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Effect of Gonadal Steroid Hormones on the Metabolic Rate of the Cold-Acclimated Gonadectomized Male and Female *Chalcides ocellatus* (Forskal)

M. K. AL-SADOON, A. A. EL-BANNA, M. M. M. IBRAHIM, N. M. ABDO, AND K. A. AL-RASHEID

Department of Zoology, College of Science, King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia

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Male and female *Chalcides ocellatus* were gonadectomized and cold acclimated at 15° for 1 week. Lizards were injected with testosterone and estradiol, and their oxygen consumption was determined at 15°. Testosterone and estradiol caused a significant increase in the whole body rate of oxygen consumption in male and female lizards, respectively.

A number of metabolic hormones are known to influence energy metabolism of reptiles (Lynn, 1970; Thapliyal *et al.*, 1983; Al-Sadoon and El-Banna, 1986; Hulbert and Williams, 1988). It has been reported that in some lizards, oxidative metabolism of whole body is controlled by different hormones and/or hormonal combinations in different seasons (Gupta, 1982). By using mammalian hormones, progress has been made in understanding some of the endocrine relationships affecting the seasonal reproductive biology of certain reptiles (Jones, 1969; Licht, 1975; Aldridge, 1982). Gonadal hormones are reported to influence reptilian oxidative metabolism (Thapliyal *et al.*, 1983; Thapliyal and Gupta, 1984), and male hormone and adrenalin are known to increase metabolic rate of whole body (Thapliyal, 1980a,b; Gupta, 1982). The physiological and ecological significance of the influence of gonadal steroid hormones on oxidative metabolism in lizards is one of the aspects which received little attention. The present study was undertaken to investigate the effect of testosterone and estradiol on oxygen consumption of cold-acclimated gonadectomized male and female *Chalcides ocellatus*. Previous studies on *C. ocellatus* (Al-Sadoon and El-Banna, 1986) indicated that the metabolic rate in this species is more sensitive to hormonal treatment at 15° and below. This sensitivity is reduced at 20–25° when the animals are approaching their preferred body temperature of 28–37°, possibly as a measure of conservation of energy (Al-Sadoon and Spellerberg, 1985). Therefore, cold acclimation at 15° was used in this study to represent a transitional temperature similar to that occurring between seasons.

MATERIALS AND METHODS

Male and female desert skinks *C. ocellatus* were collected from the Abu-Rawash region in lower Egypt and were transported to King Saud University, Saudi Arabia. Lizards were kept in the animal house in large transparent glass tanks (100 × 50 × 45 cm) with netwire sliding tops. Each tank contained 4 cm substratum of sand with vegetation and stones to simulate a natural habitat. The average room temperature was 24°. Additional soil heat gradient was provided by 100-W lamps for a daily period of 9 hr. The lizards diet included meal worms and cat food. Water was available all the time.

A group of male and female lizards was gonadectomized through abdominal incision after reducing their

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body temperature by keeping the animal at −20° for 10–15 min. This lower temperature proved to be a quite suitable method of anesthesia. The gonadectomized males and females were kept separated and allowed to recover under the same previous controlled environment. One month after gonadectomy, three groups of the males and three groups of the females (N = 10 per group) of average body weight of 16.2 g were kept at 15° in a cold room for 7 days. In both sexes, the control groups received the same volume of vehicle (corn oil). The second group of the gonadectomized males and females received 0.1 mg testosterone in 0.1 ml corn oil per animal (sc) daily for 7 days. The third group of the gonadectomized males and females received 0.4 μg estradiol in 0.1 ml corn oil per animal (sc) daily for 7 days. After the last injection in all groups, animals were left for 24 hr before the measurement of O_2 consumption.

Resting oxygen consumption rates at 15° were determined for each animal of the two sexes using a double-chamber volumetric system (see Al-Sadoon and Spellerberg, 1987). Oxygen consumption values were expressed as O_2 ml/g body weight/hr and corrected to STP. Comparisons of mean oxygen consumption among various groups were made using a computerized statistical analysis system (SAS). The significance of treatment effects were determined by analysis of variance. The general linear model (GLM) and least-square means (L S MEANS) procedures were used.

RESULTS

The mean O_2 consumption values (ml g^{-1} hr^{-1}) at 15° for the three experimental groups of male and female skinks, *C. ocellatus*, are shown in Table 1. The difference in O_2 consumption between males and females in the control groups was not statistically significant. The mean O_2 consumption value in gonadectomized males treated with testosterone was significantly ($P < 0.01$) higher than the corresponding values for gonadectomized males and females in the control groups. This group also had significantly ($P < 0.0001$) higher O_2 consumption values than all of the gonadectomized males treated with estradiol, the gonadectomized females treated with testosterone, and the gonadectomized females treated with estradiol. Meanwhile, O_2 consumption in gonadectomized males treated with estradiol was not statistically different from those of the gonadectomized males and females in the control groups.

The mean O_2 consumption value in gonadectomized females treated with estradiol was significantly ($P < 0.05$) higher than the corresponding values in the gonadectomized males and females in the control groups. Oxygen consumption in gonadectomized females treated with testosterone was not statistically different from those of the gonadectomized males and females in the control groups. It was also not statistically different from the corresponding values observed in the gonadectomized females treated with estradiol or in the gonadectomized males treated with estradiol. However, gonadectomized females treated with estradiol had a significantly ($P < 0.05$) higher mean O_2 consumption value than that in the gonadectomized males treated with estradiol.

DISCUSSION

The present investigation demonstrates that gonadal hormones influence the oxidative metabolism of male and female *C. ocellatus*. Testosterone significantly increased the whole body O_2 consumption in the go-

TABLE 1
MEAN O_2 CONSUMPTION VALUES IN THE DIFFERENT EXPERIMENTAL GROUPS

	O_2 consumption values in ml g^{-1} hr^{-1} (mean ± SE)		
	Control group	Testosterone group	Estradiol group
Male	0.030 ± 0.003	0.110 ± 0.020	0.035 ± 0.002
Female	0.040 ± 0.006	0.045 ± 0.003	0.065 ± 0.007

nadectomized male lizards but not in the gonadectomized females. Meanwhile, estradiol significantly increased O_2 consumption in the gonadectomized females but not in the gonadectomized males. Various hormones have been suggested to play a role in reptilian thermoregulation (Firth *et al.*, 1980), particularly those of thyroxine (Wilhoft, 1966a,b; Licht, 1974), α-MSH (Bradshaw and Waring, 1969; Bagnara and Hadley, 1973), and the parietal eye and associated pineal complex (Ralph *et al.*, 1979; Ralph, 1984). Gonadal hormones, in addition to their reproductive functions, are also reported to influence reptilian oxidative metabolism (Thapliyal *et al.*, 1983; Thapliyal and Gupta, 1984; Gupta and Thapliyal, 1985). The calorigenic action of gonadal hormones in lizards at lower temperatures could have an important adaptive and ecological significance since it may help the lizard to meet energy demands during transitional periods between winter and spring when animals are preparing themselves for the mating season. Furthermore, in the natural habitat and during periods of lower temperatures, testosterone in the males and estradiol in the females may function as regulators of oxidative metabolism in *C. ocellatus*. This is in contrast to the thyroidal hormones which are required on daily basis during winter days (Al-Sadoon and El-Banna, 1986).

The action of the gonadal hormones is mediated through their specific receptors (Jensen and DeSomber, 1972). The steroids are thought to bind to receptors in the cytosol of the target cells and are then translocated as steroid complexes into the cell nucleus which can be correlated to subsequent biological changes (see O'Malley *et al.*, 1975). The presence in the target cells of high-affinity specific receptors in a suitable amount could be the reason for the effectiveness of testosterone in the males and the effectiveness of testosterone in the males and the effectiveness of estradiol in the females, observed in the present investigation. Specificity of gonadal steroid action in male and female lizards has been reported (Medica *et al.* 1973; Ferguson, 1976). Crews *et al.* (1978) investigated the role of testosterone, DHT, and 17β-estradiol in controlling reproductive behavior in male *Anolis carolinensis* and found testosterone to be the only hormone capable of reliably restoring full behavior in castrated individuals. Both testosterone and DHT, but not estradiol, also stimulated hypertrophy and protein production by the renal sex segment, which is a secondary sex characteristic in males. The control of female receptivity by 17β-estradiol seems well established in *A. carolinensis*. Ovariectomy abolishes sexual receptivity and only estrogen therapy reinstates this behavior in a dose-dependent manner (Crews, 1975).

It is of interest to note that in the present study, the difference in O_2 consumption between gonadectomized males and females in the control groups was not statistically significant while the gonadectomized males treated with testosterone had a significantly higher O_2 consumption rates compared to the gonadectomized females treated with estradiol. Other studies have indicated that male reptiles tend to have higher O_2 consumption rates at specific temperatures than that of the females (Vance, 1953; Roberts, 1968; Al-Sadoon and Spellerberg, 1987).

Further study of a greater variety of reptiles is needed, however, before making any generalizations.

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