SNAIL-TRANSMITTED DISEASES OF MEDICAL AND VETERINARY IMPORTANCE IN THAILAND AND THE MEKONG VALLEY

David S. Woodruff and E. Suchart Upatham

ABSTRACT

Proposed hydropower and irrigation projects in the Mekong valley of Thailand, Laos, Cambodia and Vietnam carry the risk of increasing the local prevalence of snail-transmitted diseases in both humans and livestock. Although the blood fluke Schistosoma japonicum and its host snails, Oncomelania spp., have not yet been found in this region a number of other trematodes and a nematode are of current concern. Diseases reviewed include schistosomiasis (blood flukes: S. mekongi is transmitted to humans and dogs by Neotricula spp., S. spinale is transmitted by Indoplanorbis exustus to cattle; paragonimiasis (human lung fluke, Paragonimus heterotremus: the snail host [Brotia, Melanoides and Tarebia spp. elsewhere]) is still unknown in Thailand); opisthorchiasis (in Thailand and Laos the liver fluke, Opisthorchis viverrini, has been transmitted by Bithynia spp. to 7 million humans making this the region's most important snail-transmitted disease); clonorchiasis (in Vietnam, human liver fluke, Clonorchis sinensis, is transmitted by Bithynia spp.). fascioliasis (liver fluke, Fasciola gigantica, is transmitted by lymnaeids to cattle and sheep in northeast Thailand); fasciolopsiasis (giant intestinal fluke, Fasciolopsis buski, is transmitted by Segmentina spp. to pigs throughout the region and to humans locally); echinostomatiasis (small intestinal flukes of numerous species are transmitted by several genera of snails [Filopaludina, Indoplanorbis, Pila, Radix] and infect ducks, chickens and a few million humans); angiostrongyliasis (rat lungworm, Angiostrongylus cantonensis, is occasionally transmitted to humans by several land and freshwater gastropods).

Key words – Schistosomiasis, paragonimiasis, opisthorchiasis, fascioliasis, fasciolopsiasis, echinostomatiasis, angiostrongyliasis, trematode diseases, nematode diseases, snail hosts.

Schistosomiasis, a major debilitating disease in the tropics, is caused by snail-transmitted blood flukes. It is almost unknown in Thailand, but the Pak Mun hydropower/irrigation project in the northeast recently sparked a controversy over whether it might become established from foci in nearby Laos (Usher, 1991a, b). Risk assessment for this and other snail-transmitted diseases is difficult and quantitative methods of analysis are still poorly developed or non-existent. In this synopsis we provide planners with an introductory guide to this complexity and biologists with suggestions for further research.

The snail-transmitted diseases of concern here are caused by two types of parasitic helminthes: flukes (Trematoda) and roundworms (Nematoda). These organisms have complex life cycles that involve periods in one or more larval hosts (snails and other aquatic organisms) and an adult phase in mammals or birds. The successful transmission of these parasites between their various intermediate and final hosts may also involve free-swimming stages and the encystment of larvae on aquatic vegetation. These multispecies interactions are typically very specific (Woodruff, 1985) and at any one site only a few of the potentially interacting species are actually capable of parasite transmission. Disease risk is thus closely linked to the natural history of transmission and, in particular, to the geographic distribution of the specific intermediate host snails. An authoritative guide to this large group of diseases has been provided by Malek (1980); clinical aspects are pre-
TABLE 1. Medically and economically important snail-transmitted diseases in Southeast Asia.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Estimated Human Prevalence</th>
<th>Thailand</th>
<th>World</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schistosomiasis (blood flukes)</td>
<td>very few</td>
<td>250,000,000</td>
<td>dysentery, intestinal and hepatic cirrhosis</td>
<td></td>
</tr>
<tr>
<td>Paragonimiasis (lung flukes)</td>
<td>hundreds</td>
<td>8,000,000</td>
<td>lung damage</td>
<td></td>
</tr>
<tr>
<td>Clonorchiasis (liver fluke)</td>
<td>none</td>
<td>20,000,000</td>
<td>linked to liver cancer</td>
<td></td>
</tr>
<tr>
<td>Opisthorchiasis (liver fluke)</td>
<td>7,000,000</td>
<td>10,000,000</td>
<td>linked to liver and bile duct cancer</td>
<td></td>
</tr>
<tr>
<td>Fascioliasis (sheep liver fluke)</td>
<td>few</td>
<td>1,000,000</td>
<td>economically significant livestock pest</td>
<td></td>
</tr>
<tr>
<td>Fasciolopsiasis (glanl intestinal fluke)</td>
<td>100,000</td>
<td>10,000,000</td>
<td>heavy infections damage intestines</td>
<td></td>
</tr>
<tr>
<td>Echinostomatiasis (intestinal flukes)</td>
<td>2,000,000</td>
<td>40,000,000</td>
<td>intestinal damage in chickens, ducks, humans</td>
<td></td>
</tr>
<tr>
<td>Heterophyiasis (intestinal flukes)</td>
<td>thousands</td>
<td>few million</td>
<td>intestinal and visceral damage</td>
<td></td>
</tr>
<tr>
<td>Gastrodisciasis (intestinal flukes)</td>
<td>thousands</td>
<td>few million</td>
<td>intestinal damage</td>
<td></td>
</tr>
<tr>
<td>Angiostrongyl biasis (rat lungworm)</td>
<td>hundreds</td>
<td>few thousand</td>
<td>brain inflammation</td>
<td></td>
</tr>
</tbody>
</table>

The most significant snail-transmitted diseases in Thailand are listed in Table 1. In addition, there are a number of rarely encountered diseases caused by minute intestinal flukes (e.g., gnathostomiasis, a stomach disease typically affecting cats and dogs), and short-term disorders like dermatitis caused when bird schistosomes (Orientobilharzia, Trichobilharzia) and echinostomes infect humans. The national and global prevalence estimates in Table 1 are approximations only; the actual numbers are generally extrapolations based on the study of very few foci. In Thailand it would seem that 1 in 10 humans are debilitated by snail-transmitted parasites.

In Table 2 we list specific helminths together with their intermediate host snail genera. These data are derived, in part, from Upatham et al. (1983) and Burch & Upatham (1989). The specificity of host-parasite coevolution is underscored by the fact that less than 20 of more than 170 species of Thai freshwater snails are involved in disease transmission. Although the natural history of some Thai snail species of medical and veterinary significance is known in broad outline, there are numerous important gaps in our knowledge. By drawing attention to specific research problems here we would hope to contribute to the improvement of both disease control and risk assessment.

Schistosomiasis (Reynolds & Schneider, 1976; Upatham, 1984; Sobhon & Upatham, 1990). Schistosoma mekongi Voge, Bruckner & Bruce is found in humans along the Mekong River in Laos and Cambodia. At Khong Island, Laos, prevalence in the 1970's was 15% in Kilong town (63% in school children) and 11% in dogs. The ecology and epide-
TABLE 2. Important snail-transmitted parasites in Thailand.

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Life cycle</th>
<th>First larval stage</th>
<th>Second larval stage</th>
<th>Final host</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schistosoma</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. incognitum</td>
<td></td>
<td>Radix</td>
<td>in water</td>
<td>rodents, humans, dogs</td>
</tr>
<tr>
<td>S. mekongi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. sinensium</td>
<td></td>
<td>Tricula</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. spindale</td>
<td></td>
<td>Indoplanorbis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paragonimus</td>
<td></td>
<td>unknown</td>
<td>crabs</td>
<td>cats, dogs, humans</td>
</tr>
<tr>
<td>P. heterotremus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. westermani</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opisthorchis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O. viverrini</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fasciola</td>
<td></td>
<td>Radix</td>
<td>cyprinid fish</td>
<td>humans, cats, dogs</td>
</tr>
<tr>
<td>F. gigantica</td>
<td></td>
<td>Austropeplea</td>
<td>on water plants</td>
<td>sheep, cattle, rats, dogs, humans</td>
</tr>
<tr>
<td>Fasciolopsis</td>
<td></td>
<td>Segmentina</td>
<td>on water plants</td>
<td>pigs, humans</td>
</tr>
<tr>
<td>F. buski</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echinostomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. ilocanum</td>
<td></td>
<td>Indoplanorbis,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. malayanum</td>
<td></td>
<td>Radix, Pila, Filipaludina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. revolutum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypoderaeum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>conoideum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterophyids</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phaneropsolus</td>
<td></td>
<td>Bithynia</td>
<td>Insects</td>
<td>humans, rats</td>
</tr>
<tr>
<td>bonneti</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prosthodenrium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>molemkampi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haplerchis</td>
<td>several (Thiara, Semisulcospira)</td>
<td></td>
<td>fish</td>
<td>humans, other mammals</td>
</tr>
<tr>
<td>Stellantchasmus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasterodiscoides</td>
<td></td>
<td>Segmentina (?)</td>
<td></td>
<td>humans, other primates, pigs</td>
</tr>
<tr>
<td>G. hominis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angiostrongylus</td>
<td>several (Achatina, Pila, Hemipleca)</td>
<td></td>
<td>crabs, shrimp</td>
<td>humans, rats</td>
</tr>
<tr>
<td>A. cantonensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The taxonomy and ecology of "Neotricula aperta" (Temcharoen), the host snail, have also been studied in some detail (Kitikoon & Schneider, 1976; Davis et al., 1976; Davis, 1980; Upatham et al., 1980; Kitikoon et al., 1981). Elsewhere in the lower Mekong River in the 1970’s active transmission was occurring at Kratie, Cambodia (Schneider, 1976), and possibly around Vientiene and Pak Se, Laos, where numerous people were skin-test positive for Schistosoma (Barbier, 1966; Harinasuta et al., 1972; Schneider, 1978). In neighboring Thailand, infections were reported in humans on the Mun River in Ubon Ratchathani Province (Lee et al., 1966; Desowitz et al., 1967; Electricity Generating Authority of Thailand).
Thailand, 1984), but no major disease foci were identified. Ecological factors appear to prevent its transmission in Thailand today where five species of Neotricula are potential intermediate hosts: *N. conica* (Temcharoen) (Kitikoon, 1981) and four species currently confused under the name *N. aperta* (Staub *et al.*, 1990). The taxonomic relations and epidemiological significance of these snails require clarification. Changes in river habitat ecology associated with proposed impoundments may permit parasite transmission in northeast Thailand according to Schneider *et al.* (1974), Bruce *et al.* (1980), Upatham *et al.* (1980), Sommani (1984), Upatham (1984) and Sobhon & Upatham (1990). The appropriate malacological and epidemiological field work has yet to be done to assess these risks.

A close relative of *Schistosoma mekongi*, *S. malayensis* Greer, Ow-Yang & Yong, has been found in humans at several sites in peninsular Malaysia. Biogeographic considerations suggest the parasite may occur in rodents in extreme southern Thailand, but no systematic survey has yet been undertaken for the flukes or their intermediate host snails (*Robertsonella kaporae* Davis & Greer and *R. gismanni* Davis & Greer). The genetics and ecology of the latter has been studied by Greer *et al.* (1984), Upatham *et al.* (1985) and Yong *et al.* (1985). In 1960, *S. japonicum*-like infections were detected in 50 people in one area of Nakhon-Sithammarat Province in southern Thailand (Harinasuta & Kruastrachue, 1962): the host snails were never discovered and by 1969 the infection had apparently disappeared (Sommani, 1969; Harinasuta, 1984). The identity of the parasites themselves also remains problematic as *S. japonicum* Katsurada is still unknown in Thailand; they were probably referable to *S. malayensis*, *S. mekongi*, or a yet to be described relative. These Southeast Asian schistosomes are only distantly related to *S. japonicum* despite their long confusion with the latter (Fletcher *et al.*, 1980; Merendelender *et al.*, 1987).

In addition to *Schistosoma mekongi*, three of the several other schistosomes reported from Thailand are of medical or veterinary significance. *Schistosoma sinensis* is restricted to northern Thailand (Chiang Mai) where it is transmitted by *Tricula bollingi* Davis (Baidikul *et al.*, 1984). This snail is also capable of transmitting *S. mekongi* and *S. malayensis* in the laboratory (Kitikoon, 1984; Yuan *et al.*, 1984). *Schistosoma spindale* Montgomery is common in water buffaloes and cattle in northeast Thailand, but its economic significance has not been determined. It causes sporadic dermatitis in humans. Its host snail, *Indoplanorbis exustus* (Deshayes), is widely distributed in Thailand and Southeast Asia, and also transmits a number of echinostomes. In northeast Thailand, farmers know this species as the "itching snail." The ecology of this planorbid has been studied by Upatham & Sukhapanth (1981), Chitrarnvong *et al.* (1981) and Jantataeme *et al.* (1983). Attempts to use echinostome-schistosome antagonism to control *S. spindale* in Thailand are described by Joe *et al.* (1974a,b). *Schistosoma incognitum* Chandler occurs in north and northeast Thailand (T. Bunnag *et al.*, 1983), where its larvae are transmitted by widespread limnaeids of the genus *Radix* (probably *R. rubiginosa* Michelin) (J.B. Burch, pers. comm., 1991).

The possibility that *Schistosoma japonicum* and its host snails, *Oncomelania* spp., may one day become established in the lower Mekong valley has apparently not been considered. Certainly, the over-water dispersal of this Chinese parasite and its host snails to the Philippines and Sulawesi (Woodruff *et al.*, 1988) indicate their spread into Southeast Asia is not out of the question. Recent long-distance dispersal of other schistosome host snails by humans (Woodruff *et al.*, 1985a,b) and the existence of a major migratory bird flyway (McClure, 1974) suggest vigilance would be appropriate.

**Paragonimiasis** (Vajrasthira, 1969; Goldsmith *et al.*, 1991). Schneider *et al.* (1974) noted that in Thailand and Laos, human paragonimiasis was typically caused by *Paragonimus heterotremus* (Chen & Hsia) and that *P. westermani* (Kerbert), which is widely distributed elsewhere in Asia, has only been recovered from tigers in the Mekong Basin. Infections in humans, cats and other mammals are acquired by eating parasitized...
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uncooked crabs (the second intermediate host). The snail hosts of the two medically important lung flukes have not been identified in Thailand. In surrounding countries these parasites are transmitted by Brotia asperata (Lamarck) (Cabrera, 1969) Melanoides tuberculata (Müller) and Tarebia granifera (Lamarck). Brandt (1974) implicated B. costula (Rafinesque) and B. pseudasperta Brandt as local vectors, but this needs confirmation. B. costula, which is widespread in Thailand and Southeast Asia, is not susceptible to P. heterotremus in the laboratory (Upatham et al., 1991). Melanoides tuberculata and T. granifera also proved refractory in laboratory tests; somewhat unexpectedly, "Neotricula aperta" and Tricula bolingi were susceptible to P. heterotremus (Upatham et al., 1991). Recent genetic studies of the 14 nominal species of Brotia (including Paracrostoma Cossmann) in Thailand suggest major species-level taxonomic revisions are now required (Woodruff et al., 1986; Klinhom, 1989). We agree with Schneider et al. (1974: 147) that until the snail host is identified it is difficult to predict the effect of water-management schemes on the incidence of paragonimiasis. Nevertheless, it is unlikely that the creation of additional habitat for snails and crabs will reduce the incidence.

Opisthorchiasis (Wykoff et al., 1965; Preusksaraj et al., 1982; D. Bunnag et al., 1991). Opisthorchiasis and related clonorchiasis are potentially serious diseases caused by liver flukes acquired by eating parasitized raw fish (the second intermediate host). The first intermediate host snails of the genus Bithynia occur throughout Thailand and Southeast Asia. Brandt (1974) recognized that 12 species in Thailand and three species in the subgenus Digoniosoma (B. funiculata Walker, B. siamensis Lea, B. goniamphalos (Morelet)) transmit Opisthorchis viverrini (Poirier). The taxonomy of these snails should be validated as the disease is widespread in Thailand and Laos and prevalence is high (typically 35-50% in northeast Thailand (Preusksara et al., 1982; Electricity Generating Authority of Thailand, 1984). As the snails reach very high densities in rice fields, canals, ponds and lakes, this disease can be expected to increase in prevalence with river impoundment. Van der Schalie (1973) and Pipitgool (1980) describe the outbreak that followed the construction of the Ubolratana or Nam Pong Dam in northeast Thailand. Recent studies of the snails include Upatham & Sukhapanth (1980), Chitramvong et al. (1981), Kruatrachue et al. (1982a,b), Brockelman et al. (1986) and Chitramvong (1989). The disease has not been reported from humans in Cambodia, perhaps because raw fish are rarely eaten in that country. In Vietnam, it is replaced by the closely related parasite Clonorchis sinensis (Cobbold), although some human infections reported from Saigon as O. felineus Rivolta (Do Thi Nhu & Vu Qui Dai, 1969) may be referable to O. viverrini.

Fascioliasis (D. Bunnag et al., 1991). The three known hosts of Fasciola gigantica (Linnaeus) are limnaeids: Radix rubiginosa, R. suinhoei (Adams), Austropeplus olluia (Gould). Together, they occur throughout Thailand and Southeast Asia. The monetary losses associated with this disease in domestic animals, especially cattle in northeast Thailand where prevalence is higher, are very significant but apparently unquantified. Humans become infected by eating cysts on watercress and other plants (Manning et al., 1969; T. Bunnag et al., 1991).

Fascioloopsiasis (Cross, 1969; Manning et al., 1969; T. Bunnag et al., 1991). Although the host snails, Segmentina (Polypyllis) hemisphaerula (Benson) and S. (Trachorbis) trochoideus (Benson), occur throughout Thailand, human infections of Fascioloopsis buski (Lankester) are acquired primarily by eating water caltrop and are confined to central Thailand where such vegetables are cultivated commercially (Sadun & Maiphoom, 1953; Manning et al., 1969; Manning & Ratanarat, 1970; Ratanaponglakha et al., 1988). Brandt's (1974) suggestion that Helicorbis umbilicalis (Benson) may transmit F. buski requires confirmation. Although human infection rates are not well documented outside Thailand, this large intestinal fluke is a significant pig parasite in Laos, Cambodia and Vietnam (Schneider et al., 1974).

Echinostomatiasis (Sornmani, 1969; T. Bunnag et al., 1991). There are numerous
species of echinostomes and other small intestinal flukes in Thailand, including *Echinostoma malayanum* (Leiper), *E. revolutum* (Froelich), *E. ilocanum* (Garrison), *Hypoderaeum conoideum* (Bloch) and *Episthmium caninum* (Verma) (Bhaibulaya et al., 1964, 1966; Yokogawa et al., 1965; Radomyos et al., 1982, 1985; T. Bunnag et al., 1991). They are common larval parasites of several genera of freshwater snails. The second intermediate hosts are snails, fish and tadpoles, and intestinal infections are acquired by waterfowl, chickens, small mammals and humans by ingestion of metacercariae. Although prevalence in humans is 50% in parts of northeast Thailand, echinostomes are of minor medical significance and their snail hosts have received scant attention. An exception are the recent reports on the five species of *Pila* (Keawjam, 1986, 1990, and references therein); *P. ampullacea* (Linneaus) transmits *E. ilocanum* throughout Thailand and *P. polita* (Deshayes) hosts this parasite in north and northeast Thailand. The other species of these large snails are probably also hosts of this and related flukes. *Radix rubiginosa* and *Indoplanorbis exustus* host all four species of echinostomes listed on Table 2. *Filopaludina sumatrensis* (Dunker) and *F. martensi* (Frauenfeld) transmit various species of echinostomes in north, central and southern Thailand; their ecology is poorly documented and the genus has not received systematic attention since Brandt's (1974) review. *Gyraulus convexiusculus* (Hutton) (=*G. chinensis* according to Meier-Brook, 1983) is widespread in Asia and common throughout Thailand; it does not appear to have been the subject of any local field studies. These various snail hosts of the echinostomes all thrive in ponds and reservoirs. Schneider et al. (1974) predicted that dam construction and irrigation projects would result in an increased incidence of infection in northeast Thailand and a concomitant increase in disease severity.

**Other intestinal flukes** (T. Bunnag et al., 1991). Heterophyiasis and gastrodisciasis are caused by minute trematodes (*Phaneropsolus bonnei*, *Prosthodendrium molenkampi* Lie, *Haplorchis pumilio* Looss) whose presence in humans is rarely reported and whose natural history is almost unknown (Manning & Lertprasert, 1973; Radomyos et al., 1983, Strickland, 1991). Intermediate hosts of heterophyids include such common and widespread species as *Thiara scabra* (Müller), *Tarebia granifera*, *Melanoïdes tuberculata*, *Semisulcospira libertina* (Gould), *Indoplanorbis exustus* and *Segmentina* sp. (Malek, 1980).

The minute lecithodenrid intestinal flukes *Phaneropsolus bonnei* and *Prosthodendrium molenkampi* are transmitted in north and northeast Thailand by *Bithynia goniomphaios* snails to dragonflies and damselflies and then to rats and primates, including humans (Manning & Lertprasert, 1973); the infections are rarely diagnosed.

**Angiostrongyliasis** (Cross, 1979; Mead, 1979). These nematodes (rat lungworms) are acquired accidently by humans who handle or more typically eat uncooked snails infected with larval parasites. The disease, caused by larval migration through the brain and generally diagnosed as eosinophilic meningitis, is widespread in Thailand and Laos and less common in Cambodia and Vietnam. Hundreds of cases have been reported from some areas of central and northeast Thailand (Bhaibulaya, 1979). Locally, *Angiostrongylus cantonensis* (Chen) has been found in both freshwater snails (*Pila ampullacea*, *P. gracilis* (Lea), *Melanoïdes tuberculata* and *Sinotaia martensiana*) and in the introduced (*Achatina fulica* Bowdich) and endemic land snails (*Hemiplecta distincta*) and slugs, including *Veronicella alte* (Férussac) (Malek, 1980; Panha, 1988).

Risk assessment for any snail-transmitted disease is a complex problem whose solution presupposes the availability of verified data on the distribution and abundance of both hosts and parasites. As this review indicates, much information is now available on distribution and natural history and some of the systematic problems have been resolved. Future efforts might usefully be devoted to the continued resolution of the basic patterns and to the development of epidemiological models for specific disease foci. Currently, risk assessment is based primarily on the interpretation of natural history data; ultimately, it should be supported by quantitative analytical models. Bradley (1982) and others provide
useful examples of the strengths and pitfalls of modelling for the improvement of health in the real world (Anderson & May, 1982; Woodruff, 1983; Rollinson & Anderson, 1985). Although the snail-transmitted diseases of Southeast Asia are not currently of major health or economic significance, this status could change quickly. The recent resurgence of interest in numerous hydroelectric and irrigation projects in the lower Mekong basin could lead to the creation of new snail habitats and a rapid increase in the prevalence and intensity of some diseases. It is now appropriate that malacologists re-examine these development proposals as most were originally prepared years ago when the potential adverse effects of man-made impoundments were widely ignored (Goldsmith & Hildyard, 1985-1991). If a broad range of biological research can be undertaken early enough in the planning process, then realistic risk assessments can be prepared and, when necessary, the appropriate mitigation actions can be incorporated in a timely fashion. In the absence of more rigorous risk assessments, we can expect governments to have problems with the now more environmentally-sensitive international loan agencies (Goodland et al., 1991) and local people to suffer increased incidence of these debilitating diseases.

ACKNOWLEDGEMENTS

We thank Curt R. Schneider and J.B. Burch for their useful comments on the manuscript. Our own research has been supported by the U.S. Agency for International Development, the UNDP/World Bank/WHO Special Programme in Research and Training in Tropical Diseases, Mahidol University and the Academic Senate of the University of California.

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ENFERMEDADES TRANSMITIDAS POR CARACOLES DE IMPORTANCIA MEDICA Y VETERINARIA EN TAILANDIA Y EN EL VALLE DEL MEKONG

RESUMEN

Proyectos hidrológicos propuestos para el valle del Mekong en Tailandia, Laos, Camboya y Vietnam corren el riesgo de elevar la presencia de enfermedades transmitidas por caracoles, tanto en los humanos como en el ganado. Aunque todavía no se ha encontrado el trematódeo de la sangre *Schistosoma japonicum* ni sus caracoles hospederos intermediarios, *Oncomelania* spp., en la región, otros tremátodos y un nemático representan actualmente una preocupación. Enfermedades tratadas incluyen esquistosomiasiás (tremátodos de la sangre: *S. mekongi* se transmite a seres humanos y perros a través de *Neotricula* spp. en Laos y Camboya, y es posible que invada el noreste de Tailandia; *S. spinulic* se transmite por *Indoplanorbis exustus* al ganado); paragonimiasiás (trematódeo del pulmón humano; *Paragonimus heterotremus*: el caracol hospedero [Brotia, *Mekanoides* y *Tarebia* spp. en otras partes] todavía no se conoce en Tailandia); opistorquiiasiás (en Tailandia y Laos el trematódeo del hígado, *Opisthorchis viverrini*, se transmite por medio de *Bithynia* sp. a 7 millones de seres humanos, haciendo la enfermedad transmitida por caracol más importante de la región); clonorquiiasiás (en Vietnam, trematódeo del hígado humano, *Clonorchis sinensis*, transmitido por *Bithynia* spp.); fascioliasiás (trematódeo del hígado, *Fasciola gigantica*, transmitido por limnaéidos a vacas y ovejas en el noreste de Tailandia); fasciolopasiás (trematódeo del hígado, *Fasciolopsis buski*, se transmite por medio de *Segmentina* spp. a cerdos de toda la región y a seres humanos en algunas localidades); echinostomatiasiás (trematódeo del hígado del intestino de muchas especies no se transmite por medio de varios géneros de caracoles [*Filopailudina, Indoplanorbis, Pila, Radix*] e infectan a pavos, gallos y millones de seres humanos); angiostrongiliiasiás (nemático del pulmón en ratones, *Angiostrongylus cantonensis*, se transmite a seres humanos ocasionalmente por medio de gasterópodos terrestres y acuáticos).