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Studies on the Temperature Tolerance of Two Fresh Water Air-Breathing Teleosts, *Chana Punctatus* (Bloch) and Clarias *Batrachus* (Linn.)

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Abstract: *Both young and adult Channa and Clarias survived within 72 hours of exposure time to test temperature of 40 ^0C and 36.5 ^0C for acclimation tried i.e. 25 ^0C, 30 ^0C and 35 ^0C respectively. But none of the fishes survived at 15 ^0C in low lethal tests. The thermal tolerance area was estimated to be 700 $^0C^2$, 501 $^0C^2$ for young and adult of Channa and Claries respectively. It is concluded that Channa punctatus and Clarias batrachus are stenothermal.*

I. Introduction

There is an extensive early literature on temperature tolerance of poikilo-thermic animals which can now be considered to be of much value in judging their eco-physiological characteristics (Prosser and Brown, 1958 & 1961, Brett, 1970; Fry, 1971, Alakel et.al, 2007). But there appear to be only few studies on the temperature tolerance of Indian fresh water air breathing toleosts among which are the reports of Ananthakrishnan & Kutty (1976) on temperature tolerance of juvenile specimen (18-23 g) of Channa punctatus an Indian air breathing fish. Therefore, it is of interest to undertake a more comprehensive study on the temperature tolerance of young (immature) and adult (mature) air-breathing fishes of India.

II. Materials And Methods

The fishes chosen for study belong to different genera and families: Channa (=Ophiocephalus) punctaus (Bloch); (Channidae) Clarias batrachus (Linn.) (Claridae). These fishes are commonly available in the swamps of North Bihar and were collected in the summer season (1977) and maintained in large glass aquaria (40L.) at an ambient temperature of 30.0 ± 1 ^{0}C in the laboratory for two weeks before experiments. During this period they were fed on pieces of goat liver and small prawns on alternate days.

Prior to experiment the fishes were acclimated to 25 ^{0}C, 30 ^{0}C and 35 ^{0}C for about two weeks in temperature controlled aquaria. For reaching the specific temperature of acclimation , it was raised or lowered by 1 ^{0}C per day. The temperature was regulated to a precision of ± 0.1 ^{0}C with the thermostat. During the experimental period the water in the test bath was well aerated to maintain oxygen level close to air-saturation. All acclimations and tests were carried out in fresh-water.

The fishes were starved for 24 hours prior to tests. The method of lethal temperature study followed that described by Fry et al. (1971) and Brett (1978). In each set, six fishes of young and adult were exposed to the concerned lethal temperature by abruptly transferring them to water heated or cooled to the desired test temperature for maximum period of 72 hours. The temperature at which the animal becomes visibly incapacitated was taken as a measure of its lethal temperature and the time was noted.

The breathing behavior (areal breathing) of the fish at all acclimated and test temperatures were recorded by visual observation. The opercular frequencies were counted for a period of one minute at intervals of 30 minutes and the amplitude of their movements was also estimated by visual observation.

III. Observations

Time required for the death of 50 per cent of the exposed fish was referred as median resistance (survival) time. The median resistance time in minutes for Channa were 95,710 and 503 for young; 1120, 885 and 780 for adult at 15 ^{0}C; 3360, 4110 and 4700 for young; 3030, 3310 and 3605 for adult at 42 ^{0}C; 2130, 3873 and 3900 for young; 1860, 2510 and 2780 for adult at 42.5 ^{0}C; 800, 2600 and 2915 for young; 710, 1180 and 1790 for adult at 43 ^{0}C acclimated at 25 ^{0}C, 30 ^{0}C and 35 ^{0}C respectively (Table 1A; Fig. 1).

At similar acclimation temperatures, the median resistance times in minutes for Clarias were 1500, 1000 and 530 for young; 2000, 1310 and 860 for adult at 15 ^{0}C; 3415, 4030 and 4200 for young; 2088, 3575 and 3980 for adult at 30 ^{0}C; 3010, 3370 and 3730 for youngh; 2400, 2923 and 3410 for adult at 39 ^{0}C; 2456, 2967

and 3230 for young; 1680, 2030 and 2680 for adult at 40 ^{0}C; 1865, 2010 and 2483 for young; 813, 1605 and 2235 for adult at 41 ^{0}C respectively (Table 1B; Fig. 2).

From the observed data it was quite evident that none of the fishes whether young or adult of Channa and Clarias could withstand the low temperature of 15 ^{0}C(low lethal point). The high lethal point differ in different species as given below :- 45 ^{0}C for Channa and 38 ^{0}C for Clarias for the above acclimation and exposure time. When the percentage survival of Channa and Clarias was plotted against the test temperatures the 72 hours median tolerance limits were seen to have been in the vicinity of 44 ^{0}C for young and adult of Channa and 41 ^{0}C for Clarias (Figs. 1 & 2).

The fish acclimated at 25 ^{0}C and gradually exposed to high temperatures lost the heat tolerance characteristics of the control group (acclimated at room temperature of 30 ^{0}C) in young and adult of Channa and Clarias. The 72 hours median heat tolerance limit of young and adult fish fell respectively from 2600 min. to 800 and from 1180 min. 710 at 43 ^{0}C for Channa; 2010 to 1865 min, 1605 to 813 min. at 41 ^{0}C for Clarias. However, when exposed to low lethal temperature of 15 ^{0}C. The fishes gained the cold tolerance characteristics of the control group. The 72 hours median resistance time increased from 1000 to 1500 min.; 1300 to 2000 min; 1630 to 2100 min., 2280 to 3000 min. in young and adult of Channa and of Clarias respectively. Further, the 72 hours median heat tolerance limit of young and adult of Channa and Clarias acclimated at 35 ^{0}C, when compared with those of control groups gained the heat tolerance characteristics of the control group and lost the cold tolerance capacity as shown in Table 1A, B.

The amplitude of the opercular frequencies per minute and at intervals between air breaths in relation to ambient and test temperatures varied in young and adult of the two species studied even in the same weight groups at different temperatures. It was varied from (80-85) and (40-42); (180-182) and (115-117) in young and adult and young Channa and Clarias respectively. The opercular frequencies increased with increasing temperature but before approaching the lethal point at higher temperature, the opercular frequencies per minute decreased suddenly and continued further till lethal points were reached.

TABLE-1 Median resistance times (LT50) in minutes of fishes acclimated to 25^o, 30^o and 35^o C in tested at various lethal temperatures.

Acclimation temp.(c)	Test at low temp.15°	Tests Temperatures °C Tests at high temperatures											
		36°	36.5°	37°	38°	38·5°	39°	40°	41°	42°	42.5°	43^O	43.5^O	44^O
(A) Channa punctatus														
25°- Young	950							No Death	4080	3360	2130	800		
Adult	1120							-do-	3830	3030	1860	710		
30°- Young	710							-do-	No Death	4110	3873	2600		1762
Adult	885							-do-	-do-	3310	2510	1180		800
35°- Young	503							-do-	-do-	4700	3900	2915		2030
Adult	780							-do-	-do-	3605	2780	1790		1393

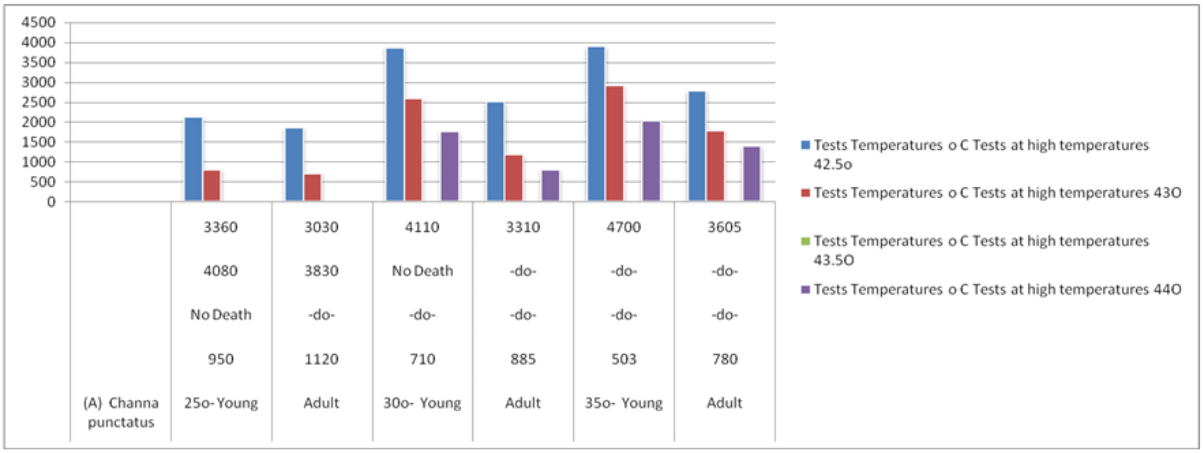
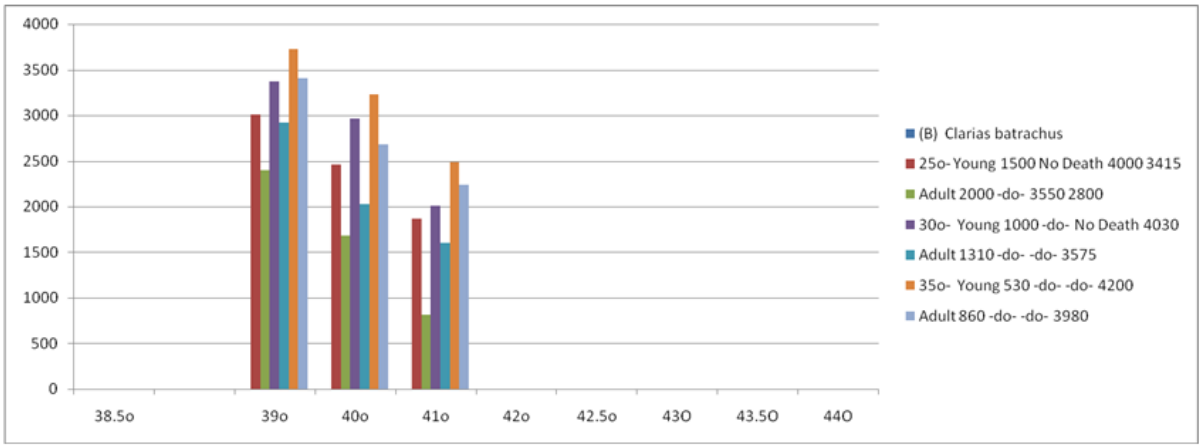


TABLE-1 Median resistance times (LT50) in minutes of fishes acclimated to 25°, 30° and 35° C in tested at various lethal temperatures.

Acclimation temp.(c)	Test at low temp.15°	Tests Temperatures ° C Tests at high temperatures												
		36°	36.5°	37°	38°	38·5°	39°	40°	41°	42°	42.5°	43°	43.5°	44°
(B) Clarias batrachus														
25°- Young	1500		No Death	4000	3415		3010	2456	1865					
Adult	2000		-do-	3550	2800		2400	1680	813					
30°- Young	1000		-do-	No Death	4030		3370	2967	2010					
Adult	1310		-do-	-do-	3575		2923	2030	1605					
35°- Young	530		-do-	-do-	4200		3730	3230	2483					
Adult	860		-do-	-do-	3980		3410	2680	2235					



IV. Effect Of Temperature On Aerial Breathing

In both young and adult of Channa and Clarias, the interval between two successive air-breaths (in min.) decreased with increasing temperature. That means the fishes depended more on air-breathing. They could withstand high temperature till the lethal limits were reached which vary in different species. It was 42.5 ^{0}C for Channa and 39.5 ^{0}C for Clarias. At these high temperatures there was a sudden drop of air-breaths and the time interval increased considerably. At 15 ^{0}C the time intervals of two successive air breaths was very feeble and could not be recorded.

An interesting behavior of air breathing was observed in Clarias which rose to the surface to take in air in groups at a time when a small population of fish was kept in an aquarium at room temperature. One fish came up to the surface to gulp in air first and followed by many fishes at a time with rapid movements.

V. Discussion

Temperature tolerance of fish varies greatly. Tropical species appear to be distinguished by low and high lethal temperatures(Allanson and Noble, 1964, Adebayo et.al, 2007)

Observation on temperature tolerance of Channa punctatus and Clarias batrachus reveal their individual characteristics. During their course of study none of the young or adult of Channa and Clarias died within72hours of exposure time to test temperature at 40 ^{0}C for Channa and 36.5 ^{0}C for Clarias for different acclimation temperature tried, i.e 25 ^{0}C, 30 ^{0}C and 35 ^{0}C respectively. But none of the fishes could survive at 15 ^{0}C in low lethal tests as indicated below: 42 ^{0}C for Channa and 38 ^{0}C for Clarias.

Animals acclimated at high temperature(35 ^{0}C) are relatively heat resistant and cold sensitive, where as animals acclimated at low temperature (25 ^{0}C) are relatively cold resistant and heat sensitive which is evident from 72 hours median tolerance limit. The size of the fish and order of occurrence of death were also examined in order to determine whether size has any critical effect in high or low temperature tolerance. At high temperature, the older fish of two species died earlier than the young ones. The younger fishes seem to remain physiologically active for a longer time as the time taking to reach the lethal incipient point is longer. The older fish though are more sensitive in high temperature, are physiologically slightly more tolerable to low temperature. This is in conformity with the views of Fry et.al.,(1971) Ananthakrishnan and Srinivasan (1977).

Just the reverse cases are observed at lower incipient lethal temperature(15 ^{0}C). The younger fishes of Channa and Clarias died earlier than older ones.

Further the total area bounded by the trapezium which denotes the thermal tolerance zone of Channa and Clarias can be expressed in $^0C^2$ units (after Fry, 1971) and this can be expected to show qualitatively the thermal tolerance of the species concerned. As such the thermal tolerance area is estimated to be 700^0C^2 and 501^0C^2 for both young and adult Channa and Clarias respectively in comparison with 1220 $^0C^2$, 420^0 C^2 and 410 $^0C^2$ for gold fish. Sockeye Salmon and Channa punctatus (Young) respectively.

Data clearly demonstrates that the tropical Channa and Clarias and the high tempo rate sockeye salmon are "Stenothermal" where as the low tempo rate gold fish is "Eurythermal".

A very interesting pattern of aerial breathing behavior observed in Clarias rising to the surface to take in air by more than one fish at a time throws light over their social mode of life. Perhaps they live together in many numbers in one eco habitat and maintain a society like other vertebrates. However, a detailed study of the social behavior pattern of Clarias in relation to their air-breathing habit would offer an interesting field of research.

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