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Cover Image: Two investigators searching for schistosome cercaria hatched from a cattle faeces sample collected from study sites (Photographer: Yu-Ting Hu from Lianxi Institute of Schistosomiasis Control).

Preplanned Studies

# Distribution Patterns of the Snail Intermediate Host of *Schistosoma japonicum* — China, 2015−2019

Lijuan Zhang[1]; Shan Lv[1]; Chunli Cao[1]; Jing Xu[1,#]; Shizhu Li[1,#]

**Summary**

**What is already known about this topic?**

The endemic status of schistosomiasis appeared to continuously decrease in China from 2015 to 2019. The snail species *Oncomelania hupensis* is the only intermediate host involved in the transmission of *Schistosoma japonicum*, and this snail's geographic distribution is strictly consistent with that of schistosomiasis.

**What is added by this report?**

The snail's habitats did not decrease significantly in China from 2015 to 2019, and some habitats have been newly detected or recurrent in some regions. Snail habitats among nine counties in Hunan and Jiangxi covered nearly half of the areas with snails.

**What are the implications for public health practice?**

Considering the situation of snail distribution, strategies and measures on snail control should focus on key areas. In addition, study of the origin and causes of the newly-detected snail habitats and recurrent areas with snails needs to be strengthened, and comprehensive measures should be taken to prevent the spread of snails.

Schistosomiasis remains a public health problem in developing regions, including Africa, Asia, and Latin America. Of three major human-infecting *Schistosoma* spp., *Schistosoma japonicum* (*S. japonicum*) is the only one distributed in China (ibuted in China (*1*–*2*). It was endemic in 12 provincial-level administrative divisions (PLADs) in the southern Yangtze River Basin. In 2019, Shanghai, Zhejiang, Fujian, Guangdong, and Guangxi continually maintained the status of schistosomiasis elimination; Sichuan and Jiangsu achieved transmission interruption; and the 5 provinces of Yunnan, Hubei, Anhui, Jiangxi, and Hunan maintained the status of transmission control (*3*). As the only intermediate host of *S. japonicum*, the snail's distribution is strictly consistent with that of schistosomiasis japonica (*4*), and surveys are an important part of routine work for schistosomiasis prevention and control. To know the characteristics and trends of snail distribution after achieving the standard of transmission control in China, data on snail habitat surveys were collected and analyzed from 2015 to 2019. According to the results, the areas deemed as snail habitats did not decrease during the five years, fluctuating from 356,287.55 hectares ($hm^2$) to 363,069.38 $hm^2$, and newly-detected snail habitats and recurrent snail habitats were found from 2015 to 2019.

In the study, data of the annual snail survey at the provincial level and county level from 2015 to 2019 were collected through the National Parasitic Diseases Control Information Management System (NPDCIMS) among 12 PLADs. All data were transferred to Microsoft Excel software (version 2013, Microsoft Office, CA, USA) for data compilation. Variables reflecting the distribution of snails including the total area of snail habitats, area of newly detected snail habitats (environments with no snails initially), area of recurrent snail habitats (snails being found in environments that previously eliminated snails), and other data from the snail survey were described and analyzed. Descriptive statistics and mapping were conducted to analyze the snail distribution at the provincial and county levels, the environmental type of snail habitats, and the distribution of snail habitats at the county level.

From 2015 to 2019, all counties reporting schistosomiasis conducted snail surveys each year. There were 253 counties (55.85%) with snails infested among 453 counties with schistosomiasis endemic in 2015, compared with 270 out of 450 in 2019 (number declined for the changes of administrative divisions). The proportion of counties with snails increased slightly (Figure 1A). The total areas of snail habitats were 356,287.55 $hm^2$ in 2015 and 362,367.87 $hm^2$ in 2019 (Figure 1B). During the 5 years, the main environmental type of snail habitats was marshland and lake regions (94.65%–96.57%), mountainous and hilly regions (3.40%–5.31%), and plains with waterway networks (0.03%–0.06%). The proportion of snail habitats in mountainous and hilly regions increased gradually (Table 1). Hunan, Jiangxi, and Hubei were the top 3 PLADs for total area of snail habitats in 2019 (Figure 1D), accounting for 47.75% of the total area (173,027.27 $hm^2$/362,367.87 $hm^2$), 23.05% (83,530.52 $hm^2$/362,367.87 $hm^2$), and 18.61% (67,433.58 $hm^2$/362,367.87 $hm^2$), respectively.

From 2015 to 2019, 2,346.54 $hm^2$ areas of snail habitats were newly found among the 12 PLADs. The newly detected areas with snails were found in 9 PLADs except Fujian, Guangdong, and Sichuan. Among the 9 PLADs, Anhui accounted for 64.06% (1,503.31 $hm^2$/2,346.54 $hm^2$) and Hunan accounted for 29.36% (689.02 $hm^2$/2,346.54 $hm^2$). A total of 12,293.57 $hm^2$ of snail habitats were recurrent among the 12 PLADs at the same time. Sichuan accounted for 29.89% (3,674.79 $hm^2$/12,293.57 $hm^2$), Jiangxi accounted for 19.63% (2,413.37 $hm^2$/12,293.57 $hm^2$), Yunnan accounted for 17.69% (2,175.10 $hm^2$/ 12,293.57 $hm^2$), and Anhui accounted for 12.75%

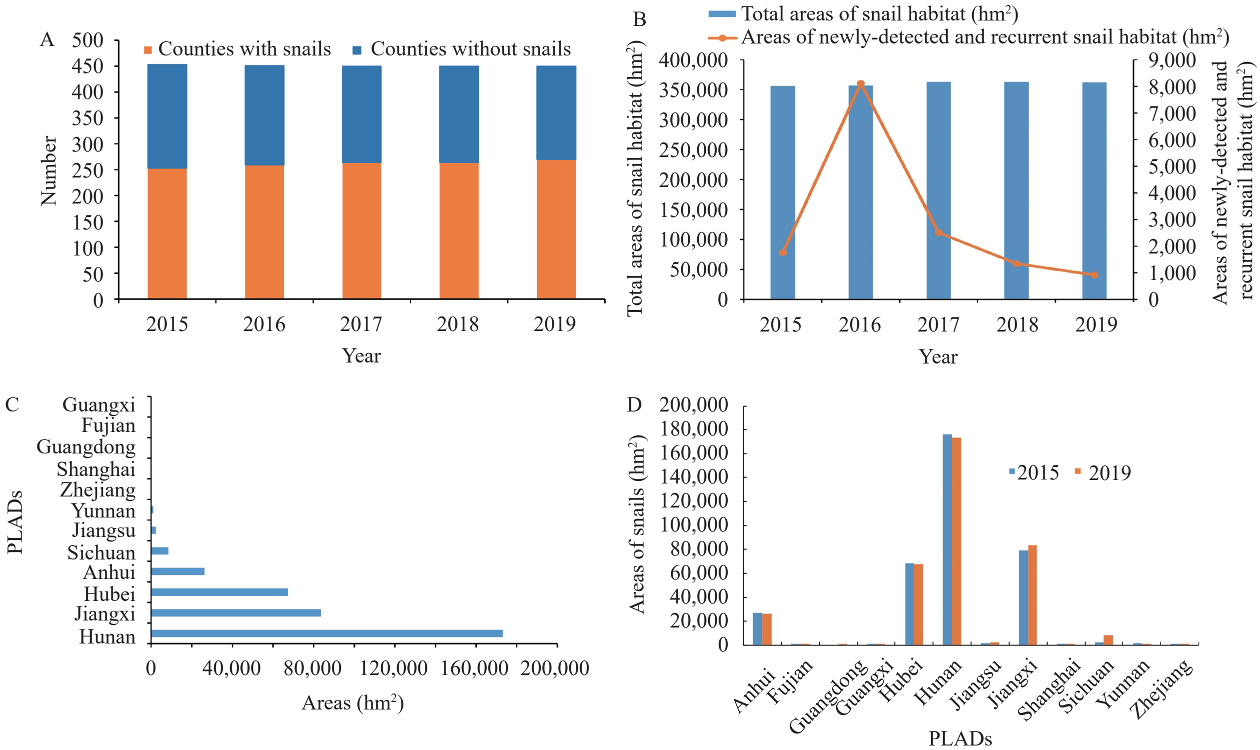


FIGURE 1. Distribution characteristics of snail habitats among the 12 PLADs in China from 2015 to 2019. (A) The changes of county number with snail infested from 2015 to 2019; (B) The change trend of total snail habitat and newly-detected and recurrent snail habitat from 2015 to 2019; (C) The areas of snail habitat in each PLAD in 2019 ($hm^2$); (D) The areas of snail habitat in 12 PLADs in 2015 and 2019 ($hm^2$).

Abbreviation: PLADs=Provincial-level administrative divisions.

TABLE 1. The changes of different environmental snail habitats, newly detected and recurrent snail habitats in China from 2015 to 2019 ($hm^2$).

| Year | Area of snail habitat | | | | Area of newly detected snail habitat | Area of recurrent snail habitat |
|---|---|---|---|---|---|---|
| | Total | Marshland and lake | Plain | Hilly and mountainous region | | |
| 2015 | 356,287.57 | 344,076.05(96.57%) | 112.69(0.03%) | 12,098.83(3.40%) | 666.04 | 1,094.16 |
| 2016 | 356,834.59 | 339,174.56(95.05%) | 135.62(0.04%) | 17,524.41(4.91%) | 1,346.48 | 6,767.50 |
| 2017 | 363,069.47 | 344,337.41(94.84% | 108.965(0.03%) | 18,623.10(5.13%) | 208.54 | 2,299.19 |
| 2018 | 363,014.40 | 343,874.04(94.73%) | 220.92(0.06%) | 18,919.44(5.21%) | 61.28 | 1,281.48 |
| 2019 | 362,367.87 | 342,987.74(94.65%) | 154.10(0.04%) | 19,226.03(5.31%) | 64.20 | 851.24 |

Note: the percentage in brackets stands for the percent of each type of snail habitat among the total snail habitat in the same year.

(1,568 hm²/12,293.57 hm²). In addition, more newly detected and recurrent snail habitats were found in 2016 than any other years during the 5 years.

According to the latest data in 2019, among the 450 counties with endemic schistosomiasis, there were 9 counties with area of snail habitats exceeding 10,000 hm², including 5 counties in Hunan (Yuanjiang, Hanshou, Yueyang, Xiangyin, and Junshan) and 4 counties in Jiangxi (Duchang, Poyang, Nanchang, and Yugan). The total area of snail habitats among these 9 counties were 172,907.34 hm², accounting for 47.72% (172,907.34 hm²/362,367.87 hm²) of the total area of snail habitats; the area of snail habitats in 46 counties were between 1,000 hm² and 10,000 hm², including 9 counties in Anhui, 7 counties in Jiangxi, 18 counties in Hubei, 11 counties in Hunan, and 1 county in Sichuan; the area of snail habitats in 89 counties were between 100 hm² and 1,000 hm², the area in 97 counties were between 1 hm² and 100 hm², and in 209 counties were less than 1 hm² or no snails detected (Table 2).

## DISCUSSION

Data on snail surveys from 2015 to 2019 suggested that the total areas of snail habitats in China decreased slowly or rebounded in some PLADs. Though more counties with endemic schistosomiasis entered the stage of elimination, the distribution of snails increased and more counties were found with infested snails. Sichuan had achieved the standard of transmission interruption in 2017 (*5*); however, the areas of snail habitats increased from 2537.55 hm² in 2015 to 8509.06 hm² in 2019. As the only intermediate host of *S. japonicum*, the increase and recurrence of snails will bring more challenges to work on schistosomiasis control, especially in the elimination of schistosomiasis. In addition, no snails were found in Guangdong for more than 30 years after the announcement of schistosomiasis eradication in 1985 (*6*). However, the snail habitat was found again in Qujiang District and Yingde County in Guangdong in 2019. Because there is a floating population of humans from regions with endemic schistosomiasis, the risk of schistosomiasis transmission among these regions cannot be neglected (*7*). County-level analysis showed that 9 counties had snail areas that exceeded 10,000 hm², accounting for 47.72% of all snail habitats, indicating a concentrating of snail habitats.

This study was subject to some limitations. First, data on types of newly-detected and recurrent snail habitats were not collected and analyzed, which was helpful to analyze the cause and origin. Second, the study was mainly on the natural distribution of snail habitats, and other factors such as activities of humans and domestic animals were not considered. So key susceptible snail habitats could not be distinguished. This report requires future study of detailed data analysis on snail habitats for accurate snail control.

Based on the results of the study, surveillance should be strengthened on snails, especially among regions that currently do not have snails but are neighboring areas with snails. Snail survey and control is an essential factor in the process of schistosomiasis elimination (*8*), which cannot be neglected especially among areas with schistosomiasis elimination. Moreover, the quality of snail surveys should be improved to detect some snail habitats. Traditional methods for snail surveys are time and resource consuming, and new technologies such as remote sensing should be applied to snail surveillance (*4*). With increasing attention on environmental protection, snail control by molluscicide was restricted in the environmental protection zone, which brought difficulties to snail control and an increased risk of schistosomiasis transmission. Strategies and measures

TABLE 2. Levels on areas of snail habitat among counties with schistosomiasis endemic in 12 provincial-level administrative divisions in 2019.

| Area of snail habitat(hm²) | Number of counties | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Shanghai | Jiangsu | Zhejiang | Anhui | Fujian | Jiangxi | Hubei | Hunan | Guangdong | Guangxi | Sichuan | Yunnan | Total |
| ≤1 | 7 | 39 | 44 | 12 | 13 | 14 | 16 | 8 | 12 | 18 | 18 | 8 | 209 |
| 1.01–100 | 1 | 19 | 10 | 8 | 3 | 9 | 9 | 7 | 2 | 2 | 20 | 7 | 97 |
| 100.01–1,000 | 0 | 6 | 0 | 21 | 0 | 5 | 20 | 10 | 0 | 0 | 24 | 3 | 89 |
| 1,000.01–10,000 | 0 | 0 | 0 | 9 | 0 | 7 | 18 | 11 | 0 | 0 | 1 | 0 | 46 |
| >10,000 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 5 | 0 | 0 | 0 | 0 | 9 |
| Total | 8 | 64 | 54 | 50 | 16 | 39 | 63 | 41 | 14 | 20 | 63 | 18 | 450 |

of snail control should be studied and focused on areas with concentrated snail habitats. Comprehensive measures for snail control should be implemented among these areas combined with agricultural, forestry, or water conservancy projects to compress the areas of snail habitats. In addition, newly detected and recurrent snail habitats should be handled promptly. The cause and origin of newly-detected snails should be investigated. Snail surveys should be expanded and strengthened after flooding (*9*), transplantation of plants from snail habitats, and the construction of wetland parks.

In conclusion, with the promotion of schistosomiasis prevention and control, schistosomiasis control in China will enter the stage of elimination before 2030 (*10*). Snail control is an important part in the process of schistosomiasis control. Overall, to achieve the goal of elimination, snail surveillance should be strengthened especially among those areas with the risk of snail spread.

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Preplanned Studies

# Assessment of the Transmission Risk of Schistosomiasis after Flooding — North Poyang Lake, Jiangxi Province, China, 2020

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**Summary**

### What is already known about this topic?

Over 90% of *Oncomelania* snails, the only intermediate host of *Schistosoma japonicum*, are distributed in the middle and low reaches of Yangtze River. Flooding can extend the distribution of *Oncomelania* snails and hence accelerate the transmission of schistosomiasis.

### What is added by this report?

Although the dispersal of *Oncomelania* snails was negligible in north Poyang Lake after flooding in 2020, 2 samples of cattle feces with *Schistosoma* egg and 2 infected snails samples were indeed found. All four risk sites were distributed in Lushan County. Cattle feces were observed in the six out of seven field sites in Lushan County.

### What are the implications for public health practice?

The present national control strategy focusing on control of infection source should be reinforced in Lushan and other schistosomiasis endemic areas. Overlaps of infected snails and cattle feces with *Schistosoma* egg were not observed, which called for intensive surveillance in Lushan County.

The *Oncomelania hupensis* is the only intermediate host of *Schistosoma japonicum* (*S. japonicum*) in China. Approximately 97.36% habitats infested by *Oncomelania* snails are in the middle and low reaches of the Yangtze River (*1*). The typical habitat of *Oncomelania* snails is marshland along the Yangtze River, its major branches, and the connected lakes (*2*). Such habitats are submerged in water in summer and emerge in winter. Therefore, rainfall and flooding impact the distribution of snails and the transmission dynamics of schistosomiasis (*3*). Acute schistosomiasis was frequently observed in patients who had contact with water due to rescue work in flooding (*4*). The water level hit a historical high at many hydrological stations in middle and lower reaches of Yangtze River in the summer of 2020. The most affected areas were in Jiangxi and Anhui provinces, which were at high risk of schistosomiasis transmission (*1*). A risk assessment in Jiangxi was conducted for schistosomiasis transmission and provided interventions after flooding. Human stool samples, *Oncomelania* snails, and animal feces released to the environment were collected in two counties, i.e., Lushan and Lianxi. Although no infected humans were found in the survey, infections in snails and animal feces were discovered from four field sites in Lushan. Our results indicated the intensive surveillance should be implemented post-flooding.

Two neighboring counties, i.e., Lushan and Lianxi, located in the northwest bank of Poyang Lake leading to Yangtze River were selected. The evidence showed that the density of *Oncomelania* snails increased significantly and exceeded that in the south lake according to survey in 2016 (*5*). The area drew attention because the only human acute schistosomiasis case and infected cattle case in 2019 was reported in this area (*6*). Two townships in each county were selected and one village was chosen in each township. About 100 residents who reported contact with water during flooding and another 100 participants without record of water contact in each village were randomly selected in the study. If there was no adequate eligible participant in the village, other potential individuals from neighboring villages in the same township were included. Stool samples of over 90 g per individual were collected for triple detection of *S. japonicum* miracidia hatching after nylon mesh bag concentration (*7*). At least three extant habitats of *Oncomelania* snails and suspected environments impacted by flooding were selected for the snail survey. More than 500 sampling frames (0.11 $m^2$) were set for screening *Oncomelania* snails in each habitat or environment, and over 1,000 snails were collected. Every 50 snail specimens were pooled for DNA extraction and detected for *S. japonicum* by loop-mediated isothermal amplification (LAMP) (*8*). The animal feces released in the surveyed snail habitats were collected. At least 20 samples (all if less than 20) were collected in each habitat. Over 150 g per sample was collected for triple detection of *S. japonicum* using a miracidial hatching test with a plastic tube. The potential host animals of stool samples were recorded.

The sentinel-1A radar image was characterized around July 12, 2020, when Xingzi hydrological station in Lushan County experienced the highest water level and on October 19 when the present field survey was commenced. The water body was extracted from the image in ENVI 5.1 (Exelis Visual Information Solutions, Boulder CO, USA) and mapped in ArcGIS 10.1 (ESRI, Redlands CA, USA). The images in the same period in 2018 and 2019 were also collected to compare the water coverage between 2020 and the previous 2 years. The test statistic for the occurrence rate of *Oncomelania* snails in sampling frames, the LAMP-positive rate of snails, and overall schistosomiasis prevalence in animal feces samples in the 2 counties were performed in IBM SPSS Statistics 19.0 (IBM Corp; Armonk NY, USA).

A total of 452 and 403 stool samples from individuals from Lianxi and Lushan counties, respectively, were collected for the survey. No infection was detected in all 5 villages. A total of 19 field sites were visited during the survey, and 11 sites were infested by *Oncomelania* snails. The mean snail density was 0.09 per frame (0.11 $m^2$) with a range between 0.01 and 0.28. The occurrence rate of *Oncomelania* snails in sampling frames was 10.17% in Lushan, which was higher than the 4.89% found in Lianxi, in which the difference was statistically significant ($P<0.05$). A total of 11 and 10 pooled samples of snails were detected for *Schistosoma* by LAMP in Lushan and Lianxi, respectively, in which only 2 samples from Lushan County were positive. A total of 71 animal-feces samples, including 46 cattle samples, 10 sheep samples, 7 dogs samples, and 8 unknown samples, were collected from 8 visiting sites. All cattle samples were collected from 6 out of 7 visiting sites in Lushan County in which 2 cattle samples were miracidial hatching positive from separated sites located in Jiaotang Township (Figure 1). However, no *Oncomelania* snail was found from the 2 positive cattle samples.

Extant snail habitats according to the national survey on *Oncomelania* in 2016 were mapped. Most habitats were submerged in water until late October 2020 (Figure 1). The time of flood waters receding was remarkably later than that in 2018 (Figure 2A) and 2019 (Figure 2B). The radar image showed there was only little increase in water area in the study area, except for the area located in southwestern Lushan County (Figure 3). Few breaches were occurring in major dams along Poyang Lake during the flooding, although the water level obviously increased compared to the average level between 2018 and 2019.

## DISCUSSION

Although no notable snail habitats extended due to flooding in 2020, risk factors including infective cattle feces and infected snails were widely identified in middle and south researching area. These findings indicated much higher risk for schistosomiasis transmission than previously evaluated risk in annual routine assessments by the National Institute of Parasitic Diseases of China CDC. Therefore, surveillance and management of domestic animal feces must be enforced, and extensive assessment should be conducted sooner.

Cattle were the major source of infection in the study area and the national control strategy (i.e., the integrated strategy with emphasis on control of source of infection) should be enforced. Domestic mammals, particularly cattle, are playing an essential role in schistosomiasis control. A new strategy commencing in 2004 focused on controlling the source of infection after pilot studies (*9*). The measures include replacing farming cattle with machines, forbidding grazing on snail-infested grassland, managing human and animal feces, etc. The remarkable decrease in the prevalence of schistosomiasis in humans and animals across the country proves the effectiveness of the strategy (*10*).

However, cattle are reemerging in some areas. All cattle in schistosomiasis-endemic areas in Lushan County were completely removed before 2018, while the number of cattle in 2018 and 2019 were 1,063 and 1,860, respectively, according to Annals of Statistics for Schistosomiasis Control. An infected cattle was found in 2019 during the routine surveillance. Animal feces were observed in six out of seven visiting sites and cattle feces were found in all the six sites, which indicated reemergence of cattle in Lushan County was common. In contrast, around 10 cattle in the endemic area of Lianxi County were reported annually since 2016, but no infection was found. Furthermore, cattle feces were not observed in all 12 visiting sites in the present study. Our findings demonstrated that emerging cattle challenged the achievement even at the stage of low prevalence. Therefore, control of infection sources, particularly cattle, is recommended in Lushan and other counties with the similar situation.

In the study four high-risk sites were identified surrounding the northern lake in Lushan County.

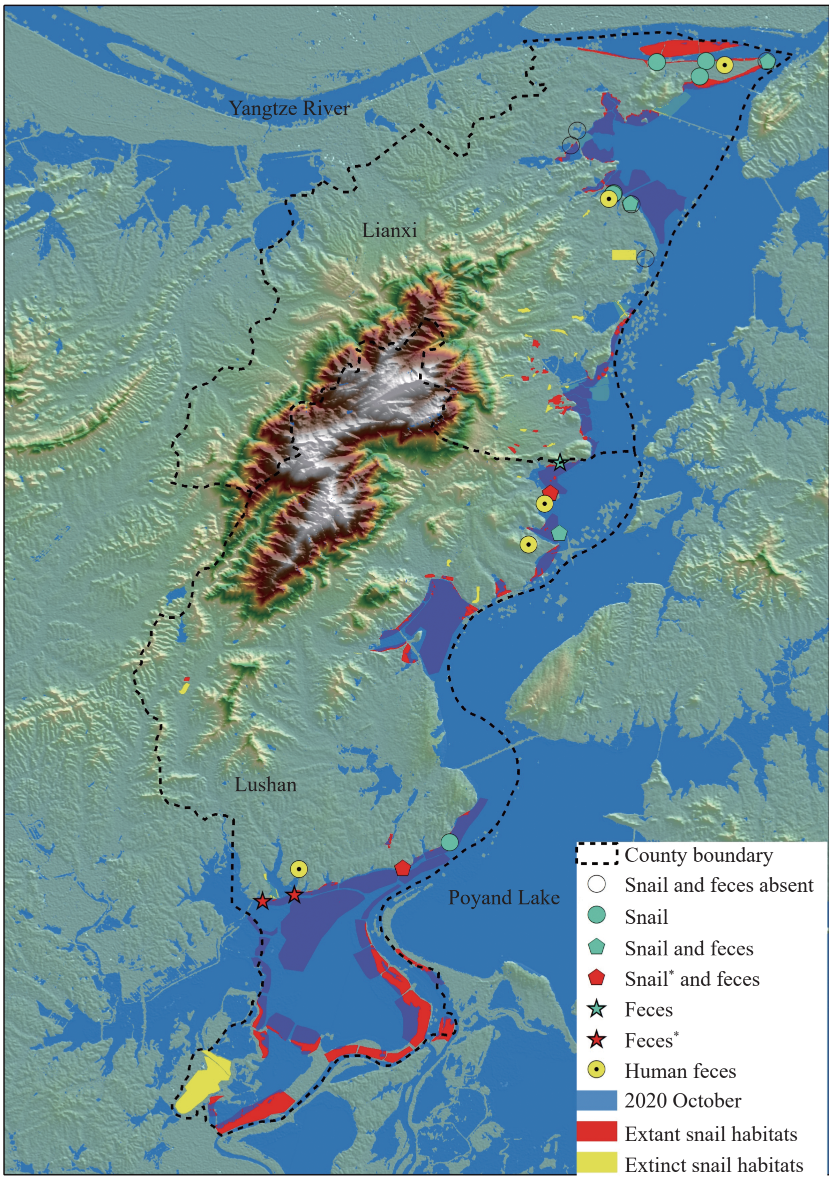


FIGURE 1. Geographical distribution of visited sites with major findings in Lianxi and Lushan counties, Jiangxi Province, China, October 2020.
Note: Snail: *Oncomelania hupensis*; Feces: animal feces released to environment; *: infected snails or feces with *Schistosoma japonica* eggs; Human feces: villages where residents' stool samples were examined for *Schistosoma* infection; 2020 October: water distribution in October 2020.

They were distributed both in north and south bank of the lake, which indicated a wide risk of schistosomiasis transmission in this county. In addition, no overlap was observed between the four sites, which implied the cattle were moving in a large range. Therefore, extensive surveillance for schistosomiasis transmission should be implemented.

It is well known that the flooding can carry *Oncomelania* snails to the new areas, and hence, the distribution of snails can extend (*4*). In our study region, the area covered by flooding was not significantly increased due to the relatively higher elevation of lake bank and few breaches in dams. In addition, the submergence of snail habitats is remarkably prolonged compared to that in previous years, which challenges the fall reproduction of *Oncomelania* snails and potentially decreases the snail density in the next spring. However, the situation in the south Poyang Lake may be different. It is worth to conducting further assessments.

This study was subjected to some limitations. Flooding in 2020 widely impacted the schistosomiasis

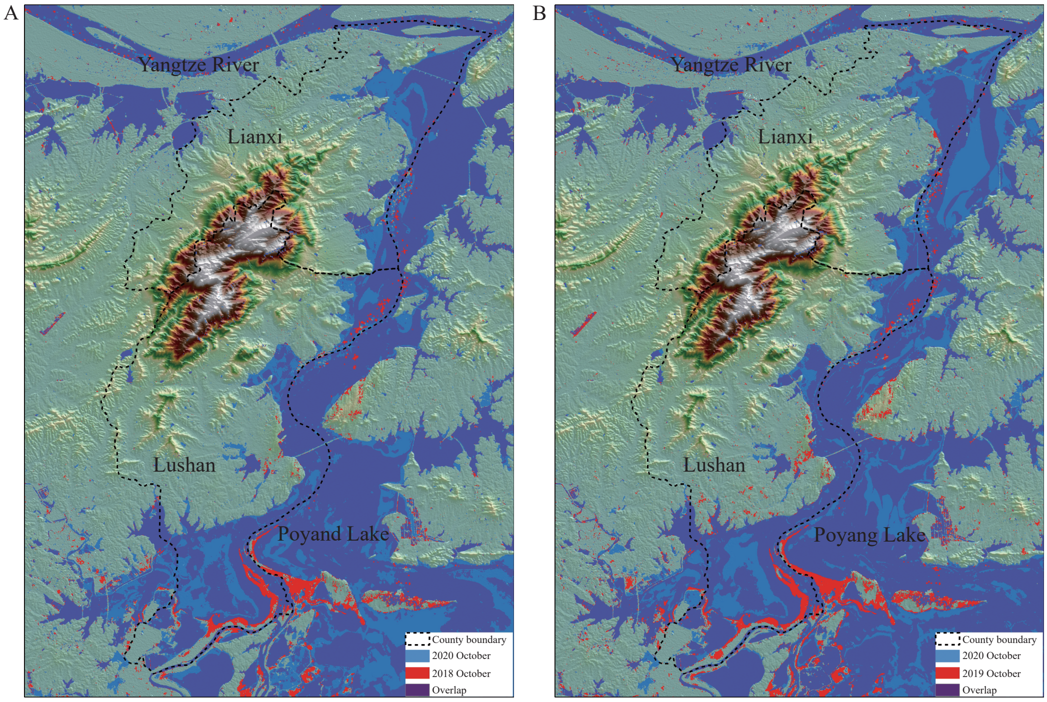


FIGURE 2. Comparison of water body distribution in north Poyang Lake during the same periods. (A) October, 2020 and October, 2018; (B) October, 2020 and October, 2019.
Note: Overlap: the overlap of water body between October, 2020 and (A) October, 2018 or (B) 2019.

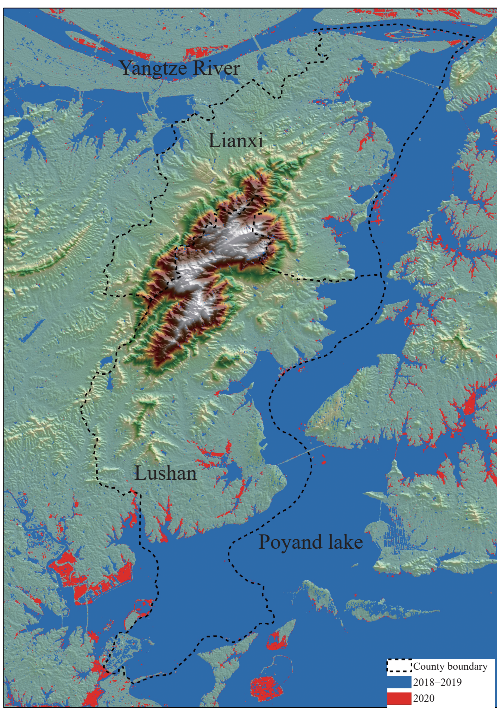


FIGURE 3. Increased area affected by flooding in 2020 compared to that in 2018 and 2019 in Lianxi and Lushan counties, Jiangxi Province, China.
Note: 2018–2019: the maximum water area at highest water levels in 2018 and 2019; 2020: the extended flooded areas during 2020 compared to 2018–2019.

endemic counties, but only 2 adjacent counties on the north bank of Poyang Lake were included in this study. Although our findings may represent the situation in some endemic counties, further assessment or surveillance should be performed in other counties.

In conclusion, our findings indicated high transmission risk of schistosomiasis in some areas. Management of infection sources, particularly cattle feces, should be strengthened in the area surrounding the lake. Further assessment on impact of flooding on snail habitats in extensive area should be conducted.

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Preplanned Studies

# The Potential Distribution Prediction of *Oncomelania hupensis* Based on Newly Emerging and Reemergent Habitats — China, 2015−2019

Yanfeng Gong[1]; Yinlong Li[1,#]; Lijuan Zhang[1]; Shan Lv[1]; Jing Xu[1]; Shizhu Li[1,#]

**Summary**

**What is already known about this topic?**

*Oncomelania hupensis* (*O. hupensis*) is the only intermediate host of *Schistosoma japonica*. The distribution of *O. hupensis* is affected by a series of climate, geographical, sand ocioeconomic factors, which reflect the risk areas of schistosomiasis.

**What is added by this report?**

There were certain geographical aggregations in the potential high distribution areas of *O. hupensis*, which were mainly distributed in Poyang Lake area, Dongting Lake area, and the middle and the lower reaches of the Yangtze River.

**What are the implications for public health practice?**

Monitoring and forecasting the distribution of *O. hupensis* is conducive to improving the early warning capabilities of the potential risk of schistosomiasis transmission and progressively promoting the elimination of schistosomiasis nationwide.

The infection rate of schistosomiasis in China now is at the lowest level in history, and the source of infection has been effectively controlled. However, the area of *Oncomelania hupensis* (*O. hupensis*), the only intermediate host of the genus *Schistosoma*, has been maintained at about 3.5 billion m$^2$. Affected by the changes in climate, environment, and human activities, newly emerging and reemergent habitats of *O. hupensis* often occur, which makes early warning of *O. hupensis* become particularly important. Based on the surveillance data of *O. hupensis* (*1*), a niche model was used to predict the distribution of *O. hupensis*. The results indicated that the distribution of *O. hupensis* had concentrated, becoming primarily distributed in the middle and lower reaches of the Yangtze River, Dongting Lake, and Poyang Lake. Forecasting the distribution of *O. hupensis* is conducive to improving the ability of early warning of potential transmission risk and the elimination of schistosomiasis.

Schistosomiasis, a widespread zoonotic disease transmitted by the parasite of *Schistosoma japonicum* (*S. japonicum*), is considered as one of the most severe public health threats in China. *O. hupensis* is the only intermediate host of *S. japonica* and plays a key role in schistosomiasis transmission, whose geographical distribution reflects the area at risk of schistosomiasis transmission. According to the National Schistosomiasis Reporting System, the reported snail distribution has been maintained at about 3.5 billion square meters since 2004, and the occurrence and recurrence of snails have been reported in many areas (*2*). In 2016 and 2020, the Yangtze River Basin and its southern region suffered from 2 catastrophic floods. After the floods, suitable areas for snail breeding were formed, which increased the potential scope and degree of schistosomiasis distribution (*3*).

The environment with newly emerging and reemergent snail habitats from the national schistosomiasis surveillance sites from 2015 to 2019 were selected as the sample points, and 14 climatic, geographical, and socioeconomic factors (Supplementary Table S1 available in http://weekly.chinacdc.cn/) influencing *O. hupensis* distribution were collected as predictors. Spatial scanning based on Poisson model in SaTScan (version 9.6) was used to analyze the aggregation of newly emerging and reemergent habitats of *O. hupensis*. A total of 10 common niche models (Supplementary Table S2 available in http://weekly.chinacdc.cn/) provided in biomod2 platform (version 3.4.6) in R software (version 3.6.1; RStudio Inc; the USA) were used to construct single models, and the area under the curve (AUC) and true skill statistics (TSS) were used as the indicators of model screening, which were threshold-related indicators and threshold independent indicators commonly used to evaluate model accuracy. Single models were selected according to the criteria of AUC >0.90 and TSS >0.85. The weights were determined according to the TSS of the results of different algorithms, and the combined niche model was calculated by the weighted average method. The judgment threshold is defined as the minimum existence threshold, and the distribution probability from 0.00 to the minimum existence threshold is taken as the no-risk area, the minimum existence threshold to 0.70 is the low-risk area, 0.70 to 0.90 is the medium-risk area, and the greater than 0.9 is the high-risk area (*4*).

According to the results of SaTScan scanning, six cluster areas in newly emerging and reemergent habitats of *O. hupensis* were detected, which were primarily distributed in the northwest region of Yunnan Province, the central part of Sichuan Province, and the junction of Jiangsu Province, Anhui Province, and Zhejiang Province (Figure 1). The prediction performance of 10 niche models was statistically significant through Kruskal-Wallis H test (AUC, H=24.720, $P$<0.05; TSS, H=29.372, $P$<0.05), and random forest (AUC=0.973, TSS=0.998) demonstrated the best prediction performance (Supplementary Table S3 available in http://weekly.chinacdc.cn/). Taken together, the importance of environmental variables in each model is different, of which the average annual rainfall and average annual temperature had more impacts (Supplementary Table S4 available in http://weekly.chinacdc.cn/ ). The current distribution of *O. hupensis* predicted by combination model indicated that the potential distribution areas of *O. hupensis* were mainly concentrated in the middle and lower reaches of the Yangtze River (Figure 2). These areas were also locally concentrated in the central part of Sichuan Province and scattered in the northwest part of Yunnan Province (Figure 2). Based on the predicted results of the niche model, the potential distribution area of *O. hupensis* accounted for 22.92% of the total area in China, and the distribution area can be categorized into areas of low-distribution (8.74%), medium-distribution (7.99%), and high-distribution (6.19%).

## DISCUSSION

The results of this study indicated that the certain geographical aggregations in the potential high distribution areas of *O. hupensis* were primarily distributed in Poyang Lake area, Dongting Lake area, and the middle and the lower reaches of the Yangtze River. These areas maintain high water levels due to

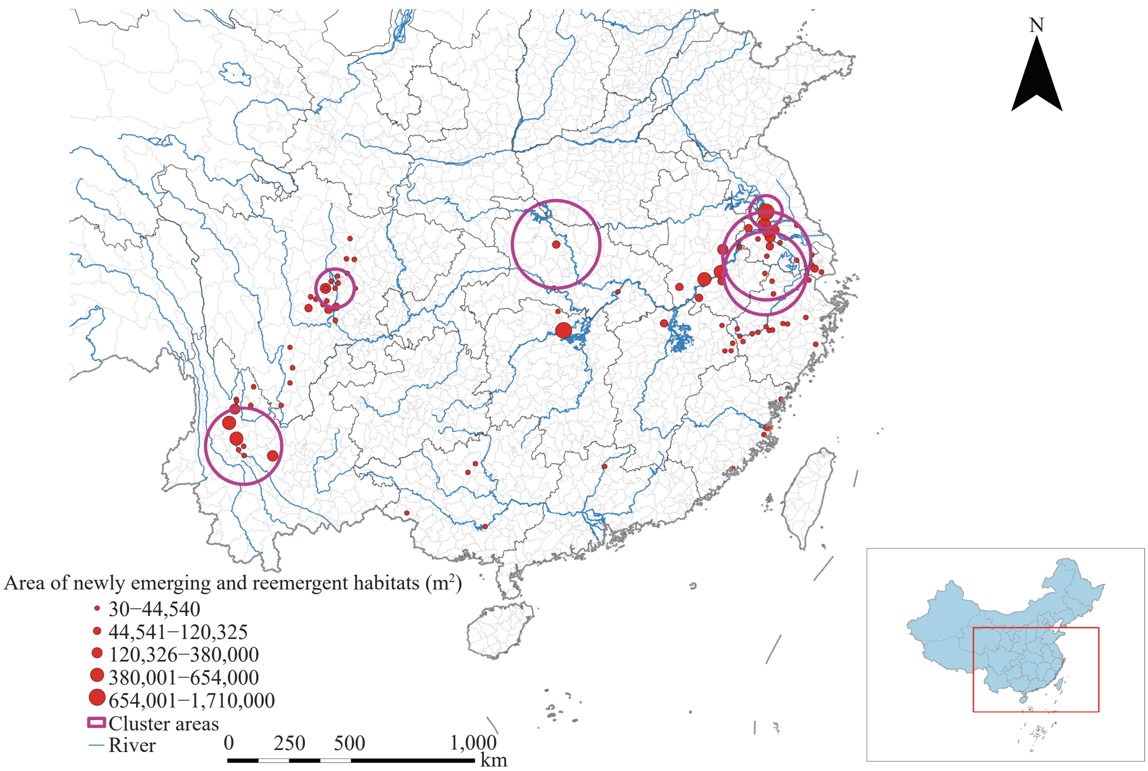


FIGURE 1. Ranges of newly emerging and reemergent habitats of *Oncomelania hupensis* and cluster area in schistosomiasis endemic areas, 2015−2019.

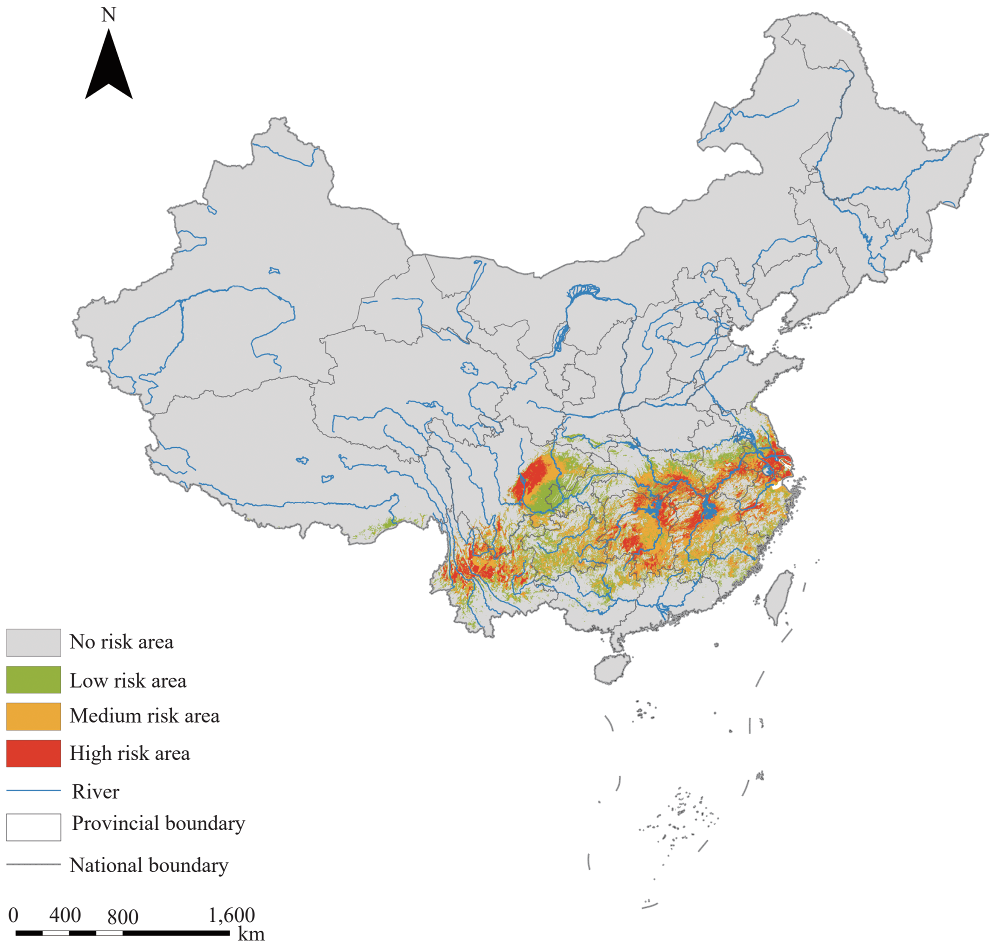


FIGURE 2. Current distribution prediction map of *Oncomelania hypensis* in China based on combination model.

floods in summer and begin to recede in fall and winter. The seasonal periodic water-level changes lead the coastal beaches to form a wet meadow ecosystem, providing a suitable breeding place for *O. hupensis* (*5*). Due to fishing, grazing, farming, and other production and living reasons, residents were more likely to be exposed to snail environment and contaminated water (*6*). *O. hupensis* was distributed locally in the central part of Sichuan Province and scattered in the northwest part of Yunnan Province. Different from lake-marsh type snails distributed along the beach, the general law of the distribution of hilly snails is that they are distributed in the breeding environment of different topography with the water system from top to bottom. The migration and diffusion of *Oncomelania* snails are related to the size, distribution, velocity, and irrigation of water system. Affected by flood erosion, *O. hupensis* with higher terrain may spread with water flowing down the mountain, increasing the potential risk of schistosomiasis transmission (*7*).

Compared with the research of Liao et al. (*8*), this study used the latest snail survey data and combined the niche model to overcome the uncertainty brought by the single model. The high-risk areas of *O. hupensis* are basically consistent with the distribution patterns of schistosomiasis transmission in China (*9*). Compared with the risk distribution of schistosomiasis transmission assessed by Duan et al. (*10*), the high-risk areas predicted in this study covered a wider area, while the range of middle-areas and low-risk areas was lower than predicted and might be related to different sample points and predictors of two studies.

This study was subjected to some limitations. First, newly emerging and reemergent habitats outside the surveillance sites might have occurred, and this study did not take these sample points into account. Second, due to the unavailability of data, this study did not consider the impact of other human factors such as water conservancy projects, water supply reconstruction, and lavatories. In future research, more complete data of snail distribution are essential and can be accurately obtained through field investigation.

More relevant variables from socioeconomic and environmental fields are necessary to be added to model training to improve the accuracy and effectiveness of the model prediction, promote the prediction results of potential snail distribution areas, and provide further technical support for the prevention, control, and monitoring of schistosomiasis.

Affected by production activities, natural disasters, water conservancy projects, climate change, and other factors, the abnormal spread of *O. hupensis* leads to the recurrence of schistosomiasis in some areas and even the spread to historically non-endemic areas. Historical experience suggests that there will be a relative peak in the area and the density of snails three years after flooding, which will increase the risk of repeated outbreaks of schistosomiasis and difficulty in schistosomiasis control (*6*). Although the national schistosomiasis control program in China has made great strides towards the interruption of transmission, the risk of schistosomiasis transmission still exists in some areas. To further consolidate the results of the national schistosomiasis control program and prevent rebound of schistosomiasis, taking comprehensive control strategies and measures in areas at risk of *O. hupensis* infestation is necessary.

**Conflicts of interest:** There are no conflicts of interest to declare.

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SUPPLEMENTARY TABLE S1. Summary of environment variables used in the study.

| Category | Variable name | Source |
|---|---|---|
| Climate factor | ≥0 °C annual accumulated temperature | http://www.resdc.cn |
| | ≥10 °C annual accumulated temperature | |
| | Aridity | |
| | Index of Moisture | |
| | Average annual precipitation | |
| | Average annual temperature | |
| Geographical factor | Landform | http://www.geodata.cn |
| | Land use | |
| | Elevation | http://www.resdc.cn |
| | Sand | |
| | Silt | |
| | Clay | |
| Socioeconomic factor | Gross domestic product | http://www.resdc.cn |
| | Density of population | |

SUPPLEMENTARY TABLE S2. Summary of niche models used in the study.

| Classification | Model name |
|---|---|
| Environmental envelope theory | Surface range envelope |
| Statistical regression algorithm | Generalized linear model |
| | Generalized additive model |
| | Multivariate adaptive regression spline |
| Statistical classification algorithm | Generalized boosted model |
| | Classification tree analysis |
| | Flexible discriminant analysis |
| Machine learning algorithm | Artificial neural networks |
| | Random forest |
| | Maximum entropy |

SUPPLEMENTARY TABLE S3. Performance evaluation indicators results of 10 niche models used in the study.

| Model | TSS (mean ± SD) | AUC (mean ± SD) |
|---|---|---|
| GLM | 0.868 ± 0.057 | 0.947 ± 0.042 |
| GBM | 0.950 ± 0.007 | 0.996 ± 0.001 |
| GAM | 0.926 ± 0.008 | 0.990 ± 0.001 |
| CTA | 0.945 ± 0.009 | 0.980 ± 0.005 |
| ANN | 0.813 ± 0.056 | 0.930 ± 0.032 |
| SRE | 0.651 ± 0.018 | 0.825 ± 0.008 |
| MARS | 0.846 ± 0.251 | 0.946 ± 0.133 |
| FDA | 0.914 ± 0.015 | 0.983 ± 0.006 |
| RF | 0.973 ± 0.004 | 0.998 ± 0.001 |
| MaxEnt | 0.815 ± 0.023 | 0.915 ± 0.023 |

Abbreviation: TSS=True skill statistics; AUC=Area under the curve; SD=Standard deviation; GLM=Generalized linear model; GBM=Generalized boosted model; GAM=Generalized additive model; CTA=Classification tree analysis; ANN=Artificial neural networks; SRE=Surface range envelope; MARS=Multivariate adaptive regression spline; FDA=Flexible discriminant analysis; RF=Random forest; MaxEnt=Maximum entropy.

SUPPLEMENTARY TABLE S4. Importance percentage (%) of environmental variables of 10 niche models used in the study.

| Model | GLM | GBM | GAM | CTA | ANN | SRE | MARS | FDA | RF | MaxEnt |
|---|---|---|---|---|---|---|---|---|---|---|
| AAT | 22.02 | 34.93 | 29.21 | 35.22 | 13.02 | 11.88 | 43.54 | 25.83 | 27.62 | 19.01 |
| AAP | 17.70 | 18.61 | 15.72 | 24.72 | 16.44 | 11.54 | 12.57 | 26.11 | 10.35 | 5.75 |
| IM | 18.45 | 9.73 | 8.24 | 0.34 | 31.16 | 10.03 | 17.78 | 15.69 | 4.75 | 9.11 |
| LF | 7.28 | 24.28 | 13.29 | 12.15 | 6.78 | 10.68 | 5.31 | 8.33 | 15.85 | 7.13 |
| GDP | 1.07 | 5.62 | 0.03 | 15.76 | 2.16 | 9.71 | 2.57 | 8.40 | 16.49 | 9.36 |
| AR | 6.32 | 1.22 | 5.53 | 0.21 | 11.17 | 9.17 | 5.71 | 2.92 | 0.90 | 11.02 |
| EL | 10.76 | 0.03 | 2.07 | 0.60 | 10.73 | 4.75 | 0.88 | 1.77 | 4.75 | 9.04 |
| AAT0 | 8.61 | 0.48 | 5.56 | 2.53 | 0.53 | 6.39 | 2.79 | 6.08 | 10.29 | 9.18 |
| DP | 1.82 | 0.45 | 0.22 | 0.12 | 4.84 | 0.68 | 1.33 | 1.35 | 3.94 | 6.19 |
| LD | 0.51 | 1.54 | 10.25 | 5.36 | 0.61 | 8.82 | 3.93 | 1.42 | 1.42 | 1.35 |
| Sand | 0.81 | 1.81 | 4.66 | 2.49 | 0.39 | 6.88 | 0.90 | 0.80 | 2.23 | 1.30 |
| AAT10 | 2.63 | 0.49 | 1.42 | 0.07 | 0.38 | 3.21 | 1.45 | 0.87 | 0.40 | 7.05 |
| Silt | 0.09 | 0.37 | 3.69 | 0.03 | 0.74 | 5.38 | 0.50 | 0.38 | 0.48 | 0.35 |
| Clay | 1.94 | 0.43 | 0.11 | 0.40 | 1.04 | 0.88 | 0.74 | 0.03 | 0.54 | 4.18 |

Abbreviation: AAT=Average annual temperature; AAP=Average annual precipitation; IM=Index of moisture; LF=Landform; GDP=Gross domestic product; AR=Aridity; EL=Elevation; DP=Density of population; LD=Land use; AAT0, ≥0 ℃ annual accumulated temperature; AAT10, ≥10 ℃ Annual accumulated temperature. GLM=Generalized linear model; GBM=Generalized boosted model; GAM=Generalized additive model; CTA=Classification tree analysis; ANN=Artificial neural networks; SRE=Surface range envelope; MARS=Multivariate adaptive regression spline; FDA=Flexible discriminant analysis; RF=Random forest; MaxEnt=Maximum entropy.

Perspectives

# A Platform to Improve Echinococcosis Control in Tibetan Populations — Sichuan Province, China, 2015–2020

Tian Tian[1]; Shuai Han[1]; Chuizhao Xue[1]; Xu Wang[1]; Shijie Yang[1]; Bo Zhong[2]; Qian Wang[2]; Wenjie Yu[2]; Sha Liao[2]; Dan Ba Ze Li[3]; Wei Li[3]; Fei Xie[4]; Qiang Wang[1]; Zelin Zhu[1]; Yuwan Hao[1]; Weiping Wu[1]; Ning Xiao[1]; Xiao-nong Zhou[1,#]

Echinococcosis is a neglected parasitic zoonotic disease that is distributed worldwide. Previous data has shown that China holds the highest disease burden of echinococcosis in the world, resulting in $22.97\times10^5$ disability adjusted life year (DALYs) lost annually (*1*). Echinococcosis is one of the epidemiological factors responsible for poverty in China. Since 2000, China's central government (CG) has taken several actions to control echinococcosis in Western China. Since 2005, special funds by the CG have been allocated to echinococcosis research. Since 2007, echinococcosis has been listed as 1 of the 6 communicable diseases that exempts medical expenses. In 2010, the Action Plan for the Prevention and Control of Echinococcosis (2010−2015) [APPCE (2010–2015)] was issued by the CG (*2*–*3*).

Ganzi Tibetan Autonomous Prefecture is located in western Sichuan Province with an average altitude of over 4,000 meters above sea level, and 97% of the population is Tibetan. Ganzi is an area with one of the highest disease burdens of endemic echinococcosis, and echinococcosis is prevalent in all 18 counties across Ganzi. In November 2015, China CDC established a work office to support the echinococcosis control program to reduce the associated morbidity and mortality. During 2016–2020, a series of control interventions has been implemented to control the echinococcosis transmission under the leadership of the work office: 1) an integrated control strategy has been implemented in 3 townships covering $1.53\times10^5$ square kilometers; 2) the morbidity rate has been reduced by 86.18%; 3) a total of 1,000 local professionals and technical staff have been trained for echinococcosis control; and 4) cultivation of health literacy has covered a population of 1.1 million. So far, echinococcosis remains highly prevalent in western China; the Ganzi work office might provide valuable experience to support the elimination of echinococcosis.

## PROMOTION OF THE ECHINOCOCCOSIS CONTROL PROGRAM IN GANZI

As one of the most severely affected areas, endemic echinococcosis is still transmitted in all 18 counties across Ganzi. According to the 2012 National Echinococcosis Survey, there was a echinococcosis prevalence rate of 12.09% in humans in Shiqu County, which was far greater than the average level in Sichuan Province (1.08%) and nationwide (0.24%). To effectively eliminate the effects on health and alleviate the poverty resulting from echinococcosis in Ganzi, China's former Ministry of Health [currently named the National Health Commission (NHC)] and Sichuan Provincial Government launched a joint project for controlling echinococcosis in 2010. The NHC issued the *Comprehensive Prevention and Control Pilot Program for Echinococcosis in Shiqu County, Ganzi Prefecture, Sichuan Province (2016–2020)* [*CPCPPESC, GPSP (2016–2020)*] that aims to effectively control echinococcosis transmission in Shiqu County through the implementation of integrated control measures (*4*–*7*).

The primary purposes of the work office established by China CDC includes the following: (*1*) understanding the current prevalence of echinococcosis in Ganzi Prefecture through epidemiological investigations; (*2*) facilitating echinococcosis control by means of a systematic package of interventions including the dog deworming, health education, and mass drug administration of patients, etc.; (*3*) researching and developing novel vaccines and drugs for echinococcosis; and (*4*) improving the capacity building of local grass-roots professionals.

During 2016–2020, a total of 25.717 million CNY (roughly 3.97 million USD) were allocated to the pilot program by the NHC and China CDC, and 49 subprojects were performed during this period supervised by the National Institute of Parasitic Diseases (NIPD) of China CDC (*5*). In terms of the number of subprojects implemented, the subprojects covered the fields of control strategy (19.6%), fundamental research (10.7%), drug research and development (drug R&D) (14.3%), detection reagent development (5.4%), diagnostic reagent development (21.4%), vaccine research (8.9%), biobank construction (14.3%), and health education (5.4%) (Figure 1).

## ROLES OF THE WORK OFFICE IN GANZI

In the pilot subproject of control strategy carried out in 3 townships of Shiqu County of Ganzi, epidemiological data indicated that the implementation of the pilot subprojects increased the awareness rate of echinococcosis control in Shiqu County from 41.2% (247/600 participants) in 2016 to 91.3% (210/230) in 2019, and greatly reduced the number of affected domestic dogs from 52,229 in 2016 to 15,981 in 2019. The positive rates of echinococcosis in dog excrement were 1.24% (8/644 samples) in 2016 and 1.67% (1/60) in 2019.

For drug R&D, albendazole and mebendazole soft capsules have been developed. New promising anti-echinococcosis formulations improved the bioavailability of the drugs and reduced the required dosages, which reduced the side effects of the drugs. In the aspect of detection and diagnostic reagents, three recombinant *Echinococcus* antigens were applied for combined diagnosis. The technology included a colloidal gold rapid detection kit for echinococcosis and a mobile traceable system with high diagnostic efficiency, simple production, low costs, ease of use, real-time analysis, and feedback and storage of test results; however, this set up could not distinguish cystic echinococcosis (CE) from alveolar echinococcosis (AE).

For biobank construction, more than 1,000 samples (800 serum samples, 200 other biological samples: cysts, tissues, feces, urines) have been collected and standardized for storage. In addition, health education was carried out in 6 schools, and nearly 1,000 people were investigated for their awareness levels after the intervention. Health education was strengthened, and more than 1,200 echinococcosis educational supplies were distributed.

In August 2020, the work office, along with the 45 subprojects, was evaluated by a panel of experts from hospitals, disease control institutions, and health administrations. Results from the final evaluation report revealed the success of the work office by having an evaluation score of 94.13 out of a total of 100 score

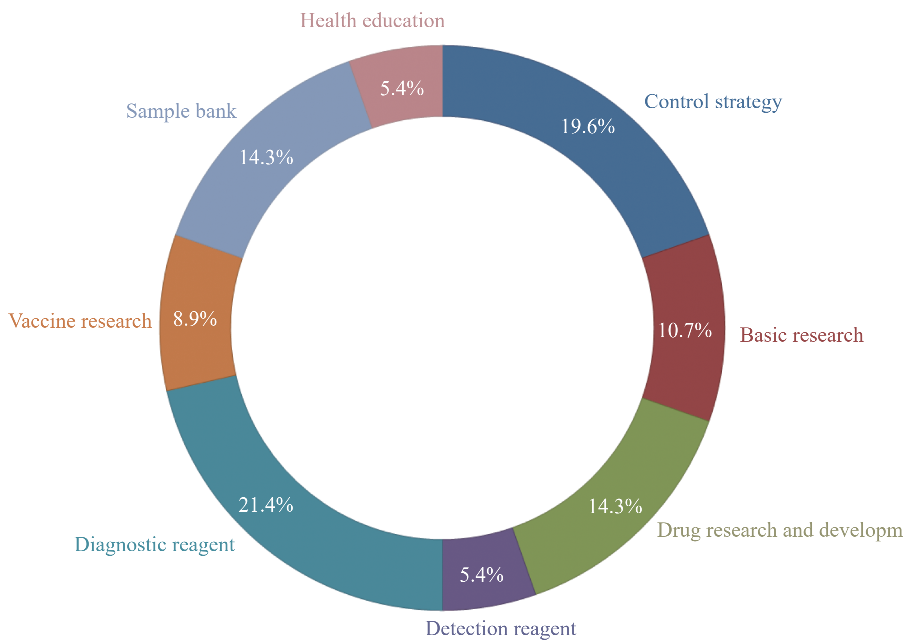


FIGURE 1. Research topics of the subprojects for the comprehensive echinococcosis prevention and control in Ganzi from 2016 to 2020*.

* The percentage presented in the figure is the proportion of the total number of investigation subprojects.

and demonstrating the major proposed objectives have been achieved.

## DISCUSSION

The promotion of echinococcosis control in the Tibet areas has been launched through the implementation of the *CPCPPESC, GPSP (2016–2020)*. Under this pilot program, financial support, technical assistance, infrastructure construction, and capacity building were targeted for echinococcosis control in local areas in Ganzi. A total of 103 echinococcosis rehabilitation and treatment centers, livestock slaughtering centers, echinococcosis prevention and control laboratories, and safe water centers have been built in Shiqu County during the past 5 years, incurring a total cost of more than 1 billion CNY (*8–11*).

Based on the "pilot first" and "point-to-area" principle, the China CDC work office has played a critical role in implementing echinococcosis field control activities since initiation. Significant achievements in echinococcosis control realized in Ganzi were characterized by great reductions in the prevalence of echinococcosis in humans and domestic and wildlife hosts, remarkable improvements in awareness and behaviors pertaining to echinococcosis control, and significantly improved capacity building (Table 1).

However, there were still some challenges for the elimination of this disease in local areas. First, financial support should be enhanced. Currently, operational funds for the China CDC work office mainly depend on the *CPCPPESC, GPSP (2016–2020)*, and limited financial support was obtained from other sources. A large number of transportation fees were reported (accounting for 27.74% (1,387,100/5,000,000 CNY) of the budget) during the implementation of field control activities due to the special climate in high-altitude areas. In addition, the current workspace of the China CDC work office primarily relies on the Ganzi CDC. The harsh high-altitude natural environments require higher levels of protection during echinococcosis field control activities. All these programs require more financial support.

Second, the integrated control strategy should be intensified. Following the implementation of the 5-year pilot project of control, great achievements have been reached in echinococcosis control such as the reduction of morbidity to 0 in children aged 6–12 years among new patients. However, a risk factor of dog reinfection still exists, and it is difficult to construct shelters for stray dogs. Meanwhile, with the implementation of the National Ecological Protection Policy, increasing wildlife density could be a potential risk factor leading to echinococcosis transmission from wildlife to local human communities. Therefore, technical support is needed from stakeholders in animal husbandry, public security, and forestry administration. Consequently, a multidisciplinary collaboration mechanism needs to be built, and the integrated control strategy for echinococcosis should be reinforced (*12–13*).

Third, the translation of scientific research for echinococcosis into the clinic or field should be increased. During the operation of the 5-year pilot

TABLE 1. Evaluation of pilot targets and indicators for comprehensive echinococcosis control in Shiqu County in 2020.

| Category | Baseline data in 2014 | End of 2020 | Results of self-assessment in 2020 | On-site technical evaluation results |
|---|---|---|---|---|
| New patient detection rate in children aged 6–12 | 2.91% | Below 1% | 0% | 0% |
| Canine infection rate | 6% | Below 2% | 0.86% | 0.45%, 0.86%* |
| Livestock infection rate | 45% | Below 25% | 8.84% | 8.84% |
| Domestic dog registration rate | 72% | Above 85% | 100% | 100%, 100%* |
| Canine deworming coverage | 73% | 90% | 100% | 100%, 100%* |
| Treatment rate of diseased organs in slaughterhouse | –† | 100% | 100% | 100% |
| Safe drinking water coverage in settlements | 80% | 100% | 100% | 100%, 100%* |
| Rodent control rate in settlements and within 1 km radius | –† | 80% | 80% | 100% |
| Awareness rate of prevention and control knowledge | 30% | Above 85% | 98.13% | 98.13% |
| Standardized treatment rate of patients | 50% | Above 85% | 93.15% | 93.15%, 100%* |
| Qualification rate of professional skills | 60% | 95% | 99.85% | 99.85%, 100%* |

* Assessment of village level.

† No data.

program, 20 national patents pertaining to echinococcosis were obtained. However, these patents are public welfare products, which lack the market collaboration mechanism to translate the patent into products. Currently, the work office is focused on epidemiological surveys of echinococcosis, assessing the risk of transmission of echinococcosis, and assessing the disease burden of echinococcosis; more attention should be given to the translation of the scientific research in the future. In addition, the work office requires the establishment of stronger collaborations with China CDC, most notably the field epidemiology training program, laboratory management, and continuing education management.

To respond to these challenges, the following suggestions are recommended. First, internal evaluations have proved the feasibility of the current operation model of the China CDC work office; therefore, we need to upgrade the current model, build a long-term mechanism, and continue to maintain a close collaboration with the expert team. Second, since echinococcosis is defined as a contributor to poverty, elimination of echinococcosis is critical to poverty alleviation. Therefore, poverty alleviation and echinococcosis control may be jointly performed to help the elimination program, build health services, and promote socioeconomic development. Third, the scientific research of echinococcosis needs to be translated into disease control products and services that are used to solve problems in the field. In addition, we need to make full use of national, intra-provincial, and extra-provincial experts in the prevention and control of echinococcosis to build a base of scientific innovation in the work office. Applied and operational studies are strongly recommended to attract market resources and funds for echinococcosis control programs. Finally, novel approaches to solve the problems of inconveniences in transportation and storage and laboratory testing of animal host samples are urgently required. Further epidemiological studies are required to investigate the transmission dynamics of wild animal echinococcosis in natural foci, to identify its risk factors, and to improve the integrated echinococcosis control in these target areas.

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Notifiable Infectious Diseases Reports

# Reported Cases and Deaths of National Notifiable Infectious Diseases — China, December, 2020

| Diseases | Cases | Deaths |
|---|---|---|
| Plague | 0 | 0 |
| Cholera | 0 | 0 |
| SARS-CoV | 0 | 0 |
| Acquired immune deficiency syndrome | 6,508 | 2,105 |
| Hepatitis | 124,433 | 64 |
| Hepatitis A | 1,196 | 0 |
| Hepatitis B | 100,209 | 52 |
| Hepatitis C | 20,438 | 10 |
| Hepatitis D | 16 | 0 |
| Hepatitis E | 1,818 | 2 |
| Other hepatitis | 756 | 0 |
| Poliomyelitis | 0 | 0 |
| Human infection with H5N1 virus | 0 | 0 |
| Measles | 96 | 0 |
| Epidemic hemorrhagic fever | 1,460 | 9 |
| Rabies* | 24 | 29 |
| Japanese encephalitis | 8 | 1 |
| Dengue | 9 | 0 |
| Anthrax | 17 | 0 |
| Dysentery | 3,272 | 0 |
| Tuberculosis | 64,097 | 161 |
| Typhoid fever and paratyphoid fever | 483 | 1 |
| Meningococcal meningitis | 5 | 1 |
| Pertussis | 294 | 0 |
| Diphtheria | 0 | 0 |
| Neonatal tetanus | 5 | 0 |
| Scarlet fever | 2,693 | 0 |
| Brucellosis | 3,694 | 0 |
| Gonorrhea | 11,691 | 0 |
| Syphilis | 44,696 | 6 |
| Leptospirosis | 19 | 0 |
| Schistosomiasis | 3 | 0 |
| Malaria | 73 | 0 |
| Human infection with H7N9 virus | 0 | 0 |
| COVID-19[†] | 529 | 0 |
| Influenza | 23,546 | 1 |
| Mumps | 11,437 | 0 |

Continued

| Diseases | Cases | Deaths |
|---|---|---|
| Rubella | 104 | 0 |
| Acute hemorrhagic conjunctivitis | 2,583 | 0 |
| Leprosy | 31 | 0 |
| Typhus | 55 | 0 |
| Kala azar | 13 | 0 |
| Echinococcosis | 412 | 1 |
| Filariasis | 0 | 0 |
| Infectious diarrhea[§] | 108,084 | 0 |
| Hand, foot, and mouth disease | 131,798 | 0 |
| **Total** | **542,172** | **2,379** |

[*] Of the 20 reported death cases of rabies, there were 7 reported in November, the other were reported previously.
[†] The data were extracted from the website of the National Health Commission of the People's Republic of China.
[§] Infectious diarrhea excludes cholera, dysentery, typhoid fever and paratyphoid fever.
The number of cases and cause-specific deaths referred to data recorded in National Notifiable Disease Reporting System (NNDRS) in China, which includes both clinically-diagnosed cases and laboratory-confirmed cases. Only reported cases of the 31 provincial-level administrative divisions in the mainland of China are included in the table, whereas data of Hong Kong Special Administrative Region, Macau Special Administrative Region, and Taiwan, China are not included. Monthly statistics were calculated without annual verification, which is usually conducted in February of the next year for de-duplication and verification of reported cases in annual statistics. Therefore, 12-month cases could not be added together directly to calculate the cumulative cases because the individual information might be verified via NNDRS according to information verification or field investigations by local CDCs.

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