How well do we know Barents Sea terrestrial biodiversity?

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Overview

- Introduce region
- Concentrate on terrestrial invertebrate fauna
- Diversity and linkages
- Knowledge gaps
- Future pressures

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Review paper

The terrestrial and freshwater invertebrate biodiversity of the archipelagoes of the Barents Sea; Svalbard, Franz Josef Land and Novaya Zemlya

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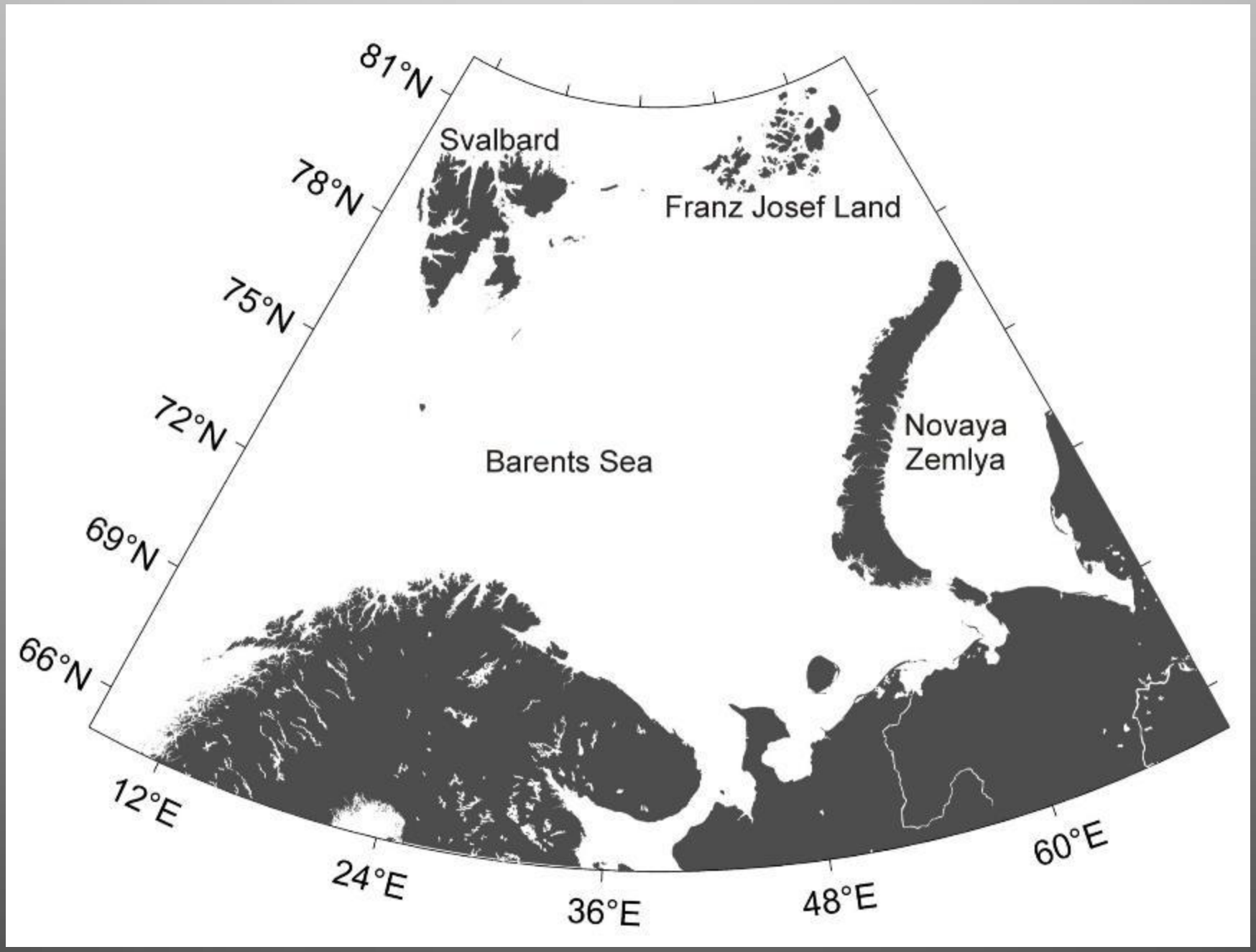
Outcome of an international workshop supported by the Research Council of Norway, 'the Invertebrate Fauna of Svalbard', March 2011.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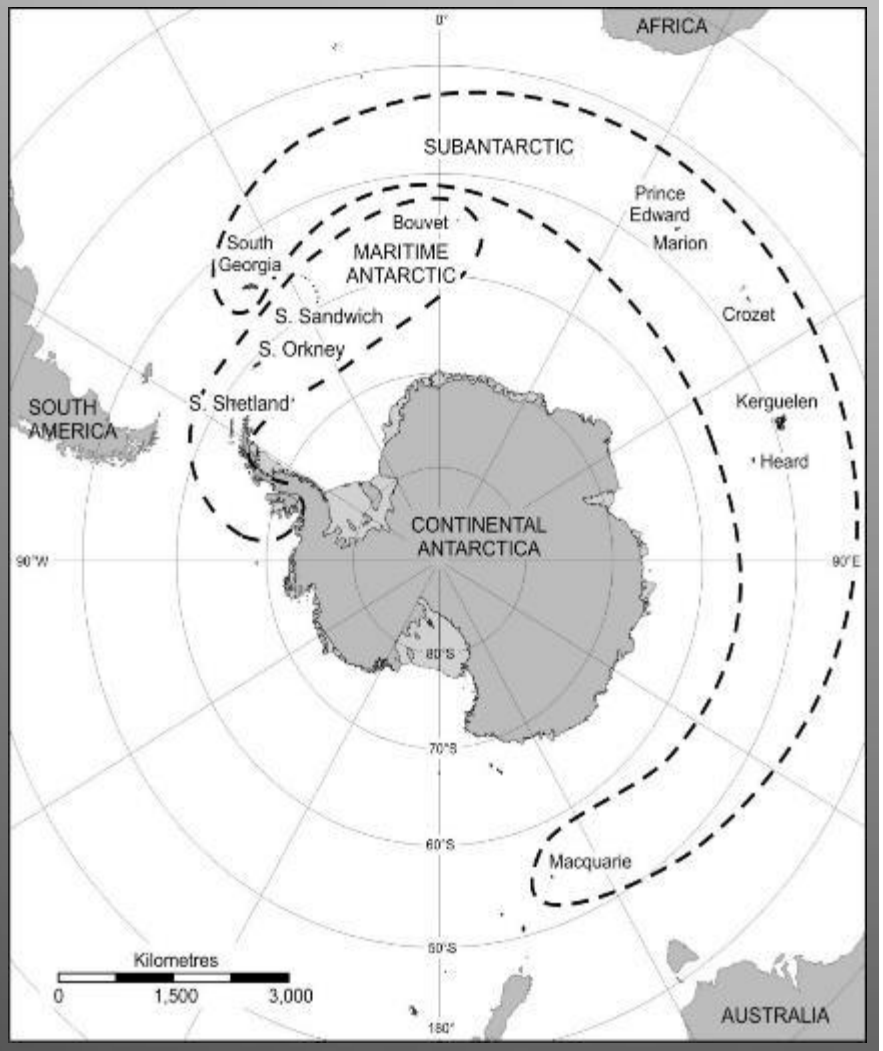
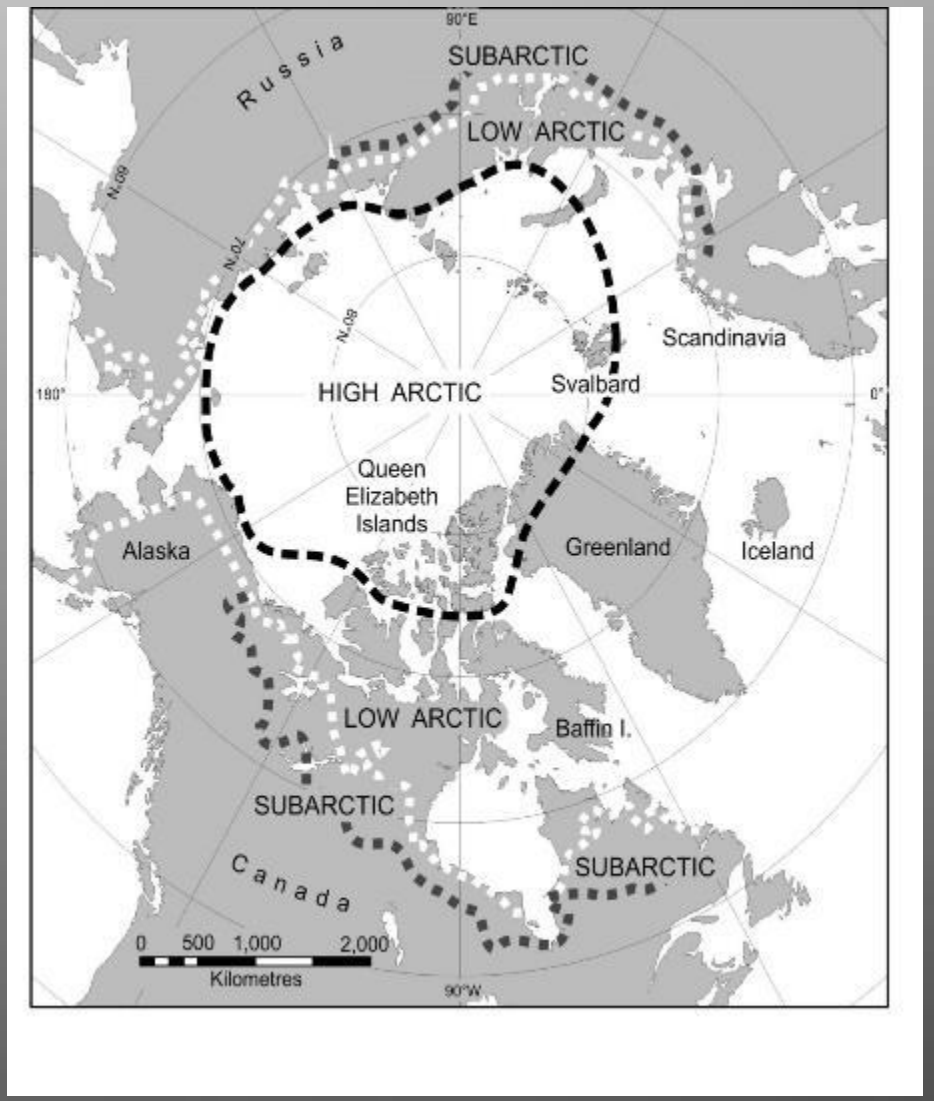
Svalbard
Franz Josef Land
Barents Sea
Novaya
Zemlya

Polar Bioregions





Typical air temperature ranges experienced in summer and winter in the three commonly-recognised Antarctic and two Arctic biogeographical zones

Zone	Months with positive mean air temperatures	Mean monthly air temperature range (°C)	Extreme air temperature range (°C)	Estimate of annual degree days above 0°C (based on mean air temperatures)
High Arctic	2 to 4	–34 to +5	–60 to + 20	50–350
Low Arctic	4	–36 to + 11		600–900
Sub-Antarctic	6 to12	–2 to +8	–10 to +25	700–1700
Maritime Antarctic	1 to 4	–12 to + 2	–45 to +15	6–100
Continental Antarctic				
- coastal	0 to 1	–30 to –3	–40 to +10	0
- inland	0	<-50 to –10	<–80 to –5	0

Convey 2007, PPRST

Svalbard – High Arctic


Photo: S. Botnen

Table 2
Similarities between the invertebrate faunas of the archipelagoes. Figures indicate: total number of species in common (total number of species in first archipelago; total number of species in second archipelago). Only species considered resident are included. Dashes indicate comparisons not possible, usually as no species of the group concerned have been recorded from Franz Josef Land.

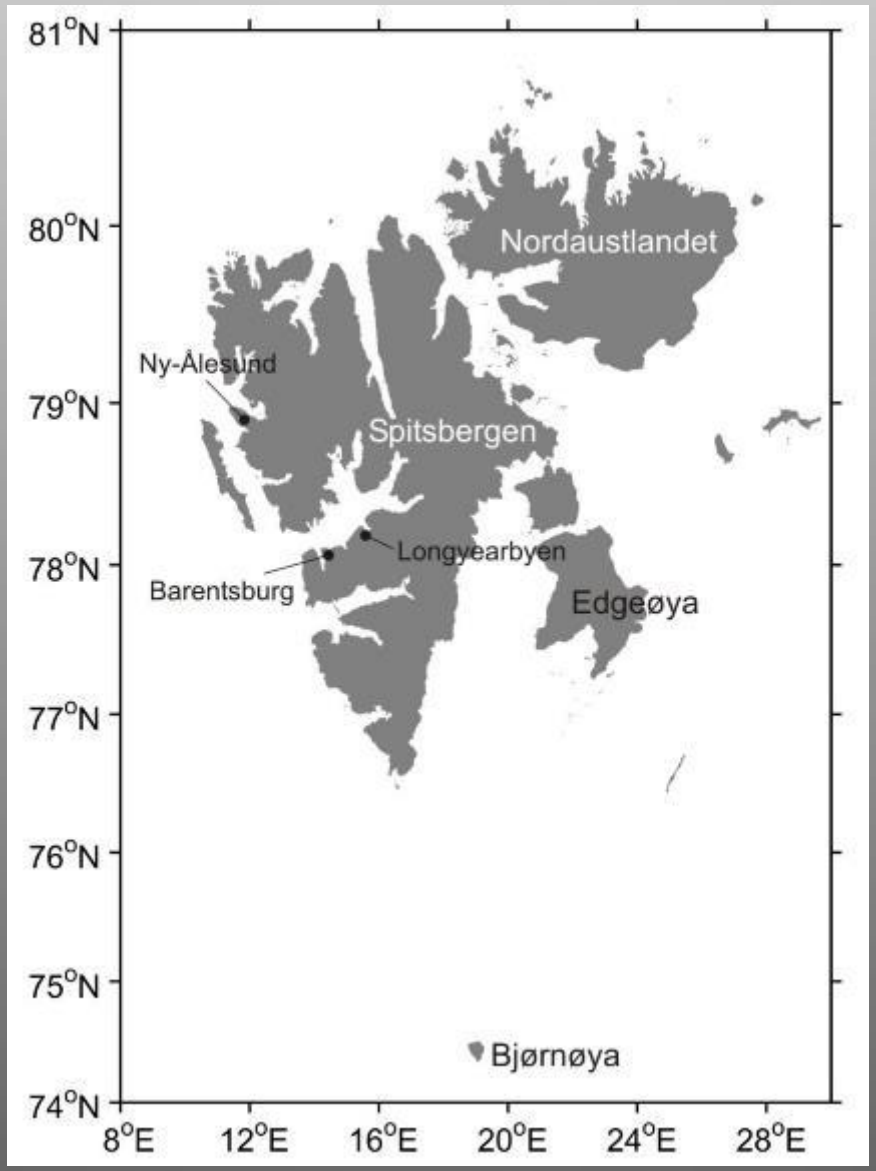
Group		Novaya Zemlya to Svalbard	Franz Josef Land to Svalbard	Franz Josef Land to Novaya Zemlya
Rotifera	Bdelloidea	1 (2:67)	3 (3:67)	0 (0:2)
	Monogononta	45 (71:134)	16 (20:134)	15 (20:71)
Gastrotricha		0 (0:1)	–	–
Nematoda	Freeliving	24 (81:95)	–	–
Annelida	Lumbricidae	0 (1:2)	–	–
Tardigrada		40 (68:92)	17 (19:92)	12 (19:68)
Acari	Mesostigmata	11 (27:29)	3 (6:29)	4 (6:27)
	Oribatida	39 (64:87)	5 (15:87)	8 (15:64)
Araneae		8 (20:14)	2 (2:14)	2 (2:20)
Collembola		20 (53:68)	12 (14:68)	8 (14:53)
Insecta	Phthiraptera	4 (7:37)	–	–
	Hemiptera	0 (1:3)	–	–
	Coleoptera	1 (28:14)	–	–
	Diptera	29 (150:122)	1 (4:122)	0 (4:150)
	Chironomidae	19 (73:66)	1 (1:66)	0 (1:73)
	Other Diptera	10 (77:56)	0 (3:56)	0 (3:77)
	Siphonaptera	1 (1:2)	–	–
	Lepidoptera	0 (14:3)	–	–
Crustacea	Cladocera	5 (8:17)	–	–
	Copepoda	1 (16:6)	–	–
	Anostraca	0 (4 : 0)	–	–
	Ostracoda	0 (5:2)	–	–
	Notostraca	1 (1:1)	–	–
	Malacostraca	0 (3:1)	–	–

Dominant Groups

- Meiofauna – nematodes, tardigrades, rotifers
- Micro-arthropods – mites, springtails
- Insects – esp. Diptera, Coleoptera (Lepidoptera on Novay Zemlya)
- Linyphiid spiders
- Crustaceans (freshwater)
- Several groups 'under-represented' on Novaya Zemyla (data) or absent from FJL
- Relatively limited overlap between Svalbard and NZ, FJL and NZ, possibly more between Svalbard and FJL

Lacking Data?

- Both literature and accessible/known data biased towards Svalbard
- Even on Svalbard, bias towards warmer areas near settlements to the west
- Several groups clearly not targeted on Franz Josef or Novaya Zemlya, both micro- and macroscopic
- Molecular phylogeographic studies still in their infancy, likelihood of much cryptic diversity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Ny-Ålesund
Spitsbergen
Longyearbyen
Barentsburg
Edgeøya
Bjørnøya

Colonisation Routes?

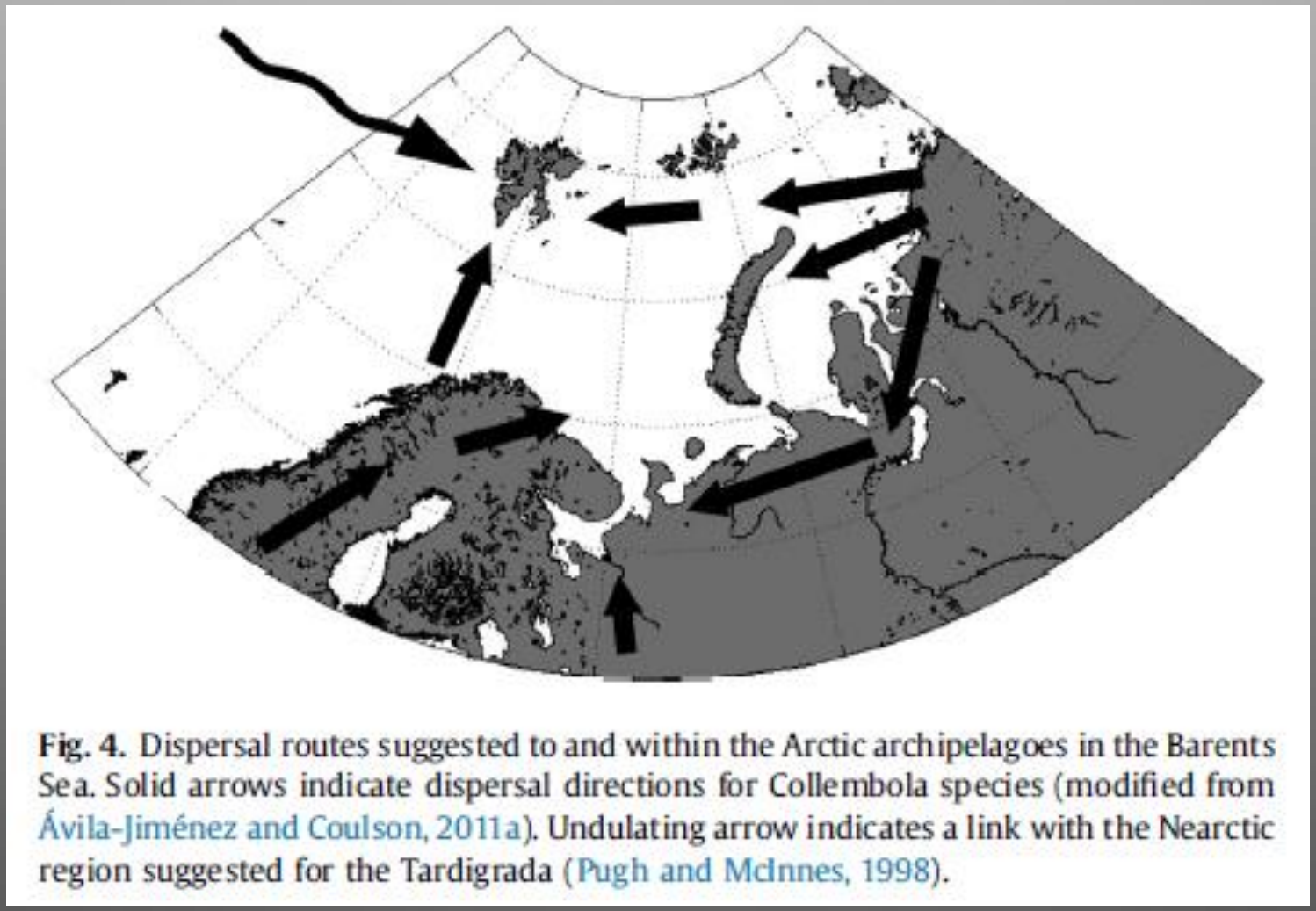


Fig. 4. Dispersal routes suggested to and within the Arctic archipelagoes in the Barents Sea. Solid arrows indicate dispersal directions for Collembola species (modified from Ávila-Jiménez and Coulson, 2011a). Undulating arrow indicates a link with the Nearctic region suggested for the Tardigrada (Pugh and McInnes, 1998).

Coulson et al. 2014 Soil Biol Biochem

Table 4 Biodiversity of native terrestrial invertebrates in the three Antarctic biogeographical zones

Group	*Sub-Antarctic*	*Maritime Antarctic*	*Continental Antarctic*
Protozoa[a]	83		33
Rotifera[a]	>59	>50	13
Tardigrada	>34	26	19
Nematoda[a]	>22	28	14
Platyhelminthes	4	2	0
Gastrotricha	5	2	0
Annelida (Oligochaeta)	23	3	0
Mollusca	3/4	0	0
Crustacea (terrestrial)	4	0	0
Crustacea (nonmarine)	44	10	14
Insecta (total)	210	35	49
(Mallophaga	61	25	34)
(Diptera	44	2	0)
(Coleoptera	40	0	0)
Collembola	>30	10	10
Arachnida (total)	167	36	59
(Araneida	20	0	0)
(Acarina[a]	140	36	29)
Myriapoda	3	0	0

[a]Large changes likely with future research due to current lack of sampling coverage, expertise and/or synonymy (see also www.eba.aq).
ND – number of representatives of group unknown.

Bi-polar Comparison

- Broadly, High Arctic Svalbard invertebrate diversity compares with entire and far milder sub-Antarctic
- physical isolation appears to drive the difference, not environmental stress

Convey 2013, Biodiversity Encyclopedia

Bi-polar Comparison

Table 3 Biodiversity of plant taxa in the three Antarctic biogeographical zones

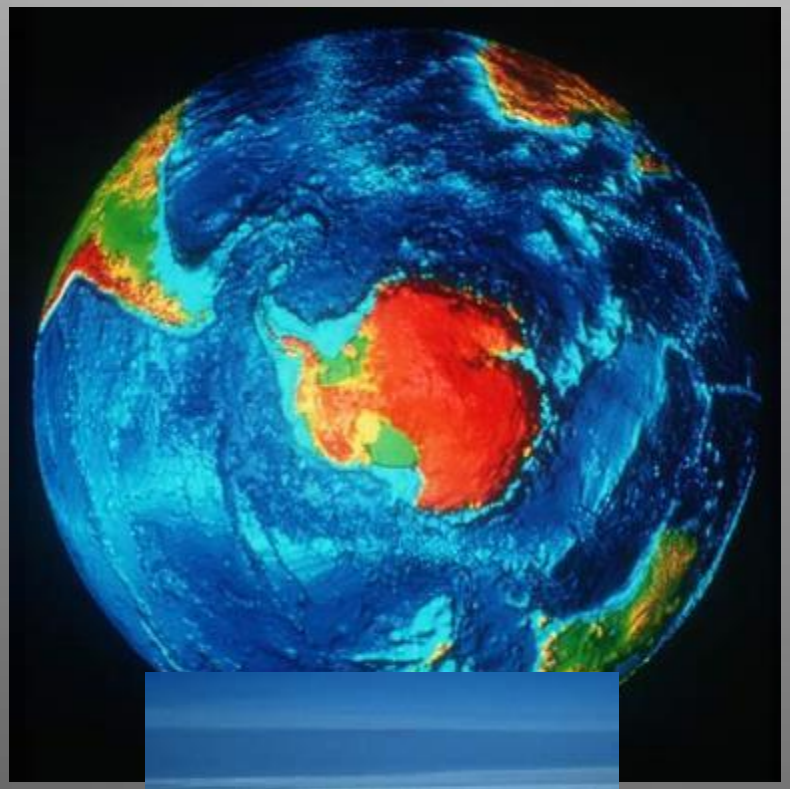
Zone	*Flowering plants*	*Ferns and club-mosses*	*Mosses*	*Liverworts*	*Lichens*	*Macro-fungi*
sub-Antarctic	60	16	250	85	250	70
maritime Antarctic	2	0	100	25	250	30
continental Antarctic	0	0	25	1	150	0

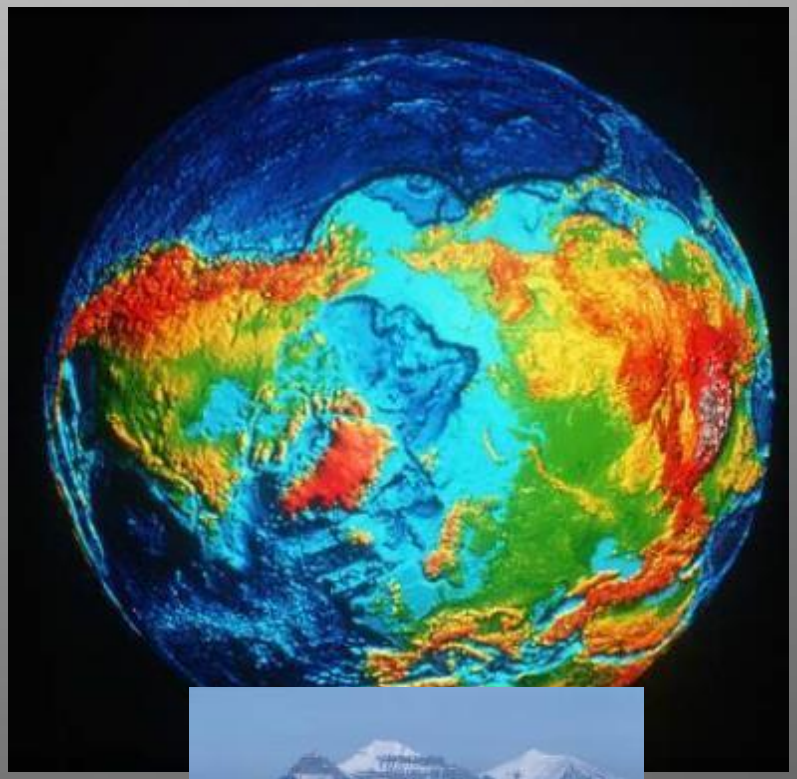
Note that figures presented are approximate, as it is likely that (i) new species records will be obtained through more directed sampling, (ii) a significant number of unrecognized synonymies are likely to exist and (iii) taxonomic knowledge of some Antarctic groups is incomplete. The Scientific Committee on Antarctic Research, through its biological program 'Evolution and Biodiversity in Antarctica', maintains up-to-date and open access databases of known biodiversity in most terrestrial faunal and floral groups (see www.eba.aq).

Convey 2013, Biodiversity Encyclopedia

- Flowering plant diversity far outweighs entire Antarctic, with mosses and lichens more comparable
- Again, isolation/dispersal appears to be limiting in Antarctic

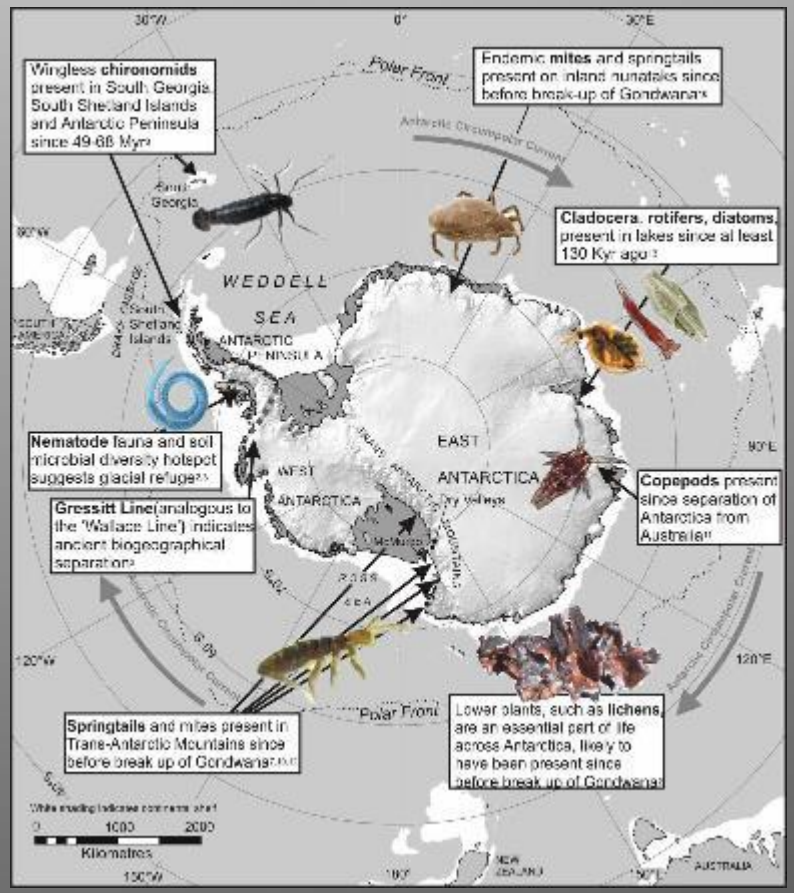
Arctic and Antarctic geography





Has Life Persisted near the Poles?

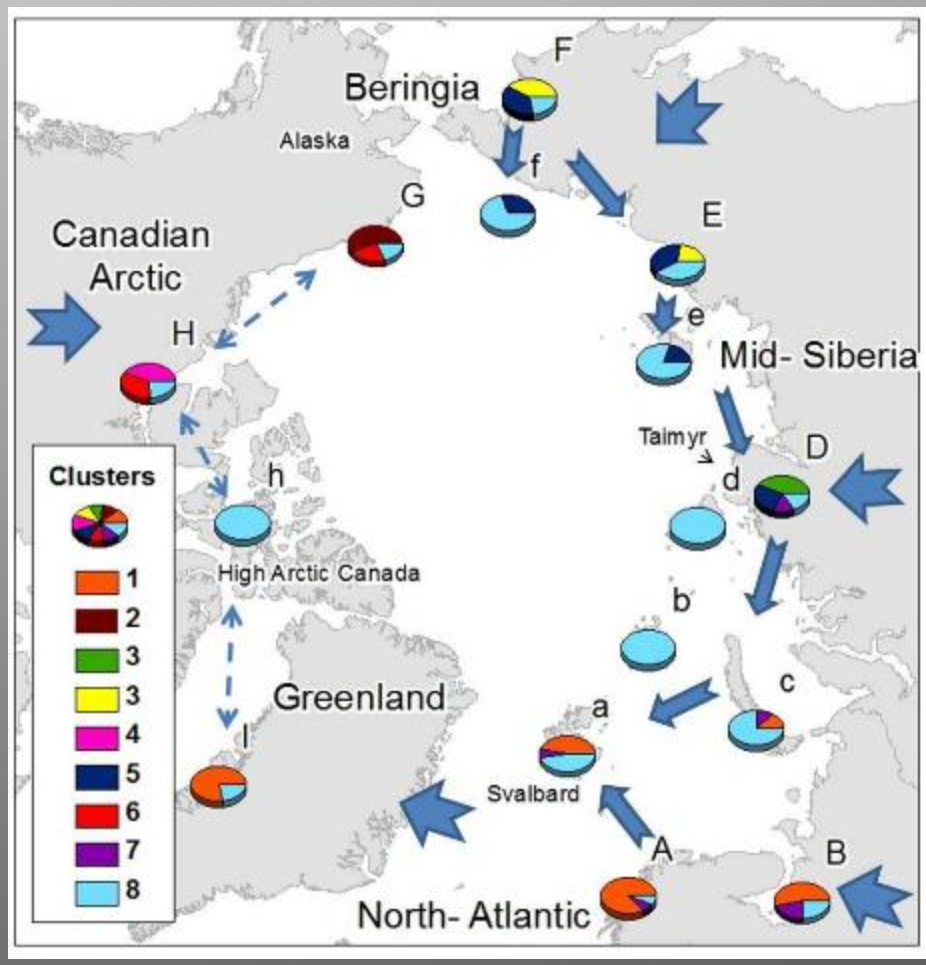
- Until recently, largely un-questioned view that terrestrial life at high latitudes was wiped out at glacial maxima
- In Antarctica examples of long-term persistence now inferred from most contemporary biological groups, most regions of the continent, and all timescales from pre-LGM to pre-Gondwana-breakup
- Molecular approaches and classical biogeography have led this paradigm change



Convey & Stevens (2007) Science, Convey et al. 2008 Biol Rev, 2009 QSR

Is the Arctic Analogous?

- Certainly intra-continental S-N movement from refugia; also patterns indicative of ocean and wind currents
- Regional Low Arctic refugia – Beringia, Siberia, Canada, Greenland; few finer-scaled or High Arctic studies yet
- Evidence for ice-free ground and plants on Svalbard....and shrub vegetation at LGM on Novaya Zemlya....
- V rapid post-glacial colonisation on land and in fw ?implies local refugia, but low endemism implies reverse



Avila-Jimenez 2011 PhD; Avila-Jimenez & Coulson 2012 *Insects*; Coulson et al. 2014 *Soil Biol Biochem*

The Future?

- Regionally rapid climate change, esp. warming, but also precipitation, snow/ice melt, permafrost and ground dynamics, changes in marine nutrient transfer
- Natural colonisation routes and frequencies largely undocumented; birds, wind, currents, debris implicated
- Threat from biological invasions, in synergy with both climate change and human activity (tourism, research, industry, shipping, military...)
- Current synthesis provides baseline against which to compare, but long-term commitment required to survey less-known areas, to robust monitoring programmes and biosecurity, and to supporting international collaboration