DOI: 10.2478/s11686-013-0132-z
© W. Stefański Institute of Parasitology, PAS
Acta Parasitologica, 2013, 58(3), 278–283; ISSN 1230-2821

Follow-up study of prevalence and control of ascariasis in swine populations in Serbia

Tamara Ilić[1], Zsolt Becskei[2]*, Aleksandar Tasić[3] and Sanda Dimitrijević[1]

[1]Faculty of Veterinary Medicine of the University of Belgrade, Department for Parasitic Diseases, Serbia;
[2]Faculty of Veterinary Medicine of the University of Belgrade, Department for Animal Breeding, Serbia;
[3]Medical Faculty of the University of Nis, Department for Microbiology and Parasitology, Serbia

Abstract

The cause of the most significant helminth diseases in swine – *Ascaris suum*, can also causes infections in humans. The use of swine manure in agriculture renders the eggs of this ascaridida an accessible source of infection, thus posing a significant risk factor for human health. With the objective of proving the prevalence of infection with *A. suum* nematodes in the territory of Serbia, investigations were carried out in the period between 2007–2011 in the territories of five districts: North Bačka, South Banat, Braničevo, Zlatibor and Nišava. The investigations covered coprological examinations of 1031 feces samples of swine originating from farms owned by individual breeders. The samples were examined using the standard flotation method with a saturated water solution of NaCl. The established prevalence of ascariasis infection amounted to 47.62% (1031/491). The biggest prevalence of infection was determined in the territory of the Braničevo District, 65.78% (301/198), and the smallest in the territory of the Nišava District, 32.24% (183/59). In spite of its prevalence and vast economic importance, there is still insufficient information about the key aspects of the biology and epidemiology of *A. suum*. Viewed from the aspect of epizootiology, it is very important to know the prevalence of swine infections with *Ascaris* because of the possible infection of humans by its migrating larvae.

Keywords

Ascariasis, swine, humans, visceral larva migrans

Introduction

Ascariasis is the most significant helminth infection in swine, which is caused by nematoda – a parasite of the small intestine. Due to the biological characteristics of the cause, the disease has spread throughout the world, it is maintained stationary under conditions of intensive and extensive breeding, and it inflicts serious economic damages to swine production.

The disease is characterised by disrupted function of the digestive tract (delayed growth and development of young animals), pneumonia (during the period of larval migration through the lungs), and lowered resistance to diseases of other etiology.

Possibilities for the infection of humans, as non-specific hosts, with migrating larvae of *A. suum* increase the importance of ascariasis, ranking it among possibly zoonoses. A more detailed analysis of the development cycle of *A. suum* in the swine organism raises two new questions in connection with the biology and pathogenesis of this cause in the human organism. Firstly, what is the migratory and developmental behaviour of *A. suum* in the human organism, and, secondly, is there a possible risk of lesions developing in the liver? In describing the life cycle of this nematode, most authors neglect the obligatory stage of development that takes place in the swine liver (Murrell *et al*. 1997). This moment is very important for human medicine, since visceral larva migrans is a consequence of the migration of parasitic larvae through the host internal organs. The tissue phase of certain nematodes in humans (*Strongyloides stercoralis* and *Ascaris lumbricoides*) can cause a syndrome similar to that of the visceral larva migrans (Sakai *et al*. 2006).

Leles *et al*. (2012) present and discuss paleoparasitological and genetic evidence that complement new data to evaluate the origin and evolution of *Ascaris* spp. in humans and pigs, and the uniqueness of the species in both hosts. They conclude that *Ascaris lumbricoides* and *A. suum* are a single species and that the name *A. lumbricoides* Linnaeus, 1758 has

*Corresponding author: beckeizolt@gmail.com

Fig. 1. Survey of distribution and prevalence of *Ascaris suum* in some districts in Serbia

taxonomic priority; therefore *A. suum* Goeze, 1782 should be considered a synonym of *A. lumbricoides.*

Hosts contact *Ascaris* infection via the faecal-oral route. It is known that when infective eggs are ingested and hatch, *Ascaris* larvae develop in host parenteral tissues. The larval migratory route is similar in both human and pig hosts. Following ingestion of infective ova, L_3 larvae covered by the L_2 cuticle, hatch in the small intestine and migrate to the caecum and proximal colon where they penetrate the mucosa. The larvae then migrate via the portal blood to reach the liver, where the L_2 cuticle is shed. After migration in the liver, the larvae advance to the lungs on days 6–8 p.i. The larvae penetrate the alveolar space and move to the pharynx where they are swallowed, resulting in returning to the small intestine on days 8–10 p.i. *Ascaris suum* moult again to L_4 stage larvae in the small intestine on day 10 p.i. Larvae mature and reach sexual maturity in the small intestine, moulting again (L_5 stage larvae) on day 24 p.i. The hepato-tracheal migration takes place over a 10–14-day period after the uptake of eggs in pigs and humans. Adult worms may reside in the intestines for approximately one year, but the majority of worms are expelled by the 23rd week of infection in pigs (Dold and Holland 2011).

From the aspect of epizootiology, it is a very important characteristic of eggs of the Ascarididae type that they maintain their infectiousness in the outer environment for a long time. The very frequent use of swine manure (in particular in the USA and Europe), renders these eggs an accessible source of infection and presents a significant possibility for a public health hazard (Anderson 1995; Maruyama *et al*. 1996).

Materials and Methods

Investigations were carried out in the territories of five districts of the State of Serbia: North Bačka, South Banat, Braničevo, Zlatibor and Nišava, in the period from 2007 until 2011. In the course of these investigations, 1031 feces samples were examined from swine originating from farms owned by individual breeders. The examined material was sampled from swine maintained under extensive and semi-intensive conditions. The material was sampled in the period March-April and September-October.

Feces was sampled twice a year, because it is necessary to conduct regular coprological investigations at least twice during the year, based on the results to devise planning programs dehelminthization.

The samples were investigated using the qualitative method of coprological examinations with a concentration of parasitic elements.The standard method of flotation with a saturated water solution of NaCl was used, of 1.200 specific weight at a temperature of 20°C (Kassai 1998).

No tested animals has been previously treated with antiparasitics, neither they have been implemented by the programs of dehelmintization.

Results

In the course of the performed investigations, out of the total number of examined samples (1031), 268 were from the territory of the Bačka District, 163 from the territory of the South Banat District, 301 from the territory of the Braničevo District, 116 from the territory of the Zlatibor District, and 183 from the territory of the Nišava District.

The results of coprological analyses demonstrate that, during the observed five-year period, the highest prevalence of infection with *A. suum* nematodes was established in the territory of the Braničevo District, where it amounted to 65.78% (301/198). In the territory of the South Banat District, the prevalence of this ascarid infection stood at 44.17% (163/72), in the territory of the North Bačka District at 42.53% (268/114), in the territory of the Zlatibor District at 41.38% (116/48), while the prevalence of infection in the territory of the Nišava District was the lowest and stood at 32.24% (183/59) (Fig. 1).

In the territory of the North Bačka District, a gradual increase in the number of infected swine was observed, with the lowest prevalence of infection being recorded in the first year of investigations, amounting to 20.00% (50/10). Each successive year showed a higher prevalence of this nematode infection, and it reached its highest value of 58.82% (68/40) in the final year of the follow-up research. A higher prevalence of infection in the territory of the South Banat District was recorded during 2008, when it stood at 50.00% (28/14), while the lowest prevalence was established in 2010, when it amounted to 39.13% (23/9). There were only slight differences in the values for the infection prevalence among swine in the territory of the Braničevo District. The presence of the studied ascaridida was most prominent during 2011, when the prevalence of infection amounted to 70.37% (81/57), while the lowest value was recorded one year previously, that of 60.53% (38/23). The highest prevalence of infection in the territory of the Zlatibor District was established in the year 2010, that of 50.00% (30/15), while the lowest value was recorded in the last year of research, when the prevalence of infection was 31.25% (16/5). In the year 2007, the highest prevalence of ascariasis was recorded in the territory of the Nišava District, 43.33% (30/13). The lowest recorded value for the prevalence of this infection was established in 2010, of 23.33% (30/7).

During the period from 2007 until 2011, a total of 1031 feces samples were examined from swine in certain localities of Serbia, and 491 were found to be positive, so that the prevalence of infection stood at 47.62% (Table I).

Samples of these investigations (1031) refer to the 4150 pigs from 195 households of private owners, which are held exclusively extensive and semi-intensive (Table II).

Since the most important potential source of *Ascaris* infection are just pigs reared in this way, we decided to determine the prevalence of ascariasis just for them. According to the last reports of the Statistical Office of the Republic of Serbia from 2011 in North Bačka District were 164,000 pigs in the South Banat 137,000, the District Braničevski 189,000,

Table I. Prevalence of swine ascariosis in certain epizootiological areas of Serbia during the period 2007–2011

District	Period of research 2007–2011			Prevalence of infection per year (%)				
	Total number of examined samples	Number of positive samples	Prevalence of infection per district (%)	2007	2008	2009	2010	2011
North Bačka	268	114	42.53	**20.00** (50/10)	**35.00** (40/14)	**43.10** (58/25)	**48.07** (52/25)	**58.82** (68/40)
South Banat	163	72	44.17	**45.00** (40/18)	**50.00** (28/14)	**40.00** (45/18)	**39.13** (23/9)	**48.14** (27/13)
Braničevo	301	198	65.78	**62.50** (40/25)	**62.68** (67/42)	**68.00** (75/51)	**60.53** (38/23)	**70.37** (81/57)
Zlatibor	116	48	41.38	**40.74** (27/11)	**40.00** (25/10)	**38.88** (18/7)	**50.00** (30/15)	**31.25** (16/5)
Nišava	183	59	32.24	**43.33** (30/13)	**33.33** (36/12)	**30.95** (42/13)	**23.33** (30/7)	**31.11** (45/14)
TOTAL	1031	491	47.62					

Table II. The total number of households in the districts from which the material was sampled and the number of pigs per household for the period since 2007 to 2011 year

District	Number of samples	Number of tested households	Number of pigs tested per household	Number of samples/number of pigs tested in households (%)
North Bačka	268	30	30 x 40 =1200	22,33
South Banat	163	40	40 x 20 = 800	20,35
Braničevo	301	55	55 x 20 =1100	27,36
Zlatibor	116	30	30 x 15 = 450	25,77
Nišava	183	40	40 x 15 = 600	30,50
TOTAL	**1031**	**195**	**4150**	**24,84**

in Zlatibor 33,000 and the Nis District 70,000. In the Northern and Southern part of Serbia (Bačka District, South Banat District and Nišava District) pigs are breeding under semi-intensive menagement, unlike in the Central Serbia where pigs are breeding traditionally under extensive conditiones.

Discussion

Investigations carried out in the past decade, in different parts of the world, most authentically demonstrate the prevalence of infections caused by this nematode (Boes *et al*. 2010; Haugegaard 2010; Sanchez-Vazquez *et al*. 2012). Roepstorff *et al.* (1998) presented data on the prevalence of swine ascariasis in Germany, Norway and Sweden (25–35%), Ireland (13%) and Finland (5%). Boes *et al*. (2000) reported that the prevalence of swine infections with *A. suum* in rural areas of China stood at 36.7%. Investigating swine maintained in intensive breeding conditions, also in China, Weng *et al*. (2005) established a 2.5% prevalence of infection. Luna and Kyvsgaard (2005) reported that a prevalence of infection with *A. suum* of 42.86% was established in Nicaragua in swine older than 6 months, and of 48.98% in swine younger than 6 months. A low prevalence of swine infection with ascarids was proven in Brazil, of 3% (Gomes *et al*. 2005). Tamboura *et al*. (2006) proved ascariasis in 40% swine in the territory of Burkina Faso (West Africa). Marufu *et al*. (2008) performed investigations in the period from 2005 until 2006 in swine in Zimbabwe and proved a relatively low prevalence of ascarid infection (7%). During this same period, Nganga *et al*. (2008) reported findings of the cause of ascariasis in 28.7% of the total number of examined swine in Kenya.

The results obtained in these investigations indicate that in the territory of Serbia, among the 5 examined localities, the prevalence of infection with *A. suum* species was the highest in the territory of the Braničevo District and stood at 65.78% (301/198). The lowest prevalence of infection with this ascarid was established in the territory of the Nišava District and stood at 32.24% (183/59). These results are explained with the fact that the general zoohygienic conditions of breeding and maintaining swine in these two localities are essentially different. Livestock of swine in the territories of the Braničevo and the North Bačka districts is considerably larger than in the territories of the other examined districts, which is also why the biggest number of swine covered by these investigations originated from these localities. The figure of 47.62% indicates that the prevalence of infection with this nematode in Serbia is relatively high, which can be explained with the fact that the examined swine had not been regularly dewormed.

From the aspect of epizootiology, it is very important to know the prevalence of swine ascarid infections because of the possibility of human infection through migrating larvae of this nematode (Lavikainen 2010). *Ascaris suum* eggs remain capable of being infectious for a long time because they are very resistant to drying and are well adapted to a wide range of temperatures (Rosypal *et al*. 2011). Humans are usually infected through the consumption of fresh vegetables cultivated using swine manure or through the consumption of insufficiently thermally processed livers of cattle or chickens that contain larvae. Cattle and poultry can be paratenic hosts for these nematodes (Maruyama *et al*. 1996). *Ascaris suum* less frequently causes visceral larva migrans in humans, with the symptoms differing depending on the number of migrating larvae and the type of the affected tissue (Nakata *et al*. 2002; Xinou *et al*. 2003).

Following infection, larvae migrate into the liver, lungs, eye, myocardium, or the CNS of humans. As a result of the localization of larvae in the liver or lungs, eosinophilic pneumonia occurs (Sakakibara *et al*. 2002), and it is also possible to find pseudotumors and lesions in the liver (Kim *et al*. 2002; Kakihara *et al*. 2004). Rare cases of myocarditis have also been established (Abe *et al*. 2002), as well as ophthalmopathy (Yokoi *et al*. 2003) and neurological disorders such as meningitis, myelitis, encephalopathy, and myeloradiculitis (Inatomi *et al*. 1999; Osoegava *et al*. 2001; Xinou *et al*. 2003).

The impact of larval migration within human hosts remains an elusive topic for obvious ethical reasons. An inflammatory reaction in the liver has been observed in *A. lumbricoides* and *A. suum* infected humans, pigs and model organisms such as calves, guinea pigs, rabbits and mice. In *A. suum* infections, white spots are white pathological lesions that are formed by the mechanical injury and inflammatory response induced by migrating larvae in the liver. White spots formation over the superficial hepatic surface and within the liver tissue is characteristic of porcine infections in response to larval migration through the liver (Dold and Holland 2011).

The prevalence of *A. suum* infection varies with geographical region and farm management practices but few swine herds are totally free of infection. Porcine ascariasis interferes with the health and performance of pigs while resulting in reduced feed to gain ratios and liver condemnation incurring economic losses (Roepstorff *et al*. 1998; Dold and Holland 2011).

Since the last two decades there are no epizootiological data about the prevalence of swine ascariasis, the objective of our study was to present actual data for the last five years. From the results it was observed a high prevalence (47,62) of ascariasis in pigs in Serbia, higher than it was presented by other authors in some European countries (Germany, Norway, Finland, Ireland and Sweden). Significant differences in the prevalence of infection could be explained by the fact that in mentioned countries pigs are maintained under intensive breeding conditiones, with implemented necessary animal husbandry and prophylactic measures.

In a large number of developing countries, including Serbia, objects on private farms are most often cleaned manually, and manure is deposited in close proximity to the object itself, which are the characteristics of the semi-intensive pig menagement. Such manure deposits present a constant source of pathogenic agents of bacterial, viral and parasitic etiology. As a measure for securing environmental protection, the best move would be to collect swine feces regularly during the fattening process and to pack it in a specific place in order to secure the biothermic destruction of the parasite eggs.

It is the task of the veterinarian to make a programme of adequate deworming for animal owners which would be aimed at improving the production results of the animals, and also at preventing possible zoonoses (van Krimpen *et al*. 2010). Under intensive breeding conditions, it is necessary to apply the following measures: the compulsory deworming of breeding sows 10–15 days prior to insemination, as well as 10–15 days prior to delivery of piglets, of breeding boar every 6 months, and of the weaned piglets before their removal to the objects where they will be fattened.

Two major classes of pharmaceutical products are available for ascariasis pigs – the benzimidazoles group which operate only as wormers and the avermectin group which also treat ectoparasites (e.g. mange and lice).

Under extensive breeding conditions, all the measures applied under intensive breeding conditions are also implemented in this case, in particular the preparation of sows ahead of delivery and during nursing as the main objective in prophylaxis is to prevent the infection of the youngest animals. Since it is impossible to prevent contacts between young and older pigs in extensive breeding conditions, it is necessary to maintain the best possible hygiene in the objects and pastures, and to deworm the animals (especially younger swine).

Conclusion

Even though possibilities for infections with endo- and ectoparasites have been reduced in contemporary production systems for breeding swine, infection with *A. suum* nematodes is still present and causes concern among breeders. In spite of modernization, the implementation of zoohygienic and zootechnical measures and the introduction of more efficient medicines, there is an increased presence of *A. suum* in certain regions during the past decade and there is seldom a herd in which at least a low intensity of infection with this ascaridida has not been diagnozed. This is also backed by the results of our investigations, from which it is evident that more than 1/3 of the totally examined swine from 5 different localities in Serbia were infected with this nematode.

The objective of deworming is to prevent the accumulation of large numbers of parasites in the animals and to avoid economic losses, as well as to prevent the excessive contamination of objects with the eggs of this parasite.

Acknowledgements. This work has been realized in keeping with projects No. TR31084 and No. 173001 financed by the Serbian Ministry of Education and Science.

References

Abe K., Shimokawa H., Kubota T., Nawa Y., Takeshita A. 2002. Myocarditis associated with visceral larva migrans due to *Toxocara canis*. *Internal Medicine*, 41, 706–708. DOI: 10.2169/internalmedicine.41.706.

Anderson T.J.C. 1995. *Ascaris* infections in humans from North America: molecular evidence for cross-infection. *Parasitology*, 110, 215–219. DOI: 10.1017/S0031182000063988.

Boes J., Willingham A.L., Fuhui S., Xuguang H., Eriksen L., Nansen P., Stewart T.B. 2000. Prevalence and distribution of pig helminths in the dongting lake region (Hunan Province) of the People's Republic of China. *Journal of Helminthology*, 74, 45–52. DOI: 10.1017/S0022149X00000068.

Boes J., Kanora A., Havn T.K., Christiansen S., Vestergaard-Nielsen K., Jacobs J., Alban L. 2010. Effect of *Ascaris suum* infection on performance of fattening pigs. *Veterinary Parasitology*, 172, 269–276. DOI: 10.1016/j.vetpar.2010.05.007.

Dold C., Holland V.C. 2011. *Ascaris* and ascariasis. *Microbes and Infection*, 13, 632–637. DOI: 10.1016/j.micinf.2010.09.012.

Gomes R.A., Bonuti M.R., Almedia K.S., Nascimento A.A. 2005. Infecções por helmintos em Javalis (*Sus scrofa scrofa*) criados em cativeiro naregião Noroeste do Estado de São Paulo, Brasil. *Ciência Rural*, *Santa Maria*, 35, 625–628. DOI: 10.1590/S0103-84782005000300021.

Haugegaard J. 2010. Prevalence of nematodes in Danish industrialized sow farms with loose housed sows in dynamic groups. *Veterinary Parasitology*, 168, 156–159. DOI: 10.1016/j.vetpar.2009.10.009.

Inatomi Y., Murakami T., Tokunaga M., Ishiwata K., Nawa Y., Uchino M. 1999. Encephalopathy caused by visceral larva migrans due to *Ascaris suum*. *Journal of Neurological Sciences*, 164, 195–199. DOI: S0022-510X(99)00078-7.

Kakihara D., Yoshimitsu K., Ishigami K., Irie H., Aibe H., Tajima T., Shinozaki K., Nishie A. 2004. Liver lesions of visceral larva migrans due to *Ascaris suum* infection. *Abdominal Imaging*, 29, 598–602. DOI: 10.1007/s00261-003-0153-4.

Kassai T. (3rd Rev. Ed.), 1998. Veterinary Helminthology. Butterworth-Heinemann Ltd., Budapest, Hungary, 186–187 pp.

Kim S., Maekawa Y., Matsuoka T., Imoto S., Ando K., Mita K., Kim H., Nakajima T., Ku K., Koterazawa T., Fukuda K., Yano Y., Nakaji M., Kudo M., Kim K., Hirai M., Hayashi Y. 2002. Eosinophilic pseudotumor of the liverdue to *Ascaris suum* infection [abstract]. *Hepatology Research*, 23, 306. DOI: 10.1016/S1386-6346(01)00187-5.

Lavikainen A. 2010. Human medical view on zoonotic parasites. *Acta Veterinaria Scandinavica*, 52 (Suppl. 1): S4. DOI: 10.1186/1751-0147-52-S1-S4.

Leles D., Gardner S., Reinhard K., Iniguez A., Araujo A. 2012. Are *Ascaris lumbricoides* and *Ascaris suum* a single species? *Parasites & Vectors*, 5, 1–7. DOI: 10.1186/1756-3305-5-42.

Luna L.A., Kyvsgaard N. 2005. Eight different species gastrointestinal parasites were identified in free roaming pigs in EL Sauce-Leon. Nicaragua. *Revista Electrónica de Veterinaria*, 6, 1–9.

Marufu M.C., Chanayiwa P., Chimonyo M., Bhebhe E. 2008. Prevalence of gastrointestinal nematodes in Mukotapigs in a communal area of Zimbabwe. *African Journal of Agricultural Research*, 3, 091–095.

Maruyama H., Nawa Y., Noda S., Mimori T., Choi W. 1996. An outbreak of visceral larva migrans due to *Ascaris suum* in Kyushu, Japan. *Lancet*, 347, 1766–1767. DOI: 10.1016/S0140-6736(96)90844-2.

Murrell K.D., Eriksen L., Nansen P., Slotved H.C., Rasmussen T. 1997. *Ascaris suum*: A revision of its early migratory path and implications for human ascariasis. *Journal of Parasitology*, 83, 255–260.

Nakata M., Saeki H., Takata I., Segawa Y., Mogami H., Mandai K., Eguchi K. 2002. Focal groundglass opacity detected by low-dose helical CT. *Chest*, 121, 1464–1467. DOI: 10.1378/chest.121.5.1464.

Nganga C.J., Karanja D.N., Mutune M.N. 2008. The prevalence of gastrointestinal helminth infections in pigs in Kenya. *Tropical Animal Health and Production*, 40, 331–334.

Osoegawa M., Matsumoto S., Ochi H., Yamasaki K., Horiuchi I., Kira Y.O., Ishiwata K., Nakamura-Uchiyama F., Nawa Y. 2001. Localised myelitis caused by visceral larva migrans due to *Ascaris suum* masquerading as an isolated spinal cord tumour. *Journal of Neurology*, *Neurosurgery & Psychiatry*, 70, 265–266. DOI: 10.1136/jnnp.70.2.265.

Roepstorff A., Nillsen O., Oksanen A., Gjerde B., Richter S.H., Ortenberg E., Christensson D., Martinsson K.B., Bartlett P.C., Nansen P., Eriksen L., Helle O., Nikander S., Larsen K. 1998. Intestinal parasites in swine in the Nordic countries: prevalence and geographical distribution. *Veterinary Parasitology*, 76, 305–319. DOI: 10.1016/S0304-4017(97)00223-9.

Rosypal C.A., Zajac M.A., Flick J.G., Bowman D.D., Lindsay S.D. 2011. High pressure processing treatment prevents embryonation of eggs of *Trichuris vulpis* and *Ascaris suum* and induces delay in development of eggs. *Veterinary Parasitology*, 181, 350–353. DOI: 10.1016/j.vetpar.2011.05.002.

Sakai S., Shida Y., Takahashi N., Yabuuchi H., Soeda H., Okafuji T., Hatakenaka M., Honda H. 2006. Pulmonary lesions associated with visceral larva migrans due to *Ascaris suum* or *Toxocara canis*: imaging of six cases. *American Journal of Roentgenology*, 186, 1697–1702. DOI: 10.2214/AJR.04.1507.

Sakakibara A., Baba K., Niwa S., Yagi T., Wakayama H., Yoshida K., Kobayashi T., Yokoi T., Hara K., Itoh M., Kimura E. 2002. Visceral larva migrans due to *Ascaris suum* which presented with eosinophilic pneumonia and multiple intra-hepatic lesions with severe eosinophil infiltration: outbreak in a Japanese area other than Kyushu. *Internal Medicine*, 41, 574–579. DOI: 10.2169/internalmedicine.41.574.

Sanchez-Vazquez J.M., Nielen M., Gunn J.G., Lewis F. 2012. National monitoring of *Ascaris suum* related liver pathologies in English abattoirs: A time-series analysis, 2005–2010. *Veterinary Parasitology*, 184, 83–87. DOI: 10.1016/j.vetpar.2011.08.011.

Tamboura H.H., Banga-Mboko H., Maes D., Youssao I., Traore A., Bayala B., Dembele M.A. 2006. Prevalence of common gastrointestinal nematode parasites in scavenging pigs of different ages and sexes in eastern centre province, Burkina Faso. *Onderstepoort Journal of Veterinary Research*, 73, 53–60. DOI: 10.4102/ojvr.v73i1.169.

vanKrimpen M.M., Binnendijk P.G., Borgsteede H.M.F., Gaasenbeek P.H.C. 2010. Anthelmintic effects of phytogenic feed additives in *Ascaris suum* inoculated pigs. *Veterinary Parasitology*, 168, 269–277. DOI: 10.1016/j.vetpar.2009.11.004.

Weng Y.B., Hu Y.J., Li Y., Li B.S., Lin R.Q., Xie D.H., Gasser R.B., Zhu X.Q. 2005. Survey of intestinal parasites in pigs from intensive farms in Guangdong Province, People's Republic of China. *Veterinary Parasitology*, 127, 333–336. DOI: 10.1016/j.vetpar.2004.09.030.

Xinou E., Lefkopoulos A., Gelagoti M., Drevelegas A., Diakou A., Milonas I., Dimitriadis A.S. 2003. CT and MR imaging findings in cerebral toxocaral disease. *American Journal of Neuroradiology*, 24, 714–718. PMID: 12695211PubMed.

Yokoi K., Goto H., Sakai J., Usui M. 2003. Clinical features of ocular toxocariasis in Japan. *Ocular Immunology and Inflammation*, 11, 269–275. DOI: 10.1076/ocii.11.4.269.18266.

(Accepted March 25, 2013)