

UDK 582.675.5:581.4

**SOME MORPHOBIOLOGICAL FEATURES OF *GLAUCIUM FLAVUM* CRANTZ.  
(PAPAVERACEAE)**

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**Introduction**

One of the most important modern problems is the task of biodiversity, including phytodiversity, preservation. This is especially true of those species, which belong to different categories of conservation status. Thus V.N. Golubev [1], V.V. Novosad and L.I. Kritskaia [9] considered *Glaucium flavum* Crantz. to the category of rare species and E.S. Krainiuk [7] brings it to the category of endangered species. This species is known as decorative and medicinal plant, due to alkaloids in its parts that are used for treatment of respiration organs diseases. In spite of its valuable features it hasn't been studied well enough. In the Crimea *G. flavum* is represented by single specimens or small populations spreaded through the territory of the Southern coast [1, 3]. That's why features of its reproductive biology and possibilities for natural reproduction supposed to be important and they were the aim of our investigations.

**Materials and methods**

Observations have been carried out on the Southern coast of the Crimea on the coastal pebbles and sea slopes. Studies of flowering rhythms and terms were studied with the methods by A.N. Ponomarev [11], Golubev V.N. and Volokitin Yu.S. [2]. For seed production determination method by Yu.A. Zlobin was used [4]. Material preparation (fixation, dehydration) and sections were made by customary embryological methods [10] and stained according to our own method [12, 13]. For taking photos camera Canon A 550 was used. Seeds and embryos measurements were made under the light microscope Axio Scope A.1 (Carl Zeiss) with analyses system Axio Cam ERc5s by the programme Axio Vision rel. 4.8.2.

**Results and discussion**

*G. flavum* is a European-Mediterranean species from genus *Glaucium* that includes nearly 30 species [8]. This is biennial or perennial plant and its native area covers sea coasts of Europe, Southwest Asia and North Africa. In the Crimea it grows on the Southern coast on the stone and sand slopes.

During the first year of life *G. flavum* forms the rosettes of leaves and in the second year leaved generative shoots appear. It could form strong specimens with numerous shoots (fig. 1). Blossom was noticed in May – July with the top in June, seed maturity – in July – September. Flowers are single, apical or in the axils of leaves, diameter is about 5 cm. They are bright yellow with two curled sepals and four petals in two rows, without nectary. Sepals are covered with bristles they gradually open and fall down at the beginning of blossoming so tripped flower is presented by the petals only, without sepals (fig. 2).



Fig. 1 General image of *G. flavum* plant



A

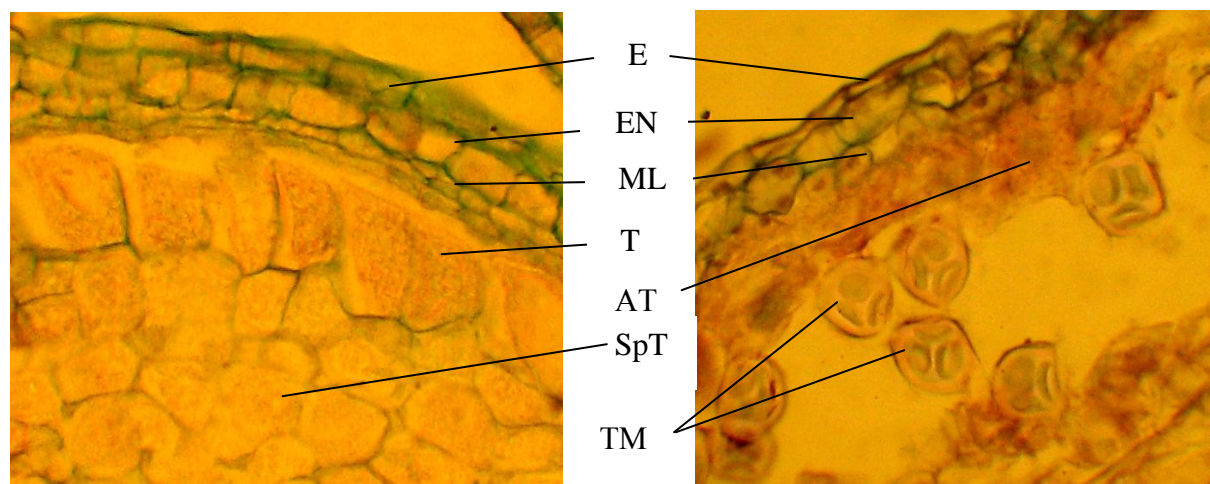
B

C

Fig. 2 Flower buds (A and B – without sepals) and open flower (C) in *G. flavum*

Androecium is presented by numerous single stamens, outer ones are shorter than inner (look fig. 2 B). Anthers with four pollen-sacs and two thecas open extrorse. Microsporangium wall development is centripetal and when it is formed consists of epidermis, endothecium, two middle layers and tapetum (fig. 3 A). Tapetum forms from the cells both of second parietal layer and parenchymal cells of connectivum. At the stage of microspores` tetrads the wall of microsporangium consists of epidermis, endothecium, one

middle layer and tapetum (fig. 3 B). At this stage transformations of tapetum cells were noticed – their walls begin to degenerate and gradually tapetum transforms into amoeboid type (fig. 3 B). These observations confirm the data received by G.M. Ilina [5] and O.P. Kamelina for species from Papaveraceae family.

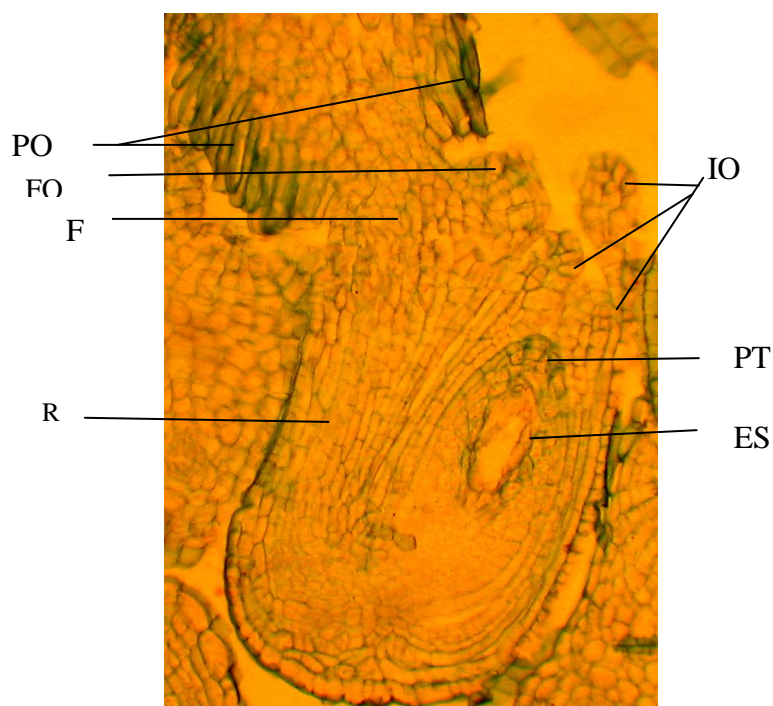


**Fig. 3** Parts of the formed microsporangium (A) and at the stage of microspores` tetrads (B): E – epidermis, EN – endothecium, ML – middle layer, T – tapetum, AT – amoeboid tapetum, SpT – sporogenous tissue, TM – microspors` tetrads

Wall of mature microsporangium consists of flattened epidermal sells, fibrous endothecium and parts of the middle layer. Mature pollen grains are two-celled, exine with three furrows and three pores. In microsporangium both normal and anomal pollen grains present. It should be noticed that during meiosis and differentiative mitosis some deviations that further lead to degeneration of some pollen grains were found out.

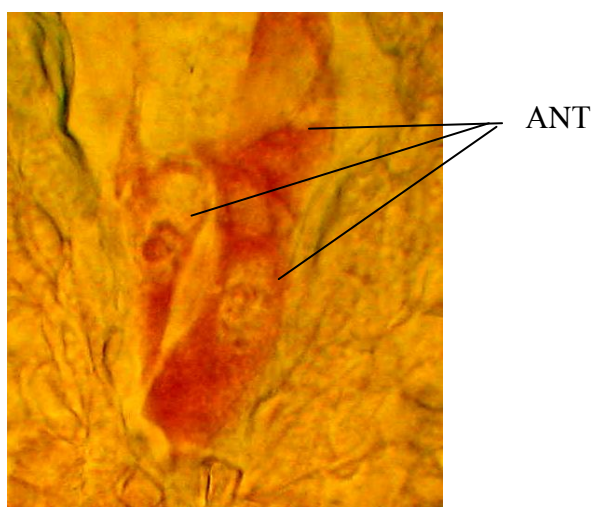
As in many species from Papaveroideae subfamily [5, 6], ovul in *G. flavum* is funiculose, campylotropous, crassinucellate, bitegmal (fig. 4). Funiculus is short, widen at the base, curved. As the result of its congenital inosculation raphe is formed. Integuments are of epidermal origin, in the apical part both enlarge and form obturators. Obturator of inner integument gradually transforms into an operculum and obturator of outer integument further forms arilode that is the part of the seed peel.





**Fig. 4** Ovule of *G. flavum* (PO – placental obturators, FO – funiculose obturator, F – funiculus, R – raphe, IO – integumentary obturators, PT – parietal tissue bands, ES – embrional sac)

In micropilar zone of nucellus rows of parietal tissue cells are well noticed. They further favour to the pollen tubes growth to the embrional sac. In halasal part of the ovule pedestal, podium and hypostase, placental obturator built of large, radially elongated, nipple-shaped cells (see fig.4). Vascular bundle stretches up to halase. Embrional sac is monosporic, consists of 7 cells, forms by Polygonum type, significantly narrowed in halasal zone. Egg complex includes two pear-shaped synergids and the egg cell. Polar nuclei are in the central cell of the embrional sac, they are more close to antipods than to the egg cell. Antipods are large; the cells could be binucleate or polyploid and take more than 2/3 of the embrional sac volume, stay long. These cells often grow out and form antipodal complex with haustorial functions (fig. 5).



**Fig. 5** Halasal part of *G. flavum* embrional sac with poliploid antipods: ANT – antipods

Blossoming of *G. flavum* flowers starts early in the morning and up to 10-11 a.m. all flowers are open and sepals fall down at once. Anthers' opening is extrorse in the flower just open. Since the stamens are moving nearly all the time anthers curve from the pistil to different sides especially while the air blowing (fig. 6). Pollen is fat. It scatters on the petals where the most of it is eaten with insects that are attracted with bright colour of petals and stamens' moving (fig. 7). Insects can eat anthers and tissues inside even before the flowers' blossom (see fig. 7 B). At that time pollen grains attach to the different parts of the small insect bodies, that comes to the petals or broad stigmas, and they spread pollen grains from one flower to another carrying pollination process (see fig. 6 and 8).



Fig. 6 *Glaucium flavum* flowers with the insects

To the end of the flowering almost all anthers are without pollen grains and they dry rapidly. Some cases of pollen grains' growth just in the anther were noticed (see fig. 7).

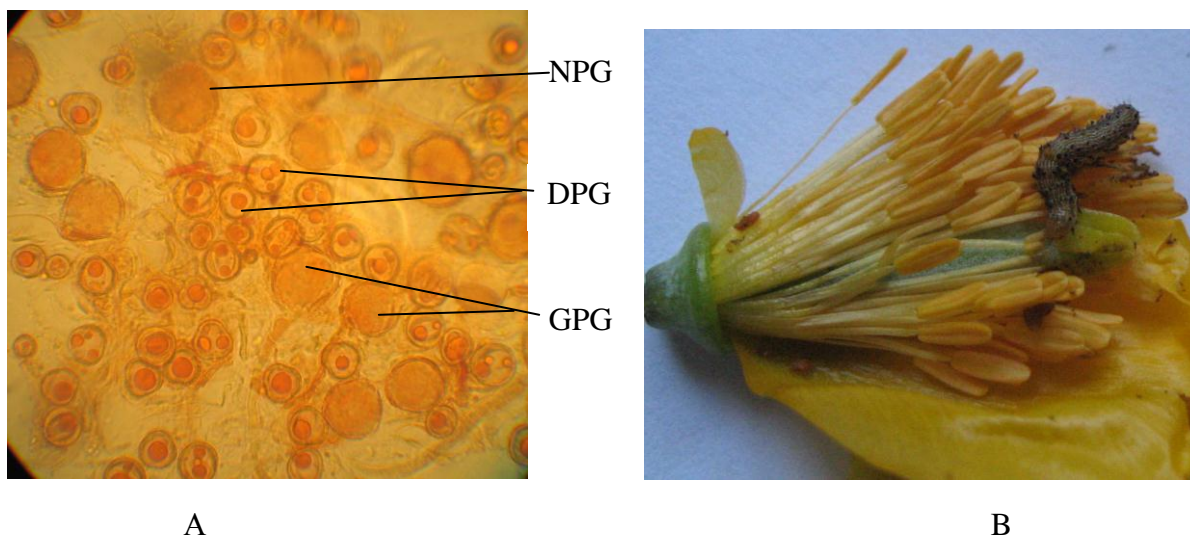


Fig. 7 Mature pollen grains of *G. flavum* from the anthers of the open flower (A) and caterpillar inside the closed flower (B): NPG – normal pollen grains; GPG – growing pollen grains; DPG – defective pollen grains with fat drops.



Flower that opens early in the morning ceases its blossoming in the evening – its petals lose turgor, become white and droop. At that time pistil curves and it may touches nonfallen petals and take the leaving pollen grains so autogeny occurs in the absence of allogeny (fig. 8).



**Fig. 8 *G. flavum* androecium and gynoecium at the time of flowering (A) and at its end (B)**

Pollination unit in *G. flavum* is a single flower. This species is characterized with presence of primary attractants (pollen and fatty oils) and secondary ones (visual attraction with bright flower and moving stamens). Neighbouring plants of *Melilotus tauricus* L. (fam. Fabaceae) (fig. 9) often play the role of false attractants.



**Fig. 9 Plant of *G. flavum* together with flowering *Melilotus tauricus***

After the pollen grains have landed on the stigma they germinate and spermiogenesis occurs in the pollen tube. The last grows on the surface of the style tissues` cells, comes to the embrional sac through one of the synergids and discharges its contents. Double fertilization takes place: one spermium fuses with the nucleus of the central cell resulting in the primary endosperm nucleus formation, and the other with the egg cell. Nuclear endosperm develops and its nuclei are located in the parietal strands of cytoplasm. Endosperm cells formation progresses from the periphery of the central cell embryonal sac towards its centre. Embryo development is of Solanad Type, Papaver variation when the derivates of the terminal cell form only the shoot apex with the preliminary differentiation of epiphyseal cell and the main organs of the embryo are formed by the cells derivative from the basal cell.

Fruit in *G. flavum* is dry pod-like capsule, length 18-20 sm, opens with two segments. In each capsule 50-55 seeds are formed. The seed is small, about 1 mm length, with two-layers seed coat and strong endosperm. Endosperm cells are large and loose with droplets of fatty oils. Embryo is poorly differentiated, small (about 200  $\mu$ m length), takes nearly 1/5 of the seed volume (fig. 10). Seeds germinate in the year of their generation and after a year of storage. For successful germination they need a period of biological rest for their ripening.

It should be noticed that flowering period is long, each plant of *G. flavum* may blossoms more than two months and generally forms great number of flowers so in the time of mass blossom flowers and fruits could be observed on the same plant (fig. 11). Formation of plants with great number of generative shoots with numerous flowers, long flowering period and formation of viable seeds guarantees high reproductive success of this species in the conditions of its native area.

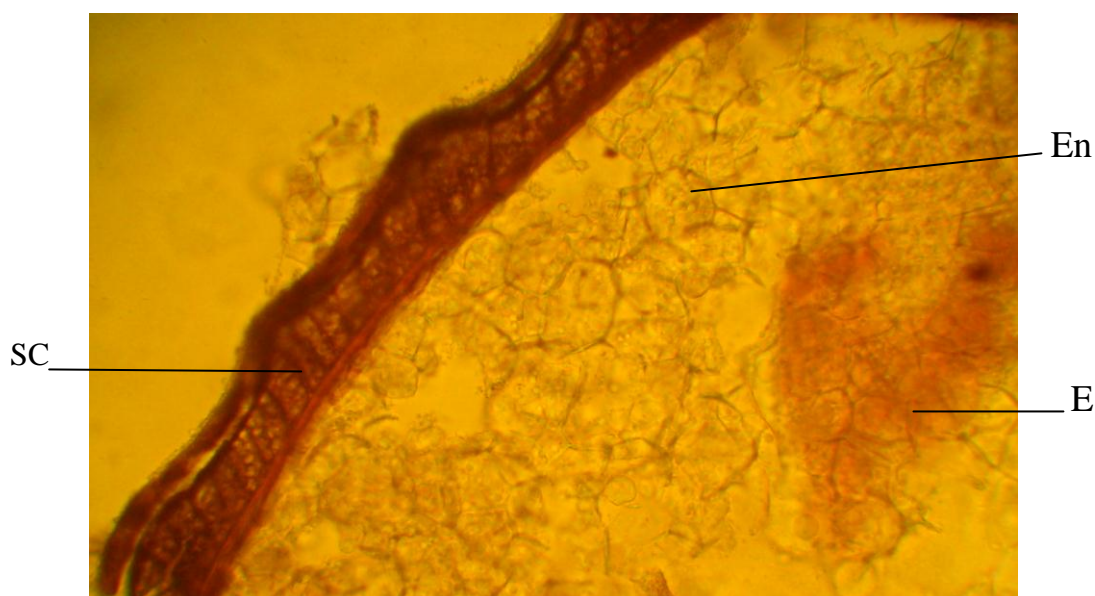


Fig. 10 Part of *G. flavum* seed (SC – seed coat, E – embryo, En – endosperm)





**Fig. 11 Plant of *G. flavum* with fruits (August 8, 2013) (GF – green fruits, DC – dry pod-like capsules)**

Three studied *G. flavum* populations differ in number of plants and potential abilities for preservation. Two populations (on the Cape Martjan and on the steep sea slope in Livadja) include 3 plants each. During three years of investigations no changes in their number have been noticed. Population in Yalta cargo port had 48 plants of different age in 2013 and 26 plants in 2014 as the rest plants were destroyed that demonstrates negative antropogenous influence. However, great number of generative shoots, flowers, fruits and seeds per plant let us to suppose potential possibility of this species multiplication in its native conditions but measures for its preservation such as culture cultivation and using as a decorative plant in parks are needed.

### Conclusions

Thus *G. flavum* in its biomorphological features doesn't differ significantly from the other species from Papaveraceae family. Its main embryological features are: centripetal type of microsporangium wall development, amoeboid tapetum and its dual origin; campilotropous, crassinucellate, bitegmal, funicular ovule; formation of placental, funicular and integumental obturators; long functional haustorial activity of antipodals that is supported by nuclei number increasing in the cells or their polyploidisation; Solanad type, Papaver variation for embryo formation; great number of fruits – dry, pod-like capsules, open with two segments, with viable seeds. Formation of numerous generative shoots, long period of each plant flowering and number of fruit and seeds give us possibility to suppose potential abilities of this species for natural reproduction. However, *G. flavum* grow in the coastal area where antropogenous influence is great and it may lead to significant decreasing of this species in nature conditions. That's why for preservation of *G. flavum* and noted its highly decorative appearance this species could be recommended for culturing and using for creation of ornamental plantings.



### References

1. Golubev V.N. Biologicheskaya flora Kryma. – Yalta, 1996. – 126 s.
2. Golubev V.N., Volokitin Yu.S. Metodicheskie rekomendatsii po isucheniu antekologicheskikh osobennostei tsvetkovykh rastenii. Funktsionalno-iekologicheskie printsipi organizatsii reproduktivnoi strukturi. - Yalta, 1986. – 38 s.
3. Ena A.V. Prirodnaia flora Krymskogo poluostrova. – Simferopol: N. Oreanda, 2012. – 232 s.
4. Zlobin Yu. A. Yembriologia tsvetkovykh rastenii: Terminologia i kontseptsii // “Mir i Semia” SPb. – T.3. – 2000. – S. 251-258.
5. Ilina M.N. Semeistvo Papaveraceae / Sravnitelnaia yembriologia tsvetkovykh rastenii Winteraceae – Juglandaceae. – Leningrad: Nauka, 1981. – S. 142-150.
6. Kamelina O.P. Sistemacheskaya yembriologia tsvetkovykh rastenii. – Dvudolnie. Barnaul: Izd-vo “Arktika”, 2009. – 501 s.
7. Krainiuk E.S. Monitoring redkikh vidov flory prirodnogo zapovednika “Mys Martian” // Nauchnye zapiski prirodnogo zapovednika “Mys Martian”. - Vyp. 2. – Yalta, 2011. – S. 43-48.
8. Morozova N.S. Semeistvo makovie (Papaveraceae) / V kn. Zhizn rastenii. Pod red. A.A. Tahtadzhiana. – Moskva: Prosveshchenie. – T. 5, Ch. 1. – S. 217-222.
9. Novosad V.V., Kritskaya A.I. Machok zhovtyi *Glaucium flavum* Crantz (G. luteum Scop.) / Chervona kniga Ukrainy. Roslynyi svit. Pod red. Ya. P. Diduha. – Kyiv: Globalkonsalting, 2009. – 538 s.
10. Pausheva Z.P. Praktikum po tsitologii rastenii. – M., 1990. – 283 s.
11. Ponomarev A.N. Izuchenie tsvetenia i opylenia rastenii / Polevaia geobotanika: [v 5 t] / Pod obshch. red. E.M. Lavrenko, A.A. Korchagina. – M.: Nauka, 1960. – T. 2. – S. 9-19.
12. Shevchenko S.V., Ruguzov I.A., Efremova L.M. Metodika okraski postoiannykh preparatov metilovym zelenym i pironinom // Biull. Nikit. Botan. sada. – 1986. – Vyp.60. – S. 99–101.
13. Shevchenko S.V., Chebotar A.A. Osobennosti yembriologii masliny evropeiskoi (*Olea europaea* L.) // Trudy Nikit. Botan. sada. – 1992. – T. 113. – S. 52-61.

**Shevchenko S.V. Some morphobiological characteristics of *Glaucium flavum* Crantz (Papaveraceae)** // Works of the State Nikit. Botan. Gard. – 2014. – V. 139 – P. 120 – 128.

The article presents study results of some aspects of *Glaucium flavum* Crantz reproductive biology. The processes of the flowering, pollination, fruit and seed formation have been described. It covers seeds` characteristic and demonstrates potential possibilities of the species reproduction in the conditions of the Southern Coast of the Crimea as well.

**Key words:** *Glaucium flavum* Crantz., anther, ovule, flowering, pollination, seed formation.