The Role of Regular ‘Accidents’

Reading: Joseph Grinnell

Earth History, Vicariance, and Dispersal

Lecture 7 Recap

Earth History, Vicariance, and Dispersal

- **Range Expansion**

- Movement away from parents as a normal part of the life cycle (*small scale*)

- Gradual expansion of geographical ranges through the spread into areas beyond the boundaries of the initial range in response to:

  - Habitat modifications
  - Climatic shifts
  - Adaptations

Earth History, Vicariance, and Dispersal

- **Jump Dispersal**
- Species level process, carried out by individuals, that involves crossing some kind of barrier through some chance or otherwise rare event
- Considered very important by some biogeographers, and important in some systems (oceanic islands)

Earth History, Vicariance, and Dispersal

- **Center of Origin**
- First postulated by Linnaeus, life spread outward from a single point as more land emerged from the sea
- If this theory explained everything (a world with no barriers) we would have mostly pan-tropical and pan-temperate species, with continental species reaching every island

  - This is obviously not the case

Earth History, Vicariance, and Dispersal

- **Effectiveness of Barriers**
- The fact that most species occupy only a limited part of their potential range demonstrates the existence and effectiveness of barriers
- The existence of endemic species requires that geographic areas remain isolated long enough for these species to evolve in the first place

Earth History, Vicariance, and Dispersal

- **Barriers are less effective for certain species**
- Some species can achieve a cosmopolitan distribution, either because the barriers are ineffective or they have good powers of jump dispersal

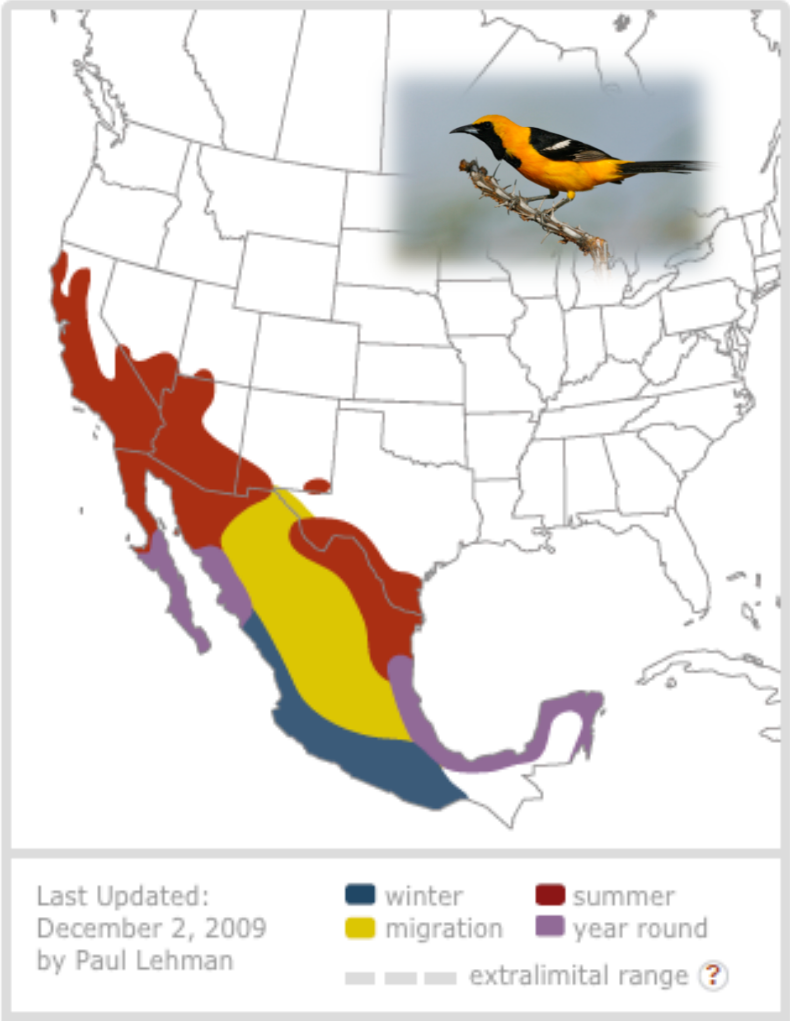
Pan-tropical distribution

Jared Diamond

Supertramp Strategy

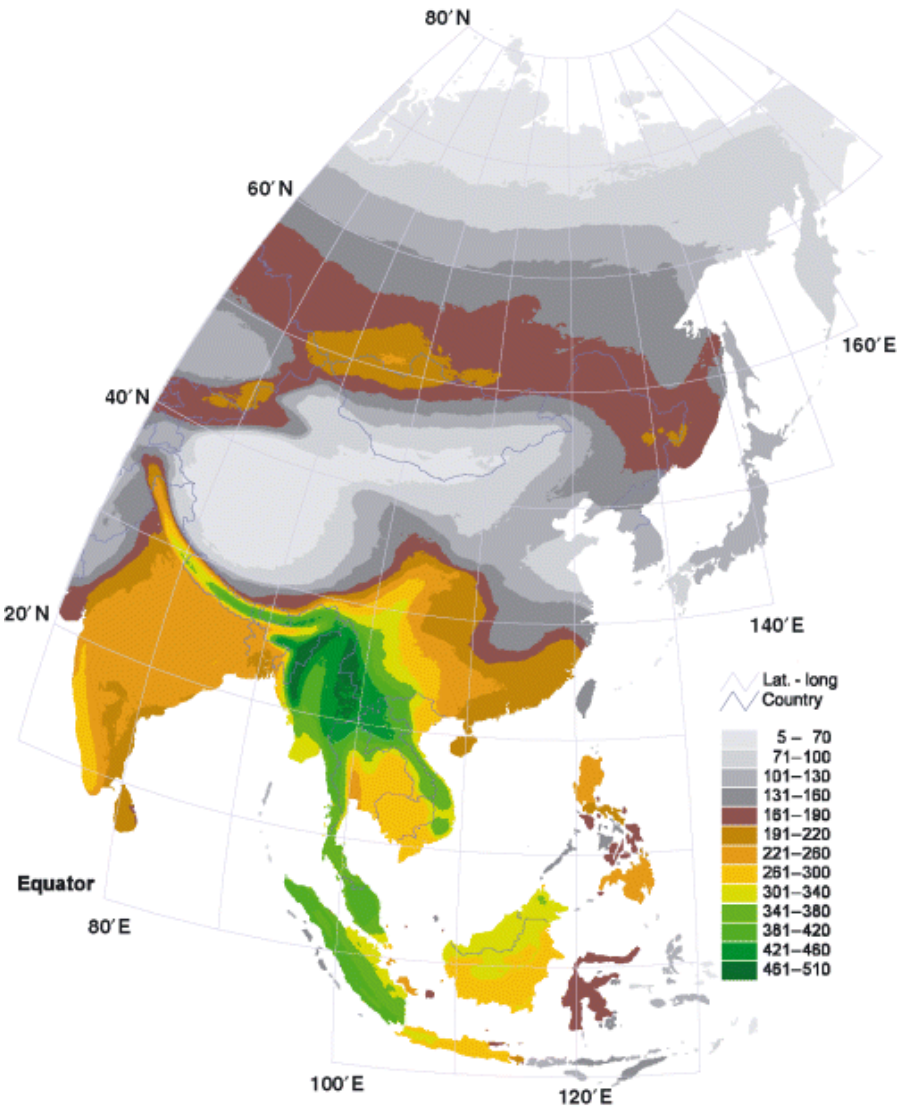
Species Ranges

- Each species lives in a geographical area – the *species range* – which is sometimes limited by topographical or climatic barriers, physiological restrictions, or interactions with other species



Species Ranges

- A species can reach the limits of its geographic distribution abruptly at a sharp topographical boundary



Species Ranges

- A species can reach the limits of its geographic distribution more subtlety at the edge of a habitat transition.

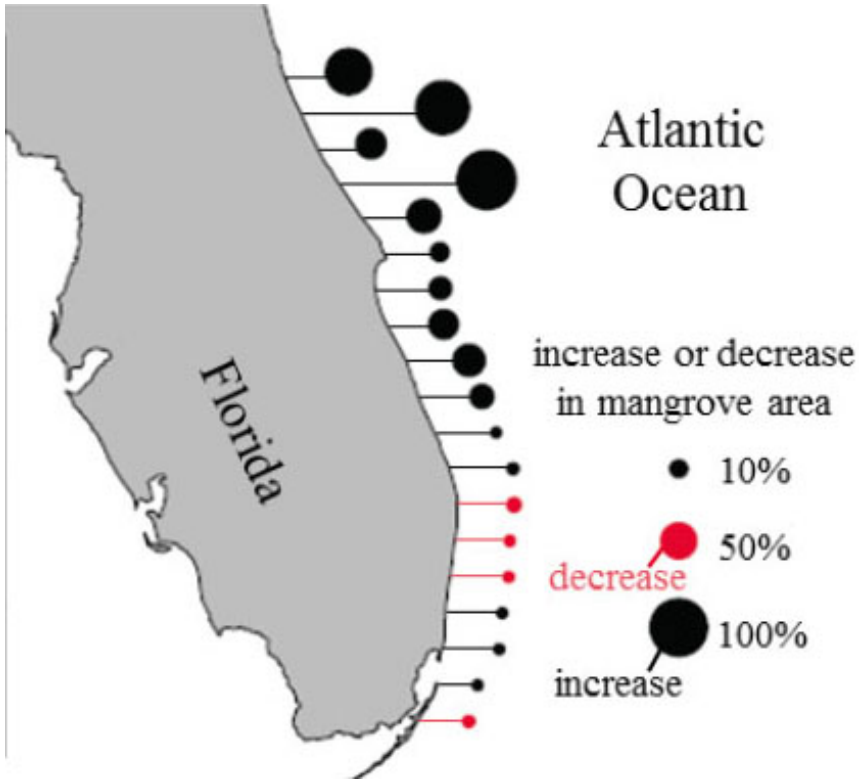
Species Ranges

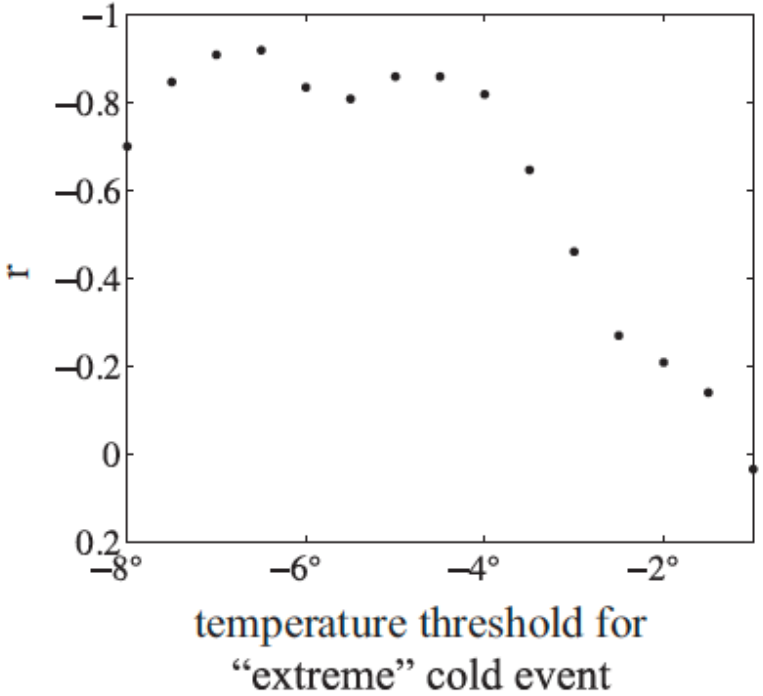
- The environment is not uniform in space or time

- As the spatial configuration of their living conditions changes, the distribution of individuals over the species range will shift accordingly, and so will the range boundaries

Species Ranges

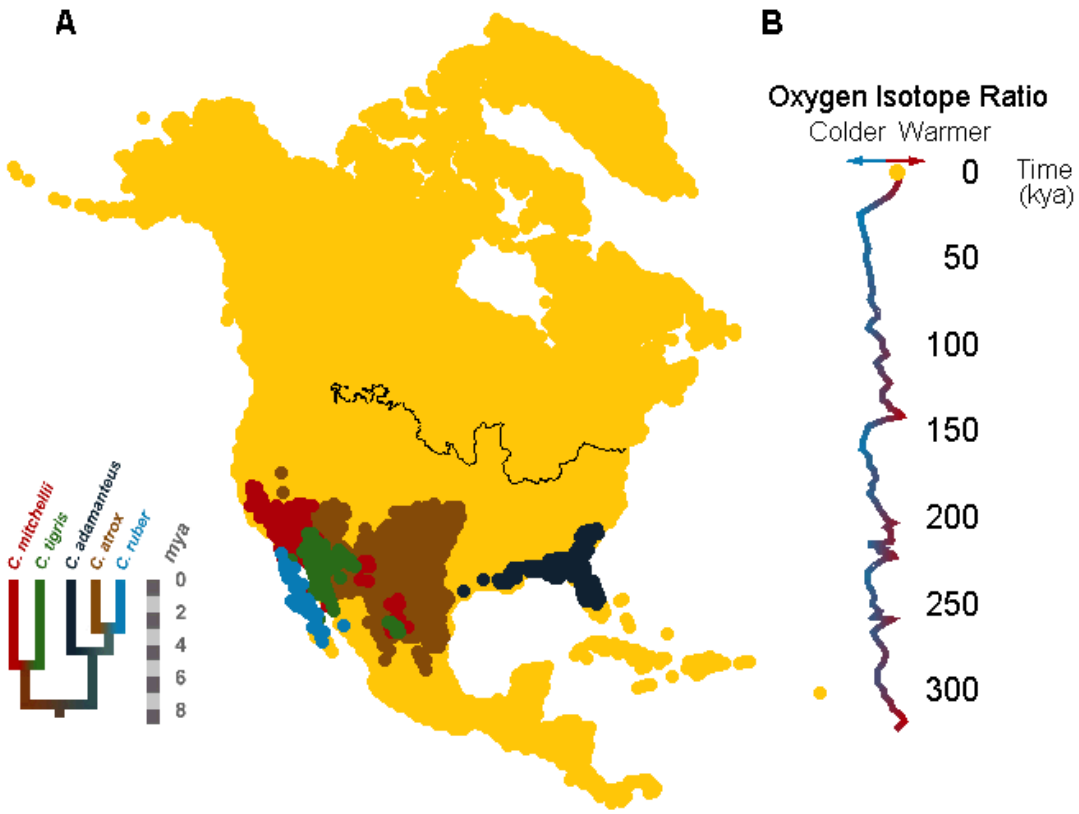
- Cavanaugh et al. 2014 – Northward expansion of mangroves with decreases in freeze days





Species Ranges

- Lawing & Polly 2011 – Change in rattlesnake ranges in response of past climate change

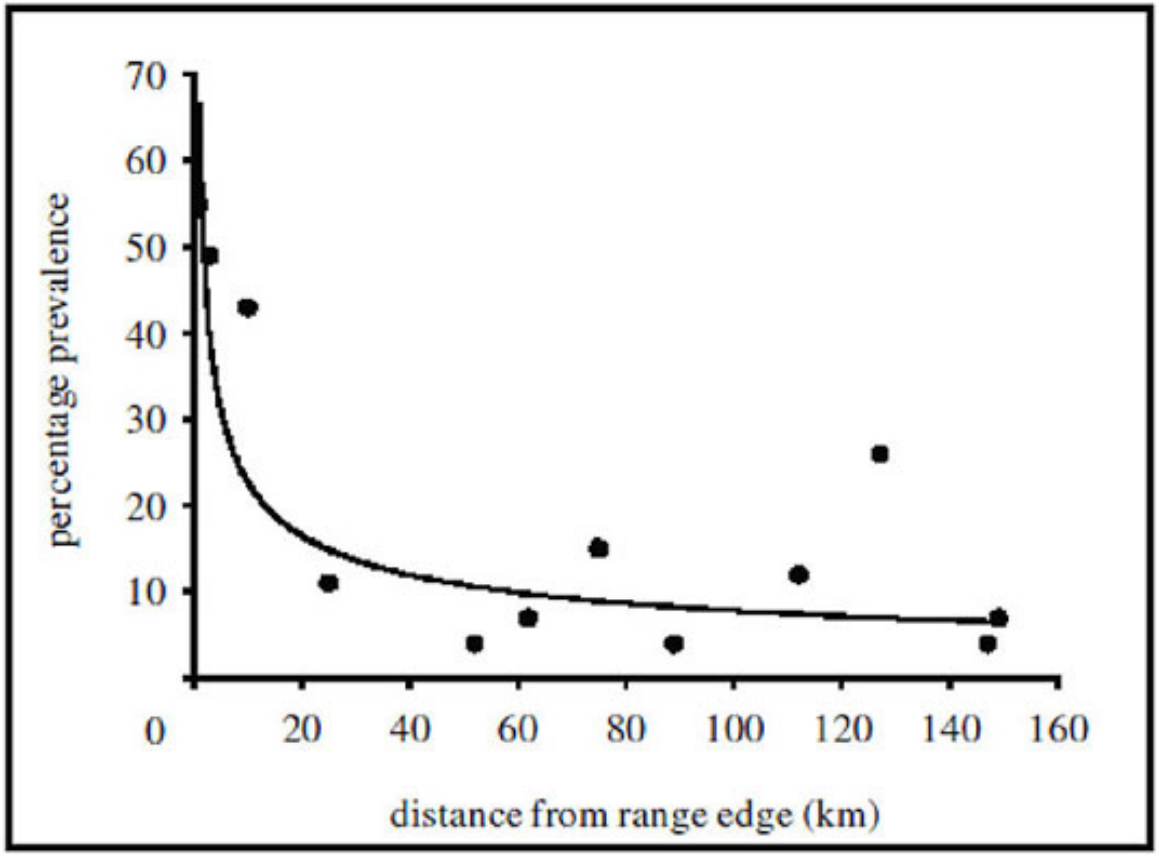


Species Ranges

- Interactions with other species can also set the range edge

Species Ranges

- Briers 2003 – Increased prevalence of parasites may limit the range edge for a snail



Species Ranges

- How a species responds to these changes depends on its dispersal ability, habitat plasticity, and other biological attributes

- Due to the variation in habitat conditions over space and time, the species needs to have some capacity to move or to be moved

Species Ranges

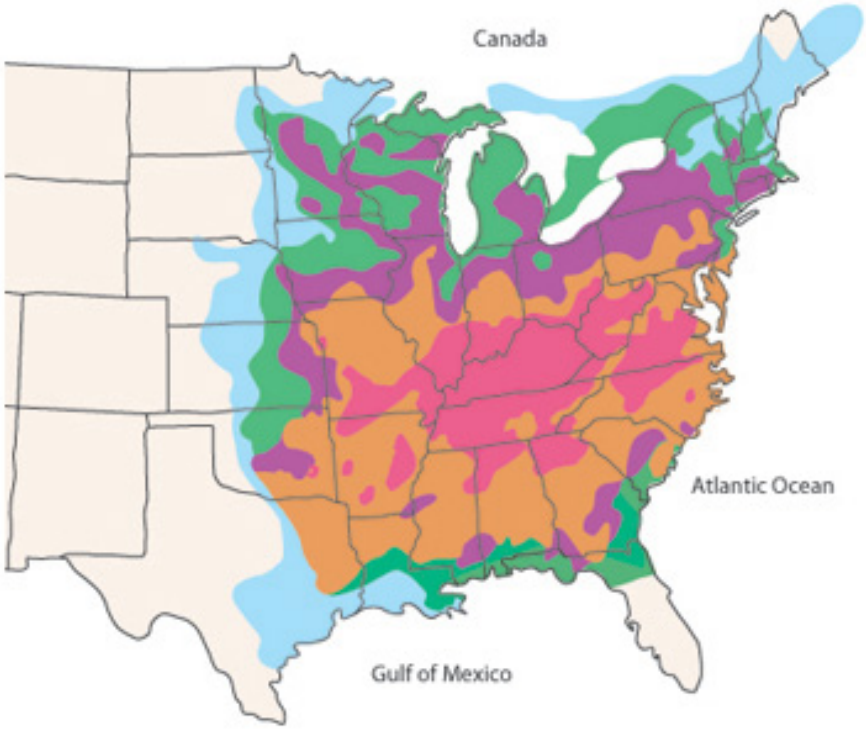
- Classical approaches to biogeography considered species ranges to be spatially static

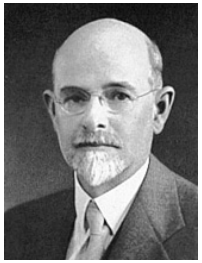
- Grinnell (1943) built on earlier work to describe a species range whereby individuals spread centrifugally from central, high density regions to those of lower density at the margins

Species Ranges

- There is evidence for this pattern with some species, although there can be abrupt changes in density due to barriers

Population Density Map of Indigo Bunting

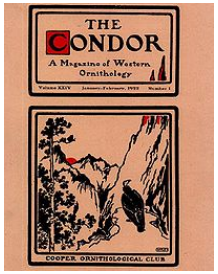




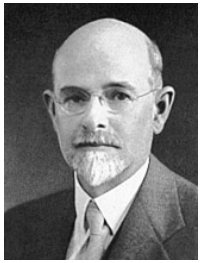
Joseph Grinnell

Species Ranges

- Joseph Grinnell is known for contributions to the fields of ecology, vertebrate zoology and biogeography



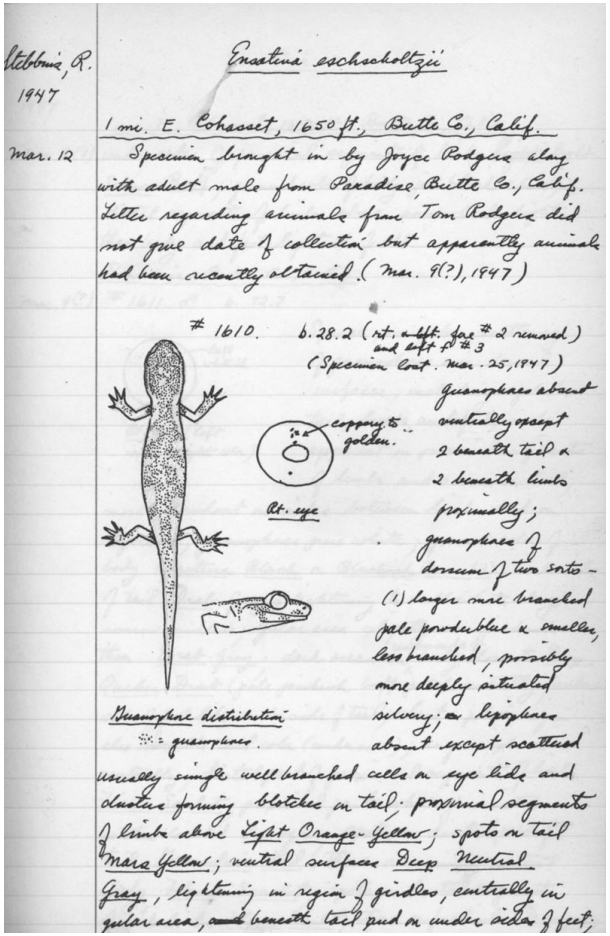
- Editor of *The Condor* from 1906 – 1939
- He was the first director of the Museum of Vertebrate Zoology at UC Berkeley and served from 1908 - 1939



Joseph Grinnell

Species Ranges

- **Grinnell method of note taking**
- Field notebook to record observations as they are happening
- Field journal of fully written entries
- A species account of the observations on a chosen species
- Catalog of where and when species were collected



Stebbins, R.
1947

Ensatina eschscholtzii

1 mi. E. Cohasset, 1650 ft., Butte Co., Calif.

Mar. 12 Specimen brought in by Joyce Rodgers along with adult male from Paradise, Butte Co., Calif. Letter regarding animals from Tom Rodgers did not give date of collection but apparently animals had been recently obtained. (Mar. 9(?), 1947)

1610. b. 28.2 (rt. ~~abdt.~~ toe # 2 removed and left ft # 3)
(Specimen lost. Mar. 25, 1947)

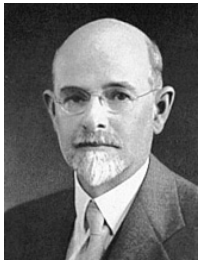
copper to golden.

Rt. eye

guanophores absent ventrally except 2 beneath tail & 2 beneath limbs proximally; guanophores of dorsum of two sorts – (1) larger more branched pale powder blue & smaller, less branched, possibly more deeply situated silvery; & lipophores absent except scattered usually single well branched cells on eye lids and clusters forming blotches on tail. proximal segments of limbs above Light Orange-Yellow; spots on tail Mars Yellow; ventral surfaces Deep Neutral Gray, lightening in region of girdles, centrally in gular area, ~~and~~ beneath tail and on under sides of feet;

Guanophore distribution
∴ = guanophores.

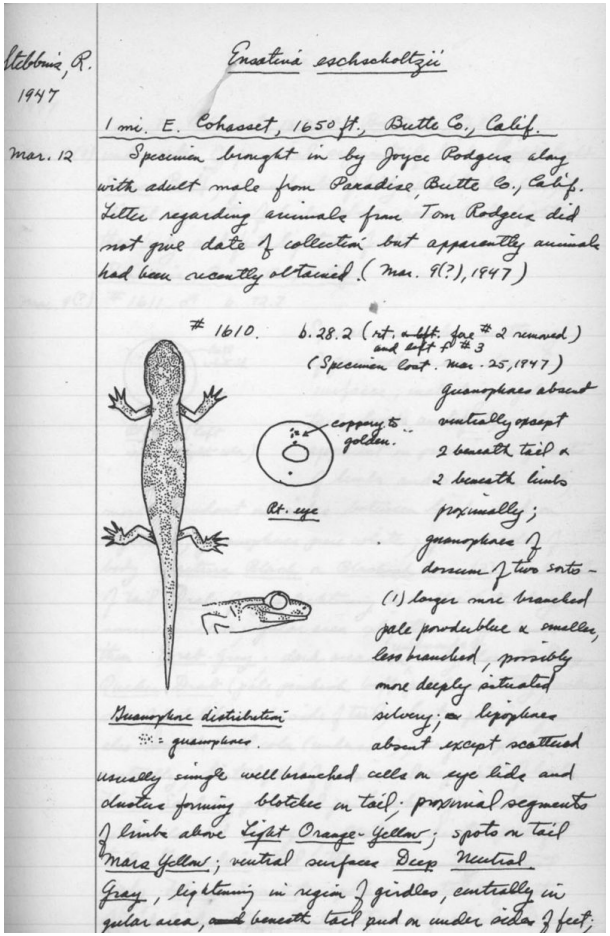
Robert Stebbins field notes 1947



Joseph Grinnell

Species Ranges

"The Journal, written in pen at the end of every day, would be considerably fuller and neater, her notes organized, sorted out, edited, expanded, with detailed observations of behavior recorded at the back, on separate pages for each individual species. For the Journal, and for Species Accounts, she created a narrative, free of sentiment or much personal reflection—a scientific document, not a diary, but with the skeleton of facts dressed in the clothes of complete sentences, so as to be readable by any stranger looking over her shoulder. All manner of facts might prove important to a student of the future, this was Grinnell's belief. Nothing in nature should be assumed insignificant." – Molly Gloss



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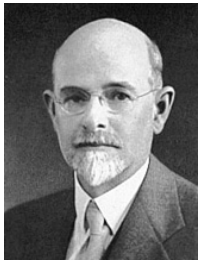
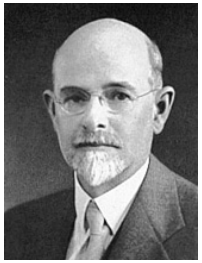


Joseph Grinnell

Species Ranges

- Grinnell's Vision for the MVZ:
  "*after the lapse of many years, possibly a century, the student of the future will have access to the original record of faunal conditions in California*"

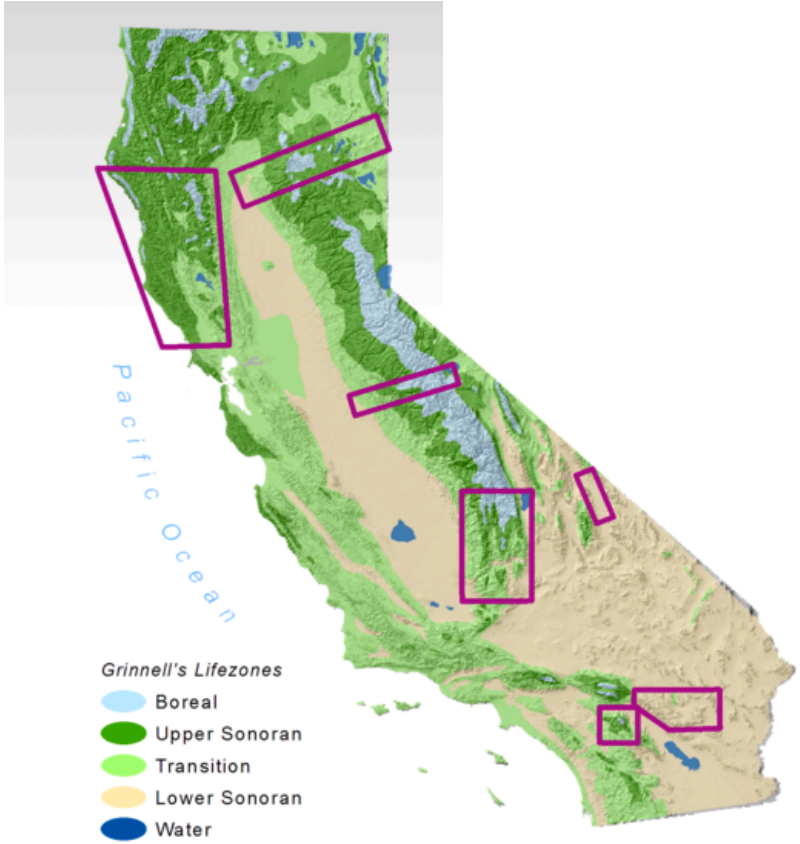
- Grinnell commenced a survey of California's fauna in 1908 focusing on the Colorado Desert, Mt. Whitney, Lassen, Yosemite, and the San Jacinto Mountains

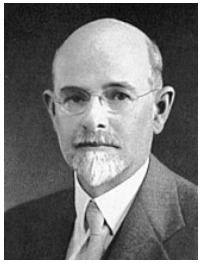


Joseph Grinnell

Species Ranges

- Grinnell Resurvey Project
- Resurvey same transects as Grinnell 100 years later
- Issues with reproducibly of sampling effort, difficult to directly compare some results





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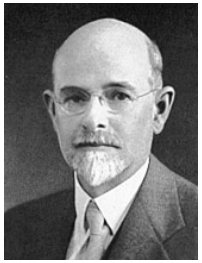
Species Ranges

- Grinnell Resurvey Project
- Import work completed on the vertical shifts of small mammals

Impact of a Century of Climate Change on Small-Mammal Communities in Yosemite National Park, USA

Craig Moritz,[1,2*] James L. Patton,[1,2] Chris J. Conroy,[1] Juan L. Parra,[1,2] Gary C. White,[3] Steven R. Beissinger[1,4]

Science AAAS



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Species Ranges

- Shows substantial (~500m on average) upward changes in elevational limits for half of the 28 species monitored
- This is consistent with a 3 degree C increase in minimum temperatures

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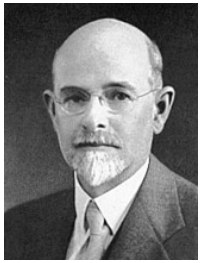
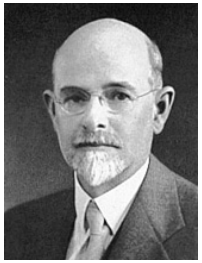


Joseph Grinnell

Species Ranges

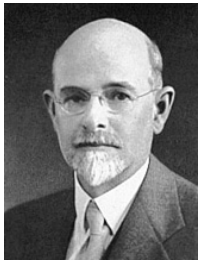
- *The Role of the 'Accidental'*
- This paper was among the first to highlight the importance of long-range dispersal of individuals to range expansion and persistence of species
- *Accidentals* refer to species recorded only once in an area or region outside their normal range



Joseph Grinnell

Species Ranges

- Grinnell noted that there was a increase in the number of accidentals noted by observers
- This could possibly be because of more and better trained observers, but Grinnell also thought this might be a regular process, and that there might be nothing accidental about it
- This could be a part of the ordinary evolutionary program

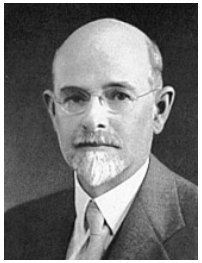


Joseph Grinnell

Species Ranges

- He noted that most of these accidentals are strong flyers, but that many others are relatively sedentary species

- Grinnell extrapolated that at the current rate of new accidental observations, this put the entire North American species list to be observed in California by the year 2331

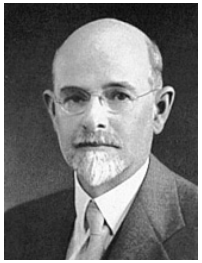


Joseph Grinnell

Species Ranges

- *”The individuals making up a given bird species and occupying a restricted habitat may be liken to the molecules of a gas in a container which are continually beating against one another and against the confining walls, with resulting pressure outwards.”*

- Birds also reproduce at a high rate

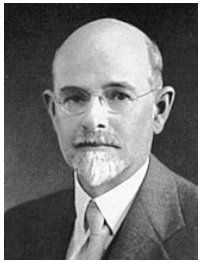


Joseph Grinnell

Species Ranges

- Here Grinnell is referencing the expansion of bird abundance from a center of high density to a periphery of low density

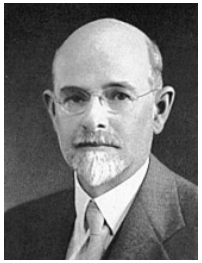
- It is at the periphery that one might expect to find these accidentals as they are testing the borders of the species range



Joseph Grinnell

Species Ranges

- *"These pioneers are of exceeding importance to the species in that they are continually being centrifuged off on scouting expeditions, to seek new country which may prove fit for occupancy."*



Joseph Grinnell

Species Ranges

- *"I might picture the behavior of the population of a given bird as like the behavior of an active amoeba. This classic animal advances by means of outpushings here and there in reaction to the environment or along lines of least resistance. The whole mass advances as well."*

Species Ranges

Main Points

- Each species lives in a geographical area – the *species range* – which is sometimes limited by topographical or climatic barriers, physiological restrictions, or interactions with other species

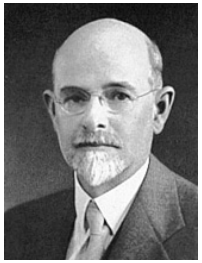
- Species ranges can end abruptly or subtlety

- Species can be arranged where individuals spread centrifugally from central, high density regions to those of lower density at the margins

- Due to increasing densities, pioneers can test the range edge, looking for areas to expand

- These areas (and thus species ranges) are continually changing in time and space

Questions on the reading?

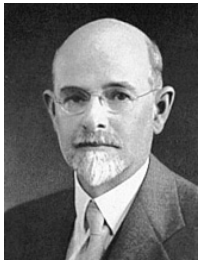


Joseph Grinnell

Discussion Point 1

- *"Geologists tell us that barriers of climate are continually moving about over the earth's surface, due to uplift and depression, changes in atmospheric currents, and a variety of other causes."*

- *"The encroaching barrier on the one side impinges against the population on that side; the strain may be relieved on the opposite side, if the barrier on that side undergoes parallel shifting, with the results that the species as a whole may, through time, flow in a set direction."*



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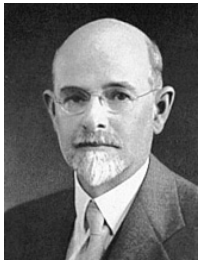
Discussion Point 1

- What happens if the barrier on the other side does not change in parallel?



Joseph Grinnell

Discussion Point 1

- What happens if the climate shifts in parallel but there is a geological or other fixed barrier in the way?

- What do you think this means for national/state parks, game reserves, protected migratory pathways?