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Research Article

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Dynamics of Biomorphological development of some species of the family *Cactaceae* Juss. in Juvenile phase genesis, in conditions of covered soils

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Abstract

The article is dedicated to the study of dynamics of the biomorphological development of 10 species (*Peireskia aculeata* Mill., *Opuntia engelmannii* Salm-Dyck, *Op. humifusa* Raf., *Op. maxima* Mill., *Cereus forbesii* (L.) Mill., *Mammillaria crucigera* Mart.&Otto, *Melocactus violaceus* Pfeiff., *Parodia mammulosa* (Lem.) N.P. Taylor var. "*Orthacanthus*", *P. erinacea* (Haw.) N.P. Taylor, *Astrophytum capricorne* (A. Dietr.) Br.&R.) from the family *Cactaceae* Juss. in the juvenile stage in the closed ground of dry subtropics.

From the research carried many years the period of establishment, growth, and development of vegetative organs, from seed germination to pre-reproductive state were determined. The data obtained make it possible to establish laws of influence of environmental conditions on the morphogenesis of juvenile plants and study other biological properties of this type of cactus, which are necessary for their successful introduction into indoor culture conditions.

Keywords: *Cactaceae* Juss., introduction, dry subtropics, biomorphology, morphogenesis, seed reproduction, seed germination, juvenile plants

Introduction

Many foreign exotic ornamental plants have been introduced recently, into the dry subtropical regions of Azerbaijan into indoor conditions. Among them, as ornamental plants, our attention was attracted by species of the *Cactaceae* Juss family. The family of *Cactaceae* according to a number of literary sources, includes about 233 genera and 5000 species and varieties [2, 4, 10-12]. The vast majority of species of the *Cactaceae* family are distributed in the desert and semi-desert regions of North and Central America [3, 14, 16]. Currently, cactus species have begun to be used in the practice of greening covered soil in the dry subtropical regions of Azerbaijan [1, 7, 9]. Therefore, taking into account the ecological-geographical and morphological heterogeneity of cactus plants and the diversity of their adaptive structures, we began studying the biology of the development of juvenile plants [13, 15].

Biology issues of seed germination were studied with the aim of introducing cactus species into covered soils conditions [8]. Since it turned out that Azerbaijan has not yet carried out special research work on the study of cactus seeds, it was not possible to find information on these issues in the literature available to us.

Materials and Methods

The object of the study was the plants of the *Cactaceae* family from the collection of the Central Botanical Garden of the National Academy of Sciences of Azerbaijan, as well as seeds obtained from delectus from various foreign botanical gardens. Studies of the morphogenesis of seed germination, the phase sequence of the development and development of a juvenile plant were carried out according to the method of I.G. Serebryakova [5], and the study and graphic depiction of the morphogenesis of the vegetative organs and rhythms of the seasonal development of a juvenile plant - according to a modified method of V.V. Skripchinsky, Y.A. Dudar and others [6]. During the research period, we studied seed propagation, morphogenesis, and the life cycle in an orangery and experimental greenhouse, as well as in a laboratory in 10 species from introduced plants of the *Cactaceae* family (*Peireskia aculeata* Mill., *Opuntia engelmannii* Salm-Dyck, *Op. humifusa* Raf., *Op. maxima* Mill., *Cereus forbesii* (L.) Mill., *Mammillaria crucigera* Mart.&Otto, *Melocactus violaceus* Pfeiff., *Parodia mammulosa* (Lem.) N.P.Taylor var. "*Orthacanthus*", *P. erinacea* (Haw.) N.P. Taylor, *Astrophytum capricorne* (A. Dietr.) Br.&R.). The study of morphogenesis in the juvenile phases was carried out by daily analysis and sketching of the vegetative organs.

Results and Discussion

Plants belonging to various subfamilies of the family *Cactaceae* have a number of features of individual development. During the study, the features of the stages of the initial development of ontogenesis of some species (*P.* aculeata, *Op. maxima*, *Op. engelmannii*, *Op. humifusa*, *C. forbesii*, *Mammillaria crucigera*, *Melocactus violaceus*, *P. mammulosa* "*Orthacanthus*", *P. erinacea* , *A. capricorne*) subfamilies *Peireskioideae*, *Opuntioideae*, *Cereoideae*.

Seedlings of representatives of the studied species of the subfamily *Peireskioideae* are similar to seedlings of other dicotyledonous plants. So, they have a thin hypocotyl, a large cotyledon and the first true leaf with a petiole. For example, *Peireskia aculeata* with a hypocotyl length of 27.00 ± 0.56 mm, a thickness of 1.90 ± 0.03 mm, a cotyledon length of 2.42 ± 0.11 mm and a width of 1.12 ± 0.10 mm has the first true petiole sheet (Fig. 1). The life span of the cotyledons of seedlings of *Peirskia aculeata* grown from seeds in conditions of covered soils in Absheron is 60-62 days. Its first shoots are formed after 10-12 days following sowing seeds.

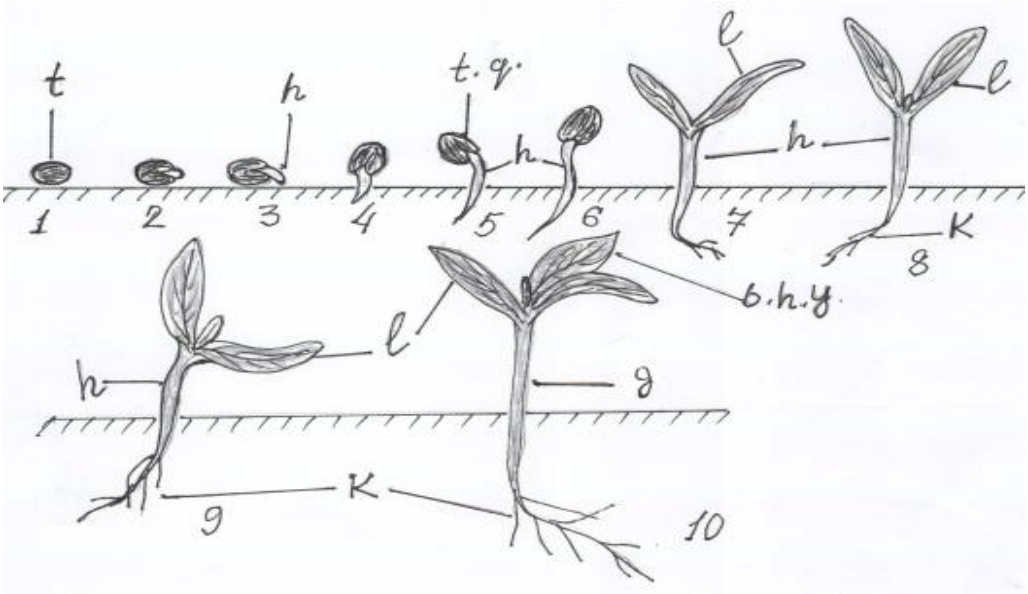

Fig. 1. Successive developmental phases of *Peireskia aculeata* from seed.

1 - seed, 2 - seed swelling, 3–4 - hypocotyl formation, 5-8 - octyledon development, 9-10 - formation of the first true leaf;
t- the seed, t.q. - seed peel, l - cotyledon, h - hypocotyl, g - stem, b.h.y. - the first true leaves, k- the root

Seedlings of the studied species (*Op. maxima*, *Op. engelmannii*, *Op. humifusa*) of the subfamily *Opuntioideae* have more succulent cotyledons (1.52 ± 0.13 mm in length, 0.75 ± 0.14 mm in width) and thickened hypocotyls (e.g.: *Opuntia maxima*: 15.13 ± 0.19 mm long, 0.75 ± 0.14 mm wide) than *Peireskia aculeata*.

Life span of cotyledons seedlings *Op. maxima* grown from seeds indoors in Absheron is 169 days. The first seedlings are formed 36 days after sowing.

Seeds of other species (*Opuntia engelmannii* (Fig. 2), *Op. humifusa*) from the subfamily *Opuntioideae*, germinate after 9-10 days following sowing. After 8-9 days following seed germination, roots are formed in these species. In other species of this subfamily, hypocotyls formation occurs simultaneously with seedlings. On the first day, the size of the seedlings is from 0.9 mm to 1.3 cm.

The hypocotyl of both species is *Opuntia engelmannii* and *Op. humifusa* are cylindrical in shape. Thus, the upper part of the hypocotyl is thickened, and the lower part is thin. The color of the hypocotyl is white with a pale greenish tint, the upper part is yellow-red, and the lower part is red. The main root develops from the upper part of the hypocotyl and spreads after 7-8 days following the shoot formation. The studied species of the genus *Opuntia* usually have 2 cotyledons, but sometimes there can be 3 or 4 pieces (as in *Op. himifosa*).

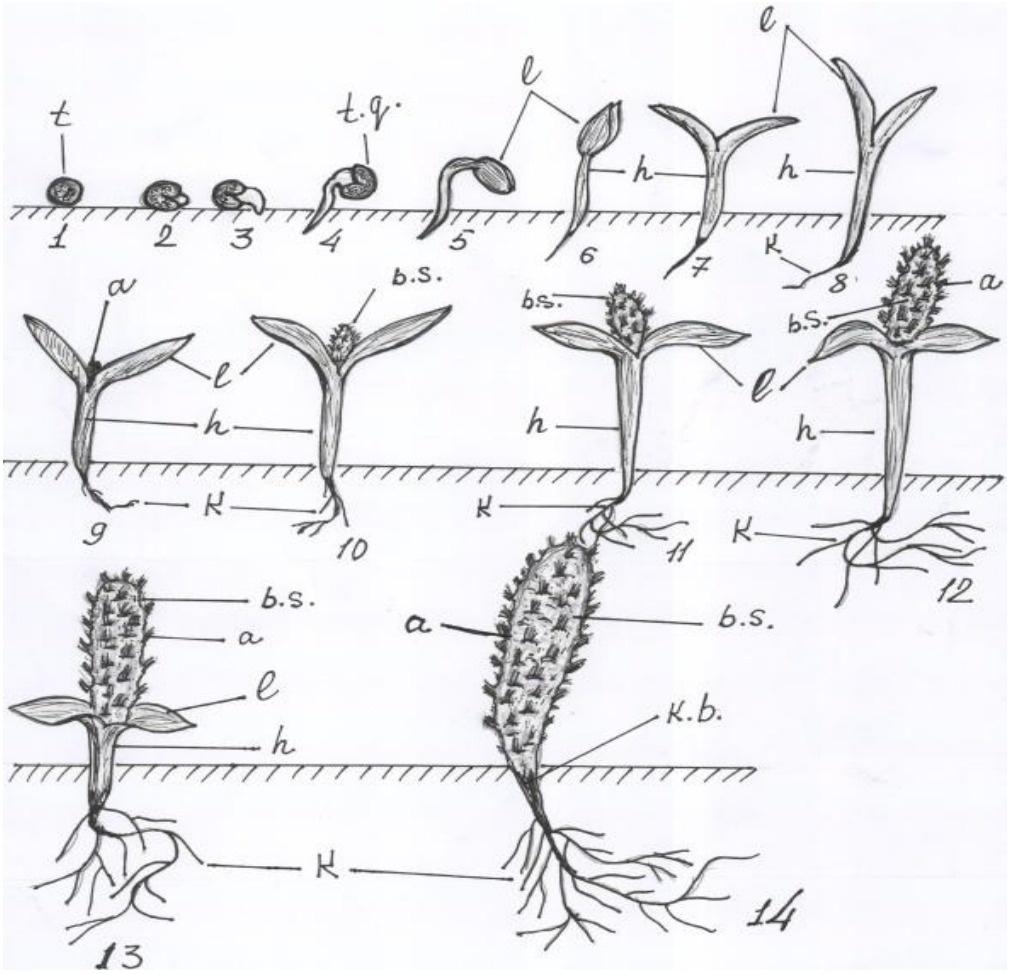

Fig. 2. Successive developmental phases of *Opuntia engelmannii* from seed.

1 - seed, 2 - seed swelling, 3-4 - hypocotyl formation, 5-8 - cotyledon development, 9 - first areola formation, 10-13 - first segment formation and formation, 14 - juvenile plants;
t - seed, h - hypocotyl, t.q. - seed peel, l - cotyledon, a - areola, b.s. - first segment, k.b.- the root neck, k-is the root.

After 2-3 days following the appearance of the first root, the cotyledon begins to grow, not exceeding 1-2 mm in width and 4-5 mm in length. The cotyledons of both species (*Op. engelmannii*, *Op. humifusa*) are whole-marginal, with a thin wax layer, convex in shape. The surface of the cotyledon is olive, and the reverse side is orange-pink. After about 10 days at the place of connection of the cotyledons, a hardly distinguishable groove (crack) is formed.

An apical bud appears from the depth of the furrow, which then turns into segments. At the top of the kidney there is a small areola consisting of tiny bristle-shaped glochidia and germinal leaves. The second segment is formed next year - in spring. Drying of cotyledons continues for a long time. For example, the drying of cotyledons of the type *Op. humifusa* lasts for 4-5 months. During this time, the process of plant growth and development is intensive. Thus, the emergence of new segments, as well as the growth of previously formed roots continues.

The seedlings of the studied species *(C. forbesii, Mamillaria crucigera, Melocactus violaceus, P. mammulosa var. "Orthacanthus", P. erinacea, A. capricorne)* of the *Cereoideae* subfamily are smaller in comparison with other subfamilies and their hypocotyl is rather thickened. The shape of the cotyledon in them changes, takes a convex or awl-shaped form. Thus, cotyledons in seedlings of the genus *Mamillaria* (Fig. 3), *Melocactus, Parodia, Astrophytum* cannot be practically distinguished from hypocotyl.

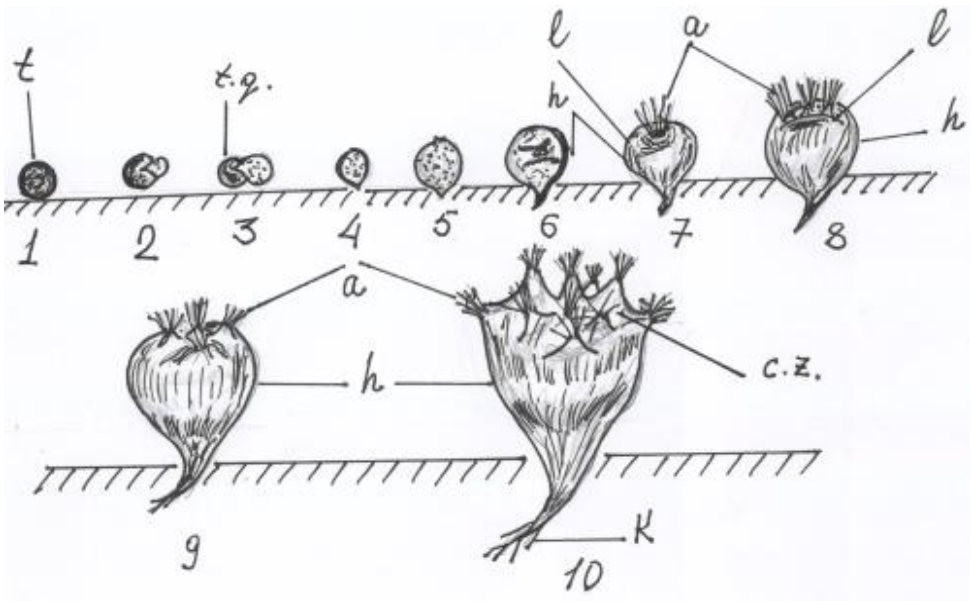

Fig. 3. Successive phases of development of *Mammillaria crucigera* from seed.

1 - seed, 2 - seed swelling, 3-5 - hypocotyl formation, 6 - cotyledon development, 7 - first areola formation, 8-9 - areola formation, 10 - juvenile plant formation;
t - seed, h - hypocotyl, t.q. - seed peel, l - cotyledon, a - areola, c.z. - formation of young shoots, k - root.

The shoots of the studied species of the genus *Parodia* have an elongated ellipsoid shape. And in rare cases, spherical forms with a well-developed thick hypocotyls and a shortened cotyledon are observed. Sometimes, when studying the ontogenesis of species (*P. mammulosa* var. *"Orthacanthus", P. erinacea*) of the genus *Parodia*, juvenile plants observed roots of a turnip form characteristic of adult plants. The cotyledons of these studied species are very short and on the apex there are clearly visible bulges with areoles.

The life span of the cotyledons of plants of the subfamily *Cereoideae* (depending on the genus) lasts from 23 to 165 days.

The study revealed a relationship between cotyledons and hypocotyls. So, if the cotyledon is thickened and plays the main role as a reserve organ, then in seedlings the hypocotyls is thin and, conversely, if the hypocotyl in seedlings is thick, then poorly developed cotyledons are observed.

The duration of periods of ontogenesis in representatives of the *Cactaceae* family is different. In plants of the genus *Parodia*, the shoot develops very quickly, and after 9-10 months, the plant passes from the juvenile to the immature stage and enters the generative period in the third year. Depending on the species, sometimes the juvenile period in some species of the *Cactaceae* family lasts several years.

Thus, the study of the growth cycle and development of juvenile plants of cactus species in closed ground gives us the opportunity to establish patterns of environmental influence on the formation of the vegetative organs of juvenile plants necessary for their successful introduction into indoor culture in dry subtropics.

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