A recent advance in insect ecology

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Phenotypic plasticity mediates climate change responses among invasive and indigenous arthropods

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Why

- Well written
- Strong questions
- Classic experiment
- Neat system
- World class researchers
- Series of well designed experiments

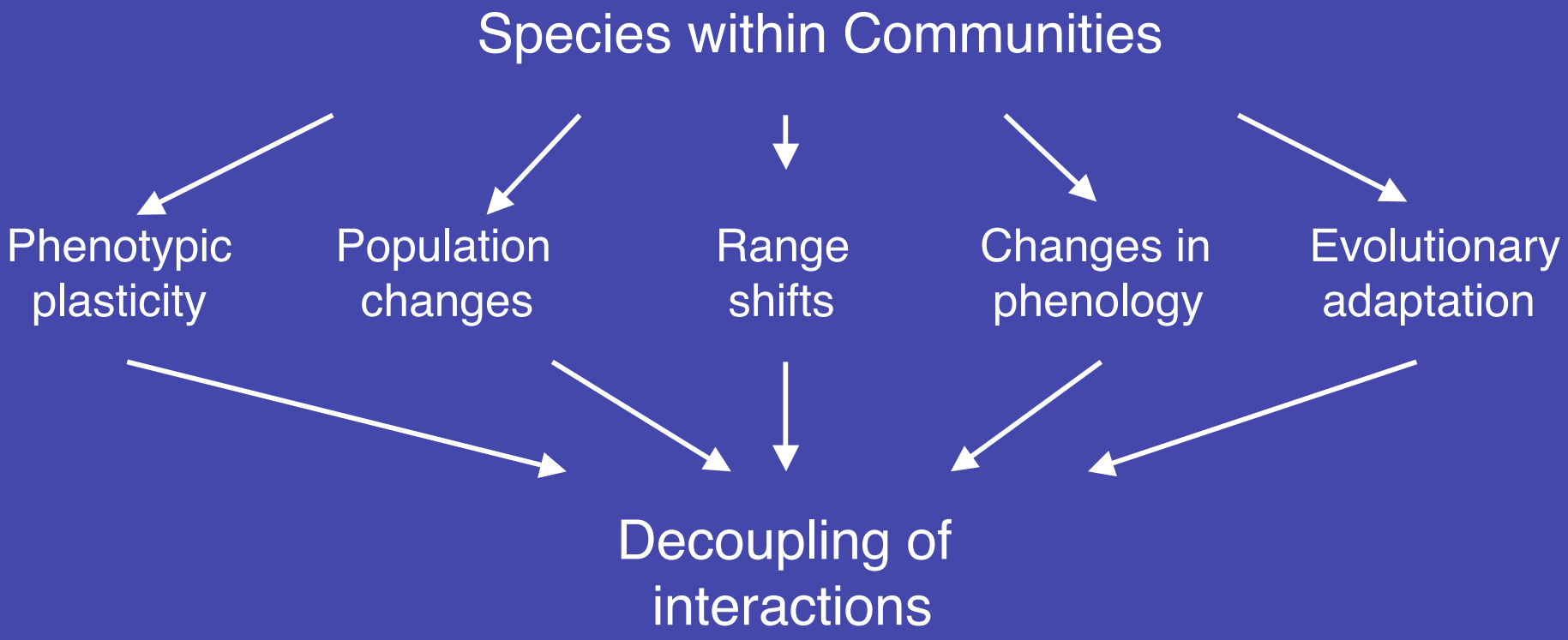
Importance

- Invasive alien species
- Climate change may promote invasion risk
- Warming and drying in temperate ecosystems
  - favour invasive over indigenous
- Added burden to conservation
- Compromising ecosystem services

Phenotypic plasticity

- Differences between introduced and native species
  - Responses to a changing climate
- One of the most significant ways organisms react to environmental change
  - Response can determine persistence of a population

Potential responses



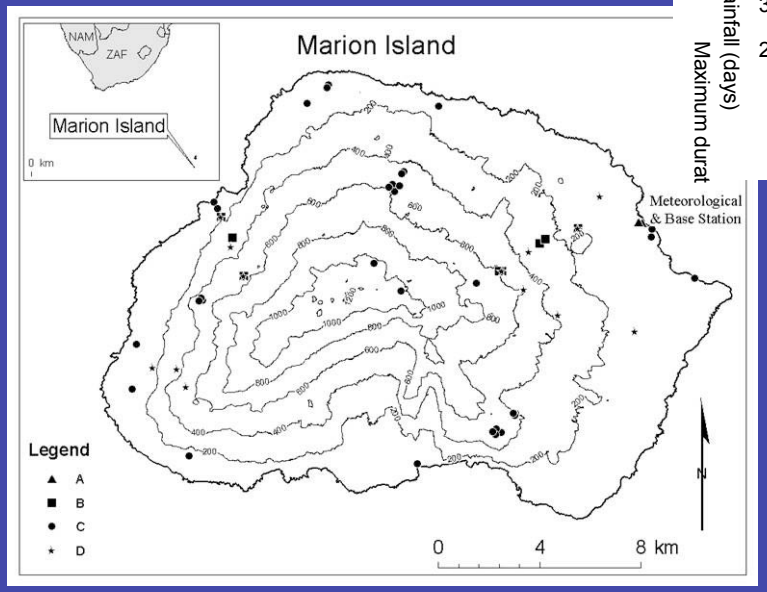
Source: Lesley Hughes Macquarie University

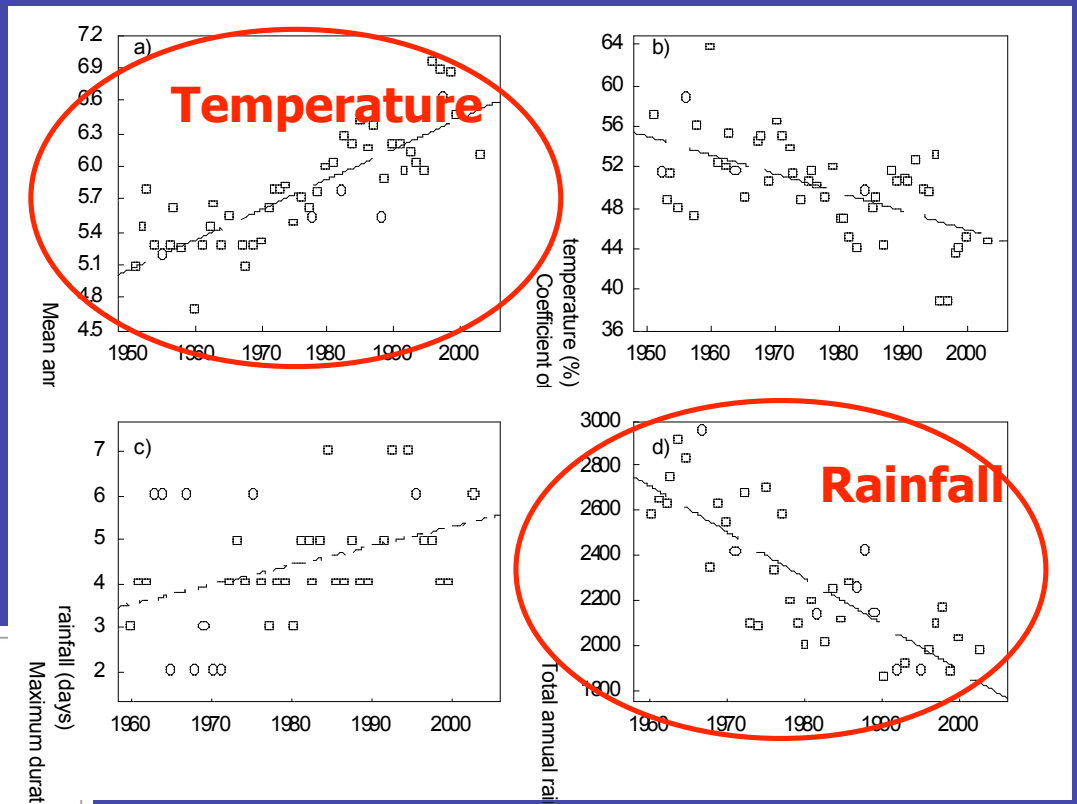
Hypotheses tested

- Greater flexibility hypothesis
  - Invasive species have a greater plasticity *per se* than indigenous species
    - Respond favourably to new conditions
- Invasive species
  - Warmer environments will be better

Marion Island

base set up 1947


Marion Island
NAM
ZAF
Marion Island
0 km
Meteorological & Base Station
Legend
A
B
C
D
0
4
8 km
N


Temperature
a)
b)
c)
d)
Mean anr
temperature (%)
Coefficient of
rainfall (days)
Maximum durat
Total annual rai
Rainfall
1950
1960
1970
1980
1990
2000

Marion Island

- 16 springtail species
  - 5 introduced
    - since base establishment
- 6 springtail species tested
  - most common
  - 2 introduced
  - 4 indigenous

exp. prep.

- collected using aspirator
- kept in 30ml plastic vials
  - detritus
- acclimation at 5°C and 15°C
  - 7-10 days

Marion Island

Survival to desiccation

- sodium chloride
  - provides constant humidity between 0 & 20°C
- test temperatures
  - 5°C and 15°C

To determine whether plasticity (or flexibility) differed among the indigenous and alien species, the largest absolute difference in survival time between the two acclimation treatments was calculated per treatment temperature and was expressed in each case as a proportional increase over the shortest survival time at that temperature.

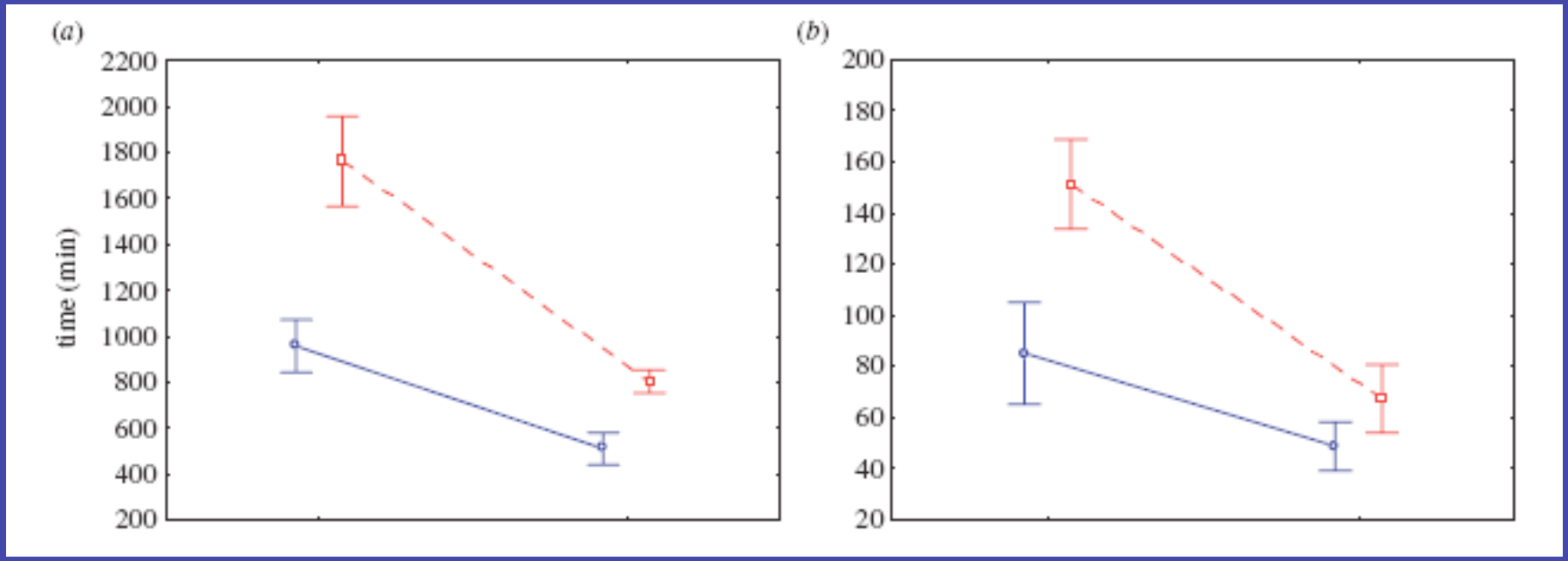
Survival time

- No differences – total survival time
  - Indigenous vs invasive
  - Mass taken into account

$(\chi^2_{1,15} = 3.01,\ p = 0.08).$

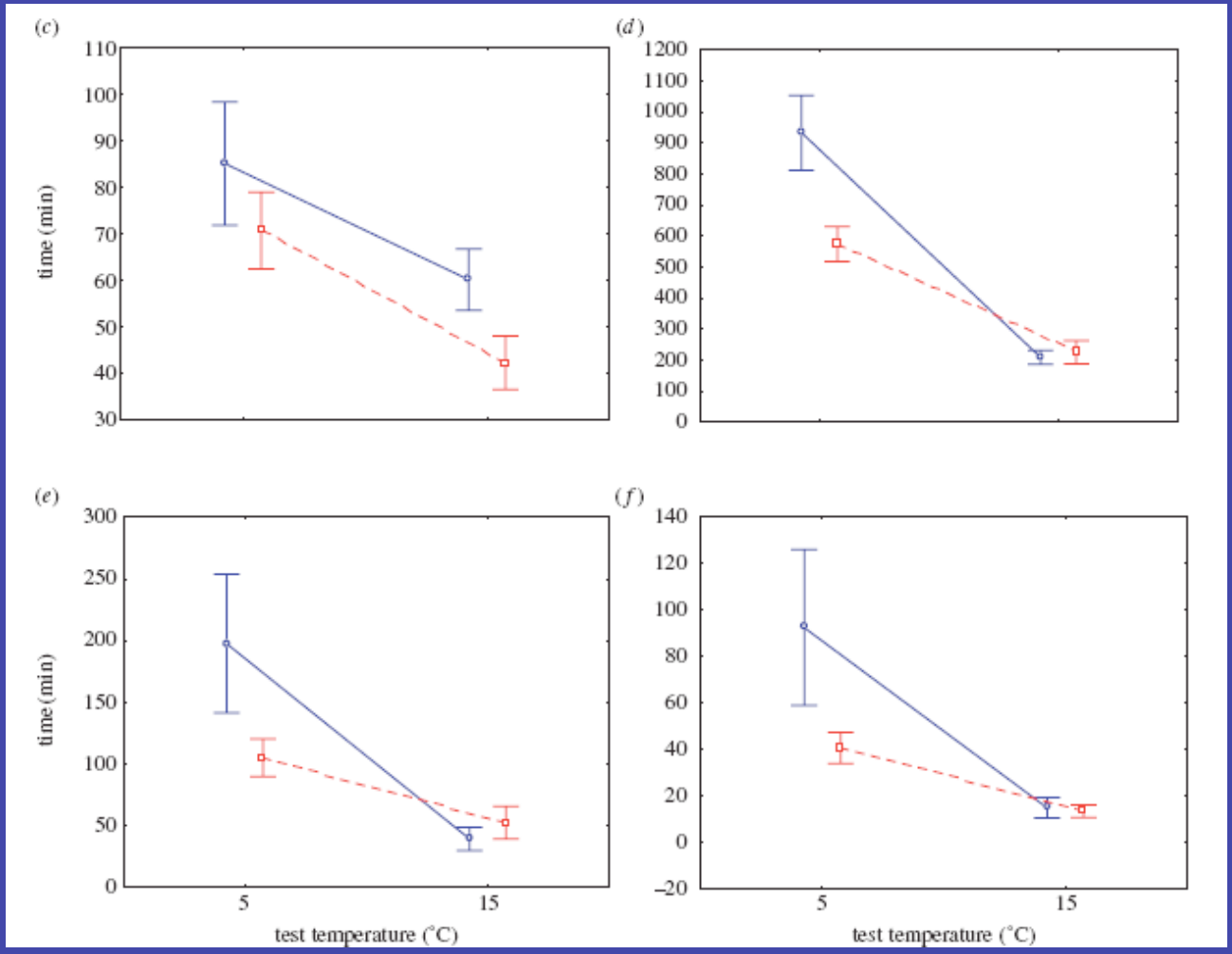
Likewise, the two groups did not differ in plasticity, expressed as a proportional change in survival time ($\chi^2_{1,8} = 1.0$, $p = 0.316$), although plasticity was smaller at the higher test temperature ($\chi^2_{1,8} = 6.07$, $p = 0.014$).

Introduced species



Mean ± s.e. of survival time (76% rel. hum). 5°C acclimation blue solid line; 15°C red stippled line at test temp 5°C and 15°C. Lines staggered.

Native species



Mean ± s.e. of survival time (76% rel. hum). 5°C acclimation blue solid line; 15°C red stippled line at test temp 5°C and 15°C. Lines staggered.

2 major responses

- invasive species acclimated to 15°C always survived longer c.f. 5°C acclimation
- indigenous species acclimated to 5°C had significantly and substantially longer survival times at 5°C c.f. 15°C

Manipulative field exp.

- Assess drying & warming on arthropods of a dominant plant species
  - *Azorella selago*

- dry-warm
  - 16 plants
  - clear polycarbonate sheets 0.1m above plant
  - stop precipitation but not indirect water sources
- control
  - 16 plants

drying-warming = fewer indigenous species

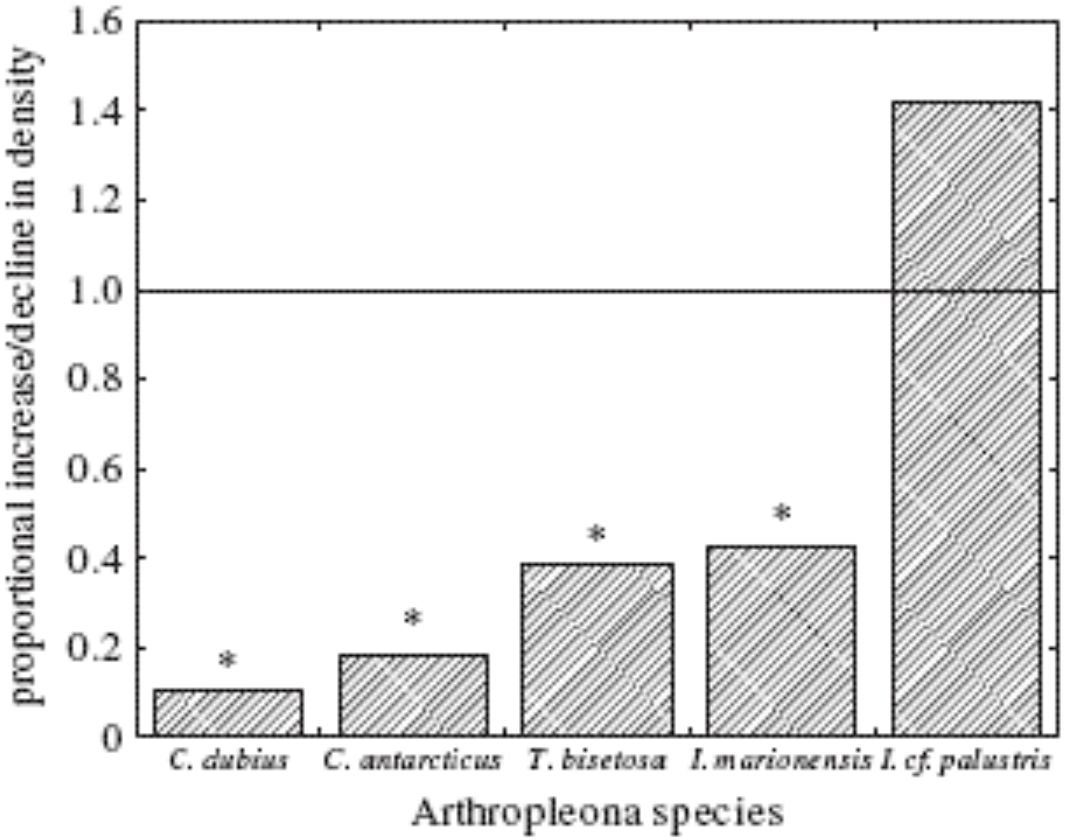


Figure 2. Proportional (relative to controls) decline (less than 1) or increase (more than 1) in the density of the Arthropleona springtail species recorded in the experimental field site. The first four species are indigenous and members of the genera *Cryptopygus*, *Tullbergia* and *Isotoma*. The fifth species is the invasive *Isotomurus cf. palustris*. *Significant differences ($p<0.05$) in absolute densities between experimental and control sites, assessed using a generalized model assuming Poisson errors and using a log link function.

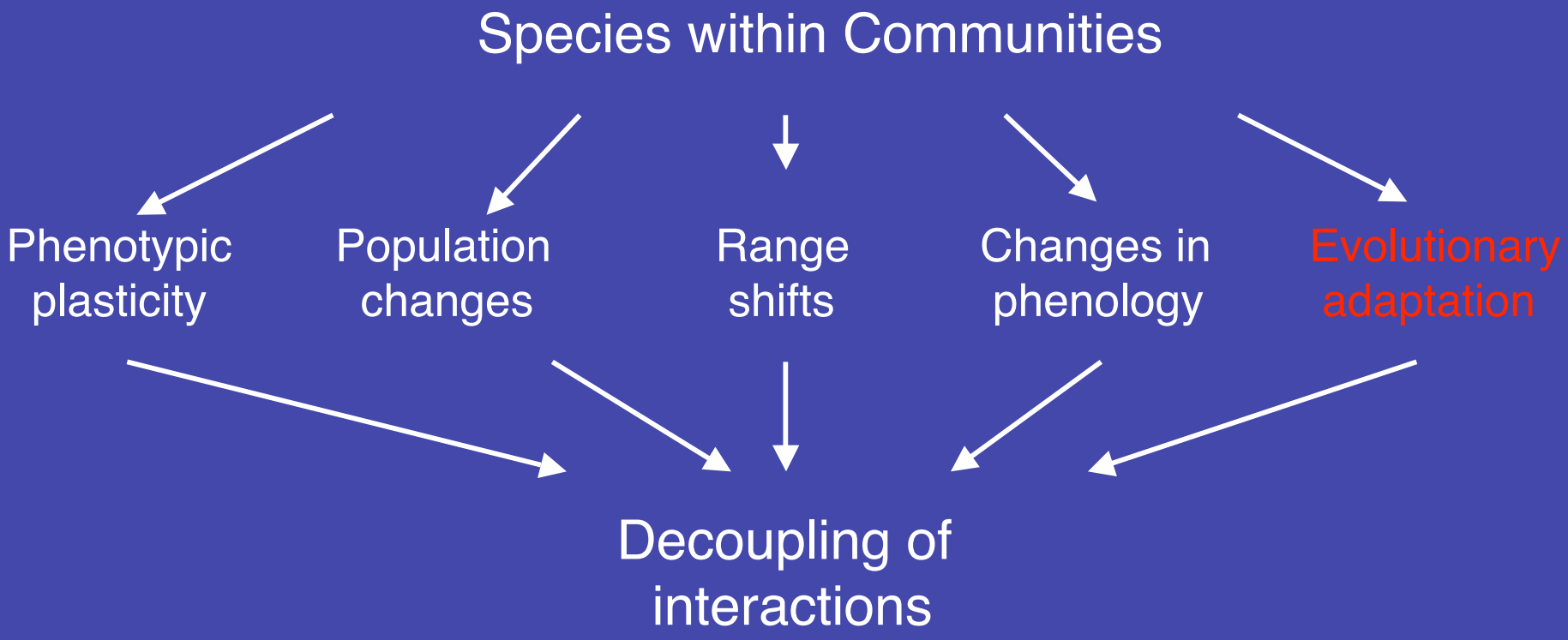
Impacts

- extent of plasticity
- but differential responses
  - indigenous & invasive species
- warming and drying
  - typical of CC
  - -ve impact on indigenous species
  - little impact on invasive species

Impacts

- climate change & biological invasions will act synergistically to compromise terrestrial ecosystems

Research on Marion



Implications

- Template for assessing indigenous vs invasive species
- Insect physiology & acclimation
- Long-term data sets
- Collaboration

Climate change research

- Physiology of species
- Acclimation trials
- Community responses
- Individual species responses
- Morphological, physiological and behavioural traits