PREFACE

Control of cestode zoonoses in Asia: role of basic and applied science

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On a global scale, human cystic and alveolar echinococcoses and cysticercosis, caused by *Taenia solium,* are classed as neglected zoonotic diseases (NZD) due to their high burden of disease which together is greater than 2 million lost DALYs (WHO, 2005, 2010; Budke *et al.* 2006; Craig *et al.* 2007). These cestodes require two mammalian hosts for the completion of their life-cycle through natural or anthropogenic-mediated predator–prey systems.

Human taeniases are caused by the adult stage of three species, *Taenia solium*, *T. saginata* and *T. asiatica* all of which are food- or meat-borne cestodiases (Ito *et al.* 2003*a*; Pawlowski, 2006; Flisser *et al.* 2011). *T. solium* is unique, since it is the only one of these three species that can cause human cysticercosis, one of the most potentially lethal helminthiases contracted from accidental ingestion of eggs of this species (Ito *et al.* 2003*a*). Animal cysticercoses, caused by the three human *Taenia* species as well as several other *Taenia* species, normally infect domestic and/or wild animals. In developed countries, where meat inspection is routine and livestock generally raised under strict controls, human taeniases are uncommon.

In this special issue, we mainly focus on taeniases/cysticercoses and echinococcoses in developing countries and regions of Eurasia. To begin with Ito (2013) reviews the caveats and advances in immunological and molecular studies of cestode zoonoses based on over 40-years' experience. The first topics in this special issue focus on human taeniases as food-borne infections. They are generally more common in rural areas where under-cooked contaminated meat (muscle) or viscera are consumed in local communities without meat inspection (Li *et al.* 2013; Wandra *et al.* 2013). Human cysticercosis, caused by the ingestion of the eggs of *T. solium*, has been considered to be the major causative agent of the late-onset epilepsy in developing countries where pork consumption is common (Lightowlers, 2013; Raoul *et al.* 2013). *T. solium* is unique, since it causes two different parasitoses in humans through its life-cycle completion: (i) cysticercosis due to the ingestion of eggs with development of cysticerci, mainly in muscles but also, more problematically, in the brain (neurocysticercosis), and (ii) taeniasis due to the ingestion of cysticerci from uncooked pork contaminated with the metacestode stage (Wandra *et al.* 2013). Pigs may be infected with Eggs not only of *T. solium* or *T. asiatica* but also other non-human *Taenia* species, such as *T. hydatigena* (Ito, 2013). The occurrence of *T. solium* transmission in a region presents a high risk for humans acquiring accidental cysticercosis, either from self-infection (e.g. adult worm carrier) or from tapeworm carriers living in the same community (Sorvillo *et al.* 1992; Li *et al.* 2013; Wandra *et al.* 2013). Taeniid eggs cannot be differentiated morphologically; therefore advanced immunological and molecular methods are essential for accurate diagnosis and should be combined with the analysis of spatial patterns of distribution for evidence-based control (Raoul *et al.* 2013; Sako *et al.* 2013). *T. solium* cysticercosis has also been classed as a potentially eradicable disease (Schantz *et al.* 1983; Pawlowski, 2006) for which accurate surveillance is of paramount importance.

Lightowlers (2013) overviews the future prospects for control of *T. solium* taeniasis/cysticercosis (T/C). Raoul *et al.* (2013) discuss spatially explicit

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approaches for epidemiological studies on T/C, while Sako *et al*. (2013) describe a new simple method for purification of diagnostic antigens applicable in endemic *T. solium* areas. Yamane *et al*. (2013) present data that confirms occurrence of hybrids between *T. saginata* and *T. asiatica*. Li *et al*. (2013) stress the usefulness of self-detection and stool microscopy in community-based mass screening for taeniases. The final article in the opening section is an overview by Wandra *et al*. (2013) on T/C in Indonesia.

By contrast with *Taenia* spp., the life cycles of *Echinococcus* species are completed through domestic animals and/or wildlife. In echinococcoses, humans are infected by accidental ingestion of parasite eggs, and are generally a dead-end for the parasite (Macpherson, 1983; Rausch, 1995). However, echinococcoses caused by metacestodes established in parenteral tissues, mainly the liver and the lungs, are severe and potentially lethal to humans.

Echinococcoses are widespread diseases caused by environmental contamination of parasite eggs by canid definitive hosts such as dogs, foxes and wolves via faeces. Human alveolar echinococcosis (AE) due to *Echinococcus multilocularis* occurs focally in regions of developed and developing countries of the northern hemisphere, while human cystic echinococcosis (CE) due to *E. granulosus* is of greater concern because it has a worldwide distribution (Giraudoux *et al*. 2013*a*; Said Ali *et al*. 2013; Torgerson, 2013).

Cystic echinococcosis, caused by the ingestion of eggs of the dog tapeworm *E. granulosus* sensu stricto (genotypes G1–G3), has been widely recognized as an endemic disease in pastoral regions. Recent molecular re-evaluation of *E. granulosus* has revealed that *E. granulosus* sensu lato includes 5 different independent species: *E. granulosus* s.s., *E. equinus, E. ortleppi, E. canadensis* and *E. felidis* (Nakao *et al*. 2010). Molecular approaches for identification of pathogenic *Echinococcus* species will become more essential for future epidemiological studies. *E. multilocularis* was originally considered to be mainly distributed in European alpine countries and in western Alaska half a century ago (Rausch and Fay, 2002); however, it has since been found widely distributed in mountainous or upland areas in almost all countries in the holarctic and central regions of Eurasia and has expanded its range in temperate areas of Europe (Craig *et al*. 2000, 2008; Romig *et al*. 2006; Torgerson *et al*. 2006; Beiromvand *et al*. 2012; Combes *et al*. 2012; Konyaev *et al*. 2012).

The second topic in this section concerns the taxonomy of the genus *Echinococcus*. McManus (2013) overviews some historical observations on the biology and taxonomy of *Echinococcus*. Nakao *et al*. (2013) consider the taxonomic status of *E. canadensis, and* Konyaev *et al*. (2013) report recent data on *Echinococcus* spp. in Russia and describe, for the first time, different genotypes of *E. multilocularis* and *E. canadensis*, G6, G7 and G10 in that country. Ito *et al*. (2013) also consider *E. multilocularis* and *E. canadensis*, G6/7 and G10 from wild canids and describe, for the first time, the sympatric occurrence of G6/7 and G10 genotypes in wolves.

Thirdly, various aspects of transmission ecology and epidemiology of echinococcoses in Eurasia are discussed. Giraudoux *et al*. (2013*a*) present regional types of transmission of *E. multilocularis* and their ecological characteristics in China and Central Asia. Torgerson (2013) overviews the current position of echinococcoses in Central Asia while Van Kesteren *et al*. (2013) assess dog demographics, roles of dogs, dog movements and faecal environmental contamination of rural communities of southern Kyrgyzstan. Moss *et al*. (2013) attempt to evaluate *Echinococcus* spp. re-infection patterns of treated dogs on the Tibetan plateau, China. The last article in this section points out the importance of investigating distributions at several scales to better understand their nested clustered structure using data from the French National Registry on human AE (Said Ali *et al*. 2013).

There are several common problems for control or eradication of NTDs (including echinococcoses and cysticercosis). (1) Major endemic areas of cysticercosis and CE are predominantly in developing countries, especially in rural or remote areas where people are living under poor socio-economic conditions; (2) The lack of priority for control of NTDs in developing countries; and (3) The absence of reliable data due to the lack of scientifically reliable tools and methods for identifying infected people in their communities.

In addition, echinococcoses and cysticercosis/taeniases are NZDs and thus present a greater problem for control because of the necessity to manage or treat domestic animals (dogs, livestock) or wildlife (foxes, wolves). This is usually complicated by the lack of communication on surveillance between human and animal health authorities. Therefore, the burden of zoonotic cestodiases is largely underestimated (Budke *et al*. 2006; WHO, 2010).

Towards control of these cestode zoonoses, we have to clarify which are the risk factors (Van Kesteren *et al*. 2013; Lightowlers, 2013; Moss *et al*. 2013; Torgerson, 2013) and their distribution in time and space (Giraudoux *et al*. 2013*a*; Raoul *et al*. 2013). It also requires us to identify the parasite species (Ito *et al*. 2013; Konyaev *et al*. 2013; Nakao *et al*. 2013; Said Ali *et al*. 2013; Sako *et al*. 2013). This can be effected by integrating human and animal epidemiology with host behaviour and parasite ecology (Raoul *et al*. 2013). In this symposium, we have tried to link molecular (Ito *et al*. 2013; Konyaev *et al*. 2013; McManus, 2013; Nakao *et al*. 2013), immunological (Sako *et al*. 2013) and spatial ecology approaches (Giraudoux *et al*. 2013*a*; Van Kesteren *et al*. 2013; Moss *et al*. 2013; Raoul *et al*. 2013) in order to provide research-based evidence towards control of cestode zoonoses (Danson *et al*. 2006; Giraudoux *et al*. 2006, 2007, 2008, 2013*b*). One of the most important strategies for efficient control of taeniasis and cysticercosis may be to establish or to introduce real-time detection of patients in the endemic areas themselves (Raoul *et al*. 2013; Sako *et al*. 2013).

A series of meetings on Cestode Zoonoses has been organized in Asia, sponsored by the Japanese Society for the Promotion of Science since 2000 (Ito, 2007). Here we have to acknowledge the pioneering contributions in China towards control of echinococcoses that have been coordinated through a team of scientists from America, Europe, Australia, New Zealand and Japan (Andersen *et al*. 1993; Craig *et al*. 2000, 2003; Craig and Pawlowski, 2002; Ito *et al*. 2003*b*, 2006; Schantz *et al*. 2003; Xiao *et al*. 2003, 2005; Mamuti *et al*. 2004, 2007; Heath *et al*. 2005; Li *et al*. 2005, 2006; Bart *et al*. 2006; Nakao *et al*. 2010; Giraudoux *et al*. 2013*b*) as well as the contribution towards the control of echinococcoses made by scientists from China (Wen *et al*. 2005) and of cysticercosis (Chen *et al*. 2005) as joint projects with scientists from Japan (Ito *et al*. 2003*b*, 2005).

This symposium, held in Shanghai in 2012, was launched and co-organized by two of the Guest-Editors, Akira Ito (Japan) and Xiao-Nong Zhou (China) and supported by the Asian Science and Technology Strategic Cooperation Promotion Programs sponsored by the Special Coordination Funds for Promoting Science and Technology, Ministry of Education, Japan (MEXT) (2010–2012) and the national office of the Chinese Center for Disease Control and Prevention.

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