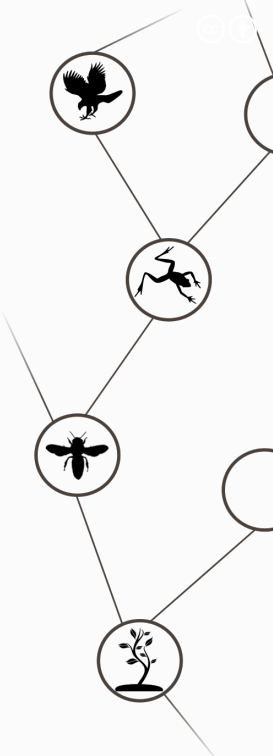
UNIVERSITÉ DE SHERBROOKE

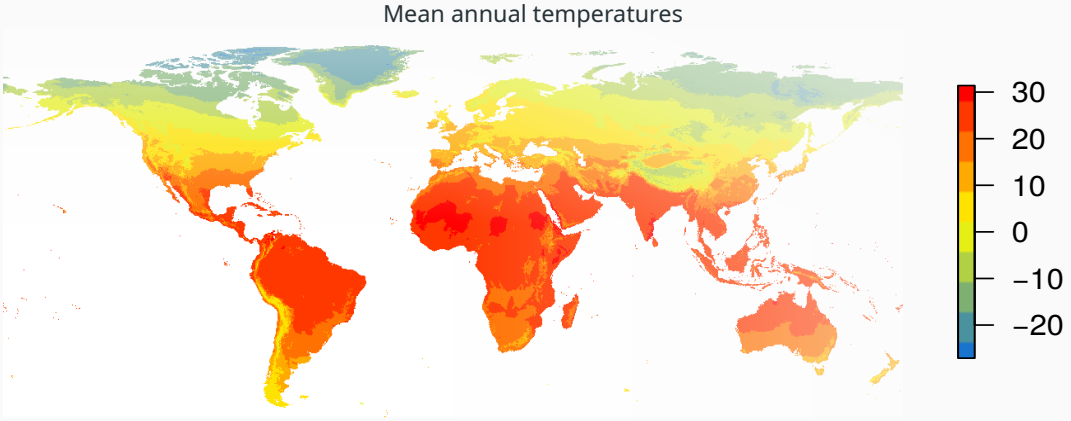
[IE] **Integrative Ecology Lab**
Laboratoire d'écologie intégrative

A consumer-resource model to assess the effects of temperature on interaction strength



Azenor Bideault
Supervisors: Dominique Gravel & Michel Loreau
Université de Sherbooke

TEMPERATURE: MAJOR ENVIRONMENTAL GRADIENT



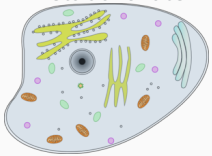
Worldclim data

EFFECTS OF TEMPERATURE

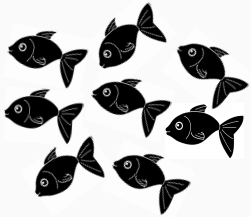
Metabolic rate

EFFECTS OF TEMPERATURE

Metabolic rate

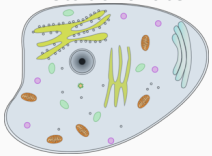


Biological rates (growth rate)

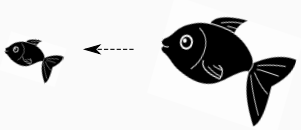


EFFECTS OF TEMPERATURE

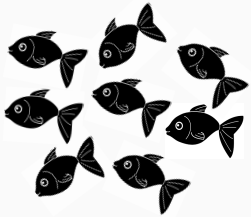
Metabolic rate



Body-size

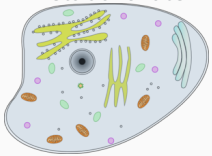


Biological rates (growth rate)

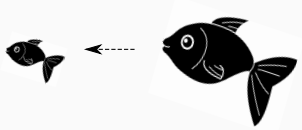


EFFECTS OF TEMPERATURE

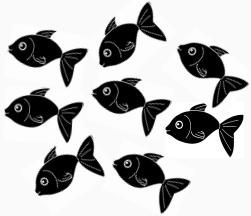
Metabolic rate



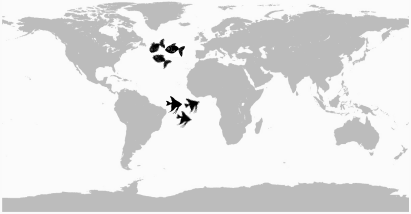
Body-size



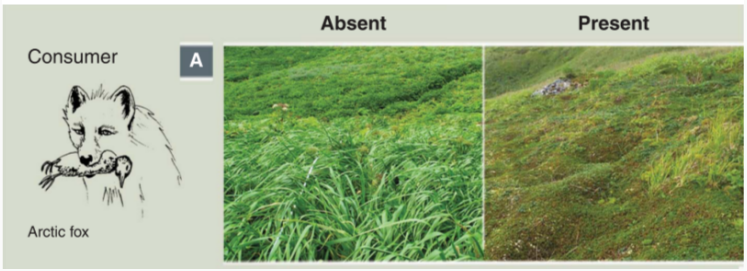
Biological rates (growth rate)



Species distribution

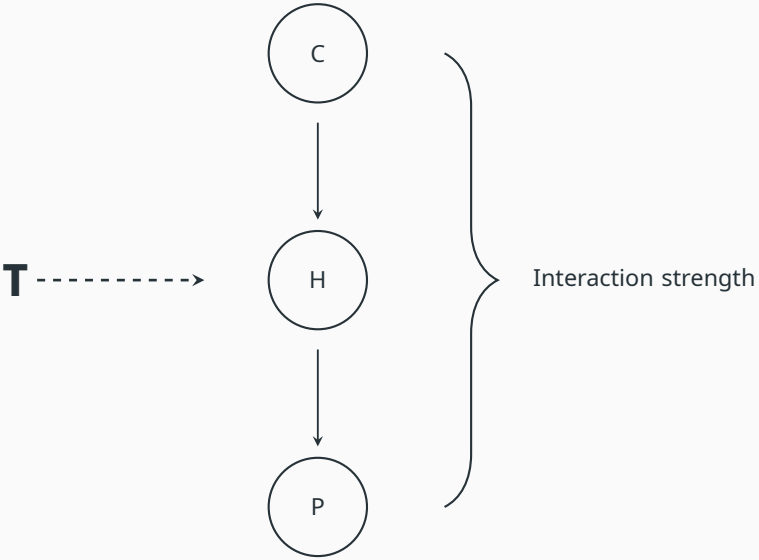


LANDSCAPE-LEVEL EFFECTS OF TROPHIC INTERACTIONS

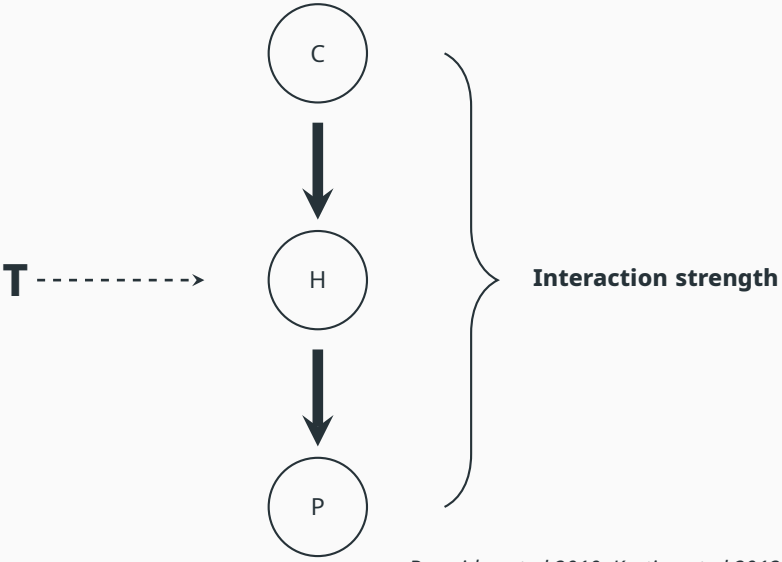


Estes et al 2011

EFFECTS OF TEMPERATURE ON TROPHIC REGULATION



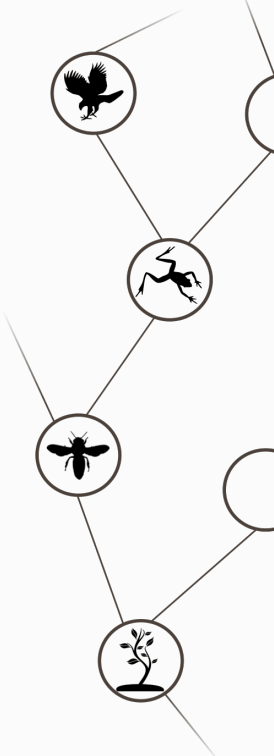
EFFECTS OF TEMPERATURE ON TROPHIC REGULATION



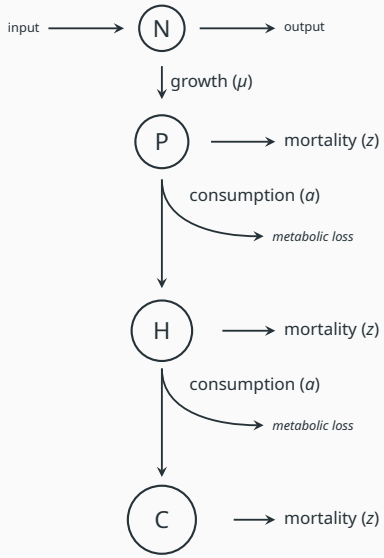
Beveridge et al 2010, Kratina et al 2012, Shurin et al 2012

§ 1

Model



TRI-TROPHIC MODEL

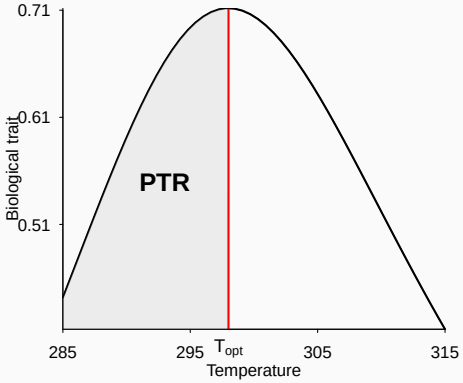


μ growth rate

a attack rate

z mortality rate

TEMPERATURE DEPENDENCE OF ORGANISMS' BIOLOGICAL RATES



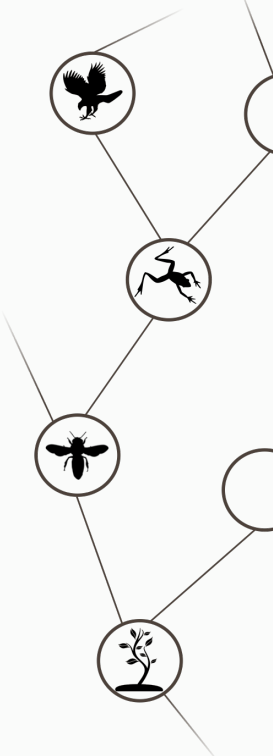
$$r(T) = r_0 \mathbf{m}^{\beta} exp\left(-\frac{\mathbf{E}}{k\mathbf{T}}\right) L(T)$$

- $r(T)$ biological rate
- m body-mass
- E activation energy
- T temperature
- $L(T)$ decreasing phase
- β, r_0, k constants

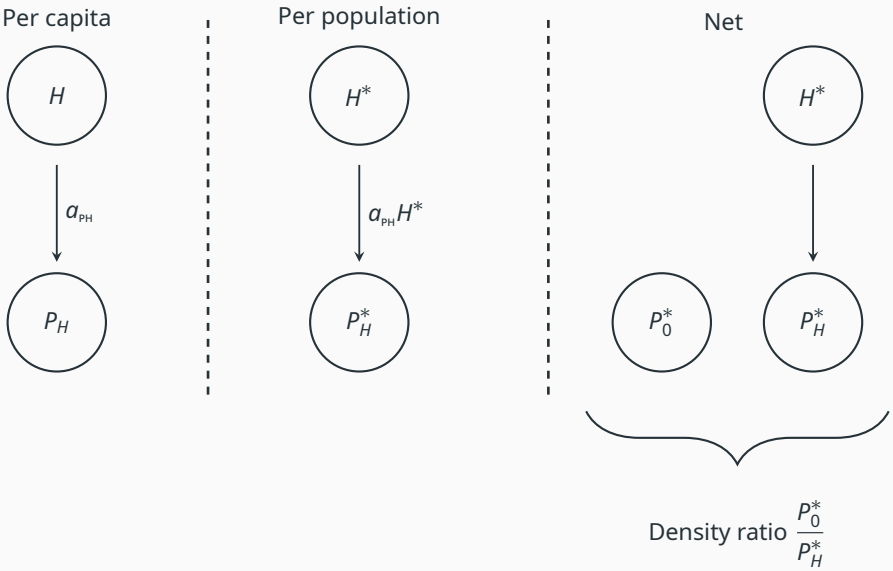
Gillooly et al 2001, Brown et al 2004, Savage et al 2004, Pawar et al 2015

§ 2

Direct and indirect effects of temperature on trophic regulation

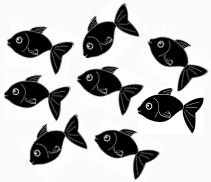


INTERACTION STRENGTH MEASURES



DIRECT AND INDIRECT EFFECTS OF TEMPERATURE

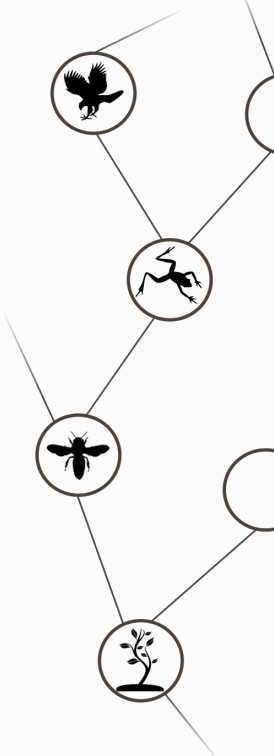
Direct effect on biological traits



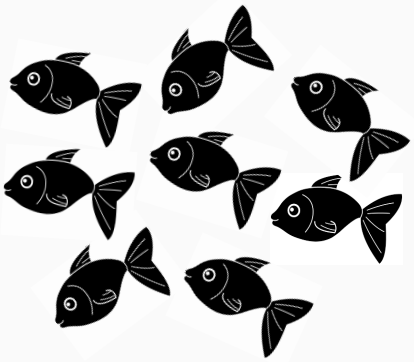
Indirect effect through decreasing body-size

§ 3

Results



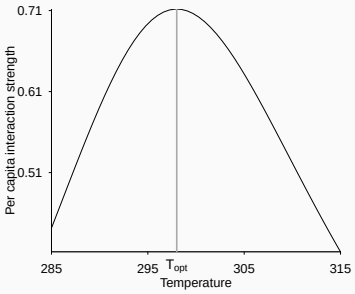
DIRECT EFFECT OF TEMPERATURE ON BIOLOGICAL TRAITS



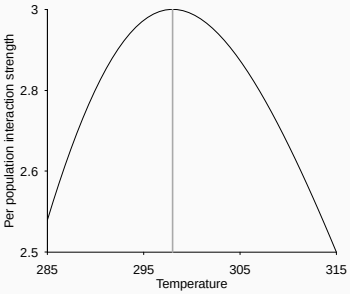
TEMPERATURE DEPENDENCE OF INTERACTION STRENGTH MEASURES ARE CONSISTENT

Effect of herbivore on primary producers

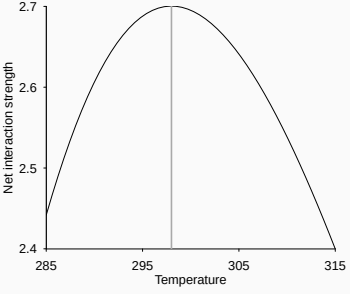
Per capita



Per population



Net



HETEROGENEOUS DEPENDENCIES

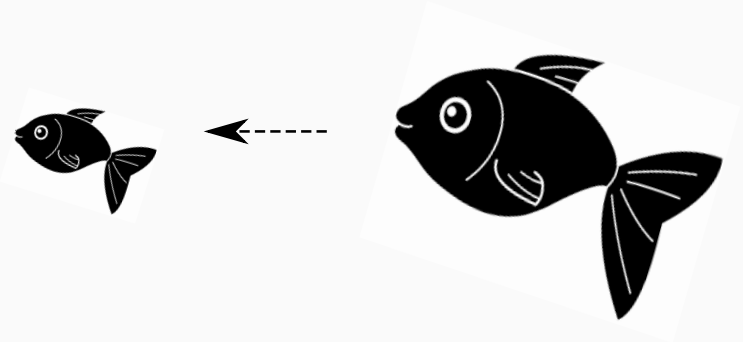
Effect of carnivores on herbivores

Fixed parameters	IS per population	IS net
$\emptyset$	$\cap$	$\cap$
a_{hc}	$\cap$	$\cup$
a_{ph}, a_{hc}	$\cup$	$\cup$
H: a_{ph}, z_h	$\cup$	$\cap$
C: a_{hc}, z_c	$\cap$	$\cup$

a attack rate

z mortality rate

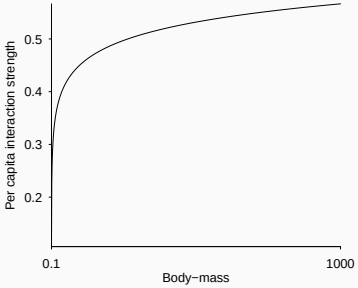
INDIRECT EFFECT OF TEMPERATURE THROUGH DECREASING BODY-SIZE



INDIRECT EFFECT OF TEMPERATURE THROUGH DECREASING BODY-SIZE

Effect of carnivores on herbivores

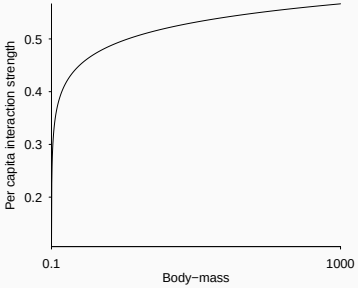
Per capita



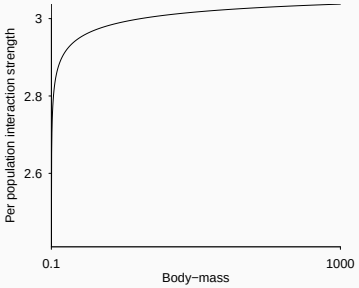
INDIRECT EFFECT OF TEMPERATURE THROUGH DECREASING BODY-SIZE

Effect of carnivores on herbivores

Per capita



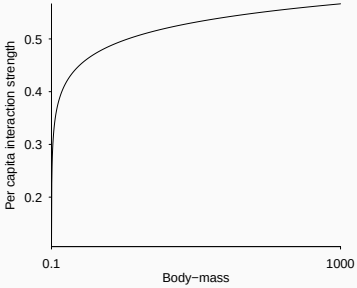
Per population



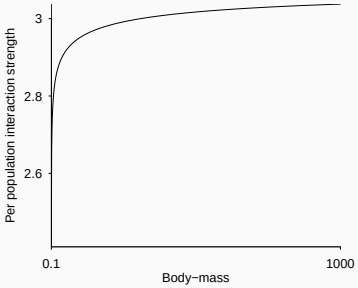
INDIRECT EFFECT OF TEMPERATURE THROUGH DECREASING BODY-SIZE

Effect of carnivores on herbivores

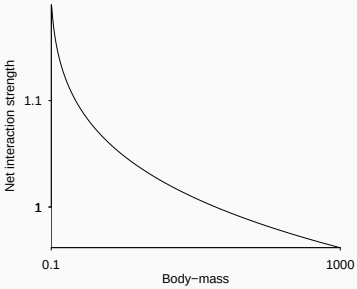
Per capita



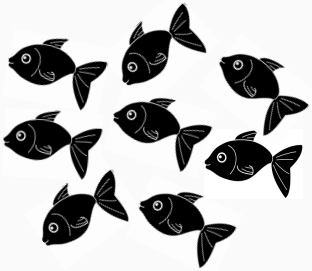
Per population



Net

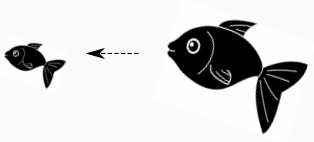


EFFECT OF TEMPERATURE ON INTERACTION STRENGTH THROUGH BIOLOGICAL TRAITS



- Temperature dependence of different interaction strength measures are consistent
- Heterogeneous dependencies: variations according to which parameters are temperature dependent

INDIRECT EFFECT OF TEMPERATURE ON INTERACTION STRENGTH



- Temperature can indirectly decrease or increase interaction strength
- The indirect effect of temperature on trophic regulation through decreasing body-size may enhance or decrease its direct effect on biological traits

VARIOUS EFFECTS OF TEMPERATURE ON INTERACTION STRENGTH

Temperature has numerous and potentially conflicting effects on interaction strength:

developping a framework that integrates various effects of temperature on interaction strength is key in understanding food web dynamics

MERCI DE VOTRE ATTENTION

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