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A taxonomically harmonized and temporally standardized fossil pollen dataset from Siberia covering the last 40 kyr

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Abstract. Pollen records from Siberia are mostly absent in global or Northern Hemisphere synthesis works. Here we present a taxonomically harmonized and temporally standardized pollen dataset that was synthesized using 173 palynological records from Siberia and adjacent areas (northeastern Asia, 42–75° N, 50–180° E). Pollen data were taxonomically harmonized, i.e. the original 437 taxa were assigned to 106 combined pollen taxa. Age–depth models for all records were revised by applying a constant Bayesian age–depth modelling routine. The pollen dataset is available as count data and percentage data in a table format (taxa vs. samples), with age information for each sample. The dataset has relatively few sites covering the last glacial period between 40 and 11.5 ka (calibrated thousands of years before 1950 CE) particularly from the central and western part of the study area. In the Holocene period, the dataset has many sites from most of the area, with the exception of the central part of Siberia. Of the 173 pollen records, 81 % of pollen counts were downloaded from open databases (GPD, EPD, PANGAEA) and 10 % were contributions by the original data gatherers, while a few were digitized from publications. Most of the pollen records originate from peatlands (48 %) and lake sediments (33 %). Most of the records (83 %) have ≥ 3 dates, allowing the establishment of reliable chronologies. The dataset can be used for various purposes, including pollen data mapping (example maps for *Larix* at selected time slices are shown) as well as quantitative climate and vegetation reconstructions. The datasets for pollen counts and pollen percentages are available at https://doi.org/10.1594/PANGAEA.898616 (Cao et al., 2019a), also including the site information, data source, original publication, dating data, and the plant functional type for each pollen taxa.

1 Introduction

Continental or sub-continental pollen databases are essential for spatial reconstructions of former climates and past vegetation patterns of the terrestrial biosphere and in interpreting their driving forces (Cao et al., 2013); they also provide data for use in palaeodata–model comparisons at a continental scale (Gaillard et al., 2010; Trondman et al., 2015). Continental pollen databases from North America, Europe, Africa, and Latin America have been successfully established (Gajewski, 2008), and a fossil pollen dataset has been established for the eastern part of continental Asia (including China, Mongolia, southern Siberia, and parts of Central Asia; Cao et al., 2013). These datasets have been used to infer the locations of glacial refugia and migrational pathways by pollen mapping (e.g. Magri, 2008; Cao et al., 2015) and to reconstruct biome or land cover (e.g. Ni et al., 2014; Trondman et al., 2015; Tian et al., 2016) and climates at broad spatial scales (e.g. Mauri et al., 2015; Marsicek et al., 2018).

Pollen records from Siberia have rather seldomly been included in global, Northern Hemisphere, or synthesis works (Sanchez Goñi et al., 2017; Marsicek et al., 2018), probably because (1) few records are available in open databases or (2) available data are not taxonomically harmonized and lack reliable chronologies. Binney et al. (2017) established a pollen dataset together with a plant macrofossil dataset for northern Eurasia (excluding East Asia; the dataset has not been made accessible yet), but the chronologies were not standardized and the pollen data restricted to 1000-year time slices. In addition, a few works that make use of Siberian fossil pollen data either present biome reconstructions (Binney et al., 2017; Tian et al., 2018), which do not require taxonomic harmonization of the data, or restrict the analyses to selected times slices such as 18, 6, and 0 ka (Tarasov et al., 1998, 2000; Bigelow et al., 2003).

Here we provide a new taxonomically harmonized and temporally standardized fossil pollen dataset for Siberia and adjacent areas.

2 Dataset description

2.1 Data sources

We obtained 173 late Quaternary fossil pollen records (generally since 40 ka) from Siberia and surrounding areas (42–75° N, 50–180° E) from database sources and/or contributors or by digitizing published pollen diagrams (Appendix A; this table is available in PANGAEA). A total of 102 raw pollen count records were downloaded from the Global Pollen Database (GPD; http://www.ncdc.noaa.gov/paleo/gpd.html, last access: August 2010); 18 pollen count records were downloaded from the European Pollen Database (EPD; http://www.europeanpollendatabase.net, last access: July 2016); 20 pollen records (16 sites have pollen count data, others with pollen percentages) were collected from the PANGAEA website (Data Publisher for Earth and Environmental Science, which also includes most pollen records found in GPD and EPD; https://www.pangaea.de, last access: July 2016); raw pollen count data of 17 sites were contributed directly by the data gatherers; and pollen percentages for the remaining 16 sites were digitized from the published pollen diagrams.

2.2 Data processing

Pollen standardization follows Cao et al. (2013), including homogenization of taxonomy at family or genus level generally (437 pollen names were combined into 106 taxa; Appendix B; this table is available in PANGAEA) and recalculation of pollen percentages on the basis of the total number of terrestrial pollen grains. To obtain comparable chronologies, age–depth models for these pollen records were re-established using Bayesian age–depth modelling with the IntCal09 radiocarbon calibration curve ("Bacon" software; Blaauw and Christen, 2011). We set up a gamma distribution accumulation rate with a shape parameter equal to 2, a beta distribution with a "strength" of 20 for all records for the accumulation variability, a mean "memory" of 0.1 for lake sediments, and a high memory of 0.7 for peat and other sediment types (following Blaauw and Christen, 2011). For the 20 pollen records without raw pollen counts, we set the terrestrial pollen sum based on the descriptions given in the original publications. Approximate values or ranges were provided for 16 records, e.g. more than 600 for the pollen record from Chernaya Gorka palsa and between 452 and 494 grains for Two-Yurts Lake, these pollen sums are assigned at

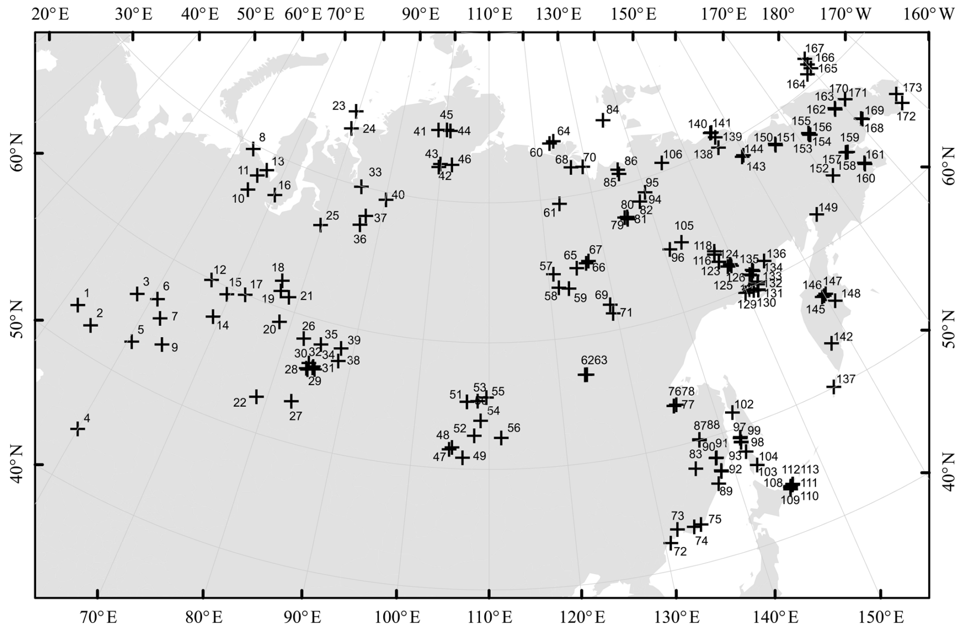

Figure 1. Spatial distribution of fossil pollen records (+) in the study area. The number of each site is used as its ID in Table A1.

600 and 470, respectively. A pollen sum of 400 is assigned for the other four records because no information was provided in the publications.. The "pollen counts" were then back-calculated using the pollen percentages and pollen sum. Finally, the pollen datasets are available with both count data and percentage data in table format in Excel software (taxa vs. samples), with age and location information for each sample.

2.3 Data quality

The Siberia pollen dataset includes pollen count data and percentages from 173 pollen sampling sites (Fig. 1). Sites are distributed reasonably evenly in eastern and western Siberia, but geographic gaps still exist in central Siberia (55–70° N, 90–120° E), where no published pollen records exist.

The dataset includes 83 pollen records from peat sediments, 57 records from lake sediments, 23 from fluvial sediments, 6 from coastal or marine sediments, 3 from palaeosol profiles, and 1 from palsa sediment (Appendix A). The peat and lake sediments generally have reliable chronologies and high sampling resolutions of the pollen records. About 83 % of the pollen records have ≥ 3 dates (~ 57 % have ≥ 5 dates); 73 % of the pollen records have sampling resolutions of $<$ 500 years per sample and only 14 % sites have $>$ 1000 years per sample (Appendix A).

Within this dataset, 91 % of the pollen records (157 sites) have raw pollen count data or percentages with complete pollen assemblages (Appendix A). Although there might be some rare pollen taxa excluded from the published pollen diagrams (16 sites) that were digitized, these pollen taxa are likely of minor importance within the pollen assemblages. In addition, during digitizing we ensured that the sum of pollen percentages for each pollen assemblage was within 100 ± 10 %, to minimize artificially introduced errors.

The pollen records were counted by different scientists that gave different pollen names to the same pollen types requiring taxonomic homogenization (from 437 original taxa to 106 combined taxa). However, this reduces the taxonomic resolution of the dataset. In cases where homogenization would have resulted in grouping pollen taxa with different growth forms (herb, shrub, or tree) together, we keep the taxa separately even though not all analysts separated them (for instance, *Betula* pollen is separated into *Betula*_shrub, *Betula*_tree and *Betula*_undiff). We also append the original pollen names to the dataset to ensure feasibility of future studies on various topics using these data.

The chronologies of most pollen records are based on a reasonable number of dates (mostly ^{14}C; at least 3 dates per record). However, we also included pollen records from under-represented areas or periods that do not meet this criterion. Furthermore, most of the pollen records cover only part of the last 40 kyr, and comparatively few pollen records cover (parts of) the last glacial (i.e. $>$ 11 ka). We interpolated pollen abundances at 16 key time slices (40, 25, 15, 13, 11, 10, 9, 8, 7, 6, 5, 4, 3, 1.5, and 0.5 ka) using the *interp.dataset* function in the R package rioja (Juggins, 2012) to produce pollen presence–absence maps for *Larix* as an example of the distribution of available sites at these 16 key time slices (Fig. 2). We also present boxplots for 14 major pollen taxa from all available sites at the 16 key time slices (Fig. 3), which illustrates the general temporal patterns.

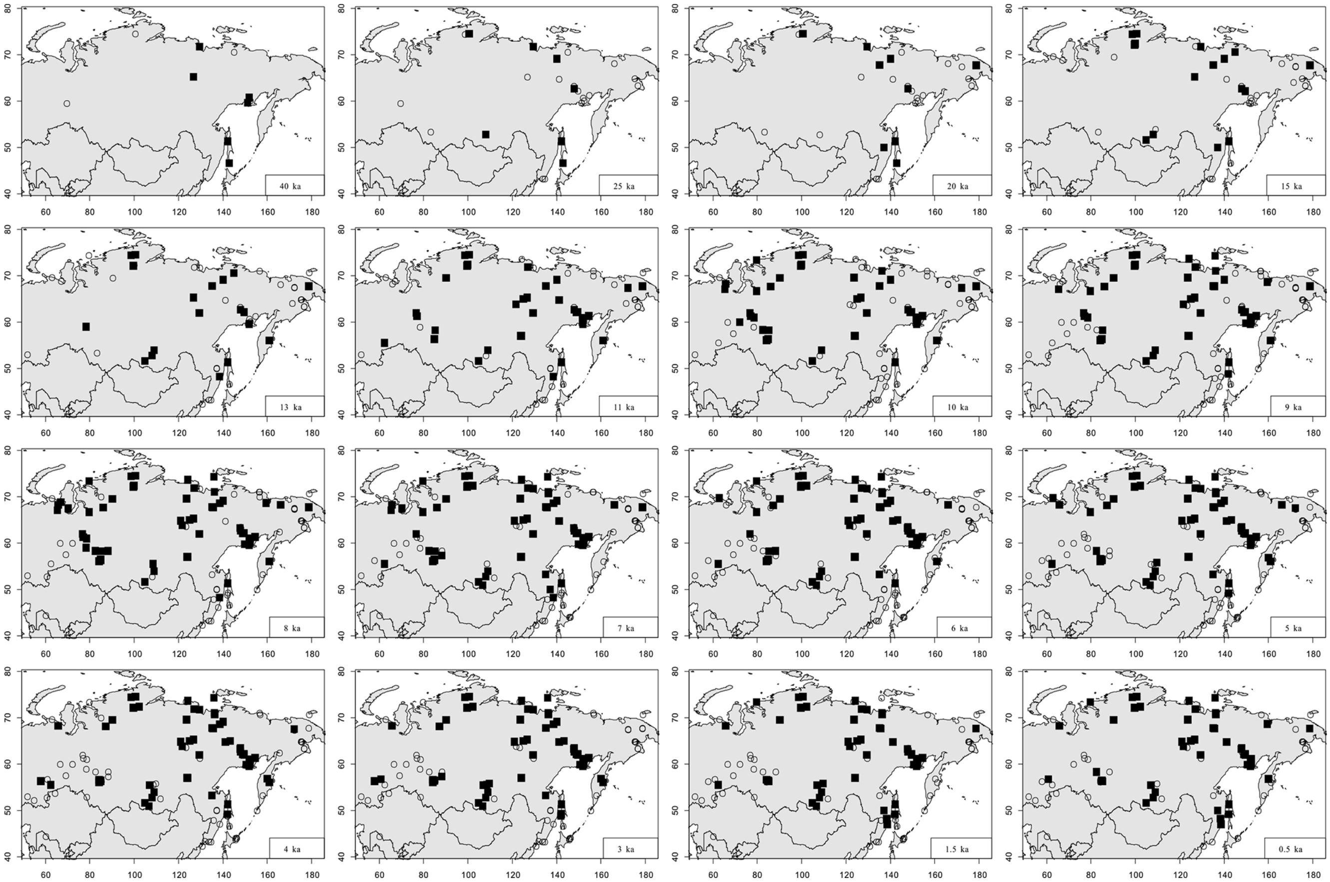

Figure 2. Pollen-inferred presence–absence maps for *Larix* at key time slices. Black squares indicate presence while empty circles indicate absence.

3 Potential use of the Siberian fossil pollen dataset

Fossil pollen data mapping can be used to reveal broadscale spatial distributions over time, as Cao et al. (2015) demonstrate. In this paper, we present presence–absence maps for *Larix* as an example (Fig. 2). *Larix* has extremely low pollen productivity (e.g. Niemeyer et al., 2015) that causes the under-representation of *Larix* pollen compared to its cover in the pollen source vegetation (Lisitsyna et al., 2011). Accordingly, *Larix* pollen is accepted as an indicator of the presence of *Larix* locally (e.g. Lisitsyna et al., 2011). The pollen presence–absence maps for *Larix* (Fig. 2) show a wide geographical range over the last 40 000 years, even during the Last Glacial Maximum, when there was very likely a relatively low density of larch. Our results generally confirm the distribution revealed by *Larix* macrofossil analysis (Binney et al., 2009). The *Larix* distribution changes revealed by our pollen dataset exemplify the usability of the dataset for vegetation reconstruction.

The Siberian fossil pollen dataset has already been used for biome reconstruction (Tian et al., 2018), although an integration of this dataset into global or Northern Hemisphere-wide biomization research is still pending.

Pollen percentages in pollen assemblages do not directly reflect species abundance in the vegetation community because of different pollen productivity. Therefore, quantitative vegetation composition is modelled using pollen productivity estimates (e.g. Sugita et al., 2010; Trondman et al., 2015). Our pollen dataset was recently used to reconstruct plant cover quantitatively using the REVEALS model to describe the compositional changes in space and time, which is more reliable than using pollen percentages directly (Cao et al., 2019b).

Modern pollen data have been published from many sites in Siberia (e.g. Tarasov et al., 2007, 2011; Müller et al., 2010; Klemm et al., 2015). These modern pollen datasets can be used to investigate modern pollen–climate relationships, and these modern relationships can be used to make quantitative climate reconstructions, as has been done previously (e.g. Marsicek et al., 2018).

4 Data availability

Five datasets including overview and reference (site information), dating data, plant functional type for each pollen taxa,

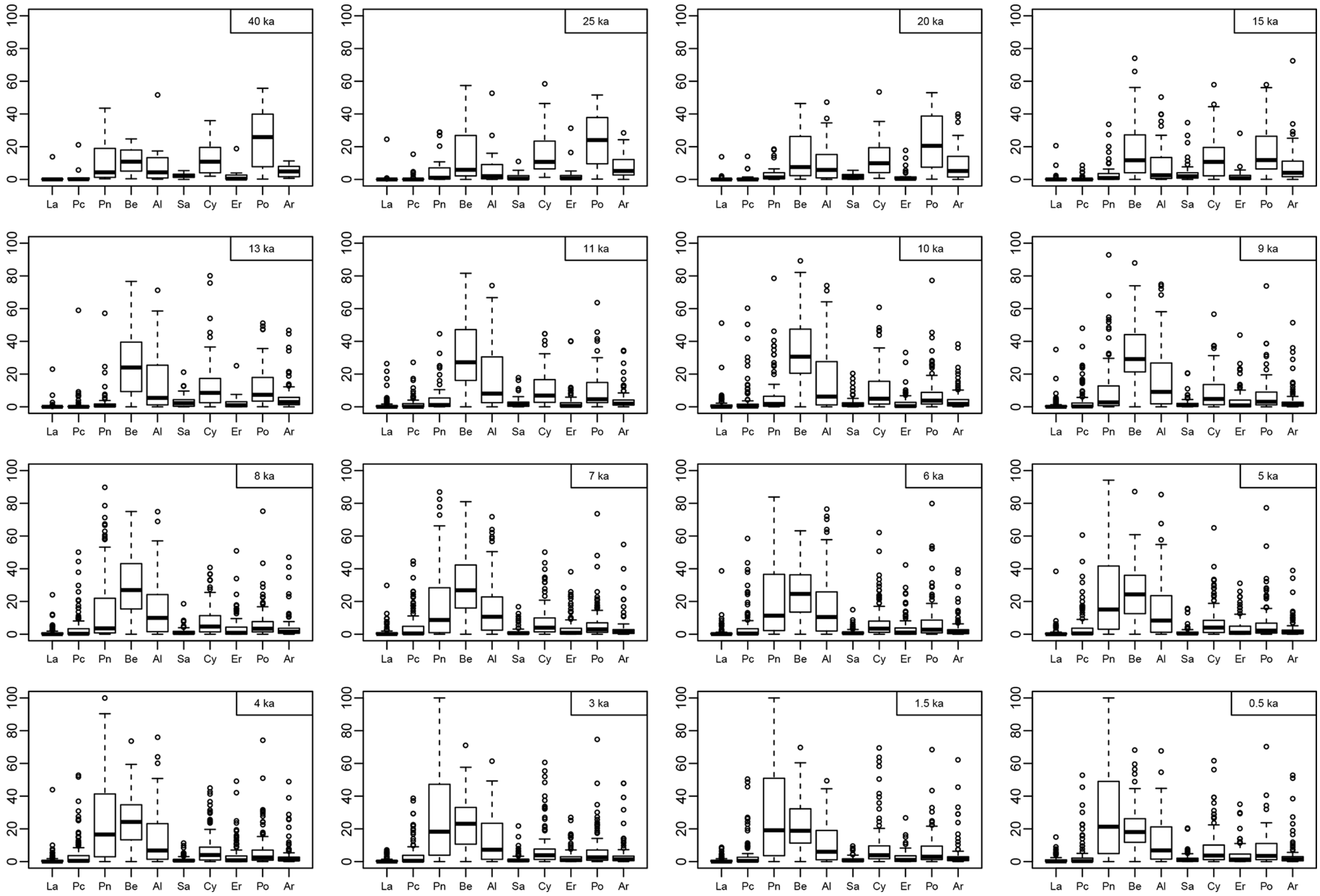

Figure 3. Boxplots of percentages of 10 major pollen taxa at all available sites at key time slices. La: *Larix*; Pc: *Picea*; Pn: *Pinus*; Be: *Betula*; Al: *Alnus*; Sa: *Salix*; Cy: Cyperaceae; Er: Ericaceae; Po: Poaceae; Ar: *Artemisia*.

and pollen count and pollen percentage for each sample are available at https://doi.org/10.1594/PANGAEA.898616 (Cao et al., 2019a).

5 Summary

We present a taxonomically harmonized and temporally standardized fossil pollen dataset of 173 palynological records with counts and percentages from Siberia and adjacent areas (northeastern Asia, 42–75° N, 50–180° E).

Our open-access dataset is a key component that can help provide quantitative estimates of vegetation or climate, which can be used to validate palaeo-simulation results of general circulation models for the Northern Hemisphere.

Appendix A

Table A1. Details of the fossil pollen records in the Siberian pollen dataset. NA – not available.

ID	Site	Lat. (°)	Long. (°)	Elev. (m)	Archive type	Data type	Source	Dating method	No. of dates & material code	Time span (ka BP)	Res. (yr)	Reference
1	Pobochnoye	53.03	51.84	58	Peat sediment	digitized	–	^{14}C	10C+6E	14.4–0	540	Kremenetski et al. (1999)
2	Novienky peat	52.24	54.75	197	Peat sediment	counts	EPD, Pan	^{14}C	1U	4.5–0	270	López-García et al. (2003)
3	Ust'Mashevskoe	56.32	57.88	220	Peat sediment	counts	EPD, Pan	^{14}C	5C	7.8-00	150	Panova et al. (1996)
4	Aral Sea	44.42	59.98	53	Lake sediment	counts	EPD, Pan	^{14}C	4U	8.7–0	260	Aleshinskaya (unpublished data)
5	Fernsehsee Lake	52.83	60.50	290	Lake sediment	counts	From author	^{14}C	10A	9.1–0.4	220	Stobbe et al. (2015)
6	Karasieozerskoe	56.77	60.75	230	Peat sediment	counts	EPD, Pan	^{14}C	3A	5.9–0.1	190	Panova (1997)
7	Zaboinoe Lake	55.53	62.37	275	Lake sediment	counts	GPD, EPD, Pan	^{14}C	1U	12.3–0.1	220	Khomutova and Pushenko (1995)
8	Cape Shpindler	69.72	62.80	20	Fluvial sediment	counts	Pan	^{14}C	12A	15.8–0	420	Andreev et al. (2001)
9	Mokhovoye	53.77	64.25	178	Peat sediment	counts	GPD, EPD, Pan	^{14}C	4C+1E	6.0–0	180	Kremenetskii et al. (1994)
10	Chernaya Gorka	67.08	65.35	170	Palsa sediment	digitized	–	^{14}C	1A+3C	10.1–6.9	70	Jankovská et al. (2006)
11	Lake Lyadhej-To	68.25	65.75	150	Lake sediment	counts	Pan	^{14}C	14A+6E	12.5–0.3	170	Andreev et al. (2005)
12	Chesnok peat	60.00	66.50	42	Peat sediment	counts	GPD, EPD, Pan	^{14}C	7C	10.6–0.5	280	Volkova (1966)
13	Baidara Gulf	68.85	66.90	30	Coastal sediment	counts	EPD, Pan	^{14}C	10C	15.8–4.6	170	Andreev et al. (1998)
14	Komaritsa peat	57.50	69.00	42	Peat sediment	counts	GPD, EPD, Pan	^{14}C	10C	10.5–0.5	350	Volkova (1966)
15	Demyanskoye	59.50	69.50	65	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	1A	50.3–22.3	2000	Bakhareva (1983)
16	Nulsaveito	67.53	70.17	57	Peat sediment	counts	EPD, Pan	^{14}C	4A+1C	8.4–6.4	70	Panova (1990)
17	Salym-Yugan	60.02	72.08	56	Peat sediment	digitized	–	^{14}C	5C	10.1–0.2	200	Pitkänen et al. (2002)
18	Nizhnevartovsk	62.00	76.67	54	Peat sediment	counts	GPD, EPD, Pan	^{14}C	3A+7C	11.1–0	300	Neustadt and Zelikson (1985)
19	Nizhnevartovskoye	61.25	77.00	55	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1A+13C+1E	12.6–0	380	Neishtadt (1976a)
20	Entarnoye peat	59.00	78.33	65	Peat sediment	counts	GPD, EPD, Pan	^{14}C	5C	14.9–0.9	460	Neishtadt (1976b)
21	Lukaschin Yar	61.00	78.50	65	Peat sediment	counts	GPD, EPD, Pan	^{14}C	13C	10.9–0.3	430	Neishtadt (1976a)
22	Big Yarovoe Lake	52.85	78.63	79	Lake sediment	counts	From author	Biwa*	–	4.3–0	190	Rudaya et al. (2012)
23	Sverdrup	74.50	79.50	7	Peat sediment	counts	GPD, EPD, Pan	^{14}C	3C	13.4–11.1	290	Tarasov et al. (1995)
24	BP99-04/06	73.41	79.67	−32	Marine sediment	counts	Pan	^{14}C	12U	10.0–0.3	190	Kraus et al. (2003)
25	Pur-Taz peatland	66.70	79.73	50	Peat sediment	counts	GPD, EPD, Pan	^{14}C	5A	10.3–4.7	80	Peteet et al. (1998)
26	Petropavlovka	58.33	82.50	100	Peat sediment	counts	EPD, Pan	^{14}C	4C+1E	10.5–0.1	160	Blyakharchuk (1989)
27	Kalistratikha	53.33	83.25	190	Peat sediment	counts	GPD, EPD, Pan	^{14}C	4A	39.0–12.7	1870	Zudin and Votakh (1977)
28	Tom' River peat	56.17	84.00	100	Peat sediment	counts	GPD	^{14}C	6C	10.1–0.2	390	Arkhipov and Votakh (1980)
29	Novouuspenka	56.62	84.17	150	Fluvial sediment	counts	EPD, Pan	^{14}C	5C	5.3–0	130	Blyakharchuk (1989)
30	Kirek Lake	56.10	84.22	90	Lake sediment	digitized	–	^{14}C	3G	10.5–1.5	190	Blyakharchuk (2003)
31	Zhukovskoye Mire	56.33	84.83	106	Peat sediment	counts	From author	^{14}C	9C+6H	11.2–0	130	Borisova et al. (2011)
32	Chaginskoe	56.45	84.88	80	Peat sediment	digitized	–	^{14}C	2C	8.8–0	320	Blyakharchuk (2003)
33	Karginskii Cape	70.00	85.00	60	Peat sediment	counts	GPD, EPD, Pan	^{14}C	13C	8.9–3.5	290	Firsov et al. (1972)
34	Ovrazhnoe	56.25	85.17	110	Peat sediment	counts	EPD, Pan	^{14}C	1C	5.8–0.1	230	Blyakharchuk (1989)
35	Bugristoye Bog	58.25	85.17	100	Peat sediment	counts	EPD, Pan	^{14}C	4C+1E	11.5–5.0	100	Blyakharchuk (1989)
36	Igarka peat	67.48	86.50	2	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1A+2C	10.9–5.9	230	Kats (1953)
37	Yenisei	68.17	87.15	68	Peat sediment	digitized	–	^{14}C	7C	6.5–1.6	110	Andreev and Klimanov (2000)
38	Teguldet	57.33	88.17	150	Peat sediment	counts	Pan	^{14}C	3C	7.3–2.4	90	Blyakharchuk (1989)
39	Maksimkin Yar	58.33	88.17	150	Peat sediment	counts	EPD, Pan	^{14}C	4C	8.3–0.2	170	Blyakharchuk (1989)
40	Lama Lake	69.53	90.20	77	Lake sediment	counts	From author	^{14}C	26A+4D+4E	19.5–0	170	Andreev et al. (2004)
41	Levinson-Lessing Lake	74.47	98.64	NA	Lake sediment	counts	Pan	^{14}C	30A+19E	35.3–0	390	Andreev et al. (2003)
42	LAO13-94	72.19	99.58	65	Peat sediment	counts	Pan	^{14}C	2C+1U	16.1–0	1240	Andreev et al. (2002)
43	LAB2-95	72.38	99.86	65	Peat sediment	counts	Pan	^{14}C	1A+1C	17.4–5.6	980	Andreev et al. (2002)
44	Taymyr Lake_SAO4	74.53	100.53	47	Lake sediment	counts	Pan	^{14}C	1C	8.7–0.4	600	Andreev et al. (2003)
45	Taymyr Lake_SAO1	74.55	100.53	47	Lake sediment	counts	Pan	^{14}C	6A+5C	57.9–0	1320	Andreev et al. (2003)
46	11-CH-12A Lake	72.40	102.29	60	Lake sediment	counts	Pan	^{14}C	8A+7E	7.0–0.1	110	Klemm et al. (2016)
47	Baikal-CON01-605-5	51.58	104.85	480	Lake sediment	digitized	–	^{14}C	12D	11.5–0	130	Demske et al. (2005)
48	Baikal-CON01-605-3	51.59	104.85	480	Lake sediment	digitized	–	^{14}C	5D	17.7–0	200	Demske et al. (2005)
49	Chernoe Lake	50.95	106.63	500	Lake sediment	counts	EPD, Pan	^{14}C	4E	7–0.7	620	Vipper (2010)
50	Khanda-1	55.44	107.00	840	Peat sediment	counts	From author	^{14}C	3C	3.1–0.3	50	Bezrukova et al. (2011)
51	Khanda	55.44	107.00	840	Peat sediment	counts	From author	^{14}C	6C	5.8–0	140	Bezrukova et al. (2011)
52	Cheremushka Bog	52.75	108.08	1500	Peat sediment	digitized	–	^{14}C	6C	33.5–0	460	Shichi et al. (2009)
53	Okunaika	55.52	108.47	802	Peat sediment	counts	From author	^{14}C	6C	8.3–2.0	120	Bezrukova et al. (2011)
54	Baikal-CON01-603-5	53.95	108.91	480	Lake sediment	digitized	–	^{14}C	10D	15.8–0	270	Demske et al. (2005)
55	Ukta Creek mouth	55.80	109.70	906	Peat sediment	counts	From author	^{14}C	3U	5.1–0	160	Bezrukova et al. (2006)
56	Bolshoe Eravnoe Lake	52.58	111.67	947	Lake sediment	counts	EPD, Pan	^{14}C	3E	7.3–0.2	710	Vipper (2010)
57	Madjagara Lake	64.83	120.97	160	Lake sediment	counts	GPD, EPD, Pan	^{14}C	7E	8.2–0.2	120	Andreev and Klimanov (1989)
58	Khomustakh Lake	63.82	121.62	120	Lake sediment	counts	GPD, EPD, Pan	^{14}C	9E	12.3–0.1	170	Andreev et al. (1989)
59	Boguda Lake	63.67	123.25	120	Lake sediment	counts	GPD, EPD, Pan	^{14}C	7E	10.9–0.4	180	Andreev et al. (1989)
60	Barbarina Tumsa	73.57	123.35	10	Peat sediment	counts	Pan	^{14}C	4C	4.9–0.3	240	Andreev et al. (2004)
61	Lake Kyutyunda	69.63	123.65	66	Lake sediment	counts	Pan	^{14}C	10E	10.8–0.3	360	Biskaborn et al. (2016)
62	Suollakh	57.05	123.85	816	Peat sediment	counts	GPD, EPD, Pan	^{14}C	8C	12.8–3.7	180	Andreev and Klimanov (1991)
63	Derput Bog	57.03	124.12	700	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1A+4C	11.7–0.8	210	Andreev and Klimanov (1991)
64	Nikolay Lake	73.67	124.25	35	Lake sediment	counts	EPD, Pan	^{14}C	6A	12.5–0	600	Andreev et al. (2004)
65	Dyanushka River	65.04	125.04	123	Fluvial sediment	counts	Pan	^{14}C	13A	12.6–0	170	Werner et al. (2010)
66	Billyakh Lake	65.27	126.75	340	Lake sediment	counts	Pan	^{14}C	1A+10E	50.6–0.2	470	Müller et al. (2010)
67	Billyakh Lake	65.30	126.78	340	Lake sediment	counts	Pan	^{14}C	7A	14.1–0	180	Müller et al. (2009)
68	Dolgoe Ozero	71.87	127.07	40	Lake sediment	counts	From author	^{14}C	1A+9B	15.3–0	210	Pisaric et al. (2001)
69	Chabada Lake	61.98	129.37	290	Lake sediment	counts	GPD, EPD, Pan	^{14}C	15U	13–0	110	Andreev and Klimanov (1989)

Table A1. Continued.

ID	Site	Lat. (°)	Long. (°)	Elev. (m)	Archive type	Data type	Source	Dating method	No. of dates & material code	Time span (ka BP)	Res. (yr)	Reference
70	Mamontovy Khayata	71.77	129.45	0	Coastal sediment	counts	Pan	^{14}C	40A+24C	58.4–0	970	Andreev et al. (2002)
71	Nuochaga Lake	61.30	129.55	260	Lake sediment	counts	GPD, EPD, Pan	^{14}C	4E	6.5–0	140	Andreev and Klimanov (1989)
72	Tumannaya River	42.32	130.73	4	Fluvial sediment	counts	GPD	^{14}C	1F	14.4–0.1	380	Anderson et al. (2002)
73	Amba River	43.32	131.82	5	Peat sediment	counts	GPD	^{14}C	1A+1C	4.2–2.0	260	Korotky et al. (1980)
74	Paramonovskii Stream	43.20	133.75	120	Fluvial sediment	counts	GPD	^{14}C	2A+1E	32.2–0.6	4530	Korotky et al. (1993)
75	Ovrazhnyi Stream-2	43.25	134.57	10	Peat sediment	counts	GPD	^{14}C	3A+1C	36.0–0.4	2250	Korotky and Karaulova (1975)
76	Selitkan-2	53.22	135.03	1300	Peat sediment	counts	GPD	^{14}C	4C	6.4–1.9	260	Volkov and Arkhipov (1978)
77	Selitkan-1	53.22	135.05	1320	Peat sediment	counts	GPD	^{14}C	6C	7.9–0	140	Korotky et al. (1985)
78	Selitkan-3	53.22	135.07	1310	Peat sediment	counts	GPD	^{14}C	2E	10.2–2.3	790	Korotky and Kovalyukh (1987)
79	Bugutakh	67.83	135.12	128	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	1A	20.4–0	1860	Anderson et al. (2002)
80	Betenkyos	67.67	135.58	135	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	1A+1E	2.2–0	230	Anderson et al. (2002)
81	Adycha River	67.75	135.58	130	Fluvial sediment	counts	GPD	^{14}C	5A	9.2–3.7	420	Anderson et al. (2002)
82	Ulakhan	67.83	135.58	130	Fluvial sediment	counts	GPD	^{14}C	3C	8.6–5.7	330	Anderson et al. (2002)
83	Kiya	47.83	135.67	100	Peat sediment	digitized	–	^{14}C	4C	10.0–0.9	210	Bazarova et al. (2008)
84	Laptev PM9462	74.30	136.00	0	Marine sediment	digitized	–	^{14}C	12U	9.3–0.2	100	Naidina and Bauch (2001)
85	Khocho	71.05	136.23	6	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1C	10.4–0.4	300	Velichko et al. (1994)
86	Samandon	70.77	136.25	10	Peat sediment	counts	GPD, EPD, Pan	^{14}C	3A+8C+4E	7.9–0.2	280	Velichko et al. (1994)
87	Gur	50.00	137.05	35	Peat sediment	digitized	–	^{14}C	13C	22.1–0	340	Mokhova et al. (2009)
88	Gurskii peat	50.07	137.08	15	Peat sediment	counts	GPD	^{14}C	7C	13.1–1.5	380	Korotky (1982)
89	Siluyanov Yar	46.13	137.83	20	Fluvial sediment	counts	GPD	^{14}C	6A	12.8–4.9	1130	Korotky et al. (1988)
90	Oumi	48.22	138.40	990	Peat sediment	counts	GPD	^{14}C	5C	2.6–0.4	80	Anderson et al. (2002)
91	Opasnaya River	48.23	138.48	1320	Peat sediment	counts	GPD	14C	7C	13.3–6.7	360	Korotky et al. (1988)
92	Venyukovka-2	47.03	138.58	6	Peat sediment	counts	GPD	^{14}C	1A+1C	3.6–0.4	140	Korotky et al. (1980)
93	Venyukovka-3	47.12	138.58	5	Peat sediment	counts	GPD	^{14}C	1A+2C	5.8–3.2	140	Korotky et al. (1980)
94	Kyurbe-Yuryakh-2	68.60	138.62	650	Peat sediment	counts	GPD	^{14}C	4C	8.8–2.6	1530	Anderson et al. (2002)
95	Byllatskoye	69.17	140.06	316	Fluvial sediment	digitized	–	^{14}C	2A	28.6–2.8	4300	Anderson et al. (2002)
96	Smorodinovoye Lake	64.77	141.12	800	Lake sediment	counts	GPD, EPD, Pan	^{14}C	6A+5F	27.1–0	360	Anderson et al. (1998b)
97	Izylmet'evskaya	48.82	141.97	4	Fluvial sediment	counts	GPD	^{14}C	2A+2E+1F	4.3–2.8	100	Korotky et al. (1997a)
98	Orokess River	48.85	142.00	6	Coastal sediment	counts	GPD	^{14}C	4A+2C+3F	9.2–0.8	320	Korotky et al. (1997a)
99	Nizmennyii Cape	49.17	142.02	5	Coastal sediment	counts	GPD	^{14}C	2A	5.9–0.3	630	Korotky et al. (1997a)
100	Sergeevka River	49.23	142.08	2	Fluvial sediment	counts	GPD	^{14}C	2C+1F	2.3–0	230	Korotky et al. (1997b)
101	Sergeevskii	49.23	142.08	6	Peat sediment	counts	GPD	^{14}C	8A+1C	8.4–2.2	110	Korotky et al. (1997b)
102	Khoe, Sakhalin Island	51.34	142.14	15	Palaeosol	digitized	–	^{14}C	5A+3E	40.9–0	360	Leipe et al. (2015)
103	Il'inka Terrace	47.97	142.17	3	Peat sediment	counts	GPD	^{14}C	2C+1F	2.6–1.1	360	Korotky et al. (1997a)
104	Mereya River	46.62	142.92	4	Peat sediment	counts	GPD	^{14}C	2C+2F	42.0–0.8	1530	Anderson et al. (2002)
105	Kuobakh-Baga River	64.98	143.38	500	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	5A	6.5–2.6	350	Anderson et al. (2002)
106	Indigirka lowlands	70.58	145.00	20	Fluvial sediment	counts	GPD	^{14}C	3A+1F	59.1–6.0	1440	Lozhkin (1998)
107	Khlebnikova Stream	43.75	145.62	3	Peat sediment	counts	GPD	^{14}C	4C	5.4–1.3	290	Korotky et al. (1995)
108	Sernovodskii	43.92	145.67	5	Peat sediment	counts	GPD	^{14}C	1C	3.5–0.7	400	Korotky et al. (1996)
109	Lesnaya River	44.00	145.75	6	Peat sediment	counts	GPD	^{14}C	5C	7.4–3.9	140	Korotky et al. (1995)
110	Seryebryanka Stream	44.05	146.00	5	Peat sediment	counts	GPD	^{14}C	4C+2F	5.9–0.1	420	Korotky et al. (1995)
111	Kosmodem'yanskaya-2	44.10	146.05	6	Peat sediment	counts	GPD	^{14}C	1A+1C	7.2–0.4	570	Korotky et al. (1995)
112	Kosmodem'yanskaya-3	44.10	146.05	6	Peat sediment	counts	GPD	^{14}C	1A+2C	7.0–5.6	100	Korotky et al. (1995)
113	Kosmodem'yanskaya-1	44.10	146.07	6	Peat sediment	counts	GPD	^{14}C	1A+1C+1E	6.6–2.4	420	Korotky et al. (1995)
114	Berelyekh River	63.28	147.75	800	Peat sediment	counts	GPD, EPD, Pan	^{14}C	3C	34.8–2.5	1600	Lozhkin et al. (1989)
115	Vechernii River	63.28	147.75	800	Peat sediment	counts	GPD	^{14}C	2A+5C	6.1–0.3	210	Anderson et al. (2002)
116	Gek Lake	63.52	147.93	969	Lake sediment	counts	GPD, EPD, Pan	^{14}C	8A+1B	9.6–0	440	Stetsenko (1998)
117	Kirgirlakh Stream_2	62.67	147.98	700	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	4A	34.5–0.2	2140	Shilo et al. (1983)
118	Kirgirlakh Stream_4	62.67	147.98	700	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	4A	7.1–1.0	610	Shilo et al. (1983)
119	Elgennya Lake	62.08	149.00	1040	Lake sediment	counts	GPD, EPD, Pan	^{14}C	6A	16.0–0	310	Lozhkin et al. (1996)
120	Figurnoye Lake	62.10	149.00	1053	Lake sediment	counts	GPD	^{14}C	4A	1.3–0	30	Lozhkin et al. (1996)
121	Jack London Lake	62.17	149.50	820	Lake sediment	counts	GPD	^{14}C	7F	19.5–0.2	320	Lozhkin et al. (1993)
122	Rock Island Lake	62.17	149.50	870	Lake sediment	counts	GPD	^{14}C	2E	6.6–0	470	Lozhkin et al. (1993)
123	Sosednee Lake	62.17	149.50	822	Lake sediment	counts	GPD	^{14}C	4E+1F	26.3–0	640	Lozhkin et al. (1993)
124	Oldcamp Lake	62.04	149.59	853	Lake sediment	counts	GPD, EPD, Pan	^{14}C	2E	3.7–0	370	Anderson (unpublished data)
125	Glukhoye Lake	59.75	149.92	10	Peat sediment	counts	GPD, EPD, Pan	^{14}C	5C	9.4–3.4	1000	Lozhkin et al. (1990)
126	Pepelnoye Lake	59.85	150.62	115	Lake sediment	counts	GPD, EPD, Pan	^{14}C	2A	4.3–0	180	Lozhkin et al. (2000b)
127	Tanon River	59.67	151.20	40	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	6A+4C+1F	42.4–6.6	1240	Lozhkin and Glushkova (1997a)
128	Maltan River	60.88	151.62	735	Peat sediment	counts	GPD, EPD, Pan	^{14}C	4A+7C	12.0–9.4	120	Lozhkin and Glushkova (1997b)
129	Chistoye Lake	59.55	151.83	91	Peat sediment	counts	EPD, Pan	^{14}C	5C	7.0–0	540	Anderson et al. (1997)
130	Lesnoye Lake	59.58	151.87	95	Lake sediment	counts	GPD	^{14}C	8A	15.5–0	400	Anderson et al. (1997)
131	Elikchan 4 Lake	60.75	151.88	810	Lake sediment	counts	GPD, EPD, Pan	^{14}C	16U	55.5–0	440	Lozhkin and Anderson (1995)
132	Podkova Lake	59.96	152.10	660	Lake sediment	counts	GPD, EPD, Pan	^{14}C	5A	6.0–0	220	Anderson et al. (1997)
133	Goluboye Lake	61.12	152.27	810	Lake sediment	counts	EPD, Pan	^{14}C	11A+2B	9.7–0	240	Lozhkin et al. (2000a)
134	Alut Lake	60.14	152.31	480	Lake sediment	counts	GPD	^{14}C	16A+9B	50.4–0	430	Anderson et al. (1998a)
135	Taloye Lake	61.02	152.33	750	Lake sediment	counts	GPD, EPD, Pan	^{14}C	7A	10.3–0	290	Lozhkin et al. (2000a)
136	Julietta Lake	61.34	154.56	880	Lake sediment	counts	From author	^{14}C	2A+4E+1I	36.1–1.4	270	Anderson et al. (2010)
137	Pernatoye Lake	50.04	155.40	6	Lake sediment	counts	From author	^{14}C	6A+1E	10.1–0.1	160	Anderson et al. (2015)
138	East Siberian Sea 11	71.07	156.25	8	Peat sediment	counts	GPD, Pan	^{14}C	2A+2C	9.5–4.5	550	Lozhkin et al. (1975)
139	Kur peat	69.97	156.37	47	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1A+4C	11.7–7.5	430	Lozhkin and Vazhenina (1987)
140	East Siberian Sea coast	71.07	156.50	9	Peat sediment	counts	GPD	^{14}C	1C	13.0–1.7	1600	Anderson et al. (2002)
141	Kurop7	70.67	156.75	7	Peat sediment	counts	GPD, EPD, Pan	^{14}C	3C	5.7–0.4	760	Anderson et al. (2002)
142	Sokoch Lake	53.25	157.75	495	Lake sediment	digitized	–	^{14}C	8E	9.7–0.3	250	Dirksen et al. (2012)
143	Stadukhinskaya-1	68.67	159.50	12	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	4C	9.5–7.2	210	Lozhkin and Prokhorova (1982)

Table A1. Continued.

ID	Site	Lat. (°)	Long. (°)	Elev. (m)	Archive type	Data type	Source	Dating method	No. of dates & material code	Time span (ka BP)	Res. (yr)	Reference
144	Stadukhinskaya-2	68.67	159.50	5	Fluvial sediment	counts	GPD, EPD, Pan	^{14}C	2C	1.0–0	180	Lozhkin and Prokhorova (1982)
145	Two-Yurts Lake-3	56.82	160.04	275	Lake sediment	percent	Pan	^{14}C	5A	6.0–2.8	140	Hoff et al. (2015)
146	Two-Yurts Lake-2	56.82	160.07	275	Lake sediment	percent	Pan	^{14}C	5A	2.5–0.1	130	Hoff et al. (2015)
147	Two-Yurts Lake-5	56.82	160.07	275	Lake sediment	percent	Pan	^{14}C	5A	4.4–2.5	120	Hoff et al. (2015)
148	Cherny Yar	56.07	161.00	148	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1C+1E	13.0–0.5	830	Osipova (unpublished data)
149	Penzhinskaya Gulf	62.42	165.42	32	Peat sediment	counts	GPD, EPD, Pan	^{14}C	2C	8.9–3.4	500	Ivanov et al. (1984)
150	Enmynveem River1	68.17	165.93	400	Peat sediment	counts	GPD, EPD, Pan	^{14}C	2C+2F	36.4–9.3	2470	Lozhkin et al. (1988)
151	Enmynveem River2	68.25	166.00	500	Peat sediment	counts	GPD, EPD, Pan	^{14}C	4C	10.7–4.0	420	Anderson et al. (2002)
152	Ledovyi Obryu	64.10	171.18	44	Lake sediment	counts	GPD, EPD, Pan	^{14}C	3A+3C+1F	19.9–9.7	1140	Lozhkin et al. (2000c)
153	Enmyvaam River	67.42	172.08	490	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1A+4C	10.6–4.3	630	Lozhkin and Vazhenina (1987)
154	El'gygytgyn Lake	67.50	172.10	(170)	Lake sediment	percent	Pan	polarity	–	20.2–1.5	650	Melles et al. (2012)
155	El'gygytgyn Lake P1	67.37	172.22	561	Palaeosol	counts	From author	^{14}C	11A	12.9–3.1	580	Andreev et al. (2012)
156	El'gygytgyn Lake P2	67.55	172.13	542	Palaeosol	counts	From author	^{14}C	9A+1E	16.6–0	470	Andreev et al. (2012)
157	Melkoye Lake	64.86	175.23	36	Lake sediment	counts	From author	^{14}C	21E	39.1–0	1260	Lozhkin and Anderson (2013)
158	Sunset Lake	64.84	175.30	36	Lake sediment	counts	From author	^{14}C	7A	14.0–0	260	Lozhkin and Anderson (2013)
159	Malyi Krechet Lake	64.80	175.53	32	Lake sediment	counts	From author	^{14}C	12A	9.6–0	400	Lozhkin and Anderson (2013)
160	Patricia Lake	63.33	176.50	121	Lake sediment	counts	From author	^{14}C	3A+7E	19.1–0	290	Anderson and Lozhkin (2015)
161	Gytgykai Lake	63.42	176.57	102	Lake sediment	counts	GPD, EPD, Pan	^{14}C	1A+8E	32.3–0	470	Lozhkin et al. (1998)
162	Amguema River 1	67.75	178.70	175	Fluvial sediment	counts	GPD	^{14}C	2C	23.8–1.6	5550	Lozhkin et al. (1995)
163	Amguema River 2	67.67	178.60	87	Fluvial sediment	counts	GPD	^{14}C	2A	3.2–0.1	390	Lozhkin et al. (1995)
164	Blossom Cape	70.68	178.95	6	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1C	13.8–0.2	3400	Oganesyan et al. (1993)
165	Wrangel Island_JLL	70.83	−179.8	7	Lake sediment	counts	GPD	^{14}C	5A+1E	16.1–0.3	790	Lozhkin et al. (2001)
166	Wrangel Island_wr12	71.17	−179.8	200	Peat sediment	counts	GPD	^{14}C	17A+3C	13.7–10.2	110	Lozhkin et al. (2001)
167	Neizvestnaya	71.55	−179.4	3	Peat sediment	counts	EPD, Pan	^{14}C	1C	5.2–1.2	1000	Oganesyan et al. (1993)
168	Kresta Gulf	66.00	−179.0	5	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1A+1C	9.3–3.4	580	Ivanov (1986)
169	Konergino	65.90	−178.9	10	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1C	9.8–0	900	Ivanov et al. (1984)
170	Dlinnoye Lake	67.75	−178.8	280	Lake sediment	counts	GPD	^{14}C	3A	1.3–0	130	Anderson et al. (2002)
171	Dikikh Olyenyeii Lake	67.75	−178.8	300	Lake sediment	counts	EPD, Pan	^{14}C	1A+4C	50.3–0	1050	Anderson et al. (2002)
172	Arakamchechen Island	64.75	−172.1	7	Peat sediment	counts	GPD, EPD, Pan	^{14}C	1C	11.5–0	1050	Ivanov (1986)
173	Lorino	65.50	−171.7	12	Peat sediment	counts	GPD	^{14}C	3C	17.9–5.1	850	Ivanov (1986)

* Indicates the inclination of age–depth model with Lake Biwa. Elev. indicates elevation. Res. (year) indicates the temporal resolution. GPD: Global Pollen Database; EPD: European Pollen Database; Pan: PANGAEA. Material codes for radiocarbon dating: A = terrestrial plant macrofossil; B = non-terrestrial plant macrofossil; C = peat–gyttja bulk; D = pollen; E = total organic matter from silt; F = animal remains and shells; G = charcoal; H = $CaCO_3$; U = unknown.

Appendix B

Table B1. Pollen taxa used in the dataset and their corresponding original Latin names.

Standardized pollen name	Original pollen name
Abies	*Abies*, *Abies sibirica*
Acer	*Acer*
Alnus (shrub)	*Alnaster*, *Alnaster fruticosa*, *Alnus* cf. *fruticosa*, *Alnus viridis*, *Alnus viridis* ssp. *fruticosa*, *Alnus viridis* type, *Duschekia fruticosa*
Alnus (tree)	*Alnus* cf. *hirsuta*, *Alnus glutinosa*, *Alnus hirsuta*, *Alnus incana*
Alnus (undiff.)	*Alnus*, *Alnus* undiff.
Apiaceae	Apiaceae, *Bupleurum*, *Heracleum*, Umbelliferae, Umbelliferae undiff.
Araliaceae	*Aralia*, Araliaceae
Artemisia	*Artemisia*, *Artemisia tilesii*, *Artemisia* undiff.
Asteraceae (non-*Artemisia*)	*Achillea*, *Anthemis*, *Aster*, Asteraceae, Asteraceae cichorioideae, Asteraceae liguliflorae, Asteraceae subfam. Asteroideae, Asteraceae subfam. cichorioideae, Asteraceae tubuliflorae, *Centaurea cyanus*, *Cirsium*, Compositae, Compositae subfam. Asteroideae, Compositae subfam. Asteroideae undiff., Compositae subfam. Cichorioideae, *Lactuca* type, *Matricaria*, *Saussurea*, *Senecio*, *Serratula*, *Taraxacum*
Betula (shrub)	*Betula* (shrub), *Betula* cf. *B. fruticosa*, *Betula* cf. *B. nana*, *Betula* cf.*nana*, *Betula divaricata*, *Betula fruticosa*, *Betula nana*, *Betula nana* ssp. *exilis*, *Betula nana* ssp. *nana*, *Betula ovalifolia*, *Betula* sect. *Fruticosae*, *Betula* sect. *Nanae*, *Betula* sect. *Nanae/Fruticosae*
Betula (tree)	*Betula alba* type, *Betula* cf. *B. pendula*, *Betula* cf. *alba*, *Betula costata*, *Betula dahurica*, *Betula ermanii*, *Betula pendula*, *Betula platyphylla*, *Betula pubescens*, *Betula schmidtii*, *Betula* sect. *Albae*, *Betula* sect. *Betula*, *Betula* sect. *Costatae*
Betula (undiff.)	*Betula*, *Betula* undiff., Betulaceae undiff.
Boraginaceae	Boraginaceae, *Lithospermum* type
Brassicaceae	Brassicaceae, Brassicaceae undiff., *Cardamine*, Cruciferae, Crucififerae, *Draba*
Campanulaceae	Campanulaceae
Cannabis	Cannabaceae, *Cannabis*
Caprifoliaceae	Caprifoliaceae, Caprifoliaceae undiff., *Diervilla*, *Knautia*, *Linnaea borealis*, *Lonicera*, *Sambucus*, *Viburnum*
Carpinus	*Carpinus*, *Carpinus cordata*, *Carpinus betulus*
Carya	*Carya*
Caryophyllaceae	Caryophyllaceae, Caryophyllaceae Sf. Silenoideae-type, Caryophyllaceae undiff., *Cerastium*, *Gypsophila repens* type, *Illecebrum verticillatum*, *Lychnis* type, *Minuartia*, *Silene*, *Stellaria holostea*
Castanea	*Castanea*
Cedrus	*Cedrus*
Celastraceae	Celastraceae, *Euonymus*
Celtis	*Celtis*
Cerealia+large Poaceae	Cerealia, *Hordeum*, *Triticum* type
Chenopodiaceae	Chenopodiaceae, Chenopodiaceae/Amaranthaceae
Convolvulaceae	Convolvulaceae
Cornus	*Cornus*, *Cornus suecica*
Corylus	*Corylus*
Crassulaceae	Crassulaceae, *Mentanthes trifoliata*, *Sedum*
Cupressaceae (other)	Cupressaceae
Cyperaceae	Cyperaceae
Dacrydium	*Dacrydium*
Dipsacaceae	Dipsacaceae, *Succisa*
Droseraceae	*Drosera*, Droseraceae
Elaeagnus	*Elaeagnus*
Ephedra	*Ephedra*, *Ephedra distachya*, *Ephedra distachya+fragilis*, *Ephedra fragilis*, *Ephedra monosperma*
Ericaceae	*Calluna*, *Cassiope*, *Empetrum*, Ericaceae, Ericaceae undiff., *Ericales*, *Ericales* undiff., *Ledum*, *Rhododendron*, *Vaccinium*
Euphorbiaceae	*Euphorbia*, Euphorbiaceae

Table B1. Continued.

Standardized pollen name	Original pollen name
Fabaceae (herb)	*Trifolium*
Fabaceae (shrub)	*Astragalus*
Fabaceae (undiff.)	Fabaceae, Fabaceae undiff., Leguminosae, Papilionaceae
Fagus	*Fagus*
Gentianaceae	*Gentiana*, Gentianaceae, Gentianaceae undiff.
Geraniaceae	Geraniaceae, *Geranium*
Hippophäe	*Hippophäe rhamnoides*
Humulus	*Humulus*
Ilex	*Ilex*
Impatiens	*Impatiens noli-tangere*
Iridaceae	Iridaceae
Juglans	*Juglans*
Juncaceae	Juncaceae
Juniperus	*Juniperus*
Koenigia	*Koenigia islandica*
Lamiaceae	*Labiatae*, Lamiaceae, Lamiaceae undiff., *Mentha* type
Larix	*Larix*, *Larix dahurica*, *Larix gmelinii*, *Larix sibirca*
Liliaceae	*Allium*, Liliaceae, *Lloydia*, *Polygonatum*, *Tofieldia*, *Veratrum*, *Zigadenus*
Linaceae	Linaceae
Lythraceae	Lythraceae, *Lythrum*
Malvaceae	Malvaceae
Myrica	*Myrica*
Oenotheraceae	*Chamaenerium*, *Circaea*, *Circaea alpina*, *Epilobium*, *Epilobium angustifolium*, *Epilobium latifolium*, *Epilobium* undiff., Onagraceae, Onagraceae undiff.
Oleaceae (temperate)	*Fraxinus*, *Fraxinus mandschurica*
Oleaceae (undiff.)	Oleaceae, Oleaceae undiff., *Syringa*
Orchidaceae	Orchidaceae
Oxalidaceae	Oxalidaceae
Papaveraceae	*Corydalis*, *Papaver*, Papaveraceae
Phellodendron	*Phellodendron*
Picea	*Picea*, *Picea abies* ssp. *obovata*, *Picea obovata*, *Picea* sect. *Eupicea*, *Picea* sect. *Omorica*, *Picea* undiff., *Picea*/*Pinus* undiff.
Pinguicula	*Pinguicula*
Pinus (Diploxylon)	*Pinus* (Diploxylon), *Pinus* subgen. *Pinus*, *Pinus* subg. *Pinus* undiff., *Pinus sylvestris*
Pinus (Haploxylon)	*Pinus* (Haploxylon), *Pinus cembra*, *Pinus koraiensis*, *Pinus pumila*, *Pinus sibirica*, *Pinus sibirica* type, *Pinus* subgen. *Strobus*, *Pinus* subgen. *Strobus* undiff., *Pinus* subgen. Haploxylon, *Pinus* subsect. *Cembrae* undiff.
Pinus (undiff.)	Pinaceae, Pinaceae undiff., *Pinus*, *Pinus* undiff.
Plantago	Plantaginaceae, *Plantago*
Plumbaginaceae	*Armeria*, *Armeria maritima* type, *Goniolimon*, *Limonium*, Plumbaginaceae
Poaceae (wildgrass)	Gramineae, Poaceae, *Stipa*
Podocarpus	*Podocarpus*
Polemoniaceae	*Helianthemum*, *Phlox*, *Phlox sibirica*, Polemoniaceae, Polemoniaceae undiff., *Polemonium*, *Polemonium acutiflorum*, *Polemonium boreale*
Polygala	*Polygala*
Polygonaceae (other)	*Oxyria*, *Oxyria digyna*, Polygonaceae, Polygonaceae undiff.
Polygonum	*Polygonum*, *Polygonum alaskanum*, *Polygonum amphibium*, *Polygonum aviculare*, *Polygonum bistorta*, *Polygonum bistortoides* type, *Polygonum czukavinae*, *Polygonum ellipticum*, *Polygonum laxmanii*, *Polygonum* sect. *Aconogonon*, *Polygonum* sect. *Bistorta*, *Polygonum* sect. *Persicaria*, *Polygonum tripterocarpum*, *Polygonum* undiff., *Polygonum viviparum*
Populus	*Populus*
Portulacaceae	*Claytonia*, *Claytonia acutifolia*, *Claytonia arctica*, *Claytonia sarmentosa*, *Claytonia sibirica*, *Claytonia* undiff., *Claytoniella vassilievii*, Portulacaceae, Portulacaceae undiff.
Primulaceae	*Androsace*, Androsaceae, *Lysimachia*, *Primula*, Primulaceae, Primulaceae undiff.

Table B1. Continued.

Standardized pollen name	Original pollen name
Pterocarya	*Pterocarya*
Pyrolaceae	Pyrolaceae
Quercus (deciduous)	*Quercus dentata*, *Quercus mongolica*
Quercus (undiff.)	*Quercus*, *Quercus* undiff.
Ranunculaceae (other)	*Anemone*, *Anemone nemorosa*, *Caltha palustris*, *Delphinium, Hepatica*, *Pulsatilla*, Ranunculaceae, Ranunculaceae undiff., *Ranunculus*, *Trollius*
Rhamnus	*Rhamnus*
Ribes	*Ribes*, *Ribes rubrum* type
Rosaceae	*Comarum palustre*, *Dryas*, *Dryas octopetala*, *Filipendula*, *Filipendula ulmaria*, *Potentilla*, Rosaceae, Rosaceae subf. Maloideae, Rosaceae undiff., *Rubus*, *Rubus atcticus*, *Rubus chamaemorus*, *Sanguisorba*, *Sanguisorba officinalis*, *Sieversia* type, *Sorbus aucuparia*, *Spiraea*
Rubiaceae	*Galium*, Rubiaceae
Rumex	*Rumex*, *Rumex aquatilis*, *Rumex* undiff., *Rumex*/*Oxyria*, *Rumex*/*Oxyria digyna*
Salix	*Salix*
Saxifragaceae (herb)	*Parnassia*, *Parnassia palustris*, *Saxifraga*, *Saxifraga cernua*, *Saxifraga gramulata* type, *Saxifraga hieracifolia*, *Saxifraga nivalis* type, *Saxifraga oppositifolia*, *Saxifraga* sp., *Saxifraga stellaris* type, *Saxifraga tricuspidata*, *Saxifraga* undiff.
Saxifragaceae (undiff.)	Saxifragaceae, Saxifragaceae undiff.
Scrophulariaceae	*Castilleja*, *Lagotis*, *Pedicularis*, Scrophulariaceae, Scrophulariaceae undiff.
Thalictrum	*Thalictrum*
Tilia	*Tilia*
Tsuga	*Tsuga*, *Tsuga canadensis*, *Tsuga diversifolia*, *Tsuga* undiff.
Ulmus	*Ulmus*, *Ulmus glabra*, *Ulmus minor*, *Ulmus* sp.
Urtica	*Urtica*
Urticaceae (non-*Urtica*)	Urticaceae
Valerianaceae	*Patrinia*, *Valeriana*, *Valeriana capitata*, *Valeriana officinalis*, *Valeriana* undiff., Valerianaceae, Valerianaceae undiff.
Violaceae	Violaceae

Author contributions. UH and XC designed the pollen dataset. XC and FT compiled the standardization for the dataset and wrote the draft. Other authors provided pollen data and all authors discussed the results and contributed to the final paper.

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