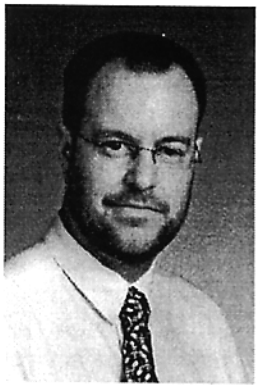
GUEST EDITORIAL



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Open Rearing of Generalist Predators: A Strategy for Improvement of Biological Pest Control in Greenhouses

Since the end of the 1980s biological pest management has been used increasingly in Germany (11). Beneficial insects are utilized in indoor ornamental and vegetable crops, and also in botanical gardens, public swimming pools and large office buildings. This development has been stimulated by the negative experience with chemical control of some pests, such as whiteflies (*Trialeurodes vaporariorum, Bemisia tabaci, B. argentifolii*), western flower thrips (*Frankliniella occidentalis*) and mealybugs (Pseudococcidae). Increasing resistance to pesticides, as well as the lack of appropriate products for certain crops, enhance the significance of biological pest management. Operator safety and ecological aspects and the negative response of many plant species and varieties to certain pesticides have contributed to the inclusion of beneficial species as an integral part of pest management. Increasing international trade has accelerated the introduction of new, partially resistant pests, as for instance the leafminers *Liriomyza trifolii* and *L. huidobrensis*. In Germany, these quarantine organisms are gaining in importance and have been increasing in distribution since 1990 (3,9). An efficient alternative is the biological control of these leafminers by the parasites *Dacnusa sibirica* and *Diglyphus isaea* (2). However, when a new pest occurs in a crop, biological pest control is completely paralyzed until an appropriate antagonist can be found and introduced. This reveals the susceptibility of the system.

In Germany we have at present 60 beneficial species for pest control in greenhouses. They can solve most of the problems in ornamental plants and vegetables. Problems arise in long-lasting cut flower production. Some pests, for instance the green rose aphid (*Rhodobium porosum*), may well adapt to the host plant and establish themselves successfully (1). Experience shows that biological aphid control is most efficient when several antagonists are used together as, for example, when the parasites *Aphidius* sp. and predators such as *Aphidoletes aphidimyza* or *Episyrphus balteatus* are combined, resulting in complete control. The aim, however, is to establish biological pest management as a system of permanent stability that does not only respond to the occurrence of pests but

also includes preventive measures. This is the underlying idea of the 'open rearing' (also termed a 'banker plant' system) increasingly included in biological pest management in Germany since the beginning of the 1990s (4,10). Cereals in pots are placed between the fills of cucumber or cut or pot flowers, or sown directly into the soil. Host-specific cereals aphids are placed onto them at an early point in time. The aphids are used to rear aphid parasites and predators which later on protect the crop. The method provides cheap and long-term multiplication of beneficial anthropods and freshly arriving pests meet established antagonists that eliminate them successfully. With open rearing starting early in the year, problems with hyperparasites are largely unknown under greenhouse conditions in Middle Europe.

A new group of beneficial flies that supports the principle of prevention has been tested in biological pest management since 1996. It includes predatory flies of the genus *Coenosia* (Diptera: Muscidae) (Fig. 1). Their body shape is very similar to that of house flies. These polyphagous predators feed on important greenhouse pests, including whiteflies (Aleurodidae), fungus gnats (Sciaridae) and leafminers (Agromyzidae), but also on leafhoppers of the genera *Eupteryx* and *Empoasca* and small dipteran species (Ephydridae, Drosophilidae) (8). The wide range of prey used as food makes them very flexible, hence especially useful. Furthermore, they are the only beneficial insects that can kill adult stages of these pests. *Coenosia* flies wait for their prey on the leaves. Upon perceiving a prey they fly up and catch it in the air with all six legs. Back to the starting point (Fig. 2), they kill the prey with the proboscis and suck it. A dagger-like tooth (formation of the discal sclerites) in the center of the mouth disc bores into the cuticula of the insect and saliva is injected into the opening (Fig. 3). This paralyzes the prey. Claw-like prestomal teeth, lateral to the labella, tear up the prey, which is then penetrated by the proboscis. The white, gelatinoid muscles are then crushed by means of the rasp-like tongue and liquified, so that they can be sucked in (5).

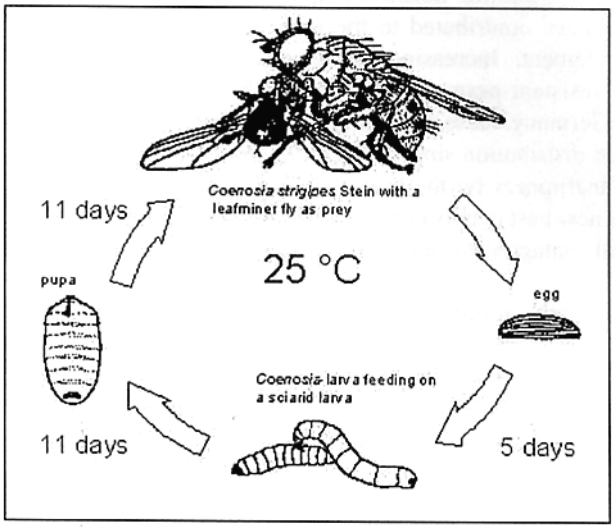

Fig. 1. Development cycle of *Coenosia strigipes* Stein.

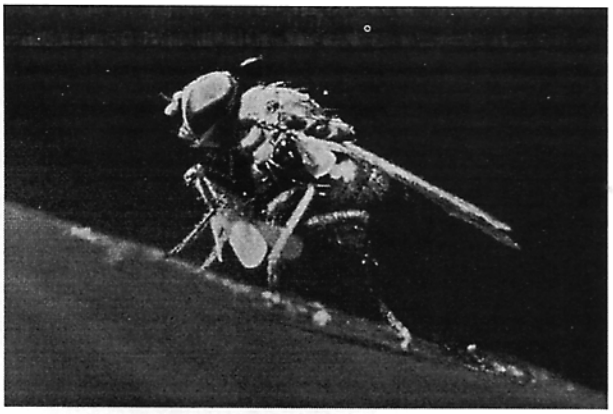

Fig. 2. *Coenosia strigipes* Stein with an adult fungus gnat as prey.

Six different *Coenosia* species occur naturally in German greenhouses, and *C. attenuata, C. humilis* and *C. strigipes* have been chosen for mass rearing. *C. attenuata* is assumed to have been introduced with young plants from southern Europe (Fig. 1). It attracted attention because *Euphorbia pulcherrima* infested with it remained nearly free from whiteflies and fungus gnats without the necessity of chemical and biological pest control measures (7). A three-step rearing method for *Coenosia* has been developed using sciarid flies (Sciaridae) as feed. The sciarid fly *Bradysia paupera* was propagated with the help of a nutrient fungus (*Fusarium* spp.) on a wood fiber substrate, a technique used for the first time.

In 1996, approximately 20,000 pupae of *C. attenuata* were first applied against the mentioned pests in ornamental and vegetable (cucumbers, tomatoes) crops on 20 ha of greenhouse area. The trials were monitored by official extension agents. The new beneficial fly was largely seen to have positive effects. In 1997, 15,000 flies of the indigenous species *C. humilis* were applied under controlled conditions. These trials did not produce the same positive effects. In 1998, *C. strigipes* will be tested in the same way. To date, the following can be stated:

- *Coenosia* can control sciarid flies and whiteflies when it propagates in the place of its use over at least one following generation.
- In contrast to that, *Coenosia* flies which are applied just once are not sufficient alone to control leafhoppers and whiteflies.
- The predatory flies were tested together with various parasites, for instance *Encarsia formosa* and *Dacnusa sibirica,* and found to be compatible (6).

An open rearing method for *Coenosia* is currently tried to allow long-term establishment of *Coenosia* flies in the place of their employment even under adverse conditions of propagation. In general it must be stated that biological pest management in greenhouses can be improved only by several measures complementing each other. Special importance is attributed to prevention by 'open rearing'. This method has to be improved in the future. New polyphagous beneficial anthropods, as for instance predatory *Coenosia* flies,

support and complement the use of more specialized species, rounding up the measures for biological pest control.

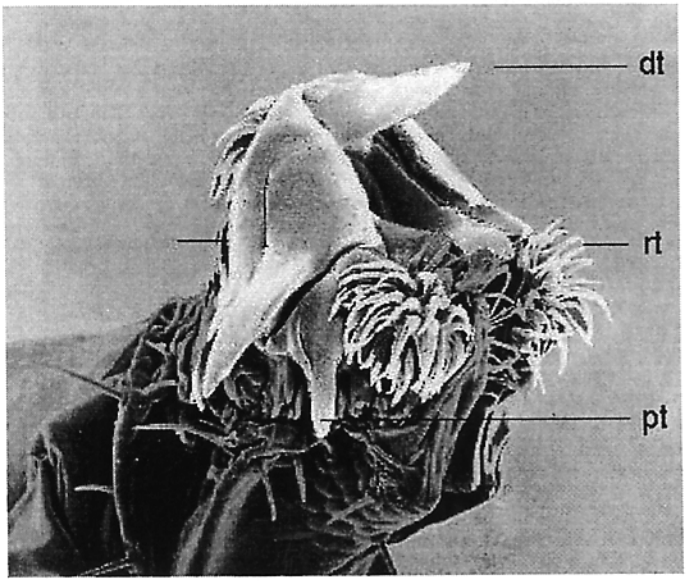

Fig. 3. Mouth disc of proboscis of *Coenosia atra* Mg.
dt dagger-like tooth
rt rasp-like tongue
pt prestomal teeth

ACKNOWLEDGMENTS

I would like to thank Mr. K. Schrameyer (Landwirtschaftsamt Heilbronn), Prof. Dr. E. Wachmann (Free University Berlin), Prof. Dr. H. Bochow (Humboldt University Berlin) and Dr. H. Bathon (BBA, Institute for Biological Control, Darmstadt) for helpful discussions and supporting me in my work.

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