



SCAR



Biodiversity: Antarctic moves in life's grand game

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Scientific Committee on Antarctic Research

Biodiversity

Biological diversity means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.

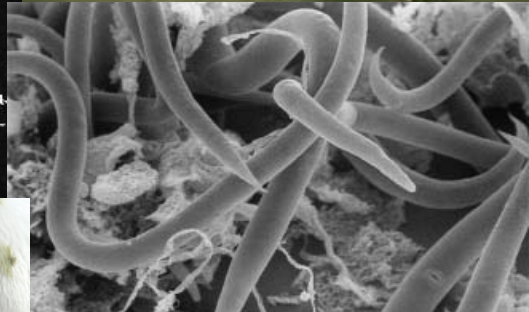
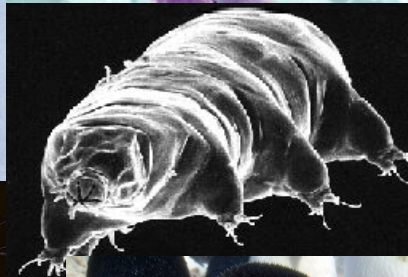


Algunas bestias

Era el crepúsculo de la iguana.

Desde la arcoirisada crestería
su lengua como un dardo
se hundía en la verdura,
el hormiguero monacal pisaba
con melodioso pie la selva,
el guanaco fino como el oxígeno
en las anchas alturas pardas
iba calzando botas de oro,
mientras la llama abría cándidos
ojos en la delicadeza
del mundo lleno de rocío.

Los monos trenzaban un hilo
interminablemente erótico
en las riberas de la aurora,
derribando muros de polen
y espantando el vuelo violeta
de las mariposas de Muzo.
Era la noche pura y pululante
de hocicos saliendo del légamo
y de las ciénagas soñolientas
un ruido opaco armaduras
volvía al origen terrestre.



Patterns in Diversity



Charles Darwin “...a grand game of chess
with the world for a board.”

Biodiversity Through Space

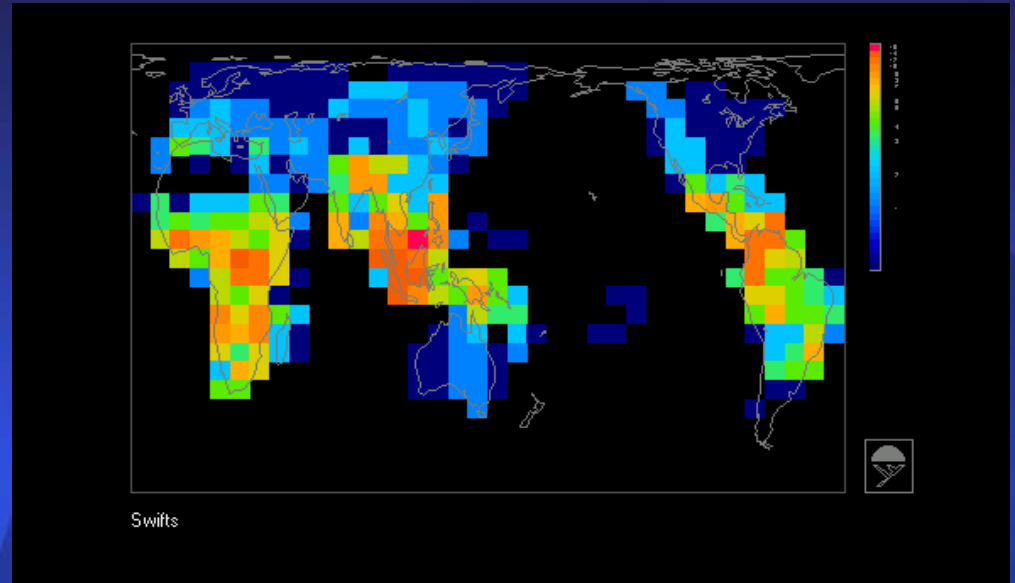
Variation in numbers and kind



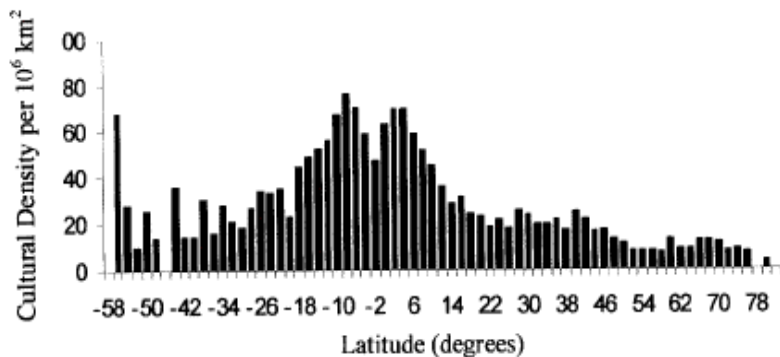
Global Scales



Alexander von Humboldt, 1804



A tropical peak in diversity of plants and animals



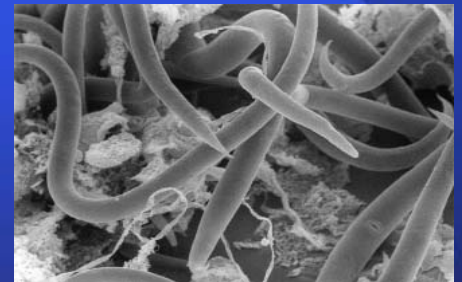
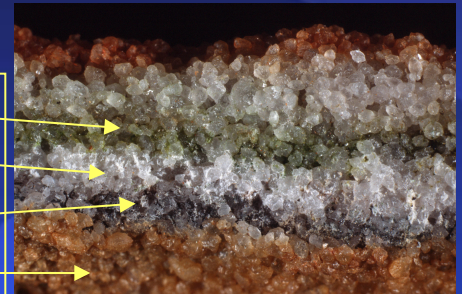
Human Cultural Diversity

Collard & Foley. 2002. *Evol. Ecol. Res.*

Is Antarctica Poor in Species?

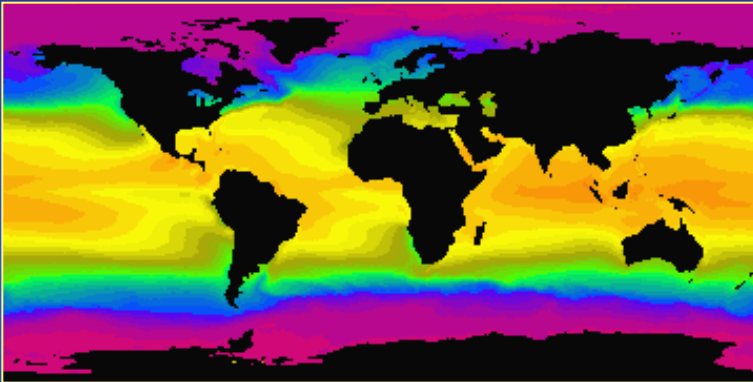
- Yes, for most terrestrial groups
- But it is home to unconventional terrestrial species
- Endolithic lichens
- Nematode worms that tolerate freezing
- Tardigrades that can dry out almost completely and then revive

Algae
Fungi
Lichen
Sandstone



What Drives the Latitudinal Gradient?

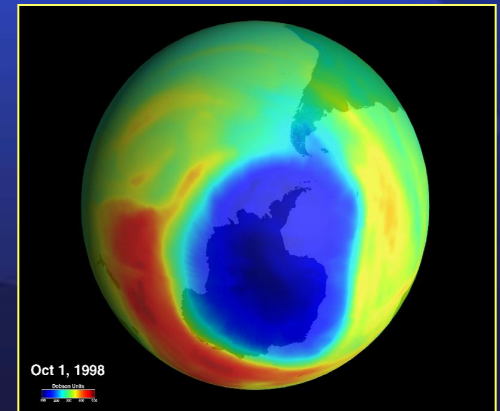
Variation in incoming energy



Global mean sea surface temperature variation

More energy $\approx$ more individuals
More individuals $\approx$ more species

Increasing UV levels over Antarctica might elevate mutation rates $\approx$ more chance of speciation



Marine Groups are Different

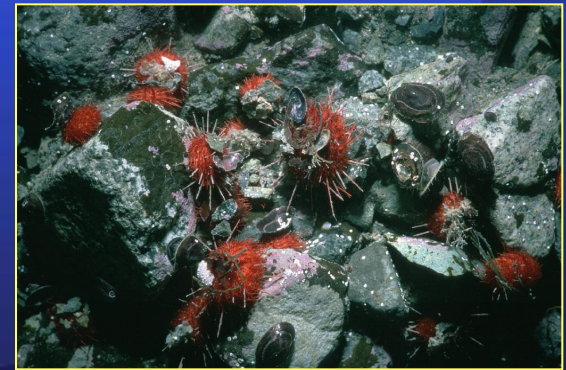
Some, such as crabs are poor in species or totally absent from the Antarctic



Others are highly diverse



Sea spiders:
global peak in
the Antarctic



Sea urchin group
rich in species

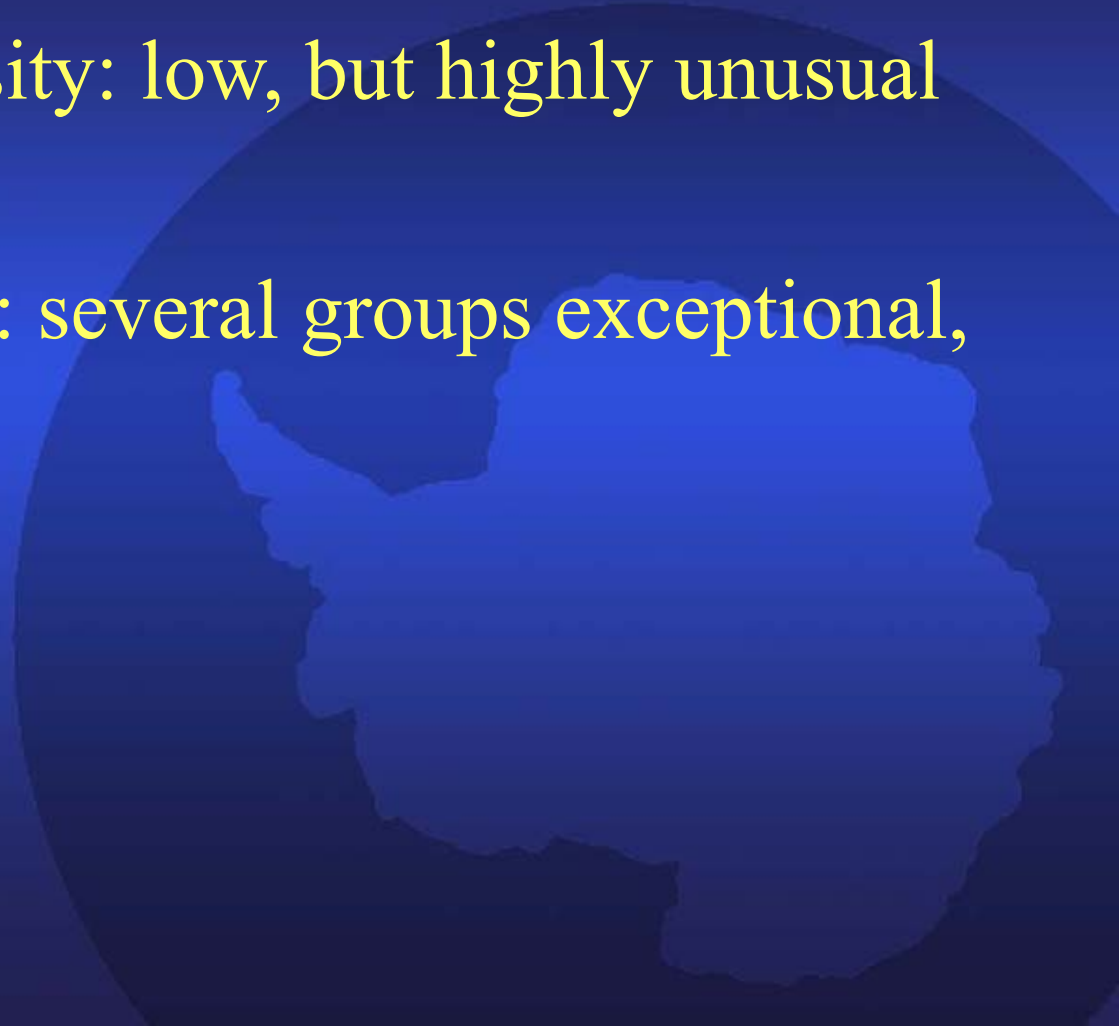
Stable marine environments
may be the key

A Biodiversity Scorecard

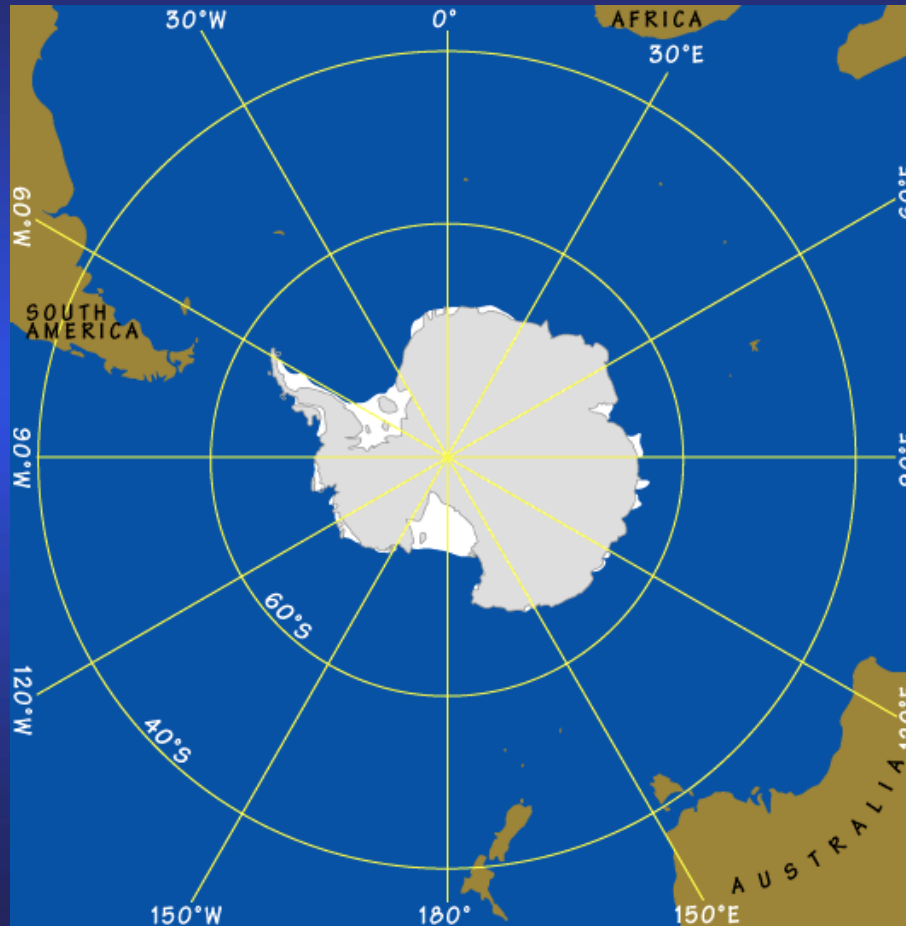
Terrestrial biodiversity: low, but highly unusual

Marine biodiversity: several groups exceptional, but others low

Life at its limits

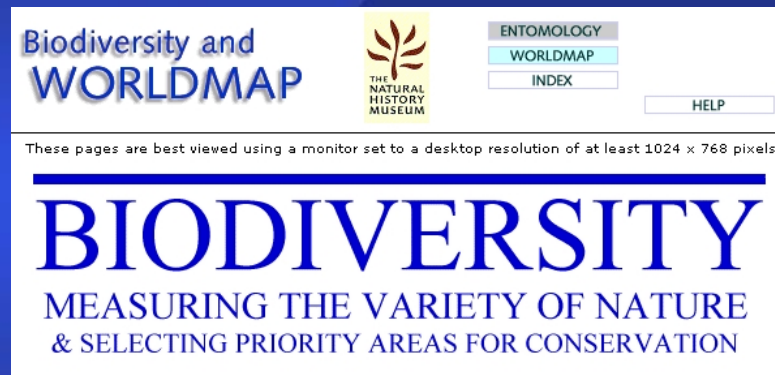


Regional Scale Diversity



Spatially Explicit Conservation Tools

For mapping biodiversity



For selecting areas of high conservation value based on one or more features of interest

Regional Complexity

- Terrestrial systems
 - There is no simple decline in diversity to the South
 - Good diversity maps typically not available
- Microfauna in Dronning Maud Land
 - 70° S: 7 species, Schirmacher Oasis
 - 73° S: 25 species, Basen
 - 75° S: 11 species, Haldorsentoppen
 - Algae
 - 60° S: 165 species, Signy Is.
 - 62° S: 68 species, King George Is.
 - 68° S: 83 species, Vestfold Hills
 - 70° S: 217 species, Schirmacher Oasis
 - 77° S: 97 species, S. Victoria Land
 - 86° S: 18 species, La Gorce Mntns.

Birds Best Known on Land and at Sea

Land : breeding areas, population sizes
and trends (SCAR Expert Group on Birds)

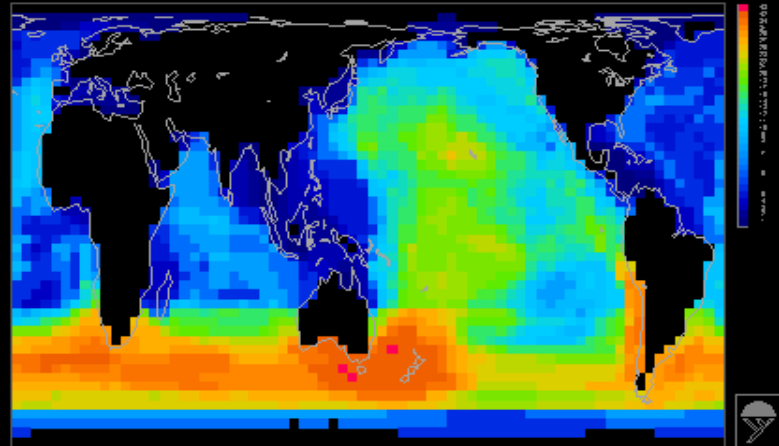
At sea: years of SCAR/COMNAP
coordinated cruises for Antarctic region

A STATISTICAL ASSESSMENT OF THE STATUS AND TRENDS
OF
ANTARCTIC AND SUBANTARCTIC SEABIRDS



© Donna Patterson

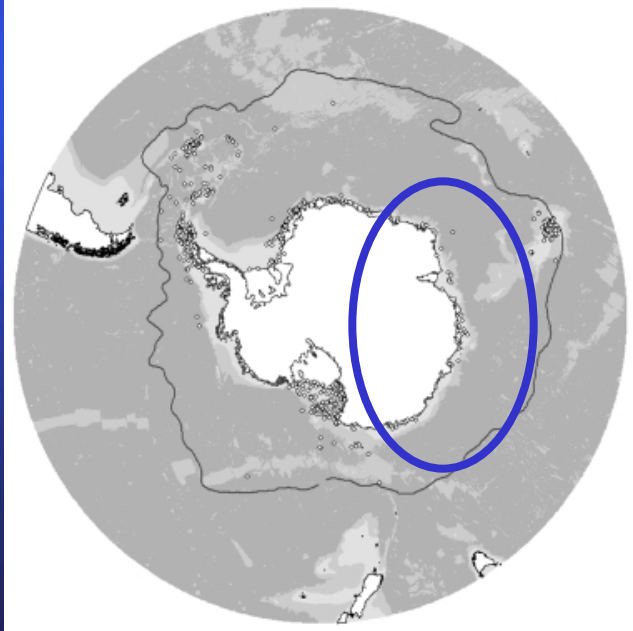
WOEHLER EJ, COOPER J, CROXALL JP, FRASER WR, KOOYMAN GL, MILLER GD, NEL DC,
PATTERSON DL, PETER H-U, RIBIC CA, SALWICKA K, TRIVELPIECE WZ & WEIMERSKIRCH H



Procellariiformes

Marine Groups

- Spatially explicit data poor – mapping problematic
- Southern Ocean Molluscan Database illustrative
- Note East Antarctic data deficiency

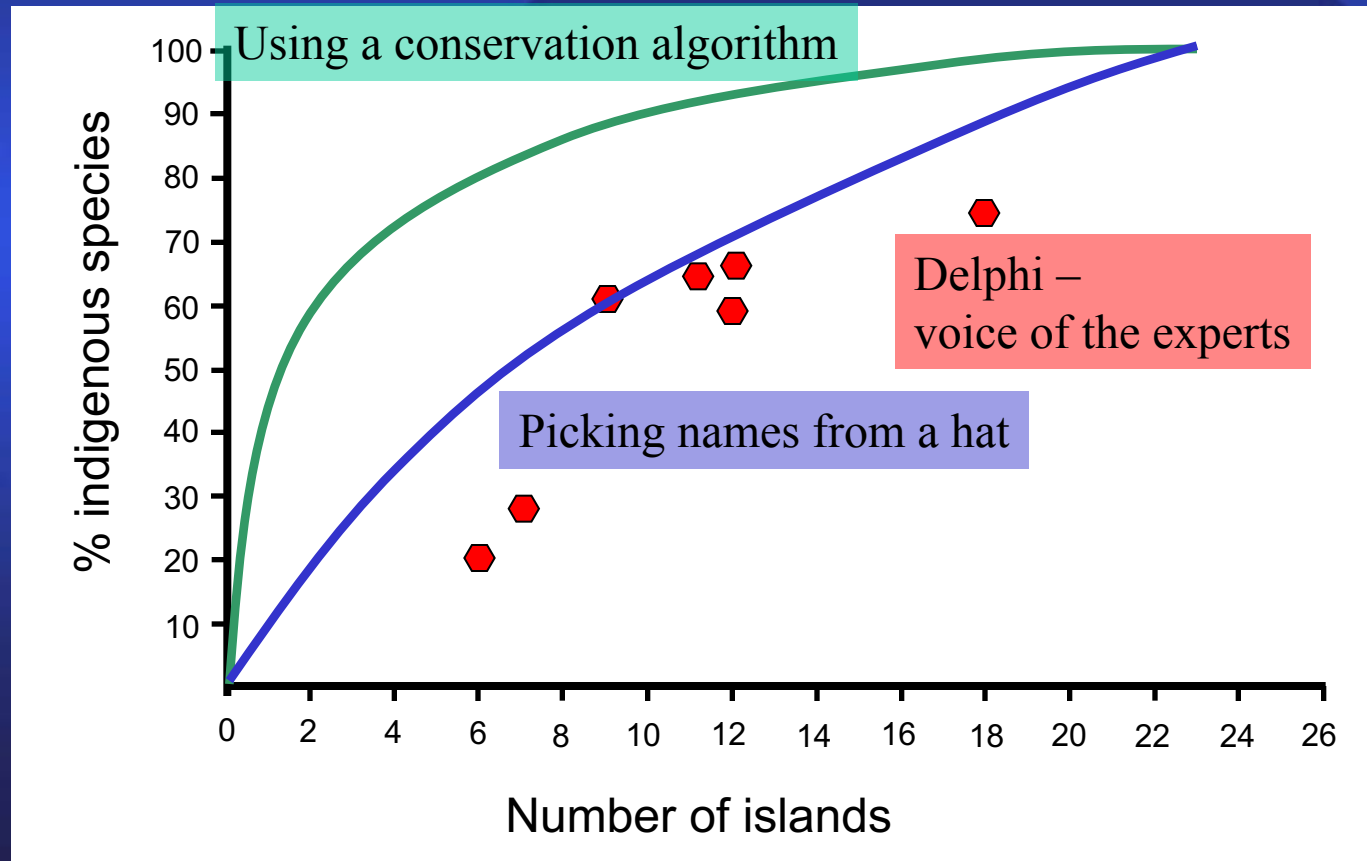


SOMBASE Data, Huw Griffiths, BAS



Why the Need for Spatially Explicit Biodiversity Information?

Conservation planning: the expert or the algorithm?



Local Scale Diversity

The scale of Antarctic Specially Protected and Specially Managed Areas

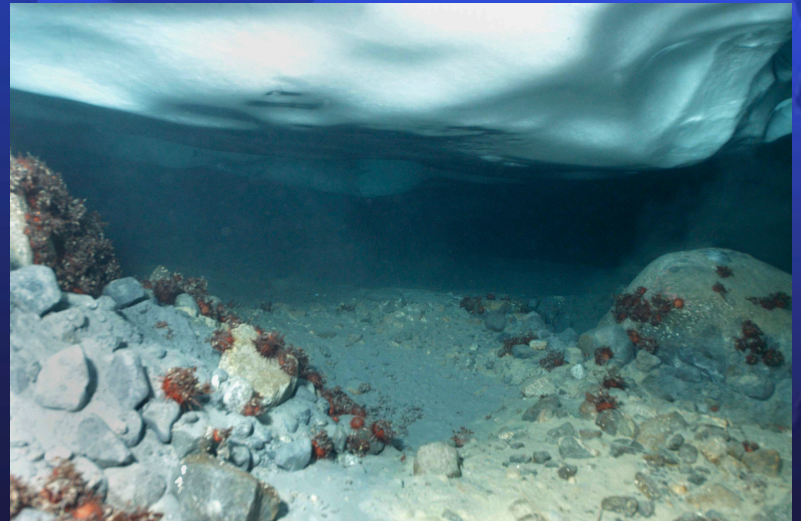


Patterns and Processes at Several Scales Well Understood

Water availability and temperature are significant in terrestrial systems

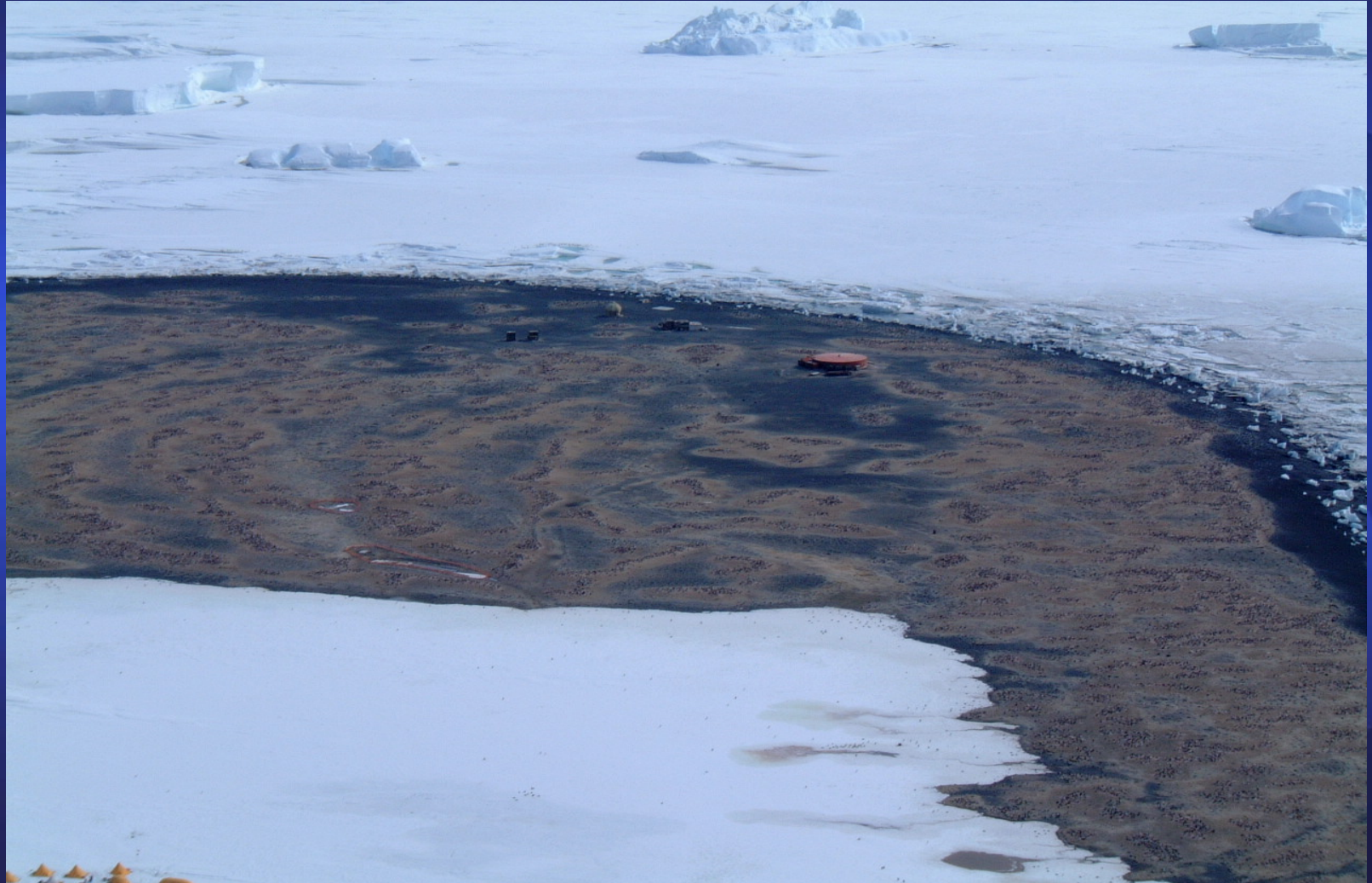


Ice scour is an important disturbance force along the near shore



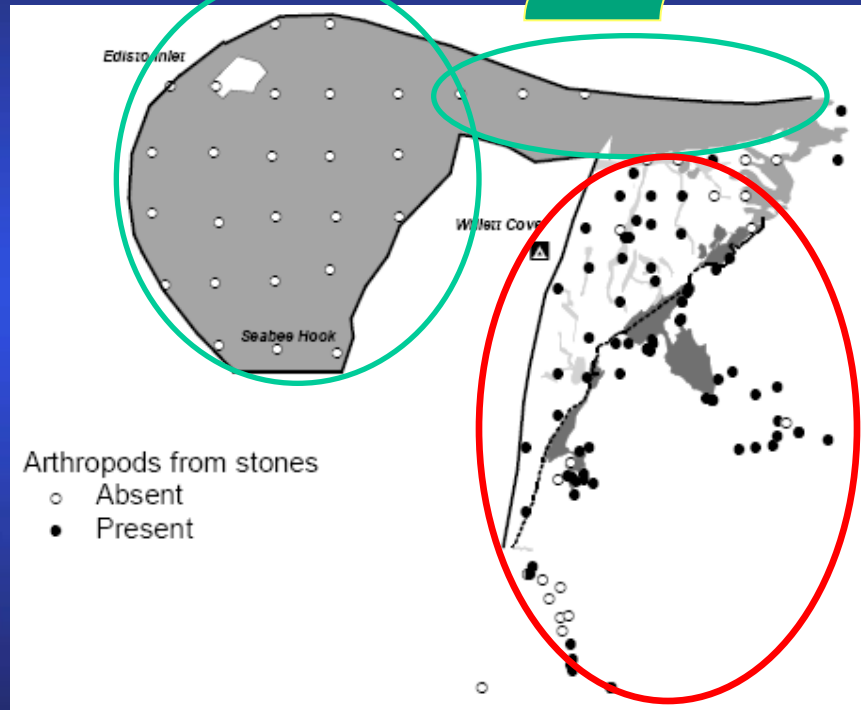
Local Scale Diversity

Cape Hallett, Victoria Land



Local Scale Diversity

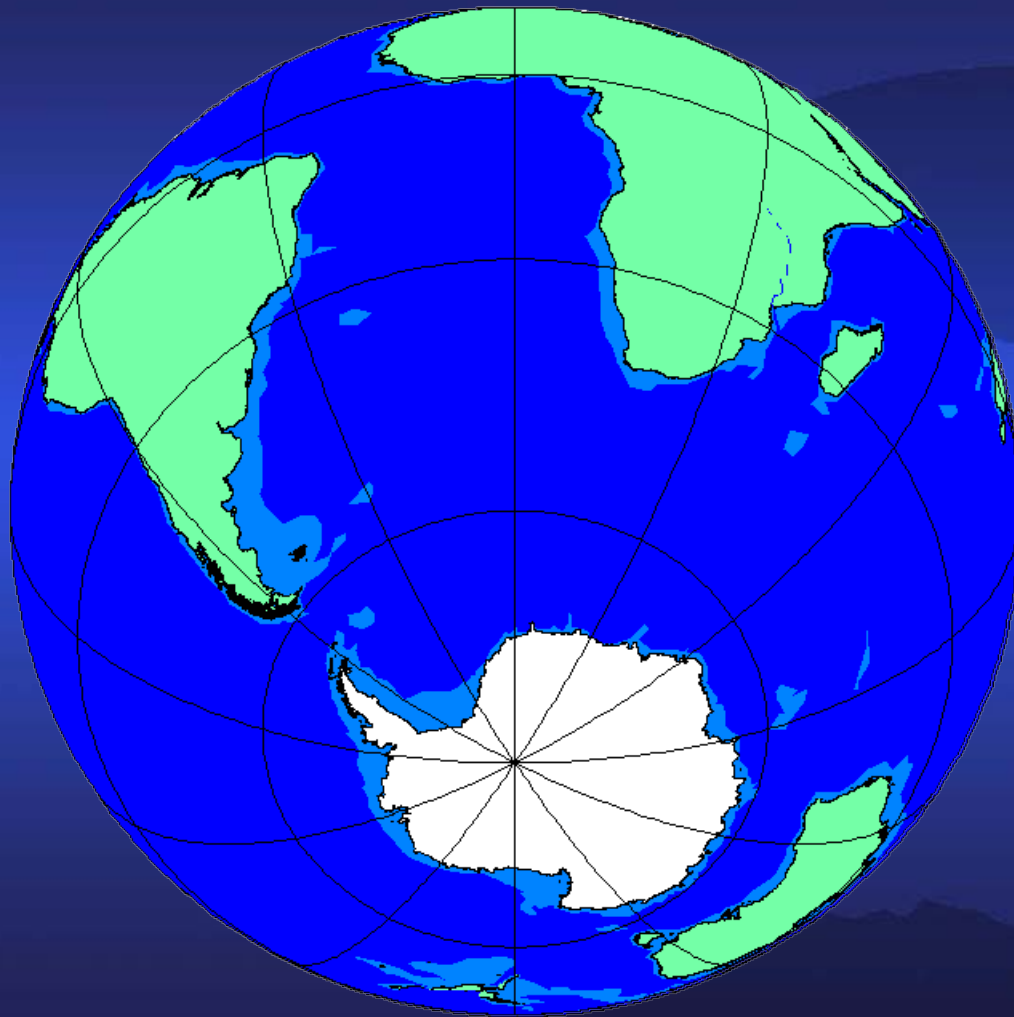
Species groups occur in different places



Spatial Take Home Messages

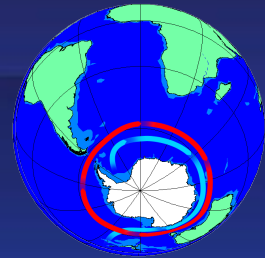
- Antarctic diversity is remarkable
- Much remains to be done to achieve a full, spatial catalogue of diversity
- Essential for information-based plans for protection of the Antarctic environment
- SCAR, in collaboration with COMNAP, is providing such information
 - Circum-Antarctic Census of Marine Life, SCAR-MarBin
 - Terrestrial genomics programmes

Biodiversity Through Time



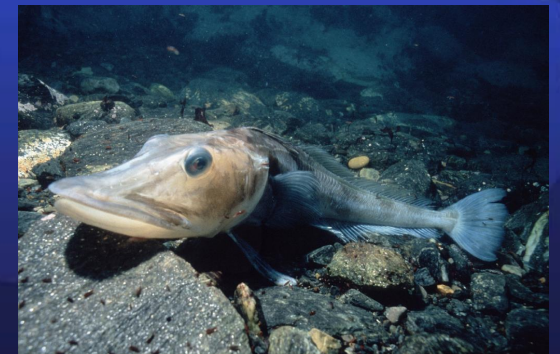
Antarctica in the Past

- The continent's spatial position has changed
- Its climate has varied substantially, and ice-sheets have been present since 34 million years ago
- Prior to substantial ice coverage, Antarctica supported a diverse assemblage of plants and animals, including dinosaurs
- Evidence for the first Cretaceous, but modern birds comes from Antarctica in the form of a fossil duck species



Effects of Glaciation

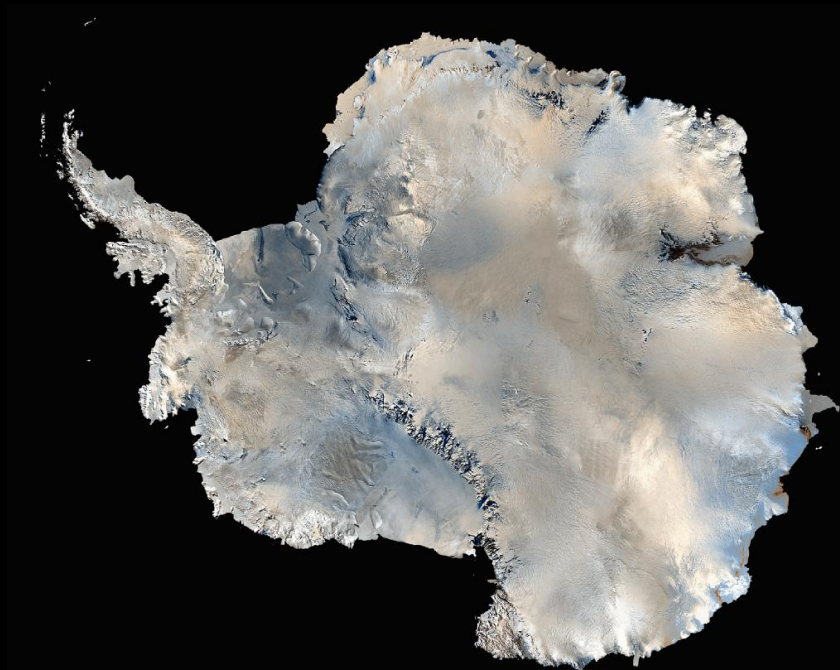
- Terrestrially only a few species, such as *Maudheimia* “beetle mites” survived
- Some groups such as the notothenioid fish have diversified tremendously, moving across the Polar Frontal Zone into the sub-Antarctic on several different occasions



Antarctica has been isolated for tens of millions of years

Many marine organisms have evolved *in situ*

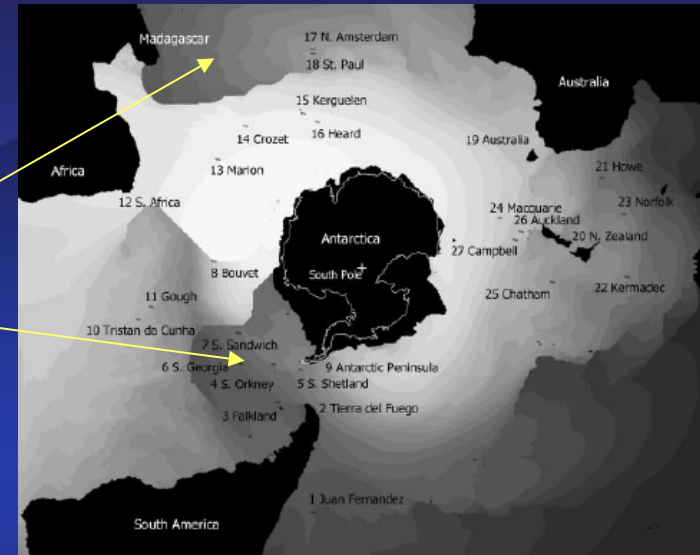
Most terrestrial organisms have arrived
by rare dispersal events



Dispersal Pathways

By wind: bryophytes around the Southern Ocean

In the image: Dark areas indicate substantial dispersal among islands by wind



Muñoz et al. 2004, Science

By bird dispersal: plant seeds, stolons, and insect eggs

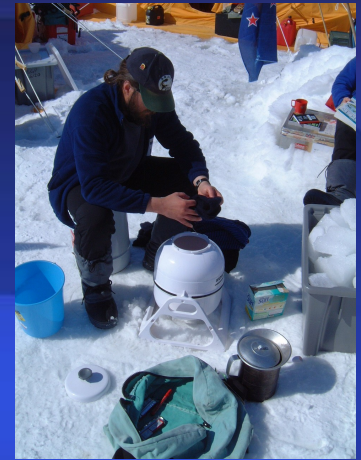


Modern Dispersal

Most organisms are small

At 70 kg we are huge by comparison with many mammals, most birds, and, of course, most invertebrates

The smallest of the insects weighs less than one millionth of a gram, and the largest in the region of 50 g



Modern Dispersal

Small organisms and/or their offspring (propagules) are easily overlooked and accidentally introduced



Some organisms are purposefully introduced with unforeseen consequences



Invasive alien species cost the global economy approximately US\$ 1.4 trillion *per annum* (5% of global GDP)

GISP

The Global Invasive Species Programme



Alien and Invasive Species in the Antarctic Region

- Microorganisms
- Fungi
- Mosses
- Flowering plants
- Insects
- Crabs
- Fish
- Birds
- Mammals



Humans as Vectors and Pathways



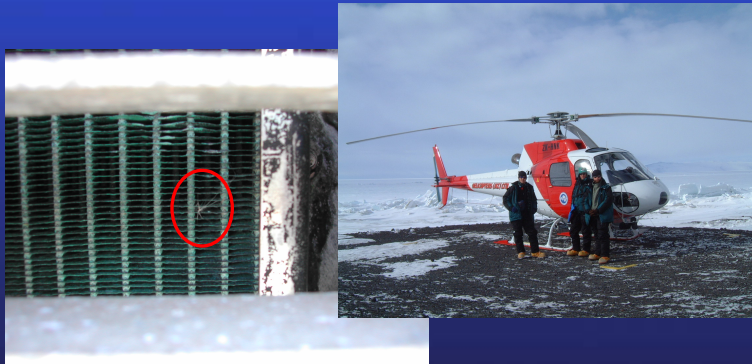
As stowaways; in sea
chests and ballast water



On and in cargo
containers



In and on food



On vehicles

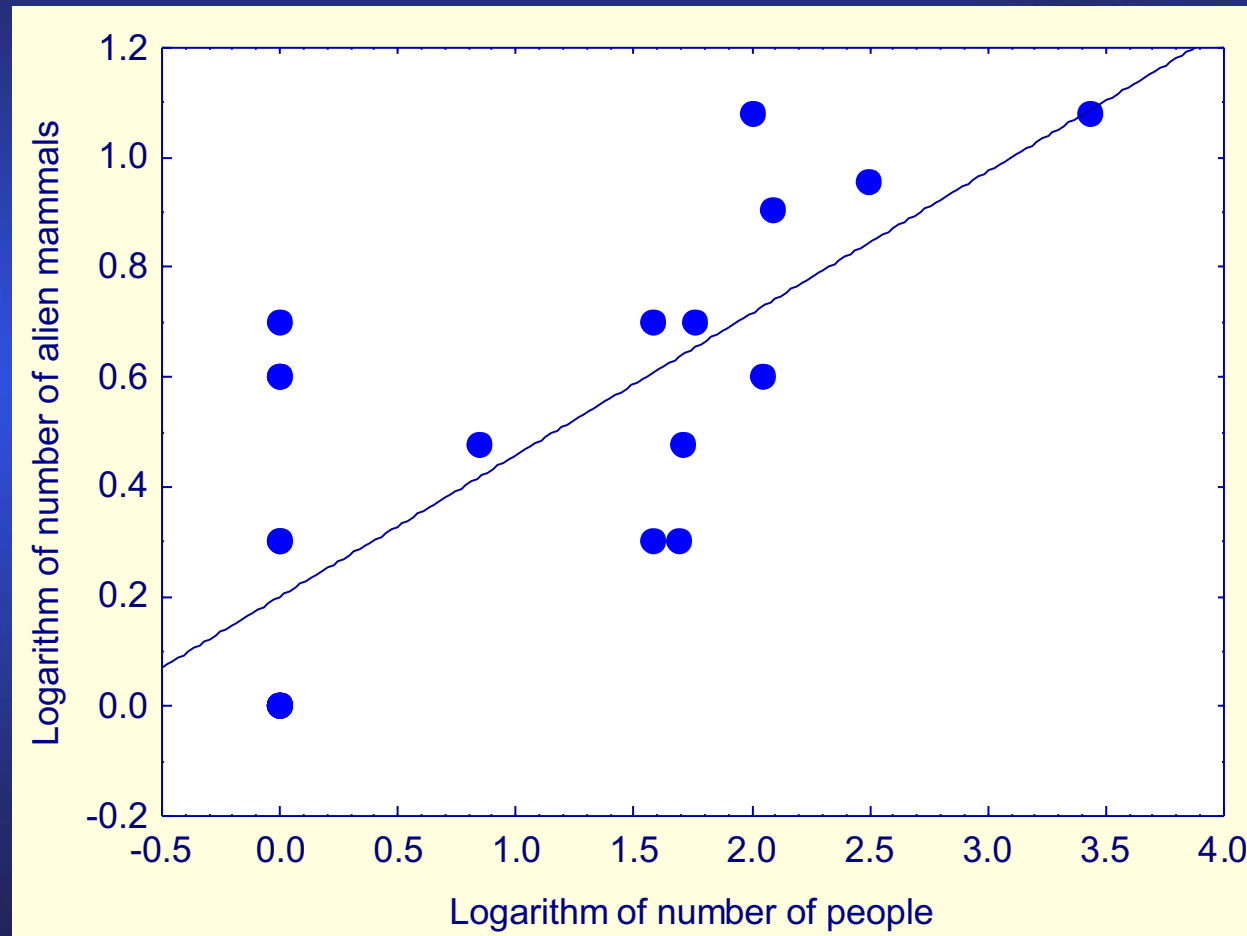


Adhering to
footwear

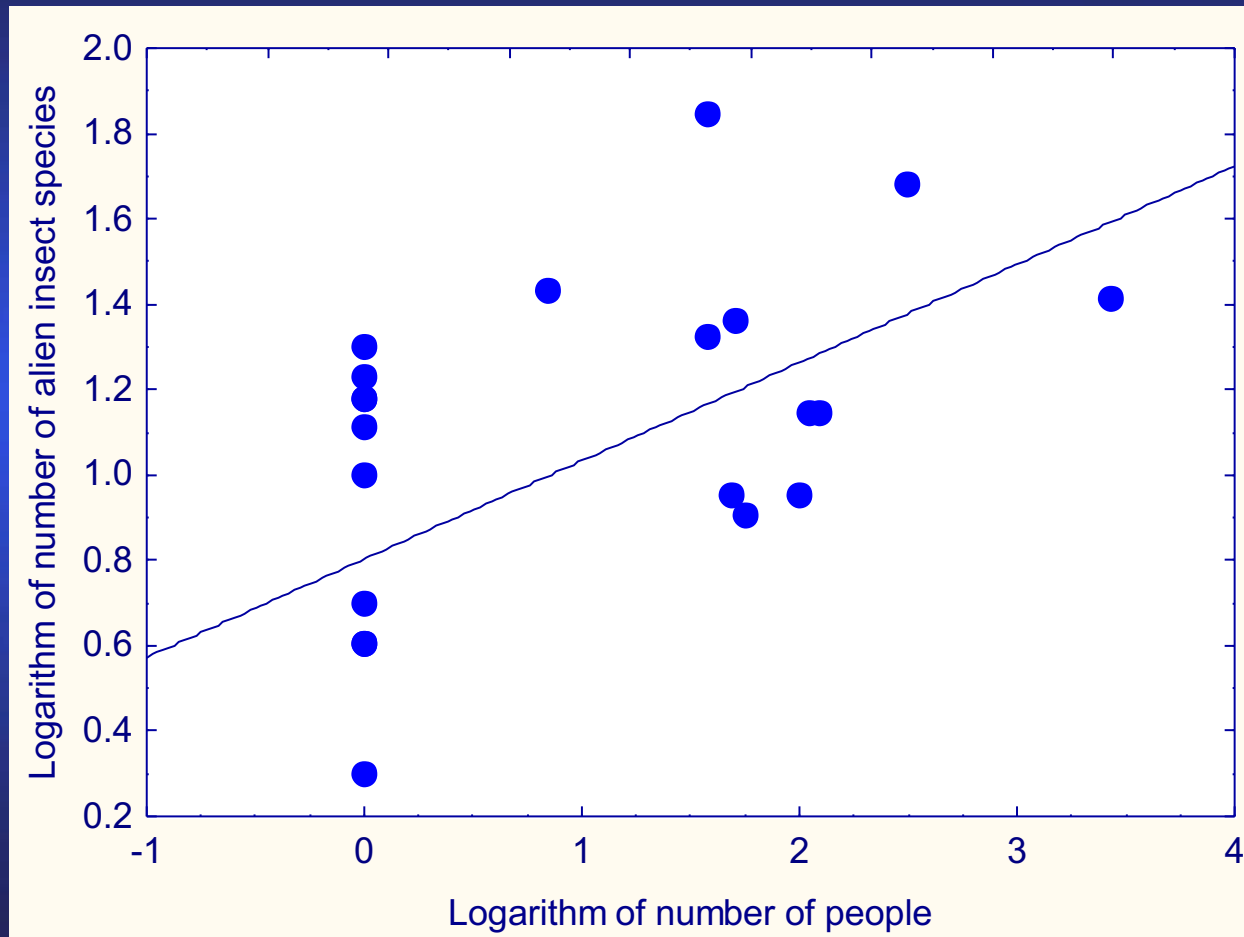


Attached to clothing

Numbers of people and numbers of alien mammal species in the sub-Antarctic



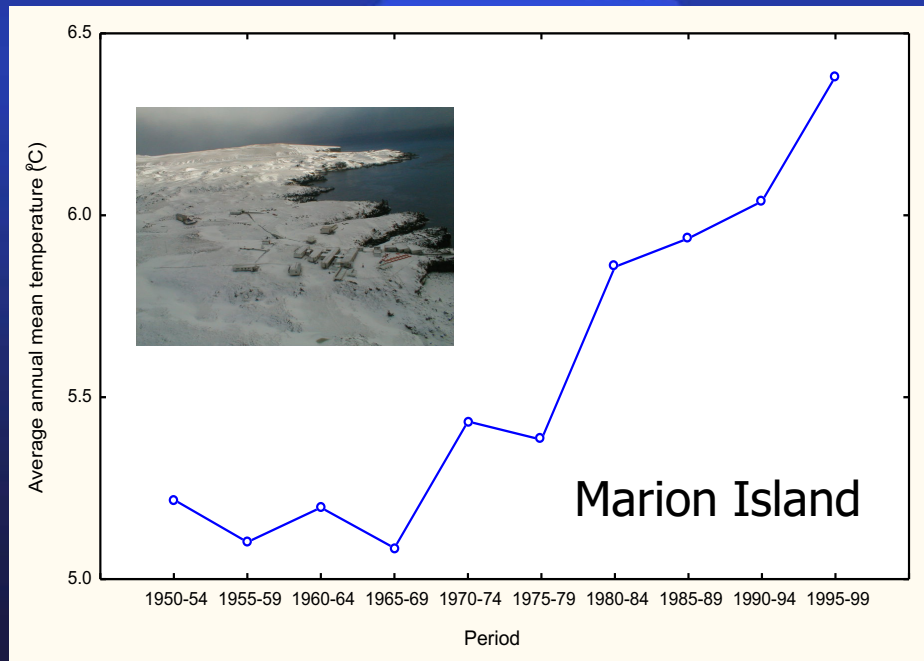
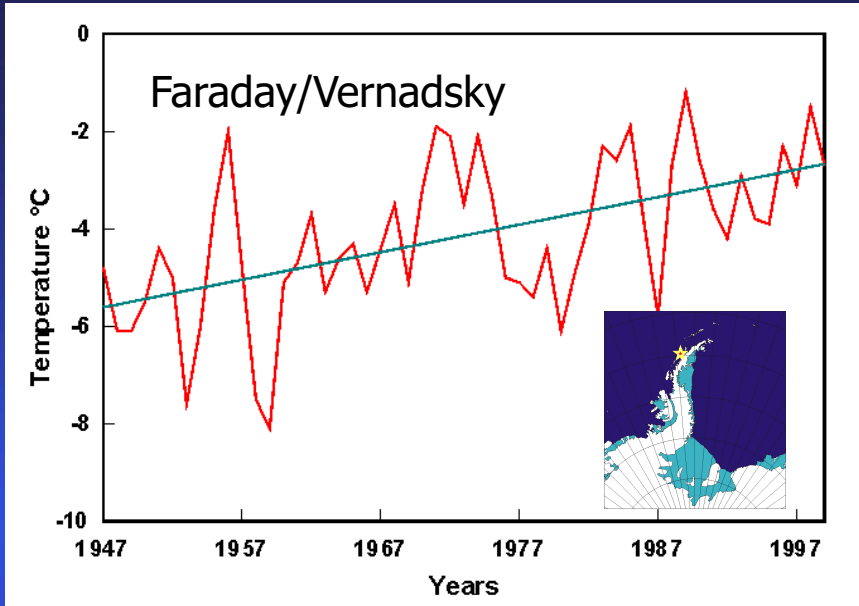
Numbers of people and numbers of alien insect species in the sub-Antarctic



Human Activity in the Antarctic

- Science operations in 2001/02: 4 390 personnel, 67 stations, 60 ships departing from 30 cities
- Tourist numbers: 6 000 in 1992, to 13 600 in 2002, to 24 000 last season
- Most visited the Peninsula area
- Port Lockroy 2004/05: 9 400 tourists

Evidence for Regional Warming



Invasive Alien Prospects

- Increased human traffic and warmer conditions mean increased opportunities for establishment
- From an alien perspective, matters have not looked this good for some time
- The environmental costs of our activities will increase, and careful examination of mitigation options is required
- Prevention is always more cost-effective than cure
- IAATO, for example, is implementing such preventative measures

Temporal Take Home Messages

- Molecular tools are solving problems of dispersal vs. *in situ* survival of groups
- Antarctica is not as isolated as it once was
- On the sub-Antarctic islands the rate of species introductions is high and their impacts are substantial
- The forecast is not optimistic: globally the interaction between climate change and invasion is of major concern



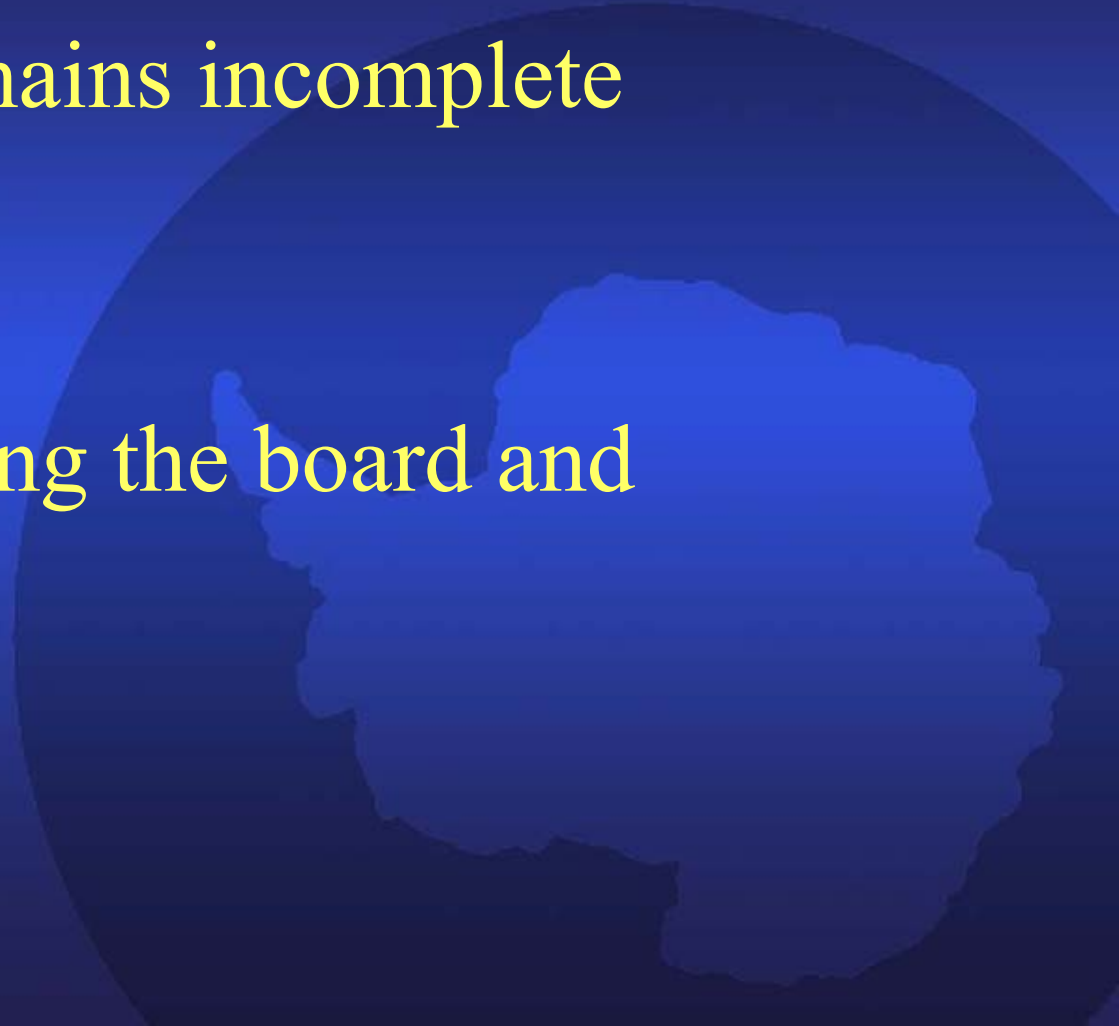
The Grand Game

“We have come a long way in understanding the rules of the game: the form of the board, why pieces come and go, and how they may move”

The Antarctic Grand Game

Our knowledge remains incomplete

And, we are changing the board and
pieces as we speak



The Antarctic Grand Game

Several marine invertebrates will tolerate no more than 1-2 degrees increase in temperature

New species continue to reach the region



Biol. Rev. (2005), 80, pp. 45–72. © Cambridge Philosophical Society
DOI: 10.1017/S1464793104006542 Printed in the United Kingdom

Biological invasions in the Antarctic: extent, impacts and implications

Understanding the Game

- Conservation science provides tools for understanding diversity and for conserving it
- The Antarctic Treaty System is charged with ensuring the protection of the Antarctic environment
- SCAR, in collaboration with COMNAP, continues to provide scientific understanding to realize these goals

SCAR

To establish through scientific research and international cooperation a broad understanding of the nature of Antarctica, the role of the Antarctic in the Earth System, and the effects of global change on Antarctica