Criteria for Determining Sex and Breeding Maturity in Snakes

By HENRY S. FITCH

A simple method for determining sex in living snakes was described by Blanchard and Finster (Ecology 14: 334-347); a blunt probe is inserted through the anal orifice and directed posteriorly. If the snake is a male, the probe can be inserted into the tail through the invaginated hemipenis on either side, usually for a distance of from one-fourth inch to more than an inch, depending on the size of the individual and the species involved. In the female the probe cannot be inserted an appreciable distance without rupturing the wall of the cloaca and the connective tissue of the tail. Blanchard (Bull. Antivenin Inst. Am., 4:95-104) also described secondary sexual differences in various kinds of common snakes. Ordinarily the relative tail length is noticeably greater in the male. This difference is correlated with the fact that the hemipenes with their attached muscles and tendons are lodged in the tail. Difference in shape of the tail is also noticeable; in the female the diameter of the tail near its base is much less than the diameter of the body immediately anterior to the anus, while in the male the base of the tail is somewhat swollen because of the hemipenes, and the tail may equal or even slightly exceed in diameter the adjacent part of the body. In certain snakes, notably the natricines, various scales in the adult male are modified as an adaptation to courtship behavior—there are keels, sometimes knobbed, on the scales of the anal region, which are used to stimulate the female, and there are sensory pits in the chin shields. Blanchard suggested that development of these structures might be indicative of breeding condition. However, insofar as known, the structures appear at about the time sexual maturity is attained and are retained subsequently throughout the remainder of the individual's lifetime including those parts of the annual cycle when the snake is sexually quiescent. The structures become more prominent as the individual grows older.

In most kinds of snakes sexual dimorphism in color pattern either is absent altogether or is but weakly developed. Color pattern of young closely resembles that of adults in many species. In others having striking ontogenetic change, the process is gradual and is seemingly not correlated with attainment of adult size or sexual maturity.

In the course of population studies pursued over the past ten years at the University of Kansas Natural History Reservation, more than 2000 snakes of 14 species have been captured alive, marked and released. In most of these snakes sex was routinely recorded. Ordinarily snakes were examined, recorded and released at the point of capture. As the snakes involved differed greatly in size, the same probe could not be employed on all, and materials available in the field, such as semi-rigid stems of growing grass, with soft ends, were generally utilized as probes.

In the early stages of the study sex was not determined in many of the young snakes that were captured; it was anticipated that sex would be evident from the ratio of tail length to total length. Unfortunately this method of sexing proved not to be feasible in some species because the proportions differ but little between the sexes in the newborn young. In

the copperhead, for instance, there is a slight average difference, but males and females overlap widely; ratio of tail-length to snout-vent-length was 17.55 ± .143 per cent in 68 males and 17.20±.055 per cent in 26 females. In sexually mature copperheads of any given size the sexes can usually be separated on the basis of tail length. The ratio of tail-length to snout-vent length averages from 1.3 per cent to 1.7 per cent more in males. Actually the ontogenetic change in each sex consists of a shortening of the tail in relation to snout-vent length; in the largest males (near 900 mm. snout-vent) the tail is relatively shorter (13.43 ± .334 per cent) than in the largest females (near 700 mm. snout-vent, with a tail ratio of 13.85 ± .099 per cent).

In snakes that are viviparous, females carry the eggs and embryos throughout a major portion of the season of activity. The gravid condition of such females is readily apparent from the distended appearance of their abdomens. Even in the oviparous species the enlarged ova may be carried over periods of weeks before they are laid. Numbers of eggs or embryos can be determined by palpation in the living snake, by sliding the thumb gently over the abdomen and counting the eggs as they slip past. Counts are most easily obtained in oviparous species, when the eggs have already entered the oviduct and their shells have formed, shortly before laying occurs. In copperheads I have sometimes made erroneous counts, overestimating the numbers of young because in the same egg the yolk and the embryo itself were felt as separate lumps.

In some snakes in which the hemipenis of the male is heavily armed with spines (for example, in *Coluber, Elaphe,* or *Agkistrodon*), the cloaca of the adult female, serving as a vagina, is correspondingly thick-walled. This cloacal capsule can be palpated from the ventral surface as a distinct hard lump in the posterior end of the body. In the adult males and young no such lump can be felt. Its presence in the female may, therefore, be regarded as an indication of sexual maturity.

As an indication of sexual maturity in males and of recent mating in females, samples of cloacal fluid were collected and examined. A few drops of Ringer's Solution were introduced by pipette into the cloaca, then withdrawn and examined under 60 power magnification with a binocular dissecting microscope with reflected light producing a "dark-field" effect. Often such samples were found to be swarming with active sperm. Females that had mated were found to retain live sperm in their cloacae for days or even weeks, but the proportion of sperm cells dead or not fully active rapidly increased with the passage of time.

In my field work in 1959 I made it a practice to test representative adults of each sex for active sperm. For this purpose I carried in the field, glass vials 50 mm. long and seven mm. in diameter, each containing several drops of Ringer's Solution. Before obtaining a sample of fluid from the snake's cloaca, I made it a practice to massage the posterior part of the abdomen, expressing any fecal material or uric acid present. After clearing the cloaca of these residual wastes, I repeated the massaging, in the male snakes, in order to squeeze sperm from the vas deferens before withdrawing a sample of the cloacal fluid. In many of the snakes examined, the hind gut had an abundant fauna of parasitic or commensal micro-organisms. Among these were protozoans approximately the same size as the sperm, for which they might have been mistaken under condi-

tions of improper lighting, but their movements were more erratic and they lacked the characteristic "tails" of the sperm cells. Presence of abundant active sperm was assumed to indicate that the individual was sexually mature and in breeding condition. Males of various kinds of common snakes were found to produce sperm at sizes and ages much below those of the most precocious breeding females. In the ring-necked snake (*Diadophis punctatus*) and racer (*Coluber constrictor*) for instance, sexual maturity is attained before the second hibernation when the snakes are approximately 13 to 14 months old and are still far short of typical adult size. In the copperhead (*Agkistrodon contortrix*) sexual maturity is usually reached before the third hibernation, at an age of approximately two years. Surprisingly, mature males of these species have active sperm throughout the season of their activity, or most of it, although ovulation and oviposition or birth of young takes place in all females of the population at approximately the same time, only once annually.

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THE NORTHWESTERN SAGEBRUSH LIZARD IN DEL NORTE CO., CALIFORNIA.—Van Denburgh (1922, Occ. Pap. Calif. Acad. Sci., 10:1-611.) gives two Del Norte Co. localities for *Sceloporus graciosus gracilis* (Baird and Girard)—near state line on road from Crescent City to Grant's Pass and Gasquet. These localities were either discounted or overlooked by Smith (1946, Handbook of Lizards.) and Stebbins (1954, Amphibians and Reptiles of Western North America). On August 23-24, 1959, my son, Donald, and I obtained twenty of these lizards from about five miles east of the town of Smith River, Del Norte Co., in the locality called the Divide Area. The reptiles were found between High and Low Divide along what once was the stagecoach road from Smith River to Grant's Pass, Oregon.

The Divide Area and adjacent environs possess a somewhat remarkable flora. Although the collecting site is only 2,200 feet in altitude, it is characterized by plants usually found at higher elevations elsewhere—dwarf juniper, *Juniperus communis* var. *saxatilis*, 6,400-11,000 ft.; pinemat manzanita, *Arctostaphylos nevadensis*, 5,000-10,000 ft.; huckleberry oak, *Quercus vaccinifolia*, 6,000-10,000 ft. (Jepson, 1923-28, A manual of the flowering plants of California; Muntz, 1959, A flora of California.)

The lizards were found among these prostrate shrubs on a substrate derived from the exposed lavas that reflect the geology of the area. The exposed rocks and low shrubs, plus intervening small patches of soil, characterize the habitat. The environment is in keeping with known situations for this lizard.

Sceloporus occidentalis was also found in the Divide Area. The only place where both *Sceloporus* were found together was next to a shack at Low Divide. The *occidentalis* were usually right next to the shack; the *graciosus*, usually in the already described situation which occurred to within a few feet of the shack. In the Divide Area *occidentalis* was most often found in open rocky areas and among more open situations of *graciosus*-like habitat.

Although the Del Norte Co. sagebrush lizard localities are only about