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Communal Nesting of *Opheodrys aestivus* in the Laboratory

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specimens of *Amphibolurus* recovered within 3 hours.

In mammals ketamine has a selective effect upon cortical and subcortical regions of the brain rather than suppressing the entire central nervous system (Corssen et al., 1968). Although the sensory pathways from the spinal cord to the brain are very similar in mammals and lizards (Ebbesson, 1978), the areas and interconnections of the lizard brain corresponding to the cortical areas in the mammalian brain have not been clearly established (Northcutt, 1978). Therefore, the anesthetic effect of ketamine in reptiles may differ substantially from that of mammals. Such a difference is indicated by the comparatively larger doses used in reptiles (Cooper, 1974; Glenn et al., 1972; Hattori et al., 1975; Terpin et al., 1978).

Pain perception in animals is often difficult to assess and may differ somewhat from that in man (Breazile and Kitchell, 1969). The humane treatment of laboratory animals requires that when an animal gives a reflex action to painful stimulus the researcher should assume that the animal perceived pain, even if in man, under similar conditions, pain would not be perceived (Breazile and Kitchell, 1969). In the present study and others (Cooper, 1974; Hattori et al., 1975) lizards and snakes have reacted to painful stimuli after receiving large doses of ketamine. Until more information is available it would be best to assume that in lizards and snakes ketamine alone may not block pain perception well enough to allow surgical procedures (McDonald, 1976).

In conclusion ketamine hydrochloride may be useful in lizards at dosages of 30 mg/kg for relatively mild procedures. It is safe and readily induces tranquility. The recovery period is relatively rapid at low dosages. It is, however, irritating upon injection in 100 mg/ml concentration and even very large doses do not induce complete anesthesia. For surgical procedures in lizards ketamine hydrochloride should not be used alone to induce anesthesia.

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COMMUNAL NESTING OF *OPHEODRYS AESTIVUS* IN THE LABORATORY.—In the course of obtaining eggs from gravid *Ophego-*

TABLE 1. STATISTICS OF CLUTCHES AND *Opheodrys aestivus* FOUND AT NESTING SITES.

Category	Site no.									
	1	2	3	4	5	6	7	8	9	10
No. clutches	29	4	0	0	0	1	1	0	0	0
$\bar{x}$ no. snakes <sup>1</sup>	4.7	1.7	.4	.2	.2	.4	.2	.1	.1	.8
No. empty <sup>2</sup>	6	14	26	32	32	26	31	35	36	19
No. singles <sup>3</sup>	2	9	10	6	4	10	6	2	1	10
No. multiples <sup>4</sup>	30	15	2	0	2	2	1	1	1	9

<sup>1</sup> Total number of snakes found under board/no. of observations.

<sup>2</sup> Number of observations in which no snakes were found.

<sup>3</sup> Number of observations in which only one snake was found.

<sup>4</sup> Number of observations in which >1 snake was found.

*drys aestivus* in a study of reproductive cycles, I collected the eggs in such a manner as to determine if intrinsic social affinities would affect place of oviposition. *O. aestivus* has been reported to nest communally (Palmer and Braswell, 1976).

At least 13 species of snakes are known to nest communally (Swain and Smith, 1978). That such behavior may not be uncommon is supported by the existence of nesting sites with several year classes of eggs and eggshells (Lynch, 1966; Foley, 1971; Covacevich and Limpus, 1972). Indeed Fitch (1975) suggested that the normal mode of nesting in *Diadophis punctatus* was communal. One explanation for such phenomena is that communal nesting likely occurs when there is a shortage of suitable oviposition sites or when a particularly ideal site exists among other sub-optimal sites (Brodie et al., 1969; Covacevich and Limpus, 1972; Parker and Brown, 1972; Swain and Smith, 1978). Alternatively, Swain and Smith (1978) suggested that communal nesting in aggregation-prone species such as *D. punctatus* and *Opheodrys* spp. may be due to the general tendency to aggregate for social reasons.

**Methods.**—Forty gravid *O. aestivus* were collected from 14 June to 14 July 1979, from forests surrounding Bald Knob Lake in White County, Arkansas. Snakes were housed in a 1.1 W × 4.9 L × 2.8 H m open-top cage with 2.5 cm mesh chicken wire extending from the floor up to 1.3 m at the back of the cage. The room in which the snakes were kept was maintained at 28 (±2) C and on a 14 L:10 D photoperiod. Crickets and water were provided ad libitum. Except when ovipositing or foraging for crickets on the floor, snakes spent most of the time climbing on the wire. Ten sequentially-numbered 30 ×

30 cm plywood boards were equally spaced on the floor down the center of the cage. Wood strips attached to each of two opposite edges supported each board 17 mm above the floor. A thin layer of wood shavings covered the floor of the cage and a thicker, moistened layer was maintained under each board. Each board with its underlying wood shavings was considered to be a nesting site. Nesting sites were inspected three times during each light period. The number of snakes under each board was recorded and any clutches and the female producing them were removed from the cage as soon as ovipositing was completed. In some instances positions of the sites were interchanged two at a time. The floor under each site was washed and the boards and their underlying substrate were exchanged, each site being placed at the former position of the other site.

**Results and discussion.**—Most snakes oviposited at site 1 (Table 1). If equal probabilities for oviposition at each site are assumed, then the probability that the observed distribution of clutches occurred by chance alone is near zero ( $\chi^2 = 42.34$ ,  $P < .0001$ ). The first 23 clutches were deposited at site 1. During this time site 1 was sequentially interchanged with sites 2, 3 and 5. Snakes oviposited at site 1 regardless of its position. These data suggest that there was a strong social component to communal nesting and that this affinity may have been mediated by olfactory cues. In only two instances were ovipositing snakes not accompanied by other females. Why snakes initially chose site 1 may have been fortuitous but it also may have been chosen because it was one of two closest sites to where snakes spent most of their time. Snakes on the wire spent most of their time near the two ends of the cage probably as a result of

thigmotactic satisfaction. Site 10 had a mean of .8 snakes/observation which was higher than any other site except 1 and 2. Site 2 had a mean of .2 snakes/observation before being exchanged with site 1 and a mean of 1.8 afterward (before eggs were laid under it). Observations of sites with no snakes, with single snakes and with multiple snakes support this contention (Table 1).

In nature these arboreal snakes probably never attain such high densities near potential nesting sites as they encountered in the lab. Also unnatural was the removal of eggs (for use in other studies) immediately after oviposition leaving only "conditioned habitat" (Dundee and Miller, 1968) to attract other females. That there may have been some stress associated with the laboratory situation is suggested by the fact that five snakes dropped their entire clutches from on top the wire onto the floor. Nevertheless, the strong tendency for most snakes to oviposit where previous clutches had been laid regardless of the position of the site suggests that such behavior was intrinsic.

Selection of a suitable nest site should be an important selective factor in the survival of species. The particular selective regimes under which sites are chosen probably vary and may result in different site selection patterns among populations (*Iguana iguana*, Rand, 1968). Any particular site selection pattern can be viewed as a cost-benefit problem. In most cases maximum survival of eggs and neonates should be achieved by dispersing individual clutches among various optimal sites. Disease would spread less easily in such situations and although it would be easier for a predator to find one of many sites than one of few, fewer eggs could be consumed when a site is found (Rand, 1967). When sites are limited and/or suboptimal, communal nesting might confer better critical requirements such as temperature and moisture. In addition certain predators, such as egg-eating snakes, might be quickly satiated at a communal site. Mammalian predators, however, probably would not be satiated with the relatively small mass of squamate eggs.

The adaptiveness of communal nesting when extrinsic factors are favorable and homogenous among sites (as in this study) is not clear. Perhaps in aggregation-prone species (*D. punctatus*, Dundee and Miller, 1968; *Demansia psammophis*, Covacevich and Limpus, 1972), communal nesting may be an expression of the tendency to aggregate as suggested by Swain and Smith

(1978). However, I have been unable to document Swain and Smith's (1978) suggestion that *Ophedryx* may be aggregation-prone. Although Stille (1954), Cook (1964) and Fowler (1966) reported communal nesting in *O. vernalis*, none of these authors commented on aggregation. Sexton and Claypool (1978) reported on six individual nests of *O. vernalis* in a restricted area but did not report communal nesting or individual aggregation. Seibert and Hagen (1947) marked and recaptured 65 *O. vernalis* over a six-month period and found no evidence of aggregation. Gregory (1975) reported on 3 gravid *O. vernalis* under a wooden platform, each near the point of laying. Gregory suggested that extrinsic factors likely influenced the aggregation but the possibility that the snakes were attracted to one another could not be discounted. The single reported instance of communal nesting in *O. aestivus* (Palmer and Braswell, 1976) involved a particularly ideal site (a discarded metal refrigeration panel filled with rock wool insulation) and is best interpreted as communal nesting which was stimulated by an extrinsic factor. It is noteworthy that gestating females of the normally aggregation-prone *Storeria dekayi* do not aggregate (Noble and Clausen, 1936).

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## BOOKS RECEIVED

- Butterfly and Anglerfishes of the World. Vol. 2. By Gerald R. Allen. Wiley Interscience. Samerset, New Jersey, 08873, \$30. 1980. pp. 149-352. This profusely illustrated companion volume to Steen's account of Australian chaetodonts and pomacentrids is a excellent follow up that summarizes the present state of knowledge of those colorful fishes. Taxonomic summaries (and a phylogenetic tree of the pomacentrids) are presented. The bulk of the book is individual species accounts, generally 1 page with at least one color photograph (when possible underwater habitat illustrations).
- Epithelial Transport in the Lower Vertebrates. Edited by B. Lahlou. Cambridge Univ. Press, 32E 57th St., New York, 10022. 366 + xiv pp. These proceedings to honor the late Jean Metz include 30 papers (5 in French, the others in English) and one abstract. Five of the papers have abstracts in both languages, one with French text has an English abstract and most abstracts in the same language as the text (two lack abstracts). In addition to summarizations and testimonies to the contributions to Jean Metz, the proceedings include Morphological aspects (7 accounts); Transport of water and solutes (14 papers); Biochemical aspects (5 papers); and Endocrine regulation (3 papers). The vast majority of the papers discuss fishes, 3½ are on frogs and 1 on a crab.
- Protection of Life in the Sea. Edited by O. Kinne and H.-P. Bulnheim. Biologische Anstalt Helgoland (vol. 33) Hamburg. 772 (+7) pp. 1980. The proceedings of the 14th European Marine Biology Symposium contains definitive accounts on the impact of human perturbations on marine life.
- The California Islands. Edited by Dennis M. Power. Santa Barbara Museum of Natural History, Santa Barbara, California 93105. vii + 787 pp. The proceedings of a 1978 symposium covering the geology, anthropology and biota of the California Islands with primary emphasis on those north of the Mexican border. Two fish, one amphibian and three reptilian papers are included.
- Comparative Ecology of Two Colubrid Snakes in Northern Utah. *Masticophis t. taeniatus* and *Pituophis melanoleucus deserticola*. By William S. Parker and William S. Brown. Milwaukee Public Museum, 800 W. Wells St., Milwaukee, Wisconsin 53233. \$9.95 (+0.75 for handling). 104 + vii pp. The results of Parker's study (1969-73) for his dissertation.