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Original Article

The prevalence of the helminth parasites of stray dogs in Ismailia City

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Abstract:
In a study on the parasites of stray dogs in Ismailia City, 50 stray dogs of different sexes and ages were humanely euthanized, necropsied, and examined for helminth parasites. Twenty helminths (14 trematodes, two cestodes, and four nematodes) were detected. The total prevalence of helminths was 100%, with trematodes (36%), cestodes (100%), and nematodes (34%). Of the recorded 14 trematodes, *Pygidiopsis summa* and *Ascocotyle rara* were recorded for the first time in Ismailia Province and might be for the first time among Egyptian dogs. The most prevalent trematode was *Pygidiopsis genata* (20%). The detected cestodes were *Dipylidium caninum* (100%) and *Taenia hydatigena* (10%). The recovered nematodes were *Toxocara canis* (20%), *Toxascaris leonina* (10%), *Spirocerca lupi* (10%), and *Rictularia affinis* (8%). There was a highly significant difference ($p<0.01$) in the prevalence of trematodes between different ages (60% in adults and 0% in young dogs). The prevalence of *Toxocara canis* was significantly higher ($p< 0.05$) in young dogs (40%) than in adult ones (6.7%). There was no significant difference ($p > 0.05$) in the prevalence of the detected helminths with the sex of dogs. Histopathological examination of the lungs and oesophagus of dogs infected with *Spirocerca lupi* revealed chronic pneumonia, pulmonary alveolar emphysema, granulation tissue formation, and an early stage of fibroma in the oesophagus. All necropsied dogs were infected with at least one zoonotic helminth parasite. In conclusion, stray dogs in Ismailia City carry several helminth parasites, thus posing a risk for both human and companion dog populations.

Key words: helminth, stray dogs, Ismailia, and prevalence

INTRODUCTION

The dog population in urban and suburban regions comprises dogs that roam only with their owners and stray and ownerless dogs that roam sporadically **(Beck, 2000)**. Of the estimated 500 million dogs worldwide, about 400 million are stray ones **(WSPA, 2009)**. Egypt has a large population of stray dogs that move freely within cities and contact other urban, suburban, and rural animals **(Nabih, 1998)**. Dogs are associated with more than 60 zoonotic diseases, among which parasites, in particular helminthiasis, can pose serious health concerns **(Rhindali et al., 2006)** as well as significant economic impacts from a veterinary standpoint. Dogs play a pivotal role as parasite bridges between wildlife and humans **(Salb et al., 2008)**.

Among zoonotic helminths that can infect dogs, *Toxocara canis* is particularly pathogenic to humans **(McManus, 2006)**. This nematode can cause visceral larva migrans (VLM), ocular larva migrans (OLM), or both in humans, especially children **(Gavignet et al., 2008)**. The human population in Ismailia City relies heavily on freshwater fish grown in aquaculture systems as a source of dietary protein. Numerous free-roaming dogs scavenge offal from fish farms and become infected by trematodes that utilize fish as an intermediate host. This trematode infection may also be transmissible to humans **(Chai et al., 1986a; Chai and Lee, 1990)**. Canine trematodes in Egypt include *Mesostephanus* spp., *Echinochasmus* spp., *Heterophyes* spp., and *Pygidiopsis genata* **(El-Gayar, 2007)**. The distribution and intensity of parasitic diseases are influenced by climatic, geographical, cultural, and economic factors. Therefore, studying the helminth parasites in every given region is necessary.

The present work aims to study the prevalence and intensity of the helminth parasites in stray dogs in Ismailia City and discuss the zoonotic risk associated with these dogs.

MATERIALS AND METHODS

This study was conducted on 50 stray dogs (23 male and 27 female) captured from Ismailia City. Their sex and age were recorded. Dogs less than one year were classified as youngs (n=20) and those over one year as adults (n=30). These dogs were humanely euthanized, necropsied, and examined for helminth parasites. At necropsy, exploration of the abdominal and thoracic cavities for the presence of extraintestinal parasites was carried out. The digestive tract and other organs (brain, lung, heart, liver, and urinary bladder) were separately examined. Each part of the alimentary canal was opened in a separate petri dish containing physiological saline. The intestinal contents were washed and inspected by the naked eye and then under a stereoscopic microscope for helminth parasites. The collected helminths were counted according to **Bwalya (2012)**. Trematodes and cestodes were stained with Acetic Acid Alum Carmine, while nematodes were clarified with lactophenol. Then, we prepared permanent mounts from these helminths according to the method of **Fleck & Moody (1993)**. The collected helminths matched the descriptive data and figures given by **Yamaguti (1939,1958), Fahmy and Selim (1959)**, **Soulsby (1982), Nabih (1998)**, and **El-Gayar (2007)**. Specimens from the lungs and nodules in the oesophagus of *Spirocerca lupi*-infected dogs were fixed in 10% formol saline, embedded in paraffin, cut 5 µm thick, and stained with H&E stain **(Drug et al., 1967)**. Chi-square test (**Snedecor & Cochran, 1991)** was used to analyze the categorical data and evaluate the statistically significant associations between the prevalence of helminths and the dog's age and sex. Differences were considered significant at ($p \leq 0.05$).

Table 1: Prevalence of helminths in stray dogs in Ismailia City

Helminthes	No. of infested/ no. of examined	Prevalence %
Trematodes	18/50	36
Cestodes	50/50	100
Nematodes	17/50	34
Total	50/50	100

RESULTS

Parasitological results:

The total prevalence of helminths was 100%, with trematodes (36%), cestodes (100%), and nematodes (34%) (Table 1). All detected parasites (Figs. 1-32) were found in the small intestine except for *Spirocerca lupi,* which was found in the oesophagus. Fourteen trematode species were recorded. The most prevalent trematode was *Pygidiopsis summa* (4%), while *Mesostephanus* spp. had the highest mean intensity of 95.5 (18-170). Two cestodes (*Dipylidium caninum* and *Taenia hydatigena*) were detected. *Dipylidium caninum* was the most prevalent cestode (100%) with a mean intensity of 62.3 (2-189) worms/dog. Four nematodes (*Toxocara canis*, *Toxascaris leonina*, *Spirocerca lupi,* and *Rictularia affinis*) were recovered. *Toxocara canis* was the most common nematode (20%) with a mean intensity of 7.3 (3-15) worms/dog (Table 2).

Table 2: Prevalence and intensity of helminth parasites in stray dogs in Ismailia City

Species	No. of infested/ no. of examined	Prevalence (%)	Intensity (range)	Mean intensity (worms/dog)
Prohemistomum vivax	2/50	4	1-5	3.0 (6/2)
Mesostephanus appendiculatus	8/50	16		
Mesostephanus melvi	3/50	6	18-170	95.5 (764/8)
***Mesostephanus* sp.**	1/50	2		
Echinochasmus liliputans	8/50	16	10-36	19.0 (158/8)
Heterophyes dispar	7/50	14	5-20	13.0 (93/7)
Pygidiopsis genata	10/50	20	10-40	26.7 (267/10)
Pygidiopsis summa	3/50	6		
Ascocotyle rara	2/50	4	2-4	3.0 (6/2)
Phagicola longus	3/50	6	2-10	5.7 (17/3)
Phagicola longicollis	2/50	4	1-3	2 (4/2)
Metagonimus yokogawai	2/50	4	2-3	2.5 (5/2)
Haplorchis pumilio	3/50	6	2-4	3.0 (6/2)
Apophallus donicus	2/50	4	1-3	2 (4/2)
Dipylidium caninum	50/50	100	2-189	62.3 (3116/50)
Taenia hydatigena	5/50	10	1-4	2 (10/5)
Toxocara canis	10/50	20	3-15	7.3 (73/10)
Toxascaris leonina	5/50	10	2-8	4.4 (22/5)
Spirocerca lupi	5/50	10	3-8	5.6 (28/5)
Rictularia affinis	4/50	8	1-2	1.8 (7/4)

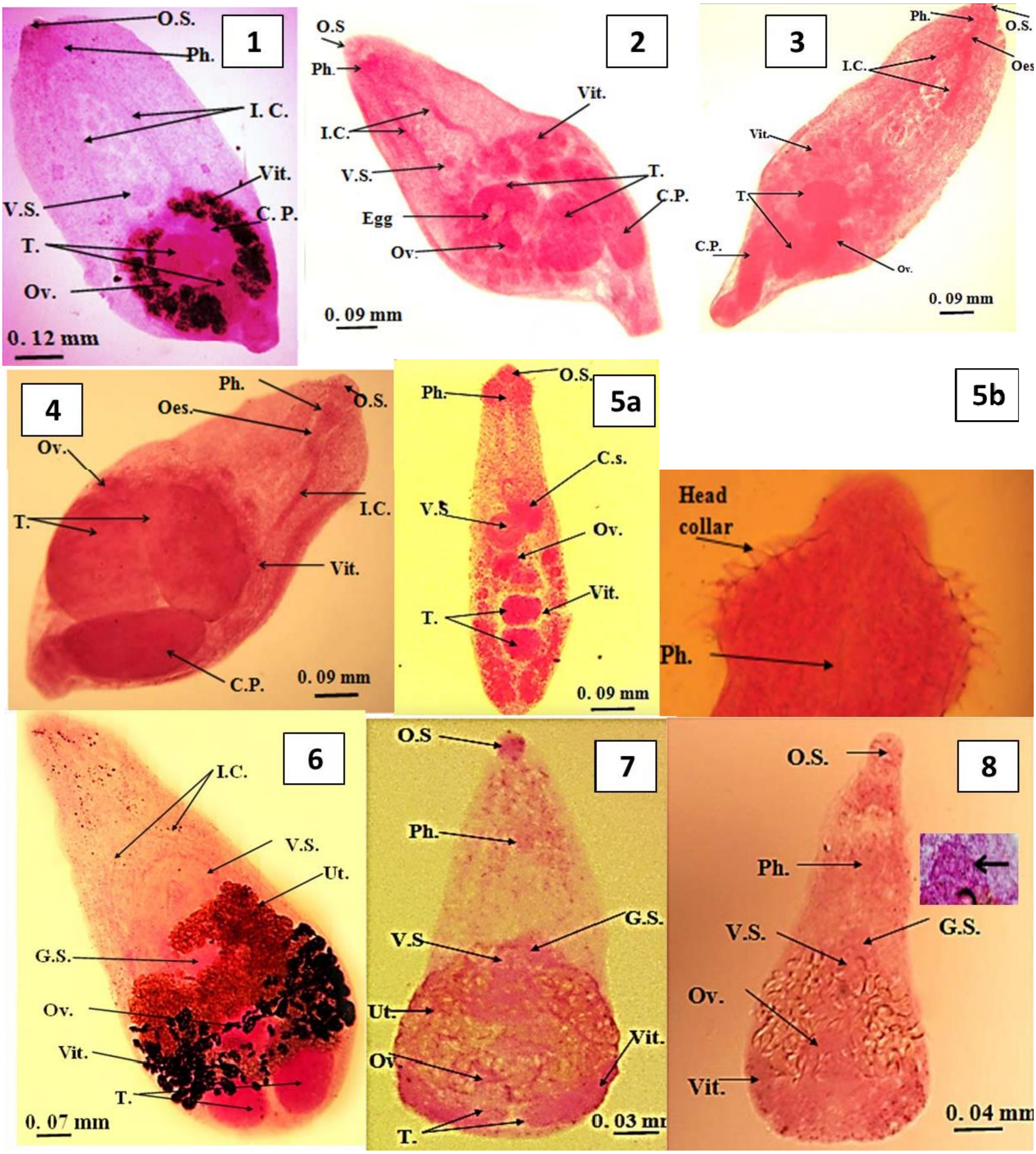

Figure 1-8: Trematodes of stray dogs in Ismailia City
1: *Prohemistomum vivax* adult,
2: *Mesostephanus appendiculatus* adult,
3: *Mesostephanus melvi* adult,
4: *Mesostephanus* sp. adult,
5a: *Echinochasmus liliputans* adult, 5b: *E. liliputans* anterior end,
6: *Heterophyes dispar* adult,
7: *Pygidiopsis genata* adult,
8: *Pygidiopsis summa* adult arrow showing spines on the genital sucker.
(O.S.: oral sucker, V.S.: ventral sucker, Ph.: Pharynx, P. Ph.: pre-pharynx, Oes.: oesophagus, T.: testis, Ov.: ovary, Vit.: vitellaria, I.C.: intestinal ceci, C.P.: cirrus pouch, G.S.: genital sucker and C.S.: cirrus sac).

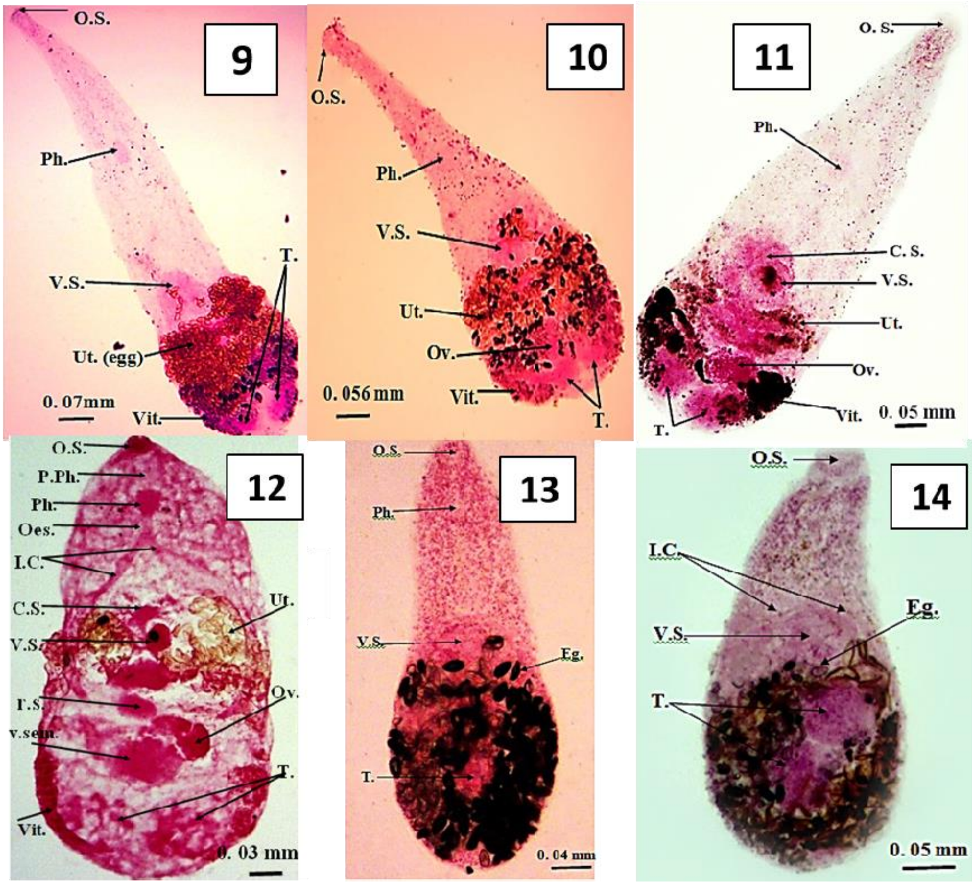

Figure 9-14: Trematodes of stray dogs in Ismailia City
9: *Ascocotyle rara* adult, 10: *Phagicola longus* adult,
11: *Phagicola longicollis* adult,
12: *Metagonimus yokogawai* adult,
13: *Haplorchis pumillio* adult,
14: *Apophallus donicus* adult
(C.S.: cirrus sac, Ut.: uterus, v. sem.: vesicula seminalis, r.s.: receptaculum seminis and Eg.: Egg).

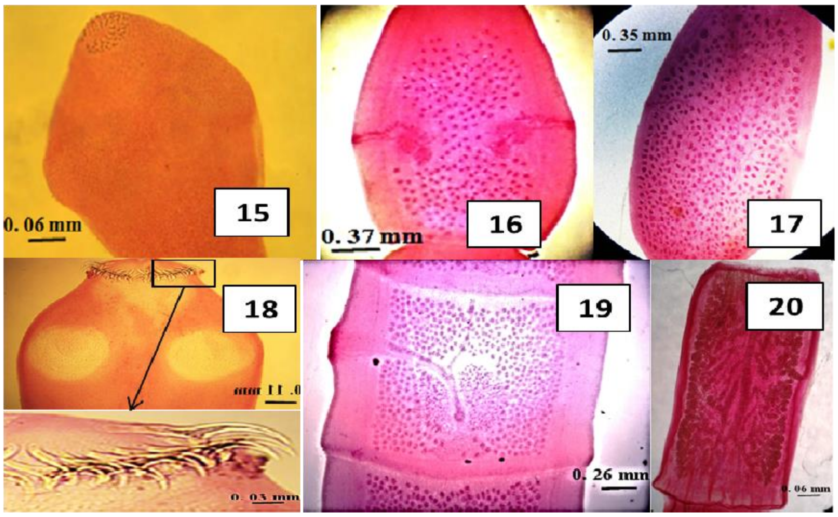

Figure 15-20: Cestodes of stray dogs in Ismailia City
15: *Dipylidium caninum* scolex,
16: *Dipylidium caninum* mature segment
17: *Dipylidium caninum* gravid segment
18: *Taenia hydatigena* scolex
19: *Taenia hydatigena* mature segment
20: *Taenia hydatigena* gravid segment

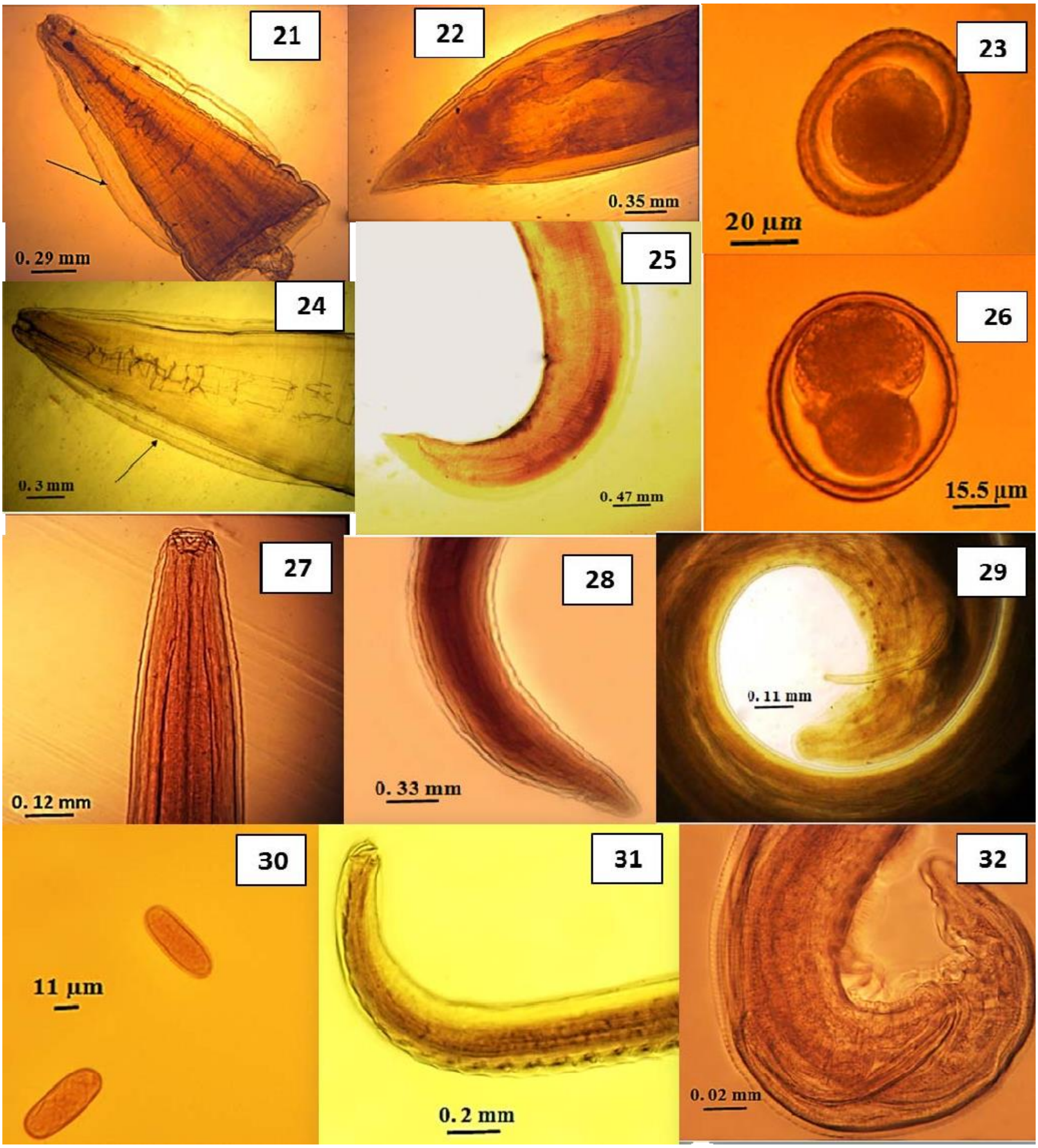

Figure 21-32: Nematodes of stray dogs in Ismailia City
21: *Toxocara canis* anterior end
22: *Toxocara canis* female posterior end
23: *Toxocara canis* eggs
24: *Toxascaris leonina* anterior end
25: *Toxascaris leonina* male posterior end
26: *Toxascaris leonina* egg
27: *Spirocerca lupi* anterior end
28: *Spirocerca lupi* female posterior end
29: *Spirocerca lupi* male posterior end
30: *Spirocerca lupi* egg
31: *Rictularia affinis* anterior end
32: *Rictularia affinis* male posterior end

As shown in Table (3), the frequency of mixed infection with helminths (70%) was higher than that of the single infection (30%). All necropsied dogs were infected with at least one zoonotic helminth parasite. The zoonotic helminths were one nematode (*Toxocara canis*), one cestode species (*Dipylidium caninum*) and seven trematodes (*Prohemistomum vivax*, *Heterophyes dispar*, *Phagicola longus*, *Pygidiopsis summa*, *Metagonimus yokogawai*, *Apophallus donicus,* and *Haplorchis pumilio*).

In tables 4 & 5, the Chi-square analysis of the prevalence of different helminths in relation to the age and sex of dogs revealed that there was a highly significant difference ($p \leq 0.01$) in the prevalence of trematodes and *T. canis* in relation to the age of dogs. However, there was no significant difference ($p > 0.05$) in the prevalence of *Taenia hydatigena, Toxascaris leonina*, *Spirocerca lupi*, and *Rictularia affinis* in relation to the age of dogs. No significant difference ($p > 0.05$) was found in the prevalence of helminths between dogs of different sexes.

Table 3: The frequency of single, multiple, and zoonotic infection

Helminthes	No. of infested/no. of examined	%
Single infection	15/50	30
Mixed infection	35/50	70
Two helminth species	10/50	20
Three helminth species	5/50	10
Four helminth species	5/50	10
More than four species	15/50	30
Zoonotic infection	50/50	100

Histopathological alterations:

The lungs of dogs infected with *Spirocerca lupi* showed pulmonary alveolar emphysema, with focal mononuclear cell infiltration and granuloma formation (Fig. 33-34). The oesophagus of *Spirocerca lupi*-infected dogs revealed focal aggregations of mononuclear cells, with marked fibrosis, granulation tissue formation, and early fibroma (Fig. 35-38).

Table 4: Chi-square analysis of the prevalence of different helminths in relation to the age of dogs

Helminthes	Age	No. of infested/ no. of examined	Prevalence (%)	X^2	p-value
Trematodes	**Young**	0/20	0.0	16.24	0.00**
	Adult	18/30	60.0		
Dipylidium caninum	**Young**	20/20	100.0	NA	NA
	Adult	30/30	100.0		
Taenia hydatigena	**Young**	0/20	0.0	2.08	0.15
	Adult	5/30	16.7		
Toxocara canis	**Young**	8/20	40.0	6.38	0.01**
	Adult	2/30	6.7		
Toxascaris leonina	**Young**	4/20	40.0	2.08	0.15
	Adult	1/30	3.3		
Spirocerca lupi	**Young**	0/20	0.0	2.08	0.15
	Adult	5/30	16.7		
Rictularia affinis	**Young**	0/20	0.0	1.37	0.24
	Adult	4/30	13.3		

* significant difference $p \leq 0.05$, ** highly significant difference $p \leq 0.01$, NA: not applicable

Table 5: Chi-square analysis of the prevalence of different helminths in relation to dog sex

Helminthes	Sex	No. of infested/ no. of examined	Prevalence (%)	X^2	p-value
Trematodes	**Male**	10/23	43.5	0.52	0.47
	Female	8/27	29.6		
Dipylidium caninum	**Male**	23/23	100.0	NA	
	Female	27/27	100.0		NA
Taenia hydatigena	**Male**	3/23	13.0	0.04	0.85
	Female	2/27	7.4		
Toxocara canis	**Male**	4/23	17.4	0.01	0.94
	Female	6/27	22.2		
Toxascaris leonina	**Male**	3/23	17.4	0.04	0.85
	Female	2/27	22.2		
Spirocerca lupi	**Male**	1/23	4.3	0.57	0.45
	Female	4/27	14.8		
Rictularia affinis	**Male**	1/23	4.3	0.12	0.72
	Female	3/27	11.1		

* significant difference $p \leq 0.05$, ** highly significant difference $p \leq 0.01$, NA: not applicable

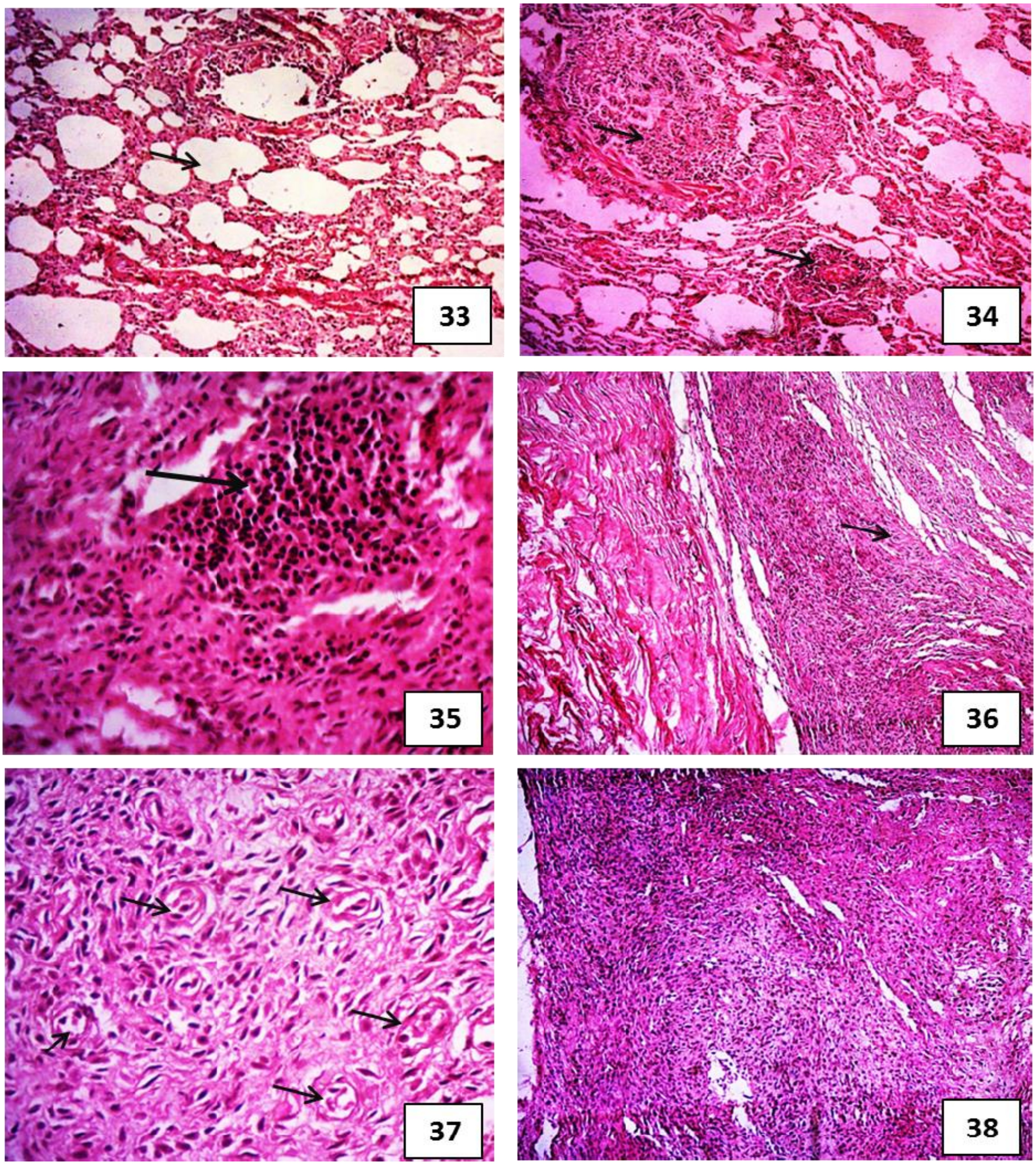

Figure 33-38: Histopathological alterations of lungs and oesophagus of dogs infected with *Spirocerca lupi* H&E stain33: Lung showing pulmonary alveolar emphysema with focal mononuclear cells infiltration
34: Lung showing a chronic inflammatory reaction with granuloma formation (arrows)
35: Oesophagus showing focal aggregations of mononuclear cells (arrow)
36: Oesophagus showing chronic inflammatory reactions with marked fibrosis (arrow)
37: Oesophagus showing granulation tissue with newly formed capillaries (arrows)
38: Oesophagus showing proliferation of fibroblasts in a characteristic form of early fibroma

DISCUSSION

This study was carried out on 50 stray dogs, and 20 helminth parasites were detected. The total prevalence of helminths was 100%, similar to **El-Gayar (2005)** (100%) in Ismailia City, **Jones *et al.* (2011)** (100%) in Ethiopia, and **Traub *et al.* (2002)** (99%) in northeastern India. However, a lower prevalence was recorded by **Abd-Alla (2002)** (86.2%), **Adamu *et al.* (2012)** (13.8%), and **Adinezadeh et al. (2013) (84%)**. The total prevalence of trematodes was 36%, higher than that recorded by **Abd-Alla (2002)** (13.79%) and **El-Gayar (2005)** (13.3%). The total prevalence of cestodes was 100%, higher than that recorded by **Abd-Alla (2002)** (86.2%) and **El-Gayar (2005)** (73%). The total prevalence of nematodes was 34%, higher than that reported by **Mehrabani *et al.* (2002)** (24.8%) in Iran but lower than that reported by **Abd-Alla (2002)** (55.17%), **El-Gayar (2005)** (46.6%), and **Yacob et al. (2007)** (95%) in Ethiopia.

The detected trematodes during this study were *Prohemistomum vivax* (4%), *Mesostephanus appendiculatus* (16%), *Mesostephanus melvi* (6%), *Mesostephanus* sp. (2%), *Echinochasmus liliputans* (16%), *Heterophyes dispar* (14%), *Pygidiopsis genata* (20%), *Pygidiopsis summa* (4%), *Ascocotyle rara* (4%), *Phagicola longus* (6%), *Phagicolla longicollis* (4%), *Metagonimus yokogawai* (4%), *Haplorchis pumilio* (6%), and *Apophallus donicus* (4%). These trematodes were previously recorded singly or collectively by several authors; **Fahmy and Selim (1959), Selim (1967)** in Cairo and Giza Governorates, **Vanparijs & Thienpont (1973)** in Belgium, **Massoud *et al.* (1981)** in Iran, **Fahmy et al. (1984)** in Assiut province, **Nieddu & Lochi (1988)** in Italy, **Ibrahim et al. (1989)** in Assiut province, **El-Seify & Nabih (1998)** in Giza Governorate, **Abd-Alla (2002)** in Zagazig City, **El-Gayar (2005)** in Ismailia City and **Wang et al. (2006)** in China. *Pygidiopsis summa* and *Ascocotyle rara* were recorded for the first time in Ismailia province, and this may be the first time to be recorded among Egyptian dogs. *Pygidiopsis summa* was firstly detected in dogs fed on brackish water fish infected with the metacercariae in Japan **(Onji & Nishio, 1916)**. *Pygidiopsis summa* is also prevalent in the Republic of Korea **(Chai & Lee, 2002)**. The descriptions and measurements of the detected trematodes were matched to those of **Fahmy & Selim (1959), Kuntz & Chandler (1956), Fahmy & Selim (1959), Yamaguti (1939), Fahmy *et al.* (1984),** and **Niemi & Macy (1974)**. *Prohemistomum vivax* was differentiated from *Mesostephanus* spp. by the absence of a caudal dorsal appendage, and the body was oval and not bipartite rather than elongated **(Yamaguti, 1939)**. *Mesostephanus appendiculatus* was differentiated from *M. melvi*, which possesses a visible oesophagus and an elongated, club-shaped cirrus pouch and lacks a vaginal sphincter. Moreover, the gonads were in the middle of the body in *Mesostephanus appendiculatus* but posteriorly in *M. melvi* **(El-Gayar, 2007)**. *Pygidiopsis genata* was differentiated from *P. summa* by the presence of a small posterior appendage on the oral sucker of *P. summa* **(Skrjabin, 1964)** and the presence of spines on gonotyl in *P. summa*. The ceca of *P. genata* reached the level of the ovary, turning slightly dorsomedial at the terminal portion, while in *P. summa* extended down to the level of anterior of testes and had distended ends instead of turning medially **(Chai *et al.*, 1986b)**. The ventral sucker was nearly round and globular in *Pygidiopsis genata* but constantly elliptical, transversely oblique, and sub-median in *P. summa*. *Phagicola longicollis* was differentiated from *P. longa* by the following: the body was much more elongate; the pharynx was situated at a considerably greater distance from the anterior end in *P. longicollis* than in *P. longa*; the ventral sucker in *P. longicollis* was round and smaller (49 µm), whereas that in *P. longa* was elongate (70 µm); and the oral sucker was armed with 14 or 15 spines compared with 16 spines in *P. longa* **(Kuntz & Chandler, 1956)**. The present specimens of *Ascocotyle rara* were compared to *Ascocotyle mcintoshi*, recorded by **El-Seify & Nabih (1998)**. *Ascocotyle rara* could be differentiated by its larger size and the absence of excretory bladder compared to the laterally branched voluminous excretory bladder of *A. mcintoshi* **(Yamaguti, 1958)**. **Kuntz & Chandler (1956)** attributed the variation in the prevalence of trematodes infesting dogs to the variation in localities from which dogs were collected and to the season during which dogs were exposed to infestation. In our opinion, the available food, such as fish, frogs, and snakes, could also play an essential role in the occurrence and prevalence of digenetic trematodes in dogs in this study. The present study revealed a highly significant difference ($p < 0.01$) in the prevalence of trematodes between different ages (60% in adults and 0% in young dogs). This difference might be related to the availability of intermediate hosts to adults due to the free-roaming character of adult stray dogs, exposing these animals to fish offal infected with encysted metacercariae.

Regarding cestodes, *Dipylidium caninum* was recorded in 100% of examined dogs. This data agreed with the results of **Selim (1967)**, who reported that *D. caninum* is the most prevalent tapeworm in Egyptian dogs. This result was higher than that recorded by **El-Gayar (2005)** (73%), **El Menyawe & Abdel Rahman (2007)** (5%), **Umar (2009)** (75.0%), **Pestechian et al. (2012)** (22.9), **Nabavi et al. (2014)** (7.2%) and **Gugsa et al. (2015)** (72.72%). The intensity of *Dipylidium caninum* was 62.3 (2-189) worms/ dog, lower than that of **Xhaxhiu et al. (2011)** (2-309), but higher than that of **Wang *et al.* (2006)** (1-96), **Umar (2009)** (5-6) and **Eslami et al. (2010)** (1) worm/dog. This high prevalence and intensity of *D. caninum* could be attributed to the high prevalence of fleas and lice, the intermediate hosts of those worms among stray dogs in Ismailia City. The prevalence of *Taenia hydatigena* was 10%, nearly like that of **Pestechian *et al.* (2012)** (13.5%), higher than that reported by **Eguía-Aguilar *et al.* (2005)** (2.5%), but lower than that reported by **Adinezadeh *et al.* (2013)** (61%), **Nabavi *et al.* (2014)** (28.6%) and **Gugsa *et al.* (2015)** (63.63%). The intensity of *T. hydatigena* was 2 (1-4) worms/dog, which agreed with that of **Umar (2009)** (5-6), **Eslami *et al.* (2010)** (2-4), and **Gugsa *et al.* (2015)** (4), while lower than that reported by **Wang *et al.* (2006)** (1–14), **Dai *et al.* (2009)** (1-17) and **Xhaxhiu *et al.* (2011)** 5.1 (1-38) worms/dog. However, no significant difference in the prevalence of *T. hydatigena* in relation to age was found in this study. *Taenia hydatigena* prevalence in adult dogs (16.7%) was higher than in young (0%). This finding was most probably because of the longer exposure of older dogs to the source of infection and the longevity of the worms **(Adinezadeh *et al.*, 2013)**.

The prevalence of *Toxocara canis* was 20%, nearly similar to that of **Minnaar *et al.* (2002)** (21%), **Yacob *et al.* (2007)** (21%), and **Eslami et al. (2010)** (22%), higher than that reported by **El-Gayar (2005)** (10%), **Umar (2009)** (6.3%), **Pestechian et al. (2012)** (6.3%), and **Adinezadeh et al. (2013)** (7%), but lower than that recorded by **El Menyawe & Abdel Rahman (2007)** (39.2%), **Xhaxhiu et al. (2011)** (75.7%), and **Abere et al. (2013)** (39.8%). The intensity of *Toxocara canis* was 7.3 (3-15) worms/dog, nearly similar to that of **Xhaxhiu et al. (2011)** 8.3 (1-54), while higher than that reported by Umar (2009) (2-4) and **Eslami et al. (2010)** (1-2) but lower than that reported by **Wang et al. (2006)** (1–72) and **Dai et al. (2009)** (1–100). There was a highly significant difference (p=0.01) in the prevalence of *Toxocara canis* in the current study with the age of dogs (40% in young dogs and 6.7% in adult ones). This result was consistent with previous studies **(Gholami *et al.*, 2011; Das *et al.*, 2012; Abere *et al.*, 2013)**. The age-related difference in the prevalence could be explained by the transmission pattern of this nematode (mainly by transplacental and transmammary routes) and the acquired age-dependent immunity caused by repeated exposure **(Gillespie & Pearson, 2001)**. The prevalence of *Toxascaris leonina* was 10%, nearly like that of **El-Gayar (2005)** (6.7%) and **Razmi *et al.* (2006)** (6%), higher than that recorded by **Gholami *et al.* (2011)** (2%) and **Xhaxhiu *et al.* (2011)** (0.9%), but lower than that reported by Dai *et al.* (2009) (32.3%), **Pestechian et al. (2012)** (21.9%) and **Adinezadeh et al. (2013)** (53%). The intensity of *Toxascaris leonina* was 4.4 (2-8) worms/dog, similar to that of **Xhaxhiu *et al.* (2011)** (4), but lower than that reported by **Dai et al. (2009)** (1–56). This variation in the prevalence and intensity of *Toxascaris leonina* can be attributed to the age effect **(Urquhart et al., 1996)**.

The prevalence of *Spirocerca lupi* was 10%, approaching that of **Minnaar et al. (2002)** (13%) in South Africa and **Gholami et al. (2011)** (6%) in Iran and lower than that recorded by **Das et al. (2011)** (40%) in Bangladesh, **Perera et al. (2013)** (22.2%) in Sri Lanka, and **Gugsa et al. (2015)** (72.7%) in Ethiopia. Our results revealed that *Spirocerca lupi* intensity was 5.6 (3-8) worms/dog, slightly lower than that recorded by **Gugsa et al. (2015)** (9.13). The high prevalence of spirocercosis could be attributed to the large number of wandering stray dogs and the ease of contact with poultry offal and insects/beetles **(Das et al., 2011)**. In the present study, the oesophagus of dogs infested with *S. lupi* exhibited focal aggregations of mononuclear cells, with marked fibrosis, granulation tissue formation, and early fibroma. This result agreed with that reported by **Mazaki-Tovi et al. (2002)** and **Ranen et al. (2004)**. The prevalence of *Rictularia affinis* was 8%, higher than that recorded by **Gholami et al. (2011)** (2%) in the north of Iran and **Pestechian et al. (2012)** (3.13%) in Isfahan but lower than that recorded by **Dalimi et al. (2006)** (12.5%) in the west of Iran. *Rictularia affinis* was previously recorded by **Abdel Aal (1990)** in foxes in the Sinai Area, but this was the first time to be recorded in dogs in Ismailia province. The prevalence of *R. affinis* depends on the availability of cockroaches and entomophagous vertebrates, such as lizards (intermediate and paratenic hosts), as food sources **(Zare-Bidaki et al., 2010)**.

Here, mixed helminth infection with two or more different species was more common (70%) than infection with one species. These results agree with that of **Eslami et al. (2010)** (mixed infection, 80%) in Iran, **Jones et al. (2011)** (mixed infection, 84.6%) in Ethiopia, **Paulos et al. (2012)**

(mixed infection, 81%) in Ethiopia, and **Perera et al. (2013)** (mixed infection 73.3 %) in Sri Lanka. The most likely explanation for the high prevalence of mixed parasitic infections in this study is that stray dogs act as scavengers and do not receive regular veterinary care **(Paulos et al., 2012)**. There was no significant difference (p > 0.05) in the prevalence of detected helminths between sexes, consistent with previous works **(Awoke *et al.*, 2011; Abere *et al.*, 2013; Onyeabor, 2014)**.

In the present study, all the necropsied stray dogs harbored at least one zoonotic helminth (100%), in agreement with **Traub et al. (2002)** (99%) and **Dalimi et al. (2006)** (100%), but higher than that reported by **Costin et al. (2011)** (61.9%). *Dipylidium caninum* accidentally infects human beings, especially children or those in close contact with dogs. The zoonotic nematode recorded in this study was *Toxocara canis*, which produces a condition known as visceral larva migrans (VLM) in children and ocular migrans in adult human beings **(Gavignet et al., 2008)**. We detected seven trematodes (*Prohemistomum vivax*, *Heterophyes dispar*, *Pygidiopsis summa*, *Phagicola longus*, *Metagonimus yokogawai*, *Apophallus donicus,* and *Haplorchis pumilio*) previously recorded in humans. **Nasr (1941)** reported the first case of human infestation with *P. vivax* in Egypt. Human infections with *H. dispar* were reported in two Korean men who returned from Saudi Arabia **(Chai et al., 1986a)** and Thailand **(Yu & Mott, 1994)**. Human infections with *P. summa* were first reported in Japan by detecting eggs in feces (Takahashi, 1929) and adult flukes in the human intestine **(Yokogawa et al., 1965)**. Additionally, **Chai & Lee (1990)** detected *P. summa* in humans in Korea. Human infections with *P. longus* were reported in Brazil **(Chieffi et al., 1992)**. *Metagonimus yokogawai* is probably the most common intestinal fluke infecting humans in the Far East **(Chai & Lee, 2002)**. Human infections with *M. yokogawai* were reported in Korea **(Chai & Lee, 1990)**, the northern provinces of Siberia, Israel, the Balkan states, and Spain **(Yu & Mott, 1994)**. Experimental human infection with *Apophillus donicus* was successful in the United States of America **(Niemi & Macy, 1974)**. There were other reports of infection with this species in humans where fish are eaten raw **(Schell, 1985)**. Human infections with *Haplorchis pumilio* were reported in the Philippines, Thailand, Laos, South China, Taiwan, and Egypt **(Yu & Mott, 1994)**.

In conclusion, stray dogs in Ismailia City carry a multitude of helminth parasites, thus posing a threat to the human population and companion dogs.

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