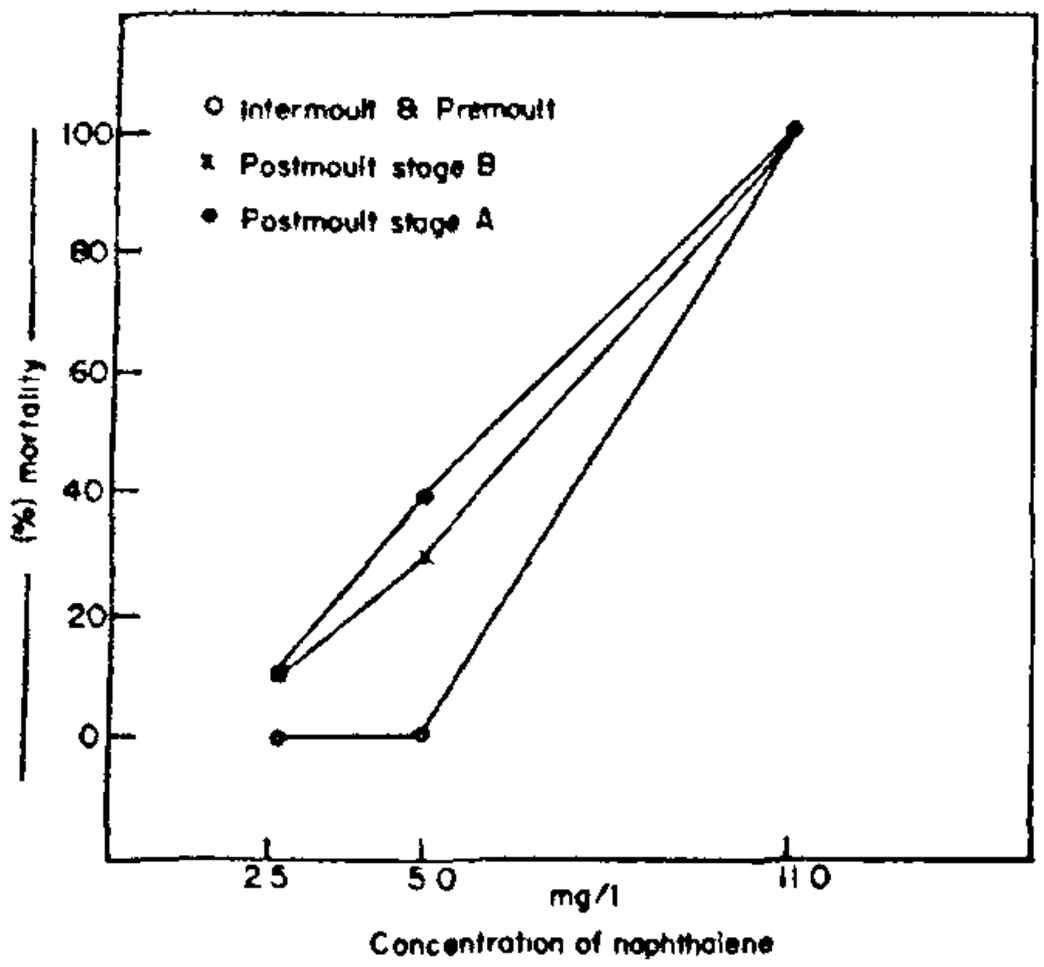

Figure 1. Sensitivities of crab *S. serrata* to naphthalene in different molting stages.

similar sensitivity to all the three concentrations of naphthalene. At the higher concentration of 11 mg/l, the mortality at these two stages began at the end of about 96 hr and all the animals gradually died by the end of the experimental period of 15 days. Both intermoult and premoult crabs could tolerate low concentration of naphthalene over a period of 15 days of the experimental period. Some of the premoult crabs even moulted in water containing low concentration of naphthalene.

Similar high sensitivity of moulting crustacean larvae to the stress of crude oil has been mentioned by few workers[3–5].

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DIURNAL RHYTHM OF BIMODAL OXYGEN UPTAKE IN AN AIRBREATHING LOACH, *LEPIDOCEPHALUS THERMALIS* (VAL.).

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DESPITE many attempts[1,2] to relate respiration to ecology in Indian airbreathing fish, virtually nothing is known on the respiratory patterns in relation to the oxygen content of their natural habitats. Though *Lepidocephalus thermalis* is known[3] to inhabit water of low oxygen content, measurements of O_2 tension are not available to assess the tolerance of the fish to hypoxia and the importance of airbreathing organs under natural conditions. The present investigation attempts to study the diurnal variations in the O_2 consumption of the fish in the absence of fluctuations in the O_2 tension. The pattern of diurnal fluctuations in the O_2 obtained through the airbreathing organs is discussed in relation to the O_2 content and its diurnal variations in the waters inhabited by *L. thermalis*.

Collection, maintenance and weight range of fish used have been described earlier[4]. Fish of either sex were starved for 24 hr before experimentation. The diurnal rhythm of O_2 consumption was studied at 29 $\pm$1°C using respiratory chambers as designed by Reddy and Natarajan[5]. The oxygen consumed under water and in air was separately determined for a day at 3 hr intervals. Total O_2 consumption at each time was obtained by summing up the values for aquatic and aerial respiration obtained at the corresponding time. Throughout the present study the O_2 content of the water was kept constant (6 ± 0.2 mg/1). The aquatic respiration of the fish without access to air was studied by the method of Job[6]. Winkler's method was used for estimating the O_2 content of water samples. The O_2 consumption of the fish in air was measured using a respirometre involving the principles of manometric technique. At each time of the day the experiment was run for only 30 min to avoid the influence of hypoxia.

The O_2 content of the water of a pool inhabited by these fish was estimated at regular intervals of 3 hr for over 4 days. Winkler's iodimetric method was used for estimating the O_2 content of water samples. The average values were noted against the times of the day at which the dissolved O_2 content was estimated.

The O_2 content of the water of a pool inhabited by *L. thermalis* fluctuated between 1.2 cc and 4.2 cc per litre with the maximum being reached at 18 hr and the

minimum at 6 hr (table 1). The pattern of diurnal fluctuations in the O_2 content reveals a gradual increase in the O_2 content during day time and a gradual decline during night.

The diurnal variations in the total O_2 consumption (table 2) reveal two major peaks and two minor peaks. Among the two major peaks, one occurred around midnight and the other in the early hours of the day. The minor peaks were recorded at 18 and 3 hr respectively. The O_2 obtained by the airbreathing organs is also maximum at these times. Minimum O_2 uptake is recorded during 15 hours. In every hour, airbreathing dominates over aquatic breathing.

The data for O_2 content of the water of a pool show that *L. thermalis* inhabits water of low O_2 tension and thereby suggest that the fish is extremely tolerant to O_2 deficiency in water provided it has access to air. This extreme tolerance is obviously due to efficient functioning of the airbreathing organs in gaseous exchange meeting about 55% of the total O_2 requirement[4].

The diurnal fluctuations in O_2 consumption now recorded reveal a rhythmical pattern in the absence of any differences in the O_2 tension in the respiratory chamber. It is of interest to note that the variations in the O_2 consumption are inversely related to the diurnal fluctuations in the O_2 content of the natural waters.

As the major portion of O_2 is obtained by *L. thermalis* from air, it may be stated that the times of greater uptake of O_2 through the airbreathing organs correspond to the times of depletion of O_2 content in the natural waters. Thus the airbreathing organs seem to be of very great functional significance in natural environment where O_2 gets very much depleted during nights. Hughes and Singh[7] have shown that in *Anabas testudineus*, the O_2 consumption from air increases when the fish is maintained in deoxygenated water. But in the present study the increased dependency on air coincides with the times of depletion of O_2 in natural waters even when the O_2 tension of water used in the experiment was maintained constant. This prompts the present author to suggest that the pattern of diurnal rhythm in the quantity of air respired is possibly innate and is of very great functional significance and selective value.

The author is thankful to Prof. G. Sundara Rajulu for encouragement and to the UGC for financial assistance.

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Table 1 *Diurnal variation in the O_2 content of the water of a pool investigated*

Hours at which estimations made							
6	9	12	15	18	21	24	3
1.20 ±0.20	2.90 ±0.26	3.00 ±0.18	3.40 ±0.33	4.20 ±0.37	2.60 ±0.20	1.90 ±0.17	1.60 ±0.21

± = Standard deviation; All values are expressed in cc/l. Each value represents the mean of 6 individual observations.

Table 2 *Oxygen consumed (ml/g/hr) by L. thermalis at different hours of the day from water and air. N = 20.*

	Hours at which estimations made							
	6	9	12	15	18	21	24	3
From Water	0.032 ±0.001	0.041 ±0.010	0.024 ±0.012	0.026 ±0.002	0.033 ±0.001	0.030 ±0.012	0.046 ±0.010	0.040 ±0.020
From air	0.430 ±0.150	0.300 ±0.100	0.290 ±0.061	0.268 ±0.033	0.346 ±0.028	0.290 ±0.064	0.422 ±0.102	0.320 ±0.072
Total	0.462 ±0.132	0.341 ±0.110	0.314 ±0.090	0.294 ±0.082	0.379 ±0.121	0.320 ±0.070	0.468 ±0.130	0.360 ±0.083

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PRELIMINARY STUDIES ON THE PRE-METAMORPHIC GROWTH OF *BUFO MELANOSTICTUS* [SCHN.]

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THE post-embryonic developmental cycle of a typical anuran involves three phases; (I) a growth phase characterised by rapid growth and little morphological changes (also called as the phase of pre-metamorphosis), (ii) a prometamorphic phase with reduced body growth and with morphological changes proceeding at a progressively accelerated pace and (iii) a phase of metamorphic climax in which body growth ceases and differentiative changes proceed with extreme rapidity[1]. The classic scheme of metamorphosis put forth for anurans is largely drawn from observations from ranids, where the normal pre-metamorphic growth is known to be completed in about 50 days[2]. However, various biotic and abiotic factors are known to influence the duration of metamorphosis in ranids[3]. Deviations from the classical scheme, in terms of the duration of total metamorphosis have also been reported in several anurans[4–6]. Presently some interesting observations on the pre-metamorphic growth of the bufonid *Bufo melanostictus*, Schneider, are described.

During October 1980 to January 1981, fertilized eggs collected from four different mating pairs were observed for their development. The spawns were separately maintained in experimental field tanks at a water temperature of 19.3 ±0.8°C and an air temperature of 21.4 ±0.8°C. From the day of hatching (which occurred within a week after spawning) measurements of total length (L in mm) and live weight (W in mg) of the tadpoles were recorded, once in every ten days.

Figure 1A and B represent the linear and quantal growth respectively of the tadpoles of *Bufo melanostictus* in relation to time. Regression of body weights of tadpoles on respective body lengths indicated that the growth pattern during the period was exponential[7]. However, in spite of this and the fact that water temperature during the period of study was uniformly high and the variation in temperature was also not marked, none of the tadpoles indicated completion of the pre-metamorphic growth in the observed period of 107 days. Eruptions of the hindlimbs were also not noticed. This is in marked contrast to the observations on species of *Rana*[1, 8] and *Rhacophorus*[7], where a significantly shorter duration has been reported to be required for completing metamorphosis. The present

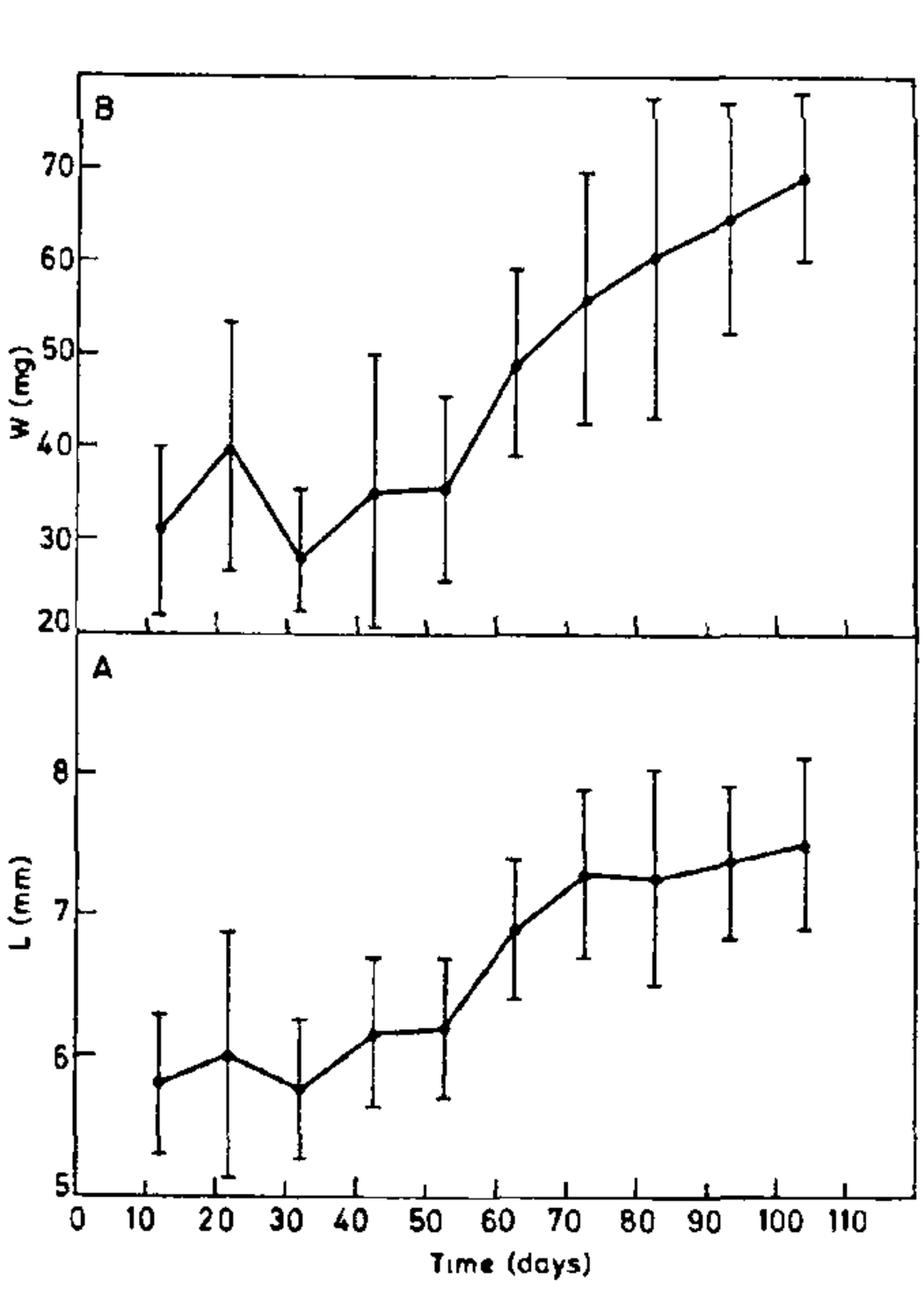

Figure 1. *Bufo melanostictus*: Linear (A) and quantal (B) growth during the pre-metamorphic period.