Anthecology of some species of *Hamanthus Bunge* and *Halimocnemis C.A. Mey*.

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Abstract. It is promising to grow the long-vegetating annual halophytes *Gamanthus Bunge* and *Halimocnemis C.A. Mey*. (*Chenopodiaceae Vent*.) in arid locations since they are important grazing plants for Karakol sheep and camels. These species' xerothermic periods are when they flower and bear fruit. Research on reproductive biology must first examine how certain traits of plant reproductive organs in harsh environments relate to environmental influences. Identification of reproductive organ adaptation to air temperature and water stress in desert plants is an issue that has not received much attention from *Chenopodiaceae* family members. Such knowledge is crucial for developing perennial agrophytocenoses and boosting the production of pastures in need. The study of *Halimocnemis* species is particularly interesting since this genus is thought to be confined to the Iran-Turonian floristic zones, with the Central Asian (Turonian) plains being its center of origin. In the studied species, there are signs that ensure the xenogamous type of pollination by entomophilia. These are proterandria in flowers, brightly colored outgrowths of pollen which are secondary attractants, morning type of flowering when insects are in high flight, and autogamous type of pollination by anemophily. Similar conditions eventually lead to funneling of *Halimocnemis* and *G. gamocarpus*.
Keywords. *Halimocnemis*, *Gamanthus*, dichogamy, proterandria, flower.

1 Introduction

Long-vegetating annual halophytes of *Gamanthus Bunge* and *Halimocnemis C.A. Mey.* (*Chenopodiaceae Vent.*) family are considered valuable pasture plants for Karakol sheep and camels, and it is promising to plant them in barren areas [1, 2]. Flowering and fruiting of these species takes place in the warm xerothermic period. Studying the relationship between environmental factors and some characteristics of plant reproductive organs in extreme conditions is a necessary step in reproductive biology research [3-5].

Identifying signs of adaptation of reproductive organs of desert plants to air temperature and water deficit stress, this problem has been little studied in representatives of *Chenopodiaceae* family [6, 7]. Such information is very important in creating perennial agrophytocenoses and increasing productivity of pastures in crisis [8, 9]. The study of *Halimocnemis* species is of particular interest because this genus is considered endemic to Iran-Turonian floristic regions, the center of origin of the genus is the Central Asian

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(Turonian) plains [10].

Flowers are of great importance in determining the relationships and evolution of plants, because the systematics of angiosperms is primarily based on the structure of the flower. Based on the morphology of flowers, the characters isolated by studying the pollination ecology of the plant and the evolution of adaptation in different living conditions serve to solve the problems of ecological adaptation [11-13].

Morphology, biology, type and style of pollination are closely related to each other. The study of these processes helps to reveal the laws of evolution of adaptation of flower organs to the influence of certain external factors. As Levina [6] pointed out, the essence of flowering biology consists of pollination ending with pollination, which is a common condition for different types of flowers and ecology of flowering. Butnik [9] divided the fruits of 23 genera and 45 species of *Chenopodiaceae* family into 4 groups. In this case, *Halimocnemis* was included in the third group with perigonial shell and *G. gamocarpus* species in the fourth group with bracteolar-perigonial shell. He studied the structure of the seed pod and the seed sac in the pollination phase of *G. Gamocarpus* and *Halimocnemis* species and showed that they belong to the amphitropic seed type. He studied the flowering process of *H. villosa* species in the conditions of Kazakhstan, and mentioned autogamy and cleistogamy type characteristic of this species [14, 15].

2 Materials and methods

Morphology of flowers and fruits was studied in laboratory conditions and in nature itself by fixing in 70% ethanol alcohol mixture. "Atlas of descriptive morphology of higher plants" was used to describe flowers [11].

Biometric measurements were studied using MBR-3, MBS-9 microscope and MOV 1-15^{x} ocular-micrometer on 25 flowers from 10 plants taken from flowers ready for anther bursting on the first day of flowering. Flowering types and styles were studied by the Ponomarev method, by observing the plant under natural growing conditions [12].

Tissue and dust grains were measured using a MOV 1–15^{x} ocular-micrometer. Drawings were made on RA-6 apparatus, photographs were taken using MFN-5 and MFN-12 photomounts and MBR-3, MBS-9 microscopes. The statistical development of the received biometric indicators was processed on a computer (MS-Excel program) based on generally accepted criteria [12].

3 Results and discussion

The characteristics of flowering biology of *Halimocnemis* and *Gamanthus* species have not been studied in relation to their morphology. The morphology and biology of Halimocnemis and *G. gamocarpus* species showed that during flowering the sepals do not fully open and the sepals are closed. Only when the anthers have matured, split open, and exited the flower, does the tip of the flower open slightly. Flowering occurs in an acropetal arrangement on the stem, and flowering begins with the emergence of anthers from the peduncle.

The study of the anthecology of the species of the genus *G. gamocarpus* and *Halimocnemis* showed that the proterandry type of dichogamy was typical for the studied species. The anthers are produced first (pollen phase), then the seed pod protrudes from the petals of the safflower, and a large number of suckers begin to grow in it (seed phase).

The species *G. gamocarpus* differs from the species of the genus *Halimocnemis* in the mechanism of accumulation of pollen grains. In the pollinator phase, the anthers emerge from the flower, then the anthers are turned to the side with the help of spherical outgrowths at the expense of the long leg and take a horizontal position.

Maturity of pollen grains, according to Monozson [139], pollen grains of *Halimocnemis* and *Gamanthus* species are characterized by large size and clear texture of the exine. The studied species differ among themselves in terms of the size of the dust grains.

According to the Erdtman classification [8], these species belong to the small group (21-30 μm) in terms of the size of the dust grains. The largest pollen grains are found in *H. macranthera* (30.76 ± 30 μm) and *H. sclerosperma* (23.86 ± 0.50 μm), and smaller pollen grains are *H. smirnovii* (22.40 ± 1.29 μm), *H. villosa* (20.96 ± 1 .16 μm) and *G. gamocarpus* (21.48 ± 0.68 μm) were observed (Figure 1).

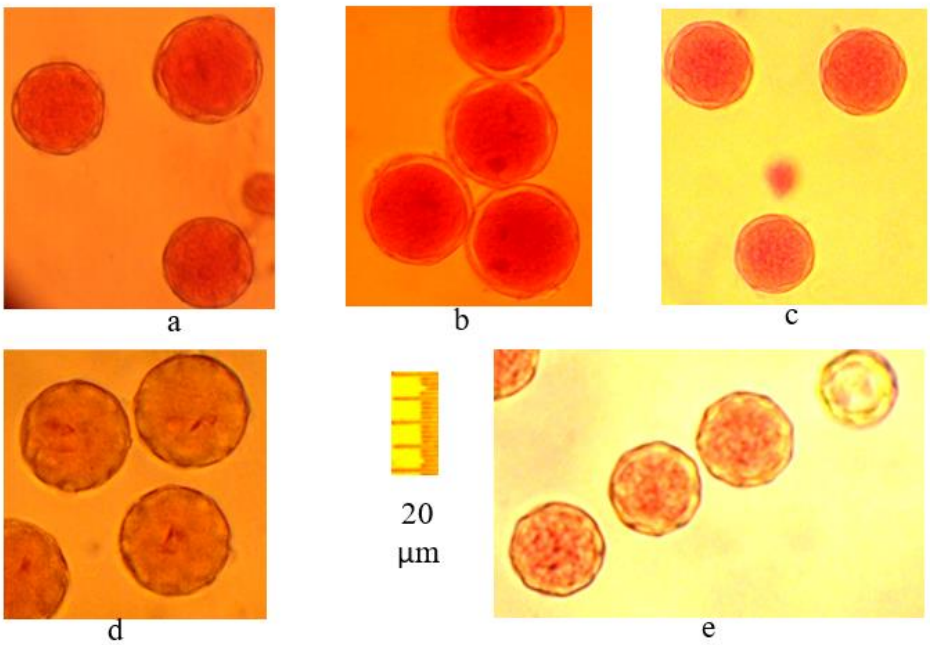

Figure 1. Pollen grains of *Halimocnemis* and *Gamanthus* species: a - *H. smirnovii*, b - *H. macranthera*, c - *H. villosa*, d - *H. sclerosperma*; and, e - *G. gamocarpus*

Pollen grain size varied, with the highest variability observed in *H. smirnovii* and *G. gamocarpus* species, and relatively low variability in *H. villosa* species (Table 1). Maturity of pollen grains is high (88.93-94.87%) in all species, only slightly lower in *H. sclerosperma* species.

Proterandria type was determined in the flowers of the studied species, and xenogamy pollination was observed by the method of entomophilia. This is due to their large anthers and anthers attracting insects, and the presence of anemophilia due to the great suction of the proboscis claws. However, the self-pollination feature (autogamy, geitonogamy) is also of special importance, that is, there is a special mechanism of pollen collection.

This is due to the funnel-like shape of the beak claws in the *H. smirnovii* and *H. macranthera* species, and the funnel-shaped pollen nests in the *G. gamocarpus* species. According to some scientists, autogamy and heterogamy are more common in annuals than in perennials.

Table 1. Description of pollen grains of *G. gamocarpus* and *Halimocnemis* species.

Species	Maturity of pollen grains, %	Size of pollen grains, µm (n = 25)	
		Degree of variability	M ± m
G. gamocarpus	92.58	16.17–27.72	21.48±0.68
H. smirnovii	94.87	10.89–33.0	22.40±1.29
H. macranthera	94.57	20.46–39.27	30.76±1.30
H. villosa	89.62	10.23–34.98	20.96±1.16
H. sclerosperma	88.93	17.49–27.72	23.86±0.50

4 Conclusions

In the species *Gamanthus gamocarpus* and *Halimocnemis*, the opening of the anther at different times and the opening of the tip at different times - xenogamy, the storage of pollen grains in the funnel formed by the tips of the tip and anther theca - autogamy, colorful pollen grains and its outgrowths - entomophilia, long suckers and small pollen grains on the tips of the tip are anemophily, i.e. labile provides a pollination system.

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