Gynoecium and Fruit Development in Heliotropium Sect. Heliothamnus (Heliotropiaceae)

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Abstract

Premise of research.Heliotropiaceae (Boraginales) are morphologically readily defined by their peculiar floral morphology, especially their conspicuous stigmatic heads. Heliotropium L. is the largest genus of the family, and within this genus, Heliotropium sect. Heliothamnus I.M. Johnst. is the sister clade to the remaining Heliotropium species. Earlier studies have pointed out a series of gynoecium morphological features of H. sect. Heliothamnus (e.g., a seemingly persisting columella and a gynobasic style) that are not present in the remainder of the genus but are paralleled in the closely related family Boraginaceae s. str. However, a detailed, ontogenetic understanding of the gynoecium and fruit morphology of H. sect. Heliothamnus has not been achieved.Methodology.Here we describe the development of the gynoecium and fruit of H. sect. Heliothamnus using SEM, light microscopy, and high-resolution X-ray computed tomography.Pivotal results.The two-carpellate, syncarpous gynoecium is characterized by four functional subunits: a nectary, an ovary with four mericarpids, a style, and a stigmatic head. All four subunits differentiate simultaneously. At first, the stigmatic head is formed, followed by the style and the gynoecial nectary disc, which is then followed by the onset of the development of mericarpids. After anthesis, the size of the mericarpids increases and their surface sculpturing differentiates. All four mericarpids are laterally attached to each other around the central tissue of the ovary, which disintegrates during fruit development. The ovary is lobed and divided through septa between and within the carpels. After detachment, the contact areas between the mericarpids leave scars, which resemble the cicatrix of the Boraginaceae s. str. In contrast to the Boraginaceae s. str., the whole gynoecium is dispersed.Conclusions.Mericarpid development in Heliotropium sect. Heliothamnus follows a different developmental trajectory than in Boraginaceae s. str. Individual nutlets separate in two steps and not simultaneously. A tissue in the center of the ovary is present in immature fruits of H. sect. Heliothamnus, but it

disintegrates during maturation and is absent in mature fruits. It is not structurally equivalent to the persisting columella characterizing the fruit of Boraginaceae s. str. The style is not gynobasic but rather distally attached to the mericarpids. The schizocarpic mericarpids in Heliotropium sect. Heliothamnus are thus not structurally correspondent to the eremocarps of the Boraginaceae s. str., as previously suggested.

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