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Short communication

Laboratory screening of potential predators of the poultry red mite (*Dermanyssus gallinae*) and assessment of *Hypoaspis miles* performance under varying biotic and abiotic conditions

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ABSTRACT

The poultry red mite, *Dermanyssus gallinae* (De Geer), is the most important ectoparasitic pest of layer hens worldwide and difficult to control through 'conventional' synthetic acaricides. The present study aimed to identify a suitable predator of *D. gallinae* that could potentially form the basis of biological control in commercial poultry systems. From four selected predatory mite species (*Hypoaspis miles* (Berlese), *Hypoaspis aculeifer* (Canestrini), *Amblyseius degenerans* (Berlese) and *Phytoseiulus persimilis* (Athias-Henriot)), *Hypoaspis* mites demonstrated the greatest potential as predators of *D. gallinae*. Experiments were also conducted to assess the effect of environmental (temperature and dust), physical (presence of harbourages) and biological (presence of alternative prey) factors on the predatory efficacy of *H. miles*. Predation of *D. gallinae per se* was observed under all conditions tested, though was found to be temperature-dependant and reduced by the presence of alternative prey.

1. Introduction

The poultry red mite, *Dermanyssus gallinae* (De Geer), is the most economically deleterious ectoparasite of laying hens in Europe (Chauve, 1998). Research has shown that in the UK up to 85% of commercial egg laying premises may be infested with *D. gallinae* (Guy et al., 2004), though global figures may be more variable (20–90%) (Sparagano et al., 2009). Higher mite populations may be seen in free range systems compared to cage units (Guy et al., 2004). This is of particular concern given that conventional cages will be prohibited in the EU from 2012 (EU Directive 99/74/EC) leading to expected increases in the proportion of hens housed in alternative systems such as free range.

Economic costs associated with both control and production losses due to *D. gallinae* have been estimated at €130 million annually for the EU egg industry (Van Emous, 2005). Where infestations are severe, *D. gallinae* may cause significant stress to hens, with resultant declines in bird condition, growth rates, egg quality and egg production (Chauve, 1998). Control of *D. gallinae* has typically been achieved by the use of synthetic contact acaricides, though the continued use of these products (at least as a 'stand-alone' solution) may be hampered by issues of mite resistance and decreasing product availability as a result of tighter legislation regarding their use (Sparagano et al., 2009).

The above in mind, it is important to identify and evaluate new approaches for management of *D. gallinae* in poultry systems. Augmentative biological control through natural enemies (of the pest) can be of great benefit in controlling crop pests, particularly in enclosed systems such

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as greenhouses where predator dispersal is limited. Whilst relatively little work has been done to assess the potential of biological control in *D. gallinae* management, the fact that hens are typically housed in at least partly enclosed systems suggests that such control might be achievable. Research suggests that suitable candidate predators may exist for use against *D. gallinae* in poultry systems. Numerous authors have reported the occurrence of the predatory mite *Cheyletus eruditus* (Schrank) in poultry houses where this species has been observed feeding on juvenile *D. gallinae* (Lesna et al., 2009). Releases of *C. eruditus* have not provided control of *D. gallinae* in experiments to date, but research has identified a further two predatory mite species, *Hypoaspis aculeifer* (Canestrini) and *Androlaelaps casalis* (Berlese), with promising *D. gallinae* management potential (Lesna et al., 2009).

The aim of the current study was to screen a selection of predators for their potential in *D. gallinae* biological control. To achieve this aim experiments considered both predation rates of different species on *D. gallinae* and the influence of environmental (temperature and dust), physical (presence of harbourages) and biological (presence of alternative prey) factors on *D. gallinae* predation by the most promising biological control candidate, *Hypoaspis miles* (Berlese). To ensure that any positive results could be rapidly translated into commercial practice, only commercially available predators were selected for study.

2. Methods

Candidate predators were initially screened based on their biology/ecology, where only species that were likely to accept *D. gallinae* as prey in a commercial setting (*e.g.* predators of mite or 'mite-sized' pests, preferably adapted to prey searching in confined environments such as soil) were considered. Four predatory mite species (*H. miles*, *H. aculeifer*, *Amblyseius degenerans* (Berlese) and *Phytoseiulus persimilis* (Athias-Henriot)) were selected for study and all obtained from Biobest (Belgium). *D. gallinae* were collected from a free-range poultry unit in Northumberland (UK) and stored at 22 °C in ventilated containers for no more than 5 days prior to use.

In order to assess their biological control potential, two predators of each species were placed in separate glass Petri-dishes, using separate dishes for each species (48 mm diameter × 12 mm height, Fisher Scientific, UK) along with ten adult *D. gallinae* (or 5–6 adult *D. gallinae* in the case of dishes containing *P. persimilis*). A control consisting of ten *D. gallinae* only (or 4–6 adult *D. gallinae* in the case of dishes containing *P. persimilis*) was paired to each 'treatment' dish and used to determine natural pest mortality. Dishes were sealed using a thin plastic film and humidity within them maintained at 80–90% RH with the addition of moistened tissue paper. All dishes were left for 48 h at 22 °C in complete darkness before mortality of *D. gallinae* was assessed under magnification. *D. gallinae* were deemed to be deceased if they exhibited no movement following agitation with an entomological pin. For each of the treatments a total of ten replicates were done, with the exception of the *P. persimilis* treatment which contained six replicates. Predation of *D. gallinae* under each treatment was expressed as the corrected % mortality (Abbott, 1925).

In order to assess the effect of environmental, physical and biological parameters on the potential of *D. gallinae* biological control by *H. miles* the same methodology was used, but with a 24 h exposure period (unless otherwise stated) and eight replicates per treatment. The effect of dust levels on predation efficacy was assessed by comparing predation under a high dust treatment (18 mg dust per dish, previously determined to represent a relatively dusty free-range facility (George et al., 2010a)) to that under a control treatment (no added dust). Dust used was obtained from the same poultry unit as *D. gallinae* and sieved to pass 5 mm before use to remove impurities. Three treatments were used to assess the effect of temperature (15, 22 and 28 °C) on predation efficacy. The effect of harbourage was assessed by comparing predation with harbourages present to that without them. Harbourages consisted of a small section (15 mm × 20 mm) of corrugated black plastic, previously found to offer suitable refuge for *D. gallinae* (George et al., 2010b). Finally, the effect of alternative food was assessed by comparing predation with and without alternative food present (with a 48 h exposure period). In dishes containing alternative food, 25 mg of Biobest substrate was added (a mixture of vermiculate, peat and meal-mites used to maintain *H. miles* in transit). For all replicates, a *D. gallinae* only control was included to determine natural pest mortality and allow predation to be expressed as the corrected % mortality (Abbott, 1925). Control mortality never exceeded 17% in any individual dish.

For predator screening results, data were found to be non-normal and were subsequently analysed using a Kruskall–Wallis test (adjusted for ties) with Mann–Whitney *U* tests to determine pair-wise differences. For all other experiments (dust, temperature, harbourage and alternative food) data were found to be appropriate for parametric testing by univariate ANOVA. All analysis was run using Minitab® v. 15.

3. Results and discussion

There was a significant difference between selected test species in predatory efficacy ($H = 25.18$, $P < 0.001$) (Fig. 1).

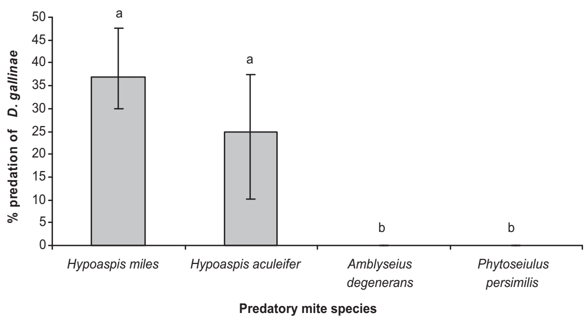

Fig. 1. Median % predation (% corrected mortality) of *Dermanyssus gallinae* by selected predatory mite species over a 48 h exposure period. Medians not sharing a common letter are significantly different ($P < 0.05$). Medians are displayed with ±inter-quartile ranges. $n = 10$ for all medians, except *Phytoseiulus persimilis* where $n = 6$.