BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM
Iraq Natural History Research Center & Museum, University of Baghdad
https://jnhm.uobaghdad.edu.iq/index.php/BINHM/Home
 Online ISSN: 2311-9799-Print ISSN: 1017-8678

Bull. Iraq nat. Hist. Mus.
(2022) 17 (2): 267-290. https://doi.org/10.26842/binhm.7.2022.17.2.0267

ORIGINAL ARTICLE

A SURVEY OF ECTO AND ENDO-PARASITES OF HOUSE MOUSE *MUS MUSCULUS* LINNAEUS, 1758 OF ERBIL CITY, KURDISTAN REGION, IRAQ

Trifa Khurshid Malla* and Louis Abdulahad Saida
Biology Department, Education College, Salahaddin University, Erbil, Iraq
*Corresponding author E-mail: Tarifa.malla@student.su.edu.krd

Recived Date: 30 July 2022, Accepted Date 1 November 2022, Published Date:20 December 2022

ABSTRACT

In the present survey 18 species of endo and ecto-parasites were recorded during the examination of 50 *Mus musculus* (Linnaeus, 1758) among 10 localities in Erbil city, of which 7 species were protozoan and as follows : *Chilomastix bettencourti* (da Fonseca 1915) 82%; *Giardia muris* (Filice, 1952) 68%; *Tritrichomonas muris* (Grassi,1879) 36%; *Entamoeba histolytica* (Schaudinn,1903) 24%; *Entamoeba coli* (Grassi,1879)32%; *Eimeria* sp. 28% and *Trypanosoma musculi* (Kendall,1906) 2%; and 8 species were helminthes as follows: 4 Cestodes: *Rodentolepis nana* (von Siebold, 1852) 8%; *Hymenolepis diminuta* (Rudolphi, 1819) 2%; larval stage of *Echinococcus granulosus* (Batsch, 1786)8%, *Cysticercus fasciolaris* (Rudolphi, 1808) 6%, 4 Nematodes: *Aspiculuris tetraptera* (Nitzsch, 1821) 8%; *Syphacia obvelata* (Rudolphi, 1802) 36%; *Syphacia muris* (Yamaguti, 1935) 2% and *Trichuris muris* (Schrank, 1788)10%; and 3 species of ectoparasites were diagnosed as follows: the Oriental rat flea *Xenopsylla cheopis* (Rothschild, 1903) 2.0%, the spined rat louse *Polyplax spinulosa* (Burmeister, 1839)16.0%, and the mite *Laelaps nuttalli* (Hirst, 1916) 4.0%. Endo-multiple infections had been noticed, as single (26%); double 50.0%; triple (22.0%) and tetra infections 2.0%. No significant differences were found between the sexes and weights of mice. The mice of Hayaskary and Langa were high infected with parasites. In the current study, we recorded the infection of the liver of *Mus musculus* with larval stage of *Echinococcus granulosus* (hydatid cyst) as the first natural infection in Iraq.

Keywords: Ectoparasite, Endoparasites, Erbil City, Iraq, *Mus musculus*.

INTRODUCTION

The importance of rodents in the spread of zoonosis is a reflection of their ecology. Rodents are present in all biotopes worldwide, being able to breed rapidly, eat a wide variety of food and adapt to fast environmental changes (Ingram *et al*., 2013). The study of animal parasites presents in human environments, such as mice and rats, is of great medical importance because some of these parasites can be transmitted to humans and cause serious diseases (Meehan, 1984). Rabiee *et al*. (2018) mentioned that rodents are significant sources

of parasitic zoonosis in humans, and they discussed the economic harm of *Mus musculus* in agriculture by causing economic losses, also it acts as a vector of diseases by transmitting many diseases to humans and animals in several ways, and its role in causing fear and terror to many people. The study of rodents due to three aims: First rodents cause economic losses in various forms in farmers, fields, facilities, homes, and others. Second, rodents are transmitting many diseases to humans and animals in several ways. Third, rodents cause fear and terror to many people (AL-Zahidy, 2001). Rodents are serving as reservoirs and vectors of at least 70 zoonotic diseases, of which 16 are helminthes parasites of Humans, and animals and the environment plays a significant role in the emergence and transmission of different infectious diseases (Thompson and Kutz, 2019).

According to the World Health Organization (WHO, 2020), any disease or infection that is naturally transmissible from vertebrate animals to humans or from humans to animals is classified as a zoonosis. Most humans are in contact with animals in a way or another; more than 60% of human pathogens are zoonotic in origin. This includes a wide variety of bacteria, viruses, fungi, protozoa, parasites, and other pathogens (Rahman *et al*., 2020). Many researches and studies have been conducted in the world about parasitic infections in rats and mice for the purpose of knowing their spread, geographical distribution and the factors affecting them because of their great importance to human health; most infectious diseases affecting humans are thought to have zoonotic potential (WHO, 2000).

Zoonotic diseases, especially those associated with rodents and other wildlife; pose a significant threat to human health and wellbeing (Daszak *et al*., 2000; Cleaveland *et al*., 2001). An increasing number of cases associated to parasitic zoonosis were recorded in some parts of the world (Han *et al*., 2015; Hassell *et al*., 2017; WHO, 2020) in which factors believed to be responsible for this escalation include, habitat modification, overpopulation, and mass migration. All these occur as a result of natural or man-made disasters (Chomel *et al*., 2007). Residential areas, especially urban settings are of great concern considering the emergence of zoonotic diseases.

In Iraq, the first study about rodent parasites was done in Baghdad by Senekji (1940), he recorded four species of intestinal flagellates as follows; *Hexamita muris*, *Trichomonas muris*, *Chilomastix muris*, and *Giardia muris*; and three species of intestinal amoeba *Entamoeba muris*, *Entamoeba histolytica* and *E. coli*., in addition to two blood protozoans (*Trypanosoma lewisi* and *Bartonella muris*). The first study in Erbil City about rodent's parasites was done by Molan and Hussein (1988) they recorded 11 species of endoparasites in the intestine, livers, and blood of a total of 232 rodents *Mus musculus*, *Rattus rattus*, and *Rattus norvegicus*. These parasites were as follows; *Trypanosoma lewisi*, *Trypanosoma musculi*, *Hymenolepis nana*, *Hymenolepis diminuta*, and larval stage *Cysticercus fascioliasis* belongs to *Hydatigera taeniaeformis*, *Mathevotaenia rodentium*, and 3 nematodes, *Syphacia obvelata*, *Aspicularis tetraptera*, *Trichuris muris*, and one Acanthocephala, *Moniliformis moniliformis* in addition to *Fasciola hepatica*. Previously at the same area, Saida (2016a) recorded 4 species of intestinal protozoan parasites (*E. muris*, *Trichomonas muris*, *Giardia muris* and *Emeria* sp., and 2 species of cestodes *Rodentolepis nana*, *Hymenolepis diminuta* with 2 species of mouse

pinworm *Aspicularis tetraptera* and *Syphacia obvelata*. The result of saida (2016a) study showed that prevalence of intestinal parasites among mice collected from Hayaskary were highly infected 29.4% compared with the other localities in the same area, and not included the study of ectoparasites in mice.

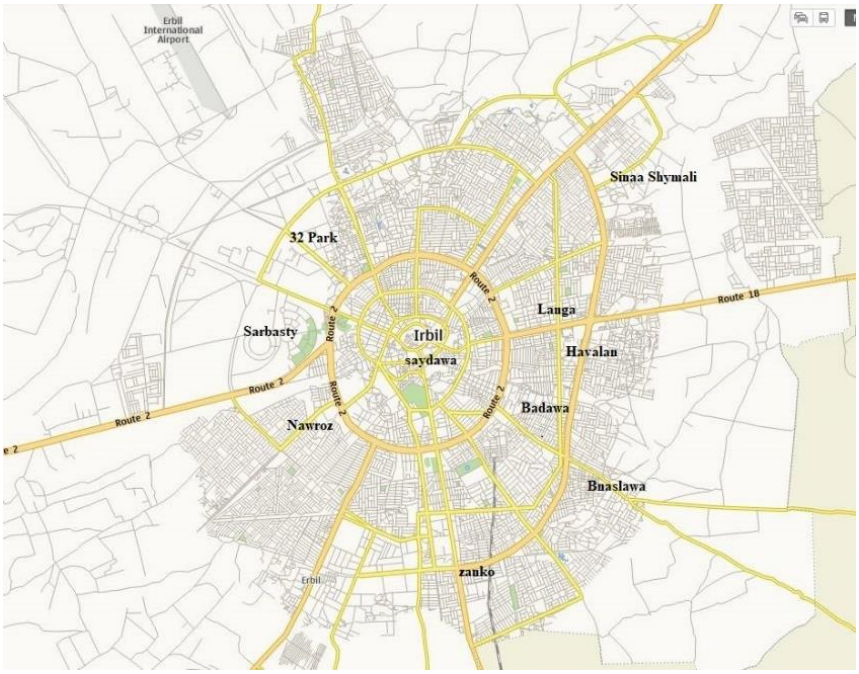
According to the role played by rodents, (rats and mice) in transmitting many parasitic diseases to humans and their pets, and since the rodents in the City of Erbil did not receive a share of interest in studies commensurate with their danger to humans, the aim of the current study came to know the parasitic fauna of *Mus musculus*.

MATERIALS AND METHODS

Mice collection

A total of 50 *Mus musculus* Linnaeus, 1758 live-captured were collected from 10 different popular localities in Erbil City during 2021 to 2022. Trapping of live mice was carried out during the period by using the homemade mouse trap (Pl. 1). Mice were collected from ten popular regions and markets as follows (each has 5 mice) (Map1). Havalan, Saydawa, Banslawa, Badawi, Park 32, Sinaa shymalia, Zanko, Hayaskary (Nawros), Langa, and Sarbasty.

Plate (1): Show homemade mouse trap (23cm. X11cm.) (Photo by T. Kh. Malla).



Map (1): Erbil City map, show the ten places of collecting house mouse. (From: https://www.google.com/search?q=map+of+Erbil+city+iraq)

Dissecting and examination of mice

The living models were brought to the laboratory of advanced parasitology research in the department of biology, college of education, Salahaddin University. The special questionnaire was organized for each mouse, which included the date and place of collection, its sex, and weight. Mice were isolated into two weight groups (<13g and 13 g and over) based on (Brooks *et al*., 1987). Cotton moistened with chloroform was used to anesthetize mice after they were weighed with an electronic scale. A 5ml syringe was used to draw blood from the heart to detect blood parasites. The external parasites are then looked for using a manual magnifying lens. Each mouse was dissected after fixing it using staples in a special dissection dish by making an incision along the ventral side, starting from the back towards the front to show the internal viscera clearly. After that, the liver and digestive tract were examined with the naked eye to detect large parasites, if present. The digestive tract was cut from its two areas connecting the pharynx and the outlet into four parts (esophagus, stomach, small intestine, and large intestine). These parts, as well as the liver, were placed in glass dishes (Petri dishes) containing physiological saline solution (normal saline) at a concentration of 0.85%. Then these parts were carefully opened with small scissors and left for 5-10 minutes to bring down the parasites, if any, to the bottom. The sludge was poured to keep the parasites at the bottom. After removing the internal organs, it became possible to see any parasites that may be present in the body cavity.

Collection and mounting of the parasites

(i) Blood parasites: After making a blood smear (light and thick), it was left to dry in the air, then fixed with absolute methyl alcohol for one minute, then it was dyed with Giemsa stain for one hour, then washed off and left to dry and then examined under the compound Olympus microscope to detect parasites at a magnification of 40X and 100X (Zeibig, 1997).

(ii) Intestinal parasites:

A-Protozoan parasites: After opening the alimentary canal, a number of its contents were taken with wooden sticks and placed on both sides of a clean glass slide. One of them was mixed with a drop of physiological salt solution (normal saline) and the other with a drop of Lugols iodine, then covered each of them with the cover slide and examined under the light microscope with a magnification of 40 &100X (Ichhpujani and Bhatia, 1994).

B- Helminthes: the intestinal sections containing tapeworms were placed in a water bath at 37°C for 15-30 minutes to facilitate the separation of the scolex from the intestine wall. After that, the tapeworms were removed and washed with normal saline and their bodies were then fixed with 10% formalin and dyed with aceto-carmine stain; the nematodes were washed with Normal saline using a dropper to remove suspended matter, then killed using hot ethyl alcohol 70%, then placed in a glass bottle numbered with the sample number containing a mixture of glycerin and alcohol (95% ethyl alcohol 70% with 5% glycerin) to fix them with Using drops of Lactophenol for clarifying the parts during the examination (Sawada *et al*., 1987) relied on Margolis *et al.* (1982), in calculating the percentage and intensity of infection.

Identification of endo and ectoparasites

Endo-parasites: The diagnosis of protozoan parasites is based on Kudo (1966). While the diagnosis of the helminth's parasites (Cestodes and Nematodes) was based on (Yamaguti, 1959; 1961; 1963; Rai *et al*., 1996).

Ectoparasites: The diagnoses of ectoparasites were based on CDC (2003). All photos of present study were taken by a camera of Samsung A31 (48 MP).

Histological examination

Liver and hydatid cysts (Pl. 3), were fixed in 10% formalin embedded in paraffin, cut into 5-µm sections, and stained with hematoxylin-eosin, and images were obtained using light microscopy to evaluate the tissue structure and pathological changes (Zhang *et al*., 2017).

Statistical analysis

The results were statically analyzed using the graph pad prism version (9). We used the chi-square X^2 test to find significant or non-significant differences between sexes, weights, and incidence rates based on Corruccini (1975).

RESULTS

A total number of 50 house mouse *Mus musculus* Linnaeus, 1758 (33 males and 17 females) were examined in the present study from ten different localities (Havalan, Saydawa, Banslawa, Badawi, Park32, Sinaa Shymalia, Zanko, Hayaskary (Nawros), Langa, and Sarbasty) in Erbil City the capital of Kurdistan Iraq. The total of mice examined and the results of parasitic infection were as follow as: 11 (22.0%) ectoparasites, 49 (98.0%) Protozoa, 12 (24.0%) cestodes and 28 (56.0%) nematodes (Tab. 1).

Table (2) shows the relation between two groups with different weights of both sexes of *Mus musculus* and their parasitic groups. Statically analysis of this table showed no significant differences (p-value = 0.3723) found between small and large mice infected with different species of parasites, despite the mice of large weights were high infected than small weights.

Table (3) shows the species of infections as single, double, triple and tetra infections. We found that the high species of infection 25 (50%) was as double infections among the total mice infected, then followed by single species 13 (26%) while the low percentage was 1 (2%) in tetra (4 species infection).

Table (4) is showing the species of helminthic parasite infections among 50 mice examined in Erbil City. In the present study, we found that the nematode *Syphacia obvelata* 18 (36%) was a high percentage of infection, followed by *Trichuris muris* 5 (10%), and *Aspicularis tetraptera*, 4(8%), *Rodentolepis nana* 4 (8%), and hydatid cysts 4 (8%), and the larva *Cysticercus fasciolaris* 3 (6%), and finally, each of *Syphacia muris* and *Hymenolepis diminuta* was 1 (2%). No significant differences were found between both males and females p-value= 0.7932. The recording of hydatid cysts during a survey in 4 of *Mus musculus* infected naturally in Erbil City in this study was the first natural infection in Iraq. In this study, we recorded three species of Ecto-parasites and seven species of protozoa parasites as follows Ectoparasites: Lice *Polyplax spinulose* 8 (16%), flea *Xenopsylla cheopis* 1 (2%) and the mite *Laelaps nuttalli* 2 (4%) and protozoan parasites were *Chilomastix bettencurti* 41 (82%), *Giardia muris* 34 (68%), *Tritrichomonas muris* 18 (36%), *Entamoeba histolytica* 12 (24%), *Entamoeba coli* 16 (32%), *Eimeria* sp. 14 (28%) and blood parasite *Trypanosoma musculi* 1 (2%). No significant differences in infection were found between males and females at a p-value = 0.6649 (Tab. 5).

DISCUSSION

(i) Protozoan parasites: The total of house mouse examined was 49 (98%) of which 7 species were infected with protozoan parasites, 6 of these species were intestinal.

Blood parasite: in the present study we found *Trypanosoma musculi* in one female mouse only, 1(2%) among five mice of Badawa locality. The *Trypanosoma musculi* was recorded for the first time in Iraq in Erbil City by Molan and Hussein (1988) during the examination of 105 *Mus musculus*, they found this parasite in 4 mice, one infection was in females (1.66%) and 3 in males (6.66%). In the present study, we found this blood parasite, one female mouse

with a percentage of 1.2%. Molan and Hussein (1988) mentioned that male of mice was highly infected with *Trypanosome musculi* and this might be due to the effect of sex factor. Andrews and White (1936) showed that the sex of the host has an effect on the rate of infection with this species of *Trypanosoma*. The rate of low infection (2%) that we found in this study was agreed with those previous studies in Iraq, in Baghdad City, the percent infection was 1.4% (Hasson, 2010). *Trypanosome musculi* is the blood parasite of subfamily mammalian host (family Murinae) and this parasite is transmitted by the flea *Xenopsylla cheopis* (Davis, 1952), in the present study we recorded this species of flea in one mouse only. Intestinal protozoa: *Giardia muris*: this species of parasite is belonging to the flagellate's intestinal protozoa parasites, and can infect both house mouse and rats, and other rodents (Smyth, 1962).

Most Protozoa have a direct life cycle and are transmitted through food contaminated with feces, and are host specific, though can have a zoonotic importance. This parasite was first recorded in Iraq, Baghdad City by Senekji (1940), in rats with the rate of infection (2.59%). The disease effect of this parasite on the host is not known, but Oldham (1967) stated that severe infections with this parasite lead to a change in the color of the intestines of the host to yellow. There are some studies conducted on the prevalence of mice protozoa in Iraq. In terms of comparison, our findings showed a high prevalence of *Giardia muris* than that recorded by many previous studies Saleh (1975) in Mosul City with an infection rate (16.1%); AL-Morshidy (2001) in Hilla City, Babylon Province recorded this parasite with an infection rate of 6.9% and Saida (2016a) in Erbil City with rate of infection (11.7%). In the current study, this parasite was recorded with a high infection rate (68%). The direct contact among different rodents plays a major role in the spread of infection with this parasite. Perhaps the difference in the rate of infection recorded in the current study with the rest of the previous studies is due to this reason, noting that Saleh (1975) showed that there was no effect of the seasons on the infection of house mice with this parasite in Mosul City.

Chilomastix bettencourti (da Fonseca 1915): This parasite is infecting both rats and mice (Smyth, 1962). This parasite was recorded for the first time in Iraq by AL-Morshidy (2001) in rats and mice of Hilla City, Babylon Province; he found the active and cystic phase of this parasite in the large intestine of House mice and black rats with rates of infection (11% and 6.3%), respectively. In our study, we recorded this parasite in the large intestine of 41 mice with a rate of infection of 82%. Females (88.2%) were highly infected than males (78.8%), and no significant infections were found between males and females at p-value = 0.6649 (Tab. 5). The reason for the high rate of infection recorded for this parasite in the present study may be due to the presence of rodents in a particular place, with the source of infection. As the transmission of parasites between animals occurs directly through contamination of their food with the cysts of the parasite shed with the feces of infected rodents, all may play a major role in the spread of infection with this parasite.

Tritrichomonas muris (Grassi, 1879): This parasite is one of the most common protozoa detected not only in mice but also in other rodents (Roach *et al*., 1988). The main transmission route of infection of this parasite is by ingestion of pseudo cysts from the feces

of an infected host. *Tritrichomonas muris* was first recorded in the large intestine of rates in Iraq by Senekji (1940), with the rate of infection 19.76%. AL-Morshidy (2001) recorded this parasite in the large intestine of both mice and rats in Hilla City, with an infection rate of (56.8%) in rats, 56.3% for males, and 57.4% for females. As for mice, the infection rate was 42.5%, (males 45.5% and females 38%). In the current study, the infection rate with this parasite was 36%, (30.30% for males and 47.05% for females). It is known that the direct contact between mice and rats plays a major role in the transmission of infection from one animal to another. In addition, this parasite is known to not have a polycystic phase in its life cycle, as the vegetative phase excreted with the feces turns into a non-cystic stage called the quiescent phase (Smyth, 1962).

Entamoeba histolytica (Schaudinn, 1903): This species is a significant cause of human parasitic morbidity and mortality worldwide in addition to malaria and schistosomiasis. This is one of the human parasites with a worldwide spread. It causes amoebic dysentery and can infect mice and rats as well (Zeibig, 1997). Senekji (1940) recorded this parasite for the first time in Iraq from rats of Baghdad City with an infection rate of 0.59%; Jawdat and Al-Jafary (1980) registered this parasite in rats and mice from different regions in Iraq with infection rates of 4.7% and 12.3%, respectively. AL-Morshidy (2001) recorded this parasite in the small intestine of both black rats and house mice, with an infection rate of 8.1% (9.4% for males and 6.4% for females), while the infection rate in mice was 19.2% (20.5% males) and (17.2% females).

In the current study, we recorded this parasite in 12 mice out of 50 mice examined (7 males 21.21%) and 5 females 29.41%) with a percentage of 24%. The difference in the rates of infection recorded with this parasite in different studies is due to several different factors that lead to an increase in the spread of this parasite in the environment, including eating food and water contaminated with mature cysts of the parasite which is responsible for infection with the parasite (Zeibig, 1997). Other factors lead to an increase in the spread of infection with this parasite, including direct contact between rodents, as well as the presence of vector insects such as flies, ants, and fleas, and providing suitable conditions (Kudo, 1966). This parasite infects humans in different parts of the world, causing amoebic dysentery in the intestines, and in untreated cases, the disease will spread to the liver, lungs, and even the brain, causing amoebic abscesses there. Epidemiological studies on the prevalence of parasitic intestinal infections in different areas have usually aimed to identify communities at risk and diseases that pose risks to human populations, making it necessary to study infections that threaten human health throughout the world (Saida, 2016b). Recently Flaih *et al*. (2021), showed during an Epidemiological study of 341,554 patients admitted to the laboratory of the parasite in hospitals of Thi-Qar Province, Iraq, 38,004 (11.1%) of which were recorded as having amoebiasis. This result accounted for the highest proportion of infections in 2015 (26.1%) and the lowest in 2020 (8.1%). Several previous studies about intestinal human parasites were recorded in Erbil City. Hamad and Ramzy (2012); Saida (2016b) and Obiead *et al.* (2020) mentioned the rate of infection with *E. histolytica* as follows and respectively: 51.2%; 61.2% and 22.47%. While Saida and Nooraldeen (2014) found that out of 72 samples examined, (20.4%) of which were contaminated with cysts of *E.histolytica*. Recently Nayyef

et al. (2022) found that (15.89%) of the patient admitted to the Al-Furat general hospital in Baghdad City was infected with *E. histolytica*.

Entamoeba coli (Grassi, 1879): This species is a non-pathogenic species of the genus *Entamoeba* that frequently exists as a commensal parasite in the human gastrointestinal tract and does not cause harm to the host. The mature cyst is the infective stage, and is known to survive longer than those of *E. histolytica*. The cyst is hard due to its strong cell wall and can survive up to weeks outside the host's body after desiccation (Haidar and De Jesus, 2021). These commensal protozoa parasite was first recorded in Iraq by Senekji (1940) in rates with percentage (0.88%), and Jawdat and Al-Jafary (1980) recorded this parasite in rats (19.7%) and mice (52.1%) in many different parts of Iraq. In the present study, the rate of infection among 50 mice examined were 16 (32.0), 9 (27.3%) were in males while in females were7 (41.2%).

Eimeria spp.: Coccidia is one of the protozoan parasites from the Apicomplexa phylum and pathogenic species to animals or humans. One of them, genus *Eimeria* is a monoxenous coccidian, primarily infecting a single host in their life cycle (Girard *et al*., 2016). *Eimeria* is also known as obligate intracellular parasites that have significant roles in medical or veterinary importance (Wiedmer *et al*., 2020). Species of the genus *Eimeria* destroy the epithelial cells lining the intestines and also lead to inflammation, bleeding, and bloody diarrhea in case of severe infections (Oldham, 1967). According to Kudo (1966) and Oldham (1967) there are 6 species of genus: *Eimeria* that infect mice (genus: *Mus*), which are: *E. falciformis* (most common distributions), *E. mus*, *E. schuffineri*, *E. kelini*, *E. hindlei* and *E. krijgsma*. Mirza and AL-Rawas (1975) recorded this genus as represented by a new record species for the first time in Iraq, *Eimeria paterae*, by examining eight samples of *Tatera indica* in Baghdad City with an infection rate of 50%. AL-Morshidy (2001) also recorded oocysts belonging to this genus in the large intestine of black rats with an infection rate of 4.5%, and in the large intestine of house mice with a rate of 27.4%. In the current study, the infection rate of this parasite was 14 (28.0%) 33 males (18.2%), and 17 females (47.0%). Infection with this parasite occurs through mature oocysts that need appropriate environmental factors to mature including temperature and humidity and become a container of sporozoites, and when the food of the rodent is contaminated with the mature oocysts of this parasite, the infection occurs.

(ii) Helminthes Parasites: (Cestodes)

Rodentolepis nana (von Siebold, 1852) (synonym: *Hymenolepis nana* (von Siebold, 1852): The dwarf tapeworm infects humans and species of rodents such as rats and mice as its final hosts (Zeibig, 1997). This worm was recorded for the first time in Iraq by Mahmoud (1974) in black rats and house mice in Baghdad City with infection rates of 3.3% and 6.1%, respectively. It was also recorded by Molan and Hussein (1988) in Erbil City; they found this parasite in (6.66%) of house mouse was infected. AL-Morshidy (2001) recorded this species of parasite in the small intestine of black rat and house mice with an infection rate of 8.1% and 8.2%, respectively.

Recently Majeed and Al-Amery (2021) recorded two species of *Hymenolipis* in house mice in Baghdad Province, and they revealed that the house mice were infected with *Rodentolepis nana* 4 (8%) and *Hymenolepis diminuta* 7 (14%). A previous study in the same area Saida (2016a) recorded *Rodentolepis nana* in 8 mice (23.5%), and he recorded this parasite in 1.2% of patients admitted to the hospitals of Erbil City. Saida and Nooraldeen (2014) found the eggs of *Rodentolepis nana* (=*Hymenolepis nana*) during the examination of leafy vegetables of Erbil City with a percentage of contamination of (10.2%). In our study, we recorded this parasite in 4 mice (8.0%). 2 of which were females (11.7%) and males (6.0%), with the severity of infection was (4.75%). No significant differences in infection were found between males and females (Tab. 4). The life cycle of the dwarf tapeworm includes either directly, that is, it does not need an intermediate host to complete its life cycle (direct life cycle) or indirectly (presence of intermediate host), as fleas of the species *Pulex irritans*, *Xenopsylla cheopis*, *Ctenocephalides canis* and grain beetles of the two species *Tenebrio moli* and *Tenebrio obscurus* are duos as intermediate hosts of this worm (Oldham, 1967). Therefore, the presence of such insects in the host's environment plays an important role in increasing the spread of this parasite, especially when rodents feed on them in cases of food shortage. It is worth noting that all of these insects mentioned above are registered in Iraq and are present throughout the year (Abu-Alhabib, 1979).

Hymenolips diminuta (Rudolphi, 1819): This species is one of the most widespread a parasitic worm in the world and it infects species of rodents, especially rats and mice (Ichhpujani and Bhatia, 1994). This worm was first recorded in Iraq by Senekji (1940), with an infection rate of 18.84%, and also recorded by Jawdat and Al-Jafary (1980) in mice (4.2%) from different regions of Iraq. AL-Morshidy (2001) found this parasite in mice (6.9%) of Hilla City, Babylon Province; also, Saida (2016a) recorded it in mice of (8.8%) in Erbil City. In the current study, the rate of infection with *H. diminuta* in mice was (2.0%). The life cycle of rat tapeworm needs an intermediate host to complete its life cycle, such as species of fleas and larvae of species of beetles (Oldham, 1967). Humans, especially children, become infected with this worm as a result of eating intermediate hosts and they infect with the larvae of this worm accidentally. But in general, infection with this worm does not cause disease symptoms in the adult human being, but in some cases, severe infection may cause moderate diarrhea (Ichhpujani and Bhatia, 1994), and in children, the infections lead to more severe symptoms (Tena *et al*., 1998).

Cystic echinococcosis: *Echinococcus granulosus* (Batsch, 1786). The definitive hosts of this parasite are wild and domestic canids. Natural intermediate hosts depend on genotype. Intermediate hosts for zoonotic species/genotypes are usually ungulates, including sheep, goats, cattle, and camels. Hydatidosis or echinococcosis unilocular is common in many Arab countries, especially in Iraq. In our survey study and among 50 house mouse *Mus musculus* we detected 4 cystic stages as cystic echinococcosis in 4 mice (2 males 6.06% and 2 females 11.76%) with a rate of infections of (8.0%). The discovery of natural infection of domestic mice with hydatid cysts in the liver of these mice is a rare case of infection with hydatidosis as naturally infection in rodents, and its recording as a new naturally infection of hydatidosis in *M. muluscus* in Erbil City and Iraq; was found in the Havalan locality of Erbil City. Plate

(2) as a picture of cystic hydatidosis and Plate (3) as picture of histopathological study, cross section of the cyst. No previous studies have been recorded as naturally infection with cystic echinococcosis in house mouse during all previous survey studies of rodents were performed in Iraq. Finding hydatid cysts in domestic mice *Mus musculus* is a rare case of infection; this rare case of infection gives us an addition for the extent of contamination of this area with the eggs of the parasite *E. granulosus* in Erbil City, especially the Havalan Region, which was found during a survey study. This indicates and confirms the infection of cats and dogs that some residents of the region raised in homes without taking health measures and procedures for hosting dogs and cats, which made them vulnerable to infection with the worm *E. granulosus*, which acts as the final host, and rodents as intermediate hosts of the worm.

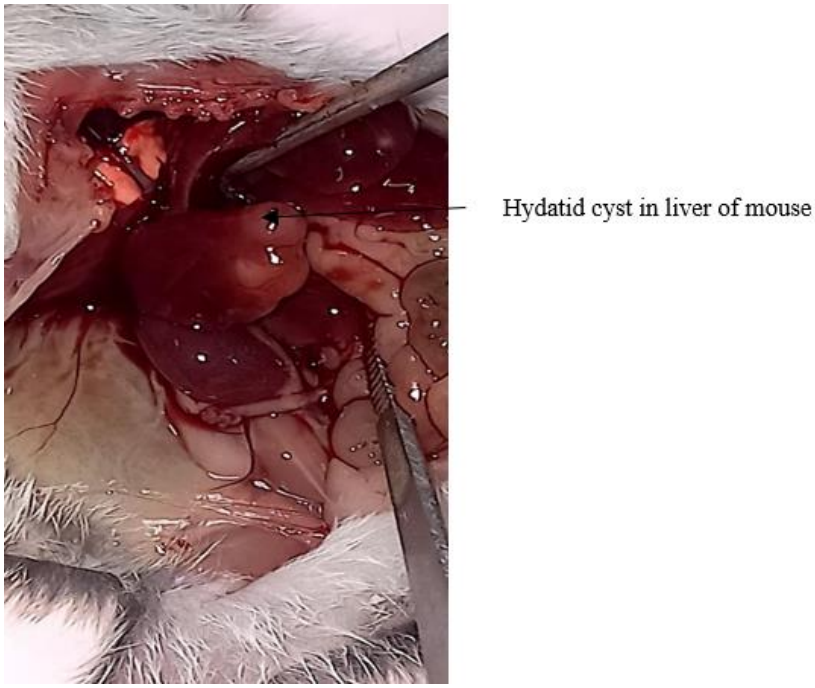


Plate (2): Liver of house mouse infected naturally with the larval stage of *E. granulosus* (hydatid cyst) as the first natural infection in Iraq (Photo by T. Kh. Malla).

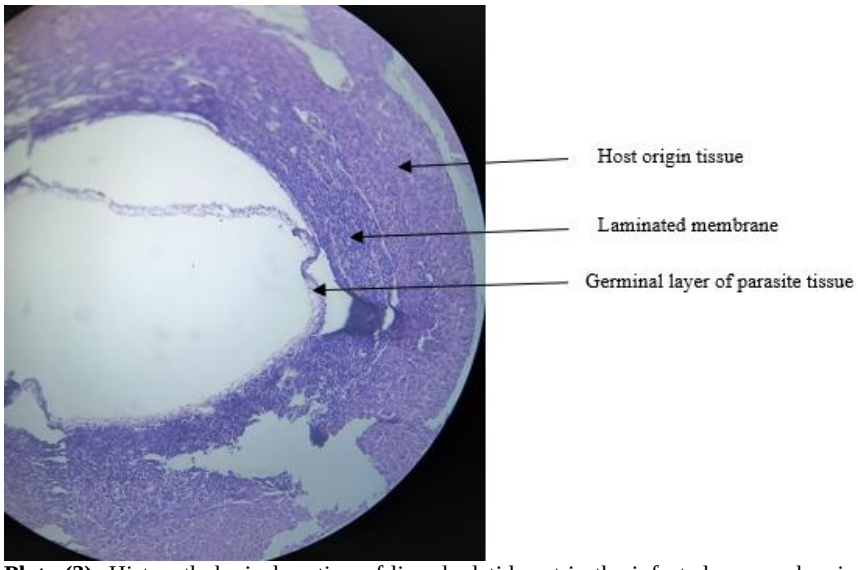


Plate (3): Histopathological section of liver hydatid cyst in the infected mouse showing germinal layer and laminated membrane (40x) (Photo by T. Kh. Malla).

Cysticercus fasciolaris (Rudolphi, 1808): This worm is the larval stage of the tapeworm *Hydatigera taeniaeformis*, which is found in the small intestine of cats, dogs, and the rest of the predator's carnivores (Sharma, 2017). The liver is where it grows into a larval worm, (Oldham, 1967). The larval stage of this worm was recorded for the first time in Iraq by Mahmoud (1974) in the house mouse with an infection rate of 12.2% and the black rat with a rate of 2.2% in Baghdad City. Saleh (1975) recorded it in the house mouse of Mosul City with an infection rate of 8.2%. While Molan *et al.* (1988) recorded these larva stage in house mice of Erbil City with an infection rate of 8.57%. Al-Zahidy (2001) recorded this larva in the house mice of Baghdad City with an infection rate of 14.4% and in Norwegian rats with a rate of 10.3%. AL-Morshidy (2001) recorded this larva in the liver of house mouse of Hilla City, with an infection rate of 16.4%.

In the current study, we recorded this larval cyst in liver of three mice (6.0%) one cyst per mouse. Cats are natural enemies of rodents, especially house mice and both cats and mice prefer to live in dwellings more than other animals (Meehan, 1984). Therefore, the possibility of infecting house mice with this larval stage is very likely due to the contamination of their food with the feces of infected cats.

(iii) Nemathelminthes: Roundworm of mice

Syphacia obvelata, *Syphacia muris*, *Aspicularis tetraptera* and *Trichuris muris*

The nematode *Syphacia obvelata* is one of the common worms that infect rats and mice. It is generally unsatisfactory, but it becomes pathogenic in severe cases, especially those infections that are accompanied by impairment in the function of the intestine, and the most important symptom in this case is rectal prolapse (Oldham, 1967). This round worm was

recorded by Kassai (1972) in Baghdad mice for the first time in Iraq. He recorded five species of intestinal nematodes on of them was *Syphacia obvelata*. The second record was in Mosul, by Saleh (1975), with the rate of infection (41.1%). while in Erbil City Molan *et al*. (1988) they found this worm in mice with a rate of infection (17.1%); and Saida, (2016a) detected this worm in the large intestine of mice (11.7%) in the same area. While AL-Morshidy (2001) found this worm in mice of Hilla City, Babylon, Iraq with an infection rate of (11.1%). In our present study, we found this worm in the large intestine in 18 (36.0%). The life cycle of this worm is direct, and infection occurs among the hosts in three ways: 1- Through contamination of food and water with the feces of the infected animal. 2- Or through the migration of larvae when eggs hatch from the outlet area of the infected animal to the colon. 3- Or through the transfer of eggs directly from one animal to another through the animal licking the back of the affected animal (Oldham, 1967) so it is necessary to provide an equal of these factors with the circumstances, the appropriate environment may play a role in the spread of infection.

Syphacia muris (Yamaguti, 1935): This species was first time recorded in Iraq by Mahmoud (1974) during the examination of three species of a mouse family in Baghdad City with the rate of infection (35.7%). This worm was not found in the previous studies conducted in Erbil City before Molan *et al*. (1988) and Saida (2016a). Also, this worm was not found by AL-Morshidy (2001) in Hilla City. While Al-Zahidy (2001) recorded the black rat with a percentage of infection of (8.3%). The present study recorded this worm in one male mouse *M. musculus* only with the percentage of infection (2%). We recorded *Syphacia muris* for the first-time in-house mice of Erbil City Kurdistan Iraq.

Aspiculuris tetraptera (Nitzsch, 1821): *A. tetraptera* is a non-pathogenic roundworm that infects both rats and mice (Oldham, 1967). This worm was first recorded in Iraq from wild rodents in Baghdad City by Mahmoud (1974) with an infection rate was 31.4% in the black rats and 32.6% in the house mouse. In Erbil City, this parasite was recorded by Molan *et al*. (1988) with an infection rate of (19%) in mice and 28.5% in rats; while Saida (2016a) recorded it in 11.7% of mice in the same area. In the present study, we found this worm with an infection rate of 4 (8%) three of which were in males (9.09%).

Trichuris muris (Schrank, 1788): The mouse whipworm *Trichuris muris* can infect many species of rodents (Smyth, 1962). This parasite was first recorded in Iraq by Senekji (1940) in an undiagnosed rat of Baghdad City with an infection rate of (1.18%). It was also recorded by Mahmoud (1974) in house mice of Mosul City, with an infection rate of 18.3%, also this worm was recorded by Saleh (1975), in house mice with a rate of infection (6.3%). In Erbil City northern of Iraq, this worm was recorded by Molan *et al*. (1988) with a rate of (7.6%). While AL-Morshidy (2001) found this worm in mice of Hilla City, Babylon Province in the large intestine, with an infection rate of (24.7%). While in the current study we recorded this worm in the large intestine of mice with a rate of infection of 5 (10%), 4 of which were males (12.1%). Whipworm eggs need moist and hot environmental conditions for embryo formation. Therefore, such environmental conditions play an important role in completing the life cycle of this worm and the spread of infection among hosts (Smyth, 1962). No significant

differences in infections were found between males and females of mice at p-value = 0.793 (Tab. 4).

(iv)Ecto- parasite:

In the present study, three species of ectoparasites belonging to three different genera were diagnosed (Pl. 4): as follows: The louse *Polyplax spinulose* was found in 8 mice with an infestation rate of 16.0%. The flea *Xenopsylla cheopis* was recorded in one male with an infection rate of 2%. And mite *Laelaps nuttall* was recorded, with an infection rate of 4%. These ecto-parasites were previously recorded in rodents of Iraq by Abu-Alhabib (1979).

The current study revealed that domestic mice were infected with these ectoparasites mentioned above, which may transmit and infect humans and cause serious parasitic diseases. Previous studies conducted on rodents in Erbil City did not talk about ectoparasites in mice and rats. As the study of Molan *et al*. (1988), and Saida (2016a). Our current study matches what Kadhim *et al*. (2000) mentioned ectoparasites in their study in Baghdad province; they found three species of ectoparasites in the house mice. Mites *Laelaps nuttlli* with an index of 0.3; flea *Xenopsylla cheopis* with an index of 0.3, and louse *Polyplax spinulosa* with an index of 0.08.

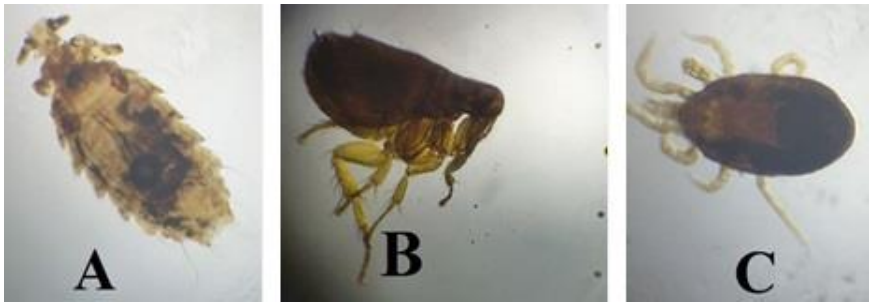


Plate (4): (A) Louse *Polyplax spinulosa* (10X), (B) Flea *Xenopsylla cheopis* (10X), (C) Mite *Laelaps nuttalli* (10X) [Photo by T. Kh. Malla].

Table (1): Shows the percentage of infections with ecto and endo-parasites of *Mus musculus* detected in different localities of Erbil.

Localities of The Study	No. of *M. musculus* infected with ectoparasite	No. of *M.musculus* infected with protozoa	No of *M. musculus* infected with cestodes	No of *M. musculus* infected with Nematodes
Havalan	1 (20%)	5 (100%)	2 (40%)	4 (80%)
Saydawa	3 (60%)	4 (80 %)	2 (40%)	3 (60%)
Banslawa	1 (20%)	5 (100%)	1 (20%)	2 (40%)
Badawa	1 (20%)	5 (100%)	2 (40%)	1 (0.0%)
Park32	2 (40%)	5 (100%)	1 (20%)	3 (60%)
Sinaa shymalia	2 (40%)	5 (100%)	0 (0.0%)	3 (60%)

Zanko	0 (0.0%)	5 (100%)	2 (40%)	2 (40%)
Hyaskary (Nawros)	0 (0.0%)	5 (100%)	0 (0.0%)	4 (80%)
Langa	0 (0.0%)	5 (100%)	2 (40%)	4 (80%)
Sarbasty	1 (20%)	5 (100%)	0 (0.0%)	2 (0%)
Total	11 (22.0%)	49 (98.0%)	12 (24.0%)	28 (56.0%)
			Helminthes= 40 (80.0%)	

Table (2): The relation between two groups with different weights of both sexes of *Mus musculus* and their parasitic groups.

Parasitic group	No. of parasites of *M. musculus* (weight ≤13gms)		No. of parasites of *M. musculus* (weight ≥13gms		Total (%)
Nematodes	Male	Female	Male	Female	
	1	1	19	7	28 (56.0)
Cestodes	5	1	3	3	12 (24.0)
Intestinal Protozoa	9	4	24	13	50 (100.0)
Blood parasites	0	0	0	1	1 (2.0)
Ectoparasites	4	1	4	2	11 (22.0)
N = 50 Male = 33 17=Female	9	4	24	13	50 (100.0)
	13 (26%)		37 (74%)		

Statically analysis result: *No significance different at p-value = 0.3723

Table (3): Shows single, double, triple & tetra infections of for both sexes of *Mus musculus* in the present study.

Parasite species	*Male (%)	*Female (%)	Total (%)
Single	7 (53.84)	6 (46.15)	13 (26.0)
Double	18 (72.00)	7 (28.00)	25 (50.0)
Triple	8 (72.27)	3 (27.27)	11 (22.0)
Tetra	-	1 (100.0)	1 (2.0)
Total of mice Examined	33(66.0)	17 (34.0)	50 (100.0)

*Statically analysis result: *No significance different between males &females at p-value = 0.3313.

Table (4): Shows the species of Helminthes parasites detected in both sex of *Mus musculus* in the present study.

Species of helminthes parasites	*Male (%)	*Female (%)	Both sex (%)	No. of parasites	Mean no. of parasite infected
Aspicularis tetraptera	3 (9.09)	1 (5.88)	4 (8.00)	33	8.25
Syphacia obvelata	12 (36.36)	6 (35.29)	18 (36.00)	327	18.16
Syphacia muris	1 (3.03)	0 (0.0)	1 (2.00)	218	218
Trichuris muris	4 (12.12)	1 (5.88)	5 (10.00)	66	13.2
Rodentoleois nana	2 (6.06)	2 (11.76)	4 (8.00)	19	4.75
Hymenolepis diminuta	0 (0.0)	1 (5.88)	1 (2.00)	15	15
Hydatid cysts	2 (6.06)	2 (11.76)	4 (8.00)	4 cysts	4 cysts
Cysticercus fasciolaris	2 (6.06)	1 (5.88)	3 (6.00)	3 cysts	3 cysts
No. of male= 33 No. of female = 17 Total =50	26 (78.78)	14 (82.35)	40 (80.00)	-	-

Statically analysis result: *No significance different between males and females at p-value =0.7932

Table (5): Shows the prevalence of protozoa and Ecto-parasites of *Mus musculus*, in the present study.

Species of parasites detected	No. of *Male infected (%)	No. of *female infected (%)	Both sexes infected (%)
Chilomastix bettencurti	26 (78.8)	15 (88.23)	41 (82.0)
Giardia muris	24 (72.7)	10 (58.8%)	34 (68.0)
Tritrichomonas muris	10 (30.3)	8 (47.05)	18 (36.0)
E. histolytica	7 (21.2)	5 (29.4)	12 (24.0)
Entameba coli	9 (27.3)	7 (41.2)	16 (32.0)
Eimeria sp.	6 (18.2)	8 (47.0)	14 (28.0)
Trypanosoma musculi	-	1 (5.9)	1 (2.0)
Lice: *polyplex spinulos*	6 (18.2)	2 (11.8)	8 (16.0)
Flea *Xenopsylla cheopis*	1 (3.0)	-	1 (2.0)
Mite *Laelaps nuttalli*	1 (3.0)	1 (5.8%)	2 (4.0)
Exam number	Male=33	Female=17	Total = 50

Statically analysis result: *No significance different of infection was found between males and females at p value =0.6649.

CONCLUSIONS

In the current study, we recorded infection of *M. musculus* with the larval stage of *Echinococcus granulosus* (hydatid cyst) as the first natural infection in Iraq. We did not find significant differences between mice with large and small weights. Most infections among mice were with the same double infection (the presence of two species of parasites) by 50%. And the lowest was in the quadruple infection (infection with four species) 2%. We did not find significant differences between mice with large and small weights. The highest infection rate of nematodes was *S. obvelata* 36%, and the lowest was *S. muris* 2%. The highest percentage of tapeworms was *Rodentolepis nana* and the larval stage of *E. granulosus* (cystic hydatid) each was 8%, and *H. diminuta* was the lowest (2%). The highest infection severity of recorded parasites was with the nematode *S. muris*, with 218 parasites, and the lowest was by the larval parasite *C. fascioliasis*, with three cysts. The highest infection rate recorded was with intestinal parasites *Chilomastix bettencourti* at 82% and the lowest was with *E. histolytica* at 24%.

AKNOWLEDGMENTS

At the end of writing this paper, I am pleased to extend my thanks and appreciation to everyone who contributed to the success of this research, especially the Assist Professor of Entomology in the Department of Biology at the College of Education, Salah El-Din University, Dr. Wand Khalis Ali for identifying the insects isolated from the infected mice.

CONFLICT OF INTERESTSTATEMENT

"The authors have no conflicts of interest to declare".

LITERATURE CITED

Abu-Alhabib, J. K. 1979. Medical and veterinary insects in Iraq: Theoretical Section. University of Baghdad Press, 451 pp.

AL-Morshidy, K. A. 2001. Parasitic infections in the black rats (*Rattus rattus*) and the house mice (*Mus musculus*) in Hilla City. Thesis, Biology (Zoology) Department, College of Science, University of Babylon, 98 pp.

AL-Zahidy, S. F. 2001. Distribution of infection of the house mice (*Mus musculus*), black rat (*Rattus rattus*) and Norway rats (*Rattus norvegicus*) with helminths and external parasites in Baghdad City. Thesis, Biology (Zoology) Department, College of Education (Ibn Al-Haitham), University of Baghdad, 96pp.

Andrews, J. and White, H. F. 1936. An Epidemiological study of protozoa parasitic in wild rats in baltimore, with special reference to *Endamoeba histolytica*. *American Journal of Hygiene*, 24 (1):184-206. [CrossRef]

Brooks, J. E., Rowe, F. P. and World Health Organization. 1987. Division of vector biology and control. Rodents: training and information guide. World Health Organization, p. 1-107. [Click here]

CDC (Communicable Disease Center). 2003. Pictorial keys to arthropods, reptiles, birds, and mammals of public health significance. Department of Health and Human Services, Centers for Disease Control and Prefention, Atlanta, Georgia, p. 1-92.

Chomel, B. B., Belotto, A. and Meslin, F. X. 2007. Wildlife, exotic pets, and emerging zoonoses. *Emerging Infectious Diseases*, 13 (1): 6-11. [Click here]

Cleaveland, S., Laurenson, M. K. and Taylor, L. H. 2001. Diseases of humans and their domestic mammals: pathogen characteristics, host range and the risk of emergence. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 356 (1411): 991-999. [Researchgate]

Corruccini, R. S. 1975. Multivariate analysis in biological anthropology: some considerations. *Journal of Human Evolution*, 4 (1):1-19.

Daszak, P., Cunningham, A. A. and Hyatt, A. D. 2000. Emerging infectious diseases of wildlife--threats to biodiversity and human health. *Science*, 287 (5452): 443-449. [CrossRef]

Davis, B. S. 1952. Studies on the trypanosomes of some California mammals. University of California Press, 57 (3): 145-250.

Flaih, M. H., Khazaal, R. M., Kadhim, M. K., Hussein, K. R. and Alhamadani, F. A. B. 2021. The epidemiology of amoebiasis in Thi-Qar Province, Iraq (2015-2020): differentiation of *Entamoeba histolytica* and *Entamoeba dispar* using nested and real-time polymerase chain reaction. *Epidemiology and Health*, 43: e2021034. [CrossRef]

Girard, Y. A., Johnson, C. K., Fritz, H. M., Shapiro, K., Packham, A. E., Melli, A. C., Carlson-Bremer, D., Gulland, F. M., Rejmanek, D. and Conrad, P. A. 2016. Detection and characterization of diverse coccidian protozoa shed by California sea lions. *International Journal for Parasitology: Parasites and Wildlife*, 5 (1):5-16. [CrossRef]

Hamad, N. R. and Ramzy, I. A. 2012. Epidemiology of *Entamoeba histolytica* among children in Erbil province, Kurdistan Region-Iraq. *Journal of Research in Biology*, 1: 57-62.

Han, B. A., Schmidt, J. P., Bowden, S. E. and Drake, J. M. 2015. Rodent reservoirs of future zoonotic diseases. *Proceedings of the National Academy of Sciences*, 112 (22): 7039-7044. [CrossRef]

Hassell, J. M., Begon, M., Ward, M. J. and Fèvre, E. M. 2017. Urbanization and disease emergence: dynamics at the wildlife–livestock–human interface. *Trends in Ecology and Evolution*, 32 (1): 55-67. [CrossRef]

Hasson, R. H. 2010. Zoonotic and Nonzoonotic endoparasites of rodents from some districts in Baghdad. *Diyala Journal for Pure Science*, 6 (3):102-112.

Haidar, A. and De Jesus, O. 2021. *Entamoeba coli*. *In*: StatPearls [Internet]. StatPearls Publishing. PMID: 33232082. [Click here]

Ichhpujani, R. L. and Bhatia, R. 1994. Medical parasitology. Jaypeen Bros., Med., Publ., New Delhi, 384 pp.

Ingram, W. M., Goodrich, L. M., Robey, E. A. and Eisen, M. B. 2013. Mice infected with low-virulence strains of *Toxoplasma gondii* lose their innate aversion to cat urine, even after extensive parasite clearance, *PLoS One* 8 (9): e75246. [CrossRef]

Jawdat, S. Z. and Al-Jafary, A. R. 1980. A survey and studies on some protozoa found in the gut of some rodents in Iraq. *Bulletin of the Biological Research Centre*, 12 (1):71-86.

Kadhim, A. H., Kasal, S. M. and Hassan, H. M. 2000. Prevalence of infestation, population density and ectoparasites of *Mus musculus*, *Rattus rattus* and *Rattus norvegicus* (Muridae: Rodentia) in Baghdad area. *Diyala Jornal of Medicine*, 1 (8): 50-56.

Kassai, T. 1972. Guide to the recognition and treatment of the main helminth parasites of the laboratory animals. Near East Anim. Health Inst., Baghdad, 7 pp.

Kudo, R. R. 1966. Protozoology. 5th edition, Charles C. Thomas Publ., Springfield IL, 1174 pp.

Mahmoud, S. N. 1974. Incidence and distribution of helminth parasites of the digestive tract of rats and mice of the family Muridae in Baghdad area, M. Sc. Thesis, Department of Biology, College of Science, University of Baghdad, 153 pp.

Majeed, S. A. and Al-Amery, A. M. 2021. Prevalence of *Hymenolepis* spp. in house mice in Baghdad City, Iraq. *The Iraqi Journal of Veterinary Medicine*, 45 (2): 21-25. [CrossRef]

Margolis, L., Esch, G. W., Holmes, J. C., Kuris, A. M. and Schad, G. 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). *The Journal of Parasitology*, 68 (1):131-133.

Meehan, A. P. 1984. Rats and mice. Their biology and control. Rentokil Ltd. Sussex, 383 pp.

Mirza, M. Y. and AL Rawas, A. Y. 1975. *Eimeria taterae* sp. n. and other intestinal parasites from the antelope rat, *Tatera indica* in Baghdad District. *The Journal of Protozoology*, 22 (1): 23-24. [Crossref]

Molan, A. L. and Hussein, M. M. 1988. A general survey of blood and tissue parasites of some rodents in Arbil province, Iraq. *APMIS*, Suppl. 3: 47-49.

Molan, A. L., Hussein, M. M. and Jasin, B. A. 1988. A general survey of intestinal helminths of some rodents in Arbil area. *Iraqi Journal of Agricultural Sciences*, 6 (2):69-79.

Nayyef, H. J., Abo-Alhur, F. J., Mohammed, S. W., Taqi, E. A. and Kahdim, S. S. 2022, January. Prevalence of *Entamoeba histolytica* among enteric infection in Al-Furat general hospital in Baghdad/Iraq. *AIP Conference Proceedings*, 2386 (1): 020011. [CrossRef]

Oldham, J. 1967. Helminths, ectoparasites, and protozoa in rats and mice. *In*: Cotchin, E. and Roe, F. J. C (Eds.) Pathology of laboratory rats and mice. Blackwell Sci. Publ., Oxford, p. 641-679

Rabiee, M. H., Mahmoudi, A., Siahsarvie, R., Kryštufek, B. and Mostafavi, E. 2018. Rodent-borne diseases and their public health importance in Iran. *PLoS Neglected Tropical Diseases*, 12 (4): p.e0006256. [CrossRef]

Rahman, M., Sobur, M., Islam, M., Ievy, S., Hossain, M., El Zowalaty, M. E., Rahman, A. M. M. and Ashour, H. M. 2020. Zoonotic diseases: etiology, impact, and control. *Microorganisms*, 8 (9):1405. [CrossRef]

Rai, S. K., Uga, S., Kataoka, N. and Matsumura, T. 1996. Atlas of Medical Parasitology, Kobe University School of Medicine Kobe, Japan, p.78. [Click here]

Roach, P. D., Wallis, P. M. and Olson, M. E. 1988. The use of metronidazole, tinidazole and dimetridazole in eliminating trichomonads from laboratory mice. *Laboratory Animals*, 22 (4): 361-364. [CrossRef]

Saida, L. A. 2016a. Prevalence of Intestinal Parasites in Houses Mice (*Mus musculus*) among Different Localities of Erbil City, Kurdistan *Journal of Zankoy Sulaimani*, 18 (4): 37-42. [CrossRef]

Saida, L. A. 2016b. Epidemiological study of intestinal parasites among population of Erbil City, Kurdistan. Iraq. *Journal of Raparin University*, 3 (9):75-86.

Saida, L. A. and Nooraldeen, K.N. 2014. Prevalence of parasitic stages in six leafy vegetables in markets of Erbil City, Kurdistan region-Iraq. *Zanco Journal of Pure and Applied Sciences*, 26 (2): 25-30.

Saleh, W. A. 1975. Studies on the protozoan and helminth parasites of some rodents in Mosul district Iraq. M.Sc. Thesis, Biology Department, College of Science, University of Mosul, 146 pp.

Sawada, I., Molan, A. L. and Saeed, I. S. 1987. A Survey on Avian Cestodes from Iraq with. *Japanese Journal of Parasitology*, 36 (6):417- 423.

Senekji, H. A. 1940. Bacteriological and parasitological survey of rats in Iraq. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 33 (6):655-657. [CrossRef]

Sharma, R., Tiwari, K., Birmingham, K., Armstrong, E., Montanez, A., Guy, R., Sepulveda, Y., Mapp-Alexander, V. and De Allie, C. 2017. *Cysticercus fasciolaris* in brown rats (*Rattus norvegicus*) in Grenada, West Indies. *Journal of Parasitology Research*, 2017: 1723406. [CrossRef]

Smyth, J. D. 1962. Introduction to Animal Parasitology, Engl. Univ. Press London, 470 pp.

Tena, D., Simón, M. P., Gimeno, C., Pomata, M. T. P., Illescas, S., Amondarain, I., González, A., Domínguez, J. and Bisquert, J. 1998. Human infection with *Hymenolepis diminuta*: case report from Spain. *Journal of Clinical Microbiology*, 36 (8): 2375-2376. [CrossRef]

Thompson, A. and Kutz, S. 2019. Introduction to the Special Issue on 'Emerging Zoonoses and Wildlife'. *International Journal for Parasitology: Parasites and Wildlife*, 9: 322. [CrossRef]

WHO (World Health Organization). 2000. WHO report on global surveillance of epidemic-prone infectious diseases (No. WHO/CDS/CSR/ISR/2000.1). World Health Organization, 25 pp. [Click here]

WHO, World Health Organization, 2020. Zoonotic disease: emerging public health threats in the Region, 85 pp. [Click here]

Wiedmer, S., Kurth, T., Buder, U., Bleischwitz, S., Entzeroth, R. and Kurth, M. 2020. Correlative light and electron microscopy of wall formation in *Eimeria nieschulzi*. *Parasitology Research*, 119(8):2667-2678. [CrossRef]

Yamaguti, S. 1959. Systema helminthum. Vol. H. The Cestodes of Vertebrates. Publ., New York, 860 pp.

Yamaguti, S. 1961. Systema helminthum. Volume III. The nematodes of vertebrates, Part I+II . Intersci. Pybl., New York, 1261 pp.

Yamaguti, S. 1963. Systema helminthum. Vol. V. Acanthocephala. Intersci. Pybl., New York, 423 pp.

Zeibig, E. A. 1997. Clinical parasitology: A practical approach, W. B. Saunders Co., Philadelphia, 320 pp. [Click here]

Zhang, R. Q., Chen, X. H. and Wen, H. 2017. Improved experimental model of hepatic cystic hydatid disease resembling natural infection route with stable growing dynamics and immune reaction. *World Journal of Gastroenterology*, 23(45): 7989-7999. [CrossRef]

BULLETIN OF THE IRAQ NATURAL HISTORY MUSEUM

Malla and Saida

Bull. Iraq nat. Hist. Mus.
(2022) 17 (2): 267-290.

دراسة مسحية للطفيليات الخارجية والداخلية للفأر المنزلي *Mus musculus* Linnaeus, 1758 في مدينة أربيل ، إقليم كردستان ، العراق

تريفه خورشيد ملا و لويس عبد الاحد سيدا
قسم علوم الحياة، كلية التربية، جامعة صلاح الدين،اربيل، العراق

تأريخ الاستلام: 2022/7/30، تأريخ القبول: 2022/11/1، تأريخ النشر: 2022/12/20

الخلاصة

سجل خلال المسح الحالي 18 نوعا من طفيليات الداخلية و الخارجية من خلال فحص 50 فأراً منزليا *Mus musculus* (Linnaeus,1758) من بين 10 مواقع في مدينة أربيل، منها 7 أنواع من الطفيليات الأولية وعلى النحو التالي:

Chilomastix bettencourti (da Fonseca 1915) 82%

Giardia muris (Filice 1952) 68%

Tritrichomonas muris (Grassi1879) 36%

Entamoeba histolytica (Schaudinn, 1903) 24%

Entamoeba coli (Grassi,1879) 32%

Eimeria sp. 28%

Trypanosoma musculi (Kendall, 1906) 2%

و تم العثور على 8 انواع من الديدان الطفيلية على نحو التالي:

4 انواع منها ديدان شريطية وهي:

Rodentolepis nana (Ransom, 1901) 8%

Hymenolepis diminuta (Rudolphi, 1819) 2.0%

Echinococcus granulosus (Batsch, 1786) 8% الدور اليرقي لدودة المشوكات الحبيبية

والدور اليرقي 6% (Rudolphi, 1808) *Cysticercus fasciolaris*؛ و منها اربعة انواع من الديدان الخيطية وهي:

Aspiculuris tetraptera (Nitzsch, 1821) 8.0%

Syphacia obvelata (Rudolphi, 1802) 36%

Syphacia muris (Yamaguti, 1935) 2.0%

Trichuris muris (Schrank, 1788) 10%

و ثلاثة انواع من الطفيليات الخارجية، التي تضمنت:

برغوث الجرذ الشرقي *Xenopsylla cheopis* (Rothschild, 1903) 2 .0%

قملة الجرذ الشوكية *Polyplax spinulosa* (burmeister, 1839) 16.0%

حلم *Laelaps nuttalli* (hirst,1916) 4.0%

كذلك تم تسجيل انواع من العدوى داخلية كما يلي: عدوى مفردة (26%)، مزدوجة(50.0%)؛ ثلاثية (22.0%) و رباعية(2.0%)؛ دون وجود فروقاً ذات دلالة إحصائية بين الجنسين و أوزان الفئران.

كانت فئران حي العسكري و لنكة شديدة الإصابة بعموم الطفيليات؛ في الدراسة الحالية ، سجل إصابة كبد *Mus musculus* بالمرحلة اليرقية من *Echinococcus granulosus* (كيس عداري) كأول إصابة طبيعية في العراق.