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Infection dynamics of *Ascaridia galli* in non-caged laying hens

Johan Höglund[a,*], Désirée S. Jansson[a,b]

[a] *Department of Biomedical Sciences and Veterinary Public Health, Swedish University of Agricultural Sciences (SLU), P.O. Box 7009, SE-750 07 Uppsala, Sweden*

[b] *Department of Animal Health and Antimicrobial Strategies, National Veterinary Institute (SVA), SE-751 89 Uppsala, Sweden*

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ABSTRACT

The infection dynamics of *Ascaridia galli* in laying hens was investigated in six commercial non-caged flocks. Three flocks were managed in accordance with the regulations for organic production and had outdoor access, whereas three flocks were housed indoors in aviaries or traditional floor systems. Faecal egg counts and total worm burdens were determined at specified intervals during the first 50 weeks of the production period. In two conventional flocks the efficacy of flubendazole on lumenal stages was investigated. All flocks became infected following the arrival of the birds (post placement) with residual infective eggs derived from the previous flock. In four flocks (two organic and two conventional) parasite eggs were first detected in faeces 6–7 weeks post placement, whereas parasite eggs were not detected until after 17–18 weeks in two flocks. This delay was observed in two of three flocks that were housed in barns that had been thoroughly cleaned and disinfected by chlorocresol. In three flocks (two conventional and one organic) flubendazole was administered to the birds in the drinking water for approximately one week. Both conventional flocks were dewormed twice approximately 20 weeks apart, whereas the organic flock was dewormed only once about 40 weeks post placement. Parasite eggs reappeared after deworming in all flocks, often within 2–4 weeks, followed by a rapid increase in parasite egg expulsion. Our results suggested impairment of host immunity post treatment, as the egg counts exceeded pre-treatment levels after 7–8 weeks on both conventional farms. Accordingly, the way by which anthelmintics and/or disinfectants are used in non-caged chicken flocks must be refined.

1. Background

The roundworm *Ascaridia galli* is a well-known nematode parasite with a worldwide distribution, which occurs in the small intestine of galliform birds of all ages (Taylor et al., 2007). The life cycle is direct and includes two principal populations, i.e., the sexually active adult parasites in the gastrointestinal tract of the host and the infective stage (L_3) contained in resistant egg in the outside environment (Anderson, 1992). The prepatent period is somewhere between 4–6 weeks in young birds and slightly longer with increasing age of the host (Anderson, 1992; Taylor et al., 2007). The eggs of *A. galli* cannot easily be distinguished from the slightly smaller eggs of the related nematode *Heterakis gallinarum* (Thienpoint et al., 1986).

In recent years, the prevalence of roundworms in Swedish laying hens has increased substantially, especially in litter-based housing systems (Jansson et al., 2010), which is clearly linked to increased exposure to parasites with a faecal–oral route of transmission (Permin et al., 1999; Jansson et al., 2010). Also, consumers and staff working in egg packing plants have repeatedly found adult *A. galli* in table eggs. The egg industry in Sweden is seriously concerned about this development. Thus, strategic deworming was recently (spring of 2009) introduced as a control option against ascarid infection in non-caged lay-

* Corresponding author. Tel.: +46 18671000; fax: +46 18309162.
E-mail address: johan.hoglund@slu.se (J. Höglund).

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Table 1
Information on flocks participating in the study.

Farm	Organic flocks			Conventional flocks		
	A	B	C	D	E	F
Housing	Aviary	Aviary	Aviary	Single-tiered floor	Single-tiered floor	Aviary
Replacement age (weeks)	16	15–16	15	15	16	14
Flock size (×1000 hens)	3	3+3	3	10	1	9
Hybrid	Hy-Line W-98	Bovans robust	LSL	Bovans robust	Hy-Line W-98	Hy-Line W-98
Litter material	Wood shavings	None	Wood shavings	Wood shavings	Wood shavings & gravel	Wood shavings
Access to litter post placement (weeks)	Start	Start	Start	4	Start	Start
Litter management	Addition of wood shaving	None	Removed 3 times	None	Replaced 3 times	Addition of wood shaving
Manure removal	Litter belts	Litter belts	Litter belts	Scrapers	None	Litter belts
Type of cleaning	High pressure	High pressure	High pressure	High pressure	High pressure/watersteam	Watersteam
Cleaning temperature (°C)	50–60	60	80	60	60–70/120	50–60
Disinfectant	3	1 and 2	None	1 and 2	None	1 and 4

1, Chlorocresol (Interkokask® RTU).
2, Multiple chlorophenolic disinfectant (TEK-TROL®).
3, Peroxygen compounds + organic acids (Virkon® S).
4, 1.6 Dihydroxy – 2.5 dioxahexane + glutaraldehyde (Rodasept®).

ing hen flocks. The situation is, however complicated by the fact that there is currently only one anthelmintic substance available for poultry (the benzimidazole substance flubendazole), which is administered to the birds for several days in the drinking water.

The presence of roundworms in chickens is an old and well-known problem for the poultry industry (Ruff and Norton, 2008). Still, it is not known if the infection originates from stationary infective larval stages surviving in the empty chicken house between flocks, with replacement pullets or, in organic flocks, if it is transmitted from free-living birds. Information on the population growth of ascarids in modern non-cage housing systems for laying hens is lacking. Also, rational action plans that can be undertaken to eliminate the infection among chickens, and proposals on how an optimal deworming program needs to be designed.

Ascaridiosis in chickens is associated with production losses and can have severe health effects (Ikeme, 1971; Dahl et al., 2002; Permin et al., 2006). For these reasons there is an obvious need to control parasite loads. The aims of this study were to document how *A. galli* is spread to laying hens and to investigate the infection dynamics of *A. galli* in modern non-cage housing systems for laying hens.

2. Materials and methods

2.1. Study farms

The study was carried out between May 2009 and August 2010 in six flocks (A–F) of commercial laying hens on separate farms, which had a history of *A. galli* infection in a previous flock (Table 1). The studied farms were representative of Swedish commercial non-cage laying hen operations in terms of management, size and housing systems, and they were located in the southern half of the country. All farms applied all-in-all-out management at flock level, and represented both conventional ($n = 3$) and organic farms ($n = 3$). The birds were housed in traditional single-tiered or multi-tiered (aviary) systems. All six flocks studied were introduced into the barns as replacement pullets at age 14–16 weeks between May and August 2009. Housing and feeding of commercial laying hens in Sweden has been previously described (Jansson et al., 2010).

The farmers and their veterinary consultants made all decisions about management and intervention, including cleaning and disinfection procedures applied before placement of pullets as well as use of anthelmintics. Accordingly, on three farms (flocks B, D and F) attempts were made to decontaminate empty barns before introduction of replacement pullets, using the broad-spectrum veterinary disinfectant chlorocresol (Interkokask® RTU), which includes a lipidsolvent that disrupts the protective outer layer of the shell of the parasite eggs (Table 1). Disinfection was performed before placement in the empty barn in accordance with the manufacturer's recommendations.

On three farms (flocks B, E and F) the farmers and their veterinary consultant decided to deworm the study flock with an oral emulsion of flubendazole, mixed in the drinking water for 5–7 days at a concentration of 1.43 mg/kg (SID PO Verminator®, Boehringer Ingelheim Vetmedica, Malmö, Sweden). In organic flock B the birds were treated after 40 weeks for 5 days, whereas both conventional flocks (E and F) were dewormed twice. In flock E, deworming was conducted 22 and 46 weeks post placement for 6 days, whereas in flock F it occurred at weeks 26 and 41 post placement for 7 days.

All six studied flocks were from different sources. Two flocks each originated from two pullet-breeding companies, but from different batches, and the remaining two study flocks were reared by the farmers themselves. The total number of birds on each farm varied between 3000 and 94,000. On all farms but one (D) there were at least two age categories present simultaneously.

2.2. Sampling and parasitological analyses

The study design is described in Fig. 1. After placement of the flocks, faecal egg counts were monitored at regular intervals during the first 50 week of the produc-