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Remarks of The Pond-Snail,

Cipangopuldina malleatus. [1]

By

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Cipangopuldina malleatus is a common snail distributed in canals, marshes and rice-fields of all districts in japan. More than 6000 individuals were collected in different seasons from the rice-fields of Kamosho village in Hyogo Prefecture and the canals made in the reclaimed land of formerly the Ogura marsh in the vicinity of Kyoto City. They were subjected to the measurements and observations of the present study. In sampling care was taken not to pick up larger snails, but to gather every specimen that came in view, regardless of the size.

Sexual Dimorphism

In some pond-snails the sexual dimorphism is remarkable and their sex is easily distinguished by the height of their shells. According to the report of Van Cleave and Lederer (1932), an American snail *Viviparus contectoides* seems to be a kind of such species: the females reach a height of more than 40 mm., whereas the males never exceed 25 mm. Sexes of the present species are, however, not so easily determined as American species. As is shown in Fig. 1, individuals whose shell is larger than 40 mm. high may safely be said to be female and two thirds of specimens larger than 32 mm. high are also females, as far as the present material is concerned. But sexes of specimens smaller than 30 mm. are hardly distinguished by their size of shells. At first glance, female gave an impression that the relative value of diameter to height of her shell is larger than in male, so that 100 individuals each of females and males were selected at random to measure the value of ratio. However, contrary to all expectations, there was no correlation between the value of this ratio and the sex of the snail. But it was only found that the larger an individual is, the smaller the value tends to become, regardless of the difference of sexes. The finding is in good accordance with Okada and Kurasawa's observation (1950) on the same species.

The ratio of the smallest diameter to the largest diameter of an opercle of shell was also calculated, but it showed no difference in both sexes. As a general feature of the male of Viviparidae, the right tentacle curves

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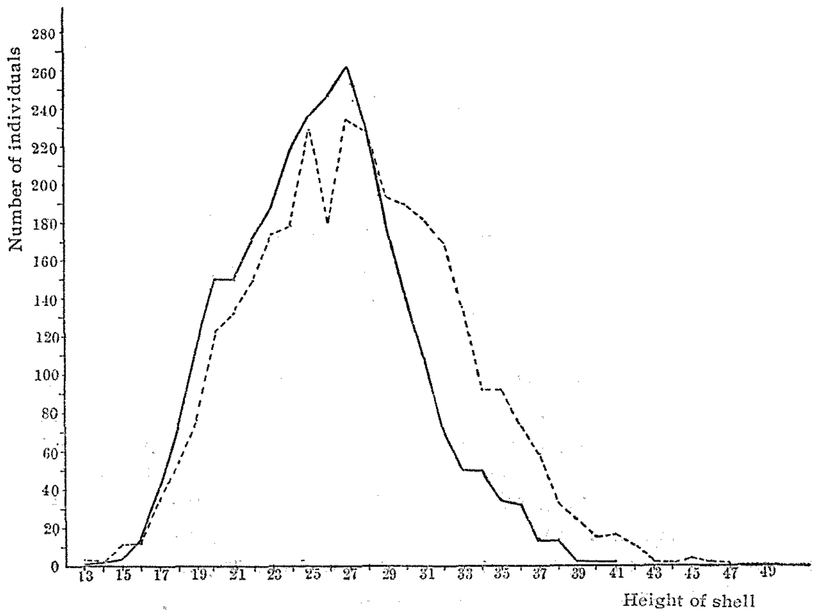

Fig. 1 Graph showing the distribution curves with respect to height of shells: male in solid line, female in broken line.

and is thicker than the left one, whereas the tentacles of the female are whip-shaped on both sides. *Cipangopuldina malleatus* is not an exception in this respect. Therefore, when the animal is creeping, the sex is readily distinguished by the shape of the right tentacle. But it is impossible to determine the sex by the shape of shell, when the animal has retracted its body into the shell.

Sex-Ratio

As there is no definite sexual difference in the shape and size of shell, especially when it is shorter than 30 mm., the sex of the animal was always determined by the gonad or, if female, by the presence of developing off-spring in the marsupium. The materials used for this examination were exclusively collected from the rice-fields of Kamosho village in different seasons: the first on June 19th, the second on October 19th of 1946 and the

Table 1. *Sex ratio in different seasons.*

Sex / Date	♂♂	♀♀	♂ : ♀	Total
June, 19 '46	367	648	1 : 1.77	1015
October, 19 '46	2122	1878	1 : 0.89	4000
April, 21 '47	375	588	1 : 1.57	963

third on April 21st of the next year.

As there occurred no special tendency that individuals of the same sex were forming groups in the natural habitat, the proportion in the numbers of male to female obtained here may give the evidence that it is variable according to the season of the year. As is shown in Table 1, the female is predominant in spring and in early summer, while the male is preponderant in mid-autumn. In mid-autumn of this village, a majority of snails had already hidden themselves in the mud of rice-fields, because the fields had been drained to harvest rice-plants. The snails, in consequence, pass the winter in the mud and come out in spring of the next year. Nevertheless, the value of the sex ratio in the third collection in April is quite different to that made in mid-autumn when the snails had retired into the hibernating place, but it is approximately equal to that of the early summer of the previous year. As far as the above data is concerned, the cause of seasonal divergence of sex ratio may be attributed, on one hand, to the predominant death of males during the hibernating period and, on the other hand, to the predominant death of females during a certain period, commencing sometime after the liberation of the young ones and ending in late summer or in early autumn. Taki (1936) states that the males of *Cipangopuldina japonica* kept in the laboratory die twice as much as the females (41 out of 64) in early and mid-summer, after they have finished the second round of reproductive activity. As to the present species, mortality was also high in the months of summer. But, comparing the sex ratio in June with that in October, it seems probable that females die more than males in that season, provided that the females and males that were liberated in the preceding parturition period are equal in number. Such a numerical inferiority of the female is likely to be compensated by the predominant death of older males during the winter, although survey in winter was not made.

Numbers of Marsupial Offspring

For this examination, the sample collected in mid-winter or shortly before the appearance of the snail from its hibernating shelter should be the most suitable, but the collection in winter being too difficult to secure a sufficient number, 1878 females collected in October were used as material.

Offspring were divided into two groups, one in which embryos or larvae were enveloped by the egg capsule and the other in which larvae already hatched or were just in a state before hatching. Although they were counted separately, the total number here is used to determine its correlation to the height of shell. The data is arranged graphically in Fig. 2. As is clear in the figure, there is an evident correlation between the number of offspring and the height of mother's shell; namely, the larger the shells are, the more numerous the offspring are. According to Okada and Kurasawa's observation (1950), the same individual measured at 16.5 mm. in height on May 4th stood at 26.0 mm. on October 10th, and ceasing its growth thereafter until April 3rd of the next year. Therefore, some of the animals less than 26 mm. in Fig. 1 could be the offspring discharged in spring or summer of the same year. There is a probability that such animals would have no faculty to bear young snails till the next year. In fact, snails of 20-21 mm. in height were most predominant in number and as many as half of them were non-gravid. Individuals 25-26 mm. high were also non-gravid, though they were a minority. Other females liberated in early spring would be capable of bearing their first brood before they entered into the first hibernation of their life span, although their embryos were always less developed and less than 8 in number. Some specimens which were 24-26 mm. in height and bore more than 15 young ones would be in the second round of reproduction. Needless to say, the snails become capable of bearing more young ones, as they grow older.

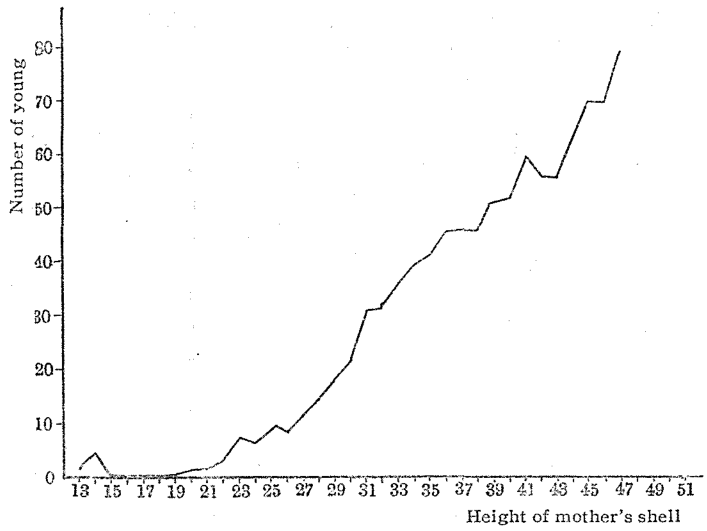

Fig.2. Graph showing the correlation between the height of mother's shell and the number of average young ones in marsupium.

The largest number of offspring borne by a single female was 84. The female was 47 mm. high and presumably 4 or 5 years old.

Birth Period

Whenever more than 100 females are collected, some of them are always gravid and contain, as a rule, embryos and larvae in their marsupium in all stages of development. The fact gives an impression that the snail can give birth to her young ones at any time of the year, but the statistical data evidenced the existence of a definitive birth period. The following table is based on a statistical analysis of the specimens collected during different seasons of the year.

Table 2. *Conditions of females as to the appearance of the marsupial young ones indicated in percentage.*

Date \ Young	O	E	L	E+L
April, 21 '47	3.0 %	3.1 %	8.2 %	85.7 %
June, 19 '46	5.9	8.6	35.6	49.9
October, 19 '46	7.6	23.5	3.0	65.9

O : non-gravid female, E : female bearing only embryos, L : female bearing only larvae hatched or shortly before hatching, E+L : female bearing both embryos and larvae.

In the case of October, more than 20 per cent of all females are non-gravid, evidently due to the joining of new females discharged in the birth period of the year. Therefore, the table is formed on basis of females larger than 22 mm., for some individuals are able to produce embryos. As a result of excluding the specimens smaller than 21 mm., the percentage of non-gravid females decreases to 7.6. This value is, however, larger than 3.0 of April. This means either that some non-gravid new females are still included, or that a part of non-gravid females dies off in the hibernating period. In October the percentage of E-females is conspicuously higher than in other months. It is also due to the joining of fresh females. As for L-females, increase of percentage is remarkable in the period from April to June, whereas the percentage of L+E-females decreases notably in the same period. Moreover, looking through the proportion of larvae to embryos in L+E-females in June, it is noticed that larvae are predominant to embryos. These facts suggest that embryos of L+E-females in April develop into larvae, hatched or just before hatching within two months from April to June. The second decrease of L-females in October shows probably the existence of the end of birth period. A given female gives birth to her young ones several times during the same birth period, and liberating several fully formed young snails at a time. When the last young one is discharged, the snail becomes non-gravid. A survey in August did not result with enough cases to determine a definitive time of the end of parturition, but one quarter of some 60 individuals collected from the Ogura Canal were non-gravid and others bore the marsupial offspring that were relatively young, although they were fully grown females. In consequence, a majority of females may finish their deliveries by the end of July. But the time when the marsupium is vacant seems to be very short, and a new brood begins again to fill the marsupium by late summer or early autumn at the latest.

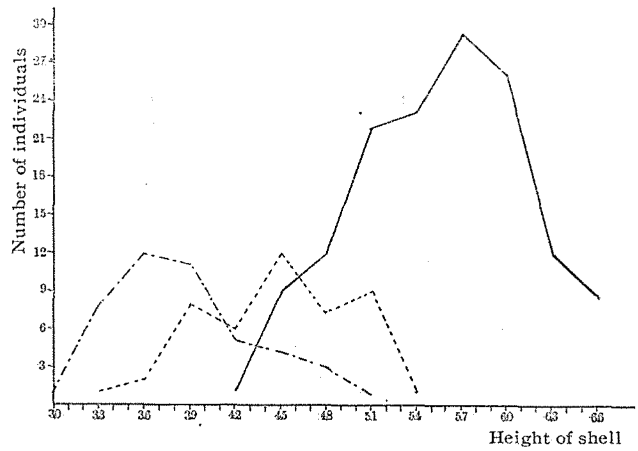

Fig.3. Graph showing the size of marsupial young ones: solid line represents hatched larvae; broken line, larvae shortly before hatching; dot-and-dash line, larvae in capsule with much jelly.

Size of the Fully Formed Young Snail

241 females collected on April 31st, 1948, from the Ogura Canal were dissected to obtain the young snails from the marsupium. The young ones were measured by the vernier calipers and prepared in the form of a graph in Fig.3. There is a remarkable individual variation in their height, ranging from 4.2 mm. to 6.6 mm., averaging 5.49 mm. Van Cleave and Lederer (1932) state that the smallest free living young ones taken from the natural habitat have exactly the same size as the fully formed marsupial young ones. Such small snails of *C. malleatus* were searcely found in fields. A reason for this would be the rapid growth of the young ones during the first few weeks of free life, and they soon become more than 15 mm. in height. A shell of a fully formed young one consists of 3 whorls or at most 3 and 1/3 whorls, regardless of its size.

Summary

1. More than 6000 individuals of *Cipangopuldina malleatus* collected from the rice-fields of Kamosho village in Hyogo Prefecture and the Ogura Canal in the vicinity of Kyoto City were measured as materials.

2. When the animal is creeping, a male is readily discriminated from a female by a peculiar shape of the right tentacle. But sexual dimorphism is not distinguished by the shape of shell. If, however, the shell is larger than 40 mm. in height, it may practically be regarded as a female. The distribution curve shown in Fig.1 gives the evidence for such an assumption.

3. Sex ratio is different according to season; 1 male to 1.57-1.77 female in spring and summer and 1 male to 0.89 female in autumn. The

fact seems to imply that the death of female is predominant in summer, while, on the contrary, the death of male is preponderant in winter.

4. Whether the life span of the animals is different or not according to their sex cannot be concluded from the present investigation, but the female may live one or two years longer than the male, because large-shells are females by an overwhelming majority.

5. The birth period of snails found in the vicinity of Kyoto seems to begin in March and to terminate in July or in August.

6. If a suitable specimen is dissected, offspring of all developmental stages may be secured at the same time in the marsupium, although embryos earlier than trochophore stage may scarcely be found.

7. Size of the young snails at birth is variable, ranging from 4.2 mm. to 6.6 mm., averaging 5.49 mm. in height of shell. Such small young ones grow up to 22 - 24 mm. before they retire into the hibernating place.

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