derably larger than previously found. The H/B ratio of the low line is 20% smaller than that of the high line rather than the 10% found by Elias et al.[18].

Heavier hearts in hypertensive rats have been reported in the SHR, the GH and the Milano stocks. For example, Takatsu and Kashii[19] found a progressive increase in heart weights with age in both the SHR and Wistar-Kyoto with the increase in the SHR more pronounced. The H/B in the SHR was significantly larger than the controls by 13 weeks. In the GH rat heart weights were not significantly heavier when compared to the controls for either young or old rats, but the hypertensive rats are significantly lighter, suggesting a H/B difference between the lines[20]. In the GH hypertensives cardiac hypertrophy occurs only in rats over 6 weeks of age who have greatly elevated pressures[3]. Heart weights were also heavier in the Milano hypertensive rats compared to normotensive controls[4]. Relatively larger hearts would be an expected outcome of sustained elevated blood pressure and this has been found to be true in the SHR, GH, Milano spontaneously hypertensive rat and now in the hypertensive mouse.

Kidney weight. No age effect was found in the 3-way analyses (age, line and sex) of variance for b.wt, right kidney weight and left kidney weight and combined kidney to b.wt ratio (K/B). The results of a subsequent 2-way analysis of variance for sex and line main effects for each variable are shown in the table. Statistically significant differences were found among lines and between sexes for each variable. There was also a significant interaction between lines and sexes caused by larger differences among the males of the 3 lines than among females. The K/B of the high line is about 10% larger than the low line.

Kidney enlargement in hypertensive animals has been reported by other investigators. In the SHR the kidneys are larger than Wistar/NIH controls by 15%[15] but apparently smaller in older SHR when compared to Kyoto Wistar normotensives[21]. Kidneys are also larger in salt hypertension in Sprague-Dawley and Wistar compared to Fisher rats[22]. Bianchi et al.[4] found larger kidneys in terms of absolute and relative weight in the Milano hypertensive rats. Larger kidneys in hypertensive animals may be due to structural alterations as suggested by Hall et al.[22]; kidney damage evidence by fibrotic tissue, distortion of glomeruli, dilation of tubules and the presence of colloid pools was reported by Smirk and Phelan[23] in the GH rats. Hormonal involvement may also be involved since kidney weight is a sensitive index of androgen activity[24] and testosterone has been shown to be directly related to blood pressure in the SWR/J mouse[25]. Whatever the mechanism, there seems to be a tendency toward larger kidneys in hypertensive animal models.

Adrenal weights. Statistically significant differences were found among the adrenal to b.wt ratios (A/B) of the 3 lines with the high line showing larger ratios than the lows and randombred lines. The A/B ratios in females were consistently larger than the males. The absolute adrenal weights were not significantly different among the 3 lines. Sjoerdsma[15] reported larger adrenals in the SHR when compared to Wistar/NIH normotensive rats. Bianchi et al.[4] found that the absolute adrenal weight was significantly heavier in the Milano hypertensive rat but the relative weight was about the same.

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Rhythmic variations in the activities of aldolase and isocitrate dehydrogenase in the heart muscle of the scorpion, *Heterometrus fulvipes* (C. Koch)

S. Mastanaiah, D. Chengal Raju, D. Ravi Varma[1] and K.S. Swami[1]

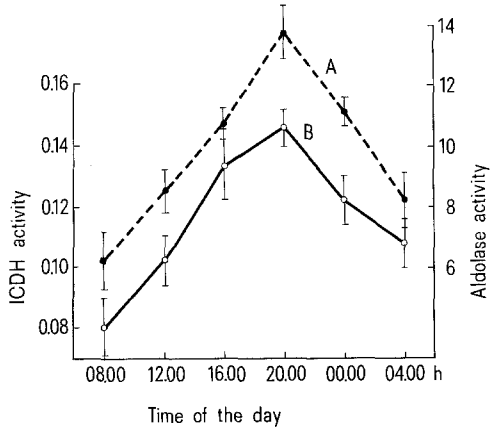
Department of Zoology, S.G.S. Arts College, Tirupati 517 501, Andhra Pradesh (India), 9 May 1978

Summary. The activity levels of aldolase and isocitrate dehydrogenase were assayed in the heart muscle of scorpion, *Heterometrus fulvipes*. The enzyme activities showed a circadian rhythmicity with a peak value at 20.00 h in the heart muscle.

Circadian rhythmicity in arachnid metabolism has received limited attention. Locomotor activity[2], neurosecretion[3], rate of heart beat[4], spontaneous electrical activity in the ventral nerve cord and segmental nerves[5], level of metabolites[6] and enzymes[7,8] had been shown to undergo regular circadian rhythmic changes in the scorpion, *Heterometrus fulvipes*.

Succinic dehydrogenase, acetylcholinesterase[9] and alkaline phosphatase[10] were reported to show higher activity level in the heart muscle at 20.00 h. In view of the above findings, it is desirable to study the activities of aldolase, which represent glycolytic enzymes, and isocitrate dehydrogenase, which pioneers the Krebs cycle dehydrogenases. The present work reports the changes of these 2 enzymes during 24-h period of the day in the heart muscle of scorpion, *Heterometrus fulvipes.*

Material and methods. The details of collection and maintenance of scorpions and sampling of tissues were described earlier[6,7]. The animals used were of the same sex (male) and size (5–6 g). The levels of aldolase and isocitrate dehydrogenase (ICDH) were assayed in the 2% heart muscle homogenates at 4-h intervals. The aldolase (fructose 1, 6-diphosphate D-glyceraldehyde-3-phosphate-lyase, EC 4.1.2.b) activity was estimated according to the method of Bruns and Bergmeyer[11]. The enzyme activity was calculated according to Bruns[12] and expressed as µmoles of fructose 1,6-diphosphate (FDP) cleaved/mg protein/h. Isocitrate dehydrogenase (EC 1.1.1.41) activity was estimated by the method of Kornberg and Pricer[13] as modified by Mastanaiah et al.[8], and expressed as µmoles of formazan/mg protein/h. Protein content was determined by the method of Lowry et al.[14]. The data was subjected to statistical processing according to standard procedures[14].



Aldolase activity (A), and isocitrate dehydrogenase activity (B) in the heart muscle of scorpion, *Heterometrus fulvipes,* as a function of the time of day. Each point represents mean of 6 estimations. (Aldolase activity expressed as µmoles of FDP cleaved/mg protein/h and ICDH activity expressed as µmoles of formazan/mg protein/h). The animals were maintained in the laboratory under natural (12 h light/12 h dark) conditions. The day and night temperature during the experiment was 33±1 °C and 28±1 °C respectively.

Results and discussion. The results presented in the figure indicate that the activity levels of aldolase and isocitrate dehydrogenase were higher at 20.00 h and lower at 08.00 h. The activity levels of aldolase and isocitrate dehydrogenase were found to range from 6.211±0.986 to 13.747±0.845 µmoles of FDP cleaved/mg protein/h, and from 0.110±0.005 to 0.143±0.003 µmoles of formazan/mg protein/h respectively. Though the activity levels of both the enzymes were maximal at 20.00 h and minimal at 08.00 h ($p < 0.001$ for both aldolase and ICDH), the pattern of rise and fall of these enzymes differed during 24-h period. Similar changes in the activities of succinic dehydrogenase[9], alkaline phosphatase[10] and rate of heart beat[4] were reported earlier in the heart muscle. The higher activity level of aldolase at 20.00 h probably reflects the possibility of increased glycolysis in the cardiac muscle around that period. Further glycogen content and phosphorylase activity were reported to decrease and increase respectively in the heart muscle of scorpion at 20.00 h[16]. The present increment in the aldolase activity is in agreement with the above findings.

The figure indicates that ICDH had also shown an increased activity level around 20.00 h and decreased activity level around 08.00 h in the cardiac muscle. Similar changes in ICDH activity was reported to occur in hepatopancreas and pedipalpal muscle of scorpion[8]. Further, succinate dehydrogenase activity was also reported to be high at this time of the day in the cardiac muscle of scorpion[8].

The scorpion is a nocturnal animal and shows a significant increase in locomotor activity at night. The metabolic rate is correspondingly high between 16.00 h and midnight (24.00 h) with a peak around 20.00 h. In addition, rate of heart beat was also shown to be higher around that period[4]. The nocturnal peaks of aldolase and ICDH activities at 20.00 h may signify increased channeling of substrates through glycolysis and Krebs cycle to sustain the raised energy requirements due to increased rate of heart beat, involving higher rate of cardiac muscle contraction during the night. Further, the variations in the heart rate were paralleled with circadian rhythmicity of neurosecretions in the scorpion[3]. It is probable that an active principle from scorpion neurosecretory system is responsible for increased channeling of substrates to the glycolysis and Krebs cycle for mobilization of energy through the activation of aldolase and isocitrate dehydrogenase in the heart muscle.

Thus the peak activities of the aldolase and isocitrate dehydrogenase around 20.00 h coinciding with the nocturnal habit of the scorpion, appears to be significant in view of the raised energy requirements to sustain the nocturnal increase of rate of heart beat.

1 Present address: Department of Zoology, S.V. University, Tirupati-517 502, A.P. (India).
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