CUSO IIIème cycle romand en sciences biologiques

PLANT SURVIVAL
National Centre of Competence in Research

Conflicts of Interest in Mutualistic Interactions

Abstracts

Biological markets in mutualisms

RONALD NOE

Trading goods, services and information with conspecifics is so typical for humans that 'trading' can be mentioned in the same breath with language and bipedalism as a defining characteristic of the human species. When two individuals trade, they usually do this to the benefit of both. Biologists use an identical definition for 'cooperation'. In nature, cooperation is most often found in the form of 'mutualism' and 'symbiosis', labels that are used for interactions between individuals belonging to different species. The 'biological markets' paradigm emphasises the similarities between human trade and cooperation. Common denominators are: partner choice, competition over access to potential partners, outbidding and fluctuations in exchange ratios of the commodities under influence of changes in supply and demand. Models of cooperation cannot only borrow from economics, but also from another field within biology: the theory of sexual selection, which is de facto a theory of 'mating markets'.

Do reef fishes solve a social dilemma?

ANDREA HOHNER

The tragedy of the commons (public goods games, collective action problems, n-player prisoner's dilemmas) illustrates the conflict between individual interests and the common good. Although a group of co-operators is always better off than a group of defectors, individual contributions to a common good (that is equally shared among group members) should cease as egoists out-compete cooperative individuals. Solutions to this problem have until now only been observed in humans (strong reciprocity, indirect gains through social prestige) or humans and hymenoptera (policing).

Here we first report a social dilemma that reef fish face during interactions with fangblennies (Plagiotremus sp.), then provide evidence that some species solve the dilemma, and finally address the question how they might achieve a solution. Fangblennies feed on small pieces of tissue which they bite off their victims. Reef fishes may chase blennies for biting, and an experiment confirmed that such punishment reduces the risk of future attacks. In the field, however, this effect was due to the blenny switching to a different victim species. Hence, one individual was bearing the costs while all look-alikes benefited. While visitors that could avoid a blenny's home range did not punish bites, residents did. Most importantly, also individuals of abundant resident species punished blennies with considerable probability. Further research makes spatial substructure, a response to immediate pain and social prestige unlikely explanations for punishment. Proximate causes and cognitive abilities of blennies as alternative explanations will be discussed.

The evolutionary stability of mutualism using the example of Petunia hybrids and their pollinators

ANNA BRANDENBURG

A mutualism is a cooperation between two unrelated species in which each of the participants benefit from each other. In pollination mutualisms, a plant offers a reward in terms of pollen or nectar, whilst a pollinator carries the male gametes from one plant to the stigma of another, thereby fertilizing the plant and ensuring its reproductive success. Mutualisms frequently offer possibilities for cheaters which profit from the existing system but do not render the expected service.

During my project I would like to find out what happens if a flowering plant (*Petunia axillaris*) reduces its nectar production. Would pollinating insects (*Manduca sexta*) ignore nectarless Petunias or visit more flowers in order to satisfy their nutritional needs?

One way to obtain plants that can be used for behavioral assays is to construct a NIL (near isogenic line) which bears introgressions of *P. integrifolia* (a related species which is low in nectar contents) at nectar-specific regions of the genome. Backcrossing techniques can be used to breed these plants. Experiments with pollinators will then be conducted in the green house and in its natural environment in South America. Another way to manipulate nectar contents in plants is to extract nectar manually. This method was applied in a field experiment in the natural environment of *Petunia axillaris* this winter.

Conflicts of interest in tritrophic interactions

MAURICE W SABELIS

Ecological interactions between plants and the enemies of their enemies are often mediated by information available as blends of volatile chemical compounds. Because the information is under control of the sender and the receiver cannot check its validity from a distance, the receiver has to base its decisions on previous experiences and this creates opportunity for the sender to cheat. Hence, we expect conflicts of interest between the sender and the receiver. We will present recent evidence for plants that cheat, i.e. produce amounts of chemical information that does not reflect the number of herbivores, so that the predators fail to select plants harbouring the highest densities of their prey. We will also present evidence showing that predatory arthropods can only partly cope with this plant-generated variability by associative learning. Based on theoretical models of the evolution of chemical languages and classic predator-herbivore-plant models extended with an information-perception interphase, we predict that the emergent non-linearities in plant-predator communication have dramatic consequences for the evolutionary and ecological dynamics of tritrophic interactions.

Variable Herbivores, Variable Plants

MERIJN R KANT, MAURICE W SABELIS, MICHEL A HARING & ROBERT C SCHUURINK

Plants protect themselves against spider mites through jasmonate-(JA)-dependent, feeding-induced accumulation of compounds that interfere with herbivore reproductive success. Successful herbivores may thus either resist, or not induce such products, or any combination thereof. This may trigger an arms race between herbivore and plant. Here, we show that spider mites exhibit variability in the defense pathways they induce in their host plant, a phenomenon well known in plant pathogens, but not in herbivorous arthropods. We made use of JA-deficient def1, wild type (normal tomato plant) and 35S::Prosystemin tomatoes (Solanum lycopersicon) to identify lines of T. urticae with different 'induction' phenotypes. Def1 is a defenseless tomato mutant (cannot produce JA) while 35S::Prosystemin is a transgenic defense overexpressor plant (always produces JA). The mite lines were selected on these plants, based on traits that render them resistant or susceptible to tomato JA-defenses but also traits that cause them to be inducers or non-inducers of these defenses. We found three lines that had the same reproductive success on def1, yet one of these lines classified as susceptible. Two other lines were resistant to wt defenses although both coping with JA-defenses in a distinct way. The first type is genuinely resistant against JA-defenses given the fact that its fecundity is always high and independent of these defenses. The second type is susceptible to constitutive JA-defenses on 35S::Prosys plants, but does not induce JA-related direct or indirect defenses in wt plants, even though it causes as much damage and produces as much offspring on wt as it does on def1 tomato. We hypothesize that this between-line variation arises from frequency-dependent selection on generalist herbivores in a mosaic of environments with different selection pressures.

How insect-damaged roots attract entomopathogenic nematodes

IVAN HILTPOLD, SERGIO RASMANN & TED C J TURLINGS

Entomopathogenic nematodes are important natural enemies of soil borne insects and as such are used in many integrated pest management and biological control programs. Infective cruiser juveniles have the capacity to actively search for their host in a complex below-ground system, using chemical and vibration signals. We have found that maize roots respond to feeding by *Diabrotica virgifera virgifera* LeConte (Coleoptera: Chrysomelidae) larvae by releasing a chemical, (*E*)-β-caryophyllene. The emission of this sesquiterpene results in increased recruitment of the entomopathogenic nematode *Heterorhabditis megidis* Poinar, Jackson & Klein (Rhabditida: Heterorhabditidae). It seems that maize breeding has resulted in loss of the (*E*)-β-caryophyllene signal in some maize varieties, drastically reducing their attractiveness to *H. megidis*. Under field conditions, the infection rate of *D. v. virgifera* by *H. megidis* were found to be fivefold higher on a maize variety producing the below-ground signal than on a variety that does not. Moreover, spiking the root system of a non-producing variety with synthetic (*E*)-β-caryophyllene decreased the emergence of *D. v. virgifera* adults to less than half. Experiments that measure the diffusion of various maize volatiles show that (*E*)-β-caryophyllene is an ideal belowground signal, further supporting the notion that this compound is involved in a mutualistic interaction between plants and nematodes.