Parasitol Res (2015) 114:4731–4735
DOI 10.1007/s00436-015-4755-x

SHORT COMMUNICATION

Unusual presence of *Ornidia robusta* (Diptera: Syrphidae) causing pig myiasis in Argentina

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Received: 3 September 2015 / Accepted: 28 September 2015 / Published online: 9 October 2015

Abstract Myiasis is caused by dipterous larvae from the Calliphoridae, Sarcophagidae, Muscidae, Cuterebridae, and Syrphidae families. In this work, *Cochliomyia hominivorax*, *Chrysomya megacephala*, and *Ornidia robusta* were identified causing vulva, ear, and leg myiasis in pigs in Tucuman province, northwestern Argentina. The report of the presence of *C. hominivorax* and *C. megacephala* is very important due to their role as myiasis-causing and disease vectors. The occurrence of *Ornidia robusta* is remarkable, since it constitutes the first record of myiasis in general and of myiasis in pigs in particular. Lastly, the presence of *Sarcophaga* spp. is also interesting, since some of them originate myiasis and are therefore of concern for cattle, wild animals, and human populations.

Keywords Myiasis · Pigs · *Ornidia robusta* · Argentina

Introduction

Myiasis is defined as the infestation of vertebral animals with dipterous larvae, which during a certain period of time feed themselves with live or dead tissues of the host, substances of the host body, or with the food that it ingests (Olea et al. 2014).This disease has a worldwide distribution, mainly in tropical and subtropical regions (FAO 2010). Although adults are not the disease-causative agents, they are known to have an important role in the development of myiasis and it is through them that the larvae reach potential hosts, and remain for a period of time, causing injuries. Besides their zoonotic importance, the greatest interest in the study of these insects is mostly veterinarian, due to their strong impact on animal health and productivity, provoking decreases in milk, meat, or wool production, and increases in secondary infections, or in severe cases, even mutilation or animal death when they become heavily parasitized (Rogers 1998).

Numerous species included in the Calliphoridae, Sarcophagidae, Muscidae, Cuterebridae, and Syrphidae families have been reported to be responsible for myiasis in livestock and, occasionally, in humans. One of these species, *Cochliomyia hominivorax*, is well-known to be responsible for the majority of myiasis cases, producing important damage both in wild and domestic animals (Mariluis and Schnack 1996).

Myiasis cases produced by *C. hominivorax* both in livestock (mainly cattle and pigs) and domestic animals, such as dogs, were reported in Trinidad and Tobago, Guyana, Suriname, and Jamaica and revealed losses related to the delayed development of the animals, reducing milk production due to the activity of the species larvae (Rawlins 1985). During the implementation of the *C. hominivorax*-eradication program in Panama, the incidence of observed myiasis showed that the largest number of cases were produced by *Dermatobia hominis*, followed by *Phaenicia* spp., *Cochliomyia macellaria* and *Chrysomyia rufifacies*, and none by screwworms. These larvae were captured mainly in cows, dogs, humans, chickens, pigs, horses, and sheep. Lastly, the incidence of myiasis by specimens of the Muscidae and

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Sarcophagidae families was low. A number of Muscidae species has been associated with myiasis cases due to poor hygiene, and was also reported in relation to enteric and urogenital myiasis (Bermudez et al. 2007).

In Argentina, myiasis was studied by Basso (1939), Jörg (1939), Mazza and Basso (1939), Del Ponte (1959), and Mariluis (1999). In the country, myiasis-causing fly species are mainly included in Calliphoridae family. Its wide geographical distribution and variety of genera, including *Cochliomyia* and *Chrysomya*, makes this family one of the most important both in medical and economic terms.

Few researches assessing myiasis-causing fly species on cattle, goats, sheep, and pigs can be found in literature. Thus, this paper is an important contribution to the knowledge on this subject. In addition, this study provides the basis for further research to be carried out considering myiasis' seasonal and/or spatial variability and the associated dipterous insects, as well as the potential effects of farm facilities on wounds that could cause the appearance of the same and, therefore, the myiasis.

In the present work, we provide the first record of the presence of myiasis produced by *Ornidia robusta* in myiasis in general, and in pigs in particular, and lastly, the presence of species of the *Sarcophaga* genus, which is of great interest since some of them are causative of myiasis of high concern for cattle, wild animals, and the human population in Tucumán province, Argentina.

Materials and methods

We sampled 50 pigs in an agro-avian farm (26° 53′ S, 65° 23′ W) located in Ticucho, Trancas department, Tucumán, northwestern Argentina. From the 50 animals, 32 were mothers, 17 were rearing and 1 was a stud. During sampling, an individual record of each animal was carried out, assessing caravan number, sex, grade, lesion location, and, when possible, the cause of injury was also determined.

Fly larvae were collected mechanically with tweezers, according to Oliva et al. (1995), Centeno et al. (2002), and Olea et al. (2014). This larvae-extraction methodology has also been used in China by Chan et al. (2005), Brazil by Gomes et al. (2009), and the USA by Bugajski et al. (2011). Larvae were reared following Olea et al. (2014) until they reached the adult stage, which were sacrificed and subsequently identified using Mariluis and Schnack's (2002) key. Specimens are deposited in the collections of the Instituto-Fundación Miguel Lillo, Tucumán, Argentina.

Results and discussion

Fifty specimens corresponding to three fly species belonging to the Calliphoridae and Syrphidae families were collected, among which *Cochliomyia hominivorax* was the most abundant species, with 26 specimens (52 %), followed by *Chrysomya megacephala* with eight specimens (16 %) and *Ornidia robusta* with seven specimens (14 %). Three specimens (6 %) belonging to the *Sarcophaga* spp. could not be determined to the species level. Finally, six specimens could not be identified since they did not reach the adult stage, among which two reached the pupal stage and four reached the larval stage.

Cochliomyia hominivorax specimens (Fig. 1) were collected in nine females with vulva injuries (Fig. 2), three animals (two males and one female) showing injuries in their left leg (Fig. 2), one female with croup injuries (Fig. 3), three specimens (two females and one male) with injuries in their back and five specimens (four females and one male) with injuries in the left ear (Table 1). *Chrysomya megacephala* was the second most abundant species (Fig. 1), with its larvae captured in three females with vulva injuries and one male with injuries in the back (Fig. 3) (Table 1).

Larvae identified as *O. robusta* in their adult stage were also collected (Fig. 1) in three females with vulva injuries, two specimens (one male and one female) with left ear injuries, one female with an injury in the right ear and one female with a back injury (Table 1). Finally, larvae of *Sarcophaga* spp. specimens (Fig. 1) were the least abundant, and they were present in only three females with vulva injuries.

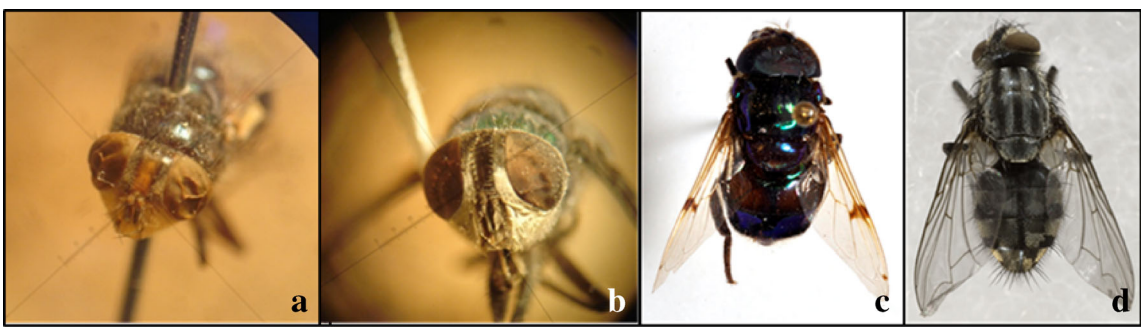

Fig. 1 Specimens identified in the laboratory of (**a**) *C. hominivorax*, (**b**) *C. megacephala*, (**c**) *O. robusta*, and (**d**) *Sarcophaga* species

Fig. 2 Injury with *C. hominivorax* larvae in the (**a**) vulva and (**b**) left leg

After larvae extraction, animals were treated with a single dose of ivermectin 0.1 mg/kg body weight (Bagomectina®, Biogénesis-Bagó S.A.) placed subcutaneously once-a-week for 4 weeks. The animals recovered completely at the end of the treatment, with no further complications. Female pigs with vulva injuries, however, required approximately 2 weeks more to reach a good condition.

Studies carried out involving the abundance of myiasis-causing fly species in pigs are actually very few (Rawlins et al. 1983; Rawlins and Chen Sang 1984; Rawlins 1985; Thomas 1987; Shinohara et al. 2004). Rawlins et al. (1983) reported myiasis caused by *C. hominivorax* in Suriname, Guyana, and Trinidad and Tobago, finding one case of myiasis in cattle and pigs. In a study in Jamaica, Rawlins and Cheng Sang (1984) found that *C. hominivorax* was the prevalent species in the island throughout the year and pigs were the most affected hosts, followed by goats, cows, horses, etc. In addition, Thomas (1987) conducted a study of the myiasis-causing fly species *C. hominivorax* and *D. hominis* during the rainy season in the Yucatan Peninsula, Mexico. The author observed that the highest prevalence of both species occurred in both domestic cattle and domestic pigs.

Published information about the presence of myiasis in cattle and sheep exists in veterinary literature (Humphrey et al. 1980; Farkas et al. 1996; Otranto 2001; Al-Eissa et al. 2008), which related myiasis with significant economic losses (Rawlins et al. 1983; Rawlins and Chen Sang 1984; Rawlins 1985; FAO 2010). Thus, the present work about fly species involved in myiasis development in pigs is of critical importance as the basis for future studies and assessments.

Cochliomyia hominivorax was the most abundant sampled species, and its larvae were found in different areas of the bodies of the pigs, such as the vulva, legs, ears, and spine, with no differences according to the sex of the animal. Myiasis caused by a screwworm is considered the most important type of zoonosis, causing enormous damage to the livestock industry (Anziani et al. 1995, 1998, 2000) and, in some cases, intolerable injuries in humans (Thyssen et al. 2012; Singh and Singh 2015). *Chrysomya megacephala* was the second most abundant species, its larvae causing lesions in the vulva, ears, legs, and spine. In Argentina, this species was reported in the provinces of Misiones, Santa Fe, Buenos Aires, and recently, in Tucumán (Mariluis and Mulieri 2003; Olea et al. 2011). This species is important because, in addition to being an epidemiologically interesting invasive species, it is considered one of the most dangerous vectors of enteric pathogens, protozoa, and helminthes (Greenberg 1973). These flies are characterized as mechanical vectors, carrying pathogenic organisms attached in their bodies, thus contaminating different substrates by direct contact or through fecal droppings or regurgitation. Finally, it was unknown and had not been reported in literature whether *O. robusta* (Syrphidae family) was related to the presence of myiasis, and therefore, this paper represents the first report of this species in myiasis lesions in pigs, specifically in body parts such as the vulva, ear, and back. According to Thompson et al. (1976), flies of this family are described as flower flies, and are of great economic importance, since adults are highly relevant pollinators which can play the role of bees in field crops. In turn, larvae of the Syrphinae subfamily are very important predators of many

Fig. 3 Injury with (**a**) *C. hominivorax* larvae in the croup and (**b**) *C. megacephala* larvae in the back

Table 1 Location of *C. hominivorax*, *C. megacephala*, and *O. robusta* larvae in pig specimens in the agro-avian farm in Tucuman, northwestern Argentina

Sex/location of larvae in pig specimens	*C. hominivorax*		*C. megacephala*		*O. robusta*	
	Female	Male	Female	Male	Female	Male
Vulva	9	0	3	0	3	0
Left leg	1	2	0	2	0	0
Right leg	0	1	0	0	0	0
Back	2	1	0	1	1	0
Left ear	4	1	1	0	1	1
Right ear	2	2	1	0	1	0
Croup	1	0	0	0	0	0

crop pests such as aphids, trips, and butterfly larvae. Finally, some species have been reported to cause accidental myiasis in humans.

In reference to specimens of the *Sarcophaga* genus, which were found in vulva lesions, their presence is important because, according to previous reports, their larvae produce a cutaneous ulcerative myiasis type. According to Zumpt (1965) and Kettle (1984), this type of myiasis usually affects humans rather than domestic animals (Gaglio et al. 2011; Szpila et al. 2014; Abdel-Hafeez et al. 2015), causing ulcerative type of injuries in tissues. Moreover, these larvae also cause myiasis of considerable importance in cattle. Although classified as cutaneous, this type of myiasis can cause damage by affecting tissues which have been previously injured, such as the lips, ears, gums, eyes, and ears.

Based on the results obtained in this study, it can be concluded that the presence of species of the Calliphoridae family is an important finding, not only due to their wide geographical distributions, but also because of their medical-veterinary importance. *Cochliomyia hominivorax* was the most abundant species found in pigs, and this study is the first in reporting the presence of this species in this type of livestock. The relevance of these findings comes also from the fact that this fly species is the most studied at the global scale, due to the large economic losses involved, related to decreases in meat and milk production. Also, this species is responsible of the increased susceptibility of contracting other diseases. On the other hand, the presence of *Chrysomya megacephala* is also relevant due to its role as a disease vector and obligatory myiasis producer. The Sarcophagidae family was present in specimens who could not be determined to the specific level, but are important nonetheless, since they affect livestock, wild animals, and human populations through myiasis. Finally, this is the first record of *O. robusta* (Syrphidae family) in pigs, constituting a basis for future research on the implications of the species of this family in myiasis production.

For all the reasons developed above, this study is an important contribution to the subject providing both information about fly species affecting pigs through myiasis and a starting point for future research.

Acknowledgments Authors are grateful to Dr. Pablo Mulieri and Dr. Luciano Patitucci, and the Museo Argentino de Ciencias Naturales Bernardino Rivadavia, for their invaluable help in the Syrphidae specimen's identification.

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