Predation

“Populační ekologie živočichů“

Stano Pekár

Total response

- mortality of prey increases with the prey density due to predation

- Total response of a predator

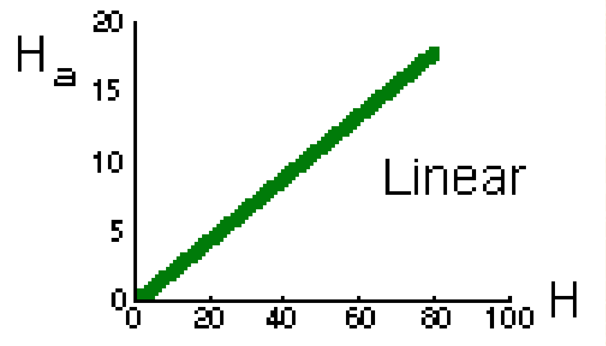
- increasing consumption rate of individual predators → **functional response**
- increasing density of predators → **numerical response**

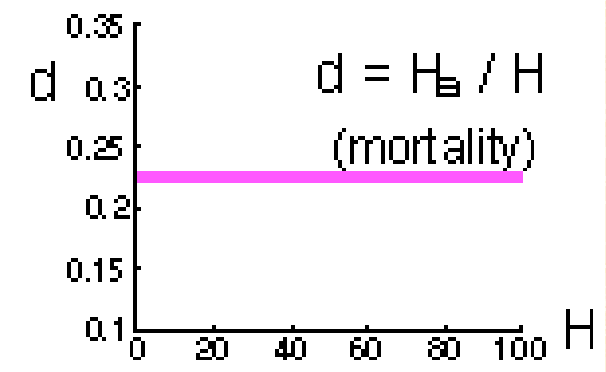
- Holling (1959) found that predation rate increased with increasing prey population density
- defined three types of functional responses

Functional response

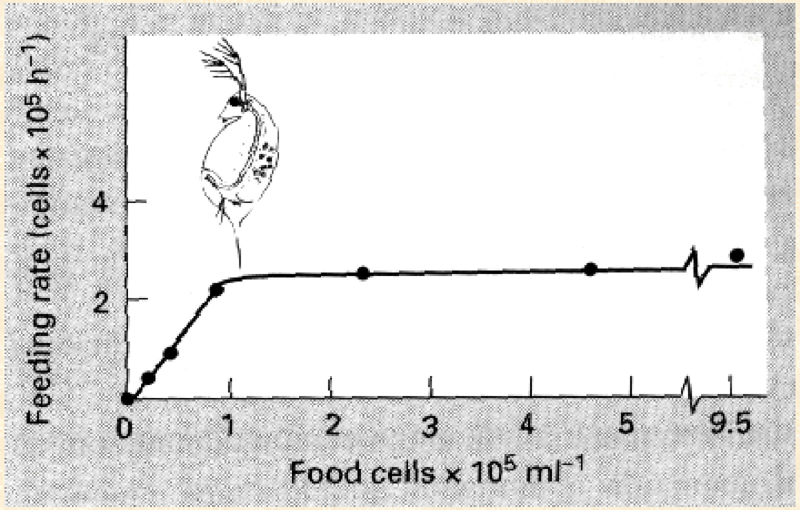
Type I

- number of captured prey is proportional to density
- prey mortality is constant
- less common
- found in passive predators (web-building spiders)
- the handling time exerts its effect suddenly





Daphnia feeding on *Saccharomyces* - above 10^5 cells *Daphnia* is unable to swallow all food

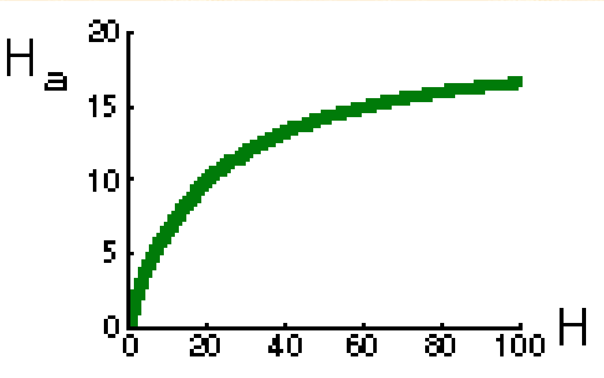


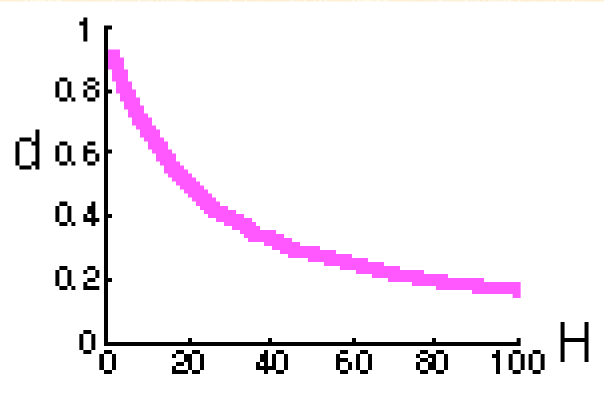
Rigler (1961)

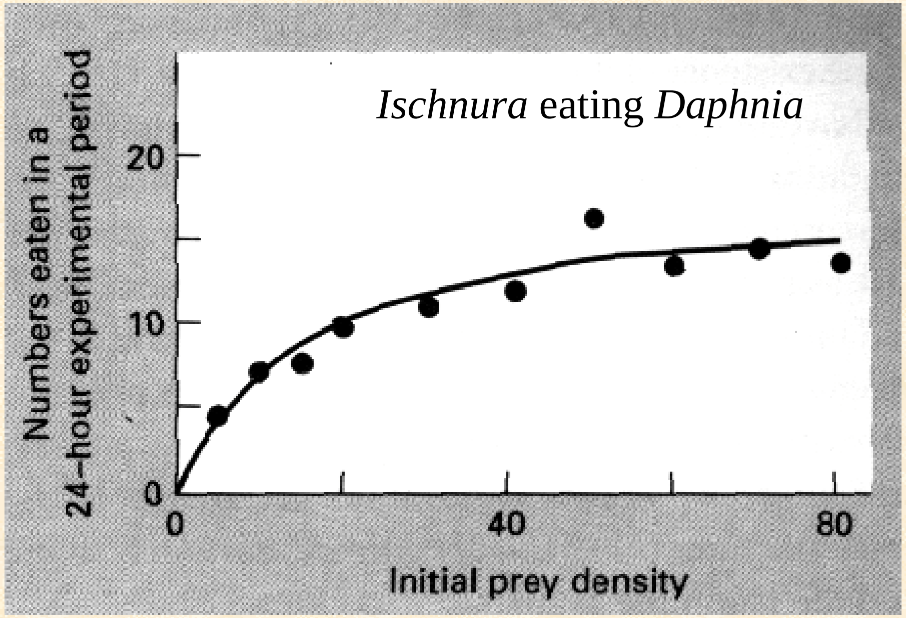
Type II

- predators cause maximum mortality at low prey density
- as prey density increases, search becomes trivial and handling takes up increasing portion of the time
- saturation of predation at high densities

- prey mortality declines with density





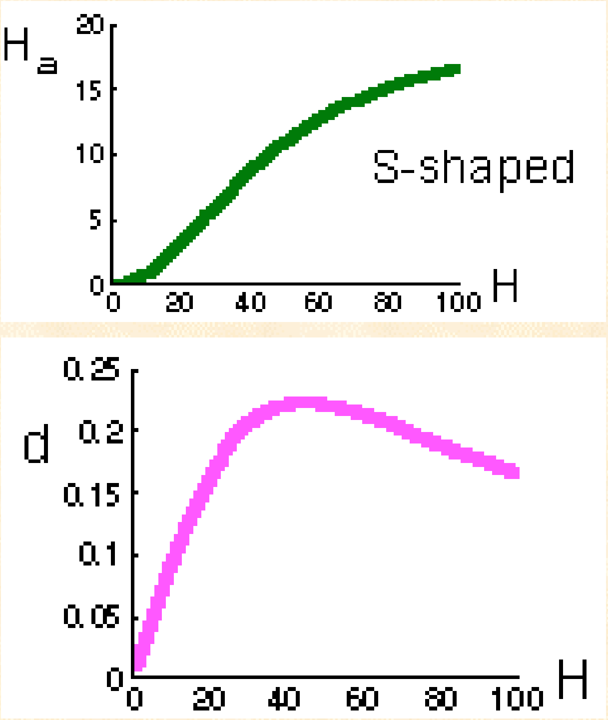


Thompson (1975)

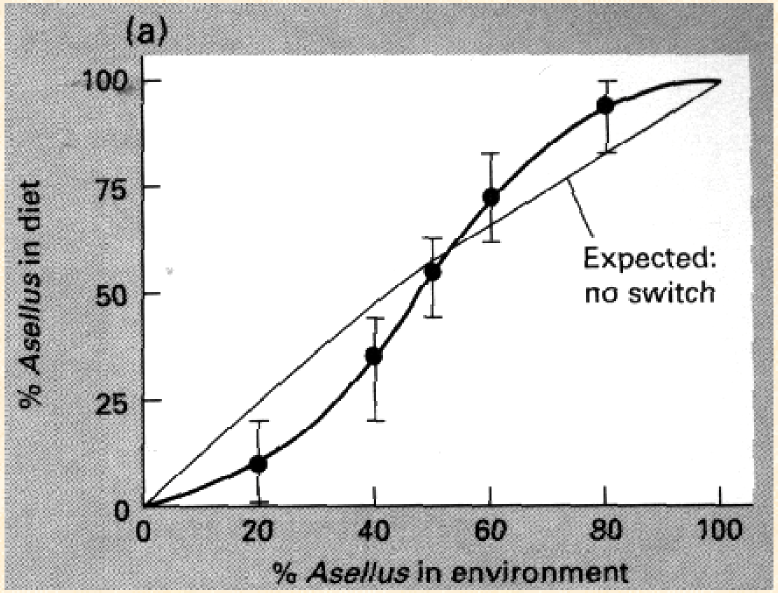
Type III

- when attack rate increases or handling time decreases with increasing density
- predators respond to kairomones
- predators develop search image
- polyphagous predators switch to the most abundant prey

- prey mortality increases then declines



Notonecta switched from *Cleon* to *Asellus* based on its abundance



Lawton et al. (1974)

Models of response

T .. total time
T_S .. searching time - searching for prey
T_H .. handling time - handling prey (chasing, killing, eating, digesting)

$$T = T_S + T_H$$

H .. prey density
H_a .. number of captured prey
a .. capture efficiency, "area of discovery", or "search rate"

Type I

- consumption rate of a predator is unlimited
- $T_H = 0$

$$\boxed{H_a = aHT_S}$$

Type II

- consumption rate of a predator is limited because even if no time is needed for search, predator still needs to spend time on prey handling
- $T_H > 0$
- predator captures H_a prey during T

$$T_H = H_a T_h$$

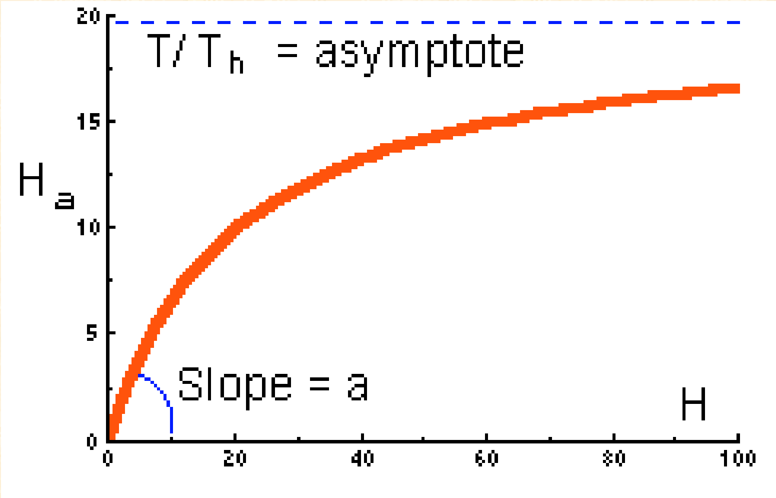
T_h .. time spent on handling 1 prey

$$H_a = aHT_S \rightarrow T_S = \frac{H_a}{aH}$$

- at low density predator spends most of the time searching, at high density on prey handling

$$T = T_S + T_H = H_a T_h + \frac{H_a}{aH}$$

$$\boxed{H_a = \frac{aHT}{1 + aHT_h}}$$



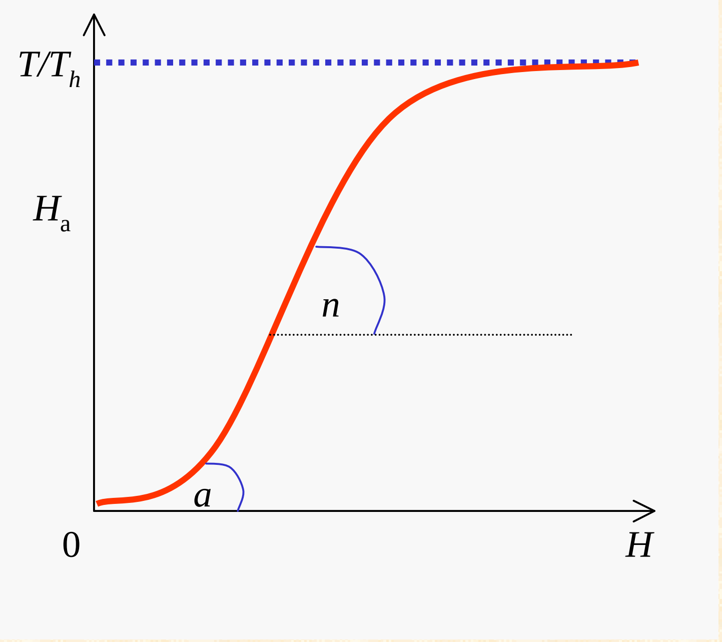
Type III

- consumption increases at low densities and decreases at higher densities

n .. rate of increased consumption at higher densities
if $n = 1 \rightarrow$ Type II

a .. rate of increase at low densities

$$\boxed{H_a = \frac{aTH^n}{1 + aT_h H^n}}$$



Numerical response

Increase of predator population may result from:

- **increased rate of reproduction**

- the more prey is consumed the more energy can predator allocate to reproduction
- delayed response

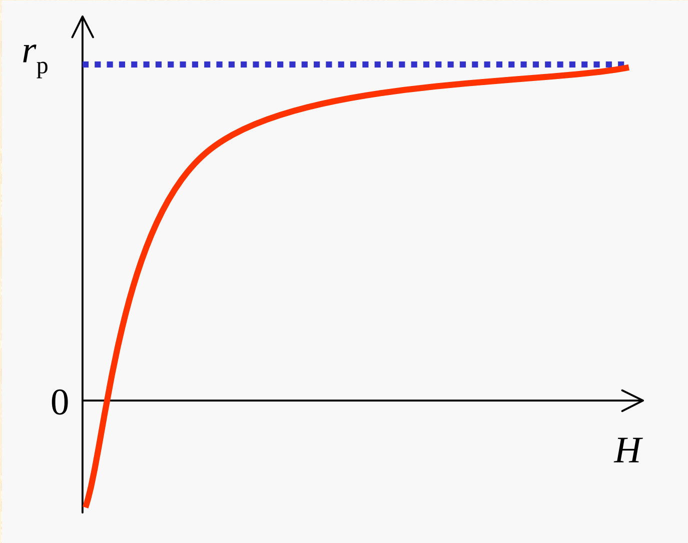
- **attraction of predators to prey aggregations**

- immediate response
- aggregated distribution makes search of predators more profitable

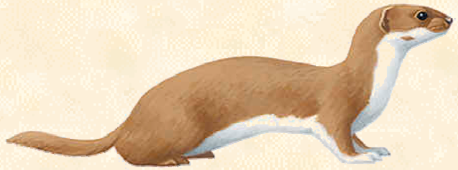
- conversion of prey into predators

$$r_p = eaHP - dP$$

e .. conversion efficiency
d .. mortality of predators



Excercise 15



Minks are kept in large-sized cages (10 m^2) individually, different number of prey (*H*) was released and after 2 days (*T*) captured prey was counted.

1. What type of functional response minks have?

2. Estimate search efficiency (a) and handling time (T_h).

H	Ha
5	2.5
10	4
20	7.9
40	9
80	12.6
160	11.6

$$H_a = \frac{aHT}{1 + aHT_h}$$

$$\frac{1}{H_a} = \frac{1}{a}\frac{1}{HT} + \frac{T_h}{T}$$

$$y = \alpha + \beta x$$

$$\boxed{T_h = \alpha T} \qquad \boxed{a = \frac{1}{\beta}}$$

```
H<-c(5,10,20,40,80,160)
Ha<-c(2.5,4,7.9,9,12.6,11.6)
plot(H,Ha)

y<-1/Ha
x<-1/(H*2)
plot(x,y)
lm(y~x)

1/3.38547
0.06446*48
```