ably due to similar causes as those described above for *Stellio caucasius*. L.E. Zikova and E.N. Panov also observed a male *S. caucasius* with a bifurcated tail in Parkhai canyon (Syunt-Chassardag nature reserve, SW Turkmenia—pers. comm.). The bifurcation of these regenerated branches was at about 30 mm posterior to the cloaca.

These cases indicate that after intervertebral autotomy in agamids not only normal but also anomalous regeneration is possible.

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The effect of high temperature and extended day length on growth of captive Nile crocodiles, *Crocodilus niloticus*, during the cold season in Kenya

A. Zilber[1], Y. Yom-Tov[2], D. N. Popper[3]

[1] Clal Crocodile Farm Ltd, Mamba Village, PO Box 85723, Mombassa, Kenya
[2] Dept. of Zoology, Tel Aviv University, Ramat Aviv, Israel 69978
Present address: Wildlife Conservation Research Unit, Department of Zoology, Oxford University, Oxford OX1 3PS, UK (author for correspondence)
[3] National Center for Mariculture, PO Box 1212, Eilat, Israel 88000

Although studies of reptile growth are scarce it is well known that their growth is inhibited during the winter; Chabreck and Joanen (1979) demonstrated this for American alligators in Louisiana. Inhibited growth may be the result of a dual effect of low temperature (Spellerberg, 1982) and shorter daylight hours as has been proven for fish (Brett, 1979).

The aim of this paper is to report results of an experiment to test the effect of increased temperature and longer day on growth and survival of young Nile crocodiles (*Crocodilus niloticus*).

Table 1. Average temperatures (°C) in the open air and the crocodile ponds during the experiments months in 1989.

	Ambient air		Pond air				Pond water			
			Unheated Ponds		Heated Ponds		Unheated Ponds		Heated Ponds	
Month	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
May	24	30.5	25	34	27.5	33	25	31	31	33
June	24.5	29.5	25	35	28	36	25	31	31	34
July	22	29	24	32	28	34	23	30	29	33
August	20	29	24	34	28	36	24	30	30.5	34
September	22	30	26	36	29	36	25.5	32	31	36
October	22	32	26	36	29	37	26	32	29	34

The experiment took place at Mamba Village, a crocodile farm near Mombassa, Kenya, between 11 May 1989 and 13 October 1989. This period coincided with the cold season in Kenya, the shortest day being 22 June.

Two-month old crocodiles, the eggs of which originated from the banks of the Tana River in Kenya, were reared in groups of 80 animals each in round, 2.27 m² concrete ponds with 0.8 m walls. The floors sloped gently towards a central drain 15 cm below the level of the base of the wall. The floor was completely covered in water to a level which enabled the crocodiles to raise their bodies above the water only near the walls. The ponds were covered by a roof of 1:1 glass and asbestos which prevented air flow but enabled direct solar radiation. *Ad libitum* food, a minced mixture of fish, chicken and red meat supplemented by minerals and vitamins, was provided once daily at sunset on raised trays which were removed before sunrise. After removal of trays the ponds were drained, washed and refilled with clean well-water each day. Average initial body length and weight were 34 cm and 84 g, respectively (fig. 1).

There were three treatments with four repetitions each composed of 20 crocodiles (a total of 240 animals):

1. Ambient day length without heating (control)
2. Ambient day length with heating
3. Extended day length and heating.

The monthly minimum and maximum water and air temperatures are presented in table 1. Heating was provided by aquarium heaters placed in the centre of each pond. The day was extended by two 0.6 m neon tube lamps (40 watts) in each pond which operated from one hour before to two hours after sunset for the entire experiment.

All the animals were weighed (to the nearest g) and total length (to the nearest mm) measured at the beginning of the experiment and again after 2, 4 and 5 months. Dead

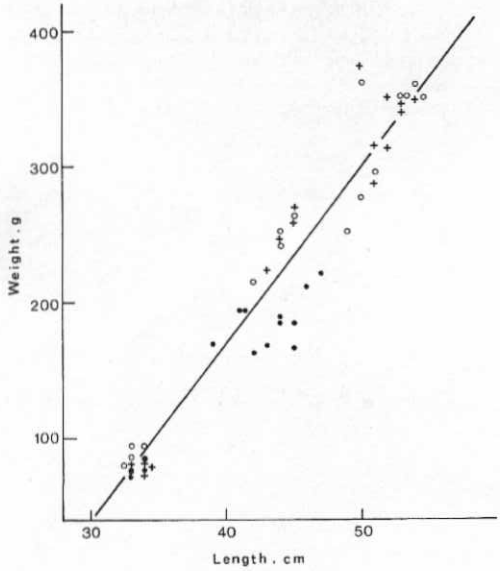

Figure 1. Weight and length of captive young crocodiles 2-7 months old under three treatments of heating and extended day length. Each symbol is a mean for 20 animals. Dots - control; Grosses - heated; Open circles - heated plus extended day. Weight (g) = 13.08 × Length (mm) - 356.06; $r = 0.951$; $p<0.001$; $n = 48$.

animals were removed, counted and replaced by equal-sized crocodiles in order to maintain the experimental density.

Weight and length were highly correlated ($r = 0.96$, $p < 0.001$) and there were no significant differences between the repetitions and treatments in heated ponds, but the control animals had a W/L ratio which was significantly smaller ($t = 2.39$; $p < 0.05$) then expected, i.e., control animals were thinner than those reared in heated ponds (fig.1). Extended day length had no effect on growth and survival, i.e., animals which grew under both experimental treatments (heated and heated plus extended day) grew at a similar rate (table 2). Heating, however, had a significant, positive effect on both growth and survival; the animals in the heated ponds reached higher body weight and length and survived better than control animals (table 2).

As expected, higher temperature had a positive effect on growth, body condition (W/L) and survival (Blake and Loveridge, 1975). Crocodiles in heated ponds added

Table 2. Final body length and weight and number of deaths after 5 months in the control, heated and heated plus extended day treatments. The differences between the heated and heated plus extended day treatments are not significant, but the differences between the control and the two other treatments are highly significant (t tests, $p<0.001$ in all cases). Sample size is 80 animals in each treatment.

Parameter		Control	Heated	Heated + extended day
Body length, cm	mean	44.6	52.7	52.5
	± SE	1.5	1.1	1.2
Body weight, g	mean	192.6	323.0	317.2
	± SE	10.7	24.4	39.6
Number of deaths		6	4	3

an average 243 g in 5 months compared to only 114 g in unheated ponds. This effect was undoubtedly due to the difference in water temperature between unheated and heated ponds.

Grizmeck (1975) reported that young Nile crocodiles increase in length by an average of 26.5 cm annually (about 2.2 cm monthly). The average monthly increment of the control animals in this study was identical to this, but crocodiles at the experimental heated ponds grew 2.5 times faster and added an average of 5.6 cm monthly to their length.

The fact that extended day length did not effect growth or survival may be associated with the feeding habits of Nile crocodiles which are active during both day and night (Cott, 1961).

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