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Cat (Felis catus)-borne parasites of Rattus norvegicus in an urban district in Kuwait

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ABSTRACT **: *In Kuwait, the density of Rattus norvegicus (the Brown rat) is high in urban areas where they are neighborhood of stray cats. In these ecological environments, the interaction between predator and prey is expected, contributing to transmission dynamics of parasites between stray cats and brown rats and shaping the prevalence of their parasitic fauna. This study was conducted to investigate the rodent parasites, which are transmitted from cats in the densely human populated community, Jleeb Al-Shuyoukh. Between January 2023 to May 2023, eighty brown rats were caught using live traps and examined for parasites. The overall parasitic infection transmitted from cats to rats was 36.3% (24/80). The most prevalent parasite was Cysticercus fasciolaris (25%) in the liver followed by Sarcocystis sp. (3.8%) in muscles. T. gondii antibodies were detected in the blood of only one rat. Fifty percent of rats had multiple infections with C. fasciolaris and the intensity of infection with this meta-cestode was 1.95 cysts/rat. The species of sarcocystis was probably S. cymruensis, which had a cat-rat life cycle. Sarcocystis is recorded for the first time in rodents in Kuwait. Transmission dynamics of parasites, including predation, between stray cats and brown rats in the urban ecosystem in the present research area, were discussed.***

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I. INTRODUCTION

Rodents are adaptable to live in many environments and geographical regions across the globe. This includes Kuwait where these pests are widespread in human habitats. *Rattus norvegicus* (Norway rat or Brown rat) is a cosmopolitan rodent species with wide distribution in urban and suburban-rural habitats, where food and water sources e.g. garbage and drainage ditches are available (Hancke *et al*., 2011)). Kuwaiti Ministry of Health declared that some areas were plagued by this rodent species and the infestation rates varied between 17-62% of examined buildings (Kuwaiti Ministry of Health, 2015).

In Kuwait it is common to see stray cats roaming streets and lurking around garbage containers. Many appear to live throughout the country in multiple colonies in urban neighborhoods (El-Azazy *et al*., 2015).

Jleeb Al-Shuyoukh is an urban district, crowdedly inhabited by poorly housed migrant workers of low income, where stray cats are a common feature, roaming its streets and rats are widespread. The ecological factors prevail in this residential neighborhood environment with low hygiene and accumulation of wastes give reason for the high densities of cat and rat populations. The co-existence of stray cats and rats in the same area allows increased predator-prey interaction and increases the transmission of pathogens, including parasites between predator and prey (Krucken *et al*., 2017). It is expected that prevalences of parasites can be high in ecosystems with contact and close predator/prey interaction. In addition, as humans are portion of such urban ecosystem,

zoonotic parasites circulating in cat and rat population could be candidate for spillover to human population, so this system are of medical and public health concern.

This study was conducted to inform about the presence of brown rat parasites, which are known to be transmitted from stray cats and to evaluate if the predation play a role in the occurrence and prevalence of these parasites in urban biotopes in Kuwait, representative by Jleeb Al-Shuyoukh neighborhood.

II. Material and Methods

Rodent trapping:

Between January 2023 to May 2023, rodents were captured using 10 special steel wire traps baited with slices of tomato, dried fish pieces of cheese or bread. In the weekends traps were distributed by the help of local people in the different selected sites at homes or beside the rodent feeding resources e.g., garbage containers. The traps were set up at night and checked in the early morning. The traps, which caught rodents, were placed in plastic bags and transferred to the laboratory for examination.

Rodent examination for parasites:

In the veterinary laboratory, PAAFR, the rats were anesthetized using ether and chloroform, then identified to species level and age differentiated to adult and young (juvenile) according to (Al-Behbehani, 1999; Abu-Madi *et al*., 2005). The rats were treated carefully without stress in adherence to the guidelines issued by the Norwegian Committee for Research Ethics in Science and Technology (NENT, 2016). After anesthesia, blood was collected from the heart of each rat to be tested for *Toxoplasma* antibodies using immunochromatography assay (VDRG® Toxoplasma Ab Rapid test, MEDIAN Diagnostics Inc., Korea). The rapid test was performed according to the manufacturer instructions.

The abdominal cavity of the rats was opened using surgical blade and a pair of forceps. Liver and other internal organs were examined for the presence of *Cysticercus* (*Strobilocercus*) *fasciolaris*. In positive case, the number of cysts in the liver was recorded and liver tissue with the cyst was removed and placed in 10% formalin to be processed for histopathological study by embedding in paraffin, then sectioned at 4 µm thickness, stained with hematoxylin and eosin, and examined under the light microscope. For examination of rats for Sarcocystis infection, 1-3 cm pieces of muscles were taken from the thigh muscles and diaphragms and pressed between 2 slides, then examined microscopically at 100-400 x magnification. When the sarcocysts were detected, the infected muscles were dropped in 10 formalin for histopathological study.

Statistical analysis:

The comparison between the infection rates of *C. fasciolaris* in different rat age groups was performed using the Chi-square test, with a 5% significance level.

III. Results

During this study, all the captured rats (no. 80) belonged to *Ratus norvegicus* (brown rat). Of 80 rats, 54 were adults (29 females and 25 males) and 27 were young. Three cat-born parasites were encountered in this study, namely: *Cysticercus* (*Strobilocercus*) *fasciolaris, Sarcocystis* sp. and *Toxoplasma gondii.* The overall infection was 36.3% (24/80). The most prevalent parasite was *C. fasciolaris* (25%) followed by *Sarcocystis* sp. (3.8%). *T. gondii* was detected in only one rat.

Out of 25 rats infected with *C. fasciolaris*, 15 (60%) were adults (7 females and 8 males) and 5 (20%) were young. The difference between age groups was not significant (p=0.408). The number of cysts in the liver of infected rats ranged between one to five (Fig. 1). One cyst was found in 10 rats, 2 cysts in 6 rats, 3 and 4 cysts each in one rat, and 5 cysts in 2 rats. The infected rats appeared healthy. The intensity of infection with this meta-cestode was 1.95 cysts/rat.

All *C. fasciolaris* cysts were white-creamy in color and each cyst presented a fibrous capsule, surrounding a slightly coiled white larva. The size of cysts varied from small nodules about 1 mm to

large cyst measuring 12 mm. The larva had scolex, which connected to bladder-like cyst with long neck of pseudo-segments. The length of the larva varied between 3 cm to 12 cm (Fig. 2). Histopathology of the infected liver showed cyst, which contained *C. fasciolaris*, and its wall was thickened by connective tissue with numerous polymorphonuclear cells and mononuclear cells cuffing around the cyst. Liver parenchyma was congested (Fig. 5).

In fresh squashed skeletal muscles of sarcocystis-infected rats, Sarcocysts appeared as elongated filamentous cysts among the muscle fibers (Fig. 3). In histologic sections, intramuscular inclusions, representing cross and longitudinal sections of sarcocysts, containing bradyzoites (Fig. 4). The muscles showed hyaline degeneration with infiltration of inflammatory cells, mostly mononuclear cells and C.T. proliferation between muscle bundles. Sarcocystis-infected rats showed no clinical signs. *Toxoplasma* antibodies were detected by immunochromatography assay (rapid test) as shown in (Fig. 6).

IV. Discussion

Brown rats were the only small mammals trapped in the present study. This finding is consistent with the previous reports that the brown rat (*Rattus norvegicus*) is the most prevalent rodent in different ecological regions of Kuwait (Al-Sanei et al. 1984; Kuwaiti Ministry of Health, 2015). High densities of this rat population in urban environment with neighborhood of animals e.g. stay cats favor transmission of parasite fauna. In such ecological areas predator-prey-parasite interaction is expected, shaping the biodiversity and prevalence of feline and rodent parasites. Previous studies have identified the circumstances where predation increases the prevalence of infection (Holt and Roy, 2007). Although predation of stray cats on brown rats is the key factor for propagation and transmission mechanism of their parasites, other factors e.g. cat diet preference, rat feeding behavior, ecology of parasites inside and outside the host, climatic conditions are also involved in the epidemiology of this parasites.

Cysticercus facsciolaris in rodents is the larval stage of *Taenia taeniaeformis* in cats. Therefore, to discuss the prevalence of *C. facsciolaris* in the brown rat, we should consider the occurrence of its adult stage in stray cats and the other circumstances, which play a role in the epidemiology of this cestode. As the life cycle of taeniid cestodes is complex, involving two hosts and a free-living stage, when looking at the epidemiology of these tapeworms the adult worms in the final host, cysticerci in the intermediate host, eggs in the environment (Gemmell and Lawson, 1982). *C. fasciolaris* was found in 25% in rats examined in the present study; however, in our previous study on parasites of stray cats in Kuwait, only 2 cats (0.8%) harbored *T. taeniaeformis* with low intensity of infection (El-Azazy *et al*., 2016). Similarly, *T. hydatigena* was reported at low infection rate in dogs, while sheep harbored heavy infections with cysticerci (Gemmell and Lawson, 1982). The output of eggs in the environment does not depend only on the rate and intensity of infection with tapeworms in the final host but also on the biotic potential of the worms. The experimental study of the productivity of *T. taeniaeformis* in cats revealed that a mean of 1606 eggs in 4 proglottids were shed daily for about one year (Williams and Shearer, 1981). This high number of eggs passed with feces of cat is enough to contaminate the environment and then rats become reliable to infection, this implication can be supported by the occurrence of multiple infections in 50% of infected rats. Another important ecological factor influencing the transmission dynamics can be coprophagia, which is very common among the Norway rats (Kenagr and Hoyt, 1980). Another reason of relatively high infection rate (25%) as recorded in the present study, compared to the low prevalence and intensity of infection in stray cat *T. taeniaeformis* as observed in our previous study (El-Azazy et al., 2016) could be related to the cat diet preferences; cats prefer small creatures for predation (Hrrera et al., 2022). As Adult brown rats have large bodies, they could be not preferred prey. Probably, reptiles constitute the main part of the stray cats' diet in Kuwait (El-Azazy et al., 2016).

The source of stary cat infection with *T. taeniaeformis* is probably young brown rats. Mice could be another source; however, in a previous study in Kuwait, only 2 mice out of 842 were found infected with *C. fasciolaris* and infection in mice was only encountered after the control of the Norway rat in Kuwait (Zakaria and Zaghloul, 1986). Al-Behbehani (1999) did not find this meta-cestode in mice. Genetic variations of the *C. fasciolaris* populations and their ability to infect intermediate hosts has been demonstrated. Brandt and Sewell (1981) reported distinct infectivity of four *T. taeniaeformis* isolated in mice and rats. In addition, Nonaka et al. (1994) observed *T. taeniaeformis* eggs derived from a meta-cestode isolated from a grey red-backed vole did not develop to cysts in rats, mice, or gerbils. In Egypt, only *R. norvigacus* was found to be infected with *C. fasciolaris* among other rodents examined (Al-Mahi, 2008). In Mexico, none of sampled mice were positive to infection, while 7.8% of the brown rats had cysts in their livers (Medina-Pinto et al., 2019). It is suggested that the rat-*C. fasciolaris* variant is prevalent in Kuwait. However, as we did not examine mice in this study, more investigation is needed to support this suggestion.

In a Previous study in Kuwait, the prevalence of *C. fasciolaris* in the brown rats was recorded at 8.4% (Zakaria and Zaghloul, 1983), much lower than that reported in the present study. This variation between results could be due to the differences between the numbers of rodents examined and their locations of collection. Also, the biodiversity of parasite fauna of rodents could be changed with time.

Only three brown rats were found to be infected with *Sacocystis* at rate of 3.8%. This is the first time to report this protozoon in the rodent in Kuwait. In our previous study, Sarcocystis oocysts were detected in the feces of one stray cat (0.4%) in Kuwait (Abdou et al., 2013). It has been known that the species of the genus *Sarcocystis* are intracellular coccidian protozoan parasites with a diheteroxenous life cycle based on prey-predator (intermediate-final) host relationships, and most spices of the genus are host-specific (Hu et al., 2011). seven Sarcocystis spp. have been mostly reported in brown rats, which act as intermediate host (Murata et al., 2018). Of these the only species that has a cat-rat life cycle is *S. cymruensis*, while the others have snakes as final host. As Jleeb Al-Shuyoukh, the area in which this study was conducted, has no snakes but numerous stray cats, it is strongly suggested that the species encountered in the brown rats in this study is *S. cymruensis*. However, this suggestion should be supported by molecular studies.

Unexpectedly, only one rat had antibodies of *Toxoplasma* as usually urban rats are important for the epidemiology of toxoplasmosis acting as a source of infection to cats (Dubey, 1998). Oocyst of This protozoan was detected in the faces of 2.1% of young stray cats in Kuwait (Abdou et al., 2013). Low prevalence of toxoplasmosis in the brown rats could reflect the scarcity of infection with *Toxoplasma* among stray cats in the area of this study. During our routine examination of the serum of farm animals by the rapid test, *Toxoplasma* antibodies were detected frequently. Perhaps, stay cats have higher infection on farms, contaminating the environment there. However, this point needs more investigation, examining rodents e.g. rats and mice on farms. Al-Karmi and Behbehani (1980) detected *Toxoplasma* infection in *Meriones crassus*, the desert rodent, and suggested that these animals could be source of infection to Bedouins in Kuwait.

As urban settings represent as significant portion of the ecosystem experienced by human population, parasite associated systems carried by stray cats and brown rats are candidates for spillover into human populations of these systems are of public health concern (Glass et al., 2009). *Tenia taeniaeformis*, which has been reported in humans (Moudgil et al., 2016), and *Toxoplasma gondii*, the important abortion agent among women, could pose risk to residents in the urban areas in Kuwait.

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Fig. (1): Photograph of rat Liver showing multiple cysts of *C. fasciolaris*

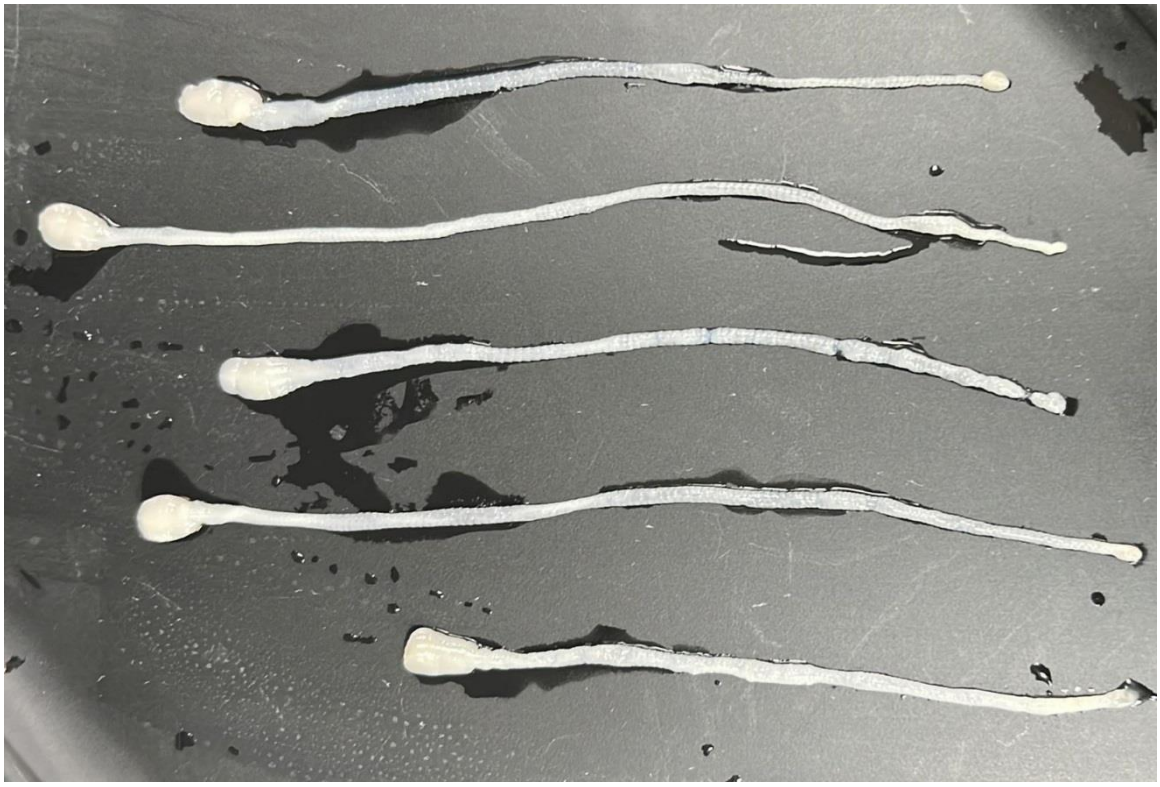

Fig. (2): Photograph of Strobila of *C. fasciolaris*.

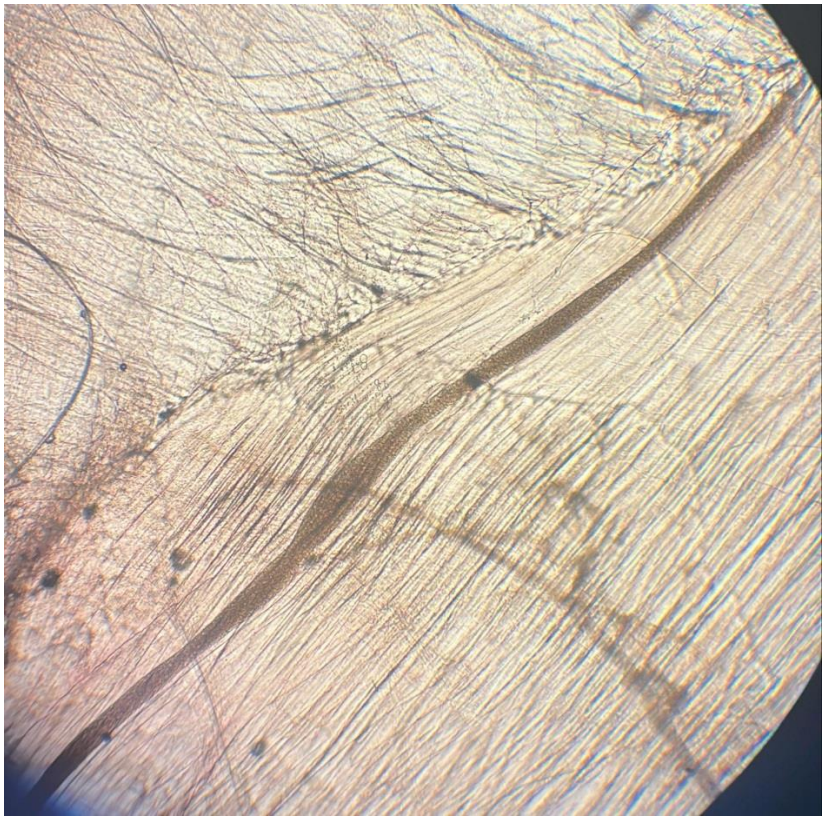

Fig. (3): Photomicrograph showing a Sarcocyst among the muscle fibers in fresh preparation.

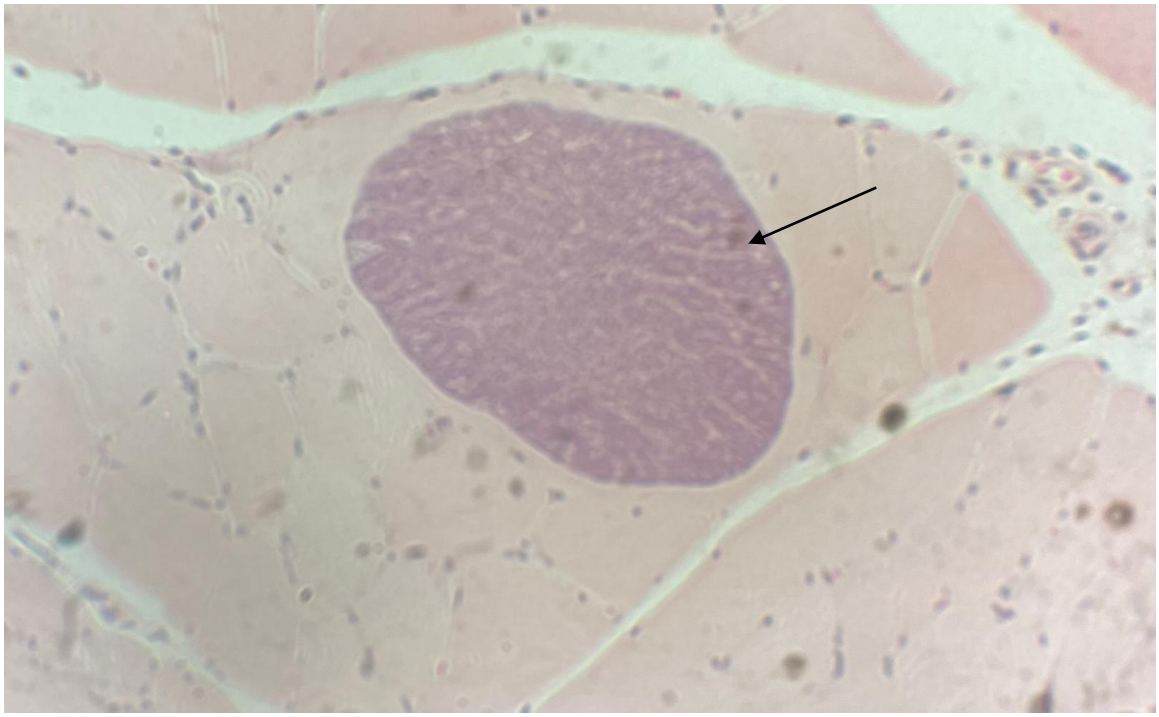

Fig. 4: Photomicrograph Cross section of muscle tissue showing the sarcocyst with bradyzoites (arrow) 200X, stained with H&E.

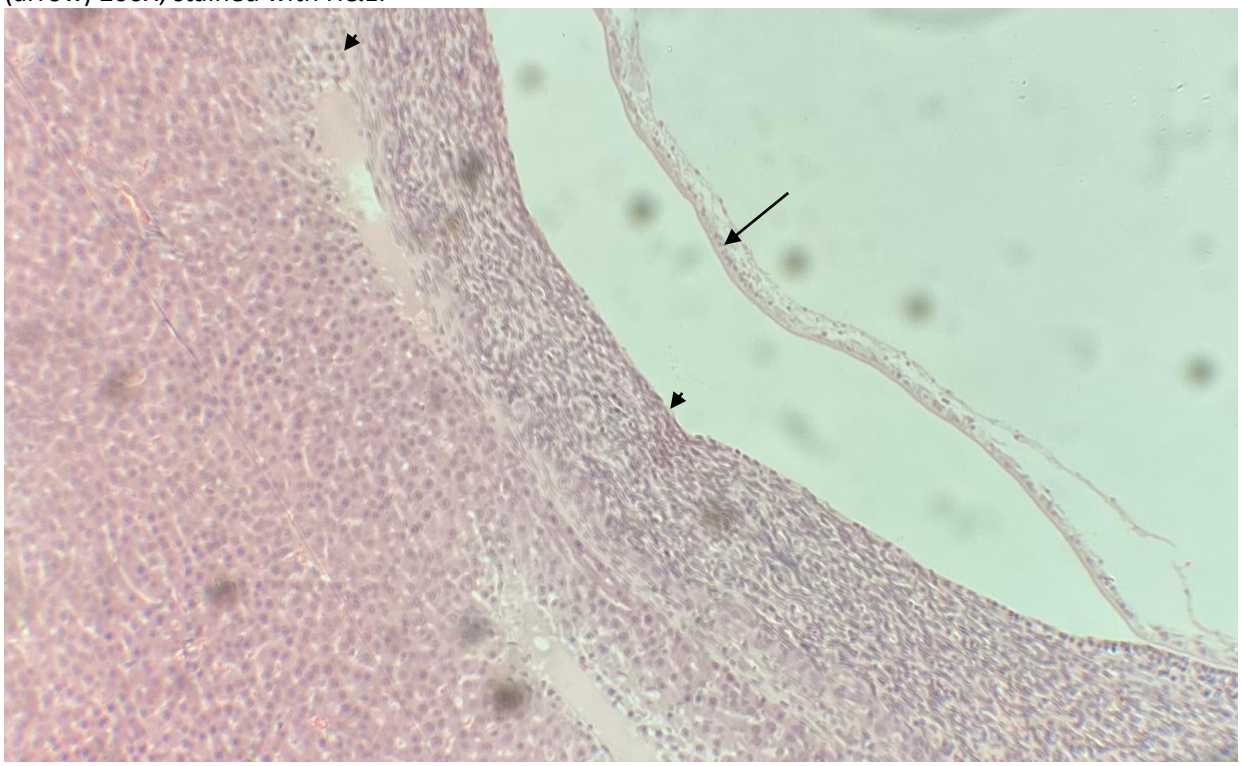

Fig. (5): Photomicrograph of Cross section of liver rat showing the thick capsule with mononuclear cells (short arrows) around the *C. fasciolaris* (long arrow) 200X, stained with H&E.

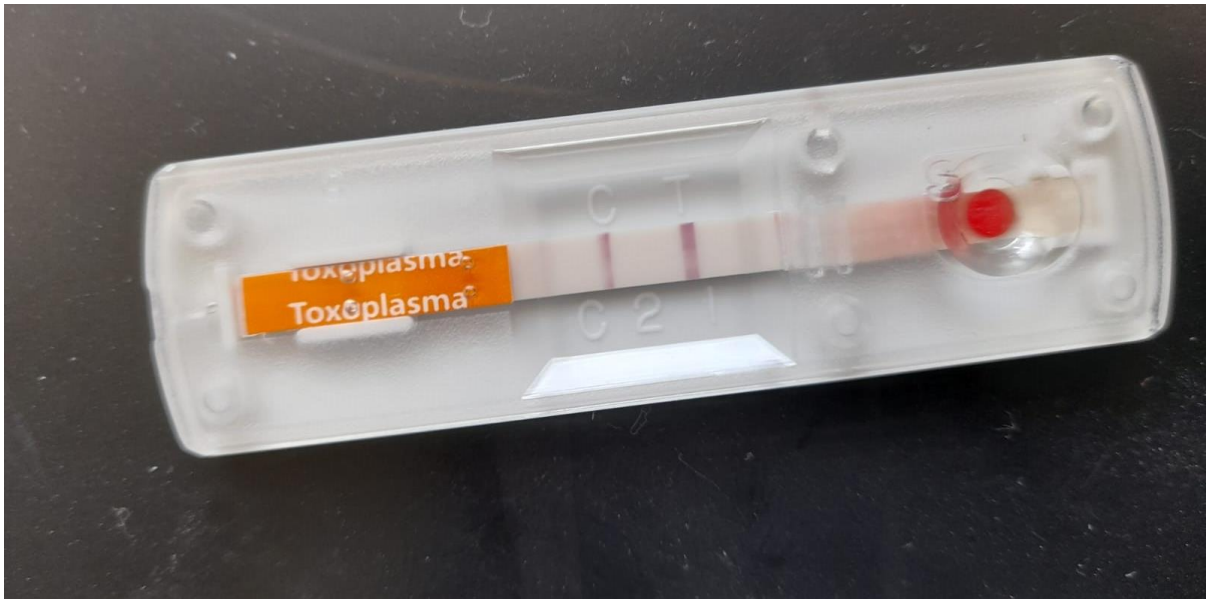

Fig. (6): Photograph of rapid test device showing the positive result of detection of *Toxoplasma* antibodies.