

Zeitschrift: Candollea : journal international de botanique systématique = international journal of systematic botany

Herausgeber: Conservatoire et Jardin botaniques de la Ville de Genève

Band: 60 (2005)

Heft: 2

Artikel: Erucastrum nasturtiifolium supsp. benacense F. Martini & F. Fen. (Cruciferae, Brassiceae) : a new taxon from Northern Italy

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DOI: <https://doi.org/10.5169/seals-879283>

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Erucastrum nasturtiifolium subsp. *benacense* F. Martini & F. Fen. (Cruciferae, Brassiceae), a new taxon from Northern Italy

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ABSTRACT

MARTINI, F. & F. FENAROLI (2005). *Erucastrum nasturtiifolium* subsp. *benacense* F. Martini & F. Fen. (Cruciferae, Brassiceae), a new taxon from Northern Italy. *Candollea* 60: 469-479. In English, English and French abstracts.

A new subspecies of *Cruciferae*, *Erucastrum nasturtiifolium* subsp. *benacense* F. Martini & F. Fen. from the Lombardy Pre Alps (North Italy), is described, illustrated and compared with the types of the other subspecies. The new taxon, *E. nasturtiifolium* subsp. *benacense*, basically differs by its leaves glabrous or with only few sparse hairs on the veins and/or on the margin, by its sepals entirely glabrous or rarely with few hairs at the apex, and by its petal-limb usually longer than the petal claw.

RÉSUMÉ

MARTINI, F. & F. FENAROLI (2005). *Erucastrum nasturtiifolium* (Poir.) O. E. Schulz subsp. *benacense* F. Martini & F. Fen. (Cruciferae, Brassiceae), un nouveau taxon de l'Italie du Nord. *Candollea* 60: 469-479. En anglais, résumés anglais et français.

Une nouvelle sous-espèce de la famille des *Cruciferae*, *Erucastrum nasturtiifolium* subsp. *benacense* F. Martini & F. Fen. des pré-Alpes de Lombardie (Italie du Nord), est décrite, illustrée et comparée avec les types des autres sous-espèces. Le nouveau taxon, *E. nasturtiifolium* subsp. *benacense*, diffère fondamentalement par ses feuilles glabres ou présentant seulement quelques poils épars sur les nervures et/ou sur la marge foliaires, ses sépales entièrement glabres ou présentant rarement quelques poils à leur apex, et ses pétales présentant un limbe généralement plus long que l'onglet.

KEY-WORDS: CRUCIFERAE – *Erucastrum* – Italy

Introduction

The Lombardy Pre Alps (South-Eastern of Alps) belong to the Insubrian district, a territory of great floristic interest, characterized in regards to the phytogeographical aspect by the stenoendemism. It is expressed, among others, by *Saxifraga presolanensis* Engl., *Linaria tonzigii* Lona, *Galium montis-arerae* Merxm. & Ehrend., *Campanula raineri* Perp., *Allium insubricum* Boiss. & Reut., *Daphne xreichsteinii* Landolt & E. Hauser and *Primula albenensis* Banfi & Ferl., recently described by BANFI & FERLINGHETTI (1993). The stenoendemic phenomenon is particularly remarkable on the Pre Alps north of the towns of Bergamo and Brescia, where it is possible to meet five species of *Moehringia*, such as *M. dielsiana* Mattf., *M. glaucovirens* Bertol., *M. markgrafii* Merxm. & Gutermann, *M. bavarica* subsp. *bavarica* (L.) Gren. and subsp. *insubrica* (Degen) W. Sauer and *M. concarenae* F. Fen. & F. Martini (FENAROLI & MARTINI, 1992).

The high rate of endemic species in this part of the Southern Alps, rich in about eighty taxa, appears to be second only to the Maritime Alps and is ascribed to the interaction among geomorphologic, climatic and phytohistoric factors (CESATI, 1848; GIACOMINI, 1943; KUNZ & REICHSTEIN, 1959; PITSCHMANN & REISIGL, 1959). In particular, these factors are:

- a central position into Alpine system;
- a marginal position related to Quaternary glacial expansions, mainly the Würmian one, with consequent persistence of wide not-icy territories («massifs de refuge»);
- some propitious climatic conditions, marked with general mildness and elevated atmospheric humidity in height with frequent summer fogs.

The genus *Erucastrum* in Europe

The genus *Erucastrum* C. Presl belongs to the subtribe *Brassicinae* Sond., marked by linear siliqua not clearly constricted between the seeds, more or less spherical seeds and flowers with median and lateral nectars (PRANTL, 1889). The European and Italian flora number only four of the fourteen known species (TUTIN & AKEROYD, 1993; PIGNATTI, 1982), as the distributing barycentre of the genus is located on the Western Mediterranean region (THELLUNG, 1918; GREUTER & al., 1986; GÓMEZ-CAMPO, 2000) and the Macaronesian one (GÓMEZ-CAMPO, 1984).

Among the European species, *E. gallicum* (Willd.) O. E. Schulz is distributed in Western Europe from Southern France to the Ardennes and the Moselle region. It results naturalised elsewhere as, for instance, Great Britain, Scandinavian peninsula, Eastern Europe (JALAS & al., 1996). In Italy, it appears to be spontaneous only in Aosta Valley (VACCARI, 1904), while it results naturalised in Trentino (Prosser, *in litt.*).

Concerning the four subspecies of *E. virgatum* (J. Presl & C. Presl) C. Presl, the subspecies *brachycarpum* (Rouy) Gómez-Campo, *pseudosinapis* (Lange) Gómez-Campo and *baeticum* (Boiss.) Gómez-Campo belong to Southern and South-Eastern Spain (GÓMEZ-CAMPO, 1983, 1993), whereas the nominal subspecies is endemic from Calabria and North-Eastern Sicily (BRULLO & al., 2001).

Erucastrum palustre (Pirona) Vis. is an endemic species of the alkaline bogs of the low plain of Friuli (NE Italy) (MARTINI & POLDINI, 1986). Because of its own rarefaction due to the disappearance of a lot of its natural *habitat*, it has been included among the threatened species of the Italian flora (CONTI & al., 1992; IRIONDO & al., 1994) as well as of the world-wide one (WALTER & GILLET, 1998).

Erucastrum nasturtiifolium (Poir.) O. E. Schulz has a South-Western European distribution, extended from South-western Europe to Northern France and Southern Germany (JALAS & al., 1996). It is also found in Western Alps, Langhe (NW Italy) (ABBÀ, 1990), and from Northern Apennines (PIGNATTI, 1982) to the Marche (BALLELLI, 1987). Elsewhere in Central and Eastern Europe and in Italy it has an adventitious character. According to the review by VIVANT (1977), although it has not been accepted by TUTIN & AKEROYD (1993), communities from Central and Western Pyrenees should be ascribed to the subspecies *sudrei* Vivant (SAULE, 1991; GÓMEZ-CAMPO, 1993), while the remaining ones have been considered to belong to the type subspecies.

Materials and methods

The morphometric analysis *in vivo* has involved 100 specimens of *E. nasturtiifolium* subsp. *nasturtiifolium* which have been reproduced from seeds collected in nature (Aosta Valley) or coming from Botanical Gardens, as specified below, and 150 specimens of the new subspecies *benacense*, partly cultivated and partly in nature. The results are reported in Tables 1-3, that report the lowest and the highest registered values, the range of variability, the mean and the median values, the standard deviation and the number of the measures.

The cariological investigation was carried out on seeds collected on the field (Gargnano, along the state road “Western Gardesana” at the km 87.5, 200 m) on root tips of seedlings, pre-treated with 8-hydroxyquinoline, fixed in a solution of glacial acetic acid: absolute ethanol (1:3, v/v) (Carnoy’s fluid), hydrolysed in HCl 1N at 60° C for six minutes and stained with Feulgen method.

The analyses on natural populations of subspecies *benacense* were carried out in the following geographical areas:

State road "Western Gardesana" at the km 87.5 (Gargnano), cliffs E exp., 200 m, 16.IV.2001;
State road "Western Gardesana" km 1 after the cross-road to Tignale, 120 m, 19.IV.2001;
State road "Western Gardesana" near the crossroad to Tremosine, cliffs, 80 m, 21.IV.2001.

The areas of seed harvesting are:

Erucastrum nasturtiifolium subsp. *nasturtiifolium*:

Italy: Aosta Valley, Cogne, Lillaz, 1600 m;
Germany: Botanical Garden of Oldenburg;
Switzerland: Botanical Garden of St. Gallen.

Erucastrum nasturtiifolium subsp. *benacense*:

Gargnano, along the state road "Western Gardesana" at the km 87.5, 200 m.

Results and discussion

Sepals dress

Important floristic treatises (THELLUNG, 1918; HESS & al., 1970) underline the almost constant presence of hairiness on the sepals of *E. nasturtiifolium* subsp. *nasturtiifolium*. Our observations on living plants and those on herbarium specimens confirm at least the external sepals to be hairy at the top, because of 0.4-0.7 mm long cilia, while in the subspecies *benacense* they are glabrous in most cases, seldom with some hair on the external sepals.

Stem and leaves dress

Erucastrum nasturtiifolium subsp. *nasturtiifolium* and also *E. nasturtiifolium* subsp. *sudrei* are hirsute plants at least at the bottom, though more frequently the hairiness is present up to the first branches of inflorescence and above. The leaves appear to be more or less hirsute too, even if this character tends to decrease in the adult leaves (VIVANT, 1977). Anyhow, our observations lead us to conclude that in both subspecies of *E. nasturtiifolium* the young leaves at least appear always hirsute. On the contrary, in the subspecies *benacense*, the dress is absent or very poor in the whole plant, and particularly in the young leaves, which are always glabrous or with some hair scattered at the margin even in the adult age; the stem is glabrous or scarcely hairy just in the lowest basal 1-3 internodia.

Petal secondary veins

Usually, the subspecies *nasturtiifolium* shows anastomosed veins, with 5-6 fields and 1-2 free veins on each side; in subspecies *benacense*, the secondary veins appear mostly free at the margin or with 1-2 anastomosed fields on each side at the most. In any case, in the subspecies *nasturtiifolium*, the anastomosed fields exceed the free ones on each side, while the opposite occurs in the subspecies *benacense*. However, this character would require further *in vivo* investigations, since bibliographical references on this matter are vague and its examination appears to be very difficult without causing damages on the herbarium specimens.

Sepals length

For the subspecies *nasturtiifolium* a range of 4-6 mm (HESS & al., 1970; PIGNATTI, 1982; TRINAJSTIĆ, 1986; GÓMEZ-CAMPO, 1993; TUTIN & AKEROYD, 1993), exceptionally to 8 mm (THELLUNG, 1918) is reported in literature. The measurements (Table 1) yield a greater length for the subspecies *benacense*, between (6-)6.7-7.9(-8.6) mm, with an average of 7.3 mm.

Petals length

Regarding to the petals, the above mentioned authors report for *E. nasturtiifolium* a range of length of 6-9 mm to 12(-15) mm in THELLUNG (1918) and HESS & al. (1970). Table 2 shows the values of the measurements *in vivo*; a displacement towards the upper limit of the variability range, with average values between 10.6 and 12.2 mm (St. Gallen). Therefore, the total range of variability for the subspecies *nasturtiifolium* cultivated specimens appears to be: (9-)10.5-12.3(-13.5) mm. As for the sepals, also in this case, the subspecies *benacense* shows higher average values, between 13.3 and 14.6 mm (Gargnano), while the total variability range is summarised as follows: (11.9-)12.9-14.7(-16.4) mm. For this character, the Student test applied to a random sample of measurements (25%) gave significant results, as shown in Table 4.

Ratio between limb and petal claw

In the subspecies *nasturtiifolium*, the limb is shorter than or equal to the claw, while in the subspecies *benacense*, it is usually longer (Table 3). Moreover, the variability ranges do not show any overlap. Therefore, it should be a sufficiently reliable quantitative character, as also confirmed by the Student test (Table 4).

Additional characters

Some additional characters disappear upon drying and therefore they have been observed only *in vivo*. Particularly the leaves of subsp. *benacense* are a little bit fleshy, flat, light green, while in the subspecies *nasturtiifolium* they show no plumpness, they are dark green and the lobes are undulate at the edge.

Cariology (by T. Cusma Velari & L. Pellizzari)

The examined population has a tetraploid chromosome number $2n = 32$, rarely with 1-4 B chromosomes, based on 15 metaphase plates (Fig. 1).

Our counts differ from the majority of references available for *E. nasturtiifolium* (f.i. HARBERD, 1972; QUEIROS, 1973; VIVANT, 1977; KIRSCHNER & al., 1982; BALTISBERGER & CHARPIN, 1989), which presents the diploid number $n = 8$ or $2n = 16$; the tetraploid number $n = 16$ (or $2n = 32$) was reported only for material from Botanical Garden (HARBERD, 1972).

Descriptions and diagnosis

Erucastrum nasturtiifolium subsp. *benacense* F. Martini & F. Fen., **subsp. nova** (Fig. 2).

Typus: ITALY. **Brescia:** provincia di Brescia, Gargnano, SS Gardesana occidentale al km 87, 180 m, *F. Fenaroli* & *F. Martini s.n.* (holo-: FI, iso-: HBBS, LJU, MFU).

Hemikryptophyton rosulatum. *Planta biennis vel perennis, caulibus erectis, (30) 40-80 (100) cm longis, superne ramosis, glabris vel 1-3 internodiis inferioribus sparsim reflexo-pilosis. Folia longe petiolata, plana, subcarnosa, radicalia lyrato-pinnatipartita vel -pinnatisecta, lobis rotundatis, superiora subsessilia, lanceolato-linearata, etiam juvenilia glaberrima, vel ad nervos et margines pauca pilosa. Flores in racemis ebracteatis; calyx viridi-flavescens, post anthesin horizontaliter patens; sepala (6-)6.7-7.9(-8.6) mm longa, obtusa, glaberrima; petala flava, (11.9-)12.9-14.7(-16.4) mm longa, limbis ellipticis, unguibus limbo saepe brevioribus et nervis lateralibus liberis vel 1-2 margine anastomosantibus; siliquae in racemis lateralibus valde elongatis, subteretes, rostratae, stylo persistente. Semina elliptica, (1.2-)1.3-1.5(-1.7) mm longa, ferruginea, testa reticulata, vix prominente.*

Differt a proximis E. nasturtiifolium subsp. nasturtiifolium et E. nasturtiifolium subsp. sudrei foliis juvenilibus plerumque omnino glabris, apicibus sepalorum omnino glabris et unguibus petalorum limbo brevioribus.

Hemicryptophyte rosulate. Biennial or perennial; stems (30-)40-80(-100) cm, glabrous or with sparsely deflexed hairs only on the 1-3 basal internodia; basal leaves lyrate-pinnatifid or –pinnatisect, even young entirely glabrous or with few, sparse hairs on the veins and/or on the margin; cauline leaves linear-lanceolate, similar to basal but smaller, with basal lobes clasping the stem. Racemes ebracteate; sepals (6-)6.7-7.9(-8.6) mm, entirely glabrous or rarely someone with few hairs (1-2) at the apex; petals yellow, (11.9-)12.9-14.7(-16.4) mm, with limb usually longer than the claw, and lateral veins free or with 1-2 anastomosing veins on each side. Seeds elliptic, (1.2-)1.3-1.5(-1.7) mm long with reticulate and scarcely prominent tegument.

Erucastrum nasturtiifolium subsp. *benacense* is strictly related to the other subspecies of *E. nasturtiifolium*, but differs for the leaves glabrous or with only few, sparse hairs on the veins and/or on the margin (instead of \pm hirsute); sepals entirely glabrous or rarely someone with few hairs (1-2) at the apex (instead of ciliate at least on the apex of the external sepals), and petals limb usually longer than the claw (shorter or equalling the claw), with lateral veins free or with 1-2 anastomosing veins on each side (usually 4-6 anastomosing veins on each side).

Flowering. – (February-) March to June(-July).

Chromosome number. – $2n = 32$.

Etymology. – The specific epithet is referred to the *locus classicus*, Garda lake (Benacus Lacus).

Distribution and ecology. – So far *E. nasturtiifolium* subsp. *benacense* has been found along the Western Garda boundary between Toscolano Maderno and M. Ponale, between 65 and 800 m, on jutting cliffs, calcareous walls and ground stones in a vegetational context dominated by pseudo-Mediterranean scrub with *Quercus ilex* L., *Fraxinus ornus* L., *Pistacia terebinthus* L., *Ostrya carpinifolia* Scop., *Cotinus coggygria* Scop., *Cupressus sempervirens* L., *Laburnum anagyroides* Medik., *Rhamnus alaternus* L., *Celtis australis* L., *Crataegus monogyna* Jacq. Moreover, *E. nasturtiifolium* subsp. *benacense* has been found in situations of apophytism along Country Road Gardesana in Trentino (Riva del Garda) too.

Specimina visa. – Lungo il sentiero Porto Tignale-Oldesio-Gardola-M. Cas (L. di Garda), ovunque comune su rupi e ghiaietto calcareo da 80 m a 750 m ca., 17.IV.1983, *F. Fenaroli s.n.* (HBBS, sub "*E. nasturtiifolium*"); Lago di Garda, a NE di Gargnano, lungo la Gardesana occidentale nei pressi del km 88, 170 m ca., 20.III.1987, *F. Tagliaferri s.n.* (HBBS, sub "*E. nasturtiifolium*"); comune di Tremosine, Lago di Garda, bordo della strada Gardesana presso la galleria di Monte Campione, 28.III.1987, *S. Danieli s.n.* (HBBS, sub "*E. nasturtiifolium*"); bordi di strada nei pressi di Tignale, 270 m, 10.I.1993, *C. Tonni Bazza s.n.* (HBBS, sub "*E. nasturtiifolium*"); Rupì tra Muslone e Gargnano, ovunque comunissima, 300 m, 18.IV.1993, *F. Fenaroli s.n.* (HBBS, sub "*E. nasturtiifolium*").

Conclusions

According to the opinion expressed by VIVANT (1977) we believe that *E. nasturtiifolium* represents a polymorphous species, with characters of collective species still little known.

The analysis of the characters has evidenced that subspecies *benacense* shows an original and well distinguishing diacritic complex within *E. nasturtiifolium*, based on both qualitative and quantitative characters and on results of cytotaxonomic research (that have to be added to Table 5). Furthermore, the subspecies *benacense* reveals a well distinguished ecology, that reminds the one described for the subspecies *sudrei*, with the difference that its gravitation environments belong to the colline-montane level (65-750 m) rather than montane-sub-alpine one (300-2000 m). Besides, it is to be emphasised that the south-eastern boundary of the genus is characterized by the presence of endemic species as *E. palustre*, typical of the low alkaline bogs of Friuli, and just *E. nasturtiifolium* subsp. *benacense*, bound to sub-Mediterranean rocky environments of eastern Insubria. On the basis of these considerations, this new taxon should deserve a subspecific rank.

Indeed, we suggest the following up-to-date analytical key for the European species [from TUTIN & AKEROYD (1996) and GÓMEZ-CAMPO (1993), modified]:

- 1 Leaves somewhat fleshy, the upper cauline conspicuously different from the basal..... 2
- 1a. Leaves not fleshy, the upper cauline similar to the basal..... 5
2. Siliqua not more than 25 mm, ± erect..... 3
- 2a. Siliqua at least 25 mm, erecto-patent..... 4
3. Siliqua 10-20mm, contracted at the base of the beak; beak about as thick as the valvar portion *E. virgatum* subsp. *virgatum*
- 3a. Siliqua 15-25 mm, not contracted at the base of the beak; beak usually thicker than the valvar portion *E. virgatum* subsp. *brachycarpum*
4. Annual or biennial; lower leaves deeply pinnatisect; siliqua at least 30 mm
..... *E. virgatum* subsp. *pseudosinapis*
- 4a. Usually perennial; lower leaves lyrate, entire to dentate; siliqua usually less than 30 mm *E. virgatum* subsp. *baeticum*
5. Raceme bracteate below; siliqua not stipitate *E. gallicum*
- 5a. Raceme ebracteate; siliqua stipitate 6
6. Lower cauline leaves pectinate-pinnatilobed, with 10-18 lobes on each side *E. palustre*
- 6a. Lower cauline leaves lyrate-pinnatisect, with 6-8 lobes on each side 7
7. Stem glabrous or sparsely pubescent only on the 1-3 basal internodia; sepals glabrous or rarely the external with single hairs; limb of petals > than the claw.....
..... *E. nasturtiifolium* subsp. *benacense*
- 7a. Stem pubescent up to the raceme; sepals, almost the external, hairy at the apex; limb of petals ≤ than the claw 8
8. Raceme with 40-60 fruits; siliqua 25-40 x 1-2 mm.....
..... *E. nasturtiifolium* subsp. *nasturtiifolium*
- 8a. Raceme with 10-30 fruits; siliqua 50-60 x 2-3 mm *E. nasturtiifolium* subsp. *sudrei*

ACKNOWLEDGEMENTS

The authors are grateful to: Dr. T. Cusma Velari and Dr. L. Pellizzari for their cariological researches; our friends Prof. Dr. Tone Wraber (Ljubljana) and Dr. F. Prosser (Rovereto) for their advice and text review; curators of the Museums that helped us in examining the herbarium material, mainly Dr. G. Alberti (Trieste), S. Armiraglio (Brescia), P. Cucuini (Firenze), G. Marcucci (Padova), S. Nardini (Udine), F. Prosser (Rovereto); and furthermore, Dr. M. Palma, for having taken care of the experimental cultivation made at City Botanical Garden of Trieste; Dr. M. Bovio (Aosta) and Dr. L. Poggio (Paradisio Alpine Garden, Cogne, Aosta) for having collected specimens and seeds of *E. nasturtiifolium*; Dr. G. Bolognini for drawing the holotypus and Dr. R. Ferluga and Dr. M. Lokar for the English translation.

Submitted on December 7, 2004

Accepted on June 27, 2005

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Table 1. – Length of the sepals [mm] in *E. nasturtiifolium* subsp. *benacense*.

	Min.	Max.	Range	Average	St. Dev.	Mode	N. of measurements
Gargnano (cult.)	6	7.7	1.7	7.1	0.4	7	40
Gargnano	6.5	8.3	1.8	7.4	0.4	7.5	80
Tignale	7	8.6	1.6	7.9	0.4	8	80
Tremosine	6	8	2	6.9	0.5	6.5	80

Table 2. – Length of the petals [mm] in *E. nasturtiifolium* subsp. *nasturtiifolium* compared with *E. nasturtiifolium* subsp. *benacense*.

	Min.	Max.	Range	Average	St. Dev.	Mode	N. of measurements
<i>E. nasturtiifolium</i> subsp. <i>nasturtiifolium</i>							
Oldenburg (D) (cult.)	10.5	12.5	2	11.4	0.5	11	40
St. Gallen (CH) (cult.)	11	13.5	2.5	12.2	0.7	12	40
Aosta (I) (cult.)	9	12.5	3.5	10.6	0.7	11	40
<i>E. nasturtiifolium</i> subsp. <i>benacense</i>							
Gargnano (cult.)	12	15.5	3.5	13.5	0.8	13	40
Gargnano	12	16.4	4.4	14.6	0.9	14.5	80
Tignale	11.9	15.1	3.2	13.7	0.6	13.9	80
Tremosine	12	14.6	2.6	13.4	0.6	13	80

Table 3. – Ratio between limb and petal claw in *E. nasturtiifolium* subsp. *nasturtiifolium* compared with *E. nasturtiifolium* subsp. *benacense*.

	Min.	Max.	Range	Average	St. Dev.	Mode	N. of measurements
<i>E. nasturtiifolium</i> subsp. <i>nasturtiifolium</i>							
Oldenburg (D) (cult.)	0.8	1.1	0.4	0.9	0.1	0.8	40
St. Gallen (CH) (cult.)	0.8	1.1	0.3	0.9	0.1	1	40
Aosta (I) (cult.)	0.8	1.1	0.3	0.9	0.1	1	40
<i>E. nasturtiifolium</i> subsp. <i>benacense</i>							
Gargnano (cult.)	1.2	1.7	0.5	1.4	0.2	1.4	40
Gargnano	1	1.5	0.4	1.2	0.1	1.1	80
Tignale	1	1.3	0.4	1.1	0.1	1.1	80
Tremosine	1	1.4	0.4	1.1	0.1	1.2	80

Table 4. – Results of the Student test.

		N. of measurements	Average	t Student	P
Petal length	subsp. <i>nasturtiifolium</i>	37	11.3622	15.352	<0.001
	subsp. <i>benacense</i>	78	13.8808		
Ratio limb/claw	subsp. <i>nasturtiifolium</i>	37	0.9189	12.145	<0.001
	subsp. <i>benacense</i>	78	1.1923		

Table 5. – Main differences between *E. nasturtiifolium* subsp. *benacense* and *E. nasturtiifolium* subsp. *nasturtiifolium*.

	<i>E. nasturtiifolium</i> subsp. <i>benacense</i>	<i>E. nasturtiifolium</i> subsp. <i>nasturtiifolium</i>
Young leaves	glabrous	hispid
Stem and leaves	glabrous or sparsely ciliate	± densely hispid
Sepals indumentum	glabrous, rarely with few hairs	ciliate at least at the apex
Sepals length [mm]	(6-)6.7-7.9(-8.6)	4-6(-8)
Petals length [mm]	(11.9-)12.9-14.7(-16.4)	(9-)10.5-12.3(-13.5)
Petal's lateral veins	free or 1-2 anastomosing on each side	4-6 anastomosing on each side
Ratio limb/claw	(1-)1.1-1.3(-1.7)	0.8-1(-1.1)
Chromosome number	2n = 32	2n = 16

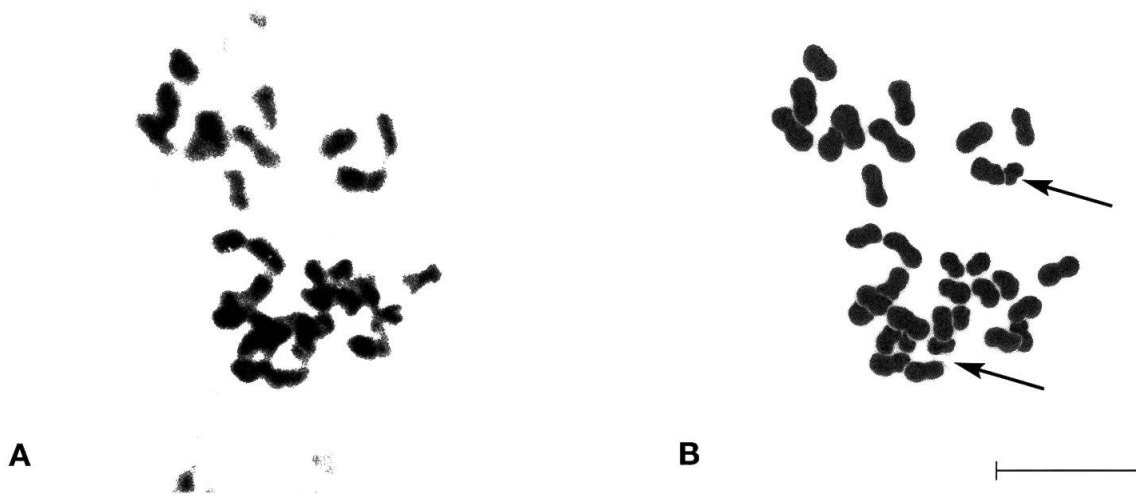


Fig. 1. – Microphotograph (A) and drawing (B) of somatic metaphase plate of *Erucastrum nasturtiifolium* subsp. *benacense* F. Martini & F. Fen. Arrows indicate B-chromosomes. Scale bar = 5 μ m. (by T. Cusma Velari & L. Pellizzari).



Fig. 2. – *Erucastrum nasturtiifolium* subsp. *benacense* F. Martini & F. Fen. (drawing of G. Bolognini).

