

Short Communication

Conservation of endemic insular plants: the genus *Ribes* L. (Grossulariaceae) in Sardinia

GIUSEPPE FENU, EFISIO MATTANA and GIANLUIGI BACCHETTA

Abstract Only two members of the genus *Ribes* L. (Grossulariaceae) occur in Sardinia, both endemic: *R. sardoum* and *R. multiflorum* subsp. *sandalioticum*. *R. sardoum* is categorized as Critically Endangered on the IUCN Red List and *R. multiflorum* subsp. *sandalioticum* is a rare species previously known from only a few localities. Both species grow only in mountainous areas. In 2006–2010 we carried out a field survey to verify the conservation status of *R. sardoum* and to estimate the number of individual plants, identify threats and assess the conservation status of *R. multiflorum* subsp. *sandalioticum*. *R. sardoum* is threatened by grazing, its small population, low seed viability and the activities of tourists, confirming its Critically Endangered status. We found *R. multiflorum* subsp. *sandalioticum* in 13 localities, three of which are new records, with the plants in scattered groups or singly, in three populations. The threats to *R. multiflorum* subsp. *sandalioticum* are overgrazing, the small populations, habitat fragmentation and the activities of tourists. We propose that *R. multiflorum* subsp. *sandalioticum* be categorized as Endangered on the IUCN Red List. Research activities and conservation measures for this genus on Sardinia have been proposed and some conservation actions have already commenced.

Keywords Endemic flora, population monitoring, *Ribes sardoum*, *Ribes multiflorum* subsp. *sandalioticum*, Sardinia, seedbank

In the Mediterranean basin the islands and islets constitute the main centres of plant diversity (Médail & Quézel, 1999) because of the narrow range of most of their flora (Rosselló et al., 2009). Of these, central northern Sardinia has been identified as one of 52 putative glacial refugia in the Mediterranean region (Médail & Diadema, 2009). This area of the island is characterized by many endemic species typical of temperate climates, such as species of *Ribes* (Grossulariaceae; Fenu et al., 2010). *Ribes sardoum* Martelli and *Ribes multiflorum* Kit ex Roem et

Schult. subsp. *sandalioticum* Arrigoni (hereafter, *R. sandalioticum*) are the only two members of this genus in Sardinia and both are endemic to the island. These two taxa are taxonomically well differentiated, belonging to different subgenera: *Oligocarpa* and *Ribesia* for *R. sardoum* and *R. sandalioticum*, respectively (Valsecchi, 1977). Sardinia is the only Mediterranean island where this genus is represented exclusively by narrow endemic species, and the genus is absent on the nearest islands and islets (Ilvensian Archipelago) or represented only by widely distributed species (Balearic Islands, Corsica, Sicily; Bolòs & Vigo, 1984; Jeanmonod & Gamisans, 2007; Gianguzzi et al., 2011).

R. sardoum, a rare and threatened species with only one small population in the Supramontes region, has been partially investigated and is categorized as Critically Endangered on the IUCN Red List (Conti et al., 1997; Bacchetta, 2001; de Montmollin & Strahm, 2005; Camarda, 2006; Bacchetta et al., 2008). However, there has previously been no distribution or abundance data available, or a conservation assessment, for *R. sandalioticum*. Because of its relatively broad geographical distribution it has previously been considered to be Lower Risk (i.e. not warranting threatened status) on the Italian plant Red List (Conti et al., 1997). The aims of the study reported here were to verify the conservation status of *R. sardoum* and assess the conservation status of *R. sandalioticum* and to propose conservation measures for both species.

The available data on the distribution, ecology and conservation status of *R. sardoum* (Bacchetta, 2001; Camarda, 2006; Bacchetta et al., 2008) were confirmed by fieldwork. The distribution of *R. sandalioticum* was determined by field surveys during 2006–2010 in the localities for which herbarium specimens and other data (Arrigoni, 1981; Fenu et al., 2010) were available and in other mountain areas where the species could potentially occur. Each area in which we located the species was mapped and monitored, ecological features noted and individual plants counted.

The extent of the one known population of *R. sardoum*, growing on limestone substrates in Monte Corraì (Bacchetta, 2001; Camarda, 2006; Bacchetta et al., 2008), was confirmed by our field surveys. Camarda (2006) reported the presence of c. 100 individual plants but our monitoring data indicated that the population consists of c. 80 plants, in an area of 700 m² at an altitude of c. 1,100 m (Table 1).

We found *R. sandalioticum* in 13 localities in three populations, on the Gennargentu massif in the Supramontes

GIUSEPPE FENU (Corresponding author), EFISIO MATTANA and GIANLUIGI BACCHETTA Centro Conservazione Biodiversità, Dipartimento di Scienze della Vita e dell'Ambiente—Università degli Studi di Cagliari, Viale S. Ignazio da Laconi, 13-09123 Cagliari, Italy. E-mail gfenu@unica.it

Received 3 February 2011. Revision requested 9 March 2011.

Accepted 13 April 2011.

TABLE 1 Characteristics of the 14 localities (numbered, in Fig. 1) in which we confirmed the presence of *Ribes sardoum* and *Ribes sandalioticum*, with mean altitude, slope, aspect, lithological substrata, estimated area occupied, and total number of individual plants and of mature plants observed in each locality.

Localities (municipality, administrative province)	Altitude (m)	Slope (°)	Aspect	Substrate	Estimated area (m ²)	Total no. of plants	No. of mature plants
<i>R. sardoum</i>							
Supramontes: Monte Corراس							
1, Prados (Oliena, Nuoro)	1,100	25–30	NE	Limestone	700	c. 80	Not determined
<i>R. sandalioticum</i>							
Supramontes: Gennargentu							
2, Girgini-Sa Minda (Desulo, Nuoro)	1,250	25	SW	Metamorphic	15	3	3
3, S'Ortu is Arangius (Desulo, Nuoro)	1,530	30	W	Granite	5,600	52	38
4, Su Sciusciu (Desulo, Nuoro)	1,550	30	SW	Granite	3,800	15	14
5, Rio Correboi (Villagrande Strisaili, Ogliastra)	1,425	15–25	NE	Metamorphic	4,000	18	15
6, Rio Baritta (Fonni, Nuoro)	1,400	20	E	Metamorphic	10	3	1
7, Nodu 'e Littipori (Fonni, Nuoro)	1,440	15	NE	Metamorphic	600	8	6
8, Sedda Niedda (Fonni, Nuoro)*	1,320	30	N	Metamorphic	4	4	2
9, Monte Novo San Giovanni (Orgosolo, Nuoro)	1,265	10–35	NE	Limestone	15,000	256	214
10, Sedda Lughia (Fonni, Nuoro)* Marghine	1,295	20	NW	Metamorphic	4	2	1
11, Nuororaghe Ortachis (Bolotana, Nuoro)	1,022	5	NE	Basalt	800	5	4
12, Mularza Noa (Bolotana, Nuoro) Limbara	1,014			Basalt	4	1	1
13, Funtana Giacommeddu (Tempio, Olbia Tempio)	1,300	0–20	N–NE	Granite	18,000	70	55
14, Punta La Pira (Tempio, Olbia Tempio)*	1,109	10	N–NE	Granite	2	1	1

*New records

region and in the Limbara and Marghine mountains (Fig. 1). We confirmed the previously known localities of the species and added three new localities (Sedda Niedda and Sedda Lughia on the Gennargentu massif and Punta La Pira in Monte Limbara; Table 1, Fig. 1). The number of plants in individual localities was 1–256. The species grows on various lithological substrata, at altitudes of 1,000–1,550 m, and on slopes with varied incline and aspect. The vegetation community where *R. sandalioticum* grows forms a shrub coenosis related to mesophilous forests of *Taxus baccata* L. and *Ilex aquifolium* L.. *Ribes* species are slow-growing shrubs and vegetative propagation is important for the persistence of populations (Pfister & Sloan, 2008). We located few seedlings or young plants and this suggests that the Sardinian *Ribes* have a similar reproductive pattern.

R. sardoum is threatened because of its small population size, low seed viability and overgrazing (Bacchetta, 2001; Camarda, 2006; Bacchetta et al., 2008) and activities of tourists (such as trampling), and fire, also threaten the species. The main threat to *R. sandalioticum* is unregulated livestock grazing on leaves and young shoots, detected in all populations. The small number of mature individuals, their low density and the limited seedling recruitment must all be considered threats to this taxon. In the Marghine population human activity, such as forestry management, selective logging and touristic/recreational activity were observed.

Stochastic environmental events (e.g. fires, landslides) pose a significant potential threat; Mattana et al. (2011) demonstrated that seed germination of this species is particularly sensitive to global warming.

Based on our surveys we propose that *R. sandalioticum* be categorized (IUCN, 2001) as Endangered based on criterion C2a(I). We found only 355 mature individuals, ranging from five (Marghine) to 294 (Gennargentu) plants per population, with no localities containing > 250 mature individuals. Considering that in eight of the 13 localities there are < 10 mature plants it is reasonable to assume a continuing decline, as also suggested by the apparent decline in extent and quality of the species' habitat.

As part of the projects funded by the Regione Autonoma della Sardegna, the Centro Conservazione Biodiversità (Università di Cagliari) initiated a conservation programme of in situ studies and long-term ex situ conservation at the Sardinian Germplasm Bank (BG-SAR) for endemic plant species of Sardinia, including *R. sardoum* and *R. sandalioticum*. To ensure the persistence of these two taxa in situ a number of specific actions are required and some conservation and research activities have already begun (Table 2). Based on preliminary results of in situ monitoring a fence was erected in 2008 around Monte Novo San Giovanni, the most important location for *R. sandalioticum*. After 3 years of exclusion of livestock grazing

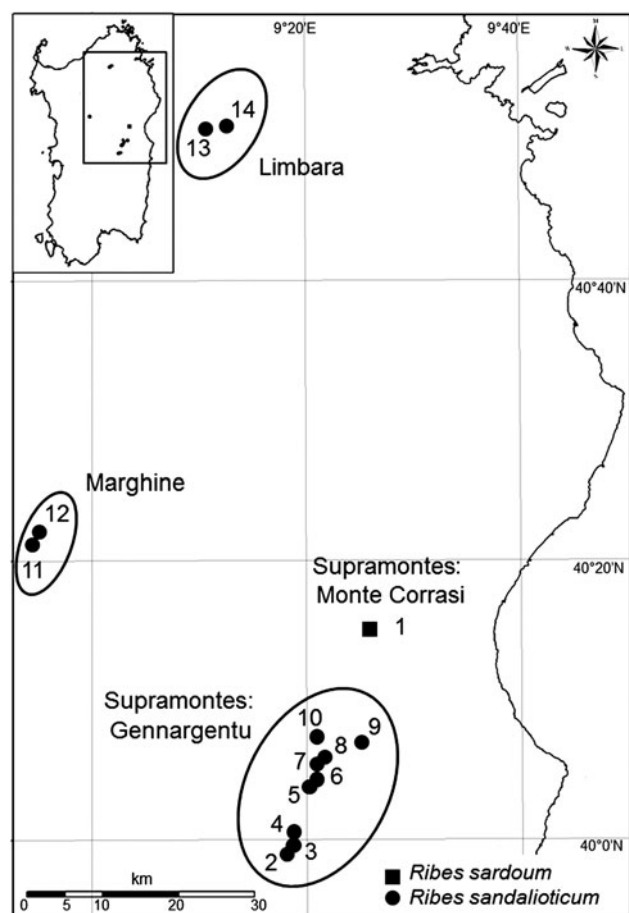


FIG. 1 Known localities of *Ribes sardoum* and *Ribes sandalioticum* in the central north of Sardinia: 1, Monte Corraisi; 2, Girgini-Sa Minda; 3, S'Ortu is Arangius; 4, Su Sciuciu; 5, Rio Correboi; 6, Rio Baritta; 7, Nodu 'e Littipori; 8, Sedda Niedda; 9, Monte Novo San Giovanni; 10, Sedda Lughia; 11, Nuraghe Ortachis; 12, Mularza Noa; 13, Funtana Giacumeddu; 14, Punta la Pira. For details of each locality, see Table 1. The ovals indicate the three populations of *R. sandalioticum*.

a substantial increase in the mean number of racemes per plant and of mature fruits per raceme has been detected (G. Fenu et al., unpubl. data). A fence was also erected in 2010 in Rio Correboi to limit livestock grazing and a fence is scheduled for the *R. sardoum* population.

Seeds of Grossulariaceae appear to be orthodox (Hong et al., 1998) and therefore long-term seed bank storage was identified as a suitable ex situ conservation measure for both species. However, seedbanking for *R. sardoum* has not started because of the low seed production of this species and therefore studies of alternative conservation measures, such as ex situ cultivation and propagation, have been initiated at the Botanical Garden of Cagliari. Seed of *R. sandalioticum* had been collected from the localities of Monte Novo San Giovanni, Rio Correboi, Funtana Giacumeddu and Nuraghe Ortachis and stored at BG-SAR. In addition duplicata of the seeds from Monte Novo San Giovanni have been sent to

TABLE 2 Conservation and research actions started (S) or proposed (P), with year, for *Ribes* in Sardinia, in collaboration with local and regional public institutions.

Conservation and research actions	<i>R. sardoum</i>	<i>R. sandalioticum</i>
In situ conservation		
Population monitoring	S (2006)	S (2007)
Limit impact of grazing	P (2008)	S (2007)
Regulate touristic activities	P (2007) ¹	
Establishment of micro-reserves	P (2009) ²	
Ex situ conservation		
Seed banking		S (2007)
Artificial propagation	S (2007)	S (2009)
Research activities		
Genetic analysis	S (2009)	S (2009)
Monitoring population & habitat	S (2006)	S (2007)
Studies of population size & distribution		S (2007)
Studies of seed biology & ecology		S (2009)

¹Local regulation of touristic activity and plant collection for the most threatened species (Municipality of Oliena, Nuoro, D.C. n. 7 of 16/02/2007)

²Proposed by Bacchetta et al. (2009) to the Regione Autonoma della Sardegna. See also Fenu et al. (2010).

the Seed Conservation Department, Royal Botanic Gardens, Kew, UK.

This study of the genus *Ribes* in Sardinia is an example of the type of conservation approach required for many of the endemic plant species of the Mediterranean area. This approach has previously been described for *Lamyropsis microcephala* (Moris) Dittrich et Greuter in Sardinia (Fenu et al., 2011) and *Aquilegia paui* Font Quer in north-east Spain (Martinell et al., 2011).

Acknowledgements

This research was supported by the Assessorato Difesa Ambiente and Ente Foreste della Sardegna (Regione Autonoma della Sardegna). We thank A. Congiu, R. Cossu, R. Guarino, M. Pappacoda and M. Serusi for their help with fieldwork.

References

- ARRIGONI, P.V. (1981) Le piante endemiche della Sardegna: 84–90. *Bollettino Società Sarda di Scienze Naturali*, 20, 233–268.
- BACCHETTA, G. (2001) *Ribes sardoum* Martelli. In *Liste rosse e blu della flora italiana* (eds S. Pignatti, P. Menegoni & V. Giacanelli). ANPA, Roma, Italy.
- BACCHETTA, G., CONGIU, A., FENU, G. & MATTANA, E. (2008) *Ribes sardoum* Martelli. *Informatore Botanico Italiano*, 40(Suppl. 1), 106–108.
- BACCHETTA, G., FENU, G. & MATTANA, E. (2009) *Relazione finale del progetto "Conservazione delle piante endemiche a maggior"*

- rischio d'estinzione della Sardegna*". Convenzione tra il Dipartimento di Scienze Botaniche dell'Università degli Studi di Cagliari e l'Assessorato Difesa Ambiente della Regione Autonoma della Sardegna (Progetto Rep. n° 44706-10 del 19.12.2007), Cagliari, Italy.
- BOLÒS, O. & VIGO, J. (1984) *Flora dels Països Catalans*, 1. Editorial Barcino, Barcelona, Spain.
- CAMARDA, I. (2006) *Ribes sardoum*. In *IUCN Red List of Threatened Species* v. 2010.4. <http://www.iucnredlist.org> [accessed 11 November 2010].
- CONTI, F., MANZI, A. & PEDROTTI, F. (1997) *Liste rosse regionali delle piante d'Italia*. Università degli Studi di Camerino, Camerino, Italy.
- FENU, G., MATTANA, E. & BACCHETTA, G. (2011) Distribution, status and conservation of a Critically Endangered, extremely narrow endemic: *Lamyropsis microcephala* (Asteraceae) in Sardinia. *Oryx*, 45, 180–186.
- FENU, G., MATTANA, E., CONGIU, A. & BACCHETTA, G. (2010) The endemic vascular flora of Supramontes (Sardinia), a priority plant conservation area. *Candollea*, 65, 347–358.
- GIANGUZZI, L., CALDARELLA, O. & ROMANO, S. (2011) First record of *Ribes uva-crispa* L. (Grossulariaceae) from the Madonie Mts., a new species of the Sicilian flora. *Plant Biosystems*, 145, 169–174.
- HONG, T.D., LININGTON, S. & ELLIS, R.H. (1998) *Compendium of Information on Seed Storage Behaviour*. Vol. 1. Royal Botanic Gardens, Kew, UK.
- IUCN (2001) *IUCN Red List Categories and Criteria version 3.1*. IUCN, Gland, Switzerland.
- JEANMONOD, D. & GAMISANS, J. (2007) *Flora Corsica*. Édisud, Aix-en-Provence, France.
- MARTINELL, M.C., LÓPEZ-PUJOL, J., BLANCHÉ, C., MOLERO, J. & SÀEZ, L. (2011) Conservation assessment of *Aquilegia paui* (Ranunculaceae): a case study of an extremely narrow endemic. *Oryx*, 45, 187–190.
- MATTANA, E., PRITCHARD, H.W., PORCEDDU, M., STUPPY, W.H. & BACCHETTA, G. (2011) Interchangeable effects of gibberellic acid and temperature on embryo growth, seed germination and epicotyl emergence in *Ribes multiflorum* ssp. *sandalioticum* (Grossulariaceae). *Plant Biology*, in press. doi:10.1111/j.1438-8677.2011.00476.x
- MÉDAIL, F. & DIADEMA, K. (2009) Glacial refugia influence plant diversity patterns in the Mediterranean Basin. *Journal of Biogeography*, 36, 1333–1345.
- MÉDAIL, F. & QUÉZEL, P. (1999) Biodiversity hotspots in the Mediterranean Basin: setting global conservation priorities. *Conservation Biology*, 13, 1510–1513.
- DE MONTMOLLIN, B. & STRAHM, W. (eds) (2005) *The Top 50 Mediterranean Island Plants: Wild Plants at the Brink of Extinction, and What is Needed to Save Them*. IUCN/SSC Mediterranean Islands Plant Specialist Group. IUCN, Gland, Switzerland.
- PFISTER, R.D. & SLOAN, J.P. (2008) *Ribes* L. In *The Woody Plant Seed Manual* (eds F.T. Bonner & R.P. Karrfalt). U.S. Department of Agriculture, Forest Service, Agriculture Handbook 727, Washington, DC, USA.
- ROSSELLÓ, J.A., COSÍN, R., BACCHETTA, G., BRULLO, S. & MAYOL, M. (2009) Nuclear and chloroplast DNA variation in *Cephalaria squamiflora* (Dipsacaceae), a disjunct Mediterranean species. *Taxon*, 58, 1242–1253.
- VALSECCHI, F. (1977) Biologia, posizione sistematica ed ecologia di *Ribes sardoum* Martelli e *Ribes multiflorum* Kit. ssp. *sandalioticum* Arrigoni. *Webbia*, 31, 279–294.

Biographical sketches

GIUSEPPE FENU has a particular interest in conservation of the endemic and threatened plants of Sardinia. EFISIO MATTANA is interested in ex situ conservation and germination ecophysiology studies on the endemic flora of Sardinia. GIANLUIGI BACCHETTA carries out geobotanical analyses in the western Mediterranean area.