Exploring Gloger's ecogeographic rule

Why organisms are darker in wetter & warmer environments

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2017-08-15
BSc Hons Biological Sciences
Critical theory essay
For Dr A. Amar & Dr P. Sumasgutner

Ecogeographic and biogeographic "rules"

Lomolino et al. (2006) outline the study of observed patterns or trends of organismal traits across geographical space. These ecogeographic "rules" (i.e. observations) highlight examples of pattern at broad ecological scales as consequence of processes at a range of scales. Indeed, the patterns themselves are also manifest at a variety of scales. As such, Lomolino et al. (2006) says, underlying causal mechanisms behind these patterns are difficult to ascertain.

Lomolino et al. (2006) also talk about theory vs empirical evidence, and varying scales, and also the evolutionary side to *eco*geographic rules.

Gaston et al. (2008) (has a def for Gloger's rule too) (also d/d's betw intrasp. traits, intersp. traits, and assemblage patterns (e.g. Bishop2016 on ants) (in community properties or community trait avgs))

Millien et al. (2006) discuss ecotypic (i.e. intraspecific, i.e. between populations) variation in terms of ecogeographic rules, too.

Olalla-Tárraga (2011) discusses approaches to studying rules too, with focus on Bergmann's rule. Olalla-Tárraga (2011) advocates a *pluralist* approach, wherein the manifestations of ecogeographical rules at multiple scales and levels of biological organisation are considered. He also outlines that "laws" and "rules" in ecology, and in science generally, need not *always* contain mechanistic statements, need not be without exception, as they are "correlative generalisations". Though, mechanistic understandings of the processes that generate these law-defining patterns is desirable, and indeed often the aim of research, this does not imply that correlative ecogeographic rules are not useful intrinsically. Not least, these rules are often the starting point of research. Thus, these rules represent interesting observed patterns that can motivate research, *and* useful generalisations that can be employed in other work.

Ontogenetic level too! (Booth, C.L. 1990)

Theory vs empiricism of "rules"

Gloger's rule

See Roulin & Randin (2015) for a good def of the rule in the abstract (e.g. fitness benefits of melanin in warma and environments). Roulin & Randin (2015) also compare this to fitness in warm/humid climes is conferred via alternative phenotypic adaptations (owls) (see their results—*it's complicated*)

Manifestations of Gloger's rules

Intrasp. Gloger's rule manifestations (= "ecotypic", sensu Millien et al. (2006)) svs intersp./community level manifestations (Lev-Yadun 2015)

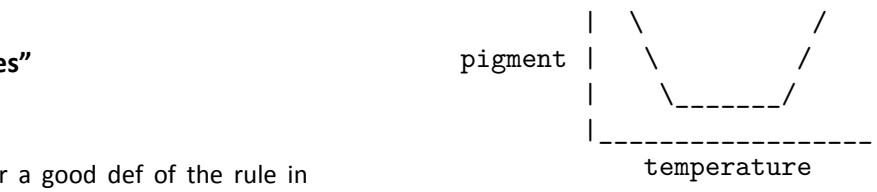
Some intro stuff, e.g. "Herein, I argue that there is sufficient evidence to support Gloger's rule as a useful and true generalisation […]"

Origins of the rule

- Gloger's observations
  - Gloger noted bird plumage darkness ~ warmth, humidity (Miksch; Burtt & Ichida 2004)
- His contemporaries' thoughts
- Theoretical reasoning behind the rule

Evidence & examples

- …
- Gloger vs anti-Gloger patterns (Lev-Yadun 2015)
  - e.g "negative Gloger's rule" in invertebrates, e.g. Collembolates (Rapoport, 1969)
- Does the pattern exist? Is it observed in the first place?
- Dissect the observations at the intrasp., intersp., and assemblage levels
- Kamilar & Bradley (2011) primate *inter*specific coat colour follows Gloger's rule -> little mechanistic work in this paper though! They speculate about 1) background matching, 2) anti-bacterial stuff, and 3) maybe thermoregulation (#FutureStudies)
  - unlikely to be UV, because primates live in trees!
    - (not even in the upper-canopy, where UV is strong—primates do not spend tonnes of time up there)
- Bishop et al. (2016) ant *assemblage* work (ECTOTHERMAL):
  - organismal darkenss as a modal pattern
  - at low temperatures for thermoregulatory needs
  - at higher temperatures for UV-B protection
  - also darkness incr with smaller body size
  - these patterns are evident at the *assemblage* level



- Animal vs plant e.g. -> differences in meaning and interpretation
  - Dominy & Lucas (2004) food colour and pri-

mates?
    * could THIS connect to an environmental pattern in plant colour?

Mechanisms behind the pattern

- …
- Burtt & Ichida -> dark pulamge resistant to bacterial degradation (~ pigments), a common problem in humid climes; mthods: measure intrasp. Δcolour vs bacterial activity
    - cf Koski & Ashman -> UV role (in plants)
- Persistent colour polymorphism (Tate et al. 2016) within a populations of a species -> equivalent fitness of the morphs in heterogeneous habitats; results: darker species forage/hunt better in darker habitats (~ hiding in the ambient background). Since (Ruan says) darker habs are wetter (ish), this relates to Gloger's rule.
- Connect evidence above to mechanisms described in their respective papers (if applicable)
- & mechanisms from other papers concerning pigment and environment (e.g. Tate et al. 2016)
- Dissect the observations at the intrasp., intersp., and assemblage levels MECHANISTICALLY
- Animal vs plant e.g. -> differences in meaning and interpretation for MECHANISM

Concluding remarks

- …

Millien et al. (2006) traits vary with geography, but also with global cliamte change!

References

Bishop, T.R., Robertson, M.P., Gibb, H., Rensburg, B.J. van, Braschler, B., Chown, S.L., Foord, S.H., Munyai, T.C., Okey, I., Tshivhandekano, P.G., Werenkraut, V. & Parr, C.L. 2016. Ant assemblages have darker and larger members in cold environments. *Global Ecology and Biogeography*. 25:1489–1499. DOI: 10.1111/geb.12516.

Dominy, N.J. & Lucas, P.W. 2004. Significance of color, calories, and climate to the visual ecology of catarrhines. *American Journal of Primatology*. 62:189–207. DOI: 10.1002/ajp.20015.

Gaston, K.J., Chown, S.L. & Evans, K.L. 2008. Ecogeographical rules: Elements of a synthesis. *Journal of Biogeography*. 35:483–500. DOI: 10.1111/j.1365-2699.2007.01772.x.

Kamilar, J.M. & Bradley, B.J. 2011. Interspecific variation in primate coat colour supports Gloger's rule. *Journal of Biogeography*. 38(12):2270–2277. DOI: 10.1111/j.1365-2699.2011.02587.x.

Lomolino, M.V., Sax, D.F., Riddle, B.R. & Brown, J.H. 2006. The island rule and a research agenda for studying ecogeographical patterns. *Journal of Biogeography*. 33(9):1503–1510. DOI: 10.1111/j.1365-2699.2006.01593.x.

Millien, V., Kathleen Lyons, S., Olson, L., Smith, F.A., Wilson, A.B. & Yom-Tov, Y. 2006. Ecotypic variation in the context of global climate change: Revisiting the rules. *Ecology Letters*. 9(7):853–869. DOI: 10.1111/j.1461-0248.2006.00928.x.

Olalla-Tárraga, M.Á. 2011. "Nullius in Bergmann" or the pluralistic approach to ecogeographical rules: A reply to Watt et al. (2010). *Oikos*. 120(10):1441–1444. DOI: 10.1111/j.1600-0706.2011.19319.x.

Rapoport, E.H. 1969. Gloger's rule and pigmentation of Collembola. *Evolution*. 23(4):622–626. DOI: 10.2307/2406857.

Roulin, A. & Randin, C. 2015. Gloger's rule in North American Barn Owls. *The Auk*. 132(2):321–332. DOI: 10.1642/AUK-14-167.1.