

## Epidemiological review of human and animal fascioliasis in Egypt

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### Abstract

One of the neglected food-borne-diseases in the international public health arena is fascioliasis. It is a serious infectious parasitic disease infecting humans and animals worldwide and tops all the zoonotic helminthes. Human cases are being increasingly reported from Europe, the Americas, Oceania, Africa and Asia. Hence, human fascioliasis is considered now as a zoonosis of major global and regional importance. In Egypt, animal and human fascioliasis is an endemic clinical and epidemiological health problem. Doubtless, understanding the epidemiology of the parasitic diseases and factors affecting their incidence provides the foundation upon which effective prevention and control programs should be established. This article reviews the history, life cycles, transmission, incidence, geographical distribution, and environmental and human determinants that contribute to the epidemiological picture of fascioliasis with special reference to Egypt.

**Key Words:** Fascioliasis, epidemiology, environment, human determinants.

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### Introduction

Food-borne trematodiasis, including fascioliasis, are neglected in the international public health arena in comparison with other helminthic diseases [1]. Fascioliasis, a serious infectious parasitic disease infecting domestic ruminants and humans, tops all the zoonotic helminthes worldwide [2]. It is caused by a liver fluke belonging to genus *Fasciola*. A large variety of animals, such as sheep, goats, cattle, buffalo, horses, donkeys, camels and rabbits, show infection rates that may reach 90% in some areas [3]. Human infection with fascioliasis was very sporadic until the last three decades when clinical cases and outbreaks were reported [4]. Human fascioliasis (HF) is a major public health problem in several areas of the world, including the highlands of Bolivia, Ecuador and Peru; the Nile Delta in Egypt; and central Viet Nam. According to a World Health Organization (WHO) report in 2007 [1], the infection was limited in the past to specific and typical geographical areas (endemiotopes), but is now widespread throughout the world, with human cases being increasingly reported from Europe, the Americas and Oceania (where only *F. hepatica* is transmitted), and from Africa and Asia (where the two species overlap). As a consequence, human fascioliasis should be considered as a

zoonosis of major global and regional importance [1].

In Egypt, animal fascioliasis (AF) and HF are clinical and epidemiological public health problems. According to the Egyptian Academy of Scientific Research and Technology Report, losses due to AF in Egypt, were estimated at 190 million Livre Egyptienne (LE) annually. Both acute and chronic fascioliasis have been found in almost all governorates and in the reclaimed desert land [5,6]. Human infection causes serious hepatic pathological consequences due to the severe damage which occurs in the liver cells mainly during the early migrating stages of the flukes. The disease is which affects the general immune status of the animal, and there is no accurate method for early diagnosis before time of egg deposition adopted [4,7].

No doubt that there is now a need to control the human infection along with the veterinary infection [8]. Doubtless, understanding the epidemiology of parasitic diseases and the factors affecting them provides the foundation upon which effective prevention and control programs should be established. This review presents an epidemiological picture of fascioliasis with a special reference to Egypt. History, transmission, incidence, geographical distribution, and

environmental and human determinants playing a role in the epidemiological pictures of fascioliasis will be discussed.

### **Fasciola Species and Distribution**

Two major species, *F. hepatica* Linnaeus, 1758 and *F. gigantica* Cobbold, 1855 are the causative agents of fascioliasis in ruminants and in humans worldwide. *F. hepatica* has a wider range than its tropical counterpart, *F. gigantica*, but their geographical distribution overlaps in many African and Asian countries and sometimes in the same country, although in such cases the ecological requirement of the flukes and their snail host are distinct [9,10,11,12]. *F. hepatica* typically occurs worldwide in temperate regions, except Oceania. *F. gigantica* causes outbreaks in tropical areas of southern Asia, Southeast Asia, and Africa. Infection is most prevalent in regions with intensive sheep and cattle production [1]. In Egypt both *F. gigantica* and *F. hepatica* co-exist in domestic animals [1,6,13,14]. The former has been present since the times of the pharaohs, while the latter was imported from Europe at the beginning of the 1900s.

Despite the importance to differentiate between the infection by either fasciolid species, due to their distinct epidemiological, pathological and control characteristics, there is, unfortunately, neither a direct coprological nor an indirect immunological test available for their diagnosis [14]. The specific differentiation can only be made by either a morphological study of adult flukes or by molecular tools [14].

### **Fasciola life cycle and its snail intermediate hosts**

Infection with *Fasciola* spp occurs when metacercariae are accidentally ingested on raw vegetation. The metacercariae exist in the small intestine, and move through the intestinal wall and peritoneal cavity to the liver where adults mature in the biliary ducts of the liver. Eggs are passed through the bile ducts into the intestine where they are then passed in the feces. As with other trematodes, *fasciola* develop in the molluscan intermediate host. Species of the Lymnaidae family are known for their role as intermediate hosts in the life cycle of *F. gigantica* or *F. hepatica*; however, throughout the years an increasing

number of molluscan intermediate hosts of *F. hepatica* and *F. gigantica* have been reported [11].

There are many ecological factors affecting snail populations including temperature, light, hydrogen ion concentration (pH), vegetation, depth of water, current of the water, chemical composition of the soil, and snail population competition [10,15]. It has been reported that the Lymnaeid intermediate hosts of *F. gigantica* are distinguishable from those of *F. hepatica*, both morphologically and as to habitat requirement [10]. The species of *Fasciola* can become adapted to new intermediate hosts under certain conditions at least based on laboratory trials. It has been reported that the most important intermediate hosts of *F. gigantica* are *L. auricularia*; however, *L. rufescens* and *L. acuminata* are the host snails in the Indian Subcontinent; *L. rubiginosa* and *L. natalensis* are the hosts in Malaysia and in Africa respectively; and the synonymous *L. cailliaudi* is the intermediate host in east Africa [10,11]. The most important and widespread (Europe, Asia, Africa and North America) intermediate host of *F. hepatica* is *L. truncatula* [11]. Other *Lymnaea* species are *L. euphratic* in Iraq and *L. auricularia* in Oman. There is some evidence, at least based on laboratory trails, that the species of *Fasciola* can become adapted to new hosts, either amphibious or aquatic, under certain conditions. The Australian *L. tomentosa* (host of *F. hepatica*) was shown to be receptive to miracidia of *F. gigantica* from East Africa, Malaysia and Indonesia.

*L. cailliaudi*, the main intermediate host in Egypt, has been detected in water bodies of the Nile Delta. These snails prefer clear, slow-running water with low salinity and abundant vegetation. The snail population is low in the summer months due to high temperatures, and increases gradually to reach its maximum in spring when the temperature is mild and vegetation flourishes. Overall, rates of snail infection vary between 10% and 40%. The highest infection rate was found to be in summer and this may be a factor responsible for lowering snail density in this season. *L. cailliaudi* has been found responsible for transmission of both *F. hepatica* and *F. gigantica* [3].

It has been reported that several snail species may contribute to the transmission of fasciolosis in Egypt. These molluscs show variable sensitivity to natural infections with the *Fasciola* species [13]. In

a study about fascioliasis in Ismailia Governorate, Egypt, the author recorded for the first time the presence of *L. truncatula* snails from East of Suez Canal (El-Abtaal village) in addition to *L. cailliaudi* [16]. However, *Radix natalensis* is considered to be the essential intermediate host for *F. gigantica* based on field and experimental studies [13]. Cercarial production from *R. natalensis* experimentally infected with *F. gigantica* is affected by the species of definitive host from which the eggs are obtained, as well as the different laboratory conditions. Another lymnaeid, *Galba truncatula*, may play a role in transmitting this parasite in Egypt, as it was found naturally infected with *F. gigantica*. At the level of intermediate hosts of *F. gigantica*, the conditions are thus favorable in Egypt to transmit fascioliasis which could also be caused by another fasciolid, *F. hepatica*, as the existence of this fluke was confirmed in Egypt [13].

### Environmental and human determinants of fascioliasis

Fascioliasis occurs mainly in children living in rural settings, but also in people living in urban areas. Anaemia is a frequent finding in infected individuals. Symptoms are usually mild or even absent in children. High prevalence in humans is not necessarily found in areas where fascioliasis is highly prevalent in animals, and in some areas eggs excreted by infected persons may be sufficient to maintain transmission, especially where the habit of defecating outdoors is widespread [1].

While normally an infection of cattle and sheep, environmental modifications and changes in human behavior are defining new geographical limits and populations at risk for fascioliasis [1]. The problem arose in Egypt for several reasons: the suitability of the climate and canals for *Lymnaea* snails and their egg masses to persist throughout the year; the resistance of metacercariae for dissociation, especially with the presence of shallow water, enough vegetation and/or humidity; continued exposure of the animals to encysted metacercariae from the banks of the canals, especially during the dry season; and no restriction on animal importation, grazing habits, and movement between the infected and treated localities [7]. However, the poor sanitary habits and low health awareness of the population

in Egypt are the main reasons for the persistence and increase of HF.

In Egypt, many species of vegetables and weeds are eaten raw as salads, including *Eruca sativa*, *Lactuca sativa* and *Allium kurrat*. They are not aquatic but are grown along the banks of the water channels and need frequent irrigation. Once collected, they are washed in the nearby canals during their preparation for marketing. Irrigation and washing expose them to the cercariae which encyst and in a few hours become infective [3].

Several studies were conducted focusing on factors that could affect the prevalence of fascioliasis in Egypt. It has been reported that prevalence of HF can be related to the patient's occupation. In 1992, the following prevalence rates of fascioliasis was recorded in Egypt: farmers (2.8%), students (3.3%) and housewives (0%) [17]. Moreover, it was also reported that fascioliasis was found to be higher in females (7.69%) than in males (5.85%) [18]. In 2007, a study about HF in Egypt showed that rural girls are often involved in household and farm work and are exposed more than boys to infected foci [19]. The lower school attendance for girls in rural areas appears to be an important factor in increasing risk of infection.

### Pathological features

Fascioliasis in animals presents in two major forms, acute and chronic. Persistence and degree of infection depends on several factors including the presence of animals in an endemic area rich in water and vegetation; age and general health condition of the animal; the dose of the metacercariae that reached the animal; and the type and frequency of medication available in relation to the transmission season and animal movement. The acute form of the disease is more commonly seen in sheep, and is not usually a feature of fascioliasis in man or other animals. It occurs when very large numbers of metacercariae (>10,000) have been ingested at once. In these cases, the resulting large number of migrating larvae invade the liver causing traumatic hepatitis, frequently resulting in death. In some cases the liver capsule may rupture into the peritoneal cavity causing death due to peritonitis. More commonly, on ingestion of fewer metacercariae, a period of fever and eosinophilia is seen. This form of the disease is much more common in all hosts, particularly human. In these cases the infection is only rarely

fatal, but, at least in domesticated animals, is of economic importance [20].

The presence of the flukes in humans causes a number of fairly non-specific symptoms including malaise, an intermittent fever, mild jaundice and anaemia, eosinophilia and, frequently, pain under the right costal margin. In addition, as *Fasciola* does not appear to be fully adapted to using man as a definitive host, the flukes may often give rise to ectopic infections, particularly in the lungs and subcutaneous tissues, where they may be found encysted [20]. Moreover, a distinct syndrome of fascioliasis, termed *halzoun* in Lebanon and *marrerra* in the Sudan, can result from consuming raw livers of infected sheep, goats, or cows. The living fluke adheres to the posterior pharyngeal wall, causing severe pharyngitis and laryngeal edema. Similarly, disease can follow consumption of sashimi of bovine liver served in "Yakitori" bars in Japan, if the liver is contaminated with juvenile worms [21].

### Epidemiological picture of Animal fascioliasis in Egypt

In Egypt, buffalo, cattle, goats, sheep, donkeys, horses, camels and rabbits were reported as hosts for *Fasciola* spp [6]. The early citation for AF in Egypt was in 1949; it was mentioned that a particular flock of 600 head of sheep was reduced to 96 head within two years because of fascioliasis [22]. In 1964, liver fluke infection resulted in an average loss of 100 and 150 liters milk / year / head for cattle and water buffaloes, respectively [23]. More recently, the prevalence of AF in Egypt has been estimated in sporadic studies [15,17,18,24,25,26,27,28,29,30,31], but the only complete available data about incidence of the disease was that done in 1988 by the general organization of veterinary services, Ministry of Agriculture (MOA) [32] (Table 1) where the low and high incidences of bovine fascioliasis recorded at that time were 3% and 59.5% in North Sinai and Dakahlia governorate, respectively. The MOA report in 1988 showed that the mean percentage of *Fasciola* infestation (through fecal examinations) in the whole country reached 25.8%. It has also been reported that during the years 1994 to 1997 the overall numbers of slaughtered animals in Egyptian abattoirs were 2,003,200 sheep and goats, 2,624,239 cattle, and 3,536,744 buffaloes

[33]. The overall rates of fascioliasis were 2.02% for sheep and goats, 3.54% for cattle, and 1.58% for buffaloes.

**Table 1.** Prevalence of animal fascioliasis in different Egyptian Governorates according to MOA.

Governorate	Prevalence of Fascioliasis	
	Cattle & Buffalo	Sheep
Qalubia	33.6%	41.2%
Monopheia	51.2%	53.0%
Gahrbia	29.7%	22.5%
Kafr El-heik	36.5%	39.6%
Behera	21.8%	29.0%
Alexandria	25.0%	30.0%
Demita	34.0%	39.0%
Dakahlia	59.5%	78.0%
Sharkia	34.0%	41.0%
Ismaelia	29.2%	31.0%
Port Said	14.8%	22.9%
Suez	16.9%	28.8%
Cairo	21.0%	33.4%
Giza	26.0%	33.0%
Benisweif	39.0%	40.0%
El-Fayom	40.0%	42.0%
El-Menia	26.5%	31.5%
Assiut	27.0%	28.0%
Sohag	22.0%	28.0%
Qena	18.5%	21.0%
Aswan	11.9%	16.5%
Matrouh	9.5%	11.6%
New Valley	7.8%	12.9%
Red Sea	6.0%	11%
North Sinai	3%	–

Comparing the incidence of AF recorded by MOA in 1988 [32] with the other sporadic studies done after this year, interestingly there was some remarkable decrease in the incidence of AF. For example, a noteworthy decrease in the incidence of sheep fascioliasis (17.8%) has been recorded in Sharkia governorate [29] compared to 41% as recorded by MOA in 1988. Moreover, notable decreases in the bovine fascioliasis have been recorded in Dakahlia governorate (11.2) and in Gahrbia governorate (21.8%)[31] compared to 59.5% and 29.7%, respectively, as recorded by MOA.

### Epidemiological picture of human fascioliasis

The epidemiological picture of HF has changed in recent years. The number of reports of humans infected with *Fasciola* sp has increased significantly since 1980 and several geographical areas have been described as presenting true human endemics, ranging from low to very high prevalence and intensity [34]. High prevalence of fascioliasis in humans does not necessarily occur in areas where fascioliasis is a major veterinary problem. HF can no longer be considered merely as a secondary zoonotic disease but must be considered a major human parasitic disease [34].

In the past, fascioliasis was limited to populations within well-defined watershed boundaries; however, recent environmental changes and modifications in human behavior are defining new geographical limits and increasing the populations at risk. Recent urbanization, migration, and development practices such as dam building and irrigation have increased the populations at risk and the incidence of human infection has increased significantly over the past 30 years [35].

Fascioliasis is increasingly recognized as causing significant human disease, with 2.4 million people infected [36,37]. Prevalence is highest in areas where extensive sheep and cattle raising occurs and where dietary practices include the consumption of raw aquatic vegetables. Fascioliasis is endemic in 61 countries and has become a food-borne infection of public health importance in parts of the world such as the Andean Highlands of Bolivia, Ecuador and Peru; the Nile Delta of Egypt; and Northern Iran. It is estimated that more than 180 million people are at risk of infection, and infection rates are high enough to make fascioliasis a serious public health concern [38].

The number of people having fascioliasis was estimated to be 360,000 in Bolivia, 20,000 in Ecuador, 830,000 in Egypt, 10,000 in Islamic Republic of Iran, 742,000 in Peru, and 37,000 in Yemen.

The largest numbers of infected people have been reported from Bolivia, China, Ecuador, Egypt, France, Islamic Republic of Iran, Peru and Portugal. Disease prevalence is particularly high in specific regions of Bolivia (65-92%), Ecuador (24-53%), Egypt (2-17%), and Peru (10%), [21].

### Human Fascioliasis in Egypt

HF has now been found in almost all governorates of the Delta region, in the city of Alex, in some governorates of upper Egypt, and in the reclaimed desert land. The population at risk in Egypt is considered to be 27 million [6].

*Fasciola* eggs have been detected in a mummy, confirming that HF has existed since Pharaonic times [39]. In 1928, two cases were reported and then in 1958, 11 cases were reported. Until the 1970s, only sporadic cases of HF were detected, and the first endemic focus, a village in the Abiss area near Alexandria, was identified only in 1978. Since 1990, human cases have been reported from most of the Delta governorates, where the overall prevalence is estimated at 3% [1]. Studies in some villages in the Delta have revealed prevalence rates varying between 2% and 17%. The population at risk in Egypt is considered to be 27 million. Accordingly, based on an estimated overall prevalence of 3%, the number of infected cases amounts to 830,000 individuals [37]. Table 2 shows the prevalence rates of HF recorded in Egypt from different citations.

**Table 2.** Some sporadic studies about the prevalence of human fascioliasis in Egypt.

Year	No. of cases reported / Prevalence of fascioliasis (%)	Governorate
1928	2	-
1958	11	-
1979	7.3	Alexandria (Abis II village) [41]
1988	6.74	Alexandria [42]
1989	6.74	Alexandria (Abis II village) [42]
1992	9.8	Sharkia villages [43]
1995	11.5	Sharkia villages (School children) [44]
1999	0.93 0.8	Ismilaia (El-Mahsma) & Ismilaia (El-Abtaal) [16]
2001	7.4	Dakahlia [45]
2004	2.4	Alexandria (El prince village) [46]

In approximately 3,000 Egyptian children, 3% were found infected. Many were severely anemic.

Among individuals who presented with fever of unknown origin to an Egyptian hospital, 4% had *F. hepatica*. *F. hepatica*-caused disease that formerly occurred in scattered endemic foci along the Nile River in Egypt now is epidemic throughout the Nile valley [21]. Another study that investigated the parasitic causes of hepatomegaly in children estimated that 8.7% of the examined cases were identified as fascioliasis.

### Prevention and control

With the development of triclabendazole for human use, fascioliasis can now move up the list of priorities to be addressed urgently in endemic areas. WHO has spearheaded and recommended community-based chemotherapy for the control of helminthic infections in endemic communities [35]. Triclabendazole (TCZ) is the treatment of choice for fascioliasis and is effective at a single dose of 10 mg/kg body weight against the adult parasites in the bile ducts and immature flukes migrating through the liver. TCZ has been used during outbreaks in several countries and for selective treatment of infected individuals in a control programme in the Nile Delta of Egypt. It has not been used in large community-based control programmes because of its limited availability [1].

In 1998, following reports on high prevalence among children in the Nile Delta, the Egyptian Ministry of Health and Population launched the first public health, school-based intervention to control HF. An innovative selective treatment approach, with chemotherapy targeted to specific high-risk age groups and villages, was adopted. First, high prevalence districts were identified by a regional baseline survey, and then screening and selective treatment of all schoolchildren took place in high prevalence villages within those districts. From 1998 to 2002 the programme screened almost 36,000 schoolchildren in six districts, treating 1,280 cases of HF. Prevalence in the endemic area was reduced from 5.6 to 1.2%. The control intervention is described in detail, including data on cost. The targeted, selective chemotherapy approach was appropriate in addressing low prevalence infection; effective in reducing prevalence rates and transmission of the disease; and, in the present situation, more cost-effective than mass distribution [8].

According to a WHO report in 2007 [1], Egypt is the only country that is currently implementing

control activities against HF. Activities started in 1996 with the identification of the six endemic districts in Beheira Governorate. Since then, school surveys have been conducted in all the Delta governorates and in some Upper Egypt governorates.

Raising health awareness in the Egyptian population is the most important tool for prevention of HF, in addition to the application of molluscicides to decrease the population of *Lymnaea* snails, early diagnosis of infection, and effective medication. Priority setting for disease control at the country level is based not only on mortality and morbidity indicators, but also on the availability of effective, safe, cheap and simple tools. Behavior changes have the potential to be the most effective and cost efficient approaches to disease control and thus education is an essential aspect of any public health effort. The primary message of *Fasciola hepatica* campaigns is to keep domestic animal herds separate from the growing sites of aquatic food plants. This limits the risk of contaminating the vegetation and thus decreases both human infection and the animal reservoir. Teaching the washing of vegetables in either 6% vinegar or potassium permanganate for 5 to 10 minutes, which destroys the encysted metacercariae, is another useful educational effort. This approach has proven more acceptable to communities than past attempts to entirely halt the consumption of raw vegetables. Despite the prevalence of fascioliasis in many regions, physicians and health workers often do not consider the possibility of *Fasciola hepatica* infection when treating patients and thus would benefit from awareness training. This would increase timely identification and treatment, decreasing both the individual disease burden and transmission by way of the human reservoir [40].

### References

1. WHO (2007) Report of the WHO Informal Meeting on use of triclabendazole in fascioliasis control. WHO/CDS/NTD/PCT/2007.1.
2. Haridy FM, Morsy TA, Gawish NI, Antonios TN, Abdel Gawad AG (2002) The potential reservoir role of donkeys and horses in zoonotic fascioliasis in Gharbia Governorate, Egypt. J. Egypt. Soc. Parasitol. 32(2): 561-570.
3. Farag, HF (1998) Human fascioliasis in some countries of the Eastern Mediterranean Region. East Mediterranean Health J 4(1) 156-160.

4. Haseeb AN, El-Shazly AM, Arafa MA, Morsy AT (2002) A review on fascioliasis in Egypt. J Egypt Soc Parasitol 32(1) 317-354.
5. El-Shazly AM, el-Nahas HA, Soliman M, Sultan DM, Abedl Tawab AH, Morsy TA (2006) The reflection of control programs of parasitic diseases upon gastrointestinal helminthiasis in Dakahlia Governorate, Egypt J Egypt Soc Parasitol 36(2) 467-480.
6. Lotfy WM and Hillier GV (2003) *Fasciola* species in Egypt. Exp Pathol Parasitol 6(11) 9-22.
7. El-Bahy NM (1998) Strategic control of fascioliasis in Egypt. Review article. Submitted to the Continual Scientific Committee of Pathology, Microbiology and Parasitology.
8. Curtale F, Hassanein YA, Savioli L (2005) Control of human fascioliasis by selective chemotherapy: design, cost and effect of the first public health, school-based intervention implemented in endemic areas of the Nile Delta, Egypt. Trans R Soc Trop Med Hyg 99(8) 599-609.
9. Pantelouris EM (1965) The common liver fluke *Fasciola hepatica* L. Pergamon Press, Oxford.
10. Malek EA (1980) Snail-transmitted parasitic disease. Library of Congress cataloging in publication data, USA II, 131-170.
11. Soulsby EJ (1982) Helminths, arthropods and domesticated animals. 7th Ed., Bailliere, Tindall and Cassell, London. pp. 40-52.
12. Mas-Coma S, Bargues MD, Valero MA (2005) Fascioliasis and other plantborne trematode zoonoses. Int J Parasitol 35: 1255-1278.
13. Dar YD, Rondelaud D, Dreyfuss G (2005) Update of fasciolosis-transmitting snails in Egypt (review and comment). J Egypt Soc Parasitol 35(2) 477-490.
14. Periago MV, Valero MA, El Sayed M, Ashrafi K, El Wakeel A, Mohamed MY, Desquesnes M, Curtale F, Mas-Coma S (2008) First phenotypic description of *Fasciola hepatica/Fasciola gigantica* intermediate forms from the human endemic area of the Nile Delta, Egypt. Infect Genet Evol 51-58.
15. Brown D (1994) Fresh water snails of Africa and their medical importance. Taylor and Francis Ltd. London.
16. Hassan MG (1999) Fascioliasis as a zoonotic parasite among animals, human and snails in Ismailia governorate. J Egypt Vet Med Ass 59(4) 1249-1269.
17. Amin M, Mowafy L, Marzouk MA, Fayek SA, Mohamad A (1992) Fascioliasis in man and animals. Zag. Vet J 20 (3): 404-411.
18. Samaha H (1989) The zoonotic importance of fascioliasis in Abbis, Alexandria governorate. Assiut Vet Med J 21(42) 118-122.
19. Curtale F, Hassanein YA, Barduagni P, Yousef MM, Wakeel AE, Hallaj Z, Mas-Coma S (2007) Human fascioliasis infection: gender differences within school-age children from endemic areas of the Nile Delta, Egypt Trans R Soc Trop Med Hyg 101(2)155-160.
20. Website 1: *Fasciola hepatica*: The Liver Fluke. Available at: <http://www.path.cam.ac.uk/~schisto/OtherFlukes/Fasciola.html>.
21. Emedicine (2007) Fascioliasis. Available at: <http://www.emedicine.com/ped/topic760.htm>.
22. Draze OA (1949) Increase in food supplement of man by combating animal diseases. Cited in Soliman and Zaki (1964). Bull. Epizootic Dis. Afr. 12 455-460.
23. Soliman KN and Zaki H (1964) The present situation concerning liver fluke disease in Egypt. Bull Epizootic Dis Afr 12 455-460.
24. Ayoub AE (1983) The interpretation of the different tests used for estimation parasitic status of *Fasciola gigantica* in Gharbia government. MVSc Thesis, Department of Parasitology, Faculty of Veterinary Medicine, Cairo University.
25. Mahmoud A (1984) Some studies on fascioliasis as animal problem. PhD Thesis, Department of Parasitology, Faculty of Veterinary Medicine, Alexandria University.
26. Aly M E (1993) Some Biochemical and serological studies on gastrointestinal helminth infections in cattle and buffaloes in Dakahlia governorate. PhD Thesis, Department of Parasitology, Faculty of Veterinary Medicine, Cairo University.
27. Lotfy A, Youssef H, Nassar A, Abdel-Aziz, (1995) Fascioliasis in slaughtered animals. The incidence and public health importance. Fleischwirtschaft 75(6) 803-804.
28. Radwan IG (1996) Prevalence of cryptosporidiosis and fascioliasis in farm animals and their care-takers. MSc Thesis, Department of Parasitology, Faculty of Veterinary Medicine, Cairo University.
29. El-Shazly AM, el-Wafa SA, Haridy FM, Soliman M, Rifaat MM, Morsy TA (2002) Fascioliasis among live and slaughtered animals in nine centers of Dakahlia Governorate. J Egypt Soc Parasitol 32(1) 47-57.
30. Morsy TA, Salem HS, Haridy FM, Rifaat MM, Abo-Zenadah NY, Adel El-Kadi M (2005) Farm animals' fascioliasis in Ezbet El-Bakly (Tamyia Center) Al-Fayoum Governorate. J Egypt Soc Parasitol 35(3) 825-832.
31. Haridy FM, El-Sherbiny GT, Morsy TA (2006) Some parasitic flukes infecting farm animals in Al-Santa Center, Gharbia Governorate, Egypt. J Egypt Soc Parasitol 36(1) 259-264.
32. MOA (1988) Fascioliasis. Report of Ministry of Agriculture, Egypt.
33. Haridy FM, Ibrahim BB, Morsy TA, El-Sharkawy IM (1999) Fascioliasis an increasing zoonotic disease in Egypt. J Egypt Soc Parasitol 29(1) 35-48.
34. Mas-Coma MS, Esteban JG, Bargues MD (1999) Epidemiology of human fascioliasis: a review and proposed new classification. Bull WHO 77 (4) 340-346.
35. Savioli L, Chitsulo L, Montresor A (1999) New opportunities for the control of fascioliasis. Bull WHO, 1999, 77 (4) 300.
36. Maurice J (1994) Is something lurking in your liver? New Scientist 1917 26-31.
37. WHO (1995) Control of foodborne trematode infections. Technical sheet no. 849, Geneva.
38. WHO (1998) Triclabendazole and fascioliasis - a new drug to combat an age-old disease. Fact sheet no. 191. Geneva.
39. Arjona R, Riancho JA, Aguado JM, Salesa R, Gonzalez-Macias J (1995) Fascioliasis in developed countries: a review of classic and aberrant forms of the disease. Medicine 74(1) 13-23.

40. Web site 2: Fascioliasis. available at: <http://www.stanford.edu/class/humbio103/ParaSites2001/fascioliasis/Fasciola.htm> .
41. Farag HF, Barakat RM, Ragab M, Omar E (1979) A focus of human fascioliasis in the Nile Delta, Egypt *J Trop Med Hyg* 82 188-190.
42. Hassan MM, Moustafa NE, Mahmoud LA, Abbaza BE, Hegab MH (1995) Prevalence of Fasciola infection among school children in Sharkia Governorate, Egypt. *J Egypt Soc Parasitol* 25(2) 543-549.
43. Salem AI, Osman MM, el-Daly S, Farahat A (1993) Studies on *Lymnaea* snails and their trematode parasites in Abis II village, Alexandria. *J Egypt Soc Parasitol* 23(2) 477-483.
44. El-Shazly AM, Soliman M, Gabr A, Haseeb AN, Morsy AT, Arafa MA, Morsy TA (2001) Clinico-epidemiological study of human fascioliasis in an endemic focus in Dakahlia Governorate, Egypt. *J Egypt Soc Parasitol* 31(3) 725-736.
45. Fawzi M, El-Sahn AA, Ibrahim HF, Shehata AI (2004) Vegetable-transmitted parasites among inhabitants of El-Prince, Alexandria and its relation to housewives' knowledge and practices. *J. Egypt. Public Health Assoc* 79(1-2)13-29.

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