# aJava

Asian Journal of Animal and Veterinary Advances

Academic
Journals Inc.

www.academicjournals.com

Asian Journal of Animal and Veterinary Advances 10 (11): 740-751, 2015
ISSN 1683-9919 / DOI: 10.3923/ajava.2015.740.751


# Parasitic Zoonoses in Livestock and Domestic Animals of Myanmar and Neighbouring Countries

Saw Bawm and Lat Lat Htun
Department of Pharmacology and Parasitology, University of Veterinary Science, 15013, Yezin, Nay Pyi Taw, Myanmar

*Corresponding Author: Saw Bawm, Department of Pharmacology and Parasitology, University of Veterinary Science, 15013, Yezin, Nay Pyi Taw, Myanmar*

## ABSTRACT
Most parasitic zoonoses are neglected diseases despite causing a considerable global burden of ill health in humans. A review of available literatures indicates that many parasitic zoonoses are endemic in neighbouring countries of Myanmar. However, the information on zoonotic parasitic diseases in Myanmar is very limited. The prevalence of some parasitic zoonoses in livestock of Myanmar and its neighbouring countries has been highlighted in this review. Prevention and control programs against sources and reservoirs of parasitic zoonoses and other zoonoses should be planned by public health and veterinary officers based on reliable information from systematic surveillance.

**Key words:** Parasitic zoonoses, helminthiasis, protozoal diseases, livestock

## INTRODUCTION
Zoonotic parasitic infections are playing a significant role in human health. The zoonotic parasites circulating in Southeast (SE) Asia are a significant burden on human health and wellbeing. Worldwide, Neglected Tropical Diseases (NTDs) predominantly affect the poor with more than 40 million people infected and 750 million at risk (Keiser and Utzinger, 2005; Hotez *et al*., 2008), furthermore, zoonotic neglected diseases make a significant contribution to the entrenchment of poverty in poor rural communities especially who derive income from livestock production (WHO., 2010). Southeast Asia is currently undergoing changes with respect to climate change, deforestation, socioeconomic development and the industrialisation of livestock production. These ecological changes can modify the interactions between hosts, vectors and parasites and these altered interactions impact on the distribution, prevalence and severity of disease.

During the last decades there have been changes in food preferences and eating habits, there is a growing market for more ready-to-eat fresh and healthy food, which may have created new situations where pathogens may be introduced into food and then to populations (Murphy, 1999). Changes in dietary practice such as the consumption of raw or undercooked meat and fish have been recently implicated as a reason for the emergence of several helminth zoonoses (Slifko *et al*., 2000). Moreover, increasing global demand for protein of animal origin has led to certain farming practices (e.g., aquaculture) increasing in developing countries, where health monitoring may not be sufficiently implemented. Humans become infected through food, water, soil and close contact with animals. Most parasitic zoonoses are neglected diseases despite causing a considerable global burden of human health and having a substantial financial burden on livestock industries.

Table 1: Parasitic zoonoses prevalence in livestock of Myanmar

| Parasitic zoonoses | Study area | Species | Prevalece (%) | Method | Reference |
|---|---|---|---|---|---|
| **Helminthiasis** | | | | | |
| *T. solium cysticercosis* | Nay Pyi Taw | Pig | 15.93 | ELISA | Tin Aye Khaing *et al*. (2014) |
| Trichinellosis | Nay Pyi Taw | Pig | 3.30 | Digestion method | |
| Dirofilariosis | Nay Pyi Taw | Dog | 18.70 | RTKSi | Thu Aung (2014) |
| **Protozoal diseases** | | | | | |
| Giardiasis | Pyawbwe and Yamethin Sandar Kyi (2009) | Cattle | 22.50 | ZN stained method | |
| Cryptosporidiosis | " | Cattle | 56.00 | " | " |
| | Mandalay | Cattle | 57.30 | " | Lay *et al*. (2008) |
| Toxoplasmosis | Mandalay | Goat | 10.00 | LAT | " |
| | Mandalay | Cattle | 6.60 | " | " |
| | Pyin Oo Lwin | Goat | 20.70 | " | " |
| | Pyawbwe | Goat | 7.90 | " | Wint Yi Maung *et al*. (2014) |
| | Nay Pyi Taw | Pig | 18.40 | " | Yunandi Thaw *et al*. (2014) |

RTK: Rapid test kit, ZN: Ziehl-Neelsen acid fast staining method, LAT: Latex agglutination test

Myanmar is located in South East Asia and sharing border with China, Laos, Thailand, India and Bangladesh. In Myanmar, the information on prevalence of parasitic zoonoses in human as well as in livestock is very limited. This review aims to bring together the current prevalence of parasitic zoonoses in neighbouring countries of Myanmar and the prevalence of some parasitic zoonoses in livestock of Myanmar (Table 1).

## ZOONOTIC HELMINTHIASIS

***Taenia solium* cysticercosis:** *Taenia solium* taeniasis and cysticercosis infection in human involve two distinct disease transmission processes and require both humans and pigs to maintain the life cycle. Humans are the definitive host, acquiring the adult tapeworm (taeniasis) following ingestion of viable larvae (cysticerci) in contaminated pork. In human, eggs are shed into the environment by the adult worm via faeces, pigs become infected following ingestion of contaminated feed or water, thus completing the life cycle. *Taenia solium* has public health significance because humans can also be inadvertently infected with cysticerci following the ingestion of eggs through poor hygiene or contaminated food and water. Human cysticercosis cases are not involved in perpetuating the life cycle but are clinically important since cysticerci may cause neurocysticercosis in brain, leading to seizures, epilepsy, neurological sequelae or death. Taeniasis and cysticercosis caused by *T. solium* has been the subject of a number of recently published reviews with an Asian focus (Ito *et al*., 2003; Dorny *et al*., 2004).

The most recent data comes from neighbouring country, Laos where surveys were conducted in 24 village communities in four northern provinces and among pigs at slaughter. Human cysticercosis prevalence was determined to be 2.2% by antigen capture ELISA and there was strong evidence of a focal distribution with just over half of the cases detected residing in three villages in Oudomxay province. No significant risk factors for cysticercosis were found and although infection was rare, the highest prevalence was observed in people of the Mon-Khmer ethnic group. In Lao pigs, *T. solium* cysts were infrequently detected, 0.8% (5/590) of pigs at slaughter had visible cysts and all were heavy infections. *Taenia hydatigena* cysts were detected in 22.4% of pigs (132/590) and *T. asiatica* cysts were detected in 0.2% (1/590). Seroprevalence of swine cysticercosis by antigen ELISA was 68.5% (404/590) and was disproportionate to the prevalence of all Taenia cysts detected by inspection (Willingham *et al*., 2010). There are several reports of porcine cysticercosis in neighboring countries: 3-26% in India (Singh *et al*., 2010), 13.7-30% in China (Shao *et al*., 2011) and 0.4% in Thailand (Waikagul *et al*., 2006).

In Myanmar, the prevalence of porcine cysticercosis in meat inspection was 23.67% (71/300) and base on antibody enzyme-linked immunosorbent assay (Ab-ELISA) survey in Nay Pyi Taw area, seroprevalence of *T. solium* cysticercosis in pigs was 15.93% (58/364) (Khaing *et al*., 2015). In addition, epidemiological survey showed that husbandry system, feed types for pig rearing and habits of farmer are main risk factors for porcine cysticercosis.

**Trichinellosis:** Trichinellosis is a direct zoonosis caused by infection with nematodes of the genus *Trichinella* and is one of the most widely distributed parasitic zoonoses worldwide (Dupouy-Camet, 2000; Pozio and Murrell, 2006). Infection occurs via the consumption of encysted larvae in the muscle of infected animals. The enteral phase is associated with excystment, sexual maturation, reproduction and larval penetration of the intestinal wall and a parenteral phase is associated with the migration of larvae, via lymphatic and blood vessels, to striated muscles where they encyst in a nurse cell complex. Clinical symptoms in humans are related to the number of viable larvae consumed and are typically associated with the parenteral phase (Bruschi *et al*., 2002). Humans are a dead-end host and not involved in perpetuating the life cycle. Three *Trichinella* species associated with human disease have been documented in the SE Asian region, the encapsulated *T. spiralis* and the non-encapsulated *T. pseudospiralis* and *T. papuae* (Pozio *et al*., 2009). Among these species, *T. spiralis* has a regional distribution with the majority of outbreaks recorded in the ethnically diverse regions of central and northern Laos, northern Thailand and northwest Vietnam where consumption of uncooked pork is common (Barennes *et al*., 2008; Kaewpitoon *et al*., 2008; Taylor *et al*., 2009). In Thailand, outbreaks of trichinellosis and *Taenia solium* taeniasis and cysticercosis are concentrated in remote areas populated by ethnic minority groups who practice traditional pig production methods and consume uncooked or improperly cooked pork (Waikagul *et al*., 2006; Anantaphruti *et al*., 2010; Kaewpitoon *et al*., 2008). The main source of infection in Thailand has been pigs, but wild boar, jackal and black bear were also reported as sources of trichinosis. In Laos, the seroprevalence of Trichinella antibodies in human was 19.1% (Conlan *et al*., 2014). The prevalence of trichinellosis showed 4% of pigs in China (Cui *et al*., 2013) and the presence of encapsulated larvae of *Trichinella* sp. has also documented in domestic cats, in a wild toddy cat (*Paradoxurus hermaphroditus*), in a wild civet cat (*Viverricula indica*) and in domestic pigs. Furthermore, the prevalence of this infection has also documented in China as 16.2% in dogs slaughtered in abattoirs, 1.1-15.1% in brown rats, 1.5% of black rats (*R. norvegicus*) and 0.8% in wild mice (*Apodemus chevrieri*). *Trichinella* sp. larvae have also been detected in foxes, bears, wild boars, weasels (*Mustela sibirica*), raccoon dogs, bamboo rats (*Rhizomys sinensis*), shrews (*Tupaia belangeri*) and moles (*Parascapter leucurus*) (Wang *et al*., 2007).

In Myanmar, a total of 270 muscle samples from 3 different parts of body (tongue, masseter muscle and diaphragmatic muscle) of 90 slaughtered pigs from three slaughterhouses in Nay Pyi Taw area has been collected by Khaing (2012) and examined for the presence of *Trichinella* larvae by using artificial digestion method. Among the examined samples, three muscle samples (3.3%) showed to be positive for *Trichinella* infection. *Trichinella* species larvae were observed from two diaphragmatic muscles and one masseter muscle.

**Dirofilariosis:** A number of species of *Dirofilaria* infected to humans are *D. immitis, Dipetalonema repens*, *D. roemeri*, *D. tenuis*, *D. ursi*, *D. striata*, *D. subdermata*, *D. magnilarvatum* and *D. corynodes*. The filariae are transmitted by a range of mosquito (*Culex, Aedes* and

*Anopheles* spp.) or *Simulium* spp. (in the case of *D. ursi*) vectors. Human infection is rare and most infections are asymptomatic. The majority of cases of human dirofilariosis in the US and Japan involve the lungs, whereas in Europe, the majority of cases are subcutaneous or ocular in distribution (Simon *et al*., 2009). *Dirofilaria immitis* worms cause vasculitis and granuloma formation, "Coin like lesions", in the lungs and most infections are diagnosed incidentally during examinations for other reasons. The burden from dirofilariosis is the costs due to differential diagnosis, usually using imaging techniques and also DNA techniques on biopsies. The presence of *D. immitis* in dogs supposes a risk for the human population. In China, prevalence of dirofilariosis in dogs was reported as 13.5% (42/310) by serological test (Sun *et al*., 2012) and 16.6% (213/886) and 24.0% (147/886) by microscopic examination and PCR, respectively (Hou *et al*., 2011). The prevalence of dirofilariosis in dogs was reported as 22.69% in India detected by ELISA (Borthakur *et al*., 2015) and 18.2% in Thailand (Boonyapakorn *et al*., 2008). The information of occurrence of indigenous *D. immitis* has also been reported in Bangladesh by Fuehrer *et al*. (2013).

In Myanmar, Aung (2014) reported that the overall prevalence of *D. immitis* was 7.3% (10/150), 18.7% (28/150) and 16% (24/150) when testing with Direct Blood Examination, Rapid Test Kit and Modified Knott's technique, respectively, in Nay Pyi Taw area.

**Fascioliasis:** In Southeast Asia, clinically important trematodes include *Opisthorchis viverrini, Clonorchis sinensis, Fasciola* spp. and *Paragonimus* spp. (Sripa *et al*., 2010). Fascioliasis is caused by liver flukes of two species, *Fasciola hepatica* and *F. gigantica*. Humans become infected through ingestion of water or freshwater plants with adherent metacercaria (Mas-Coma, 2005; Ashrafi *et al*., 2006) or juvenile forms (Taira *et al*., 1997). The parasite requires replication in *Lymnaea* snails as intermediate hosts. In human, fascioliasis may be asymptomatic in 50% of infected patients. Clinical symptoms may appear as intermittent fever, lethargy, weight loss, hepatomegaly, abdominal pain, hives, cough, jaundice, pancreatitis and gastrointestinal signs (WHO., 2015). Liver fluke endemic countries, including Laos, Thailand and Vietnam are among the top six countries worldwide with the highest incidence of liver cancer (Ferlay *et al*., 2010). Although the information of *O. viverrini* and *C. sinensis* infections has been reported from neighbouring countries, no information is available yet from Myanmar. In Thailand, the total prevalences of infection in cattle (*Bubalus bubalis* and *B. taurus*) were 67.27 and 52.94%, respectively (Phalee and Wongsawad, 2014). Yuan *et al*. (2015) reported that the prevalence in cattle of China ranged between 13.3 and 46.2% and water buffalo ranged between 10.3 and 35.4%. In India, an overall prevalence of fascioliasis was recorded 8.8 -26.21% in large ruminants (Yadav *et al*., 2009; Fatima *et al*., 2012) and slaughtered animals showed 27.26%, 10% and 20.92% in cattle, buffaloes and goat, respectively (Kabir *et al*., 2010) and 31.14% in cattle (*F. gigantica*) in Bangladesh (Affroze *et al*., 2013). The prevalence of fasciolosis based on faecal examination has been investigated as 22% in Lashio, the city of northern Shan State, Myanmar by Kham (2010). In Taunggyi area, the prevalence of *Fasciola* species infestation was 18.9% in cattle farm and 51% in slaughtered cattle (Thu, 2013).

## ZOONOTIC PROTOZOAL DISEASES

**Giardiasis:** *Giardia* infections are common in humans and domesticated animals, especially livestock, but also occur in dogs, cats, numerous species of wild mammals and birds (Thompson, 2004). The life cycle of *Giardia* is direct and involves just two major stages, the trophozoite, which is the replicative stage and the cyst, which is the infective stage. Infection is initiated either by consumption of contaminated food or water or by the faecal-oral route via person-to person or animal-to-animal contact. *Giardia* is a common cause of diarrhoeal disease in humans, particularly in children, it causes chronic infections which contribute to poor growth and other nutritional disorders (Thompson and Monis, 2004). In young livestock, *Giardia* infections may adversely impact on production (Olson *et al*., 2004). Giardiasis in domestic ruminants has a negative effect on performance, resulting in decreased rate of weight gain, impaired feed efficiency, lower carcass weight and increased time to slaughter (Olson *et al*., 1995).

Humans are considered to be the source of infection in non-human primates and painted dogs in Africa, marsupials in Australia, beavers and coyotes in North America, muskoxen in the Canadian arctic, house mice on remote islands and marine mammals in various parts of the world (Graczyk *et al*., 2002; Appelbee *et al*., 2010). In contrast, in Aboriginal communities in isolated regions of northern Australia, reverse zoonotic transmission occurs between humans and dogs but the fact that the dogs are frequently infected with their own host-adapted species of *Giardia, Giardia canis* (Hopkins *et al*., 1997; Thompson and Monis, 2004). In neighbouring country, Thailand, the overall prevalence of *G. duodenalis* in dairy cows was 5.0% (45/900) by zinc sulphate centrifugal flotation and 6.0% (54/900) by PCR (Inpankaew *et al*., 2015). In China, prevalence of *G. duodenalis* in cattle was 2.12-7.2% (128/1777) on microscopic analysis (Huang *et al*., 2014; Wang *et al*., 2014) and 6% (16/545) in Yak by PCR (Qi *et al*., 2015).

The detected prevalence of *Giardia* infection in the cattle of Myanmar was 22.5% (90/400) within Pyawbwe and Yamethin Townships and it was lower than that of *Cryptosporidium* infection (Kyi, 2009).

**Cryptosporidiosis:** Many documents proved that the main reservoir of zoonotic *Cryptosporidium* is livestock, with the potential transmission of *Cryptosporidium parvum*, to humans via contaminated water or through direct contact with livestock (Robertson *et al*., 2010). In cattle, direct transmission through the contamination of surroundings by infected animals seems to be the principal mode of infection. Farm animals play significant role in contributing parasite cysts in large proportion because of their high abundance on farms (Hunter and Thompson, 2005) and can act as the causal agents of human cryptosporidiosis. *Giardia* and *Cryptosporidium* have emerged as important parasites of dairy cattle because of their proven pathogenecity, economic losses and the potential public health significance of zoonotic transmission (Olson *et al*., 2004). *Cryptosporidium* infections are common in humans and calves and also occur in various animals such as dogs, cats, pigs, horse, sheep, goats and wildlife (Fayer, 2004). The infection can be a particular problem in immunosupressed and HIV positive individuals resulting in severe, chronic disease and infection can be fatal. In immunocompetent patients, cryptosporidiosis is usually a self-limiting disease of the intestinal tract. Cows can serve as a major host of *Cryptosporidium* worldwide, causing potentially high risk to the human population (Scott *et al*., 1994).

Cryptosporidiosis in dairy calves usually occurs in the first few weeks of age and, in most cases is a self-limiting disease (O'Handley *et al*., 1999). *Cryptosporidium* infections in calves can cause diarrhoea, lethargy, anorexia and dehydration. Calves with severe cryptosporidiosis can take 4-6 weeks to recover fully (Olson *et al*., 2004). Economic loss in the cattle farming industry is due to neonatal diarrhoea which causes dehydration, inhibition of normal development and even death (De Graaf *et al*., 1999).

There has also been considerable interest and discussed regarding potential of zoonotic transmission of this pathogen, particularly from livestock. Farm animals are believed to play the most significant role in contributing parasite oocysts in large proportion because of their high abundance on farms (Hunter and Thompson, 2005; O'Handley and Olson, 2006). Transmission of this type may occur through either direct contact in the case of farmers, veterinarians and petting zoos or through indirect routes such as contaminated surface water or foods (Dixon, 2009). A high prevalence of both *Giardia* and *Cryptosporidium* has been reported worldwide in dairy and beef cattle. In China, the prevalence for *Cryptosporidium* spp. was 4.0 % (22/545) in Yak by PCR method (Qi *et al*., 2015) and 1.61% in cattle by microscopic examination (Huang *et al*., 2014). It was also reported that *Cryptosporidium* spp. oocysts were detected in 34.4% of pig samples in China (Chen *et al*., 2011). In Bangaladesh, a total of 15 and 3% samples of goat were found positive in microscopic study and in nested PCR analysis, respectively (Siddiki *et al*., 2015). *Cryptosporidium* infection in bovids of the northern parts is 35.4%, which is higher than in the eastern or southern parts of India (Paul *et al*., 2008).

Kyi (2009) stated that the overall prevalence of *Cryptosporidium* was 56% (224/400) in Yamethin and Pyawbwe Townships, Mandalay region, Myanmar. Similar results have been reported from farms around Mandalay City by Lay *et al.* (2008) who demonstrated that the prevalence of *Cryptosporidium* was 57.3% in 1-17 weeks old calves. Furthermore, the prevalence was found as 24.56, 100 and 52.54% in mithun, cattle and buffaloes, respectively, within Matupi Township, Chin State (Moe, 2015). The present detection rate of *Cryptosporidium* infection based on microscopic examination is much higher compared to the obtained prevalence in former studies in Thailand with the prevalence of 0.6% (Jittapalapong *et al*., 2006).

**Toxoplasmosis:** *Toxoplasma gondii* is an intracellular protozoan parasite found in virtually all warm-blooded mammals including man. Transmission to man is commonly associated with exposure to either the oocyst stage in cat feces or meat containing *T. gondii* tissue cysts. *Toxoplasma gondii* is an obligate intracellular coccidian protozoan parasite with worldwide prevalence. It has been estimated that up to one third of the world's population has been infected. Transmission to susceptible hosts occurs by ingestion of infective oocysts in food or water due to soil contamination; ingestion of raw or improperly cooked tissues with tissue cysts containing bradyzoites; inhalation and rarely by blood transfusions or organ transplants. *Toxoplasma* can also be transmitted vertically or by predation. Cats are the definitive hosts can pass oocysts in their feces leading to contamination of *T. gondii* oocysts in soil. Many other mammals and birds (including dogs) can serve as intermediate hosts. Toxoplasmosis is not only a problem for the unborn child through congenital transmission. It is also a serious problem in immunosuppressed individuals such as HIV patients and transplant patients (Dubey and Beattie, 1988; Dubey, 2008). In Southeast Asian countries, culinary habits (e.g., eating undercooked meat) of people and low water quality may be a more significant risk factor for *T. gondii* than cat ownership (Nissapatorn *et al*., 2003). Serological studies in human serum in Myanmar have shown that 31.8-41.0% were infected with *Toxoplasma* infection (Chan *et al*., 2008; Andiappan *et al*., 2014).

In India, recent reports showed that prevalence of *T. gondii* infection was 50% in sheep, 41.2% in goat, 64.4% in cattle and 0.5% in Mithun (*Bos frontalis*) serum samples. (Singh *et al.,* 2015; Chamuah *et al.,* 2015). In Bangladesh, cattle, goats and sheep showed a high seroprevalence of 12-16, 12-32 and 18-40%, respectively (Shahiduzzaman *et al*., 2011).

In Myanmar, our recent serologic study revealed that 10% of goat and 6.6% of cattle in Mandalay, 4.7% of goats and 18.4% of pigs in Nay Pyi Taw (Thaw *et al*., 2014), 20.7% of goats in Pyin Oo Lwin, were infected with *T. gondii*. The seroprevalence of *T. gondii* in goats within

Pyawbwe Township was 7.9% (Maung *et al*., 2014). Unlike our result, lower prevalence was recorded, 3.3% of goats in Heilongjiang, China (Wang *et al*., 2011). Relatively higher prevalences than Pyawbwe Township were also recorded, 14.1% in Shaanxi of China (Zhao *et al*., 2011) and 30.8% in Yunnan, China (Zhao *et al*., 2011), 30.3% in India (Chhabra *et al*., 1985) and 27.9% in Thailand (Jittapalapong *et al*., 2005).

As result of demographic growth and an increase in quality of life in developed countries, in order to meet rising demand for livestock products, agriculture has been intensified and the number and concentration of livestock is increasing rapidly. The major share of this growth will be supplied by developing countries, where, between 2001 and 2050, meat production is expected to rise 1.8% annually (FAO., 2009) and where biosecurity regimes may be not always sufficient in preventing livestock from disease. Control and prevention of emerging parasitic zoonoses are complex tasks that require an integrative and multidisciplinary approach. Environmental and ecological modifications are also needed to be implemented to reduce not only the parasitic load, but also the risk of parasite transmission. Moreover, financial resources specifically allocated to prevention and control of zoonotic parasitic diseases need to be contributed by local and national authorities as well as through international cooperation in order to successfully control and prevent these infections (Chomel, 2008).

## CONCLUSION

It needes to confront all aspects of parasite ecology as a collaborative international research community, employing the latest diagnostic techniques and the involvement of international agencies and institutions, as well as the commitment of policymakers, scientists and field workers, are key means for the sustainable control. Although the information on prevalence of some important parasitic zoonoses such as echinococcosis, leishmaniasis and schistosomiasis has been often documented from neighbouring countries, it is still lacking from Myanmar. In addition, further studies relevant to the genetic identification of these parasites and risk factors associated with human infection from public health aspects are also necessary to conduct.

## ACKNOWLEDGMENTS

The authors would like to thank Ph.D and MVSc students of Department of Pharmacology and Parasitology, University of Veterinary Science, Yezin, Nay Pyi Taw, Myanmar. The authors are grateful to all the stockmen who participated and the townships veterinary officers and staff for their very considerable support and assistance.

## REFERENCES

Affroze, S., N. Begum, M.S. Islam, S.A. Rony, M.A. Islam and M.M.H. Mondal, 2013. Risk factors and gross pathology of bovine liver fluke infection at Netrokona district, Bangladesh. J. Anim. Sci. Adv., 3: 83-90.

Anantaphruti, M.T., M. Okamoto, T. Yoonuan, S. Saguankiat and T. Kusolsuk *et al*., 2010. Molecular and serological survey on taeniasis and cysticercosis in Kanchanaburi Province, Thailand. Parasitol. Int., 59: 326-330.

Andiappan, H., V. Nissapatorn, N. Sawangjaroen, M.H. Nyunt and Y.L. Lau*et al*., 2014. Comparative study on *Toxoplasma* infection between Malaysian and Myanmar pregnant women. Parasit. Vectors, Vol. 7. 10.1186/s13071-014-0564-9

Appelbee, A.J., R.C.A. Thompson, L.M. Measures and M.E. Olson, 2010. *Giardia* and *Cryptosporidium* in harp and hooded seals from the Gulf of St. Lawrence, Canada. Vet. Parasitol., 173: 19-23.

Ashrafi, K., M.A. Valero, J. Massoud, A. Sobhani and S. Solaymani-Mohammadi *et al*., 2006. Plant-borne human contamination by fascioliasis. Am. J. Trop. Med. Hyg., 75: 295-302.

Aung, S.T., 2014. Prevalence and associated risk factors of *Dirofilaria immitis* in dogs within Nay Pyi Taw area. M.Sc. Thesis, University of Veterinary Science, Yezin, Nay Pyi Taw.

Barennes, H., S. Sayasone, P. Odermatt, A. De Bruyne and S. Hongsakhone *et al*., 2008. A major trichinellosis outbreak suggesting a high endemicity of *Trichinella* infection in Northern Laos. Am. J. Trop. Med. Hyg., 78: 40-44.

Boonyapakorn, C., L. Srikitjakarn, N. Morakote and F. Hoerchner, 2008. The epidemiology of *Dirofilaria immitis* infection in outpatient dogs at Chiang Mai University small animal hospital, Thailand. Southeast Asian J. Trop. Med. Public Health, 39: 33-38.

Borthakur, S.K., D.K. Deka, S. Islam, D.K. Sarma and P.C. Sarmah, 2015. Prevalence and molecular epidemiological data on *Dirofilaria immitis* in dogs from Northeastern States of India. Sci. World J., 10.1155/2015/265385

Bruschi, F., J. Dupouy-Camet, W. Kociecka, E. Pozio and F. Bolas-Fernandez, 2002. Opinion on the diagnosis and treatment of human trichinellosis. Expert Opin. Pharmacother., 3: 1117-1130.

Chamuah, J.K., A. Sakhrie, P. Perumal, K. Khate, K. Vupru and C. Rajkhowa, 2015. Seroprevalence of *Toxoplasma gondii* in mithun (Bos frontalis) from north eastern hilly region of India. J. Parasit. Dis., 39: 560-562.

Chan, B.T., R.N. Amal, M.I. Hayati, H. Kino and N. Anisah *et al*., 2008. Seroprevalence of toxoplasmosis among migrant workers from different Asian countries working in Malaysia. Southeast Asian J. Trop. Med. Public Health, 39: 9-13.

Chen, Z., R. Mi, H. Yu, Y. Shi and Y. Huang *et al*., 2011. Prevalence of Cryptosporidium spp. in pigs in Shanghai, China. Vet. Parasitol., 181: 113-119.

Chhabra, M.B., S.L. Gupta and O.P. Gautam, 1985. Toxoplasma seroprevalence in animals in Northern India. Int. J. Zoonoses., 12: 136-142.

Chomel, B.B., 2008. Control and prevention of emerging parasitic zoonoses. Int. J. Parasitol., 38: 1211-1217.

Conlan, J.V., K. Vongxay, B. Khamlome, M.A. Gomez-Morales and E. Pozio *et al*., 2014. Patterns and risks of *Trichinella* infection in humans and pigs in Northern Laos. PLoS Negl. Trop. Dis., 10.1371/journal.pntd.0003034.

Cui, J., P. Jiang, L.N. Liu and Z.Q. Wang, 2013. Survey of *Trichinella* infections in domestic pigs from Northern and Eastern Henan, China. Vet. Parasitol., 194: 133-135.

De Graaf, D.C., E. Vanopdenbosch, L.M. Ortega-Mora, H. Abbassi and J.E. Peeters, 1999. A review of the importance of cryptosporidiosis in farm animals. Int. J. Parasitol., 29: 1269-1287.

Dixon, B.R., 2009. The Role of Livestock in the Food Borne Transmission of *Giardia* Duodenalis and *Cryptosporidium* spp. to Humans. In: *Giardia* and *Cryptosporidium*: From Molecules to Disease, Ortega-Pierres, M.G., S.M. Caccio, R. Fayer and H. Smith (Eds.). CAB International, Wallingford, UK., pp: 107-122.

Dorny, P., R. Somers, T.C.T. Dang, V.K. Nguyen and J. Vercruysse, 2004. Cysticercosis in cambodia, LAO PDR and vietnam. Southeast Asian J. Trop. Med. Public Health, 35: 223-226.

Dubey, J.P. and C.P. Beattie, 1988. *Toxoplasma* and Toxoplasmosis in Animals Including Man. CRC Press, Boca Raton, Florida.

Dubey, J.P., 2008. The history of *Toxoplasma gondii*-the first 100 years. J. Eukaryotic Microbiol., 55: 467-475.

Dupouy-Camet, J., 2000. Trichinellosis: A worldwide zoonosis. Vet. Parasitol., 93: 191-200.

FAO., 2009. How to feed the world in 2050. Proceedings of the Expert, June 24-26, 2009, FAO Headquarters, Rome.

Fatima, M., M.Z. Chishti, F. Ahmad and B.A. Lone, 2012. Epidemiological study of fasciolosis in cattle of Kashmir valley. Adv. Biol. Res., 6: 106-109.

Fayer, R., 2004. Cryptosporidium: A water-borne zoonotic parasite. Vet. Parasitol., 126: 37-56.

Ferlay, J., H.R. Shin, F. Bray, D. Forman, C. Mathers and D.M. Parkin, 2010. GLOBOCAN 2008: Cancer incidence and mortality worldwide. IARC CancerBase No. 10, International Agency for Research on Cancer, Lyon, France.

Fuehrer, H.P., M. Treiber, K. Silbermayr, T.A. Baumann, P. Swoboda, A. Joachim and H. Noedl, 2013. Indigenous *Dirofilaria immitis* in Bangladesh. Parasitol. Res., 112: 2393-2395.

Graczyk, T.K., J. Bosco-Nizeyi, B. Ssebide, R.C.A. Thompson, C. Read and M.R. Cranfield, 2002. Anthropozoonotic *Giardia duodenalis* genotype (assemblage) a infections in habitats of free-ranging human-habituated gorillas, Uganda. J. Parasitol., 88: 905-909.

Hopkins, R.M., B.P. Meloni, D.M. Groth, J.D. Wetherall, J.A. Reynoldson and R.C.A. Thompson, 1997. Ribosomal RNA sequencing reveals differences between the genotypes of *Giardia* isolates recovered from humans and dogs living in the same locality. J. Parasitol., 83: 44-51.

Hotez, P.J., P.J. Brindley, J.M. Bethony, C.H. King, E.J. Pearce and J. Jacobson, 2008. Helminth infections: The great neglected tropical diseases. J. Clin. Invest., 118: 1311-1321.

Hou, H., G. Shen, W. Wu, P. Gong and Q. Liu *et al*., 2011. Prevalence of *Dirofilaria immitis* infection in dogs from Dandong, China. Vet. Parasitol., 183: 189-193.

Huang, J., D. Yue, M. Qi, R. Wang and J. Zhao *et al*., 2014. Prevalence and molecular characterization of *Cryptosporidium* spp. and *Giardia duodenalis* in dairy cattle in Ningxia, Northwestern China. BMC Vet. Res., Vol. 10. 10.1186/s12917-014-0292-6

Hunter, P.R. and R.C.A. Thompson, 2005. The zoonotic transmission of *Giardia* and *Cryptosporidium*. Int. J. Parasitol., 35: 1181-1190.

Inpankaew, T., T. Jiyipong, N. Thadtapong, C. Kengradomkij, N. Pinyopanuwat, W. Chimnoi and S. Jittapalapong, 2015. Prevalence and genotype of *Giardia duodenalis* in dairy cattle from Northern and Northeastern part of Thailand. Acta Parasitologica, 60: 459-461.

Ito, A., M. Nakao and T. Wandra, 2003. Human taeniasis and cysticercosis in Asia. Lancet, 362: 1918-1920.

Jittapalapong, S., A. Sangvaranond, N. Pinyopanuwat, W. Chimnoi, W. Khachaeram, S. Koizumi and S. Maruyama, 2005. Seroprevalence of *Toxoplasma gondii* infection in domestic goats in Satun Province, Thailand. Vet. Parasitol., 127: 17-22.

Jittapalapong, S., N. Pinyopanuwat, W. Chimnoi, C. Siripanth and R.W. Stich, 2006. Prevalence of *Cryptosporidium* among dairy cows in Thailand. Ann. N.Y. Acad. Sci., 1081: 328-335.

Kabir, M.H., M. Eliyas, M.A. Hashem and O.F. Miazi, 2010. Prevalence of zoonotic parasitic diseases of domestic animals in different abattoir of Comilla and Brahman Baria region in Bangladesh. Univ. J. Zool., 28: 21-25.

Kaewpitoon, N., S.J. Kaewpitoon and P. Pengsaa, 2008. Food-borne parasitic zoonosis: Distribution of trichinosis in Thailand. World J. Gastroenterol., 14: 3471-3475.

Keiser, J. and J. Utzinger, 2005. Emerging foodborne trematodiasis. Emerg. Infect. Dis., 11: 1507-1514.

Khaing, T.A., 2012. Study on the prevalence of *Trichinella* infection in slaughtered pigs from three slaughterhouses in Nay Pyi Taw Area. M.Sc. Thesis, Department of Pharmacology and Parasitology, University of Veterinary Science, Yezin, Nay Pyi Taw.

Khaing, T.A., S. Bawm, S.S. Wai, Y. Htut and L.L. Htun, 2015. Epidemiological survey on porcine cysticercosis in Nay Pyi Taw area, Myanmar. J. Vet. Med. 10.1155/2015/340828

Kham, N.M., 2010. Comparative study on the prevalence of gastrointestinal nematodes and flukes infestation of cattle between middle Myanmar and Northern Shan State. M.V.Sc. Thesis, Department of Pharmacology and Parasitology, University of Veterinary Science, Yezin, Nay Pyi Taw.

Kyi, S., 2009. Prevalence of *Cryptosporidium* species and *Giardia* species in cattle within Pyawbwe and Yemathin Townships. M.V.Sc. Thesis, Department of Pharmacology and Parasitology, University of Veterinary Science, Yezin, Nay Pyi Taw.

Lay, K.K., H.C.F. Hoerchner, N. Morakote and K. Kreausukon, 2008. Prevalence of *Cryptosporidium*, *Giardia* and other gastrointestinal parasites in dairy calves in Mandalay, Myanmar. Proceedings of the 15th Congress of FAVA and OIE Joint Symposium on Emerging Diseases, October 27-30, 2008, Bangkok, Thailand, pp: 273.

Mas-Coma, S., 2005. Epidemiology of fascioliasis in human endemic areas. J. Helminthol., 79: 207-216.

Maung, W.Y., S. Bawm, L.L. Htun, S.S. Wai and M.Y. Win, 2014. Seroprevalence of *Toxoplasma gondii* and its associated risk factors in goats within Pyawbwe Township. Proceedings of the Annual Meeting of Myanmar Veterinary Association, December 27, 2014, Mandalay, Myanmar.

Moe, K.T., 2015. Prevalence and associated risk factors of cryptosporidiosis in mithun, cattle, buffaloes within Matupi Township, Southern Chin State. M.Sc. Thesis, Department of Pharmacology and Parasitology, University of Veterinary Science, Yezin, Nay Pyi Taw, Myanmar.

Murphy, F.A., 1999. The threat posed by the global emergence of livestock, food-borne and zoonotic pathogens. Ann. N.Y. Acad. Sci., 894: 20-27.

Nissapatorn, V., M.A. Noor Azmi, S.M. Cho, M.Y. Fong and I. Init *et al*., 2003. Toxoplasmosis: Prevalence and risk factors. J. Obstetr. Gynnaecol., 23: 618-624.

O'Handley, R.M. and M.E. Olson, 2006. Giardiasis and cryptosporidiosis in ruminants. Vet. Clin. North Am.: Food Anim. Pract., 22: 623-643.

O'Handley, R.M., C. Cockwill, T.A. McAllister, M. Jelinski, D.W. Morck and M.E. Olson, 1999. Duration of naturally acquired giardiosis and cryptosporidiosis in dairy calves and their association with diarrhea. J. Am. Vet. Med. Assoc., 214: 391-396.

Olson, M.E., R.M. O'Handley, B.J. Ralston, T.A. McAllister and R.C.A. Thompson, 2004. Update on *Cryptosporidium* and *Giardia* infections in cattle. Trends Parasitol., 20: 185-191.

Olson, M.E., T.A. McAllister, L. Deselliers, D.W. Morck, K.J. Cheng, A.G. Buret and H. Ceri, 1995. Effects of giardiasis on production in a domestic ruminant (lamb) model. Am. J. Vet. Res., 56: 1470-1474.

Paul, S., D. Chandra, D. Ray, A.K. Tewari and J.R. Rao *et al*., 2008. Prevalence and molecular characterization of bovine *Cryptosporidium* isolates in India. Vet. Parasitol., 153: 143-146.

Phalee, A. and C. Wongsawad, 2014. Prevalence of infection and molecular confirmation by using ITS-2 region of *Fasciola gigantica* found in domestic cattle from Chiang Mai province, Thailand. Asian Pac. J. Trop. Med., 7: 207-211.

Pozio, E. and K.D. Murrell, 2006. Systematics and epidemiology of *Trichinella*. Adv. Parasitol., 63: 367-439.

Pozio, E., E. Hoberg, G. La Rosa and D.S. Zarlenga, 2009. Molecular taxonomy, phylogeny and biogeography of nematodes belonging to the *Trichinella* genus. Infect. Genet. Evol., 9: 606-616.

Qi, M., J. Cai, R. Wang, J. Li and F. Jian *et al*., 2015. Molecular characterization of *Cryptosporidium* spp. and *Giardia duodenalis* from yaks in the Central Western region of China. BMC Microbiol. 10.1186/s12866-015-0446-0

Robertson, L.J., B.K. Gjerde and E.F. Hansen, 2010. The zoonotic potential of *Giardia* and *Cryptosporidium* in Norwegian sheep: A longitudinal investigation of 6 flocks of lambs. Vet. Parasitol., 171: 140-145.

Scott, C.A., H.V. Smith and H.A. Gibbs, 1994. Excretion of *Cryptosporidium parvum* oocysts by a herd of beef suckler cows. Vet. Rec., 134: 172-172.

Shahiduzzaman, M., M.R. Islam, M.M. Khatun, T.A. Batanova, K. Kitoh and Y. Takashima, 2011. *Toxoplasma gondii* seroprevalence in domestic animals and humans in Mymensingh district, Bangladesh. J. Vet. Med. Sci., 73: 1375-1376.

Shao, D., Z. Shi, J. Wei and Z. Ma, 2011. A brief review of foodborne zoonoses in China. Epidemiol. Infect., 139: 1497-1504.

Siddiki, A.Z., S.A. Mina, Z. Farzana, B. Ayesa, R. Das and M.A. Hossain, 2015. Molecular characterization of *Cryptosporidium xiaoi* in goat kids in Bangladesh by nested PCR amplification of 18S rRNA gene. Asian Pac. J. Trop. Biomed., 5: 202-207.

Simon, F., R. Morchon, J. Gonzalez-Miguel, C. Marcos-Atxutegi and M. Siles-Lucas, 2009. What is new about animal and human dirofilariosis? Trends Parasitol., 25: 404-409.

Singh, B.B., R. Sharma, J.K. Sharma and P.D. Juyal, 2010. Parasitic zoonoses in India: An overview. Rev. Sci. Tech. Int. Off. Epiz., 29: 629-637.

Singh, H., A.K. Tewari, A.K. Mishra, B. Maharana, V. Sudan, O.K. Raina and J.R. Rao, 2015. Detection of antibodies to *Toxoplasma gondii* in domesticated ruminants by recombinant truncated SAG2 enzyme-linked immunosorbent assay. Trop. Anim. Health Prod., 47: 171-178.

Slifko, T.R., H.V. Smith and J.B. Rose, 2000. Emerging parasite zoonoses associated with water and food. Int. J. Parasitol., 30: 1379-1393.

Sripa, B., S. Kaewkes, P.M. Intapan, W. Maleewong and P.J. Brindley, 2010. Food-borne trematodiases in Southeast Asia: Epidemiology, pathology, clinical manifestation and control. Adv. Parasitol., 72: 305-350.

Sun, M., W. Zhuo, S. Guo, S. Liao and D. Shi *et al*., 2012. Serological survey of canine dirofilariosis in Chongqing, Kunming, Nanchang, Fuzhou, Guangzhou, Shenzhen and Nanning in Southern China. Vet. Parasitol., 185: 225-228.

Taira, N., H. Yoshifuji and J.C. Boray, 1997. Zoonotic potential of infection with *Fasciola* spp. by consumption of freshly prepared raw liver containing immature flukes. Int. J. Parasitol., 27: 775-779.

Taylor, W.R.J., G. Van Tran, T.Q. Nguyen, D. Van Dang and V.K. Nguyen *et al*., 2009. Acute febrile myalgia in Vietnam due to trichinellosis following the consumption of raw pork. Clin. Infect. Dis., 49: e79-e83.

Thaw, Y., T.A. Khaing, S.S Wai, K.S. Lin, L.L. Htun and S. Bawm, 2014. Seroprevalence and associated risk factors of porcine toxoplasmosis within Nay Pyi Taw area. Proceedings of the Annual Meeting of Myanmar Veterinary Association, December 27, 2014, Mandalay, Myanmar.

Thompson, R.C.A. and P.T. Monis, 2004. Variation in *Giardia*: Implications for taxonomy and epidemiology. Adv. Parasitol., 58: 69-137.

Thompson, R.C.A., 2004. The zoonotic significance and molecular epidemiology of *Giardia* and giardiasis. Vet. Parasitol., 126: 15-35.

Thu, M.J., 2013. Prevalence and associated risk factors of liver fluke infestation in cattle from Taunggyi area. M.Sc. Thesis, Department of Pharmacology and Parasitology, University of Veterinary Science, Yezin, Nay Pyi Taw, Myanmar, Asia.

WHO., 2010. First WHO report on neglected tropical diseases: Working to overcome the global impact of neglected tropical diseases. WHO/HTM/NTD/2010.1, World Health Organzation, Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/44440/1/9789241564090_eng.pdf.

WHO., 2015. Foodborne trematode infections. World Health Organzation, Geneva, Switzerland. http://www.who.int/foodborne_trematode_infections/infections_more/en/.

Waikagul, J., P. Dekumyoy and M.T. Anantaphruti, 2006. Taeniasis, cysticercosis and echinococcosis in Thailand. Parasitol. Int., 55: S175-S180.

Wang, C.R., J.H. Qiu, J.F. Gao, L.M. Liu and C. Wang *et al*., 2011. Seroprevalence of *Toxoplasma gondii* infection in sheep and goats in northeastern China. Small Rumin. Res., 97: 130-133.

Wang, H., G. Zhao, G. Chen, F. Jian and S. Zhang *et al*., 2014. Multilocus genotyping of *Giardia duodenalis* in dairy cattle in Henan, China. PLoS ONE, Vol. 9. 10.1371/journal.pone.0100453

Wang, Z.Q., J. Cui and L.J. Shen, 2007. The epidemiology of animal trichinellosis in China. Vet. J., 173: 391-398.

Willingham, III A.L., H.W. Wu, J. Conlan and F. Satrija, 2010. Combating *Taenia solium* cysticercosis in Southeast Asia: An opportunity for improving human health and livestock production. Adv. Parasitol., 72: 235-266.

Yadav, C.L., R. Garg, P.S. Banerjee, R.R. Kumar and S. Kumar, 2009. Epizootiology of *Fasciola gigantica* infection in cattle and buffaloes in Western Uttar Pradesh, India. J. Vet. Parasitol., 23: 135-138.

Yuan, W., J.M. Liu, K. Lu, H. Li and M.M. Duan *et al*., 2015. Molecular identification and seasonal infections of species of *Fasciola* in ruminants from two provinces in China. J. Helminthol., (In Press). 10.1017/S0022149X15000383

Zhao, G.H., M.T. Zhang, L.H. Lei, C.C. Shang and D.Y. Cao *et al*., 2011. Seroprevalence of *Toxoplasma gondii* infection in dairy goats in Shaanxi Province, Northwestern China. Parasit. Vectors, Vol. 4. 10.1186/1756-3305-4-47