Functional response

In ecology is the intake rate of a consumer (i.e. predator) as a function of food density (amount of food available in a given ecotope (i.e. host, prey, pests)

1. Functional response helps assessing the potential of a biological control agent in pest management (Ferna´ndez-Arhex and Corley 2003).

2. This is important to know because the number of eaten preys is the basis to the development, survival and reproduction of predators and parasitoids (Oaten and Murdoch 1975).

3. Functional responses can provide significant information regarding the voracity of a bio-control agent (predator) on the food-finding efficiency i.e. hosts and prey (Fathipour et al. 2018; Chaco´n-Herna´ndez et al. 2019).

Equation for Functional response:

$Na/N0$= exp $(p0+p1N0+ p2 N02+p3N03)/1+\exp(p0+p1N0+ p2 N02+p3N03)$

- Whereas, Na = number of eaten preys, No = number of offered preys
- *P1* stand for linear, *P2* for quadratic *P3* for cubic coefficients and *P0* is intercept
- These coefficients were estimated by the maximum likelihood (like and dislike) of predator to prey.

Functional response types: I, II & III

- **Type I:** not significance means the environment does not change in favor of one species.
- There is a linear relation between prey density and the maximum number of prey killed.

1. prey population finds ample food at all times
2. Predators have limitless appetite

Type II: Significantly negative means proportion of prey consumed declines monotonically with its initial prey density provided.

- For example with Chrysoperla predator and pest, as the number of pest increases while *Chrysoperla* predator constant, the number of pest kills increases and then levels off (equal).

Type III: prey proportion fed is proportional to the density of prey provided (Juliano, 2001).

- It is similar to type II, proportion of the prey consumed is positively density-dependent over some regions of prey density.

A functional response models help to evaluate two vital parameters:

- **Handling time:** the time needed to attack, consume, and digest the prey.
- **Attack rate or searching efficiency:** the rate at which a predator searches for finding its prey.

1. Many predators released as biocontrol agents have shown to exhibit a type II response on their prey (Xiao and Fadamiro, 2010).
2. Predators with higher Attack rate /searching efficiency (*a*) and lower handling time (T_h) are better agents. Predators exhibiting the type III response are efficient biocontrol agents;

- Predator *C. carnea* (Neuroptera) on *M. persicae* (Homoptera). The interaction between *C. carnea* and *M. persicae*, without any green peach aphid food modifies the type of functional response as green lacewing presents a type II response when feeding on the green peach aphid.

Functional Response Parameters of Some Important Predators Examples

Species	Prey	Prey stages	References
Amblyseius swirskii (*mite*) Type-II	*Tetranychus urticae*	Egg+larvae	Maleknia et al. (2015), Karimi et al. (2014)
Scolothrips longicornis (Thysanoptera) Type-II	*T. urticae* *T. viennensisae*	Egg+nymph	Pakyari et al. (2009), Farazmand et al. (2013)
Stethorus Gilvifrons (coleoptera)Type-III & II	*T. Urticae* *T. turkestani*	Eggs+ Nymph+larvae	Mehrkhou et al. (2006), Karami and Shishehbor (2012)
weaver ant, *Oecophylla longinoda* (Hymenoptera) Type-I &II	Lepidoptera, Hemiptera, Diptera	Larvae+nymphs+adults	Fast et al. (2015)
Paper wasp, *Polistes dominulus* (Hymenoptera)	Shield beetle (*Cassida rubiginosa*) Coleoptera	Larvae	Schenk and Bacher (2002)

Species	Prey	Prey stages	References
Rhynocoris longifrons (Hemiptera) Type-II	*Dysdercus cingulatus* (Pyrrhocoridae), *Phenacoccus solenopsis* (Pseudococcidae) *Aphis gossypii* (Aphididae)	Nymph Nymph+adult Nymph+adult	Sahayaraj et al. (2012)
Rhynocoris marginatus (Heteroptera) Type-II	*Spodoptera litura* (Lepidoptera)	Larvae	Ambrose and Claver (1996)
Earwig, *Doru lineare* (Dermaptera) Type-II	*Spodoptera frugiperda* (Lepidoptera)	Larvae	Sueldo et al. (2010)
Ringlegged earwig,*Euborellia annulipes* (Dermaptera) Type-II	Diamondback moth *Plutella xylostella* (Lepidoptera)	Larvae+pupae	Nunes et al. (2018)
Dragonfly *Tetragoneuria cynosura* (Odonata) Type-II	Midges	Larvae	Crowley and Martin (1989)