Acta Tropica 163 (2016) 46–53

Contents lists available at ScienceDirect

Acta Tropica

journal homepage: www.elsevier.com/locate/actatropica

Swine cysticercosis in the Karangasem district of Bali, Indonesia: An evaluation of serological screening methods

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ARTICLE INFO

Article history:
Received 5 June 2016
Received in revised form 5 July 2016
Accepted 28 July 2016
Available online 29 July 2016

Keywords:
Taenia solium
Taenia hydatigena
Cysticercosis
Pig
Serology
ELISA
Western blot
Necropsy
Bali
Indonesia

ABSTRACT

A serological assessment was undertaken on pigs from the Kubu and Abang sub-districts of Karangasem on the island of Bali, Indonesia, where earlier studies had detected patients with cysticercosis. Antigens purified from *Taenia solium* cyst fluid by cation-exchange chromatography were used to evaluate antibody responses in the pigs and the serological tests were also evaluated using sera from pigs experimentally infected with *T. solium* eggs. A total of 392 serum samples from naturally exposed pigs were tested using an ELISA that could be read based on both a colour change perceptible by the naked eye and an ELISA based on absorbance values. Twenty six (6.6%) pigs were found seropositive by the naked-eye ELISA and were categorized into three groups: strongly positive (absorbance values >0.8, $n=6$), moderately positive (absorbance values between 0.2 and 0.8, $n=7$), and weakly positive (absorbance values <0.2, $n=13$). Necropsies performed on 11 strongly and moderately positive pigs revealed that six strongly positive pigs were infected either solely with *T. solium* cysticerci ($n=3$), or co-infected with both *T. solium* and *Taenia hydatigena* ($n=3$). Four moderately positive pigs were infected solely with *T. hydatigena*. No cysticerci were found in one pig that was moderately positive by the naked-eye ELISA. Two experimentally infected pigs became antibody positive by 6 weeks post-infection, whereas eight control pigs remained negative. An additional 60 pigs slaughtered at authorized abattoirs on Bali were tested using the same ELISA. All 60 pigs were seronegative with no evidence of *Taenia* infection at necropsy. The results confirm the presence of porcine cysticercosis on Bali and, while the serological responses seen in *T. solium* infected animals were much stronger than those infected with *T. hydatigena*, the diagnostic antigens are clearly not species specific. Further studies are necessary to confirm if it is possible to draw a cut off line for differentiation of pig infected with *T. solium* from those infected with *T. hydatigena*.

1. Introduction

The larval form of the pork tapeworm, *Taenia solium*, causes cysticercosis in pigs and humans that become infected primarily via accidental ingestion of eggs or gravid proglottids released with the faeces of human tapeworm carriers. The parasite's life cycle is well maintained in poor, rural communities or villages where

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http://dx.doi.org/10.1016/j.actatropica.2016.07.022
0001-706X/

meat inspection is absent or inadequate, and where pigs roam freely with poor sanitation (Ito et al., 2014, 2016; Lightowlers et al., 2016; Molyneux et al., 2011; Pawlowski, 2016; Pawlowski et al., 2005; Schantz et al., 1993, 1998; Wandra et al., 2015). Serology is used to try to identify infected pigs in a relatively non-invasive manner. However, antigen detection ELISA is limited in its ability to detect swine cysticercosis since it cannot differentiate pigs infected with other *Taenia* species, including *Taenia hydatigena* and *Taenia asiatica* (Geerts et al., 1992; Ito, 2013; Ito et al., 2016). This is especially true for areas with known *T. hydatigena* infections, such as regions of Africa, Southeast Asia, and Latin America (Braae et al., 2015; Sato et al., 2003; Sciutto et al., 1998). Limited data exist on the specificity of serological testing when applied to pigs in *T. hydatigena* co-endemic areas (Braae et al., 2015; Devleesschauwer et al., 2013; Ito et al., 2014, 2016; Sato et al., 2003; Sciutto et al., 1998).

Antigens purified from *T. solium* cyst fluid by preparative isoelectric focusing (IEF) have been found to be useful for detecting human cysticercosis cases (Ito et al., 1998) as well as pigs and dogs naturally infected with *T. solium* in China, Indonesia, and Ecuador by both ELISA and immunoblot (Ito et al., 1999, 2002). However, simpler and less expensive purification methods are needed to make these diagnostic tests more user-friendly under field conditions, with cation-exchange chromatography (CEC) showing promising results (Sako et al., 2013). Unfortunately, there has been no critical evaluation of the cross-reactivity of these diagnostic antigens in pigs infected with other *Taenia* species, including *T. hydatigena* and/or *T. asiatica*. Therefore, caution is needed when assessing serological findings using these tests for pigs in *T. solium* endemic areas (Ito, 2013; Ito et al., 2014, 2016; Wandra et al., 2015).

As the definitive host for *T. hydatigena* is the dog, and both pigs and dogs are typically present in *T. solium* endemic areas, it

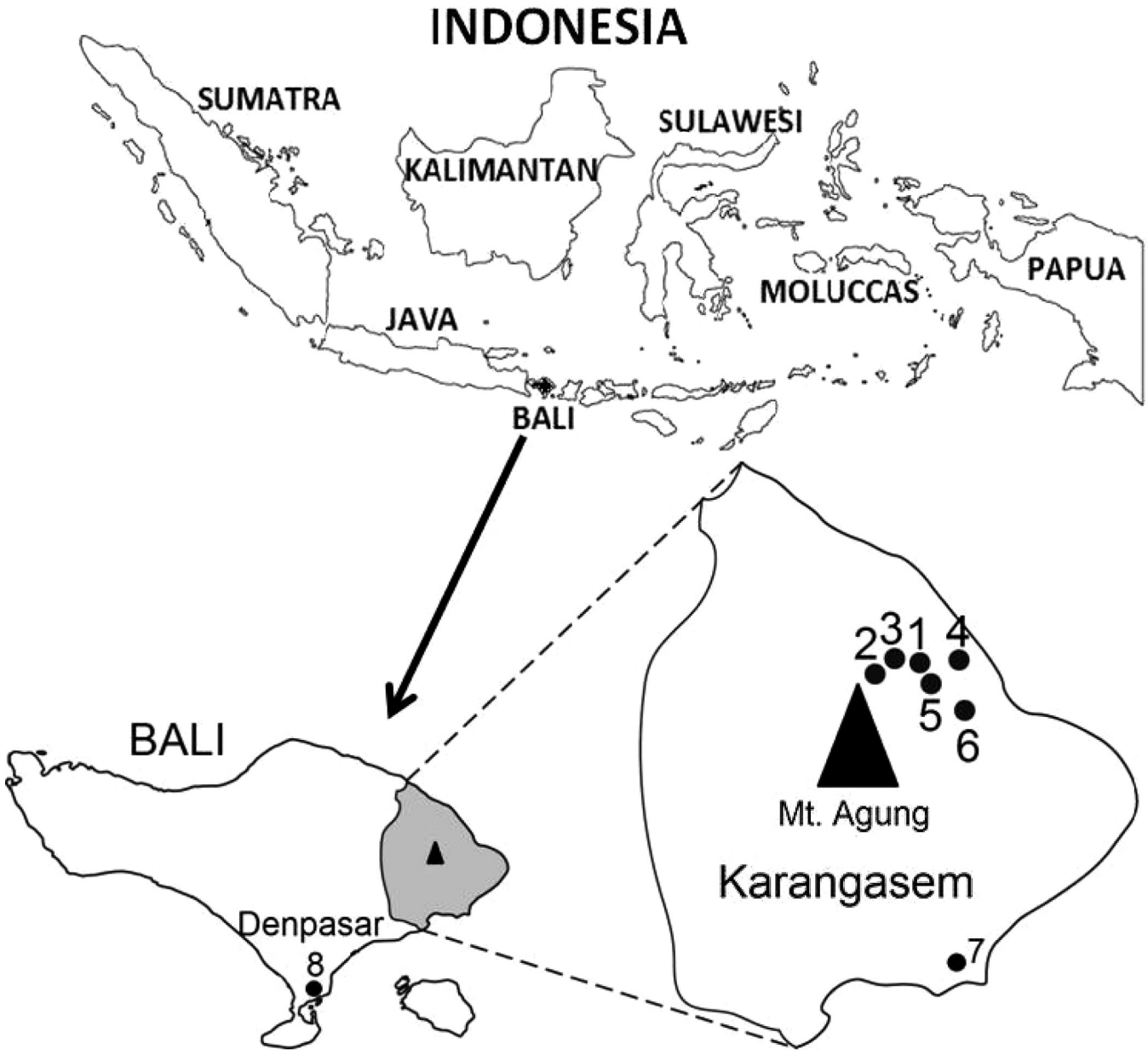

Fig. 1. Map of Bali showing Karangasem, one of Bali's 9 districts. Karangasem is now recognized as a focal endemic area for *T. solium* transmission. *T. solium* in pigs and humans have been confirmed from 6 banjars shown as 1–6 on the map (1: Pangeno, 2: Batugiling, 3: Bahel, 4: Batudawa Kelod, 5: Batudawa Kaja, 6: Bingin). Two authorized abattoirs in Karangasem and Denpasar are also shown as 7 and 8, respectively. Endemic areas are located on the eastern slope of Mt. Agung, which tends to be more socioeconomically disadvantaged compared to other parts of Bali (Wandra et al., 2015).