EPIDEMICOLGY AND CONTROL OF SCHISTOSOMIASIS IN THE PEOPLE’S REPUBLIC OF CHINA

MAO SHOU-PAI

Institute of Parasitic Diseases, Chinese Academy of Preventive Medicine 207 Rui Jin Er Lu, Shanghai 200025, P. R. China

BIOLOGY

The parasite — The schistosome species involved in human schistosomiasis in the mainland of China is Schistosoma japonicum, the Taiwan strain being entirely zoophilic (Hsu et al., 1956). Nevertheless, experiments have shown the susceptibility of Oncomelania snail from Taiwan foci to anthropophilic strains of S. japonicum (Cross et al., 1980). So far S. mekongi has not been identified in China, even in areas adjacent to the existing foci in Southeast Asia inspite of the presence of Tricula spp. in Chinese territory.

A rodent species, Schistosoma sinensium, laying eggs with lateral spine and with Tricula humida as its intermediate host, was discovered in Southwest China and described by Bao in 1959 (Fig. 1). No human cases have been detected except in Thailand (Attawibol et al., 1983; Baidikul et al., 1984). Schistosomes depositing spine eggs were reported independently in 1986 by three authors from Xishuangbanna of Yunnan Province. The first was identified as S. bovis from a cattle (Huang et al., 1986). The second report (Chen et al., 1986) was about the presence of furcocercariae in Indoplanorbis exustus, giving rise to S. spindale like eggs after inoculation to mice. The third was from an elephant suffering from diarrhoea with terminal spine eggs (Fig. 2) and apparently cured by praziquantel (Wu, 1986).

The intermediate host — Oncomelania hupensis hupensis is the only vector of human schistosomiasis japonica in the mainland of China, though malacologists are still debating in its taxonomy. Geographic strains of the parasite and/or the snail may exist as suggested by the fact that artificial infection of snails with miracidia from the same area resulted in an infection rate of 78.9% while the infection rates of snails from different areas with the same source of miracidium ranged from 55.4% to 0% and that the snail-parasite incompatibility increased with the geographic distance (Guo & Ni, 1980) (Fig. 3).

The reservoir host — Thirty one species of wild animals belonging to five orders (Table I) and nearly all the domestic mammal species have been found naturally infected with W. japonicum, though their importance in the maintenance of schistosomiasis varies greatly from one endemic area to another (Mao & Shao, 1982).
Epidemiology

Distribution — Schistosomiasis has been endemic in the provinces of Jiangsu, Zhejiang, Anhui, Jiangxi, Fujian, Hubei, Hunan, Guangdong, Sichuan and Yunnan, Shanghai Municipality and Guangxi Autonomous Region, all situated in the southern part of China between 22°50′ and 33°25′ N.L. (Fig. 4) (Qian et al., 1985).

Stratification — Three types of endemic regions are classified according to topography, snail habitats, infection sources and water-contact pattern (Mao, 1984). The plain region is mainly confined to the Yangzi Delta, including suburbs of Shanghai Municipality and a great part of Jiangsu and Zhejiang Provinces. It is a rice-producing area with dense population. Both the prevalence and intensity of infection were high. About one third of schistosomiasis patients were from that area covering only 7.8% of the total snail-ridden area.

The lake region consists of areas surrounding big lakes and along the shore of Yangzi River and its principal tributaries. Its snail-ridden area amounted to 82.8% of the total infested area with 43.7% of the total patients.

The mountain and hill regions comprise rather two different types. The mountain type is confined to Sichuan and Yunnan Provinces while the hill type occurs in Guangxi Autonomous Region and Fujian Province, and also in small areas intercalating with lake and plain regions. Less than 10% of snail-infested area belonged to mountain and hill region with 22.7% of the total number of patients.
TABLE I

List of wild animals naturally infected with Schistosoma japonicum in the mainland of China

Order RODENTIA
- Apodemus agrarius ningpoensis
- Cricetulus erythrueus ningpoensis
- Eothenomys melanogaster columnus
- Hystric subrisciata subrisciata
- Lepus europaeus
- Lepus similis
- Microtus mandarinus
- Mus musculus
- Rattus confucianus socer
- Rattus flavipes flavipes
- Rattus fulvescens
- Rattus lese exognus
- Rattus nitidus
- Rattus norvegicus
- Rattus rattus
- Rattus rufus

Order CARNIVORA
- Felis bengalensis chinensis
- Felis pardus fusca
- Helicis moschata ferrae-grisea
- Herpestes urva
- Meles meles leptorhynchus
- Mustela sibirica davidiana
- Nyctereutes procyonoides procyonoides
- Viverrictula indica pallida
- Vulpes vulpes hoolie

Order ARTIODACTYLA
- Myadromes inermis inermis
- Muntiacus reevesi
- Sus scrofa chridonta

Order INSECTIVORA
- Crocidura attenuata
- Erinaceus europaeus

Order PRIMATE
- Macaca mulatta
  (from Mao and Shao, 1982)

TABLE II

General characteristics of Oncomelania h. hupensis in different types of endemic regions

<table>
<thead>
<tr>
<th>Region type</th>
<th>Distribution</th>
<th>Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain</td>
<td>spotty or linear along banks of water courses</td>
<td>medium size moderately ribbed</td>
</tr>
<tr>
<td>Lake and marshland</td>
<td>surface distribution on flatlands flooded yearly for 3-8 months</td>
<td>big size coarsely ribbed</td>
</tr>
<tr>
<td>Mountain and hill</td>
<td>surface distribution on mountain slopes; spotty or linear along stream banks</td>
<td>small size smooth or finely ribbed</td>
</tr>
</tbody>
</table>

As indicated in Table II, the snail habitats differ with the type of endemic regions. Besides, the outer morphology of Oncomelania is also different from one region to another, though not without exceptions.

In plain and hill regions, human patients are the main infection source while rodents, sewing rat in plain region and wild rabbit in hill region, are of some importance. In lake region, bovines, especially buffaloes, are believed to play a more important role than patients. It is interesting to note that Microtus fortis, the predominant rodent species in lake region, has never been found naturally infected and experimental infection with schistosome cercariae yielded negative results.

The water contact pattern also differs with the region types, resulting in differences in age and sex distribution of schistosomiasis patients (Fig. 5).

CONTROL AND PROBLEMS

Direction – National Schistosomiasis Control Programme was inaugurated in late 1955, under the guidance of Central Directing Board for Schistosomiasis Control, which was replaced in 1986 by the newly formed Bureau of Endemic Diseases under the Ministry of Public Health. The policies formulated in early days consisted of four items: to prevent and treat actively while putting prevention first; to use comprehensive measures while considering local and seasonal conditions; to integrate scientific techniques with mass movement; to fight repeatedly.

Achievement (Fig. 4) – As of 1986, Shanghai Municipality, Guangdong and Fujian Provinces were free from schistosomiasis. Of 372 counties historically endemic for schistosomiasis, the infection is still prevailing (i.e. in attack phase) in 94, practically eliminated in 154 (i.e. in consolidation phase) and eliminated in 124 (i.e. in surveillance phase). There still remained about one million cases to treat and more than 3.2 billion m² of snail-infested area to deal with.
Fig. 4: Southern part of China showing distribution of schistosomiasis japonica. Abbr. Ah: Anhui Province; Fj: Fujian Province; Gd: Guangdong Province; Gx: Guangxi Autonomous Region; Gz: Guizhou Province; Hb: Hubei Province; Hn: Hunan Province; Js: Jiangsu Province; Jx: Jiangxi Province; Sh: Shanghai Municipality; Sc: Sichuan Province; Yn: Yunnan Province; Zj: Zhejiang Province.

**Problem** — Lake region and mountain region are problem areas in the national control programme. High mountain region is characterized by thin-population, difficult accessibility, retarded socio-economic development and different ethnic behaviours. Less than 10% of schistosomiasis patients and 1% of snail-ridden area are found in this type of endemic region.

Lake regions are hard nuts for following reasons:

a) It is a vast area covering five provinces along the Yangzi River, involving long river shores and numerous lakes of different capacities, most of them serving as reservoirs for flooding water and silt too, from upper reaches of Yangzi River. An early report by the Bureau of Hydraulics of Hunan Province stated that the silt brought down yearly to the Dongting Lake amounted to 132 million m², adding 1,120
hectares of land in the Lake, which would be potential snail habitat. The same is true for long shores along the Yangzi River from Hubei to Jiangsu Provinces. According to a survey in Huarong County, Hunan Province, 584 hectares were newly formed from 1971 to 1983, or an annual increase of 40.4%. Weeds and reeds would grow on the land 2 to 3 years after its formation, to be followed by settlement of Oncomelania snails in another 2 to 3 years (Zhu & Zeng, 1986). It seems that in recent years the increase of snail breeding places might overbalance their elimination through routine snail control efforts.

b) Lake regions are densely populated and very important for rice-production and fisheries. Agricultural activities result in frequent exposure to schistosome infection and acute cases recorded yearly by thousands. Should newly infected cases outnumber those treated in the same period, one must consider the chemotherapy programme a failure.

c) Bovines are important reservoirs, if not more important than humans as source of infection. Their relative potential contamination index may be as high as 70-90%, in contrast to less than 20% in plain region.

d) The migration of boatmen and fishermen hinders the implementation of chemotherapy project.

Pilot studies — With the advent of praziquantel for mass chemotherapy, several field studies in Lake region were supported in early 80s by the National Schistosomiasis Research Committee to investigate the usefulness of selected population chemotherapy with focal mollusciciding or integrated with other control measure. Prevalence reduction of 18% in villagers and 5% in bovines was recorded when only infected humans were treated while prevalence reduction of 83% in humans and 82% in bovines was noted when integrated measures were used (Table III). It is too early to draw conclusions as follow-up studies are still going on.

As to the cost estimates listed in Table IV they are barely comparable, because though the expenditure for case treatment is the same, that for case detection varied with the prevalence while the snail-infested area to be covered by molluscicides varied greatly from one pilot site to another.

### TABLE III

Results of 5 years' pilot studies in lake regions by selected population chemotherapy of humans(H), bovines(B), focal (F) or comprehensive(C) mollusciciding and other(O) measures

<table>
<thead>
<tr>
<th>Locality Prov.</th>
<th>Author</th>
<th>Population</th>
<th>H</th>
<th>B</th>
<th>F</th>
<th>C</th>
<th>O</th>
<th>Change in preval. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jianli</td>
<td>Yang</td>
<td>1.453</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td>44.9 – 23.1 –</td>
</tr>
<tr>
<td>Hubei</td>
<td></td>
<td></td>
<td></td>
<td>37.2</td>
<td>21.9</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Tongling</td>
<td>Wu</td>
<td>2.433</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td>43.0 – 13.6 – 25.5 –</td>
</tr>
<tr>
<td>Anhui</td>
<td></td>
<td></td>
<td></td>
<td>1.5</td>
<td>0</td>
<td>17.7</td>
<td></td>
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<tr>
<td>Xinzi</td>
<td>Zhang</td>
<td>1.630</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td>20.8 – 20.4 –</td>
</tr>
<tr>
<td>Jiangxi</td>
<td></td>
<td></td>
<td></td>
<td>1.9</td>
<td>4.3</td>
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<td></td>
<td></td>
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<tr>
<td>Yingchen</td>
<td>Wan</td>
<td>956</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>60.4 – 37.7 – 50.0 –</td>
</tr>
<tr>
<td>Hubei</td>
<td></td>
<td></td>
<td></td>
<td>9.1</td>
<td>1.0</td>
<td>5.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guichi</td>
<td>Su</td>
<td>3.301</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>13.4 – 3.4 – 5.6 –</td>
</tr>
<tr>
<td>Anhui</td>
<td></td>
<td></td>
<td></td>
<td>2.3</td>
<td>1.1</td>
<td>0.9</td>
<td></td>
<td></td>
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### TABLE IV

Cost estimates (RMB/c/y in 5 years)

<table>
<thead>
<tr>
<th>Locality</th>
<th>Author</th>
<th>Measures used</th>
<th>% reduction prevalence</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Tongling</td>
<td>Wu</td>
<td>H B F</td>
<td>96.5</td>
<td>4.80</td>
</tr>
<tr>
<td>Guichi</td>
<td>Su</td>
<td>H B C O</td>
<td>82.8</td>
<td>7.08</td>
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<tr>
<td>Cunshan</td>
<td>Li</td>
<td>H B C</td>
<td>74.2</td>
<td>11.54</td>
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<tr>
<td>Wahan</td>
<td>Dai</td>
<td>H F</td>
<td>69.6</td>
<td>6.53</td>
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<tr>
<td>Songzi</td>
<td>Xu</td>
<td>H B F</td>
<td>46.0</td>
<td>3.43</td>
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</table>
REFERENCES


