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Relationship Between Sluicing for Irrigation and Spreading of *Oncomelania hupensis* in Hubei Province

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ABSTRACT

The snails *Oncomelania hupensis,* can drift into a ditch inside the sluice when it was opened for irrigation. Of 381 sluices on the dike of 14 main rivers in Hubei province, 226 (59.3%) of the sluices were snail - ridden inside and/or outside. Fifty of 226 sluices (22.1%) in the dich inside the sluice were confirmed being snail - ridden due to irrigation. The areas of snail spreading were 23,084.9 mu (1 mu = 0.00667 ha), or 68.57% of the snail habitats in areas covered by irrigation. The opening of sluices for irrigation would cause the snails to drift into the ditch inside the sluice. Such phenomenon did not correspond with the time when snail was found in the ditch inside the sluice. Also there was no singnificant difference during the investigation period from 1980 to 1987 and the size of snail habitats outside the sluice. There was no direct proportion to the number of outlets and the flow of sluice, the number of annual average days of opening sluices, and the frequency of opening sluices. Of 26 sluices with increasing number of snails, the increase in length and area of snail - ridden in the ditch inside the sluice was 2.26 times and 5.02 times respectively in 1987 to those in 1980. It showed that the speed of snail eradication could not keep pace with the speed of snail spreading.

Key Words : *Schistosoma japonicum, Oncomelania hupensis,* Hubei.

INTRODUCTION

Hubei province is situated in the middle and lower reaches of the Yangtze River. There are a great number of rivers and lakes, the channels criss - crossing inside dike of the rivers, and the rapidly changing range of the water levels in the rivers. Along with the development of the irrigation network, sluices have been very important in regulating the sources of water. But when the sluice was opened for irrigation, the snails *Oncomelania hupensis* could be drifted into the ditch inside the sluice (Xu and Fang, 1988). Moreover, there is a wide distribution of snail - ridden areas (The compilation of research data on schistosomiasis, 1987). The spreading snail was affecting the achievement on the control of schistosomiasis.

To ascertain the relationship between the sluicing for irrigation and the spreading of snails, it is necessary to obtain data for devising countermeasures on the control of snails. The investigation was made at the sluice on the dike and the distribution of the snails around the sluices in the endemic areas of Hubei province.

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MATERIALS AND METHODS

The base - line data of the sluice function and the condition of opening sluices was collected from the local Water Conservation Department. Snail survey was carried out from March to May and from September to November every year. The quadrat samples and selection samples were taken in habitats favorable to the snail during the snail inspection seasons according to the manual of prevention and treatment of schistosmiasis (1981) and Malek (1985).

Control of snail was a combination of the focal molluscicide of water contact sites near villages with the water conservancy project to exterminate the snail microhabitats in endemic areas inside the sluice. But outside the sluice, because the water level was uncontrolable on the beach of the rivers, only focal molluscicide to the susceptible areas of infection snail was performed (Mao, 1963 and Zhao, 1983).

RESULTS

The distribution of sluices in endemic areas:

There were 381 sluices on the dike of 14 main rivers in the whole province. These sluices were divided according to the snail habitats within 2 km^2 inside and/or outside the sluices: 155 sluices (40.7%) were snail - free inside and outside the sluice, 226 sluices (59.3%) were snail - ridden inside and/or outside the sluice. Of 226 sluices, 25 or 11.1% were snail - ridden inside, 114 or 50.4% were snail - ridden outside, and 87 or 38.5% were snail - ridden inside and outside the sluice. Of 87 sluices, 50 or 57.5% referring to the eight main rivers were snail - free in ditch inside the sluice previously, but later became snail - ridden. This incidence was indicating that the spreading of *O. hupensis* was due to irrigation.

The condition of snails spreading in 50 sluices of eight main rivers was shown in Table 1. The areas by irrigation of 50 sluices were 2,286,699 mu.* The snail habitats within the irrigated areas were 33,667.3 mu, of which 23,084.9 mu (68.6%) were caused by snails spreading through sluices for irrigation.

Basic condition of 50 sluices:

A. Number of outlets of 50 sluices: 82% were with one outlet, 10% with two outlets, 2% with three outlets, and 6% with four outlets and more (Figures 1 - 5).

Table 1 The areas of snails spreading in 50 sluices of eight main rivers.

Main rivers	No. of sluices	Total irrigated area (mu)*	Area under snail habitat (mu)	Area caused by spreading snails (mu)	%
Yangtze River	15	746,451	3,744.8	3,708.8	99.04
Han River	1	7,679	1,822.0	1,088.0	59.71
Hanbei River	12	1,276,486	22,551.8	15,356.5	68.09
Fu River	2	100,000	0.6	0.6	100.00
Songzi River	5	15,688	1,386.1	541.0	39.03
Fushui River	3	36,195	1,651.0	1,621.0	98.18
Weishui River	5	69,000	919.0	85.0	9.25
Hudu River	7	35,200	1,592.0	684.0	49.96
Total	50	2,286,699	33,667.3	23,084.9	68.57

*1 mu = 0.00667 ha

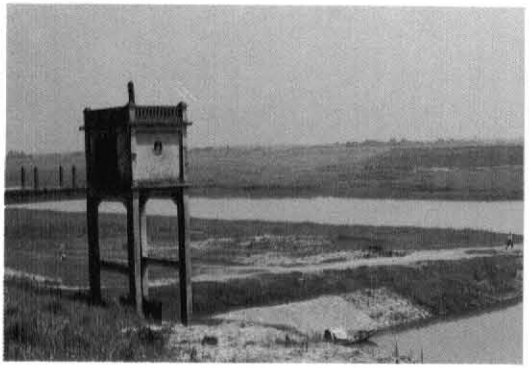

Figure 1. Sluice with one outlet.

Figure 2. Sluice with two outlets.

Figure 3. Sluice with three outlets.

Figure 4. Sluice with four outlets.

Figure 5. Sluice with more than four outlets.

B. The water flow of 50 sluices: 62% were below 10 m^2/sec, 26% were from 10 to 40 m^2/sec, 6% were from 41 to 80 m^2/sec, and 6% were over 80 m^2/sec.

The relationship between the size of snail area outside the sluices, the number of annual average days of opening sluices, and the frequency of opening sluices were shown in Table 2. Fifty sluices were divided into 4 grades according to the size of snail habitats outside the sluices. The percentage of those below 500 mu was much higher than that of the others. Moreover, the percentage of the number of annual average 50 to 150 days of opening sluices and those opening sluices at intervals were also much higher than those of the other conditions.

The relationship between different sizes of snail - ridden areas outside the sluices and the time when snails were first found in ditch inside the sluices were shown in Table 3, Fifty sluices were divided into 4 groups according to the time when snails were first detected in ditch inside the sluices after the sluice was set up and in the snail habitats outside the sluices. The percentage of 3 groups were similar except that of the group of 7 - 9 years and those below 500 mu.

Table 2 The percentage of 50 sluices in different grades of snail areas and the condition of opening sluice.

No. of annual average days of opening sluices and the frequency of opening sluices		Snail habitats outside sluice (mu)				
		< 500	500-	1000-	2000-	Total
No. of days	< 50	16	0	12	6	34
	50 - 150	42	6	6	2	56
	151 - 250	6	2	0	2	10
	Total	64	8	18	10	100
Frequency	Frequent	8	2	0	4	14
	At intervals	46	6	16	8	76
	Occasional	8	0	2	0	10
	Total	62	8	18	12	100

Table 3 The percentage of 50 sluices in different snail areas and the time when snails were first found in ditch inside the sluices.

The time when snails first found in ditch inside the sluices. (years)	Snail habitats outside the sluices (mu)				
	< 500	500-	1000-	2000-	Total
1 - 3	22	6	4	0	32
4 - 6	22	2	2	4	30
7 - 9	6	0	0	2	8
> 10	12	2	6	10	30
Total	62	10	12	16	100

The characteristices of the rising and falling of spreading snails inside the sluices were shown in Table 4. Thirty of the 50 sluices were selected for observation. The length and the area of spreading snails in ditches inside the sluice were calculated from 1980 to 1987, during 1980, 1983, 1985, 1987. Of those 26 sluices with rising condition, the length and the area were 2.26 times and 5.02 times respectively in 1987, which was higher than those in 1980. But, of those 4 sluices with falling condition, the decreasing in the range of the length and the area of spreading snail were relatively slow.

DISCUSSION AND CONCLUSION

There are 14 main rivers with 381 sluices on the dike of rivers in regions of endemic schistosomiasis in Hubei province. Of these, 226 sluices were snail - ridden inside and/or outside the sluice. In 50 of 226 sluice (22.1%), it was confirmed that snails were constantly introduced

Table 4 The change of the length and the area of spreading snails in ditches inside the sluices in 30 sluices.

Year	The rising condition in 26 sluices				The falling condition in 4 sluices			
	Length (m)	Ratio*	Area (mu)	Ratio*	Length (m)	Ratio*	Area (mu)	Ratio*
1980	71,022	1.00	1,033.1	1.00	10,800	1.00	228	1.00
1983	91,390	1.29	2,307.6	2.23	5,960	0.55	135	0.59
1985	86,653	1.22	3,075.7	2.98	5,360	0.50	119	0.52
1987	160,461	2.26	5,181.4	5.02	3,570	0.33	65	0.29

* Ratio = Relative ratio with fixed base.

into the ditch inside the sluice due to the opening of sluices for irrigation. The areas of snail spreading were 23,084.9 mu, of which 68.57% were within the snail habitats of the areas under irrigation.

Of all the surveyed sluices, most of them were small ones. Among the 226 sluices, sluices with one outlet were 73.9%. The percentage was almost the same as the 50 sluices (82%) which were confirmed as a source for spreading snails. The water flow of the sluice at below 10 m^2/sec were 58% of 226 sluices. The percentage was also the same as that of the 50 sluices (62%). It was suggested that the small sluices played an important role in spreading snails. For the control of snails, work done on the smaller sluices are simpler than that of the larger ones.

The degree of snail spreading of the 50 sluices did not correlate with the size of the snail habitats outside the sluice, and also not with the number of annual average days of opening sluices and the sluices frequently opened. On the contrary, the number of annual average days of opening sluices of 50 - 150 days, and the opening sluices at intervals had a much higher proportion in snail spreading. It was noteworthy that the number of annual average days of opening sluices below 50 days were as high as 34% in the 50 sluices, indicating that snails have a higher probability to drift in the running water into the ditches inside the sluice when the sluice was opened. Therefore, it is suggested that irrigation water should be drawn from snail - free areas to prevent snail spreading.

After the sluice was set up, the time when snails were first found in the ditch inside the sluice did not correlate with the size of snail habitats outside the sluice. But the percentage of the snail habitats below 500 mu outside the sluice was much higher than those of other three grades (Table 2). The situation may be due to the distance between the snail habitat and the sluice, and also the density of snails outside the sluices.

Among the 30 sluices, only 4 sluices were decreasing slowly in length as well as the area of the snail - ridden in the ditch inside the sluice. The snail areas of 228 mu dropped 71% during seven years. While those of 26 sluices that were increasing in length as well as area of snail - ridden in the ditch inside the sluice were 2.26 times and 5.02 times respectively in 1987 and were higher than those in 1980 which increased by several times. Both the increasing and the decreasing status included two factors consisting of elimination of the snail habitats inside the sluice by environmental modification and molluscicide and the spreading of the snail from outside the sluice to inside by irrigation. It was indicative that although the searching and eradicating of

snails were taken repeatedly every year in these regions, the speed of snail eradication could not keep pace with the speed of snail spreading. Great effort should be made by confining snail eradication at chosen areas and locations, and keeping it snail - free constantly inside the sluices. Within the range of 2 km outside the sluice, a safety snail - free region should be kept to cut down the spreading of snails into the ditch inside the sluice when the sluice was opened.

The results of this investigation demonstrated that opening of sluices for irrigation caused snails to drift into the ditch inside the sluices. It was not related to the size of snail habitats outside the sluice, nor the time when snails were first found in the ditch inside the sluice. Also it has no direct proportion with the number of sluice outlets, the water flow of the sluice, the number of annual average days of opening sluices and the frequency of opening sluices. With snails outside the sluices, once the sluice is opened for irrigation, snails will drift into the ditch inside the sluice. Also, the speed of snail eradication could not keep pace with the speed of snail spreading. Therefore, effective counter - measures are needed for the control of snail spreading, so that the achievement of anti - schistosomiasis measure inside the sluice could be achieved satisfactorily.

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