High prevalence of *Taenia saginata* taeniasis and status of *Taenia solium* cysticercosis in Bali, Indonesia, 2002-2006

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Taenia saginata or Taenia asiatica is a human tapeworm which can cause taeniasis by the presence of adult worm (s) in the small intestine. *Taenia solium* is a human tapeworm which can cause two distinct clinical presentations: taeniasis, and cysticercosis by the presence of larval stage (cysticercus/cysticerci) in the tissues including brain, muscle, eyes etc.

Field survey (in Papua)

There are three endemic provinces for taeniasis/cysticercosis in Indonesia. They are: Bali, Papua (former Irian Jaya), and North Sumatra. Case with taeniasis and/or cysticercosis have also been reported sporadically from several other provinces. In this dissertation we focused on taeniasis/cysticercosis in Bali.

The important issues in Bali are: 1) Although the majority of population in Bali is Hindu (93.4%) they eat beef, and as such would be expected to be infected with *T. saginata*; 2) Previous surveys showed that local people consumed pork more frequently, but *T. saginata* taeniasis was more common. It was assumed that the infection in humans resulted from *T. asiatica*. However, there was no molecular data on these parasite infections to clarify the true source of human infection at that time; 3) It is thought that *T. solium* taeniasis/cyticercosis was introduced into Papua from Bali.

The objectives of the study are: 1) To determine the present situation of taeniasis/cysticercosis in Bali; 2) To identify the species of Taenia; 3) To determine risk factors/transmission of this parasitic disease in Bali; and 4) The most importantly to utilize the knowledge obtained from 1), 2), and 3) to contribute to control programs of taeniasis/cysticercosis in Bali.

Laboratory work

An epidemiological study was carried out in five villages in four districts of Bali in 2002-2006. In the field, diagnosed of taeniasis was


With President of Asahikawa Medical College and colleagues

based on questionnaire method and demonstrated of proglottid and/or results of stool examination, and then taeniasis patients were treated with praziquantel. Suspected cysticercosis was based on anamnesis particularly history of epileptic seizures and physical examination including palpation of subcutaneous nodule. Identified of parasite by morphological examination. Later, serological examination (ELISA and immunoblot) and molecular analysis (multiplex PCR and DNA sequencing) were carried out at Asahikawa Medical College.

Among 540 local people, prevalence rates of *T. saginata* taeniasis were detected to be ranged from 1.1% in Badung in 2004 and in Karang Asem as well in 2006 up to 27.5% in Gianyar (Ketewel village) in 2004. The prevalence rates of *T. saginata* taeniasis were increased dramatically in Gianyar including in 2002 (25.6%) and 2005 (23.8%), compared to previous surveys in 1977 (2.1%) and in 1999 (1.3%), respectively. It is suggested due to the number of families consumed raw beef (beef *lawar*) has increased. Interestingly, based on passive case finding, only seven *T. saginata* taniasis cases were found in 2002. However, when 48 taeniasis patients in Gianyar, who expelled tapeworm after treatment in 2002-2005, were re-examined in 2003-2006, there were no cases of re-infections with *T. saginata*. All of them reported that they stopped eating beef *lawar* after they recognized that they harbored tapeworms but few persons could not afford to stop eating beef *lawar* after one-three months expulsion of tapeworms. In another village of Gianyar (Pagesangan) in 2006, only 2 (3.6%) of *T. saginata* taeniasis patients among 56 local people were found.

By contrast, *T. solium* taeniasis/ cysticercosis is now rather rare in Bali probably due to improvement in sanitation and pig husbandry. Among 596 local peoples, there was no indication of *T. solium* taeniasis, history of epileptic seizures and subcutaneous nodules except 2 seropositive of 451 serum samples, included 0.8% (1/125) in Gianyar in 2002 and 2.8% (1/36) in Karang Asem in 2006, respectively. Compared to previous reports (1960-1997), a total of six *T. solium* taeniasis were detected. Both subcutaneous cysticercosis (SCC) and neurocysticercosis (NCC) were reported with the frequency of NCC (33) approximately three times was higher than SCC (12). Based on mitochondrial (mt)DNA analysis, all 66 tapeworms


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expelled from 66 worm carriers during 2002-2006 were confirmed to be *T. saginata*. There is no evidence the existence of *T. asiatica* in human in Bali probably due to local people like uncooked meat with blood (*pork lawar*), but they do not like uncooked viscera.

Mitochondrial DNA of cysticercus sample from a NCC patient in hospital with two subcutaneous nodules was analyzed. *Cox1* fragment of 1188-bp was successfully amplified from this sample. DNA sequencing of the PCR product revealed the cysticercus *T. solium* Asian genotype. Compared to samples from Papua, there is no evidence so far can proves that *T. solium* taeniasis/cyticercosis was introduced into Papua from Bali. The molecular analysis of these samples revealed the difference nucleotide sequences at 4 positions *cox1* gene. In addition, the nucleotide at position 650 was thymine (T) instead of cytosine (C). So far, the nucleotide at 650, T, is unique to *T. solium* isolates from Bali. The nucleotide sequences of *T. solium* from Bali, Papua are from AB271234, AB066488, respectively.

The source of infection with *T. saginata* taeniasis was related to consuming of local raw beef dish (beef *lawar*) under inadequate meat and food (*lawar*) inspections. According to Bali Provincial Livestock Office Services in 2004, many cattle/pigs from many places in Bali were also slaughtered in *illegitimate* slaughterhouses, and then distributed to the markets. Quality control of beef/pork in these *illegitimate* slaughterhouse as well as meat hygiene in the markets is rather difficult due to the limitation number of inspectors. The risk factors for *T. saginata* taeniasis are: age, gender, level of education, consumption of beef *lawar*, and source of *lawar*. Furthermore, a total of 3 of 66 taeniasis cases were *lawar* sellers and had suffered from *T. saginata* taeniasis for 1-10 years. Several the other taeniasis carriers also bought lawar from these sellers.

In order to control of taeniasis/cysticercosis in Bali, the following strategies appear to have priority: 1) Active case finding (active surveillance) and treat the tapeworm carriers; 2) Check *lawar* hygiene in the market including *lawar* sellers' health, periodically; 3) Establish a system to check the quality of beef/pork and look for distribution of infected animals in Bali; and 4) Sustainable public health education.