Thermal acclimatory responses of salivary amylase of Periplaneta americana (Linn.)

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Summary. A differential thermal acclimatory response of salivary amylase is evident in P. americana-nymphs demonstrating a translational and males a rotational pattern, while females exhibit the translational cum rotational pattern (Prosser's type IV-D).

The process of thermal acclimation has been explained in terms of activities of enzymes in tissues of a host of vertebrates and a few invertebrates[1]. However, insects have not been explored fully in this respect. Activities of succinic dehydrogenases, catalase and glycerophosphatase were found to be greater in cold adapted than in warm adapted potato-beetles[2]. Carlson[3] and Precht[4] reported increased co-carboxylase activity in both summer and winter Leptinotarsa decemlineata due to cold adaptation. Periplaneta americana and Tenebrio molitor, adapted to low temperature, exhibited higher muscle apyrase and succinic dehydrogenase activities as compared to warm adapted ones[5]. Thiessen and Mutchmor[6] reported similar observations in the leg muscle of Periplaneta americana and Musca domestica, accompanied by an increased number of mitochondria due to cold acclimation. These observations show the capacity of insects for acclimatory responses at the enzymatic level due to thermal changes. However, little is known so far regarding the behaviour of digestive enzymes during thermal adaptation of insects in particular, and poikilothermic animals in general. Hence, the present investigation was aimed at finding the pattern of thermal acclimation, if any, of salivary amylase activity in nymphal, male and female cockroaches, Periplaneta americana (Linn.) adapted to low and high temperatures.

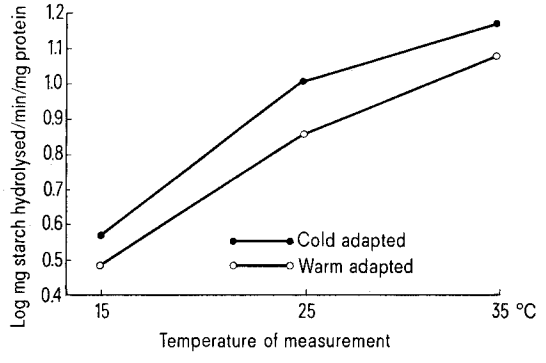

Fig. 1. Effect of temperature on the activity of salivary amylase of cold and warm adapted nymphal cockroach.

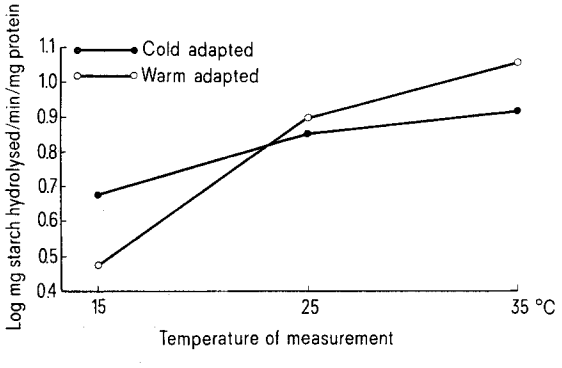

Fig. 2. Effect of temperature on the activity of salivary amylase of cold and warm adapted male cockroach.

Nymphs and adults of both sexes of P. americana (Linn.), after collection from the local grocery stores, were adapted to 15 °C ± 1 °C and 35 °C ± 1 °C in B.O.D. incubators for at least 3 weeks prior to their use in the experiments. The insects were quickly dissected and both salivary glands (without the hypopharynx) were removed. The complete glands of both sides (from one individual) were homogenized in 6.0 ml phosphate buffer (pH 6.9). The extract was diluted 50 times with the buffer in case of female insects, but only 25 times in case of nymphal and male individuals because of the different size of the glands in the 2 sexes and in nymphs. The distinction with respect to sex among nymphs themselves for enzyme activity was not made. The activity of salivary amylase of insects of both thermal categories was measured at 15, 25 and 35 °C based on the starch-iodine test following the photometric method of Smith and Roe[7]. The protein content of the salivary glands was measured with the Folin-Ciocalteau reagent, as suggested by Lowry et al.[8], using bovine serum albumin as the standard. The enzyme activity was expressed as mg starch hydrolyzed per min per mg protein of salivary gland.

The data presented in figures 1–3 show the following significant facts:

1. The 15 °C-adapted nymphs exhibit a significantly higher amylase activity than the 35 °C-adapted individuals at all temperatures of measurement. The degrees of difference between the 2 thermal categories of nymphs are 24% at 15 °C ($p < 0.01$), 40% at 25 °C ($p < 0.001$) and 26% at 35 °C ($p < 0.001$). The table illustrates no significant change in the value of Q_{10} for this enzyme activity in nymphs due to adaptation to low and high temperatures. However, with an increase in temperature of measurement of the rate process, a decrease in the value of Q_{10} is evident in nymphs of both thermal groups (30–48%). The nymphal insects exhibit an almost translational pattern (Prosser's type II-A)-shifting of the R–T curve towards the left, indicating the probability of a quantitative change in the enzyme concentration and a change in the controlling conditions like ionic strength, pH and water activity, or a change in relationship among enzymes in series or parallel.

2. The 2 thermal categories of male roaches present a reverse relationship at higher (25 and 35 °C) temperatures. While the activity of salivary amylase of cold adapted male insects is 61% higher ($p < 0.001$) than that of warm adapted ones when measured at 15 °C, the warm adapted males have a 20% higher value ($p < 0.02$) at 25 °C and 37% higher value ($p < 0.001$) at 35 °C than the cold adapted ones. As obvious from the table, male insects demonstrate a decrease (50%) of the thermal coefficient value in the lower thermal range due to cold adaptation, whereas in the higher thermal range this

Q_{10} values for the activity of salivary amylase of cold and warm adapted cockroaches

		Q_{10} values 15–25 °C	25–35 °C
Nymph	15 °C-adapted	2.7	1.4
	35 °C-adapted	2.3	1.6
Male	15 °C-adapted	1.5	1.2
	35 °C-adapted	3.0	1.3
Female	15 °C-adapted	1.3	1.2
	35 °C-adapted	2.1	1.3

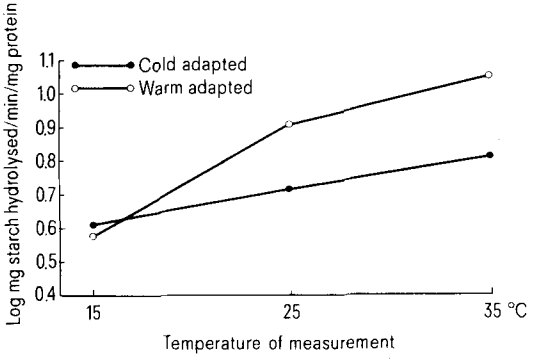

Fig. 3. Effect of temperature on the activity of salivary amylase of cold and warm adapted female cockroach.

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thermal characteristic remains unaltered. Warm adapted males exhibit a decrease (57%) of the Q_{10} value with an increase in temperature of measurement of the enzyme activity. An approximate rotational pattern (Prosser's type III) is observed for this rate process in males resulting in an alteration of the energy of activation ('μ') which signifies a qualitative change in the nature of enzymatic protein followed by a change in some cofactor, or a shift to an alternate pathway.

3. The warm adapted females exhibit an increased amylase activity -55% ($p < 0.01$) at 25 °C and 74% ($p < 0.001$) at 35 °C in comparison with cold adapted insects. In contrast, the situation is reversed when measurements are taken at 15 °C where the value for this rate process is 8% higher ($p < 0.05$) in cold adapted female roaches than in warm adapted ones. However, this minute difference may practically be insignificant. A decrease (38%) in the value of Q_{10} in the lower thermal range due to cold adaptation is observed in female roaches, but no such change is visible in the higher thermal range. A decreased Q_{10} value (38%) with an increase in temperature of measurement is evident in warm adapted females but remains stationary in cold adapted ones. Female roaches demonstrate 'Prosser's type IV-D' pattern of acclimation for the activity of its salivary amylase. This pattern is rarely met with and is non-compensatory in nature.

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Thiamine deficiency and protein secretion by pancreatic slices in vitro

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Summary. Pancreatic slices incubated in glucose medium take up oxygen and glucose and liberate pentose, pyruvate and proteins. Thiamine deficiency decreases oxygen consumption but increases liberation of pentose, pyruvate and proteins by pancreatic slices.

Among the vital organs of the body, the pancreas occupies an important position in view of its exocrine and endocrine functions. These functions involve active processes concerned with carbohydrate metabolism, protein biosynthesis and protein secretion. Pancreas has a high thiamine content[1], which gets depleted to a great extent (73%) at the peak of thiamine deficiency. The transketolase activity of this tissue is also decreased considerably (63%) despite increased tissue nitrogen content following thiamine deficiency[1].

Earlier studies from this laboratory have indicated that thiamine deficiency brings about various biochemical alterations such as a significant elevation in the blood levels of glucose, pyruvate and nonprotein nitrogen, and a marked decrease in the glucose tolerance[2]. Anorexia is one of the prominent symptoms of thiamine deficiency[3,4]. The behaviour of pancreatic slices during incubation in a glucose-saline medium was thought to be able to throw some light on pancreatic secretion of enzymes and other metabolites which could perhaps explain the anorexia in thiamine-deficient state.

Materials and methods. Male albino rats, 2 months of age and made thiamine-deficient[2], were sacrificed along with controls and 3 portions of pancreas, viz. duodenal (head), gastric (body) and splenic (tail) parts were cut out, and

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