

Insects associated with chicken manure in a breeder poultry farm of Central Chile

Insectos asociados a fecas de pollo en una avícola de Chile Central

J Retamales^{a,*}, F Vivallo^{a,b}, J Robeson^a

^aInstituto de Biología, Facultad de Ciencias, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile.

^bLaboratorio de Biología Comparada de Hymenoptera, Programa de Pós-Graduação em Entomologia, Universidade Federal do Paraná, Curitiba, PR, Brasil.

RESUMEN

Los insectos son muy comunes en las instalaciones de la industria avícola y diferentes medidas de bioseguridad se aplican para evitar su propagación debido al hecho que pueden acarrear agentes patógenos. Por lo tanto, es de suma importancia saber qué insectos comúnmente están presentes en los galpones avícolas para optimizar los protocolos de control. Ya que la información sobre este tema es escasa, el objetivo de la presente investigación fue determinar los principales grupos taxonómicos de insectos presentes en el guano de una granja avícola industrial en la zona central de Chile. Las muestras de guano fueron recolectadas en una granja avícola en la Región de Valparaíso, Chile, de áreas adyacentes a las líneas de alimentación y depósitos de agua. Las muestras fueron refrigeradas, transportadas al laboratorio y procesadas para la clasificación taxonómica de los adultos y estados inmaduros de insectos. Los resultados indican una colonización marcada por el escarabajo *Alphitobius diaperinus* y por los dípteros *Fannia* sp. en relación con otras seis familias de insectos que se determinaron. Alrededor del 94% de los insectos encontrados en el guano estaban presentes en las muestras procedentes de las zonas adyacentes a las reservas de agua. Por lo tanto, las fugas de los dispositivos de suministro de agua se han convertido en un punto crítico de control de estas plagas entomológicas de las aves de corral, las cuales han sido reportadas como portadoras de una gran variedad de virus, bacterias y parásitos eucariotas.

Key words: *Alphitobius diaperinus*, insect vectors, poultry farms.

Palabras clave: *Alphitobius diaperinus*, insectos vectores, galpón avícola.

INTRODUCTION

The Chilean poultry industry has increased its production with the incorporation of new control technologies to prevent insect colonization (Armijo 2006). However, insects are very invasive and the implemented biosecurity measures do not curtail completely the entry of insects into hatcheries. Therefore, they may become active agents that mediate outbreaks of infectious diseases in birds, generating significant financial losses (Cedó 2001, Ricaurte 2005).

There is evidence that insects have an active role in the transport and spread of various avian pathogens in broiler breeder houses (Gray *et al* 1999, Olsen and Hammack 2000). *Alphitobius diaperinus* Panzer (Coleoptera: Tenebrionidae) is a major insect pest on poultry farms worldwide, and besides generating structural damage, pest control expenses and decreased feeding efficiency (Roche *et al* 2009), it has been associated with the ability to transmit disease agents such as bacteria of the genera *Escherichia*, *Salmonella* and *Campylobacter* (Chernaki-Leffer *et al* 2002, Segabinazi

et al 2005, Templeton *et al* 2006), viruses such as fowl pox and Newcastle (De las Casas *et al* 1976), fungi of the genera *Aspergillus*, *Penicillium* and *Candida* (De las Casas *et al* 1972), and protozoans such as *Eimeria* (Coccidiosis) (Goodwin and Waltman 1996). *A. diaperinus* also acts as a vector of cecal worms and avian tapeworms (Watson *et al* 2000).

Despite the importance of insect pest control in the poultry industry, little is known about the entomofauna associated with poultry production and it is scarcely studied in Chile. Therefore, we decided to determine the major insect taxa present in chicken manure in poultry breeder facilities on a major poultry farm in Chile. As a result of this investigation we generated a checklist of the different taxonomic groups of insects associated with poultry faeces in order to facilitate optimization of control measures to minimize dissemination of infectious agents and to preserve or improve the quality of poultry production.

MATERIALS AND METHODS

SAMPLING

Insects were collected from eight industrial poultry houses (10 birds/m²) located in the Province of San Antonio, Region

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* Av. Universidad 330, Curauma, Valparaíso, Chile; julio_retamalesl@yahoo.es

of Valparaíso, Chile, during April and May of 2005; a total of 432 manure samples were collected from this site.

Each house was open-sided with the long axis oriented east to west and containing chickens 43-48 weeks of age at the time of collection. The concrete house floors were covered with a 20 cm layer of accumulated manure that is removed on a yearly basis. Above that, two feeder lines spanned the length of each house, located at 2 m from both the north and south walls. The sampling sites, Sector 1 (S1) and Sector 2 (S2), were located under the north and south feeder lines, respectively. Furthermore, two water drinking lines spanned the central region; sampling sites of Sector 3 (S3) were located under these drinking lines. The moisture content of faeces was determined through a visual and tactile analysis of manure (Rivera *et al* 2007). We found that moisture increased significantly in S3 compared to S1 and S2.

Populations of insects established at 48 weeks of flock age were sampled following Strother and Steelman (2001) with modifications; samples (0.2 kg each) were collected using a garden shovel from sites at S1, S2 and S3 to a maximum depth of 15 cm, zigzagging along the slopes of the barn houses. The 432 samples were individually deposited in labeled transparent plastic bags and brought to the laboratory in a refrigerated cooler to avoid the deterioration of specimens.

IDENTIFICATION OF THE ENTOMOFAUNA

Insects were taken out from the faeces samples and placed in labeled vials according to their place of collection and preserved in 70% ethanol. Within 3 days they were processed for identification. The insects were identified at

family and/or species level, depending on the abundance percentage (number of individuals per family / total number of insects found of these taxa) and the distribution (presence of insect family / total number of samples examined) throughout the breeding barns.

The criteria for identifying adults were based on the taxonomical characters cited by Artigas (1994) and Toro *et al* (2003). Immature stages were identified according to Chu (1949).

RESULTS AND DISCUSSION

Insects have the ability to colonize poultry manure and therefore key factors for the establishment of a particular entomofauna are the reproductive and developmental characteristics of insects, the food availability present in the poultry houses and the physical and chemical characteristics, humidity in particular (Strother and Steelman 2001). In fact, both larvae and adults of orders Hymenoptera, Diptera, Coleoptera and Lepidoptera were found in the poultry farm studied. The same groups of insects were described by other investigators (Kaufman *et al* 2000) with the exceptions of Lepidoptera (Incurvariidae and Eriocraniidae) and Hymenoptera (Formicidae) which presumably were not using the poultry farm houses as a site for oviposition and the development of immature stages (figure 1).

Of the 1,131 insects examined, 74.6% belonged to the order Coleoptera, the most frequently represented families being Histeridae and Tenebrionidae. The most abundant insect found associated with poultry manure on the farm examined was the beetle *Alphitobius diaperinus*. This is in agreement with results obtained by

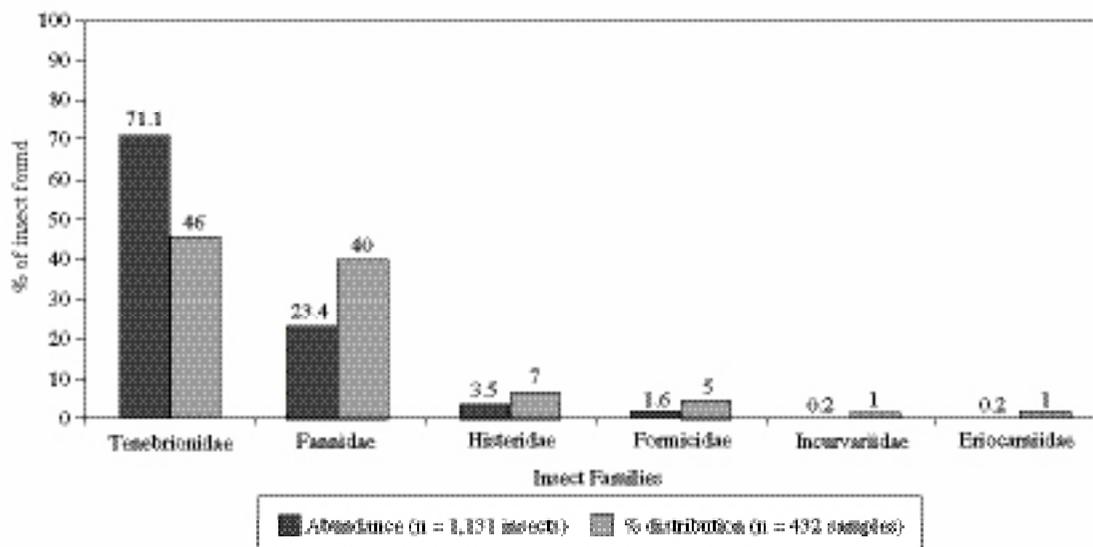


Figure 1. Percentage of abundance (number of individuals per family / total number of insect found) and distribution (presence of family insect / total number of samples examined) of insect families in chicken manure.

Porcentaje de abundancia (número de individuos por familia / número total de insectos encontrados) y distribución (presencia de la familia de insecto / número total de muestras examinadas) de las familias de insectos en el guano avícola.

Calibeo-Hayes *et al* (2005) as well as by Strother and Steelman (2001), and Salin *et al* (2003), who reported that this insect is the most resistant and persistent in avian rearing facilities even when a combination of insecticides is applied.

A. diaperinus is known to be actively involved in the transmission of various infectious agents and parasites found in birds (table I). In natural conditions, results obtained by Chernaki-Leffer *et al* (2002) and Segabinazi *et al* (2005) suggest a limited role of *A. diaperinus* in the spread of *Salmonella*, a pathogen associated with the poultry industry. Nevertheless, there are still disputes about the role of *A. diaperinus* in the dispersal of *Salmonella* in experimental conditions depending on the serovar involved. For example, Davies and Wray (1995) indicate that *A. diaperinus* does not possess the ability to transmit *S. Enteritidis* whereas Roche *et al* (2009) found that larvae and adults of *A. diaperinus* could act as vectors for the transmission of *S. Typhimurium* to broilers.

Fannia sp. (Diptera: Fanniidae) was the second most abundant insect found in poultry faeces (23.4%, only immature stages). It had also been cited as an important colonizer of this kind of faeces worldwide (Kaufman *et al* 2000). This taxon serves as a mechanical vector of different diarrheal pathogens (Manrique and Delfín 2007). Moreover, *Fannia* sp. has been recently reported as a vector of *Dermatobia hominis* larvae (Diptera: Oestridae), an agent that causes myiasis in humans and animals (Barreto and Souto 2004).

A. diaperinus and *Fannia* sp. are present in similar percentages of distribution in the chicken breeding barns examined, followed by *Carcinops pumilio* (figure 1). Another important feature observed for *A. diaperinus* and other groups of insects is that the *et al* onize and establish mainly in areas of high substrate moisture. In fact, 94.1% of the insects found were associated with the high-humidity manure sector S3. Also, the abundance of *A. diaperinus* adults and *Fannia* larvae decreases significantly from sector S3 towards sectors S2 (3.4%) and S1 (2.5%).

Table 1. Transport of avian pathogens.
Transporte de patógenos aviares.

Insect		Pathogens	Reference
<i>A. diaperinus</i>	Virus	Fowl pox and Newcastle virus	De las Casas <i>et al</i> 1976
		Avian leukosis virus	Eidson <i>et al</i> 1966
		Infectious Bursal Disease (Gumboro Disease).	McAllister <i>et al</i> 1995
	Bacteria	<i>Escherichia coli</i>	Chernaki-Leffer <i>et al</i> 2002
		<i>Salmonella</i> sp.	Skov <i>et al</i> 2004
		<i>Campylobacter</i> sp.	Roche <i>et al</i> 2009
		<i>Clostridium perfringens</i>	Templeton <i>et al</i> 2006
Fungi	<i>Staphylococcus</i> sp.,	Strother <i>et al</i> 2005	
	<i>Streptococcus</i> sp.	Bates <i>et al</i> 2004	
	<i>Bacillus subtilis</i> .	Vittori <i>et al</i> 2007	
Protozoa	<i>Aspergillus, Penicillium</i>	Goodwin and Waltman 1996	
	<i>Fusarium, Candida</i>	De las Casas <i>et al</i> 1972	
Helminths	<i>Eimeria</i> sp.	Goodwin and Waltman 1996	
	Cecal worms <i>Choanotaenia infundibulum</i> (tapeworm)	Watson <i>et al</i> 2000 Elowni and Elbiharis 1979	
<i>Fannia</i> sp.	Insect	<i>Dermatobia hominis</i>	Barreto and Souto 2004
<i>C. pumilio</i>	Bacteria	<i>Salmonella enteritidis</i>	Gray <i>et al</i> 1999
		<i>Campylobacter</i> sp.	Skov <i>et al</i> 2004

Relation of the main insects found in poultry houses with the transport of avian pathogens.

Relación de los principales insectos encontrados en las granjas avícolas y el transporte de patógenos aviares.

The activity of the histereid beetle *Carcinops pumilio* is interesting to highlight. This insect is known worldwide for its ability to prey upon fly larvae, including the house fly and representatives of the genus *Fannia* (Tobin *et al* 1999, Achiano and Giliomee 2006). Therefore, the presence of both tenebrionids and fanniids in sectors of high moisture could be accounted for by the fact that *A. diaperinus* eats the eggs of *C. pumilio*, thus reducing the number of the natural biological controllers of *Fannia* sp. (Dunford and Kaufman 2006).

Overall, it seems important to investigate the complex interactions between insects in poultry rearing facilities to enhance the use of biological pest control tools in these environments, an approach that could considerably reduce the economic cost incurred by the massive use of insecticides (Kaufman *et al* 2002).

In summary, the insects reported in this study could generate significant financial losses due to destruction of facilities, parasitism in birds and spread of infectious agents. Nevertheless, some of them play important ecological roles in poultry farms, acting as controlling agents of other insect pest populations, a trait that could be positively employed. Moreover, improvements in water drainage systems become mandatory since they are critical control points for insect pest management.

SUMMARY

Insects are common in poultry facilities and different biosecurity measures are enforced to prevent their spread due to the fact that they may carry pathogenic agents. Therefore, it is of utmost importance to know what insects are commonly present in poultry sheds to optimize control protocols. Since information on this subject is scarce, this investigation aimed to determine the main insect taxa present in chicken manure on a major poultry farm in Central Chile. Samples of hen manure were collected at a poultry farm in the Region of Valparaíso, Chile, from areas adjacent to feeding lines and water reservoirs. Samples were chilled, transported to the laboratory and processed for taxonomic classification of both adult and immature stages of insects. Results indicated a marked colonization of the beetle *Alphitobius diaperinus* and of the dipterans *Fannia* sp., compared to other six families of insects that were also determined. About 94% of the insects found in chicken manure were present in samples from areas adjacent to water reservoirs. Therefore, leaks from water supply devices become a critical point of control of these entomological poultry pests that have been reported to carry a variety of viral, bacterial and eukaryotic parasites.

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