Investigations into the molecular basis of chemically mediated interactions between the poultry red mite, *Dermanyssus gallinae* and the domesticated chicken, *Gallus gallus domesticus*

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Lay Summary

The poultry red mite (PRM), *Dermanyssus gallinae*, is a small blood-feeding parasitic arthropod that lives off hosts and infests chickens in modern poultry facilities. Due to the prevalence of PRM in poultry houses and the economic damage inflicted by infestations, PRM is viewed as the most significant blood-feeding parasite in the UK poultry industry. Despite this, relatively little is known about the interactions between PRM and its primary host of economic concern, the domesticated chicken *Gallus gallus domesticus*.

Arthropods detect and respond to chemicals through a process called chemosensation. Chemosensation is the most widespread sensory modality in arthropods and elucidating the molecular and chemical basis of PRM chemosensation could contribute significantly to understanding PRM biology and control. This BEMB Trust sponsored thesis investigated aspects of PRM chemosensing, from fundamental studies into the genes and proteins involved, to field trials testing novel formulations of kairomone blends. Kairomones are semiochemicals, emitted by an organism, which mediate interspecific interactions in a way that benefits an individual of another species which receives it and harms the emitter. This “eavesdropping” is often disadvantageous to the producer. *Wikipedia*

The sequencing of the PRM genome in 2018 presented the opportunity to investigate which genes and proteins were involved in PRM host location. This was done by identifying genes with putative chemosensory functions in closely related species and comparing them with genes in the PRM genome. However, this process can be unreliable as genes that appear similar can have different functions. In order to validate the function of putative PRM chemosensory genes and infer their biological role, differential expression analysis and RNAi mediated chemosensory gene silencing was performed.

RNA sequencing was used in this project to analyse the gene expression patterns of PRM exposed to live chickens. Results indicated that two gene families had a role in mediating the interactions between PRM and chickens: ionotropic receptors (IRs) and odorant binding proteins (OBPs). Ionotropic receptors are transmembrane ligand-gated ion channels and odorant binding proteins are transporters of odorant molecules. Whereas IRs and OBPs have been widely implicated in insect chemosensation, little information existed pertaining to the role of IRs and OBPs in mite species.

The function of *DegalOBP1* was further investigated through RNAi mediated gene silencing. The idea was to silence the *DegalOBP1* gene present in the PRM genome and observe how PRM behavior changed when confronted with chicken derived attractive extracts.

Semiochemicals are behaviour-modifying chemicals that can form a key component of integrated pest management (IPM) systems. They represent an effective, non-toxic, reliable and permanent method of control for several economically and ecologically important pests. Due to this, the effectiveness of a prototype PRM semiochemical lure was explored through field trials in UK poultry housing.

In Conclusion

The work presented in this thesis has increased understanding of the fundamental interactions between PRM and chickens, revealed novel targets for control and shed light on the unique biology of the most economically important ectoparasite affecting the UK poultry industry.