Candidate natural enemies for control of 
_Rhizoglyphus robini_ Claparède (Acari: Astigmata) in lily bulbs: exploration in the field 
and pre-selection in the laboratory

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ABSTRACT

To find suitable candidates for biological control of the bulb mite, _Rhizoglyphus robini_ Claparède (Acari: Astigmata) on lilies, exploration was undertaken in areas where the bulb mite is an established pest (The Netherlands, Taiwan and Japan). Among the predators, found in association with _R. robini_ in the field and under storage conditions, mesostigmatic mites predominate. The most abundant species were *Hypoaspis aculeifer* (Canestrini), *Lasioseius bispinosus* Evans and *Parasitus fimetorum* (Berlese). These predators appeared to feed and reproduce on a diet of exclusively _R. robini_ and they were able to control the bulb mite in small-scale population experiments initiated with a 1:20 predator-prey ratio. Under laboratory conditions corresponding to lily bulb propagation (lily scales mixed with vermiculite and stored at 23°C and > 90% RH) the laelapid mite, *H. aculeifer*, was the most effective predator; the ascid predator, _L. bispinosus_, was much less effective, but being relatively small and being successful in attacking the juvenile stages of the bulb mite it may be better able to search for bulb mites hidden inside the lily bulb. The parasitid predator, *P. fimetorum*, failed to control the bulb mite when vermiculite was used as a medium, but turned out to suppress this prey when peat was used instead. Various strains of _H. aculeifer_ or closely related species were compared with respect to their impact and performance on bulb mites as prey: two Dutch strains, one obtained from Breezand and the other from 't Zand, a Taiwanese strain, a German strain that in contrast to the previously mentioned strains was not collected from lily bulbs, but from agricultural areas near Bremen and, in addition, a Canadian strain of a related species (_Hypoaspis miles_ Berlese), known to control sciarid fly larvae. These comparative experiments showed that _H. miles_ died out without noticeable impact on the bulb mite population whereas all strains of _H. aculeifer_ were able to suppress the bulb mites to very low numbers. However, the numerical responses of the _H. aculeifer_ strains differed in that those collected in association with the pest (Breezand > Taiwan > 't Zand) were superior to the strain from Bremen. These results do not provide support to the Hokkanen and Pimentel hypothesis, which states that predators forming an evolutionary new association with the pest are often more effective in biological control.

Key words: Biological control, predator-prey interaction, _Rhizoglyphus robini_, _Tyrophagus putrescentiae_, _Hypoaspis aculeifer_, _Lasioseius bispinosus_, _Parasitus fimetorum_, lily bulbs.
INTRODUCTION

Developing a method of biological pest control involves exploration for potential natural enemies and selection of suitable candidates (Luck et al., 1988). Exploration usually results in a large number of species and strains of natural enemies found in association with the pest organisms. As it is not possible to test them all under practical conditions and at a practically relevant spatial scale, there is a need for pre-selection of suitable candidates, based on simple small-scale experiments in the laboratory.

In this article we report on the results of exploration for mesostigmatic predators found in association with the bulb mite, *Rhizoglyphus robini* Claparède (Acari: Astigmata), an important pest of lily bulbs in The Netherlands as in many other countries. As the co-occurrence of predator and prey does not necessarily imply a predator-prey association, at first simple feeding tests were carried out with *R. robini* as the only prey. Simultaneously with the observations to assess feeding events, oviposition was recorded since mesostigmatic predators utilize much of the food ingested for egg production. If these tests had positive results, then the species were subjected to further investigation in small-scale population experiments carried out on lily bulbs in closed vials under laboratory conditions.

Exploration for predators could be carried out under natural conditions on wild lilies and under conditions of lily bulb cultivation. However, exploring wild lilies is subject to severe constraints. Wild lilies are scattered over large areas in East Asia and they are not easy to find unless in a flowering stage and infested lily bulbs are even more difficult to find. Moreover, the sample size is limited due to regulations for protected plants. Hence, given time constraints for each foreign exploration trip (approximately 2 weeks) it seemed wise not to focus on sampling wild lilies.

Hence, exploration was concentrated on cultivated lily bulbs. Four phases of cultivation should be investigated: growth in the field for bulb production, growth in the greenhouse for flower production, bulb propagation in storage rooms (at 22–23°C) and cold storage (at 0 to −2°C). Each of these phases differs with respect to climatic conditions and in the likelihood of predators developing an association with bulb mites. To maximize the probability of finding predators associated with bulb mites we decided to direct exploration primarily to fields where lily bulbs are cultivated and to inspect plants infested by bulb mites for the presence of predators. The other cultivation phases are less likely to provide success in exploration because treatments preceding the greenhouse phase (soil steaming) and the propagation phase (hot water treatment of bulbs at 39–41°C for 2 h and pesticide applications) virtually preclude survival of the predators and cold storage conditions are simply not conducive to predatory activity.

As lily bulbs are grown world-wide, it seemed worthwhile undertaking foreign exploration in addition to exploration in The Netherlands. We selected countries and sampling areas that satisfied the following criteria: (1) evidence of the