THE SURVIVAL OF *ONCOMELANIA NOSOPHORA*, THE VECTOR
SNAIL OF *SCHISTOSOMA JAPONICUM* UNDER THE
DRIED CONDITION AND THEIR WATER LOSS*

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On the resistance of *Oncomelania nosophora* to dryness, several reports are available (Cort, 1919; Yamanouchi, 1919; Bartch, 1929; Sugiura, 1933; Kawamoto, 1954). They all observed only their survival under the dried condition. *Oncomelania nosophora*, a Japanese vector snail of *Schistosoma japonicum*, however, has an amphibious character and can survive for a certain period under dried conditions. The effect of dryness on snails is considered to result in more evaporation of water from the snail body and inflict the gradual loss of water which would be the cause of their death. The purpose of this work is to know the relation between the rate of the water loss from snail body and the survival rate of the snail when put under a continuous dried condition.

MATERIALS AND METHODS

The experiments were carried out both during the summer and winter. Snails applied in the winter experiment were collected in late October, 1957 and those applied in the summer experiment in August, 1957 at an endemic area of Yamanashi Prefecture. They were used for experiments within ten days after the collection. Before the application to experiments they all were washed with distilled water, their shells being cleansed. Then they were put on filter paper and divided into male and female according to the sex differentiating technic by observing penis through the shell. All snails except the youngest were divided into male and female groups. They were also divided into three groups according to the shell length; adult group (shell length 7-9 mm), younger group (shell length 5-7 mm) and youngest group (shell length 3-5 mm). Owing to the immaturity of the sex organ, members of the youngest group could not be divided by sex.

All snails put on filter papers were found soon to close their opercula and showed no movement. Then they were weighed on each experimental group, and put into Petri dishes under a dried condition at room temperature for about 120-130 days. The temperature and humidity during the experiment were recorded by the aid of autographs.

The number of snails of each experimental group was 300 to 500. On every tenth day after the commencement of experiments 20-40 snails were randomly taken from each group, weighed and examined. Their death was finally ascertained by dissection. The diminished

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b) *The survival of the younger and their water loss:* Snails of this group showed 100% death rate 20 days sooner than that of the adult with the water loss of 43.1%.

They showed 20 days after exposure to dryness a death rate of 11.1% with the water loss of 13.2% and after 91 days a death rate of 77.8% with the water loss of 33.6%. Owing to a hindrance the result after 40 days in this experiment could not be examined.

The Results of Experiments in Winter

The experiments on the sex difference in the survival rate under the dried condition were also carried out. Concerning this problem only the adult and the younger were used, because the sex organ in snails of the youngest group was not developed enough to enable sex differentiation. The temperature during the experiments was 10–14°C (mean 13°C) and the mean relative humidity 60%.

a) *The death rate of snails of each group and the water loss:* The results of experiments during the winter was Fig. 2.

Fig. 2. Relation between the rate of water loss and the mortality of *Oncomelania nosophora* under the dryness (winter).

Mortality { ●—● Adult   Water loss { ○····○ Adult
 ▲—▲ Younger   △····△ Younger
 x—x Youngest   x····x Youngest

Water loss (excluding shell) { ■---■ Adult
 □---□ Younger

Temperature 10°–14°C. Mean temperature 13°C.

Mean relative humidity 60%.

Duration: 1 Dec. 1957 → 10 Mar. 1958.

i) Snails of the adult group: On the 11th days of exposure to dryness no snails were found dead. On the 21st day, however, 11% of snails were found dead with a water loss of 15%. Forty days after exposure the death rate was 16.2% with 25.1% of a water loss, after 60 days the death rate 48.6% with a water loss of 34.1% and after 102 days all snails were found dead with a water loss of 43.1%.

ii) Snails of the younger group: Ten days after exposure to dryness some snails (7%) were already found dead with a water loss of 10.9%, after 49 days a death rate of 41.9% and a water loss of 35.9% and after 91 days all snails were found dead with a water loss of 44.8%.

Fig. 3. Relation between the rate of water loss and the mortality of *Oncomelania nosophora* under the dryness (winter).

Comparison between male and female in adult snail.

Mortality {●—● ♀   Water loss {○····○ ♂
                  {▲—▲ ♂   {△····△ ♂

Water loss (excluding shell) {■—■ ♀
                                          {□—□ ♂

Temperature 10°—14°C. Mean temperature 13°C.

Mean relative humidity 60%.

Duration: 1 Dec. 1957 → 10 Mar. 1958.

Fig. 4. Relation between the rate of water loss and the mortality of *Oncomelania nosophora* under the dryness (winter).

Comparison between male and female in younger snail.

Mortality {●—● ♀   Water loss {○····○ ♀
                  {▲—▲ ♂   {△····△ ♂

Water loss (excluding shell) {■—■ ♀
                                          {□—□ ♂

Temperature 10°—14°C. Mean temperature 13°C.

Mean relative humidity 60%

Duration: 1 Dec. 1957 → 10 Mar. 1958.

iii) Snails of the youngest group: A death rate of 13.6% was seen 11 days after the exposure and thereafter the death rate increased remarkably as the time elapsed so as to be 81.8% on the 49th day and 100% on the 60th day. Thus, as

the size of the snail became smaller, the resistance to dryness inclined to diminish. It is noted on snails of the younger group that the rate of water loss to the dried body weight could not easily be calculated because of the difficulty of removing the body from the shell.

b) *Sex of snails and their resistance to dryness:*

i) Snails of the adult group: Fig. 3 shows the resistance of both sexes to dryness among snails of adult group. The male snails showed rather less resistance in an early stage, but later the time when the male showed about 50% death rate coincided with that when the female did.

ii) Snails of the younger group: As seen in Fig. 4, the male snails of the younger group also showed a lower resistance to dryness as compared with the female.

DISCUSSION

As already seen in Fig. 2, the resistance of the adult to dryness appears to be larger than that of the younger, while the rate of water loss of the adult snails smaller than that of the younger, the fact suggesting that the water loss of snails

Fig. 5. Relation between the rate of water loss and the mortality of *Oncomelania nosophora* under the dryness (winter).

Comparison between male and female in younger and adult.

Mortality { ●—● ♀   Water loss { ○—○ ♀
 ▲—▲ ♂   △—△ ♂

Water loss (excluding shell) { ■—■ ♀
 □—□ ♂

Temperature 10°—14°C. Mean temperature 13°C.

Mean relative humidity 60%.

Duration: 1 Dec. 1957 → Mar. 1958.

is an important factor for their survival. The water contained in snails can be distinguished into two portions, one being held in the space between the shell and the snail body (outer water) and the other inside the snail body (inner water). The figures showing the rate of water loss in Fig. 2 indicate that the rate of the water loss tends to diminish as the time of exposure is prolonged. Such a tendency

Fig. 6. Relation between the rate of water loss and the mortality of *Oncomelania nosophora* under the dryness.

Comparison between winter and summer in adult snail.

Mortality {●—● Winter snail {○—○ Summer snail   Water loss {●····· Winter snail {○····· Summer snail

	Temperature	Mean temp.	Mean relative humidity
Summer	20°—24°C	21°C	77%
Winter	10°—14°C	13°C	60%

Fig. 7. Relation between the rate of water loss and the mortality of *Oncomelania nosophora* under the dryness.

Comparison between summer and winter in younger snail.

Mortality {●—● Winter snail {○—○ Summer snail   Water loss {●····· Winter snail {○····· Summer snail

	Temperature	Mean temp.	Mean relative humidity
Summer	20°—24°C	21°C	77%
Winter	10°—14°C	13°C	60%

suggests that during the initial period chiefly the outer water is lost and later followed by the gradual loss of the inner water. It is considered that the shorter survival of the younger snails under the dried condition can be explained by the more rapid water loss due to more rapid evaporation.

Figs. 5, 6 and 7 show the comparison of the resistance to dryness (in adult and younger groups, respectively) between males and females and in summer and winter as well. The figures indicate that both adult and younger snails tend to show lower resistance to dryness in summer than in winter probably because of the more rapid water loss in summer, although the possible effect of hibernation in winter can not be excluded.

The problem of whether there exists sexual difference in the resistance to dryness can not be clarified yet. As far as our experiments are concerned, however, the female seems to have a rather higher resistance.

SUMMARY

To know the relation between survival of *Oncomelania nosophora* and its water loss under the dried condition, several experiments were carried out and the results are summarized as follows:

1. The death rate of snails under the dried condition was not so prominent up to the 40th day of the exposure but increased rather rapidly thereafter and attained 100% after 60 days with the youngest while after 80-100 days with the younger and the adult groups.
2. The water loss of the snails after the exposure to dryness was achieved rapidly up to 30 days after the exposure but afterwards became slow and after the 60th day practically no loss of water was recognized. From that time the mortality of snails increased rapidly until it reached 100% very soon. Roughly speaking, about 40% water loss appeared to be critically detrimental for the survival of snails.
3. As compared with the adult, younger snails showed a rather lower resistance to dryness. Such a difference is considered to depend chiefly upon the difference in the water loss from them.
4. Snails showed a relatively lower resistance to dryness in summer than in winter, which is likely to have been caused by the seasonal difference in the metabolism.
5. Males appeared to show a lower resistance to dryness than the females.

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