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Data Article

Data on the present and future distribution of suitable niches of the black vanilla orchid (*Nigritella nigra* s.l., Orchidaceae) and its pollinators

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A B S T R A C T

The black vanilla orchid (*Nigritella nigra* s.l.) is a perennial plant found in the main European mountain ranges. It occurs in large numbers in the Alps, but it has become a rare and endangered species in Scandinavia due to the loss of suitable habitats. Here we present occurrence data on the occurrence of *N. nigra* s.l. and pollinators of this species which were used to evaluate the impact of climate change on the future distribution of the black vanilla orchid and its pollen vectors. Moreover, the values of bioclimatic variables for each locality are provided. The binary distribution models of both, orchids and insects, created using ecological niche modeling (ENM) technique are presented together with the information about changes in the coverage of suitable niches of studied organisms. Our data were used to evaluate the impact of climate change on orchid and its pollinator (https://doi.org/10.1016/j.gecco.2021.e01560) and datasets can be reused in other research on past and future distribution of suitable niches of

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the black vanilla orchid and its pollinators as well as in other biogeographical studies. Moreover, presented outcomes of research can be useful in establishing conservation plans for montane orchids and their pollinators.

Specifications Table

Subject	Environmental Science - Ecological Modeling
Specific subject area	Impact of climate change on distribution of orchid and its pollinators
Type of data	Geographic coordinates Bioclimatic data Table Figure
How data were acquired	Georeferencing of herbarium specimens, surveys, queries to other databases and maximum entropy approach implemented in MaxEnt
Data format	Raw - occurrence data and values of bioclimatic variables, MaxEnt outcomes - binary models of potential distribution, Analysed – changes in the coverage of suitable niches
Parameters for data collection	Of all the available georeferenced occurrence data only records georeferenced with the precision of at least 2 km were used. The initial catalogue was further thinned to remove duplicate records and to reduce bias caused by sampling in more accessible areas. The final database included only records distanced one from another by at least 10 km.
Description of data collection	The database of localities of the studied orchid and its pollinators was compiled based on data available in Global Biodiversity Information Facility and these raw data were processed using an ecological niche modelling approach.
Data source location	GBIF location data: *Adscita statices*: https://doi.org/10.15468/dl.uhm50b *Boloria euphrosyne*: https://doi.org/10.15468/dl.p1yva9 *Crambus perlella*: https://doi.org/10.15468/dl.ro7kq5 *Crocota tinctaria*: https://doi.org/10.15468/dl.mmxzgl *Diasemia litterata*: https://doi.org/10.15468/dl.q3rh6z *Lasionycta imbecilla*: https://doi.org/10.15468/dl.lmnxl6 *Leucania comma*: https://doi.org/10.15468/dl.ypph0b *Nigritella nigra*: https://doi.org/10.15468/dl.xyfl4n *Thricops aculeipes*: https://doi.org/10.15468/dl.rebcru Bioclimaitc variables: “present-time” data: https://www.worldclim.org/data/worldclim21.html Future predictions: https://www.worldclim.org/data/cmip6/cmip6_clim2.5m.html
Data accessibility	With the article
Related research article	M. Kolanowska, A. Rewicz, S. Nowak, Significant habitat loss of the black vanilla orchid (*Nigritella nigra* s.l., Orchidaceae) and shifts in its pollinators availability as results of global warming, Glob. Ecol. Conserv. https://doi.org/10.1016/j.gecco.2021.e01560.

Value of the Data

- Models of potential ranges of studied species are first estimation of the impact of global warming on the climatic niches of *Nigritella nigra* s.l. and its pollen vectors.
- Presented data will be useful in establishing conservation plans for montane orchids and their pollinators.
- Provided data can be used in all other biogeographical studies on the black vanilla orchid and its pollinators.

1. Data Description

Raw occurrence data are geographic coordinates of *Nigritella nigra* and its pollinators provided in World Geodetic System 1984 (WGS 84) standard. Supplementary Table 1 contains occurrence data for the orchid together with values of bioclimatic layers for each locality, while Supplementary Table 2 contains pollinator-related information. Binary distribution models are raster data converted from the ESRI Grid to Tagged Image File format. Separated models are presented for northern and southern populations of the black vanilla orchid. The present and future (year 2070) potential geographical range of each species is shown in Figs. 1–10, specifically: *N.*

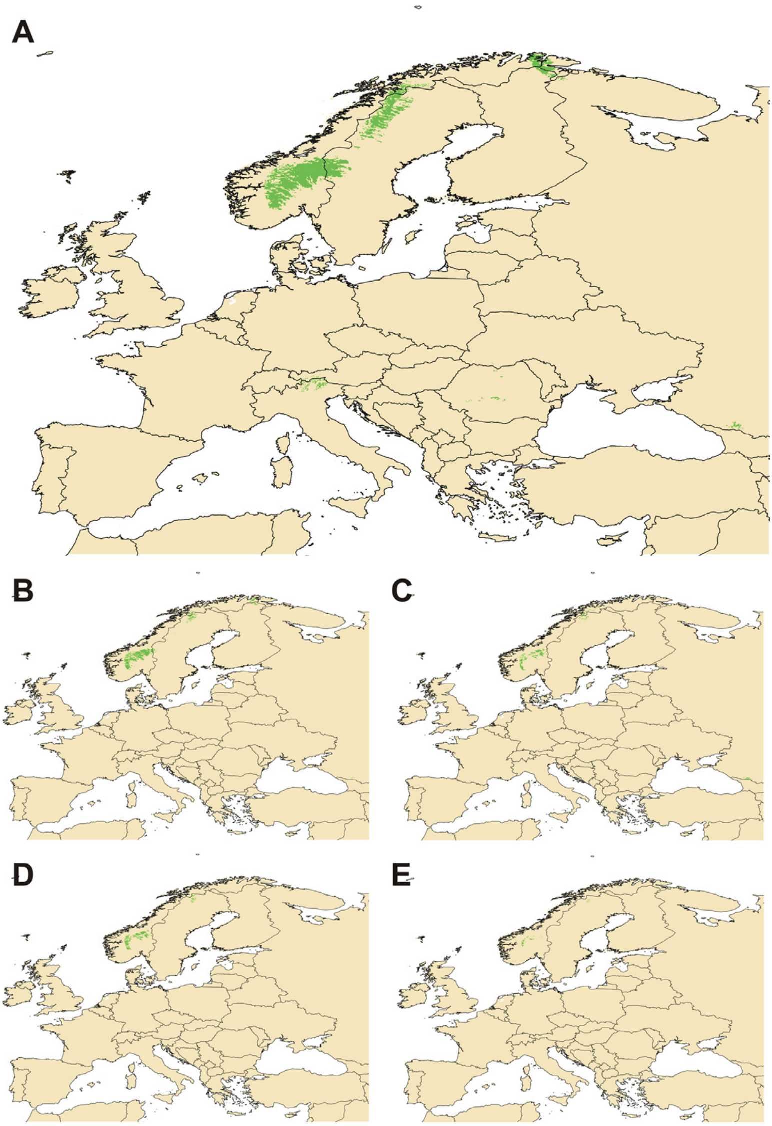

Fig. 1. Predicted distribution of *Nigritella nigra* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

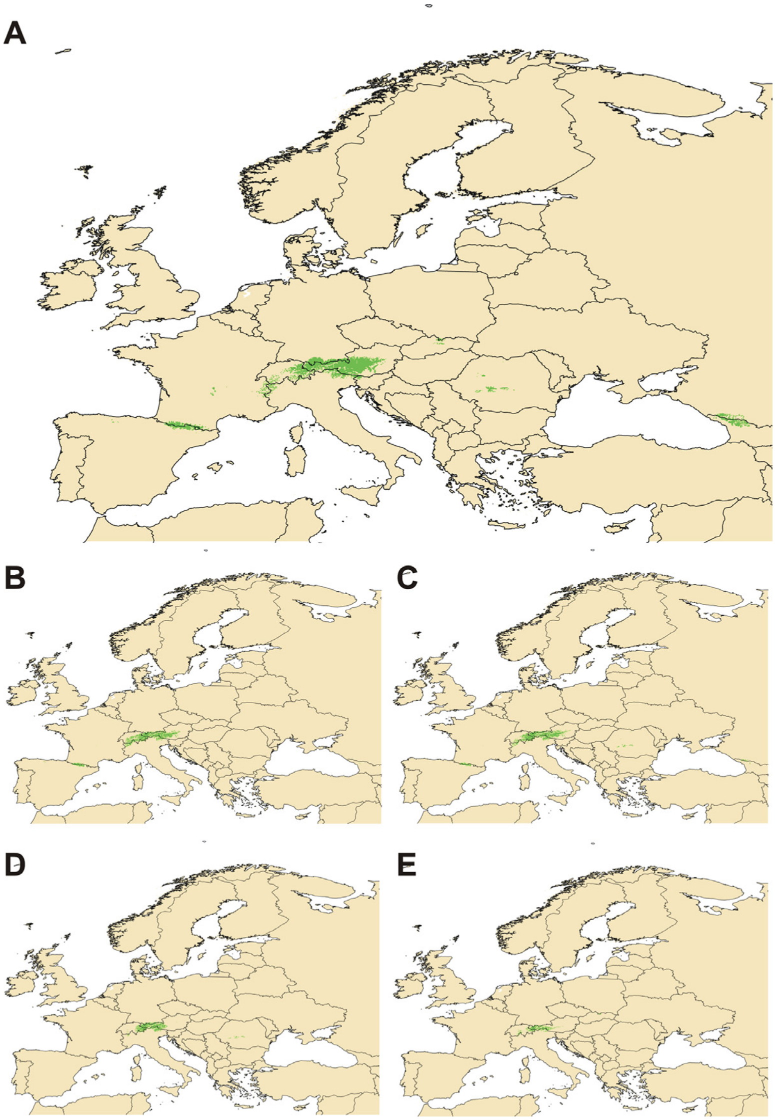

Fig. 2. Predicted distribution of southern populations of *Nigritella nigra* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

nigra (Figs. 1 and 2), *Adscita statices* (Fig. 3), *Boloria euphrosyne* (Fig. 4), *Crambus perlella* (Fig. 5), *Crocota tinctaria* (Fig. 6), *Diasemia reticularis* (Fig. 7), *Lasionycta imbecilla* (Fig. 8), *Leucania comma* (Fig. 9), *Thricops aculeipes* (Fig. 10). Table 1 contains the pairwise Pearson correlation coefficients calculated for the 19 bioclimatic variables considered. Table 2 contains codes and descriptions of variables used in ecological niche modeling. Table 3 contains information about changes in the coverage area in various climate change scenarios for the studied orchid and insects.

Table 1
Variables correlation – values of Pearson's Correlation Coefficient (R).

	bio1	bio2	bio3	bio4	bio5	bio6	bio7	bio8	bio9	bio10	bio11	bio12	bio13	bio14	bio15	bio16	bio17	bio18	bio19
bio1	x	0.543	0.741	-0.437	0.853	0.912	-0.288	0.042	0.858	0.899	0.941	-0.093	-0.015	-0.274	0.380	-0.015	-0.231	-0.579	0.283
bio2		x	0.530	0.104	0.778	0.282	0.389	-0.005	0.550	0.657	0.379	-0.427	-0.287	-0.539	0.516	-0.309	-0.528	-0.611	-0.120
bio3			x	-0.764	0.465	0.836	-0.557	-0.335	0.803	0.455	0.859	0.156	0.168	-0.009	0.231	0.175	0.030	-0.389	0.446
bio4				x	0.059	-0.755	0.949	0.458	-0.547	-0.004	-0.714	-0.499	-0.415	-0.367	0.067	-0.442	-0.406	0.010	-0.599
bio5					x	0.575	0.248	0.208	0.695	0.980	0.642	-0.415	-0.276	-0.567	0.509	-0.291	-0.538	-0.709	-0.024
bio6						x	-0.650	-0.155	0.847	0.649	0.993	0.171	0.179	-0.011	0.213	0.194	0.037	-0.404	0.483
bio7							x	0.376	-0.358	0.142	-0.579	-0.589	-0.469	-0.513	0.221	-0.500	-0.544	-0.180	-0.595
bio8								x	-0.351	0.248	-0.151	-0.385	-0.366	-0.183	-0.151	-0.377	-0.205	0.142	-0.548
bio9									x	0.701	0.880	0.019	0.094	-0.251	0.440	0.094	-0.195	-0.665	0.462
bio10										x	0.702	-0.355	-0.226	-0.500	0.469	-0.239	-0.470	-0.663	0.028
bio11											x	0.111	0.141	-0.084	0.277	0.152	-0.035	-0.468	0.450
bio12												x	0.909	0.811	-0.247	0.928	0.844	0.609	0.813
bio13													x	0.556	0.101	0.992	0.590	0.452	0.846
bio14														x	-0.670	0.580	0.989	0.786	0.448
bio15															x	0.078	-0.662	-0.551	0.125
bio16																x	0.613	0.471	0.853
bio17																	x	0.762	0.498
bio18																		x	0.075
bio19																			x

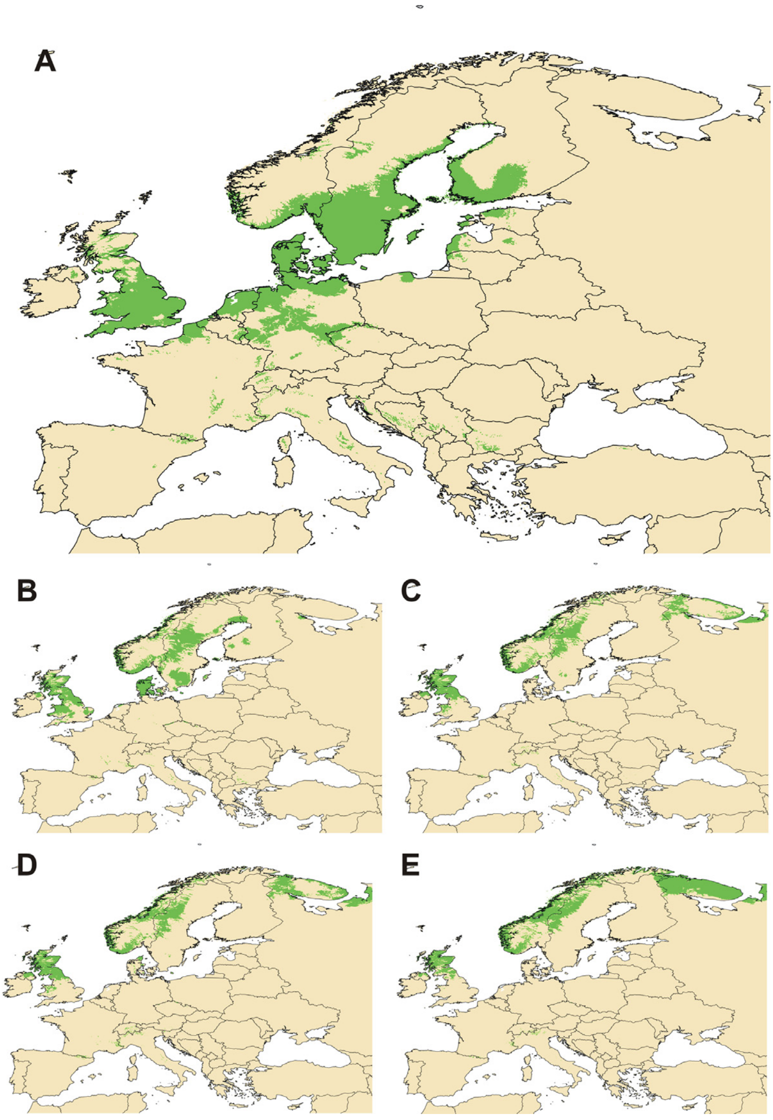

Fig. 3. Predicted distribution of *Adscita statices* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

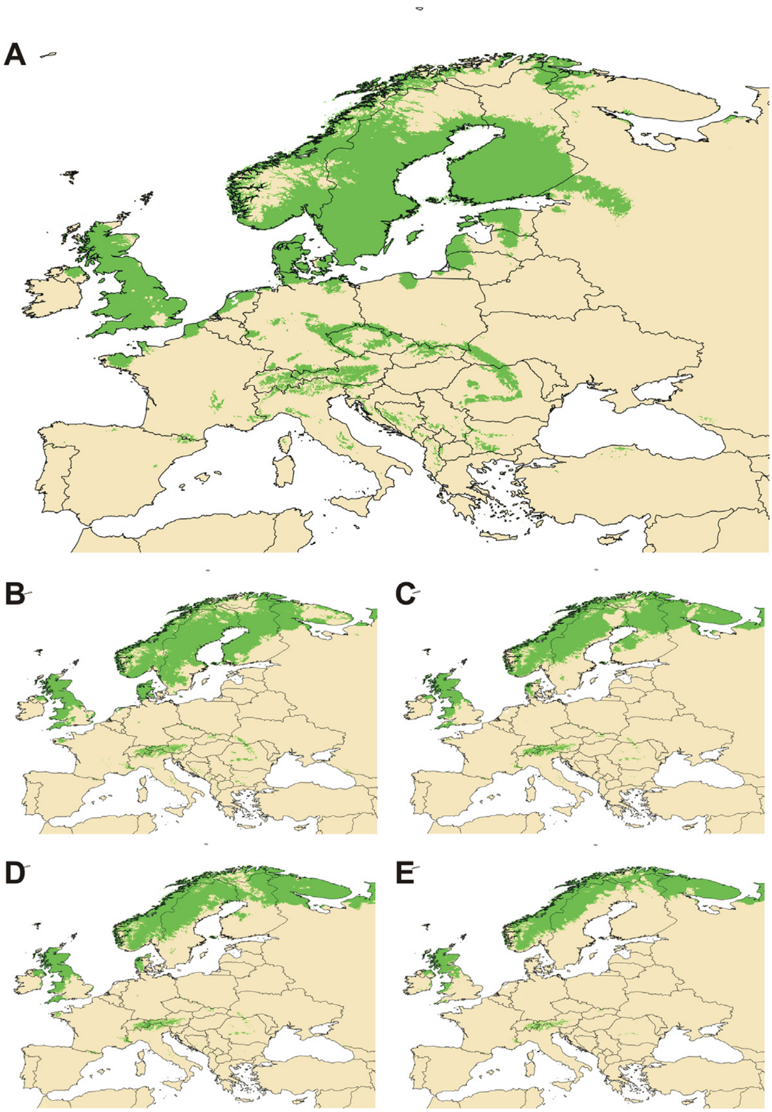

Fig. 4. Predicted distribution of *Boloria euphrosyne* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

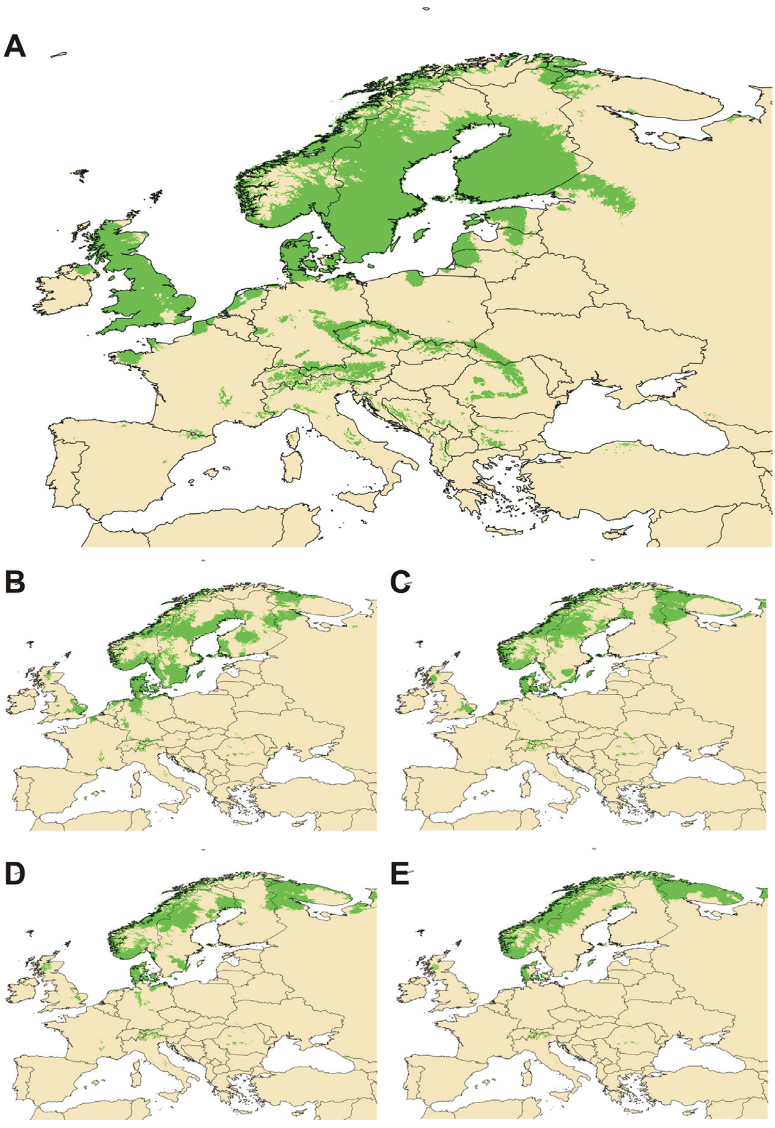

Fig. 5. Predicted distribution of *Crambus perlella* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

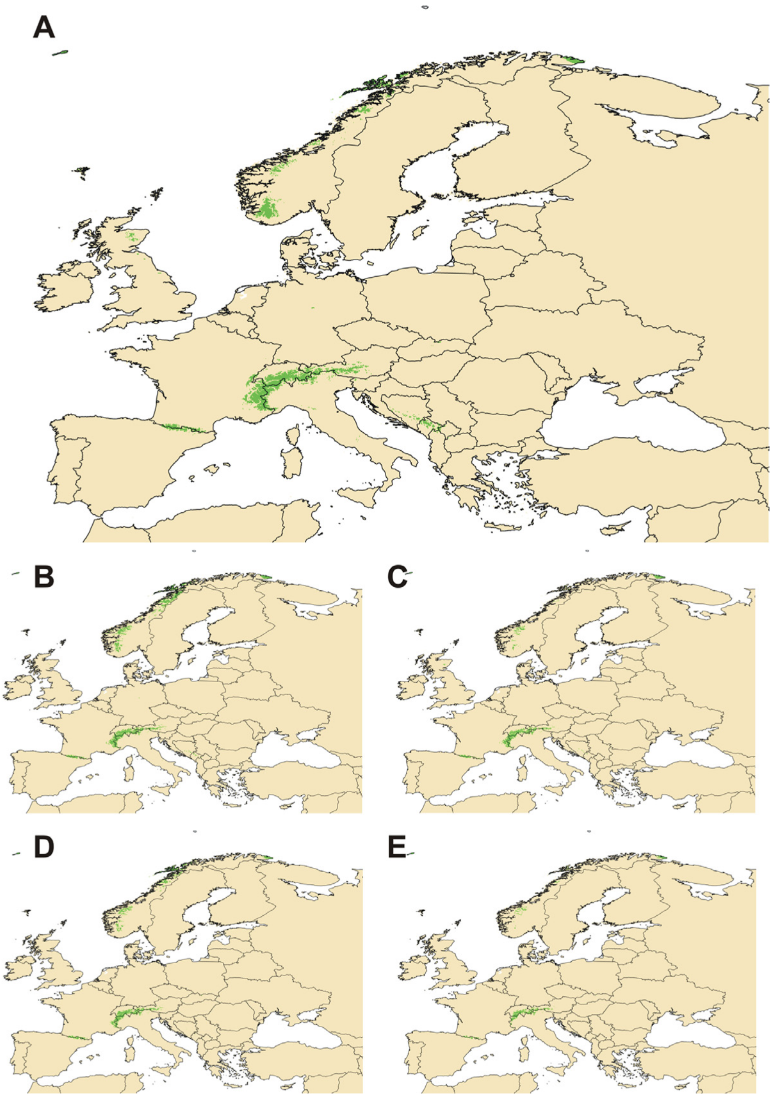

Fig. 6. Predicted distribution of *Crocota tinctaria* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

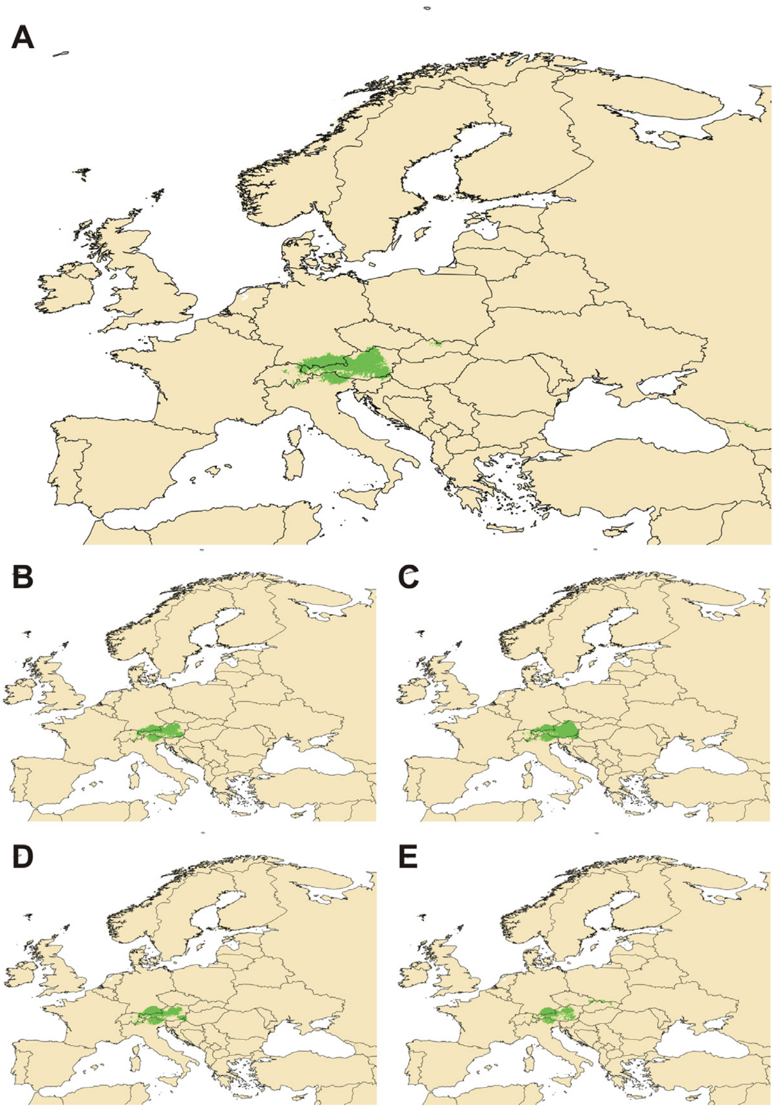

Fig. 7. Predicted distribution of *Diasemia reticularis* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

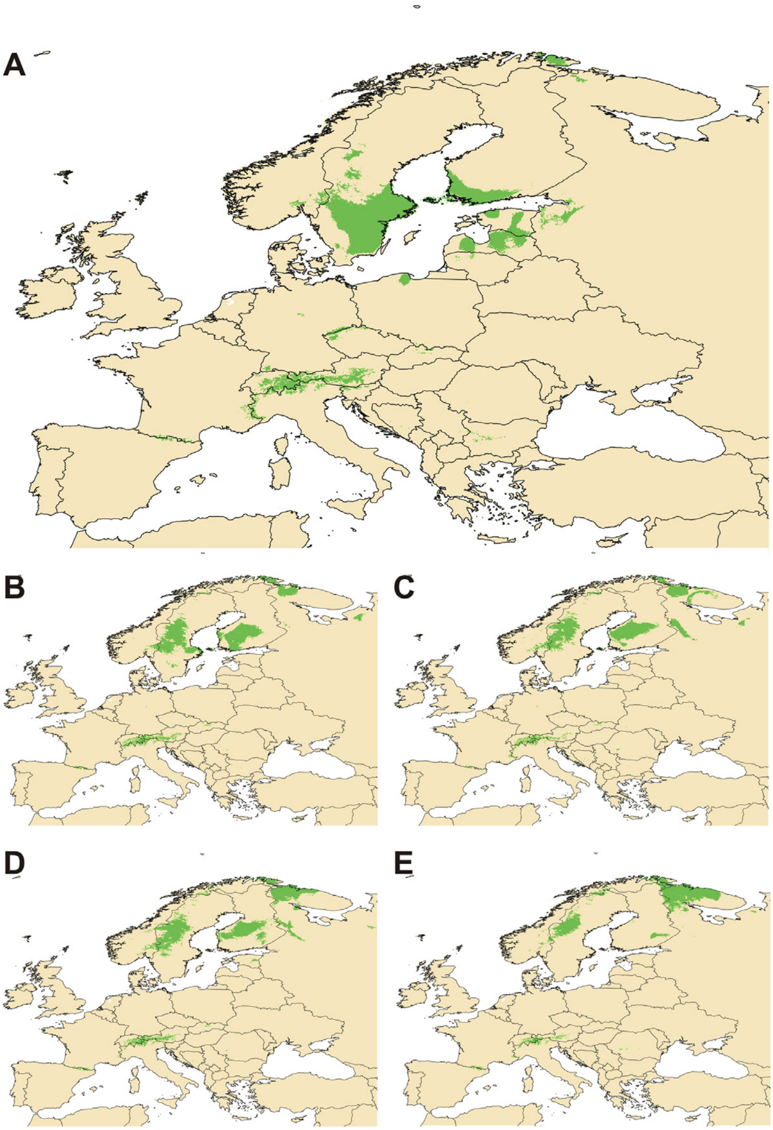

Fig. 8. Predicted distribution of *Lasionycta imbecilla* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

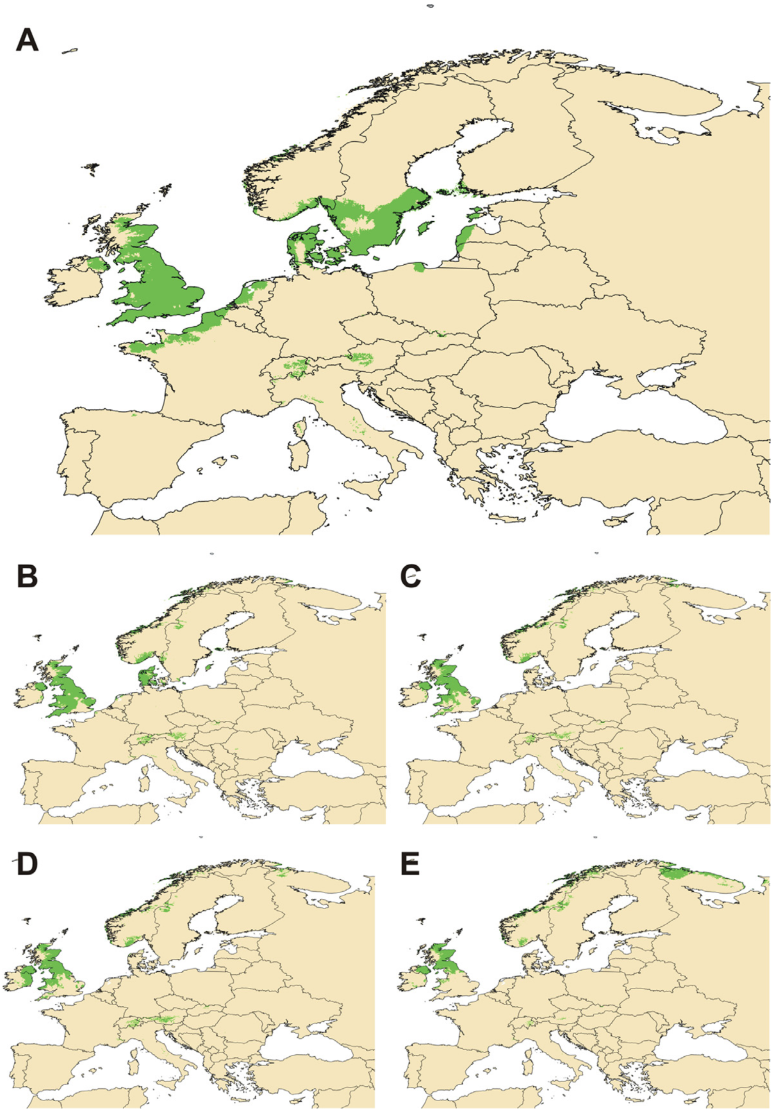

Fig. 9. Predicted distribution of *Leucania comma* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

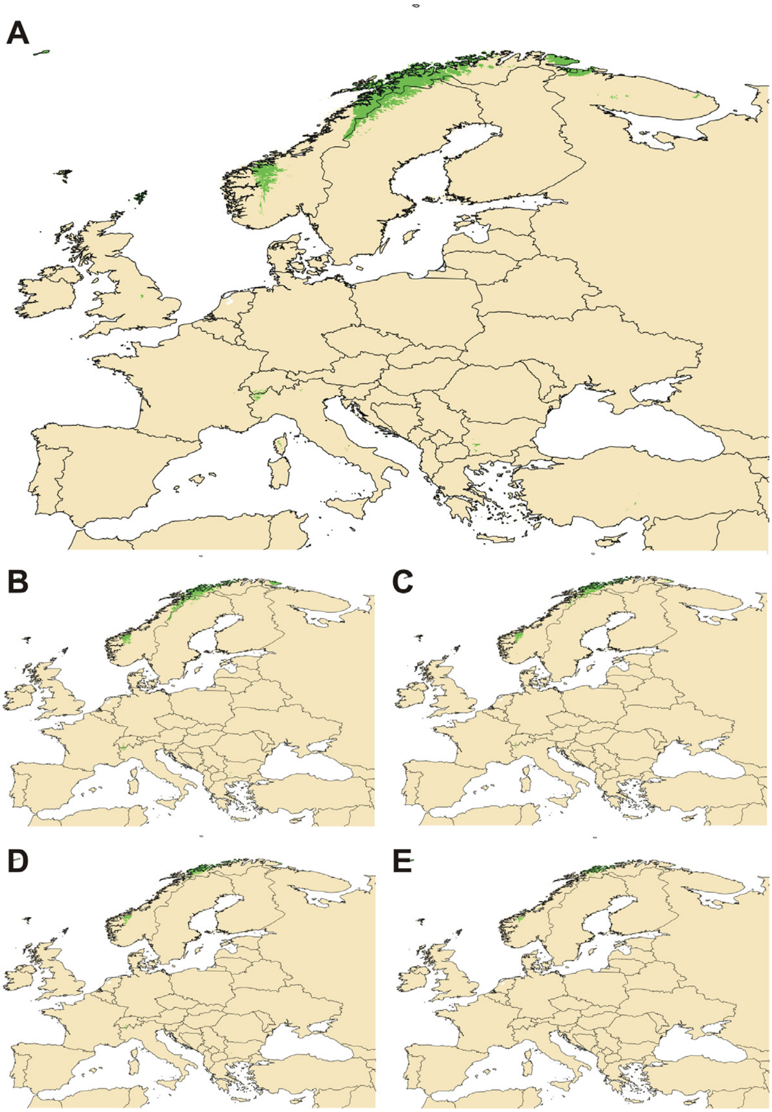

Fig. 10. Predicted distribution of *Thricops aculeipes* (green shading) at present (A) and in year 2070 (B-E). For the latter set of projections, rcp2.6 (B) rcp4.5 (C), rcp6.0 (D), and rcp8.5 (E) were considered.

Table 2
Variables - codes of climatic variables. Variables used in the analyses marked with asterisk.

Code	Description
bio1*	Annual Mean Temperature
bio2*	Mean Diurnal Range = Mean of monthly (max temp − min temp)
bio3*	Isothermality (bio2/bio7) * 100
bio4*	Temperature Seasonality (standard deviation * 100)
bio5	Max Temperature of Warmest Month
bio6	Min Temperature of Coldest Month
bio7	Temperature Annual Range (bio5-bio6)
bio8*	Mean Temperature of Wettest Quarter
bio9*	Mean Temperature of Driest Quarter
bio10*	Mean Temperature of Warmest Quarter
bio11	Mean Temperature of Coldest Quarter
bio12*	Annual Precipitation
bio13	Precipitation of Wettest Month
bio14*	Precipitation of Driest Month
bio15*	Precipitation Seasonality (Coefficient of Variation)
bio16	Precipitation of Wettest Quarter
bio17	Precipitation of Driest Quarter
bio18*	Precipitation of Warmest Quarter
bio19*	Precipitation of Coldest Quarter

2. Experimental Design, Materials and Methods

2.1. Localities of studied species

The database of localities of *N. nigra* s.l. and its pollinators was compiled based on data available in GBIF [1]. From the total of 3324 localities of the studied orchid and 127143 of eight insect species only records georeferenced with the precision of at least 2 km were used. Numerous localities in the database were overlapping with each other or were located in a close proximity giving little analytical value. The initial catalogue was therefore thinned to remove duplicate records and to reduce bias caused by sampling in more accessible areas [2,3,4] and finally included only records distanced one from another by at least 10 km. The final database contained 69 localities of southern and 26 of northern populations of *N. nigra* s.l. (Supplementary Table 1) which is more than the minimum number of records required to obtain reliable predictions in MaxEnt [5,6]. Each locality was complemented with the values of bioclimatic layers used in ecological niche modeling. The list of pollinators localities included a total of 5584 records (*Adscita statices* – 1104, *Boloria euphrosyne* – 2410, *Crambus perlella* – 874, *Crocota tinctaria* – 13, *Diasemia reticularis* – 84, *Lasionycta imbecilla* – 84, *Leucania comma* – 996, *Thricops aculeipes* – 19; Supplementary Table 2).

2.2. Ecological niche modeling

Ecological niche modeling was conducted using the maximum entropy method implemented in MaxEnt version 3.3.2 [7,8,9] based on presence-only data. Considering the outputs of previous studies [10] the area of ENM analyses was restricted to 12°W- 45°E and 74°-34°N. The correlation between 19 bioclimatic variables was calculated using the Pearson correlation coefficient (Table 1) and the final dataset consisted of 12 layers (Table 2) in 2.5 arc minutes (± 21.62 km2 at the equator) of interpolated climate surface [11] obtained from WorldClim (version 1.4, www.worldclim.org)

Predictions of the future coverage of the climatic niches of *N. nigra* and its pollinators in 2070 were modelled using climate projections of the Community Climate System Model (CCSM4) for four representative concentration pathways (RCPs: rcp2.6, rcp4.5, rcp6.0, rcp8.5). These scenar-

Table 3
Comparison of the current and future potential range of *N. nigra* and its pollinators. Changes are presented in four categories as range expansion (−1), no occupancy (0), no change (1) and range contraction (2), and expressed as area (km^2).

species	Change	rcp2.6	rcp4.5	rcp6.0	rcp8.5
N. nigra N	−1	3734.73	3246.78	2101.96	1370.03
	0	9433881.49	9434369.44	9435514.26	9436246.19
	1	24454.06	10247.06	10791.32	694.40
	2	63096.36	77303.36	76759.10	86856.02
N. nigra S	−1	8426.61	6906.44	3378.15	2664.99
	0	9437897.73	9439417.90	9442946.19	9443659.36
	1	39374.23	39186.55	23834.73	11091.60
	2	39468.07	39655.74	55007.56	67750.70
Adscita statices	−1	195426.05	282976.47	306698.60	417070.31
	0	8506147.32	8418596.90	8394874.77	8284503.06
	1	245460.22	78917.37	74657.14	31210.36
	2	578133.05	744675.91	748936.13	792382.91
Boloria euphrosyne	−1	329914.01	433717.09	469581.79	357108.12
	0	7585845.08	7482042.00	7446158.52	7558650.96
	1	948697.48	638583.19	600034.73	394699.44
	2	660710.08	970824.37	1009372.83	1214708.12
Crambus perlella	−1	246961.62	358234.17	469581.79	373998.88
	0	8056290.17	7945017.63	7446158.52	7929252.92
	1	516782.07	280930.81	600034.73	151566.39
	2	705132.77	940984.03	1009372.83	1070348.46
Crocota tinctaria	−1	17716.53	3847.34	7413.17	1670.31
	0	9412768.04	9426637.23	9423071.40	9428814.26
	1	62852.38	44835.57	51385.43	27775.91
	2	31829.69	49846.50	43296.64	66906.16
Diasemia reticularis	−1	10659.94	29784.03	17735.29	10134.45
	0	9421926.58	9402802.50	9414851.23	9422452.07
	1	78298.04	83083.75	70715.97	56640.34
	2	14282.07	9496.36	21864.15	35939.78
Lasionycta imbecilla	−1	159054.62	197828.29	214700.28	160030.53
	0	9078443.67	9039670.00	9022798.01	9077467.76
	1	91810.64	51873.39	57165.83	31322.97
	2	195857.70	235794.96	230502.52	256345.38
Leucania comma	−1	61407.28	64147.34	84566.39	111216.25
	0	8953489.61	8950749.56	8930330.51	8903680.65
	1	243264.43	144716.25	127844.26	76083.47
	2	267005.32	365553.50	382425.49	434186.27
Thricops aculeipes	−1	1857.98	1144.82	600.56	37.54
	0	9417685.13	9418398.29	9418942.55	9419505.58
	1	45135.85	30759.94	20944.54	12949.58
	2	60487.68	74863.59	84678.99	92673.95

ios describe the future climate of the Earth considering various emission of greenhouse gases [12,13].

In all analyses the maximum number of iterations was set to 10000 and the convergence threshold to 0.00001. The “random seed" option which provided a random test partition and background subset for each run was applied. 10% of the samples were used as test points. The run was performed as a bootstrap with 1000 replicates, and the output was set to logistic. All operations on GIS data were carried out on ArcGis 10.6 (Esri, Redlands, CA, USA). The evaluation of the created models was made using the most common metric - the area under the curve (AUC [14,15]).

2.3. Changes in the distribution of suitable niches

SDMtoolbox 2.3 for ArcGIS [16] was used to calculate changes in the distribution of suitable niches of the studied orchid and its pollinators caused by global warming. To compare the distribution model created for current climatic conditions with future models all outcome maps were converted into binary rasters (Fig. 1-10) and projected using Albers equal-area conic (EAC) as projection. The presence threshold was estimated based on the modelled habitat suitability values in locations where the studied species occur in models created using present-time data – for southern populations of the black vanilla orchid and all pollinators the threshold was set to 0.4 and for the northern populations of the orchid to 0.3. Moreover, the binary models of the predicted occurrence of the studied plant were compared with the future distributions of its pollinators' niches. The number of grid cells in which both the orchid and the insects can occur was calculated to estimate the pollinator availability. The calculated changes in the potential coverage of the niches of the studied orchid and its pollinators are presented in Table 3.

Ethics Statement

Hereby, we consciously assure that this material is the authors' own original work, which has not been previously published elsewhere, the paper reflects the authors' own research and analysis in a truthful and complete manner, the paper properly credits the meaningful contributions of co-authors and co-researchers, all sources used are properly disclosed (correct citation). All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

This work did not include experiments on human subjects and/or animals.

CRediT Author Statement

Marta Kolanowska: Conceptualization, Methodology, Data curation, Software, Visualization, Writing - Original draft preparation, Writing - reviewing and editing; **Sławomir Nowak:** Methodology, Data curation, Writing - Original draft preparation, Writing- Reviewing and Editing; **Agnieszka Rewicz**: Methodology, Data curation, Software, Visualization, Writing - Original draft preparation, Writing - reviewing and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.107187.

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