IFNext Practical Tips

1. Biosecurity: Management of misplaced insects (escapes and incursions) in closed farms (version 1.0)

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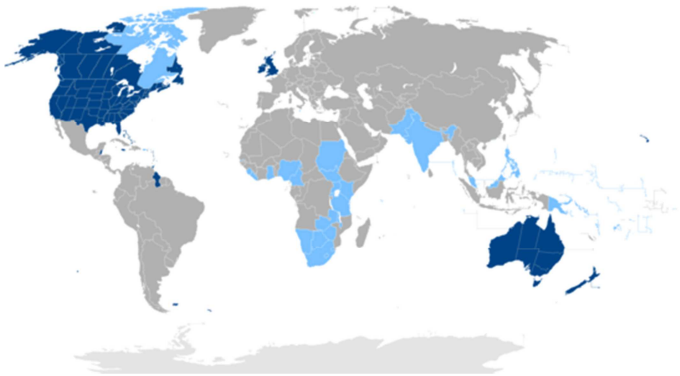

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1. Introduction

As in every animal-keeping facility, the farmer seeks to control the flow of animals into and out of the rearing installations. “Misplaced” in this sense refers to farmed insects outside their enclosures and wild insects entering the rearing facilities alike.

Some animal species may be conditioned to come back to their owners, e.g. dogs, cats, and some birds. In this way, the animal has recognized the benefits of living in human custody. Most species, however, have not mad this step and therefore, precautions must be undertaken to prevent their escape.

Escaping can never be prevented fully, regardless what lifeform escapes. This is true for zoo animals, pets, livestock, and also for productive insects (Fig. 1). However, precautions must be taken to minimize the risk and to keep the impact of the escape at a minimum.

Fig. 1: Male Jamaican flied cricket (*Gryllus assimilis*), just escaped from his box. Image by N.T. Grabowski

2. Impact of misplaced insects

The impact of escaping productive insects can be economically and/or ecologically. On one hand, escaping insects mean an economic loss, be it that some esteemed breeds or strains are lost, be it that a large amount of animals escapes. Besides, getting them back may also cause costs, let aside the payment of damages caused by the escaped insects. On the other hand, there can an ecological impact. Most of the currently-reared species are known to be pests. In fact, this habit is what recommended them to be reared in the first place. This is particularly true for locusts and mealworms, but also for crickets, which are the most common productive insects worldwide. Non-European countries have been experimenting with other pest species, e.g. weevils, fruit flies and moths and butterflies. An escape of a large number from a farm may have a significant impact on the

surroundings. My personal horror scenario is a truck full of living locusts that crashes on the road and releases thousands of them into the wild. This is why it is so important to kill the animals on the farm. If this thought is already disturbing, the situation would become even more aggravated if the reared species is not native to the rearer's country, and a neozoa problem may be created. This is why local legislation, particularly in terms of nature conservation and management of neozoa should be consulted before rearing a foreign species is attempted.

Insects entering the rearing facility must also be controlled, but incursions will be just as unavoidable as trying to keep the farmed ones inside. For vertebrate livestock, wild insects may act as vectors for pathogens and feed on the diet intended for the lifestock. A similar situation also exists when the farmed animals are insects. However, as there are more entomopathogens than pathogens for which the insects act as vectors, the risk of introducing a disease that may affect the colonies is greater than with ordinary lifestock.

3. Control measures

Managing the escape of productive insects is therefore centred on avoiding that the farmed insects leave the installations they are reared in. Of course it's best to have them in containers that fit tight. However, sealed containers do not allow a proper circulation o fair and may favour the development of moulds in the enclosure. Besides, one has to open them to feed and handle the animals, and they can escape in that occasion. This is why the escape of animals must be managed at each door that lies between the insects and the environment.

A series of measures are listed in Tab. 1. The farmer will possibly use a combination of these methods to manage the incursion and escape of animals.

Tab. 1: Measures to control the incursion and escape of animals to an insect farm

Measure	Target animals	Advantages	Disadvantages
Anti-insect lamps	Flying insects	Little labour intensive	Requires electricity
Chemical attractant taps	Fruit flies, moths, according to the model	Economic, easy to handle and to exchange	Not applicable to all pest species; also attract productive insects
Glue strips around doors (double-sided tape)	Crawling insects	Economic	Not handled that easily; visitors typically step onto the tape; frequent renewal
Hanging glue traps	Flies, moths	Economic, easy to handle and to exchange	May hamper routine work if positioned in one's way
Insect curtains for doors	All animals markedly larger than the mesh dimensions	Economic and easy to handle, depending on the model	Provides no full protection as the curtains swings open while passing; when combined with glue strips around the door, there must be a suiting distance between strips and curtains so that the curtain may not serve as a stairway
Insect screens for windows	All animals markedly larger than the mesh	Economic and easy to handle, depending on the model	Smaller instars may pass the mesh, particularly fly larvae and moths

	dimensions		caterpillars that squeeze through
Manual catching (hands, containers, fly swats, vacuum cleaners, brooms)	Operator's choice	Good for catching a specific insect type	Very labour intensive; when using a vacuum cleaner, ensure to kill the animals by freezing
Predatory arthropods (mantises, spiders)	According the prey preferences of the predator	Little labour intensive	Animal welfare regulation, possible neozoa; ensure to prevent the escape of the predator
Traps for rodents	Rodents	Effective	Observe animal welfare regulations; do not use any poisons!

Although definitely a method to enhance one's reflexes and touch delicacy, **catching the animals by hand** is time-consuming when larger amounts of insects have escaped. Sweeping them together with a large broom and collecting them in a dustpan with a long handle that closes when lifted is helpful when crawling insects are to be recovered. Valuable specimens can be collected in containers, also from furniture, walls, or from the ground.

Using a **vacuum cleaner** may be an efficient method if insects hide in poorly accessible areas, e.g. on the ceiling, high walls, in corners or below furniture. However, one must aware that many models are strong, and insect may be hurt or even killed. If the individuals are to be caught and returned to their containers, a model with less power should be used, e.g. a hand-held model. However, their power also varies with the model, and shop clerks should be consulted. If the insects are to be destroyed anyway, the vacuum clear bag should be placed in the freezer right after usage to avoid any suffering.

Glue traps or anti-insect lamps do not discriminate between farm stock and entering pest species, even if they are sold as being specific to some insect type (Fig. 2 and 3).

Fig. 2: Commercial insect trap specific for pyralid flour moths; apart from the target species, it catches several others including black soldier flies reared in the facility. Image by N.T. Grabowski

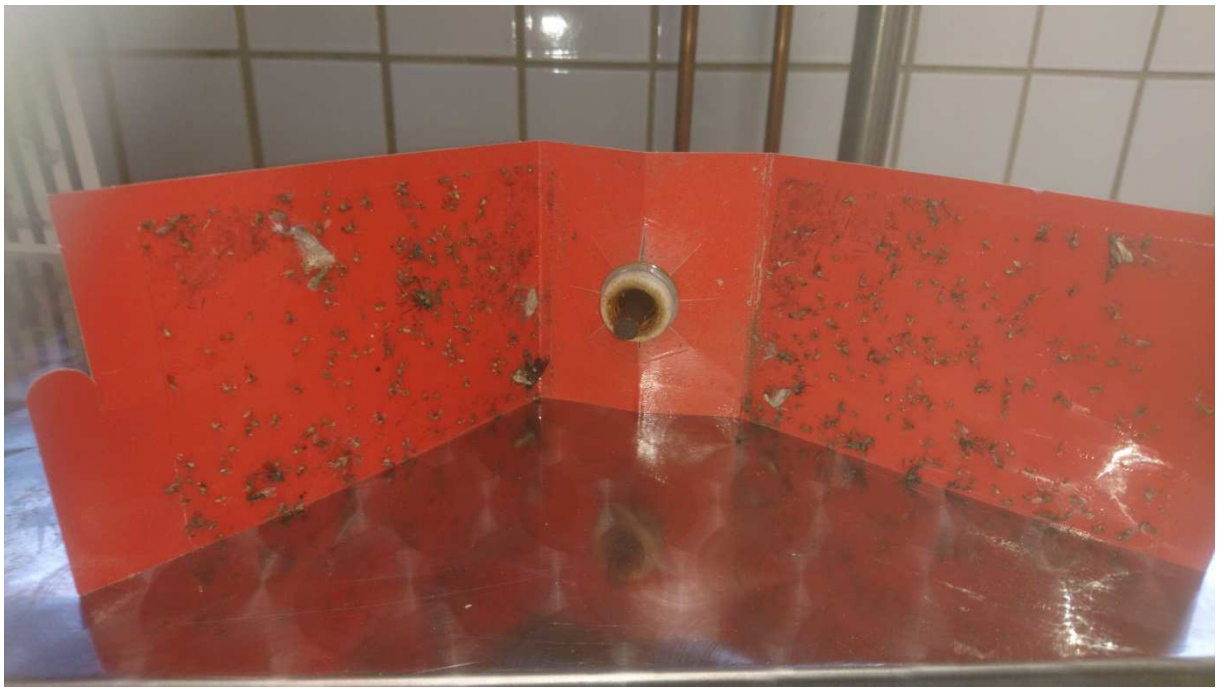

Fig. 3: Commercial insect trap specific for fruit flies (opened); apart from the target species, it catches several others (e.g. flour moths) including black soldier flies reared in the facility. Image by N.T. Grabowski

Anti-insect lamps attract the animals because of their light, electrocuting them when they touch the wires. This can be effective to control larger or constant escapes resp. incursions (Fig. 4), but the animal welfare issue will have to be dealt with in the future.

Fig. 3: Escaped black soldier flies trapped in an anti-insect lamp. Image by N.T. Grabowski

Arthropod **predators** seem an interesting option to control insects. Local spider species will find their way into the farm anyway. Where there are species that also represent a health risk to the operators

(spiders, scorpions, centipedes etc.), these animals should be eliminated. Vertebrate predators such as reptiles, amphibians or birds must be controlled so that they do not have free access to the farmed insects that are kept in their containers. Somewhat "fancy" is rearing arthropod predators in the rooms where insect rearing containers are kept, so that they can take of escapees or undesired free-ranging insects, e.g. mantises (Fig. 5). In the future, this practice may be debated in terms of animal welfare[1]. In any way, rearing predatory insects on misplaced insects and selling them afterwards may be another income for the insect farmer. However, extreme care must be taken that these predators do not enter the production and processing cycles of the farmed insects.

Fig. 4: Giant Indian mantis (*Hierodula membranacea*) housed in the rearing room to control misplaced insects. Image by N.T. Grabowski

Apart from actively catching the insects, measures to prevent them to leave or enter a building are mandatory. **Insect screens** in front of windows and doors keep many animals where they are supposed to be, although there is no complete guarantee. **Nets** covering enclosures like containers should also be checked critically and periodically. On one hand, many larvae, moreover soft-bodied ones as fly larvae or moth caterpillars may squeeze through meshes that would retain the harder-bodied instars. We tried to establish a colony of wax moths (*Galleria mellonella*) but were confronted with a high degree of escapes, even through the tiniest holes and the ordinary insect meshes. After using a metal mesh and keeping the rearing box in another box that could be sealed tightly, we decided to discontinue this species.

On the other hand, farming insect may simply chew holes in the mesh and escape this way. We have observed this in crickets and wax moths.

Finally, escaped insects may leave a building by simply clinging to the staff's clothes. Therefore, a close check before leaving the room is a good practice. Special clothes used for working inside the installation (overalls, lab coats, caps, etc.) that remain inside the facility also help reducing this risk.

Not mentioned in Tab. 1, the use of **insecticides** is decidedly discouraged in routine management practices. Neither are they selective, nor can it be excluded that the insecticides remain the harvested insects, posing thus a risk for the product quality. The only use we can see is to decontaminate a room that is not destined for insect rearing.

[1] On one hand, insects preying on other insects display a natural behaviour, and pet owners rearing these animals naturally feed the insects to the predators, particularly the common feed insects which basically are also edible for humans. On the other hand, some animal welfare legislations forbid to "chivy" one animal onto the other. This is, of course, focused on vertebrate animals and refers to dog fights or cockfights, but may be extrapolated to invertebrates.

4. Conclusion

As with other life forms, a total control of specimens is impossible and cannot be guaranteed. But there are ways to reduce the risk. In our experience, managing misplaced insects is a constant learning process of trial and error in which the best combination of methods will be found individually. As with other biological systems, the situation regarding misplaced insects will change over the time, making it necessary to constantly re-evaluate and adapt the measures.