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Ophrys apifera Huds. (Orchidaceae) on a heap of limestone mine waste – the first population found in the Sudetes and the second in Poland

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Abstract. The paper reports the finding of a new locality of *Ophrys apifera* – the first locality of this species in the Sudeten range and the second in Poland. A new population was found in the Kaczawskie Mts. (Western Sudetes). It consists of 23 flowering plants and occurs in an operating limestone quarry. The detailed data on this population and its habitat are included.

Key words: *Ophrys apifera*, bee-orchid, orchids, distribution changes, Sudetes

1. Introduction

The genus *Ophrys* L. is known to botanists and orchid enthusiasts as a model system of floral evolution and pollination mimicry. These orchids developed a specialized flower-pollinator relationship of pollination by deception, more precisely – sexual deception (pseudocopulation; Schiestl 2005). It is based on the complex of flower features, particularly insect-like labellum and secretion of pseudo-pheromones identical to female sex pheromones of pollinator species. Pollinators are usually young, inexperienced male bees, wasps or even beetles of several families (Paulus 1997, 2019). Both botanists and enthusiasts have been interested in this genus for centuries.

Representatives of the genus *Ophrys* are easily recognizable, but the differentiation within the genus remains problematic. After 2000, the number of distinguished taxa increased from 19 species and 46 subspecies (Pedersen & Faurholdt 2007) to over 250 species (Delforge 2005). The species-rich classifications have become dominant in recent years, however, species diversity, the number of species, including cryptic diversity and endemism, as well as relationships between species requires further research (Devey *et al.* 2008; Triponez *et al.* 2013). Generally, this terrestrial genus is limited to Old World (Canary Islands, North Africa, Europe, Middle East up to Caucasus and Turkmenistan), but mostly occurrs in the Mediterranean region. Areas of high diversity comprise southern Italy and the Aegean region (Soliva *et al.* 2001); the number of *Ophrys* species decreases to the north and north-east of Europe. In Central Europe, up to the end of the 20th century, only a few species were noted: 4 in Germany (*O. insectifera* L., *O. apifera*, *O. holosericea* (Burm.f.) Greuter, *O. sphegodes* Mill. – Rothmaler 2002; another species – *O. araneola* Rchb. – is currently included in *O. sphegodes* – Soliva *et al.* 2001), the same 4 in the Czech Republic (Kaplan 2019) and only 1 in Poland (*O. insectifera* – Mirek *et al.* 2002).

In Poland, the fly orchid is rather rare, limited to the southern part of the country. It occurrs on limestone substratum in uplands and Western Carpathians. Without any doubt, this species is a native element of Polish flora (Kaźmierczakowa & Zarzycki 2014). In 2010, another species – *O. apifera*, was noted for the first time in Poland (Osiadacz & Kręciała 2014). It is one of the oldest species of the genus, genetically well isolated and morphologically different. It is also one of the most widely distributed *Ophrys* orchids, with sub-Mediterranean to sub-Atlantic distribution, which occurs from Ireland and British Islands, through the whole Mediterranean region to Caucasus (Soliva *et al.* 2001). Despite doubts about its origin, the first Polish

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locality was considered natural and the species was included in the Polish red list of vascular plants as critically endangered (Kaźmierczakowa *et al.* 2016) and protected for 5 years by the local law of Silesian voivodeship (Directive 29/2017).

In summer of 2020, the second Polish locality of *O. apifera* was found in the Kaczawskie Mountains (Western Sudetes, SW Poland). It is the first record of any *Ophrys* species in the whole Sudeten range. We decided to undertake detailed research of new population and its habitat to assess its abundance, condition and survival chances.

2. Materials and methods

O. apifera was found in July 2020, in the end of its flowering season. Due to a small number of plants, a herbarium specimen was not collected, the site and selected plants were photographed, and all found specimens were mapped. We tried to document (*i*) the area occupied by the population, (*ii*) size and abundance of population, (*iii*) plant communities occurring in the place of the species occurrence. The classification of plant communities was given according to Mucina (2016), while the species names of plants according to Hassler (2019).

3. Results

The area of study is situated on the Połom Hill (ATPOL BE61; Fig. 1), a limestone hill about 667 m.a.s.l. high and damaged to a large extent by still operating limestone quarry. The locality of *Ophrys apifera* is situated below the top, in the area of the quarry, at the treeless heap of limestone mine waste, formed last time in 1998. Substratum is initial soil and well-drained limestone rubble with a diameter of up to 15 cm. Habitat is sunny and sheltered from the northern wind.

The bee orchid occurred in an area of *ca.* 1,100 m^2 and its population consisted of 23 flowering plants scattered over the entire area. In time of research, the majority of orchids finished flowering and we observed the last, fading flowers (Fig. 2). All leaves of the plants were almost completely destroyed by snails, the plants were starting to turn yellow, and some of them already carried well-formed capsules (Fig. 3). We did not observed any juvenile rosettes of leaves.

The habitat of *O. apifera* is anthropogenic, highly disturbed and covered by calcareous plant community developed as a result of secondary succession. Vegetation is related to calcareous grasslands of the *Festuco-Brometea* Br.-Bl. et Tx. ex Soó 1947 class, but is

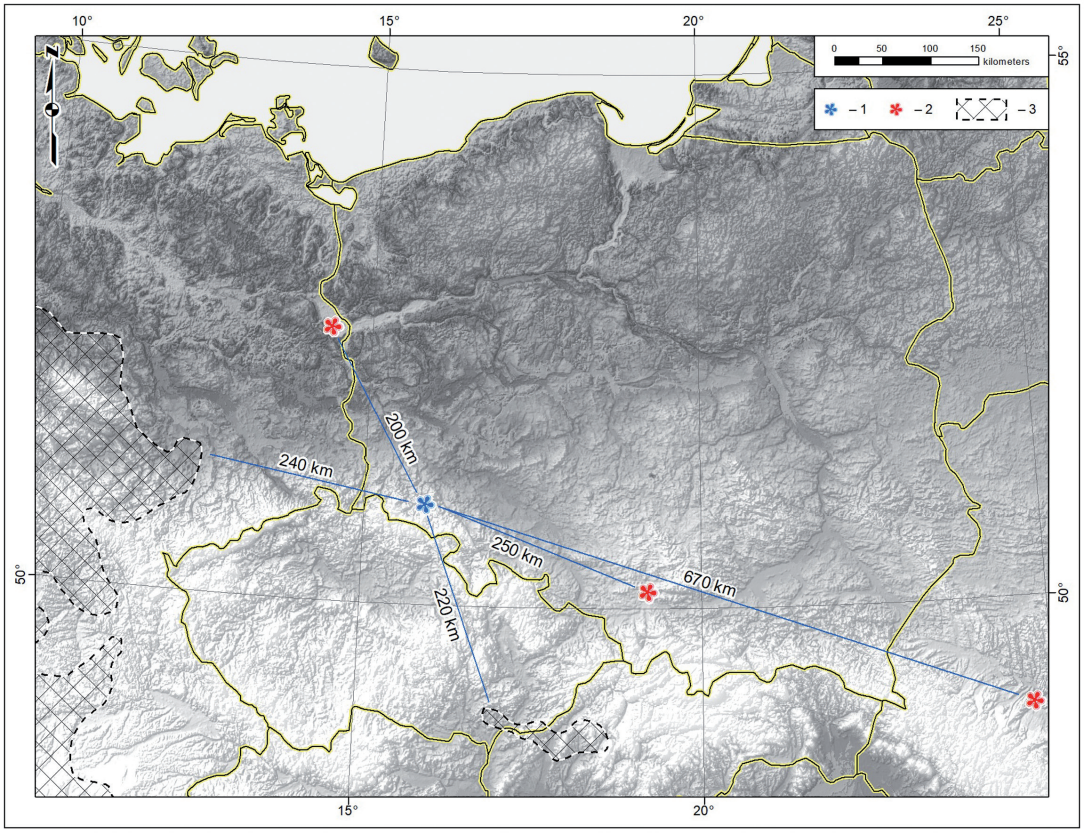

Fig. 1. *Ophrys apifera* Huds. in Poland (according to Osiadacz & Kręciała 2014; actualized)

Explanations: 1 – a new locality in the Kaczawskie Mts, 2 – isolated localities, the closest to the new one, 3 – parts of European range; continuous range in Germany (west) and Czech populations (south)

Fig. 2. *Ophrys apifera* Huds. – last flower (photo E. Szczęśniak, 13.07.2020)

Fig. 3. *Ophrys apifera* Huds. – plant with fertile capsules (photo D. Wójcicki, 13.07.2020)

strongly influenced by species from many neighboring natural and anthropogenic plant communities. We observed three stages of grassland development depending on soil depth and moisture.

First stage. The most pioneer stage, developed on the shallow, well-drained soil near the edge of the heap top; herb layer coverage up to 40%, about 42 species/20 m^2; co-dominant species: *Carex flacca* Schreb., *Euphorbia cyparissias* L., and *Leontodon hispidus* Cav., species with significant coverage: *Brachypodium pinnatum* (L.) P.Beauv., *Centaurea jacea* L., *Gentianopsis ciliata* (L.) Ma, *Hieracium bifidum* F.Sch., *Leucanthemum vulgare* Lam., *Sanguisorba minor* Scop., and *Tussilago farfara* L.

Second stage. Well-developed herb community on moister substratum, herb layer coverage up to 60%, about 43 species/20 m^2, co-dominant species: *Carex flacca* and *Centaurea jacea*, species with significant coverage: *Brachypodium pinnatum*, *Carex caryophyllea* Latourr., *Hieracium bifidum*, *Leontodon hispidus*, *Leucanthemum vulgare*, *Picea abies* (L.) H. Karst., and *Trifolium pratense* L.

Third stage. Plot dominated by *Calamagrostis epigejos* (L.) Roth, herb layer coverage up to 75%, about 29 species/20 m^2, co-dominant species: *Calamagrostis epigejos* and *Carex flacca*, species with significant coverage: *Fragaria vesca* L., *Leontodon hispidus*, and *Leucanthemum vulgare*.

Due to high randomness of species composition, plant community is difficult to classify. It is the most similar to xerothermic grasslands, however, the share of meadow species (Cl. *Molinio-Arrhenatheretea* Tx. 1937) and thermophilous fringe taxa (Cl. *Trifolio-Geranietea* T. Müller 1962) is significant. *Ophrys apifera* was scattered over the entire surface, slightly more often in the plot with *Calamagrostis epigeios*.

4. Discussion

The global warming enables thermophilous species to extend their ranges to areas previously inaccessible to them. Presumably, *Ophrys apifera* is one of such species . Up to the end of 20th century, this species was limited do sub-Atlantic and sub-Medieterranean area of Europe. Over the past 20 years, its range has shifted to the north-east, new localities were recorded in southern Scotland (BSBI & BRC 2008), two in Denmark (in 2004 and 2009; Mattiasson 2015), some in central and north-eastern Germany (floraweb.de; Zimmermann 2011), one in south Sweden (in 2014; Nilsson 2014) and two in south Poland (in 2010; Osiadacz & Kręciała 2014; our finding). In all locations, this species is able to survive and increase the size of populations.

The stability of orchid population depends on its viability and presence of juvenile plants, i.e., effective pollination and sowing. For species with a specific pollination biology, like *Ophrys* taxa, a problem of pollinators may arise in new sites isolated from continuous range. Latin, English or Polish names of *O. apifera* suggest that the pollinators are bees, but results of research have documented that despite various male insects of the genera *Eucera* and *Tetralonia* (Apidae) were attracted to the orchid flowers and attempted copulation (Kullenberg 1961), the role of insects as pollinators is not essential to the survival of this species. According to Claessens & Kleynen (2002), *O. apifera* is almost obligate autogamic. According to Kullenberg & Bergstrom (2008) pollination can be carried out either by males of *Eucera* or autogamically. Moreover, *O. apifera* enters anthropogenic habitats and becomes a synanthrope. In Great Britain, its habitats include grasslands, scrub, railway banks, roadsides, lawns, sand dunes and limestone pavement; also, disturbed sites such as quarries, gravel-pits and industrial waste ground (BSBI & BRC 2008). Both localities in Denmark are situated in abandoned quarries (Mattiasson 2015). The only limiting factor seem to be climate. If climatic conditions are favorable, population once stabilized will survive.

In the studied population, pollination was successful and many flowers developed into capsules. We were not able to assess the full size and structure of this population due to lack of juvenile rosettes at the time of research. However, lack of leaves on the flowering plants indicated that it might be rather an effect of snail feeding that disturbed population structure.

Regardless the condition of *O. apifera* populations, there is still a question about the origin of new sites. It could be human intentional or accidental introduction or spontaneous establishment due to wind dispersal of seeds. A new Swedish population, initially assessed as natural, turned out to be anthropogenic. Seeds of *O. apifera* were unintentionally introduced with grass-seed mixture (Mattiasson 2015). The closest to Poland, *O. apifera* locality near Seelow (Brandenburg, Germany) is also of anthropogenic origin, plants were planted there without permission and in violation of the low (Lüdicke 2007; Zimmermann 2011).

The origin of both Polish localities raises doubts about their natural character. According to our best knowledge, these localities are among the most north-eastern locations of *O. apifera*, without any intermediate locations between them and known natural populations and any occurrences in natural or seminatural habitats adjacent to resisting populations. Both occur in strongly disturbed anthropogenic habitats, and both are isolated and remote from natural sites.

In the Sudetes, the heap colonized by *O. apifera* is about 22 years old, moreover, climate conditions, especially winter temperatures, prevent the development of species with such high thermal requirements up to the beginning of the 21st century. The observed site could be an effect of this species expansion caused by global warming. Minute and light seeds of orchids can be transported by wind hundreds and more kilometers (Molnár *et al.* 2011). Migration from the Czech Republic to the Sudetes via Moravian Gate or other passage is very unlikely due to direction of prevailing winds and the barrier of Sudetes. The closest to western Poland, there is *O. apifera* locality near Seelow (Zimmermann 2011), less than 20 km from the Polish border, but about 200 km from the Sudeten locality. Potential natural source of seeds, i.e., natural populations in Germany, is approx. 250 km away. Prevailing air circulation theoretically makes this way of dispersion possible. However, seeds of *O. apifera* are not very viable, germination capacity under laboratory conditions is 20% (Ponert *et al.* 2011), moreover, plants need about 10 years to mature and produce seeds (Summerhayes 1951). The number of flowering plants suggests that population is rather older than *ca.*15 years or started from more than 1 plant. In natural conditions without human interference, both possibilities are unlikely but not impossible. On the other hand, *O. apifera* is one of the most popular *Ophrys* species in cultivation. Seeds, seedlings and flowering plants are offered in internet and are not very expensive (see Amazon, eBay and others). Specifically understood mission of Polish flora enrichment and introductions of foreign plant species by their enthusiasts are not rare phenomenon and concern many species of ornamental or rare plants, and were many times observed in Lower Silesia e.g., *Salvinia modesta* D. S. Mitch., *Pistia stratiotes* L., *Azolla filiculoides* Lam., *Sedum album* L., *Miscanthus sinensis* Andersson (Szczęśniak unpublished).

Połom Hill., before it was destroyed by limestone quarries, was famous of very rich calcareous flora and one of the richest orchid locations in the Polish Sudetes (e.g., Fiek 1881; Schube 1903; Limpricht 1944). The habitat, even so damaged, is still favorable for orchids. Despite the devastation of the hill, we observed there one of the largest Sudeten populations of *Cypripedium calceolus* L., abundant populations of *Cephalanthera damasonium* (Mill.) Druce, *C. longifolia* (L.) Fritsch, *Gymnadenia conopsea* (L.) R.Br., *Listera ovata* (L.) Br., *Epipactis helleborine* (L.) Crantz and *E. atrorubens* (Hoffm.) Besser; *Corallorhiza trifida* Châtel is also still present. In the past, *Orchis ustulata* L. and *O. militaris* L. were regularly noted in this locality (Fiek 1881; Schube 1903; Limpricht 1944). For the latter species, Połom Hill was its last locality confirmed in the Polish Sudetes in the 20th century (Wilczyńska 1979) and for 50 years, the species was considered extinct, until one plant was found in the Śnieżnik Massif, Eastern Sude-

tes (Świerkosz & Reczyńska 2010). Połom Hill is well known and well explored place, however, representatives of the *Ophrys* genus were never reported from this area (Kwiatkowski 2006). Furthermore, none of the *Ophrys* species has ever been reported from the Sudetes (Fiek 1881; Schube 1903; floraweb.de; Kaplan 2019). Perhaps the origin doubts will be clarified by a genetic study of *O. apifera* populations planned for the next year. However, until then, the status of the species in the Polish flora remains unresolved. It may be an introduced and already naturalized alien species (neophyte) or a red-list taxon (sozophyte; Nowak 2006) that has established itself only in anthropogenic habitats.

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Drafting the article: E. Szczęśniak
Critical revision: E. Szczęśniak
Final approval: E. Szczęśniak

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