Canine myiasis by *Lucilia eximia* in North America

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Abstract. Myiasis is the invasion of Diptera larvae in live vertebrates tissues. It has been registered in tropical areas, but not in urban animals of North America. Moreover, there is no information about lesions description, laboratory tests, and treatment applied to canines. We report a myiasis located in the dorsum of an overweight male canine. Insect larvae were identified as *Lucilia eximia*, an opportunistic species that scarcely infest live vertebrates, and with no records in North America animals before. Abnormalities of complete blood count like leukocytosis by neutrophilia and serum biochemical changes like elevations in alanine aminotransferase, aspartate aminotransferase, creatine kinase, globulins and amylase were detected. Because *Lucilia* is characterized by lower host-specificity and infestation outbreaks occur worldwide, it is imperative to continue increasing the understanding of *Lucilia* myiasis, its clinical presentation, risk factors, therapy and correct entomological classification. Otherwise, more cases could occur in animals and humans.

INTRODUCTION

Myiasis is the invasion of Diptera larvae in live vertebrates tissues, causing traumatic injuries of cutaneous tissue, body cavities and organs. Diptera associated with this pathology are blow flies (Calliphoridae), flesh flies (Sarcophagidae) and bot flies (Oestridae). Whereas Oestridae is composed by obligated parasites, Calliphoridae and Sarcophagidae are not (Zumpt, 1965). In pets, maggots affect dogs, rabbits and cats in a lesser extent (Anderson & Huitson, 2004). Myiasis is well registered in tropical areas, and not in urban companion animals from North American temperate zones. Nevertheless, records of canine myiasis by Sarcophagidae flies exist in livestock areas of Italy, Morocco and Hungary. Ears, legs and genitals are the most frequently affected anatomical regions (Farkas *et al.*, 2009; Giangaspero *et al.*, 2011), and risk factors for animals and humans include open wounds, poor hygiene, advanced age, vascular occlusive disease, and the inability to discourage flies from depositing eggs or larvae because of physical impairment (Sanford *et al.*, 2014). However, no information exists about description of lesions, laboratory tests and treatment in canines.

CASE HISTORY

In September of 2013 an 8 year-old overweight male Pembroke Welsh Corgi (PWC) from Mexico City Metropolitan Area, was presented with pale gums and larval infestation located on the dorsum (Fig. 1a). Dog owner referred a two-days history of inappetence, depression and fetid odor.

Maggots were unnoticed by owner because the patient had dense coat, a Corgi variety commonly named "fluffy Corgi". Under general anesthesia with isoflurane dorsal area was shaved, and then skin lesions were observed. Fig. 1b shows the extensive ulceration of the skin with purulent exudate and necrotic tissue.

Larvae were manually removed, killed in hot water (>80ºC), fixed in 70% alcohol, and further microscopically identified as *Lucilia eximia* (Wiedemann, 1830) based on morphological characters described by Florez and Wolff (2009), i.e. shape and size of posterior spine bands, spiracles and cephalopharyngeal skeleton (Fig. 2). Maggots were at the same developmental stage (L3), indicating no successive infestation. Biochemical profile and complete blood count were performed. Findings on complete blood count included leukocytosis (25.7 x 10^9/L, reference range 6.0–17.0 x 10^9/L) by neutrophilia (21.8 x 10^9/L, reference range 3.0–11.5 x 10^9/L). Serum biochemical abnormalities were elevation in alanine aminotransferase (122 U/L, reference range <70 U/L), aspartate aminotransferase (69 U/L, reference range <55 U/L), triglycerides (1.28 mmol/L, reference range 0.57–1.14 mmol/L), creatine kinase (773 U/L, reference range <213 U/L), globulins (43.0 g/l, reference range 23.5–39.1 g/l) and amylase (6373 U/L, reference range <1100 U/L) and decrease in albumin (25.0 g/L, reference range 29.1–39.7 g/L) and albumin/globulin ratio (0.6, reference range 0.78–1.46). The patient was hospitalized for 3 days. Wounds were cleaned daily with povidone-iodine and chlorhexidine, and the pharmacological treatment was metronidazole (Otrozol 500; Pisa Laboratories®; 60 mg/kg BW, q24h) and ivermectin (Iverfull; Aranda Laboratories®; 200 µg/kg BW, one dosage). At the fourth day the dog followed antibiotic treatment with enrofloxacin (Enroxil; Senosiain Laboratories®; 10 mg/kg PO, q24h) for 10 days at home. After one month, wounds were completely healed and repeated blood tests indicated no alterations in the biochemical profile and blood count.

Figure 1. Dorsal cutaneous myiasis by *Lucilia eximia* in a Pembroke Welsh Corgi. (1a) Dorsal view with larva infestation, the arrows shows alive maggots. (1b) Skin lesions viewed after shaving. (1c and 1d) Healed wound.

Figure 2. *Lucilia eximia* larvae. (2a) *Lucilia eximia* third-stage larvae. (2b) Caudal view of the larvae with posterior spiracles located centrally. (2c) Posterior spiracle. (2d) Cephalopharyngeal skeleton (magnification, x4).

DISCUSSION

Herein, we report the first case of primary myiasis of *L. eximia* in the dorsal area of an adult dog from a temperate city of North America. *L. eximia* is a necrophagous blow fly, distributed in rural, urban, and forest habitats from United States to Argentina; the oviposition temperature in *L. eximia* ranges from 26 to 28.8°C, and the adult fly is primary attracted to a wide variety of substrates such as garbage, carcasses, and scats for food and oviposition (Kirkpatrick & Olson, 2007). It also acts as facultative ectoparasite attracted by wounds of sick, injured or moribund animals; however, records of attack on healthy animals exist in South America during hot months (Azeredo-Espin & Madeira, 1996). The infestation in the PWC occurred in late summer, which is congruent with the season when several species of maggots attack humans and farm and companion animals in United States, Italy and Israel (Giangaspero *et al.*, 2011; Schnur *et al.*, 2009; Sherman, 2000). Myiasis caused by *L. eximia* has been reported in tropical zones of Brazil, in urogenital region and abdomen of young animals, a puppy and a kitten of 10 and 15 days old respectively (Azeredo-Espin, 1996). According to Anderson and Huitson (2004), presence of traumatic cutaneous myiasis is associated with neglected dogs with insufficient daily care. Therefore, *L. eximia* colonization success in PWC could be attributed to a suitable environment generated by dense and bad groomed coat, backyard life, rainy season and obesity. Fatness is a predisposing factor of being parasitized by larval flies previously reported in cats (Rodríguez & Pérez, 1996), but physiological factors behind that association have not yet explained. Recently, a case of human infestation by *L. eximia* was first reported in a presumably necrotic leg of an elderly homeless from United States and the probable cause of infestation was that his extremity was cooler than the rest of the body, favoring colonization and larval development (Sanford *et al*., 2014). Here, we hypothesize that a lower trunk temperature, caused by obesity and a wet and dense fur, was the primary predisposing factor; because in the case of necrophagous parasites, previous studies demonstrated that low host temperature improve the parasite chances of locating a host (Wharton, 1999). Savastano *et al.* (2009) confirm that obese humans show lower skin temperatures in trunk than in peripheral regions. The effect was attributed to the insulating layer of subcutaneous adipose tissue that impedes heat loss across skin. This effect is higher in body areas of increased fat, like dorsum; and enhanced temperature reduction could occur on dorsal region for the influence of excessive humidity on the dense and bad-groomed coat. Wet fur is a poor insulator because water increases conductivity causing to lose heat faster than dry fur (Dickerson *et al*., 2012).

There are few data available concerning the systemic and immune response to cutaneous myiasis compared with the response to other ectoparasites (e.g. fleas and ticks), then some complete blood count and serum biochemical abnormalities found in PWC cannot be easily explained. Limited information exists about development of disease, biology of *L. eximia* acting as parasite, and host and environmental characteristics that favour its occurrence. Information on the genus refers primarily to *L. sericata* and *L. cuprina*. Larvae of *L. cuprina* can excrete ammonium that becomes toxic nonionized ammonia at the wound site and in the blood. High blood concentration of nonionized ammonia causes reduction of mature neutrophils, lymphocytes, eosinophils and serum globulin (Otranto, 2001). Changes in circulating neutrophils, lymphocytes, eosinophils and serum globulin found in the present are not in conformity with previously reported in *L. cuprina*, and this maybe was related to concomitant antigen response. The hematological results show leukocytosis with neutrophilia induced by inflammatory response, possibly caused by associated pyogenic bacteria. This finding has been previously reported in severe cases of human wound myiasis accompanied by secondary infection (Kaczmarczyk *et al*., 2014), and in twenty-two canine patients with dorsal furunculosis, including 3 PWC, many of them associated with *Pseudomonas aeruginosa* (Cain & Mauldin, 2015). Cutaneous myiasis is frequently complicated by concurrent bacterial infection and the most common isolated are *Pseudomonas* spp. and *Staphylococcus intermedius* in sheep and cats, respectively (Otranto, 2001; Rodríguez & Pérez, 1996). PWC successful treatment response was attributed to the use of broad-spectrum antimicrobials and antiparasitic drugs. Enrofloxacine is a systemic anti-microbial drug commonly used in treatment of bacterial skin infections (Beco *et al*., 2013), and Ivermectin has been used successfully eliminating blow flies in domestic cats (Rodríguez & Pérez, 1996). Presence of serum chemistry abnormalities like increased levels of aspartate aminotransferase, alanine aminotransferase and creatine kinase typically indicate major muscle damage, when liver pathology is excluded (Valentine *et al*., 1990). Skin pathologies caused by *L. eximia* in PWC correspond to those described in sheep affected by *L. cuprina* (Otranto, 2001). Studies in *L. cuprina* demonstrate that feeding maggots will aggressively invade tissue through the skin dermis and deeper layers, like muscle, with the help of proteolytic enzymes discharged in larval excretory-secretory products (one chymotryptic and two tryptic). The activity of these enzymes with elastase and plasmin substrates suggested their involvement in the immunopathogenesis of cutaneous lesions (Otranto, 2001), and concomitant systemic response, like increase of liver transaminases and creatine kinase. Other abnormalities as increased plasma triglycerides and amylase could be associated with obesity.

Attention should be paid to new cases of *L. eximia* myiasis in domestic animals; especially those living in close proximity to persons, because it could represent a potential source for human infestation; especially in high-risk groups such as homeless people and patients at risk of diabetic foot. The first case of *L. eximia* myiasis in human occurred in a homeless from United States (Sanford *et al.*, 2014), and more cases could occur because *Lucilia* shows low host-specificity. Other *Lucilia* species infest humans and outbreaks occur worldwide. For example, 35 cases of *L. sericata* wound myiasis have been reported in US until 2000 (Sherman, 2000). Sanity experts and vets are inexperienced with maggots, and there is lack of knowledge about managing or preventing the disease in pets and humans. Then, is imperative to continue increasing the understanding of myiasis, its clinical presentation, risk factors, therapy and correct entomological classification.

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