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***Hymenostylio recurvirostri-Pinguiculetum poldinii* ass. nova in the Valbrenta ravines (Venetian Prealps): a new palaeoendemic plant association belonging to the class *Adiantetea* Br.-Bl. 1948**

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Abstract

The paper presents some new remarkable findings of *Pinguicula poldinii* in the ravines and canyons of the Valbrenta (Venetian Prealps). The stands of this rare species are distributed along an unglaciated characteristic area which preserves important endemisms. The consistence, composition and ecology of the proposed new endemic phytocoenosis *Hymenostylio recurvirostri-Pinguiculetum poldinii*, belonging to *Adiantion*, are evaluated by means of 12 relevés. The role of ravines and canyons located into refuge massifs of southeastern Alps during the Last Glacial Maximum, where calciphilous species survived, is shown out.

Key words: *Adiantion*, *Pinguicula poldinii*, preglacial relicts, ravines, Venetian Prealps

Introduction

In 1987, during some excursions for surveying the ravine vegetation in the Valbrenta (Venetian Prealps), a very showy pinguicula whose characteristics seemed compatible with the *Longifolia*-group was found. After the discovery of *Pinguicula poldinii* in the Prealps of Friuli-Venezia Giulia (NE Italy), having perceived that the found plants seemed to correspond to the new species described by Casper & Steiger (2001), we revisited the stations where the *Pinguicula* was found and we had the confirmation it was just *Pinguicula poldinii*. The enlargement of exploration into adjacent valleys has highlighted thirteen new stands of *Pinguicula poldinii* edifying a veritable endemic phytocoenosis into the ravines carved in the *Dolomia Principale*.

The genus *Pinguicula*, belonging to the family of carnivorous *Lentibulariaceae*, counts more than 80 currently accepted species (Steiger 1998, Legendre 2000) distributed in all the continents except Oceania, while in Africa it is present only in northern Morocco (Casper, 1966; Romo *et al.*, 1996). Molecular analysis (Jobson *et al.*, 2003; Müller *et al.*, 2004; Cieslak *et al.*, 2005) have recently shown the monophyletic feature of the genus, that may have diversified from a paratropical laurophyllous vegetation that was present in the Tertiary under warmer and more humid climatic conditions (Cieslak *et al.*, 2005). These authors recognize within the genus ambit five descent lines that reflect as many radiation centres into well definite geographic areas. The number of species

recognized in the fundamental monographic study of Casper (1966) is continuously increasing owing to description of new various entities, in particular in the principal centres of differentiation: central America and Europe (Legendre, 2000). In the last years in the Old World numerous descriptive works of endemisms, with mostly localized distribution in Iberian Peninsula (Mateo & Crespo, 1995; Zamora *et al.*, 1996) and in Italian Peninsula, have followed. Casper (1972) included 12 species in the Flora Europaea, five of which occur in the Italian Peninsula (Pignatti, 1982): *Pinguicula vulgaris*, *Pinguicula alpina* and *Pinguicula leptoceras* limited to the Alps, *Pinguicula reichenbachiana*, reported for Tuscany and Abruzzo (central Italy), *Pinguicula crystallina* subsp. *hirtiflora*, occurring only in Campania and Calabria (southern Italy). Recently new species have been recognized for our peninsula: *Pinguicula fiorii* (Tammaro & Pace, 1987), endemic to Abruzzo, and *Pinguicula poldinii* (Casper & Steiger, 2001) endemic to Friuli-Venezia Giulia. Conti and Peruzzi (2006) have carried out a taxonomic study of central Italian *Pinguicula*, identifying various systematic units: *Pinguicula vallis-regiae*, *Pinguicula vulgaris* subsp. *vulgaris*, *Pinguicula vulgaris* subsp. *anzalonei*, *Pinguicula vulgaris* subsp. *vestina*, *Pinguicula vulgaris* subsp. *ernica*. To these we must finally add the recent description of two new species for Apuan Alps, *Pinguicula mariae* and *Pinguicula apuana* (Ansaldi & Casper, 2009), and the recent finding of *Pinguicula grandiflora* within the borders of our Country (Compostella *et al.*, 2010).

Study area

The Valbrenta, area covered by this study, is a prealpine valley situated between the Grappa Massif and the Asiago Plateau. It characterizes the stretch of valley interesting the province of Vicenza, between the village of Martincelli, placed on the administrative border with the province of Trento, and Bassano del Grappa.

The valley shows in its upper stretch the classic U-shaped section, typical of the glacial ruts, while the lower-middle part takes on the appearance of river valley. It is for good part dug into the Dolomia Principale, with the exception of a short stretch, between Cison del Grappa and Primolano, where the Monte Zugna Formation (Calcari Grigi Group), normally situated above the Dolomia Principale, characterizes its basal part. The highest part of the valley is concerned by stratifications of Rosso Ammonitico surmounted by the Maiolica. The chart of the average annual rainfall indicates values of 1200 mm in the foothills quickly reaching the 1700 mm in the middle part of the valley (Tonini & Pulselli, 1970). The climate is temperate semicontinental-subcontinental (Blasi & Michetti, 2005). The stands of *Pinguicula poldinii* are situated in a characteristic band of the Valbrenta, beyond the elbow of Carpanè-Valstagna, point where the valley narrows considerably, the slopes become more precipitous and the lateral ravines and canyons assume a typical direction NNW-SSE. These engravings dug by the water on steep sides, enclose narrow, moist and practically isolated, often inaccessible ravines. The stands follow one another, faithfully tied to the Dolomia Principale, and sometimes also to deeply dolomitized limestones, on a stretch of about 10 kilometers, in a particularly rainy sector with average annual rainfall between 1500 and 1600 mm. In addition to the conditioning factors Dolomia Principale and heavy rainfall, they are located in ravines that formed the thermic oasis of large refuge slopes put in a marginal position as regards the terminal part of the Brenta Glacier during the Last Glacial Maximum. The position reached by the front of the glacier is unknown, in that the respective morainic deposits have been completely dismantled by subsequent erosion of the river Brenta (Taramelli, 1882). The author, however, claimed that the original morainic front of the glacier stopped at the confluence of the river Cison with the river Brenta (Barbieri & Grandesso, 2007) (Fig.1). According to the hypothetical reconstruction made by Trevisan (1939) it collapsed in the area of Enego, becoming exhausted in a short stretch of 8 kilometers near Ponte Subiolo, a village just to the north of Valstagna. The only traces of the most southern morainic rest of the Würmian Glacier in Valbrenta are those found along

the shoulder between Enego and Grignerebbe, while in the opposite terrace much more modest traces near the Sella of Valnevera above S. Vito are known (Secco, 1880; 1883) (Fig.1).

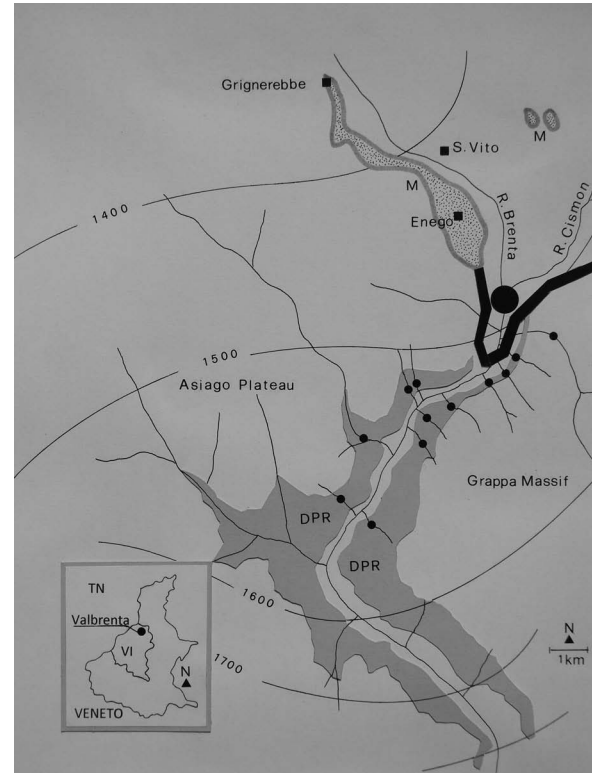


Fig.1 – Distribution of *Pinguicula poldinii* Steiger & Casper and the Quaternary Glaciation in the Valbrenta.

•: stands of *Pinguicula poldinii*
 M (light grey line with internal dotting): more southern morainic remains
 DPR (dark grey): Dolomia Principale
 •: hypothetical terminal morain (according to Taramelli, 1882), at the confluence of the river Brenta with the river Cison (the thick black line points out the boundary line between the possible terminal morain and the unglaciated refuge area)

Materials and methods

In a stretch between the elbow of Carpanè-Valstagna and the plain of Cison del Grappa, about six kilometers as the crow flies, 12 relevés of ravines phytocoenosis with *Pinguicula poldinii* were carried out, according to the classical sigmatist method of the School in Zurich-Montpellier (Braun-Blanquet, 1964; Westhoff & van der Maarel, 1978), with coverage values modified by Pignatti (1976).

The floristic nomenclature follows Conti *et al.* (2005), that of bryophytes Dierßen (2001) and Cortini-Pedrotti (2001, 2006), that of higher syntaxonomic levels Aeschmann *et al.* (2004). For ecological bioindication we refer to Poldini (1991) and Ellenberg *et al.* (1992).

As regards the chorological and biological spectra we followed Poldini (1991) and Aeschmann et al. (2004) for the vascular flora, Dierßen (2001) and Ellenberg et al. (1992) for the bryophytes. They have been calculated on the basis of the general number of the presences in the single relevé.

On the basis of the reconstruction of the Quaternary

Glaciation in the Asiago Plateau, including the path and the thickness of the Brenta Glacier, derived with inductive method (Trevisan, 1939), we have approximately established, on 1: 25.000 I.G.M. maps, the highest point reached by the glacier in correspondence of the ravines engraving the slopes of the Grappa Massif and the Asiago Plateau in the aforesaid section.



Fig. 2 – Typical ravine in the Valbrenta with *Pinguicula poldinii* niches.

This work was followed by a detailed research on the field designed to locate the concentration points of pre-glacial species, to substantiate the boundaries between the refuge area and the front of the glacier on the basis of the method set by Gortani (1959) and supported by Poldini (1991), i.e. a floristic survey to identify locally the distributive details of the relictic species and to verify the assumptions incurred by quaternalists.

Results and discussion

The problem of refuge centres is one of the most fascinating of floristic research. Following, therefore, the Gortani's method, we obtained a distribution pattern of preglacial species that would show the important role of the ravines carved on both orographic sides of the middle stretch of the Valbrenta. By the dislocation of species such as: *Pinguicula poldinii*, *Moltkia suffruticosa*, *Minuartia graminifolia*, *Primula auricula*, *Primula spectabilis*, *Paederota bonarota*, *Physoplexis comosa*, *Cortusa matthioli*, *Asplenium seelosii*, *Saxifraga petraea*, *Aquilegia brauneana*, *Genista*

radiata, *Iris cengialti* it is possible to trace a border between the refuge area and the glaciated one (Fig.1) that would seem to confirm the front of the terminal moraine apparatus of the Brenta Glacier near the confluence with the river Cismon, therefore in agreement with the hypothesis supported by Taramelli (1882).

Pinguicula poldinii is present in Val Goccia (0036/3), Val Nassa (0036/3), Val dei Ponti (0036/3), Val Gallina (0036/3), Val S. Lorenzo (0136/1) Val dell'Asta (0136/1), Val di Caprile (0136/1), Val della Corda (0136/1), Val Pian dei Zocchi (0136/1), along the left orographic side of Valbrenta (western slope of the Grappa Massif), and in Val Capra (0036/3), Val di Pieretti (0036/3), Val Gadena (0136/1), Val dell'Olier (0135/2), along the right orographic side of the valley (eastern slope of the Asiago Plateau) (Fig.1).

The altimetrical range goes from 280 to 650 m. a.s.l.

The populations, often very beautiful and flourishing, are established inside niches in the shadow of rain, where the species, characterized by a rather than selective ecology (stenocic), lives sinking the thin radical apparatus inside shallow wall mudslides

formed by carbonatic precipitates, largely covered by a gelatinous coating of *Cyanophyceae* with filamentous or cerebriform forms (*Scytonemataceae* and *Nostocaceae* respectively). The particular geomorphological and topographical features of these environments determine the combination of microclimatic factors that shape the optimal habitat of *Pinguicula poldinii*. It is represented by rocky recesses in the shadow of rain, from inclined to subvertical, which create a shelter against the direct solar radiation and, even where they are not directly conditioned by dripping, are in balance with the average air vapor pressure, maintained high by the proximity of springs and in relation to the evaporation potentiality of the surrounding environment. These niches keep a fairly high humidity scheme, measurable from frequent condensing steam that occurs in hollows of rocky surface. The peculiar feature of this ravine vegetation is a remarkable independence from the climate of the region, on which the microclimate, induced by the constant presence of water which tends to level the differences, has the upper hand (Fig.2).

The phytocoenosis is dominated by *Pinguicula poldinii* and belongs to the alliance *Adiantion* Br.-Bl. 1948, on the basis of the presence of *Hymenostylium*

recurvirostrum, *Preissia quadrata*, *Adiantum capillus-veneris*, *Eucladium verticillatum* and *Pellia endiviifolia*, species considered differential of alliance (Zechmeister, 1993; Tomaselli *et al.*, 2011) (Fig. 3). The new proposed plant association has been named *Hymenostylium recurvirostri-Pinguiculetum poldinii* ass. nova hoc loco (holotypus relevé n° 3, Tab. 1) on the basis of the two guide-species *Hymenostylium recurvirostrum* and *Pinguicula poldinii*.

The associations of *Adiantion* alliance are related to the Habitat 7220 “petrifying springs with tufa formation”.

The above listed species define class, order and alliance, since there are no unique characteristic species. The associations of the *Adiantion* alliance, in the presence of a greater water supply and a more thick layer of soil, get rich in cormophytes and come into catenal contact with the associations of the *Cratoneurion* Koch 1928 (Habitat 7220) to which the habitat in question is closely associated. The populations of *Pinguicula poldinii* from the Valbrenta have their optimum distribution precisely at the “corridors” of the springs that characterize the low-middle parts of the ravines, as emphasized by the presence of bryophytes belonging to the class *Montio-Cardaminetea* Br.-



Fig. 3 – *Pinguicula poldinii* on calcareous/dolomitic mudslides covered by a gelatinous coating of *Cyanophyceae*.

Bl. et Tüxen ex Klika 1948, especially *Cratoneuron filicinum*, *Palustriella commutata*, *Aneura pinguis*, *Bryum pseudotriquetrum* (II class), and sometimes *Brachythecium rivulare* and *Eurynchium praelongum*. In this regard, analysing the community of the springs of temperate Europe, Zechmeister & Mucina (1994) have proposed a syntaxonomic revision of the class *Montio-Cardaminetea* which includes the *Adiantetea* as an alliance. The topics in this classification of *Adiantion* in the class *Montio-Cardaminetea* are based on common mosses to *Adiantion* and *Cratoneurion*, and on the lack of vascular characteristic species, except *Adiantum capillus-veneris*. For this review they used relevés of *Cratoneurion*, without *Adiantum capillus-veneris*, coming from the Alps and Central Europe, and relevés of the *Adiantetea* communities from the outposts of this class, i.e. the southern fringes of the Alps and Pyrenees. Nevertheless the revision of Deil (1996, 1998), not restricted to Europe, but also based on stands from the whole Mediterranean area, including North-Africa and neighboring countries, confirms the independence of the class *Adiantetea*, clearly separated from a floristic and ecological point of view from all other Mediterranean vegetation units. Water is the discriminating factor that selects the community of the *Adiantetea* from those of *Montio-Cardaminetea*: when we switch from a situation of steam condensation or simple dripping to a continuous flow we witness an affirmation of *Cratoneurion* community, with enrichment of hydrophilous vascular species, especially bryophytes (Diaz Gonzalez *et al.*, 1982).

The presence of *Orthothecium rufescens* (III class) and *Carex brachystachys* (II class) equally shows a contact with the associations of *Cystopteridion* Richard 1972, i.e. with the populations of the damp and cold rocks. Under the same environmental conditions we often find, in fact, niches similar to those occupied by *Pinguicula poldinii*, but less sheltered and consequently more conditioned by the local climate, where *Pinguicula alpina*, a species distinguishable when is not in flowering for its much more large and fleshy roots, dominates. Similar stands were described by Braun-Blanquet (1948) as *Eucladio-Pinguiculetum alpinae* and returned to the *Asplenio-Caricetum brachystachyos* as a form of transition between the *Cratoneurion* and *Cystopteridion* (Mucina, 1993). There are also catenal contacts with the *Carici brachystachyos-Seslerietum* recently described for the Venetian-Friulan Prealps (Poldini *et al.*, 2009), with *Carex firma* and *Bellidiastrum michelii* (V class) to emphasize the rocky and then primitive feature of *Pinguicula poldinii* stands. The frequent presence of *Petasition paradoxii* species as *Aquilegia brauneana* and *Adenostyles glabra/glabra* (IV class), particularly constant in the gravelly substratum of the ravine

environment, increases the biodiversity of these phytocoenoses. Very interesting is the catenal contact with relictic stands occupied by *Cortusa matthioli*, a splendid species with preglacial origin, situation that can be found at the highest altitudinal points attained by *Pinguicula poldinii* (650 m). Among the other notable preglacial entities we must especially emphasize the presence of *Physoplexis comosa* that, preferring the niches in the shadow of rain, confirms the rain-phobia character as *Pinguicula poldinii*. The participation of elements tied to basic bogs, especially *Tofieldia calyculata*, beside *Molinia caerulea* subsp. *arundinacea*, both very faithful to these slides moistened by muddy sand castings, confirms the typical composition of the *Adiantetea* stands. The only difference between classic half cavity (balme), embedded in the rock, and these niches, represented by more simple recesses under rain, is in the spatial arrangement of the contact series: well spaced in the former, tightened, for question of very small space, especially in terms of depth, in the latter.

The phytocoenosis is largely formed by hemicryptophytes (72,7%) and a much lower percentage of camephytes (21,8%), with the addition of a sporadic percentage of geophytes (3,3%) and phanerophytes (2,2%) (Fig. 4).

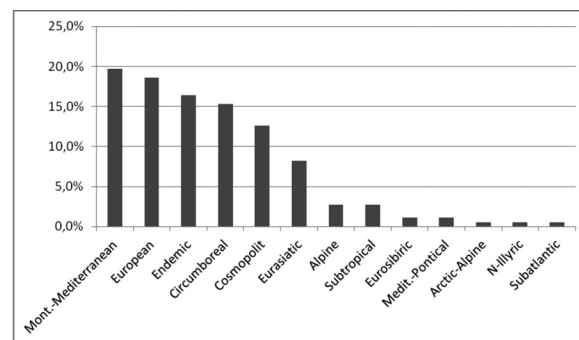


Fig. 4 - Biological spectrum of *Hymenostylio recurvirostri-Pinguiculetum poldinii* ass. nova

The chorological spectrum shows a high percentage of species belonging to Temperate Group (26,8%) which includes Eurasian and European elements, followed by the Montane-Mediterranean species (19,7%); the Endemic Group is well represented (16,4%) as well the Boreal (16,9%) which includes Arctic-Alpine, Circumboreal and Euro-sibiric species, and Cosmopolitan Group (12,6%). We point out, at the end, a weak oriental mark (1,6%) formed by Mediterranean-Pontical and N-Illyric chorological elements (Fig. 5).

As regards the more thermophilous *Eucladio-Adiantetum*, basal association of the *Adiantetea*, the *Hymenostylio recurvirostri-Pinguiculetum poldinii* shows a bond to more wet and slightly less bright

stands. The phytocoenosis shows an ecological behaviour characterized from mean to high moisture values, from subneutral to basic reaction values, oligotrophic nutrient availability, medium rich humus substrates, texture largely < 0,002 mm (muddy soil), from moderately shady to moderately shiny habitats, altimetric range between the colline and submontane belt, and middling-continental/subcontinental climate. The briophytic flora, in particular, is very significant, numbering species that show a clear index of subcontinentality (*Hymenostylium recurvirostrum*, *Preissia quadrata*, *Orthothecium rufescens*) or transition from suboceanicity to subcontinentality (*Pellia endiviifolia*, *Palustriella commutata*, *Aneura pinguis*, *Bryum pseudotriquetrum*, *Plagiochyla asplenioides*, *Lophocolea bidentata*). The environmental indicator that most distinguishes this phytocoenosis is *Hymenostylium recurvirostrum*, a loyal moss, more hygrophilous and mesophylous than *Eucladium verticillatum* which builds the *Eucladio-Adiantetum* and that is sporadically here present only in the stands with a higher thermic availability.

The environments of the *Adiantetea* are characterized by certain peculiarities. As pointed out by Deil (1995, 1996, 1998), the climatic conditions are very constant (stenothermic, permanent contribution of water), in such a way as to make their vegetation independent of the rainfall patterns of the climatic area, as well as the climate changes that have occurred in the past. The stands cover small areas and are highly fragmented and dispersed (characteristics of islands). The communities they have hosted protect palaeoendemic species vicariants of the genera *Pinguicula*, *Hypericum*, *Primula*, in addition to present outposts of tropical ferns. The communities are relictic in a double sense: they are impoverished remains of the Tertiary vegetation, reduced to small areas by the climatic changes in the Quaternary and Holocene periods and protect ancient forms within large genera, which are linked to the *Adiantetea* since a long period and have undergone their evolution and speciation process in this sociological and ecological context (Deil, l.c.). We may suppose that the floristic differences between stands are more the result of the vegetation history, the age and the permanence of every stand, the reproductive strategy, the efficiency of taxa, the evolutionary processes, than the recent ecological differentiation of stands themselves (Deil, l.c.). Deil (1995) has dealt with the description of vegetation units by supraspecific taxa, the so-called concept of coeno-syntaxon, i.e. the classification at the level of sections and subgenera. The coeno-syntaxon concept is used to classify vegetation units which are poor in species but rich in local, vicarious and relict endemics. This rank is not provided by the Code of Phytosociological Nomenclature (Weber *et al.*, 2000).

The *Pinguicula* series *Longifoliae* characterizes the *Coeno-Pinguiculion* Deil 1989 which is distributed in the north-west of Mediterranean region and is considered a synonymous of *Pinguiculion longifoliae* F. Casas 1970 (Rivas-Martínez *et al.*, 2001).

According to Casper & Steiger (2001) the habitats with *Pinguicula poldinii* are reminiscent of those colonized by the *Adiantetea* communities described and named *Coeno-Pinguiculion*. Nevertheless *Pinguicula poldinii*, as moreover *Pinguicula mariae*, belongs to a group of species distinguished by its common temperate north-central Mediterranean homophyllous growth type, by its tetraploid chromosome level (Casper & Stimper, 2009) and by its ecology and geography, so as to be interpreted as a self-series, different from the heterophyllous *Longifoliae*, and definable as *Prealpicae* series (Casper & Steiger, 2001; Ansaldi & Casper, 2009). The highly endemic, predominantly petrophilous, long-leaves *Pinguicula* species with homophyllous or heterophyllous growth-types of the Iberian and Italian peninsulas could identify an archaic core of genetic diversification within the section *Pinguicula* in the north-central Mediterranean region (Casper & Steiger, 2001). These features are fully confirmed even for the communities of *Adiantetea* in the Valbrenta and even more reinforced and enhanced by the predominant primordial character of the ravines, the impressive isolation of the niches and the indisputable location within refuges identifiable on the ground through a marked belt of preglacial species, that have here found unparalleled conditions of protection and survival.

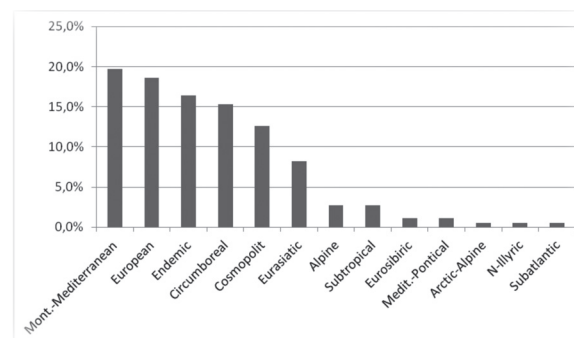


Fig. 5 - Chorological spectrum of *Hymenostylium recurvirostri-Pinguiculetum poldinii* ass. nova

Conclusion

The extraordinary presence of *Pinguicula poldinii* in the Valbrenta ravines confirms the high biogeographical value of this prealpine sector.

During the Last Glacial Maximum these areas located at the south-east edge of the Alps, concerned only marginally by large valley glaciers, played a role of refuge for several endemic species, so as to form "hot

spots” of many relictic entities.

The niches segregated inside the ravines and canyons host a real phytocoenosis, whose independence and membership in the class *Adiantetea* seem clear.

The extension of the distribution area toward the west, from Friuli Venezia Giulia to Valbrenta, passes through the recent discovered stand of Lamen Valley in Vette Feltrine (Belluno), as reported in a note by Ansaldi & Casper (2009), making this species an endemism of Veneto and Friuli. The most beautiful and rich stands, where this rare entity builds an endemic phytocoenosis, are mainly located on the left orographic side of the Valbrenta and belong to the Grappa Massif. *Pinguicula poldinii* represents today, full title, the most rare species of this mountain already very well known since past for its remarkable flora.

The relevés reported in this work refer to a rather narrow area but, as the ecology of the species is as much narrow, we can reasonably suppose that the distribution of the new plant association is larger and coinciding on the whole with that of *Pinguicula poldinii*.

The evaluation of the depletion or disappearance risk

of this species from the Valbrenta, for environmental alterations or indiscriminate collections, is largely corroborated by the fact that the populations are located inside inaccessible and protected ravines. The orographic features of this prealpine mountain portion, distinguished by high wilderness, were the primary warranty of a conservation state in the past and will certainly be in the future. The perfect state of preservation of the *Hymenostylio recurvirostri-Pinguiculetum poldinii* stands, verified through the floristic comparison with past data (relevés carried out in 1987 in Val dei Ponti and Val Nassa), without noticing any significant variation, both as regards the species composition and the coverage data, is a witness of the environmental integrity maintained by these ravine biotopes over a period of 25 years since the first discovery of these populations in Valbrenta.

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Syntaxonomic scheme

Adiantetea Br.-Bl. 1948

Adiantetalia Br.-Bl. 1948

Adiantion Br.-Bl. ex Horvatič 1939

Hymenostylio recurvirostri-Pinguiculetum poldinii ass. nova hoc loco

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Appendix: dates and locations of relevés

Tab. 1:

Rel. n° 1 Val Nassa (VNA), 05.05.2008; rel. n° 2 Val dei Ponti (VPO), 05.05.2008; rel. n° 3 Val Pian dei Zocchi (VPZ), 08.05.2008; rel. n° 4 Val dell'Asta (VAS), 08.05.2008; rel. n° 5 - 6 - 7 Val della Corda (VCO), 10.05.2008; rel. n° 8 Val Gallina (VGA), 12.05.2008; rel. n° 9 Val Caprile (VCA), 05.05.2009; rel. n° 10 Val Gadena (VGD), 05.05.2009; rel. n° 11 - 12 Val Capra (VCA), 10.05.2009.