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Does it really work? 25 years biological control in Germany

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Stored-product protection, museum environments as well as protection of materials are growing fields of application of macro-organisms for biological control in Central Europe during the last 25 years.

Material destroying pests

Stored-product pests may destroy materials as well, either on their way to pupation sites or because the materials contain ingredients suitable for development. This initiated the interest in biological control of these pests in museums and other environments with cultural heritage items, as well as research in specific natural enemies of museum pests.

Spider beetles are mainly scavengers feeding equally on plant or animal materials. Beside their natural habitats, a number of species infest historic houses feeding on organic insulation materials and become a nuisance in residences (Howe, 1959). Moreover, spider beetles were found to infest historic books and herbaria (Gamalie, 2006). A number of spider beetle species were found to be suitable hosts for the larval parasitoid *Lariophagus distinguendus*, such as *Ptinus* spp. (Kaschef, 1955), *Gibbium psylloides* (Czenpinski, 1778) (Kaschef, 1961) and *Niptus hololeucus* (Faldermann, 1835) (Schöller and Prozell, 2011). Spider beetles are difficult to control in houses because the larvae develop hidden within walls and in dead floors, and no monitoring devices are available. In recent years, *L. distinguendus* was released against the hump beetle *G. psylloides* and the golden spider beetle *N. hololeucus* in Germany by pest control companies and became a regularly applied control technique (Kassel, 2008).

Larder beetles (Dermestidae) are among the cultural heritage pests most difficult to control by chemical means. Two approaches for biological control were tested so far, the control by a parasitoid naturally occurring in houses, and the control by a generalist predator transferred from the stored-product environment. The parasitoid *Laelius pedatus* (Say, 1836) (Hymenoptera: Bethylidae) is a gregarious ectoparasitoid of several larder beetle species including *A. verbasci* and *T. angustum*. The shiny black wasps measure 2 to 3 mm in length. During its life span a female wasp paralysed 74 ± 20 larvae of *A. verbasci* (Al-Kirshi, 1998). The average number of eggs per female wasp and day was 1.42 ± 0.2 if larvae of *T. angustum* were used as host. Most egg-laying activity was observed at temperatures between 25° and 28°C, while no oviposition occurs at 15°C. A mated female lives 6 to 8 weeks at room temperature (Al-Kirshi 1998). This parasitoid is occuring spontaneously in Central Europe in buildings, but there are not studies on the biological control potential of laboratory-reared wasps in field trials.

Stored product pests

Biological control in stored products is commercialized since 1998. Most applications were against stored-product moths in bakeries, food processing industries, retail trade and private households, and against weevils in grain on farms. Fifty percent of the types of application are control of pyralid stored-product moths. The reasons for this might be the fact that biological control of pyralids was the first commercialized application and is best known in the public, and/or the fact that *Trichogramma* spp. are hardly visible under practical conditions due to their small size. The adults of these egg-parasitoids are 0.3 mm long. They lay their eggs into lepidopteran eggs, preferring freshly-laid eggs. Upon hatching, the wasp larva consumes the content of the egg. It pupates inside the egg and emerges as an adult wasp. Adult wasps mate shortly after emergence. A female wasp will parasitize approximately 50 eggs in her life-span of 3 to 14 days. While foraging for moth eggs, the females are usually walking. Typically parasitized eggs fixed to a card are applied (Prozell & Schöller, 2003). These cards are placed on shelves and palettes. The cards can be stored at 8 to 12°C in the dark for seven days.

Habrobracon hebetor is a cosmopolitan idiobiont gregarious ectoparasitoid. It develops on larvae of many Lepidoptera, mainly members of the family Pyralidae (Schöller, 1998). Actually the number of hosts even increased, but this is probably due to the presence of different strains in fields and warehouses (Heimpel et al., 1997). Today, *H. hebetor* is recommended for biological control and it has been studied from the biological and demographical point of view (Eliopoulos and Stathas, 2008; Akinkurolere et al., 2009).

Anisopteromalus calandrae is one of the most frequently found parasitoids in stored grain, and it is widely distributed. It has been reported as natural enemy of the following pests: *S. granarius*, *S. zeamais*, *Rhyzopertha dominica* (F.), *Stegobium paniceum* (L.), *L. serricorne*, *A. obtectus* (Say), and *Callosobruchus maculatus* (F.) (Williams and Floyd, 1971; Arbogast and Mullen, 1990; Ngamo et al., 2007). *A. calandrae* is a primary, idiobiont ectoparasitoid attacking the late larval stages and early pupae of beetles inside seeds and cocoons (Shin et al., 1994).

Lariophagus distinguendus has been reported as potential agent for biological control for a wide number of beetles that infest stored agricultural products (Steidle and Schöller, 1997): *S. oryzae* (Lucas and Riudavest, 2002), *S. granarius* (Steidle and Schöller, 2002), (Wen and Brower, 1994), *R. dominica* (Menon et al., 2002), *L. serricorne*, *S. paniceum* and *A. obtectus*. It is a solitary ectoparasitoid of larvae and prepupae.

In the meantime biological control was adopted by the conventional sector after its start in the organic market. Moreover, many pest control operators are using natural enemies. On the one hand, customers are demanding pesticide-free solutions and products, on the other hand the evaluation of non-chemical alternatives prior to the application of synthetic insecticides is regulated by law.

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Storage of Mungbean in Hermetic PVC Tank

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Abstract

This research was carried out to evaluate the effect of hermetic storage on quality of mungbean. About 260 kg of mungbean samples were stored in an especially design 350 L capacity hermetic PVC tanks (hermetic tank) and non-hermetic PVC tanks (control tank). Hermetic PVC tanks were closed air-tightly. All tanks were randomly placed in a warehouse. Each hermetic and control PVC tanks were artificially infested by 50 unsexed *Callosobruchus chinensis* kept in 4 glass jars containing 100 g of mungbean and jars were dipped in four different depths. The gas concentrations in the tanks were monitored up to 6 months intervals. Percentages of germination, moisture content, and grain damage were evaluated at the end of the storage. The oxygen content of hermetic samples was dropped to 11±1.2% and carbon dioxide content was increased up to 7±0.7% within 6 months of storage. Live insects of *C. chinensis* were not found in hermetic samples after 6 months but abundant population of *C. chinensis* was found in the control PVC tank just after one month. After 6 months, germination percentage of the mungbean samples stored in hermetic tanks had decreased from 95±3% to 82±4%, whereas it was decreased from 95±3% to 47±7% in control tanks due to grain damage. Percent grain damage of the hermetic sample was only 4.5±1% compared to the heavy insect damage of the control samples. Moisture content of hermetic samples remained unchanged compare to the control.

Keywords: Hermetic storgae, PVC tank, Mungbean, *Callosobruchus chinensis*