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A cytoembryological study of *Sonchus asper (Asteraceae)*

Abstract

Jurukova-Grančarova, P. D.: A cytoembryological study of *Sonchus asper (Asteraceae).* – Bocconea 5: 717-720. 1997. – ISSN 1120-4060.

A comparative study of two subspecies of *Sonchus asper* growing in Bulgaria (subsp. *asper* and subsp. *glaucescens*) was performed. In both, the anthers are predominantly tetrasporangiate; meiosis in the microspore mother cells runs normally, and the simultaneously formed microspore tetrads are tetrahedral; the mature pollen is 3-celled; the embryo sac formation is of the *Polygonum* type; the embryo develops according to the Asterad type; and the endosperm is initially nuclear. *S. asper* proves to be a strongly proterandrous and sexually reproducing species. Its two subspecies here studied can be distinguished, not only by their morphology but by embryological features as well.

Introduction

Sonchus asper (L.) Hill is a very common species in Bulgaria. Two subspecies of it are of widespread occurrence, *S. asper* subsp. *asper* (annual) and subsp. *glaucescens* (Jord.) Ball (a biennial herb).

Karyological studies of Bulgarian populations of *Sonchus asper* (including population No. 9984, studied in the present paper) revealed a somatic chromosome number of $2n$ = 18 (Kuzmanov & Georgieva 1976) and, for a single population, $2n$ = 36 (Kuzmanov & Georgieva 1980).

Previous embryological data on taxa of the genus *Sonchus* L., a cosmopolitan genus of c. 50 species, are scant and concern three species only: *S. asper, S. arvensis* L., and *S. oleraceus* L. (Dahlgren 1920, Walter & Kuta 1971, Kaul & al. 1975). In this paper, results of a comparative embryological study of two Bulgarian populations, representing the two Bulgarian subspecies of *S. asper,* are presented.

Material and methods

The material studied stems from two natural populations: one of *Sonchus asper* subsp. *asper* (No. 9984, from the S. Black sea coast, near Sozopol), the other of *S. asper* subsp. *glaucescens* (No. 99204, from the Strandža Mts, near the village of Bulgari). Voucher specimens were deposited at SOM.


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Flower buds and capitula of different age, collected in the wild, were fixed in Navashin's mixture and treated according to standard paraffin methods of wax embedding. Microtome sections, 6-15 μm thick, were stained with Heidenhain's haematoxylin. The acetocarmine squash method was also used.

Results and discussion

The anther is predominantly tetra- or more rarely bisporangiate (pop. 99204), or tetrasporangiate only (pop. 9984). The development of the anther wall corresponds to the dicotyledonous type (Davis 1966), consisting of four layers: epidermis, endothecium, middle layer, and anther tapetum. The middle layer is ephemeral and soon degenerates, at the stage I of meiosis prophase in the microspore mother cells (MMC). The fibrous thickenings on the endothecial cells are not clearly expressed. At the beginning of its formation, the anther tapetum consists of uninucleate cells. During the heterotypic division of meiosis in the MMC the tapetum cells become 4-6- (pop. 9984) or up to 8-nucleate (pop. 99204) as a result of mitosis with inhibited cytokinesis. Later, when one-celled pollen grains in the anthers have become well developed, the tapetum differentiates from a secretory type into a false or real periplasmodium (in both populations).

The sporogenous tissue in the anthers is one- to two-layered (Fig. 1). After a marked increase the sporogenous cells function directly as MMC. In general, meiosis in the MMC runs normally. The microspore tetrads in the anthers, being formed simultaneously, are tetrahedral (Fig. 2), apart from some isobilateral ones found in pop. 99204. The anther tapetum degenerates after the formation of two-celled pollen (Fig. 3). The mature pollen, when shed, is three-celled.

The well developed ovule is anatropous, tenuinucellate, and unitegmic. The archaesporium, being hypodermal, consists of one cell (pop. 9984) or one to two cells (pop. 99204). The sporogenous tissue in the anthers is formed considerably earlier than the archaesporium in the ovule. The archaesporial cell functions directly as a megaspore mother cell and undergoes meiosis (Fig. 4), giving rise to a linear tetrad of megaspores (Fig. 5).

The chalazal megaspore functions as an embryo sac mother cell and develops successively into a 2-, 4-, and 8-nucleate embryo sac (ES). Thus, ES formation is of the *Polygonum* (monosporic) type. In some ovules, the micropylar megaspore may persist for a prolonged period of time, sometimes even showing a tendency to develop further. The presence of two mature ES in each of two ovules noted in pop. 99204, a tendency towards polyembryony, is probably due to this circumstance. The innermost cell layer of

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Fig. 1-10. Embryological features of *Sonchus asper* (1, 4, 8: pop. 99204; 2-3, 5-7, 9-10, pop. 9984). – 1, Sporogenous tissue in the anthers; 2, tetrahedral microspore tetrads; 3, two-celled pollen (no traces of anther tapetum are seen); 4, MMC in meiosis prophase I; 5, linear megaspore tetrad; 6, egg cell and central cell of ES; 7, three-celled antipodal complex; 8, two-celled antipodal complex; 9, first division of the zygote; 10, multicellular embryo and nuclear endosperm. – Magnification in 1-2: × 100; in 3-4, 7, 9: × 160; in 5-6, 8, 10: × 400.

a single integument differentiates into the endothelium (integumentary tapetum) after the uninucleate stage of the ES, or even somewhat later (pop. 99204). At the time of endothelium formation the nucellar endosperm is completely degenerated in pop. 9984, whereas in pop. 99204 it is still viable.

The mature ES consists of an egg apparatus (an egg cell and two synergids), two polar nuclei (a central cell after their fusion) and an antipodal complex. The two synergids are cylindrical and clearly hooked in the ES of pop. 9984, pear-shaped and but slightly hooked in the ES of pop. 99204. The two polar nuclei fuse before fertilization, forming the secondary nucleus (central cell) which lies near the egg apparatus (Fig. 6). The antipodal complex is 3-celled in pop. 9984 (Fig. 7) but more often 2-celled in pop. 99204. In the latter case, the lower antipodal cell is always binucleate (Fig. 8).

Fertilization is porogamous. Syngamy and triple fusion take place more or less simultaneously. The synergids and the antipodal cells degenerate after the stage of young embryo and endosperm formation. Wall orientation during the first division of the zygote is transversal (Fig. 9).

The embryo develops according to the Asterad type.

The endosperm in *Sonchus asper* is initially nuclear (Fig. 9, 10), not cellular as stated by Walter & Kuta (1971) and Kaul & al. (1975). Wall formation takes place later, between c. 12 free endosperm nuclei.

Thus, our embryological study of *Sonchus asper* indicates that it is a strongly proterandrous and sexually reproducing species. The two subspecies studied can be naturally and quite successfully distinguished, not only by their morphology but also by embryological features.

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