BOULENGER, G. A. 1893. Catalogue of the snakes in the British Museum (Natural History). Vol. I. Trustees of the British Museum (Natural History), London. 448 pp.
COGGER, H. G. 1979. Type specimens of reptiles and amphibians in the Australian Museum. Rec. Aust. Mus. 32(4–6):163–210.
GOLDMAN, J., L. HILL, AND P. J. STANBURY. 1969. Type specimens in the Macleay Museum, University of Sydney II. Amphibians and reptiles. Proc. Linn. Soc. N.S.W. 93(3):427–438.
MACLEAY, W. 1877. The ophidians of the *Chevert* expedition. Proc. Linn. Soc. N.S.W. 2:33–41.
MALNATE, E. V., AND G. UNDERWOOD. 1988. Australasian natricine snakes of the genus *Tropidonophis*. Proc. Acad. Nat. Sci. Philadelphia 140:59–201.
PARKER, F. 1982. The snakes of Western Province. Wildlife in Papua New Guinea (82/1):1–78.
WELLS, R. W., AND C. R. WELLINGTON. 1985. A classification of the Amphibia and Reptilia of Australia. Aust. J. Herp., Suppl. Ser. (1):1–61.

Accepted: 23 August 1989.

Journal of Herpetology, Vol. 24, No. 3, pp. 314–316, 1990

Observations on Reproduction in the Black Caiman, *Melanosuchus niger*

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The black caiman, *Melanosuchus niger,* has been eliminated from most of its original range and is in danger of extinction (Groombridge, 1982; Plotkin et al., 1983). Knowledge of the reproductive natural history of the black caiman is needed for conservation efforts, but little information exists. Medem (1980) reviewed the scant literature on nesting periods, nest locations, clutch sizes, and nest guarding, and advocated further studies encompassing more aspects of reproduction.

Here we report observations on the natural history of reproduction of a female black caiman in southeastern Peru. We monitored this female's nest, eggs, and young from the time the nest was built until one week after hatching. To our knowledge, this is the first record of black caiman reproduction to include egg deposition behavior, exact incubation time, egg survival, and female presence at the nest during hatching.

We made our observations at Cocha Cashu, a 20 ha oxbow lake located at 11°5′S, 71°19′W in Manu National Park, Peru. In 1983 this lake contained approximately 115 black caiman, including 15–20 adults (Herron, 1985). More detailed information about Cocha Cashu and its caiman population appears in Otte (1974), and Herron (1985, 1989). Information about the area surrounding Cocha Cashu is given by Terborgh (1983). Observations from 30 September to 20 November 1983 were made by JCH; those from 21 November to 7 January 1984 by LHE and JEC. The female we observed was easily recognizable because she was missing her right eye. She had probably lived in Cocha Cashu since at least 1979 (S. Robinson, pers. comm.). Based on a comparison of the one-eyed female and her nest (an object of known size), we estimated her total length at 3 m.

We found the female's nest 30 September 1983 in the partial shade of overhanging trees on the SE shore of the lake. Built on a gently sloping mud shelf between the high and low water marks, the nest was an irregular, oval-shaped mound of leaf litter and twigs. The nest appeared to be under construction, because there were drag marks in the nest mound, fresh scrape marks in the surrounding leaf litter, and broken *Heliconia* plants nearby. Like those described by Bolivian informants interviewed by Medem (1980), the nest was exposed to the sun during the afternoon. Magnusson et al. (1985) noted that most crocodilian nests have some type of heat source, so this could be an important criterion in nest site selection. The nest site also carried a risk, however, in being below the high water mark: the study nest was submerged by a flood just six days after the hatchlings left it (see below). Sympatric spectacled caiman, *Caiman crocodilus,* may use different criteria in selecting their nest sites. On 18 October we found a nest which we identified as that of a spectacled caiman on the basis of clutch size (20) and egg sizes (mean ± SE [range] of 10 eggs: length, 67.71 ± 0.48 mm [64.80–70.00]; width, 39.78 ± 0.10 mm [39.15–40.35]; weight, 65.6 ± 0.59 g [62.0–69.5]). This nest was located on a termite mound by a tree trunk, about 20 m beyond the bank of the lake's flood plain and 200 m from the water.

On 1 October we began making sporadic observations of the black caiman nest from a blind at the top of the bank, about 10 m from the nest. The female continued to add material to the nest, although never in our presence. On 4 October the mound was larger than on 30 September, and had a new drag mark across the top.

The female laid her eggs on 5 October. At 1720 h we found her lying across the top of the nest mound with her blind side facing inland. She appeared to be using her hind feet to create a chamber in the center of the nest mound, or to arrange eggs already deposited in the chamber. At 1732 she raised her body slightly and dropped one or two eggs into the nest. For the next hour and 40 min the female periodically raised her body, by arching her back and supporting herself on her chest and tail, and arranged the contents of the nest with one rear foot or the other. She did not drop any more eggs that we observed, and by 1914 she had begun to cover the egg chamber. She periodically raised herself and reached laterally, first with one rear leg, then with the other, to scrape leaves under her body. She repeated this motion as she gradually moved forward off of the nest mound. By 2052 the female was completely clear of the nest, although she continued to perform the scraping behavior, drawing leaves under her body.

We opened the nest on 30 October. The nest measured approximately 220 × 190 cm at its base, and 50 cm in height. Measured to its nearest edge, the nest was 2 m from the water. The egg chamber was slightly east of the center of the nest mound, with its roof at a depth of about 25 cm from the top of the nest. The chamber measured about 25 × 20 × 15 cm, with the eggs arranged irregularly in 2 or 3 layers. The clutch contained 38 eggs, placing it within the range of 30–75 reported by Medem (1980). The eggshells were hard, and covered with tiny ridges which made the eggs look and feel as though made of crystalline sugar. The measurements (mean ± SE [range]) of ten typical eggs were: length, 90.38 ± 0.94 mm (87.70–97.60); width, 51.21 ± 0.22 mm (49.55–51.85); mass, 141.7 ± 1.65 g (132.0–148.0). These sizes are similar to those found by Hagmann (1902) in Brazil (length, 86–97 mm; width, 52–56 mm; most over 100 g). Three of the eggs not included in our means and ranges were abnormal: one was cracked; one was very small (75.65 × 46.40 mm; 97 g); and one was misshapen, resembling a bean. After examining the eggs we returned them to the nest and covered them.

The one-eyed female remained in the area of her nest, but apparently did not closely watch or defend it. After reburying the eggs on 30 October, we placed a few small sticks in the pattern of an asterisk on top of the nest mound, and several more in a ring around the nest. These sticks remained undisturbed until at least 20 November, suggesting that the female did not lie on the nest. In addition, from 6 October to 21 November we sporadically searched for the female at the nest site and in the lake. On the evening of 16 October we saw a large black caiman at the water's edge, 1–2 m north of the nest. It appeared to be missing its right eye, but it had its left side to us, and was therefore impossible to identify with certainty. We otherwise never saw the one-eyed female at the nest, although we did see her in the southern part of the lake several times. The female's behavior is in contrast to the reports of the sources cited by Medem (1980). Several of these stated that females often lie on their nests, and one noted that females vigorously defend their nests. However, Cott (1926) reported that not all female *Melanosuchus* watch and defend nests, and that some females are entirely absent from the nest site. The one-eyed female's behavior may have been affected by our activities near her nest; Crawshaw and Schaller (1980) found that female Paraguayan caiman (*Caiman yacare*) sometimes stopped guarding their nests after only one or two visits by humans. The female's behavior may also have been affected by the loss of an eye.

We checked the nest daily from 21 November until 1 January 1984. The nest was undisturbed at 0800 h on 1 January, but at 1700 h the nest was uncovered and the female was in the water beside it. The top third of the nest had been smoothly scraped off, presumably by the female, and the eggs were exposed. The eggs were hatching, and three hatchlings were moving toward the water. We captured one hatchling before it left the nest. It measured 139 mm from the tip of the snout to the anterior edge of the vent and 307 mm in total length, and weighed 91 g. Its belly was distended with yolk. Hatching occurred 88 days after deposition on the day of the first major rainfall (80 mm) of the wet season. This incubation time is considerably longer than the five to six week times reported by Hagmann (1902) and Cott (1926). However, Medem (1980) gathered information from Bolivian hide hunters that implies an incubation time similar to what we observed. Also roughly similar to our observation is Medem's (1963) estimate that in Brazil incubation lasts two or three months. Much of this apparent variation in development time could be due to variation in nest temperature.

From 1–7 January, the young remained together in the water at the lake edge. The female appeared to stay with them continuously, remaining in the lake 0.5–3 m away from them and almost always facing the shore. Heavy rains fell during this time, and on 7 January the nest was submerged by the rising lake. The lake continued to rise on 9 and 10 January, and the female and young left the immediate vicinity of the nest site. On 27 January we saw 4 small hatchling black caiman in a large floating grassmat on the S end of the lake, about 150 m from the nest site, but we do not know if they were members of the same clutch.

When we excavated the nest on 7 January, it contained 28 hatched eggshells, 2 infertile eggs with their yolks intact, 2 unhatched eggs containing fully developed dead embryos, and 2 eggs from which the young had hatched, but died before leaving the nest. All of these materials were preserved and placed in the collection of the United States National Museum of Natural History (USNM 257787–91).

Acknowledgments.—JCH thanks John Terborgh for the opportunity to study black caiman at Cocha Cashu, Dave Bolster for assisting while JCH opened the nest, and Raymond Huey for his comments on the manuscript. JCH's work was funded by Dr. Kenneth E. Herron, Grant 215 of the Joseph Henry Grant Fund (National Academy of Sciences), the Council on International Educational Exchange, the Woodrow Wilson School of Public and International Affairs, and Princeton University.

LITERATURE CITED

COTT, H. B. 1926. Observations on the life-habits of some batrachians and reptiles from the lower Amazon, and a note on some mammals from Marajó Island. Proc. Zool. Soc. London 1926:1159–1178.
CRAWSHAW, P. G., AND G. B. SCHALLER. 1980. Nesting of Paraguayan caiman (*Caiman yacare*) in Brazil. Papéis Avulsos Zool., S. Paulo 33(18):283–292.
GROOMBRIDGE, B. 1982. The IUCN Amphibia-Reptilia Red Data Book. Part 1. Testudines, Crocodylia, Rhynchocephalia. IUCN, Gland, Switzerland. 426 pp.
HAGMANN, G. 1902. Die eier von *Caiman niger*. Zool. Jahrb. (System.) 16:405–410.
HERRON, J. C. 1985. Population status, spatial relations, growth, and injuries in black and spectacled caiman in Cocha Cashu. Unpubl. A.B. Thesis. Princeton Univ. Princeton, New Jersey. 71 pp.
———. In Press. Growth rates of the black caiman (*Melanosuchus niger*) and spectacled caiman (*Caiman crocodilus*) and the recruitment of breeders in hunted caiman populations. Biol. Conser.
MAGNUSSON, W. E., A. P. LIMA, AND R. M. SAMPAIO. 1985. Sources of heat for nests of *Paleosuchus trigonatus* and a review of crocodilian nest temperatures. J. Herpetol. 19(2):199–207.
MEDEM, F. 1963. Osteologíca craneal, distribución

geográfica y ecología de *Melanosuchus niger* (Spix) (Crocodylia, Alligatoridae). Rev. Acad. Colombiana Ciencias Exactas, Físicas, y Naturales 12(45): 5–19.

———. 1980. The breeding biology of the black caiman (*Melanosuchus niger*)—what we don't know. Soc. Study Amphib. Rept. (Crocodile Symposium) 6–10 August. Milwaukee, Wisconsin (abstract).

OTTE, K. C. 1974. Project 579 research programme *Melanosuchus niger* in the Manu National Park. *In* P. Jackson (ed.), World wildlife yearbook 1973–74, pp. 257–260. World Wildlife Fund, Morges, Switzerland.

PLOTKIN, M. J., F. MEDEM, R. A. MITTERMEIER, AND I. D. CONSTABLE. 1983. Distribution and conservation of the black caiman (*Melanosuchus niger*). *In* A. G. J. Rhodin and K. Miyata (eds.), Advances in herpetology and evolutionary biology, pp. 695–705. Museum of Comparative Zoology, Cambridge, Massachusetts.

TERBORGH, J. 1983. Five New World primates: a study in comparative ecology. Princeton Univ. Press, Princeton, New Jersey. 260 pp.

Accepted: 25 August 1989.

Journal of Herpetology, Vol. 24, No. 3, pp. 316–317, 1990

Observer Effects in *Anolis sagrei*

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Sugerman and Hacker (1980) presented evidence that collared lizards, *Crotaphytus collaris*, significantly decreased their activity in response to an observer who was discernible to them. Prior to this finding, the references to the relative timidity of a lizard species were anecdotal rather than based on experimental data (Greenberg, 1978; Jenssen, 1978). The purpose of this paper is to examine a different species of lizard to determine if it is also significantly affected by an observer.

The genus *Anolis* was selected for use in this study because many species in this genus have been watched without the use of covert observation techniques (Greenberg and Noble, 1944; Carpenter, 1965; Cooper, 1971; Echelle et al., 1971; Jenssen, 1971; Stamps, 1973; Stamps and Barlow, 1973). Jenssen (1971) stated that "In the field, the activity of *A. nebulosus* was little affected by an observer, even when observed from only a few yards away." This summarizes what many authors have assumed from casual observation of many lizard species. In the current study, *Anolis sagrei* was used to determine the effect of a visible observer on their activity level. This common anole appeared to the author to be relatively insensitive to people.

Twenty healthy male *A. sagrei*, weighing an average of 5.0 g (3.17–7.02 g), were purchased from a commercial dealer and placed in individual one-gallon terraria. All terraria contained potting soil, a water dish, live crickets and meal worms, and branches to

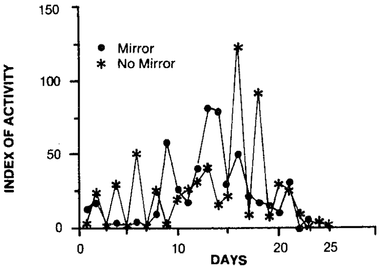

FIG. 1. Summary of the index of activity (display-actions-patterns, dewlap extensions, and head bobs) for each pair of animals during two 30 min periods, one with the one-way mirror down and the second with no mirror in place and the investigator visible, over 25 test days.

perch on, and were lit on a 13L:11D cycle. All terraria were heated with light bulbs. The light bulbs were positioned so as to provide a temperature gradient through the terraria and made it possible for the lizards to reach their preferred temperature. All lizards gained weight during the testing period. The test cage was a 64.6 L hexagonal terrarium inside a plywood observation box (78 × 64 × 94 cm) with a removable 900 cm^2 one-way mirror on the front. The one-way mirror could be raised, which made the observer readily visible through an 841 cm^2 opening, or lowered to hide the observer.

Twenty-five h of testing was performed between 2 May and 16 July 1987. The test paradigm was as follows. A randomly-chosen lizard was placed into the test terrarium and allowed a minimum of two days to acclimate. On the test day, a second randomly-chosen animal was placed into the test terrarium. A one h testing period began immediately upon the second animal entering the cage. The test period was divided into two 30 min periods. During one of the 30 min periods, the one-way mirror was down, and during the other 30 min period, the one-way mirror was up and the observer's face was visible to the animals. At the end of the hour, the original lizard was removed and the second lizard, randomly chosen from the remaining nineteen animals, was allowed a minimum of two days to acclimate in the test cage until the next test. On each subsequent test day the sequence of the one-way mirror (up or down) was alternated. Each test was started between 1130 h and 1300 h.

The activity of both animals was recorded on videotape for later analysis. The camera's field of view was through the opening for the mirror at the front of the observation box. The number of display-action-patterns (DAPs), dewlap extensions, and head bobs were recorded for each animal during each min of the one h test period. All displays for both animals were summed to produce an index of activity for each 30 min period.

The results (Fig. 1 and Table 1) were analyzed using Wilcoxon's Signed-Ranks Test. In this test paradigm,

TABLE 1. Comparison of the mean number of display-action-patterns (DAP), dewlap extensions (DE), and head bobs (BOBS) performed during the 30 min, no mirror and mirror test periods.

	No mirror			Mirror		
	DAP	DE	BOBS	DAP	DE	BOBS
$\bar{x}$	5.64	15.56	2.88	4.12	11.08	5.65
Range	0–36	0–85	0–15	0–22	0–40	0–60
N	25			25		

no difference was seen in the activity level of *A. sagrei* during the times when the lizards could or could not see the observer (Ts = 158, $P > 0.05$, N = 25). These results indicate that *A. sagrei* does not require covert testing techniques for the experimental work on displays and animal interactions. These results differ significantly from those found in collared lizards (Sugerman and Hacker, 1980), which are affected by the presence of a visible observer under similar conditions.

There is an obvious difference in the effect of a visible observer on collared lizards and *A. sagrei*. This difference is probably related to environmental or behavioral factors. Collared lizards range in temperate, open, rocky areas and are "alert" to the movements of potential predators at some distance (Fitch, 1956). Evans (1951) reported that *Ctenosaura pectinata*, which are also large lizards that sun themselves on rocks in open areas, are extremely wary of an observer. Anoles, on the other hand, are mostly small lizards which inhabit the subtropics and tropics and are found in more protected environs such as shrubs, trees, and vines. Thirteen species of anoles were studied without covert observation techniques by Greenberg and Noble (1944), Carpenter (1965), Cooper (1971), Echelle et al. (1971), Jenssen (1971), Stamps (1973), and Stamps and Barlow (1973). The authors assumed that the anoles were not affected by their visible presence. However, none of the species have been tested for the effect of an observer. It is likely that anoles are relatively insensitive to an unobtrusive observer. However, based on the sensitivity of some lizards, it is strongly recommended that specific species of lizards be tested using this methodology to determine their sensitivity to the presence of a visible observer.

LITERATURE CITED

CARPENTER, C. 1965. The display of the Cocos Island anole. Herpetologica 21(4):256–260.

COOPER, E., JR. 1971. Display behavior of hatchling *Anolis carolinensis*. Herpetologica 27(4):498–500.

ECHELLE, A., F. ECHELLE, AND S. FITCH. 1971. A comparative analysis of aggressive display in nine species of Costa Rican *Anolis*. Herpetologica 27(3): 271–288.

EVANS, L. T. 1951. Field study of the social behavior of the black lizard, *Ctenosaura pectinata*. Amer. Mus. Nat. Hist. Novitates 1493:1–26.

FITCH, S. 1956. An ecological study of the collared lizard (*Crotaphytus collaris*). Univ. Kansas Publ. Mus. Nat. Hist. 8(3):213–274.

GREENBERG, N. 1978. Ethological considerations in the experimental study of lizard behavior. *In* N. Greenberg and P. MacLean (eds.), Behavior and neurology of lizards: an interdisciplinary conference. N.I.M.H., Rockville, Maryland, pp. 203–226.

GREENBERG, B., AND G. K. NOBLE. 1944. Social behavior of the American chameleon (*Anolis carolinensis* Voigt). Physiol. Zool. 17(4):391–439.

JENSSEN, T. A. 1971. Display analysis of *Anolis nebulosa* (Sauria, Iguanidae). Copeia 1971(2):197–209.

———. 1978. Display diversity of anoline lizards and problems of interpretation. *In* N. Greenberg and P. MacLean (eds.), Behavior and neurology of lizards: an interdisciplinary conference. N.I.M.H., Rockville, Maryland, pp. 269–285.

STAMPS, J. A. 1973. Display and social organization in female *Anolis aeneus*. Copeia 1973(2):264–272.

———, AND G. W. BARLOW. 1973. Variation and stereotype in the displays of *Anolis aeneus* (Sauria: Iguanidae). Behaviour 47(1–2):67–94.

SUGERMAN, R. A., AND R. A. HACKER. 1980. Observer effects on collared lizards. J. Herpetol. 14(2):188–190.

Accepted: 6 September 1989.

Journal of Herpetology, Vol. 24, No. 3, pp. 317–320, 1990

Twinning in Leatherback Sea Turtle (*Dermochelys coriacea*) Embryos

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Monozygotic twinning in reptiles has received little research attention. There are no data to evaluate whether individual females are genetically predisposed to the production of twins or, in the case of oviparous species, whether particular incubation environments bias in favor of twinning. Isolated cases of embryonic twinning in crocodilians are summarized by Ferguson (1985). Hubert (1964) was able to induce twinning in the lizard, *Lacerta vivipara*, by dividing blastoderms with a fine glass needle. Despite relatively more data on twin sea turtle embryos developing within a single egg (*Caretta*: Fujiwara, 1964; Blanck and Sawyer, 1981; *Chelonia*: Glaesner, 1924; Fowler, 1979; Hewavisenthi, 1989; *Dermochelys*: Deraniyagala, 1930, 1932; Hughes et al., 1967; Chan, 1985; Whitmore and Dutton, 1985), rates of twinning by