The basic color pattern (without the spots) serves two adaptive functions. The median stripe bisects the image of the snake and presents a predator with the configuration of two half snakes, not an uncommon strategy. The ground coloration with black adjacent to the median stripe, grading laterally into the lighter olive-green, is the opposite of the shading produced with natural lighting on a uniformly colored convex structure. In the terms of Cott's (Adaptive Coloration in Animals, Dover Publ. Inc., New York, 1957, 508 pp.) analysis, this pattern combines obliterative countershading and the disruptive effect of contrasting adjacent tones to produce a concave aggregate image.

Moreover, when *Thamnophis s. ornata* is startled in nature, it immediately inflates its body. This causes the body to suddenly appear larger and, concomitantly, the red spots to become conspicuous. This behavior startles predators. Since birds are the primary diurnal predators with color vision, they would presumably be important predators involved.

The behavior described is difficult to relate to classical Batesian mimicry, as red protective coloration in snakes often occurs for one or both of two reasons. Today, at least, there are no poisonous models (coral snakes) anywhere in the range of the New Mexico gartersnake, and coral snakes (genera *Micurus* and *Micruroides*) have a pattern of red annuli rather than red spots.

In summary, the New Mexico gartersnake *Thamnophis sirtalis ornata* achieves concealing benefits from obliterative countershading and a simple disruptive striped pattern, and is further benefited by a behavioral mechanism of sudden pattern change that startles and therefore detains or discourages predators.—*Thomas R. Van Devender, Department of Geosciences, University of Arizona, Tucson.*

NOTES ON REPRODUCTION IN THE NIGHT SNAKE (*HYPSIGLENA TORQUATA*).—Present knowledge of reproduction in *Hypsiglena torquata* is based on reports of eggs laid by, or found in, a total of four specimens (Dundee, Herpetologica, 6: 28–30, 1950; Gates, Trans. Kansas Acad. Sci., 60: 403–418, 1957; Hibbard, Copeia, 1937: 74, 1937; and Werler, Zoologica, 36: 37–48, 1951).

On 11 June 1971 Lieb collected a gravid night snake adjacent to Interstate Highway 19, 2 mi S of State Route 289, Santa Cruz County, Arizona. Eggs laid by this specimen (Fig. 1-A, Table 1) were incubated and hatched in the laboratory. This night snake, its hatchlings and their egg shells are catalogued in the Texas Cooperative Wildlife Collection (TCWC) as No. 36373.

Our report combines data from this Arizona specimen, from dissections of five night snakes in the TCWC and one in the Brigham Young University collection (BYU), and from the literature to augment what is known about reproduction in this reptile.

Time of oviposition.—Dundee (1950) reported a clutch laid on 7 July by a night snake from Beckham County, Oklahoma. Werler (1951) recorded a clutch laid 25 April by a specimen from Zapata County, Texas. A specimen (TCWC 13225) from Brewster County, Texas (a locality which lies between those of Dundee and Werler) contained oviducal eggs on 28 May. Three other specimens (TCWC 31369, 31371, 33662) from other intermediate localities (Reagan and Loving Counties, Texas) contained enlarged ovarian eggs on 10 April and 2 May. The oviducal eggs would probably have been laid within several days of the capture date. The enlarged ovarian eggs ranged from 12.7 to 19.9 mm in length and were probably several weeks away from reaching ovulatory size; i.e. about 28 mm as judged from lengths of newly oviposited eggs described below. Thus these data indicate a north-south cline in timing of egg production (later farther north) assuming no more than one clutch is produced per female per year.

Hibbard (1937) reported a specimen containing four eggs on 12 June from Clark County, Kansas. Sizes of the eggs and whether they were ovarian or oviducal were not indicated. Judging from the above data, these eggs were probably ovarian and at least four weeks away from being laid.

Thus far the discussion applies to *H. t. texana*. Three records for *H. t. ochrorhyncha* are available from southern Arizona. On the basis of the apparent north-south cline in *texana*, laying would be predicted for June in southern Arizona, but such is not the case. TCWC 36373 from Santa Cruz County laid on 15 July. Similarly, TCWC 33731 from Pima County had ovarian eggs measuring 14.9, 14.5, and 11.2 mm on 22 June. The third record (Gates, 1957) represents a specimen from adjacent Maricopa County with four eggs (presumably ovarian) which averaged 9.8 mm in length on 22 July. This third individual would seem to represent a still later reproductive schedule. W. W. Tanner (pers. comm.) called our attention to a gravid specimen of *H. t. ochrorhyncha* x *deserticola* (BYU 14643) from Kane County, Utah. This snake has oviducal eggs in the left oviduct and an enlarged follicle in the right ovary. It was collected (and presumably preserved) on 18 May. The simplest hypothesis for these observations is that timing of the reproductive cycle in this area is controlled by a highly variable environmental factor, probably rainfall. Multiple clutches per female per year could also explain these observations.

Tanner (Great Basin Nat., 5: 25–92, 1944) recorded a presumed laying by a *H. t. loreala* from Emery County, Utah on 17 June. However, other data given below indicate that it is prudent to exclude this record from consideration.

Clutch size.—Records of clutch size have been reported by Hibbard (1937), Dundee (1950), Werler (1951), and Gates (1957). To these we are able to add counts from seven clutches. Known clutch sizes and snout-vent lengths (SVL) of females which produced them are 2 (307 mm), 3 (328 mm), 3 (337 mm), 3 (340 mm), 3 (347 mm), 4 (425 mm), 4 (SVL unrecorded), 4 (SVL unrecorded), 6 (338 mm). Of these nine clutches, four were ovarian, two others are presumed ovarian, and three were laid. Clutch size had to be estimated for the two specimens with oviducal eggs (TCWC 13225 and BYU 14643), because demarcations between eggs in the oviducts were not clear. Both estimates were four eggs, and SVLs were 361 and 367 mm. For these eleven records, clutch size ranges from 2 to 6 with a mean ($\pm$ 1 S.E.) of 3.6 $\pm$ 0.3 eggs.

Tanner (1944) found three eggs and nine egg shells in a collecting bag with a female *H. t. loreala*. The shells ". . . were folded together in a cluster." Tanner (pers. comm.) indicates the snake was only 282 mm in SVL and says, "I rather doubt that that many [eggs] would ever have been laid and I am unable to explain the presence of the extra shells . . ." Tanner (pers. comm.) also notes that two eggs appeared normal and had lengths of 15.2 and 15.5 mm. However, other data summarized below show that lengths for 13 oviposited eggs of *Hypsiglena torquata* are substantially larger, ranging from 22 to 31.9 mm. Given these facts, we postulate that the snake in question had eaten 12 lizard eggs (probably *Sceloporus undulatus;* Tanner, pers. comm.) and regurgitated the remains after being placed in the bag. Whatever the actual situation, it seems prudent to set this record aside.

Egg size and shell texture.—Combining data from the three-egg clutch of TCWC 36373 (Table 1) with data from Dundee (1950) and Werler (1951), it was found

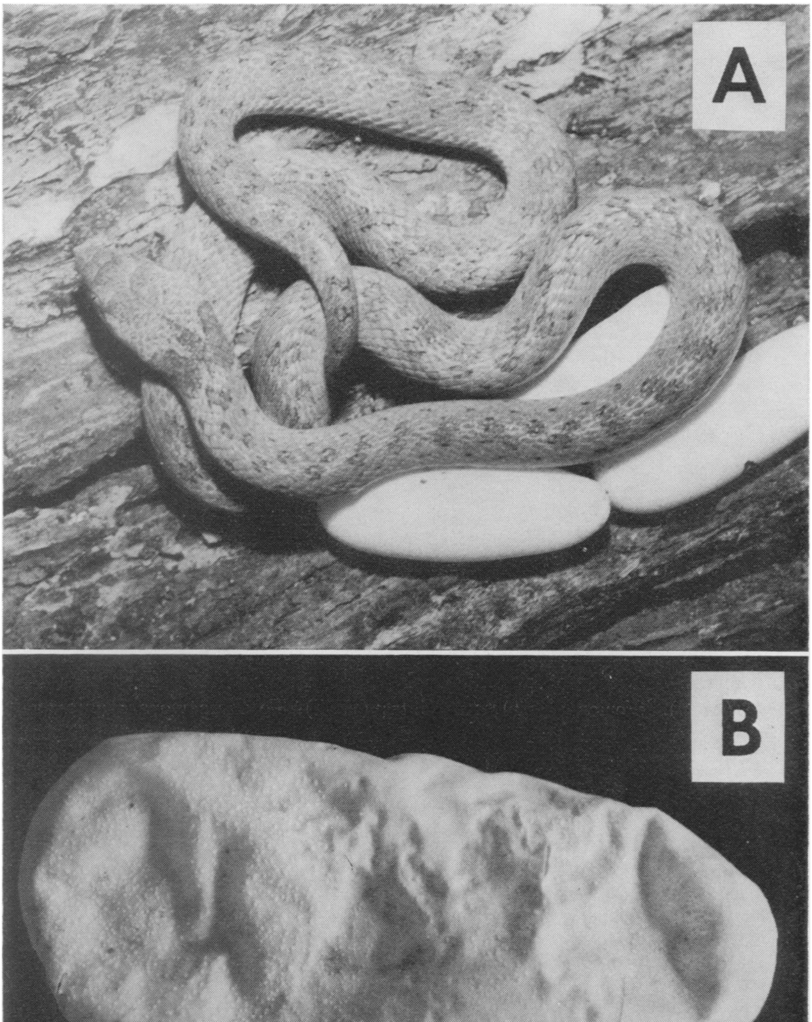

Fig. 1. A: Female *Hypsiglena torquata* (TCWC 36373) and her three-egg clutch on date of ovposition, 15 July 1971. Snout-vent and tail measurements for the snake are 340 and 56 mm. B: Shell of egg "A" after hatching; note granular texture. Shell is 29.5 mm. long.

that 13 eggs average 27.6 mm in length (range 22–31.9 mm), seven eggs average 10.1 mm in width (range for 13 is 9–11.5 mm), and nine eggs average 1.94 g in weight (range 1.6–2.41 g) at laying. Clutch weight relative to female weight was 91% in the specimen recorded by Dundee (1950), and it was 61% for TCWC 36373.

Werler (1951) noted that the eggs from Zapata County, Texas had "... smooth, non-granular shells . . ." However, the eggs of TCWC 36373 from Santa Cruz County, Arizona have rough, granular shells (Fig. 1-B). Possibly this difference is characteristic of the two subspecies represented by these two clutches.

TABLE 1

Characteristics of eggs and hatchlings of a night snake (*Hypsiglena torquata*, TCWC 36373) from Santa Cruz County, Arizona. Egg "C" did not hatch and was dead when opened after 62 days of incubation. Lengths and widths are in millimeters, weights are in grams

	Eggs/hatchlings		
	A	B	C
Eggs at laying			
Length	31.5	31.9	30.9
Width	10.0	10.2	10.4
Weight	2.41	2.41	2.22
Hatchlings			
Sex	♂	♀	♂
Snout-vent length	160	134	110
Tail length	32	23	23
Weight	2.30	0.78	0.66

Incubation.—Werler (1951)) incubated a clutch of four eggs at temperatures ranging from 21–32° C. Two of this clutch laid on 25 April hatched on 18 June after 54 days of incubation. The three eggs of TCWC 36373 were incubated at temperatures ranging from 24–33° C. They were laid 15 July and two hatched on 12 September after 59 days of incubation.

On 23 August after 39 days of incubation (i.e. incubation was 66% complete), the three eggs of TCWC 36373 had increased in weight by 90.1, 47.5, and 77.6%. They had increased in length by 12.7, 6.0, and 12.6%, and they had increased in width by 54.0, 36.3, and 37.5%.

Hatchlings.—Werler (1951) recorded SVLs and tail lengths for two hatchlings: 146, 23; 153, 22 mm. Eggs "A" and "B" hatched in our laboratory (Table 1). However, egg "C" was opened and found dead after 62 days of incubation. Development was complete except for absorption of yolk. The large disparity in size between hatchlings "A" and "B" was due, at least in part, to solidification of 0.86 g (wet weight) of the yolk supply of "B". Perhaps due to invasion by fungus, this yolk material assumed a consistency similar to pencil eraser, and the embryo was forced to complete development without it.

We thank J. R. Dixon and W. W. Tanner for use of specimens under their care. For helpful suggestions and data we are grateful to W. W. Tanner. For critical re-

views of the manuscript we thank R. J. Baldauf and J. R. Dixon. We thank R. J. Baldauf for taking the photographs. This is Contribution No. 9713 of the Texas Agricultural Experiment Station.—*Donald R. Clark, Jr. and Carl S. Lieb, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, 77843.* (Present address: Patuxent Wildlife Research Center, Laurel, Maryland 20810; and Dept. Biological Sciences, Univ. Southern California, Los Angeles 90007.

MARKING LARVAL SALAMANDERS WITH FLUORESCENT PIGMENTS. —In population studies, adult salamanders are usually marked by toe clipping and subsequent application of 0.1 N beryllium nitrate to retard regeneration (Heatwole, Ecology, 42: 593–594, 1961). Toe clipping is ineffective for marking larval salamanders due to absence of toes in small larvae and small size of toes in larger larvae. Branding has been used successfully by Clark (Copeia 1971: 148–151, 1971) on adult amphibians, but this method is not applicable to small larvae.

During a demographic investigation of the gray-bellied salamander (*Eurycea multiplicata*), a method for marking all sizes of larvae was developed. Four colors (red, blue, green, yellow) of fine grained (20μ) fluorescent pigments were obtained from Scientific Marking Materials, Seattle, Washington. The pigments are solid solutions of fluorescent dyes in a melamine-sulfonamide-formaldehyde resin. Similar pigments, applied under pressure, have been successfully used by Phiney, Miller and Dahlberg (Trans. Am. Fish. Soc., 96: 157–162, 1967) to mark fish. For salamanders the fluorescent pigments were mixed with acetone to the consistency of paste and applied to larvae with a blunt probe heated with a portable propane torch. The hot probe burns throughthe outer layers of epithelium producing a small scar (1 mm) but the damaged tissue regenerates within 15 days. The pigments were incorporated in the regenerated epithelium. After application, fluorescent tags were easily seen by putting the larvae in a petri dish containing water, placing the dish in a cardboard box painted flat black, and exposing them to long wave ultra violet light from a battery powered lamp.

This technique was tested in the laboratory by marking 70 *Eurycea multiplicata* larvae and 40 *Ambystoma annulatum* larvae. The *Eurycea multiplicata* larvae ranged from 14 mm to 45 mm in body length, measured from tip to snout to posterior end of vent, ($\bar{X}=31$, 1 S.E. $= \pm 8$). The *Ambystoma annulatum* larvae ranged from 16 to 32 mm body length ($\bar{X}=22$, 1 S.E. $= \pm 5$). All larvae were tagged on the mid-dorsal surface. By combining different colors of pigments in one tag, and tagging on different body regions it would be possible to recognize a large number of individuals.

Two *E. multiplicata* retained tags beyond 150 days, but 50% of the sample had lost the tag after 70 days. Larvae of *A. annulatum* did not retain tags as long as *E. multiplicata* (Table 1).

This method was field tested by uniformly tagging and immediately releasing 1022 *E. multiplicata* larvae. Two population size estimates were conducted concurrently on the same population 15 days after tagging. One estimate was based on recaptures, the second estimate utilized the linear regression technique developed by Schnabel (Am. Math. Monthly, 45: 348–352, 1938). The linear regression method of estimating population size is not dependent on recovering previously marked individuals. Confidence limits (99%) of the two independent population size estimates overlapped, indicating the same degree of error in both techniques. In the laboratory 30% of the *E. multiplicata* lost tags after 15 days. Apparently in