hatching. Many of the deaths were caused by embolism, as the sea water flowing into the rearing tanks was usually supersaturated with air.

Reintjes (1962) described the development of yellowfin menhaden embryos and prolarvae, but the postlarvae remain undescribed. I preserved a few larvae at intervals during the rearing experiment, and two are illustrated. The smaller larva (Fig. 1 upper) was 7.6 mm 11 days after hatching; the larger larva (Fig. 1 lower) was 11.9 mm 27 days after hatching.

I thank Dr. Richard W. Lichtenheld who assisted in collecting the gametes and in rearing the larvae and Herbert R. Gordy who made the illustrations.

**LITERATURE CITED**


**HERPETOLOGICAL NOTES**

**THE LARVAL LIFE OF THE THREE-LINED SALAMANDER, *Eurycea Longicauda Guttolineata*.—**Most accounts of the life history of *Eurycea longicauda* concern the northern subspecies, *E. l. longicauda* (for recent summaries see Anderson and Martino, 1966; Franz, 1967). Some aspects of the life history of the southern representative, *E. l. guttolineata*, were studied by Gordon (1953); however, the available literature on egg-laying and larval development for this subspecies is limited to brief notes on small collections of larvae (see later citations).

Between 1965 and 1969, I collected 159 larvae of *E. l. guttolineata* from the following localities in the Blue Ridge Province of southwestern North Carolina: 1) Cox Cove, elev. 2280 ft, 35° 17.8' N-83° 11.8' W, Jackson Co. A series of grassy pools in wet pastureland adjacent to a small stream. 2) Bennett Spring, elev. 2280 ft, 35° 15.0' N-83° 11.1' W, Jackson Co. A brick springhouse adjacent to the marshy flood plain of Cullow-
hee Creek. 3) Caney Fork, elev. 2480 ft, 35° 18.7' N-83° 04.3' W, Jackson Co. A small pond in deciduous woodland in the flood plain of Caney Fork Creek. 4) Horse Cove, elev. 2960 ft, 35° 02.8' N-83° 10.2' W, Macon Co. An artificial pond draining into Edwards Creek.

Specimens were preserved in 7% formalin within several hours after collection. Measurements were not taken until the salamanders had been in formalin for at least 24 hr. The standard measurement used throughout this paper is the snout-vent length, the distance from the tip of the snout to the posterior end of the cloacal opening. Although I was unable to obtain complete series of larvae at any one locality in a single year, the data from different years conform to a common pattern, indicating that the timing of larval development is relatively uniform from one year to the next.

To determine the extent of the larval period, estimates of the dates of hatching and metamorphosis are required. The hatching period has been estimated from the date on which advanced embryos and hatchlings were found at Bennett Spring and from the dates of collection of small larvae at Cox Cove. The period of metamorphosis has been determined from observations of morphogenetic processes in large larvae. Entry into metamorphosis is indicated by reduction of the labial folds, development of eyelids, and resorption of the tail fin. Metamorphosis is completed upon loss of the external gills and closure of the gill slits. Although transformation is accompanied by pigmen-
tary changes, the development of the adult pigmentation is a gradual process beginning early in larval development, and is not a precise indicator of metamorphosis.

Embryos and hatchling larvae of E. l. guttolineata were found at Bennett Spring on 17 March 1969. They were discovered in a brick cistern measuring 2½ ft in length by 2 ft in width by 2 ft in height. The cistern is covered with a concrete slab, and is supplied by an underground clay pipe which delivers water from an uphill seepage. At the time of collection the springhouse had recently been cleared of debris and contained 13 inches of water. The sandy bottom was strewn with empty egg capsules and capsules containing advanced embryos. The numerous small larvae present obviously represented the late occupants of the empty capsules. No attending females were seen, and the eggs were neither attached to any object nor grouped in any recognizable pattern. Perhaps the recent cleaning of the springhouse had scattered the females and disturbed the disposition of the eggs, or, alternatively, the eggs may have washed into the cistern from deposition sites in the seepage or intake pipe. Of an estimated 200 larvae and encapsulated embryos, 18 were collected; however, the embryos hatched on returning to the laboratory and they could not be distinguished from the other small larvae taken at the same time.

On 16 March 1969, the day prior to the discovery of hatchlings at Bennett Spring, I collected 11 small larvae at Cox Cove. Although the mean snout-vent length of these larvae (12.3 mm) was greater than that of the Bennett Spring sample (11.0 mm), the length-frequency distributions of the two samples show considerable overlap (Fig. 1). It seems likely that hatching at Cox Cove in 1969 occurred within the two week period prior to the collection date.

Frequency distributions of snout-vent length for other samples from Cox Cove are shown in Figure 2. Although searches were made in February, the earliest collection date is 8 March when 18 larvae were taken.
The mean snout-vent length of this sample (11.3 mm) is similar to that of the Bennett Spring hatchlings, indicating that these Cox Cove larvae were probably not more than several days beyond hatching. The remaining samples from Cox Cove show that the larvae more than double in snout-vent length between early March and late June. On the latter date transformation had begun and no larvae or recently-metamorphosed individuals were found in July and August.

The collections made in August at Caney Fork and Horse Cove contain individuals in various stages of metamorphosis (Fig. 1). The mean snout-vent lengths of these samples (24.0 mm at Caney Fork, 25.2 mm at Horse Cove) are similar to that of larvae taken in late June at Cox Cove (24.8 mm). The smallest transforming salamanders were 28–24 mm in the Cox Cove, Caney Fork, and Horse Cove samples, and the average lengths of metamorphosing and just-metamorphosed individuals were 24.4, 25.6, and 26.6 mm, respectively. If hatching dates were similar at the three localities, then growth rates were less at Caney Fork and Horse Cove than at Cox Cove.

Inasmuch as I have not found larvae from September through February, and as all the length-frequency distributions are unimodal, it appears that the larval period is of 3½–5½ months duration in these populations, or extending from a late winter hatching period to the metamorphic period of the succeeding summer.

Some indication of geographic variation in the pattern of life history of *E. longicauda* can be acquired from a consideration of the literature. Mohr (1943), in a Pennsylvania mine, located eggs in early segmentation stages on 2 January; these were near hatching by the following 14 March. Franz (1964), in a limestone cave in Maryland, found a partial clutch of five uncleaved eggs attended by a female on 23 November. Both Gordon (1953) and Anderson and Martino (1966) provided indirect evidence for a late autumn or winter egg-laying season. Hutchison (1956), finding gravid females in Virginia in July and August, suggested that *E. longicauda* has a prolonged or variable breeding season. Although I have collected gravid females between 30 June and 17 September, my data on young larvae indicate a restricted season of oviposition, probably in late autumn; thus, it is likely that females carry large ovarian eggs for a considerable time prior to oviposition. The evidence points to autumn and early winter as the time of egg-laying throughout a large part of the geographic range.

For New Jersey populations of *E. longicauda*, Anderson and Martino (1966) estimated a 90–100 day larval period, with hatching in late winter followed by metamorphosis in June. Gordon (1953) believed that juveniles (29–39 mm, S-V) present in a Florida population in August had metamorphosed during the preceding June or July at an age of 6–7 months from a December oviposition date. Franz and Harris (1965) found metamorphosing larvae (18–21 mm, body length) on 5 July in Maryland. Sinclair (1951) located two recently-metamorphosed individuals (22.5 and 24 mm, S-V) on 1 June in Tennessee. In western North Carolina Dunn (1917) and Huheey and Stupka (1967) each found a single metamorphosing larva in July. Although there are records of presumably older larvae (Rossman, 1960; Franz, 1967), it appears that the larval period of

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**Fig. 2.** Length-frequency distributions for larvae of *Eurycea longicauda guttulineaeta* from Cox Cove. Light squares = larvae, crosses = metamorphosing larval.
E. longicauda usually varies from three to six months, with metamorphosis occurring in the late spring or summer following a late winter hatching date.

For assistance in the field I am indebted to W. Earl Sipe. My work at Horse Cove was assisted by NSF GB-2496 awarded to the Highlands Biological Station. Specimens have been deposited in the vertebrate collection of the Department of Zoology, Duke University.

**Literature Cited**


**Observations on Gestation in the Garter Snake, Thamnophis Sirtalis Sirtalis.**—During a study on placentalation in the common garter snake, T. s. sirtalis (Hoffman, 1968) observations were made on the number of fetuses in each female and the occurrence of reproductive abnormalities. As few accounts are available on the presence of fetuses in the peritoneal cavity of snakes, it was deemed worthwhile to report these findings. All snakes were obtained in the vicinity of Ithaca, New York.

T. sirtalis is a live-bearing snake; the fetuses develop for about nine weeks (calculated from time of ovulation) in the oviducts, within which are developed both chorio-allantoic and omphaloplacentae (Hoffman, 1968). Females of this species can reach sexual maturity by the second spring after birth (Carpenter, 1952) at which time they would be 500 mm or more in total length. In this study, a female examined 11 July 1967 was found to have 12 normal embryos in her oviducts while being only 451 mm in total length with a "body length" (rostrum to tip of anal scale) of 368 mm. This would appear to be the smallest gravid T. sirtalis on record.

The number of developing young per female ranged from 6 to 34 in the 42 gravid females examined; the mean per female was 15.8, with 9.8 in the right oviduct and 6.0 in the left. Figures similar to this have been reported by other workers (cf. Wright and Wright, 1957). In addition to the normal fetuses, approximately one-half of the gravid females contained one or more abnormal or arrested embryos. When these abnormal young were added to the total normal embryos, the average number of fertilized eggs became 18.2 per female, equaling the number of corpora lutea in the ovaries. The abnormal young were generally either partially mineralized or in a semi-fluid state-apparently indicative of active resorption. A high incidence of abnormal embryonic development has been reported in snakes when the females were maintained at suboptimal temperature levels (Fox et al., 1961). This may account for some of the irregularities reported here, as part of the snakes were housed in an outdoor pit, thereby restricting their selection of optimal environmental conditions and perhaps adversely affecting embryonic development.

In addition to the gravid females examined during the summer months, numerous snakes were sacrificed at other times of the year. A number of females inspected during hibernation (removed from the outdoor pit) or in the spring were found to have oviductal...