SUBJECT- ENVIRONMENTAL SCIENCE

SEMESTER – 4TH SEMESTER (CC8)

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TOPIC- BIOGEOGRAPHY

Biogeography

Biogeography is the study of the geographical distribution of living and fossil plants and animals as a result of ecological and evolutionary processes. Biogeography analyzes organism-environment relations through change over space and time, and it often includes human-biota interactions. The main questions explored by biogeographers deal with organism patterns to understand the underlying processes. Biogeographers ponder questions such as

- why is a species present in a given area. Conversely, if a species is not present, then
- why is it missing from the area?
- What are the historical and ecological factors that help determine where a species occurs?
- What are the effects of evolution and plate tectonics?
- How have humans altered geographic distribution of organisms?

The science of biogeography has been refreshed in the past 60 years due to our understanding of plate tectonics, mechanisms limiting distributions, island biogeography theories, and mathematical and technological tools. Current work in biogeography uses spatial patterns of organisms, past and present, to determine ecological processes. Biogeographers use experimental testing and quantification of biotic interactions. Vegetation dynamics is the primary focus for approximately half of the biogeographic research conducted by geographers. Other major focuses include

- ecosystem structure and function,
- zoogeography,
- paleoecology, and
- development of new biogeographic methodology.

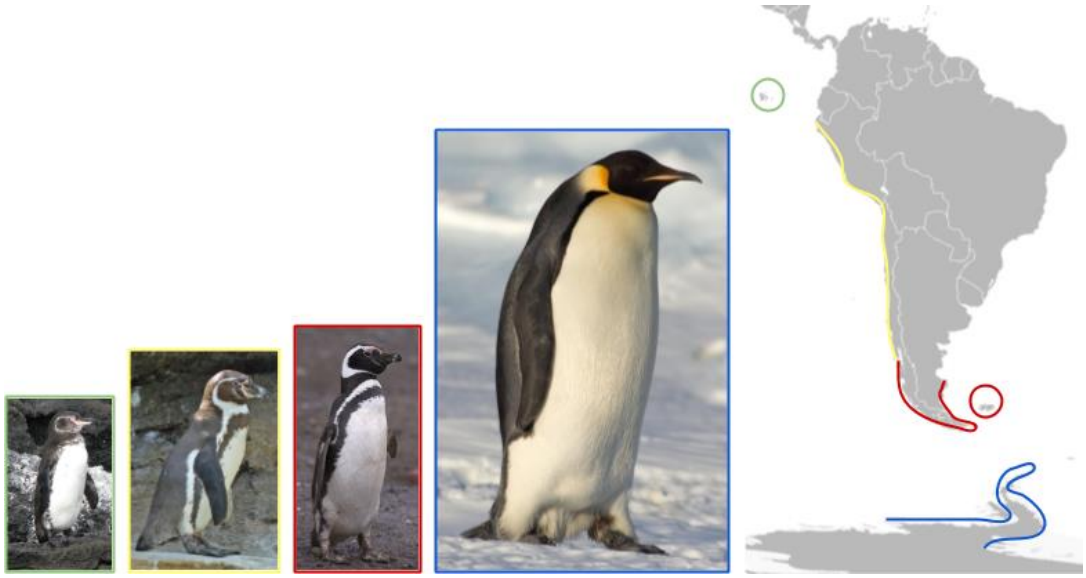
In particular, mapping and modeling spatial patterns of abundance and distribution of species of plants and animals have greatly advanced with geographic information systems and remote sensing technology.

Rules in Biogeography

A biologeographic rule is a generalized law, principle, or rule of thumb formulated to correlate and understand patterns observed in living organisms with respect to special and temporal aspects.

Bergmann's Rule- is a principle correlating external temperature and the ratio of body surface to weight in warm-blooded animals. Birds and mammals in cold regions have been observed to be bulkier than individuals of the same species in warm regions. Body size is large in cold climates and small in warm climates. Large bodies have a smaller surface area to volume ratios.

The principle was proposed by Carl Bergmann, a 19th-century German biologist, to account for an adaptive mechanism to conserve or to radiate body heat, depending on climate.

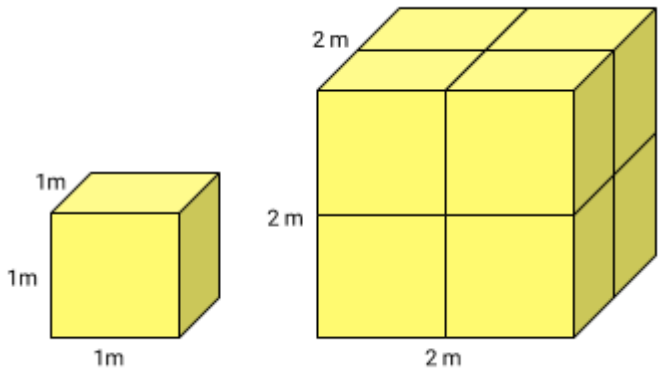


The body size of different penguin species is increasing the closer their distribution area is to the South Pole. The tiny Galapagos penguin is only around 50 cm (19 in) tall and lives on the Galapagos Islands, west of Ecuador. Southwards, down the Pacific coast, we find its around 15 cm (0.6 in) taller relative, the Humboldt penguin. Even further south, at the southern tip of South America lies the home of the Magellan penguin. Its size is in average 5 cm (0.2 in) above the one of a Humboldt penguin. Finally, the tallest in the penguin family is the Emperor penguin with a height of about 122 cm (4.8 in). It lives in the southern tip of the Earth, in Antarctica.

Animals in colder regions are bigger to reduce heat loss to the environment, as their surface is comparably smaller in relation to their volume than in smaller animals. For animals living in warmer regions, it's just the other way round as they need to get rid of the heat. Animals evolved this way so that they can minimize the energy need for their body's thermoregulation system.

The correlation between surface and volume probably requires some further explanation. An animal consists of millions and millions of cells. Each living cell produces heat that can only be lost to the environment over an animal's surface. In a colder climate, it's better to lose less heat because one needs less energy to keep a constant body temperature. In a warmer climate, it's better to lose heat fast, else one would need more energy to bring down the body temperature.

To understand how the relation of the body surface to the body volume plays a role in heat loss, imagine an animal as a cube. Assume we have two cube animals.

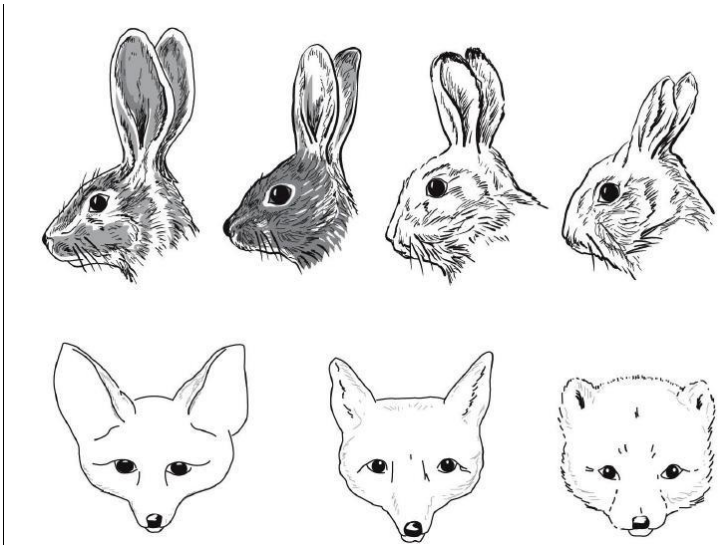


The small cube animal on the left and the big cube animal on the right.

The first one is 1 m (3.3 ft) high, 1 m wide and 1 m deep. Therefore, its volume is 1 m x 1 m x 1 m = 1 m3 (35.3 cu ft) and its surface is 1 m x 1 m x 6 = 6 m2 (64.6 sq ft). The second one is bigger: 2 m (6.6 ft) high, 2 m wide and 2 m deep and it has a volume of 8 m3 (282.5 cu ft) and a surface of 24 m2 (258.3 sq ft).

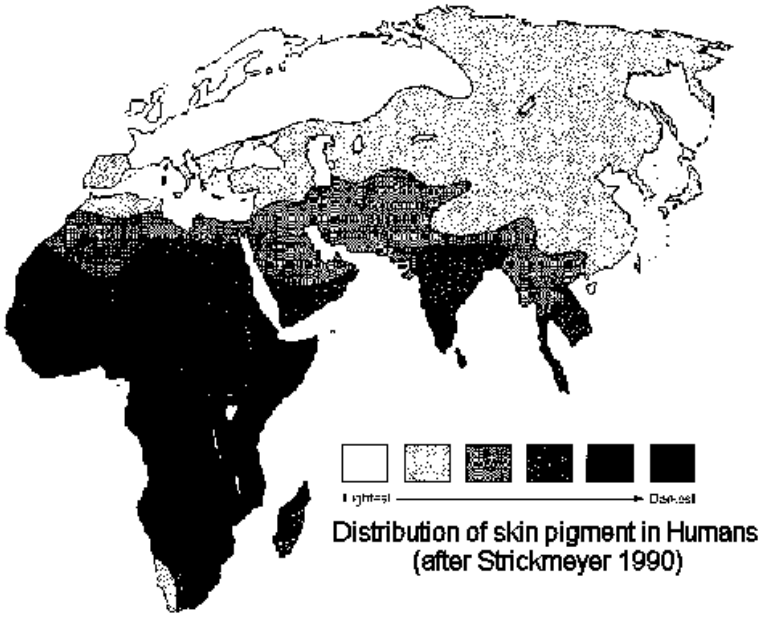
Now you can see, that the volume of the bigger cube animal is eight times larger (8 m3 / 1 m3) in comparison to the smaller cube animal. At the same time, its surface is only four times larger (24 m2 / 6 m2). Its mass of heat producing cells increased eight times, but the area, where the cells lose heat did only increase four times. Therefore, larger animals produce more heat (because they have more cells in their body volume) but lose less heat, because their body surface is relatively smaller.

Allen's Rule: body form or shape is linear in warm climates and more rounded and compact in cold climates. Round forms have a smaller surface area to volume ratios. Mammals which are endothermal animals, in cold climates need to conserve more energy as their exposure to the surface is more and which causes great heat loss and therefore these mammals from colder region show shorter extremities.



Ear length of foxes and rabbits gradually decrease as the climate moves from hot desert in the left to cold tundra in the right (Adapted from Feldhamer *et a.l* 2007)

Glogers Rule: Individuals of many species of insects, birds, and mammals are darkly pigmented in humid climates and lightly coloured in dry ones. This may well be a camouflage adaptation—moist habitats are usually well vegetated and tend to lack pale colours. There are many exceptions to this so-called rule. The rule was proposed in 1833 by the German zoologist Constantin Wilhelm Lambert Gloger (1803–63).



Gloge's Rule in Human pigmentation

Geist Rule: In a 1986 study, Valerius Geist opposed the Bergmann's rule. Instead of latitudinal variations, Geist found that body size is proportional to the duration of the annual productivity pulse, or food availability per animal during the growing season.

Gause's law or the **competitive exclusion principle**, named after Georgy Gause, states that two species competing for the same resource cannot coexist at constant population values. The competition leads either to the extinction of the weaker competitor or to an evolutionary or behavioral shift toward a niche differentiation.