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Pinguicula (Lentibulariaceae) in central Italy: taxonomic study

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A morphometric and taxonomic study of *Pinguicula* in central Italy was carried out. Six allopatric units occur in this area, all belonging to sect. *Pinguicula*: *P. fiorii* Tammaro & Pace, *P. vulgaris* L. subsp. *vulgaris* and four new taxa: *P. vulgaris* subsp. *anzalonei* Peruzzi & F. Conti *subsp. nova*, *P. vulgaris* subsp. *ernica* Peruzzi & F. Conti *subsp. nova*, *P. vulgaris* subsp. *vestina* F. Conti & Peruzzi *subsp. nova* and *P. vallisregiae* F. Conti & Peruzzi *sp. nova*. A key to the Italian species and subspecies of *Pinguicula* is provided.

Key words: morphology, new taxa, *Pinguicula*, taxonomy

Introduction

Pinguicula is the second most diverse genus of the "carnivorous" family Lentibulariaceae, with more than 80 currently accepted species (Steiger 1998, Legendre 2000). However, this number is continuously increasing, as a consequence of taxonomic studies especially in Central America (*see* literature cited in Cieslak *et al*. 2005). In the Mediterranean area, five new species were described in the last twenty years (Tammaro & Pace 1987, Romo *et al*. 1996, Zamora *et al*. 1996, Casper & Steiger 2001).

The family Lentibulariaceae, order Lamiales, has recently been shown to be monophyletic (Jobson *et al*. 2003), as has the genus *Pinguicula* (Cieslak *et al*. 2005). The latter authors explored also the phylogenetic relationships within this genus, showing that many of the infrageneric taxa recognised by Casper (1966) were poly- or paraphyletic. Recently, Degtjareva *et al*. (2004) provided useful new taxonomic information on seed morphology, while Peruzzi (2004) summarized the karyological knowledge of this genus.

Casper (1972) included 12 species in the flora of Europe, five of which occur in the Italian Peninsula (Pignatti 1982): *P. vulgaris*, *P. alpina* and *P. leptoceras*, all limited to the Alps (northern Italy); *P. reichenbachiana*, quoted for Tuscany and Abruzzo (central Italy); and *P. hirtiflora*, occurring only in Campania and Calabria (southern Italy). The latter species is the only one overwintering as a rosette (tropical growth-type) in Italy (Peruzzi *et al*. 2004). More recently, according to Conti *et al*. (2005), the range of *P. vulgaris* was extended throughout the peninsula

up to central Italy (*see* also Anzalone 1983, Conti 1998), and an additional two Italian species have recently been recognized: *P. fiorii* (Tammaro & Pace 1987) endemic to Abruzzo, and *P. poldinii* (Casper & Steiger 2001) endemic to Friuli-Venezia Giulia (NE Italy). The taxonomic status especially of *P. fiorii* was much debated: it was synonymized with *P. reichenbachiana* by Conti (1998) and Legendre (2000), but considered a good species by other taxonomists (Steiger 1998, Casper & Steiger 2001). The latter authors also emphasized the need for modern taxonomic studies for *Pinguicula* from Abruzzo, especially concerning the plants referred to *P. reichenbachiana*.

We carried out a taxonomical study of central Italian *Pinguicula*, by means of macro- and micromorphology (1) to verify the identity of the plants so far named *P. reichenbachiana*, (2) to make the taxonomic status of *P. fiorii* clear, and (3) to investigate the variability of *P. vulgaris s. lato*.

Material and methods

General morphology

General observations (dozens of individuals for each studied population) were carried out on growth type, rosette type, colouring patterns of the corolla, and indicative opening angles between upper and lower lips. Moreover, we studied five to ten individuals from each studied population (*see* Table 1, also for abbreviations) for shape, length and width of leaves, scape size (except for VUL-AB, VUL-ANZ and VUL-VES), and shape and length of capsule (except for VUL-AB, VUL-ANZ and VUL-VES).

Floral morphometry

Floral morphometry was studied by measuring in the field ten quantitative continuous floral characters on 10–20 individuals from each popu-

Table 1. Populations studied.

"*P. reichenbachiana*" (VRE)	C Italy, Abruzzo [Parco Nazionale d'Abruzzo, Lazio e Molise: Camosciara, Villetta Barrea (L'Aquila), rupi stillicidiose, 1073 m a.s.l., 41°45.925´N, 13°54.535´E, 2.VII.2004, *F. Conti, F. Bartolucci*]
P. fiorii Tammaro & Pace (FIO)	C Italy, Abruzzo [Parco Nazionale della Majella, Scrimacavallo tra il Blockhaus e il Focalone, Pennapiedimonte (Chieti), rupi stillicidiose, 2010–2040 m a.s.l., 42°08.051´N, 14°07.813´E, 8.VII.2004, F. Conti, D. Lakusic]
P. vulgaris L. *s. lato* (VUL-ALP)*	N Italy, Trentino Alto adige [C-E Alps: Gruppo di Brenta, Molveno (prov. di Trento), along the pathway towards Rifugio Croz dell'Altissimo, ca. 1300 m a.s.l., 46°09´N, 10°57´E, 24.VII.2005, *L. Peruzzi, G. Aquaro, D. Uzunov, K. F. Caparelli*]
P. vulgaris L. *s. lato* (VUL-AB)	C Italy, Abruzzo [Parco Nazionale Gran Sasso-Monti della Laga: M.ti della Laga, Fosso dell'Acero, Cesacastina (Teramo), prati torbosi lungo il ruscello, 1643 m a.s.l., 42°35.814´N, 13°24.919´E, 9 Jul. 2004, F. Conti, D. Lakusic; M.ti della Laga, Lago di Campotosto, Campotosto (L'Aquila), torbieretta, 1333 m a.s.l., 42°33.722´N, 13°21.640´E, 6.VII.2004, F. Conti, F. Bartolucci]
P. vulgaris L. *s. lato* (VUL-ANZ)	C Italy, Latium [Simbruini, tra Subiaco e Jenne (Roma), loc. "Piscicarello di Jenne", rupi stillicidiose, 495 m a.s.l., 41°53. 912´N, 13°08.374´E, 26.V.2005, F. Conti, F. Bartolucci, A. Bernardini]
P. vulgaris L. *s. lato* (VUL-VES)	C Italy, Abruzzo [Parco Nazionale Gran Sasso-Monti della Laga: Gran Sasso, Valle del Rio Arno, Pietracamela (Teramo), torbieretta, 1140 m a.s.l., 42°30.813´N, 13°32.789´E, 6 Jul. 2004, *F. Conti, F. Bartolucci*; Gran Sasso, tra Vado di Corno e la Valle dell'Inferno, Isola del Gran Sasso (Teramo), rupi stillicidiose, 1730 m a.s.l., 42°27.510´N, 13°35.406´E, 17.VII.2004, *F. Conti, F. Bartolucci*]
P. vulgaris L. *s. lato* (VUL-VES)	C Italy, Abruzzo [Ernici, sottogruppo dei M.ti Cantari, Riserva Naturale Zompo Lo Schioppo, Morino (L'Aquila), rupi stillicidiose ai piedi della cascata, 730 m a.s.l., 41°50.928´N, 13°24.070´E, 4.VII.2004, *F. Conti. F. Bartolucci, M. Iocchi*]

* sampled only for seeds.

lation (Table 1): corolla length, spur length, upper lobes length, upper lobes width, lower lip central lobe length, lower lip central lobe width, lower lip lateral lobes length, lower lip lateral lobes width, calyx upper lip length, and calyx upper lip width. The variables were processed with the software of statistical and multivariate analysis Data Desk 6.1; boxplots expressing the variability of each character were made.

Seed morphology, anatomy and morphometry

General seed morphology was studied with binocular lens on 40 seeds from each sample (Table 1). Four seeds from each sample were studied with SEM. For SEM studies, the material was coated with a thin gold layer, then observed and photographed at 20 kV.

Due to the taxonomic significance of seed anatomy in *Pinguicula*, already shown by Degtjareva *et al*. (2004), we studied four seeds from each sample using a light microscope. Cross and longitudinal sections were made using a hand razor and the seeds mounted in glycerine. Before sectioning, seeds were maintained for three days in a mixture of equal parts of glycerine, ethyl alcohol and water at 56 °C. The sections were stained with Ruthenium red. The following characters were observed: cotyledon features (number, symmetry, type of aestivation), exotesta cell features (number, shape, size), presence/absence of chalazal end appendage, and the micropylar seed appendage/seed length ratio.

Seed morphometry was studied by measuring total length, maximum width, and length of mycropilar appendage in 40 seeds from each considered population (Table 1). The variables were processed with the software of statistical and multivariate analysis Data Desk 6.1; boxplots expressing the variability of each character were made.

Results

General morphology

All the investigated plants clearly belong to *Pinguicula* sect. *Pinguicula*, sharing several features such as temperate growth type (overwintering as *hibernacula*), homophyllous rosettes (with some doubt of what concerns VRE), five to nine ovate to obovate-oblong lanceolate leaves, and scapes and capsules of comparable shape and size. As for the corolla features, six systematic units can be identified on the basis of the peculiar combination of colouring patterns (Fig. 1) and opening angles (Fig. 2). "*Pinguicula reichenbachiana*" (VRE) has a violet corolla, white at the centre with violet stripes, and appears fully open (opening angle 120°–180°). *Pinguicula fiorii* (FIO) has a blue-violet corolla, often without dots, and shows an opening angle of 90°–120°. Within *P. vulgaris*, VUL-AB and VUL-ANZ appear close and share a blue-violet corolla with white hairs/dot near the throat; but the latter also shows a white V-shaped dot on the median lower lip, surrounded by deep violet. Moreover, VUL-AB has a not well-opened corolla (30°–80°), while VUL-ANZ shows an opening angle of 90°–120°. Also VUL-VES and VUL-ERN appear close to each other, sharing a pale violet corolla, whitish-rose on the lower lip, with a yellowish stripe on the median lower lip; however, VUL-VES has a less opened corolla (30°–80°) than VUL-ERN (70°–90°).

Floral morphometry

Six out of the ten measured quantitative continuous floral characters are of particular significance. Corolla (Fig. 3A) and spur (Fig. 3B) lengths well separate VRE from others, without overlaps.

The co-variance (here shown as ratio) between length and width in lobes of the corolla upper lip (Fig. 3C) separates well between VRE and FIO while, within *P. vulgaris*, it separates VUL-AB and VUL-ANZ from VUL-VES and VUL-ERN.

The lengths of the lower lip lateral lobes (Fig. 4A) and central lobe (Fig. 4B) clearly separate VRE and FIO from the others (*P. vulgaris*); within the latter species, there is a clear gradient from VUL-AB to VUL-ERN in reduction of both lengths.

Calyx upper lip length (Fig. 4C) appears smaller in VUL-ERN than in any other unit.

Variation in the shape and size of calyx is also remarkable, showing the affinities of VRE

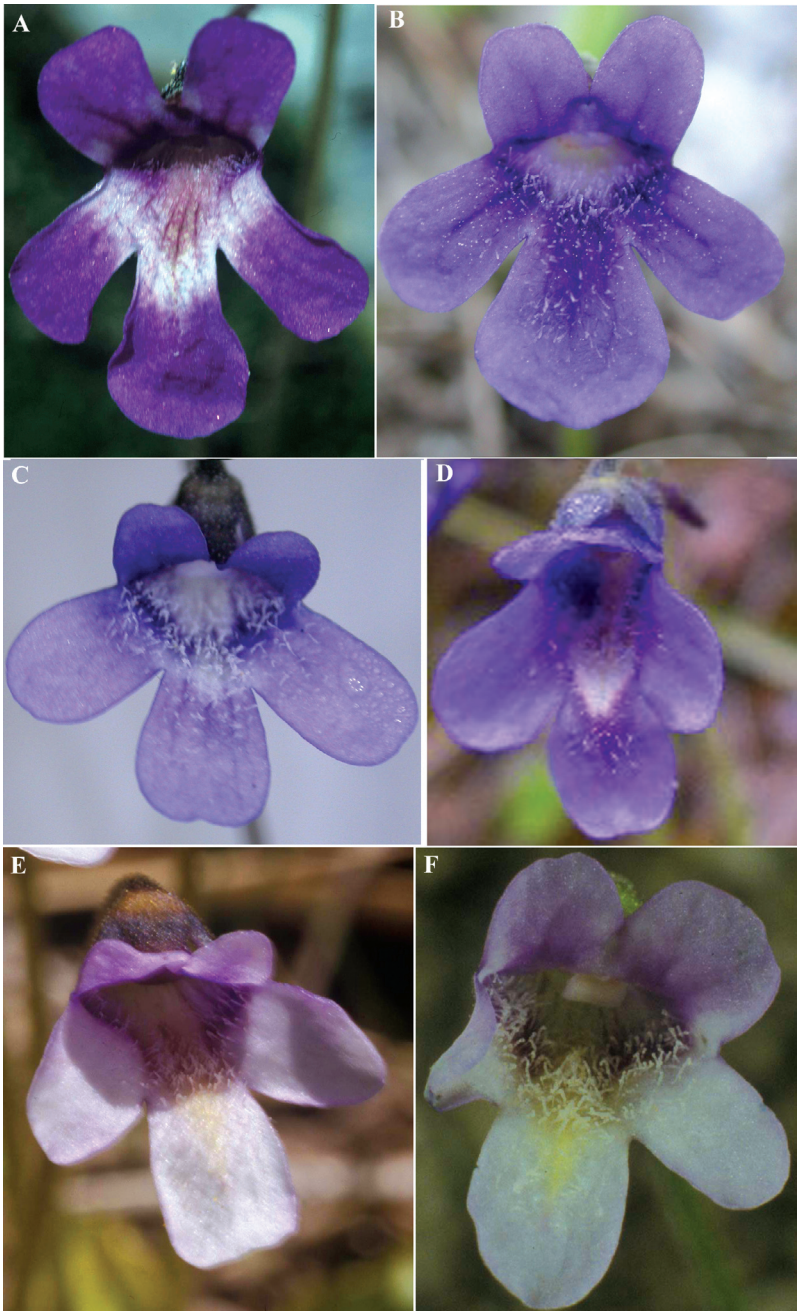

Fig. 1. Front views of flowers. — **A**: *P. vallis-regiae* (VRE). — **B**: *P. fiorii* (FIO). — **C**: *P. vulgaris* subsp. *vulgaris* (VUL-AB). — **D**: *P. vulgaris* subsp. *anzalonei* (VUL-ANZ). — **E**: *P. vulgaris* subsp. *vestina* (VUL-VES). — **F**: *P. vulgaris* subsp. *ernica* (VUL-ERN).

and FIO, VUL-AB and VUL-ANZ, VUL-VES and VUL-ERN respectively (Fig. 5).

Seed morphology, anatomy and morphometry

General seed morphology revealed some interesting variation patterns. VRE, FIO and *P. vulgaris s. lato* (including the VUL-ALP accession from the Alps) all show comparable seed length and width but VUL-ERN, which has seeds that clearly tend to be longer (Fig. 6A) and thinner (Fig. 6B) than others, resulting in a spindly (instead of elliptic) shape. Also the covariance (here showed as ratio) among micropylar seed

Fig. 2. Lateral views of flowers. — **A**: *P. vallis-regiae* (VRE). — **B**: *P. fiorii* (FIO). — **C**: *P. vulgaris* subsp. *vulgaris* (VUL-AB). — **D**: *P. vulgaris* subsp. *anzalonei* (VUL-ANZ). — **E**: *P. vulgaris* subsp. *vestina* (VUL-VES). — **F**: *P. vulgaris* subsp. *ernica* (VUL-ERN).

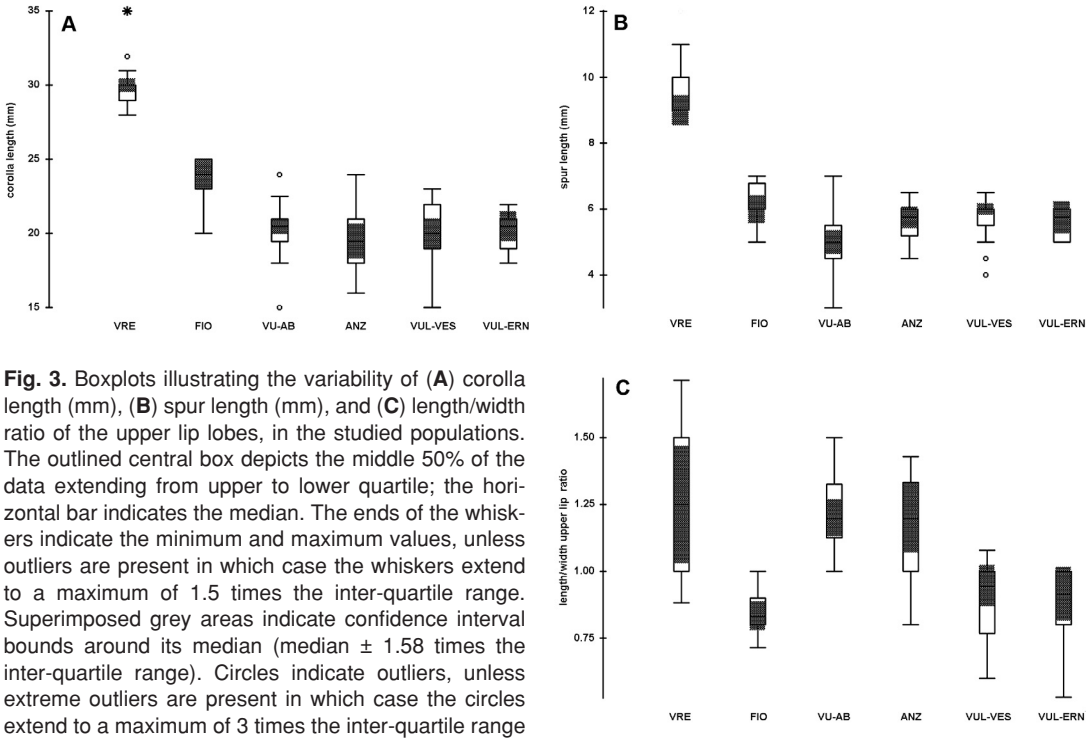

Fig. 3. Boxplots illustrating the variability of (**A**) corolla length (mm), (**B**) spur length (mm), and (**C**) length/width ratio of the upper lip lobes, in the studied populations. The outlined central box depicts the middle 50% of the data extending from upper to lower quartile; the horizontal bar indicates the median. The ends of the whiskers indicate the minimum and maximum values, unless outliers are present in which case the whiskers extend to a maximum of 1.5 times the inter-quartile range. Superimposed grey areas indicate confidence interval bounds around its median (median ± 1.58 times the inter-quartile range). Circles indicate outliers, unless extreme outliers are present in which case the circles extend to a maximum of 3 times the inter-quartile range and the extreme outliers are indicated as asterisks.

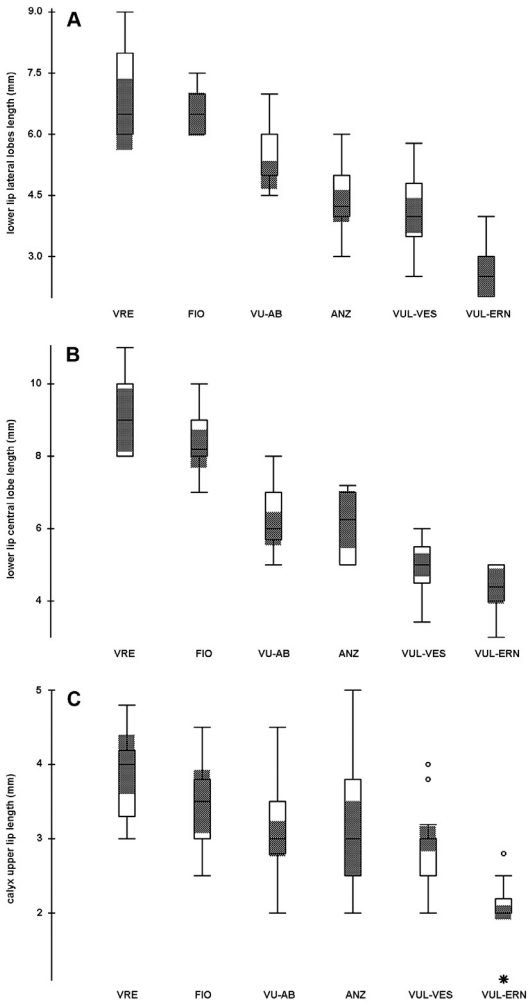

Fig. 4. Boxplots illustrating the variability of (**A**) length of lower lip of the corolla lateral (mm), (**B**) central lobe length (mm), and (**C**) calyx upper lip length (mm) in the studied populations (for more explanations *see* caption to Fig. 3).

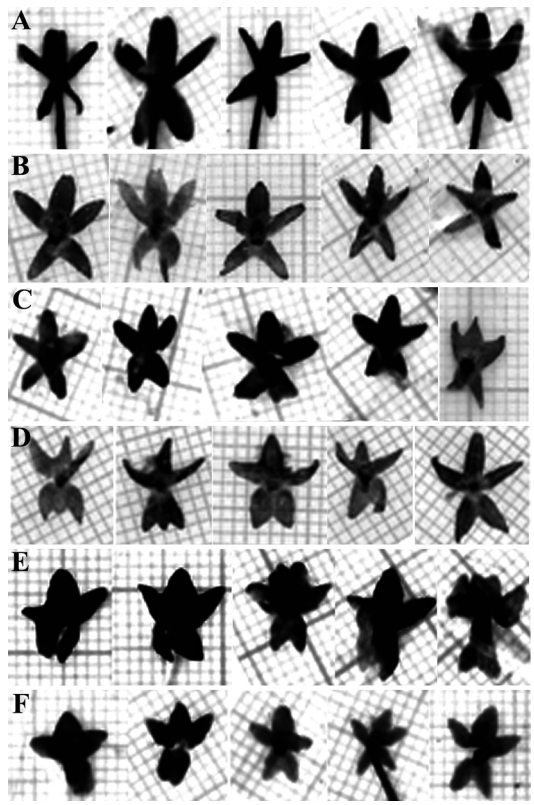

Fig. 5. Variability in calyx. — **A**: *P. vallis-regiae* (VRE). — **B**: *P. fiorii* (FIO). — **C**: *P. vulgaris* subsp. *vulgaris* (VUL-AB). — **D**: *P. vulgaris* subsp. *anzalonei* (VUL-ANZ). — **E**: *P. vulgaris* subsp. *vestina* (VUL-VES). — **F**: *P. vulgaris* subsp. *ernica* (VUL-ERN). Calyces are mounted on millimeter paper.

appendage and seed lengths shows the same trend, although less markedly (Fig. 6C).

SEM analysis (Fig. 7) of seeds also showed that all units share rounded-polygonal exotesta cells, divided more or less evidently by a furrow. The size (length and width) of exotesta cells is approximately similar in all units, but tends to be bigger in VUL-ERN. In the latter unit, the anticlinal walls of exotesta cells are also deeper than in other units (Fig. 7H), while in VRE they are markedly the least evident ones (Fig. 7B). The latter unit (Fig. 7A) and VUL-ERN (Fig. 7G) have both > 200 exotesta cells, while the other units all have < 200 (Figs. 7C–7E). Finally, only in VRE a light chalazal end appendage was noted (Fig. 7A). VUL-ANZ and VUL-VES seeds are not shown, but they are nearly identical to those of VUL-AB (Fig. 7E).

All units have only one plicate cotyledon. Cotyledon in VRE, VUL-ALP, VUL-VES and VUL-ANZ is asymmetric in cross section, while in VUL-AB and VUL-ERN it is almost symmetric. In FIO the cotyledon was symmetric.

Discussion

By comparing our results with the data known for similar species, it becomes clear that VRE — formerly quoted as "*P. reichenbachiana*" (i.e. by Tammaro & Fiori 1987), but already noted to

be different from it by Steiger (1998) and Casper and Steiger (2001) — has indeed several different characters from the "true" *P. reichenbachiana* (Schindler 1906, Casper 1966). They include the (likely) homophyllous rosette and the very different colouring pattern of corolla. On the other hand, the colouring pattern is nearly identical to that of the recently described homophyllous *P. poldinii* (Casper & Steiger 2001), from which VRE is well distinguished by the bigger size of scape and leaves and by the capsule shape (Table 2). The presence of a seed chalazal end appendage — nearly identical to that observed by us in VRE — was known, within sect. *Pinguicula*, only for *P. reichenbachiana* (Degtjareva *et al*. 2004). Unfortunately, there is no detailed information available on the seed structure of *P. poldinii*. The latter species, due to its putatively taxonomic isolation, was regarded by Casper and Steiger (2001) as possibly belonging to the informal series "*Prealpicae*". In our opinion, *P. reichenbachiana*, *P. poldinii* and VRE are all closely related from taxonomic (and perhaps also phylogenetic) point of view, but any taxonomic recognition at supraspecific level is premature. Nonetheless, it is worth noting that in the recent phylogenetic study by Cieslak *et al*. (2005) *P. reichenbachiana*, *P. poldinii* (and *P. leptoceras*) were considered sister to all other studied species of *Pinguicula* sect. *Pinguicula* (including *P. fiorii* and *P. vulgaris*). The bootstrap support was high (96% to 100%, depending on the algorithm used).

FIO — described as *P. fiorii* (Tammaro & Pace 1987) — has also several unique traits, which allow us to distinguish it from the other units discussed above, such as the shape, size and colouring pattern of the corolla, and the symmetric cotyledon cross section. The latter feature is instead shared with *P. leptoceras* (Degtjareva *et al*. 2004), but this species has very different corolla features (Casper 1966, *see* Table 2).

According to Casper (1966), central Italy is one of the southernmost areas where *P. vulgaris* occurs and it is isolated from the main distribution range of the species. In particular VUL-AB occurs in northern Abruzzo (M.ti della Laga), and its morphological features are widely overlapping with those reported for *P. vulgaris* from the Alps and other European localities by

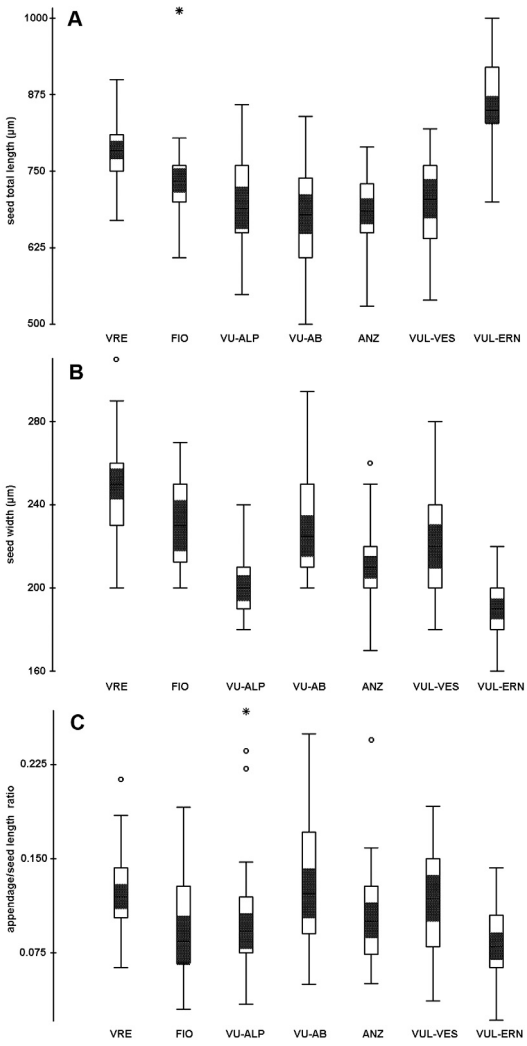

Fig. 6. Boxplots illustrating the variability of (**A**) seed total length (µm), (**B**) width (µm), and (**C**) mycropylar seed appendage/seed length ratio in the studied populations (for more explanations *see* caption to Fig. 3).

several authors (Casper 1966, Romo *et al*. 1996, Blanca *et al*. 1999, Blanca 2001, Degtjareva *et al*. 2004, Heslop-Harrison 2004, L. Legendre & T. Cieslak, unpubl. data; *see* Table 3). Each of the remaining three systematic units circumscribed by us within the species have instead peculiar corolla and calyx features associated with stenoendemic distribution: VUL-VES occurring in central Abruzzo (Gran Sasso and Altopiano delle Rocche), and VUL-ANZ and VUL-ERN occurring instead in western central Abruzzo (Ernici) and CE Latium (Simbruini), respectively. All

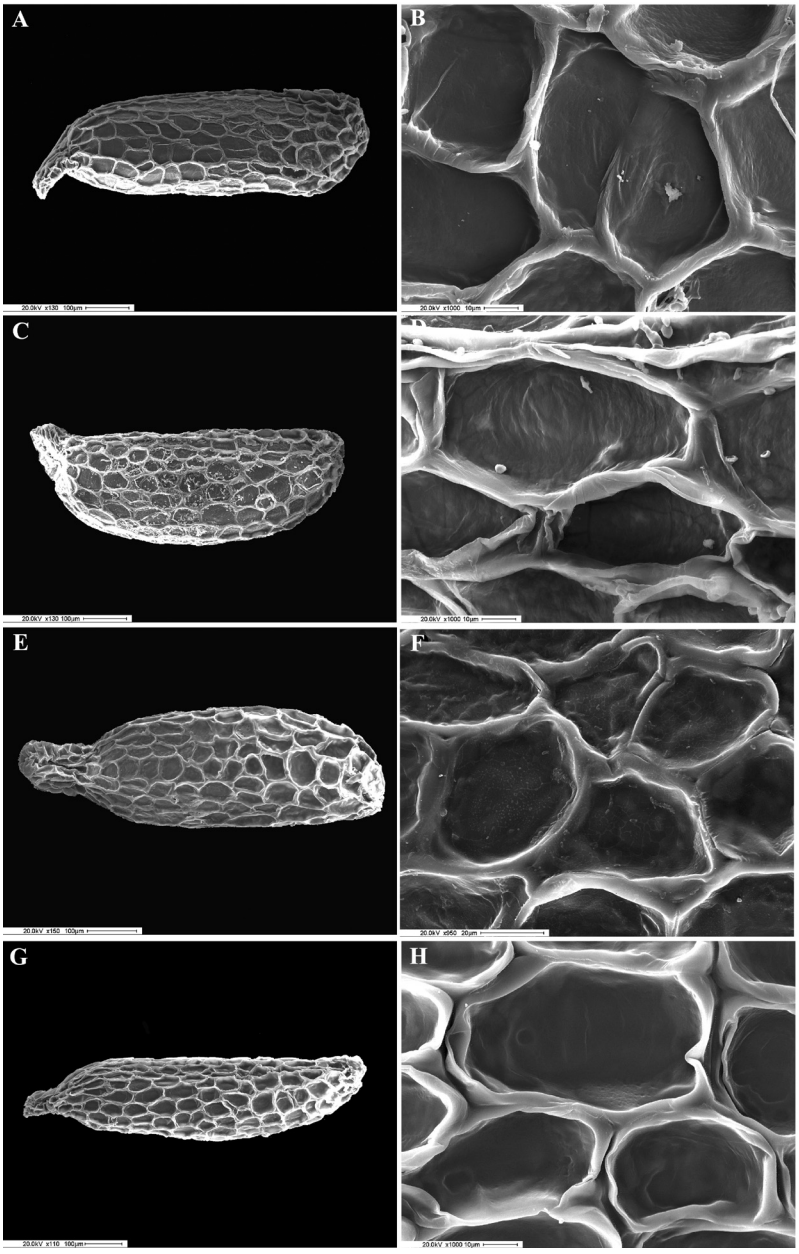

Fig. 7. SEM microphotographs of seeds (general view and details of exotesta cells). — **A** and **B**: *P. vallis-regiae* (VRE). — **C** and **D**: *P. fiorii* (FIO). — **E** and **F**: *P. vulgaris* subsp. *vulgaris* (VUL-AB). — **G** and **H**: *P. vulgaris* subsp. *ernica* (VUL-ERN).

these units show low intra- and inter-populational variability.

According to our results, and considering the allopatric occurrence of all the studied units (Fig. 8) in central Italy, we treat VRE and FIO as belonging to two clearly distinct species, in the light of their peculiar and unique features. VRE needs to be described as new to science, since it cannot be placed in any known taxon; while for FIO the validly published name *P. fiorii* is available.

As for the other systematic units (*P. vulgaris s. lato*), VUL-AB can be doubtlessly identified with *P. vulgaris s. stricto*, while for the remaining three — all clearly belonging to the latter taxon but showing a distinctive combination of characters related to geographic isolation — we think that taxonomic recognition at the subspe-

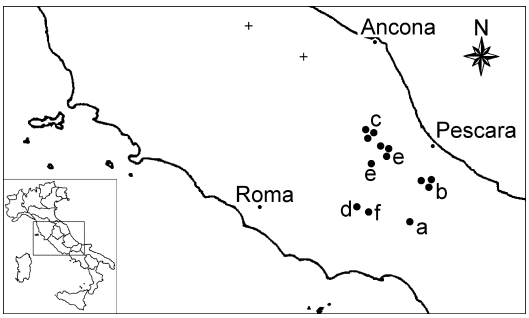

Fig. 8. Distribution of *Pinguicula* in central Italy: (a) *P. vallis-regiae* (VRE); (b) *P. fiorii* (FIO); (c) *P. vulgaris* subsp. *vulgaris* (VUL-AB); (d) *P. vulgaris* subsp. *anzalonei* (VUL-ANZ); (e) *P. vulgaris* subsp. *vestina* (VUL-VES); (f) *P. vulgaris* subsp. *ernica* (VUL-ERN,). "+" indicates two extinct localities from Marche, likely to be referred to *P. vulgaris* subsp. *vulgaris*.

cies rank is appropriate. In our opinion, none of them can be placed in previously described taxa, and they are therefore here described as new to science.

All the studied populations grow in very rare and fragile habitats and deserve protection, in particular VRE (here described as *P. vallis-regiae*), VUL-ERN (here described as *P. vulgaris* subsp. *ernica*) and VUL-ANZ (here described as *P. vulgaris* subsp. *anzalonei*) occur all in single localities and would deserve special conservational attention. Uncontrolled collection of these "carnivorous" plants by amateurs can be particularly dangerous. We suggest the insertion of all these taxa in the Red Book of Italian Plants.

Taxonomic treatment

Pinguicula vallis-regiae F. Conti & Peruzzi, *sp. nova* (Figs. 1A, 2A, 5A, 9)

Pinguicula reichenbachiana auct., Fl. Ital. *p.p.*

Planta (75)84–156(170) mm alta. Rosula verosimiliter homophylla; folia (30)34.5–61.7(72) mm longa. Corolla late ampliata (120°–180° angulo aperturae), viola, centro albo, striis longitudinalibus violaceis notatis, 28–31.8(35) mm longa; lobi labii inferi oblongi, non rotundati, inter se non tegenti; calcar 9–11(12) mm longum. Labium superum calycis valde tripartitum; lobi labii superi elliptico-lineari. Capsula ovoidea.

Fig. 9. General view of *Pinguicula vallis-regiae* from Camosciara (Abruzzo).

HOLOTYPE: Italy. Abruzzo, Abruzzo National Park, Camosciara, Villetta Barrea (L'Aquila), rupi stillicidiose, 1073 m a.s.l., 41°45.925′N, 13°54.535′E, 26.V.1994 *F. Conti* (APP).

Herb perennial, small, rosette-forming, scapose, succulent. Stem short, with ascending, not branching rhizome and numerous adventitious fibrous roots. Rosettes to 60–150 mm in diameter with few, 5–9 leaves lying more or less flat on ground, likely homophyllous. Overwintering as buds (*hibernacula*). Leaves in outline obovate-oblong, obtuse at apex, narrowed at base, 3–4 × as long as broad, (30)34.5–61.7(72) mm long, 10.9–18 mm broad, margin entire, sometimes slightly incurved, brittle, upper surface densely covered with mucilaginous sessile and stalked glands. Scapes 1–2, erect, (75)84–156(170) mm tall, terete, 1-flowered, directly beneath flower densely covered with stipitate glands, to base sparsely glandular. Flowers relatively large, 28–31.8(35) mm long (spur included). Calyx distinctly bilabiate, densely covered on both sur-

Table 2. Comparison of *Pinguicula fiorii* (data from Tammaro & Pace 1987, Degtjareva *et al.* 2004, our personal observations), *P. vallis-regiae* (data from our personal observations), *P. reichenbachiana* (data from Schindler 1906, Casper 1966, Degtjareva *et al.* 2004), *P. poldinii* (data from Casper & Steiger 2001) and *P. leptoceras* (Casper 1966, Degtjareva *et al.* 2004). Quantitative data are expressed in 10–90 percentiles, with extreme values in brackets.

	P. fiorii	*P. vallis-regiae*	*P. reichenbachiana*	*P. poldinii*	*P. leptoceras*
Growth type	temperate	temperate	temperate	temperate	temperate
Rosette type	homophyllous	homophyllous(?)	heterophyllous	homophyllous	homophyllous
Leaf					
number	7–8	5–9	5–11	(4)5–6(8)	5–8
shape	obovate-oblong	obovate-oblong to lanceolate	ovate-oblong to lanceolate	obovate-oblong	ovate-oblong
length (mm)	(20)24–36	(30)34.5–61.7(72)	(25)40–70(115)	(22)25–35(39)	(19)25–40(65)
width (mm)	(9)11–14(16)	(10.9)12–16.7(18)	(5)9–12(19)	(5)7–10(13)	(6)10–16(22)
Scape size (mm)	50–76	(75)84–156(170)	60–80	(32)45–70(78)	(13)40–100(133)
Calyx					
upper lobe shape	ovate, the central one sometimes slightly bifid	elliptic-linear, the central one often bifid	linear, the central one often bifid	ovate-oblong, the central one often bifid or multifid	triangular, acute at apex
upper lobe size (mm)	2.5–4.5	3–4.8	ca. 6	4–5	ca. 5
bottom lobe shape	divergent, united for 1/3	divergent, united for 1/3-1/2	lanceolate	united for 1/6-1/2	narrowly lanceolate
bottom lobe size (mm)	2.5–4	3.2–4.8	ca. 6	4–5	ca. 5
Spur					
length (mm)	(4.5)5–7	9–11(12)	(5)8–11(15)	(7)9–11(13)	(1)4–6(9)
shape	straight	slightly curved downwards	slightly curved downwards	slightly curved downwards	straight
Corolla					
length, spur included (mm)	(19.5)20–25(25.5)	28–31.8(35)	(16)24–34(44)	(21)24–28(32)	(10)16–25(31)
colour	blue-violet	violet, white at the centre with violet stripes	violet with three white dots	violet, white at the centre with violet stripes	blue-violet with three white dots
lower lip lobes	close but not overlapping	not overlapping	close but not overlapping	not overlapping	overlapping
throat	white	white	white	white	white
opening angle	90–120°	120–180°	90–120°	120–180°	45–90°
upper lobe length (mm)	3.2–5	4.6–6	?	5-7	?
upper lobe width (mm)	3.9–6	(3)3.5–5(6.8)	?	?	?
lateral lobe length (mm)	6–7.5	6–8(9)	?	?	?
lateral lobe width (mm)	4–5.5	(3.5)4–5.7(8)	?	?	?

median lobe length (mm)	7–10	8–10(11)	?	9–11	?
median lobe width (mm)	5.2–8	(5)6–8.3	?	5–7	?
Capsule					
length (mm)	?	4.5–5	?	5	7–8
shape	ovoid	ovoid	ovoid to subglobose	globose	ovoid
Cotyledon					
number	1	1	1	?	1
symmetry	symmetric	asymmetric	asymmetric	?	symmetric
aestivation	plicate	plicate	plicate	?	plicate
Outer parts of anticlinal walls					
of adjacent exotesta cells	divided by a furrow	divided by a furrow	divided by a furrow	?	divided by a furrow
Exotesta cells					
shape	rounded-polygonal	rounded-polygonal	rounded-polygonal	rounded-polygonal	rounded-polygonal
number	< 200	> 200	> 200	?	< 200
length (µm)	(25)36–86(89)	(47)50–85(89)	42–79	?	30–93(120)
width (µm)	(18.7)29–45(47)	(25)30–48(53)	21.4–43.5(50)	?	(15)21.7–45
Depth of anticlinal walls of exotesta cells (µm)	(40.1)40.4–80(80.3)	20.4–50.6	?	?	(20)21.5–37.9(45)
Chalazal seed appendage	no	yes	yes	?	no
Micropylar seed appendage/seed length ratio	(0.02)0.05–0.13(0.16)	(0.06)0.08–0.15(0.21)	0.16	?	0.10
Seed					
shape	elliptic	elliptic	elliptic	elliptic	elliptic
length, appendage included (µm)	(610)642–791(850)	(670)703–841(900)	850–1000	600–700(800)	700–885
width (µm)	(200)210–258(270)	210–274(310)	200–400	300–400	200–300

Table 3. Comparison within *Pinguicula vulgaris*. Data for from the Alps and extra-Italian localities derive from works of Casper (1966), Romo *et al.* (1996), Blanca *et al.* (1999), Blanca (2001), Heslop-Harrison (2004) for general morphology; Degtjareva *et al.* (2004), L. Legendre & T. Cieslak (unpubl. data) and our personal observations for details of seed morphology. Quantitative data are expressed in 10–90 percentiles, with extreme values in brackets.

	P. vulgaris including the Alps and other extra-Italian provenances	*P. vulgaris* subsp. *vulgaris* (Abruzzo)	*P. vulgaris* subsp. *anzalonei* (Latium)	*P. vulgaris* subsp. *ernica* (Abruzzo)	*P. vulgaris* subsp. *vestina* (Abruzzo)
Growth type	temperate	temperate	temperate	temperate	temperate
Rosette type	homophyllous	homophyllous	homophyllous	homophyllous	homophyllous
Leaf					
number	5–11	5	5–6	5–6	6–7
shape	ovate to oblong-lanceolate	obovate-oblong	obovate-oblong	obovate-oblong	obovate-oblong
length (mm)	(10)20–50(90)	(39)41–66(75)	(10)13.7–31.6(34)	33–51(55)	(21)25.8–56.8(58)
width (mm)	(7)10–20(27)	(16)18–23(24)	(4)7.6–12	(8)10.7–18.1(19)	(13)14.2–22.8(24)
Scape size (mm)	(25)75–180(272)	?	?	(127)131–175(180)	?
Calyx					
upper lobe shape	united for 1/2, triangular-ovate to elliptic	united for 1/3, triangular-ovate	united for 1/3, triangular-ovate	united for 1/2, triangular	united for 1/2, triangular; the central one often bifid
upper lobe size (mm)	2.5–3	2–4.5	3–5	1.1–2.8	2–3.8
bottom lobe shape	united for 1/2–2/3	united for 1/2 or more, ovate	united for more than 1/2, ovate often with a third central lobe	united more than 1/2 (often completely), ovate	united for 2/3 or more, ovate
bottom lobes size (mm)	1.5–4.5	1.8–3.5	2.5–4.5	1.5–2.7	2–4
Spur					
length (mm)	(1)3–6(10)	3.5–7	4.5–6.5	5–6	4.5–6.5
shape	straight to slightly curved downwards	straight downwards	slightly curved downwards	slightly curved downwards	slightly curved
Corolla					
length, spur included (mm)	(9)15–22(32)	15–22.5	16–24	18–22	15–23
colour	blue-violet	blue-violet, with white hairs/dot near the throat	blue-violet, with few white hairs a white V-shaped dot on median lower lip, surrounded with deep violet	pale violet, whitish-rose the lower lip, with white hairs; a yellow stripe on median lower lip	pale violet, whitish-rose the lower lip, with white hairs; a yellowish stripe on median lower lip

lower lip lobes	not overlapping	not overlapping	close, but not overlapping	not overlapping	not overlapping
throat	white	white	white	yellowish	white-yellowish
opening angle	30°–80°(120°)	30°–80°	90°–120°	70°–90°	30°–80°
upper lobe length (mm)	2.2–6	3–6	2–5	2–4	2.2–4
upper lobe width (mm)	2.2–5.2	3–4.5	2.2–3.5	2.5–5	2.5–5.2
lateral lobe length (mm)	2–6.8	4.5–6.8	3–6	2–4	2.5–5.8
lateral lobe width (mm)	2.3-5.2	3–5	3–5	2.3–3.8	2.5–5.2
median lobe length (mm)	5–7.5	5–8	5–7.2	3–5	3.4–5.8
median lobe width (mm)	2.4–6.5	3.1–5.5	3.5–6.5	2.9–4.5	2.4–6
Capsule					
length (mm)	4-6(10)	?	?	4–5	?
shape	ovoid to globose	?	?	ovoid	?
Cotyledon					
number	1	1	1	1	1
symmetry	± asymmetric	slightly asymmetric	asymmetric	slightly asymmetric	asymmetric
aestivation	plicate	plicate	plicate	plicate	plicate
Outer parts of anticlinal walls					
of adjacent exotesta cells	divided by a furrow	divided by a furrow	divided by a furrow	divided by a furrow	divided by a furrow
Exotesta cells					
shape	rounded-polygonal	rounded-polygonal	rounded-polygonal	rounded-polygonal	rounded-polygonal
number	< 200 (> 200)	< 200	< 200	> 200	< 200
length (µm)	(23)36–81(103)	(40)45–78(81)	(38)42–75(80)	(44)54–97(103)	(39)40–76(85)
width (µm)	(17)18–40(75)	(24)26–38(45)	(22)27–39(45)	(21)23–71(75)	(24)23–35(44)
Depth of anticlinal walls					
of exotesta cells (µm)	(20)23–81(150.9)	30.6–80.5(80.8)	(31)35–71(79)	(50.5)60.1–140.9(150.9)	(29)30–79.5(82)
Chalazal seed appendage	no	no	no	no	no
Micropylar seed appendage/					
seed length ratio	(0.02)0.05–0.19(0.26)	(0.05)0.08–0.2(0.25)	(0.04)0.06–0.13(0.24)	(0.02)0.05–0.12(0.14)	(0.03)0.07–0.17(0.23)
Seed					
shape	elliptic (spindly)	elliptic	elliptic	spindly	elliptic
length, appendage included (µm)	(500)680–816(1000)	(520)540–763(840)	(550)615–765(790)	(700)800–964(1000)	(540)580–805(820)
width (µm)	(160)200–280(320)	200–261(270)	(170)180–240(260)	170–210	(180)190–255(280)

faces and margins with stipitate glands, 6–10 in total diameter, upper lip divided nearly to base into 3 lobes elliptic-linear, central one often bifid; lower lip divided to 1/2 into 2 short lobes. Throat relatively densely covered with white clavate hairs. Spur slightly curved downwards, thin, 9–11(12) mm long. Corolla distinctly bilabiate, violet, white at centre with violet stripes, at throat white, spur violet, upper lip with 2 nearly identical lobes, 0.9–1.3 × as long as broad, 4.6–6 mm long, erect, apex subtruncate to rounded; lower lip much larger than upper lip, with 3 lobes not overlapping, middle lobe distinctly longer and broader than lateral lobes, apex rounded to slightly truncate, front part of lobes bending downwards; whole corolla appears wide open (opening angle 120°–180°). Capsule ovoid, 4.5–5 mm in diameter, 1-loculate. Seeds minute, like sawdust, with reticulate surface, elliptic, (670)703–841(900) μm long, 210–274(310) μm wide. Micropylar seed appendage/seed length ratio (0.06)0.08–0.15(0.21). Number of exotesta cells > 200, exotesta cells (47)50–85(89) μm long, (25)30–48(53) μm wide, depth of anticlinal walls of exotesta cells 20.4–50.6 μm, outer parts of anticlinal walls of adjacent exotesta cells divided by a furrow, presence of a light chalazal seed appendage. Cotyledon 1, plicate, hardly asymmetric in cross section. Flowering May, fruiting May–June.

ETYMOLOGY: The name of this species comes from "*Vallis Regia*", old medieval name of high Sangro Valley, from which also the name "*Barrea*" stems.

DISTRIBUTION: Endemic to Camosciara (southern Abruzzo; Fig. 8).

HABITAT ECOLOGY: Dripping calcareous cliffs.

Pinguicula fiorii Tammaro & Pace (Figs. 1B, 2B, 5B)

Inform. Bot. Ital. 19: 430. 1987.

HOLOTYPE: Italy. Abruzzo, Versante orientale della Majella, in località Cannelluccia di Bocca di Valle in una forra, su rupi calcaree muschiose soggette a stillicidio, 750 m, 30.V.1983 *Tammaro* (AQUI!; isotypes FI!, RO!).

ILLUSTRATIONS: Tammaro & Pace (1987: 433, fig 2);

ETYMOLOGY: This species was dedicated by Tammaro and Pace (1987) to Prof. Adriano Fiori (1865–1950), an eminent Italian botanist.

DISTRIBUTION: Stenoendemic to few localities in Majella Massif (eastern Abruzzo; Fig. 8).

HABITAT ECOLOGY: Dripping calcareous cliffs from 750 to 2046 m a.s.l.

Pinguicula vulgaris L.

Sp. Pl.: 17. 1753. ("*Habitat in Europae uliginosis*").

LECTOTYPE (designated by Casper 1966): Herb. Linn. No. 33.1 (LINN, microfiche!).

subsp. ***vulgaris***

DISTRIBUTION: Circumboreal (Casper 1966). In central Italy on Laga Mountains (Marche, Lazio, Abruzzo). A. S. B. Brilli-Cattarini (pers. comm.) found *P. vulgaris* — very likely subsp. *vulgaris* — also in other localities in Marche: M. Carpegna and M. Catria. However, in both latter localities the plant is presently extinct because of human activities (Fig. 8).

HABITAT ECOLOGY: Marshes, bogs, humid grasslands, from 300 to 2600 m a.s.l. (Heslop-Harrison 2004). In central Italy mainly on siliceous substrates.

subsp. ***anzalonei*** Peruzzi & F. Conti, *subsp. nova* (Figs. 1D, 2D, 5D)

Corolla late ampliata (90°–120° angulo aperturae), violaceo-caerulea, lobus medius labii inferi macula alba, viola intense marginata V-forme notata; labium inferum lobis lateralibus 3–6 mm longum. Labium inferum calycis saepe trilobum.

HOLOTYPE: Italy. Latium, Simbruini, tra Subiaco e Jenne (Roma), loc. "Piscicarello di Jenne", rupi stillicidiose di cappellaccio travertinoso, 495 m a.s.l., 41°53.912′N, 13°08.374′E, 26.V.2005 *F. Conti, F. Bartolucci, A. Bernardini* (APP; isotype APP).

Leaves in outline obovate-oblong, obtuse at apex, narrowed at base, 2–3 × as long as broad, (10)13.7–31.6(34) mm long, (4)7.6–12 mm wide. Calyx distinctly bilabiate, densely covered on both surfaces and margins with stipitate glands, 6–10 mm in total diameter, upper lip divided for 1/2–2/3 into 3 triangular-ovate lobes, lower lip divided up to half of its own length, or less,

into 2(3) very short ovate lobes. Throat relatively densely covered with white clavate hairs. Spur slightly curved downwards, 4.5–6.5 mm long. Corolla distinctly bilabiate, blue violet, with few white hairs and a white V-shaped dot on median lower lobe, spur violet, upper lip with 2 nearly identical lobes, 1–1.5 × as long as broad, 2–5 mm long, erect, apex rounded; lower lip much larger than upper lip, with 3 lobes (rarely 4) not overlapping (lateral lobes 3–6 mm), apex rounded to slightly truncate; whole corolla appears with an opening angle 90°–120°. Seeds minute, like sawdust, with reticulate surface, elliptic, (550)615–765(790) μm long, (170)180–240(260) μm wide. Micropylar seed appendage/seed length ratio (0.04)0.06–0.13(0.24). Number of exotesta cells < 200, exotesta cells (38)42–75(80) μm long, (22)27–39(45) μm wide; depth of anticlinal walls of exotesta cells (31)35–71(79) μm; outer parts of anticlinal walls of adjacent exotesta cells divided by a furrow; chalazal end appendage absent. Cotyledon 1, plicate, asymmetric in cross section. Flowering May, fruiting May–June.

ILLUSTRATIONS: Anzalone (1984: 197, "*Pinguicula vulgaris* L. (subsp. nova?)".

ETYMOLOGY: This subspecies is dedicated to Prof. Bruno Anzalone (University of Rome "La Sapienza") who first hypothesized that this unit was differing in some way from *P. vulgaris s. stricto* (Anzalone 1983, 1984).

DISTRIBUTION: Known only from a single locality in Simbruini mountains (east Latium), where two main populations occur (Fig. 8).

HABITAT ECOLOGY: Dripping cliffs at low altitude.

subsp. ***vestina*** F. Conti & Peruzzi, *subsp. nova* (Figs. 1E, 2E, 5E)

Corolla pallide violacea, lobo medio labii inferi stria lutea notata, labium inferum roseo-album. Calyx 2–3.8 mm longus; lobus medianus labii superi saepe bilobus. Semina elliptica (540)580–805(820) µm longa.

HOLOTYPE: Italy. Abruzzo, Gran Sasso, M. Prena, versante settentrionale, Fossaceca, presso la Fonte del Peschio, 1400 m, 6.VI.05 *F. Conti*, *A. Manzi* (APP).

Calyx distinctly bilabiate, 4–8 mm in total diameter, upper lip divided for 1/2 into 3 triangular-ovate lobes, central one often bilobe, lower lip divided up to 1/3 of its own length, or less, into 2 very short ovate lobes. Throat relatively densely covered with white clavate hairs. Spur slightly curved downwards, 4.5–6.5 mm long. Corolla distinctly bilabiate, pale violet, whitish-rose lower lip, with white hairs, a yellowish stripe on median lower lobe, spur violet, upper lip with 2 nearly identical lobes, 0.7–0.9 × as long as broad, 2.2–4 mm long, erect, apex rounded, lower lip much larger than upper lip, with 3 lobes not overlapping (the median one 3.4–5.8 mm long), apex rounded; whole corolla appears with an opening angle 30°–80°. Seeds minute, like sawdust, with reticulate surface, elliptic, (540)580–805(820) μm long, (180)190–255(280) μm wide. Micropylar seed appendage/seed length ratio (0.03)0.07–0.17(0.23). Number of exotesta cells < 200, exotesta cells (39)40–76(85) μm long, (24)23–35(44) μm wide; depth of anticlinal walls of exotesta cells (29)30–79.5(82) μm; outer parts of anticlinal walls of adjacent exotesta cells divided by a furrow. Chalazal end appendage absent. Cotyledon 1, plicate, asymmetric in cross section. Flowering June–July, fruiting July–August.

ETYMOLOGY: The name comes from the ancient Italian people called *Vestini* that lived in the Gran Sasso area.

DISTRIBUTION: Endemic to Gran Sasso Massif, where it grows in several localities: M. Prena, Pietracamela, between Vado di Corno and Valle dell'Inferno, Corno Piccolo and Altopiano delle Rocche in loc. Campo di Rovere (Fig. 8).

HABITAT ECOLOGY: Marshes, bogs, humid grasslands on calcareous substrate.

subsp. ***ernica*** Peruzzi & F. Conti, *subsp. nova* (Figs. 1F, 2F, 5F)

Differt a P. vulgare subsp. vestina: calyce minore longitudine (1.1–2.8 mm); labio infero calycis saepe unilobo; semina fusiformia majore amplitudine (700)800–964(1000) × 170–210 µm.

HOLOTYPE: Italy. Abruzzo, Ernici, sottogruppo dei M.ti Cantari, Riserva Naturale Zompo Lo Schioppo, Morino (L'Aquila), rupi stillicidiose ai piedi della cascata, 730 m

a.s.l., 41°50.928´N 13°24.070´E, 4.VII.2004 *F. Conti, F. Bartolucci, M. Iocchi* (APP).

Calyx distinctly bilabiate, 2–5 mm in total diameter, upper lip divided for 1/2 into 3 triangular-ovate lobes, lower lip divided up to half of its own length, or less (often not divided), into 2 very short ovate lobes. Throat relatively densely covered with white clavate hairs. Spur slightly curved downwards, 5–6 mm long. Corolla distinctly bilabiate, pale violet, whitish-rose lower lip, with white hairs, a yellow stripe on median lower lobe, spur violet; upper lip with 2 nearly identical lobes, 0.7–1 × as long as broad, 2–4 mm long, erect, apex rounded; lower lip much larger than upper lip, with 3 lobes not overlapping (the median one 3–5 mm long), apex rounded; whole corolla appears with an opening angle 70°–90°. Seeds minute, like sawdust, with reticulate surface, spindly, (700)800–964(1000) μm long, 170–210 μm wide. Micropylar seed appendage/seed length ratio (0.02)0.05–0.12(0.14). Number of exotesta cells > 200, exotesta cells (44)54–97(103) μm long, (21)23–71(75) μm wide; depth of anticlinal walls of exotesta cells (50.5)60.1–140.9(150.9) μm; outer parts of anticlinal walls of adjacent exotesta cells divided by a furrow. Chalazal end appendage absent. Cotyledon 1, plicate, almost symmetric in cross section. Flowering June–July, fruiting July–August.

Etymology: The name comes from Ernici mountains.

Distribution: Stenoendemic, restricted to one locality (Zompo Lo Schioppo cascade) in Ernici mountains (western Abruzzo; Fig. 8).

Habitat ecology: Dripping calcareous cliffs at ca. 700 m a.s.l.

Identification key to Italian *Pinguicula* (corolla lengths include spur)

Note: According to Degtjareva *et al*. (2004), seed anatomy features in *P. crystallina* and *P. hirtiflora* are significantly different, supporting the re-evaluation of two distinct species. For this reason we treat here the latter as a distinct species, despite its evident macromorphological affinity with *P. crystallina*. In Peruzzi *et al*. (2004) and Conti *et al*. (2005) this taxon appeared as *P. crystallina* subsp. *hirtiflora*.

1. Corolla (7)8–16(21) mm long, white, with a yellow dot on median lower lip ..... *P. alpina*
1. Corolla (9)15–32(44) mm long, whitish-rose to violet .. 2
2. Corolla opening angle 30°–80° 4
2. Corolla opening angle ≥ 90° (up to 180°) 3
3. Corolla 20–25 mm long, uniformly blue-violet with white throat ..... *P. fiorii*
3. Corolla 16–32(44) mm long, colour-pattern not as above 7
4. Corolla with three distinct white dots on lower lip; lobes of lower lip overlapping ..... *P. leptoceras*
4. Corolla without three distinct white dots on lower lip; lobes of lower lip not overlapping 5
5. Corolla blue-violet, median lobe of lower lip 5–8 mm long, without a yellowish stripe .... *P. vulgaris* subsp. *vulgaris*
5. Corolla pale violet, median lobe of lower lip 3–5.8 mm long, with a yellowish stripe 6
6. Seeds spindly (700)800–964(1000) × 170–210 μm, calyx upper lip 1.1–2.8 mm ..... *P. vulgaris* subsp. *ernica*
6. Seeds elliptic (540)580–805(820) × (180)190–255(280) μm, calyx upper lip 2–3.8 mm .... *P. vulgaris* subsp. *vestina*
7. Corolla lobes of lower lip distinctly bilobe, rose and white, with yellow throat; overwintering as a rosette .... *P. hirtiflora*
7. Corolla lobes of lower lip entire, violet to blue-violet with white throat; overwintering as a bud (*hibernaculum*) 8
8. Spur 4.5–6.5 mm, corolla 16–24 mm, blue-violet, with a white V-shaped dot, surrounded of deeper blue-violet on median lower lip ..... *P. vulgaris* subsp. *anzalonei*
8. Spur (5)8–11(15) mm, corolla (16)24–34(44) mm, violet, with different colour pattern 9
9. Corolla violet with three distinct white dots on lower lip, opening angle 90°–120°, plant heterophyllous (spring and summer leaves more or less differing) .... *P. reichenbachiana*
9. Corolla violet white at centre with violet stripes, opening angle 120°–180°, plant homophyllous (spring and summer leaves nearly identical) 10
10. Leaves (22)25–35(39) mm long, scape size (32)45–70(78) mm, capsule globose ..... *P. poldinii*
10. Leaves (30)34.5–61.7(72) long, scape size (75)84–156(170) mm, capsule ovoid ..... *P. vallis-regiae*

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