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The poultry red mite *Dermanyssus gallinae*: Developing novel management solutions for a complicated and neglected pest

David George[1,12], Robert Finn[1], Kirsty Graham[1], Monique Mul[2], Jonathan Guy[3], Christina Strube[4], Fiona Tomley[5], Pedro Hernández-Crespo[6], Tove Steenberg[7], Helena Eriksson[8], Øivind Øines[9], Gerald Coles[10], Tristan Cogan[10], Kathryn Stafford[10], Alasdair Nisbet[11], Olivier Sparagano[13]

[1]Faculty of Health and Life Sciences, Northumbria University, UK; [2]Animal Sciences Group, Wageningen UR Livestock Research, The Netherlands; [3]School of Agriculture, Newcastle University, UK; [4]Institute for Parasitology, University of Veterinary Medicine Hannover, Germany; [5]Department of Pathology and Pathogen Biology, The Royal Veterinary College, UK; [6]Department of Environmental Biology, Centro de Investigaciones Biológicas (CSIC), Spain; [7]Department of Agroecology, Aarhus University, Denmark; [8]Department of Animal Health and Antimicrobial Strategies, National Veterinary Institute, Sweden; [9]Norwegian Veterinary Institute, Norway; [10]School of Veterinary Sciences, Bristol University, UK; [11]Moredun Research Institute, UK; [12]Stockbridge Technology Centre, UK; [13]Coventry University, UK.

Corresponding author: David George [david.george@northumbria.ac.uk]

The poultry red mite *Dermanyssus gallinae* (PRM) poses a significant threat to egg-laying hens in many parts of the world, though it is particularly significant in Europe where in excess of 80% of poultry premises are infested (Fig 1). Though all domestic fowl are at risk from PRM, infestation appears most significant in laying hens where economic costs associated with control and production losses have been estimated at €130 million per year for the EU egg industry (van Emous, 2005).

As reported in a recent review (Sparagano et al., 2014), there is a relationship between PRM infestation and hen mortality, with some reports recording a ten fold increase in death rates following severe infestation. Although causal factors may vary, in extreme cases PRM numbers may be so high that hens become severely anemic, with mortality resulting from exsanguination alone. At a sublethal level, mite feeding may result in significant stress to hens, increased feed and water intake and decreased bird condition, also impacting upon production by causing declines in egg quality (through shell thinning and spotting) and egg laying. Increases in aggressive feather-pecking and cannibalistic behaviors have been reported following infestation, logically supporting the view that any proposed ban on beak-trimming should be preceeded by a concerted effort to improve prevention and control of PRM.

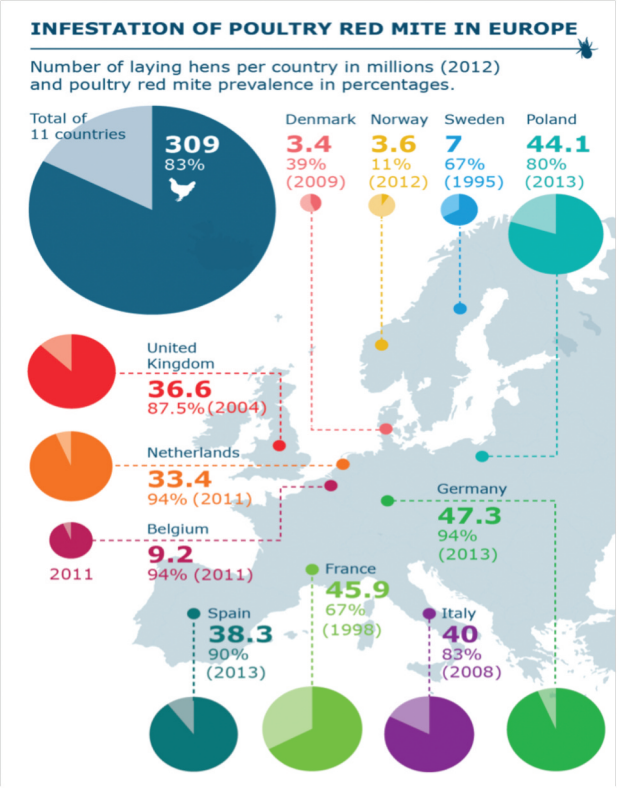

Figure 1. Infestation of PRM in poultry premises throughout Europe. Infographic supplied by Monique Mul, Wageningen UR Livestock Research.

Even relatively small mite populations may have significant impact, as PRM may serve as a disease vector for numerous pathogens including *Salmonella*, *Pasteurella*, *Listeria*, *E. coli*, *Staphylococcus*, *Streptomyces*, Newcastle disease, Fowl poxvirus, St. Louis encephalitis and various other forms of encephalitis (Valiente Moro et al., 2009). In addition to spreading disease, infestation may limit hen immunological responses to pathogens and/or vaccination strategies. Heavy infestations are reported to reduce antibody titers to some viral vaccines, or suppress host antibody production.

Though PRM have historically been regarded as avian-specific, increased reports of non-avian infestations suggest a possible wider threat to veterinary and medical health (George et al., 2013). The full significance of PRM to these sectors has yet to be fully ascertained and warrants urgent attention. This is especially true given the cosmopolitan distribution of PRM (also occurring in association with feral and synanthropic birds) and its significant potential as a vector of zoonotic disease. A recent review has confirmed an increasing incidence of PRM attacks on humans (George et al., 2013), including propensity for persistent infestation when feeding on human blood alone. Transmission of spirochetes, rickettsiae, Salmonellae, Bartonellae, Pasteurellae, Sporozoa, hemogregarines, flagellates, and filariae have all been suggested as possible through bird mites *per se*. More recent evidence supports acquisition of *Bartonella* via *Dermanyssus* spp. and links attacks to Lyme disease, *Bartonella* and/or *Babesia* (George et al., 2013).

Research concerning all aspects of PRM has increased in recent years as the need to better understand and manage this pest has begun to be recognised. Numerous groups from research and public health sectors to industries and poultry organizations throughout Europe have interests in PRM, but

Figure 2. Attendees of the 'Workshop on Red Mite Biology and Control', hosted by the British Egg Marketing Board, London, 11-12 November 2013. Attendees subsequently formed the CEN-PRM, whose membership now exceeds seventy. Picture supplied by Dr Pedro Hernandez-Crespo.

these remain highly fragmented and nationally focused. Combining the potential for research into biological control, vaccination, lighting, novel products, acaricide resistance and hazard analysis could lead to advances in IPM of PRM in the near future. This could be supported by recent and ongoing projects with a focus on mite infestation routes and population modelling. Systems to monitor PRM populations are also being developed (Mul et al., 2013) and could play a valuable role in informing treatment timings.

While theoretically a strong PRM networks exist, including the British Egg Marketing Board initiated Collaborative European Network on Poultry Red Mite (CEN-PRM; Fig 2), in practice the full potential of the transnational scientific community to contribute to PRM control remains unrealised. There is significant potential to advance and develop knowledge that will lead to innovative tools to understand, diagnose, quantify, prevent and control PRM by activating and incentivising this multidisciplinary network. This is set to be achieved in the immediate future through EU Cost Action funding via the COREMI project. This will aim to consolidate existing expertise and knowledge to gain a better understanding of PRM and the economic and societal impacts of this pest, using this information to implement more efficient and sustainable control methods. More information on the COREMI project can be accessed at http://www.cost.eu/COST_Actions/fa/Actions/FA1404

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