Review

Review of Parasitic Zoonoses in Egypt

Ahmed I. Youssef[1,2] and Shoji Uga[2]*

Received 29 August, 2013   Accepted 8 November, 2013   Published online 11 February, 2014

Abstract: This review presents a comprehensive picture of the zoonotic parasitic diseases in Egypt, with particular reference to their relative prevalence among humans, animal reservoirs of infection, and sources of human infection. A review of the available literature indicates that many parasitic zoonoses are endemic in Egypt. Intestinal infections of parasitic zoonoses are widespread and are the leading cause of diarrhea, particularly among children and residents of rural areas. Some parasitic zoonoses are confined to specific geographic areas in Egypt, such as cutaneous leishmaniasis and zoonotic babesiosis in the Sinai. Other areas have a past history of a certain parasitic zoonoses, such as visceral leishmaniasis in the El-Agamy area in Alexandria. As a result of the implementation of control programs, a marked decrease in the prevalence of other zoonoses, such as schistosomiasis and fascioliasis has been observed. Animal reservoirs of parasitic zoonoses have been identified in Egypt, especially in rodents, stray dogs and cats, as well as vectors, typically mosquitoes and ticks, which constitute potential risks for disease transmission. Prevention and control programs against sources and reservoirs of zoonoses should be planned by public health and veterinary officers based on reliable information from systematic surveillance.
Key words: parasites, helminth, protozoa, arthropods, zoonoses, Egypt

INTRODUCTION

Zoonotic parasites can be separated into four categories: direct-zoonotic, meta-zoonotic, cyclo-zoonotic, and sapro-zoonotic. Direct zoonotic parasites infect humans directly from animals and include *Entamoeba histolytica*, *Cryptosporidium parvum*, *Toxoplasma gondii*, and *Sarcoptes scabiei*. Meta-zoonotic parasites, which include *Fasciola* spp. and *Schistosoma* spp. can infect humans from invertebrate intermediate hosts. Cyclo-zoonotic parasites have vertebrate intermediate hosts and include *Echinococcus granulosus*, *Taenia saginata*, and *Taenia solium*. Sapro-zoonotic parasites can infect humans from soil or water and include *Ancylostoma caninum* and *Strongyloides stercoralis*.

It has been reported that 25% of the world's population may be suffering parasitic infection. These infections are typically prevalent in underdeveloped agricultural and rural areas of tropical and subtropical regions, causing reduced worker productivity and a waste of economic resources [1]. In Egypt, the clinical and economic impacts of parasitic zoonoses have been reported by several researchers. School-age children are prone to intestinal parasites because of crowding and behavioral patterns that greatly contribute to the spread of parasitic infection. A high prevalence of parasitic infection of children has been recorded, with levels reaching up to 48% [2–6]. In addition, parasitic diseases are prevalent among the residents of rural areas. Several surveys of parasitic infections performed on villages revealed high infection rates of single and multiple gastrointestinal parasitic infections, with levels reaching up to 85% in small villages [3, 7, 8]. Parasitic diseases exert serious public health effects on both immunocompromised and immunocompetent patients [9, 10]. Unlike Sub-Saharan countries, many serious parasitic diseases such as visceral leishmaniasis and African trypanosomiasis are not endemic in Egypt. This difference might be related to the absence of vectors. In addition, the World Health Organization (WHO) has reported a marked improvement in drinking water sources and sanitation facilities over the last three decades. Over 90% of the Egyptian population has improved drinking water sources. Moreover, the health of people in the

[1] Department of Animal Hygiene, Ethology, and Zoonoses, Faculty of Veterinary Medicine, Suez Canal University, Ismailia, 41522, Egypt
[2] Department of Parasitology, Faculty of Health Sciences, Kobe University Graduate School of Health Sciences, Tomogaoka, Suma-ku, Kobe 654-0142, Japan
*Corresponding author:
Department to Parasitology, Faculty of Health Sciences, Kobe University Graduate School of Health Sciences, Tomogaoka, Suma-ku, Kobe 654-0142, Japan
Tel & Fax: +81-78-796-4548
E-mail: ugas@kobe-u.ac.jp

Table 1. Diseases which decreased in trends of prevalence in Egypt in the last decades as a result of successful implementation of control programs

Disease Name	Year and prevalence				
Schistosomiasis					
S. haematobium	In 1925, 60–70%	In 1996, 5%	In 2000, in Upper Egypt, 7.8%		2000–2005, among outpatients in Sharkia (0.02%)
S. mansoni	In 1932, 32% [56]	In 1996, 12% [56]	In 2000 in Lower Egypt, 36.4% [57]	In 2003 in Delta, 12.3% [63] In 2006, 5.3% [21] In 2009, 2.5% [9]	2000–2005, among outpatients in Sharkia (0.33%) [99]
Fascioliasis					
Animal fascioliasis	1949, sheep (16%)	In 1988, 59.5% in Dakahlia and 29.7% in Gharbia	In 2006, 11.2% in Dakahlia and 21.8% in Gharbia [60]	1994–1997, marked decrease in incidence with overall rates of 2% in sheep, 3.5% in cattle and 1.6% in buffalo [60]	In 2002, in sheep 12.7% [65]. In 2005, among sheep 20.6% [64].
Human fascioliasis	Until 1960 only sporadic human cases [60]	Since 1980, the number of cases has risen drastically. [59]	In 1990, overall prevalence of 3%. [59]	In 2003, 12.8% [63]	In 2006, in Dakahlia, 4.8% [21]. In 2009, 0% [9]

workforce has improved significantly compared with regional averages [11]. As a result of such improvement in hygienic conditions, public health awareness and successful implementation of control programs, the prevalence of diseases such as schistosomiasis and fascioliasis was markedly decreased among humans and animals (Table 1).

Many animals have been implicated as reservoirs of parasitic diseases, including livestock animals and pets, as well as wild animals. All of these animals can transmit and spread parasitic infections directly and indirectly. The geographical distribution of is being related to the presence of reservoirs and vectors such as cutaneous leishmaniasis and zoonotic babesiosis (Fig. 1).

Egypt is divided into 27 Governorates, which include the central area, the nine Governorates of Lower Egypt in the Nile Delta region, the eight Governorates of Upper Egypt along the Nile River south from Cairo to Aswan, and the five frontier Governorates covering Sinai and the deserts that lie west and east of the Nile (Fig. 1).

Most of investigations on parasitic infections in humans and animals in Egypt have been conducted on the Governorate level in Lower and Upper Egypt or as detailed surveys focusing on small areas or villages. However, nationwide epidemiological surveillance of zoonotic parasites has not been thoroughly well-documented. Therefore, this review presents a comprehensive picture of the major zoonotic parasitic diseases in Egypt with special reference to their prevalence among humans and animals, reservoirs of infections, and sources of human infection.

PREVALENCE OF PARASITIC ZOONOSES AMONG HUMANS AND ANIMALS IN EGYPT

Zoonotic protozoa
Intestinal infection

Gastrointestinal protozoon parasites are a major health problem with a high prevalence worldwide [12]. The prevalence of parasitic diseases depends on environmental, social and economic factors to such an extent that the presence of intestinal parasites is an indicator of vast collective ill-health. In Egypt, parasites are considered to be the main etiologic agent of diarrhea, with prevalence among individuals suffering diarrhea reaching 61% [4, 6, 13–15]. According to one survey, on patients with gastrointestinal troubles, the prevalence of helminth infection was 9.9% while the prevalence of intestinal protozoa infection was 57.6% [16]. In a survey conducted in the Delta region, 67.1% of chronic diarrheic patients suffered from parasitic infections. Single infection represented 54.2% of all patients, and mixed infections were present in 12.9% of total chronic diarrhea patients [17]. A high incidence of intestinal protozoa infection has been reported among both immunosuppressed and immunocompetent patients in Egypt [9, 10].

The prevalence of *E. histolytica* in Egypt varies from 0% [14] to 57% in diarrheic patients [4, 16, 17]. In comparison to other African countries, *E. histolytica* infection in Egypt tends to be asymptomatic at high rates (> 21%), whereas the rate of infection in South Africa and Cote d'Ivoire ranges between 0 and 2% [18]. In animals, amoebi-
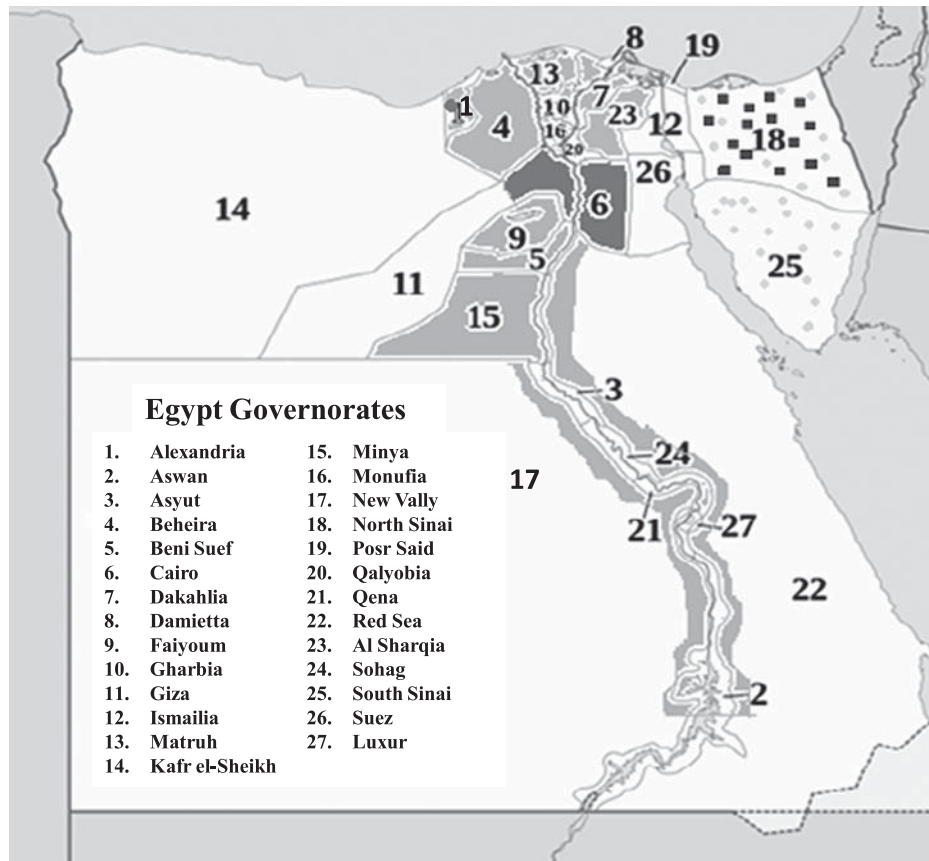
Fig. 1. Map of Egypt showing Governorates indicated by numbers from 1 to 27, Lower Egypt in the North, including Nile Delta (light green colour), Cairo area (Deep gray colour), and Upper Egypt (light gray colour). Distribution of cutanous leishmaniasis is marked by blue cubes in North Sinai Governorate and zoonotic babesiosis indicated by green circles in the Sinai Peninsula. Past history of visceral leishamaniasis in El-Agami area in Alexandria Governorate is indicted by red circle.

asis has been reported in wild animals [19] as well as domestic animals [20]. In addition, the prevalence of *E. coli* among outpatients in the Dakahlia Governorate was 9.7% [21].

Giardiasis is a major diarrheal disease found throughout the world. In most mammals, giardiasis is caused by *Giardia intestinalis*, which is also called *G. duodenalis*. However, the two older names for the organism, *G. lamblia* and *Lamblia intestinalis*, are no longer considered to be taxonomically valid. The rate of human infection with *G. intestinalis* in Egypt varies between 10 and 34.6% [4, 10, 22, 23]. Among children, the prevalence of *G. intestinalis* was 11% [4] and 15.4% [2]. Among chronic diarrhea patients, the prevalence reaches 27.3% [17]. The most frequent genotype of *G. intestinalis* is the assemblage B (80%) [22]. However, Helmy *et al.* found that the most prevalent genotype was assemblage A [23]. Other assemblages, C and E, have also been recorded [24]. Animals are considered reservoirs for *Giardia* spp. infections. *Giardia* spp. cysts were detected in 2% of stray cats [25], while *G. intestinalis* was

detected in 8% of wild rats [19] and 7.9% of soil samples [26]. Moreover, it is noteworthy that fish have been proposed as a potential reservoir for *G. duodenalis*, as the parasite has been detected in fish with a prevalence of 3.3% [27].

Cryptosporidium spp. infection is a leading cause of diarrhea in Egypt. *Cryptosporidium* spp. prevalence among individuals with diarrhea visiting inpatient and outpatient clinics in Egypt ranges from 0%–49% [13, 21, 28, 29]. The most common protozoan infection in immunosuppressed patients has been found to be *C. parvum* (60.2%) [9]. Moreover, the zoonotic potential for cryptosporidiosis has been proven in farmers and their farm animals infected with *C. parvum* [30]. A high prevalence of *C. parvum* was reported among individuals with diarrhea (31.1%) [13]. Other species of *Cryptosporidium* have been reported among human patients, including *C. hominis* and *C. bovis* [29]. In animals, *Cryptosporidium* spp. infection implies both an economic loss and a significant source for zoonotic infection. A *Cryptosporidium* spp. prevalence of 32.2% has been reported in ruminants [29]. In particular, a high infection rate of *Cryp-*

tosporidium spp. oocyst was detected in the fecal specimens of neonatal calves (30.2%) [31] and neonatal lambs (30%) [32]. Different genotypes have been detected in animals. In parallel to human infection, *C. parvum* was the most prevalent with reported infection at rates of 65.7% [29] and 82.8% [31]. Other species detected in domestic animals include *C. ryanae* (11.8%), *C. bovis* (4.1%) [29] and *C. andersoni* (6.9%) [31]. In wild rats, *Cryptosporidium* spp. was reported with prevalence of 22.7% (*C. parvum*) and 20.3% (*C. muris*) [19].

Blastocystis hominis is now gaining attention as an agent of human intestinal disease. A high prevalence of *B. hominis* has been reported in Egypt among asymptomatic patients (22.4%) [21], patients with diarrhea and immuno-suppressed children (12.1%) [33]. *Blastocysis* spp. isolation from animals and birds has not been reported in Egypt.

Sarcocystosis is zoonotic, and parasitic diseases that are highly prevalent in livestock animals and caused by *Sarcocystis* spp.. *S. cruzi*, *S. hirsute*, and *S. hominis* have canids, felids, and humans as definitive hosts, respectively, and can affect bovines as intermediate hosts producing muscle cysts. The infection has potential public health importance because humans may become infected via consumption of undercooked meat from infected cattle and pigs [34]. The disease is highly endemic in Egypt; macroscopic and microscopic cysts are frequently detected in cattle and buffalo carcasses during meat inspection [35, 36]. The prevalence of *Sarcocystis* spp. infection in stray cats was reported to be 1% [25]. However, the paper about human infection is not found.

Other species of intestinal protozoa have been documented in Egypt with varying prevalence such as *Iodamoeba butschlii* (16%), *Isospora hominis* (7.7%), *Endolimax nana* (6.9%), *E. hartmani* (5.9%), *Dientamoeba fragilis* (5.1%), *Chilomastix mesnili* (5.1%), *Trichomonas hominis* (4.2%), *Microsporidia* spores (3.2%), *Enteromonas hominis* (1.9%), and *Embadomonas intestinalis* (1.3%) [21].

Blood and tissue infection

T. gondii infection is a growing global health concern, with up to one-third of the world's population estimated to be infected with the parasite [37]. In humans, toxoplasmosis is a major health problem. High rates of sero-prevalence of *T. gondii* in Egypt have been reported by several authors. Among 260 asymptomatic blood donors, 155 (59.6%) were anti-*Toxoplasma* IgG positive, as determined by enzyme-linked immunosorbent assay (ELISA) [38]. Toxoplasmosis exerts a variety of effects, especially on pregnant women facing a potential risk of feto-maternal transmission leading to miscarriage, pre-mature birth and mental retardation of the newborn. The risk of feto-maternal transmission of

Toxoplasma spp. has been recorded with an antibody prevalence 51.5% of pregnant women, as determined by ELISA [39]. Ibrahim *et al.* reported that sero-positivity to specific anti-*Toxoplasma* IgG antibodies was 57.9%, 58.1%, and 44.7% in serum samples from randomly collected specimens, full-term pregnant women, and aborted women, respectively. Whereas, the sero-positivity to specific anti-*Toxoplasma* IgM for the same groups was 10.5%, 6.5%, and 23.7% [39]. Moreover, Mabrouk *et al.* reported that 10 out of 42 meningoencephalitis patients (26%) were positive for *Toxoplasma* IgG antibodies in cerebro-spinal fluid specimens assessed by immunofluorescent antibody (IFA) assay [40]. High infection rates of *T. gondii* infection among cats and other animals have been recorded. Among stray cats, the prevalence of *T. gondii* was 9%, which indicates a high risk of *T. gondii* human infection [25]. In domestic animals, high levels of antibodies have been recorded by various authors. Antibodies to *T. gondii* were observed in 172 (95.5%) of 180 cats examined by the modified agglutination test [41]. IFA antibody was detected in the serum of slaughtered animals at a prevalence of 48.8% [42]. Anti-*Toxoplasma* antibodies were detected using a modified agglutination test in 59.5% of domestic turkeys, 47.2% of chickens, and 50% of ducks [43], in addition to 10.8% of cattle as detected by ELISA [39].

Leishmaniasis is an insect-transmitted parasitic disease with a worldwide distribution. *Leishmania* spp. infections cause a broad spectrum of clinical signs, ranging from skin lesions to fatal visceral disease. The Sinai Peninsula in the northeast of Egypt, a sparsely populated area, has seen sporadic cases of zoonotic cutaneous leishmaniasis [44]. The vectors of *Leishmania* spp., such as *Phlepotomus papatasi* (predominant) and *P. sergenti* sandflies, have been identified in endemic areas [44–46]. Previous research on the etiologic agent of cutaneous leishmaniasis has consistently identified *Leishmania major* and *L. tropica* as the primary and secondary agents, respectively [45]. Wild-caught rodents were identified as reservoir host of *Leishmania* spp. infection in endemic areas. *Gerbillus pyramidum floweri* have been observed to be naturally infected with *L. major* [44] and *L. tropica* [45]. Another rodent species, *Rattus norvegicus*, was identified as a reservoir host of *Leishmania* spp. infection in non-endemic areas [47].

Visceral leishmaniasis caused by *L. donovanii* has been documented in Egypt, mainly in the Alexandria Governorate. It was reported that 27 cases of visceral leishmaniasis were detected in Alexandria Governorate from 1982 to 1985 through active and passive case detection. Of them, 22 cases were reported in El-Agamy, a resort town of 50,000 residents located 15 km west of the city of Alexandria (Fig. 1) [48]. Another case of infantile visceral leishmaniasis was

identified in an adult farmer in Banha city. Moreover, sporadic cases were confirmed among hypersplenic patients in the Dakahlia Governorate [49]. Since these sporadic cases, no new cases have been reported. However, a previous history of visceral leishmaniasis raises the possibility of infection in Egypt. Dogs are a main reservoir host for visceral leishmaniasis. An epidemiological study demonstrated that antibody to *Leishmania* spp. was observed in 5 out of 50 (10%) dogs tested for visceralizing *Leishmania* spp. [50].

Zoonotic *Babesia* sp. infection has been reported in the Sinai Peninsula. Rodents have been identified as reservoirs of zoonotic *Babesia microti* infections in endemic areas. *Acomys* sp. were identified as reservoir hosts of *B. microti* [51]. *Ixodes ricinus* ticks were identified as a vector of zoonotic *B. microti* infection by transovarian and transstadial transmissions in endemic areas (Fig. 1) [52].

Neospora caninum is a microscopic protozoan parasite with a worldwide distribution. Many domestic animals (e.g., dogs, cattle, sheep, goats, horses, and chickens) and wild animals (deer, rodents, rabbits, coyotes, wolves and foxes) can be infected. In one study, antibodies to *N. caninum* were detected in 7.9% of pregnant women by ELISA, whereas the detection rate was 20.4% in cattle and 1.9% in rabbits [39].

Zoonotic infection of *Trypanosoma evansi* has been reported in Egypt [53].

Zoonotic trematodes

Schistosomiasis is the third-leading endemic parasitic disease in the world after malaria and amoebiasis. It was reported that more than 200 million people in 74 countries are infected and that 120 million have symptoms of the disease [54]. In 2011, 42 countries in Africa were endemic for this disease [55]. The three major species of schistosomes, *S. mansoni*, *S. haematobium*, and the *S. japonicum* complex (including *S. japonicum* and *S. mekongi*) are distinguished by snail vectors, their location within the host vasculature, and egg morphology. In Egypt, the implementation of schistosomiasis control programs hasaccelerated the decline of the disease (Table 1). *S. hematobium* rates decreased from approximately 60–70% in 1925 to 5% in 1996, and *S. mansoni* rates fell from 32% in 1932 to 12% in 1996 [56]. High rates of schistosomiasis occur near bodies of fresh water. Working in agriculture is an obvious risk factor for *Schistosoma* spp. infection [7]. The prevalence and species distribution of schistosomiasis differ in different Governorates and regions in Egypt. A study performed in nine Governorates revealed that *S. mansoni* was unusual in Upper Egypt, being consequential in only the El-Fayoum Governorate where a prevalence of 4.3% was recorded. However, the prevalence of *S. mansoni* in five Governorates in Lower Egypt, where it is endemic, ranged from 17.5% to 42.9% with an average of 36.4% [57]. The prevalence of *S. haematobium* in four Governorates in Upper Egypt where it is also endemic ranged from 4.8% to 13.7% with a mean of 7.8%. Contrary to this finding, *S. haematobium* was rare in the Governorates in Lower Egypt [57]. Currently, even though control programs are being implemented, *Schistosoma* spp. infections are still recorded with relatively high prevalences of *S. mansoni*, including 1% [16], 2.5% [7] and 5.3% [21]. In animals, *S. mansoni* and *S. haematobium* were observed as a natural double infection in the Nile rat, *Arvicanthis niloticus*, from a human endemic area in Egypt [58].

Fascioliasis, a cyclo-zoonotic disease caused by a liver fluke (*Fasciola* spp.), is one of the neglected food-borne-diseases in the global public health arena. In Africa, infection with fascioliasis represents a major animal and human health problem [59]. In Egypt, animal as well as human fascioliasis is a growing problem, as it has been recorded in almost all Governorates, especially those of the Nile Delta in Lower Egypt [60]. The two most important species are *Fasciola hepatica* and *F. gigantica*. Both species are present among human and animals in Egypt [61, 62]. Human infection with fascioliasis was sporadic until the last three decades when clinical cases and outbreaks were reported [59]. Fascioliasis is hyper-endemic in villages in the Nile Delta with varying prevalence. A prevalence of 4.8% of outpatients in the Dakahlia Governorate has been reported [21]. Another study revealed a prevalence of 5.2–19.0% (mean = 12.8%) which was the highest obtained in Egypt [63]. Recently, lower prevalence of human infections has been recorded (See Table 1). In addition to grass-grazing animals (cattle, buffalo, sheep, and goats), infection of donkeys and camels with *F. gigantica* has been recorded in Egypt [59]. Among these animal species, fascioliasis is highly endemic in sheep, particularly in Nile Delta Governorates indicated by macroscopic detection of liver flukes in slaughtered sheep during abattoir surveys (20.6%) [64] and by microscopic detection of *Fasciola* spp. egg by fecal examination (12.7%) [65]. *Fasciola* spp. are vegetable-transmitted parasites, and those eggs were found in 2.4% of vegetable prepared for eating in a village in the Alexandria Governorate [8].

Heterophyiasis is a highly endemic disease in Egypt. Infected fish is the main source of infection. Heterophyid infections occur in brackish and fresh water fish in northern Egypt, where the parasites are indigenous [66]. The highest intensity of infection has been detected among fishermen (33.8%) [67] and local residents in northern Egypt (13.3%) [68]. The overall prevalence of heterophyid infection of fish has been reported to be 32%, that is, 22% for brackish water fish and 42% for fresh water fish [68]. In the Ismailia Gov-

ernorate, the prevalence of heterophyid metacercaria in fresh water fish was found to be 95.4% [69]. Many heterophyids have been identified from fish. Adult heterophyids from *Heterophyes heterophyes*, *H. aequalis*, *Pygidiopsis genata*, *Haplorchis yokogawai*, *Prohemostomum vivax*, *Phagicola ascolonga*, and *Stictodora tridactyla* were recovered from encysted metacercaria-fed puppies [66, 68, 69]. The prevalence of *H. heterophyes* was 3% amongstray cats in Kafr Elsheikh province in the northern region of the Delta [25].

Diphylobothrium spp. infection has not been reported in Egypt.

Zoonotic cestodes

Vampirolepis nana (previously known as *Hymenolepis nana*, *H. fraterna*, and *Taenia nana*) and *H. diminuta* are common parasitic infections, particularly among children. In Egypt, hymenolypiasis infections are exceedingly prevalent with high detection rates recorded by many researchers. In a cross-sectional study of 2,292 farmers in a village in Menoufia Governorate, the rate of detection of *V. nana* eggs in stool samples was 3% [7]. In another study on outpatients of a hospital in the Dakahlia Governorate, the detection rate of *V. nana* in stool samples was 3.9% [21]. In children, adverse clinical manifestations was caused by *V. nana* infections with a high reported prevalence of 16% [5]. *H. diminuta* infections are also commonly reported. However, compared with the incidence of *V. nana*, a lower incidence of *H. diminuta* (1.4%) has been recorded [21]. Rodents are considered the main reservoirs of *H. diminuta* infections, the parasite being detected at a high incidence (23.8%) [19].

Echinococcosis is one of the major zoonotic parasitic diseases in the Middle East and Arabic North Africa. Both cystic and alveolar echinococcosis have been reported from these areas. However, cystic echinococcosis is more prevalent in all the countries in the Middle East and Arabic North Africa, and it is endemic in Egypt [70]. Although most human studies have focused on surgical reports, several population studies have been performed using serological and imaging techniques. In a retrospective study on human cystic echinococcosis conducted between 1997 and 1999 using 492,353 patient records, 133 (0.03%) new human cystic echinococcosis cases were recorded in Egypt [71]. Another study on sero-positivity levels of echinococcosis using the indirect haemagglutination test revealed that five out of 100 patients (5%) with acute and chronic hepatic diseases in the Assiut and Aswan Governorates were positive. In parallel, the overall prevalence of *E. granulosus* in street dogs was 5% and the prevalence has been reported to be significantly higher in rural than in urban areas [72]. In the intermediate hosts, the overall five-year hydatidosis prevalence from August 2000 to August 2005 was 2.5%, 0.3% and 0.7% in camels, sheep and goats, and pigs, respectively [73]. In particular, a high level of hydatidosis in camels has been recorded in many investigations, reaching up to 7.7% [72, 74]. Moreover, the high fertility rate of hydatid cysts recovered from camels compared with other domestic animals reached 60.4% [74]. Studies on the strain specificities of *E. granulosus* in the Middle East revealed that the sheep strain (G1) is present in sheep, goats, cattle, camels and humans, and the camel strain (G6) in camels, sheep, cattle and humans [70]. The G6 and G1 genotypes have been identified in Egypt with a high predominance of the G6 genotype (the dog/camel genotype) in humans and animals [70, 75].

Intestinal infection of humans with the adult form of the parasite *T. saginata* and *T. solium* is called taeniasis. Cysticercosis is defined as infection of any tissue with the larval form of the parasites. In Egypt, because most people abstain from pig's pork for religious reasons, taeniasis and cysticercosis caused by *T. solium* are not common. Few records of human taeniasis are available. The detection rate in humans of *T. saginata* was 1.1% [21]. In intermediate host animals, although cysticercosis has little effect on health, it is socially and economically significant as a zoonosis because the affected meat is usually condemned, and control measures are usually expensive. In an abattoir investigation including a total of 6,434,039 slaughtered animals over a period of four years (1994–1997), the individual animal species infection rate was 0.2% in domestic cattle, 7.3% in imported cattle, 0.1% in buffaloes and 0.1% in pigs with an overall prevalence of cysticercosis (*Cysticercus bovis* and *C. cellulosae*) of 0.7% [76].

Dipylidium caninum has not been reported as a zoonotic infection in humans. However, it was detected at a low incidence in dogs [72] and with an incidence of 5% in stray cats [25].

Zoonotic nematodes

Human toxocariasis (visceral-and ocular larva migrans) is a widespread parasitic disease. Children are more frequently infected because of their closer contact with contaminated soil and relatively frequent geophagia. In Egypt, the high prevalence of human toxocariasis indicated by anti-*Toxocara* antibodies has been recorded by many researchers. The sero-prevalence of IgG antibodies has been reported as 7.7% among the general public [77], 6.2% among suspected children [78] and 18% among adults [78]. Patients with bronchial asthma, hepatomegaly or heptosplenomegaly, lymphadenopathy, neurological disorders, gastrointestinal troubles and dermatitis are thought to be prone to toxocariasis [77, 78]. The reservoirs of *T. canis* infection are dogs. A survey study indicated that 56% (14/25) of dogs were infected with *T. canis* and 8% (2/25) were in-

fected with *T. leonina* [79]. Because both non-embryonated and embryonated *T. canis* eggs are found in the hair of pet dogs, direct contact with dogs may be a potential risk factor for transmission of *T. canis* eggs to humans [80]. In addition, *T. cati* and *Toxoascari sleonine* have been reported in stray cats at a prevalence of 9% and 5%, respectively [25].

Lymphatic filariasis or bancroftian filariasis, a parasitic disease caused by *Wuchereria Bancrofti*, has been identified as the second-leading cause of permanent and long-term disability. Approximately 50 million people in Egypt and sub-Saharan Africa have bancroftian filariasis, and together, they represent approximately one-third of all cases of lymphatic filariasis worldwide [81]. In a longitudinal study of bancroftian filariasis in the Nile Delta of Egypt, the baseline prevalence of microfilaremia and filarial antigenemia among 1,853 subjects more than nine years of age was 7.7% and 11.2%, respectively, while the one-year incidence was 1.8% and 3.1%, respectively [82]. Another study indicated a high prevalence of asymptomatic patients with *W. bancrofti* as detected via examination of night blood (38%) [83]. As for mosquitoes vectors, *W. bancrofti* DNA was detected in *Culex pipiens* in 91 (13.9%) of the 655 mosquito collected from an Egyptian village [84]. Moreover, high rates of microfilaria were detected in mosquito vectors collected from households with significant risk factors for microfilaria transmission [82, 84]. In animals, microfilaria was detected in a stray cat from the Assiut Governorate [85].

Human dirofilariosis, caused by *Dirofilaria repens*, is a parasitic infection that has been observed in many areas of the Old World and is currently considered an emerging zoonosis. Dogs are the main host of *D. repens*. Three new cases of human infection with *D. repens*, one pulmonary and two subcutaneous, were reported in the Assiut Governorate, representing the first report of human pulmonary dirofilariosis caused by *D. repens* in Africa [86]. Antibodies to *D. immitis* antigens were observed in the sera of 6 (3.4%) of 174 feral cats (*Felis catus*) collected from Cairo [41].

In Africa, human trichinellosis is rare, and stems mostly from religious practices and food habits [87]. Sylvatic trichinellosis is prevalent in the Mediterranean and African regions. However, domestic trichinellosis (*Trichinella spiralis*) is present in Egypt. Few reports of *T. spiralis* infection in fresh and processed pork in Egypt are availabe [88]. In addition, *T. spiralis* infection was detected among 1,025 rodents collected from and around abattoirs in Alexandria with a prevalence of 13.3% [89].

Ancylostoma caninum is responsible for cases of eosinophilic enteritis and unexplained abdominal pain with peripheral eosinophilia in humans. The prevalence of IgG antibodies to *A. caninum* among patients with obscure acute or recurrent abdominal pain was 11/95 (11.6%) in one study

[90]. Another study showed a low prevalence of *A. duodenale* (0.1%) [21].

Capillaria spp. are a nematode parasite that usually causes gastrointestinal troubles. A low prevalence of *Capillaria* spp. has been recorded by many authors in the Nile Delta (1%) [16]. In the Upper Egypt, a relatively high prevalence of human infection was reported where *C. philippinensis* is is considered to be a newly emerging parasite in that area [91]. In animals, *Capillaria* spp. were detected in stray cats with a prevalence of 3% [25].

The prevalence of parasitic infections with *Ascavis lumbricoides* among 1,674 school children aged 6–13 years in Alexandria was 10.2% [2]. Other studies showed lower prevalence, that is (1.8%) [21] and (1.4%) [16]. An 8% infection rate among dogs by *A. lumbricoides* was reported. Therefore, it was suggested that dogs could act as the reservoir host of *A. lumbricoides* and an environmental contaminator increasing the risk of infection in humans [79].

Anisakiasis is not a common disease in Egypt. A low prevalence of 2.2% (1/45) has been reported from the orange-spottedtrevally, *Carangoides bayad* (Carangidae) fish caught from the Red Sea [92].

Other species of nematodes have been reported in various studies, such as *Trichostrongylus* sp. (2.6%), *Strongyloides stercoralis* (1.5%), *Entrobius vermicularis* (1.1%) and *Trichuris trichura* (0.7%) [21].

Zoonotic arthropods

Arthropods are found in humans and animals as ecto-parasites as well as endo-parasites. In Egypt, *S. scabiei* is the most prevalent mite of medical importance infesting humans. This is particularly true in overcrowded and unhygienic areas. In Egypt, there have been few reports of sarcoptic infection in humans, but its presence in domestic and sylvatic animals is well documented. Cutaneous manifestations (pruritic dermatitis) caused by the zoonotic species of bird and rat mites (*Ornithoyssus* sp., Family Macronyssidae) have been reported among field workers in poultry farms [93]. In addition, other species of rat ecto-parasites have been reported, such as *Xenopsylla cheopis*, *Hyalomma dromedarii* (nymph), *Echinolaelaps echidninus*, and *Hemolaelaps glassgowi* [94]. Dogs and cats are sources of many zoonotic arthropods. *Linguatula serrata* (2%) and mites eggs (13%), were detected in a survey on gastrointestinal parasites in 113 fecal samples from stray cats [25]. In general, some myiasis producers are zoonotic parasites. However, myiasis-causing flies are not prevalent in Egypt.

MODE OF TRANSMISSION AND PREVALENCE OF PARASITIC ZOONOSES AMONG RESERVOIR HOSTS

Domestic and wild animals and birds play a pivotal role in maintaining zoonotic parasitic infections under natural conditions, and they act as reservoir hosts of human infections. In Egypt, livestock and pets (dogs and cats) are kept inside houses in most rural areas. In addition, because Egypt has wide areas of desert, wild rodents and roaming animals, particularly dogs and cats, are considered to be reservoirs of infection of many zoonotic parasitic diseases. The dog's role as a definitive host for a number of zoonotic parasites has been widely studied and recognized as a significant public health problem worldwide [72]. Rodents are the main reservoir hosts of intestinal helminth in different Egyptian agro-ecosystems. A epidemiological study of wild rats indicated that the overall infection rate of parasites was 54% (93/172), including 28% cestodes, 7% nematodes, 8% *Acanthocephala* sp., and 41% protozoa [19]. In addition a cross-sectional study showed that the overall prevalence of helminths in domestic rodents in the Dakahlia Governorate was 53%, and a total of 24 species of helminths were identified [95].

The sources of zoonotic infections, animate and inanimate, carry the infective stage of a zoonotic disease and to infect humans by one or more of modes transmission such as contact, ingestion, inhalation, parental and arthropod bites. Consequently, contaminated food, drinking water, infected arthropods, and soil can be sources of zoonotic infections. Generally, direct contact with animals can result in the direct or indirect transmission of diseases, particularly to people lacking personal hygiene. The undercooked food is considered to be the main source of infection by various parasitic zoonoses. Contaminated or polluted water undoubtedly plays a vital role as a parasite source [96]. Vegetable-transmitted parasites are a main source of human parasitic infections. A serious and consistent effort through public health activities is essential to educate housewives about vegetable-transmitted parasites, their transmission and methods of prevention [8]. There are many parasitic infections that can be transmitted via contaminated soil at different stages of parasites caused by outdoor defecation by humans, particularly children. This is more to occur in fields, public gardens and the sides of streets or canals. In addition, the feces of domestic and wild animals and birds play a role in soil contamination [97]. Arthropod-borne zoonotic parasites commonly pose a public health concern. Insect prevention and control are necessary to prevent the transmission of pathogens that could affect animal and human health, as is the maintenance of proper hygiene. The importance of some arthropods is also related to the fact that some species are the vectors for certain parasitic diseases, such as infected sandflies of the genus *Phlebotomus*, the source of leishmaniasis [44, 46] or ticks, the source of *Babesia* sp. infection [52]. In addition, non-blood-sucking insects play an important role in the dissemination of human parasites, such as insects that are commonly found in animal and human environments, including the American cockroach (*Periplaneta americana*) and the house fly *Musca domestica var. vicina* [98]. Improper disposal of human sewage and animal manure and its direct use as fertilizer are the main source of contamination of vegetable and fruits by parasites. Therefore, the prevention and control of parasitic zoonoses should be based on the treatment and/or elimination of animal reservoirs and sources of infection and measures to promote public awareness of parasitic zoonoses modes.

CONCLUSION

It can be concluded that many parasitic zoonoses caused by helminth and protozoa are endemic in Egypt. Intestinal infections of parasitic zoonoses are exceedingly common and widespread and are a leading cause of diarrhea, particularly among children and in rural areas. Some parasitic zoonoses are confined to certain geographic areas in Egypt, such as cutaneous leishmaniasis and zoonotic babesiosis in the Sinai Peninsula. Other areas have a past history of certain parasitic zoonoses, such as visceral leishmaniasis in the El-Agamy area in Alexandria. As a result of the implementation of control programs, a marked decrease in the prevalence of particular zoonotic parasitic diseases has been established, including schistosomiasis and fascioliasis. Animal reservoirs of parasitic zoonoses have been identified in Egypt, particularly rodents, stray dogs and stray cats as well as mosquitoes and ticks and other vectors, which constitute a potential risk of disease transmission. Therefore, prevention and control programs should be implemented by public health and veterinary officers to combat the sources and reservoirs of zoonoses.

REFERENCES

1. Reeder MM, Palmer PES. Parasitic disease. In: Freeny P, Stefenson GW, eds. Margulis and Burhenne'salimentary tract radiology. 5th edn. St. Louis: Mosby; 1994. pp 913–951.
2. El Sahn FF, Deghedi BM, Mahdy NH, El Sahn A. The impact of intestinal parasitic infections on the nutritional status of primary school children in Alexandria, Egypt. J Egypt Public Health Assoc 1997; 72: 113–151.
3. El-Hakim MA, El-Sahn A. Association of parasites and di-

arrhoea among children less than five years of age in a rural area in Egypt. J Egypt Public Health Assoc 1996; 71: 439–463.

4. el-Naggar SM, el-Bahy MM, Abd Elaziz J, el-Dardiry MA. Detection of protozoal parasites in the stools of diarrhoeic patients using different techniques. J Egypt Soc Parasitol 2006; 36: 487–516.

5. Khalil HM, el Shimi S, Sarwat MA, Fawzy AF, el Sorougy AO. Recent study of *Hymenolepis nana* infection in Egyptian children. J Egypt Soc Parasitol 1991; 21: 293–300.

6. Banta JE, Akers TG, Arm HG, Freeman NL. An Epidemiologic Study of Diarrhea in an Alien Student Population in Cairo, Egypt. Am J Public Health Nations Health 1964; 54: 940–946.

7. Bakr IM, Arafa NA, Ahmed MA, Mostafa Mel H, Mohamed MK. Prevalence of intestinal parasitosis in a rural population in Egypt, and its relation to socio-demographic characteristics. J Egypt Soc Parasitol 2009; 39: 371–381.

8. Fawzi M, El-Sahn AA, Ibrahim HF, Shehata AI. Vegetable-transmitted parasites among inhabitants of El-Prince, Alexandria and its relation to housewives' knowledge and practices. J Egypt Public Health Assoc 2004; 79: 13–29.

9. Abdel-Hafeez EH, Ahmad AK, Ali BA, Moslam FA. Opportunistic parasites among immunosuppressed children in Minia District, Egypt. Korean J Parasitol 2012; 50: 57–62.

10. Baiomy AM, Mohamed KA, Ghannam MA, Shahat SA, Al-Saadawy AS. Opportunistic parasitic infections among immunocompromised Egyptian patients. J Egypt Soc Parasitol 2010; 40: 797–808.

11. WHO. Egypt: health profile. Available from: http://www.who.int/gho/countries/egy.pdf, 2013.

12. Abd El Bagi ME, Sammak BM, Mohamed AE, Al Karawi MA, Al Shahed M, Al Thagafi MA. Gastrointestinal parasite infestation. Eur Radiol 2004; 14: E116–E131.

13. Mousa KM, Abdel-Tawab AH, Khalil HH, El-Hussieny NA. Diarrhea due to parasites particularly *Cryptosporidium parvum* in great Cairo, Egypt. J Egypt Soc Parasitol 2010; 40: 439–450.

14. Nazeer JT, El Sayed Khalifa K, von Thien H, El-Sibaei MM, Abdel-Hamid MY, Tawfik RA, Tannich E. Use of multiplex real-time PCR for detection of common diarrhea causing protozoan parasites in Egypt. Parasitol Res 2013; 112: 595–601.

15. Zaki AM, DuPont HL, el Alamy MA, Arafat RR, Amin K, Awad MM, Bassiouni L, Imam IZ, el Malih GS, el Marsafie A, et al. The detection of enteropathogens in acute diarrhea in a family cohort population in rural Egypt. Am J Trop Med Hyg 1986; 35: 1013–1022.

16. El-Kadi MA, Dorrah AO, Shoukry NM. Patients with gastrointestinal complains due to enteric parasites, with reference to *Entamoeba histolytica*/*dispar* as detected by ELISA *E. histolytica* adhesion in stool. J Egypt Soc Parasitol 2006; 36: 53–64.

17. Bayoumy AM, Mohammed KA, Shahat SA, Ghannam MM, Gazy Mel S. Role of parasites among chronic diarrheic patients. J Egypt Soc Parasitol 2010; 40: 679–698.

18. Stauffer W, Abd-Alla M, Ravdin JI. Prevalence and incidence of *Entamoeba histolytica* infection in South Africa and Egypt. Arch Med Res 2006; 37: 266–269.

19. Abd el-Wahed MM, Salem GH, el-Assaly TM. The role of wild rats as a reservoir of some internal parasites in Qalyobia Governorate. J Egypt Soc Parasitol 1999; 29: 495–503.

20. Abo-Shady AF, Ali MM, Hegazi MM. Natural *Entamoeba histolytica* infection in domestic animals and rodents in Dakahlia Governorate, Egypt. J Egypt Soc Parasitol 1983; 13: 125–128.

21. El Shazly AM, Awad SE, Sultan DM, Sadek GS, Khalil HH, Morsy TA. Intestinal parasites in Dakahlia Governorate, with different techniques in diagnosing protozoa. J Egypt Soc Parasitol 2006; 36: 1023–1034.

22. Foronda P, Bargues MD, Abreu-Acosta N, Periago MV, Valero MA, Valladares B, Mas-Coma S. Identification of genotypes of *Giardia intestinalis* of human isolates in Egypt. Parasitol Res 2008; 103: 1177–1181.

23. Helmy MM, Abdel-Fattah HS, Rashed L. Real-time PCR/RFLP assay to detect *Giardia intestinalis* genotypes in human isolates with diarrhea in Egypt. J Parasitol 2009; 95: 1000–1004.

24. Soliman RH, Fuentes I, Rubio JM. Identification of a novel Assemblage B subgenotype and a zoonotic Assemblage C in human isolates of *Giardia intestinalis* in Egypt. Parasitol Int 2011; 60: 507–511.

25. Khalafalla RE. A survey study on gastrointestinal parasites of stray cats in northern region of Nile delta, Egypt. PLoS One 2011; 6: e20283.

26. el-Beshbishi SN, Abdel-Magied AA, el-Nahas HA, Azab MS, el-Shazly AM, Morsy AT, Gamal-Edin MK, el-Kadi MA. Geoparasites in rural Dakahlia Governorate, a preliminary based study for development of the community-based intervention programs. J Egypt Soc Parasitol 2005; 35: 1051–1070.

27. Ghoneim NH, Abdel-Moein KA, Saeed H. Fish as a possible reservoir for zoonotic *Giardia duodenalis* assemblages. Parasitol Res 2012; 110: 2193–2196.

28. Youssef FG, Adib I, Riddle MS, Schlett CD. A review of cryptosporidiosis in Egypt. J Egypt Soc Parasitol 2008; 38: 9–28.

29. Helmy YA, Krucken J, Nockler K, von Samson-Himmelstjerna G, Zessin KH. Molecular epidemiology of *Cryptosporidium* in livestock animals and humans in the Ismailia province of Egypt. Vet Parasitol 2013; 193 (1–3): 15–24.

30. El-Sherbini GT, Mohammad KA. Zoonotic cryptosporidiosis in man and animal in farms, Giza Governorate, Egypt. J Egypt Soc Parasitol 2006; 36: 49–58.

31. Amer S, Honma H, Ikarashi M, Tada C, Fukuda Y, Suyama Y, Nakai Y. *Cryptosporidium* genotypes and subtypes in dairy calves in Egypt. Vet Parasitol 2010; 169: 382–386.

32. Abd-El-Wahed MM. *Cryptosporidium* infection among sheep in Qalubia Governorate, Egypt. J Egypt Soc Parasitol 1999; 29: 113–118.

33. Abdel-Hafeez EH, Ahmad AK, Ali BA, Moslam FA. Opportunistic parasites among immunosuppressed children in Minia District, Egypt. Korean J Parasitol 2012; 50: 57–62.

34. Fayer R. *Sarcocystis* spp. in human infections. Clin Microbiol Rev 2004; 17: 894–902.

35. El-Dakhly KM, El-Nesr KA, El-Nahass el S, Hirata A, Sakai H, Yanai T. Prevalence and distribution patterns of *Sarcocystis* spp. in buffaloes in Beni-Suef, Egypt. Trop Anim Health Prod 2011; 43: 1549–1554.

36. Khalifa RM, El-Nadi NA, Sayed FG, Omran EK. Comparative morphological studies on three *Sarcocystis* species in Sohag, Egypt. J Egypt Soc Parasitol 2008; 38: 599–608.

37. Montoya JG, Liesenfeld O. Toxoplasmosis. Lancet 2004; 363: 1965–1976.

38. Elsheikha HM, Azab MS, Abousamra NK, Rahbar MH, Elghannam DM, Raafat D. Seroprevalence of and risk factors for *Toxoplasma gondii* antibodies among asymptomatic blood donors in Egypt. Parasitol Res 2009; 104: 1471–1476.

39. Ibrahim HM, Huang P, Salem TA, Talaat RM, Nasr MI, Xuan X, Nishikawa Y. Short report: prevalence of *Neospora caninum* and *Toxoplasma gondii* antibodies in northern Egypt. Am J Trop Med Hyg 2009; 80: 263–267.

40. Mabrouk MA, Dahawi HS. *Toxoplasma* antibodies in patients with meningoencephalitis. J Egypt Soc Parasitol 1991; 21: 547–551.

41. Al-Kappany YM, Lappin MR, Kwok OC, Abu-Elwafa SA, Hilali M, Dubey JP. Seroprevalence of *Toxoplasma gondii* and concurrent *Bartonella* spp., feline immunodeficiency virus, feline leukemia virus, and *Dirofilaria immitis* infections in Egyptian cats. J Parasitol 2011; 97: 256–258.

42. Ibrahim BB, Salama MM, Gawish NI, Haridy FM. Serological and histopathological studies on *toxoplasma Gondii* among the workers and the slaughtered animals in Tanta Abattoir, Gharbia Governorate. J Egypt Soc Parasitol 1997; 27: 273–278.

43. El-Massry A, Mahdy OA, El-Ghaysh A, Dubey JP. Prevalence of *Toxoplasma gondii* antibodies in sera of turkeys, chickens, and ducks from Egypt. J Parasitol 2000; 86: 627–628.

44. Hamadto HA, Al FA, Farrag AB, Abdel Maksoud MK, Morsy TA. Zoonotic cutaneous leishmaniasis: reservoir host and insect vector in north Sinai, Egypt. J Egypt Soc Parasitol 2007; 37: 843–850.

45. Shehata MG, Samy AM, Doha SA, Fahmy AR, Kaldas RM, Furman BD, Villinski JT. First report of *Leishmania tropica* from a classical focus of L. major in North-Sinai, Egypt. Am J Trop Med Hyg 2009; 81: 213–218.

46. Hanafi HA, Fryauff DJ, Modi GB, Ibrahim MO, Main AJ. Bionomics of phlebotomine sandflies at a peacekeeping duty site in the north of Sinai, Egypt. Acta Trop 2007; 101: 106–114.

47. Morsy TA, Hamadto HA, Rashed SM, el-Fakahany AF, Abdalla KF. Animals as reservoir hosts for *Leishmania* in Qualyobia Governorate, Egypt. J Egypt Soc Parasitol 1990; 20: 779–788.

48. Faris R, Massoud A, el Said S, Gadallah MA, Feinsod FM, Saah AJ, Londner M, Rosen G. The epidemiology of human visceral leishmaniasis in El Agamy (Alexandria Governorate), Egypt: serosurvey and case/control study. Ann Trop Med Parasitol 1988; 82: 445–452.

49. el Mahdy A, Morsy TA, Youssef MS, el Shazly AM, Hammoda NE. Visceral leishmaniasis among hypersplenic patients in Dakahlia Governorate, Egypt. J Egypt Soc Parasitol 1993; 23: 563–577.

50. Rosypal AC, Bowman SS, Epps SA, El Behairy AM, Hilali M, Dubey JP. Serological survey of dogs from Egypt for antibodies to *Leishmania* species. J Parasitol 2013; 99: 170–171.

51. el-Kady GA, Makled KM, Morsy TA, Morsy ZS. Rodents, their seasonal activity, ecto- and blood-parasites in Saint Catherine area, South Sinai Governorate, Egypt. J Egypt Soc Parasitol 1998; 28: 815–826.

52. Mazyad SA, Shoukry NM, El-Alfy NM. Efficacy of *Ixodes ricinus* as a vector of zoonotic babesiosis in Sinai Peninsula, Egypt. J Egypt Soc Parasitol 2010; 40: 499–514.

53. Haridy FM, El-Metwally MT, Khalil HH, Morsy TA. *Trypanosoma evansi* in dromedary camel: with a case report of zoonosis in greater Cairo, Egypt. J Egypt Soc Parasitol 2011; 41: 65–76.

54. Chitsulo L, Engels D, Montresor A, Savioli L. The global status of schistosomiasis and its control. Acta Trop 2000; 77: 41–51.

55. WHO. Weekly epidemiological record. 2013; 88: 81–88.

56. El Khoby T, Galal N, Fenwick A. The USAID/Government of Egypt's Schistosomiasis Research Project (SRP). Parasitol Today 1998; 14: 92–96.

57. El-Khoby T, Galal N, Fenwick A, Barakat R, El-Hawey A, Nooman Z, Habib M, Abdel-Wahab F, Gabr NS, Hammam HM, Hussein MH, Mikhail NN, Cline BL, Strickland GT. The epidemiology of schistosomiasis in Egypt: summary findings in nine governorates. Am J Trop Med Hyg 2000; 62: 88–99.

58. Mansour NS. *Schistosoma mansoni* and *Sch. haematobium* found as a natural double infection in the Nile rat, *Arvicanthis n. niloticus,* from a human endemic area in Egypt. J Parasitol 1973; 59: 424.

59. Haseeb AN, el-Shazly AM, Arafa MA, Morsy AT. A review on fascioliasis in Egypt. J Egypt Soc Parasitol 2002; 32: 317–354.

60. Soliman MF. Epidemiological review of human and animal fascioliasis in Egypt. J Infect Dev Ctries 2008; 2: 182–189.

61. Dar Y, Amer S, Mercier A, Courtioux B, Dreyfuss G. Molecular identification of *Fasciola* spp. (Digenea: Fasciolidae) in Egypt. Parasite 2012; 19: 177–182.

62. Periago MV, Valero MA, El Sayed M, Ashrafi K, El Wakeel A, Mohamed MY, Desquesnes M, Curtale F, Mas-Coma S. First phenotypic description of *Fasciola hepatica/ Fasciola gigantica* intermediate forms from the human en-

demic area of the Nile Delta, Egypt. Infect Genet Evol 2008; 8: 51–58.

63. Esteban JG, Gonzalez C, Curtale F, Munoz-Antoli C, Valero MA, Bargues MD, el-Sayed M, el-Wakeel AA, Abdel-Wahab Y, Montresor A, Engels D, Savioli L, Mas-Coma S. Hyperendemic fascioliasis associated with schistosomiasis in villages in the Nile Delta of Egypt. Am J Trop Med Hyg 2003; 69: 429–437.

64. El-Shazly AM, Abdel-Magied AA, El-Nahas HA, El-Metwaly MS, Morsy TA, El Sharkawy EM, Morsy AT. On the main reservoir host of *Fasciola* in Dakahlia Governorate, Egypt. J Egypt Soc Parasitol 2005; 35: 243–252.

65. Mazyad SA, el-Nemr HI. The endoparasites of sheep and goats, and shepherd in North Sinai Governorate, Egypt. J Egypt Soc Parasitol 2002; 32: 119–126.

66. Elsheikha HM, Elshazly AM. Preliminary observations on infection of brackish and fresh water fish by heterophyid encysted metacercariae in Egypt. Parasitol Res 2008; 103: 971–977.

67. Abou-Basha LM, Abdel-Fattah M, Orecchia P, Di Cave D, Zaki A. Epidemiological study of heterophyiasis among humans in an area of Egypt. East Mediterr Health J 2000; 6: 932–938.

68. Lobna SM, Metawea YF, Elsheikha HM. Prevalence of heterophyiosis in *Tilapia* fish and humans in Northern Egypt. Parasitol Res 2010; 107: 1029–1034.

69. Ibrahim MM, Soliman MF. Prevalence and site preferences of heterophyid metacercariae in *Tilapia zilli* from Ismalia fresh water canal, Egypt. Parasite 2010; 17: 233–239.

70. Sadjjadi SM. Present situation of echinococcosis in the Middle East and Arabic North Africa. Parasit Int 2006; 55 Suppl: S197–S202.

71. Kandeel A, Ahmed ES, Helmy H, El Setouhy M, Craig PS, Ramzy RM. A retrospective hospital study of human cystic echinococcosis in Egypt. East Mediterr Health J 2004; 10: 349–357.

72. Elshazly AM, Awad SE, Abdel Tawab AH, Haridy FM, Morsy TA. Echinococcosis (zoonotic hydatidosis) in street dogs in urban and rural areas, Dakahlia Governorate, Egypt. J Egypt Soc Parasitol 2007; 37: 287–298.

73. Haridy FM, Ibrahim BB, Elshazly AM, Awad SE, Sultan DM, El-Sherbini GT, Morsy TA. *Hydatidosis granulosus* in Egyptian slaughtered animals in the years 2000–2005. J Egypt Soc Parasitol 2006; 36: 1087–1100.

74. Dyab KA, Hassanein R, Hussein AA, Metwally SE, Gaad HM. Hydatidosis among man and animals in Assiut and Aswan Governorates. J Egypt Soc Parasitol 2005; 35: 157–166.

75. Aaty HE, Abdel-Hameed DM, Alam-Eldin YH, El-Shennawy SF, Aminou HA, Makled SS, Darweesh SK. Molecular genotyping of *Echinococcus granulosus* in animal and human isolates from Egypt. Acta Trop 2012; 121: 125–128.

76. Haridy FM, Ibrahim BB, Morsy TA, Ramadan NI. Human taenaisis and cysticercosis in slaughtered cattle, buffaloes and pigs in Egypt. J Egypt Soc Parasitol 1999; 29: 375–394.

77. El-Shazly AM, Abdel Baset SM, Kamal A, Mohammed KA, Sakrs TI, Hammad SM. Seroprevalence of human toxocariasis (visceral larva migrans). J Egypt Soc Parasitol 2009; 39: 731–744.

78. Antonios SN, Eid MM, Khalifa EA, Othman AA. Seroprevalence study of *Toxocara canis* in selected Egyptian patients. J Egypt Soc Parasitol 2008; 38: 313–318.

79. Shalaby HA, Abdel-Shafy S, Derbala AA. The role of dogs in transmission of *Ascaris lumbricoides* for humans. Parasitol Res 2010; 106: 1021–1026.

80. El-Tras WF, Holt HR, Tayel AA. Risk of *Toxocara canis* eggs in stray and domestic dog hair in Egypt. Vet Parasitol 2011; 178: 319–323.

81. Ramzy RM. Field application of PCR-based assays for monitoring *Wuchereria bancrofti* infection in Africa. Ann Trop Med Parasitol 2002; 96 Suppl 2: S55–S59.

82. Weil GJ, Ramzy RM, El Setouhy M, Kandil AM, Ahmed ES, Faris R. A longitudinal study of Bancroftian filariasis in the Nile Delta of Egypt: baseline data and one-year follow-up. Am J Trop Med Hyg 1999; 61: 53–58.

83. Hassan M, Sanad MM, el-Karamany I, Abdel-Tawab M, Shalaby M, el-Dairouty A, Assal K, Gamal-Edin MK, Adel el-Kadi M. Detection of DNA of *W. bancrofti* in blood samples by QC-PCR-ELISA-based. J Egypt Soc Parasitol 2005; 35: 963–970.

84. Kamal IH, Fischer P, Adly M, El Sayed AS, Morsy ZS, Ramzy RM. Evaluation of a PCR-ELISA to detect *Wuchereria bancrofti* in *Culex pipiens* from an Egyptian village with a low prevalence of filariasis. Ann Trop Med Parasitol 2001; 95: 833–841.

85. Makhlouf LM, Monib ME, Abou-Zkam AA, Romia SA, el-Ganayni GA, Handousa A. A microfilaria in a stray cat from Assiut, Egypt. J Egypt Soc Parasitol 1989; 19: 247–249.

86. Abdel-Rahman SM, Mahmoud AE, Galal LA, Gustinelli A, Pampiglione S. Three new cases of human infection with *Dirofilaria repens*, one pulmonary and two subcutaneous, in the Egyptian governorate of Assiut. Ann Trop Med Parasitol 2008; 102: 499–507.

87. Pozio E. Current status of food-borne parasitic zoonoses in Mediterranean and African regions. Southeast Asian J Trop Med Public Health 1991; 22 Suppl: 85–87.

88. Siam MA, Michael SA, Ghoneim NH. Studies on the isolation of the infective stages of *Trichinella spiralis* and *Toxoplasma gondii* from fresh and processed pork in Egypt. J Egypt Public Health Assoc 1979; 54: 163–170.

89. Loutfy NF, Awad OM, El-Masry AG, Kandil GM. Study on rodents infestation in Alexandria and prevalence of *Trichinella spiralis* infection among them. J Egypt Soc Parasitol 1999; 29: 897–909.

90. Bahgat MA, El Gindy AE, Mahmoud LA, Hegab MH, Shahin AM. Evaluation of the role of *Ancylostoma caninum* in humans as a cause of acute and recurrent abdominal pain. J Egypt Soc Parasitol 1999; 29: 873–882.

91. Attia RA, Tolba ME, Yones DA, Bakir HY, Eldeek HE, Kamel S. *Capillaria philippinensis* in Upper Egypt: has it

become endemic? Am J Trop Med Hyg 2012; 86: 126–133.

92. Abdou Nel S, Dronen NO. Studies on the juveniles of a species of *Anisakis* (Nematoda: Anisakidae) from the *orangespotted trevally*, *Carangoides bayad* (Carangidae), from the Red Sea, Egypt. J Egypt Soc Parasitol 2007; 37: 1055–1064.

93. Mazyad SA, Abel El-Kadi M. *Ornithonyssus* (Acari: Macronyssidae) mite dermatitis in poultry field-workers in Almarg, Qalyobiya governorate. J Egypt Soc Parasitol 2005; 35: 213–222.

94. Shoukry NM, El-Naggar MH, Darwish AB, Soliman BA, El-Sawaf BM. Studies on rodents role as reservoir hosts of leishmaniasis with specical reference to their ectoparasites in Suez Governorate. J Egypt Soc Parasitol 2006; 36: 93–106.

95. Elshazly AM, Awad SI, Azab MS, Elsheikha HM, Abdel-Gawad AG, Khalil HH, Morsy TA. Helminthes of synanthropic rodents (Rodentia: Muridae) from Dakahlia and Menoufia, Egypt. J Egypt Soc Parasitol 2008; 38: 727–740.

96. El Shazly AM, Soliman M, Nemr HI, El Moafyo N, Abel Gawad AG, El Bendary M. Nematodes and water pollution in eastern part of Nile Delta. J Egypt Soc Parasitol 2003; 33: 631–636.

97. El-Shazly AM, Mohammed RM, El-Beshbishi SN, Azab MS, El-Ghareeb AS, Abdeltawab AH, Zalook TK. Soil-parasites particularly *Toxocara* eggs in Egypt. J Egypt Soc Parasitol 2009; 39: 151–162.

98. El-Sherbini GT, Gneidy MR. Cockroaches and flies in mechanical transmission of medical important parasites in Khaldyia Village, El-Fayoum, Governorate, Egypt. J Egypt Soc Parasitol 2012; 42: 165–174.

99. Zaher T, Abdul-Fattah M, Ibrahim A, Salah H, El-Motyam M, Abdel-Dayem WA, Refaey M. Current Status of Schistosomiasis in Egypt: Parasitologic and Endoscopic Study in Sharqia Governorate. Afro-Egypt Infect Endem Dis 2011; 1 (1): 9–11.