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Review

THE DARKLING BEETLE (*ALPHITOBIUS DIAPERINUS*) – A HEALTH HAZARD FOR BROILER CHICKEN PRODUCTION

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ABSTRACT

The purpose of this publication was to review the available literature on one of emerging and largely unknown problems related to broiler chicken production. The literature review provides data about both the life cycle of the darkling beetle, *Alphitobius diaperinus* (Pancer, 1797) (Coleoptera: Tenebrionidae), and the potential health risks of its presence in poultry premises. *Alphitobius diaperinus* is an acknowledged vector of a number of bacterial, viral and parasitic pathogens. It is also possibly involved in the hypoglycaemia spiking mortality syndrome in broilers. Analysis of author's own data is also included.

Key words: *Alphitobius diaperinus*, broiler chickens, risk for the health, economic importance

The darkling beetle, *Alphitobius diaperinus* (Pancer, 1797) (Coleoptera: Tenebrionidae), is the most encountered beetle in the litter of poultry facilities (1). It is also called darkening or night due to its highest activity at dusk. *Alphitobius diaperinus* usually infests flour and other cereals, especially in poorly maintained grain storehouses (2). It has been associated with wheat, barley, rice, oat, soybean, pea, and peanuts. It is also reported in connection with linseed, cottonseed, oilseeds, tobacco etc. (3). Due to its tropical origins, the beetle prefers warm and humid environments.

According to some researchers, poultry manure is rich in both adult beetles and larvae (1), while others affirm that larvae are always more numerous than adults (4).

Populations of hundreds and thousands of beetles spread by bats are found to inhabit caves in various parts of the world, including Texas and Kenya (5). It is acknowledged that larvae feed on bat's guano, soil, sick or dead bats, chickens and pigeons (5). They could also feed on animal body parts, such as bird feathers or smaller beetles (cannibalism).

The female darkling beetle could lay over 2,000 eggs (200 to 400 in average). Adults lay eggs in cracks or gaps of poultry facilities, in the manure or the litter, in grain husks, and under the feed and water lines. During the duration of their life (from 3 to 12 months), they produce eggs at 1- to 5-day intervals.

Hatching of larvae takes 4 to 7 days, and the development into adults occurs after 40 to 100 days depending on the ambient temperature and the quality of available food. The development requires 30-33 ^{o}C and about 90% air humidity. A number of studies were performed on the insect's development conditions (3, 6, 7).The life cycle (from egg to adult) was reported to be 89 days at 22 ^{o}C and 26 days at 31 ^{o}C (6). Therefore, the temperatures in poultry facilities (between 25

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and 30 ^{o}C) are ideal for the development of the beetle, and the fattening period of broilers (approx. 50 days) corresponds to the completion of the full life cycle of the beetle (8, 9).

Larvae feed on spilled feed, manure, sometimes on dead or sick birds and cracked eggs. Mature larvae spread in all directions to find isolated sites for the pupal stage, often by making tunnels into the thermal insulation of the building. Tunnels are further expanded when adult beetles start looking for food. Both stages (larval and adult) are nocturnal, and are most active at dusk. They are very energetic, making holes in the litter when dispersing. Adults live for a long time, normally persisting for more than a year, but under experimental conditions, they could live for more than 2 years (5).

The controlled temperature in poultry facilities, the constant accumulation of manure and the adequate humidity level provide favorable conditions for development of darkling beetles all year round 10). The climate has an impact on beetles when they are hide outdoor in the environment (11). The spatial distribution of adults benefits from the high humidity and low density of the soil, whereas larvae and pupae are indifferent to humidity (9).

Although the economic importance of *A. diaperinus* for grain production is minor, it is usually encountered in products, already damaged by other biological agents, mostly molds. It is however essential for poultry industry as a vector of numerous avian diseases and the related risk for the health of people, which are in contact with the pest. Energy costs of buildings with thermal insulation damaged by the beetles are by 67% higher compared to intact premises. Darkling beetles could, however, be useful in some ways. When they are active, they aerate and drain the manure.

Diaperinus are important vectors of a number of poultry pathogens and parasites. They spread the viruses causing leukosis, Marek's disease, Gumboro (5), turkey corona virus (12, 13), Newcastle disease and avian influenza viruses (3). They could be vectors of bacteria such as *Salmonella* Typhimurium, *E. coli*, *Aspergillus* spp., *Staphylococcus* spp. (14, 15, 16, 17), and *Campylobacter* spp. (18). They could also transmit protozoa as *Eimeria* spp. (3, 19); fungi (20, 21); and helminths as the nematode *Subulura brumpti* Lopes-Neira (22); avian cestodes (23). Both adults and larvae of *A. diaperinus* could provoke intestinal obstruction (23).

Alphitobius diaperinus is possibly involved in the etiology of the hypoglycaemia spiking mortality syndrome in broilers. The disease was successfully reproduced through beetles collected from the manure in the poultry facility (24).

Recent studies relate *Alphitobius diaperinus* with the occurrence of the so-called viral poult enteritis complex "Runting Stunting Syndrome" (25). It affects chickens 5 to 12 days of age, but older birds could be also affected. The syndrome is more severe in the offspring of young breeder flocks. It is more frequent when the litter is used repeatedly and the premises remain free of birds for a shorter period. Astro- and reoviruses have been isolated from darkling beetle' larvae. With regard to rotaviruses, PCR was inconclusive. Viral isolates, after being inoculated to 6-8-day old chickens, succeeded to produce diarrhoea and stunted growth (25).

We have also observed a high prevalence of adult beetles and its larvae in the litter of poultry facilities in different regions of northeast, northwest and south Bulgaria. These cases were usually encountered with relation to diarrhoea during the first two weeks of age followed by stunted growth in a large proportion of the chicken population (over 15%). Parts of beetles or larvae were occasionally discovered in the intestinal content of some of affected chickens.

Another concern related to *A. diaperinus* is the human health problems it could cause. Tenebroid beetles, including *A. diaperinus*, produce highly reactive benzoquinones for self-protection against enemies (26). Quinones could be dangerous for human health and pose a hazard in case of prolonged exposure to insects. Reports of complaints related to *A. diaperinus*, include signs of asthma, headache, dermatitis, allergic angioedema, rhinitis, erythema (reddening) and formation of papules (5, 27, 28). The exposure to quinone vapours could cause conjunctivites and corneal ulcerations (5, 27).

Quinones produced by tenebroids are thought to be carcinogenic. This way, quinone-producing insects are hazardous to health at all stages of production and distribution of foods (29; 30).

CONCLUSIONS

The analysis of literature data confirms the existing risk of the presence of the darkling beetle, *Alphitobius diaperinus* (Pancer, 1797) (Coleoptera: Tenebrionidae) in poultry buildings for the health of birds. It is related to its role as vector of numerous bacterial, viral and parasitic agents, as well as to its direct effect on birds. Also, there is a certain risk for the health of people in continuous contact with these insects.

The economic losses for the poultry industry are also exacerbated by the harmful impact of *Alphitobius diaperinus* on the quality of grain used in fodder production and the higher energy costs from the impaired thermal insulation of poultry facilities.

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