We report the occurrence of the tapeworm cyst, the metacestode larval stage of Taenia taeniaformis in a laboratory rat (Rattus norvegicus). The macroscopic and histopathological features of the parasite are described as well as the serology of Taenia taeniaformis. The epidemiology of Taenia taeniaformis is discussed, particularly as it relates to the possibility of altered research results in studies conducted in T. taeniaformis-infected rats (immune-modulation) as well as the slight zoonotic potential that this metacestode presents.

INTRODUCTION

Adult Taenia taeniaformis occurs in the small intestine of wild and domestic cats throughout the world [1]. The rodent serves as the intermediate host for the cat tapeworm Taenia taeniaformis. Rodents become infected by ingesting feed or bedding contaminated with cat faecal material. Following ingestion of the infectious egg, the larva migrates through the intestinal wall of the rodent and develops into cysticerci or cysts (the intermediate metacestode form) in the rodent liver or peritoneum [1]. The life cycle is completed when the cat (the definitive host) ingests the infected rodent. The metacestodes are common in the liver of mice, rats, black rats, cotton rats, voles and other wild rodents [1]. The infection in the rodent is considered harmless, but the metacestode has slight zoonotic potential and the presence of the metacestode cyst in laboratory animals will potentially affect research results [2]. In addition, Letonja and coworkers (1987) have reported that T. taeniaformis infection in mice may induce partial suppression of the host’s immune system [3].

Taenia taeniaformis is found throughout the world including India [4], Japan [5] and Mexico [6]. Taenia taeniaformis metacestode cysts have been reported in the livers of wild rats (Rattus norvegicus) in the west Indies [7], Korea [8], Serbia [9], in wild mice in India [10], in synanthropic rodents in Egypt [11], in rodents and shrews in Taiwan [12], in rats in Colombia [13] and insmall mammals in Malaysia [14]. The helminth community structures of two urban rat populations in Malaysia were investigated and three cestodes and one acanthocephalan were recovered [15]. In addition, T. taeniaformis was noted in rodents in Kuala Lumpur [16]. Taenia taeniaformis infected voles were noted in Switzerland [17] and T. taeniaformis infected musk rats were observed in Belgium [18] and the Netherlands [19]. Taenia taeniaformis was also noted in the wood mouse in Southern England [20]. Taenia taeniaformis has been reported in the common and water vole in Western Australia [21].

T. taeniaformis has been reported in the intestines of stray cats in Iran [22] and in the intestinal contents of cats on the Antillian Islands [23]. Furthermore T. taeniaformis has been reported in stray cats at an incidence of 75.8% in Qatar, a highly arid region [24]. Taenia taeniaformis is present in the faecal samples of feral cats in Korea [25] and has been noted in the carcasses of Eurasian lynx in Estonia [26]. Taenia taeniaformis has been reported in semi-stray dogs in Jordan [27] and Rossin and coworkers (2004) were able to experimentally reproduce the adult stage of Taenia taeniaformis in domestic dogs [28]. The adult worm measures 15 to 60 cm in length and is 5 to 6 mm in width and the scolex possesses two crowns with hooks [1].

The objective of this study was to identify the parasitic cyst found in the liver of a laboratory rat and to highlight the epidemiology of Taenia taeniaformis, particularly as it relates to the possibility of altered research results in studies conducted in T. taeniaformis-infected rats (immune-modulation) as well as the slight zoonotic potential that this metacestode presents.

MATERIALS AND METHODS

The white female Albino Wistar rat (aged six months) was submitted to Cerberus Sciences, a rodent health monitoring company. The rat was housed in an animal facility at the University of Adelaide. The submitted live rat was inspected...
by veterinary surgeons and then underwent necropsy. At necropsy, histopathology, serology and parasitology samples were harvested.

The rat was euthanized with an overdose of carbon dioxide in a CO₂ chamber and a necropsy was performed. Upon discovery of a macroscopic lesion at necropsy, tissue samples of the liver were fixed in 10% neutral buffered formalin for histopathological examination.

The parasitology tests included a cellophane tape test for ectoparasites (mites, fleas, lice, mallophages). The cellophane tape samples were then placed on a glass slide and examined by light microscope.

Further parasitological tests included the faecal flotation which was performed on faeces flushed through the entire small and large intestinal system using a syringe and 10ml of 10% neutral buffered formalin (Confix Green, Australian Biostain, Australia). Briefly, the faecal contents were mixed with 10% neutral buffered formalin and 2.5 ml of this solution was added to 2.5 ml of a saturated NaNO₃ solution (specific gravity above 1.18). A cover slip was placed on the meniscal surface of the solution and left in place for 20 min. The cover slip was placed on a glass slide and examined microscopically.

Parasite eggs and protozoa were also examined by adding a drop of iodine solution (Oxoid, Australia) onto two, separate, small sections of cecum and duodenum (with adherent faeces) which were placed on a glass slide, covered with cover slips, sealed with clear nail varnish and examined under the light microscope.

RESULTS

Macroscopic pathology

At necropsy, a raised, yellow cyst measuring 3mm in diameter filled with fluid and fluctuating white material was noted on the capsular surface of the underside of the left liver lobe (Figure 1).

Histopathology

Upon histopathological examination a thick fibrous connective tissue capsular wall (Figure 2) was observed which contained a moderate to severe lymphocyte, plasma cell and eosinophil cell infiltrate. The cyst contained a single metacestode (i.e. with calcareous bodies (Figure 3), cuticle and muscle strands typical of *Taenia taeniaformis*.

Parasitology

Tape test and faecal flotation were negative. Wet mounts of the caecum revealed *Trichomonas* spp. and *Entamoeba muris* spp. present at moderate numbers.

Serology

ELISA testing on the serum was negative for rat coronavirus, parvovirus (rNS1), pneumonia virus of mice and *Mycoplasma pulmonis* (ELISA kits obtained from Bioresearch, US).

DISCUSSION AND CONCLUSION

*Taenia taeniaformis* has been transmitted to humans [29] however this is quite rare. The close association of rats in areas such as Kuala Lampur potentially contaminating the environment, water and food sources remains a public health hazard [16]. A child with an unusual *Taenia taeniaformis* (from a cat) infection has been reported in Sri Lanka [30]. The zoonotic potential of this parasite is only of concern if laboratory workers were to consume the laboratory rat including the liver with the cyst. Alternately, humans would need to eat the ova in/from the faeces of the definitive host (cat) in order to develop cysticercosis or tapeworms within the intestine. The rat in this case study was infected with eggs from cat faeces and the most likely sources are food, water, bedding, and other materials introduced into the animal cage. In laboratory animal facilities food and bedding are autoclaved or gamma-irradiated for the purpose of killing rodent pathogens. This process is usually highly effective, however complete sterilization cannot be guaranteed. The water used is tap water, usually with additional treatments including one or more of autoclaving, filtration, UV treatment, chlorination or acidification. Once again this process is usually effective or highly effective, but complete sterilization cannot be guaranteed.

Fichet-Calvet and coworkers (2003) presented evidence that the prevalence of *Taenia taeniaformis* in *Mircotis arvalis*
The histopathology of the cyst or Strobilocercus fasciolaris metacestode cyst found in the laboratory rat in this study is similar to that reported in the livers of white mice [34] and includes the presence of plasma cells, macrophages, eosinophils and fibroblasts. Two of five male Sprague-Dawley rats with hepatic tapeworm cysts (Cysticercus fasciolaris; the larval stage of Taenia taeniaformis) develop large multinodular fibrosarcomas which envelop the tapeworm cysts and extend through the peritoneal and pleural cavity [35]. The development of sarcomas in rats induced by Taenia sp. is thought to be attributable to the chronic inflammatory reaction of the capsule. Tapeworm cysts in liver of Wistar rats induce hepatic sarcoma and gastroenteropathy in stomach and intestine [36], although these phenomenon are considered to be rare. The gastropathy is characterised by gastric mucosal hyperplasia, dilatation of gastric glands with secretion, intestinal mucosal cell hyperplasia and proliferation of duodenal submucosal glands [36] and may be T cell driven [37]. Lagapa et al., 2008 [38] speculate that the intestinal hyperplasia is likely to be related to the associated gastropathy; although the mechanisms are undefined [38] and Konno and coworkers (1999) [39] state that the gastropathy results in hyperplasia of the gastric mucosa and hypergastrinaemia and an increase in intragastric pH.

Praziquantel has been developed to treat cestode infections (including T. taeniaformis) in cats [40]. Different UV lamps have been shown to have an inhibitory effect on Taeniid eggs, including those of T. taeniaformis [41].

The negative serology results (negative for rat coronavirus, parvovirus (rNS1), pneumonia virus of mice and Mycoplasma pulmonis) are not unexpected in a laboratory rat and the presence of Trichomas spp. and Entamoeba musris protozoa in the caecal contents of this laboratory rat is extremely common [42].

This case remains important due to the possibility of altered research results in studies conducted in T. taeniaformis-infected laboratory rats as well as the very small zoonotic potential that this metacestode presents.

In conclusion, this study demonstrates that it is possible for laboratory rats to become infected with T. taeniaformis and that this has implications for the possibility of altered research results in studies conducted in T. taeniaformis-infected laboratory rats as well as a small zoonotic potential.

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Figure 3 The cyst contained a single metacestode with cuticle (A), muscle strands (B) and calcareous bodies (C).


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