, E = 23.2 - 23.7 µm. 2n = 42; x = 7.

Distribution and ecology

Black Sea Coast, NE Bulgaria, Balkan foothill region, Stara Planina, Vitosha Mt., Znepole region, Slavjanka Mt., Rila Mt., Sredna gora, Rhodope Mts., Thracian plane,

Tundža hilly plane, Strandza Mt., 15 - 900 (1300) m (Fig. 3). Balkan Peninsula (Serbia, N Greece).

Open, dry stony limestone habitats, rarely on rocky terrains, in the oak vegetation belt in xerophilous plant communities dominated by *Carpinus orientalis*, *Fraxinus ornus*, *Quercus pubescens*, *Syringa vulgaris*, in the hilly planes, foothills and mountains.

Flowering May to June (- mid-July).

Examined specimens: Black Sea coast: Ad Monasterium Aladža prope Varna, 16.VII.1930, K.H. Rechinger [BP, G]. – Varna, beim Kloster Aladža, 16.VII.1930, K. Ronniger [W 1961-21282]. – Prope Varna, ad Gebedže, 31.V.1907, C K. Schneider [W 1907-21336]. – Dobrogea, 3 km SW Cape Kaliakra, 25.VII.2001, A. & A.L. Anderberg [S, SO]. – S Dobrudža, Galata S Varna, 12.VIII.1958, K. Meyer 460 [JE]. – Distr. Tolbuhin, 3 km S Balcik, road to Varna, 16.VIII.1968, H. Merxmüller & B. Zollitsch 14562 [M]. – Provadia, near Varna, 15.VI.1902, I. Urumov [PRC]. – 2 km SE Sozopol, ca. 30 m, 8.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-568 [W 2003-00618]. – S Shabla, along the road from Gorun to Tyulenovo, ca. 6 km W Tyulenovo, ca. 100 m, 04.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-217 [W 2003-00617]*. – 1 km S of the border to Romania, ca. 4 km NE Durankulak, 03.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-150 [W 2001-14390]*. – Balchishka tuzla, 100 m, 10.VII.1983, M. Ančev A8356 [SOM 3521]. – E Balchik, coast ca. 3 km NW Kap Kaliakra, 04.VI.1998, Uzunov, Gussev &Vitek 98-275 [W 2001-10739]*. – E Balchik above Russalka, ca. 100 m, 04.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-270 [W 2001-14392]*. – Pobiti kamani, VIII.1986, M. Ančev A86322 [SOM 2985]. – Above Zlatni pjasatzi, VIII.1987, M. Ančev A791 [Ančev]. – Above the vill. Vetrino, near to Varna, 25.VIII.1983, M. Ančev A83161 [SOM 2655], (ANČEV 2001)**. – NE Varna, near Aladza Manastir, ca. 80 m, 22.V.2000, A. Polatschek [W 2000-05754]*. – Ca. 4 km NE Varna, Atsivar N Vinitsa, ca. 200 m, 05.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-306 [W 2001-10740]*. – S Varna, S Bliznaci, along the road, 20.V.2000, A. Polatschek [W 2000-05753]*. – Ca.11 km W Varna, E Poveljanovo, ca. 1 km W Pobiti kamani, ca. 160 m, 05.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-332 [W 2001-10741]*. – N Nessebar, Sl. Ančev Brjag, sand dunes S Hotel Burgas, 07.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-427 [W 2001-10745]*. – 4 km S Sozopol, ca. 1 km NW K. Sv. Agalina, 08.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-591 [W 2001-10746]*. – 1-2 km S Primorsko, 01.VII.1970, F. Krendl [W 1974-7523]*. – S Burgas, Arkutino, 24.VII.1980, M. Ančev A80244 [Ančev], (ANČEV & al. 1987)**. – NE Bulgaria: In collinis siccis prope Provadia, 1902, I. Urumov [SOM 33181]. – Madara, 440 m, VII.1985, M. Ančev A86266 [Ančev], (ANČEV 2001)**. – 29 km S Russe, valley of river Lom, 3 km NE Pepelina, ca. 200 m, 02.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-110 [W 2001-10742]*. – Ca. 2 km NE Bjala along road in direction to Russe, ca. 160 m, 02.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-82 [W 2003-08712]*. – Ad ripam fluvii Lom prope Russe, 12.VII.1930, K.H. Rechinger 553 [W]. – Lomtal bei Russe, 12.VII.1930, K. Ronniger [W 1961-21284]. – Prope Šumla (Šumna), SSW Silistra, loco Velky Kabink, 3.VI.1891, F. Milde [PRC]. – NE Dobrič, Dobrudzha, S. Kardam; 24.V.2000, A. Polatschek [W 2000-05757]. – Balkan foothill region: In aridis collinis prope Trnovo, 2.V.1900, I. Urumov 574, sub *E. diffusum* ssp. *welchevii* [BP]. – Bei Trnovo, 20.IV.1899, I. Urumoff 189, sub *E. exaltatum* [PRC]. – Ad fluvium Jantra prope Trnovo, 20.IV.1901, I. Urumov 573 [BP]. – Ad aridis collinis prope Trnovo, 2.V.1900, I. Urumov 574 [BP]. – Trnovo, in declivio herboso, calcareo, 100 m, 5.V.1922, Schirjaev [BRNU]. – In fauce fluvii Jantra prope Tirnovo, 18.VII.1930, K.H. Rechinger [W]. – Trnovo, Plateau des Hügels gegenüber Zarewitz, 10.VI.1961, J. Bisse & U. Schneider [JE]. – Distr. Trnovo, near Letnitza, 1898, I. Urumoff [WU]. – Bei Trnovo, 1896, I. Urumov 77 [WU]. – Suhindol, 1896, I. Urumov, det. B. Achtarov, sub *E. canescens* [SOM 33164]. – NW Montana, Shiroka Planina, Mitrovitsi, 17.V.2002, A. Polatschek [W 2002-13551]. – Drjanovo, 280 m, 25.VIII.1983, M. Ančev A83163 [SOM 2652], (ANČEV 2001)**. – NW Vratsa, Vrachanska Mt., bed of the river, 17.V.2002, A. Polatschek [W 2002-13525]*. – WNW Veliko Tarnovo, road from Emen to Vishovgrad, 300 m, togeter with *E. cuspidatum*, 23.VI.1997, A. Polatschek [W 1997-8186]*. – NE Veliko Tarnovo, vicinity of Monastir "Sv. Troitsa", 220-320 m, 22.VI.1997, A. Polatschek & M. Ančev [W 1997-8182]*. – Stara Planina Mt.: Bei Gabrovo, 1898, I. Urumov [WU]. – Ad p. Sipka, in tumulo Donkava Mogila, 600 m, 2.VI.1930, G. Sirjaev [BRNU]. – N Sofia, Iskar-Tal, nahe Ritlite, 16.V.2002, A. Polatschek [W 2002-13523]. – Balkan: Gipfel des Stoletov am Schipka-Paß, 1300-1326 m, 18.8.1968, H. Merxmüller & B. Zollitsch 24622 [M]. – Sliven, Barmuka, 500-750 m, 6.VII.1970, F. Krendl [W 1974-7522]. – seeds of this collection, cult. Alpengarten Belvedere, 1973/74, A. Polatschek [W 1975-

3062]*. – Koru-Dere, above vill. Gabarevo, 25.VIII.1974, M. Ančev A4142 [SOM 2656]**. – Trojanski prohod, above vill. Karnare, 650 m, 25.VII.1984, M. Ančev A8440 [SOM 2667], (Ančev 2001)**. – Sliven, up to Balgarka, ca. 500-600 m, 06.VII.1970, F. Krendl [W 1974-7522]*. – Znepole region: N Radomir, 700 m, 4.VIII.1985, M. Ančev A85120 [SOM 2647]**. – Straza Mt., 900 m, 31.V.1995, M. Ančev A956 [W 1996-5627]. – W Sofia, nahe Tran, Zavalska Berge, 800 m, 18.V.2002, A. Polatschek [W 2002-13519]*. – Sredna gora: Chirpanski vazvishenia, 20.VII.1982, M. Markova A8260 [Ančev]**. – Slavjanka Mt., near vill. Lovcha, 700 m, 29.VII.1977, M. Ančev A7116 [SOM 2668]**. – Rila Mt.: Sokoletz, 16.VII.1986, R. Hardalova A86157 [SOM s.n.], (ANČEV 1995)**. – Rhodope Mts.: In collinis siccis ad Lazene, 1912, I. Urumov [SOM 33126]. – South of Assenovgrad, 500 m, 30.VII.1981, M. Ančev A81183 [SOM 2654], (ANČEV & al. 1987)**. – 5 km south of Shiroka Laka, 1200 m, VI.1980, H. Malicky [W 1981-2439]*. – 4 km NE Peshtera, valley of Peshterska river, 500-600 m, 25.VII.1971, M.A. Fischer, cult. in Alpengarten Belvedere Wien, 1977/78, A. Polatschek [W 1978-12964]*. – 17 km SSE Pazardzik, hills SW Kozarsko (between Peshtera and Kričim), 400-500 m, 13.V.1978, G. & M.A. Fischer [W 1979-16317]*. – Thracian plane, 1 km S Dimitrovgrad, 07.VII.1970, F. Krendl [W 1974-7510]*. – seeds of this collection, cult. in Alpengarten Belvedere, 1973/74, A. Polatschek [W 1975-3062]*. – 2-3 km SW Dimitrovgrad, 07.VII.1970, F. Krendl [W 1974-7537]. – seeds from this collection, cult. in Alpengarten Belvedere 1974/75, A. Polatschek [W 1975-17566]*. – E Dimitrovgad, Branitsa Mt., near Mramor, 400 m, VI.1980, H. Malicky [W 1981-2443]*. – Strandža Mt.: Supra Veleka, N Malko Tarnovo, 27.V.2000, M. Marek, sub *E. diffusum* [LI]. – S. Gramatikovo, near Veleka-bridge, 20.V.2000, A. Polatschek [W 2000-5726]. – SW Tzarevo, Kosti, 20.V.2000, A. Polatschek [W 2000-5744]. – The road from Tsarevo to Malko Tarnovo, ca 300 m, NE river Veleka, 120 m, 10.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-782 [W 2001-14391]*.

9. *Erysimum bulgaricum* (VELEN.) ANČEV & POLATSCHEK

Ann. Naturhist. Mus. Wien, B, 104: 692 (2002).

≡ *E. goniocaulon* var. *bulgaricum* VELEN., Fl. Bulg. Suppl. I: 20 (1898); STOJ. & STEF., Fl. Balg. ed. 1, 1: 523 (1924); HAYEK, Prodr. Fl. Penins. Balc. 1: 384 (1925).
Lectotype (ANČEV & POLATSCHEK 2003): In declivibus m. Rhodope, 1894, V. Střibrný [PRC].
Figures: ANČEV & POLATSCHEK 2003: 693.

= *E. crepidifolium* auct., non REICHENB.: STOJ. & STEF., Fl. Bulg. ed. 1, 1: 522 (1924); HAYEK, 1.c., p.p.; ASSENOV, Fl. R. P. Bulg. 4: 358 (1970).

Biennial, grey-green, with well developed 60 - 120 mm long narrowly fusiform main root. Stem almost cylindric, simple or with few branches, 30 - 75 (- 125) cm tall, pubescent, mostly with bifid, few 3-fid and very few 4-fid hairs, with long petiolate, runcinate, acute toothed basal leaves, forming a distinct rosette which is dry at flowering time, covered by bifid and stellate hairs. Cauline leaves linear lanceolate, pubescent, 10 - 82 × 1 - 2 (- 4) mm, acute, entire or sometimes on the margin with 3 (- 4) distant short hyaline teeth. Hairs branched, 2 - 3-fid on the stem and the leaf midrib, (2 -) 3 - 4 (- 5)-fid on the basal and cauline leaves. The synflorescence is racemose with 0 - 3 (- 6) short branches, elongating during fruit development. Pedicels 3 - 5 (- 6) mm, pubescent. The flowers are almost without scent. Sepals pubescent on outer surface, 5 - 6 (- 7) × 1.5 - 1.7 (- 2) mm. Petals pale yellow, 8-15 × 1.5 - 2.5 (- 3) mm, cuneate; the blade 4 - 5 × (1.5 -) 2 - 2.5 (- 3) mm. Stamens glabrous, anthers 2.5 - 3 mm long. Lateral and median nectaries developed. Siliquae 38 - 68 mm long, 1.1 - 1.3 mm thick, 4-angled in cross-section, grey-greenish; edges glabrescent. Angle between the axis of the raceme and the pedicel 45° - 50°; siliqua divergent at 20° - 30°. Style 1-3 mm. HT (2) + 3 + 4 + (5) + ((6)). Stigma clavate. Pollen grains tricolpate: P = 17.5 - 19 µm, E = 15.5 - 17.5 µm. 2n = 14; x = 7.

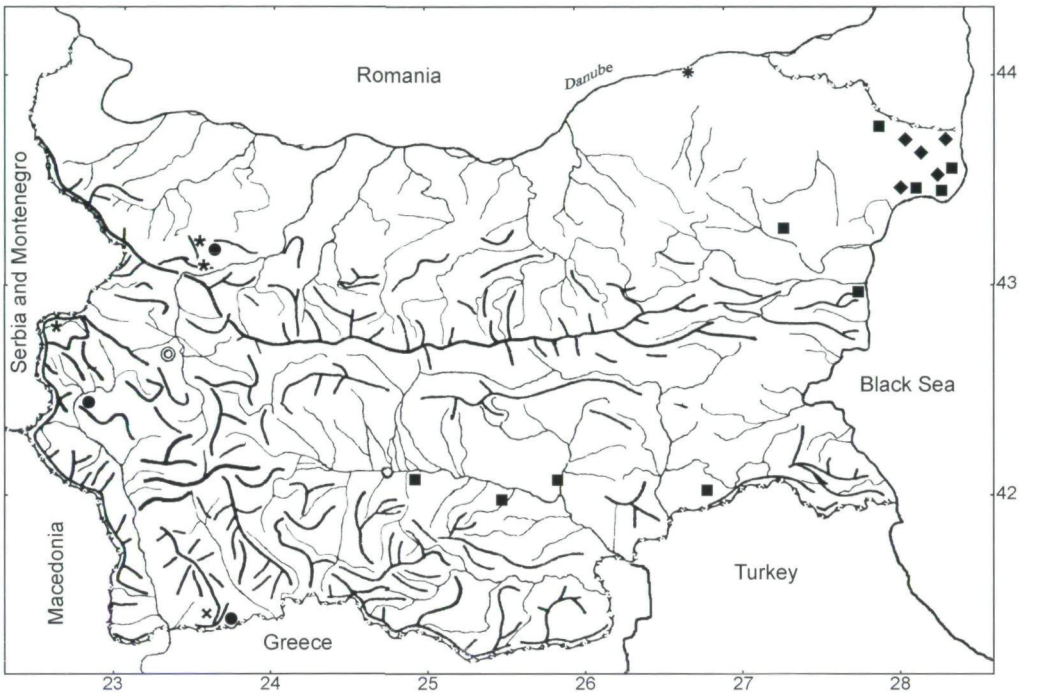

Fig. 10: Distribution of *Erysimum* in Bulgaria: *E. bulgaricum*, ■ examined herbarium specimens, ◆ populations studied for chromosome number (2n = 14). *E. cheiranthoides*, ✱ examined herbarium specimens. *E. comatum*, ● examined herbarium specimens, populations studied for chromosome number ✱ 2n = 14; ✖ 2n = 14 + 0-2 B.

Distribution and ecology

Black Sea Coast, NE Bulgaria (Kardam, Bejanovo, Nevša), E Stara Pl. Mt. (Kamchiiska Planina Mt.), Rhodope Mts. (Assenovgrad), Thracian plane, Tundža hilly plane (Derventski vazvishenia, close to the village of G. Dervent), from 100 up to 700 m a.s.l. (Fig. 10). Romania (N. Dobrudza), European Turkey, Greece.

On open, dry, stony and often limestone substrate, in the hilly planes and foothills.

Flowering: May to June.

Note: *E. crepidifolium* was reported by VELENOVSKÝ (1891: 32) for Razgrad and Varna, and by DAVIDOV (1904) for habitats around Shumen. STOJANOV & STEFANOV (1924: 522) indicated *E. crepidifolium* "mainly for N Bulgaria". The species has been mentioned later for the region of Tarnovo and Svishtov (URUMOV 1928). ASSENOV (1970: 361) summarizing previous data reported the species for habitats along the Black Sea coast, in NE Bulgaria, the Danube plane, the Balkan foothill region and the Thracian plane. In fact most of the herbarium specimens collected in NE Bulgaria and along the Black sea coast, determined as *E. crepidifolium* RCHB. belong to *E. bulgaricum* and few specimens to *E. diffusum*.

E. bulgaricum is a mesoxerophyte to xeromesophyte, growing in open, dry and stony terrains in secondary steppe communities, typical of the hilly planes and the foothills of SE and NE Bulgaria. The species was wrongly reported for Strandza Mt., Petrova niva, north of M. Tarnovo, (JORDANOV 1939: 90, sub *E. goniocaulon* var. *bulgaricum* VELEN.) instead of *E. diffusum* s. l.

Examined specimens: Black Sea coast: In collis calcareis Dobrožae circa urbem Balchik, 16.V.1904, B. Davidov, sub *Erysimum odoratum* EHRH., rev. B. Achtarov, sub *E. crepidifolium* RCHB. [SOM 33252]. – White Coast, Cap Imeto E of Balchishka Tuzla, 50-70 m, 43°24'41"N/28°15'53"E, 3.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-164 [SOM s.n., W 2001-10747]*. – ca. 12 km WNW Shabla, NE of Vidno, plane E of valley Goren dere, ca. 75 m, 43°34'38"N/28°24'28"E, 4.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-305 [SOM s.n., W 2001-10737]. – Open steep marl slopes south of cape Chirakman near Kavarna, 100 m, 23.V.2000, M. Ančev & A. Polatschek [SOM 162378, W 23000-05721]. – Kaliakra cape, calcareus steppe terrains, pastures, 23.V.2000, A. Polatschek & M. Ančev [Ančev]. – Balgarevo to Kaliakra Cape, 23.V.2000, A. Polatschek & M. Ančev [SOM 162379, W 2000-05751]*. – North-Eastern Bulgaria: In collis siccis Dobrožae, ad pagum Harman-Kujussu [Kardam], 12.VII.1900, B. Davidov, sub *Erysimum crepidifolium* RCHB. [SOM 33252[. – In collis siccis Deli-Orman supra stationem Nevša, 18.V.1902, B. Davidov, sub *Erysimum odoratum* EHRH. [SOM 33250]. – 10 kilometers West of Durankulak, 24.V.2000, A. Polatschek [W 2000-05760]*. – Grassy gravely places along the road Kardam - Shabla, east of village of Bejanovo, 24.V.2000, A. Polatschek & M. Ančev [SOM 162380], (ANČEV & POLATSCHEK 2003)**. – Stara Planinna Mt.: In collis siccis mt. Balkan orient., Kamčijska pl., 11.V.1898, B. Davidov, sub *Erysimum crepidifolium* RCHB. [SOM 33261]. – Thracian plane: Rumelia orientalis, Karabunar (Gara Galabovo), VII.1900, J. Podpera [PRC]. – In aridis collis ad vicum Papazlii [Popovitza], distr. Plovdiv, 13.VII.1909, I. Urumov, sub *Erysimum moesiacum* VELEN. [SOM 33158]. – In nemoribus ad Papazlii, VI.1909, V. Střibrný, sub *Erysimum moesiacum* VELEN. [BRNU, W 1913-8954]. – Papazlii, VI.1910. V. Střibrný, sub *E. canescens* EHRH. [PR, WU]. – In Papazlii, pasbishta, VI.1910, V. Střibrný, sub *Erysimum canescens* ROTH [PR 24724]. – In graminosis ad Nova Mahala, VII.1914, V. Střibrný, sub *Erysimum moesiacum* [SOM 01485]. – Papazlii, pasbishta, V-VI [sine anno], V. Střibrný, sub *Erysimum moesiacum* VELEN. [SOM 01486]. – Nova Mahala, VI.1914, V. Střibrný, sub *Erysimum odoratum* EHRH. (*Erysimum pannonicum*) [SOM 01489]. – Pastures along oak forests south of Popovitza, 26.VI.2001, M. Ančev [SOM 162381]. – Pastures south of Popovitza, 12.V.2002, M. Ančev & A. Polatschek [SOM 157478, SOM 157479, W 2002-13560]. – SE Popovitza, 12.V.2002, A. Polatschek [W 2002-13560]. – Tundža hilly region: Derventski vazvishenia, stony terrain, east of Coljam Dervent, Jambol District, 24.IV.1937, D. Jordanov, sub *Erysimum goniocaulon* var. *bulgaricum* VELEN. [SO 29092].

10. *Erysimum odoratum* EHRH.

Beitr. Naturk. 7: 157 (1792); VELEN., Fl. Bulg.: 32 (1891) et Suppl. I: 20 (1898); ASSENOV, Fl. R. P. Bulg. 4: 361 (1970); BALL, Fl. Eur. ed. 2, 1: 334 (1993); JALAS & SUOMINEN, Atlas Fl. Eur. 10: 76 (1994).

Lectotype (POLATSCHEK 1974: 178): *E. odoratum* EHRH., Plantae selectae Europaeum, nr. 77 [M].

= *E. hieracifolium* L., Cent. Pl. I: 18 (1755), nom. ambig.

Biennial, green to dark-green. Root 5 -10 cm, with fusiform side roots. Stem simple, (35 -) 45 - 70 cm tall in flowering, up to 130 cm in fruit, angular with conspicuous low wings, with dense 2-fid and few 3-fid hairs; basal leaf rosette formed in first year, often remaining during flowering and withered in fruit. Cauline leaves 17 - 75 × 2 - 15 mm, ovate-lanceolate to lanceolate, repand-dentate to repand-denticulate, sometimes distantly denticulate, the lowest petiolate, middle and upper ones sessile, with fascicles of small leaves in the axils, with many 3-fid, few 2-fid and 4-fid hairs, and very few 5-fid to 7-fid ones. Inflorescence of 1 - 10 ascending branches, conspicuously elongating in fruit, each with 4 - 8 well-developed leaves. Flowers golden-yellow, conspicuously fragrant;

pedicels 3 - 5 mm; sepals (6 -) 7 - 10 × 1.5 - 2 mm, narrow ovate, with 2-fid and 3-fid hairs and very few 4-fid ones. Petals 13 - 16 (- 20) × 4 - 8 mm , spathulate, pubescent outside with 3-fid hairs mixed with few 2-fid and very few 4-fid ones. Stamens with 3-fid and 2-fid hairs, and few 4-fid ones. Siliquae erect, 35 - 53 (- 72) × 1 - 1.2 (- 1.5) mm, grey-greenish, densely covered with bifid hairs, mixed with few 3-fid and very few 4-fid ones, edges glabrous; pedicels 2.5 - 5 mm in flower, up to 5 - 7 (- 11) mm in fruit, with 2-fid and 3-fid hairs; angle between the axis and the pedicel 40°, siliqua diverging at 20° - 40°. Style 1 - 2 (- 3) mm, slightly set up on the fruit with many 3-fid, some 2-fid and few 4 - 5-fid hairs; stigma shallowly bilobate. Seeds (1.5 -) 1.7 - 2 × 1 mm, light-brown. 2n = 32; x = 8.

Distribution and ecology

Scattered loclities in NE Bulgaria, Danube plane, Balkan foothill region, Znepole region, Thracian plane, 300 - 700 (- 1000) m. (Fig. 7). C & S Europe (eastwards to Moldavia and Ukraine).

On dry, gravely terrains, in shrubs along forest margins, in the hilly planes and on mountain foothills.

Flowering May to June.

Examined specimens: Danube plane: Rustschuk, in Weingärten. 1840, Noe s.n. [G]. – Balkan foothill region: NW of Montana, Shiroka Planina, Mitrovtsi, 17.V.2002, A. Polatschek, M. Ančev [W 2002-13554]. – In sterilibus prope Trnovo, 7.IV.1903, I. Urumov 580 [BP]. – Prope Tran, in saxosis calcareis ad Dragoevski kamak, ca. 1100 m, 25.VI.1933, B. Achtaroff [PR]. – Znepole region: Zavalska Planina, roadsides 2 km south of Ezdimirtzi, 18.V.2002, A. Polatschek, M. Ančev [SOM 157242, SOM 157245]. – W Sofia, SE Tran, Strezimirovtsi, ca. 900 m, 18.V.2002, A. Polatschek [W 2002-13529]*. – Thracian plane: In graminosis ad Papazli, V.1914, J. Mrkvicka [SOM 33332].

11. *Erysimum cuspidatum* (BIEB.) DC.

Regn. Veg. Syst. Nat. 2: 493 (1821); VELEN., Fl. Bulg.: 32 (1891); ASSENOV, Fl. R. P. Bulg. 4: 363 (1970); BALL, Fl. Eur. ed. 2, 1: 335 (1993); JALAS & SUOMINEN, Atlas Fl. Eur. 10: 84 (1994).

≡ *Cheiranthus cuspidatus* BIEB., Tabl. Prov. Meer. Casp.: 116 (1798).

≡ *Syrenia cuspidata* (BIEB.) RCHB., Fl. Germ. Exc.: 689 (1832).
Lectotype (DOROFEEV 1986): "Tauria" [LE].

= *E. cuspidatum* f. *brevistylos* NEJČEV, God. Sof. Univ. Fiz.-Mat. fac. 2: 135 (1906).
Lectoype (hic designatus): [Bulgaria] Stara Planina, po pripečnite varovitzi visoko v Korudere, VII. 1903, I Nejčev [SO 29021].

= *E. baumgartenianum* auct. bulg., non SCHUR.

= *E. witmannii* auct. bulg., non ZAW.

= *E. goniocaulon* var. *bulgaricum* p.p. auct., non VELEN., Fl. Bulg. Suppl. I: 20 (1898).

Biennial, in first year forming partly woody basal stock, in second year with 1 - 4 stems. Stem simple (20 -) 30 - 70 cm tall in flower, up to 100 cm in fruit, with dense 2-fid, few 3-fid and very few 4-fid hairs, in the upper part angled, with a basal rosette often remaining until anthesis and (5 -)15 - 30 cauline laeves, with vegetative short shoots in upper leaf axils; both rosette and lower cauline leaves withered in fruit; tunic absent or inconspicuous, of broad leaf bases. Leaves 15 - 80 × 4 - 20 mm, basal ones petiolate,

spathulate to narrowly obovate, entire to conspicuously dentate, obtuse, middle and upper ones gradually smaller, sessile, ovate-lanceolate to broadly lanceolate, denticulate to deeply dentate, acute, more or less auriculate and clasping, with many 3- to 4-fid, very few 2-fid and few 5-fid to 6-fid hairs, some 3- to 4-fid hairs conspicuously larger than the rest. Inflorescence occupying the upper 1/3 – 1/2 of the stem, with 2 - 8 (- 12) erect branches from an erecto-patent base, each with several well-developed leaves and often secondary branches, conspicuously elongating in fruit; racemes mostly 10 - 35 (- 60) flowered. Pedicels 1 - 2 mm in flower, up to 3 (- 4) mm in fruit, thinner than the siliqua, with many 3-fid, few 2-fid and very few 4-fid hairs. Flowers deep yellow, not fragrant or in some mountainous populations conspicuously fragrant; sepals 5 - 7 × 1 - 1.3 mm, narrowly ovate-lanceolate, with many 3-fid, some 4-fid, few 2-fid and 5-fid hairs. Petals 9 - 12 (- 13) × 1.8 - 3 (- 4) mm , cuneate, pubescent outside with mixed 3- and 4-fid and few 2-fid and 5-fid hairs. Stamens with some 3- and 4-fid, few 5-fid and very few 2-fid and 6-fid hairs. Siliquae 10 - 24 (- 30) × 2 - 3 (- 3.5) mm, laterally compressed, winged on the subglabrous margins, with many 4- and 5-fid, few 3-, 6- and 7-fid hairs, angle between the axis of the raceme and the pedicel 0° - 10°; style (3 -) 4 - 6 (- 10) mm, thinner than siliqua, with many 4-fid, some 3- and 5-fid and few 6-fid hairs, stigma capitate, slightly retuse. Seeds 1 - 1.2 (- 1.5) × 0.5 - 0.6 mm, ovoid-lenticular, light-brown. Pollen grains: P = 22.5 - 23.4 µm, E = 22.5 - 23.2 µm. 2n = 16 + 0-2 B; x = 8.

Distribution and ecology

Scattered all over the country, from the sea level up to 1000 (- 1900) m (Fig. 11). SE Europe (Balkan Peninsula), Romania, S Ukraine (eastwards of Volga), SW Asia, Caucasus, Iran.

In dry, mostly limestone terrains, along forest margins, roadsides and rail embankments, by field margins and grazed fields, on shallow and undeveloped humus-carbonate soils, in the hilly planes and mountains in the oak vegetation belt, seldom in gravely meadows in the coniferous belt.

Flowering (mid-April -) May to July.

Examined specimens: Black Sea coast: Balchik, ca. 2 km NW Chirakman S Kavarna, 100-200 m, 4.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-299 [W 2000-3430]*. – 50 km W Varna, E Provadija, 80 m, 5.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-333 [W 2000-3432]. – Varna, oberhalb des Klosters Aladža, 16.VII.1930, K. Ronniger, sub *Syrenia cuspidata* [W 1961-21321]. – Northern coastal area of the Black Sea E of Balchik, coast SW of Rusalka, protected area "Tauk Liman", 0-10 m, 43°24'41"N/28°29'57"E, 4.VI.1998 D. Uzunov, Ch. Gussev & E. Vitek 98-258 [W 2000-3431]. – In dumosis ad Varnam frequens, VII.1885, J. Velenovský [PRC]. – Regio Varna: Varna: Asparuchova, sandiges Meeresufer, 25.V.2000, M. Marek [LI]. – Ad Gebedže, V.1897, V. Střibrný [PRC]. – Distr. Burgas, Eminska planina SW Banja, 350 m, 16..VI.1973, W. Greuter 1119 [W 1974-10810]. – Östlichster Ausläufer des Balkan-Gebirge (= Stara planina), Eminska planina (= Emine Gebirge), Bergland beim Kap Emine am Schwarzen Meer N Nessebar, zwischen Burgas und Varna, 11.VI.1973, F. Ehrendorfer [WU]. – NE Nessebar, Eminska planina, 6 km SW Banja, 21.V.2000, A. Polatschek [W 2000-5740]. – NE Nessebar, Valley of Kozlushka River N Elenite, 40-80 m, 7.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-507 [W 2000-3429]. – Distr. Burgas, im W-Teil der Eminska planina gegen das Dorf Banja, 350 m, 11.VI.1973, W. Greuter 11119 [C]. – North-Eastern Bulgaria: Vlesich Mosar (oder Masar) Par Deliorman, VIII.1885, J. Velenovský [PR]. – Ad viarum margines prope Šumla, 5.VIII.1890, K. Polak [PR, PRC]. – Shumen, Felstrift, und Karsttrift oberhalb der Stadt, VI.1928, J. Hruby 2170, sub *E. erysimoides* [BRNU]. – In collis dumesis Deli-Orman supra stationem Nevsa, 19.V.1902, B. Davidov [SOM 33241]. – Shumen, Kjoshkovetz, 8.VI.1902, I. Javashev [SOM 33280]. – Madarsko plato, 28.VI.1995, D. Uzunov [SOM 15382]. – Grassy habitats in the forest Kara-Orman near vill. Sracimir, Silistra distr., 19.VI.1952, N.

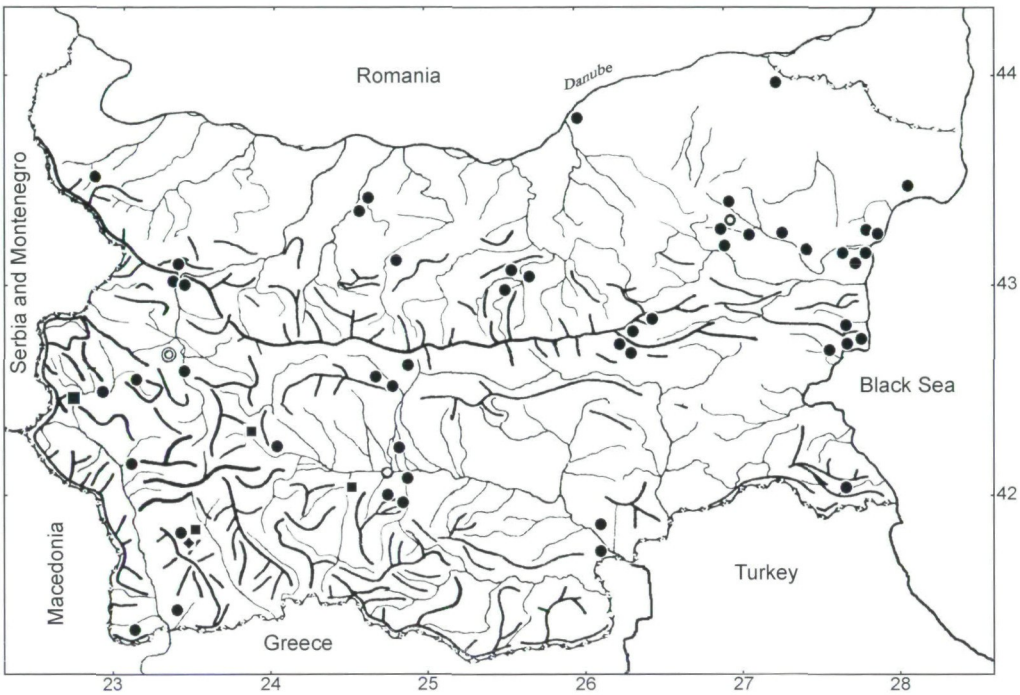

Fig. 11: Distribution of *Erysimum cuspidatum* in Bulgaria: ● examined herbarium specimens; ⊙ doubtful reference data; populations studied for chromosome number ■ 2n = 16; ◆ 2n = 16 + 0-2 B.

Stojanov, B. Kitanov, V. Velchev [SOM 33337]. – In collis dumesis ad Shumenska Trapeza, 13.VIII.1912, B. Davidoff [SOM 33244]. – Russe, VI.1900, A. Drenovsky [SOM 33238]. – Danube plane: In lapidosis ad urbem Pleven, 1924, I. Urumov [SOM 33266]. – Distr. Pleven, ad p. Borustica, 1925, I. Urumov 77, sub *Syrenia cuspidata* [BP]. – Ad Pleven, 1884, I. Urumov 165, sub *Syrenia cuspidata* [BP]. – Balkan foothill region: Ad Loveč, 1910, I. Urumoff 139, sub *Syrenia cuspidata* [BP]. – Tirnovo, E-Hang des Hügels am S-Rand der Jantra, 10.VI.1961, J. Bisse & U. Schneider 0083 [JE]. – Tirnovo, Plateau des Hügels ober Zarewitz, Schibljak, mit *Syringa*, 10.VI.1961, J. Bisse & U. Schneider 0088 [JE]. – Tirnovo, Blumenberg NE des Bhf., 9.VI.1961, J. Bisse & U. Schneider 0055 [JE]. – Tirnovo, ad viam loco umbroso, 3.VI.1922, J. Schirjaew [BRNU]. – In dumosis et silvaticis ad Trnovo, 1895, I. Urumov [SOM 33268]. – Bei Tirnovo, 1896, Urumoff 28 [W 1977-6231]. – Bei Tirnovo, 16.VI.1898, 1899, I. Urumoff 109, 187 [PRC, BRNU]. – V. Tarnovo, the locality Tzarevetz, 28.VIII.1974, M. Ančev A4185 [SOM 2987], (ANČEV 2001)**. – Belogradčik, Dolni Lom, Kalkfelsen N des Dorfes, 26.V.1976, F.K. Meyer 12065 [JE]. – Belogradčik, W Stara planina (Predbalkan), Täler bei Prevala, 31.VIII.1958, F.K. Meyer 1036 [JE]. – Ad Zernava, 1908, I. Urumoff 42 [BP]. – Stara planina: Mezdra a Iskar, Triften um G. Kremena, VI.1928, J. Hruby 2170, sub *E. erysimoides* [BRNU]. – Svoge, near Sofia, VII.1908, s.coll. [BRNU]. – Near the tourist house Kozya stena, 15.VI.1995, I. Apostolova, T. Meshinev [SOM 152862]. – Monastier "St. Maria" von Kalofer (Ostrumelien), VII.1835, C. Hinker 237 [BP]. – In dumosis et silvaticis inter Kotel et pag. Zheravna, 25.VII.1907, I. Urumov [SOM 33243]. – Sliven, 1886, Škorpil [PRC]. – Sliven, Monastirski boaz, ca. 350 m, 12.VII.1938, G. Brizicky [BRNU]. – Prope Sliven, ad collum Šekerdzi in graminosis, 16.VII.1907, C.K. Schneider 425 [W 1907-21046]. – In collis dumosis mt. Balkan oriental, Avrenska pl. (Momino Plato), 20.IV.1901, B. Davidoff [SOM 33248]. – Szlivno, s.dat., Frivaldsky, sub *E. odoratum* [BP]. – Umgebung und oberhalb Gara Lakatnik (ca. 45 km N Sofia), ca. 500-600 m, 7.VIII.1971, M.A. Fischer [W 1981-13930]. – Sofia region: SE Sofia, S Pancharevo reservoir, gorge, 19.V.2002, A. Polatschek [W 2002-13528]. – Znepole region: Golo brdo bei Pernik, Hang NW der Hütte "Slavej", 21.VI.1972, R. Marstaller [JE]. – Zemenska

Mt., 650 m, 19.VIII.1975, M. Ančev A5294 [SOM 3526], (ANČEV 1978)**. – Struma valley: Konjovska pl., circa Kalishte, VII.1904, I. Mrkvicka [SOM 33249]. – Südliches Strumatal-Gebiet, Melnik, 22.V.1974, H. Manitz & R. Marstaller [JE]. – Rila: Sestrimo, 30.VI.1935, A. Radoev [SOM 33230]. – Above town of Rila to Rila Monastir, 750 m, 27.VI.1997, A. Polatschek [W 1997-8218]*. – Pirin: In collinis siccis ad pagum Bansko, 18.VII.1925, I. Urumov [SOM 33271]. – Hiža Banderica, 1800 m, 24.VII.1915, B. Davidov [SOM 33239]. – Vichren, 2100 m, 5.VII.1968, J. Dvorak, sub *E. baumgartenianum* [BRA] – Banderishka poljana, 1900 m, 7.VII.1996, M. Ančev A9660 [SOM 3549], (ANČEV 2001; ANČEV & GORANOVA 2003)**. – Banderitsa to Dolen Kazan, 1750-1850 m, 28.VIII.1997, A. Polatschek [W 1997-8221]*. – Pirin planina, oberhalb der Hütte Banderitsa, 1850 m, 8.VIII.1994, V. Goraniva & M. Ančev A94151 [SOM 3492, W 1996-5633], 2n = 16 + 0-2 B (ANČEV 2001, ANČEV & GORANOVA 2003)**. – Hiža Banderica, 1800 m, 27.VII.1971, M. Fischer 277 [Fischer]. – Steilhang oberhalb der Straße zw. Hiža Banderica und Hiža Vihren, 1900-2100 m, 29.VII.1971, M. Fischer 0303 [Fischer]. – Aufstieg von der Metscha Poljana zur Palaschica (v. d. H. Banderitsa), ca. 1750 m, 17.VI.1971, F.K. & J. Meyer 10450 [JE]. – Banski Suhodol, ca. 1900 m, 25.VII.1980, B. Kuzmanov, M. Ančev [SOM 145097]. – Sredna gora Mt.: ad p. Hisar, I. Urumov 192 [BP]. – Rhodope Mts.: in rupestribus submontanis, V.1916, Adamovic, sub *E. goniocaulon* [W 1907-12978, WU]. – In rupestribus submontanis mt. Rhodope, V.1906, Adamovic [M, WU]. – Rhodope, SW Plovdiv, 5 km S Kucim, Vucha-Valley, 11.V.2002, A. Polatschek [W 2002-13520]. – Ad Stanimaka, 1895, Střibrný [PRC]. – E Assenovgrad, N-Hang, 9.VI.1971, F.K. & J. Meyer 10142 [JE]. – Assenovgrad, Koru-dere unterhalb der Abzweigung der Straße zur Hütte "Bezovo", 28.VI.1972, R. Marstaller [JE]. – Ad Eli Dere, VI.1907, 1908, 1914, V. Střibrný, sub *E. goniocaulon* [BP, BRNM, FI, H, M, PR, PRC, S, SOM 33267, W 1926-29208, WU]. – Belasitza Mt.: Kolarovo, 10.6.1980, B. Kuzmanov [B]. – Thracian plane: In nemorosis ad Manolovo, VI.1909, V. Střibrný [BP]. – Sadovo, VII.1915, V. Střibrný [SOM 33274]. – In sterilibus lapidosis dumosis ad pag. Hisar, distr. Plovdiv, 24.V.1927, I. Urumov [SOM 33237]. – Rumelia orientalis, Hebibčevo (Ljubimec), VII.1900, J. Podpera [BRNU]. – Rumelia orientalis, Duganovo pr. Kavaklij, VII.1900, J. Podpera [BRNU]. – Rumelia orientalis, Harmanli, VI.1900, J. Podpera [BRNU]. – Rumelia orientalis, Ak bunar pr. Haskovo, VI.1900, J. Podpera [BRNU]. – Rumelia, s.dat., Frivaldsky [W 1889-306648]. – The mount near to Mezek, Svilengrad distr., 29.V.1980, M. Markova, J. Cherneva [SOM 139547]. – Bezirk Pazardžisko, im Marica-Tal zwischen Kostenec und Belovo, bei der Abzweigung nach und beim Bahnhof Sestrimo, ca. 400 m, 11.V.1978, G. & M. Fischer [W 1979-16320, Fischer]*. – Strandza Mt.: Sakar Planina mountains, road from Sredec to Bolyarovo, at crossing with road to hut Boschura, ca. 300 m, 42°18'00"N/27°09'04", 11.VI.1998, D. Uzunov, Ch. Gussev & E. Vitek 98-856 [W 2000-3433].

12. *Erysimum quadrangulum* (L'HERITIER) DESF.

Tabl. Bot.: 129 (1804). – Fig. 12.

≡ *Cheiranthus quadrangulus* L'HERITIER, Strip. Nov.: 91 (1785), nom. illeg. (based on same type as *E. montanus* PALL.).

≡ *Cheiranthus montanus* PALL., Reise d. Prov. 1: 496 (1771).
Lectotype (hic designatus): Ad Wolgam lectus, s.dat., Pallas s.n. [LE! – The plant at the right side of the sheet, the plant at the left side on the same sheet is *Sisymbrium* sp.].
Note: DESFONTAINES made a new combination for this taxon and correctly did not use the Epithet montanum, because there is the earlier *Erysimum montanum* CRANTZ (1769).

= *Syrenia sessiliflora* (R.BR.) LEDEB., Fl. Ross. 1: 193 (1842), nom. val.

≡ *Erysimum sessiliflorum* R.BR. in AIT., Hort. Kew., ed. 2, 4: 116 (1812), nom. illeg.

= *Syrenia cana* auct., non (PILLER & MITTERP.) NEILR., Aufz., Nachtr.: 73 (1870); ASSENOV, Fl. R. P. Bulg. 4: 368 (1970); BALL, Fl. Eur. ed. 2, 1: 335, p.p. (1993); JALAS & SUOMINEN, Atlas Fl. Eur. 10: 88, p. p. (1994).

Biennial. Root 12 - 15 (- 20) cm, side roots fusiform. Stem simple 30 -76 cm tall in flower, 50 - 80 cm in fruit, almost round in crossection, grey-green, with dense 2-fid and few 3-fid hairs, tunic absent or with few broad leaf bases. Leaves (7 -) 20 - 70 (- 110) × 0.3 - 2 (- 5) mm, slightly succulent, in the axils from the stem base to the inflorescence with

Fig. 12: *Erysimum quadrangulum*, characteristic specimen from Kazakhstan [W 1991-10745].

Table 5. Characters distinguishing *Erysimum quadrangulum* from *Erysimum canum.*

Characteristics	*Erysimum quadrangulum*	*Erysimum canum*
Leaves	40-70 × 1-3 mm	90-110 × 1.7-1.8 mm
Siliqua	7-10 (12) mm	12-17 mm
Style	(5) 7-10 mm	(3) 4-7 mm
Hairs on the stem	bifid and rarely 3-fid	bifid mixed with few 3- fid, and rarely 4-fid
2n	28	14

fascicles of short branches and small leaves; lower cauline leaves withered in fruit, cauline sessile, narrow lanceolate to linear, acute, entire, very rarely distantly denticulate, with many 2-fid and few 3-fid hairs. Inflorescence occupying the upper 1/3 of the stem, without or with 1 - 7 ascending branches with 1 -2 short secondary branches, all with fascicles of small leaves. Flowers golden yellow, honey fragrant; sessile or pedicels c. 1 mm; sepals 8 - 10 × 1.5 - 2 mm, ovate-lanceolate, lateral saccate, densely covered by 2-fid hairs mixed with few 3-fid ones. Petals 12 - 17 × 4 - 6 mm, spathulate, glabrous. Stamen glabrous with Siliquae (5 -) 6 - 8 (- 11) × 2 - 3 mm, laterally compressed, winged on the margins, quadrangular in crossection; valves with many 2-fid hairs lieing transversaly, on the margins with few 3-fid ones mixed with very few 4-rayed stellate hairs; angle between the axis of the raceme and the pedicel 10° - 30°; style (5 -) 7 - 8 (- 10) mm, conspicuously narrower than the siliqua, with many 2-fid, few 3-fid hairs, stigma slightly bilobed. Seeds 1 - 1.8 × 0.8 - 1.2 mm, ovoid-lenticular, redish-brown. 2n = 28; x = 7.

Distribution and ecology

In few localities at the Black Sea coast in the area of Pobitite kamani west of Varna, 50 - 250 m (Fig. 7). E Europe (Romania, Ukraine (scattered localities in the low Danube basin), Caucasus, W Siberia.

On marly sands.

Flowering May to June.

Note: *E. quadrangulum* is a polyploid species with chromosome number 2n = 28, counted in plants from the area of the Black Sea coast, Pobiti kamani, west of Varna. This chromosome number confirmed earlier countings in plants from Romania (A. POLATSCHEK not published). In its morphology *E. quadrangulum* is similar to *E. canum* (PILLER & MITTERP.) POLATSCHEK from Central and East Europe (Hungary, Slovakia) (POLATSCHEK 1982). *E. quadrangulum* differs from *E. canum* by its shorter leaves and siliquae, longer style and polyploid chromosome number (Table 5). FERAKOVA & MURIN (1979: 23 - 24) reported "2n = 32", most probably a wrong count (plants from the same locality in Romania have been counted 2n = 28, unpublished result A. POLATSCHEK).

Examined specimens: Black Sea coast: In arenosis loco dicto Dikilitaš prope Varna ad Pontum, 11.VII.1967, N. Vihodzevsky, sub *E. sessiliflorum* [L]. – In arenosis loco dicto Dikilitaš prope vicum Beloslav, Distr. Stalin, 2.VII.1953, N. Vihodzevsky 153, sub *E. sessiliflorum* [H, JE, PR, W 1955-1156]. – Pobiti kamani, the Teterlika locality, south of Beloslav, 11.VIII.1992, Ant. Petrova, sub *Syrenia cana* [SOM 152688]. – Pobiti kamani, sand dunes south of Beloslav, 14.VIII.1986, M. Ančev A86320 [Ančev], (ANČEV & HARDALOVA 1989, sub *Syrenia cana*)**.

13. *Erysimum repandum* L.

Demonstr. Pl.: 17 (1753); VELEN., Fl. Bulg.: 31 (1891); ASSENOV, Fl. R. P. Bulg. 4: 363 (1970); BALL, Fl. Eur. ed. 2, 1: 335 (1993); JALAS & SUOMINEN, Atlas Fl. Eur. 10: 85 (1994).

Lectotype: (EBEL in CAFFERTY & JARVIS 2002: 533): Herb. Linn. no. 837.5 [LINN].

Annual. Root short, fusiform. Stem slightly flexuous, 4 - 33 cm in flower, up to 47 cm in fruit, usually simple, rarely with a few basal branches, with vegetative short shoots in the upper leaf axils, with 10 - 15(- 25) evenly distributed leaves, in the upper part terrete, with dense bifid and few 3-fid hairs. Leaves 9 - 70 × 1 - 13 mm, lanceolate to linear, lower and middle ones petiolate, upper sessile, lower ones with few teeth to pinnatisect, upper ones with some very small teeth, all with some 2-fid, many 3-fid and very few 4-rayed stellate hairs. Inflorescence in well-developed specimens occupying about 1/2 of the stem, with 2-8 branches, conspicuously elongating in fruit; racemes 6- to 25-flowered, pedicels and siliquae patent, forming an angle of c. 90° to the axis; pedicels 0.8 - 3 mm in flower, up to 5 mm in fruit, almost as thick as the siliquae, with dense 2-fid and few 3-fid hairs. Flowers pale to deep yellow, not fragrant; sepals 3 - 6 × 1 mm, narrowly ovate-lanceolate, with dense medifixed and some 3-rayed hairs; petals 6 - 10 × 1 - 2 mm, narrowly cuneate, pubescent outside with some 2-fid and many 3-fid hairs. Anthers and filaments glabrous. Siliquae 30 - 100 × 1 - 1.5 mm, square in cross-section, slightly torulose, with dense 2-fid, some 3-fid and very few 4-rayed hairs; style 0.5 - 1 (- 1.5) mm, almost as thick as the siliqua, with some 2-fid, many 3-fid and very few 4- to 5-rayed hairs; stigma capitate, slightly retuse. Seeds (1 -) 1.2 - 1.5 × 0.5 mm, ellipsoid, brown. 2n = 16; x = 8.

Distribution and ecology

Distributed all over the country, mainly in the planes, 50 - 900 m. (Fig. 4). C, E and S Europe, the Mediterranean, SW Asia, Caucasus, C Asia. Alien in N America

Roadsides, along railroads, in fallow fields, sometimes on waste ground.

Flowering from late March to June..

Examined specimens: Black Sea coast: Zwischen Bal'ik und Tuzlata, 29.IV.1974, R. Marstaller [JE]. – NE Bulgaria: Madara, 12.V.1980, B. Zheljazova [SOM 33359]. – Devnya, 11.IV.1902, J. Javashev [SOM 33393]. – In pascuis saxosis Dobrodzae, ad pag. Kalakcii (Prisojna), 11.IV.1918, B. Davidov [SOM 33383]. – In graminosis et campis ad Provadia, 1899, I. Urumov [SOM 33374]. – In herbidis Shumenska Trapeza, 30.V.1895, B. Davidoff [SOM 33381]. – Balkan foothil region: Bei Lowtscha (Lowetsch), 1895, I. Urumoff [WU]. – Sofia region: Bei Sofia, VI.1890, Pichler [Brixen]. – Ad Sofia, I. Urumov 575 [BP]. – Ad Sofia, waste places, 3.VII.1956, N. Vihodevski [SOM 93884]. – Ad Knjazhevo, IV.1904, A. Drenovski [SOM 33377]. – Ad pagum Banki, distr. Sofia, 1926, I. Urumov 154, sub *E. goniocaulon* [BP]. – Prope urbem Sophiam, V.1890, C. Keck & Th. Pichler [WU]. – Distr. Sofia, in ruderalis prope pagum Katina, 5.VII.1966, N. Vihodcevsky [GOET]. – Znepole region: In graminosis prope Zemen, distr. Kjustendil, 15.VI. 1911, I. Urumov 593 [SOM 33372, BP]. – In herbidis agri ad urbem Radomir, 650 m, 21.V.1910, B. Davidoff [SOM 33384]. – Golo Bardo bei Pernik: an der Straße zwischer Radomir und Hütte "Orlite", 13.V.1974. H. Manitz & R. Marstaller [JE]. – Ad vill. Buchino, 550 m, 25.V.1932, N. Fenenko, B. Achtarov [SOM 33362]. – Struma valley: Eastward of town Kula, 22.VIII.1975, M. Ančev A5311 [SOM 2992], (ANČEV 1978, ANČEV 1983)**. – Vill. Dolno Sp Ančevo, 33.VII.1987, M. Ančev A87121 [SOM 2983], (ANČEV 2001)**. – Thracian plane: In campi ad Nova Mahala, IV.1914, I. Mrkvicka [SOM 33375]. – In campi ad Papazli, VI.1894, V. Střibrný [SOM 33380]. – Slavjanka Mt.: Near the vill. Petrovo, 6.V.1992, I. Pashaliev [SOM 151520].

14. *Erysimum cheiranthoides* L.

Sp. Pl. ed. 1: 661 (1753); ASSENOV, Fl. R. P. Bulg. 4: 367 (1970); BALL, Fl. Eur. ed. 2, 1: 335 (1993); JALAS & SUOMINEN, Atlas Fl. Eur. 10: 87 (1994).
Lectotype (POLATSCHEK 1974: 174): nr. 837.6 [LINN].

Annual, green to dark-green with 1 - 3 stems. Root short, branched. Stem in flower 6 - 34 cm tall, in fruit 30 - 118 cm, with dense 2-fid hairs, mixed with few 3-fid ones. Leaves 19 - 72 × 4 - 19 mm, lower oblong-lanceolate, distinctly petiolate, entire, repand-dentate to repand-denticulate, middle and upper ones lanceolate, almost sessile, with dense 3-fid, many 4-fid, few 2- and 5-fid hairs. Inflorescence simple or with 2 -9 side branches, sometimes with short additional branches. Flowers yellow to dark-yellow, not fragrant; pedicels 6 - 12 mm, with 2-fid and 3-fid hairs. Sepals 2 - 5 × 1 - 1.3 mm, narrowly ovate-lanceolate, with 2-fid and 3-fid hairs, sometimes with very few 4-fid ones. Petals 3 - 5 × 1 - 2 mm, cuneate, outside pubescent; blade 4.5 - 8 × (2.5 -) 3 - 6.5 mm; stamens glabrous. Siliquae 13 - 30 × 1 - 1.5 mm, covered with mixed 3-fid, 4-fid and 5-fid hairs; angle between the axis of the raceme and the pedicel 75° - 90°, siliqua diverging at 40° - 55°; style 0.3 - 0.5 mm, with 3-fid, 4-fid and 5-fid hairs, stigma capitate. Seeds 1.2 - 1.8, brown. 2n = 16 (many counts, but no Bulgarian material counted).

Distribution and ecology

NE Bulgaria (on the Danube island of Kosuy, Silistra region), W. Balkan foothillregion (near Berkovictza), from 100 up to 450 m (Fig. 10). Europe, Mediterranean, C and SE Asia, Siberia, Himalaya, E. Asia. Alien species in N America.

Grassy habitats, along roads, riversides.

Flowering late May to June.

Note: *E. cheiranthoides* is an annual species with Euro-Asiatic area of distribution. In Europe it is a ruderal or a weedy plant, growing on alluvial soils, along riversides and fallow fields, usually in plant communities of *Chenopodium* spp., *Polygonum* spp., *Sisymbrium officinale*, sometimes as a weed in vegetable crops (STEPANEK 1992, JANKUN 1965). *E. cheiranthoides* does not occur in Italy, Albania, Greece, Turkey.

Until recently in the Bulgarian flora *E. cheiranthoides* was known only from the locality near Bercovica according to the collection of Střibrný dating from 1915. The second locality of *E. cheiranthoides* situated on the Danube island of M. Kosuy near Silistra (DIMITROV 1991: 75) is with more recent origin. GEORGIEV (1889) reported *E. cheiranthoides* "near the railroad" in the surroundings of Pazardjik, but there were not found any specimens for this record. The localities of *E. cheiranthoides* in Bulgaria, on the north of Stara Planina, are the only ones in the south-eastern part of the Balkan Peninsula.

Examined specimens: North-Eastern Bulgaria: The island of Malak Kosuy, between the villages of Pojarevo and Dunavec, Silistra region, 14.VII.1986, G. Baeva & D. Stojanov [SOM 145660]. – Bercovitza, VII.1915, Střibrný [SOM 33207].

Unclear records

DELIPAVLOV & DIMITROV (1973) reported *E. pusillum* BORY & CHAUB. for Pirin Mt., the area around "Banderitza". In the Bulgarian Herbariums (SO, SOA, SOM) were not found any materials related to this report. - It can probably be refered to *E. drenowskii*, which occurs in this area.

Table 6: Hair types on different parts of the *Erysimum* species distributed in Bulgaria: **2**: 2-fid hairs dominant (more than 50%); 2: 2-fid hairs common (10-50%); (2): 2-fid hairs uncommon (up to 10%);((2)): 2-fid hair rare; **3**: 3-fid hairs dominant, etc. A dash (-) in the column Basal leaves indicates that they are usually absent on flowering and fruiting plants.

Species	Stem	Basal leaves	Cauline leaves	Pedicels	Sepals	Petals	Stamens	Siliqua	Style
E. bulgaricum	**2** + (3) + ((4))	-	(2) + **3** + 4 + (5) + ((6))	**2** + 3 + (4)	**2** + 3 + (4)	2 + **3** + (4)	glabrous	**2** + 3 + (4)	(2) + 3 + 4 + (5) + ((6))
E. cheiranthoides	**2** + (3)	-	(2) + **3** + 4 + (5)	2+ 3	2 + 3 + ((4))	3 + 4	glabrous	3 + 4 + 5 + ((6))	3 + 4 + 5 + ((6))
E. comatum	**2**	-	**2** + ((3))	**2**	**2** + (3)	**2** + ((3))	glabrous	**2** + (3)	**2** + ((3))
E. crassistylum	**2**	-	**2** + (3) + ((4))	**2**	**2** + (3)	**2** + (3)	((2 + 3))	**2** + ((3))	(2) + **3** + ((4))
E. cuspidatum	**2** + (3) + ((4))	-	((2))+ 3 + **4** + (5) + ((6))	(2) + **3** + ((4))	(2) + **3** + 4 + (5)	(2) + 3 + 4 + (5)	((2)) + 3 + 4 + (5) + ((6))	(3) + 4 + 5 + (6) + ((7))	3 + **4** + 5 + (6)
E. diffusum	**2**	-	**2** + (3)	**2**	**2** + (3) + ((4))	**2** + ((3))	**2**	**2** + (3) + ((4))	(2) + **3**
E. drenowskii	**2**	-	**2** + ((3))	**2**	**2** + (3)	2 + 3	glabrous	**2** + ((3))	2 + 3 + ((4))
E. odoratum	**2** + (3)	-	(2) + **3** + (4) ((5 + 6 + 7))	2 + 3	2 + 3 + ((4))	2 + **3** + ((4))	2 + **3** + (4)	**2** + (3) + ((4))	2 + **3** + (4) + ((5))
E. pirinicum	**2**	-	**2**	**2**	**2** + (3)	**2** + (3)	glabrous	**2**	**2** + (3)
E. pseudoatticum	**2** + ((3))	**2**	**2** + ((3))	**2**	**2**	**2**	glabrous	**2**	(2) + **3**
E. quadrangulum	**2** + (3)	-	**2** + (3)	**2**	**2** + (3)	glabrous	glabrous	**2** + (3) + ((4))	**2** + (3)
E. repandum	**2** + (3)	-	2 + **3** + ((4))	**2** + (3)	**2** + 3	2 + **3**	glabrous	**2** + 3 + ((4))	2 + 3 + ((4))
E. slavjankae	**2**	**2** + (3)	**2** + (3)	**2**	**2** + (3)	glabrous	glabrous	**2**	2 + 3
E. welchevii	2	-	**2** + (3) + ((4))	**2**	**2** + 3	**2** + **(3)**	((2))	**2** + (3)	2 + **3** + ((4))

According to BALL (1993) *E. pusillum* subsp. *microstylum* ranges in "C. & N. Greece, S. Jugoslavia, S.W. Bulgaria & S. Albania". Our research did not confirm the distribution of *E. pusillum* subsp. *microstylum* in Bulgaria.

Two species, *E. strictum* GAERTNER, MEYER & SCHERB. and *E. exaltatum* BESSER, reported for Bulgaria (BALL 1993: 334; JALAS & SUOMINEN 1994: 74, 80), remain with unconfirmed distribution in the Bulgarian flora.

VELENOVSKÝ (1898: 32) reported "*E. strictum* Fl. W." [*E. strictum* GAERTNER, MEYER & SCHERB., Flora Wetterau 2: 451 (1800)] for the vicinity of Lom, following PANČIČ (1886: 16). STOJANOV & STEFANOV (1924: 523) followed VELENOVSKÝ (l. c.), and proposed the combination "*E. hieracifolium* ssp. *strictum* Fl. Wett. II, 1800, p. 451", later homonym of *E. hieracifolium* subsp. *strictum* (GAERTNER, MEYER & SCHERB.) ROUY & FOUC., 1895.

URUMOV (1900: 16) probably first mentioned *E. exaltatum* for habitats near Jantra river arround Tarnovo, Drjanovo and Samovodene in N Bulgaria. STOJANOV & STEFANOV (1924: 524) coined the idea of a hybrid origin of this species: "*E. exaltatum* (ANDRZ.) SCHMALH.= *E. canescens* [= *E. diffusum*] × *odoratum*", considering that the indumentum of *E. exaltatum* combines characters typical for the supposed parental species.

In the second and the third editions of Flora of Bulgaria (STOJANOV & STEFANOV 1933: 477; 1948: 524) *E. strictum* and *E. exaltatum* are in subspecies combinations with *E. hieracifolium*. In the fourth edition of the same Flora and later in Flora N. R. Bulgaria (ASSENOV 1970: 363) was adopted *E. hieracifolium* with "var. *hieracifolium*" and "var. *exaltatum* (ANDRZ.) HAYEK." In the synonymy of "var. *hieracifolium*" was included "*E. hieracifolium* subsp. *strictum* (GAERTNER., G. MEYER & SCHERB.) STOJ. & STEF.". *E. hieracifolium* var. *hieracifolium* was indicated for the Danube plane (Lom, Orjahovo), probably according to the data of PANČIČ (l.c.) and VELENOVSKÝ (l.c.) for *E. strictum*. There is not any new information about the distribution of "var. *exaltatum*", indicated for "Balkan foothill region (Tarnovo, Drjanovo)", by URUMOV (1900).

Analysis of this data shows that in the Bulgarian botanical literature the information about the distribution of these two species follows the reports of PANČIČ (1886) for *E. strictum* and URUMOV (1900) for *E. exaltatum*. In the Bulgarian herbaria, as well as in collections of BP, PR, PRC and W, were not found specimens, belonging to these species from the territory of Bulgaria. *E. strictum* and *E. exaltatum* were also not confirmed during our field studies in the Danube plane and the Balkan foothill region in the vicinities of Lom, V. Tarnovo and Drjanovo.

Species wrongly reported for Bulgaria

Erysimum pulchellum (WILLD.) GAY

BALL (1993) reported this species for the "mountains of E. Albania, S. Jugoslavia, Bulgaria". *E. pulchellum* is an endemic for the flora of Turkey (CULLEN 1964) and does not occur in Europe (JALAS & SUOMINEN 1994). The report of *E. pulchellum* for Bulgaria is based on a plant collection of T. Pichler, and one specimen of this collection was kindly sent to us for revision from Kew. It contains eight plants, six of which are with flowers, two are juvenile ones, with leaf rosettes only. They all belong to *E. pulchellum*. The herbarium sheet has a label: "*Erysimum pulchellum* W. Bei Kalofer am Fuss des Balkan,

Aug. 1874, Th. Pichler". 1962 the material has been revised by P.W. Ball, who confirmed the species identity. There is hardly any explanation but having a technical mistake when labelling the herbarium collections of T. Pichler from Anatolian Turkey. In the same year 1874 T. Pichler collected *E. pulchellum* in Bithynian Olympus, and there is a specimen from this collection in the Herbarium of the Plovdiv Agriculture University: "*Erysimum pulchellum* WILLD., In Olympo Bithyn, Juny 1874, T. Pichler" [SOA 8800]. STEFANOV (1930) also paid attention to the fact, that few species described by Boissier, probably collected by his collaborators T. Pichler and Noe in Asia Minor, including *Thesium brachyphyllum* and *Johrenia pichleri*, were wrongly indicated as occuring in Bulgaria.

BALL (1993) related to the synonymy of *E. pulchellum* the Balkan endemic *E. korabense* KÜMMERLE, distributed in Albania and neighbouring mountains of former Jugoslavia (cf. JALAS & SUOMINEN 1994). None of these two species have been found in Bulgaria, including through the field studies in Central Stara Planina around Kalofer and Sopot from the foothills of the mountain up to the alpine area between the summits Levsky and Triglav.

E. smyrnaeum BOISS. & BALANSA

VELENOVSKÝ (1891: 32) reported this species for the region of Bjala on the material of Janka – "... In collinis ad Bjela (Jka)". *E. smyrnaeum* is an Anatolian species, indicated in question for the islands of the Eastern Aegean, and does not occur in continental Europe (CULLEN 1964, KUZMANOV 1979, POLATSCHEK in GREUTER & al. 1986, JALAS & SUOMINEN 1994, ANČEV 2001).

Table 7: Characters distinguishing *E. witmannii* from *E. cuspidatum*.

Characters	*E. witmannii*	*E. cuspidatum*
Sepals	8-12 mm	5 - 7 mm
Petals	(12) 15 - 24 × 5 - 9 mm	9 - 13 × 2.5 - 4 mm
Siliqua	(25 -) 35 - 85 (- 120) mm,	10 - 30 mm,
	lateraly not compressed	lateraly compressed
	not winged	winged
Style	1 - 1.3 mm	3 - 7 mm
2n	14	16

E. witmannii ZAWADZKY

STOJANOV (1941: 159) reported for Central Stara Planina, the summit of Kozjata Stena in Troyanski Balkan, *E. baumgartenianum* SCHUR, 1866 (= *E. witmannii* ZAWADZKY, 1835). Later following STOJANOV (l. c.) this species was accepted for the Bulgarian flora (STOJANOV & STEFANOV 1948, STOJANOV & KITANOV 1966, STOJANOV, STEFANOV & KITANOV 1966). The plant material collected and identified by N. Stojanov in 1940 is kept in the Herbarium of Sofia University: "*E. baumgartenianum* SCHUR, In graminosis calcareis cacum Kozjata stena, m. Trojanski Balkan, ca. 1650 m s. m., 26.VII.1940, N. Stojanov" [SO 28989]. These are two plants with flowers, which belong to *E. cuspidatum*.

The fruits are not completely developed, and possibly because *E. baumgartenianum* differs from *E. cuspidatum* mainly on the morphology of the siliqua, the plants were not correctly identified. ASSENOV (1970: 363) first elucidated this problem, and included "*E. witmannii* auct. bulg." and "*E. baumgartenianum* auct. bulg." in the synonymy of *E. cuspidatum.* BALL (1993), probably following some of the earlier references on the Bulgarian flora, indicated *E. witmannii* for Bulgaria. *E. witmannii* occurs in the mountains of S Poland, Hungary, Slovakia and Roumania (JALAS & SUOMINEN 1994).

Discussion

Most probably the ancient centre of species differentiation of *Erysimum* was closely related to the SW Asia and the Irano-Turanian region as the highest species diversity here is associated with a high percentage of species endemicity (cf. POLATSCHEK & RECHINGER 1968).

In the Mediterranean area and S. Europe more than 100 perennial, biennial and annual species occur, many of which are endemics for the Balkan Peninsula, the Apennines and the Iberian Peninsula. Some of the supposedly oldest species in the genus, shrubs and semishrubs from section *Cheiranthus* (L.) SNOGERUP, have distribution areas in the East Mediterranean, limited mostly to the Aegean flora (SNOGERUP 1967a, b; GREUTER & al. 1986; POLATSCHEK & SNOGERUP 2002).

Ecological characteristics

The European representatives of *Erysimum*, distributed from the sea level up to the alpine vegetation of the high mountains, all more or less confined to arid habitats. They are xerophytes, mesoxerophytes or xeromesophytes. Out of 80 species in Europe only *E. virgatum* and *E. cheiranthoides* reach the extreme northern latitudes of the continent, approximate twenty species occur to the north up to the fifty-fifth degree of latitude. So the northern limits of *Erysimum* in Europe are more or less correlated with the northern border of the deciduous forests.

In the Bulgarian flora 6 of the 14 species are xerophytes: *E. comatum*, *E. crassistylum, E. diffusum*, *E. pirinicum*, *E. quadrangulum* and *E. welchevii*. They live in open habitats in the planes, on the slopes of foothills and mountains in the xeromesophyte and mesophyte oak and hornbeam forest belts, rarely reaching up to the beech forest area in the mountains of SW Bulgaria. All these species are mainly calcicole plants, but *E. diffusum* and *E. crassistylum* occur also on silicate substrate.

The perennials *E. drenowskii*, *E. pseudoatticum* and *E. slavjankae* are xeromesophytes. *E. pseudoatticum* has the widest vertical distribution and occurs in scattered localities from the vegetation belt of the oak forests up to the alpine area, where it grows on open mountain slopes, preferably on gneisses and granites, only sometimes on limestones. *E. drenowskii* is a calcicole plant, occuring in the beech and coniferous vegetation belts of Central Stara Planina, N Pirin and Slavjanka Mts., from 900 up to the 1900 m. *E. slavjankae* has a confined distribution in the subalpine belt of Pirin and Slavjanka Mts..

The biennial *E. cuspidatum* is a calcicole mesoxerophyte with scattered localities all over the country, most of them in the lowlands and planes, on the slopes of the moun-

tain foothills and low mountains in plant communities in the oak vegetation belt. Individual populations, more or less morphologically differentiated, form ecotypes in the zone of the beech and coniferous forests in Central Stara Planina and N Pirin Mt.

The annual *E. repandum* is a mesophyte to xeromesophyte. It is a ruderal and often weedy plant distributed all over the country, prefering moderately moist terrains. To the ecological category of the xeromesophytes also belong the biennial *E. odoratum* and *E. bulgaricum*.

Perennial *E. drenowskii*, *E. pseudoatticum* and *E. slavjankae* form mosaic and patchy populations of low density. Biennial *E. diffusum, E. moesiacum, E. welchevii, E. bulgaricum* with populations occuring in open habitats usually have small populations, and rarely form large populations, numbering several to several hundreds individuals.

Reproductive Biology

Bulgarian species of *Erysimum* have flowers with erect, often linear lanceolate sepals with narrow membranous margins, the outer sometimes horned near apex, the inner usually saccate at the base, a character better expressed in the perennials. Petals are from pale yellow to golden yellow, the blade wide to narrow obovate or spathulate, more or less gradually narrowed into an erect claw. Stamens in the Bulgarian species are with clearly expressed tetradynamy. Nectaries with different shape are present around the outer stamens, and usually also outside the inner ones. The flowers of *E. drenowskii*, *E. pseudoatticum*, *E. slavjankae*, *E. comatum*, *E. pirinicum, E. diffusum*, *E. crassistylum*, *E. welchevii, E. bulgaricum* and *E. cuspidatum* are dichogamous, morphologically protogynous, the style standing out of the still closed flower bud, or with differences in the position of the stigma towards the anthers in functionally protogynous ones. The protogyny has been oberserved for many genera of the Cruciferae (AL-SHEBAZ 1977), for *Erysimum* this observation is published here the first time.

E. drenowskii, *E. pseudoatticum* and *E. slavjankae* have large flowers with 11 to 22 mm long petals. They are morphologically protogynous plants with the protogyny correlating with fragrant flowers. Especially characteristic in this respect is *E. slavjankae* which has flowers with a very well expressed balmy fragrance. *E. drenowskii*, *E. pseudoatticum* and *E. slavjankae* are supposedly crosspollinating, allogamous plants, although the flower development does not exclude the possibilities of selfing and autogamy.

Morphological protogyny was observed in populations of *E. comatum*. The plants have large flowers, attracting mining bees (Andreninae), sweet bees (Halictidae) and syrphid flies, sometimes honey bees.

Plants of *E. cuspidatum*, distributed in the lowlands and on the foothills from the sea level up to 900 m have functionally protogynous flowers. By contrast with these populations, the plants growing in the coniferous vegetation belt of N Pirin Mt. are morphologically protogynous.

Biennial *E. bulgaricum*, *E. diffusum, E. crassistylum* and *E. welchevii*, in comparison with the perennial species, have smaller flowers without fragrance, with petals 8 - 12 mm in *E. crassistylum* and *E. diffusum*, and 8 - 15 mm long in *E. bulgaricum* and *E. welchevii*. The flowers are functionally protogynous, as morphological protogyny was

observed in none of the more than 50 investigated populations. Although flowers are rarely visited by small hymenopterous insects, syrphid flies mostly, the plants form numerous seeds - probably a result of selfpollination.

E. cheiranthoides and *E. repandum* are proven autogamous plants (FELINER 1990), although in Bulgarian populations of *E. repandum* plants were observed with morphological protogyny which allows crosspollination (ANČEV 1983).

Bulgarian species of *Erysimum* propagate by seeds, which are small and light-weight, as the average seed weight varies from 0.49 mg in *E. slavjankae* to 0.23 mg in biennials *E. comatum*, 0.11 mg in *E. diffusum,* 0.08 mg in *E. crassistylum.*

In Bulgarian species under the conditions of predominantly temperate continental climate the seeds ripen 70-80 days after flowering. Thus, depending on the altitude and time of the flowering, the seeds ripen in the following sequence:

Altitude	Flowering	Ripe seeds
0 - 700 m	10 May - 30 May	20 July - 20 August
700 - 1300 m	20 May - 15 June	5 August - 30 August
1300 - 2000 m	10 June - 30 June	25 August - 20 September
2000 - 2500 m	1 July - 20 July	15 September - 10 October

The seeds are dispersed by barochory, anemochory and rain floods. Anemochory, although not specialized, is probably an important pattern for seed dispersal and occupying of new habitats with expanding the distribution area. At the same time the insular distribution of populations of *E. drenowskii*, *E. pseudoatticum* and *E. slavjankae* in the subalpine and alpine mountain areas of the Rilo-Rhodope Massif supposes a possibility of long distance dispersal. This could be achieved by "episodical dispersal" of diaspores, seeds or plants with fruits as a result of a transport by storms which are not so rare phenomenon for the mountains of the Rilo-Rhodope Massif. The success of the distribution far away from the parental population depends on the reproductive system and the propagation of the first plants in the newly occupied habitat. At least some of these plants probably form seeds by gejtonogamy (crosspollination between flowers of the same plant) or by selfpollination and autogamy.

Chromosome numbers and karyotypes

Because the chromosomes in *Erysimum* are small and mostly with rather faint position of the centromere, in the literature there are very little data about the chromosome morphology, structure and symmetry of the karyotype, and probably only in the cytotaxonomic investigations on *Erysimum* sect. *Cheiranthus* provided by SNOGERUP (1967). Nevertheless, some characters of the karyotype and especially the chromosome number and the ploidy level, treated together with the species morphology, ecology and phytogeography are helpful in the systematic investigations in *Erysimum.*

The chromosome numbers and the karyotypes of 12 out of 13 *Erysimum* species occuring in Bulgaria, were studied in specimens of 116 populations distributed in 19 out of the 20 floristic regions of the country. 11 of the 13 studied species have a basic chromosome number x = 7, known for most of the European representatives of the genus,

Table 8: Chromosome numbers of *Erysimum* in Bulgaria.

Species	x	ploidy level	chromosome number
E. bulgaricum	7	2 x	14
E. comatum	7	2 x	14 + 0-2 B
E. pirinicum	7	4 x	28
E. quadrangulum	7	4 x	28
E. diffusum polyploid complex			
E. crasssistylum	7	2 x	14
E. diffusum	7	4 x	28
E. welchevii	7	6 x	42
E. drenowskii polyploid complex			
E. drenowskii	7	2 x	14 + 0-2 B
E. pseudoatticum	7	6 x	42
E. slavjankae	7	12 x	84 + 0-6 B*
E. cuspidatum	8	2 x	16 + 0-2 B
E. repandum	8	2 x	16
E. odoratum	8	4 x	32

* This is the highest known chromosome number in the European species of the genus.

and probably the most widely distributed in *Erysimum.* Three species have chromosome complements with basic number x = 8. The results are given in Table 8.

Accessory chromosomes were observed in karyotypes studied in plants from populations of *E. drenowskii*, *E. slavjankae*, *E. comatum* and *E. cuspidatum*. They are the shortest in the karyotype, dark stained, often without well visible centromere. In the high-polyploid karyotype of *E. slavjankae* the accessory chromosomes are usually 1 - 2, and in separate chromosome sets with chromosome number c. 90 observed in specimens from one and the same plant population, they are 5 or 6. In these karyotypes, because of the small lenght of the short chromosomes, the shortest one spot-like, it is not possible to distinguish the accessory chromosomes from the shortest A-chromosomes.

The karyotypes of the studied species consist of chromosomes with a length from 0.6 mμ to 1.7 mμ, rarely some longer. Provisionally according to their relative lenght they can be classified in three groups: long, medium-sized and short chromosomes.

In the karyotypes of the diploid cytotypes the chromosomes are well differentiated in their length. They are mostly of sm- type and one or two pairs of m-type. In most of the observed karyotypes one chromosome pair exceeds in lenght all others, and another one is a little shorter than the longest one. The tetraploid karyotypes have also two long chromosome pairs. In the hexaploid karyotype of *E. pseudoatticum* two to five chromosome pairs are longer than the rest of the chromosomes in the set.

In the diploid karyotypes the primary constriction of the chromosomes is well visible in the long and medium-sized ones, and is often rather faint or not visible in the short chromosomes. In the polyploid karyotypes the position of the centromere appears in the long chromosomes, and sometimes in some of the medium -sized ones.

The karyotype of *E. slavjankae* is markedly asymmetric with 10 - 12 pairs relatively long chromosomes and 30 - 32 pairs shorter ones, the shortest of which 10 - 12 pairs have a length of 1/3 to 1/2 of the longest chromosomes in the karyotype. The position of the centromere could be determined only in some of the long chromosomes which are of m- and sm-type. In the short chromosomes the primary constriction is not expressed, some of them remind of telocentric chromosome morphology, as five pairs are almost spot-like. A high-ploidy chromosome number and the asymmetry of the karyotype suppose an allopolyploid origin with the participation of two or more parental genomes.

In all studied diploid karyotypes one satellite chromosome pair was observed. In the polyploid chromosome sets the satellite chromosomes are one to three pairs. The satellites are small, of microsatellite-type.

In *Erysimum* the origin of the polyploid species and their role for the evolution of the group has been of permanent interest. Considering the morphology, distribution and species geography of *Erysimum* in the Bulgarian flora, two groups of morphologically closely related diploid and polyloid species are of interest: the polyploid complexes of *E. drenowskii* and *E. diffusum*. They probably arouse independently in different time and under different biocenotic conditions.

Members of the first group are the diploid/tetraploid *E. drenowskii*, the hexaploid *E. pseudoatticum* and the dodecaploid *E. slavjankae*. They are loosely to densely caespitose entomophylous perennial plants with short racemose inflorescences with morphologically protogynous, comparatively large fragrant flowers. The species of this group prove a development of forest and alpine mesophyllous and xeromesophyllous ecotypes.

The diploid *E. crassistylum*, the tetraploid *E. diffusum* and the hexaploid *E. welchevii* are members of the second polyploid complex represented in Bulgaria. The decaploid *E. andrzejovskianum* BESSER (2n = 70), distributed from W Serbia and Central Europe to N Caucasus also belongs to this group. These biennial plants have racemose inflorescences with numerous smaller, functionally protogynous flowers without scent. Concentrated in open xerophylous plant communities, they have wider areas of distribution, supposedly as a result of the biennial life form and better competitive abilities.

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