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Effect of Salinity & Temperature on the Gastropod *Thais rudolphi* (Lamarck) from Waltair Coast

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Effects of salinity and temperature, and their combined effect on the survival of *T. rudolphi* were studied. Salinities 2 and 63 ‰ were lethal to the animals. With increase in temperature (34 to 43 C) there was a decrease in the time of survival. Survival time was comparatively more at 33°, 35 C and 20 ‰ salinity combinations. They could tolerate low temperatures (16° C) better within a salinity range 20-33 ‰.

Temperature and salinity are 2 ecological factors that influence the distribution of animals in general[1]. Tolerance experiments conducted under controlled conditions in the laboratory define the limits within which survival is possible. Such experimental studies with adult snails are scanty. Fraenkel[2-5] has described lethal high temperatures for marine invertebrates *Limulus polythenus*, *Littorina littorea* and *Pagurus longicarpus*. Salinity as a limiting factor in the distribution of marine organisms is well known[6]. Segal[7] has made a review on the thermal acclimation in molluscs. Effect of temperature, salinity and their combinations on marine and brackish water animals has been discussed by Kinne[8]. Influence of water temperature on the life of the dog whelk *Thais lapillus*[9] and the salinity tolerance of some common prosobranchs[10] have been reported. Intertidal ecology of the rocky shore at Mandapam camp[11] and some aspects on the ecology of marine intertidal gastropods from Ratnagiri shore[12] have been studied. Bertnus and Schneider[13] have described the temperature relations of puget sound thaids with reference to their intertidal distribution.

The present study was undertaken to find out the effects of salinity and temperature on the marine snail, *Thais rudolphi*, from Visakhapatnam coast (lat. 17°40'30'' and 17°45' N and long. 83°16'15'' and 83°21'30'' E). The tidal levels and their vertical ranges on the Visakhapatnam coast were earlier described[14]. These snails were mostly confined to the region around mean high water neaps. Young snails were most abundant in between mean sea level and mean low water neaps.

The present investigation was carried out from March to Sept. 1980. The lowest and highest salinities obtained in the field during the period were 26 and 33 ‰ respectively. Experiments were conducted in low salinities from 4 to 20 ‰ and in high salinities from 36 to 63 ‰. Lower salinity concentrations were prepared by diluting sea water of about 27 ‰ with required volumes of distilled water and high salinity concentrations by adding sea salt to normal sea water, and the salinity values were obtained by Harvey's method[15].

In each experiment 5 to 10 animals were used and each experiment was repeated 5 times. The snails were kept in large glass troughs filled with the required grade of salinity. Sea water was changed daily and aerated frequently. All experiments were conducted at 27° ± 1° C.

Resistance of the animals to high temperature was studied by the method described by Fraenkel[2-5] by exposing the animals to different temperatures for 1 hr and testing their revival capacity. They were kept there for exactly 1 hr before bringing them back to room temperature (28° C). The recovery of the animals was followed for 2 days after the experiment. Those that did not recover even after 2 days were considered dead and this fact was confirmed by breaking open the shells. The criterion for recovery was the resumption of normal activities like protruding the snout with cephalic tentacles from the shell and resumption of normal locomotion. In addition, the animals which were positive to 'opercular reflex' immediately after the experiment were termed as 'reactive after treatment'[5].

Effect of low temperature was studied by the method of Fraenkel[5]. The temperature of sea water was first brought to 1° or 2° lower than the required temperature in a refrigerator. Then it was immediately transferred to a B.O.D. incubator set at the required low temperature. The snails were then transferred into the incubator after the temperature of sea water has stabilized. After 1 hr they were returned to room temperature and examined for recovery. High (32° to 42° C) and low (16° to 18° C) temperature tolerance experiments were conducted at salinity 27 ‰.

Effect of low salinity—When snails were plunged in fresh water 100% mortality occured within 12 hr. The time required for 100% mortality decreased with

decrease in salinity (Table 1). Salinities below 7 $^0/_{00}$ were critical to the animals as there was a steep decrease of their survival period below this concentration. The lower lethal salinity was 2 $^0/_{00}$.

Effect of high salinity—The time required for 100% mortality decreased with increase in salinity from 36 to 63 $^0/_{00}$ (Table 1). These observations suggest that salinities above 51 $^0/_{00}$ are critical to the animals as there is a steep decrease in the period of their survival above this salinity. The upper lethal salinity was 63 $^0/_{00}$.

Resistance to high temperature—In temperatures ranging from 32° - 36° C the animals recovered very quickly when they were brought back to room temperature after 1 hr exposure. From 38° - 41° C although they revived the time taken for revival is progressively larger and some animals took 1 or 2 days for complete revival (Table 2). The table further indicates that the highest temperature from which 50% of the animals recovered sufficiently to resume normal activity is 42° C. There are no recoveries from 43° C.

Since a definite trend showing decline in the capacity of the animals to thermal resistance is evident from 39°C and above, experiments were conducted to study their resistance for shorter periods of 5, 15 and 30 min from 39° - 44° C with 1° intervals. The number of animals recovering increased with decreasing periods of exposure. Almost all recovered from 39° - 41° C, 60% from 42° C and none from 43° C after 30 min exposure. After 15 min exposure 50% recovered at 43°C and none from 44°C for the same period of exposure. It is interesting to note that none recovered from 44° C even after a small exposure period of 5 min.

Table 1—Effect of Salinity on the Mortality Rate of *T. rudolphi*

[Number of animals in each experiment was 10. Temperature used was 26°C]

Salinity $^0/_{00}$	Time in days required for mortality	
	50%	100%
Low		
4	½ - ¾	1
7	2½ - 3	4
10	10 - 12	15
13	18 - 20	25
16	20 - 25	30
20	35 - 38	45
High		
36	4 - 4½	5
42	2 - 2½	3
45	1 - 1½	2
48	1 - 1½	2
51	½ - 2/3	1
54	1/3 - 2/3	1
57	¼ - 1/3	½
60	½ - ¼	1/3
63	—	—

Table 2—Resistance of *T. rudolphi* to Different Temperatures after Exposure for 1 hr

[Number used in each experiment was 6]

Temp. °C	No. recovered	Remarks
High		
34	6	
36	6	All recovered within ½ hr
38	6	All recovered within 1 hr
39	5	1 reactive after treatment died later
40	4	2 reactive up to 6 hr died later
41	3	3 reactive up to 5 hr died later
42	2	4 reactive up to 5 hr died later
43	—	No revivals
Low		
16	10	All recovered within 5 min
14	10	-do-
12	10	Recovered within 15 min
10	10	Recovered after 1 hr
8	10	Recovered after 2½ hr

Effect of gradual rise in temperature—Up to 38° C the animals are active exhibiting spontaneous movements in the form of moving foot and cephalic tentacles (Table 3). But there after they remained quiet. In the range 38° - 42° C they responded by slightly moving their foot and cephalic tentacles to the stimuli offered to them by prodding the foot with a pin or by applying 'opercular reflex'[5]. This is the 'irritability range'[16]. All of them recovered when brought back to room temperature from the above range (38° - 42° C). Above 42° C they did not respond to stimuli and were in a heat coma, but 60% from 43° C and about 20% from 44° C revived when brought back to room temperature. There are no recoveries from 45° C. It is interesting to note that out of the 10 animals taken from 44° C 2 recovered whereas there are no recoveries from the same temperature even after a brief exposure for 5 min in the previous experiment.

There is a steep fall in the time required to reach 100% mortality between 37° C and 40° C (Table 4).

Combined effects of salinity and temperature—At 33° and 35° C a salinity range of 16-37 $^0/_{00}$ was favourable to the animals. At 37° and 39° C, 20-34 $^0/_{00}$ was good. At 9° C 20-40 $^0/_{00}$ and at 16° C 12-37 $^0/_{00}$ salinities were much tolerant.

T. rudolphi tolerated wide range in salinity. It could survive for nearly 12 hr in fresh water. Its lower and upper lethal salinities were 2 and 63 $^0/_{00}$ respectively. In *Gibbula cineraria* there was a rapid decline of

Table 3—Effect of Gradual Rise in Temperature (1°C/5 min) on *T. rudolphi*

Time hrs	Temp. °C	No. brought to room temp.	No. recovered	Remarks
1300	30	—	—	
1305	31	—	—	
1310	32	—	—	
1315	33	—	—	
1320	34	—	—	
1325	35	—	—	
1330	36	—	—	
1335	37	—	—	
1340	38	—	—	All are active
1345	39	10	10	All recovered within 1 hr
1350	40	10	10	-do-
1355	41	10	8	2 reactive, but died after 24 hr
1400	42	10	7	3 reactive, but died after 12 hr
1405	43	10	5	Recovered after 1 day
1410	44	10	1	-do-
1415	45	10	—	No recoveries

activity in 18 $^{0}/_{00}$ salinity, whereas *Nucella lapillus* showed activity in salinities as low as 12 $^{0}/_{00}$.

T. rudolphi could tolerate temperatures up to 42° C. Such high temperatures are observed rarely in the rocky shore. *T. lapillus* becomes completely inactive below 3° C and the rate of feeding increased rapidly and reached maximum above 20°C[9]. The temperatures at which the spontaneous movement ceases and the animal loses its irritability are comparatively higher in *T. rudolphi* than in the temperate species of *Littorina*, *Gibbula*, *Nucella* and *Osilinus*[17]. Further it is seen that the range of temperatures which *T. rudolphi* can tolerate after its spontaneous movement ceases, before dying, is less (6-7° C) whereas in the British snails it is comparatively more (9-14° C). Meyer[18] points out that the tropical animals often live at temperatures very near to their thermal death points unlike the arctic ones which often live in water as much as 13 to 16° C below their death points.

Table 4—Resistance of *T. rudolphi* to High Temperatures
[Number in each experiment: 10]

Temp. °C	Exposure period in hr for mortalities	
	50%	100%
34	72 - 96	120
37	48 - 60	72
39	10 - 12	24
40	6 - 8	12
42	3 - 4	7½

According to Fraenkel[4] the magnitude of the temperatures to be tolerated would depend on the climatic characteristics of a particular area. The capacity of *T. rudolphi* to resist high temperatures may be due to the prevailing high temperatures at a tropical location like Waltair.

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