

## EXPRESSION OF SEXUAL POLYMORPHISM IN *HERACLEUM SIBIRICUM* (APIACEAE) INFLORESCENCES IN MOSCOW REGION

V. N. Godin<sup>a,#</sup>, T. V. Arkhipova<sup>a</sup>, and J. I. Ialamova<sup>a</sup>

<sup>a</sup> Moscow Pedagogical State University  
Kibalchicha Str., 6, Bldg. 3, Moscow, 129164, Russia

<sup>#</sup>e-mail: vn.godin@mpgu.su

DOI: 10.31857/S0006813621060053

Sexual polymorphism and the structure of synflorescences of *Heracleum sibiricum*, a biennial or perennial taproot herb, were studied in 2017–19 in three populations in the Moscow Region. Four types of *H. sibiricum* individuals were identified according to the degree of branching of the inflorescence (double umbels on shoots of I, I–II, I–III, and I–IV orders of branching), which correspond to three types of synflorescences: a single terminal double umbel, a raceme of double umbels, and a panicle of double umbels. With an increase in the degree of synflorescence branching, an increase in the size of the double umbels and their structural components occurs, as well as decrease in the number of staminate flowers on shoots of the same branching order. Simple umbellets can include both bisexual, pistillate, and staminate flowers (the latter always occupy a central position), only bisexual (on plants in terminal double umbels with a high degree of synflorescence branching), bisexual and staminate flowers (most often in double umbels on shoots of III and IV orders), and only pistillate (in rarely found exclusively females on shoots of only I–II orders of branching). In *H. sibiricum*, a combination of andromonoecy and gynodioecy is observed in the populations, which is expressed as andromonoecious (bisexual and staminate flowers; the share of such plants in populations varies from 88.9 to 92.1 percent), polygamomonoecy (bisexual, pistillate, and staminate flowers; the share of these plants ranges from 6.8 to 8.4 percent), and female (only pistillate flowers; the frequency of such plants varies from 0.9 to 3.4 percent). The reasons and significance of sexual polymorphism in flowering plants are discussed.

*Keywords:* sexual polymorphism, *Heracleum sibiricum*, Apiaceae, population, andromonoecy, polygamomonoecy, gynodioecy

### REFERENCES

- Barrett S.C.H., Harder L.D. 1996. Ecology and evolution of plant mating. – *Trends Ecol. Evol.* 11 (2): 73–79. [https://doi.org/10.1016/0169-5347\(96\)81046-9](https://doi.org/10.1016/0169-5347(96)81046-9)
- Brunet J., Charlesworth D. 1995. Floral sex allocation in sequentially blooming plants. – *Evolution.* 49 (1): 23–44. <https://doi.org/10.2307/2410293>
- Charlesworth D. 2006. Evolution of plant breeding systems. – *Curr. Biol.* 16 (17): R726–735. <https://doi.org/10.1016/j.cub.2006.07.068>
- Dem'yanova E.I. 2011. The spectrum of sexual types and forms in the local floras of the Urals (Cis- and Trans-Urals). – *Bot. Zhurn.* 96 (10): 1297–1315 (In Russ.).
- Dem'yanova E.I., Shestakova O.M., Detkova A.G. 2000. About sexual structure of gynodioecious populations of

- plants of Apiaceae in the West Ural territories. — Vestnik Permskogo universiteta. Biology. 2: 58–61 (In Russ.).
- Downie S.R., Spalik K., Katz-Downie D.S., Reduron J.-P. 2010. Major clades within Apiaceae subfamily Apioideae as inferred by phylogenetic analysis of nrDNA ITS sequences. — *Plant Div. Evol.* 128 (1–2): 111–136. <https://doi.org/10.1127/1869-6155/2010/0128-0005>
- Endress P.K. 2020. Structural and temporal modes of heterodichogamy and similar patterns across angiosperms. — *Bot. J. Linn. Soc.* 193 (1): 5–18. <https://doi.org/10.1093/botlinnean/boaa001>
- Godin V.N. 2019. Distribution of gynodioecy in APG IV system. — *Bot. Zhurn.* 104 (5): 669–683 (In Russ.). <https://doi.org/10.1134/S0006813619050053>
- Godin V.N. 2020. Distribution of gynodioecy in flowering plants. — *Bot. Zhurn.* 105 (3): 236–252 (In Russ.). <https://doi.org/10.31857/S0006813620030023>
- Godin V.N., Ialamova J.I. 2020. Sexual types of flowers morphology in *Heracleum sibiricum* (Apiaceae). — *BIO Web of Conferences.* 24: 00025. <https://doi.org/10.1051/bioconf/20202400025>
- Godin V.N., Perkova T.V. 2017. Flowering biology and sexual polymorphism in the Apiaceae species (Moscow region). — *Bot. Zhurn.* 102 (1): 35–47 (In Russ.). <https://doi.org/10.1134/S0006813617010033>
- Grosset H.E. Modificational variability of *Seseli peucedanoides* (Bieb.) K.-Pol. and the sexual polymorphism of this species and *Heracleum sibiricum* L. — *Byulleten MOIP. Otd. Biologii.* 79 (6): 57–77 (In Russ.).
- Hegi J. 1926. *Illustrierte Flora von Mittel-Europa.* Munchen. Bd. 5. H. 2. S. 1415–1457.
- Knuth P. 1898. *Handbuch der Blütenbiologie.* Bd 2. T. 1. Leipzig. 705 s.
- Kuznetzova T.V. 1982. Morfologiya sotsvetij semeystva zontichnykh Umbelliferae Juss. — Apiaceae Lindl.) [The morphology of inflorescences of the family Umbelliferae (Umbelliferae Juss. — Apiaceae Lindl.)]: Abstr. ... Diss. Kand. Sci. Moscow. 16 p. (In Russ.).
- Kuznetzova T.V., Timonin A.C. 2017. Inflorescence: morphology, evolution, bearing on taxonomy (considered in the light of Bohr's principle of complementarity. Moscow. 183 p. (In Russ.).
- Lloyd D.G., Webb C.J. 1977. Secondary sex characters in plants. — *Bot. Rev.* 43 (2): 177–216. <https://doi.org/10.1007/BF02860717>
- Lovett-Doust J. 1980. Floral sex ratio in andromonoecious Umbelliferae. — *New Phytol.* 85 (2): 265–273. <https://doi.org/10.1111/j.1469-8137.1980.tb04468.x>
- Mandenova I.P. Rod Borshchevik — *Heracleum* L. — In: *Flora USSR.* Vol. 17. Moscow; Leningrad. P. 223–259 (In Russ.).
- Pangalo K.I. 1943. Sex and flowering in cultivated Cucurbitaceae. — *Bot. Zhurn.* 28 (1): 10–23 (In Russ.).
- Pellmyr O. 1987. Multiple sex expressions in *Cimicifuga simplex*: dichogamy destabilizes hermaphroditism. — *Biol. J. Linn. Soc.* 31 (2): 1161–1174. <https://doi.org/10.1111/j.1095-8312.1987.tb01987.x>
- Plunkett G.M., Pimenov M.G., Reduron J.P., Kljukov E.V., van Wyk B.E., Ostroumova T.A., Henwood M.J., Tilney P.M., Spalik K., Watson M.F., Lee B.Y., Pu F.D., Webb C.J., Hart J.M., Mitchell A.D., Muckensturm B. 2018. Apiaceae. — In: *Flowering Plants. Eudicots.* 15: 9–206. [https://doi.org/10.1007/978-3-319-93605-5\\_2](https://doi.org/10.1007/978-3-319-93605-5_2)
- Reuther K., Claßen-Bockhoff R. 2010. Diversity behind uniformity — inflorescence architecture and flowering sequence in Apiaceae-Apioideae. — *Plant Div. Evol.* 128 (8): 181–220. <https://doi.org/10.1127/1869-6155/2010/0128-0009>
- Sandina I.B. 1959. Borshchevik Sosnovskogo (*Heracleum sosnowskyi* Manden.), ego biologiya i opyt vyrashchivaniya v Leningradskoy oblasti [Sosnovsky's hogweed (*Heracleum sosnowskyi* Manden.), its biology and cultivation experience in the Leningrad region]: Abstr. ... Diss. Kand. Sci.]. Leningrad. 18 p. (In Russ.).
- Sazyperova I.F. 1984. *Heracleum* species of the USSR — new fodder plants. Leningrad. 223 p. (In Russ.).
- Schlessmann M.A. 2010. Major events in the evolution of sexual systems in Apiales: ancestral andromonoecy abandoned. — *Plant Div. Evol.* 128 (1–2): 233–245. <https://doi.org/10.1127/1869-6155/2010/0128-0011>
- Schubert M.T.R., van Wyk B.E. 1997. A revision of *Centella* series Capenses (Apiaceae). — *Nord. J. Bot.* 17 (3): 301–314. <https://doi.org/10.1111/j.1756-1051.1997.tb00318.x>
- Sokal R.R., Rohlf F.J. 2012. *Biometry: the principles and practice of statistics in biological research.* New York. 937 p.
- Spalik K. 1991. On evolution of andromonoecy and “overproduction” of flowers: A resource allocation model. — *Biol. J. Linn. Soc.* 42 (3): 325–336. <https://doi.org/10.1111/j.1095-8312.1991.tb00566.x>
- Tkachenko K.G. 1989. Features of flowering and seed productivity of some species of *Heracleum* L. grown in the Leningrad region. — *Rast. resursy.* 25 (1): 52–61 (In Russ.).
- Webb C.J. 1981. Andromonoecism, protandry, and sexual selection in Umbelliferae. — *New Zealand J. Bot.* 19 (4): 335–338. <https://doi.org/10.1080/0028825X.1981.10426389>
- Wróblewska A. 1992. Flowering and pollen value of selected species of umbelliferous family — Umbelliferae Juss. (Apiaceae Lindl.) in Lublin region. Part 1. Biology and abundance of flowering. — *Acta agrobotanica.* 45 (1–2): 5–24. <https://doi.org/10.5586/aa.1992.001>
- Yampolsky C., Yampolsky H. 1922. Distribution of sex forms in the phanerogamic flora. — *Bibliotheca Genetica.* 3: 1–62.