ORHIDS IN SAND DUNES IN KAMCHIYA PROTECTED AREAS BY NATURE 2000 ECOLOGICAL NETWORK (BULGARIA)

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Abstract

In the Kamchiya protected area (BG0000116) of the Natura 2000 ecological network in Bulgaria, five types of dune natural habitats were studied in terms of the distribution of species from the Orchidaceae family. Four species from the Orchidaceae family have been identified: Anacamptis papilionacea (L.) R.M.Bateman, Pridgeon & M.W.Chase (= Orchis papilionacea L.), Anacamptis pyramidalis (L.) Rich., Himantoglossum jankae Somlyay, Kreutz. & Ovari, and Ophrys scolopax subsp. cornuta (Steven) E.G.Camus (= Ophrys cornuta Steven). For each of these species, a characteristic of the habitat, the population, as well as the accompanying plant species has been prepared, which includes various indicators: projective cover, life form, biological type, and floristic element. A correction is proposed in the distribution in Bulgaria of one of the accompanying species: Campanula sparsa Friv. Botanical literature in Bulgaria states that this species is established above 300 m a.s.l. In our research, we found it at sea level.

Key words: *Bulgaria, Orchidaceae, dune natural habitats, sand substrate*

INTRODUCTION

Five types of dune natural habitats are described along the Bulgarian Black Sea coast according to the classification of the Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (Annex I). They are interconnected and represent successive stages in the development of vegetation on the coastal sandy substrate. For this reason, the boundaries between them are not always clearly defined and in some cases, they can form complexes with each other. Of course, there are differences in their characteristics that allow them to be identified. What these five types of dune habitats have in common is the presence of a sandy substrate along the seashore. The sandy substrate is characterized by good drainage properties, but with a low content of plant nutrients. It is not a particularly favorable environment for the development of soil fungi, many of which form mycorrhizal relationships with neighboring plants. The sandy substrate it is a poorly studied environment for the development of mycorrhizal fungi, which play a key role in the existence of species from the Orchidaceae family. It has long been known that these plants need mycorrhizal fungi for seed germination and young plant development. The reason is the lack of reserve nutrients in the seeds of this group of plants (Dearnaley et al., 2016). But that's not all: some researchers believe that mycorrhizal fungi also play an important role in adult orchids and thereby influence their

spatial distribution: see research review from McCormick and Jacquemyn (2014).

Despite the unfavorable conditions of the sand dunes along the sea coast, they are colonized by various types of plants, including orchids. These plants don't just exist, they reproduce and propagate successfully. Jacquemyn et al. (2020) found that coastal dune populations of *Epipactis helleborine* (L.) Crantz produced viable seeds that were able to germinate and establish, maintaining metapopulation dynamics and allowing further expansion.

The presence of different species of the Orchidaceae family in dune habitats has been established in different parts of the European continent. In the Ireland natural habitat 2130* Fixed coastal dunes with herbaceous vegetation (grey dunes) by Nature 2000 ecological network is an important habitat for orchids such as *Anacamptis pyramidalis* (L.) Rich. and *Ophrys apifera* Huds.*,* and habitat 2190 Humid dune slacks includes orchids such as *Epipactis palustris* (L.) Crantz, *Dactylorhiza* spp., and *Neottia ovata* (L.) Bluff & Fingerh. (Delaney et al., 2013). Habitat 2190 Humid dune slacks includes the following typical dune slack species in different countries in Europe: *Liparis loeselii* (L.) Rich., *Dactylorhiza incarnata* (L.) Soó, *Epipactis palustris* (L.) Crantz, and *Spiranthes aestivalis* (Poir.) Rich. *Liparis loeselii* is confined to short swards of rich fens and damp calcareous dune slacks. Studies in South Wales showed that the orchid occurred most frequently in communities less than 40 years old and that seedling survival was best in young, partially vegetated slacks with some bare soil (Houston, 2008).

In the Sand Dune Vegetation Survey of Great Britain are listed following species from Orchidaceae family: *Aceras anthropophorum* (L.) R.Br. (accepted name is *Orchis anthropophora* (L.) All.)*,* *Corallorhiza trifida* Châtel., *Epipactis leptochila* var. *dunensis* (Godr.) Godf. (accepted name is *Epipactis dunensis* Godfery), *Epipactis phyllanthes* G.E.Sm., *Goodyera repens* (L.) R.Br., *Himantoglossum hircinum* (L.) Spreng., *Liparis loeselii* (L.) Rich., and *Orchis ustulata* L. (accepted name is *Neotinea ustulata* (L.) R.M.Bateman, Pridgeon & M.W.Chase) (Radley, 1994; Dargie, 1993; Dargie, 1995). In the coastal dune slacks along the Belgian coast are distributed some orchid species included two *Epipactis* species (*E. neerlandica* (Verm.) Devillers-Tersch. & Devillers (accepted name is *Epipactis helleborine* subsp. *neerlandica* (Verm.) Buttler) and *E. palustris* (L.) Crantz), three *Dactylorhiza* species (*D. fuchsii* (Druce) Soó, *D. incarnata* (L.) Soó, and *D. praetermissa* (Druce) Soó), *Herminium monorchis* (L.) R.Br., and *Liparis loeselii* (L.) Rich. (Jacquemyn et al., 2017). Coastal dune populations of *Epipactis helleborine* (L.) Crantz can be found in conifer plantations and open dune vegetation in France (Normandy), in wet dune slacks along the Belgian and Dutch coast, and in coastal habitats in Denmark and South Wales (Jacquemin et al., 2020). In the Netherlands *Anacamptis pyramidalis* (L.) Rich. is a rare species, which occurs in the calcareous grasslands and in the calcareous coastal dunes (Londo et al., 2016). In the Mallorca, Spain *Anacamptis fragrans* (Pollini) R.M.Bateman (accepted name is *Anacamptis coriophora* (L.) R.M.Bateman, Pridgeon & M.W.Chase), is established in dunes and in the ecotone of the marshes and dunes (Bateman and Hollingsworth, 2004).

In the Red Data Book of the Republic of Bulgaria. Volume 1. Plants and mushrooms (Peev (ed.), 2015) only one species from the Orchidaceae family *Epipactis palustris* (L.) Crantz that inhabits the dune slacks is included. In the checked botanical literature,

we did not find any other information on the distribution of species of the Orchidaceae family in Bulgaria on sand as a substrate or on dune types of natural habitats.

MATERIAL AND METHODS

The aim of the present study was to determine the presence of species of the Orchidaceae family in coastal dune habitats in the Kamchiya protected area (BG0000116) of the Natura 2000 ecological network in Bulgaria. (Information system for protected areas from ecological network Natura 2000. Ministry of Environment and Water.)

Period of the study: The present study was conducted by the route method in the period May 2022 – July 2023.

Studied Area. The Kamchiya protected area (BG0000116) is located in Eastern Bulgaria and borders the Black Sea (Figure 1). It has been declared for the protection of natural habitats and wild flora and fauna under Directive 92/43/EEC with Order No. RD-309 of 31 March 2021 of the Minister of Environment and Water. 14 types of natural habitats, one plant species (*Himantoglossum caprinum* (Biebl) C.Koch., accepted name is *Himantoglossum jankae* Somlyay, Kreutz. & Ovari) and a large number of animal species are the subject of conservation. Out of a total of 5 natural habitats of the dune group (2110, 2120, 2130*, 2180, and 2190), species of the Orchidaceae family were found in only one: 2130* Fixed coastal dunes with herbaceous vegetation (grey dunes).

Dune identification. The following sources were used to identify the dune habitats: Guide for the identification of habitats of European importance in Bulgaria (Kavrakova et al. (ed.), 2009) and Red Data Book of the Republic of Bulgaria. Volume 3. Natural Habitats (Biserkov (main ed.), 2015).

Species identification. In determining all plant species, including associated species, was used Plant Determinant in Bulgaria (Delipavlov et al., 2011) and Key to the Native and Foreign Vascular Plants in Bulgaria (Stoyanov et al., 2022).

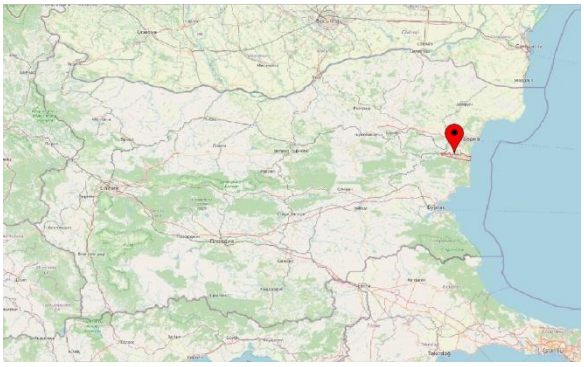

Figure 1. Map of the Kamchiya protected area: Geographical location of Kamchiya protected area in Bulgaria (OpenStreetMap)

Names of the species are according to The World Flora Online (WFO, 2023). For *Himantoglossum jankae* Somlyay, Kreutz. & Ovari the Latin name is adopted according to the data from the Report of the Republic of Bulgaria under Art. 17 of the Habitats Directive in 2019 (for the period 2013-2018), available in the European Environment Information and Observation Network (6927 *Himantoglossum jankae*. Species Report), which corresponds to the data in the Eur+Med Database and the most recent data in the Bulgarian botanical literature (Stoyanov et al., 2022).

Floristic characteristic. Projective cover of associated species is according to Braun-Blanquet (Westhoff and Maarel, 1973). The following rating scale was used: 5 – from 75 to 100%, 4 – from 50 to 75%, 3 – from 25 to 50%, 2b – from 12.5 to 25%, 2a – from 5 to 12.5%, 2m – projective cover less than 5% and number over 50 individuals, 1 – projective cover less than 5% and number among 6 and 50 individuals, + – projective cover less than 5% and number among 2 and 5 individuals, r – projective cover less than 5% and only one individual. Life forms are represented in the system of Raunkiaer

(1934). The following notations are used: Ph – phanerophytes, H – hemicryptophytes, Ch – hamephytes, Th – therophytes. Biological types are defined by Stoyanov et al. (2022). The following notations are used: a – annual plant, b – biannual plant, p – perennial plant, sh – shrub, t – tree.

Floristic elements are according to Conspectus of the Bulgarian vascular flora. Distribution maps and floristic elements (Asyov et al., 2012). The following notations are used: Adv – Adventive, As – Asiatic, Bal – Balkan, Boreal – Boreal, Carp – Carpathian, Eur – European, Kos – Cosmopolitan, Med – Mediterranean, Pont – Pontic, Sib – Sibirian, Prefixes: E – East, W – West, N – North, S – South, C – Central.

Distribution map. The marking of the boundaries of the populations of the species was done with the help of a GPS receiver Garmin Oregon 450. The WGS 84 UTM 35N coordinate system was used. The distribution map of species from Orchidaceae family was created using QGIS 3.32.0 Lima software and GoogleSatelite image.

RESULTS AND DISCUSSION

On the sand dunes of the Kamchiya protected area (BG0000116), populations of 4 species of the Orchidaceae family have been established (Figure 2): *Anacamptis papilionacea* (L.) R.M.Bateman, Pridgeon & M.W.Chase (= *Orchis papilionacea* L.), *Anacamptis pyramidalis* (L.) Rich., *Himantoglossum jankae* Somlyay, Kreutz. & Ovari, and *Ophrys scolopax* subsp. *cornuta* (Steven) E.G.Camus (= *Ophrys cornuta* Steven). All species are established within the boundaries of natural habitat 2130* Fixed coastal dunes with herbaceous vegetation (grey dunes) by Nature 2000 ecological network.

1.*Anacamptis papilionacea* (L.) R.M.Bateman, Pridgeon & M.W.Chase (Figure 3).

Figure 2. The location of the populations of 4 species of the Orchidaceae: **A.** *Anacamptis papilionacea* (north subpopulation); **B.** *Anacamptis papilionacea* (south subpopulation); **C.** *Anacamptis pyramidalis*; **D.** *Himantoglossum jankae*; **E.** *Ophrys scolopax* subsp. *cornuta* (Original map).

Morphology. Perennial herbaceous plant, 15-40 (-55) cm tall; 3-9 basal leaves, spreading to near erect, linear-lanceolate, pointed, unmarked, 3-18 cm x 0.5-2 cm; 2-5 cauline leaves, smaller, clasping, upper 1-2 leaves bract-like, sometimes washed red; bracts membranous, washed red, almost equaling ovary or longer than it; inflorescence initially dense then lax, ovoid to (near-) cylindrical; 4-15 (-22) flowers; sepals and petals forming a loose hood, clearly veined, near obtuse, pink, crimson-red or purple; lateral sepals linear-lanceolate, asymmetrical, 8-22 mm x 4-7.5 mm, directed forwards to spreading; dorsal sepal near erect; petals narrower; lip pendent, entire, orbicular, 9-26 mm x 7-27 mm, concave to flat, concolorous with hood but brighter and shinier, unmarked or veined with lines, streaks and dark dots, base pale, contracted into 2 ridges separated by a groove, then abruptly widening to a wedge- or heart-shape, margins scalloped, sometimes undulate; spur 8-14 mm long, conical, appearing

spindly, initially horizontal then curved or bent downwards; 2n=32 (Delforge, 2006).

Ecology. Environmental conditions in habitats are full sun to mid-shade on dry to moist substrates, above all alkaline, often calcareous. In Europe it is found in the following habitats: short, poor grassland, garrigue, maquis, open woodland (Delforge, 2006). In Bulgaria the species occurs in glades and meadows. It is distributed in almost the whole country from sea level to 1000 m a.s.l. (Stoyanov et al., 2022).

Characteristics of the population. In the course of the research, we found a population of several hundred individuals, divided into two subpopulations (Figure 2) – northern and southern. GPS points that describe the boundaries of the northern subpopulation have the following coordinates: 43.010404°N, 27.887310°E; 43.009926°N, 27.887824°E; 43.009465°N, 27.887892°E; 43.009472°N, 27.887272°E; 43.009794°N, 27.887313°E; 43.010257°N, 27.886858°E. The area occupied by the northern subpopulation is 4756 sq. m.

GPS points that describe the boundaries of the southern subpopulation have the following coordinates: 43.007787°N, 27.887534°E; 43.007861°N, 27.886331°E; 43.007999°N, 27.885875°E; 43.008307°N, 27.885645°E; 43.008379°N, 27.885896°E; 43.008201°N, 27.886137°E; 43.008253°N, 27.886368°E; 43.008202°N, 27.886638°E; 43.008069°N, 27.886513°E; 43.007886°N, 27.886778°E. The area of the southern subpopulation is 2897 sq. m. The distance between the boundaries of the two subpopulations is 150 m in a straight line.

Characteristics of the habitat. There is no slope. The total vegetation cover is 80% and total lichen coverage is 20%.32 associated species were identified (Table 1). They are divided into three floors: shrub, grass and ground with lichens. In the shrub floor Crataegus monogyna Jack. dominates and a total of 5 species are involved. The grass floor is dominated by *Teucrium chamaedrys* L. and Sanguisorba minor Scop. and a total of 26 species participate. In the lichen floor with the highest projective cover is *Cladonia subrangiformis* Sandst. The biological spectrum includes following life forms: 16,1% phanerophytes, 45,1% hemicryptophytes, 29,0% therophytes, and 9,8% others.

Figure 3. *Anacamptis papilionacea*: A. Habitat; (Photo: D. Zahariev, May 24, 2022)

Among the floristic elements, species of European origin (Eur, Eur-Med, Eur-As, Eur-Sib, etc.) predominate (48.4%). In second place (19.4%) is the group of species with Mediterranean origin (subMed and Med-CAs).

2.*Anacamptis pyramidalis* (L.) Rich. (Figure 4).

Morphology. Perennial herbaceous plant, 20-60 (-80) cm tall; 4-10 leaves, lower erect, linear-lanceolate, pointed, 8- 25 cm x 0.7-2 cm, upper leaves almost bract-like, bracts often purplish, longer than ovary; inflorescence dense, initially conical then oblong, 3-12 cm tall; flowers rather small, pink to pale or dark lilac, rarely white or red; sepals and petals oval-lanceolate, pointed, slightly keeled; lateral sepals spreading, 4-8 mm long, dorsal sepal near erect, connivent with petals in a loose hood, 3.5 6 mm long; lip wedge-shaped, 3-lobed, 6-9 mm long, with 2 prominent, near parallel ridges a I base; lobes near equal, oblong to ovoid, median lobe slightly longer and often

narrower than laterals; spur filiform, spindly, curved downwards, 10-16 mm long; 2n=36, 54, 72 (Delforge, 2006).

Table 1. Associated species in the population of *Anacamptis papilionacea*

Plant species	Projective cover	Life form	Biological type	Floristic element
Crataegus monogyna Jack.	3	Ph	sh-t	sub Boreal
Teucrium chamaedrys L.	3	Ph	sh	Sub Med
Cladonia subrangiformis Sandst.	2b	-	-	-
Sanguisorba minor Scop.	2b	H	p	Sub Boreal
Pyrus pyraster (L.) Burgsd.	2a	Ph	t	Sub Med
Pyrus pyraster (L.) Burgsd.	2a	Ph	t	Sub Med
Carex colchica J.Gay	2m	H	p	Eur
Cerastium dubium (Bastard) Guépin	2m	Th	a	Eur
Crepis sancta (L.) Babc.	2m	Th	a	Sub Med
Cruciata pedemontana (Bellardi) Ehrend.	2m	Th	a	Med-CAs
Fragaria viridis Weston	2m	H	p	Eur-Sib
Medicago minima (L.) L.	2m	Th	a	Eur-WAs
Poa angustifolia L.	2m	H	p	Kos
Rumex acetosella L.	2m	H	p	Eur-sub Med
Bromus tectorum L.	1	Th	a	Boreal
Campanula sparsa Friv.	1	Th	a	Bal-Carp
Cota tinctoria (L.) J.Gay	1	H	p	Eur-Sib
Erigeron annuus (L.) Pers.	1	Th-H	a-p	Adv
Erysimum diffusum Ehrh.	1	Th-H	a-b	CS Eur
Moenchia mantica Bartl.Cat.Sem.Hort. Gotting. ex W.D.J.Koch	1	Th	a	Eur-Med
Periploca graeca L.	1	Ch	p	Pont-Med
Pilosella cymosa (L.) F.W.Schultz&Sch.Bip.	1	H	p	Eur-Sib
Plantago lanceolata L.	1	H	p	Kos
Poa bulbosa L.	1	H	p	Eur-As
Potentilla argentea L.	1	H	p	SPont
Trifolium campestre Schreb.	1	Th	a	Eur-Med
Veronica austriaca L.	1	H	p	Eur-Med
Xeranthemum annuum L.	1	Th	a	Sub Med
Chondrilla juncea L.	+	H	b	Eur-Sib
Chondrilla juncea L.	+	H	b	Eur-Sib
Hypericum perforatum L.	+	H	p	Kos
Paliurus spina-christi Mill.	+	Ph	sh	Eur-As
Tragopogon dubius Scop.	+	H	b	Eur-Med
Ligustrum vulgare L.	r	Ph	sh	Sub Med

Figure 4. *Anacamptis pyramidalis*: A. Habitat; B. Inflorescence (Photo: D. Zahariev, June 20, 2023)

Ecology. Environmental conditions in habitats are full sun on calcareous substrates, usually dry. In Europe it is found in the following habitats: short grassland and garrigue (Delforge, 2006). In Bulgaria the species occurs in glades and scrub on calcareous substrates. It is distributed in the whole country from sea level to 1000 m a.s.l. (Stoyanov et al., 2022).

Characteristics of the population. We found one population of the species, which occupies an area of 423 sq. m between GPS points with coordinates: 43.009674°N,

27.886050°E; 43.009305°N, 27.885823°E; 43.009610°N, 27.885782°E (Figure 2C). The population size is 49 individuals in a generative state.

Characteristics of the habitat. There is no slope. The total vegetation cover is 60% and total lichen coverage is 50%. The sum of the covers exceeds 100% because higher plants and lichens are located in separate floors and overlap each other. 21 associated species were identified (Table 2). They are divided into three floors: shrub, grass and ground with lichens. In the shrub floor *Paliurus spina-christi* Mill. dominates. The grass floor is dominated by *Melica ciliata* L. and *Jurinea kilaea* Azn. and a total of 18 species participate. In the lichen floor with the highest projective cover is *Cladonia subrangiformis* Sandst. The biological spectrum includes following life forms: 10,0% phanerophytes, 60,0% hemicryptophytes, 15,0% therophytes, and 15,0% others. Among the floristic elements, species of European origin (Eur-Med, Eur-subMed, Eur-As, and Eur-Sib) predominate (50,0%). In second place (25.0%) is the group of species with Pontic origin (Pont-Med, Pont-Bal, Pont-Sib, and SPont).

3.*Himantoglossum jankae* Somlyay, Kreutz. & Ovari (Figure 5).

Morphology. Perennial herbaceous plant, 25-80 (-100) cm tall; basal leaves 7-17 cm x 2-3.5 cm; inflorescence (near) lax; (10-) 15-40 (-50) flowers, scent fetid; sepals oval-lanceolate, 6-9 mm broad, dorsal sepal 10-15 mm long, lateral sepals very asymmetrical, 13-19 mm. long; petals linear to narrowly rhomboidal, 9-15 mm x 2-4 mm; lip with centre hairy, white blotched with purple, margins more richly colored, reddish-brown or dark purple, very rarely green; median lobe 45-90 mm long, with notch at tip 10-50 mm deep; lateral lobes linear, pointed, (5-) 10-30 mm long; spur thick, obtuse, 5-6.5 (-13) mm long (Delforge, 2006). **Ecology.** Environmental conditions in habitats are full sun to mid-shade on dry, calcareous substrates. In Europe it is found in the following habitats: short, poor grassland, banks, woodland edges, open woodland, often oak groves (Delforge, 2006).

Table 2. Associated species in the population of *Anacamptis pyramidalis*

Plant species	Projective cover	Life form	Biological type	Floristic element
Cladonia subrangiformis Sandst.	3	-	-	-
Melica ciliata L.	2b	H	p	Eur-sub Med
Jurinea kilaea Azn.	2a	H	p	Pont-Bal
Odontarrhena obtusifolia C.A.Mey.				Pont-Med
Alyssum strigosum [Soland.]	1	Th	a	Sub Med
Campanula sparsa Friv.	1	Th	a	Bal-Carp
Chondrilla juncea L.	1	H	b	Eur-Sib
Cota tinctoria (L.) J.Gay	1	H	p	Eur-Sib
Daucus carota L.	1	H	b	Eur-As
Iris pumila L.	1	H	p	Sub Med
Jasione heldreichii Boiss. & Orph.	1	Th-H	a-b	Eur-Med
Moehringia trinervia [Clairv.]	1	Th-H	a-p	Eur-As
Rumex acetosella L.	1	H	p	Eur-sub Med
Xeranthemum annuum L.	1	Th	a	Sub Med
Artemisia campestris L.	+	H	p	Eur-Sib
Centaurea arenaria M.Bieb. ex Willd.	+	Th-H	a-b	Eur-Med
Hypericum perforatum L.	+	H	p	Kos
Linaria genistifolia (L.) Mill.	+	H	p	Pont-Sib
Potentilla argentea L.	+	H	p	SPont
Teucrium capitatum L.	+	Ph	sh	Pont-Med
Paliurus spina-christi Mill.	r	Ph	sh	Eur-As

In Bulgaria the species occurs in scrub. It is distributed in the whole country from sea level to 1100 m a.s.l. (Stoyanov et al., 2022).

Characteristics of the population. We found a small population of the species, which occupies an area of 3 sq. m in GPS point with coordinates: 43.009713°N, 27.886007°E (Figure 2D). The population size is 3 individuals in the generative state.

Figure 5. *Himantoglossum jankae*
(Photo: D. Zahariev, June 20, 2023)

Characteristics of the habitat. There is no slope. The total vegetation cover is 50% and total lichen coverage is 60%. The sum of the covers exceeds 100% because higher plants and lichens are located in separate floors and overlap each other. 11 associated species were identified (Table 3). They are divided into three floors: shrub, grass and ground with lichens. In the shrub floor *Crataegus monogyna* Jack. and *Paliurus spina-christi* Mill. Dominates. The grass floor is dominated by *Alyssum obtusifolium* Steven ex DC., *Artemisia campestris* L., and *Cleistogenes serotina* (L.) Keng. and a total of 8 species participate. In the lichen floor with the highest projective cover is *Cladonia subrangiformis* Sandst. The biological spectrum includes following life forms: 20,0% phanerophytes, 70,0% hemicryptophytes, and 10,0% therophytes. Among the floristic elements, species of European origin (Eur-subMed, Eur-As, and Eur-Sib) predominate (50.0%). In second place (20.0%) is the group of species with Mediterranean origin (subMed and Med).

Table 3. Associated species in the population of *Himantoglossum jankae*

Plant or lichen species	Projective cover	Life form	Biological type	Floristic element
Cladonia subrangiformis Sandst.	4	-	-	-
Odontarrhena obtusifolia C.A.Mey. (=Alyssum borzaeanum Nyár.)	2a	H	p	Pont-Med
Artemisia campestris L.	2a	H	p	Eur-Sib
Crataegus monogyna Jack.	2a	Ph	sh-t	SubB oreal
Cleistogenes serotina (L.) Keng	2a	H	p	Eur-Sub Med
Iris pumila L.	2m	H	p	Sub Med
Cota tinctoria (L.) J.Gay	1	H	p	Eur-Sib
Daucus carota L.	1	H	b	Eur-As
Hypericum perforatum L.	1	H	p	Kos
Crucianella angustifolia L.	+	Th	a	Med
Paliurus spina-christi Mill.	+	Ph	sh	Eur-As

4.*Ophrys scolopax* subsp. *cornuta* (Steven) E.G.Camus (Figure 6)

Morphology. Perennial herbaceous plant, up to 50 cm tall; inflorescence lax to near dense; (2-) 4-9 (-14) medium-sized flowers; sepals whitish, pink, lilac or pale purple, oval-lanceolate, 9-15 mm x 5-7 mm long, spreading to turned backwards; petals concolorous, villous, ± triangular-rounded, ± obscurely auriculate, rather elongated, (3-) 4-6 mm x 2-3 mm, separated at base; lip near horizontal to pendent, (10-) 11-14 (-15) mm long, dark brown to blackish-brown, deeply 3-lobed at base; lateral lobes acuminate, parallel to weakly outspread, often angled slightly downwards, (4-) 6-8 (-9) mm long, with dense, straight, pale buff marginal hairs, outside as well as on inner face, except at base; median lobe sepioid,

globular in centre, sides strongly turned under, with a complete submarginal band of pale hairs, narrower on lateral-distal quarters, bordered by a rather broad, hairless, greenish, margin; speculum basal, bluish-grey, edged yellowish, often only slightly extended and slightly complex; appendage transverse, sometimes near stalked, ± obscurely 3-toothed, directed forwards, greenish to brownish-green; stigmatic cavity and basal field concolorous, rusty-brown to blackish, lighter than, or same colors, centre of lip; stigmatic cavity transverse, slightly constricted at base, c. 60% of optical width of median lobe, with a distinct ledge bordered by 2 rounded, blackish pseudo-eyes (Delforge, 2006).

Table 4. Associated species in the population of *Ophrys scolopax* subsp. *cornuta*

Plant species	**Projective cover**	**Life form**	**Biological type**	**Floristic element**
Cladonia subrangiformis Sandst.	4	-	-	-
Crataegus monogyna Jacq.	2b	Ph	sh-t	SubB oreal
Inula salicina L.	2b	H	p	Eur-As
Pyrus pyraster (L.) Burgsd.	2a	Ph	t	Sub Med
Cota tinctoria (L.) J.Gay.	2m	H	p	Eur-Sib
Cruciata pedemontana (Bellardi) Ehrend.	2m	Th	a	Med-CAs
Fragaria viridis Weston	2m	H	p	Eur-Sib
Moenchia mantica Bartl.Cat.Sem.Hort.Gotting. ex W.D.J.Koch	2m	Th	a	Eur-Med
Rumex acetosella L.	2m	H	p	Eur-Sub Med
Sanguisorba minor Scop.	2m	H	p	SubB oreal
Trifolium campestre Schreb.	2m	Th	a	Eur-Med
Achillea millefolium L.	1	H	p	Eur-Sib
Ammophila arenaria (L.) Link	1	H	p	Eur-Med
Anacamptis papilionacea (L.) R.M.Bateman, Pridgeon & M.W.Chase	1	Cr	p	Sub Med
Campanula sparsa Friv.	1	Th	a	Bal-Carp
Chrysopogon gryllus Trin.	1	H	p	Pont-Med
Potentilla argentea L.	1	H	p	S Pont
Potentilla pedata Willd. ex Hornem.	1	H	p	Med
Prunus spinosa L.	1	Ph	sh	S Pont
Silene dichotoma subsp. euxina (Rupr.) Coode & Cullan	1	Th-H	a-p	Pont
Periploca graeca L.	+	Ch	p	Pont-Med
Rubus grabowskii Weihe	+	Ph	sh	Eur
Ligustrum vulgare L.	r	Ph	sh	Sub Med
Quercus cerris L.	r	Ph	t	Eur-Sub Med

Ecology. Environmental conditions in habitats are full sun to shade on dry to moist, alkaline substrates. In Europe it is found in the following habitats: garrigue, short grassland, scrub, open woodland (Delforge, 2006). In Bulgaria the species occurs in glades and scrub. It is distributed in the whole country from sea level to 1400 m a.s.l. (Stoyanov et al., 2022).

Characteristics of the population. We found one population of the species, which occupies an area of 101 sq. m between GPS points with coordinates: 43.010262°N, 27.887193°E; 43.010159°N, 27.887259°E; 43.010160°N, 27.887138°E; 43.010239°N, 27.887079°E (Figure 2E). The population size is 26 individuals in a generative state.

A correction is proposed in the distribution in Bulgaria of one of the accompanying

plant species: *Campanula sparsa* Friv. Botanical literature in Bulgaria states that this species is established above 300 m a.s.l. In our research, we found it at sea level.

Figure 10. *Ophrys scolopax* subsp. *cornuta*: Habitat; (Photo: D. Zahariev, May 24, 2022)

CONCLUSIONS

We expect that future studies will prove the distribution of species from the Orchidaceae family on sandy substrate in other parts of the Black Sea coast of Bulgaria. Collecting horological data is only the first step. An important direction in future research is to understand the mechanisms that allow these plants to successfully inhabit such an inhospitable substrate as coastal sands.

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