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

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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

<table>
<thead>
<tr>
<th>Parasitic zoonoses</th>
<th>Study area</th>
<th>Species</th>
<th>Prevalence (%)</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helminthiasis</strong></td>
<td></td>
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<tr>
<td><em>T. solium</em> cysticercosis</td>
<td>Nay Pyi Taw</td>
<td>Pig</td>
<td>15.93</td>
<td>ELISA</td>
<td>Tin Aye Khaing <em>et al.</em> (2014)</td>
</tr>
<tr>
<td>Trichinellosis</td>
<td>Nay Pyi Taw</td>
<td>Pig</td>
<td>3.30</td>
<td>Digestion method</td>
<td></td>
</tr>
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<td>Dirofilariosis</td>
<td>Nay Pyi Taw</td>
<td>Dog</td>
<td>18.70</td>
<td>RTKSi</td>
<td>Thu Aung (2014)</td>
</tr>
<tr>
<td><strong>Protozoal diseases</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giardiasis</td>
<td>Pyawbwe and Yamethin Sandar Kyi (2009)</td>
<td>Cattle</td>
<td>22.50</td>
<td>ZN stained method</td>
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<td>Cryptosporidiosis</td>
<td>Mandalay</td>
<td>Cattle</td>
<td>56.00</td>
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<td>Toxoplasmosis</td>
<td>Mandalay</td>
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<td>Lay <em>et al.</em> (2008)</td>
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<td>Mandalay</td>
<td>Goat</td>
<td>10.00</td>
<td>LAT</td>
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<td>Goat</td>
<td>6.60</td>
<td>&quot;</td>
<td>&quot;</td>
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<td>Pyin Oo Lwin</td>
<td>Goat</td>
<td>20.70</td>
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<td>Pyawbwe</td>
<td>Goat</td>
<td>7.90</td>
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<td>Wint Yi Maung <em>et al.</em> (2014)</td>
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<td>Nay Pyi Taw</td>
<td>Pig</td>
<td>18.40</td>
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<td>Yunandi Thaw <em>et al.</em> (2014)</td>
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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 based 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. straita, 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).

ZOO NOTIC PRO TOZOAL 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 (Ky, 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 pathogenicity, 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 immunosuppressed 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 Bangladesh, 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 higher 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 (Jittapala 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 needs 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.

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