Ecology of grasshoppers

CMR Working Group
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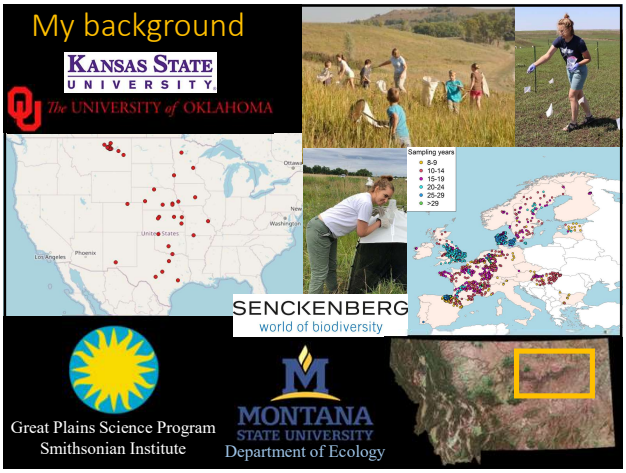
MONTANA STATE UNIVERSITY

1

My background

KANSAS STATE UNIVERSITY

The UNIVERSITY of OKLAHOMA



Great Plains Science Program
Smithsonian Institute

MONTANA STATE UNIVERSITY
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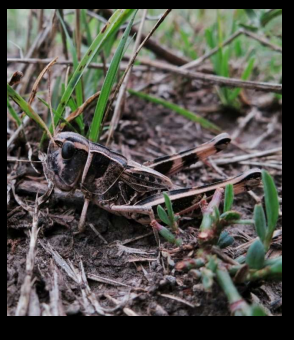
2

Grasshoppers: Pest or Keystone Ecological taxa?

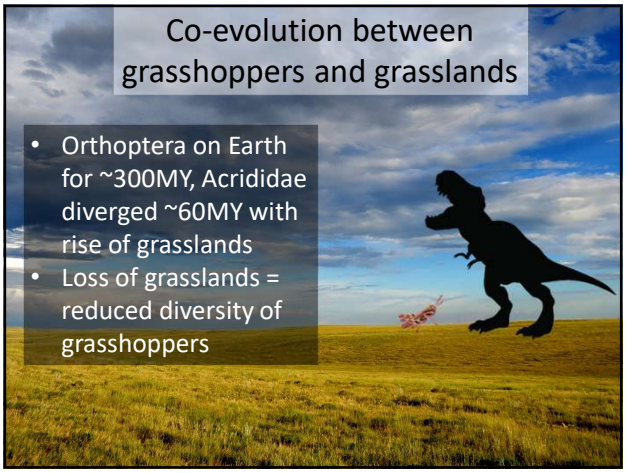
- Can eat 28-168% of the aboveground plant biomass eaten by cattle (Onsanger 2000)
- 12/~100 species in Montana considered of economic concern
- Native
- Play key roles in grassland ecosystems



3

Co-evolution between grasshoppers and grasslands

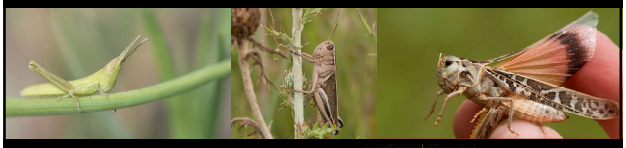
- Orthoptera on Earth for ~300MY, Acrididae diverged ~60MY with rise of grasslands
- Loss of grasslands = reduced diversity of grasshoppers



4

What is a grasshopper?

- This talk: Grasshopper = "Short-horned grasshopper" (Family Acrididae)



- Order Orthoptera also includes:
  - Katydids (Family Tettigoniidae)
  - Crickets (Family Gryllidae)

5

Usual & unusual grasshoppers of Montana

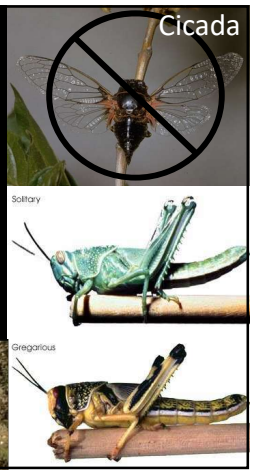
Carolina grasshopper | Migratory grasshopper | White-whiskered grasshopper | Two-striped grasshopper

Plains Lubber (>2 inches) | Painted grasshopper | Green fool grasshopper

6

What about locusts?

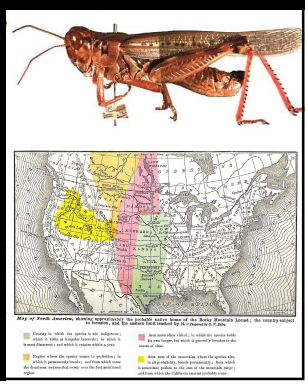
- Locusts are a kind of grasshopper
- Environmental cues decide if they will be solitary or gregarious (swarming) as adults
- Occur in East Africa/Middle East, N China/Mongolia, & Australia
- No extant species in North America



7

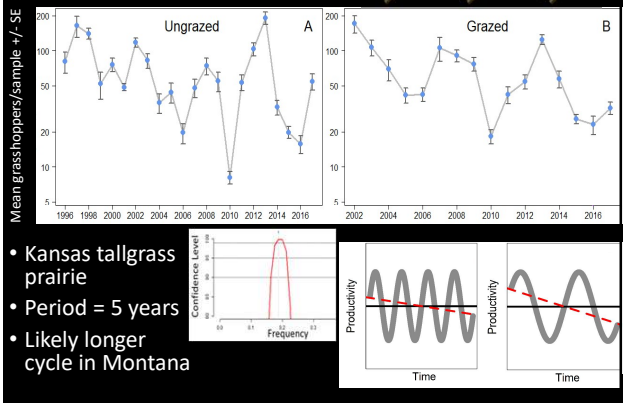
Rocky Mountain locust

- Huge swarms in late 1800s
- Last living documented specimens collected in 1902
- Locust was the focus of the career of C.V. Riley, who helped form the USDA
- Why extinct? Habitat change/ bottleneck
- Extinction may have reduced nutrient cycling, given rise to competitors, driven the Eskimo curlew to extinction



8

Are abundances cyclic?

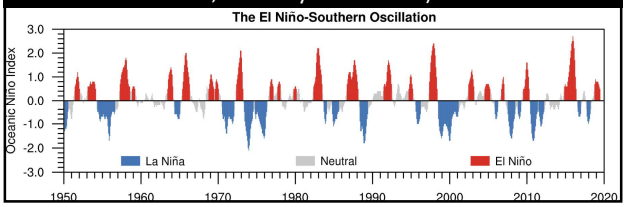


- Kansas tallgrass prairie
- Period = 5 years
- Likely longer cycle in Montana

9

Why are abundances cyclic?

- ???
- Predator-prey cycles
- Large scale climate oscillations: El Niño, Pacific Decadal Oscillation, North Atlantic Oscillation (Jonas et al. 2015, Welti et al. 2020, Humfreys et al. 2022)



10

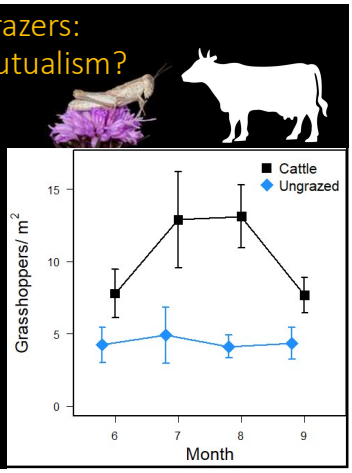
What weather do grasshoppers like?

- Warm winter
  - ➢ Fewer hard freezes with no snow cover
- Drier spring/early summer
  - ➢ Fewer fungal pathogens
  - ➢ Plants that are moderately water-limited may have higher nutrient densities or are not chemically defended

11

Big and little grazers: Competition or mutualism?

- More grasshoppers in grazed v. ungrazed areas in this region
- Likely driven by cattle increasing plant nutrients
- Grasshoppers often more limited by plant quality than plant quantity (in non-drought years)

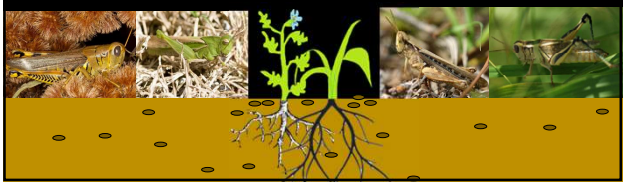


12

Grasshoppers' role in grasslands

Nutrient cyclers

- Herbivory is more than loss
- Swop "brown food web/slow cycle" for "green food web/fast cycle"
- Grasshopper poop is a fast-decomposing, N-rich fertilizer (on average increase soil N by 8%; Belovsky & Slade 2018)
- Speed up plant litter decomposition



13

Grasshoppers' role in grasslands

Nutrient cyclers

- Grasshoppers can increase plant productivity/forage amount through fertilization; on average by 18% (Belovsky & Slade 2000; 2018)

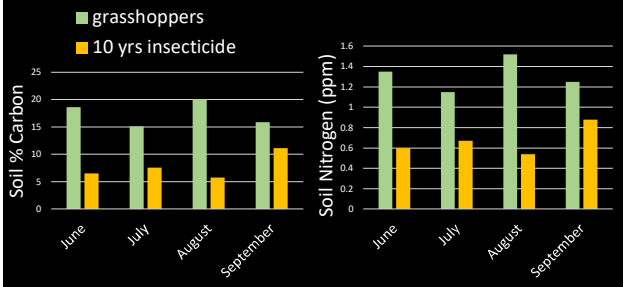
➢ Unlikely in drought years as plants need a certain amount of water to access soil nutrients

➢ More likely to occur with grasshopper species that prefer lower quality plants

14

Grasshoppers' role in grasslands

Soil C & N in Phillips Co. 2022



- Soil C increased by 225% with grasshoppers
- Soil N increased by 196% with grasshoppers

15

Grasshoppers' role in grasslands

Food: Peanuts of the prairie

16

Grasshoppers' role in grasslands

Food: Peanuts of the prairie

- 40-70% crude protein
- 30-90% of the diets of small (and some large) grassland birds

➢ Including Sage Grouse chicks, Chestnut-collared Longspur, Sprague's pipit, Kestrel, nonbreeding Swainson's Hawk

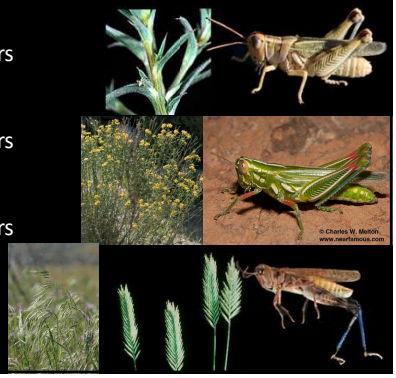
- Healthy bird communities in ND eat 30-50% of grasshoppers/yr (George & McEwen 2001)

17

Grasshoppers' role in grasslands

Eat unwanted plants

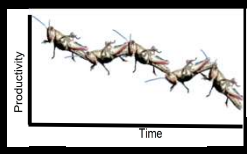
- Russian thistle grasshopper prefers Russian thistle
- Snakeweed grasshopper prefers broom snakeweed
- Big-headed grasshopper prefers cheatgrass & crested wheatgrass

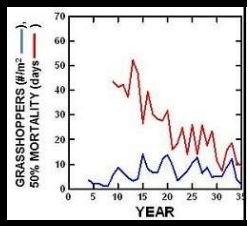


18

Trends in global grasshopper populations

- Highly variable with location and taxa
- >¼ of European Orthoperan species listed as threatened
- Worsening plague locusts in East Africa/ Middle East
- 2%/year declines over 20 yrs in a Kansas tallgrass prairie; 11 species declined, 1 increased, 10 no trend (Welti et al. 2020)
- Colorado: declines in 18 species, increases in 7 species across 45 yrs (Nufio et al. 2010)
- National Bison Range, MT: densities have no trend, but days to 50% mortality declining between 1978-2019 (LTREB Database, Belovsky Lab)
- Suggests more abrupt seasonal peaks in grasshopper abundance





19

Conclusions

- Grasshoppers are not always good or bad
- Cyclic abundances can lead to extreme grasshopper years
- Compete with cattle for forage in drought years
- Can be key nutrient cyclers
- Important food source for many grassland animals
- Global grassland loss is reducing grasshopper diversity, but local trends and specific species are highly variable and understudied

20

Thanks!

21