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Results of Parasitological Examinations of Faecal Samples from Cats and Dogs in Germany between 2003 and 2010

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Abstract

In a retrospective study, the results of parasitological examinations of faecal samples from 8,560 cats and 24,677 dogs between January 2003 and December 2010 in Germany were analysed. 30.4 % of the examined dogs and 22.8 % of the cats were infected with endoparasites. The examination of the faecal samples from dogs revealed stages of *Giardia* spp. (18.6 %), *Toxocara canis* (6.1 %), *Toxascaris leonina* (0.6 %), Ancylostomatidae (2.2 %), *Trichuris vulpis* (1.2 %), *Capillaria* spp. (1.3 %), *Crenosoma vulpis* (0.4 %), *Angiostrongylus vasorum* (0.5 %), Taeniidae (0.4 %), Dipylidiidae (< 0.1 %), *Mesocestoides* spp. (< 0.1 %), *Isospora* spp. (5.6 %), *I. ohioensis*-complex (3.9 %), *I. canis* (2.4 %), *Sarcocystis* spp. (2.2 %) and *Hammondia heydorni*/*Neospora caninum* (0.3 %). Dogs in the age groups up to 3 months and > 3 up to 6 months of age showed significantly higher infection rates with *Giardia* spp. (37.5 % and 38.2 %, respectively), *Toxocara canis* (12.0 % and 12.4 %, respectively), *Toxascaris leonina* (1.1 % and 1.6 %, respectively), *Isospora* spp. (23.4 % and 11.8 %, respectively), *I. ohioensis*-complex (15.6 % and 7.2 %, respectively) and *I. canis* (11.8 % and 5.2 %, respectively) compared to older dogs. In faecal samples from cats, stages of *Giardia* spp. (12.6 %), *Toxocara cati* (4.7 %), *Toxascaris leonina* (0.1 %), *Ancylostoma tubaeforme* (0.2 %), *Aelurostrongylus abstrusus* (0.5 %), *Capillaria* spp. (1.0 %), Taeniidae (0.6 %), *Dipylidium caninum* (< 0.1 %) *Mesocestoides* spp. (< 0.1 %), *Isospora* spp. (6.0 %), *I. felis* (4.4 %), *I. rivolta* (2.2 %), *Toxoplasma gondii*/*Hammondia hammondi* (0.8 %) and *Sarcocystis* spp. (0.3 %) were detected. Cats in the age groups up to 3 months and > 3 up to 6 months of age showed significantly higher infection rates with *Giardia* spp. (19.5 % and 24.0 %, respectively), *T. cati* (8.1 % and 6.9 %, respectively), *Isospora* spp. (12.8 % and 8.6 %, respectively), *I. felis* (10.0 % and 5.9 %, respectively) and *I. rivolta* (4.6 % and 2.9 %, respectively) compared to older cats.

Introduction

Dogs and cats are frequently infected with various helminth and protozoan endoparasites. In particular the vertical transmission of *Toxocara* spp., the intrauterine in dogs and the transmammary in cats, ensures a high infection rate of the offspring. But also protozoan parasites such as *Giardia* spp. and *Isospora* spp. are often found in young animals, due to high infection pressure during breeding and a low immunological competence of the newborn offspring. These parasites pose a threat to the health of animals and some of them also to humans. Veterinarians and pet owners have the responsibility to take care for these conditions, and apply appropriate measures to protect the animals and also humans. However, one of the major problems in parasite control is the low awareness of the owners and a variable perception of their responsibility to adequately acting for this situation. Responsible owners usually care for their pets and consult veterinarians to get appropriate advice as well as treatment and prevention measures. Such advice should be evidence-based, either on the results of an individual diagnosis or on knowledge of the parasite prevalence in a population. Retrospective data analysis of the results from diagnostic laboratories is one option to provide such information and is a worthwhile tool to allow assessment of parasite prevalence. However, such data may represent only the group of concerned pet owners who care appropriately for their pet by consulting veterinarians and getting samples analysed. Another weakness of such data analysis is the fact that parasitological examinations in diagnostic laboratories are usually cross-sectional studies. Samples are taken at one individual point in time, which may underestimate the true parasite prevalence. Sager et al. (2006) have demonstrated that parasite prevalence is usually much higher in dogs examined in a longitudinal study compared to cross-sectional studies. In addition, the type of the subpopulation of which such data are collected will have an influence on the results. Data analysis performed in animals which are well cared and kept under control measures may yield in lower prevalence data compared to populations with less care and no control measures such as stray animals or pet shelter animals before they are appropriately treated. Martinez-Carrasco et al. (2007) demonstrated that in pet shelter population higher parasite prevalence occur compared to a well cared population. Even if all these shortfalls are taken into consideration, it is still important that large-scale retrospective studies are performed and published in order to allow evidence-based assessment of parasite prevalence and appropriate measures in terms of pet owner education and respective veterinary care.

Materials and methods

Study population

Between January 2003 and December 2010 faecal samples from 24,677 dogs (Tab. 1) and 8,560 cats from Germany had been submitted to the commercial Veterinary Laboratory Freiburg for parasitological examination. Samples were obtained from privately owned dogs and cats presented at local veterinary surgeons from all parts of Germany for either gastrointestinal disorders, routine examination and animal vaccination, general health check or without specified reason. Age data of 6,627 examined cats (Tab. 2) and 21,516 dogs provided the basis to analyse the age dependence of the determined infection rates.

Faecal examination

All specimens were tested by a standardised flotation method with a saturated salt solution with zinc chloride and sodium chloride (specific gravity 1.3). For detecting *Giardia* spp., all samples were analysed by a coproantigen ELISA (ProSpecT® *Giardia* Microplate Assay, Remel Europe Ltd., distributed by Sekisui Virotech GmbH, Germany) or sodium acetate formaldehyde SAF technique (Marti and Escher 1990) to concentrate cysts of *Giardia*. Depending on the quantity of material, the faeces were additionally examined by sedimentation and a

Tab. 1 Number of coproscopically examined dogs and cats between 2003 and 2010

Year	Number of examined dogs (n)	Number of examined cats (n)
2003	2,139	755
2004	2,525	840
2005	2,608	917
2006	2,590	960
2007	3,425	1,158
2008	3,978	1,213
2009	3,709	1,208
2010	3,703	1,509
2003–2010	24,677	8,560

modified Baermann funnel technique. The results of the coproscopical examinations were recorded and analysed in an excess data bank (Microsoft Access 2007). Infections with *I. ohioensis*, *I. burrowsi* and *I. neorivolta* found in dogs were documented as *I. ohioensis*-complex. These three protozoan species having smaller oocysts than *I. canis* do not show distinctive morphological criteria in terms of oocyst size or structure and can therefore not be separated by microscopic examination (Lindsay et al. 1997). Due to inadequate morphological characteristics, eggs from the genus *Capillaria* and from the cestode family Taeniidae were not differentiated.

Statistical analysis

The data were supplied in electronic form for the statistical analysis. The analysis was performed with the validated programme Testimate Version 6.4 from IDV Gauting (validation of software, hardware and user according to FDA 21 CFR Part 11). All evaluation steps were completely documented. The group differences for dogs and cats concerning age were tested with Rx2-frequency tables. The null hypothesis was that of no differences $\mathbf{H_0 : p_1 = p_2 = ... = p_k}$ (the so-called homogeneity hypothesis). The classical p values were computed with Pearson without continuity correction and only for smaller samples with the Fisher's exact p values (two-sided, alpha = 0.05). If the result was significant, two-group comparison for each age group vs. all animals was performed with the Fligner-Wolfe test without any alpha correction for multiple testing. The predefined alpha level two-sided was 0.05.

Results

The majority of cats (46.4 %) and dogs (36.1 %) participating in the study were up to one year old (Fig. 1). 7.7 % of the cats and 11.2 % of the dogs were > 1–2 years old. The percentage of sampled cats and dogs per year decreased in the age groups > 2 and up to 15 years of age continuously from 5.3 % to 2.0 % per year and 7.6 % to 0.6 %

Tab. 2 Number of coproscopically examined dogs and cats with known age between 2003 and 2010

Age group	Number of examined dogs (n)	Number of examined cats (n)
< 3 months	2,661	1,227
> 3–6 months	735	421
> 6–12 months	4,364	1,427
> 1–5 years	6,489	1,360
> 5–10 years	4,856	1,100
> 10 years	2,411	1,092
total	21,516	6,627

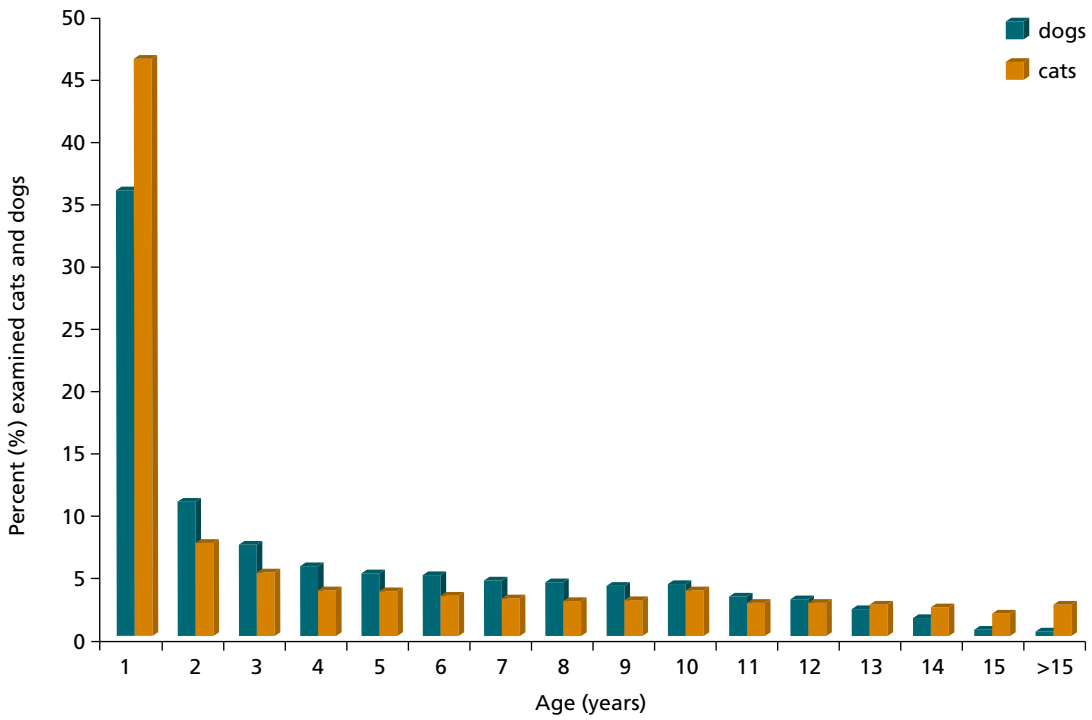

Fig. 1 Structure of age of coproscopically examined dogs (n = 21,516) and cats (n = 6,627) with known age between 2003 and 2010

per year, respectively. Cats and dogs older than 15 years were rarely tested for parasites. 30.4 % of the examined dogs were infected with endoparasites. The most commonly parasite found in dogs (Fig. 2) was *Giardia* spp. (18.6 %), followed by nematodes (10.8 %), coccidia (8.0 %) and cestodes (0.5 %). The examination of the faecal samples from dogs (Tabs. 3 and 4) revealed infections with *Toxocara canis* (6.1 %), *Toxascaris leonina* (0.6 %), Ancylostomatidae (2.2 %), *Trichuris vulpis* (1.2 %), *Capillaria* (1.3 %), *Crenosoma vulpis* (0.4 %), *Angiostrongylus vasorum* (0.5 %), Taeniidae (0.4 %), Dipylidiidae (< 0.1 %), *Mesocestoides* spp. (< 0.1 %), *Isospora* spp. (5.6 %), *I. ohioensis*-complex (3.9 %), *I. canis* (2.4 %), *Sarcocystis* (2.2 %) and *Hammondia heydorni*/*Neospora caninum* (0.3 %). With reference to the prevalence of parasites per year in the period 2003 to 2010 (Tabs. 3 and 4) the determined rates of infection with parasites per year in dogs showed only minor variations.

To analyse the age dependence of infections with endoparasites, dogs with known age have been grouped in six age groups (Figs. 3–5). Dogs in the age groups up to 3 months and > 3 up to 6 months of age showed significantly higher infection rates ($p < 0.05$) with *Giardia* spp. (37.5 % and 38.2 %, respectively), *Toxocara canis* (12.0 % and 12.4 %, respectively), *Toxascaris leonina* (1.1 % and 1.6 %, respectively), *Isospora* spp. (23.4 % and 11.8 %, respectively), *I. ohioensis*-complex (15.6 % and 7.2 %, respectively) and *I. canis* (11.8 % and 5.2 %, respectively) compared to older dogs. The significant highest values ($p < 0.05$) for *Giardia* spp., *Toxocara canis* and *Toxascaris leonina* were determined in dogs > 3 months up to 6 months of age, whereas in age groups older than 6 months of age their prevalence rates decreased continuously and stepwise. Significant higher rates ($p < 0.05$) were determined for Ancylostomatidae and *Trichuris vulpis* in dogs > 3 up to 6 months and > 6 months up to 1 year of age compared to the other age groups. Infections

with *Capillaria* spp., *Crenosoma vulpis, Angiostrongylus vasorum*, cestodes, *Sarcocystis* spp. and *Hammondia heydorni/Neospora caninum* indicated only minor changes in prevalence rates and seemed to be equally distributed amongst all age groups. With reference to seasonal variation, eggs of *Toxocara canis* (Fig. 6) and cysts of *Giardia* spp. (Fig. 8) in faecal samples were more often found between November and March compared to other months with highest values in January. In contrast to that, infections with *Isospora* spp. (Fig. 7) were most frequently found in August with continuously decreasing rates until February.

From 8,560 examined cats, a total of 22.8 % proved to be infected with endoparasites. Cysts of *Giardia* spp. (Fig. 2) were detected in 12.6 %, followed by coccidia (7.0 %), nematodes (5.9 %) and cestodes (0.7 %). Stages of *Toxocara cati* (Tab. 5) were found in 4.7 %, of *Toxascaris leonina* in 0.1 %, of *Ancylostoma tubaeforme* in 0.2 %, of *Aelurostrongylus abstrusus* in 0.5 %, of *Capillaria* spp. in 1.0 %, of Taeniidae in 0.6 %, of *Dipylidium caninum* in < 0.1 %, of *Mesocestoides* spp. in < 0.1 %, of *Isospora* spp. (Tab. 6) in 6.0 %, of *I. felis* in 4.4 %, of *I. rivolta* in 2.2 %, of *Toxoplasma gondii/Hammondia hammondi* in 0.8 % and of *Sarcocystis* spp. in 0.3 % of the examined samples. With reference to the prevalence of parasites per year in the period 2003 to 2010 (Tabs. 5 and 6) the determined rates of infection with parasites per year in cats showed only minor variations.

Cats in the age groups up to 3 months and >3 up to 6 months of age (Figs. 3, 9 and 10) showed significantly higher infection rates ($p < 0.05$) with *Giardia* spp. (19.5 % and 24.0 %, respectively), *T. cati* (8.1 % and 6.9 %, respectively), *Isospora* spp. (12.8 % and 8.6 %, respectively), *I. felis* (10.0 % and 5.9 %, respectively) and *I. rivolta* (4.6 % and 2.9 %, respectively) compared to older cats. No age-related distribution was seen regarding infections with *Toxascaris leonina*, *Capillaria* spp., *Aelurostrongylus abstrusus*, *Ancylostoma tubaeforme*, cestodes, *Sarcocystis* spp. and *Toxoplasma gondii/Hammondia hammondi*. A seasonal pattern concerning the detection of eggs of *T. cati* (Fig. 11), cysts of *Giardia* spp. (Fig. 13) and oocysts of *Isospora* spp.

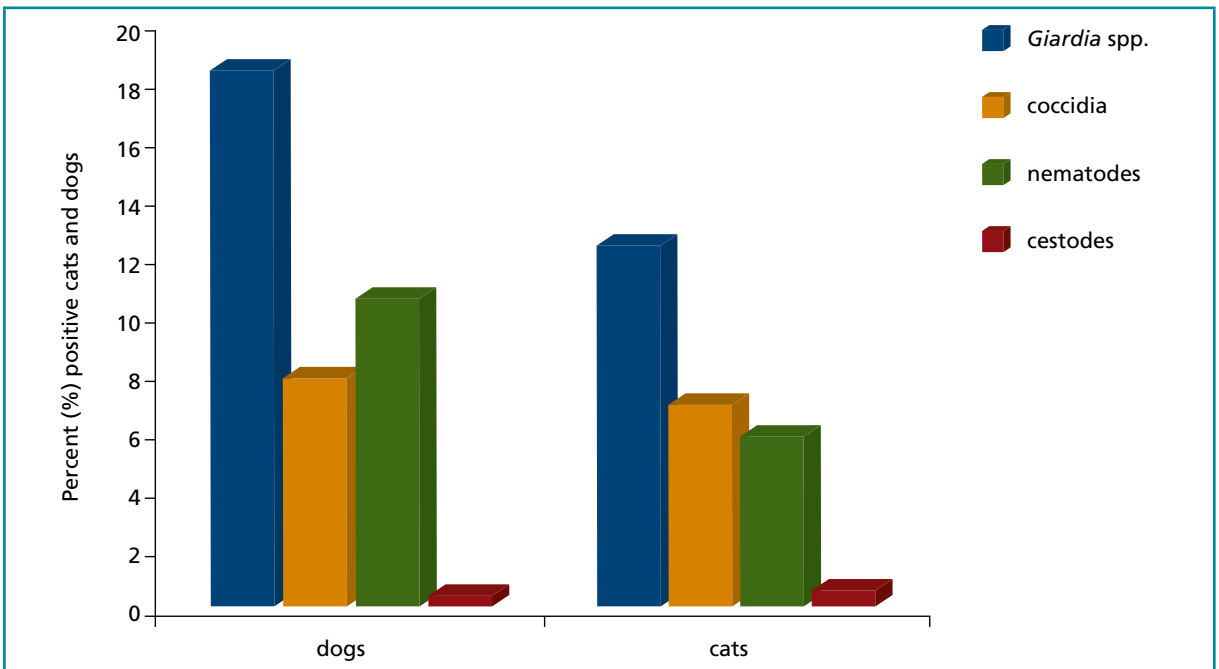

Fig. 2 Infections with endoparasites in cats (n = 8,560) and dogs (n = 24,677) coproscopically examined between 2003 and 2010

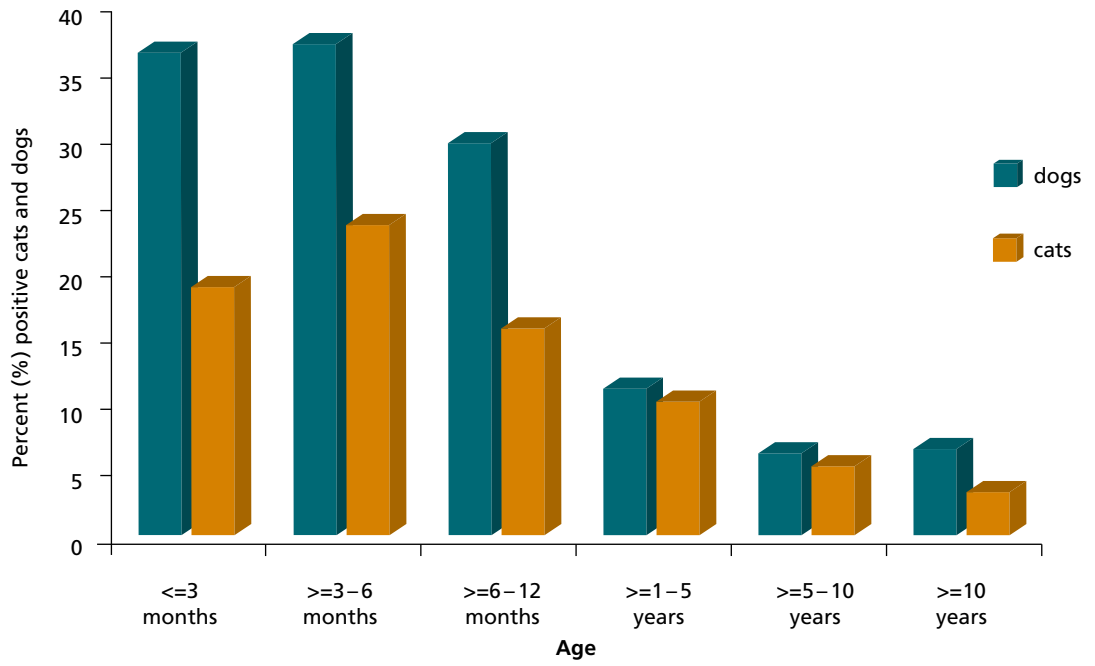

Fig. 3 *Giardia* infection in coproscopically examined dogs (n = 21,516) and cats (n = 6,627) with known age between 2003 and 2010

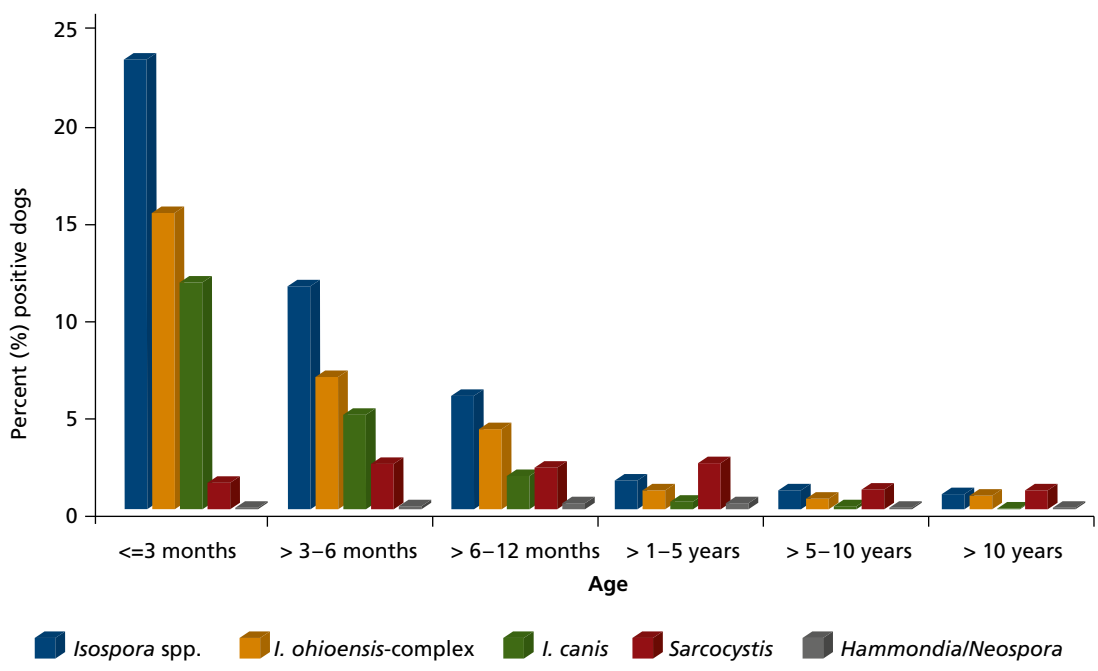

Fig. 4 Infections with coccidia in coproscopically examined dogs (n = 21,516) with known age between 2003 and 2010

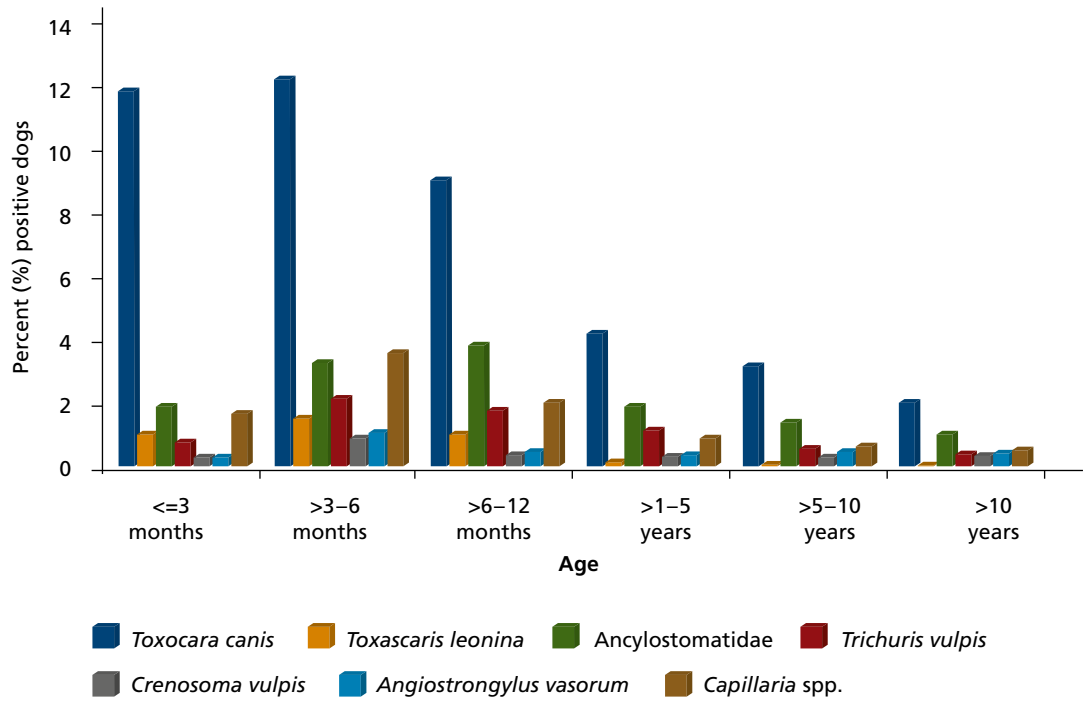

Fig. 5 Infections with nematodes in coproscopically examined dogs (n = 21,516) with known age between 2003 and 2010

(Fig. 12) in faecal samples could be demonstrated. *T. cati* and *Giardia* spp. were most often found from November until January and October until December, respectively, compared to other months. In contrast to that, infections with *Isospora* spp. were more frequently found in August and September.

Discussion

Analyses of results of coproscopical examinations provide an overview about the occurrence and prevalence of endoparasites in dogs and cats. The data presented give an image of the current status of endoparasite infections in pet animals in Germany and the development of parasite prevalence rates within the last eight years. The results are of value to estimate parasite impact and to assist researchers, veterinarians and pet owners with suitable information to control parasites. The monitoring of parasite distribution in the present study demonstrates an unchanged high prevalence of endoparasites in dogs and cats in Germany. 30.4 % of the examined dogs and 22.8 % of the cats proved to be infected with endoparasites. This corresponds almost exactly with the last large-scale analysis done by Barutzki and Schaper (2003), who found 32.2 % of the dogs and 24.3 % of the cats being infected with endoparasites. Over the sample period of the study presented the determined rates of infection with parasites per year in cats and dogs showed only minor variations. That means protozoa, helminths and to a lesser extend cestodes occur frequently, particular in younger dogs and cats. The data presented allow an assessment of the current status of endoparasites in pet animals over a longer period and a comparison to data of other authors in Germany as well as in other European countries.

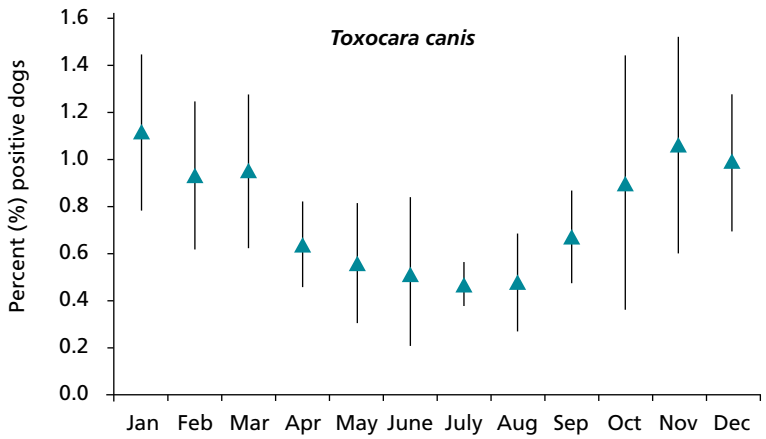

Fig. 6 Seasonal dynamic of *Tococara canis* in coproscopically examined dogs (n = 24,677) between 2003 and 2010

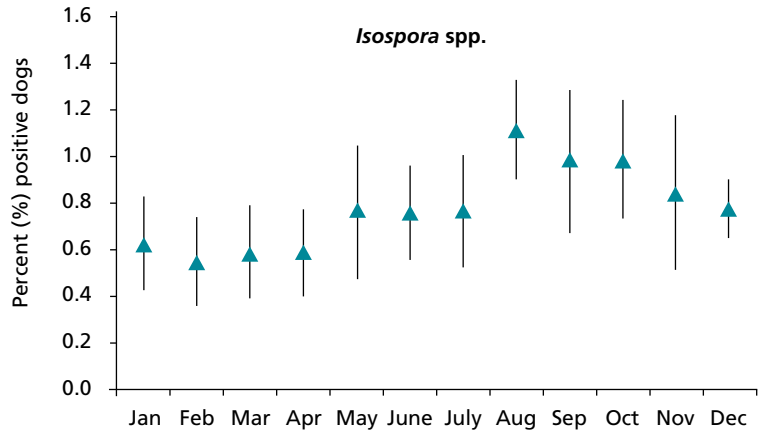

Fig. 7 Seasonal dynamic of *Isospora* spp. in coproscopically examined dogs (n = 24,677) between 2003 and 2010

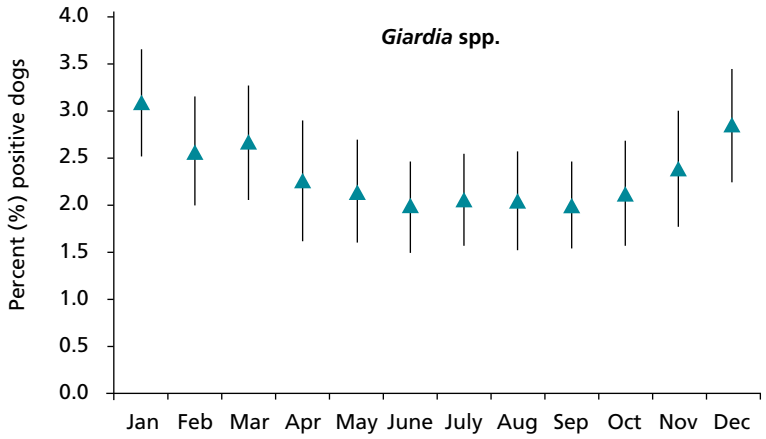

Fig. 8 Seasonal dynamic of *Giardia* spp. in coproscopically examined dogs (n = 24,677) between 2003 and 2010

Prevalence of endoparasites – comparison to other data in Europe

Toxocaridae in dogs

Gastrointestinal nematodes are endemic in dogs throughout Europe, with *T. canis* being the most frequently encountered and ubiquitous species. Infection with *T. canis* still appears particularly predominant in young puppies, where it is traditionally estimated that all pups are infected at birth. At least, for this species reasonable data for comparison are available from other European countries. In the study reported here, the prevalence rate of *T. canis* in dogs was 6.1 % in total, however, in the age groups up to 3 months and > 3 up to 6 months of age it was 12.0 % and 12.4 %, respectively. In a survey carried out in dogs of Murcia in Spain, the prevalence of *T. canis* in dogs < 1 year old was 20 % compared to 5 – 11 % for older age groups (Martinez-Carrasco et al. 2007). In a study conducted in Belgium (Claerebout et al. 2009), *T. canis* were present in 4.4 % of household dogs and 26.3 % of dogs from kennels, whereof around 50 % were pups. In Greece, Haralabidis et al. (1988) reported that 22.4 % of dogs were infected with *T. canis* with the highest prevalence in the up to six-month-old dogs. These results from epidemiological studies in other European countries confirm that infections rates with *T. canis* are considerably higher in puppies and young dogs compared to older dogs.

Results from a study from Fok et al. (2001) suggest higher prevalence rates in some eastern European countries compared to western European countries. The authors reported a prevalence of 24.3 – 30.1 % *T. canis* in the dog population surveyed, with prevalence in pups aged less than three months of 48.7 %. A difference in prevalence rates between urban and rural dogs in the Czech Republic was illustrated by Dubná et al. (2007), where 13.7 % of rural dogs had patent *T. canis* compared with 6.2 % of urban dogs. In Scandinavia, adult Finnish dogs were reported to have a prevalence of 3.1 % *T. canis* and 2.6 % *Uncinaria stenocephala* (Pullola et al. 2006). These comparative data demonstrate that the infection level with *T. canis* predominantly depends on the age of the dogs but also on keeping conditions of the animals and probably on the living condition of the pet holder, too. The prevalence rate of *T. canis* in the dog population of Germany seems to be somewhat lower compared to other countries. This may result from the subgroup of animals studied, which probably represent dogs of concerned pet owners, being under continuous veterinary control, with a higher degree of care and preventative measures.

Ancylostomatidae in dogs

In this study, the prevalence rate of Ancylostomatidae in dogs was 2.2 % and corresponds to approximately earlier surveys in Germany (Barutzki and Schaper 2003). Hookworms, particularly *A. caninum*, may also be seen in young pups where infection is endemic. In a survey of dogs in Murcia in Spain (Martinez-Carrasco et al. 2007), only 0.7 % of pet dogs had evidence of hookworms. In contrast to this, the prevalence of the Ancylostomidae in up to one-year-old dogs was considerably higher and amounted to 6 %. According to this, the prevalence rates of hookworms in dogs from Hungary were 8.1 – 13.1 % and predominant in puppies and young dogs (Fok et al. 2001). In Greece, Haralabidis et al. (1988) reported that hookworms first appeared in dogs aged 6 to 12 months with an overall prevalence of 3 %. A survey in Belgium (Claerebout et al. 2009) indicated analogue data with 3 % hookworm infections in kennel dogs. Dubná et al. (2007) reported for the Czech Republic a prevalence of 0.7 – 0.9 % of hookworms in rural dogs compared to 0.4 % in urban dogs. Pullola et al. (2006) reported a prevalence of 2.6 % for *U. stenocephala* in adult Finnish dogs. Hookworm infections with either *Ancylostoma caninum* or *Uncinaria stenocephala* tend to be variable and focused in regional geographic areas. But they represent the second most common nematode in dogs. In the study presented, eggs of hookworms were more frequently found in dogs > 3 months up to 1 year of age compared to older and younger dogs. This is an indication that *A. caninum* is not endemic in Germany. Because of the low mean temperature

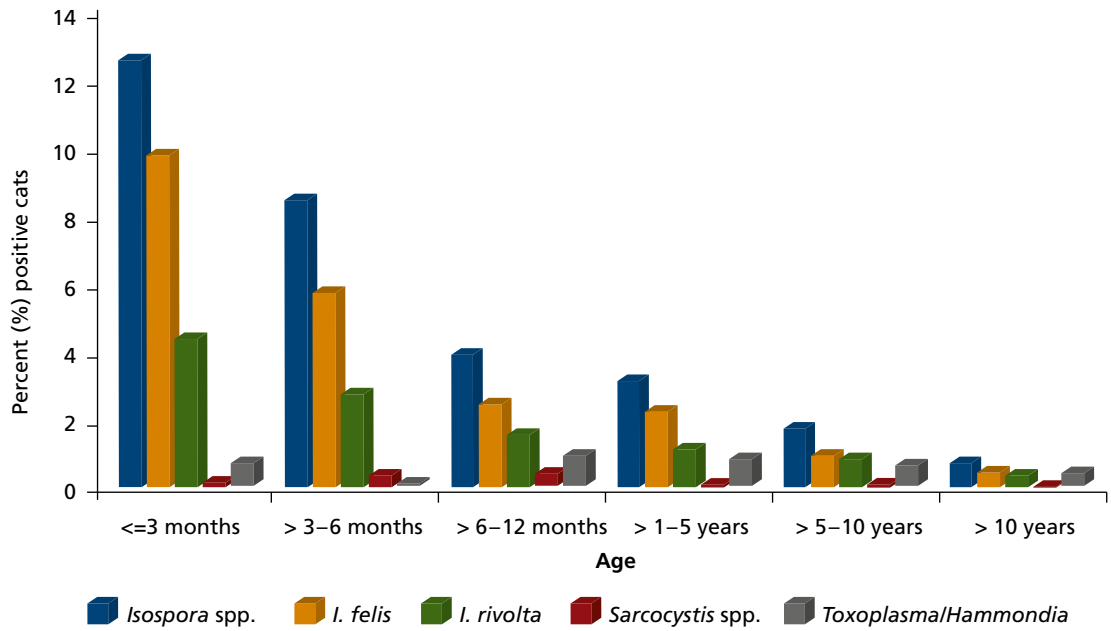

Fig. 9 Infections with coccidia in coproscopically examined cats (n = 6,627) with known age between 2003 and 2010

it is most likely that only *U. stenocephala* is common North of the Alps. *A. caninum* is transmitted by transmammary infection and should lead to higher prevalence rates in young puppies.

Helminths in cats

In contrast to dogs, much less data are available for cats. In the study reported here, stages of *Toxocara cati* were found in 4.7 %, of *Toxascaris leonina* in 0.1 %, of *Ancylostoma tubaeforme* in 0.2 % of the examined cats. Compared to a previous survey (Barutzki and Schaper 2003) the prevalence rate of *T. cati* has been slightly declined, whereas the values for the other parasites stayed almost unaltered. Depending on the subpopulation being tested, the occurrence and distribution of *T. cati* in Germany vary considerably. Hecking-Veltman et al. (2001) demonstrated a prevalence of 43.3 % for *T. cati* in stray cats. Similar high levels for shelter cats were confirmed by Rohen (2009), who found 27.1 % of cats positive for *T.cati*. In a multicentre study, Coati et al. (2003) found eggs from *T. cati* in 11.6 % of the examined samples. In contrast to that, the results of routinely done parasitological examination of cats at the Institute for Parasitology, University of Veterinary Medicine Hannover, showed only 3.9 % *T. cati*-positive samples (Epe et al. 2004). Prevalence rates of *A. tubaeforme* and tapeworms did rarely exceed 1 %, however, in stray cats these were 2 % for hookworms and 4.1 % for tapeworms (Hecking-Veltman et al. 2001). This level was confirmed in shelter cats by Rohen (2009), who found 1.1 % hookworm-positive cats and *Taeniidae* in 2.0 % of the cats.

Giardia spp.

In this study, the most commonly found parasite in dogs and cats was *Giardia* spp. (18.6 % and 12.6 %, respectively). This confirms the high prevalence rates of *Giardia* spp. published in a previous study (Barutzki and Schaper 2003). For Germany, a number of studies have been performed more recently and provide a robust data basis for comparison. Beelitz et al. (2006) found *Giardia* spp. in 40.2 % of dogs kept in groups and in 27.6 % of dogs kept individually in southern Germany. Heusinger (2007) analysed commercial lab data and confirmed

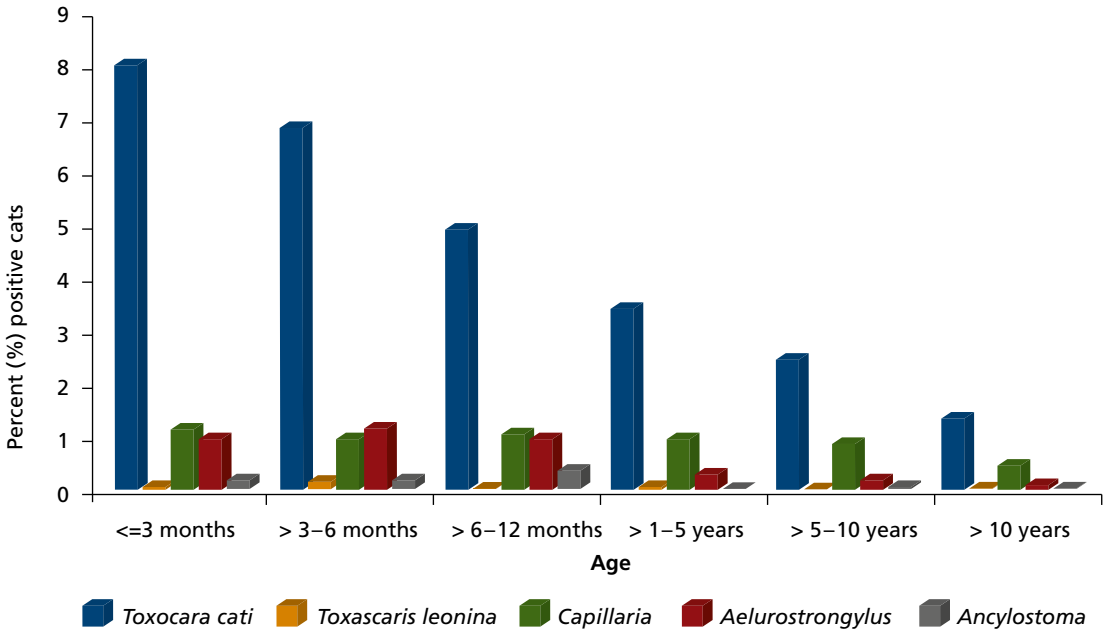

Fig. 10 Infections with nematodes in coproscopically examined cats (n = 6,627) with known age between 2003 and 2010

a high prevalence of *Giardia* spp. in dogs, however, with variable results depending on the method used. Testing by ELISA revealed an average infection rate of 20.58 % and with flotation method only of 8.05 %. For the UK, Batchelor et al. (2008) reportet an infection rate of 8.4 % in dogs and a significantly higher rate of 16.3 % in dogs under 12 months of age. Upjohn et al. (2010) investigated *Giardia* spp. prevalence in Central London shelter dogs and found an infection rate of 21 %. In Belgium, Claerbout et al. (2009) investigated the prevalence of endoparasites in different dog populations. In kennel dogs, the prevalence of *Giardia* spp. was 43.9 %, in household dogs only 9.3 %. Dogs with gastrointestinal symptoms showed a prevalence of 18.1 %. In Italy, Scaramozzino et al. (2009) investigated the prevalence of *Giardia* spp. in dogs in kennels and found a rate of 20.5 %.

In a recent large scale analysis of cross-sectional data from commercial laboratories, Epe et al. (2010) confirmed a high prevalence of *Giardia* spp. across a number of different European countries. In dogs, prevalence of *Giardia* spp. was 28.47 % for Belgium, 23.75 % for Germany, 25.10 % for Spain, 27.53 % for France, 25.89 % for Italy, 24.62 % for the Netherlands and 14.62 % for the UK. These comprehensive data support the findings of this study: *Giardia* spp. is the most prevalent endoparasite in dogs across a number of European countries. Due to the zoonotic potential of this parasite, an ongoing surveillance of the prevalence is warranted. In this study, also data from cats were published. The prevalence was 26.32 % for Belgium, 24.59 % for Germany, 14.59 % for Spain, 15.31 % for France, 17.71 % for Italy, 13.20 % for the Netherlands and 11.54 % for the UK.

Coccidia

In dogs, coccida were the third most prevalent parasite group in dogs with a rate of 8 %, however, with a prevalence of *Isospora* spp. in the age group up to 3 months of age of 23.4 % and > 3–6 months of age of 11.8 %. In cats the corresponding figures for *Isospora* spp. were 6.0 % overall, cats up to 3 months of age and > 3 months up to 6 months of age showed significantly higher infection rates

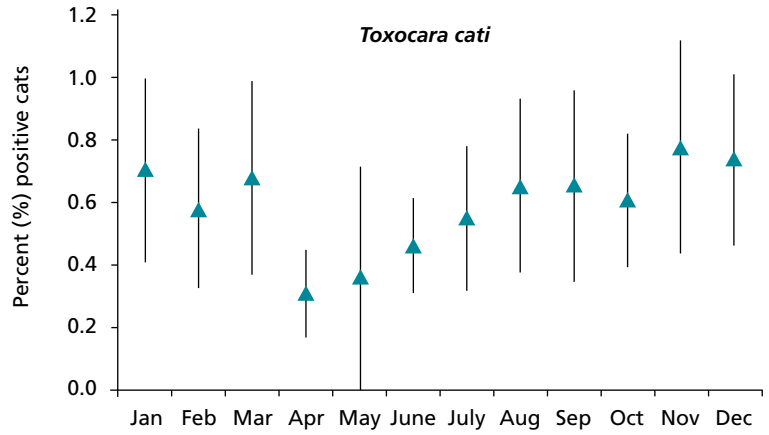

Fig. 11 Seasonal dynamic of *Toxocara cati* in coproscopically examined cats (n = 8,560) between 2003 and 2010

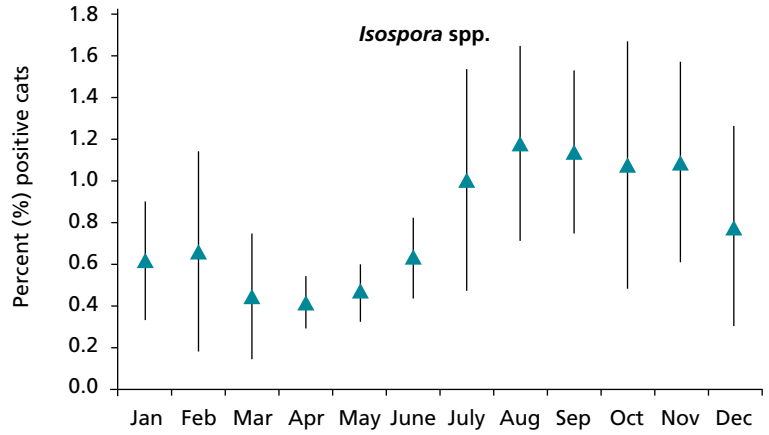

Fig. 12 Seasonal dynamic of *Isospora* spp. in coproscopically examined cats (n = 8,560) between 2003 and 2010

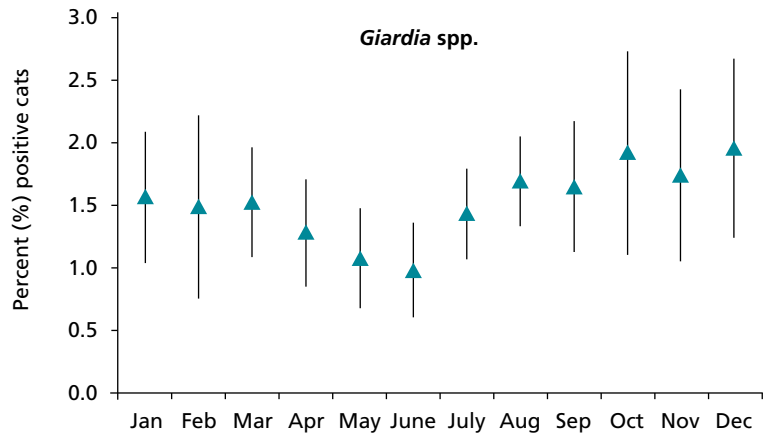

Fig. 13 Seasonal dynamic of *Giardia* spp. in coproscopically examined cats (n = 8,560) between 2003 and 2010

Tab. 3 Number (n) and percent (%) of helminth-positive dogs found by coproscopical examination from 2003–2010 in Germany

Year	Number of examined dogs	*Toxocara canis* number/ share positive dogs		*Toxascaris leonina* number/ share positive dogs		Ancylostomidae number/ share positive dogs		*Trichuris vulpis* number/ share positive dogs		*Crenosoma vulpis* number/ share positive dogs		*Angiostrongylus vasorum* number/ share positive dogs		*Capillaria* number/ share positive dogs	
		(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
2003	2,139	147	6.9	15	0.7	42	2.0	33	1.5	3	0.1	1	0.1	37	1.7
2004	2,525	143	5.7	13	0.5	43	1.7	34	1.3	4	0.2	2	0.1	20	0.8
2005	2,608	135	5.2	20	0.8	46	1.8	25	1.0	4	0.2	4	0.2	24	0.9
2006	2,590	148	5.7	11	0.4	55	2.1	24	0.9	9	0.3	4	0.2	39	1.5
2007	3,425	220	6.4	15	0.4	69	2.0	46	1.3	13	0.4	16	0.5	52	1.5
2008	3,978	284	7.1	29	0.7	111	2.8	53	1.3	31	0.8	38	1.0	68	1.7
2009	3,709	215	5.8	15	0.4	88	2.4	40	1.1	21	0.6	31	0.8	44	1.2
2010	3,703	223	6.0	19	0.5	84	2.3	37	1.0	16	0.4	32	0.9	35	0.9
2003–2010	**24,677**	**1,515**	**6.1**	**137**	**0.6**	**538**	**2.2**	**292**	**1.2**	**101**	**0.4**	**128**	**0.5**	**319**	**1.3**

with *Isospora* spp. at 12.8 % and 8.6 %, respectively. This corresponds with the results of a similar study conducted previously (Barutzki and Schaper 2003). Data about coccidian prevalence in Europe are scarcely published. Most of the studies have shown that puppies and young animals are more likely infected with protozoa than older dogs and cats (Daugschies et al. 2000; Barutzki and Schaper 2003; Buehl et al. 2006). These high prevalence data in especially young animals demonstrate that coccidia are frequently found and likely pose a higher thread to the animals than previously thought.

A seasonal pattern was noticed for the excretion of cysts of *Giardia* spp., eggs of *T. canis* and *T. cati* and oocysts of *Isospora* spp. of cats and dogs. A peak of infection with *Giardia* spp. was found in January for dogs and in December for cats. Eggs of *T. canis* and *T. cati* were mostly found from November till January and oocysts of *Isospora* spp. from dogs and cats in August. The reason for this phenomenon is unknown but was already described by Batchelor et al. (2008) for *I. canis*. Further work would be necessary to determine if these seasonal patterns are constant.

Lungworms

In terms of lungworm infections in dogs there seems to be an increasing trend, supported by data from a similar study conducted by Barutzki and Schaper (2009). Compared to a previous study (Barutzki and Schaper 2003), the prevalence rates of *Capillaria* spp. have been raised from 0.7 % to 1.3 %, of *Crenosoma vulpis* from 0.3 % to 0.4 %, and of *Angiostrongylus vasorum* from 0.1 % to 0.5 % whereas the rate of *Aelurostrongylus abstrusus* in cats decreased from 0.7 % to 0.5 %. Although the infection rates are still relatively low overall, this fact is somewhat surprising and may indicate a further spread of lungworm parasites in dogs, as it was also discussed in more recent studies performed in Germany by Barutzki and Schaper (2009) and Taubert et al. (2009).

Cestodes

Stages of tapeworms belonging to the family Taeniidae, Dipylidiidae and the genus *Mesocestoides* were only accidentally found. The results presented for dogs and cats document percentages not exceeding a rate of 1 %. These low values determined by faecal examination do not represent the

Tab. 4 Number (n) and percent (%) of protozoa-positive dogs found by coproscopical examination from 2003–2010 in Germany

Year	Number of examined dogs	*Isospora* spp. number/ share positive dogs		*I. ohioensis*-complex number/ share positive dogs		*I. canis* number/ share positive dogs		*Hammondia*/ *Neospora* number/ share positive dogs		*Sarcocystis* number/ share positive dogs		*Giardia* spp. number/ share positive dogs	
		(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
2003	2,139	136	6.4	100	4.7	49	2.3	12	0.6	34	1.6	375	17.5
2004	2,525	155	6.1	103	4.1	68	2.7	6	0.2	60	2.4	518	20.5
2005	2,608	181	6.9	121	4.6	79	3.0	7	0.3	73	2.8	525	20.1
2006	2,590	154	5.9	113	4.4	66	2.5	11	0.4	61	2.4	481	18.6
2007	3,425	205	6.0	147	4.3	92	2.7	9	0.3	71	2.1	705	20.6
2008	3,978	198	5.0	131	3.3	91	2.3	10	0.3	95	2.4	650	16.3
2009	3,709	179	4.8	130	3.5	70	1.9	12	0.3	74	2.0	698	18.8
2010	3,703	183	4.9	128	3.5	73	2.0	13	0.4	74	2.0	639	17.3
2003–2010	**24,677**	**1,391**	**5.6**	**973**	**3.9**	**588**	**2.4**	**80**	**0.3**	**542**	**2.2**	**4,591**	**18.6**

true prevalence as demonstrated by a comparison of coproscopical and post-mortem examinations in dogs. By means of coproscopical examination 1 % cestode-positive dogs were determined, whereas in the same population necropsy revealed 47 % tapeworm-infected dogs (Martinez-Carrasco et al. 2007). The discrepancy between coproscopical and post-mortem examination is due to the excretion behaviour of cestodes. Eggs packets of *Dipylidium caninum* are seldom seen free in faeces. They might be expressed from the gravid proglottid, but in general, mature proglottids are released from the tapeworm's posterior end and leave the host in faeces passively or even by active emigration passing the faeces without maceration. Also proglottides of Taeniidae are motile and they represent the diagnostic stage, which may be found on the surface of faeces. This holds true for *Mesocestoides*, whose eggs are stored in the paruterine organ. The whole proglottid is the diagnostic stage, which is seldom seen in the faeces. Therefore, it can be concluded that the real prevalence of tapeworm infections in dogs and cats is certainly much higher than documented in the present study.

Tab. 5 Number (n) and percent (%) of helminth-positive cats found by coproscopical examination from 2003–2010 in Germany

Year	Number of examined cats	*Toxocara cati* number/share positive cats		*Toxascaris leonina* number/share positive cats		*Ancylostoma tubaeforme* number/share positive cats		*Aelurostrongylus abstrusus* number/share positive cats		*Capillaria* number/share positive cats	
		(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
2003	755	43	5.7	0	0	1	0.1	3	0,4	16	2.1
2004	840	45	5.4	0	0	1	0.1	0	0	13	1.5
2005	917	56	6.1	2	0.2	0	0	4	0.4	9	1.0
2006	960	45	4.7	1	0.1	0	0	2	0.2	7	0.7
2007	1,158	59	5.1	1	0.1	4	0.3	6	0.5	18	1.6
2008	1,213	32	2.6	2	0.2	2	0.2	9	0.7	8	0.7
2009	1,208	44	3.6	1	0.1	3	0.2	8	0.7	7	0.6
2010	1,509	77	5.1	1	0.1	3	0.2	13	0.9	4	0.3
2003–2010	**8,560**	**401**	**4.7**	**8**	**0.1**	**14**	**0.2**	**45**	**0.5**	**82**	**1.0**

Tab. 6 Number (n) and percent (%) of protozoa-positive cats found by coproscopical examination from 2003–2010 in Germany

Year	Number of examined cats	*Isospora* spp. number/share positive cats		*I. rivolta* number/share positive cats		*I. felis* number/share positive cats		*Toxoplasma/ Hammondia* number/share positive cats		*Sarcocystis* number/share positive cats		*Giardia* spp. number/share positive cats	
		(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
2003	755	44	5.8	26	3.4	25	3.3	4	0.5	2	0.3	96	12.7
2004	840	51	6.1	14	1.7	42	5.0	4	0.5	0	0	90	10.7
2005	917	60	6.5	20	2.2	45	4.9	13	1.4	4	0.4	124	13.5
2006	960	54	5.6	22	2.3	36	3.8	7	0.7	8	0.8	134	14.0
2007	1,158	77	6.6	22	1.9	60	5.2	13	1.1	4	0.3	159	13.7
2008	1,213	65	5.4	19	1.6	51	4.2	8	0.7	4	0.3	156	12.9
2009	1,208	65	5.4	22	1.8	44	3.6	9	0.7	2	0.2	164	13.6
2010	1,509	96	6.4	46	3.0	72	4.8	8	0.5	4	0.3	159	10.5
2003–2010	**8,560**	**512**	**6.0**	**191**	**2.2**	**375**	**4.4**	**66**	**0.8**	**28**	**0.3**	**1,082**	**12.6**

Conclusion

In Germany, endoparasites in dogs and cats still remain on a considerable high level, especially compared to a similar study conducted previously by the same authors. In this study, for the first time a detailed age-dependant analysis could be accomplished, presenting the high level of parasite infections especially in the age group up to three months, and >3–6 months of age. This highlights even more the need for parasite control, supported by veterinarians and organisations such as the European Scientific Counsel Companion Animal Parasites. Taking into consideration the shortfalls of a cross-sectional study and the fact that data from a well-cared population have been analysed, it may be concluded that the true prevalence in the average population is on a substantially higher level. Thus it is evident, that the veterinary profession must not forget this important aspect of animal welfare, when caring for their patients and advising their owners accordingly. Performance of such studies indicating stable or even increasing parasite prevalence rates is delivering robust data to take evidence-based decisions and highlight the need for further efforts in the control of parasites. The experiences of the last years demonstrate that despite detailed knowledge of the parasites life cycles, proved disinfectant and hygiene measures, various routes of transmission and high tenacity of exogenous stages ensure the survival and maintenance of parasites.

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Compliance statement

All of the studies reported herein were performed in compliance with current, applicable, local laws and regulations.

Disclosure statement

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