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Breeding Cycle in the Ground Skink, *Lygosoma laterale*

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HENRY S. FITCH and HARRY W. GREENE

The biology of the ground skink has been made fairly well known through the efforts of many workers, and especially the studies of Lewis (1951) and Johnson (1953). These latter studies were made at Houston, Texas, and New Orleans, Louisiana, respectively, both localities near the Gulf Coast in the southern part of the species' range. Certain important questions were raised but not definitely answered by these studies. Our study was therefore undertaken with the hope of attaining a better knowledge of the breeding cycle of this small skink. We were especially interested in the reproductive potential, specifically, in the time required to attain breeding maturity, the effect of size of female on the number of eggs in her clutch, geographic variation in size of clutch, and the seasonal timing of breeding. Because of the great abundance and extensive geographic range of the ground skink, it was considered an almost ideal subject for such investigation.

In our joint project a total of 523 specimens in The University of Kansas Natural History Museum, the Fort Worth Children's Museum, the Stephen F. Austin State Teachers College collection, and the private collection of Harry W. Greene were examined, from Kansas, Oklahoma, Texas, Missouri, Arkansas, Louisiana, Mississippi, and Georgia. These included several substantial series, notably 22 from near Lewisville, Lafayette County, Arkansas, August 16 and 20, 1926, 31 from Texas, June 22, 27 and 28, 1930, 44 from Huntsville, Walker County, Texas, April 2 and 3, 1963, and 91 from Wister Dam, Le Flore County, Oklahoma, August 11 to 15, 1963.

Reproductive cycles differ in details in different genera and species of reptiles. In the continental United States the prevailing pattern is that of a spring (and/or fall) breeding season, and ovulation in early summer, with the hatchlings or newborn young appearing in late summer or early autumn. One clutch or litter per year has been found to be the most general rule. However, in recent years many species of common lizards, especially iguanids occurring in the southern half of the country, have been found to deviate from this pattern in producing two or more clutches in a single season, for example *Holbrookia texana* (Cagle, 1950:230), *Anolis carolinensis* (Hamlett, 1952:184), *Sceloporus undulatus* (Crenshaw, 1955:273), *Crotaphytus collaris* (Fitch, 1956:237), *Cnemidophorus* sp. (Milstead, 1957:439; Fitch, 1958:36), *Sceloporus olivaceus* (Blair, 1960:89), *Uta stansburiana* (Tinkle, 1961:230), and *Gerhonotus liocephalus* (Burkett, 1962:211).

In his study of *Lygosoma*, Johnson (*op. cit.*) found that some adult females

contained simultaneously both oviducal eggs and enlarging follicles (two millimeters or more in diameter) and he suggested the possibility that such individuals might produce two clutches per season. This idea was further supported by Johnson's finding of females containing oviducal eggs in every month from March through August.

There is no true hibernation in this species in the southern part of its range. Lewis (*op. cit.*:234) wrote that at Houston even in mid-winter on warm sunny afternoons the skinks could be found active in the open. Although intermittent periods of inactivity are enforced by the arrival of winter storms and cold fronts, the populations along the Gulf Coast have a relatively long growing season. In winter both Lewis and Johnson found their samples to consist almost entirely of adult skinks, with a few well grown young. Since Johnson found two sizes of young in summer, he was uncertain whether young attained adult size in the first year or in the second year.

In a series of 72 skinks that we examined from Texas, collected in late March and April (mostly from Huntsville, April 2 and 3) only three were below minimum adult size and these were well grown (34, 31 and 29 millimeters snout-vent). These undersized individuals may be interpreted as young that hatched unusually late in the season or that failed to grow at the usual rate. The young present in summer have hatched at different times, and hence do not constitute a clear cut size group, especially since growth is remarkably rapid in the early weeks of life. Also, a series of 64 skinks collected in Texas in June are all adults.

A series collected in Lafayette County, southwestern Arkansas, August 20, 1926, and another series collected by the senior author at Wister Dam, Le Flore County, southeastern Oklahoma, August 11 to 15, 1963, are combined because they represent approximately the same latitudes and times of year. The combined series numbers 113 skinks. Thirty-nine per cent are young of the year and make up a size group fairly distinct from the adults but covering a wide size range—from hatchlings to adolescents (Fig. 2). Since egg-laying was not quite completed at the time of collection, it is evident that many young of the year, perhaps the majority of the second brood, were still not hatched, whereas the oldest young, having hatched in late June, as forerunners of the first brood, had grown for six or more weeks and were already approaching the size of the smallest adults. The young of this combined series show some tendency to bimodality, but the tendency is slight, and perhaps most of these young or all of them represent the hatch of the first brood.

The rate of growth and maturation in the developing ova cannot be definitely determined from the available records, but can be inferred from the information available for other kinds of lizards. In the collared lizard (*Crotaphytus collaris*) a female living under natural conditions was recorded to have laid two successive clutches with an interval of three weeks or a little more (Fitch, 1956:237). Blair (1960:89) found that an interval of about a month between clutches was usual in the rusty lizard (*Sceloporus olivaceus*). Johnson (1960:298) found that in north-central Texas the greater earless lizard (*Holbrookia texana*) produced on the average five clutches of eggs in the course of the breeding season, with an average interval of about 35 days between clutches.

When the Huntsville series of *Lygosoma* was collected, several adults including three females of typical appearance, were kept alive to determine when they would produce eggs. Doubtless their normal cycles were disturbed

by the conditions of captivity. One produced a clutch in late April and another laid on May 31. Other clutches may have been laid and eaten before they were discovered as all the lizards were kept in the same container. When the eggs deposited on May 31 were discovered on the following day, a skink was eating one of them. On August 5 all three females were killed and examined and their ovaries were found to be small. Available evidence suggests that the eggs enlarge rapidly after the breeding season has begun.

Of Kansas females two collected on April 1, 1930, had oviducal eggs and a third had ovarian eggs four millimeters in diameter, although these lizards must have emerged from hibernation only a short time before. In normal years in northeastern Kansas these skinks first appear near the end of March. In 1930 mean temperature for March deviated only .1 degree Fahrenheit from the sixty-year average (Flora, 1948:181).

Of the 71 adult females of *Lygosoma* examined and collected in May, June, and July, 42 had oviducal eggs, 16 had enlarged ovarian eggs, and 13 had small ovaries, suggesting that the period of rapid growth of the eggs in the ovaries is shorter than their period of retention in the oviducts. Johnson (1953:22) reported embryos 1.54 to 3.10 millimeters in length in oviducal eggs, indicating that the early stages of embryonic development are passed in the oviducts before the eggs are laid, and some other species of *Lygosoma* are viviparous. In *L. laterale* oviducal eggs have been reported as early as March 25 in Mississippi (Cook, 1943:19) and April 7 and April 10 in Texas (Lewis, *op. cit.*: 235). Werler (1951:39) recorded clutches laid at San Antonio on April 19, April 27, and May 1. Recorded incubation periods are somewhat variable but most of those recorded approximate one month. Therefore early broods of young might be expected to appear in late May in the vicinity of the Gulf Coast. Johnson (*op. cit.*:18) found no hatchlings before June, but his May sample was relatively small (15). Lewis (*op. cit.*:237) wrote that at Houston in 1947 hatchlings were first noted on June 30. Johnson found that females having oviducal eggs often also had several ovarian eggs considerably enlarged, evidently destined to form a second clutch, with their development already well underway.

All things considered, there must be an interval of somewhat more than a month, perhaps five weeks, between successive clutches in the breeding season. In the region of the Gulf Coast such an interval would allow ample time for four broods that might be spaced about as follows: late April, end of May, beginning of July, first half of August. Because most females have enlarged ova in either ovaries or oviducts or both in this entire period, it seems unlikely that fewer than three clutches would be produced by most individuals.

Farther north the breeding season becomes progressively shorter. Of 19 females collected in Kansas in April, five had oviducal eggs, five had ovarian eggs two to four millimeters in diameter, and the remaining nine had small ovaries. Of six collected in May two had oviducal eggs, two had enlarging ovarian eggs and the remaining two had small ovaries. Two females collected on July 17 and July 19 and three collected on August 17 all had small ovaries. On July 9 at The University of Kansas Natural History Reservation a clutch of three eggs of *Lygosoma* was found associated with a communal nest of the five-lined skink (Fitch, 1954:70). The eggs of the ground skink were within a few days of hatching and therefore must have been laid not later than mid-June. On the Reservation a gravid female was recorded on May 29, 1958. Two other females collected in Douglas County, Kansas, on May 30, 1960,

were both gravid but in one of them the ova were only 3.5 millimeters in diameter, hence probably several weeks short of laying. On the Reservation a hatchling was seen on July 29, 1957, and a juvenile of 29 millimeters was caught on August 20. Of adult females collected in southern Missouri, six taken in the latter half of April all had ovarian follicles 2.5 to 4.5 millimeters in diameter, and others with oviducal eggs were collected on May 3, June 19, and June 26 (3). Of 16 ground skinks collected in southern Missouri in late March and April, six were immature, having the following snout-vent lengths: 27, 30, 32, 34, 34, 37. Smith (1961:169) stated that in southern Illinois eggs are laid in July and hatchlings are abundant in late August. These scanty records indicate that even in the northern part of the range egg-laying probably

extends from some time in April into July—allowing ample time for at least two broods. The relatively long and severe winter in the northern part of the range has the effect of compressing the breeding season by preventing breeding in early spring and preventing it in late summer and early autumn, thus enforcing on the population a more uniform breeding schedule than prevails in the southern part of the range.

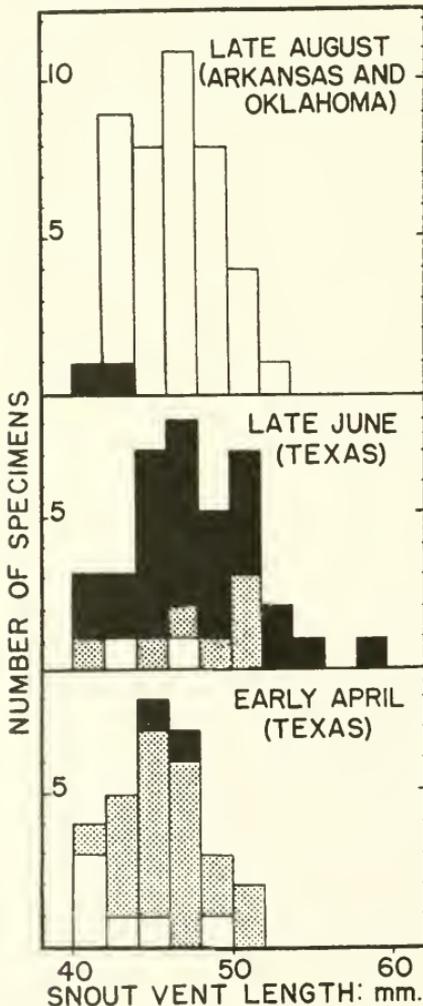


FIG. 1. Histograms showing size and breeding status of adult female ground skinks in three collections. Open columns represent specimens in which ova are small (all less than two millimeters in diameter)—non-breeders or those in an early stage of the breeding cycle; stippled columns represent specimens having enlarged ovarian follicles (two to six millimeters in diameter); black columns represent specimens having oviducal eggs. In early April (lowest figure) most females are in an early stage of the breeding cycle, with ovarian eggs still not mature. Ten weeks later most females are in a late stage of the breeding cycle, with eggs, presumably their second clutches for the season, nearly ready to be laid. By late August, in Arkansas and Oklahoma, the breeding season is over except for a few of the smallest and youngest females, which lag behind the majority in their breeding schedules.

In the series of skinks from Huntsville, Texas, representing early spring, the 28 adult females fall into three distinct groups as regards their reproductive status. Two of near average size (44 and 45 millimeters snout-vent) have oviducal eggs that seem almost ready to be laid. Twenty-one others have smaller, ovarian eggs. Those eggs obviously represent clutches that would have

matured and would have been laid somewhat later in the season. In this group the ova tend to fall in a fairly narrow size range; in 19 skinks they are from three to five millimeters in diameter. In two others eggs are two and one-half and two millimeters in diameter. In the third group, with six females, ovaries are still small, and three of these females are the smallest of the entire series; hence their retardation can probably be attributed to immaturity.

Of the 37 adult female skinks from Texas collected in late June 35 (94.5 per cent) were gravid. Of these 35, 28 had oviducal eggs and probably were near the time of egg-laying, and the remaining individuals had ova 5, 5, 5, 3, 2½, 2½ and 2 millimeters in diameter. First clutches probably had already been laid, and some individuals, notably the two with small ovaries, may have already laid their second clutches. Oviducal eggs in late June probably represented clutches that would have been deposited in early July. Development of the later clutches may be more rapid than development of first clutches, because of the higher temperatures prevailing in summer.

Of six adult females collected in Arkansas in July (no definite dates recorded) four had oviducal eggs and the other two were not breeding. In a female from Texas obtained on July 16 and in three collected on August 17, there were neither enlarging ova nor oviducal eggs, but two others collected on July 20 and August 7, both had oviducal eggs. In the Arkansas-Oklahoma series, representing dates from August 11 to August 20, only the two smallest (40 and 42 millimeters snout-vent) of the 42 adult females had oviducal eggs representing late clutches, and none had enlarging ovarian eggs, indicating that at these localities the breeding season was ending by mid-August.

In the ground skink three is the most frequent number of eggs produced at one laying, but recorded clutches vary from one to seven. Johnson (*op. cit.*:19) found an average of $3.3 \pm .05$ oviducal eggs in 31 females from Louisiana. Ten additional females from Louisiana examined in our study contained an average of 2.9 eggs. We examined 57 females from Texas that were gravid (having either oviducal eggs or enlarged ovarian follicles) and these had an average clutch of $3.02 \pm .15$. Lewis (*op. cit.*:235) found an average of 2.82 eggs in 11 females from the vicinity of Houston. But, in 17 females from Arkansas and Oklahoma the average was only $2.35 \pm .20$. In 17 females from Kansas and 14 from Missouri the clutch averaged $3.77 \pm .24$. Although smaller than might be desired, this northern series seemed to have a significantly larger number of eggs per clutch than any from the more southern populations.

Johnson (*op. cit.*:19) concluded that a significant correlation between

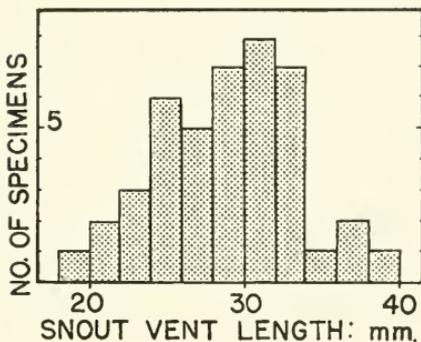


FIG. 2. Lengths of immature ground skinks in a collection from Arkansas and Oklahoma in late August. Those of sizes up to 36 millimeters are almost certainly young of the year hatched early in the summer. At the time of collection some eggs were still to be laid, and doubtless many others laid in late July or early August had not yet hatched. Hence young of the second brood probably are poorly represented or not represented at all in this sample.

number of eggs per clutch and snout-vent length of female did not exist in the series that he examined, as the regression coefficient was .069. However, the trend of his data did suggest a correlation, with the two-egg clutches found mostly in the smaller females, and the four- or five-egg clutches found in the larger females. In our study we found a definite positive correlation between size of female and number of eggs in clutch, as follows:

- 11 females 54 to 59 millimeters averaged $3.63 \pm .41$ eggs
- 45 females 48 to 53 millimeters averaged $3.76 \pm .16$ eggs
- 61 females 42 to 47 millimeters averaged $2.65 \pm .11$ eggs
- 13 females 36 to 41 millimeters averaged $1.84 \pm .18$ eggs

Or, arranging the same data differently, grouped according to the number of eggs in the clutch:

- 11 females with 1-egg clutches averaged 43.3 ± 1.31 millimeters
- 36 females with 2-egg clutches averaged $44.6 \pm .57$ millimeters
- 43 females with 3-egg clutches averaged $47.0 \pm .62$ millimeters
- 26 females with 4-egg clutches averaged $49.4 \pm .59$ millimeters
- 11 females with 5-egg clutches averaged 50.5 ± 1.78 millimeters
- 3 females with 6-egg clutches averaged 52.6 millimeters
- 1 female with 7-egg clutch was 52 millimeters

The correlation between number of eggs in clutch and snout-vent length of female is further clarified by Fig. 3. It would perhaps be correct to say that the smallest adult females always have minimal numbers of eggs per clutch, and that with increasing average size proportionately larger clutches are

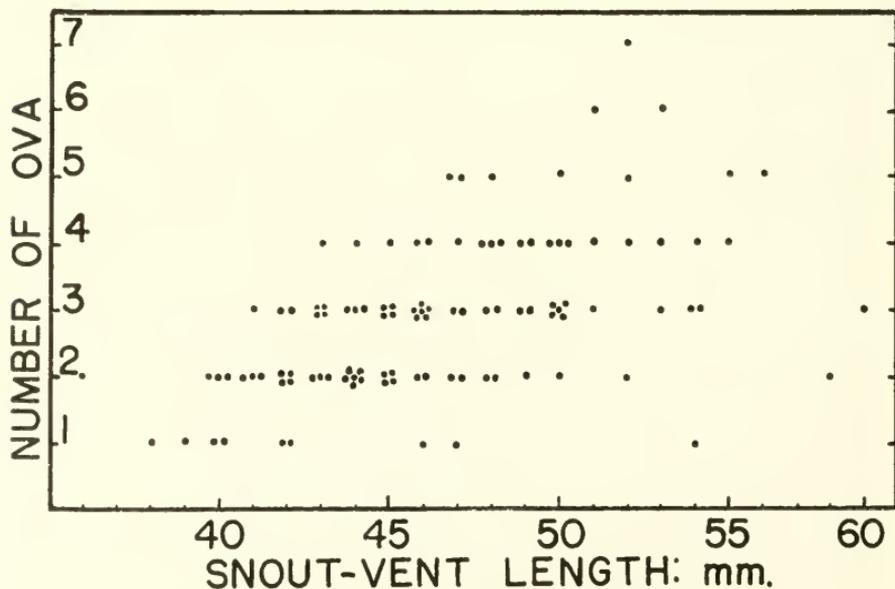


FIG. 3. Number of ova and size in fecund ground skinks. On the average, the larger females produce more eggs, but occasionally large females produce small clutches.

produced, but large females occasionally produce clutches with a small number of eggs perhaps because of senility, lateness of season or for other reasons.

The lack of opportunity for individuals to produce successive clutches in one season in the northern part of the range because of the relatively short

breeding season is in part compensated for by a greater number of eggs per clutch. Larger size in northern populations may be a factor also. Over the extensive geographic range of *Lygosoma laterale* no subspecies have been named and geographic variation has not been demonstrated. In our study we found that ground skinks from Kansas differed slightly in general appearance from those of the Gulf Coast, and averaged slightly larger but the difference is not necessarily indicative of significant geographic variation. Table 1 shows the average sizes of adult males and females (those 36 millimeters or more in snout-vent length) in the larger series examined by us. It is shown that females are approximately four millimeters longer than their male counterparts. Differences in age structures of the population samples involved are probably more important than geographic variation in affecting the figures. This is illustrated by the two series from Texas. Almost all of the skinks collected in early April were adults, but many of them were recently matured individuals of the previous years' brood. The June sample represents essentially the same population after approximately ten weeks of additional growth; both sexes had made substantial gains, but the females had grown more than the males.

TABLE 1.—SNOUT-VENT LENGTHS IN MILLIMETERS OF MALE AND FEMALE GROUND SKINKS IN SEVERAL SERIES

Locality	Females	Males
Kansas	48.9 ± .81 in 37	43.0 ± .84 in 21
Oklahoma	46.3 ± .47 in 37	42.3 ± .53 in 27
Arkansas	46.4 ± .74 in 27	42.1 ± .69 in 22
Louisiana (Johnson, 1953:23; females with oviducal eggs only)	47.3 ± .88 in 32
Texas (in April)	45.3 ± 1.24 in 19	42.6 ± .46 in 31
Texas (in June)	47.2 ± .67 in 37	43.2 ± .62 in 27

In keeping with their larger size, the June-taken females from Texas averaged slightly more eggs per clutch—3.0, as compared with 2.76 for the April-taken females. In this southern part of the range June is the peak of the breeding season and the clutches produced that month are often both preceded and followed by others. Late clutches, produced as the breeding season wanes, probably tend to be smaller than others produced earlier. In our Arkansas-Oklahoma sample, eight females collected in April averaged 2.88 enlarged follicles or oviducal eggs, but in six females collected in July and August there was an average of only 1.83. It might be expected that at latitudes where the growing season is shortened to the extent that broods are eliminated, the size of clutch would increase abruptly.

In summary, the ground skinks of the Gulf Coast have a long growing season with hibernation short and intermittent. There is ample time for at least four broods and some individuals possibly produce more. The majority of females have developing ovarian follicles in early April and first clutches

of eggs are laid from late April through May. Some young must hatch before the end of May but none has been recorded until June. A few females are several weeks ahead of the majority in their breeding schedule; others are still not sexually mature in early spring and their breeding schedule is several weeks behind that of the majority. In the northern part of the range at the latitude of Kansas the breeding season is relatively short, but the average female probably produces at least two clutches in the seven-months growing season. At this latitude egg-laying occurs in late April, June and July. At the latitude of southern Oklahoma and Arkansas egg-laying extends into early August.

Three is the modal number of eggs per clutch but in the north clutches with four, five, and even six eggs are common. There is positive correlation between size of female and number of eggs per clutch. Those females that are of minimum adult size or only slightly larger produce clutches with fewer than the average number of eggs. The largest females produce the largest clutches but occasionally some of them produce small clutches. The time of year also affects number of eggs per clutch; toward the end of the breeding season clutches have fewer eggs on the average, even though females average larger then.

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