Follow-up survey of the prevalence, diagnosis, clinical manifestations and treatment of *Spirocerca lupi* in South Africa

Author:
Remo Lobetti[1]

Affiliation:
[1]Bryanston Veterinary Hospital, Bryanston, South Africa

Correspondence to:
Remo Lobetti

Email:
rlobetti@mweb.co.za

Postal address:
PO Box 67092, Bryanston 2021, South Africa

Dates:
Received: 16 Feb. 2014
Accepted: 21 June 2014
Published: 14 Nov. 2014

How to cite this article:
Lobetti, R., 2014, 'Follow-up survey of the prevalence, diagnosis, clinical manifestations and treatment of *Spirocerca lupi* in South Africa', *Journal of the South African Veterinary Association* 85(1), Art. #1169, 7 pages. http://dx.doi.org/10.4102/jsava.v85i1.1169

Note:
This article is a follow up to a previous article by the author published in *Journal of the South African Veterinary Association* (http://dx.doi.org/10.4102/jsava.v71i1.676). Please see the reference list of this article for the full reference.

Spirocercosis is an important disease in South Africa. The object of this study was to determine if there had been a change in the prevalence, clinical manifestations and treatment of *Spirocerca lupi* over a 14-year period. A questionnaire was sent to 577 veterinary practices throughout South Africa in 2012. Of responders, 76% indicated that *S. lupi* occurred in their area, whilst 24% indicated that it did not; 84% considered *S. lupi* not to be a new phenomenon, whereas 16% considered it to be new. Monthly or seasonal distribution of the disease was not reported, and 76% of responders reported it to occur in no specific breed of dog, whereas 24% reported a breed risk, most considering large breeds to be at greater risk. No specific age or sex was identified as at higher risk. Common owner complaints were vomiting, weight loss, cough, or regurgitation. Reported clinical findings tended to mirror the clinical signs reported by owners. Most common diagnostic methods used were radiology, endoscopy, faecal flotation, and *post mortem* examination. Forty-four percent did not report seeing asymptomatic cases, 40% reported asymptomatic cases and 16% did not know. Associated complications were reported by 85% of responders, and included oesophageal neoplasia, hypertrophic osteopathy and acute haemothorax. Four different drugs were used as therapy: doramectin, ivermectin, milbemycin and Advocate®, with 9% of the responders using a combination of these four; 85% considered treatment to be effective and 15% ineffective. Treatment was considered more effective if the disease was diagnosed early and there were no complications. Two important conclusions were that more cases are being seen and that efficacy of therapy has increased, with a decrease in the mortality rate.

Introduction

Spirocerca lupi is a nematode parasite of carnivores found primarily in dogs but reported in numerous wild carnivores (Fox, Burns & Hawkins 1988). Natural infections have been reported in man, goats, ponies and a donkey (Ndiritu & Al-Sadi 1976). Spirocercosis occurs throughout the world, having a predominantly tropical and subtropical distribution (Urquhart *et al*. 1991), although there are colder regions with a high incidence (Ndiritu & Al-Sadi 1976). Infection depends upon canine population density and the degree of contact between definitive, intermediate and transport hosts (Bailey 1963). The adult parasite is most commonly found embedded in a nodule within the host's thoracic oesophagus, although it can occur in the thoracic aorta, stomach, vertebra, pleura, lungs, kidneys, mediastinum and skin (Reinecke 1983). In the oesophagus the adult female worm passes larvated eggs into the lumen, that are finally shed with the faeces and hatch only after having been ingested by an intermediate host (coprophagous beetles) (Fox *et al*. 1988; Reinecke 1983; Soulsby 1986). Transport hosts (birds, amphibians, reptiles and small mammals) can become infected if they ingest the intermediate host (Fox *et al*. 1988).

The definitive host becomes infected by ingestion of either the intermediate or transport host. Once ingested, the infective larvae are liberated in the stomach. From there they penetrate the stomach wall, enter an arteriole and migrate in the wall of the gastric and gastric-epiploic arteries to the coeliac artery and then to the thoracic aorta. From the aorta the larvae emerge and migrate to the adjacent oesophagus. This process takes approximately six months (Fox *et al*. 1988; Reinecke 1983; Soulsby 1986). The pathology of spirocercosis results from larval migration, presence of adult worms in the oesophagus and secondary bacterial infections (Fox *et al*. 1988). In some cases the oesophageal nodule can undergo malignant transformation to form a sarcoma, with or without metastases (Ivoghli 1978). Hypertrophic osteopathy and spondylitis of the thoracic vertebrae (T6–T12) may also be evident (Fox *et al*. 1988; Kirberger *et al*. 2013; Ndiritu & Al-Sadi 1976).

Clinical signs of spirocercosis include vomiting, regurgitation, weight loss, salivation and dysphagia (Evans 1983; Fox *et al*. 1988). Aortic infection is asymptomatic unless rupture occurs, whereupon haemothorax and sudden death may take place (Soulsby 1986). Aortic thrombo-embolism secondary to aortic aneurysm with sudden-onset hindquarter paralysis can also occur (Gal *et al*. 2005; Kirberger & Zambelli 2007). Diagnosis is based on survey and contrast radiographs (Evans 1983), oesophagoscopy (Bailey 1963) and finding larvated eggs on faecal flotation (Reinecke 1983; Soulsby 1986). The latter is, however, not a common finding, as the adult female can only shed eggs if there is an opening in the nodule and the eggs are also only shed for an unpredictable, short period of time (Reinecke 1983). As the eggs are heavier than other helminth eggs, a flotation fluid of higher specific gravity is also required (Christie *et al*. 2011).

One small study reported a prevalence of 74% (Kok *et al*. 2010), whereas it has been speculated that in endemic areas the prevalence of infection can be 100%, which is probably associated with the many opportunities for acquiring infection from the various intermediate and transport hosts (Urquhart *et al*. 1991).

In 1998 a questionnaire survey of 716 veterinary practices was undertaken to determine the prevalence of *S. lupi* in dogs in South Africa (Lobetti 2000). In total 351 (49%) questionnaires were returned, which showed a possible prevalence of 28% with no specific age or sex identified as at higher risk. Large breeds were considered to be at greater risk. The most common complaints by owners and clinical findings were vomiting, weight loss, coughing or regurgitation. Diagnostic methods used were radiology, endoscopy, *post mortem* examination and faecal flotation. Specific treatments used by 58% of respondents were ivermectin, doramectin, other anthelmintics (benzimidazoles, nitroscanate), and disophenol, whereas 42% of respondents either used no treatment or recommended euthanasia. The majority of respondents considered treatment ineffective and regarded the disease to have a high mortality rate.

The purpose of this study was to repeat the questionnaire survey that was done in 1998 on the prevalence, importance and distribution of *S. lupi* in South Africa.

Materials and methods

In conjunction with Bayer Animal Health, the same questionnaire (Appendix 1) that was used in 1998 was sent out to 577 veterinary practices throughout South Africa in 2012. The questionnaire was divided into four main sections: (1) presence or absence of *S. lupi*, and whether the presence was a new phenomenon or not, (2) if *S. lupi* was associated with time of year, breed, age and sex, (3) presenting features, clinical signs, diagnosis and presence of complications or asymptomatic cases and (4) treatment(s) and effectiveness, and mortality rate of the disease.

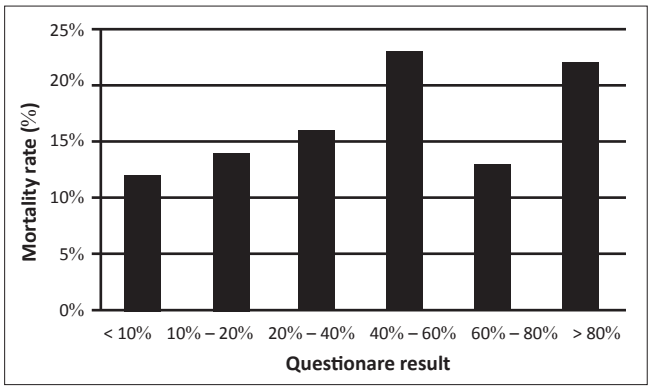

FIGURE 1: Mortality rate reported in the 2012 questionnaire.

Results

In total 316 (55%) questionnaires were returned. Of these, 240 (76%) of the responders indicated that *S. lupi* occurred in their area, whereas 76 (24%) indicated that it did not.

Of those that responded positively, 197 (84%) considered *S. lupi* not to be a new phenomenon, whereas 37 (16%) considered it to be new; no specific year was given that showed an increase in prevalence. Less than four cases per year were recorded by 82 (35%) responders, 4–12 by 97 (41%), 12–24 by 33 (14%), 24–48 by 15 (6%) and more than 48 by eight (4%).

Monthly or seasonal distribution of the disease was not reported. Provincial distribution was as follows: Eastern Cape 3%, Free State 6%, Gauteng 58%, KwaZulu-Natal 22%, Mpumalanga 2%, North-West 6%, Northern Cape 1% and Western Cape 2%.

No specific breed was reported to have been affected by 178 (76%) responders, whereas 55 (24%) reported a breed risk, most considering large breeds to be at greater risk. No specific age or sex was identified to be at higher risk for *S. lupi* infection.

The most common complaints by owners were vomiting (49%), weight loss (28%), cough (17%) or regurgitation (32%). Reported clinical findings tended to mirror the clinical signs reported by the owners. Other clinical signs reported included salivation, dysphagia, fever, anaemia, dyspnoea or acute death. Only one of the responders reported no abnormal clinical findings. The most common diagnostic methods used were radiology (81%), endoscopy (34%), faecal flotation (9%) and *post mortem* examination (3%). Other diagnostic methods used were blood smear examination, response to treatment, history and clinical signs. Forty-four percent did not report seeing asymptomatic cases, whilst 40% reported asymptomatic cases and 16% did not know. Complications associated with *S. lupi* were reported by 85% of responders, and included oesophageal neoplasia (58%), hypertrophic osteopathy (47%) and acute haemothorax (35%). Rare

complications reported were spondylitis, salio-adenitis, oesophagitis, and aortic thrombosis.

Four different drugs were used as therapy: doramectin (84%), ivermectin (10%), milbemycin (3%) and a combination of imidacloprid and moxidectin (3%) (Advocate®, Bayer Animal Health), with 9% of responders using a combination of the four. Eighty-five percent considered treatment to be effective, whereas 15% considered it ineffective. Treatment was considered more effective if the disease was diagnosed early and no complications were present. Mortality rate (Figure 1) was divided as follows: 10% was recorded by 12%, 10% – 20% by 14%, 20% – 40% by 16%, 40% – 60% by 23%, 60% – 80% by 13%, and 80% by 22%.

The results of the 1998 survey and this survey are summarised in Table 1.

Discussion

This survey indicated that *S. lupi* is still common in South Africa, having an apparent prevalence of 76%, the highest prevalence still occurring in the provinces of Gauteng and KwaZulu-Natal. This prevalence is similar to that reported by Kok *et al*. (2010), and higher than in the previous survey (Lobetti 2000), where the reported prevalence was 28%. The current survey showed that there was an increase in the number of cases seen between 1998 and 2012, which may be as a result of heightened awareness rather than a true increase in prevalence of the disease.

In both this and the previous survey there was no obvious distinction between urban and rural areas. It has previously been reported that *S. lupi* is common in rural dogs in South Africa (Evans 1983; Reinecke 1983); however, out of 1063

TABLE 1: Comparison between the 1998 and 2012 surveys.

Surveys	Variables	1998	2012
Questionnaires	Practices sampled	716	577
	Questionnaires returned	351 (49%)	316 (55%)
Cases seen	Yes	28%	76%
	No	72%	24%
New phenomenon	Yes	22%	16%
	No	78%	84%
Case numbers	4 cases per year	79%	35%
	4–12	14%	41%
	12–24	3%	14%
	24–48	0%	6%
	48	1%	4%
Seasonal prevalence	Yes	52%	None
	No	48%	None
Specific breeds	Yes	Large	24% - large
	No	Not reported	76%
Owner complaints/clinical signs	Vomition	46%	49%
	Weight loss	27%	28%
	Cough	21%	17%
	Regurgitation	20%	32%
Diagnostic methods	Radiology	74%	81%
	Endoscopy	27%	34%
	Necropsy	34%	3%
	Faecal	4%	9%
Asymptomatic cases	Yes	20%	40%
	No	80%	44%
Complications	Oesophageal neoplasia	41%	58%
	Hypertrophic osteopathy	38%	47%
	Haemothorax	30%	35%
Therapy	Ivermectin	52%	10%
	Doramectin	27%	84%
	Disophenol	8%	Not available
	Milbemycin	Not available	3%
	Advocate®	Not available	3%
	Combination	Not reported	9%
Efficacy	Yes	63%	85%
	No	31%	15%
Mortality rate†	10%	8%	12%
	10% – 20%	0%	14%
	20% – 40%	4%	16%
	40% – 60%	6%	23%
	60% – 80%	6%	13%
	80%	44%	22%

†, In the 1998 survey 32% of the responders were unsure as to the outcome of their cases.

dogs examined for helminths, *S. lupi* was reported in only three dogs (Verster 1979). Faecal examination is, however, unreliable as only a small percentage of positive dogs can be identified by faecal analysis. In one study 18 of 132 (14%) dogs that were autopsied in South Africa were positive for *S. lupi* (Minnaar & Krecek 2001). In a Kenyan study, 39 clinical cases and 206 of 1607 (13%) dogs autopsied over a 10-year period were reported to be positive for *S. lupi* (Wandera 1976). In other studies in Kenya 78% of dogs autopsied were positive for *S. lupi*, the prevalence being higher in rural than urban dogs (85% versus 38%) (Bradey *et al*. 1977). In the rural dogs there was a close association with cattle, chickens and dung beetles.

In an Iranian study 76% of sick or stray dogs were infected with *S. lupi*, with oesophageal lesions present in 58% (Ivoghli 1978). In Malaysia, 23% of dogs autopsied were positive (Retnasalapathy & Khoo-Teik 1976). In India, varying incidences of 20% (Prasad, Singh & Prasad 1971), 58% (Singh, Srivastava & Tewari 1970) and 78% (Ragan & Mohiyuddeen 1974) have been reported. In a study in Southern Texas in the United States of America (USA) it was found that the incidence ranged from 15% to18% (Turk 1960). In Auburn, Alabama, USA, 8% of dogs autopsied were positive (Bailey 1963). It thus appears that the most significant factor involved in the prevalence of *S. lupi* infection is related to the proximity of the dogs to the intermediate and transport hosts.

The previous survey indicated a tendency towards a summer seasonal prevalence, which was not reported in the current survey.

The previous survey indicated a tendency for large breeds to be at greater risk, with the German shepherd dog at highest risk, which is similar to what has been reported in the literature (Bailey 1972; Lobetti 2012; Wandera 1976). However, this finding was not supported in the current survey. No specific age or sex was identified to be at higher risk for *S. lupi* infection, although in the literature it has been reported that the most common age group affected with *S. lupi* is that 1–4 years of age (Chkabra & Singh 1972; Dixon & McGee 1967). In a report from West Africa the age distribution ranged from 1 month to 12 years (Hassan 1982). As this report was based on a faecal survey, the age distribution of dogs less than six months old can be questioned, since the development period of the parasite is 6 months (Fox *et al*. 1988; Reinecke 1983; Soulsby 1986). Two publications reported male dogs to be more commonly affected (Prasad *et al*. 1971; Singh *et al*. 1970), which was not supported in either the previous or the current survey in South Africa.

Complaints by owners and clinical signs (vomiting or regurgitation, weight loss, cough, fever, anaemia, dyspnoea) as well as associated complications (oesophageal neoplasia, hypertrophic osteopathy, acute haemothorax, spondylitis, oesophagitis and aortic thrombosis) were the same as those previously reported (Evans 1983; Fox *et al*. 1988; Reinecke 1983; Soulsby 1986). The previous survey found that a number of dogs showed no abnormal clinical findings, which was not supported by the current study.

The most common diagnostic methods used in diagnosis of *S. lupi* were radiology (both survey and contrast), endoscopy and *post mortem* examination, which is what has been described in the literature (Evans 1983; Fox *et al*. 1988; Reinecke 1983; Soulsby 1986). In the current survey the use of *post mortem* diagnosis was greatly reduced over the 14-year period. Although faecal analyses have been used to determine the incidence of *S. lupi* in other studies (Christie *et al*. 2011), it was not a commonly used diagnostic method in this survey. This could be attributed to the poor sensitivity of the test as well as the need for a special flotation fluid. In Sierra Leone (West Africa) a faecal survey of dogs showed an infection rate of 3.5% (Hassan 1982), in Kenya 56% (Bradey *et al*. 1977), in India 37% (Chkabra & Singh 1972), in Malaysia 40% (Retnasalapathy & Khoo-Teik 1976), in rural areas of the south-eastern states of the USA (Alabama and Mississippi) 33.5% (Dixon & McGee 1967), and in Auburn (Alabama), USA 47% (Bailey 1963). It has also been shown that the incidence of the disease can vary, as in a follow-up faecal study done in the same area of Auburn the number of positive cases on faecal examination dropped to 12.7% (Bailey 1972). This was attributed to a decrease in rural areas, and thus rural dogs, and in dung beetle populations as a result of increased use of insecticides.

The mortality rate of spirocercosis in the previous survey was high and probably associated with late diagnosis, presence of complications and no proven available effective anthelmintic. In the current survey the mortality rate was lower, which could be attributed to greater awareness of the disease and increased efficacy of therapy.

The only anthelmintics registered for the therapy of *S. lupi* are disophenol (Seneviratna, Fernando & Dhanapala 1966), which is no longer available, and Advocate® (Austin *et al*. 2013). In this current survey there was a marked reduction in the use of ivermectin and an increase in the use of doramectin. Doramectin has been shown to be effective in the therapy of spirocercosis (Berry 2000; Lavy *et al*. 2002; Lobetti 2012); however, its use is extra-label, as the product is not registered for use in dogs. The use of Advocate® was low, which could be attributed to the product having entered the South African market only recently.

Conclusion

In summary, the major changes over the 14 years between the 1998 and 2012 surveys are as follows:

- More cases, as well as more asymptomatic cases, are being seen.
- Increase in the use of radiographs, oesophagoscopy and faecal analysis in making a diagnosis.
- Reduced number of necropsy diagnoses.

- Increased numbers of oesophageal neoplasia and hypertrophy osteopathy being seen as a complication.
- Marked reduction in the use of ivermectin as treatment.
- Marked increase in the use of doramectin as treatment.
- Increased efficacy of therapy, with a decrease in high mortality rates.

Acknowledgements

The author would like to thank Bayer Animal Health, South Africa for distributing the questionnaire and collating the data, and all of the veterinarians who made this survey possible.

Competing interests

The author declares that he has no financial or personal relationship(s), which may have inappropriately influenced him in writing this article.

References

Austin, C.M., Kok, D.J., Crafford, D. & Schaper, R., 2013, 'The efficacy of a topically applied imidacloprid 10%/moxidectin 2.5% formulation (Advocate®, Advantage® Multi, Bayer) against immature and adult *Spirocerca lupi* worms in experimentally infected dogs', *Parasitology Research* 112 (Suppl. 1), 91–108. http://dx.doi.org/10.1007/s00436-013-3284-8

Bailey, W.S., 1963, 'Parasites and cancer: Sarcoma associated with *Spirocerca lupi*', *Annals of the New York Academy of Sciences* 108, 890–923. http://dx.doi.org/10.1111/j.1749-6632.1963.tb13429.x

Bailey, W.S., 1972, '*Spirocerca lupi*: A continuing inquiry', *Journal of Parasitology* 58, 3–22. http://dx.doi.org/10.2307/3278233

Bradey, R.S., Thomson, R.G., Sager, P.D. & Eugster, B., 1977, 'Spirocerca lupi infection in dogs in Kenya', *Veterinary Parasitology* 3, 49–59. http://dx.doi.org/10.1016/0304-4017(77)90007-3

Berry, W.L., 2000, 'Spirocerca lupi esophageal granuloma in 7 dogs: Resolution after treatment with doramectin', *Journal of Veterinary Internal Medicine* 14, 609–612. http://dx.doi.org/10.1111/j.1939-1676.2000.tb02284.x

Chkabra, R.C. & Singh, K.S., 1972, 'Spirocercosis in dogs in Bareilly (Uttar Pradesh), India', *Indian Journal of Animal Sciences* 42, 734–736.

Christie, J., Schwan, E.V., Bodenstein, L.L., Sommerville, J.E. & Van der Merwe. L.L., 2011, 'The sensitivity of direct faecal examination, direct faecal flotation, modified centrifugal faecal flotation and centrifugal sedimentation/flotation in the diagnosis of canine spirocercosis', *Journal of the South African Veterinary Association* 82, 71–75. http://dx.doi.org/10.4102/jsava.v82i2.37

Dixon, K.G. & McGee, J.F., 1967, 'Further observations on the epidemiology of Spirocerca lupi in the Southeastern United States', *Journal of Parasitology* 53, 1074–1075. http://dx.doi.org/10.2307/3276842

Evans, L.B., 1983, 'Clinical diagnosis in dogs', *Journal of the South African Veterinary Association* 54, 189–191.

Fox, S.M., Burns, J. & Hawkins, J., 1988, 'Spirocercosis in dogs', *Compendium on Continuing Education for the Practicing Veterinarian* 10, 807–822.

Gal, A., Kleinbart, S., Aizenberg, Z. & Baneth, G., 2005, 'Aortic thromboembolism associated with Spirocerca lupi infection', *Veterinary Parasitology* 130, 331–335. http://dx.doi.org/10.1016/j.vetpar.2005.03.037

Hassan, I.C., 1982, 'Gastro-intestinal helminth parasites of dogs in the Western Area – Free Town (Sierra Leone)', *Beiträgezur Tropischen Landwirtschaftund Veterinärmedizin* 20, 401–407.

Ivoghli, B., 1978, 'Esophageal sarcomas associated with canine spirocercosis', *Veterinary Medicine and Small Animal Clinician* 73, 47–49.

Kirberger, R.M. & Zambelli, A., 2007, 'Imaging diagnosis – aortic thromboembolism associated with spirocercosis in a dog', *Veterinary Radiology and Ultrasound* 48, 418–420. http://dx.doi.org/10.1111/j.1740-8261.2007.00270.x

Kirberger, R.M., Clift, S.J., Van Wilpe, E. & Dvir E., 2013, 'Spirocerca lupi-associated vertebral changes: A radiologic-pathologic study', *Veterinary Parasitology* 195, 87–94. http://dx.doi.org/10.1016/j.vetpar.2012.12.039

Kok, D.J., Williams, E.J., Schenker, R., Archer, N.J. & Horak, I.G., 2010, 'The use of milbemycin oxime in a prophylactic anthelmintic programme to protect puppies, raised in an endemic area, against infection with *Spirocerca lupi*', *Veterinary Parasitology* 174, 277–284. http://dx.doi.org/10.1016/j.vetpar.2010.08.029

Lavy, E., Aroch, I., Bark, H., Markovics, A., Aizenberg, I., Mazaki-Tovi, M. et al., 2002, 'Evaluation of doramectin for the treatment of experimental canine spirocercosis', *Veterinary Parasitology* 109, 65–73. http://dx.doi.org/10.1016/S0304-4017(02)00250-9

Lobetti, R.G., 2000, 'Survey of the incidence, diagnosis, clinical manifestations and treatment of Spirocerca lupi in South Africa', *Journal of the South African Veterinary Association* 71, 43–46. http://dx.doi.org/10.4102/jsava.v71i1.676

Lobetti, R.G., 2012, 'Successful resolution of oesophageal spirocercosis in 20 dogs following daily treatment with oral doramectin', *Veterinary Journal* 193, 277–278. http://dx.doi.org/10.1016/j.tvjl.2011.09.002

Minnaar, W.N. & Krecek, R.C., 2001, 'Helminths in dogs belonging to people in a resource-limited urban community in Gauteng, South Africa', *Onderstepoort Journal of Veterinary Research* 68, 111–117.

Ndiritu, C.G. & Al-Sadi, H.I., 1976, 'Pathogenesis and lesions of canine spirocercosis', *Modern Veterinary Practice* 57, 924–931.

Prasad, M.C., Singh, P.N. & Prasad, C.R., 1971, 'Incidence of spirocercosis in dogs', *Indian Journal of Animal Health* 10, 227–229.

Ragan, A. & Mohiyuddeen, S., 1974, 'Incidence of spirocercosis in some uncommon sites', *Kerala Journal of Veterinary Science* 5, 139–147.

Reinecke, R.K., 1983, *Veterinary Helminthology*, Butterworth, Durban.

Retnasalapathy, A. & Khoo-Teik, S., 1976, 'Observations on the incidence of spirocercosis in local dogs', *Malaysian Veterinary Journal* 6, 69–71.

Seneviratna, P., Fernando, S.T. & Dhanapala, S.B., 1966, 'Disophenol treatment of spirocercosis in dogs', *Journal of the American Veterinary Medical Association* 148, 269–274.

Singh, N.P., Srivistava, P.S. & Tewari, A.N., 1970, 'Studies on the incidence of canine spirocercosis in the foothills of Himalayas', *Indian Journal of Science and Industry* 4, 65–70.

Soulsby, E.J.L., 1986, *Helminths, Arthropods and Protozoa of Domestic Animals*, 7th edn., Baillière Tindall, London.

Turk, R.D., 1960, 'Occurrence of the nematode Spirocerca lupi in unusual locations', *Journal of the American Veterinary Medical Association* 137, 721–722.

Urquhart, G.M., Armour, J., Duncan, J.L., Dunn, A.M. & Jennings, F.W., 1991, *Veterinary Parasitology*, Longman Scientific and Technical, Essex.

Verster, A., 1979, 'Gastro-intestinal helminths of domestic dogs in the Republic of South Africa', *Onderstepoort Journal of Veterinary Research* 46, 79–82.

Wandera, J.G., 1976, 'Further observations on canine spirocercosis in Kenya', *Veterinary Record* 99, 348–351. http://dx.doi.org/10.1136/vr.99.18.348

Appendix 1 continues on next page →

Appendix 1

Appendix 1: *Spirocerca lupi* questionnaire.

Practitioner and practice details

Practitioner: .....

Practice name: .....

Physical address: .....

Postal address: .....

Province: .....

Postal code: .....

Tel: ( ) .....

Fax: ( ) .....

Email: .....

Please circle the appropriate response or answer in the space provided.

1. Do you see cases of *Spirocerca lupi* in your practice?

YES	NO

If the answer is no, please stop here and return the questionnaire in the envelope provided. Negative responses are very important.

2. Is *Spirocerca lupi* a new phenomenon in your practice?

YES	NO

If yes, when did you first see it?

.....

.....

3. How many cases do you see per year? (Please circle)

<4	4–12	12–24	24–48	>48

4. During which month(s) do you see most cases? (Please circle)

Jan	Feb	Mar	Apr	May	Jun
Jul	Aug	Sep	Oct	Noc	Dec

5. Do you diagnose *Spirocerca lupi* more commonly in certain:

Breeds?

YES	NO

If yes, specify: .....

Age groups?

YES	NO

If yes, specify: .....

Sexes?

YES	NO

If yes, specify: .....

6. What are the most common owner complaints?

.....

.....

.....

7. What are the most common clinical findings?

.....

.....

8. How do you diagnose *Spirocerca lupi*?

.....

.....

.....

9. Do you see asymptomatic cases of *Spirocerca lupi*?

.....

.....

.....

10. Do you see complications with *Spirocerca lupi*? (Acute haemothorax, neoplasia, Marie's disease)

YES	NO

If yes, specify:

.....

.....

.....

11. Which drug(s) do you use to treat *Spirocerca lupi*? Please provide details (dose, frequency, and duration of treatment):

.....

.....

12. What other treatment(s) do you utilise?

.....
.....
.....
.....

13. Do you considered the drug(s) and/or treatments to be effective in the treatment of *Spirocerca lupi*?

YES	NO

If no, specify:

.....
.....
.....
.....

14. What is the mortality figure (%)?

.....
.....
.....

15. What was the source of information for this questionnaire?

Computer records	Paper records	Memory	Combination

16. Would you be interested in being involved in future projects on *Spirocerca lupi*?

.....
.....
.....
.....