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Raw attitudes, wetland cultures, life-cycles: Socio-cultural dynamics relating to *Opisthorchis viverrini* in the Mekong Basin

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ABSTRACT

Opisthorchis viverrini is one of the most common and medically important food-borne parasites in the Lower Mekong area of Southeast Asia. As we learn more about its ecology, pathology and epidemiology we see the need to consider more deeply the socio-cultural dynamics with which food-borne species complexes are associated. This paper argues that the Mekong region is characterized by strong livelihoods and life-style associations within wetland ecosystems, which are inseparable from human eating habits ("raw attitudes"). Within the fish-rice economies of the region there are many long-cherished food cultures based on eating raw, semi-cooked and fermented fish dishes, which are known to lead to opisthorchiasis, and potentially cholangiocarcinoma. This paper examines evidence from northeast Thailand showing that dedicated health outreach campaigns do help to reduce prevalence of opisthorchiasis over time. For disease prevention and health education approaches to be most effective, they must be sensitive to culture, livelihood economics, gender, and age. Further integrative, inter-disciplinary and international research must incorporate the complex dynamics of parasite ecology, human behavior, socio-economics, and public health awareness.

1. *Opisthorchis viverrini*, human infection and wetland cultures in the Lower Mekong Sub-region

Food-borne parasitic infections are recognized globally as 'emerging' [1], 'neglected' [2], and 'under-estimated' problems of world health today [3]. In Southeast Asia, the most important of these parasites is *Opisthorchis viverrini*, which is distributed throughout the Lower Mekong Sub-region (Fig. 1), where the Northeast of Thailand has been an epicenter of research on prevalence, human infection and the opisthorchiasis-associated cholangiocarcinoma [3–10]. In the Mekong Basin there are significant health risks associated with the consumption of raw, semi-cooked or fermented fish and other aquatic animals that may contain infective parasite life stages, including liver, lung and intestinal flukes [5,8,11]. There are estimated to be 9 million people infected with *O. viverrini* in the north and northeast of Thailand and in Laos alone [7,12], with approximately 6 million of these being from Thailand at a mean prevalence of 9.4% based on a 2001 national survey [13]. For the Lower Mekong Sub-region there is still only patchy evidence as national data are incomplete in Cambodia [14–16], Laos [4,17–25], and Vietnam [26–28].

The life-cycle of *O. viverrini* is well established, however it is greatly complicated by the genetic variability found in different wetland habitats, with specific genotypes related to habitat types and/or intermediate host species in different wetlands [29,30]. After a developmental phase in small aquatic snails of the genus *Bithynia*, cercariae are released. These then actively seek one of the at least 18 species of cyprinid fish which act as second intermediate hosts. The *O. viverrini* cercariae penetrate into the tissues, muscles, fins, scales or visceral organs of their host fish, many species of which are commonly eaten in local diets [7,11,21,31,32]. Dogs, cats and humans may then become infected with the flukes by ingesting tiny *O. viverrini* metacercariae in raw (including marinated), partially cooked or fermented fish dishes.

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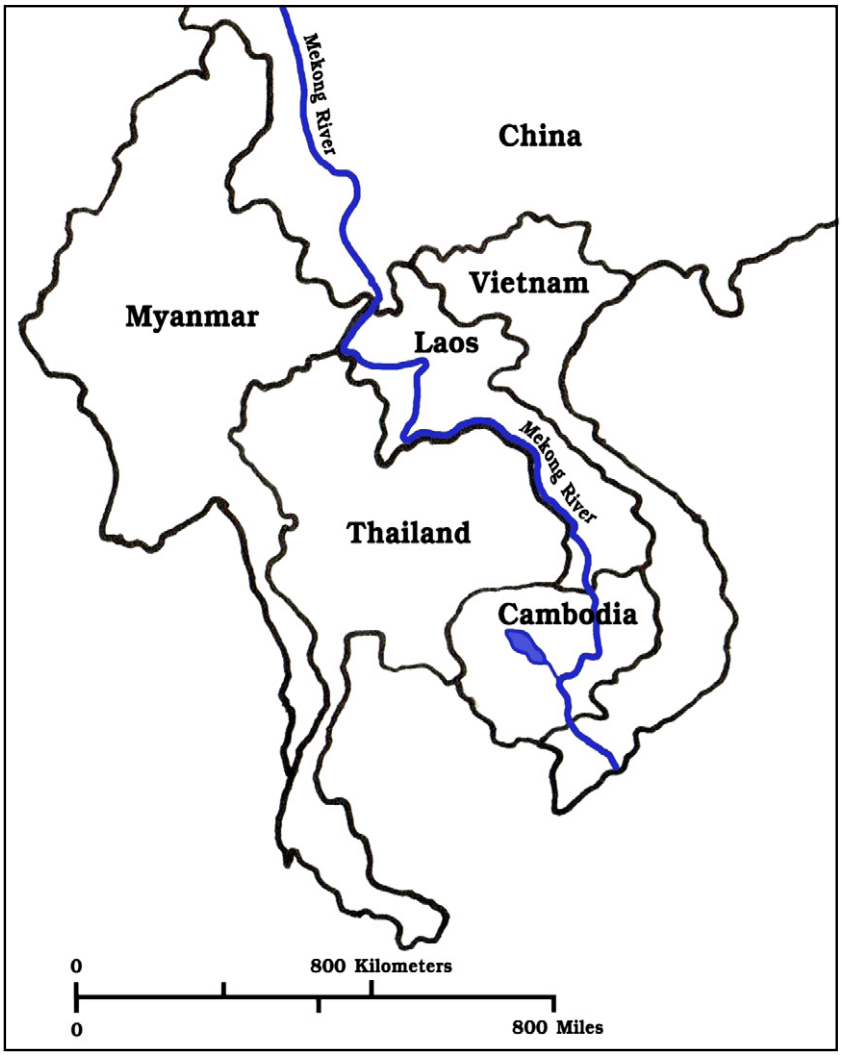

Fig. 1. Map of the Lower Mekong Basin in Southeast Asia covering Thailand, Lao PDR, Cambodia and Vietnam.

The fish to human links are also complicated due to the critical dietary significance of fish in local diets, livelihood linkages with the ecosystem, relatively high localized dependence on fisheries, and food cultures based on a variety of raw, semi-cooked, and fermented fish dishes. Indeed, given the high significance of fish (wild capture and aquaculture) in diets, of rice-fish livelihoods, and the association of wetlands rhythms and seasons affecting rural cultural practices, we may talk of various 'river-based livelihoods' [33], 'fishers who farm' [34], and 'wetland livelihoods' [35]. In Cambodia's Tonle Sap and the vast area of surrounding wetlands and floodplain, agriculture and fishing are so intertwined that they are inseparable [36], and there are different degrees of dependence on fish relating to settlement relations with the 'flood pulse', with people in 'floating villages' almost entirely dependent on fishing as a way of life [37].

2. Uneven geographies of *O. viverrini* infection in the Mekong Region

One important grounded public health reality remains throughout the region, and that is the largely unexplained human geographic variability of *O. viverrini* infection, sometimes between villages within the same district. As one study [3] observed substantial variation in prevalence, ranging from 4% to 33%, still remains in affected populations. Within Khon Kaen province (northeast Thailand), infection levels range from 2% to 71% based on an inter-district survey of 18,393 people aged 35–69 years, by examining fecal samples for eggs [38]. In the Lao People's Democratic Republic (Lao PDR), it is estimated that over 2 million people are infected with *O. viverrini*[39], mainly in the central and southern areas [25], including regions along the Mekong River such as Khammuane, Saravane or Savannakhet provinces showing prevalence between 21.5% and 32.2% [39]. An even higher prevalence of infection of 58.5% was found among 814 persons sampled from 13 villages in a survey in Champasak province, Southern Lao PDR [23]. Moreover, in a nationwide survey in primary school children, including 17 provinces and the Vientiane Municipality, the prevalence of *O. viverrini* infection was estimated to be 10.9% of 29,846 participants. In a study of 13 randomly selected villages in Saravane, prevalence rates reached over 80% in some places where people's knowledge about food-borne parasitic infections was very poor, there were few latrines, and people ate raw and semi-cooked fish dishes regularly as part of their diet [25].

The Lower Mekong has numerous rivers, streams, human-made water diversions, irrigation ditches, reservoirs, natural lakes, aquaculture ponds, and paddy fields. Most of the millions of people in the Lower Mekong Basin rely on the aquatic resources from these various wetlands for food or as a potential source of income [4,11,33–35,40–42]. An understanding of the macro- and micro-social-ecological interactions and geographical variations of *O. viverrini* prevalence and infection in humans should be the focus of integrated, inter-disciplinary research in order to appreciate the scope of public

health interventions needed to help stem the spread of infections and disease in human populations.

3. Fish dependence and food-cultures

Fisheries are a key source of livelihood, providing the major source of animal protein to large populations, and fishing is both a primary and secondary occupation for many farmers supplement their incomes and family diets through small-scale fishing activity [11,33–37,40,41,43]. The role of migrating cyprinid fish species, including several species common in local diets, in the potential long distance and cross-border transport of *O. viverrini* metacerceriae within the region remains to be determined, however, evidence exists that only limited gene flow occurs between different wetland populations of *O. viverrini*[44]. Furthermore, there is no doubt that commonly eaten cyprinid fishes infected with *O. viverrini* are common across borders [45,46].

The "rice-fish cultures" of the region are strongly associated with rain-fed and irrigated paddy-fields in the floodplains of the Lower Mekong, although there are variants of this in higher valleys where people still farm, fish and use small-pond aquaculture techniques. Commonly cultured species in Thailand and Lao PDR are carps such as silver barb (*pla tapian*), common carp (*pla nai*), mrigal (*pla nuan chan*), and grass carp (*pla gin ya*).

There are also significant zones of peri-urban wetlands around key cities and towns, such as Khon Kaen, Udon Thani, Ubon Ratchathani (Thailand), Vientiane (Laos) and Phnom Penh (Cambodia). Indeed, future research needs to consider the ways in which livelihoods, land-use, water-use, and fish culture interrelate in the differentiated wetlands of the region. For example, high prevalence of *O. viverrini* infection in the environment and in human populations exist in the peri-urban zones of, for example, Khon Kaen city [9,10,38,47], Vientiane [17,19], and Phnom Penh [48].

Cambodia is a potential hot-spot for multiple water-borne and food-borne parasitic infections, including *O. viverrini*, and there are studies indicating that the prevalence in children is high [14,15], and strong evidence in some areas, such as Takeo and Kampong Cham, that *O. viverrini* reaches 40% in screened persons [16]. Average fish-dependence of Cambodians is the highest of all countries in the Mekong Basin [37,41], and the Mekong River and Tonle Sap Lake receive many migratory cyprinid species that are also found in Thailand and southern Laos [41,42,45]. Unlike Lao PDR and Thailand, the Cambodian diet is based less on eating "raw fish" than on the consumption of the hugely popular "*prahoc*" (Khmer fermented fish-paste) which is popular in both urban and rural contexts [49]. However, there has yet to be a systematic study of whether *O. viverrini* metacercariae survive well in *prahoc* made from small cyprinid fishes.

There is plenty of evidence of high prevalences and incidences of *O. viverrini*, particularly in commonly eaten cyprinid fishes, including some cultured fish species [3,11,15,19,21–23,25,50]. For example, one small-scale survey of intestinal helminth infections among residents of Pakse, a Mekong River trading town in Laos, found that out of 137 fecal samples from staff of the provincial government, their families and primary schoolchildren, *O. viverrini* was present in over 43%. The primary cause of infections was said to be the consumption of raw and fermented fish dishes locally known as "*pla ra*", "*som fak*", and "*pla som*" [18]. In many rural areas, sticky rice, fermented and raw fish are regularly consumed, sometimes on a daily basis [51,52], and definitely on special occasions in most places [51].

Raw fish consumption needs to be contextualized within societies, and local attitudes that accept many different kinds of raw food consumption. Such practices are deeply rooted in local cultures, meaning that a black and white health warning about "raw meat" being bad for the body is effectively at odds with long-held practices, local belief systems, and collective rituals utilizing dishes such as "*koi pla*" (a dish made from finely chopped raw fish mixed with chili, lemon-juice, vegetables, and spices) eaten on special occasions (Fig. 2). Consumption of *koi pla* is popular in the fishing and farming villages of northeast Thailand and Lao PDR as a cheap form of protein for local people. *Koi pla* is relatively quick and easy to prepare, taking approximately 20 minutes, and so it is very convenient for fishers and farmers who may be preparing the dish at some distance from their homes. High consumption (92%) of raw or partially cooked fish in local dishes, such as *koi pla*, as well as "*pla som*" (moderately fermented fish) (Fig. 3) and "*pla ra*" or "*pa dek*" (Laos) (long-term fermented and highly salted fish) (Fig. 4), undoubtedly help the spread of liver fluke infections in human populations. *Koi pla* is definitely a higher risk dish than the fermented dishes where 'viable metacercariae are rare' [7]. Food culture is strongly related to the livelihoods of local people, many of whom are fishers and rice-paddy farmers, and when working in the fields they are a long way from toilet facilities. Furthermore, cooking utensils used for making a dish like *koi pla* in field-huts may be relatively unclean due to lack of clean fresh water.

Fig. 2. The traditional raw fish dish known as "koi pla" commonly eaten in Thailand and Lao PDR.

Lack of adequate sanitation and hygiene control systems are also linked to the spread of the *O. viverrini* parasites. Eggs from adult flukes must reach water before being eaten by and therefore infecting *Bithynia* snails. In the predominantly rural and rice-fish cultures of the Mekong Basin, hundreds of thousands of villages lack proper sanitation and public infrastructure for sewerage treatment [53]. Virtually all the farmers in Laos use temporary huts with no latrines as their "second homes" during important periods of the farming cycle [54]. In the rainy season, there is the possibility of pollution of the ponds near the village by matter containing *Opisthorchis* eggs, echinostome eggs, minute intestinal fluke eggs, and other parasite

Fig. 3. The short term fermented fish preparation (pla som) in Lao PDR. It is usually kept for 1–2 days before consumption.

Fig. 4. Fermented fish (pla ra) with longer fermentation period (weeks to months) used for direct consumption or as ingredient for traditional cooking in Thailand and Lao PDR.

eggs. In fact, there are relatively few parts of the rural Mekong region where there is systematic water quality monitoring, yet the wetlands and water-bodies of the region are critical habitats in the ecology of infective larvae of pathogenic flukes [53,55].

Gender differences also influence "raw attitudes" to meat and fish. Local studies stress that eating "raw" meat is related to issues of masculinity and virility, as well as offerings to spirits [56]. Usually men like to eat such dishes, particularly *koi pla* with locally made, very strong rice whiskey or "*lao kao*." The practice of drinking "white whiskey" is extremely common amongst fishermen along the stretches of the Mekong bordering Thailand and Laos. Very often, they congregate on islets in rivers, or at meeting points on the river banks, to talk, eat simple food and share a bottle of *lao kao*. Research in Thailand has indicated that 'alcohol was portrayed as having the ability to strengthen the body and prevent illness, as a means of pain relief, and a mood enhancer' [57]. We have also found that many local fishermen believe that strong alcohol kills germs and worms. There are also associated beliefs that plentiful lime-juice on raw fish (*nam manao*) removes parasites. Our field observations indicate that some women fish-traders consume *lao kao* with the men. Nevertheless, it is a common practice mostly amongst fishermen, partly due to the fact that after a night's fishing activity, they are able to consume *koi pla* and whiskey before they go to sleep in the late morning, whereas, the women still have many activities to do relating to fish processing, marketing, and helping with their families (Grundy-Warr, unpublished).

Research in Laos indicates that 'mostly men' eat raw fish dishes, and men are resistant to any alteration in their habits [54]. However, the same study also notes that women are still at risk because they often taste food, including raw fish dishes, during preparation. Attitudes to what is "raw" and what is not are also different from the views of researchers. 'Everybody claimed to eat "*pa dek*" almost daily as a snack, dip or sauce in different dishes, as an ingredient in papaya salad or on its own. Interestingly, no one considered *pa dek* as a raw fish dish and further risks of infection may be associated with a half cooked tepid sour fish soup called "*laap pa sot*" [58].

It is apparent that there are significant gender differences in food preferences and eating habits, however, women still eat some dishes with "raw fish" contents, and there are different gender roles and attitudes between villages. Health interventions may seek to have a spectrum of fish dishes that indicate which ones are more risky for contracting *O. viverrini* and which ones are less risky. Women could play a very important role in such campaigns given their central role in food preparation, in special village occasions and rituals, and their influence on the younger members of families. Even so, simple prohibitive messages such as "do not eat raw fish" or "eat cooked food" are problematic given that "raw attitudes" cover a wide variety of popular dishes deeply embedded into local food cultures and a source of regional cultural identity rather like the widespread practice of eating "*khow neow*" (sticky rice) [59].

Raw attitudes are not the only issue. We also need to give much more attention to people's attitudes to treatment and prevention. The drug praziquantel is highly effective against *O. viverrini* infection and is the basis for treatment of infections incorporated into control programs. The existence of such a drug and similar ones to remove parasites may have contradictory consequences on local attitudes. Indeed, it is worthwhile recording one of the field-based conversations between Dr. Paiboon Sithithaworn (he is a coauthor) and one of the fishermen from Phu Wiang District.

> 'PS (in Thai): 'You know about the liver parasite. You know that it can be harmful to your health. And you do realize that "koi pla" is a known source of the parasite.'
>
> Fisherman: 'Yes, I know, but I still love "koi pla". It is too delicious. And that is why I go to the hospital to take the drug [praziquantel] to get rid of the worms.'
>
> PS: 'So, if you continue to eat raw fish you can get re-infected'.
>
> Fisherman: 'Yes, I know, but I also know the drug is available.'

Although praziquantel is a strong and effective drug used for expelling intestinal liver flukes, it does not protect against further parasitic infections or alleviate the damage done through periductal fibrosis and inflammation and therefore may not prevent the onset of cholangiocarcinoma [60]. Nevertheless, the fisherman's responses indicate that some people believe that the availability of a drug means they can continue unabated with their raw fish eating habits.

4. Health education and prevention of disease: Some lessons

One extremely important lesson from northeast Thailand is the value of long-term dedicated disease prevention and health education campaigns. Prior to the so-called "*tom yum goong* crisis" ("spicy shrimp soup" crisis) the Thai nickname for the financial meltdown in 1997, there was dedicated state funding for a liver fluke control program from 1984 to 1996 to prevent the spread of *O. viverrini*. Prevalence of *O. viverrini* declined in monitored provinces in northeast Thailand from approximately 34% in 1982 to around 12% by 1996, but in the same provinces the figure was rising and reached 15% by 2001 [10,12,61].

The Isaan region (northeast Thailand) is one of the epicenters of global, regional and national health campaigns on liver flukes, but the relative lack of sustained funding and limited reach of existing disease prevention programs has meant that many local people still have poor attitudes towards opisthorchiasis and it remains a serious 'neglected' health problem, underestimated globally, regionally, nationally and locally [2,3,10,12,62,63]. Recent research has revealed that out of a surveyed population of 1,654 people (of which 21.2% of males and 19.5% of females were infected with *O. viverrini*) the majority of people reported regular consumption of a variety of raw, semi-cooked and fermented fish dishes (*koi pla*, *lap pla*, *pla som*, *mum pla*, *jaew bong*, *pla jom*, *som khai pla*) [64,65]. This indicates both the resilience of local food culture and the need for sophisticated participatory health education programs. Scientific evidence can help to create a better local understanding of the most risky fishes and dishes allowing local people to make informed choices.

The situation in the rest of the Lower Mekong region is a similar story with considerable evidence of pockets of high prevalence of *O. viverrini* infection in areas where health screening and scientific studies have been possible [14–28]. There are grey areas outside these zones where little is known with any precision about the prevalence of *O. viverrini* in human populations.

Dedicated, long-term, inter-disciplinary research programs incorporating both scientific and social methodologies may help facilitate plans for grounded disease prevention strategies and health education measures in many parts of the region. School children are a priority for participatory health outreach, but new strategies can fuse good science with local knowledge, focusing on differential raw attitudes between genders, generations and social groups. [66]

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