Features of development of the clonal plant *Scutellaria scordiifolia* Fischer ex Schrank (*Lamiaceae*) in Siberia

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Abstract. Ontomorphogenesis of individuals of the clonal stoloniferous vegetative annual plant *Scutellaria scordiifolia* was studied in natural habitats. Ramets are represented by partial dicyclic shoots with an adventious root system. The ontogenesis of *S. scordiifolia* can be expressed by a sequence of phases of morphogenesis: [a partial shoot – a branched partial shoot] (v–g3) – a system of partial shoots (g2–g3) – a partial shoot (g2–ss). Individuals annually die off completely, regeneration takes place due to formation of tuberous stolons which are formed on the maternal stolon.

1 Introduction

Currently, vegetatively propagated plants called clonal [1,2]. Clonal stoloniferous herbaceous polycarpous plants represent an isolated group of plants integrated on the basis of their common ability of vegetative propagation with the help of specific shoots. Development of stolons provides an intensive vegetative propagation of plants and better assimilation of environmental resources [3]. Significant separation of daughter individuals from the maternal one helps to remove competitive relationships among them. At present of great interest are vegetative short-lived plants which G. N. Vysotskiy described [4] as plants whose maternal specimens that gave a new vegetatively–daughter generation die off before long. Their ultimate forms are vegetative annuals, vegetatively-daughter plants of which exist not more than one year [5]. Study of clonal plants allowed Yo. L. Lyubarskiy [6] to set aside an additional branch in the evolution of life forms of angiosperms, it leads from herbaceous perennial plants through vegetative short-lived plants to vegetative annuals. The species under study *Scutellaria scordiifolia,* a clonal stoloniferous herbaceous polycarpous plant is a vegetative annual. The scientists note that the group of vegetative annuals is the least studied from the biomorphological point of view [7,8,9]. In this regard the aim of the work was study of features of individual development of the clonal vegetative annual *S. scordiifolia* in natural habitats.

2 Materials and methods

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Ontomorphogenesis was described on the basis of study of *S. scordiifolia* individuals in the Republics of Khakasiya, Buryatia, Altai and Zabaikal Krai. Study was conducted on individuals in a number of communities: steppe meadow – true steppe –meadow steppe.

When determining a life form, I. G. Serebryakov's [8] ecological-morphological classification of life forms and G N. Vysotskiy's [4] classification based on vegetative mobility pattern and ways of vegetative propagation of plants were used. The notions of morphogenesis phases were also used [10,11,12]. Ontogenesis was studied in accordance with the concept of discrete description proposed by T.A. Rabotnov [13] and A. A. Uranov [14].

3 Results

In all studied habitats only one life form – stoloniferous is formed in *S. scordiifolia* individual. Sterilization and loss of propagation by seeds take place in most of clonal stoloniferous plants [15, 16]. Predominance of vegetative propagation is characteristic of *S. scordiifolia*, seed individuals have not been found in nature. In this regard, morphogenesis of only vegetative individuals (ramets) was studied. In ontogenesis they pass the following phases: [a partial shoot – a branched partial shoot] (v–g3) – a system of partial shoots (g2–g3) – a partial shoot (g2–ss).

Development of individuals at different ontogenetic stages occurs according to one scheme. Elongated hypogeonous stolons of order n+1 develop on the stolon of the maternal ramet from the lateral buds. Due to accumulation of nutrient substances in the internodes, they thicken almost completely (only one-two metamers in the basal part remain not thickened) and resemble a tuber. In scaly-leaf axils lateral buds which as a terminal one are buds of regeneration are set on the stolon. Stolons may branch out due to bud opening in the basal part of a tuberous section, these stolons of order n+2 are elongated and completely thickened. Secondary roots develop in the nodes over the total length of stolons. At the end of the vegetative season not thickened metamers of the stolons of order n+1 and internode in the basal part of stolons of order n+2 decay, each stolon with the secondary root system keeps existing independently. In the next year due to pulling approximate metamers, in the apical part of the stolon is formed an apogeotropic section, and from the terminal bud develops an above-ground orthotropic elongated annual shoot with a shortened basal part consisting of 2–5 approximate metamers with scale shaped leaves. The shoot branches out: in the above-ground sphere from lateral buds develop vegetative enrichment shoots and paracladia, in the underground sphere on the stolon are formed daughter stolons giving rise to a new ramet generation. The maternal stolon gradually dies off from the basal end during a year. Thus, *S. scordiifolia* exists in the form of partial dicyclic shoots.

Ontogenesis of ramets begins with the virginal stage (Fig. 1). A partial shoot is vegetative, in late June it begins branching out: in the above-ground part develop elongated orthotropic vegetative shoots, and on the stolon start in growth stolons of order n+1. In the next year new ramets would be at the virginal and young generative stages.

Virginal individuals with reduced vitality may be also formed in the populations. Such individuals are represented by monocyclic anisotropic shoots with adventious root system, they are formed from the lateral buds on the plagiotropic section of the stolon of the individuals at the middle-aged generative stage, completely die off at the end of the vegetative season.

At the young generative stage a partial shoot is generative, an inflorescence - simple frondose raceme. As a result of branching in the above-ground part of a shoot develop elongated vegetative enrichment shoots, and on the stolon emerge new thickened stolons coloured violet from the distal end. In late vegetative season the maternal individual dies off, and stolons overwinter. Ramets pass to the middle-aged generative stage.

At the middle-aged generative stage on the tuberous stolon on the apogeotropic part in the axils of 1–2 metamers serial buds are set, there are only two of them: lower and upper. The lower bud is set later, but in the process of development it overgrows the upper one. Stolon of order n+1 developing from the lower bud is more vigorous, may reach 30 cm in length, 0,3–0,5 cm in diameter, at most branches out, stolons of order n+2 appear. On the base of stolons of order n+1 develop middle-aged and old generative individuals, and on the base of stolons of order n+2 – virginal and young generative ones. Stolons of order n+1 developing from upper serial buds and usual lateral buds do not branch out, on the base of them develop middle-aged generative individuals. In total from 5 to 10 (20) new stolons develop on the maternal stolon.

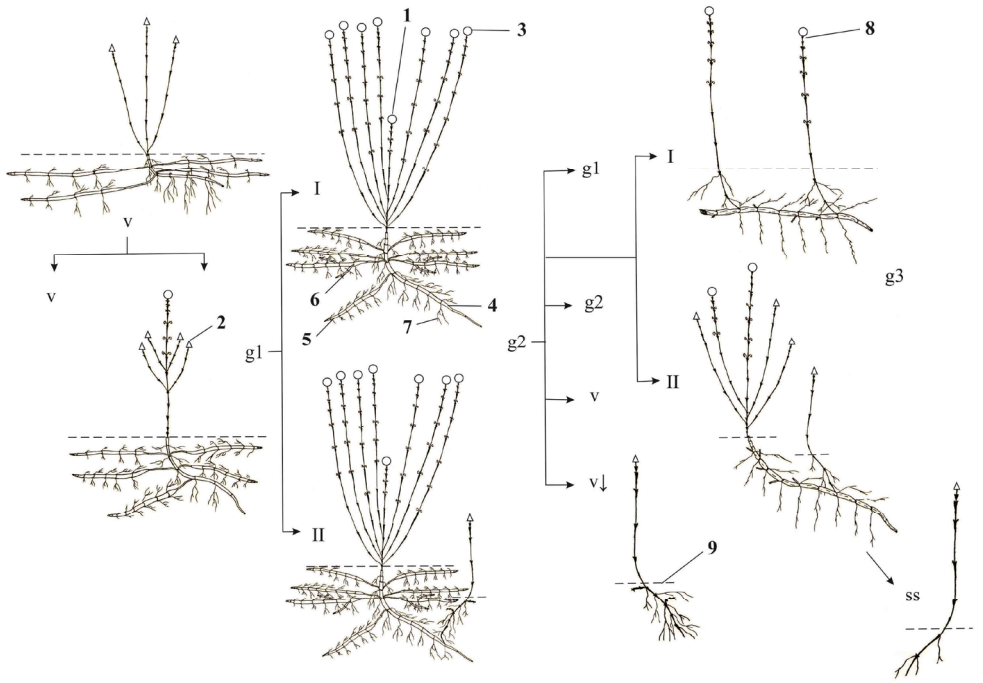

Figure 1. Ontomorphogenesis of *Scutellaria scordiifolia* stoloniferous life form.
Legend – I, II – variants of individual structures at the ontogenetic stage; v↓ – an individual at the virginal stage with reduced vitality. 1 – a dicyclic anisotropic generative shoot, 2 – a monocyclic vegetative enrichment shoot, 3 – paracladium, 4 – a tuberous stolon of order n, 5 –a tuberous stolon of order n+1, 6 – a stolon of order n+2, 7 – adventitious roots, 8 – a monocyclic orthotropic generative shoot, 9 –soil level.

The tuberous stolon of the individuals at the old generative stage is covered by transversal and longitudinal constrictions and has a yellow tint. Most often at the old generative stage new stolons do not develop or die off at the early stages of development and individual ontogenesis is over. In some cases lateral buds on the plagiotropic part of the stolon start in growth, a system of partial shoots is formed. In the same year the system disintegrates, a shoot decays at the base and separates from the maternal stolon, emerges a ramet at the subsenile stage. Such an individual dies off completely in late vegetative season.

Sometimes a terminal stolon bud at the old generative stage dies off after overwintering, then lateral buds on the plagiotropic stolon part start in growth, a system of partial shoots, which does not disintegrate as a rule, is formed. Such structures may also form at middle-aged generative stage, monocyclic anisotropic vegetative shoots develop from the lateral

buds. In these cases the disintegration of the system occurs due to decay of the basal part of a shoot, new ramets at the virginal stage are formed . We consider such ramets to belong to the virginal individuals with reduced vitability.

Thus, *S. scordiifolia* throughout the range in different conditions of habitation develops as a clonal stoloniferous herbaceous polycarpous plant. It is a vegetative annual according to the classification of G. N. Vysotskiy. As in most of stoloniferous species prevails vegetative propagation which takes place due to development of tuberous branched stolons, at the middle-aged generative stage the intensity of vegetative propagation increases due to opening of serial buds. Ramets are represented by dicyclic partial anisotropic shoots with an adventious root system. Each vegetatively-daughter generation dies off completely at the end of the vegetative year. The course of ontogenesis of *S. scordiifolia* is similar to the ontogenesis of species with a similar life form. Ontogenesis is abbreviated and represented by a cycle of development of specialized dicyclic anisotropic shoots. Particularization of individuals can lead to a rejuvenation of the daughter particles to the virgin stage. Depending on the individual ontogenetic state through the following phases of morphogenesis: [a partial shoot – a branched partial shoot] (v–g3) – a system of partial shoots (g2–g3) – a partial shoot (g2–ss).

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