

Epidemiological survey of zoonotic helminths in feral cats in Gran Canaria island (Macaronesian archipelago-Spain)

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Abstract

The presence of zoonotic parasites in feral cats have been widely considered all over the world. In Gran Canaria (Macaronesian archipelago, Canary Islands, Spain) the number of feral cats has grown out of control in urban and rural areas. 48 of *Felis catus* captured in different Gran Canaria areas were studied. Animals were necropsied and several organs were systematically examined in order to collect and identify macroscopic parasites. In addition, coprological tests were done in 28 cats. There were no statistically significant differences in the prevalence rate among sex, age or capture area, showing an overall prevalence of helminths of 77.1%. The most common tapeworms were *Dipylidium caninum* (64.6%) and *Taenia taeniaeformis* (31.3%), followed by the nematodes *Toxocara cati* (20.8%), *Ancylostoma tubaeforme* (18.8%), *Aelurostrongylus abstrusus* (10.4%) and *Trichuris vulpis* (2.08%). We also find several eggs of *Alaria alata* in the small intestine of one cat (2.08%), being the first description of this trematode in cats in the Canary Islands. Approximately, 40% of the studied cats harboured more than one parasite. High rates of zoonotic species found in these animals suggest the need of controlling parasitic infections and preventive measures against them.

Keywords

Macaronesian archipelago, Canary Islands, prevalence, zoonosis, helminths, feral cat

Introduction

Although clinicians and researchers are aware about the role that feral and wildlife animals could have as potential reservoirs of many human diseases, the authorities and society are still not aware of this situation. Recent papers have highlighted that feral animals could potentially harbour many zoonotic parasites (Adams *et al.* 2008; Headley *et al.* 2012).

There are several surveys about the prevalence of parasites in feral animals from world-wide areas (Dubey *et al.* 2009; Stojanovic and Foley 2011). The increase of feral animals population close to the rural or urban areas may constitute the reservoir of many diseases that can be spread to human beings, as well as domestic animal species of our environment. (Beugnet *et al.* 2014).

Feral cats may become infected by several parasites, but helminths have shown the highest prevalence (Millán and Casanova 2009). Household cats may become infected by helminth cysts and eggs voided in the feces of feral cats and

this may lead to human infection (Nichol *et al.* 1981a). Species such as *Toxocara cati* and *Toxascaris leonina* have an oro-faecal transmission cycle and produce infection by fecal contamination of food, water or the environment (gardens, sandpits and playgrounds) or direct contact (Overgaauw *et al.* 2009). *Ancylostoma* spp. has also been identified in cats (Millán and Casanova 2009; Coelho *et al.* 2011), representing another potential public health problem. *Aelurostrongylus abstrusus* has also been observed in feral cats from other countries such Spain and Portugal (Miró and Gómez 1999), producing respiratory problems. Recently, *Dirofilaria immitis* infection was diagnosed in household, as well as feral animals on the island of Gran Canaria (Morchón *et al.* 2004; Montoya-Alonso *et al.* 2011).

Gran Canaria is the second most densely populated island of Spain, as well as of Macaronesia, a collection of several archipelagos in the North Atlantic Ocean of the coast of Europe and Africa that belong to three countries: Portugal, Spain, and Cape Verde. Its geographical situation and the number of

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visitors (more than 2.2 million each year) are very important in terms of the potential for many of these parasites to be transmitted to humans, thus the zoonotic connection. In the countryside of Gran Canaria exists abundant population of feral cats that -as in other locations- do not receive any treatment against parasites, but they have access to food resources other than wild preys, such as farms or garbage bins; thus they usually being in good physical conditions and therefore these animals may survive with parasites (Millan and Casanova 2009). These factors and the difficulty in controlling the droppings of feral cats makes necessary to pay special attention to controlling parasites (ESCCAP 2010).

The study of the parasitological status of cats is important to establish the role of these animals as a potential hazard to human and animal health. Therefore, the aim of the present work was to determine the prevalence -by means of coparasitological examinations and parasitological necropsy- and evaluate the parasites in feral cats in different areas of Gran Canaria.

Materials and Methods

In this study, 48 feral cats (*Felis catus*) captured in Gran Canaria (Canary Islands, Spain) during authorized predator con-

trol campaigns were studied. These animals were collected from different Gran Canaria locations following the scheme of climate zones described by Rodríguez-Ponce *et al.* (1995). Four different isoclimatic zones are found on Gran Canaria, ascending in altitude from the coast to the central peak of the island: Dry and Desert zone (DD), Dry and Steppe zone (DS), Temperate Mild zone (TM), and Temperate Cold zone (TC). All these areas were classified in two groups in relation to the climatic zone similarities; “coast area” (Dry zones: area number 1) and “central and top areas” (Temperate zones : area number 2) (Fig. 1).

Of the cats analyzed, 36 were adults (20 males, 16 females) and 12 juveniles (<12 months, 4 males, 8 females). Animals were anesthetized with a combination of ketamine (Imalgene®, Merial, France) and xylazine (Rompun®, Bayer, Spain) and then humanely euthanized with intravenous injection of sodium pentobarbital (Dolethal®, Vetoquinol). This protocol was done following the recommendations approved by the Ethical Committee of the Veterinary Faculty of Las Palmas de Gran Canaria University (Protocol 52/2009).

Each animal was necropsied to examine different organs such as the esophagus, trachea, lungs, heart, stomach, small and large intestines. Parasites obtained from these organs were stored in 70% ethanol. For Cestodes, the specimens were stained with carmine, differentiated in acid-alcohol, dehy-

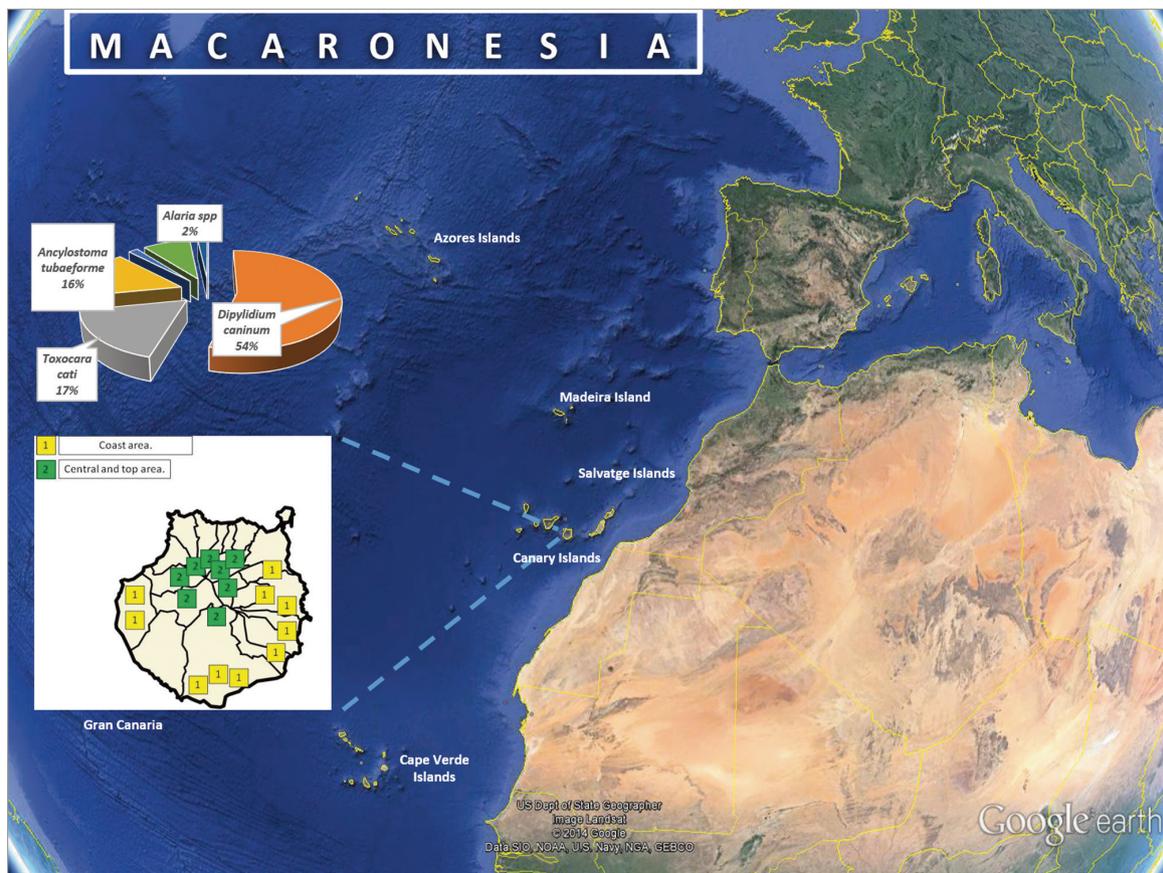


Fig. 1. Cartographical distribution of different regions where the feral cats were captured

Table 1. Number and prevalence (%) of parasites in feral cats in the two capture areas of Gran Canaria Island, Spain. Prevalence by groups and variables. Samples studied and overall prevalence according to epidemiological variables of each group

	Age		Sex		Capture Area		Total	
	>12 months (n = 36)	<12 months (n = 12)	Male (n = 24)	Female (n = 12)	Zone 1 (n = 18)	Zone 2 (n = 18)	Zone 1 (n = 18)	Zone 2 (n = 18)
Cestodes	80.6% (n = 29)	58.3% (n = 7)	79.2% (n = 19)	70.8% (n = 17)	83.3% (n = 15)	70% (n = 21)	83.3% (n = 15)	70% (n = 21)
<i>Taenia taeniaeformis</i>	33% (n = 12)	25% (n = 3)	25% (n = 6)	37.5% (n = 9)	22.2% (n = 4)	36.7% (n = 11)	22.2% (n = 4)	36.7% (n = 11)
<i>Dipylidium caninum</i>	66.7% (n = 24)	58.3% (n = 7)	75% (n = 18)	54.2% (n = 13)	83.3% (n = 15)	53.3% (n = 16)	83.3% (n = 15)	53.3% (n = 16)
Nematodes	16.7% (n = 6)	41.7% (n = 5)	33.3% (n = 8)	12.5% (n = 3)	16.7% (n = 3)	26.7% (n = 8)	16.7% (n = 3)	26.7% (n = 8)
<i>Toxocara cati</i>	16.7% (n = 6)	33.3% (n = 4)	29.2% (n = 7)	12.5% (n = 3)	11.1% (n = 2)	26.7% (n = 8)	11.1% (n = 2)	26.7% (n = 8)
<i>Ancylostoma tubaeforme</i>	13.9% (n = 5)	33.3% (n = 4)	29.2% (n = 7)	8.3% (n = 2)	11.1% (n = 2)	23.3% (n = 7)	11.1% (n = 2)	23.3% (n = 7)
<i>Trichostrongylus axei</i>	2.08% (n = 1)			2.08% (n = 1)	2.08% (n = 1)		2.08% (n = 1)	2.08% (n = 1)
<i>Aelurostrongylus abstrusus</i> ¹	8.3% (n = 3)	16.7% (n = 2)	12.5% (n = 3)	8.3% (n = 2)	11.1% (n = 2)	10% (n = 3)	11.1% (n = 2)	10% (n = 3)
Trematodes	2.08% (n = 1)			2.08% (n = 1)	2.08% (n = 1)		2.08% (n = 1)	2.08% (n = 1)
<i>Alaria</i> spp ²	2.08% (n = 1)			2.08% (n = 1)	2.08% (n = 1)		2.08% (n = 1)	2.08% (n = 1)
Total Helminths	80.6% (n = 29)	66.7% (n = 8)	83.3% (n = 20)	70.8% (n = 17)	83.3% (n = 15)	73.3% (n = 22)	83.3% (n = 15)	73.3% (n = 22)

¹larvae stage in feces by coprological analysis

²eggs in feces by coprological analysis

75% (n = 36)

31.3% (n = 15)

64.6% (n = 31)

22.9% (n = 11)

20.8% (n = 10)

18.8% (n = 9)

2.08% (n = 1)

10.4% (n = 5)¹

2.08% (n = 1)

2.08% (n = 1)²

77.1%

Table II. Number of parasites per animal in capture areas of Gran Canaria Island.

	Age		Sex		Capture Area		Total
	>12 months (n = 36)	<12 months (n = 12)	Male (n = 24)	Female (n = 24)	Zone 1 (n = 18)	Zone 2 (n = 30)	
Total parasites/cat							48 (100%)
0	19.4% (n = 7)	33.3% (n = 4)	16.7% (n = 4)	29.2% (n = 7)	16.7% (n = 3)	26.7% (n = 8)	11 (22.9%)
1	41.7% (n = 15)	8.3% (n = 1)	33.3% (n = 8)	33.3% (n = 8)	38.9% (n = 7)	30% (n = 9)	16 (33.3%)
2	19.4% (n = 7)	25% (n = 3)	16.7% (n = 4)	25% (n = 6)	27.8% (n = 5)	16.7% (n = 5)	10 (20.8%)
3	13.9% (n = 5)	25% (n = 3)	29.2% (n = 7)	4.2% (n = 1)	16.7% (n = 3)	16.7% (n = 5)	8 (16.7%)
4	5.6% (n = 2)	8.3% (n = 1)	4.2% (n = 1)	8.3% (n = 2)	0% (n = 0)	10% (n = 3)	3 (6.3%)
Zoonotic RiskParasite/cat*							
0	30.6% (n = 11)	33.3% (n = 4)	16.7% (n = 4)	45.8% (n = 11)	16.7% (n = 3)	40% (n = 12)	15 (31.3%)
1	52.8% (n = 19)	33.3% (n = 4)	54.2% (n = 13)	41.7% (n = 10)	72.2% (n = 13)	33.3% (n = 10)	23 (47.9%)
2	5.6% (n = 2)	8.3% (n = 1)	8.3% (n = 2)	4.2% (n = 1)	0% (n = 0)	10% (n = 3)	3 (6.3%)
3	11.1% (n = 4)	25% (n = 3)	20.8 (n = 5)	8.3 (n = 2)	11.1 (n = 2)	16.7% (n = 5)	7 (14.6%)

drated in serial concentrations of ethanol, cleared in xylene, mounted in DPX, and then identified morphologically to species according to existing descriptions and keys (Yamaguti 1958, 1959; Schmidt 1986). Nematode specimens were fixed in 70% (v/v) warm ethanol and stored in 70% ethanol containing 5% glycerol before being cleared by lactophenol and identified to species according to existing descriptions and keys (Skrjabin *et al.* 1991).

Faecal samples collected from the intestine were examined for parasitic infection. Ether-sedimentation and saturated sodium chloride flotation techniques were used to identify by light microscopy the parasitic dissemination elements.

Statistical analysis was done using SPSS (version 21.0). Chi-squared test (χ^2) was used to compare prevalence between age, sex or capture zone and parasite infection rates. Differences were considered significant at $p < 0.05$. Confidence intervals (95 %) were calculated by means of exact Clopper-Pearson method.

Results

Most of the analyzed cats showed at least one species of helminth (77.1%). Seven helminth species (one trematode, two cestodes and four nematodes) were identified based on their morphology (Table I).

Cestodes were the most prevalent (75%) and 36 out of 48 cats were positive at least to one species of cestode, being *Dipylidium caninum* (64.6%) and *Taenia taeniformis* (31.3%) the only species observed. In the case of nematodes, the prevalence was 22.9% and there were four species detected: *Toxocara cati* (20.8%), *Ancylostoma tubaeforme* (18.8%), *Aelurostrongylus abstrusus* (10.4%) and *Trichuris vulpis* (2.08%) (Table I). Interestingly, *Dirofilaria immitis* was not detected in any of the animals of the present study.

High prevalence of zoonotic parasitic helminths was found, and 68.7% of the cats were parasitized by at least one of the five potential zoonotic parasites found: 23 cats (47.9%) harbored a single zoonotic species, 3 cats (6.3%) harbored two zoonotic species and other 7 cats three zoonotic species. Only 22.9% were negative to any parasite (Table II).

The fecal samples done in 28 out of 48 animals showed the occurrence of single infections and co-infections by different species of parasites (58.3%). Five of these animals revealed the presence of L1 of *Aelurostrongylus* spp. However, in relation to trematodes, only one animal showed *Alaria* spp. eggs.

There were not significant differences between sex, weight and age, and captured areas. No relationship of captured areas with parasite prevalence was detected ($p = 0.5$).

Discussion

In touristic areas, close contact of cats with humans can increase transmission of zoonotic diseases and affect public

health (Soriano *et al.* 2010). There are potential feline transmitted zoonotic parasites, such as *Dipylidium caninum*, *Toxocara* spp, *Ancylostoma tubaeforme* and *Dirofilaria immitis* that have been reported in different countries (Fenoy *et al.* 1997; Overgaauw 1997; Millán and Casanova 2009; Genchi *et al.* 2011). In the present study, the feral cats harbored five zoonotic parasites, *Ancylostoma tubaeforme*, *Toxocara cati*, *Dipylidium caninum*, *Taenia taeniformis* and *Trichuris vulpis*, showing a prevalence of 18.8%, 20.8%, 64.6%, 31.3% and 2.08% respectively. In Gran Canaria, as in many touristic areas, cats freely scavenge rubbish, gardens and street for food. In addition, tourists find that feeding these stray animals contribute to their welfare. This factor, couple with the public's poor understanding of disease transmission, and the hazards of pet faeces with respect to transmitting infectious diseases, underscores the importance of education in reducing the incidence of infections to avoid its transmission to other pets and humans.

Although numerous studies have described the worldwide prevalence of intestinal parasites in feral cats, only few published reports involved feline populations in the Canary Islands (Sánchez 2013). The overall prevalence of 77.1% of helminths in this study was higher than that reported in other studies involving stray cats in Spain (Miró *et al.* 2004; Torres *et al.* 2006), Portugal (23.1%) (Duarte *et al.* 2010), Germany (33.6%) (Becker *et al.* 2012) and the UK (34.8%) (Nichol *et al.* 1981b). However, our data are in accordance with those reported by Millán and Casanova (2009) in Majorca Island (Spain) –another popular Spanish tourist destination in Europe– where all the 58 feral cats were parasitized by at least one species of helminth. This high prevalence could suggest a lack of parasite control and easier access to intermediate hosts as have been reported in other studies (Calvete *et al.* 1998; Millán and Casanova 2009).

In relation to the detected species in this study, *Dipylidium caninum* (64.6%), followed by *Taenia taeniformis* (31.3%) showed the highest prevalence. The abundance of cestodes has been reported in the small intestine of dogs, cats, mice and wild carnivores since 1959 by Jimenez and continues to be valid nowadays (Calvete *et al.* 1998; Millán and Casanova 2007, 2009).

The ascarid, *Toxocara cati* (20.8%) and the hookworm, *Ancylostoma tubaeforme* (18.8%) were the most commonly detected nematode. Necropsy surveys have shown that these worms represent the most common intestinal helminth parasites of cats worldwide (Barutzki and Schaper 2003; Ferreira *et al.* 2011), both with zoonotic potential. The prevalence of *Toxocara* infections in our study was similar to that found in stray cats and animal shelters (Calvete *et al.* 1998; Robben *et al.* 2004; Gracenea *et al.* 2009; Millán and Casanova 2009). However, lower prevalence has been observed in faecal analysis in household cats (Overgaauw *et al.* 2009), which is probably related with a lower exposure rate and the preventive deworming treatments. In the case of *Ancylostoma tubaeforme*, the prevalence found in this study was 18.8%. Other

studies on feral cats elsewhere have found similar results (Coman *et al.* 1981; Shaw *et al.* 1983; Vanparijs *et al.* 1991). In contrast, higher prevalence (91%) was observed in the gastrointestinal tract of cats analysed in Balearic Island, Spain (Millán and Casanova 2009). These two helminth species (*Toxocara* and *Ancylostoma*) may produce several larva migrans syndromes, including severe ocular or neurological damage in humans in case of *Toxocara* (Lee *et al.* 2010). Data obtained in this survey suggest that cats may constitute a potential source of infection to domestic animals and humans and can contribute significantly to the environmental burdens of these parasites in rural and urban areas. This fact has been recognized by several authors as being a significant feature in the spread of zoonotic and animal parasites (Széll *et al.* 2013).

Alaria spp. was found in this survey parasitizing the small intestine in one of the feral cats. This could be the first report of the presence of *Alaria* spp. in the Macaronesian area. However, we only detected the presence of *Alaria* spp. eggs in faeces, but not any parasite adults were observed in the intestine. This finding could suggest a pseudoparasitism originated by predation of some prey. Infestations by trematodes of genus *Alaria* are common in wild carnivores in many European countries (Criado-Fornelio *et al.* 2000; Wolfe *et al.* 2001; Segovia *et al.* 2003; Moks *et al.* 2006; Saeed *et al.* 2006). Infection are generally non-pathogenic for cats and dogs (Zajac and Conboy 2006). Although there are not been reported human cases of alariosis in Europe (Rentería-Solís *et al.* 2013), it is evident that a zoonotic risk can be presumed and a potential danger of this parasite has to be taken into consideration (Mohl *et al.* 2009; Portier *et al.* 2011). Therefore, the German Federal Institute for Risk Assessment (BfR), in its opinion No.027/2007, 1 July 2007 (Anonymous 2007), emphasized the pathogenic potential of this parasite.

Aelurostrongylus abstrusus was found in the faeces of five of the analysed animals (10.4%). This is the first description of these lungworms in the Canary Islands (Spain). Bronchopulmonary infestations by *A. abstrusus* have been well documented in cats throughout most European countries with similar prevalence rates that ranged from 1% to 24.4%, according to sampled populations and detection procedures (e.g., copromicroscopy or molecular detection) (Grandi *et al.* 2005; Taubert *et al.* 2009; Jefferies *et al.* 2010; Traversa *et al.* 2010). In the present study, lizards and birds were found in the digestive tract of our animals, suggesting that they could act as paratenic hosts for many metastrongylid species when they are predated upon by cats, as has been reported by Jefferies *et al.* (2010). Recent reports have indicated that infection in cats may be much more common than previously thought in endemic areas of Europe (Payo-Puente *et al.* 2008; Traversa *et al.* 2008, 2010). Moreover, emphasis should be placed on the diversity and potential for co-infections of cat metastrongylid species in Europe (Jefferies *et al.* 2010).

Interestingly, in spite of the high prevalence of *Dirofilaria immitis* in dogs from Gran Canaria, this parasite was not detected in any of the heart samples examined. Nevertheless, re-

ports done by Montoya-Alonso *et al.* (2011) in cats from Gran Canaria island showed high seroprevalence (33%) using a commercial ELISA test kit. This high percentage could be due to tests used for the detection of circulating antibodies may overestimate the number of infected cats, with a high number of false positives (Berdoulay *et al.* 2004).

In conclusion, the present study demonstrated that the prevalence of parasites in feral cats in Gran Canaria island was high. These animals are reservoir of helminthes that may affect their health status and increase the zoonotic risk. We did not found differences between age, sex and captured areas parameters, suggesting a widespread distribution of helminth infective forms. Rates of intestinal and lung parasites and of zoonotic species found in feral cats in this study suggest the need of controlling these parasitic infections through regular diagnostic testing, effective therapeutic protocols and preventive measures.

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Conflict of interest

The authors declare no conflict of interest

References

- Adams P.J., Elliot A.D., Algar D., Brazell R.I. 2008. Gastrointestinal parasites of feral cats from Christmas Island. *Australian Veterinary Journal*, 86, 60–63. DOI: 10.1111/j.1751-0813.2007.00246.x
- Anonymous. 2007. Bundesinstitut für Risikobewertung Wildschweinfleisch kann den gefährlichen Dunckerschen Muskelegel enthalten. Stellungnahme Nr.027/2007 des BfR, 1 July 2007. Available at http://www.bfr.bund.de/cm/343/wildschweinfleisch_kann_den_gesundheitsgefahrlichen_dunckerschen_muskelegel_enthalten.pdf (accessed 9 January 2013)
- Barutzki D., Schaper R. 2003. Endoparasites in dogs and cats in Germany 1999-2002. *Parasitology Research*, Suppl 3, S148–150
- Becker A.C., Rohen M., Epe C., Schnieder T. 2012. Prevalence of endoparasites in stray and forested dogs and cats in Northern Germany. *Parasitology Research*, 111, 849–857. DOI: 10.1007/s00436-012-2909-7
- Berdoulay P., Levy J.K., Snyder P.S., Pegelow M.J., Hooks J.L., Tavares L.M., Gibson N.M., Salute M.E. 2004. Comparison of serological tests for the detection of natural heartworm infection in cats. *Journal of American Animal Hospital Association*, 40, 376–384
- Beugnet F., Bourdeau P., Chalvet-Monfray K., Cozma V., Farkas R., Guillot J., Halos L., Joachim A., Losson B., Miró G., Otranto D., Renaud M., Rinaldi L. 2014. Parasites of domestic owned cats in Europe: co-infestations and risk factors. *Parasites & Vectors*, 7, 291. DOI: 10.1186/1756-3305-7-291

- Calvete C., Lucientes J., Castillo J.A., Estrada R., Gracia M.J., Peribanez M.A., Ferrer M. 1998. Gastrointestinal helminth parasites in stray cats from the mid-Ebro Valley, Spain. *Veterinary Parasitology*, 75, 235–240
- Coelho W.M., Amarante A.F., Apolinário J.C., Coelho N.M., Bresciani K.D. 2011. Occurrence of *Ancylostoma* in dogs, cats and public places from Andradina city, São Paulo state, Brazil. *Revista do Instituto de Medicina Tropical de São Paulo*, 53, 181–184
- Coman B.J., Jones E.H., Driesen M.A. 1981. Helminth parasites and arthropods of feral cats. *Australian Veterinary Journal*, 57, 324–327
- Criado-Fornelio A., Gutierrez-Garcia L., Rodriguez-Caabeiro F., Reus-Garcia E., Roldan-Soriano M.A., Diaz-Sanchez M.A. 2000. A parasitological survey of wild red foxes (*Vulpes vulpes*) from the province of Guadalajara, Spain. *Veterinary Parasitology*, 92, 245–251
- Duarte A., Castro I., Pereira da Fonseca I.M., Almeida V., Madeira de Carvalho L.M., Meireles J., Fazendeiro M.I., Tavares L., Vaz Y. 2010. Survey of infectious and parasitic diseases in stray cats at the Lisbon Metropolitan Area, Portugal. *Journal of Feline Medicine and Surgery*, 12, 441–446. DOI: 10.1016/j.jfms.2009.11.003
- Dubey J.P., Moura L., Majumdar D., Sundar N., Velmurugan G.V., Kwok O.C., Kelly P., Krecsek R.C., Su C. 2009. Isolation and characterization of viable *Toxoplasma gondii* isolates revealed possible high frequency of mixed infection in feral cats (*Felis domesticus*) from St Kitts, West Indies. *Parasitology*, 136, 589–594. DOI: 10.1017/S0031182009006015
- ESCCAP (European Scientific Counsel Companion Animal Parasites). 2010. Guideline 01 second edition. Worm Control in dogs and cats
- Fenoy S., Cuéllar C., Guillén J.L. 1997. Serological evidence of toxocarasis in patients from Spain with a clinical suspicion of visceral larva migrans. *Journal of Helminthology*, 71, 9–12
- Ferreira F.S., Pereira-Baltasar P., Parreira R., Padre L., Vilhena M., Távora Tavira L., Atouguia J., Centeno-Lima S. 2011. Intestinal parasites in dogs and cats from the district of Évora, Portugal. *Veterinary Parasitology*, 179, 242–245. DOI: 10.1016/j.vetpar.2011.02.003
- Genchi C., Kramer L.H., Rivasi F. 2011. Dirofilarial infections in Europe. *Vector Borne Zoonotic Diseases*, 11, 1307–1317. DOI: 10.1089/vbz.2010.0247
- Gracenea M., Soledad-Gómez M., Torres J. 2009. Prevalence of intestinal parasite in shelter dogs and cats in the metropolitan area of Barcelona (Spain). *Acta Parasitologica*, 54, 73–77. DOI: 10.2478/s11686-009-0005-7
- Grandi G., Calvi L.E., Venco L., Paratici C., Genchi C., Memmi D., Kramer L.H. 2005. *Aelurostrongylus abstrusus* (cat lungworm) infection in five cats from Italy. *Veterinary Parasitology*, 134, 177–182
- Headley S.A., Gillen M.A., Sanches A.W., Satti M.Z. 2012. Platynosomum fastosum-induced chronic intrahepatic cholangitis and Spirometra spp. infections in feral cats from Grand Cayman. *Journal of Helminthology*, 86, 209–214. DOI: 10.1017/S0022149X11000265
- Jefferies R., Globokar Vrhovec M., Wallner N., Roman Catalanc D. 2010. *Aelurostrongylus abstrusus* and *Triglostrongylus* sp. (Nematoda: Metastrongyloidea) infections in cats inhabiting Ibiza, Spain. *Veterinary Parasitology*, 173, 344–348. DOI: 10.1016/j.vetpar.2010.06.032
- Jiménez-Millán F. 1959. Contribución al estudio de los helmintos parásitos de los animales domésticos. *Revista Ibérica de Parasitología*, 19, 25–68
- Lee A.C.Y., Schantz P.M., Kazacos K.R., Montgomery S.P., Bowman D.D. 2010. Epidemiology and zoonotic aspects of ascarid infections in dogs and cats. *Trends of Parasitology*, 26, 155–161. DOI: 10.1016/j.pt.2010.01.002
- Millán J., Casanova J.C. 2007. Helminth parasites of the endangered Iberian lynx (*Lynx pardinus*) and sympatric carnivores. *Journal of Helminthology*, 81, 377–380
- Millán J., Casanova J.C. 2009. High prevalence of helminth parasites in feral cats in Majorca Island (Spain). *Parasitology Research*, 106, 183–188. DOI: 10.1007/s00436-009-1647-y
- Miró G., Gómez M. 1999. Parasitosis Respiratorias y Cardiopulmonares. In: Parasitología Veterinaria. Editores: Cordero del Campillo, M. e Rojo Vasquez, F.A McGraw-Hill, Interamericana, pp. 696–697.
- Miró G., Montoya A., Jiménez S., Frisuelos C., Mateo M., Fuentes I. 2004. Prevalence of antibodies to *Toxoplasma gondii* and intestinal parasites in stray, farm and household cats in Spain. *Veterinary Parasitology*, 126, 249–255
- Mohl K., Grosse K., Hamedy A., Wuste T., Kabelitz P., Lucker E. 2009. Biology of *Alaria* spp. and human exposition risk to *Alaria mesocercariae* – a review. *Parasitology Research*, 105, 1–15. DOI: 10.1007/s00436-009-1444-7
- Moks E., Jogisalu I., Saarma U., Talvik H., Jarvis T., Valdmann H. 2006. Helminthologic survey of the wolf (*Canis lupus*) in Estonia, with an emphasis on *Echinococcus granulosus*. *Journal of Wildlife Diseases*, 42, 359–365
- Montoya-Alonso J.A., Carretón E., Corbera J.A., Juste M.C., Mellado I., Morchón R., Simón F. 2011. Current prevalence of *Dirofilaria immitis* in dogs, cats and humans from the island of Gran Canaria, Spain. *Veterinary Parasitology*, 176, 291–294. DOI: 10.1016/j.vetpar.2011.01.011
- Morchón R., Ferreira A.C., Martín-Pacho J.R., Montoya A., Mortarino M., Genchi G., Simón, F. 2004. Specific IgG antibody response against antigens of *Dirofilaria immitis* and its *Wolbachia endosymbiont bacterium* in cats with natural and experimental infections. *Veterinary Parasitology*, 125, 313–321. DOI: 10.1016/j.vetpar.2004.08.003
- Nichol S., Ball S.J., Snow K.R. 1981a. Prevalence of intestinal parasites in domestic cats from the London area. *The Veterinary Record*, 109, 252–253
- Nichol S., Ball S.J., Snow K.R. 1981b. Prevalence of intestinal parasites in feral cats in some urban areas of England. *Veterinary Parasitology*, 9, 107–110
- Overgaauw P.A.M. 1997. Prevalence of intestinal nematodes of dogs and cats in the Netherlands. *Veterinary Quarterly*, 19, 14–17
- Overgaauw P.A.M., Van Zutphen L.V., Hoek D., Yaya F.O., Roelfsema J., Pinelli E., Knapen F.V., Kortbeek L.M. 2009. Zoonotic parasites in fecal samples and fur from dogs and cats in The Netherlands. *Veterinary Parasitology*, 163, 115–122. DOI: 10.1016/j.vetpar.2009.03.044
- Payo-Puente P., Botelho-Dinis M., Carvaja Urueña A.M., Payo-Puente M., Gonzalo-Orden J.M., Rojo-Vazquez F.A. 2008. Prevalence study of the lungworm *Aelurostrongylus abstrusus* in stray cats of Portugal. *Journal of Feline Medicine and Surgery*, 10, 242–246. DOI: 10.1016/j.jfms.2007.12.002
- Portier J., Jouet D., Ferté H., Gibout O., Heckmann A., Boireau P., Vallée I. 2011. New data in France on the trematode *Alaria alata* (Goeze, 1792) obtained during *Trichinella* inspections. *Parasite*, 18, 271–275
- Rentería-Solis Z.M., Hamedy A., Michler F.U., Michler B.A., Lücker E., Stier N., Wibbelt G., Riehn K. 2013. *Alaria alata mesocercariae* in raccoons (*Procyon lotor*) in Germany. *Parasitology Research*, 112, 3595–3600. DOI: 10.1007/s00436-013-3547-4
- Robben S.R.M., le Nobel W.E., Döpfer D., Hendrikx W.M.L., Boersema J.H., Franssen F., Eysker M.E. 2004. Infections with helminths and/or protozoa in cats in animal shelters in the Netherlands. *Tijdschrift Voor Diergeneeskunde*, 129, 2–6

- Rodríguez-Ponce, E., Molina, J.M., Hernández, S., 1995. Seroprevalence of goat toxoplasmosis on Grand Canary Islands. *Preventive Veterinary Medicine*, 24: 229–234
- Saeed I., Maddox-Hyttel C., Monrad J., Kapel C.M. 2006. Helminths of red foxes (*Vulpes vulpes*) in Denmark. *Veterinary Parasitology*, 139, 168–179
- Sánchez S. 2013. Contribución al conocimiento de la parasitofauna (Helminths y Artrópodos) de mamíferos no lagomorfos de Canarias. PhD University of Barcelona, pp. 425
- Schmidt G.D. (Ed.). 1986. Handbook of tapeworm identification. CRC Press, Boca Raton
- Segovia J.M., Guerrero R., Torres J., Miquel J., Feliu C. 2003. Ecological analyses of the intestinal helminth communities of the wolf, *Canis lupus*, in Spain. *Folia Parasitologica*, 50, 231–236
- Shaw J., Dunsmore J., Jakob-Hoff R. 1983. Prevalence of some gastrointestinal parasites in cats in the Perth area. *Australian Veterinary Journal*, 60, 151–152
- Skrjabin K.I., Shikhobalova N.P., Mozgovoi A.A. 1991. Suborder Ascaridata Skrjabin, 1915. In: Skrjabin K.I. (ed) Key to parasitic nematodes. Amerind, New Delhi, pp. 423–595
- Soriano S.V., Pierangeli N.B., Rocca I., Bergagna H.F.J., Lazzarini L.E., Celescinco A., Saiz M.S., Kossman A., Contreras P.A., Arias C., Basualdo J.A. 2010. A wide diversity of zoonotic intestinal parasites infects urban and rural dogs in Neuquén, Patagonia, Argentina. *Veterinary Parasitology*, 167, 81–85. DOI: 10.1016/j.vetpar.2009.09.048
- Stojanovic V.L., Foley P. 2011. Infectious disease prevalence in a feral cat population on Prince Edward Island, Canada. *Canadian Veterinary Journal*, 52, 979–982
- Szél Z., Marucci G., Pozio E., Sréter T. 2013. *Echinococcus multilocularis* and *Trichinella spiralis* in golden jackals (*Canis aureus*) of Hungary. *Veterinary Parasitology*, 197, 393–396. DOI:10.1016/j.vetpar.2013.04.032
- Taubert A., Pantchev N., Globokar Vrhovec M., Bauer C., Hermosilla C. 2009. Lungworm infections (*Angiostrongylus vasorum*, *Crenosoma vulpis*, *Aelurostrongylus abstrusus*) in dogs and cats in Germany and Denmark in 2003–2007. *Veterinary Parasitology*, 159, 175–180
- Torres, J., Miquel, J., Casanova, J.C., Ribas, A., Feliu, C., Morand, S. 2006. Endoparasite species richness of Iberian carnivores: influences of host density and range distribution. *Biodiversity and Conservation*, 15:4619–4632. DOI: 10.1007/s10531-005-5824-8
- Traversa D., Di Cesare A., Milillo P., Iorio R., Otranto D. 2008. *Aelurostrongylus abstrusus* in a feline colony from central Italy: clinical features, diagnostic procedures and molecular characterization. *Parasitology Research*, 103, 1191–1196. DOI: 10.1007/s00436-008-1115-0
- Traversa D., Di Cesare A., Conboy G. 2010. Canine and feline cardiopulmonary parasitic nematodes in Europe: emerging and underestimated. *Parasites & Vectors*, 3, 62. DOI: 10.1186/1756-3305-3-62
- Vanparijs O., Hermans L., Van der Flaes L. 1991. Helminth and protozoan parasites in dogs and cats in Belgium. *Veterinary Parasitology*, 38, 67–73
- Wolfe A., Hogan S., Maguire D., Fitzpatrick C., Vaughan L., Wall D., Hayden T.J., Mulcahy G. 2001. Red foxes (*Vulpes vulpes*) in Ireland as hosts for parasites of potential zoonotic and veterinary significance. *The Veterinary Record*, 149, 759–763
- Yamaguti S. 1958. Systema Helminthum, vol 1. The digenetic trematodes of vertebrates. Interscience, New York
- Yamaguti S. 1959. Systema Helminthum, vol 2. The cestodes of vertebrates. Interscience, New York
- Zajac A.M., Conboy G.A. 2006. Veterinary Clinical Parasitology, 7th edition. Blackwell Publishing; Ames, Iowa, pp. 64

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