Bio-Productivity, Collective Learning, and Evolution of Human Social Organization: A Biogeographical Study

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In the context of this study, complex human social organization (CHSO) refers to

Human societies that are characterized by

1. Development of cities
2. Social stratification
3. Concentration of surplus production
4. Symbolic communication form (typically, writing systems)
5. Political and/or cultural institutions

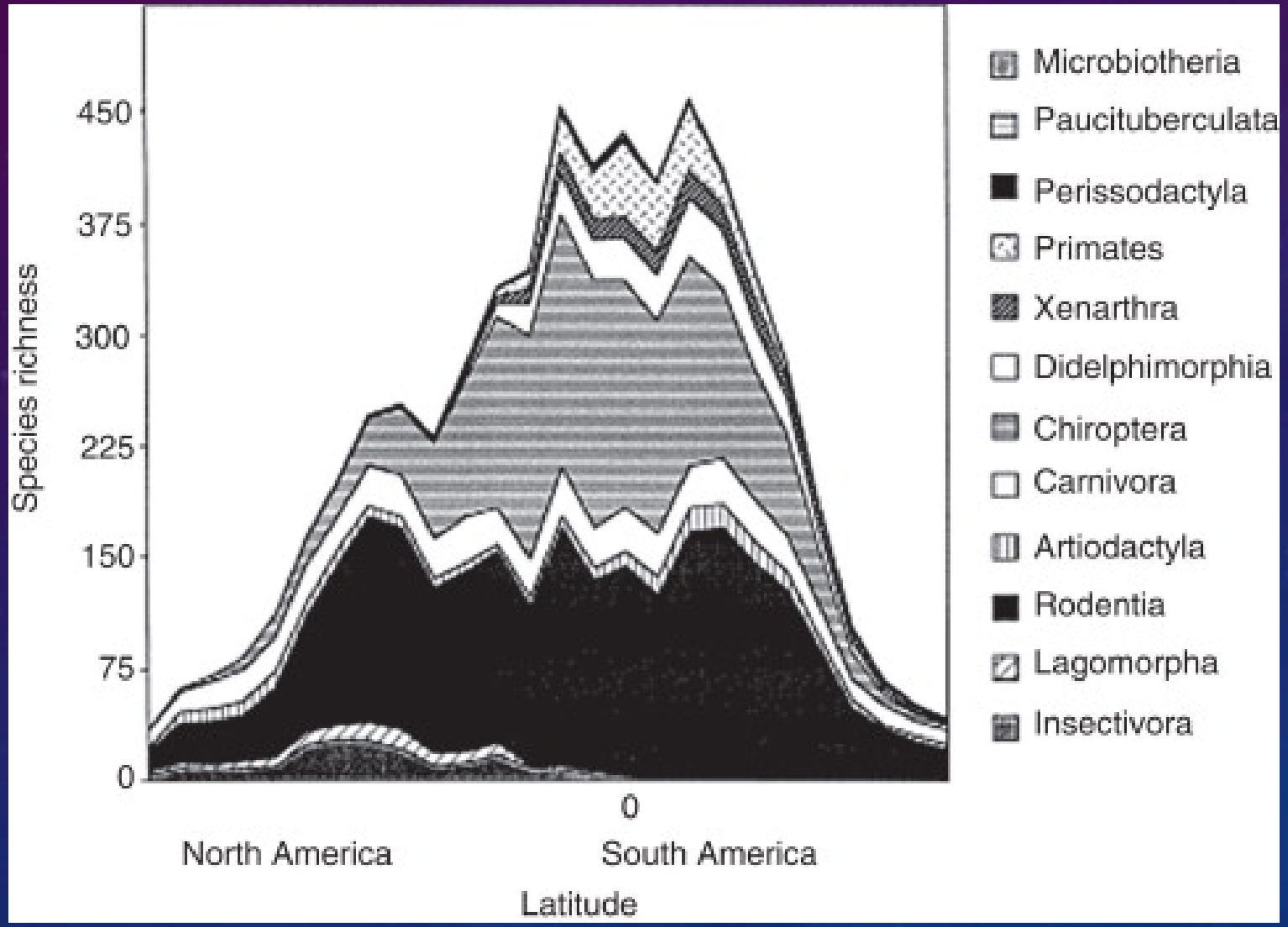
Arthur Cotterell, 1988, Encyclopedia of Ancient Civilizations, Penguin Books

Development of early CHSO – Geographic explanation – Gerad Diamond (1997) and Ian Morris (2010)

Lucky Latitudes – major early CHSO developed within 20-35° N due to :

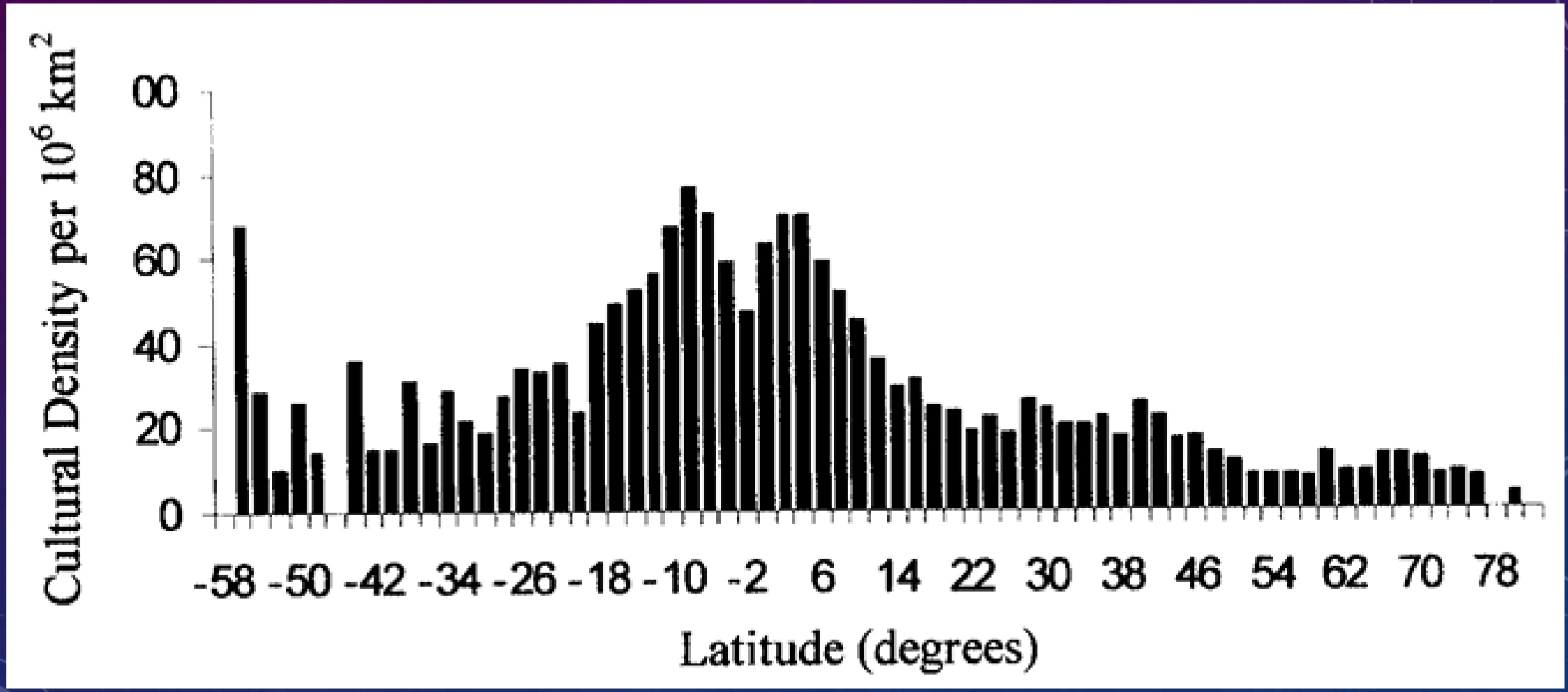
- presence of many domesticable plants & animals
- broad non-stopped east-west axis of the Eurasia continent

Latitudinal gradient of species diversity



Gillman, et al. 2015

Latitudinal gradient of human cultural diversity



Gavin and Stepp 2014

A further hypothesis: early CHSO developed in geographic areas that favor *Collective Learning*

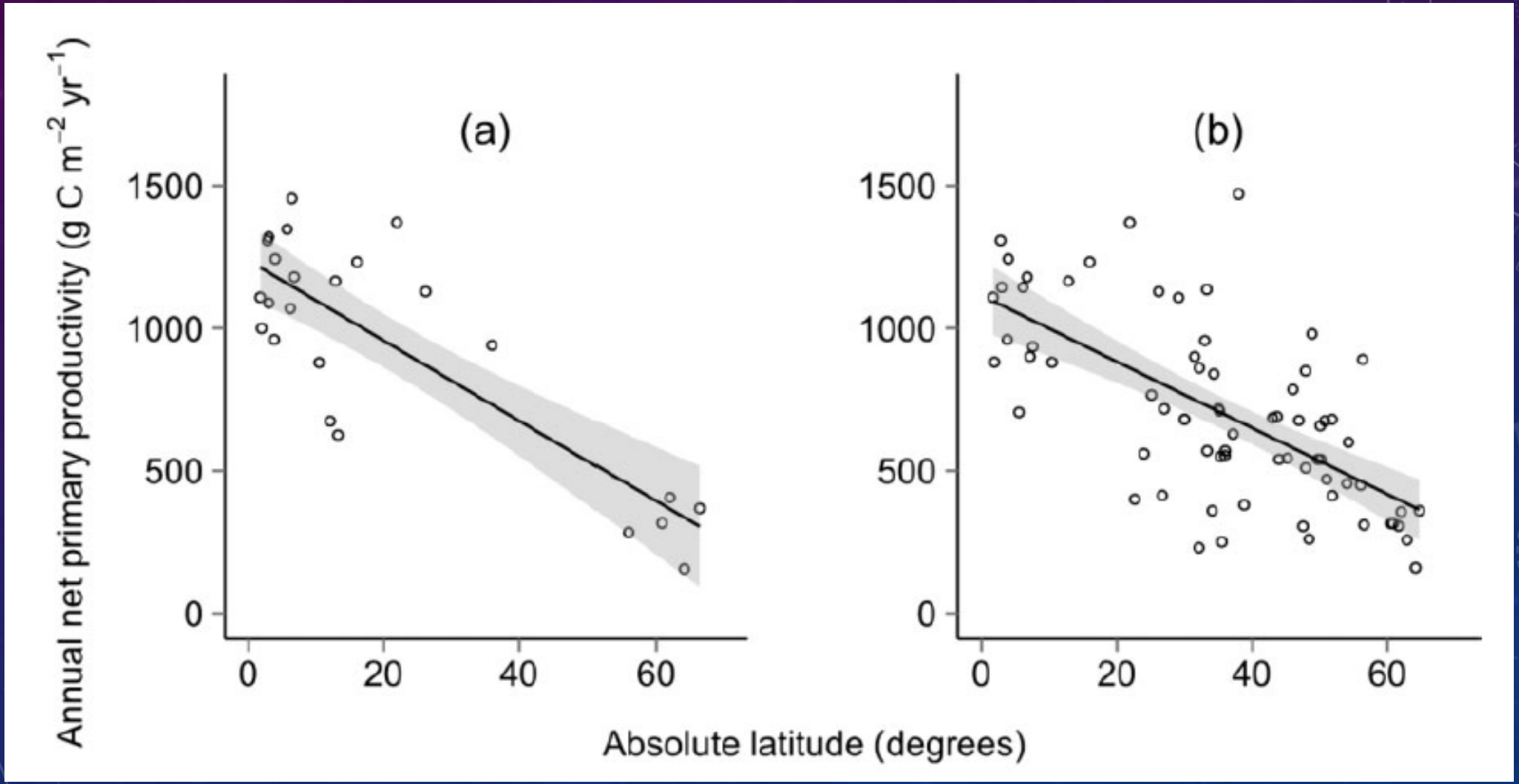
Collective Leaning has been considered as a key concept and unifying theme of human history (Christian 2003, Baker 2016)

Collective Learning is favored by

- Human population size
- Human group interactions (competition, war, cooperation)
- Simplicity of the environment (inverse of diversity)

Bio-productivity is a common factor of all the above

Latitudinal gradient of annual net primary productivity

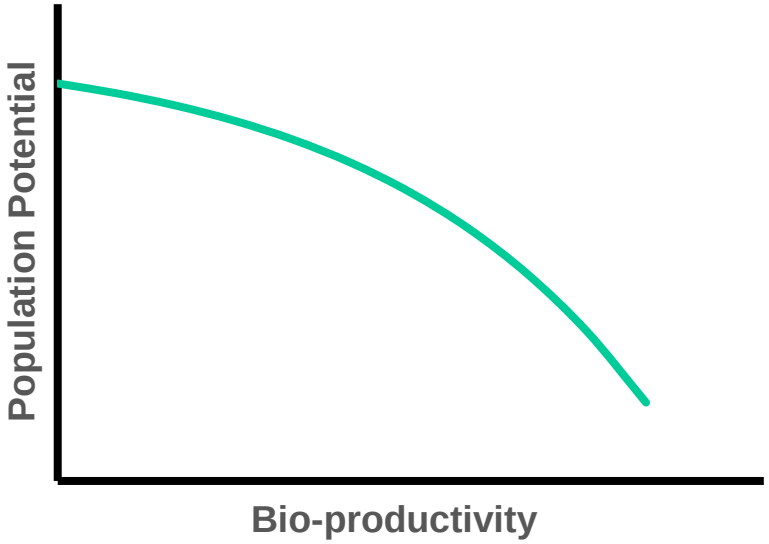


Gillman, et al. 2015

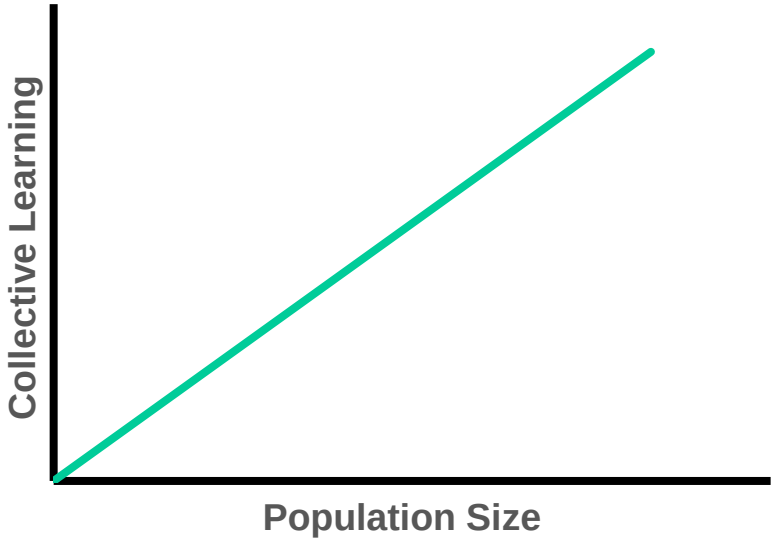
At low latitude, high bio-productivity favors hunter-gatherer population growth, and collective learning

The high bio-productivity at low latitude potentially supports larger pre-historical hunter-gatherer population and hence favors collective learning

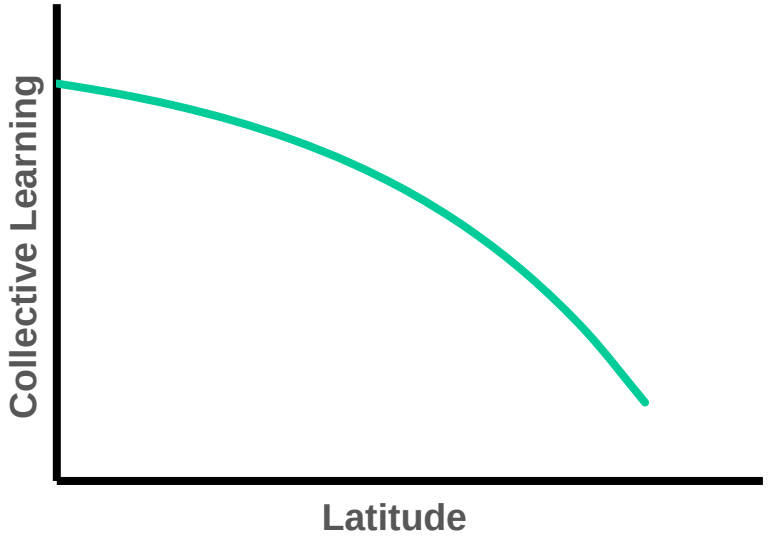
Pre-historical population potential in relation to bio-productivity



Collective learning in relation to population size



Latitudinal variation of collective learning due to bio-productivity

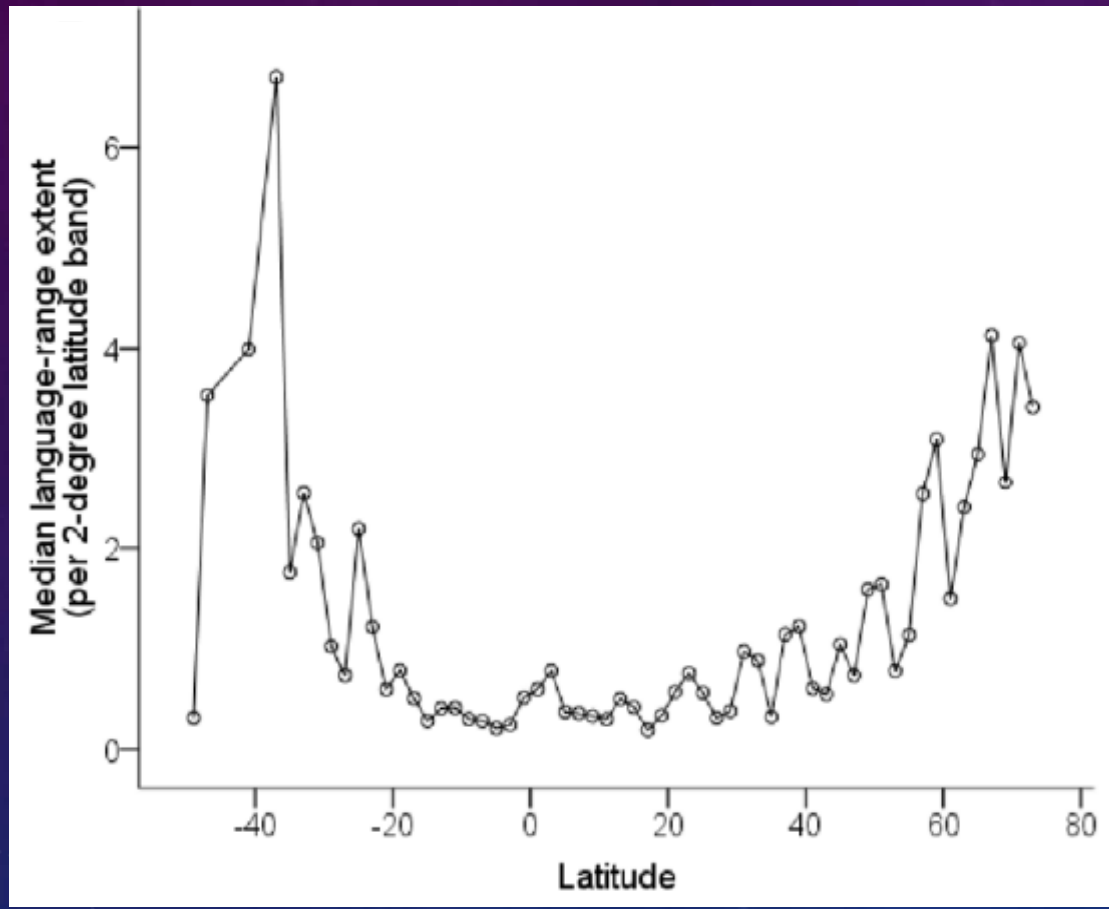


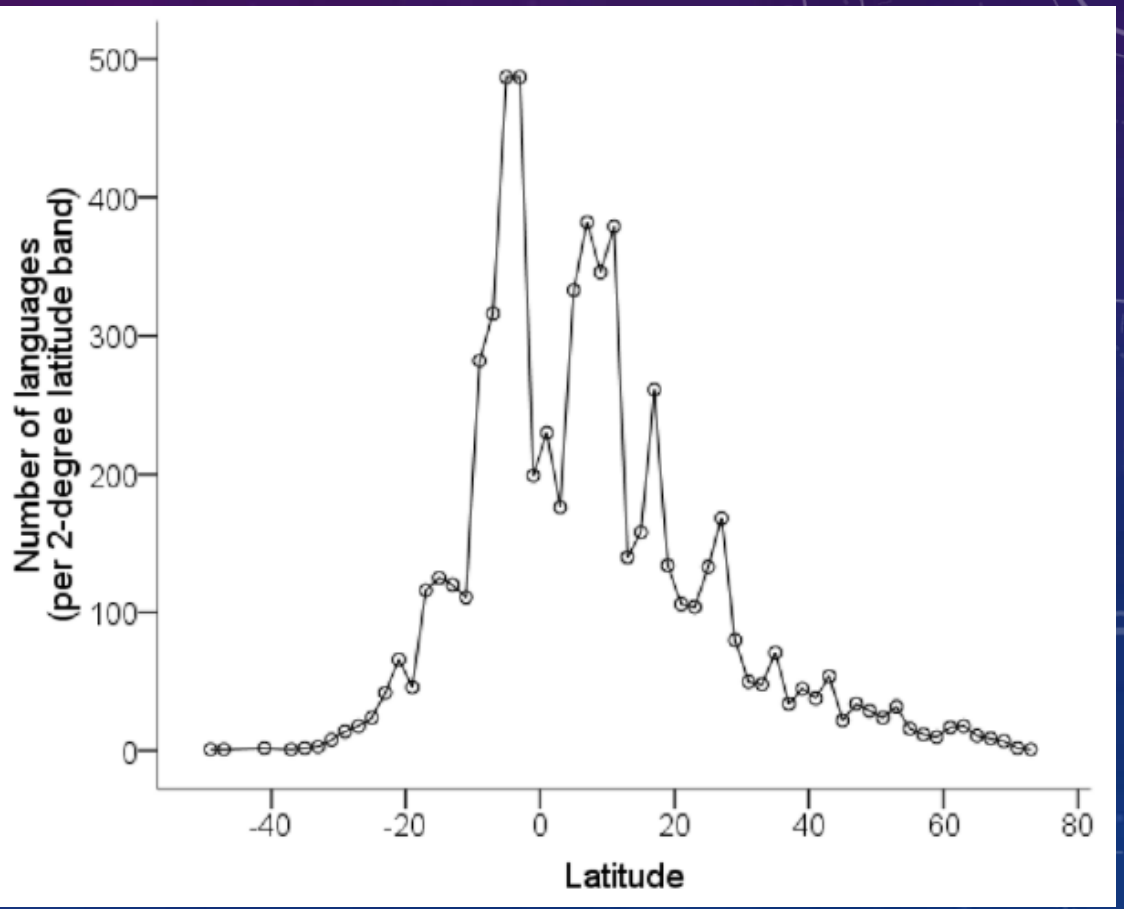
Bio-productivity is double blade: other impacts on collective learning

The high bio-productivity at low latitude can also disfavor collective learning due to less necessity for group interactions

- Consistent food resources → less cooperation and less competition
- Each group needs a smaller range → more groups per unit area
- Greater diversity of plants and animals → slow learning
- Higher parasite species richness → restrict contacts among groups to reduce infections

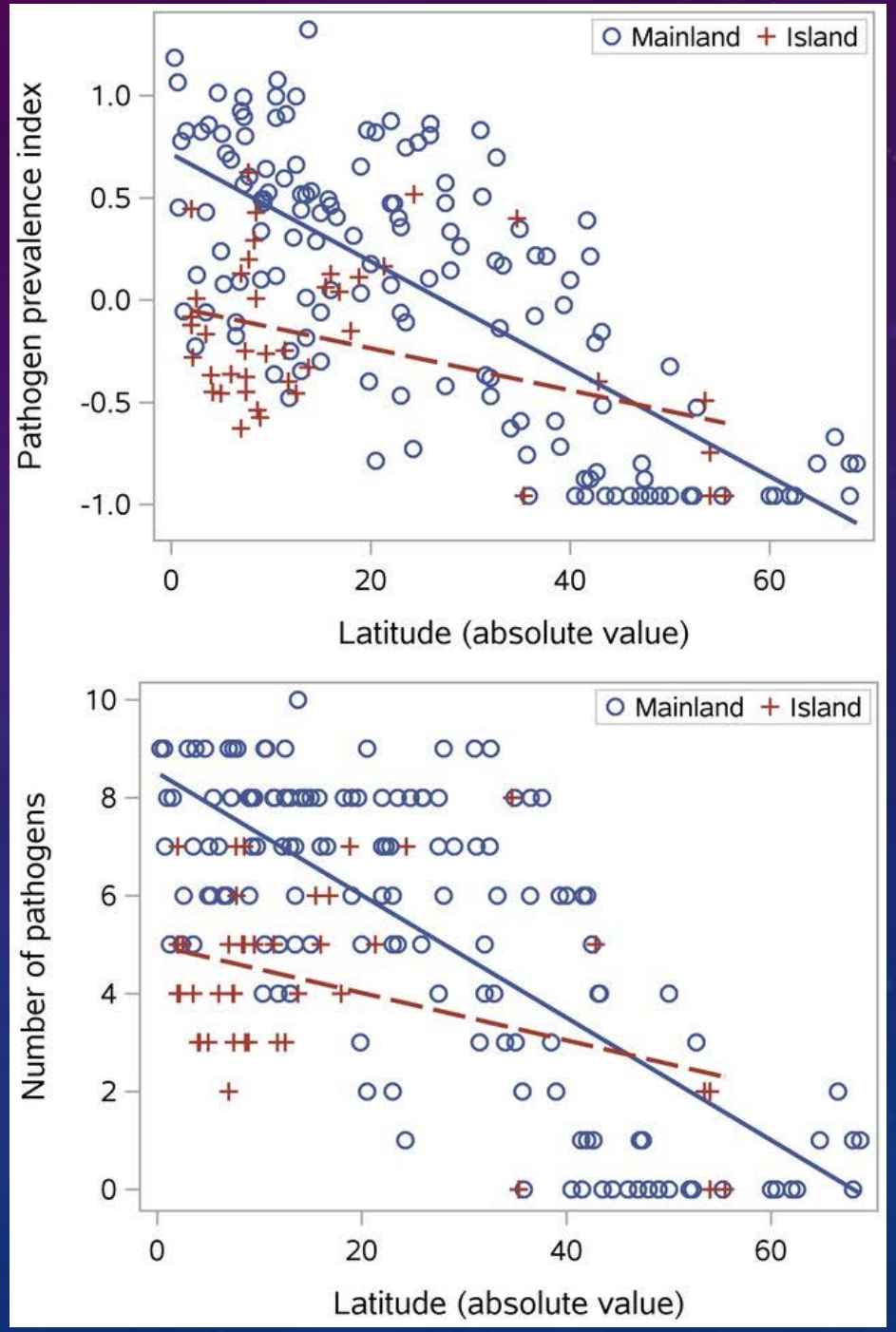
Language range extent and diversity in relation to latitude





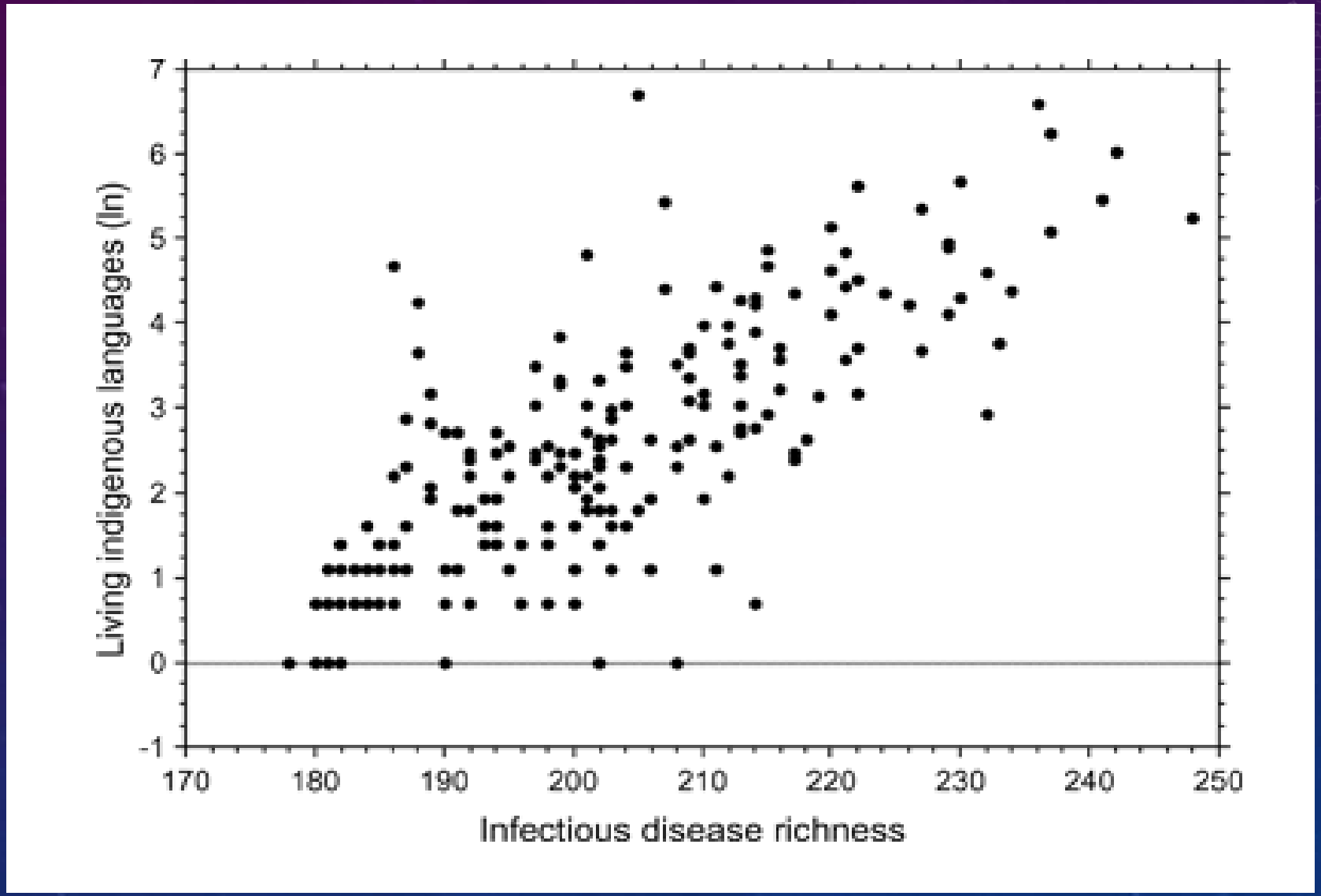
Gavin and Stepp 2014

Latitudinal gradients of parasites



Cashdan, 2014. PLoS One

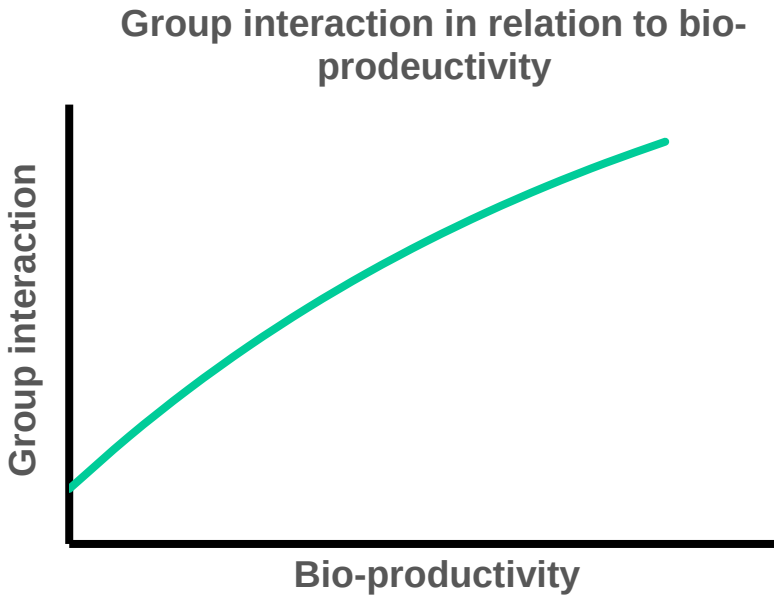
Indigenous language diversity and infectious diseases richness

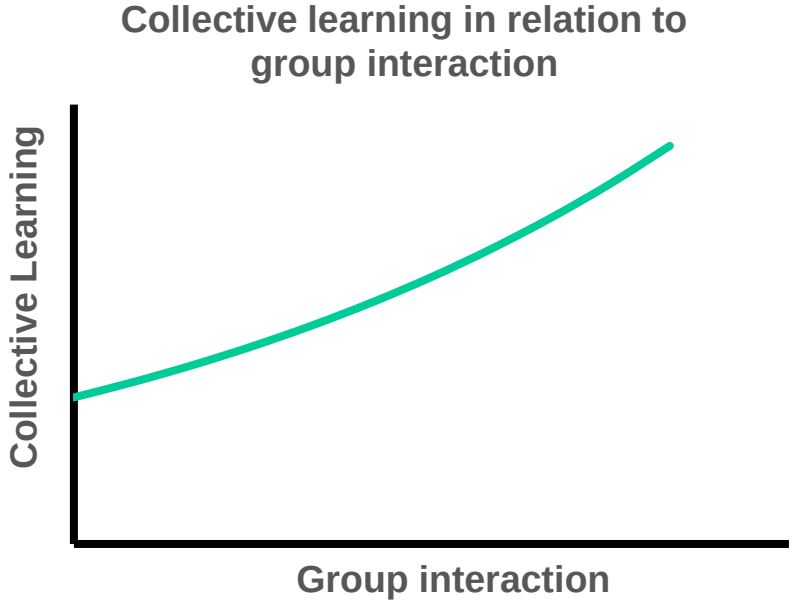


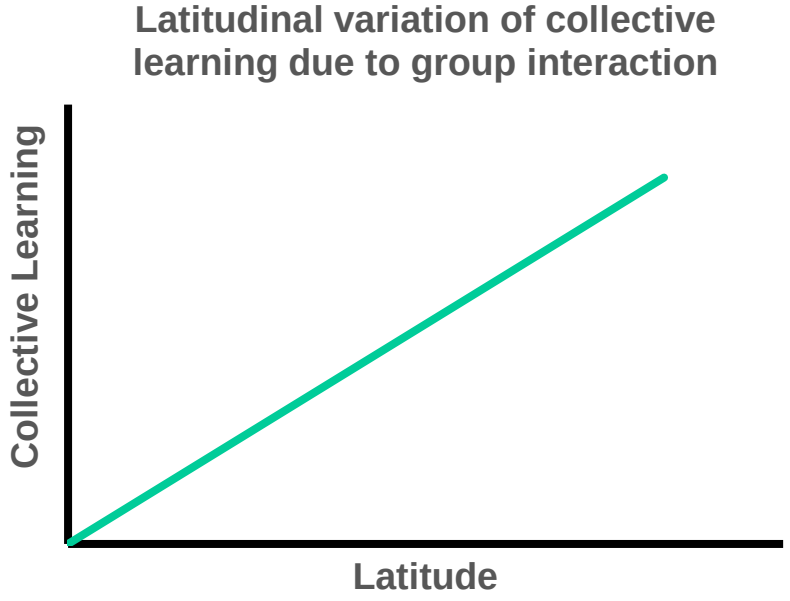
Fincher and Thornhill 2008. Oikos.

At higher latitude, lower bio-productivity necessitates more group interaction, and promotes collective learning

- Stress in food resources → more cooperative and more competitive interactions
- Each group needs a broader range → less groups per unit area
- Less diversity of plants and animals → faster collective learning
- Less pathogen stress → restrict contacts among groups to reduce infections

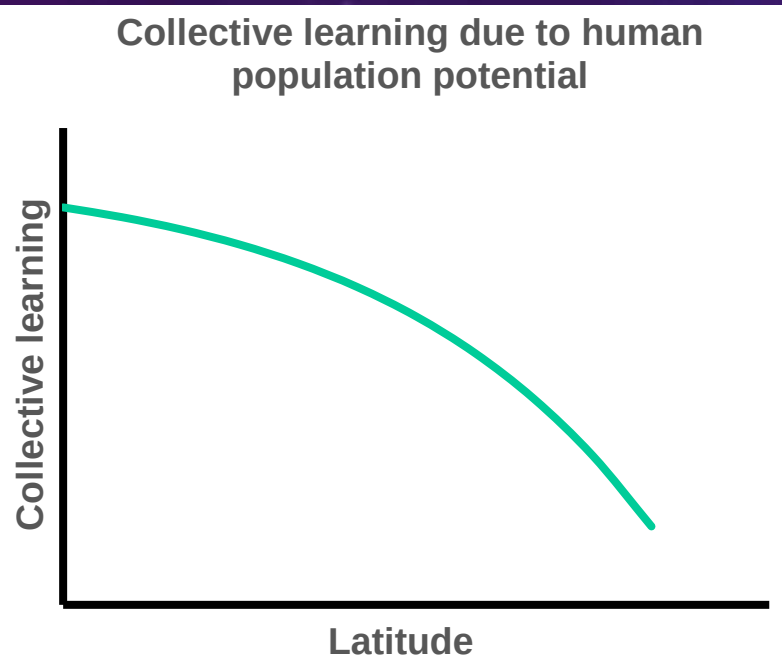


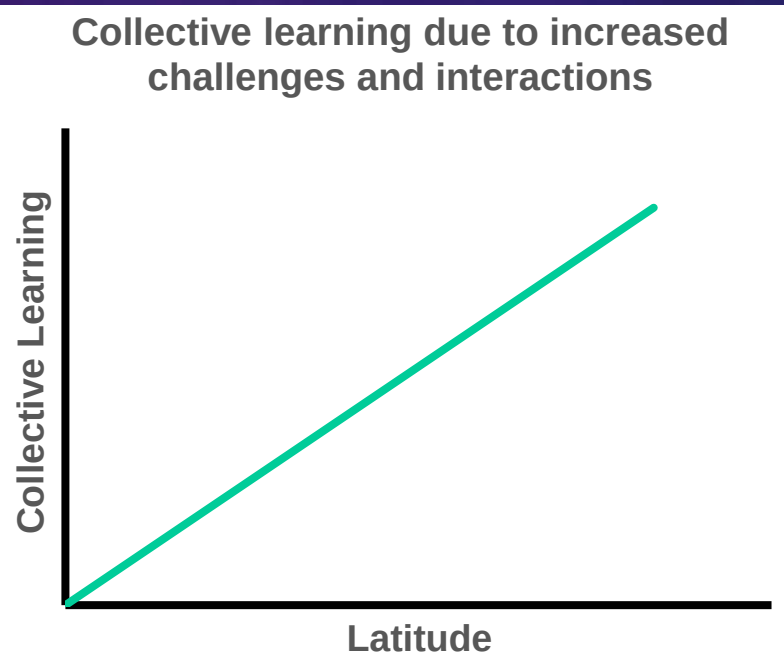


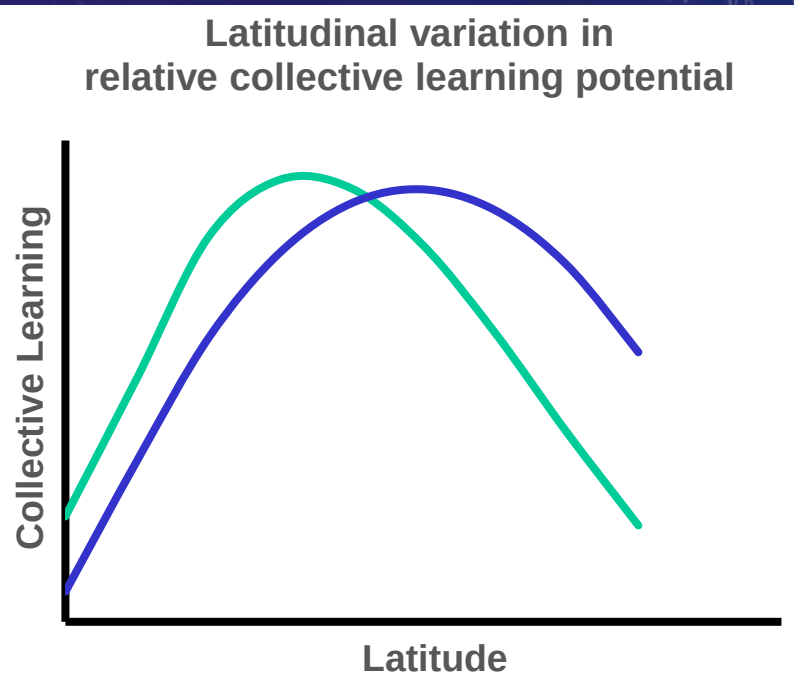


Maximum collective learning at intermediate latitude due to opposing effects of bio-productivity

- Collective learning due to human demography declines with increasing latitude
- Collective learning due to enhanced group interaction increases with increasing latitude
- Overall, the total collective learning peaks at intermediate latitudes







Emergence of early CHSO in “lucky latitudes”: intermediate bioproductivity maximizes collective learning

- Bio-productivity generally declines with increasing latitudes
- Early CHSO developed in latitudes where collective learning is most effective
- Collective learning is most effective at intermediate latitudes where there is a balance between a large human population, extensive group interaction, and a moderate level of environmental complexity.
- At low latitudes, although there is a high human population potential, limited group interaction and complex ecosystems hinder collective learning.
- Similarly, at high latitudes, although group interaction can be extensive and ecosystems are simpler, the low population potential restricts collective learning.

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