TÜBİTAK

Turkish Journal of Botany

http://journals.tubitak.gov.tr/botany/

Research Article

Turk J Bot
(2013) 37: 1061-1069
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doi:10.3906/bot-1212-4

Morphological and ecological evidence for a new infraspecific taxon of the wallflower *Erysimum cheiri* (Brassicaceae) as an indigenous endemism of the southwestern Mediterranean

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Received: 05.12.2012 • **Accepted:** 02.07.2013 • **Published Online:** 30.10.2013 • **Printed:** 25.11.2013

Abstract: The wallflower *Erysimum cheiri* is a horticultural cruciferous growing as garden-escaped with a wide distribution in West and South Europe. In Algeria, it is locally found on the northern cliffs of the National Park of Gouraya (Kabylia). The aim of this study is to compare the populations of *E. cheiri* identified in Algeria with those found in Mediterranean France. To study the differences between both sites, a morphological and ecological analysis was undertaken on 6 populations growing in Algeria and France. Ecological communities where wallflower is growing in Algeria are dominated by indigenous plants with a significant proportion of endemic taxa, while in France the whole populations are growing in subruderal positions with the presence of other xenophytes and/or garden-escaped. Statistical analysis of the morphological traits revealed significant differences between the 2 sites following fruit discriminating variables (stylus and seeds). Based on ecological and morphological divergences, we can conclude that the Algerian populations of wallflower are indigenous and represent a new endemic taxon named here *E. cheiri* subsp. *inexpectans*, distinguished from subspecies *cheiri* by a smaller and thinner fruit stylus and seeds that are often less numerous and always uniseriate within siliqua.

Key words: Biometrical morphology, cliff plants, community, *Erysimum*, garden escaped, glacial refugia

1. Introduction

Habitat destruction by human activities is the main cause of species extinction (Pimm and Raven, 2000; Gurevitch and Padilla, 2004). To protect biodiversity, a promising approach was to identify "hotspots" of biodiversity that are especially rich in endemic species and particularly threatened by human activities (Médail and Quézel, 1999; Myers et al., 2000; Mittermeier et al., 2004). In the Mediterranean region, areas with high rate of endemism are mainly associated with glacial refugia and consist of areas of persistence such as Pliocene- and Pleistocene-like islands, rocky cliffs, and mountain peaks (Verlaque et al., 1997; Médail and Diadéma, 2009). The high heterogeneity of species richness, endemic species, and human activities led biologists to identify at fine scale several regional hotspots of biodiversity (Médail and Quézel, 1997). One that has been recently identified (Véla and Benhouhou, 2007) is the "Kabylies–Numidia–Kroumiria" complex, including Algerian–Tunisian Tell mountains and coastal areas, and many Important Plant Areas (IPAs). These IPAs are characterized by the presence of "trigger species", like narrow endemic species (Yahi et al., 2012).

Here we focus on the Gouraya IPA, which includes at least 4 rupicolous endemic species (Quézel and Santa, 1962, 1963). *Allium trichocnemis* J.Gay is associated with rocks with southern exposure, while *Bupleurum plantagineum* Desf., *Hypochaeris saldensis* Batt., and *Silene sessionis* Batt. occur on vertical cliffs with northern exposure (Pons and Quézel, 1955; Rebbas et al., 2011). In addition, several infraspecific taxa formally described, and probably others not yet described, are completing the previous list of endemics from the Gouraya area (Yahi et al., 2012). Among these, *Erysimum cheiri* (L.) Crantz [syn.: *Cheiranthus cheiri* L.] shows unexpected stands. The "wallflower" was first reported in Algeria as commonly cultivated in home gardens (Munby, 1847: 114) and later described growing in the walls and rocks near Pointe Pescade near Algiers, but the indigenous occurrence of this species was doubtful (Battandier, 1888, 1890). That is probably why it was ignored in the last flora of Algeria

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(Quézel and Santa, 1962, 1963) and in the publication of Pons and Quézel (1955). Nevertheless, in the flora of northern Africa, Maire (1977, published postmortem) mentions them as "parfois subspontanée sur les rochers maritimes, par exemple au Cap Carbon près Bougie, sous le phare" ("sometimes subspontaneous on maritime rocks, for example at Cap Carbon near Bougie, under the semaphore"). It is important to note that, currently, the wallflower seems to be no longer cultivated in gardens in Algeria or growing as an escaped-garden plant. Thus, local populations on cliffs in the National Park of Gouraya (Bejaia) are all the more surprising.

In contrast to the situation from Algeria, where it shows narrow restricted distribution, wallflowers present in Europe show a wider distribution and occur from Sweden to the Aegean Sea. It has been cultivated for centuries and is also considered growing as garden-escaped (Snogerup, 1967a). *Erysimum cheiri* is assigned to the genus *Erysimum* L., section *Cheiranthus* (L.) Wettst. By its large distribution, it is different from other species of section *Cheiranthus*, all of them endemic from the Aegean Sea. The only study on this section was presented by Snogerup (1967a, 1967b). The origin of this horticultural species remains controversial (Polatschek and Snogerup, 2002).

The aims of this study are: 1) to describe the ecological and taxonomical status of populations from Gouraya in Algeria and 2) to determine the differences between *Erysimum cheiri* populations from Algeria and *E. cheiri* proven as escaped from gardens in France. Our focusing hypothesis is to explore the possibility that the plants described in Algeria as *Erysimum cheiri* could be different from the typical *E. cheiri* growing in Europe, by using morphological and ecological approaches.

2. Materials and methods

2.1. Study sites

The study took place in Algeria and France (Figure 1). The first site is situated in the National Park of Gouraya (Bejaia, Algeria). It is a coastal protected area, and it was named as a 'Man and Biosphere Reserve' by UNESCO. The park covers an area of 2080 ha and has 11.5 km of coastline and cliffs (Loukkas, 2006). The climate is typically Mediterranean, with winter rainfall and summer drought and an annual precipitation around 809 mm/year (recorded between 1970 and 2004, meteorological station of Bejaia: unpublished data). Three populations of *Erysimum cheiri* were sampled (only 4 are known). The first population is situated in the northern cliffs facing Cap Carbon, the second population in an ancient motel at the top of Cap Bouak, and the last one in cliffs under Cap Bouak near Aiguades beach. The 3 populations were distant from each other by several hectometers or kilometers and are facing the Mediterranean sea.

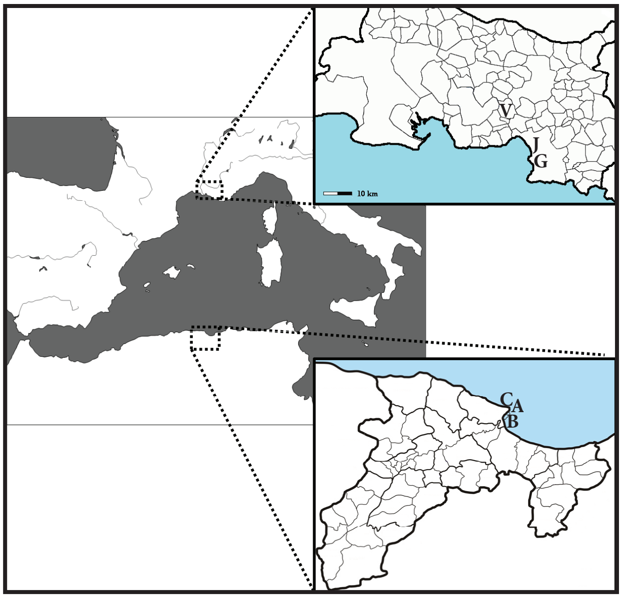

Figure 1. Localization of the sampled populations. France: Notre Dame de la Garde (G), Garden (J), Vitrolles (V). Algeria: Cap Bouak (B), Cap Carbon (C), Aiguades (A).

The second site concerns Bouches-du-Rhône county in southeastern France, where 3 populations were sampled. The climate is Mediterranean, with an annual precipitation of around 544 mm/year (recorded between 1961 and 1990, meteorological station of Marignane: Météo-France, 1996). *Erysimum cheiri* was revealed to have a wider distribution in France. It can be easily found on house walls, home gardens, and periurban cliffs. The first sampled population is located in Vitrolles old city, specifically around an old chapel on top of a cliff about 30 m high. The 2 other populations are located within the city of Marseilles. The first is in the rocks around the Notre-Dame-de-la-Garde church (downtown), and the second is in a private home garden (northern district) with walls and cement pavements.

2.2. Biotope sampling and measures

The description of the ecological characteristics of each population was carried out in situ. The physical characteristics were designed with an estimation of exposition, altitude, slope, and the proportion of mineral soil, rocks, and pebbles. Five vegetable strata (herbaceous, small shrubs, tall shrubs, small trees, tall trees) were used to estimate the proportion and organization of vegetation cover (<10%, 10%–25%, 25%–50%, 50%%–100%). Values for this variable ranged from 0% (no vegetation cover) to 100% (full vegetation cover). All occurring plant species were also identified and listed.

The morphological measures were carried out on 5 individuals in each population. Because the experiment was destructive, and in order to maintain the integrity of the population, some measures such as length and diameter of main stem were realized in situ. For this reason, recordings (measurements on leaves, flowers, and fruit) were mainly restricted to one sample (secondary axis) of each individual that was collected.

The replication was realized on 5 organs of each specimen and the mean value was calculated and considered. The measurements consisted of length of large leaves on main stem and small leaves taken from the inflorescence; and the length and width of petals, sepals, siliqua, and style, including stigmata. The length of the stamens on the flora was also measured. Finally we quantified the number of seeds and the number of seed series on the fruit. These measurements were realized using a caliper electronic ruler (±0.1 mm).

2.3. Statistical analysis

In order to compare ecology of different populations, a principal components analysis (PCA) was performed to provide an assessment of the physical characteristics of each location. The sampled locations were also compared from a floristic point of view using correspondence analysis (CA).

Another PCA was performed on 25 morphological variables. In order to exploit the qualitative data, these have been coded. Codes have been used to represent color of sepals: green = 0, purple = 1, purplish green = 0.5, green/purplish green = 0.25 (individual with some green purplish and some green sepals simultaneously), purplish green/purple = 0.75 (individual with some green purplish and some purple sepals simultaneously). The same approach was used for petal color (yellow = 0, purple = 1, etc.). To show whether the observed morphological differences are significant, analyses of variance (ANOVAs) were performed between French and Algerian populations.

To improve visualization of data and to better understanding the results, a hierarchical cluster analysis (HCA) using a second-order moment algorithm (Ward's method) was carried out on data resulting from CA or PCA. All statistical analyses were computed with XLstat software.

3. Results

3.1. Description of plant communities

Figure 2 reveals 2 distinct floristic groups. The first group contains the populations in France and the second group contains the populations in Algeria. The Algerian group splits into 2 subgroups, with a distinction between populations of the Cap Bouak motel and those from both other localities.

A comparative biogeographical analysis was carried out in order to better understand the ecology of plots where *Erysimum cheiri* is occurring. The analysis focused on endemic versus exotic species. These results provide 3 principal facts:

1) The presence of narrow endemic species in Algeria and their absence in France. Four taxa endemic from northeastern Algeria are cooccurring with Algerian *E. cheiri*: *Bupleurum plantagineum*, *Pancratium foetidum* Pomel var. *saldense* Batt., *Sanguisorba ancistroides* (Desf.) A.Br. var. *battandieri* Maire, and *Sedum multiceps* Pomel. They are only found within the cliffs subgroup.

2) The highest proportion of naturalized exotic species in France rather than in Algeria. Four spontaneously

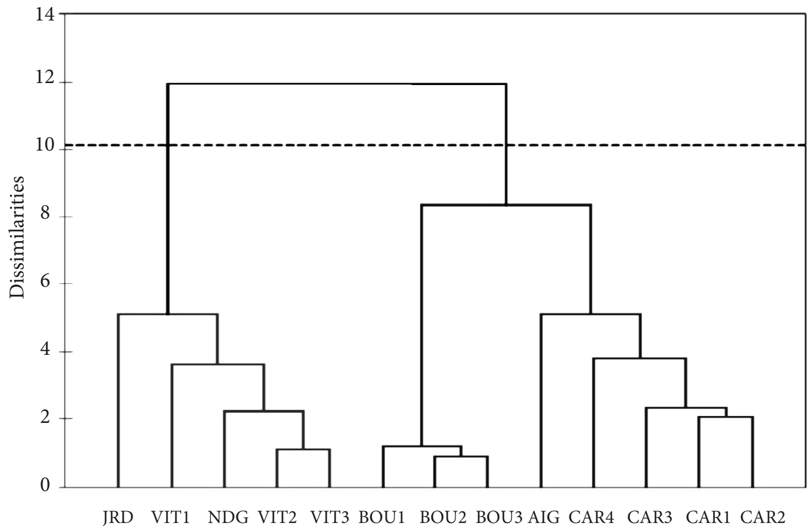

Figure 2. Dendrogram performed by hierarchical cluster analysis after correspondence analysis on floristic data from all sampled locations. France: Notre Dame de la Garde (NDG), Garden (JRD), Vitrolles (VIT). Algeria: Cap Bouak (BOU), Cap Carbon (CAR), Aiguades (AIG).

cooccurring exotic species were encountered on studied French *Erysimum cheiri* plots: *Crepis sancta* (L.) Babc., *Euphorbia serpens* Kunth, *Phytolacca americana* L., and *Prunus cerasifera* Ehrh. They are found in home gardens but also in other habitats. Only one species was cooccurring with Algerian *Erysimum cheiri*: *Opuntia stricta* (Haw.) Haw. It was only found in the motel subgroup.

3) Additional exotic species, formerly cultivated but perennial, are still encountered in some plots. In Algeria, *Agave americana* L. was planted in the home garden of the former motel at Cap Bouak. In France, *Freesia* sp., *Punica granatum* L., and *Sternbergia lutea* (L.) Ker-Gawler, were planted in a home garden at Marseilles.

3.2. Ecological characteristics of Erysimum cheiri habitat

PCA revealed differences between Algerian and French sites according to 6 factors: slope, soil characteristics (rocks, stone, bare soil), and vegetation recovery (herbaceous, trees).

A hierarchical ascending classification (HAC) was performed on PCA coordinates and discriminated 2 main groups (Table 1): group 1 with most Algerian sites and group 2 with most French sites.

Algerian sites (except BOU1 and BOU2) are mainly gathered in group 1 and are characterized by a steep slope, a high proportion of rocks, and low shrub cover. These characteristics are those of a cliff ecosystem. Therefore, one French site (VIT1) belongs to group 1, because the sampled site was located on the cliffs at the Vitrolles locality.

Group 2, which is mainly composed of French sites, is divided into 2 subgroups. The first subgroup (100% French) is characterized by a high proportion of blocks, stones, and gravel, and a high herbaceous cover. These are characteristic of rupicolous environments, including anthropogenic old walls.

Table 1. Main groups obtained from HAC.

Group 1	Group 2	Subgroups of 2
CAR 1 (ALG)	BOU 1 (ALG)	2b
CAR 2 (ALG)	BOU 2 (ALG)	2b
CAR 3 (ALG)	JRD (FR)	2b
BOU 3 (ALG)	VIT 2 (FR)	2a
AIG (ALG)	VIT 3 (FR)	2a
CAR 4 (ALG)	NDG (FR)	2a
VIT 1 (FR)		

Abbreviations: FR = France, NDG = Notre-Dame-de-la-Garde, JRD = Garden, VIT = Vitrolles, ALG = Algeria, BOU = Cap Bouak, CAR = Cap Carbon, AIG = Aiguades.

The second subgroup includes the Algerian sites of Cap Bouak (BOU1 and BOU2) and the French home garden (JRD). All these sites are characterized by a very low slope, dominant tree cover (partially ornamental), and a high proportion of bare soil. The similarities observed in this subgroup are assigned to the Cap Bouak site, which is situated in a garden of a former motel similar to the French home garden site.

3.3. Morphological study

In Algeria, sampling was done at the end of the flowering period, so the number of specimens with simultaneous flowers and fruits was low. Data collected were not sufficient to provide discriminant analysis; this is why we decided to provide morphological analysis in 2 parts. We have separated individuals with flowers and individuals with fruits. For both analyses, vegetative parameters were included.

A PCA was performed on both floral and vegetative parameters and revealed 2 groups. One corresponds to specimens with big flowers and the second to specimens with small flowers. Both groups include individuals from France and Algeria. Floral parameters cannot discriminate between French and Algerian populations.

The PCA performed on both fruit and vegetative parameters (Figure 3) revealed some discriminant parameters: length of leaves, length and width of stylus, number of seeds, and number of series for seeds in each fruit box.

A dendrogram obtained by HAC highlights 2 groups of individuals: the first group consists of 11 specimens from

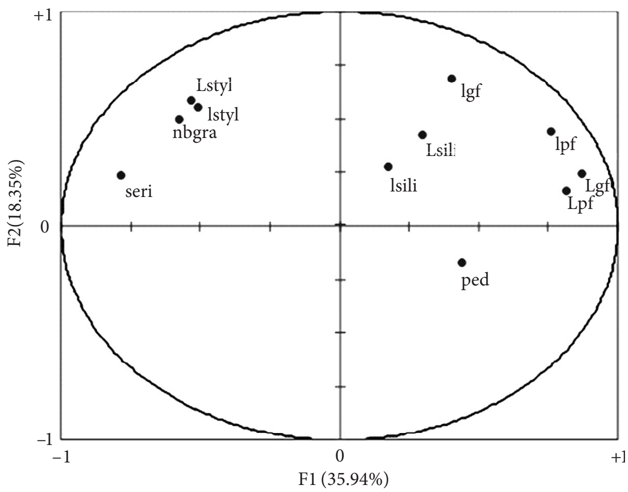

Figure 3. Ordination of the 11 variables from a PCA of morphological parameters. Variables: Lgf (length of biggest leaves), Lpf (length of smallest leaves), lgf (width of biggest leaves), lpf (width of smallest leaves), Lsili (length of siliqua), lsili (width of siliqua), ped (pedicel), Lsty (length of stylus), lsty (width of stylus), nbgra (number of seeds), and seri (number of series for seeds in each fruit box).

15 Algerian sites, and the second group contains all of the French specimens as well as the remaining 4 from Algeria. Algerian individuals have bigger leaves with statistical value, but this criterion is not totally diagnostic. In fact, variability within populations alone cannot distinguish between specimens from Algeria or from France.

In order to confirm the discriminant value of fruit morphology, a PCA and HAC were performed on fruit morphological data alone (Figure 4). Except for one French specimen (FRA9), the analysis completely discriminated between the Algerian and French specimens

Fruits have some morphological characteristics that permit us to distinguish between specimens from Algeria and those from France: length and width of stylus, number of seeds, and disposition of seeds within fruit box (Figures 5 and 6). The ANOVAs realized on quantitative variables (i.e. length and width of stylus, number of seeds) revealed the high significance of the differences between French and Algerian populations on these 3 variables (Table 2).

Despite the relatively low number of individuals sampled (28 in Algeria and 23 in France), the 3 Algerian populations sampled correspond to almost all of the known populations. Only a fourth small population is known, at a location 4.5 km westwards on an unattainable cliff at the M'Cid el Bab locality. The global population of these plants in the National Park of Gouraya at Bejaia (i.e. in Algeria) can be estimated at only 100 or a few hundred mature individuals (unpublished data).

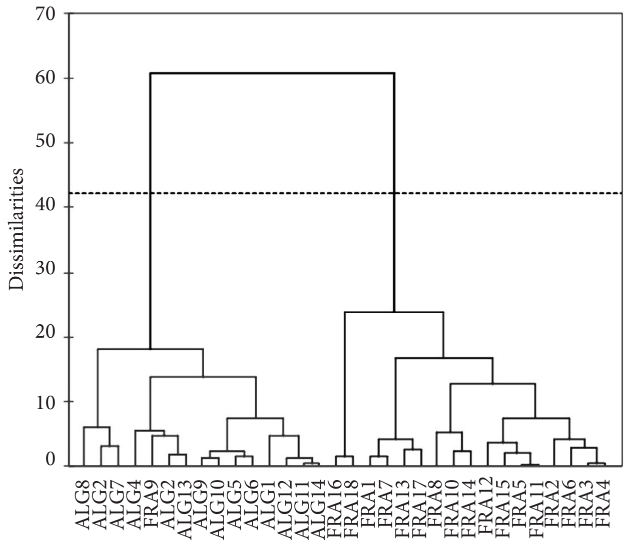

Figure 4. Dendrogram performed by HCA after PCA on fruit morphological data alone, from all sampled locations (FRA = France; ALG = Algeria).

4. Discussion

4.1. Indigenous plant ecology

Two ecological groups have been identified in the comparison between French and Algerian populations. The presence of xenophyte species in French populations reveals the ruderal and/or horticultural nature of communities. Cooccurring plant species with wallflower populations in Algeria are mostly indigenous, including several endemic plants. These taxa are perennial and belong to the geophyte or chamaephyte type, and they often grow in very specialized habitats, including cliffs and crevices of rocks. These habitats are common in the National Park of Gouraya and promote the presence of endemic species (Bacchetta et al., 2007), unlike annual species who require stirred and/or soft soil to express themselves and/or maintain seed bank.

Maire had already reported the occurrence of *Erysimum cheiri* in the flora of North Africa, in the National Park of Gouraya with several endemics, whereas it seems it cannot be found elsewhere in northern Africa (Maire,

Figure 5. Illustration of the top of siliqua and stylus (Algeria on the left, France on the right).

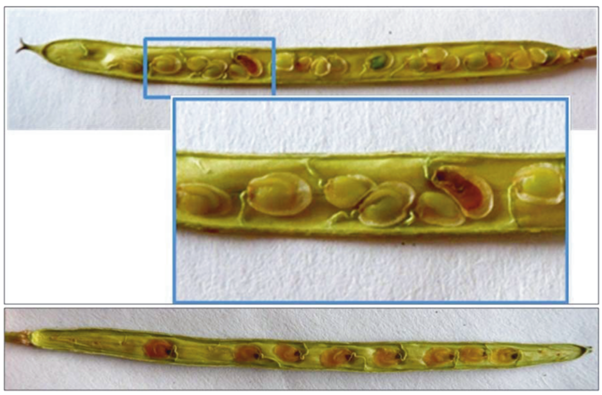

Figure 6. Illustration of subbiseriate seeds in France (top and middle) and uniseriate seeds in Algeria (bottom).

Table 2. Results (ANOVAs) of comparisons of fruit morphological criteria between Algerian (CAR, BOU, AIG) and French (VIT, NDG, JRD) populations.

	Algeria (n = 17)	France (n = 17)	d.f.	F
Stylus width (mm)	1.23 (Average) Min: 1.0/Max: 2.0	1.51 (Average) Min: 1.0/Max: 2.1	1	6.689*
Stylus length (mm)	2.27 (Average) Min: 1.5/Max: 3.0	3.02 (Average) Min: 2.1/Max: 4.1	1	18.91**
Number of seeds	29.18 (Average) Min: 24.6/Max: 37	33.4 (Average) Min: 25/Max: 42	1	9.488***
Disposition of seeds	1 series (uniseriate)	+ or – 2 series (subbiseriate)	-	-

***: $P < 0.001$, **: $P < 0.01$, *: $P < 0.05$.

1977; Pottier-Alapetite, 1979). Its nonoccurrence on the old walls and rocks of the neighboring town of Bejaia, and near old forts and houses of the Gouraya National Park, implies that its status as garden-escaped can be questioned.

The exception concerns one population located around a former motel (Cap Bouak) located at the top of a cliff: they are morphologically closer to Algerian cliff populations than French populations, while, in contrast, they are ecologically distinct from Algerian cliff populations without also being similar to the French escaped populations. In this locality, wallflowers with spontaneous morphological characteristics appear to be locally secondarily escaped.

4.2. Identities and origins of wallflowers

Based on Snogerup's studies (1967a), *Erysimum cheiri* is characterized from *Erysimum* sect. *Cheiranthus* by: small seeds generally occurring in 2 rows along sides of the siliqua; a thick style; and purple glandular sepals. The results of this study have shown that Algerian and French populations were significantly different according to the following diagnostic criteria: length and width of fruit style, seed number, and the number of seed rows in the siliqua. Other nondiagnostic criteria, such as length and width of leaves, statistically discriminate the 2 groups. Despite the plants of Cap Bouak motel behaving like plants escaped from gardens, they are morphologically closer than others to the Algerian populations. We can thus conclude that the populations of both countries can be considered as 2 different taxa and the populations occurring in Algeria are not *Erysimum cheiri* sensu stricto.

In order to identify the taxon of the Gouraya National Park, a comparison with *Erysimum* section *Cheiranthus* was undertaken. The only serious study on this section was presented by Snogerup (1967a, 1967b). Other works such as *Flora Iberica* (Nieto Feliner et al., 1993), *Flora Hellenica* (Polatschek and Snogerup, 2002), and "Flore de l'Afrique du Nord" (Maire, 1977) where this species has also been described present some inconsistencies. They concern seed dispositions, which are considered biserial, whereas they are subbiserial. Whereas the seeds are smaller than the width of loculus, they are on 2 rows (see Figure 6). *Erysimum* occurring in Gouraya National Park are different from *E. cheiri* sensu stricto: the seeds are as wide as the width of the loculus, so are always in a single row, and the style is thin and short. This new taxon also has similarities with *E. cheiri* sensu stricto, concerning glandular and (partially) purple sepals. The presence of glandular sepals was verified retrospectively in the laboratory. This test cannot be done systematically in the field, because it needs specific material (binoculars).

According to the taxonomic criteria of *Erysimum* section *Cheiranthus* (Snogerup, 1967a), the populations of Gouraya do not correspond exactly to any known species of *Erysimum*, but they are closer to *E. cheiri* than the other taxa from section *Cheiranthus* (Snogerup, 1967a). We can thus conclude that plants spontaneously growing in Gouraya National Park are a neglected taxon closely related to the typical (cultivated) *E. cheiri*.

Because of the controversial origin of horticultural *E. cheiri*, we hypothesize that the new taxon identified in Gouraya National Park could be the wild strain used in the development of horticultural forms. The Roman Empire founded Saldae (now Bejaia and formerly Bougie) and might have cultivated the indigenous taxon of Gouraya for ornamental purposes, and then introduced them in relatively large extension.

Erysimum cheiri is an exception within the *Cheiranthus* section, because the latter includes only species endemic to the Aegean Sea. These species are regarded to be rupicolous and appear to be present in very specialized habitats (Snogerup, 1967a, 1967b). Endemism depends on the phylogeny of species, some species having a predisposition to be developed and maintained in environments promoting speciation (Lavergne et al., 2004). This could suggest that endemism of the taxon encountered at Gouraya is possible. The hypothesis is supported by its presence only in sublittoral cliffs with other very specialized and endemic taxa. Endemism of the new taxon from Gouraya implies that the geographic range of *Erysimum* section *Cheiranthus* extends to Algeria.

This distribution is not unique; other species have similar patterns of distribution, shared between the Kabylia, the center of the Mediterranean, and the shores of the Aegean, such as *Lithodora rosmarinifolia* and *Euphorbia dendroides* (Quézel and Santa, 1962, 1963; Pignatti, 1982; De Bolos and Vigo, 1990) or *Romulea leichtliniana* (Véla and De Bélair, unpublished data).

4.3. Taxonomical identity of Gouraya's populations

For both proven morphological and presumed phylogenetic proximities, it seems appropriate to consider the new endemic taxon on Gouraya's cliffs near Bejaia as conspecific with *Erysimum cheiri*. At least, considering its particular ecology and morphology, the taxon could be considered as an ecotype and ranked as a variety. However, the uniqueness and the geographical isolation of the Algerian populations combined with their high biogeographical significance belonging to the IPA of Gouraya's cliffs (Yahi et al., 2012) allow us to rank it as a subspecies. Independently we consider it native, either the source of the cultivated wallflower or as an exogenous and formerly escaped wallflower cultivated in ancient times. We have good reasons to hypothesize that for these severely isolated subsets of populations, a geographic speciation process is occurring for a more or less long time. This is why we opted to describe the new taxa as a subspecies rank.

Erysimum cheiri (L.) Crantz subsp. ***inexpectans*** Véla, Ouarmim & Dubset, **subsp. nov.** (Figures 7–8)

Holotype: Algeria, Kabylia: Saldae (Bejaia), Gouraya National Park, in front of Cap Carbon, alt. 200 m, 20.06.2011, *E. Vela* 0001 (MPU, 021842).

Additional examined specimens (paratypes): Algeria, Kabylia: Saldae (Bejaia), Gouraya National Park, northern face of Cap Bouak, alt. 20 m, 22.06.2011, *E. Vela* 0002 (G), *E. Vela* 0003 (Ecole Nationale Supérieure Agronomique d'El-Harrach, Alger). Algeria, Kabylia: Saldae (Bejaia), Gouraya National Park, in front of Cap Carbon, alt. 200 m, 20.06.2011, *E. Vela* s.n. (Gouraya National Park herb.).

Diagnosis: *Differt a subspecie cheiri carpi stylo minoris (1.5–3 mm, non 2–4) et angustioris (1.2 mm mediocris, non 1.5), saepe paucioribus et semper in siliqua uniseriatis seminibus (non sub-biseriatis). Crescit in calcareis saxis in septentrionem spectantibus Mediterranei maris propinquis.*

Etymology: "inexpectans" refers to the unexpected discovery of an indigenous taxon close to the horticultural wallflower *Erysimum cheiri*.

4.4. Molecular perspectives

Beyond this morphological and ecological study, a molecular work on the populations of Algeria, France, and Greece would be very useful in order to investigate the origin of the Algerian population. The numbers of such surprising patterns of disjunct areas are known regarding Mediterranean flora and fauna, and some of them were successfully explored by molecular methods. About the extreme east–west disjunction of *Buxus balearica* Lam. (Rosselló et al., 2007) or *Microcnemum coralloides* (Loscos and J.Pardo) Font Quer (Kadereit and Yaprak, 2008), ITS and/or cpDNA sequence variations have proven the indigenous origin of both geographical subpopulations by vicariance after a migration process. The same kind of variation on nrDNA and cpDNA allowed Migliore et al. (2012) to detect the origin of multiple Macaronesian and Saharan colonizations from the Mediterranean genus *Myrtus* during the Pleistocene. About the Saharo-Mediterranean *Olea europaea* complex, Besnard et al. (2007, 2013) explored such biogeographical relations and succeeded in tracing the genetic origin of cultivated olive trees from wild oleasters. Studies on animals with fragmented western Mediterranean distribution have shown interesting results, such as the exogenous and multiple origin of the monkey *Macaca sylvanus* on the Gibraltar rock (Modolo et al., 2005) or the trans-Mediterranean Neolithic origin of the snail *Tudorella sulcata* in southeastern France (Véla et al., 2008; Jesse et

Figure 7. Holotype from *Erysimum cheiri* subsp. *inexpectans*.

Figure 8. Illustration of living *Erysimum cheiri* subsp. *inexpectans* with flowers (9 March 2011) and fruits (22 June 2011) on Cap Bouak northern cliffs near Les Aiguades beach (Bejaia, Algeria).

al., 2012). Exploring the genetic variability of Algerian populations of subsp. *inexpectans*, European populations of subsp. *cheiri*, and Aegean populations of closely related taxa from *Erysimum* sect. *Cheiranthus* could help us to understand the phylogeographic relationship between indigenous and escaped wallflowers. Such molecular data, combined with new morphological characters such as trichomes of inner surfaces of fruit valves (Mutlu, 2010) or quantitative metric data such as corolla color and shape (Abdelaziz et al., 2011), will help us to distinguish cryptic species, particularly within the genus *Erysimum*, as demonstrated by Abdelaziz et al. (2011).

Acknowledgments

We want to thank Ali Mahmoudi (former director), Dries Fatsah (engineer), and the whole staff of Gouraya National Park for their warm welcome and logistical support, and professor Aïssa Moali (head of the Ecology and Environment Laboratory at Abderrahmane Mira University of Béjaia) for administrative hosting and material availability. We also wish to thank Claude Roux (Mirabeau, France) for the Latin diagnosis, Jean-François Léger (Missour, Morocco) for having stimulated a closer look at the identity of this taxon, and Peter Schäfer (MPU) for his valuable advices on typification and deposit of types specimen.

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