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Supplement of

Newly dated permafrost deposits and their paleoecological inventory reveal an Eemian much warmer than today in Arctic Siberia

Lutz Schirrmeister et al.

Correspondence to: Lutz Schirrmeister (lutz.schirrmeister@awi.de)

Supplement material_

Tables

Table S1: Modern occurrences of plants recovered in Krest Yuryakh deposits after GBIF and MTWA at these locations according to the updated database of Leemans and Cramer (1991). The minimum values for thermophilous species or, respectively, the maximum detected values for cryophytes are given, together resulting in a mutual climatic range or coexistence interval

Taxon	Occurrence in Yakutia with the highest or lowest MTWA	Source of the occurrence	$MTWA_{Min}$ [°C]	$MTWA_{Max}$ [°C]
Alnus hirsuta	63.8 °N, 141. °8E	GBIF, 2024a	12.7	18.4
Alnus alnobetula subsp. *fruticosa*	72.6 °N, 126.4 °E	GBIF, 2024b	7.5	18.4
Betula fruticosa	71.5 °N, 126.7 °E	GBIF, 2024c	9.1	18.4
Potamogeton perfoliatus	68.8 °N, 161.3 °E	GBIF, 2024d	10.3	18.4
Myriophyllum spicatum	69.0 °N, 161.6 °E	GBIF, 2024e	10.3	18.4
Larix gmelinii	72.3 °N, 125.8 °E	GBIF, 2024f	8.0	18.4
Betula divaricata	71.8 °N, 128.1°E	GBIF, 2024g	7.6	18.4
Arctostaphylos uva-ursi	70.7 °N, 127.3 °E	GBIF, 2024h	10.6	18.4
Moehringia lateriflora	70.6 °N, 147.9 °E	GBIF, 2024i	9.9	18.4
Sparganium minimum	69.0 °N, 161.6 °E	GBIF, 2024j	10.3	18
Cherleria arctica	73.5 °N, 142.0 °E; 63.9 °N, 131.8 °E	GBIF, 2024k	3.3	13.3
Coptidium lapponicum	73.5 °N, 142.0 °E 62.1 °N, 129.8 °E	GBIF, 2024l	3.5	18.4
Silene involucrata	73.5 °N, 142.0 °E 66.8 °N, 123.3 °E	GBIF, 2024m	3.3	15.7
Sagina nivalis	75.5 °N, 138.8 °E 69.7 °N, 135.1 °E	GBIF, 2024n	2.6	12.9
Potentilla hyparctica	75.5 °N, 138.8 °E 66.0 °N, 126.2 °E	GBIF, 2024o	2.6	14.6
Ranunculus nivalis	75.5 °N, 143.9 °E 64.5 °N, 109.6 °E	GBIF, 2024p	1.6	15.3
Coexistence interval MTWA [°C] Bol'shoy Lyakhovsky	Minimum of *Sparganium minimum* Maximum of *Sagina nivalis*		10.3	12.9
Coexistence interval MTWA [°C] Oyogos Yar	Minimum of *Alnus hirsuta* Maximum of *Ranunculus nivalis*		12.7	15.3

GBIF, 2024a. https://www.gbif.org/occurrence/2570528215
GBIF, 2024b. https://www.gbif.org/occurrence/3004116521
GBIF, 2024c. https://www.gbif.org/occurrence/2570527169
GBIF, 2024d. https://www.gbif.org/occurrence/3467615661
GBIF, 2024e. https://www.gbif.org/occurrence/3496990363
GBIF, 2024f. https://www.gbif.org/occurrence/1697158965
GBIF, 2024g. https://www.gbif.org/occurrence/3464847162
GBIF, 2024h. https://www.gbif.org/occurrence/3467619303
GBIF, 2024i. https://www.gbif.org/occurrence/3465025758
GBIF, 2024j. https://www.gbif.org/occurrence/3496988350
GBIF, 2024k. https://www.gbif.org/occurrence/3464890601; https://www.gbif.org/occurrence/3710512588
GBIF, 2024l. https://www.gbif.org/occurrence/3465027647; https://www.gbif.org/occurrence/1697230123
GBIF, 2024m. https://www.gbif.org/occurrence/3464892630; https://www.gbif.org/occurrence/1697223244
GBIF, 2024n. https://www.gbif.org/occurrence/3465037654; https://www.gbif.org/occurrence/3467613504
GBIF, 2024o. https://www.gbif.org/occurrence/3464890595; https://www.gbif.org/occurrence/3710506639
GBIF, 2024p. https://www.gbif.org/occurrence/2570552746; https://www.gbif.org/occurrence/2570552150

Table S2: Plant macro remain taxa from both coasts

Plant communities (syntaxa)	Plant taxa	Present at Bol'shoy Lyakhovsky	Present at Oyogos Yar
dry variant	*Arctostaphylos uva-ursi* (L.) SPRENG.		X
	Moehringia laterifolia (L.) FENZL	X	X
	Stellaria longifolia MUEHL. EX WILLD.		X
	Chamaenerion angustifolium (L.) SCOP.		X
Forests & forest tundra (Betulo-Adenostyletea BR.-BL. & R.TX. 1943; Vaccinio-Piceetea BR.-BL. 1939; Epilobietea angustifolii R.TX. &PRSG.EX V. ROCHOW)	*Larix gmelinii* (RUPR.) KUZEN.		X
	Pinaceae indet.		X
	Alnus hirsuta Turcz.		X
	Alnus alnobetula subsp. *fruticosa* (RUPR.) RAUS	X	X
	Boschniakia rossica (CHAM. & SCHLECHT.) B. FEDTSCH.	X	
	Betula cf. *pendula* ROTH		X
	Betula divaricata LEDEB.		X
	Betula fruticosa PALL.	X	X
	Betula nana L. s.l.	X	X
	Betula sp. L.	X	X
	Betulaceae indet.	X	X
wet variant, associated to bogs	*Vaccinium vitis-idaea* L.	X	X
	Andromeda polifolia L.		X
	Empetrum nigrum L.	X	
	Rhododendron tomentosum (STOKES) HARMAJA	X	
	Chamaedaphne calyculata MOENCH		X
	Ranunculus lapponicus L.	X	X
Wetland & riparian vegetation (Oxycocco-Sphagnetea Br.-Bl. & R.Tx. 1943; Scheuchzerio caricetea nigrae (NORDH. 1936) R.TX. 1937)	*Chrysosplenium alternifolium* L.	X	X
	Micranthes hieracifolia (WALDST. & KIT.) HAW.		X
	Carex lugens H.T. HOLM		X
	Carex aquatilis WAHLENB.	X	X
	Carex sect. Phacocystis DUMORT.	X	X
	Eriophorum scheuchzeri HOPPE	X	X
	Eriophorum brachyantherum TRAUTV. ET C.A. MEY	X	X
	Eriophorum russeolum FRIES		X

		Eriophorum cf. gracile KOCH	X	
		Eriophorum angustifolium HONCK.	X	X
		Caltha palustris L.	X	X
		Carex parallela subsp. *redowskiana* (C.A.MEY.) T.V.EGOROVA		X
		Comarum palustre L.	X	X
		Silene violascens (TOLM.) V.V.PETROVSKY & ELVEN	X	
		Parnassia palustris L.	X	
		Epilobium davuricum L.	X	
		Epilobium palustre L.	X	X
		Sparganium hyperboreum LAEST.	X	X
		Sparganium minimum HILL	X	
		Menyanthes trifoliata L.	X	
Aquatic vegetation (Potamogetonetea pectinati R. TX. & PRSG 1942)		*Nitella* sp.	X	
		Hippuris vulgaris L.	X	X
		Myriophyllum spicatum L.		X
		Batrachium sp. (DC.) S.F. GRAY	X	X
		Callitriche hermaphroditica L.	X	X
		Potamogeton perfoliatus L.		X
		Stuckenia filiformis (PERS.) BÖRNER		X
		Stuckenia vaginata (MAGNIN) HOLUB	X	X
		Potamogeton sp. L.		X
		Ranunculus hyperboreus ROTTB./ *gmelinii* DC.	X	X

Plant communities (syntaxa)		Plant taxa	Present at BLI	Present at Oyogos Yar
		Ranunculus hyperboreus ROTTB./ *gmelinii* DC.	X	X
	(halophytic) pioneers of lake littoral (Bidentetea tripartitae R.TX. ET AL. AP. R.TX. 1950)	*Rorippa palustris* (L.) BESSER	X	
		Tephroseris palustris (L.) REICHENB.	X	X
		Rumex maritimus L.	X	
		Chenopodium sp. L.		X
		Chenopodium cf. *glaucum* L.		X
		Stellaria crassifolia EHRH.	X	

	Spergularia salina J. et C. Presl.		X
	Tripleurospermum hookeri Sch.Bip.	X	
	Eleocharis palustris (L.) Roem. et Schult.		X
mesic grassland vegetation (Asteretea tripolii Westh. et Beeft. In Beeft. 1965; Molinio-Arrhenateretea R.Tx. 1937)	*Puccinellia* sp. Parl.	X	X
	Alopecurus cf. *pratensis* L.	X	X
	Deschampsia sp. Beauv.	X	X
	Arctagrostis latifolia (R.Br.) Griseb.		X
	Rumex arcticus Trautv.	X	X
	Equisetum arvense L.		X
	Ranunculus propinquus s.l. C.A.Mey.	X	
	Calamagrostis sp. Adans.	X	X
	Allium cf. *schoenoprasum* L.		X
	Poa sp. L.	X	X
	Festuca sp. L.		X
Steppes (Koelerio-Corynephoretea Klika & Nowak 1941, Festuco-Brometea Br.-Bl. & R.Tx. 1943)	*Rumex acetosella* L. *s.l.*	X	X
	Carex duriuscula C.A. Mey	X	X
	Eritrichium sericeum (Lehm.) A.DC.		X
	Carex supina var. *spaniocarpa* (Steud.) B.Boivin	X	X
	Alyssum cf. *obovatum* (C.A. Mey) Turcz.		X
	Asteraceae cf. *Achillea* L. / *Ptarmica* Hill		X
Tundra steppes (Carici rupestris- Kobresietea bellardii Ohba 1974)	*Potentilla stipularis* L.	X	X
	Androsace septentrionalis L.	X	
	Potentilla cf. *arenosa* (Turcz.) Juz.	X	
	Artemisia sp. L.	X	X
	Potentilla nivea L.	X	X
	Ranunculus pedatifidus var. *affinis* (R.Br.) L.D. Benson	X	X
	Rhododendron sp. L.	X	X
	Carex myosuroides Vill.	X	X
	*Dryas octopetala s.l. (*Juz.) Hult.	X	X
	Gagea serotina (L.) Ker Gawl.	X	
	Physaria arctica (Wormsk. ex Hornem.) O'Kane & Al-Shehbaz	X	

	Silene involucrata (CHAM. & SCHLTDL.) BOCQUET	X	X
	Cherleria arctica (STEVEN EX SER.) A.J.MOORE & DILLENB.	X	
	Bistorta vivipara (L.) S.F.GRAY	X	
	Saxifraga cf. *oppositifolia* L.		X
Arctic (and alpine) pioneer vegetation (Thaspitea rotundifolii BR.-BL. 1948)	*Stellaria longipes* GOLDIE s.l.	X	X
	Cerastium beeringianum CHAM. ET SCHLECHT.	X	X
	Cerastium cf. *jenissejense* HULT.	X	
	Draba sp. L.	X	X
	Papaver Sect. Scapiflora RCHB.	X	X
	Sabulina rubella (WAHLENB.) DILLENB. & KADEREIT	X	X
	Chamaenerion latifolium (L.) TH. FRIES		X
	cf. *Descurainia sophioides* O.E. SCHULZ	X	X
	Eutrema edwardsii R.Br.	X	
	Potentilla cf. *hyparctica* Malte	X	
	Sagina nivalis (LINDBLOM) FR.	X	
	Luzula confusa LINDEB.	X	X
	Luzula wahlenbergii RUPR.	X	X
Snow bed vegetation (Salicitea herbaceae BR.-BL. 1947)	*Ranunculus nivalis* L.		X
	Juncus biglumis L.	X	X
	Salix sp. L.	X	X
Without indication	*Asteraceae indet.*	X	X
	Poaceae indet.	X	X
	Carex indet. tricarpellata	X	X
	cf. *Corydalis* sp.	X	

Table S3: GDGT proxy data for core L14-04.

Altitude (m)	BIT	Ri/b	GDGT-1+3/(GDGT-1+cren)	Air GST
11.6	1.00	0.02	0.39	0.9
11.3	1.00	0.01	0.61	2.1
11.0	1.00	0.00	0.72	1.7
10.5	1.00	0.01	0.32	2.4
9.6	1.00	0.01	0.86	1.0
8.1	1.00	0.02	0.27	0.8
6.7	0.98	0.09	0.33	-0.1

Table S4: Number of species, number of individuals, and Menhinick index (D_{Mn}) (Menhinik, 1964) of fossil beetle assemblages in different stratigraphic units

Unit	**Number of samples (S)**	**Number of species (N)**	**Number of individuals**	**D_{Mn}**
Late Holocene flood plain (MIS 1)	3	53	453	2.49
Holocene thermokarst (MIS 1)	2	55	380	2.82
Yedoma Ice Complex (MIS 3-2)	7	33	306	1.89
Krest Yuryakh (MIS 5e)	4	91	588	3.75
Yukagir and Kuchchugui (MIS 7-6)	14	39	366	2.04

Reference
Menhinick, E.F. (1964). A comparison of some species-individuals diversity indices applied to samples of field insects. Ecology, 45, 859–861. https://doi.org/10.2307/1934933

Table S5: Insects from MIS 5 samples from the DLS area (aq. – aquatic, ri – riparian, - xe – xerophilous, dt - dry tundra, ms – meadow steppe, mt - mesic tundra, fo -forest zone, pl – plant litter, ss – sedge (cryoxerophilous) steppe, oth - others, sh - shrubs, st - steppe, ar – arctic tundra).

taxa	eco	L-11-B17	R-22-B15	R-22-B16	L-11-B19	Oya-6
Subphylum Hexapoda, Class Insecta						
Ord. Coleoptera						
Fam. Gyrinidae						
Gyrinus opacus Sahlb.	aq	1	0	0	0	0
Fam. Carabidae						
Subfam. Nebriinae						
Nebria frigida Sahlb.	ri	2	0	0	0	0
Notiophilus aquaticus L.	xe	3	2	1	2	0
Pelophila borealis (Payk.)	ri	1	0	0	0	0
Subfam. Carabinae						
Carabus shilenkovi O.Berlov	dt	3	1	1	0	0
C. kolymensis Kryzh. et Bud.	ms	0	0	0	1	0
Subfam. Elaphrinae						
Blethisa catenaria Brown	mt	0	0	0	1	0
Diacheila polita (Fald.)	mt	3	2	2	0	0
Elaphrus riparius L	ri	1	0	0	0	0
E. lapponicus Gyll.	ri	0	0	0	1	0
Subfam. Trechinae						
Bembidion (Asioperyphus) umiatense Lindrth.	ri	6	0	2	2	0
B. (Peryphanes) grapii Gyll.	dt	2	1	0	1	0
B. (Peryphanes) dauricum Motsch.	dt	0	0	0	1	0
B. (Plataphus) hyperboraeorum Munch	ri	0	0	0	1	0
B. (Notaphus) varium (Ol.)	ri	0	0	0	0	1
Subfam. Harpalinae						
Dicheirotrichus mannerheimii (Sahlb.)	dt	1	2	2	0	0
Harpalus vittatus kiselevi Kat. et Shil.	ms	2	0	1	0	0
H. vittatus vittatus Gebl.	ms	2	0	0	0	0
H. amputatus amputatoides Mlynar	ms	0	0	0	0	1
Cymindis arctica Kryzh. et Em.	st	0	3	0	0	0
Agonum (Agonothorax) impressum Panz.	ri	2	1	0	0	0
Sericoda quadripunctata (DeG)	ri	0	1	0	0	0
Poecilus (Derus) nearcticus Lindrth.	dt	3	2	0	0	0

Pterostichus (Cryobius) brevicornis (Kby.)	mt	24	20	4	8	0
P. (Cryobius) nigripalpis Popp.	dt	2	3	2	1	0
P. (Cryobius) pinguedineus Esch.	mt	6	5	0	2	0
P. (Cryobius) ventricosus Esch.	mt	2	2	4	2	4
P. (Cryobius) spp.	mt	14	3	4	5	0
P. (Lenapterus) costatus Men.	mt	2	0	1	0	0
P. (Lenapterus) vermiculosus Men.	mt	4	0	0	0	0
P. (Tundraphilus) sublaevis Sahlb.	dt	3	0	2	2	2
P. (Lenapterus) agonus Horn.	mt	0	3	0	0	0
P. (Lenapterus) vermiculosus Men.	mt	0	0	0	1	0
P. (Petrophilus) eximius Mor.	dt	0	1	0	0	0
P. (Petrophilus) magus Mann.	fo	0	0	0	1	0
P. (Petrophilus) montanus (Motsch.)	dt	0	0	0	1	0
P. (Petrophilus) tundrae Tschitsch.	dt	0	0	0	1	0
Stereocerus haematopus (Dej.)	dt	3	3	0	0	0
Amara (Amarocelia) interstitialis Dej.	dt	0	1	0	1	0
A. (Curtonotus) alpina Payk.	dt	23	45	11	8	8
A. (Curtonotus) bokori Csiki	dt	0	0	0	0	1
Carabidae gen. indet. (larvae heads)	pl	0	1	0	0	2
Fam. Dytiscidae						
Subfam. Agabinae						
Agabus moestus (Curt.)	aq	0	0	1	2	2
A. thomsoni (Sahlb)	aq	7	0	0	0	0
Subfam. Colymbetinae						
Colymbetes dolabratus (Payk.)	aq	2	2	1	1	1
Subfam. Hydroporinae						
Hydroporus fuscipennis Schaum.	aq	6	0	0	0	0
H. acutangulus Thoms.?	aq	0	0	2	0	0
Fam. Hydrophilidae						
Subfam. Helophorinae						
Helophorus obscurellus Popp.	aq	0	0	0	0	2
H. sibiricus (Motsch.)	aq	0	0	1	0	2
H. splendidus Sahlb.	aq	1	2	3	0	2
Subfam. Hydrophilinae						
Hydrobius fuscipes (L)	aq	1	0	0	1	0
Subfam. Sphaeridiinae						

Cercyon sp.	pl	6	0	0	0	0
Fam. Leiodidae						
Subfam. Leiodinae						
Anisotoma sp.	pl	0	0	0	0	2
Cyrtoplastus irregularis Rtt.	pl	2	0	0	0	1
Subfam. Coloninae						
Colon sp.	pl	1	0	0	0	1
Subfam. Cholevinae						
Cholevinus sibiricus (Jean.)	mt	5	4	4	1	5
Cholevinus sp.	pl	0	0	0	0	2
Fam. Staphylinidae						
Subfam. Omaliinae						
Eucnecosum tenue (LeC.)	pl	3	1	1	0	2
Olophrum consimile Gyll.	mt	16	3	4	6	0
Subfam. Tachyporinae						
Tachinus arcticus Motsch.	mt	10	24	9	1	1
T. brevipennis Sahlb.	mt	0	0	0	0	6
Tachyporus sp.	pl	0	1	0	1	0
Subfam. Aleocharinae						
Gymnusa sp.	pl	0	0	0	0	1
Subfam. Steninae						
Stenus sp.	ri	1	0	0	1	1
Subfam. Paederinae						
Lathrobium longulum Grav.?	pl	0	0	0	0	1
Lathrobium sp.	pl	2	1	0	1	0
Subfam. Staphylininae						
Quedius sp.	pl	1	0	0	1	0
Staphylinidae gen. indet.	pl	1	0	1	1	0
Fam. Scarabaeidae						
Subfam. Aphodiinae						
Aegialia kamtschatica Motsch.	ri	1	1	0	0	0
Aphodius distinctus Muell.?	xe	1	0	3	1	0
Aphodius sp.	xe	0	0	0	0	1
Fam. Byrrhidae						
Subfam. Byrrhinae						
Morychus viridis Kuzm. et Kor.	ss	12	29	4	4	3

Simplocaria arctica Popp.	dt	7	1	5	1	0
S. elongata Sahlb.	dt	0	0	0	0	1
Subfam. Syncalyptinae						
Curimopsis cyclolepidia Muenst.	dt	1	1	0	2	0
Fam. Ptinidae						
Subfam. Anobiinae						
Caenocara bovistae Hoffm.	pl	0	0	0	0	1
Fam. Melyridae						
Protapalochrus arcticus (L.Medv.)	ms	2	0	0	0	1
Fam. Coccinellidae						
Subfam. Coccinellinae						
Hippodamia arctica Schneid.	ri	0	0	0	0	1
Scymnus sp.	ri	0	1	0	0	0
Coccinellidae gen. indet.	oth	0	1	0	0	0
Fam. Lathridiidae						
Subfam. Corticariinae						
Corticaria sp.	pl	1	2	1	0	0
Fam. Chrysomelidae						
Subfam. Chrysomelinae						
Chrysolina brunnicornis bermani Medv.	st	0	3	0	0	0
Ch. subsulcata Mann.	tt	0	6	2	0	0
Ch. septentrionalis Men.	mt	0	1	2	1	0
Ch. bungei Jac.	tt	0	1	1	0	0
Chrysolina sp.	oth	0	0	0	0	1
Gonioctena affinis Gyll.	sh	0	0	0	0	1
Hydrothassa glabra Hbst.	ri	1	0	0	0	0
H. hannoverana F.	ri	0	0	1	1	2
Phaedon concinnus Steph.	me	0	0	0	1	0
Phratora sp.	sh	1	0	0	0	0
Subfam. Eumolpinae						
Bromius obscurus (L)	me	1	0	0	0	0
Fam. Brentidae						
Subfam. Apioninae						
Hemitrichapion tschernovi T.-M.	dt	0	0	1	1	0
Fam. Brachyceridae						
Subfam. Erirhininae						

Notaris bimaculatus F.	ri	1	1	0	0	0
Fam. Curculionidae						
Subfam. Ceutorhynchinae						
Pelenomus velaris Gyll.	ri	0	0	0	0	1
Pelenomus sp.	ri	1	0	0	0	0
Subfam. Entiminae						
Phyllobius kolymensis Kor. et Egor.	ms	0	0	0	0	1
Sitona borealis Kor.	dt	1	2	0	0	0
Subfam. Hyperinae						
Hypera diversipunctata (Schrank.)	dt	0	2	1	2	0
H. ornata (Cap.)	dt	3	1	1	0	1
Subfam. Lixinae						
Coniocleonus sp.	ms	1	2	1	0	1
Stephanocleonus eruditus Faust	st	0	4	0	0	0
S. fossulatus F.-W.	st	0	1	0	0	0
Subfam. Molytinae						
Lepyrus nordenskioeldi Faust	sh	1	2	0	2	0
Subfam. Curculioninae						
Dorytomus imbecillus Faust	sh	1	1	0	0	0
Isochnus flagellum Erics.	sh	1	0	0	0	0
I. arcticus Kor.	ar	0	0	1	0	0
Ord. Hymenoptera						
Fam. Formicidae						
Leptothorax acervorum (F.)	fo	0	0	0	0	1
Ord. Hemiptera, suboder Heteroptera						
Fam. Saldidae						
Salda littoralis L.	ri	0	0	0	0	1
Salda sp.	ri	0	0	1	0	0
Saldula pallipes (F.)	ri	0	0	0	0	1
Fam. Pentatomidae						
Sciocoris microphthalmus Flor.	fo	0	0	0	0	1
Ord. Hemiptera, suboder Auchenorrhyncha						
Fam. Cicadellidae						
Cicadellidae gen. indet.	me	0	0	0	0	3
Ord. Trichoptera						

Trichoptera gen. indet. (larvae)	aq	0	2	0	0	0
Ord. Diptera						
Fam. Chironomidae						
Chironomidae gen. indet. (larvae)	aq	1	2	0	0	0
Fam. Tipulidae						
Tipulidae gen. indet. (larvae head)	pl	0	0	0	0	2
Diptera gen. indet. (puparia)	oth	1	0	0	0	4
Subfillum Crustacea, Class Branchiopoda						
Ord. Notostraca						
Fam. Triopsidae						
Triopsidae gen. indet. (mandibles)	aq	0	0	0	0	5
		217	**202**	**89**	**72**	**69**

Table S6: Mutual Climatic Range estimates for selected beetle species found in the Krest-Yuryakh Suite(MIS 5e) of the Dmitry Laptev Strait

Species	$MTWA_{Min}$ [°C]	$MTWA_{Max}$ [°C]	$MTCO_{Min}$ [°C]	$MTCO_{Max}$ [°C]	Reference
Diacheila polita	2.5	16	–41.75	0	Elias (2000)
Blethisa catenaria	7	13.5	–38.5	–21	Elias (2000)
Pelophila borealis	7.5	16.5	–37	–3.5	Elias (2000)
Bembidion umiatense	7.5	10	–33	–28.5	Elias (2000)
Bembidion dauricum	7.5	13.5	–37.5	–17	Elias (2000)
Bembidion grapii	8.5	20.5	–37.5	–2.5	Elias (2000)
Elaphrus lapponicus	10.5	16.25	–35	–1.75	Elias (2000)
Dicheirotrichus mannerheimii	6	15.5	–39.5	–17.5	Elias (2000)
Poecilus nearcticus	7	11	–36	–27	Elias (2000)
Pterostichus brevicornis	4.5	15	–41.5	–15	Elias (2000)
Pterostichus pinguedineus	7	15.5	–38	–15.5	Elias (2000)
Pterostichus ventricosus	6	15.5	–39	–1.5	Elias (2000)
Pterostichus agonus	5	13	–39	–15	Elias (2000)
Pterostichus costatus	5.25	10.25	-36.75	–20.25	Elias (2000)
Pterostichus costatus	1.5	13	–37	–21.5	Alfimov et al. (2003)
Pterostichus vermiculosus	7	14	–38	–17	Elias (2000)
Pterostichus sublaevis	6.5	14	–39	–13.5	Elias (2000)
Pterostichus sublaevis	3.5	16	–40	–19	Alfimov et al. (2003)
Stereocerus haematopus	5	18.5	–40.5	–6.5	Elias (2000)
Stereocerus haematopus	3.5	17.5	–48	–17	Alfimov et al. (2003)
Amara alpina	5	10.5	–39.5	–5.5	Elias (2000)
Amara bokori	7	16	–38	–12.5	Elias (2000)
Agabus moestus	5	17.5	–41	–9.5	Elias (2000)
Colymbetes dolobratus	4.5	15	–41	–9.5	Elias (2000)
Helophorus splendidus	8.25	10.25	–34.25	–27.25	Elias (2000)
Helophorus splendidus	8.5	15	–40	–12	Alfimov et al. (2003)
Tachinus brevipennis	3.5	10.5	–36.5	–17.5	Elias (2000)
Tachinus arcticus	3.5	14	–38	–17	Alfimov et al. (2003)
Aphodius distinctus	9.5	27	–33	+8.5	Elias (2000)
Morychus viridis	4	14.5	–50	–26	Alfimov et al. (2003)
Chrysolina subsulcata	2	10	–34	–18.5	Alfimov et al. (2003)

Chrysolina septentrionalis	2.5	21	–35	–5	Alfimov et al. (2003)
Stephanocleonus eruditus	12	19	–46.5	–14	Alfimov et al. (2003)
Stephanocleonus fossulatus	12	21	–46.5	–14	Alfimov et al. (2003)

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Elias, S.A. Climatic tolerances and zoogeography of the late Pleistocene beetle fauna of Beringia. Géographie physique et Quaternaire, 54, 143-155, 2000.

Table S7: Number of taxa, number of individuals, and ecology of fossil cladoceran assemblages obtained from profile samples at the shores of the Dmitry Laptev Strait.

Taxa	*Acroperus harpae*	*Alona guttata/C. rectangula*	*Biapertura affinis /A. quadrangularis*	*A. guttata tuberculata/ C. rectangula pulchra*	*Alona intermedia*	*Alonella excisa*	*Bosmina sp.*	*Chydorus* cf. *sphaericus*	*Ceriodaphnia* sp.	*Daphnia pulex* gr.	*Eurycercus* sp.	*Leydigia leidigi*	*Sida crystallina*	Summe of Cladocera individuals	N of taxa	Abundance of individuals of Cladocera per gram
Bol'shoy Lyakhovsky Island																
L7-11-07	0	0	0	0	0	0	0	4	0	0	0	0	0	4	1	1
L7-11-12	0	0	0	0	0	0	3	3	0	1	0	0	0	7	3	2
Oyogos Yar																
Oya-5-1	1	45	1	1	1	1	44	57	0	2	0	0	0	153	9	n/a
Oya-3-11	0	1	0	2	0	0	1	22	2	0	0	1	0	29	6	11
Oy7-01-06	0	0	0	0	0	0	0	1	0	1	0	0	0	2	2	4
Oy7-01-08	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	2
Oy7-01-10	0	0	0	0	0	0	0	2	0	0	0	0	0	2	1	4
Oy7-08-07	1	0	0	0	0	0	1	6	0	17	0	0	0	25	4	10
Oy7-08-11	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2	4
Oy7-08-19	1	2	2	0	0	1	1	23	0	0	3	0	1	34	9	13
Oy7-08-24	0	0	0	0	0	0	0	2	0	0	0	0	0	2	1	4

Ecology													
Temperature tolerance	C	E	-	E	C	-	-	E	-	-	-	T	T
Habitat	L, Ph	L	L	L	L,B	L, Ph	P	L, B	P	P	L, Ph	L,B	L, Ph
Saprobic Index	o-b	o-b	b	o-b	o	o-b	o-b	o-b	-	-	o-b	b-a	o

Explanations: C – cold-water, E – eurythermic, T – thermophilic; L – littoral, B – benthic, Pl – planktonic, Ph – photophilic; o – oligo saprobic, o-b – oligo-β-mesosaprobic, b-a – β-α-mesosaprobic. Referred to for information about ecology are Flößner (2000) and Bledzki, Rybak (2016).

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Table S8: Species list of Last Interglacial freshwater ostracods obtained from profiles sampled at the shores of the Dmitry Laptev Strait.

Location	Bol'shoy Lyakhovsky		Oyogos Yar		
Profile ID	L7-11	L7-14	Oy7-01	Oy7-08	Oya 5-1
Reference	Schneider (2010)	Wetterich et al. (2009)	Schneider (2010)	Wetterich et al. (2009)	Kienast et al. (2011)
juvenile Candoninae	x	x	x	x	x
Candona candida	x	x	x	x	x
Candona muelleri-jakutica			x	x	x
Candona cf. *neglecta*		x		x	
Fabaeformiscandona harmsworthi	x	x	x	x	x
Fabaeformiscandona levanderi		x	x	x	x
Fabaeformiscandona pedata					
Fabaeformiscandona rawsoni		x	x	x	x
Fabaeformiscandona tricicatricosa	x	x		x	x
Eucypris dulcifons	x	x	x		x
Ilyocypris lacustris		x		x	x
Ilyocypris sp.	x		x		
Cytherissa lacustris	x	x		x	x
Limnocytherina sanctipatricii	x	x	x	x	
Limnocythere sp.	x				
Limnocythere falcata		x	x	x	
Limnocythere suessenbornesis		x		x	
Tonnacypris cf. *glacialis*			x		
Cypria exsculpta				x	x
Cypria laevis		x		x	
Cypria ophtalmica					x
Cyclocypris ovum					x
Bradleystrandesia reticulata					x

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Wetterich, S., Schirrmeister, L., Andreev, A.A., Pudenz, M., Plessen, B., Meyer, H., Kunitsky, V.V.: Eemian and Late Glacial/Holocene palaeoenvironmental records from permafrost sequences at the Dmitry Laptev Strait (NE Siberia, Russia), Palaeogeography, Palaeoclimatology, Palaeoecology 279, 73-95 doi:10.1016/j.palaeo.2009.05.002, 2009.

Table S9: Clumped and stable isotope measurements for biogenic carbonates. Highlighted samples are outliers (> $\overline{x} \pm 2\sigma$), and those with elevated Δ48 values, indicative of contamination, which have been excluded from final analyses.

Sample ID	Sample Name	$\delta^{13}C$ ‰ VPDB	$\delta^{18}O$ ‰ VPDB	Δ47 ‰ iCDES	Δ48 ‰ (local reference frame)
Oy 5 - 1 C candida					
2023-06-27 23:50	Oy 5 - 1 Candida	-6.3	-14.03	0.651	0.168
2023-06-28 20:04	Oy 5 - 1 Candida	-6.48	-14.08	0.762	0.497
2023-06-29 14:07	Oy 5 - 1 Candida	-6.32	-14.1	0.648	0.2
2023-06-30 09:20	Oy 5 - 1 Candida	-6.38	-14.05	0.65	0.222
2023-06-30 21:23	Oy 5 - 1 Candida	-6.37	-14.02	0.614	0.006
2023-07-01 11:41	Oy 5 - 1 Candida	-6.38	-14.2	0.678	0.132
2023-07-01 18:58	Oy 5 - 1 Candida	-6.27	-14.17	0.688	0.033
2023-07-02 03:53	Oy 5 - 1 Candida	-6.36	-14.21	0.647	0.13
2023-07-02 20:05	Oy 5 - 1 Candida	-6.31	-14.12	0.729	0.192
2023-07-03 13:25	Oy 5 - 1 Candida	-6.47	-14.24	0.709	0.154
2023-07-04 00:12	Oy 5 - 1 Candida	-6.36	-14.16	0.681	0.08
2023-07-04 09:10	Oy 5 - 1 Candida	-6.42	-14.15	0.628	-0.022
2023-07-04 17:33	Oy 5 - 1 Candida	-6.52	-14.19	0.587	-0.041
2023-07-09 05:03	Oy 5 - 1 Candida	-6.23	-14.12	0.575	0.052
2023-07-09 23:09	Oy 5 - 1 candida	-6.2	-14.05	0.582	0.006
2023-07-10 04:30	Oy 5 - 1 Candida	-6.19	-14.05	0.62	0.173
2023-07-18 02:19	Oy 5 - 1 candida	-6.37	-14.11	0.645	0.079
2023-07-18 14:56	Oy 5 - 1 candida	-6.34	-14.08	0.635	0.2
2023-07-18 20:47	Oy 5 - 1 candida	-6.39	-14.08	0.572	-0.087
Oy 5 - 1 C lacustris					
2023-07-01 17:18	Oy 5 - 1 Lacustris	-9.45	-14.25	0.679	0.058
2023-07-02 07:46	Oy 5 - 1 Lacustris	-9.42	-14.24	0.708	0.173
2023-07-03 00:09	Oy 5 - 1 Lacustris	-9.43	-14.23	0.7	0.1
2023-07-03 16:54	Oy 5 - 1 Lacustris	-9.44	-14.18	0.683	-0.114
2023-07-03 22:33	Oy 5 - 1 Lacustris	-9.25	-14.16	0.712	0.129
2023-07-04 10:51	Oy 5 - 1 Lacustris	-9.26	-14.14	0.644	-0.086
2023-07-04 15:54	Oy 5 - 1 Lacustris	-9.47	-14.26	0.621	0.081
2023-07-09 03:26	Oy 5 - 1 Lacustris	-9.17	-14.33	0.603	0.081
2023-07-09 07:01	Oy 5 - 1 Lacustris	-9.25	-14.35	0.585	0.111
2023-07-09 10:22	Oy 5 - 1 Lacustris	-9.32	-14.39	0.594	0.057
2023-07-09 21:13	Oy 5 - 1 Lacustris	-9.3	-14.32	0.586	-0.018
2023-07-10 00:53	Oy 5 - 1 Lacustris	-9.17	-14.34	0.576	0.109
2023-07-10 02:31	Oy 5 - 1 Lacustris	-9.23	-14.39	0.619	0.043
2023-07-10 06:28	Oy 5 - 1 Lacustris	-9.41	-14.4	0.613	0.16
2023-07-11 12:53	Oy 5 - 1 Lacustris	-9.22	-14.31	0.602	0.244
2023-07-18 04:18	Oy 5 - 1 Lacustris	-9.31	-14.2	0.641	0.073
2023-07-18 12:58	Oy 5 - 1 Lacustris	-9.2	-14.32	0.637	0.027

2023-07-18 16:53	Oy 5 - 1 Lacustris	-9.1	-14.25	0.723	0.204
2023-07-18 22:45	Oy 5 - 1 Lacustris	-9.13	-14.31	0.636	0.08
2023-10-16 07:52	Oy 5 - 1 Lacustris	-4.76	-13.28	0.519	-0.209
2023-10-16 17:06	Oy 5 - 1 Lacustris	-8.47	-14.57	0.679	-0.112
2023-10-18 22:43	Oy 5 - 1 Lacustris	-8.45	-14.55	0.615	-0.155
Oy 5 - 1 P casertanam					
2023-05-06 12:38	Oy 5 - 1 P casertanam	-8.09	-14.69	0.687	-0.02
2023-05-07 16:05	Oy 5 - 1 P casertanam	-8.64	-15.11	0.651	-0.034
2023-05-08 21:23	Oy 5 - 1 P casertanam	-8.57	-14.56	0.642	-0.198
2023-05-25 09:53	Oy 5 - 1 P casertanam	-8.21	-14.66	0.67	0.065
2023-05-25 15:27	Oy 5 - 1 P casertanam	-8.39	-14.6	0.664	-0.03
2023-05-31 12:20	Oy 5 - 1 P casertanam	-8.24	-14.86	0.661	0.023
2023-06-01 06:36	Oy 5 - 1 P casertanam	-7.82	-14.64	1.335	1.326
2023-06-02 15:16	Oy 5 - 1 P casertanam	-8.34	-14.65	0.653	-0.055
2023-06-17 00:11	Oy 5 - 1 P casertanam	-8.23	-14.68	0.62	-0.306
2023-06-17 16:20	Oy 5 - 1 P casertanam	-8.25	-14.62	0.64	-0.174
2023-06-18 10:34	Oy 5 - 1 P casertanam	-8.12	-14.79	0.65	-0.196
2023-06-18 23:39	Oy 5 - 1 P casertanam	-8.33	-14.68	0.667	-0.169
2023-06-19 18:46	Oy 5 - 1 P casertanam	-8.3	-14.65	0.643	-0.24
2023-06-20 21:16	Oy 5 - 1 P casertanam	-8.39	-14.67	0.674	-0.255
2023-06-21 17:28	Oy 5 - 1 P casertanam	-8.3	-14.69	0.653	-0.287
2023-06-22 08:47	Oy 5 - 1 P casertanam	-8.33	-14.63	0.707	-0.23
2023-06-23 05:11	Oy 5 - 1 P casertanam	-8.14	-14.47	0.646	-0.254

Table S10: Models contributing to PaleoMIP lig127k.

Model	Institution	nominal resolution (km)	simulation years in lig127k
AWI-ESM-1-1-LR	AWI	250	100
FGOALS-f3-L	CAS	100	500
FGOALS-g3	CAS	250	500
CNRM-CM6-1	CNRM	250	300
ACCESS-ESM1-5	CSIRO	250	200
EC-Earth3-LR	EC Earth Consortium	100	210
INM-CM4-8	INM	100	100
IPSL-CM6A-LR	IPSL	250	550
MIROC-ES2L	MIROC	500	100
GISS-E2-1-G	NASA	250	100
CESM2	NCAR	100	700
NorESM1-F	NCC	250	200
NorESM2-LM	NCC	250	100
HadGEM3-GC31-LL	NERC	250	200
NESM3	NUIST	250	100

Supplement material_Figures

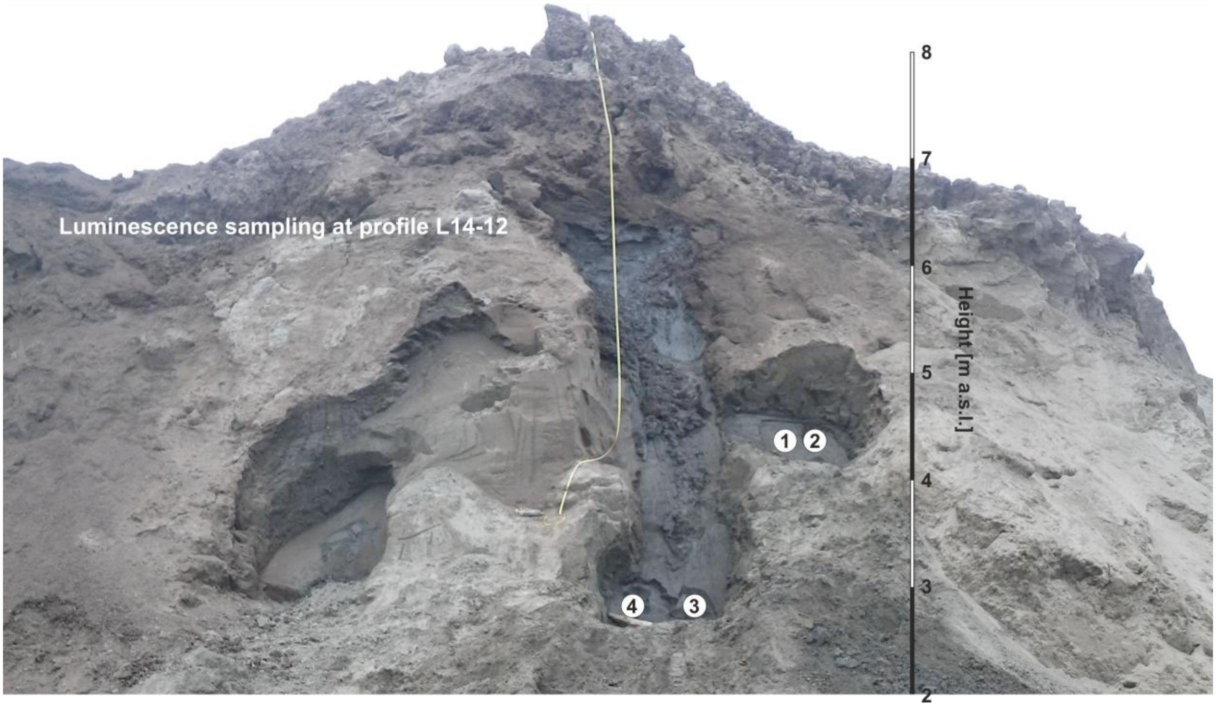

Figure S1 Sampling points for the OSL dating at profile L14-12.

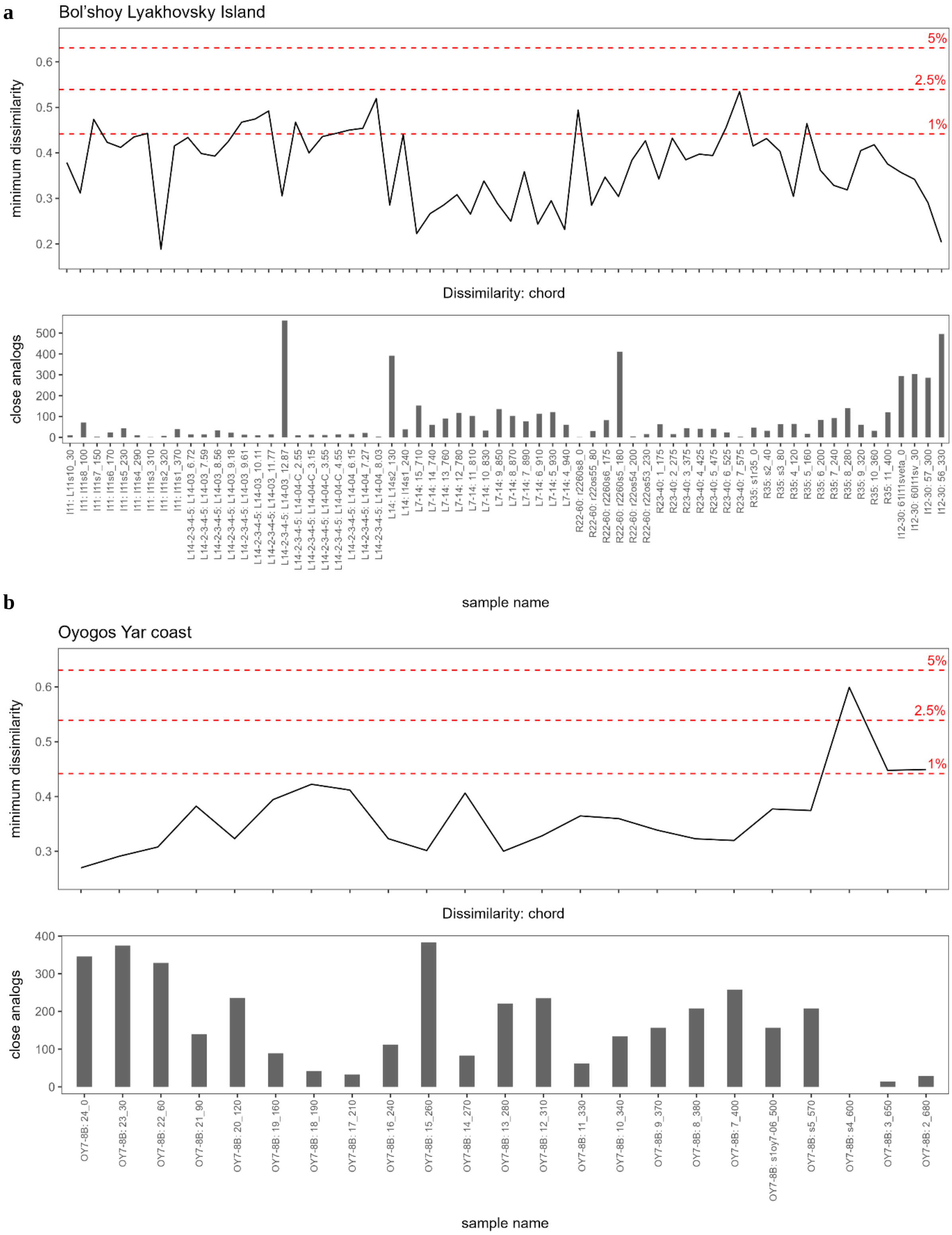

Figure S2: Number of modern analogs (lower figure) and the minimum dissimilarity of the closest modern analog to each Eemian sample (upper figure), compared to the percentage distribution of all dissimilarities in the modern training dataset. All values below the 5% threshold are considered analogs. Most samples have even "close analogs", with dissimilarity values below the 1% threshold. (a) Bol'shoy Lyakhovsky Island; (b) Oyogos Yar coast.

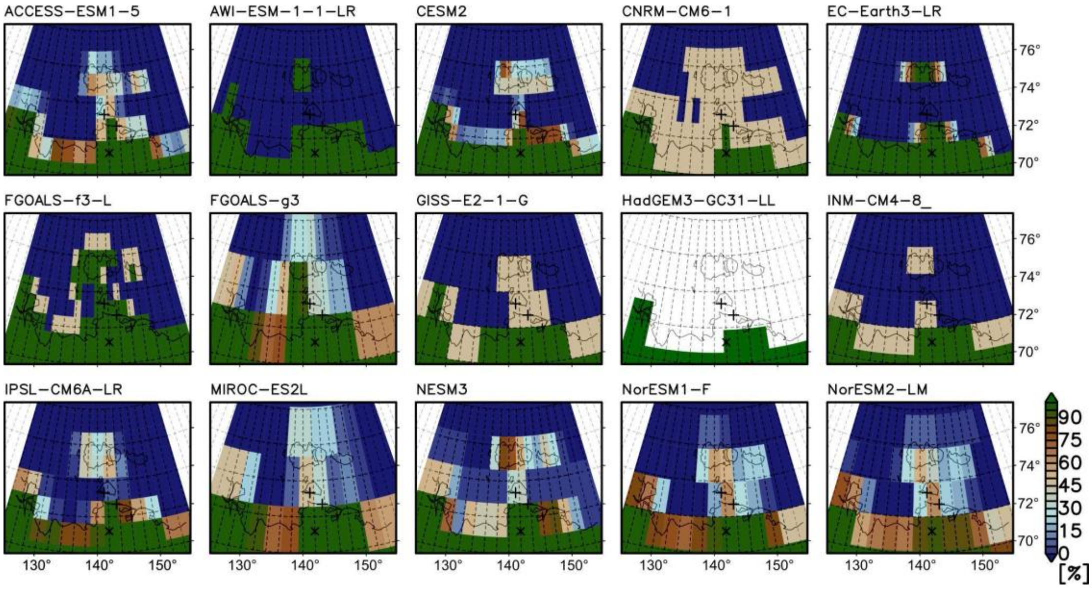

Figure S3: Land sea masks of the PaleoMIP models. Not all models provide land fractions. For CNRM-CM6-1, FGOALS-f3_L, GISS-E2-1-G, and INM-CM4-8, grid cells with fractional land coverage are generically marked with 50% land due to a lack of detailed information. For HadGEM3-GC31-LL, only grid cells being 100% land could be identified. Note that the generic land point marked with the x is situated in grid cells with 100% land for all models.

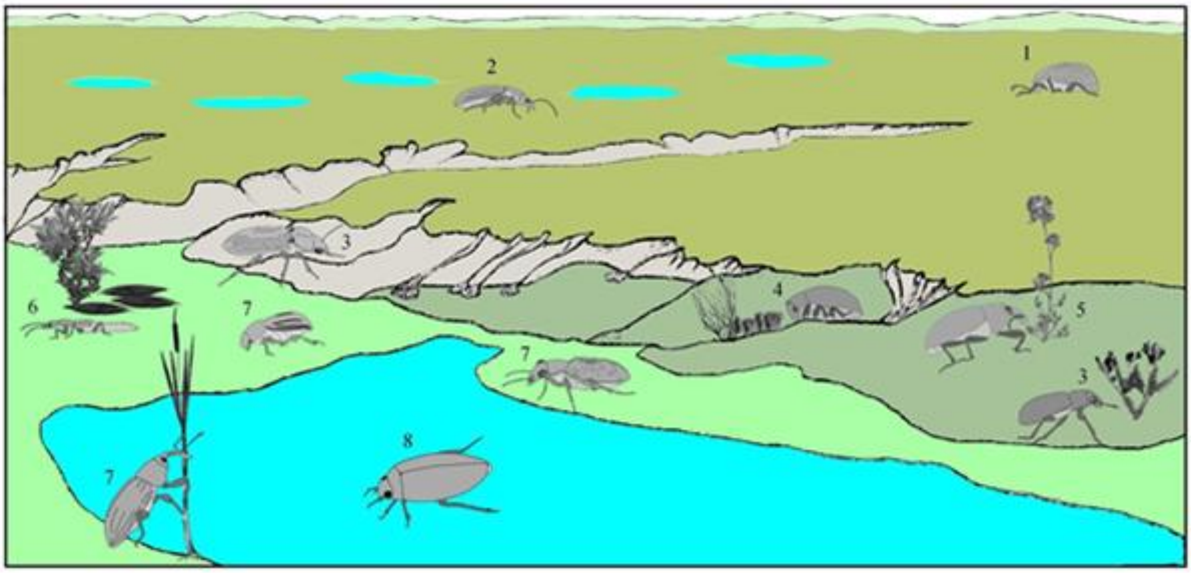

Figure S4: The beetle paleo-environments: Thermokarst landscape and habitats of different ecological groups of beetles. Groups: 1 arctic tundra, 2 wet and mesic tundra, 3 dry tundra, 4 cryoxerophilous steppe, 5 thermophilous steppe, 6 plant litter, 7 riparian, 8 aquatic. Thermokarst created different landscape forms, such as north and south-faced slopes, wetland depressions, and disturbed ground. Such variation supports more habitats than flat tundra.

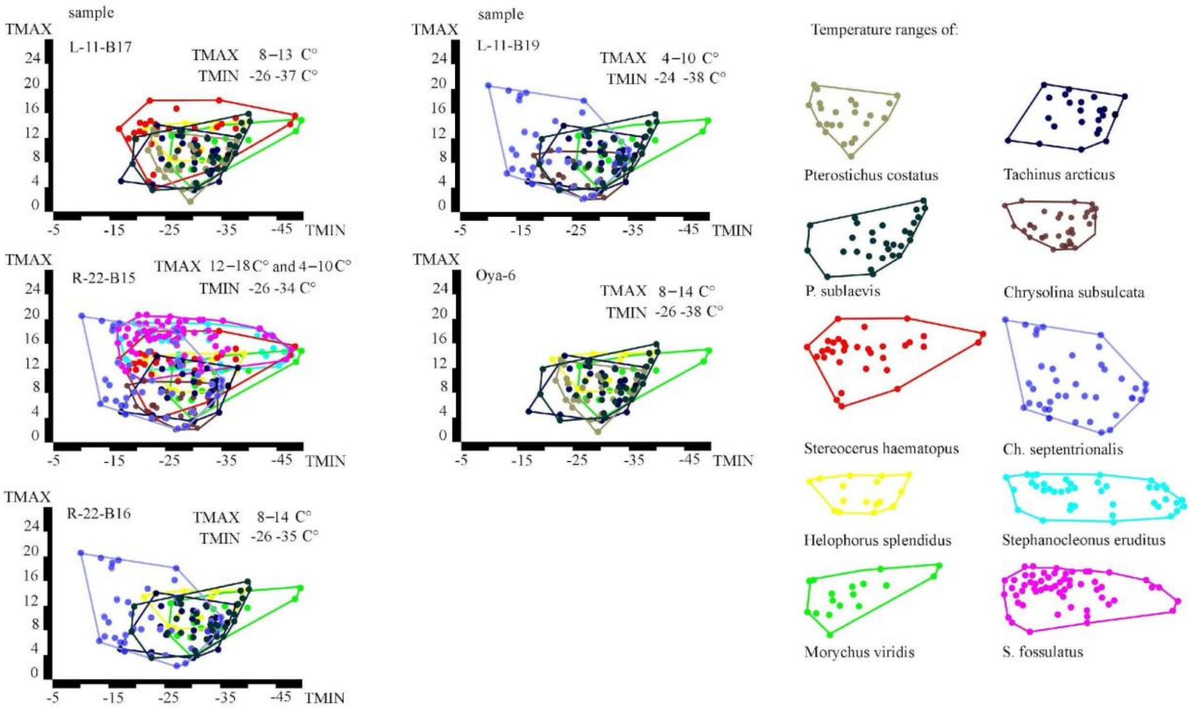

Figure S5: Climate ranges of selected beetle species (from Alfimov et al., 2003) and MCR evaluation for the Last Interglacial samples from the Dmitry Laptev Strait area

References

Alfimov, A.V., Berman, D.I., and Sher, A.V.: Tundra-steppe insect assemblages and reconstruction of Late Pleistocene climate in the lower reaches of the Kolyma River, Zoologicheskiy Zhurnal, 82(2), 281–300 (in Russian), 2003.

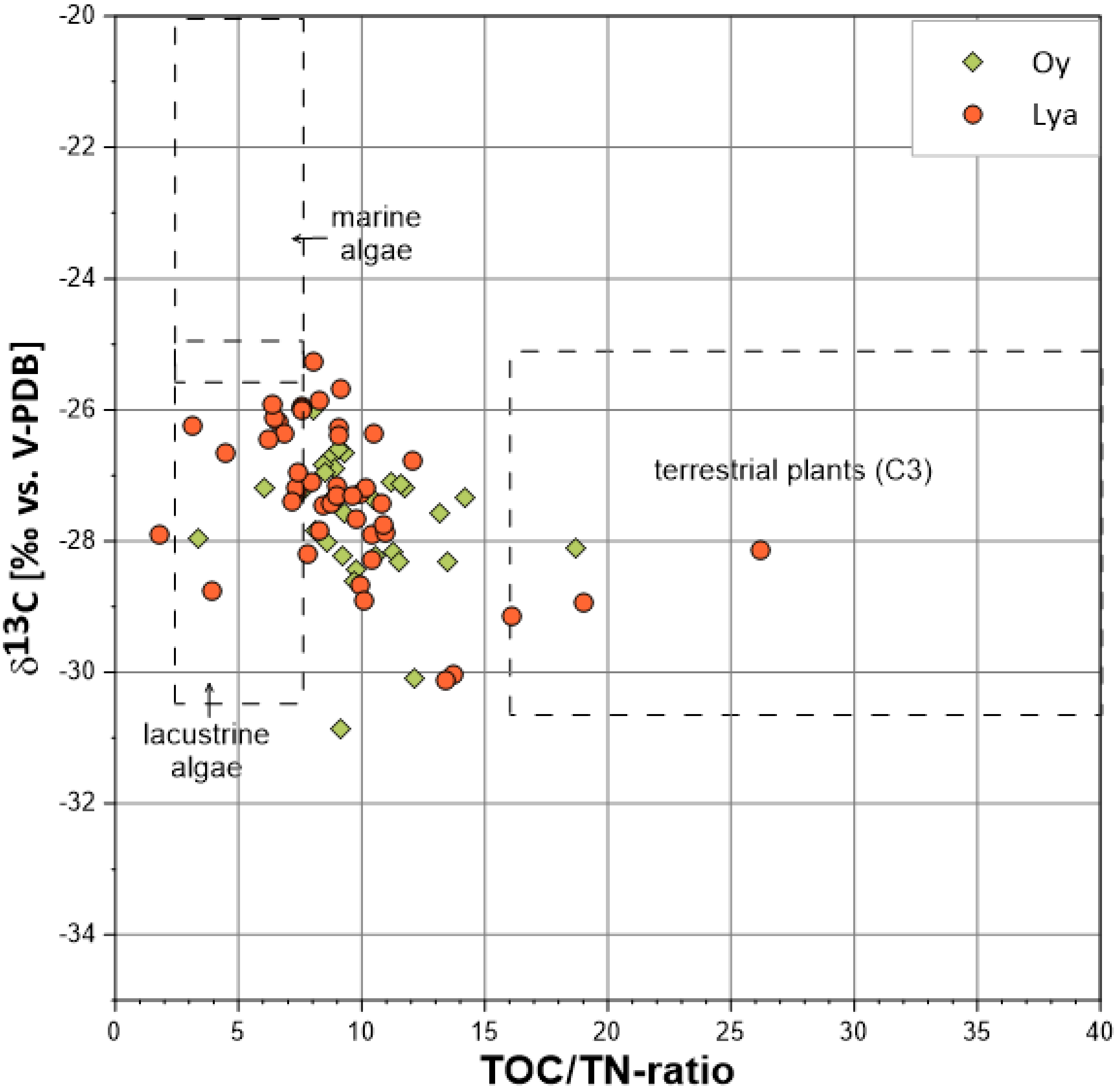

Figure S6: The ratio of TOC/TN to $\delta^{13}C$ values of Krest-Yuryakh deposits.

Supplement material_Equation S1

$$\mathrm{lig127k}_{\mathrm{proxy}} = \underbrace{(\mathrm{lig127k} - \mathrm{PI})}_{\text{model climate change signal}} + \underbrace{\left(\mathrm{anomPI}_{\mathrm{GlobTemp}} + \mathrm{Ref}_{\mathrm{ERA5}}\right)}_{\text{observed PI}}$$

$\mathrm{lig127k}_{\mathrm{proxy}}$ … derived absolute values of the models for the LIG

lig127k … modelled LIG climate

PI … modelled pre-industrial climate

$\mathrm{lig127k} - \mathrm{PI}$ … modelled climate change signal with reference to the pre-industrial

$\mathrm{anomPI}_{\mathrm{GlobTemp}}$ … NOAA GlobTemp observed pre-industrial anomaly with reference to 1991-2020

$\mathrm{Ref}_{\mathrm{ERA5}}$ … observed climate for 1991-2020 from ERA5