

*Botany*

## Reproduction Biology of the Caucasus Endemic *Salvia garedji* Troitzk. (Lamiaceae) with Regard to *ex Situ* Conservation

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**ABSTRACT.** Reproduction biology of the Caucasian endemic *Salvia garedji* Troitzk., included in the Red List of Georgia, was studied with the aim of successful further *ex situ* conservation. The target plant species occurs locally in arid conditions of Georgia. It grows solitarily or in small groups on schistose sandstone slopes (600-800 m a.s.l.) of Garedji desert in Gare Kakheti region and experiences decline caused by overgrazing and trampling. The results of the study and a seed stock planned to be created at the Caucasus Regional Seed Bank, Tbilisi Botanical Garden and Institute of Botany, will allow establishment of a seedling collection and further re-introduction *in situ*. The species is resistant to extreme temperature fluctuations and can be successfully cultivated as an ornamental and oleiferous plant. © 2010 Bull. Georg. Natl. Acad. Sci.

**Key words:** *Salvia garedji*, endemic, the Caucasus, reproduction biology, conservation.

*Salvia garedji* is a rare endemic of the Caucasus. The species was included in the Red Data Book of Georgia [1]; at present it is included in the Red List of Georgia [2]; thus, it is subject to protection and needs *ex situ* conservation. The aim of our study was to collect data on the seed formation processes of *S. garedji* for further *ex situ* conservation of the species. The morphology of *S. garedji* is insufficiently studied and no data exist on its reproduction biology that makes an obstacle to conservation activities of the species. *S. garedji* is described from Georgia [3]. The species is xerophilous. It grows on sandstone at 600-800 m a.s.l. in narrow ravines.

The target population grows in the vicinity of David Garedji Monastery. Some authors [4] suppose that the plant was used by monks for religious purposes owing to its ornamental value. We think that the species might

also be used as a medicinal plant for presence of essential oils. The species distribution range is disjunctive. Plants are solitary or grow in small groups.

One of the factors keeping the number of individuals low is overgrazing and plant trampling by tourists visiting the monastic complex of David Garedji.

In the present study individuals of both wild populations and living collections of the Plant Conservation Department of Tbilisi Botanical Garden and Institute of Botany were used. Pollen fertility degree was determined by counting fertile pollen grains stained with acetocarmine in a 1000 visual field. Seed germination time and germination per cent were determined on Petri dishes by recording the numbers of sown and germinated seeds on filter paper and in pots.

*S. garedji* is a 20-40 cm tall perennial semi-shrub. Stem is branched. Leaves are pinnatisect, consisting of

2-4 small leaflets. Stem, leaves and flowers are pubescent and covered with simple glands producing abundant essential oils. Inflorescence is simple, 16-25 cm long, composed of 5 layers with 6-8 flowers in each. Calyx size is 1.7-2.0 cm, the calyx upper lip is bigger than the lower one; it is tridentate with weakly visible lateral lobes and wide and tipped middle lobe, has purple stripes, is tomentose and covered with glands. *S. garedji* starts its growing season in the first third of March. Flowering phase starts in the second half of April and lasts for a month. Fruits mature in June. Thus, the species completes its development cycle in 3 months.

Its worth mentioning that flowers of *Salvia* species differ from each other by peculiarities of their morphology, which relates to their adaptation to different pollinators [5,6].

The flower of *S. garedji* is purple-violet, 0.5 cm long. Upper lip is straight, lower wide, with deflected sides and two conspicuous nectar guide stripes. Flower tube has a hairy ring protecting the nectar located deep in the tube against undesirable insects. Four ovules develop in an ovary. Style is quite long, exceeding the upper lip and ended in bipartite stigma. There are 4 stamens.

In the species of the genus *Salvia* the stamen structure and degree of reduction is quite different. Stamens of *S. garedji* are distinguished by the following features. In right and left pairs of the 4 stamens the upper and lower ones have a shared filament and are attached to the corolla tube wall. Stamens are also distinguished by the anther and septum shape and size. The anthers of the upper two stamens are twice as long as those of the lower ones, have shorter and mobile hinge and contain fertile pollen. Lower anthers are rounded and fan-shaped. Halves of their anthers are stationary, interconnected by well-formed long septa.

Flower of *S. garedji* is entomophilous. The adaptation to pollination by insects is so strict that other ways of pollination such as wind pollination is occasional and does not contribute to seed formation. An insect visiting a flower of *S. garedji* lands on the wide lower lip of the corolla and proceeds along the nectar guides toward nectaries located deep inside the corolla tube and available only to insects with long proboscis. An insect hits the lower anthers, which make the upper stamens move, as the lower and upper stamens are bound with each other. Pollen from the stamens is

brushed onto the insect and then it is deposited on the stigma of the next flower it visits, including other flowers of the same inflorescence. Thus, geitonogamy takes place. Autogamy is prevented by the length of the style much exceeding the stamens.

After fertilization sepals markedly enlarge and envelope maturing seeds. Of the 4 ovules 2 or 3, rarely all the 4 develop into seeds. Seeds are blackish, oily, quite big, reaching 0.4-0.5 cm. *S. garedji* propagates only sexually. Vegetative propagation is not characteristic of the species.

Seeds sown in Petri dishes in order to test their ability for and degree of germination did not germinate and moulded, which must have been caused by the presence of essential oils excreted from the seeds in water-containing medium. Of 100 seeds sown in pots filled with soil 10 healthy seedlings were obtained after 3 months. The seedlings developed into normal individuals.

Despite quite a low germination ability of *S. garedji* seeds, natural production of large amount of seeds allows the species to survive in the wild. Small populations of *S. garedji* require permanent monitoring.

The existing data on *S. garedji*, provided that a big stock of seeds is available (seed storage at a seed bank), will allow extensive *ex situ* conservation actions conducted for establishment of a seedling collection, as a basis for future re-introduction *in situ*:

1. All the phenological phases of the target species pass rapidly and normally.
2. Generative organs are fertile.
3. The species is entomophilous – pollination by insects is the prior way of pollination; anemophily is occasional with almost no contribution to seed formation.
4. Along with cross-pollination self-pollination (geitonogamy) also takes place; autogamy is prevented owing to flower morphology.
5. Of the potential possibility of seed formation, i.e. of 4 ovules in each ovary 2-3 (rarely all 4) develop into seeds.
6. Seeds are visually normal and rapidly germinate (3 months).
7. Seeds sown in pots filled with soil give 10% viable offspring.
8. The species renewal depends only on seed formation, which makes *ex situ* conservation of *S. garedji* necessary.

ბოტანიკა

## კავკასიის ენდემური სახეობის *Salvia garedji* Troitzk. (Lamiaceae)-ს რეპროდუქციის ბიოლოგია

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ნაშრომში შესწავლილია “საქართველოს წითელ წიგნში” შეტანილი კავკასიის ენდემური სახეობის *Salvia garedji*-ს რეპროდუქციის ბიოლოგია მისი *ex situ* საკონსერვაციო სამუშაოების წარმატებით განხორციელების მიზნით.

კვლევით მიღებულ მონაცემებზე დაყრდნობით, აგრეთვე თესლის ბანკში საჭირო რაოდენობის თესლის მარაგის თავმოყრით შესაძლებელია სახეობის აღმონაცენტა ბაზის შექმნა; საჭიროების შემთხვევაში კი მათი რეინტროდუქციისათვის გამოყენება.

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