Mem. Inst. Oswaldo Cruz, Rio de Janeiro, Vol. *87* (1): 15-19, jan./mar. 1992

INFLUENCE OF TEMPERATURE ON SURVIVAL, GROWTH AND FECUNDITY OF THE FRESHWATER SNAIL *INDOPLANORBIS EXUSTUS* (DESHAYES)

S. K. RAUT; M. S. RAHMAN & S. K. SAMANTA

Ecology and Ethology Laboratory, Department of Zoology, University of Calcutta, 35 Ballygunge Circular Road, Calcutta 700 019, India

To note the effect of temperature on survival, growth and fecundity, newly hatched (zero day old) snails Indoplanorbis exustus *were cultured at 10°, 15°, 20°, 25°, 30° and 35 °C constant temperatures and room temperature (17.5° – 32.5 °C). Individuals exposed to 10 °C died within 3 days while those reared at 15°, 20°, 25°, 30°, 35 °C and room temperature survived for a period of 6, 27, 18, 16, 12 and 17 weeks respectively. An individual added on an average 0.21 mm and 0.45 mg, 0.35 mm and 7.94 mg, 0.63 mm and 15.5 mg, 0.81 mm and 27.18 mg, 1.07 mm and 41.48 mg and 0.78 mm and 31.2 mg to the shell diameter and body weight respectively at those temperatures per week. The snails cultured at 15 °C died prior to attainment of sexual maturity. On an average, an individual produced 31.9 and 582.77, 54.86 and 902.18, 56.01 and 968.45, 49.32 and 798.68 and 62.34 and 1143.97 capsules and eggs respectively at 20°, 25°, 30°, 35 °C and room temperature (17.5° – 32.5 °C).*

Key words: *Indoplanorbis exustus* – temperature – survival – growth – fecundity

The freshwater snails *Indoplanorbis exustus* (Deshayes) are registered intermediate hosts of helminth worms causing diseases in man and his domestic animals (Liston & Soparkar, 1918; Rao, 1933; Chatterjee, 1952; Malek & Cheng, 1974; Ghosh & Chauhan, 1975; Godan, 1983; Raut, 1986). They are found in large numbers in the ponds, ditches, lakes, streams and canals of India (Subba Rao, 1989). Since snail-borne diseases are serious threat to human health and livestock efforts are being paid to note the natural history of these snails occurring under varying ecological conditions with a view to devising suitable control measure. However, scanty information on the life cycle of *I. exustus* is available from the studies of Brumpt (1936), Durani & Chaudhury (1967) and Islam (1977), and on the nature of egg capsules from the observations of Raut & Ghosh (1985). As these snails are thriving well in water bodies having a wide range of temperature, information on their natural history under such conditions is essential with a view to ascertaining the trend of population build-up. Since the trend of population growth rate of a species is dependent on a number of biological parameters, in the first step an attempt was made to note the rate of growth of the snail individuals as well as their rate of egg production under different temperatures, experimentally, in laboratory, and the findings are described in this paper.

Received 23 August 1991.
Accepted 4 December 1991.

MATERIALS AND METHODS

To have the required number of newly hatched snails a good number of healthy, sexually mature *I. exustus* were collected from the pond located in the Ballygunge Science College campus, Calcutta University. They were released into an aquarium 30 x 20 x 20 cm in size. The aquarium was provided with pond water up to 18 cm of its height. A few examples of *Chara, Vallisneria* and *Ipomoea* were also kept in the water of the aquarium with a view to providing resting support to the snails and also substratum for deposition of egg capsules. The snails were supplied with lettuce leaves regularly as food. The snails deposited egg capsules within a few days. These egg capsules were collected from the aquarium daily. They were kept inside a petri-dish containing pond water. A number of petri-dishes were thus used to keep the egg capsules in respect to the date of deposition. In one petri-dish 10-15 egg capsules deposited within a period of 24 h of a day were kept together. The water of the petri-dishes was changed regularly for fresh pond water. Through con-

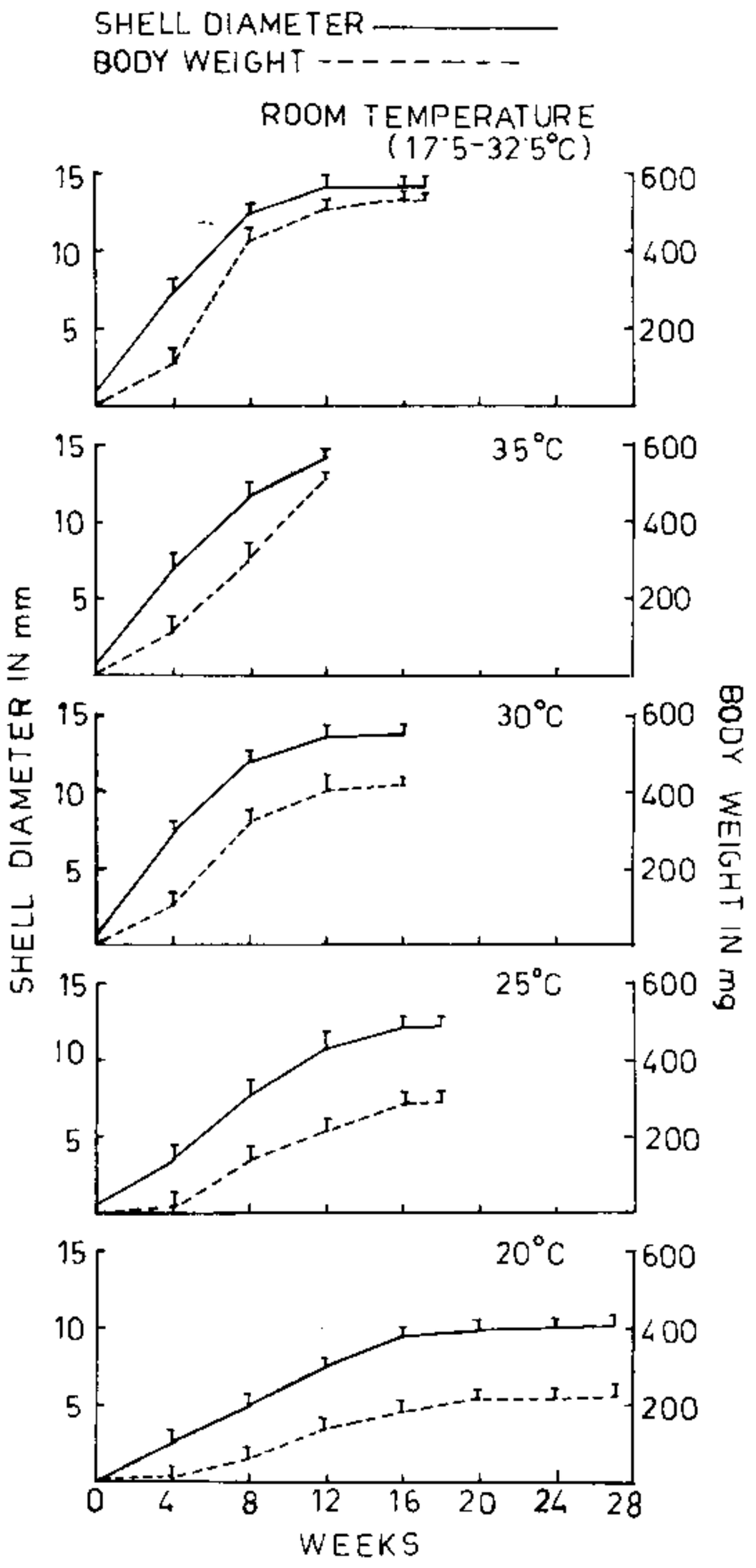
stant watch newly hatched (zero day-old) snails were isolated regularly from the petri-dishes and the required number, i.e. individuals when available were considered for an experiment. Accordingly 53, 44, 77, 64, 58, 50 and 65 individuals were released separately into 7 containers which were kept at 10°, 15°, 20°, 25°, 30°, 35 °C constant temperatures and room temperature (17.5° – 32.5 °C), respectively, for the studies of growth rate and egg laying potentiality. In all the containers different types of aquatic vegetation belonging to the above-mentioned species were kept to provide resting and egg laying sites for the snails. Throughout the experiment pond water was used. Lettuce and mustard leaves were supplied regularly as food. A strict hygienic condition was maintained throughout by changing the water and by removing dead snails, faecal pellets and the unconsumed food regularly.

Measurements of growth rate of the shell diameter and total body weight were taken weekly on 10 individuals selected at random from the total snail individuals considered for the studies. But when the individuals were either 10 or less all of them were used for data collection. In case of study of egg laying potentiality the total number of egg capsules produced by the individuals of the container were recorded daily through constant watch. The number of eggs present in these capsules was also counted and recorded.

RESULTS

All the snails exposed to 10 °C died within 3 days while the snails cultured at 15°, 20°, 25°, 30°, 35 °C constant temperatures survived for a maximum period of 6, 27, 18, 16 and 12 weeks respectively. Those reared at room temperature (17.5° – 32.5 °C) kept alive for 17 weeks. The snails cultured at 15 °C died prior to attainment of sexual maturity while those exposed to other temperatures survived for a considerable length of time following attainment of sexual maturity.

The snails exhibited a varying growth rate while cultured at different temperatures (Fig.). At 15 °C, of the 44 snails, only 4 survived up to the 6th week. During this period they added on the average 1.24 mm and 2.71 mg to the initial 0.6 mm shell diameter and 0.12 mg body weight. The zero day-old snails with an average 0.7 ± 0.031 mm shell diameter and 0.14 ± 0.009 mg body weight grew to 3.5 ± 0.16 mm and 21.62 ± 3.06 mg within a period of 6 weeks while cultured at 20 °C. Those 5 snails survived for 27 weeks, when they measured on an average 10.1 ± 0.12 mm in shell diameter and 214.61 ± 6.11 mg in body weight. The snails of zero day-old with a mean of 0.78 ± 0.04 mm shell diameter and 0.154 ± 0.005 mg in body weight attained 6.0 ± 0.57 mm in shell diameter and 61.9 ± 4.9 mg in body weight by the end of 6th week while cultured at 25 °C. Of the 64 snails only 3 survived for 18 weeks. They grew to 12.2 ± 0.29 mm in shell diameter and 279.18 ± 11.65 mg in body weight. The snails cultured at 30 °C grew to



Weekly rate of growth in shell diameter and body weight in *Indoplanorbis exustus* maintained at different temperatures throughout the life span.

TABLE

Fecundity in *Indoplanorbis exustus* in respect to temperature (°C)

Temperature (°C)	Number of snails taken at zero-day	Number of individuals on		Duration of reproduction period (days)	Total number of production		Average production per individual	
		first day of egg laying	last day of egg laying		capsule	egg	capsule	egg
10	53	*a*	–	–	–	–	–	–
15	44	*a*	–	–	–	–	–	–
20	77	53	7	57	940	17162	31.90	582.77
25	64	31	8	50	1017	16880	54.86	902.18
30	58	11	9	23	569	9863	56.01	968.45
35	50	6	4	16	253	4154	49.32	798.68
Room temperature (17.5 - 32.5)	65	22	2	49	679	12171	62.34	1143.97

a: snails died prior to the age of attainment of sexual maturity.

10.3 ± 0.27 mm and 256.82 ± 12.34 mg within a period of 6 weeks from an average of 0.81 ± 0.03 mm in shell diameter and 0.16 ± 0.003 mg in body weight at zero day. Out of 58 snails of zero day-old only 2 survived for 16 weeks. They were on the average 13.75 ± 0.75 mm and 435.00 ± 24.00 mg in shell diameter and body weight respectively. The zero day-old snails with an aveerage 0.9 ± 0.02 mm and 0.27 ± 0.04 mg in shell diameter and body weight grew to 9.7 ± 0.22 mm and 222.21 ± 17.35 mg within a period of 6 weeks and to 13.75 ± 0.75 mm and 498.00 ± 29.00 mg within a period of 12 weeks respectively in shell diameter and body weight while maintained at 35 °C. Out of 50 individuals of zero day-old only 2 survived for 12 weeks. A total of 65 snails of zero day-old, with an average 0.92 ± 0.02 mm and 0.15 ± 0.01 mg in shell diameter and body weight were cultured under laboratory conditions (17.5° – 32.5 °C temperatures). They grew to 10.15 ± 0.28 mm and 282.1 ± 18.29 mg in shell diameter and body weight respectively within a period of 6 weeks. Out of these snails only 4 survived for 17 weeks and the average measurements of shell diameter and body weight were 14.2 ± 0.4 mm and 530.5 ± 29.5 mg respectively.

The snails maintained at 15 °C did not produce any egg capsule within a period of 42 days. At 20°, 25°, 30°, 35 °C and room temperature (17.5° – 32.5 °C) they became sexually mature at the age of 127, 69, 49, 56 and 58 days respectively. Of the 77 snails exposed to 20 °C, 53 survived up to sexual maturity. Egg laying was continued for a period of 57 days. But during that period 46 individuals died and the remaining 7 stopped deposition of egg capsules on and from the 58th day, dying within the next 5 days. They laid a total of 17,162 eggs in 940 capsules. On an average an individual laid 582.77 eggs in 31.90 capsules in its life span. At 25 °C, of the 64 snails 31 survived up to sexual maturity. They continued deposition of egg capsules daily, for a period of 50 days, depositing a total of 16,880 eggs in 1,017 capsules. This means that an individual, on an average, produced 18.043 eggs in 1.097 capsules per day. Of the 58 individuals exposed to 30 °C only 11 survived to take part in reproduction. Since the day of attainment of sexual maturity at the age of 49 days egg capsules bearing eggs were obtained daily for a period of 23 days and an individual on an average laid 968.45 eggs in 56.01 capsules in its life span. At 35 °C only 6 out of 50 individuals survived to take part in reproduction. On an average an individual produced 798.68 eggs in 49.32 capsules in its life span. Likewise, an individual deposited 1143.97 eggs in 62.34 capsules in its life span at room temperature (Table).

DISCUSSION

From the results it appears that the snails *I. exustus* are unable to complete their life cycle at constant 10° and 15 °C water temperature. However, they can thrive for a few weeks at 15 °C water temperature. At the other four constant temperatures viz. 20°, 25°, 30° and 35 °C, though favourable for life-cycle activities, the rates of growth varied with the tem-

peratures. The weekly mean growth rates were 0.35, 0.63, 0.81 and 1.07 mm in shell diameter and 7.94, 15.5, 27.18 and 41.48 mg in body weight respectively at 20°, 25°, 30° and 35 °C. The snails though survived for 6 weeks added on an average 0.21 mm to the shell diameter and 0.45 mg to the body weight per week while exposed to 15 °C. At laboratory conditions (17.5° – 32.5 °C) the average weekly growth rates in shell diameter and body weight were 0.78 mm and 31.2 mg respectively. It is clear that the growth rates were gradually higher with the gradual increase of temperature from 15 °C to 35 °C at an interval of 5 °C. From the weekly average data it is clear that the rate of growth always becomes almost double, with the increase of 5 °C temperature, than the intermediate preceding thermal grade.

Growth rates in freshwater gastropod molluscs have been studied by a good number of workers (vide, Hyman, 1967; Browne, 1978). But studies on the effect of temperature on the rate of growth and related parameters are limited to Chernin (1967), El-Hassan (1974), Michelson (1961), Sturrock (1970), Foster (1964), Shiff & Garnett (1967), Sturrock & Sturrock (1972) and Vianey-Liaud (1982). While all other workers are in opinion that temperature plays important role in regulating the growth rate in snails, Vianey-Liaud (1982) has clearly indicated that the rate of growth in shell diameter of *Biomphalaria glabrata* was higher at 30 °C than at 25 °C. He also reported that at 33 °C the young *B. glabrata* grew faster than the adults. That higher but tolerable temperature accelerates growth rates in snails is well established from the studies on *B. glabrata* and *I. exustus*. Though data on the rates of growth in snails at tolerable lowest to highest temperature grades are not available for any species, the present findings clearly indicate that a constant 15 °C and or lower temperature are not at all favourable for survival of the snail *I. exustus*.

The results of the present studies clearly indicate that the rate of egg production in *I. exustus* is greatly influenced by temperature. It is evident that the rate of egg production is gradually increased with the rise of temperature from 20 °C to 30 °C at an interval of 5 °C. Temperature above 30 °C and more precisely a fixed 35 °C reduces the rate of egg production but the rate was higher than that noted at 20 °C. Though the rate of egg production in *I. exustus* was higher at 30 °C than that of 25 °C, as noted in the present study, Vianey-Liaud (1982) has noted higher number of eggs in *B. glabrata* at 25 °C than at 30 °C. This indicates that the effect of temperature also varies with the species. However, it can safely be concluded that the rate of egg production is always higher at natural i. e. fluctuating temperatures. This is well evidenced from the fact of production of highest number of eggs by an individual of *I. exustus* while maintained at room temperature (17.5° – 32.5 °C). Since in India and more specifically in the plains of West Bengal the temperatures of pond and lake waters usually lie between 18° – 35 °C (except few hours during winter) the snail *I. exustus* would produce eggs in maximum number so far as influence of temperature is concerned.

ACKNOWLEDGEMENTS

To the Head, Department of Zoology, University of Calcutta, for providing the necessary facilities and to Dr T. C. Saha, Lecturer, Darjeeling Government College, for his cooperation in this study.

REFERENCES

BROWNE, A. R., 1978. Growth, mortality, fecundity, biomass and productivity of four lake populations of the prosobranch snail, *Viviparus georgianus. Ecology, 59:* 742-756.

BRUMPT, E., 1936. *Schistosoma bovis* et *Schistosoma mansoni* ne sont pas transmis par *Planorbis (Indoplanorbis) exustus*. Observations biologiques concernant ce Planorbe (autofécondation, érosion de la coquille, élevage, etc.). *Ann. Parasitol., 14*: 464-471.

CHATTERJEE, K. D., 1952. *Human parasites and parasitic diseases.* The World Press Ltd., Calcutta, VI + 766 p.

CHERNIN, E., 1967. Behavior of *Biomphalaria glabrata* and other snails in a thermal gradient. *J. Parasitol., 53:* 1233-1240.

DURANI, M. Z. & CHAUDHURY, A. H., 1967. Studies on the life-cycle of *Indoplanorbis exustus* (Planorbidae: Gastropoda) under controlled conditions. *Pak. J. Vet. Sci., I:* 14-16.

EL-HASSAN, A., 1974. Laboratory studies on the direct effect of temperature on *Bulinus truncatus* and *Biomphalaria alexandrina,* the snail intermediate hosts of Schistosomes in Egypt. *Folia Parasitol.,* Czechol., *21:* 181-187.

FOSTER, R., 1964. The effect of temperature on the development of *Schistosoma mansoni* Sambon 1907 in the intermediate host. *J. Trop. Med. Hyg., 67:* 289-292.

GHOSH, R. K. & CHAUHAN, B. S., 1975. Fifty years of faunistic survey in India. *Rec. Zool. Surv. Ind., 68:* 367-381.

GODAN, D., 1983. *Pest slugs and snails.* Springer-Verlag, Berlin, Heidelberg, New York. VI + 445 p.

HYMAN, L. H., 1967. *The Invertebrates,* Vol. 6, Mollusca I, McGraw Hill, London, 792 p.

ISLAM, K. S., 1977. A note on the life-cycle of *Indoplanorbis exustus* (Deshayes) under laboratory conditions. *Ind. J. Anim. Sci., 47:* 374-376.

LISTON, W. G. & SOPARKAR, M. B., 1918. Bilharziosis among animals in India. The life-cycle of *Schistosomum spindalis. Ind. J. Med. Res., 5:* 567-569.

MALEK, E. A. & CHENG, T. C., 1974. *Medical and economic malacology.* Academic Press, London, 398 p.

MICHELSON, E. H., 1961. The effects of temperature on growth and reproduction of *Australorbis glabratus* in the laboratory. *Am. J. Hyg., 73:* 66-74.

RAO, M. A. N., 1933. A preliminary report on the successful infection with nasal schistosomiasis in experimental calves. *Ind. J. Vet. Sci. Anim. Husb., 3:* 160-162.

RAUT, S. K., 1986. *Disease transmitting snails. II. Population Studies of* Indoplanorbis exustus *(Deshayes).* First year's PRS thesis, Calcutta University.

RAUT, S. K. & GHOSH, U., 1985. Egg capsules of some freshwater vector snails. *Environ. & Ecol., 3:* 214-217.

SHIFF, C. J. & GARNETT, B. G., 1967. The influence of temperature on the intrinsic rate of natural increase of the freshwater snail *Biomphalaria pfeifferi* (Krauss) (Pulmonata: Planorbidae). *Arch. Hydrobiol., 62:* 429-438.

STURROCK, R. F., 1970. An investigation of some factors influencing the survival of St. Lucian *Biomphalaria glabrata* deprived of water. *Ann. Trop. Med. Parasitol., 64:* 365-371.

STURROCK, R. F. & STURROCK, B. M., 1972. The influence of temperature on the biology of *Biomphalaria glabrata* (Say), intermediate host of *Schistosoma mansoni* in St. Lucia, West Indies. *Ann. Trop. Med. Parasitol., 66:* 385-390.

SUBBA RAO, N. V., 1989. *Freshwater molluscs of India.* Hand Book, Zoological Survey of India, Calcutta, xxiii + 1-289 p.

VIANEY-LIAUD, M., 1982. Effets des hautes températures sur la reproduction de *Biomphalaria glabrata* (Mollusca Basommatophora). (Proc. 7th Intern. Malacol. Congr.). *Malacologia, 22:* 159-165.