ideal captive. Establishment of captive breeding colonies should be easy, and could solve some of the conservation problems caused by uncontrolled killing by fishermen, on one hand, and by overcollecting by reptile enthusiasts, on the other.

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LITERATURE CITED

Ar, A., R. Dmiʻel and R. A. Ackerman. 1983. Metabolism, growth, gas and water exchange of reptile embryos. Annual scientific report (# 2407/81) to the U.S.-Israel Binational Science Foundation (BSF).

Dmiʻel, R. 1970. Growth and metabolism in snake embryos. J. Embryol. Exp. Morph. 23:761-772.

Hoffmann, R. 1984. Reptile breeding in captivity. Hardun 2:52-53. (In Hebrew).

Pesach, Y. 1984. Reptile breeding in captivity. Hardun 2:54. (In Hebrew).

Pesach, Y. 1986. Reptile breeding in captivity. Hardun 3:45-46. (In Hebrew).

Werner Y.L. 1966. The reptiles of Israel. Department of Zoology, Hebrew University of Jerusalem. (In Hebrew).

Werner, Y.L. 1988. Herpetofaunal survey of Israel (1950-85), with comments on Sinai and Jordan and on zoogeographical heterogeneity. *In:* Yom-Tov, Y. and Tchernov, E. (Eds). The zoogeography of Israel. Dr. W. Junk Publishers, Dordrecht.

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TECHNIQUES

VOLUNTARY INGESTION OF RADIOTRANSMITTERS BY SNAKES IN THE FIELD

Most radiotelemetric studies of snakes in the field have used either surgically-inserted or force-fed transmitters (e.g. Parker and Brown 1972; Madsen 1984; Reinert 1984). One major disadvantage of both techniques has been disturbance to the animal, which may result in modified behavior (e.g. decreased locomotor activity, greater tendency to flee from humans) for some unknown time period following implantation. These problems are exacerbated if study is brief in duration, due to equipment malfunction or limitations of battery-life in the transmitters.

We attempted to overcome these problems in a study of free-ranging blacksnakes (*Pseudechis porphyriacus*, Elapidae) in the Macquarie Marshes of central New South Wales, Australia (Shine 1987). Live white laboratory mice were carried in the field. When a foraging or basking blacksnake was sighted, we killed a mouse by cervical dislocation, disembowelled the mouse and inserted a radio-transmitter (J. Stuart Enterprises, model # TT-IU-160: 55 x 20 mm, 38 g). The abdomen of the mouse was then sutured closed with cotton thread. A 2 m lengthof fine nylon fishing line was passed through a fold of skin near the base of the mouse's tail (using a sewing needle), and a single knot was tied at the end of the line to prevent the mouse from slipping off. The free end of the fishing line was attached to a 4 m fibreglass fishing pole. The entire procedure took less than two minutes.

The mouse was then dragged along the ground ca. 1 m in front of the snake's head, and in most cases was immediately seized (Fig. 1). When the mouse was securely held by the snake, a hard jerk on the fishing line pulled the knot through the mouse's skin, freeing the mouse to be swallowed by the snake. Thirteen snakes were implanted in this way. The only failures of the technique were (1) snakes too small to swallow the transmitter, despite repeated attempts; and (2) snakes frightened by our approach. We also used the technique successfully on an eastern brownsnake, *Pseudonaja textilis*, and on many other blacksnakes (for practice rather than transmitter insertion). Snakes generally took longer to swallow the unit than would have been required to ingest a similarly-sized mouse without the transmitter.

Our success using the voluntary ingestion technique is surprising in view of the open nature of the terrain (we were clearly visible to each snake when offering the mouse), and the unnatural type and presentation of the prey. Mammals constitute only a small proportion of the diet in *P. porphyriacus* (Shine 1977) and have never been recorded in gut contents of Macquarie Marshes specimens (Shine, unpublished data). Success of the technique was probably due to the fact that blacksnakes are voracious feeders: freshly captured specimens have consumed other reptiles while in collecting bags (personal observation), and one blacksnake was seen to eat a desiccated, flattened road-killed frog (D. Wotherspoon, personal communication). We found that blacksnakes ate mouse-transmitter packages larger than we thought possible, and certainly larger than we would have considered force-feeding. On later dissection, one small snake sacrificed at the end of the study showed lesions at the hind end of the stomach, at the point where the transmitter lay against the gut epithelium. These lesions may have resulted from internal physical trauma when the snake tried to crawl through an opening too small to allow passage of the transmitter; on one occasion we saw this animal reverse direction from a crack in a log after the protruding bulge of the transmitter prevented its repeated attempts at forward movement. Whether digested food could pass around the transmitter in these smaller animals is not known. The technique may be applicable to other large snakes and lizards (Christian et al. 1983), and is particularly worth considering for short-term studies where disturbance artifacts may be major problems.

Figure 1. A blacksnake seizing a dead mouse with an implanted radiotransmitter; note open nature of vegetation in study area.

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LITERATURE CITED

Christian, K., C.R. Tracy and W.P. Porter. 1983. Seasonal shifts in body temperature and use of microhabitats by Galapagos land iguanas (*Conolophus pallidus*). Ecology 64:463-468.

Madsen, T. 1984. Movements, home range size and habitat use of radio-tracked grass snakes (*Natrix natrix*) in southern Sweden. Copeia 1984:707-713.

Parker, W.S. and W.S. Brown, 1972. Telemetric study of movements and oviposition of two female *Masticophis t. taeniatus*. Copeia 1972:892-895.

Reinert, H.K. 1984. Habitat separation between sympatric snake populations. Ecology 65:478-486.

Shine, R. 1977. Habitats, diets and sympatry in snakes: a study from Australia. Canad. J. Zool. 55:1118-1128.

_____. 1987. Intraspecific variation in thermoregulation, movements and habitat use by Australian blacksnakes, *Pseudechis porphyriacus* (Elapidae). J. Herpetol. 21:165-177.

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