Back calculation of age was done by using Lea's formula modified by Tesh[7]. Using the formula the growth values of the females during 1st, 2nd, 3rd and 4th year of life were calculated (table 1).

TABLE 1

Calculated total length at the end of each year of life female M. keletius by using otoliths

Age of the fish at capture (in years)	No. of fish	Average back calculated length at each annulus (in mm)			
		1	2	3	4
I	62	48.11			
II	19	52.82	70.69		
III	16	54.21	73.62	84.33	
IV	6	57.42	77.73	90.14	98.42
Mean weighted length (in mm)		50.5	72.9	85.9	98.4
Mean annual increment (in mm)		50.5	22.4	13.0	12.5
Total	103				

It seems that annulus formation in this species occurs only once in a year from July to September. This catfish breeds during these months and the energy required for gonadial activity leaves its impression as a transport zone in the otolith[8]. A similar observation was made by Davis[4] in *Tandanus tandanus*. A maximum of four annuli was observed in the present study and the occurrence of four broods (*i.e.* four different age group of this species) in length frequency studies by Santhankumar[8] leads to the conclusion that *M. keletius* lives in this ecosystem upto four years.

Otolith method of determination of the age and growth shows that it is quite reliable, particularly with this species. Nair[9] also found that otoliths were useful in age studies of oil sardines.

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CHANGES IN GLYCOGEN LEVELS IN AN AIR-BREATHING FISH, *CHANNA GACHUA* (HAMILTON) FOLLOWING AERIAL EXPOSURE

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AIR-BREATHING fish show a drop in oxygen uptake when exposed to aerial conditions[1-3], indicating the onset of oxygen debt. Though anaerobic glycolysis is suggestive of such an oxygen debt in air-breathing fish, direct evidence for the utilization of stored glycogen under aerial exposure is lacking. An attempt is made in the present investigation to estimate the glycogen levels of liver, heart and muscle tissues of the air-breathing fish, *Channa gachua* under normal and air-exposed conditions in order to understand the pattern of energy metabolism of the fish upon exposure to aerial conditions.

Channa gachua (Order: Acanthopterygii; Family: Channidae) is an obligatory air-breathing fish[3], inhabiting tropical freshwater ponds. Specimens of *C. gachua* (40-50 g), collected from local ponds around Coimbatore, were acclimatized to laboratory conditions in large cement tanks and regularly fed with earthworms and boiled eggs.

Weighed samples of liver, heart and muscle were dissected out from normal fishes and used for biochemical estimation of glycogen. Similarly, tissue samples were also collected from fishes which were previously exposed to aerial conditions (exposed fishes) for 5 and 10 hr. Exposure of the fish was done by maintaining the fish (either for 5 hr or 10 hr) in a glass trough (of 5 litre capacity), covered with wire-mesh containing water-soaked cotton.

The glycogen content of liver, heart and muscle was estimated by employing the method of Kemp and Kits[4]. The glycogen levels in different tissues were

TABLE 1

Glycogen levels in liver, heart and muscle of normal and exposed C. gachua, expressed in mg/g of tissue ± S. E. (N).

Tissues	Normal	5 hr exposed	10 hr exposed
Liver	5.496 ± 1.059 (12)	1.467 ± 0.676 (10) (-73%)	0.462 ± 0.005 (10) (-92%)
Heart	0.255 ± 0.066 (10)	0.355 ± 0.068 (10) (+40%)	0.466 ± 0.132 (10) (+82%)
Muscle	0.227 ± 0.077 (10)	0.340 ± 0.023 (10) (+50%)	0.256 ± 0.094 (12) (+13%)

(+%) denotes per cent increase from normal level
(-%) denotes per cent decrease from normal level

expressesd in mg/g of tissue and changes in the glycogen levels of exposed fishes (either increase or decrease) from those of normal fishes were expressed in percentages.

The glycogen levels in liver, heart and muscle of normal and exposed *C. gachua* are presented in table 1 and figure 1. Table 2 provides the changes in glycogen levels of the tissues upon exposure to aerial conditions for 5 and 10 hr.

Of the three tissues, liver appears to be the major site of stored glycogen with the highest level of glycogen content in normal fish. A drop in liver glycogen level, to about 73% and 93%, could be observed in fish exposed for 5 and 10 hr respectively. On the contrary, the heart tissue showed a gradual accumulation of glycogen, with a 40% increase in 5 hr-exposed fish and 82% in 10 hr-exposed fish. The muscle glycogen content rose to the tune of about 50% from normal levels when exposed for 5 hr and to about 13% from normal level upon exposure for 10 hr.

TABLE 2

Per cent changes in the glycogen levels of liver, heart and muscle of exposed C. gachua from normal levels.

Tissue	5 hr-exposed	10 hr-exposed
Liver	− 73	− 92
Heart	+ 40	+ 82
Muscle	+ 50	+ 13

+ denotes increase from normal level.
− denotes decrease from normal level.

Utilization of stored glycogen and lactate accumulation as functions of exercise have been reported in fish muscle[5,6]. Though the fish muscle is well designed for anaerobic metabolism during 'burst activity', it is possible that other tissues also participate in the breakdown of glycogen during oxygen debt[7].

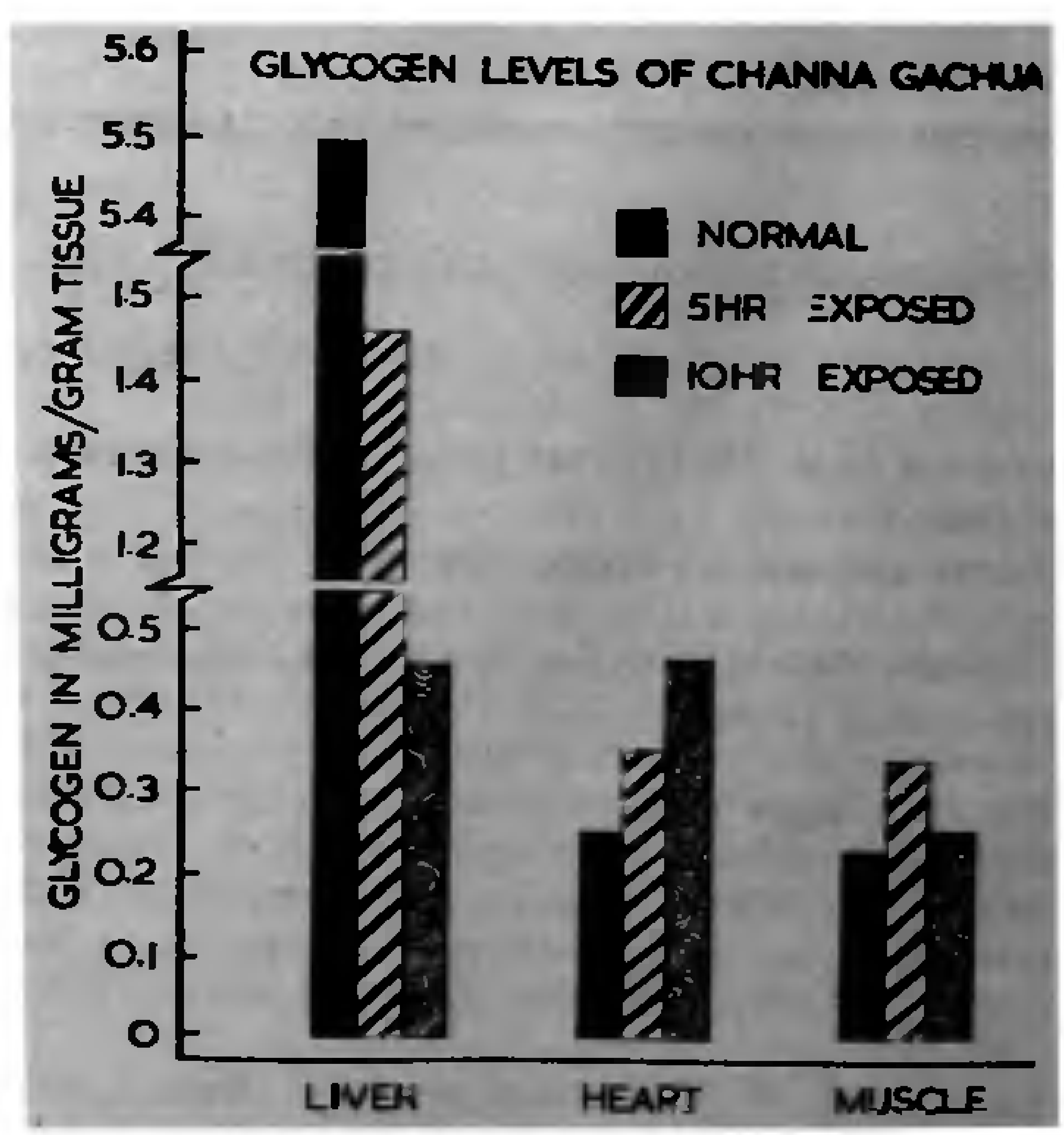

Figure 1. Glycogen levels in liver, heart and muscle of normal and exposed *Channa gachua*.

The continuous drop in liver glycogen content of *C. gachua* is suggestive of mobilization of glycogen from liver to other tissues where glycogen storage is advantageous for energy release.

Increased cardiac activity is an adaptive response to air-breathing[8,9]. Studies on the ultrastructure of heart and muscle of two air-breathing, burrowing Amazon fish, *Lepidosiren paradoxa* and *Symbranchus marmoratus*[10] indicated an overwhelming dependence upon glycogen as a carbon and energy resource. Based on heart LDH studies, Hochachka and Hulbert[10] also suggested that heart glycogen in *L. paradoxa* and *S. marmoratus* serves primarily as a carbon reservoir for energy under conditions of oxygen lack. The accumulation of glycogen in the heart, observed in the present study, could be considered as adaptive to meet the energy demand during increased cardiac function under prolonged exposure. The sudden spurt in muscle glycogen content in 5 hr exposed fish also suggests an adaptive storage of glycogen to be used as energy source for effective air-breathing. The decline in muscle glycogen in 10 hr-exposed fish perhaps indicates a secondary dependency on muscle glycogen (unlike that of 'diving syndrome' where muscle glycogen is the primary source of energy during oxygen debt) as a source of energy upon prolonged exposure to aerial conditions, supplementing the utilization of liver glycogen.

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NEWS

KARNATAKA WEATHER GUIDE CALENDAR

KARNATAKA WEATHER GUIDE CALENDAR published by Mr. D. Krishna Rao, "Margosa Lodge', Chamarajapuram, Mysore-570 004.

The Karnataka Weather Guide is a new and novel type of Calendar Climatological features of Karnataka are presented month-wise in maps. The two main maps in each month show lines of equal rainfall and details of rainy days, temperature and humidity at selected places. Small maps of India showing mean sea level isobars (pressure) and direction of prevailing winds, for different months are also given. Special maps showing the normal dates of onset and withdrawal of southwest and northwest monsoon, normal tracks of storms affecting Karnataka are included in the appropriate months. Salient weather features of the State in each month are also briefly mentioned.

The meteorological information given in this calendar will be useful to scientists, agriculturists and general public.