BIOLOGY AND IMPACT OF PREDATORS

Notes

I. Definitions of Predator and Prey

A. Predator: An animal that feeds upon other animals (prey) that are either smaller or weaker than itself
B. Prey: Those animals fed upon by predators

II. Characteristics of Predators

A. An immature predator will consume a number of prey in the process of completing development to the adult stage.
B. The predator is free living in all life stages except the egg.
C. The eggs are usually laid in the vicinity of the prey.
D. Upon hatching from the egg, predator nymphs or larvae actively seek out, capture, kill, and consume prey.
E. Many predators are carnivorous in both the immature and adult stages (but there are exceptions [e.g., syrphid flies]).

III. Feeding Habits

A. Predators may be categorized based on feeding mechanisms:

1. Those with chewing mouth parts which simply chew up and swallow their victims. This includes ladybugs, ground beetles and preying mantis; and
2. Those with piercing-sucking mouthparts which stick the mouthpart into the prey and suck out the body contents. These predators often have powerful toxins and digestive enzymes that immobilize the prey. This group includes the assassin bugs, lacewing larvae, and syrphid larvae.

B. Predators may be grouped with respect to host range:

1. Monophagous: those species that are highly restricted in their host range. Sometimes limited to one species of prey (e.g., the vedalia beetle);
2. Oligophagous: those species with a somewhat restricted host range. Limited to a few species (e.g., aphid-feeding coccinellids and syrphids);
3. Polyphagous: those species with a broad host range (e.g., green lacewing, preying mantis).

C. Predators may be grouped with respect to the stage of prey attacked which can either be egg, larval (or nymphal), pupal, adult, or a combination of these.

IV. Orders of Insecta which include Predators:

A. All orders include predators except for the Protura, Embioptera, Zoraptera, Isoptera, Mallophaga, Anoplura, Homoptera, and Siphonaptera.
B. List of orders including predators is provided in handout along with the predatory stage (immature and/or adult) and prey attacked (from Hagen *et al.* 1976). The list is provided for your information only.

Notes

V. Predatory Araneae and Acari

A. Research conducted on effectiveness of spiders as predators is limited. However, many studies indicate that spiders have not adapted to the fluctuations in the numbers of specific pest species. They are considered a stabilizing influence on the invertebrate community due to their shifts from one prey species to another when the prey are numerous. Recent work by Cerruti R. R. Hooks, University of Hawaii at Manoa, indicates that the spider, mostly *Nesticodes* (=*Theridion*) *rufipes* (Araneae: Theridiidae), may be contributing substantially to the control of lepidopterous pests within the broccoli habitat.

B. The most attention has been given to the phytoseiid mites as predators of tetranychid mites. This attention has only been during the last 30 years. Because of their relatively small size they can survive on low populations of prey and thus have the potential to regulate spider mites at low densities. Some of the well known phytoseiids include *Phytoseiulus persimilis* and *Amblyseius fallacis*. The predator *Phytoseiulus macropilus* may be found in Hawaii's papaya plantings where it preys upon the carmine spider mites, *Tetranychus cinnabarinus*, on the foliage.

VI. Biological aspects of predatory insects

A. Life stages

1. Eggs - diversity of eggs carries more genotypic characteristics than the phenotypic adaptive modifications found among parasitic insects
2. Nymphs or larvae - body parts are modified compared with phytophagous cousins. Mouthparts may be held horizontally, anterior legs may be more raptorial, or smeared with resin for capturing prey. Internally the alimentary tract may be longer and the salivary glands may produce alkaline secretions for injection into prey to cause paralysis. In some the mouthparts have evolved into effective tools for sucking out body juices.
3. Adults - in the holometabolous predators the mouthparts may be similar in both the larvae and adults, but usually they are quite different (e.g., syrphid flies).

B. Phenology

1. Diapause
2. Thermal thresholds

C. Relationships of Predators to Prey

1. Searching ability - Predators respond to a sequence of environmental cues to locate prey.

   a. Habitat selection
   b. Prey finding
   c. Prey acceptance
   d. Prey Suitability

Notes

2. Most adult stage predators require a *minimum* number of prey to produce eggs and oviposit. A minimum number must be consumed by immature stages to provide energy for maintenance, searching, growth and development. Number of prey required depends upon:

   a. Size of predator
   b. Extent of its searching and other energy consuming activities
   c. Size and nutritional quality of prey

3. Ease with which prey can be found depends on:

   a. Predator's searching efficiency
   b. Prey's population size
   c. Prey's spatial distribution
   d. Obstructions in habitat (e.g., plant hairs)

4. Ovipositional sites and predatory stages

   a. Eggs deposited in immediate vicinity of prey

      i. Immature stages only are predatory aculeate
         · Hymenoptera (i.e., Sphecidae); Diptera: Cecidomyiidae, Syrphidae
      ii. Immature and adult stages are predatory on similar types of prey (e.g., Neuroptera: Chrysopidae, Hemerobiidae, Coniopterygidae; Thysanoptera; Coleoptera: Coccinellidae)
      iii. Immature and adult stages predatory on different types of prey (e.g., Diptera: Anthomyiidae)

   b. Eggs deposited only in the general environment of the prey

      i. Immature stages only are predatory (e.g., Usually aquatic: Plecoptera, Trichoptera, some Neuroptera [i.e., Corydalidae]; Some Diptera species: Families: Culicidae, Tipulidae, Chironomidae, Tabanidae, Bombyliidae)
      ii. Immature and adult stages are predatory on different types of prey (e.g., Odonata, Diptera (Asilidae, Dolichopolidae)

   c. Eggs deposited independent of prey

      i. Immature stages only are predatory (e.g., Meloidae)
      ii. Immature and adult stages are predatory on similar types of prey (e.g., Orthoptera, Thysanura, some Hemiptera)
      iii. Immature and adult stages are predatory on different types of prey (e.g., Mantispidae & Raphidoidea)
      iv. Adult stage only is predatory (e.g., Mecoptera, Diptera & Hymenoptera [host feeding])

VII. Impact of Predators

A. Classical biological control projects

1. Only about 11% of the successful BC projects have utilized predators as the major BC agent.

Notes

2. A number of pest species have been controlled by relatively few predator species.
3. Types of pests successfully controlled by predators are usually essentially sessile, nondiapausing, non-migratory species associated with evergreen perennial plants or crops (e.g., scale insects, mealybugs, eggs of leafhoppers).
4. Attributes of successfully introduced predators include multivoltinism (nondiapausing), narrow prey specificity (monophagus or oligophagus), high searching efficiency by long-lived adults, and thermal thresholds for activity close to those of the prey.
5. Successful introduced predators include the vedalia beetle (*Rodolia cardinalis*) and *Cryptognatha nodiceps*. The latter beetle is a predator of the coconut scale.
6. Reasons for failure of introduced predators include poor climate fit between origin and release areas, lack of high prey specificity, absence of symbiotic microorganisms in certain predators or in the target release area, and lack of ecological diversity in release area (agro-ecosystems).

B. Indigenous predators agro-ecosystems

1. It is very difficult to show impact of predators in agricultural habitats due to the difficulty in isolating their action among a complex of natural control factors in field situations.
2. DeBach considered general predators "as sort of a balance wheel in the pest-natural enemy complex". They tend to feed upon whatever pest is present in abundance. Even though they don't achieve complete natural control, they slow down the rate of increase of many pests.
3. Predators are especially important in cotton where general predators often prevent damaging outbreaks of certain noctuids (e.g., beet armyworm, cabbage looper). Controlling predators include *Geocoris*, *Orius*, *Nabis*, and *Chrysopa* spp.
4. Generalist predators may feed on both pest and beneficial species. This has been referred to as “intrguild predation” (see Rosenheim 1998) in which specific predators which attack the same pest organism may also feed upon each other. In Hawaii, during the early spring months (primarily April and May), two specialist beetles, *Stethorus siphonulus* and *Oligota* sp. are associated with carmine mites on papaya. The beetles feed upon the mites, thereby suppressing them. However, if the spider *Nesticodes rufipes*, is present, it feeds on the beetles and the spider mite populations increase (Jay Rosenheim, unpublished data).

C. Augmentation of predators (see class notes on ‘Augmentation’)

1. Supplementary foods have been provided in plantings to retain, arrest, or attract predators and to increase their oviposition. Compounds used include sucrose, yeast products with sugar ("artificial honeydew), and pollen (for augmentation of predatory mite populations).
2. Inundative releases of predators include *Cryptolaemus montrouzieri* (mealybug destroyer), *Chrysopa* spp., and predatory mites such as *Phytoseiulus persimilis*. These predators may be purchased from commercial insectaries.

QUESTIONS

1. What traits characterize a predatory insect?
2. What is an oligophagus natural enemy?
3. How effective are spiders as biological control agents?
4. To which family do *Phytoseiulus persimilis* and *Amblyseius fallacis* belong.
5. What factors influence egg production and oviposition in predatory insects?
6. Describe variations in egg deposition among predators.
7. Predators usually provide the most effective biological control on what types of pests?
8. What is intraguild predation?

REFERENCES

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READING ASSIGNMENT:

Chapter 3: pp. 37; 53–63, **Van Driesche, R. G. and T. S. Bellows, Jr. 1996.** Biological control. Chapman and Hall, New York. 539 pp.