




Data to the distribution and ecology of *Ophrys tetraloniae* W.P. Teschner (Orchidaceae)

ATTILA MOLNÁR V.^{1,*}, MIKLÓS ÓVÁRI², SZABOLCS KIS¹, HENRIETTA BAK¹
& RÉKA FEKETE^{1,3}

¹HUN-REN–UD Conservation Biology Research Group, Department of Botany, University of Debrecen, H-4032 Debrecen, Egyetem sq. 1., Hungary;

 <https://orcid.org/0000-0001-7096-9579>;  <https://orcid.org/0009-0003-1287-088X>;

 <https://orcid.org/0000-0002-5500-0150>

²H-8900 Zalaegerszeg, Gorkij str. 1/d., Hungary; E-mail: ovarimiklos58@gmail.com

³Seed Ecology Research Group, Institute of Ecology and Botany, HUN-REN Centre for Ecological Research; H-2163 Vácrátót, Alkotmány street 2–4., Hungary;

E-mail: feketereka722@gmail.com;  <https://orcid.org/0000-0002-9255-0012>

* Corresponding author: E-mail: mva@science.unideb.hu

Received 21 December 2024 | Accepted by V. Pešić: 16 January 2025 | Published online 21 January 2025.

Abstract

During studies of European orchids in anthropogenic habitats (such as roadsides, cemeteries, and tree plantations), we unexpectedly encountered previously unrecorded occurrences of *Ophrys tetraloniae* in Montenegro and Bosnia and Herzegovina. By utilising taxonomically verified data from both published literature and online resources, we present an updated distribution map for the species. Considering recent climatic trends and the expansion of other orchid species with similar habitat preferences, a northward range extension of *Ophrys tetraloniae* is likely. In Montenegro, we documented pseudocopulatory pollination by a male *Eucera fulvescens*. A comparison of the phenology of *Ophrys tetraloniae* and its pollinator revealed that, although both the orchid's flowering period and the bee's swarming period span approximately two months, the median date of the orchid's flowering is significantly earlier (4th June) than the median date of the bee's swarming (1st July). This phenological discrepancy may be attributed to deceptive pollination: earlier-flowering individuals of the orchid are more likely to encounter virgin and naïve male bees of the protandrous species, thereby enhancing reproductive success.

Key words Balkans; Bosnia and Herzegovina; Citizen science; *Eucera fulvescens*; Facebook; GBIF; Montenegro; Phenology; Sexually deceptive pollination; Roadside verges.

Introduction

The species *Ophrys tetraloniae* W.P. Teschner was first described from Northern Istria, Croatia, with the type specimen collected on Mount Kobiljak near Prodani (Teschner 1987). It differs from the more widespread *Ophrys holosericea* (Burm. f.) Greuter (syn. *O. fuciflora* (F.W. Schmidt) Moench) in its later flowering period (from late May to early July), smaller flowers (labellum 7–11 mm long and 8–13 mm wide), its slender and delicate habit (15–60 cm tall), and a different pollinator. The specific epithet

refers to the name previously used for its pollinator (*Tetralonia fulvescens* = *Eucera fulvescens*). According to the most recent and comprehensive European orchid monograph (Kreutz 2024), the species is currently known only from Croatia and Italy (Piedmont, Liguria, Lombardia, Friuli Venezia Giulia, Abruzzo, Umbria, Cilento, and Molise). The Flora Croatica Database (Nikolić 2013+) and the GBIF (2024a) report additional occurrences from Croatia, predominantly along the Adriatic coast, and *O. tetraloniae* has also been recorded in Slovenia (Ravnik 2002; Dolinar 2015).

Materials and methods

The geographic coordinates of the two newly discovered locations were determined using a Garmin GPS handheld device in WGS 84 format.

For the phenological study of both species, we only included records with an exact date (to a single day), and for *Ophrys tetraloniae*, specific identification was validated through photographic or herbarium documentation (Table 1). The observation/collection dates were converted to ordinal days, where 1st January corresponds to day 1, and 31st December corresponds to day 365. A two-sample t-test was used to compare the temporal distribution of observations for both species.

Table 1. Source of data and number of records used for flowering phenological characterisation of *Ophrys tetraloniae* and for the swarming phenological characterisation of *Eucera fulvescens*.

<i>Ophrys tetraloniae</i>
GBIF (2024a): 43
Facebook (2024): 19
JACQ consortium (2004): 2
Italia Felix (2024): 1
Paulus (2014): 2
Baumann <i>et al.</i> (2006): 1
Delforge (2006): 2
Delforge (2001): 1
GIROS (2016): 1
Soca (2014): 1
Kreutz (2024): 2
Own observations: 3
<i>Eucera fulvescens</i>
GBIF (2024b): 126
Paulus (2014): 2
Own observation: 1

The distribution map of *Ophrys tetraloniae* was created using data from the GBIF (2024b), Flora Croatica Database (Nikolić 2013+), and Dolinar (2015) with QGIS Desktop 3.30.2 software.

Results

Data to the distribution of Ophrys tetraloniae

The species was discovered in two previously unknown localities, thus representing a new addition to the vascular flora of Bosnia and Herzegovina and Montenegro.

- Bosnia and Herzegovina: Sutjeska Valley, near the public road M20 (43.37546°N 18.72577°E, 665 m altitude), 4th July 2023, A. Molnár V., Sz. Kis, H. Bak & R. Fekete, photodocumented (Fig. 1: A–C); 2 flowering specimens located 20 and 30 cm from the road;

- Montenegro: Bar, near Brijega, along the public road M2 (42.23898°N, 19.02228°E, 283 m altitude), 9th June 2010, A. Molnár V. & M. Óvári, photodocumented (Fig. 1: D–F); approximately 50 flowering individuals 1–10 m from the road.

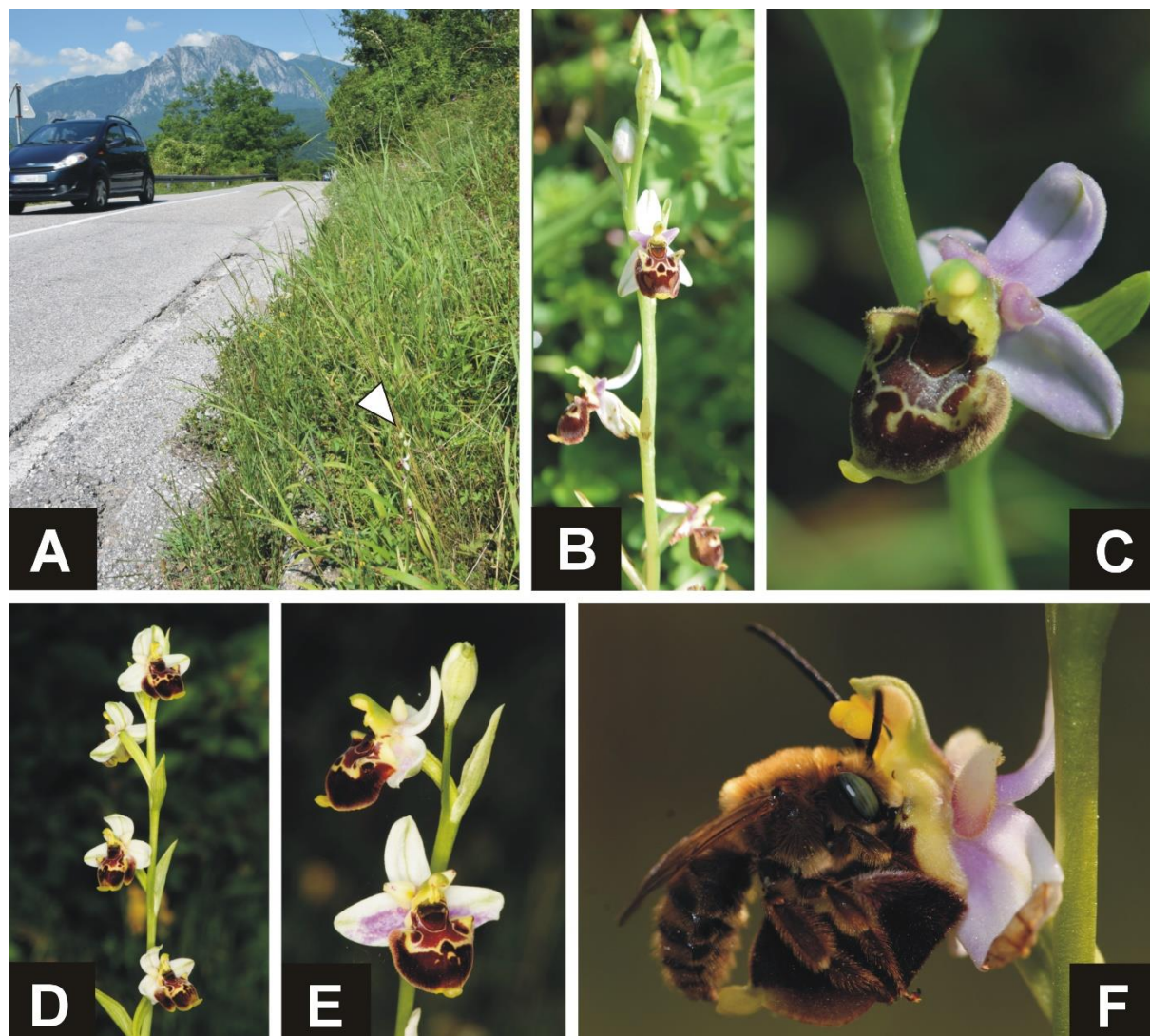


Figure 1. Photodocumentation of *Ophrys tetraloniae* in Bosnia and Herzegovina (Sutjeska Valley, 4th July 2023, A–C) and Montenegro (near Brijega, 9th June 2010, D–F). Photographs by A. Molnár V. (A, B, F), M. Óvári (D, E), and Sz. Kis (C).

Pollination and phenological characteristics

On 9th June 2010, at the Montenegrin site, we observed and documented pseudocopulatory pollination behaviour by a male longhorn bee on four flowers of an individual of *Ophrys tetraloniae*. The pollinator spent 10–30 seconds on the flowers, and the pollinia of the visited flowers adhered to its head (Fig. 1F). Based on photographic documentation, the species was identified by Hannes Paulus as *Eucera fulvescens* (Giraud, 1863) [syn. *Tetralonia fulvescens* Giraud, 1863; *Tetraloniella fulvescens* (Giraud, 1863)].

The phenological data (Table 1) allowed for a comparison of the timing of orchid flowering and pollinator swarming (Fig. 2). Based on 78 observations, *Ophrys tetraloniae* flowering occurred over a 55-day period, from the earliest on 14th May 2013 to the latest on 8th July 2010. The median day of flowering was 4th June (median ordinal day \pm SD = 155 \pm 10.4). Swarming of *Eucera fulvescens* lasted approximately 66 days annually, with the earliest recorded on 31st May 2020 and the latest on 8th August 2014. The median day of swarming was 1st July (median ordinal day \pm SD = 182 \pm 14). The first, median, and last days of orchid flowering were 17, 26, and 29 days earlier, respectively, than the

corresponding days for pollinator swarming. A two-sample t-test revealed a significant difference ($p < 0.01$) between the timing of orchid flowering and pollinator swarming.

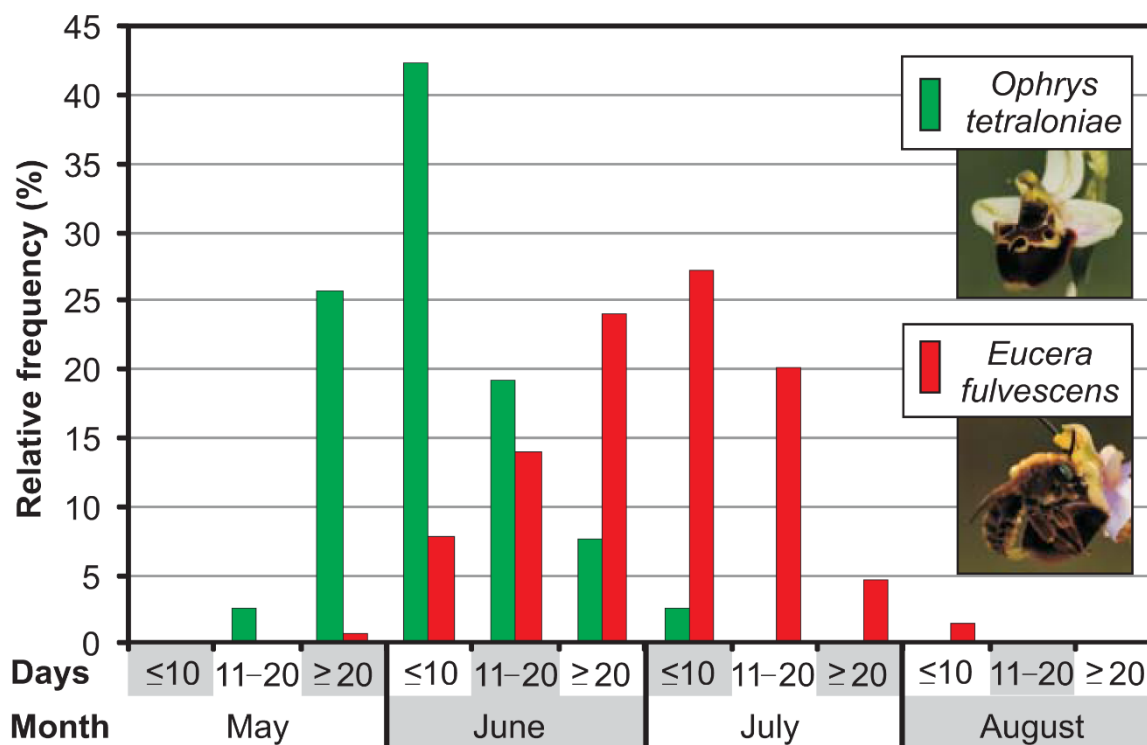


Figure 2. Phenogram of *Ophrys tetraloniae* and its pollinator, *Eucera fulvescens*. The green columns show the frequency of orchid flowering observations ($n = 78$) and the red columns show the relative frequency of pollinator observations ($n = 129$).

Discussion

We detected new occurrences of *Ophrys tetraloniae* in two Balkan countries (Bosnia and Herzegovina, Montenegro). The species appears to be more widespread (Fig. 3) in the Adriatic coastal area than previously thought (Kreutz 2024; Delforge 2006), and its distribution is not confined only to Croatia, Italy, and Slovenia. Similar to other European orchid species (Fekete *et al.* 2017, 2019, 2020, 2023), *O. tetraloniae* is capable of colonising grassy road verges. The new site in Bosnia and Herzegovina is situated approximately 90 km from the Adriatic coast and the species is also known from Croatia, northeast of Zagreb, around 140 km from the Adriatic sea (Nikolić 2013+). Based on these findings, further spread of the species is anticipated, as several orchid species (eg. *Himantoglossum adriaticum* and *H. calcaratum*) in the region are known to be expanding northwards (Molnár V. *et al.* 2024; Tóth & Teleki 2024; Kacsinecz *et al.* 2025). Its distribution is unlikely to be constrained by the absence of its specific pollinator, as occurrences of *Eucera rufescens* are known further north, including in Austria, near Vienna (GBIF 2024b).

It is noteworthy that the phenology of *Ophrys tetraloniae* and its pollinator, *Eucera fulvescens*, differ significantly. While overlap in the phenology of both species is essential for successful pollination, the flowering peak of *O. tetraloniae* precedes the swarming peak of *E. fulvescens*. This discrepancy may be attributed to the deceptive nature of the relationship. Orchids with deceptive pollination strategies typically flower earlier than rewarding orchids (Internicola *et al.* 2008; Internicola & Harder 2012; Pellissier *et al.* 2010). As pollinators learn to avoid deceptive flowers (Schiestl 2005; Gaskett 2011), earlier-flowering orchids are more likely to encounter naïve, virgin pollinators. This is particularly significant in the case of pseudocopulatory pollination by male individuals of protandrous bee species (Vereecken & Patiny 2005).

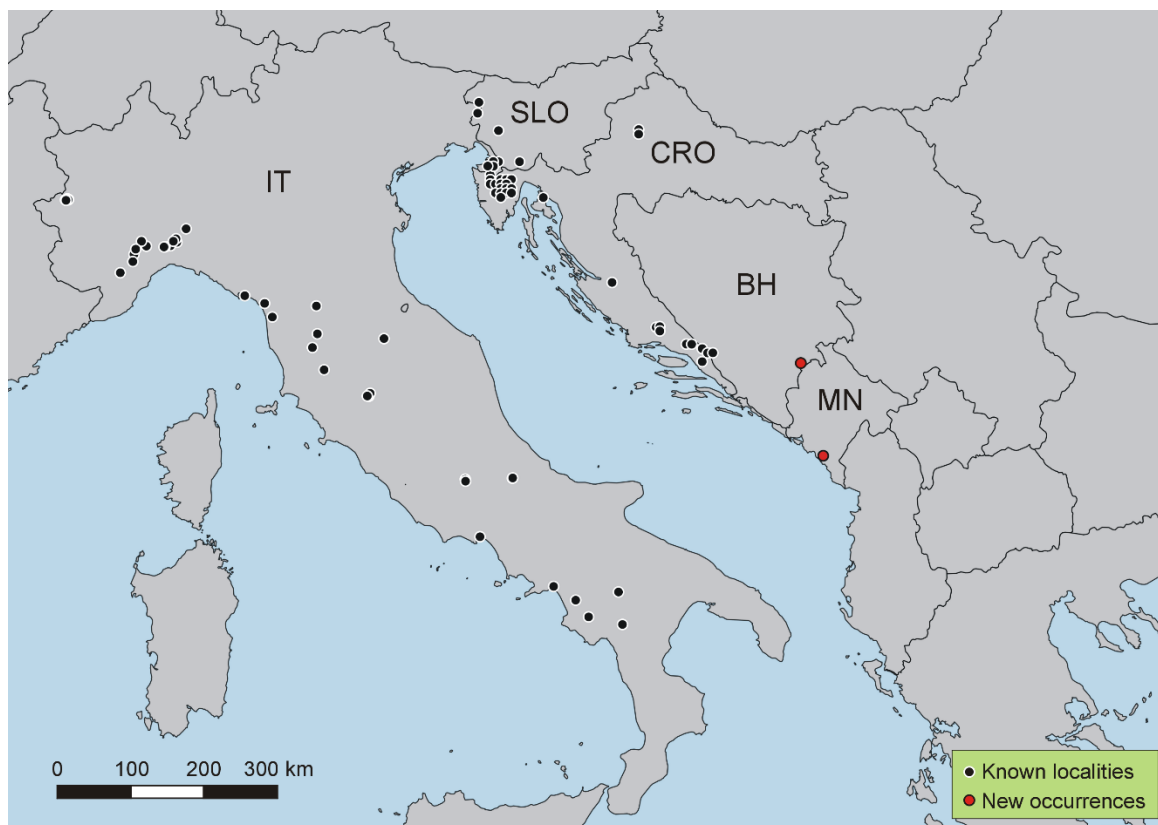


Figure 3. Distribution of *Ophrys tetraloniae*.

Acknowledgements

The authors are grateful to Prof. Hannes Paulus (Vienna) for the identification of pollinator and sincerely appreciate all valuable suggestions of Siniša Škondrić on the previous version of the manuscript. This research was funded by National Research, Development and Innovation Office of Hungary (grant numbers NKFIH–OTKA K132573 and PD143425).

References

- Baumann, H., Künkele, S. & Lorenz, R. (2006) *Orchideen Europas*. Ulmer Verlag, Stuttgart, Germany, p. 168.
- Delforge, P. (2001) *Guide des Orchidées d'Europe, d'Afrique du Nord et du Proche-Orient, 2nd ed.* Delachaux et Niestlé, Lausanne – Paris, 482 pp.
- Delforge, P. (2006) *Orchids of Europe, North Africa and the Middle East*. A&C Black, London, 640 pp.
- Dolinar, B. (2015) Contribution to the knowledge of the taxa from the groups *Ophrys sphegodes* s. lat. and *Ophrys holosericea* s. lat. in Slovenia. *Folia Biologica et Geologica*, 56, 37–49.
https://ojs.sazu.si/fovia_bio_geo/article/view/4550/4236
- Facebook (2024) *European Orchids and their Habitats group*. Available from: <https://www.facebook.com/groups/1435119153462796> (Date of access: 22. 12. 2024).
- Fekete, R., Bódis, J., Fülöp, B., Süveges, K., Urgyán, R., Malkócs, T., Vincze, O., Silva, L. & Molnár V., A. (2020) Roadsides provide refuge for orchids: Characteristic of the surrounding landscape. *Ecology and Evolution*, 10, 13236–13247. <https://doi.org/10.1002/ece3.6920>
- Fekete, R., Löki, V., Urgyán, R., Süveges, K., Lovas-Kiss, Á., Vincze, O. & Molnár V., A. (2019) Roadside verges and cemeteries: Comparative analysis of anthropogenic orchid habitats in the Eastern Mediterranean. *Ecology and Evolution*, 9, 6655–6664.
<https://doi.org/10.1002/ece3.5245>

- Fekete, R., Nagy, T., Bódis, J., Biró, É., Löki, V., Süveges, K., Takács, A., Tökölyi, J. & Molnár V., A. (2017) Roadside verges as habitats for endangered lizard-orchids (*Himantoglossum* spp.): Ecological traps or refuges? *Science of the Total Environment*, 607, 1001–1008. <https://doi.org/10.1016/j.scitotenv.2017.07.037>
- Fekete, R., Vincze, O., Nagy, J., Löki, V., Süveges, K., Bódis, J., Malkócs, T., Lovas-Kiss, Á. & Molnár V., A. (2023) North-facing roadside slopes: Anthropogenic climate microrefugia for orchids. *Global Ecology and Conservation*, 47, e02642. <https://doi.org/10.1016/j.gecco.2023.e02642>
- Gaskett, A. C. (2011) Orchid pollination by sexual deception: pollinator perspectives. *Biological Reviews*, 86, 33–75. <https://doi.org/10.1111/j.1469-185X.2010.00134.x>
- GBIF (2024a) *Ophrys tetraloniae* gbif occurrence download. Available from: gbif.org (Date of access: 18. 12. 2024) <https://doi.org/10.15468/dl.ngfhp>
- GBIF (2024b) *Tetraloniella fulvescens* gbif occurrence download. Available from: gbif.org (Date of access: 23. 12. 2024) <https://doi.org/10.15468/dl.2j6gvk>
- GIROS (2016) *Orchidee d'Italia. Guida alla Orchidee spontanee, 2nd ed.* Il Castello, Cornaredo, Italy.
- Internicola, A.I., Bernasconi, G. & Gigord, L.D. (2008) Should food-deceptive species flower before or after rewarding species? An experimental test of pollinator visitation behaviour under contrasting phenologies. *Journal of Evolutionary Biology*, 21, 1358–1365. <https://doi.org/10.1111/j.1420-9101.2008.01565.x>
- Internicola, A.I. & Harder, L.D. (2012) Bumble-bee learning selects for both early and long flowering in food-deceptive plants. *Proceedings of the Royal Society (London) B: Biological Sciences*, 279, 1538–1543. <https://doi.org/10.1098/rspb.2011.1849>
- Italia Felix (2024) *Italia Felix*. Available from: https://www.italiafelix.it/orchids/orchids_marche/_Op-tetr-txt.htm (Date of access: 18. 12. 2024).
- JACQ consortium (2004) Virtual Herbaria Website. Available from: <https://www.jacq.org/> (Date of access: 18. 12. 2024).
- Kacsinecz, G., et al. (2025) Adatok a Pannon Ökorégió őshonos növényfajainak ismeretéhez II. *Kitaibelia* 30, <https://doi.org/10.17542/kit.30.065>.
- Kreutz, C.A.J. (2024) *Guide to the orchids of Europe, North Africa and the Middle East*. Kreutz Publishers, Eys, the Netherlands. p.: 936.
- Molnár V., A., Bak, H., Bodics, D., Bordé, S., Chabrecsek, T., Fekete, R., Gilicze, B., Gyurisán, D., Hunyadi, T., Jordán, S., Kelecsényi, P., Kis, Sz., Kiss, G., Koloszár, A., Lovas-Kiss, Á., Löki, V., Mäh, Z., Mészáros, A., Simon, P., Süveges, K., Szabó, Gy., Vikár, J., Vizler, Cs., Jakab, G. & Takács, A. (2024) Adatok a Pannon Ökorégió őshonos növényfajainak ismeretéhez I. (1–5). *Kitaibelia*, 29, 160–172. <https://doi.org/10.17542/kit.29.046>
- Nikolić, T. (ed.) (2013+) *Flora Croatica Database*. Available from: <https://hirc.botanic.hr/fcd/> (Date of access: 22. 12. 2024).
- Paulus, H.F. (2014) Zur Bestäubungsbiologie von *Serapias lingua* und einiger *Ophrys*-Arten in Kroatien (Orchidaceae und Insecta, Apoidea). *Journal Eurpäischer Orchideen*, 46, 503–560.
- Pellissier, L., Vittoz, P., Internicola, A.I. & Gigord, L.D.B. (2010) Generalized food-deceptive orchid species flower earlier and occur at lower altitudes than rewarding ones. *Journal of Plant Ecology*, 3, 243–250. <https://doi.org/10.1093/jpe/rtq012>
- Ravnik, V. (2002) *Orhideje Slovenije*. Tehniška založba Slovenije, Ljubljana, Slovenia, 192 pp.
- Schiestl, F.P. (2005) On the success of a swindle: pollination by deception in orchids. *Naturwissenschaften*, 92, 255–264. <https://doi.org/10.1007/s00114-005-0636-y>
- Soca, R. (2014) Description of ten new *Ophrys*-hybrids (Orchidaceae) of the Abruzzo (Italy). *Journal Eurpäischer Orchideen*, 46, 661–678.
- Teschner, W.P. (1987) *Ophrys tetraloniae* spec. nov. – eine spätblühende Verwandte der Hummel-Ragwurz in Istrien. *Die Orchidee*, 38, 220–224.
- Tóth, I.Zs. & Teleki, B. (2024) Botanikai adatok Tolnából és Baranyából IV. *Kitaibelia*, 29, 17–33. <https://doi.org/10.17542/kit.29.047>
- Vereecken, N. J. & Patiny, S. (2005) On the pollination of *Ophrys catalaunica* O. Danesch & E. Danesch by pseudocopulating males of *Chalicodoma pyrenaica* (Lepelletier) (Hymenoptera, Megachilidae). *Les Naturalistes belges*, 2005, 86, 57–64.