



Aplikovaná ekologie hmyzu 2014 – 9

Functional response

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a

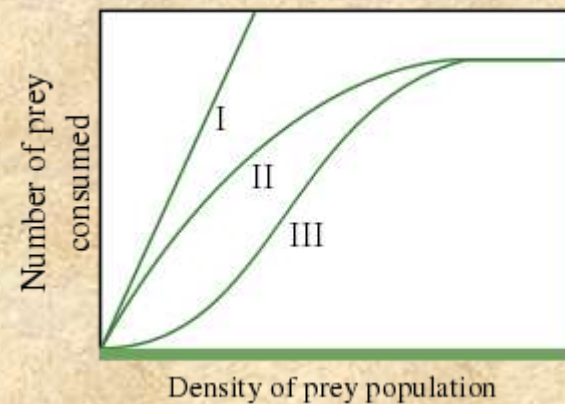
oddělení ekofyziologie

Entomologický ústav BC AV ČR



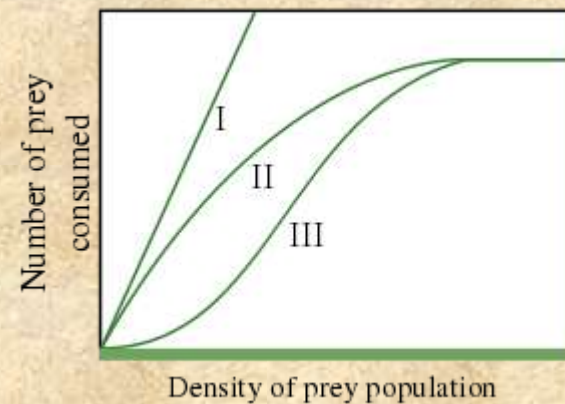
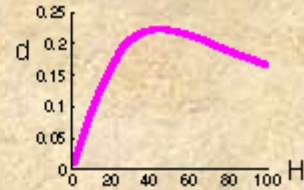
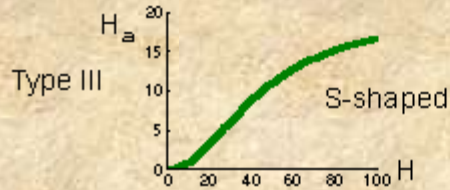
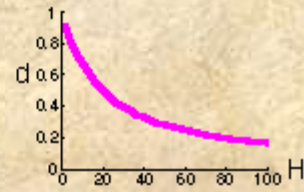
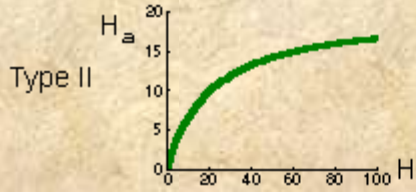
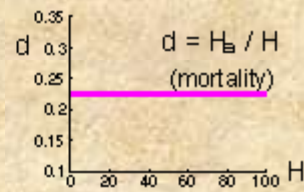
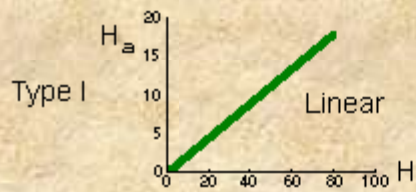
Functional response

- Funkční odpověď
 - množství přijaté potravy
 - jako funkce její nabídky
- obdoba Početní odpovědi
 - vlivu množství potravy na plodnost
- Intake rate
 - consumer
 - function of food density
- Numerical response
 - reproduction rate (fecundity)
- Crawford Stanley Holling



Functional response

- určitá stálá hustota
- určité počáteční množství
- constant prey density
- constant prey number
 - $R = \text{initial food density} = \text{number}$

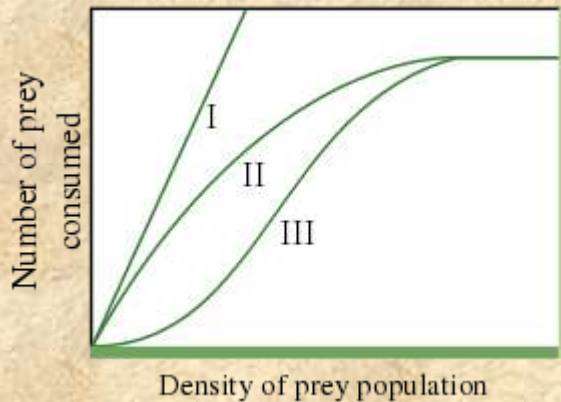


Functional response

- Typ 1

$$T_{\text{handling}} = H_a T_h$$

$$T = T_{\text{search}} + T_{\text{handling}}$$



- Type I

- linear increase
- up to a maximum
- = satiation

- Searching time

- Handling time

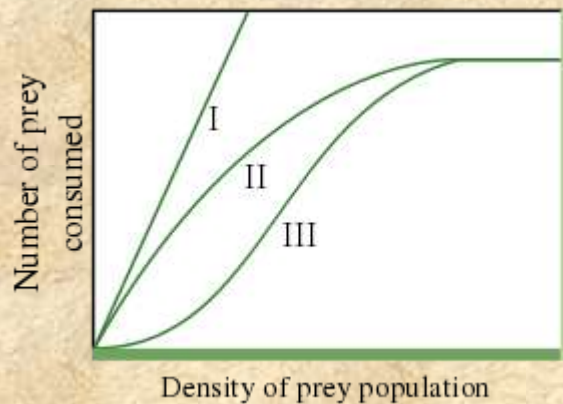
- negligible
- $f(R) = a.R$ or $f = \max$
- often unrealistic
- use in Lotka-Volterra model



Functional response

- Typ 2

$$f(R) = \frac{aR}{1 + ahR}$$



- Type II

- decelerating intake rate
- maximum = handling

- Searching time

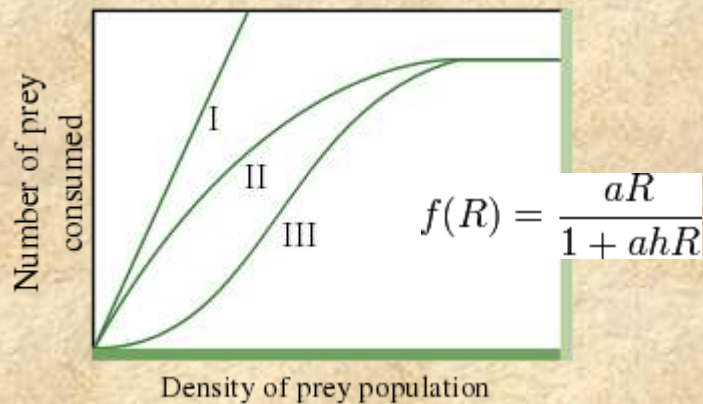
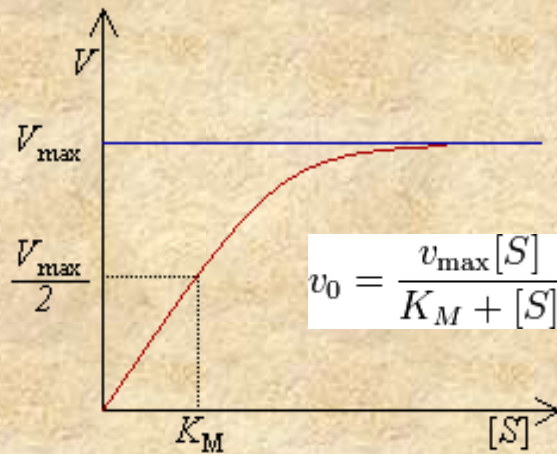
- Handling time

- mutually exclusive
- $f(R) = a.R / (1+a.h.R)$
- a = attack rate
 - rate at which the consumer encounters food items per unit of food density
- h = handling time
 - average time spent on processing a food item



Functional response

- Typ 2



- Type II

- Monod equation
 - microorganism growth
- Michaelis–Menten equation
 - rate of enzymatic reactions

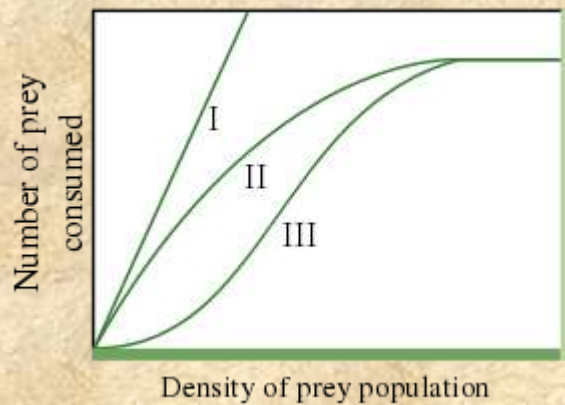


Functional response

- Typ 3

- Type III

- low density – accelerating
- high density – decelerating intake rate
- maximum = handling
- Searching time
- Handling time
- Learning time
- Prey switching



Functional response

- Typ 3



Sawfly larvae (above) and adult (below)



- Type III

- Learning time

- experience – improvement of
- searching and attacking efficiency
- handling efficiency
- a, h not constant

$$f(R) = \frac{aR}{1 + ahR}$$



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Functional response

- Typ 3



- Type III

- Prey switching

- select more common of two or more



Functional response

- Nasycení



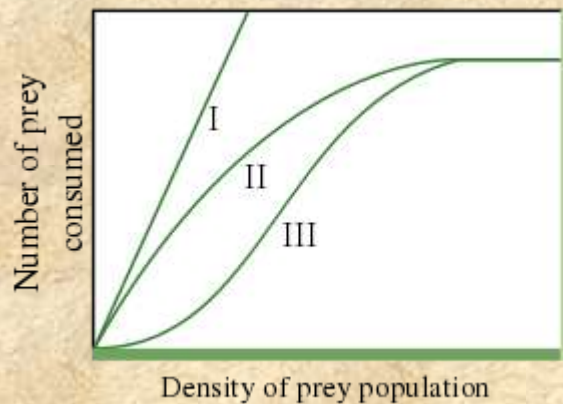
- Predator satiation

- predator saturation
- escape from natural enemies
- safety in numbers
- aphids
- plant seeds
- periodical cicada



Functional response

- Určení typu



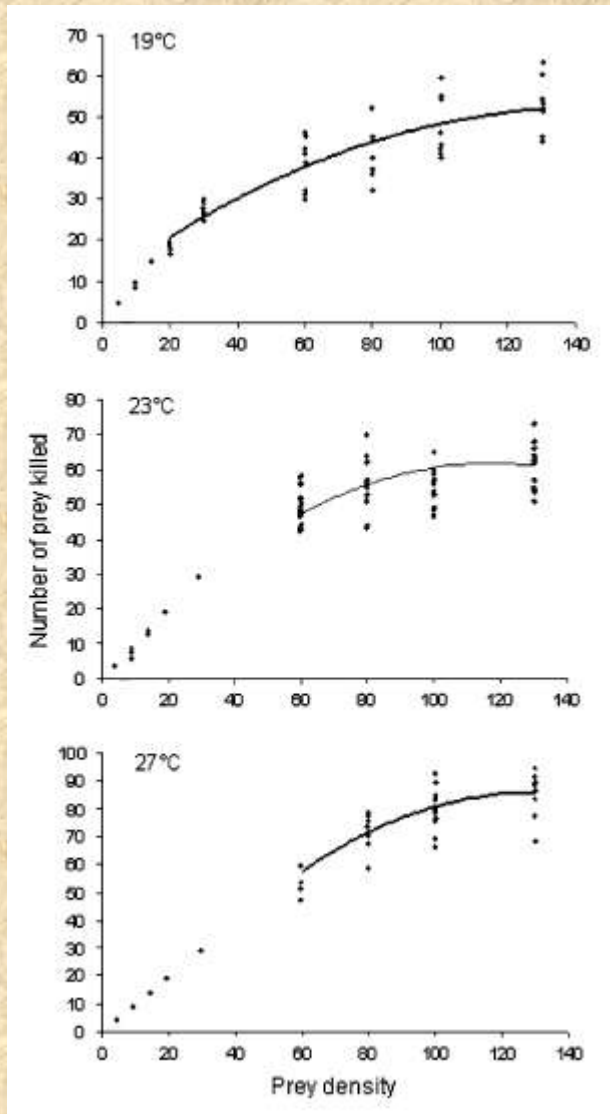
- Type determination

- prey depletion method
- prey densities: 5, 10, 15, 20, 30, 60, 80, 100, 130 aphids per leaf
- 10 replications with predator
- control without predator
- 24-h period
- corrected mortality
- $N_e = N_0 (N_d - N_c) / (N_0 - N_c)$
- N_0 = initial number
- N_d = mortality in treatment
- N_c = mortality in control



Functional response

- Typy



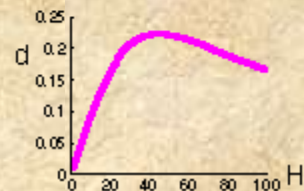
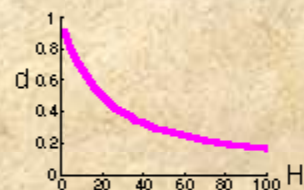
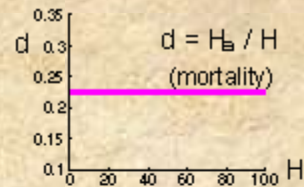
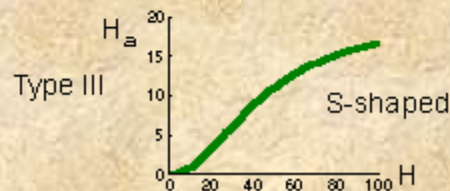
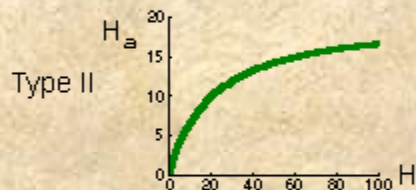
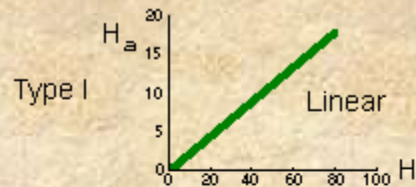
- Type determination

- polynomial logistic regression
- $N_e/N_0 = \exp \left(\frac{P_0 + P_1 \cdot N_0 + P_2 \cdot N_0^2 + P_3 \cdot N_0^3}{1 + \exp(P_0 + P_1 \cdot N_0 + P_2 \cdot N_0^2 + P_3 \cdot N_0^3)} \right)$
- negative linear parameter (P1) and negative quadratic parameter (P2) = functional response is type II
- positive linear parameter (P1) and a negative quadratic parameter (P2) = functional response is type III
- $N_e = N_0 \cdot \{1 - \exp[a \cdot (T_h \cdot N_e - T)]\}$
- $N_e = N_0 \cdot \{1 - \exp[(d + b \cdot N_0) \cdot (T_h \cdot N_e - T)] / (1 + c \cdot N_0)\}$
- a = attack constant, T = total time available (24 h), T_h = handling time per prey



Functional response

- Typy



- Type determination
- I: passive predators like web spiders
- II: small mammals destroy most of gypsy moth pupae in sparse populations of gypsy moth
- III: predators responding to kairomones
- birds switch to the most abundant prey



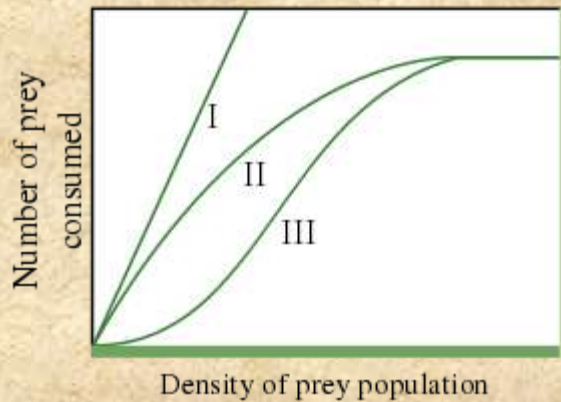
Functional response

- Typy
- Efficiency
 - predict success or failure of a predator as a biocontrol agent
 - numerical response
 - intrinsic growth rates
 - host patchiness
 - competition
 - environmental complexities (abiotic and biotic factors)
- Handling includes:
 - chasing
 - killing
 - eating
 - digesting



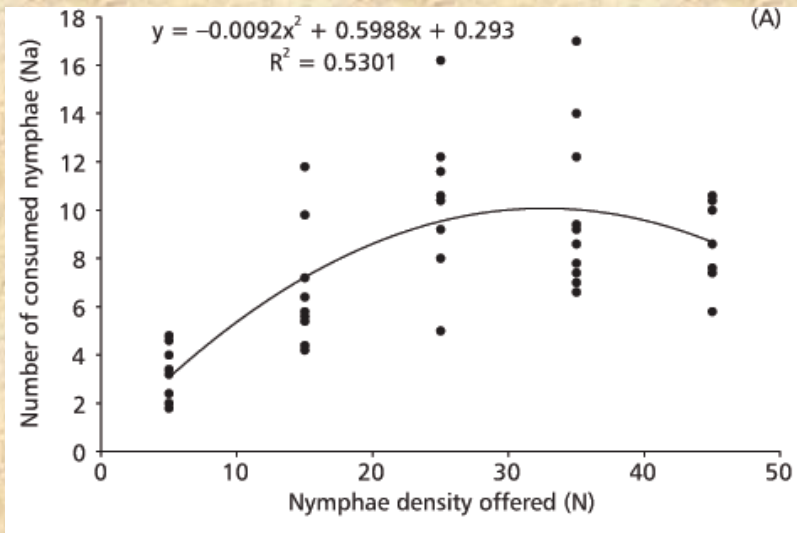
Functional response

- Typ 4



- Type IV

- decrease of predation at very high densities
- lethal plant defence paradox
- Reduviidae vs. Coreidae
- spider
- *Coccinella* vs. *Aphis nerii*

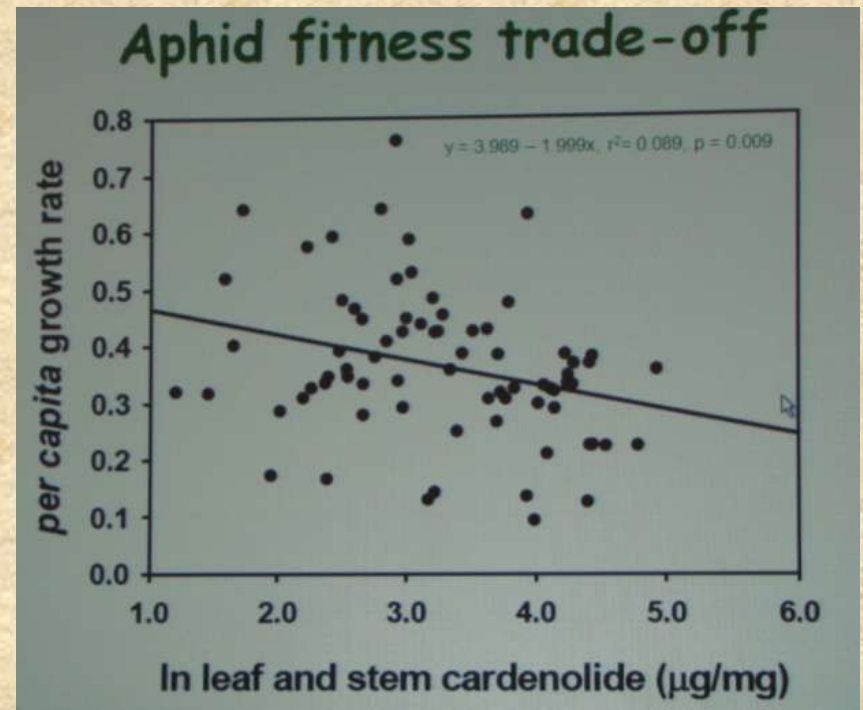
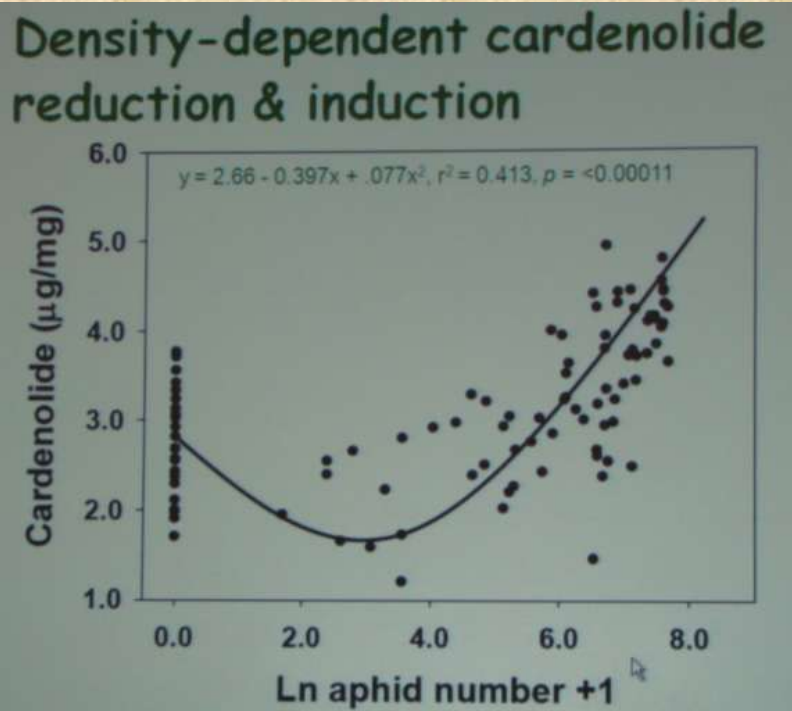


Functional response

- Typ 4

- Type IV

– lethal plant defence paradox

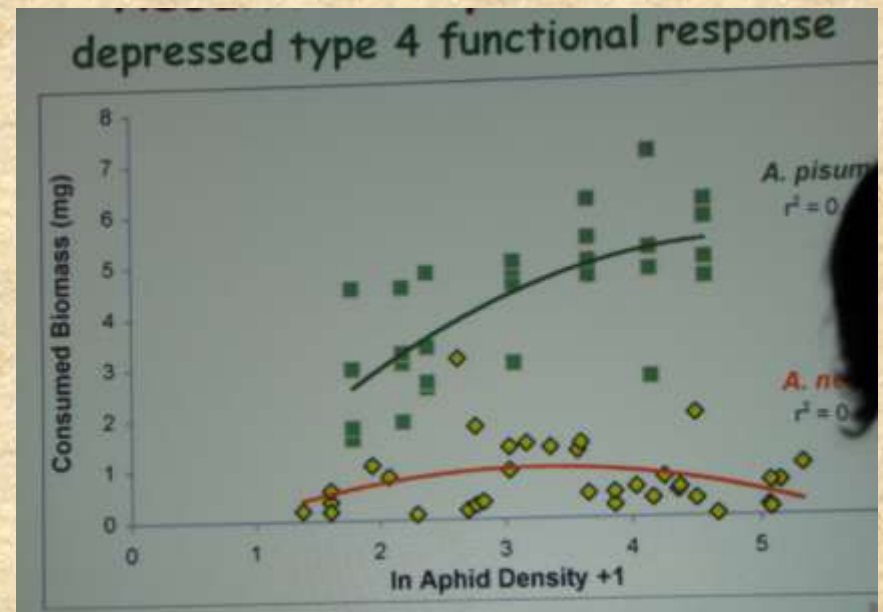
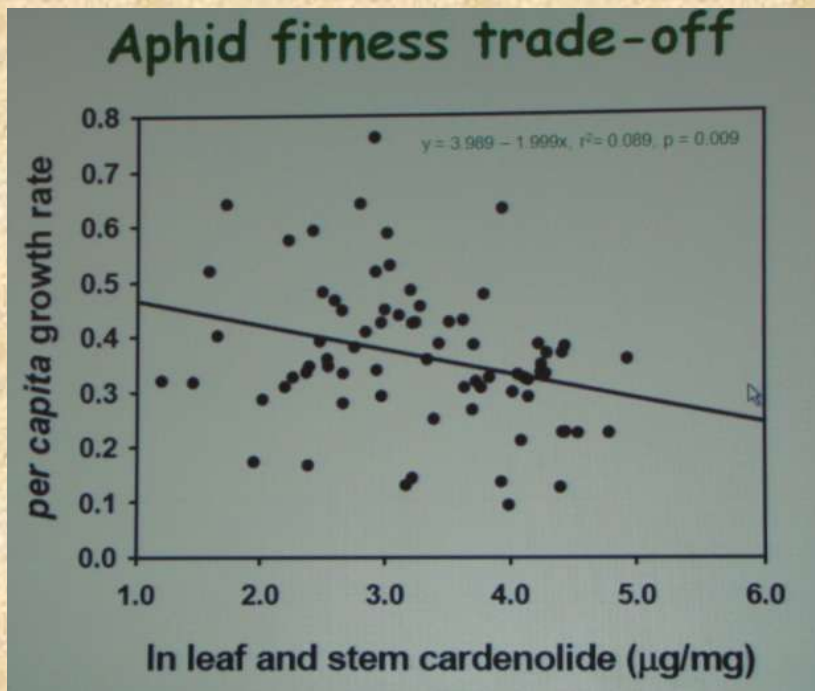


Functional response

- Typ 4

- Type IV

– lethal plant defence paradox



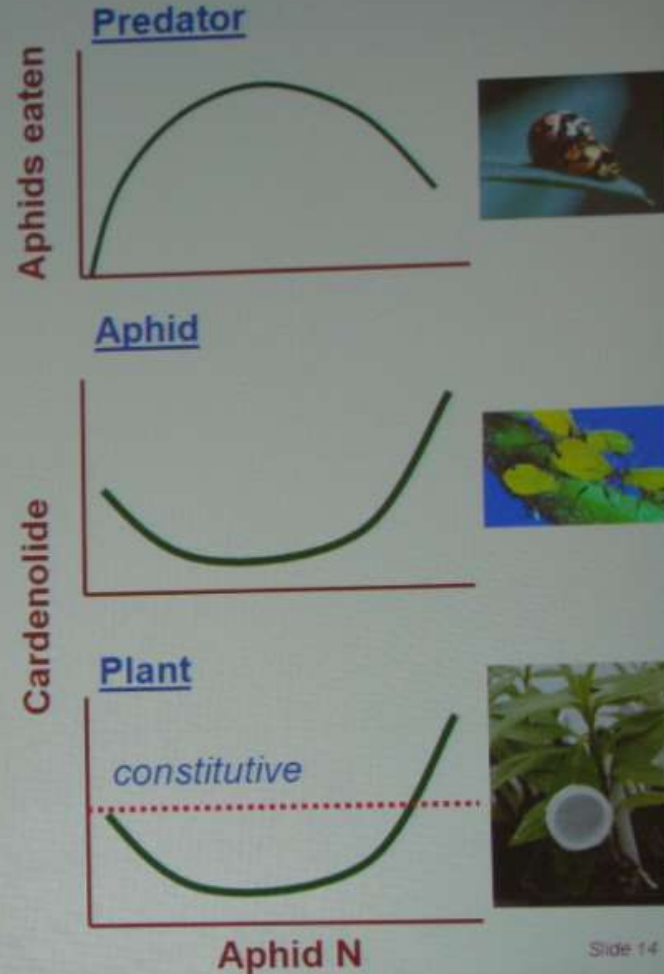
Functional response

- Typ 4

- Type IV

Conclusions:

- Density-dependent cardenolide reduction and induction in hostplant by aphids.
- Density-dependent sequestration of host cardenolides by aphids.
- Aphid fitness cost of CG.
- Density-dependent aphid defence generates a depressed and domed, or type 4 functional response in a predator.



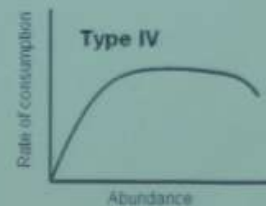
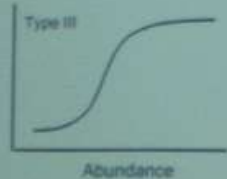
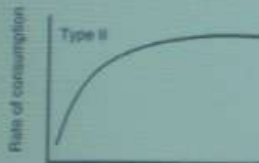
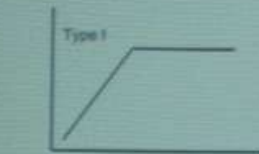
Functional response

- Typ 4

- Type IV

Funkční odpověď (FO)

→ závislost počtu atakované kořisti jedním predátorem
na populační hustotě kořisti



- 3 základní typy
- 4. typ Holling pouze teoreticky předpokládal, dodnes pozorován pouze v několika případech, málo prozkoumaný



Functional response

- Typ 4

- Type IV

