TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCE
87(3–4), 1984, pp. 98–104

Additional Instances of Multiple Egg-clutch Production in Snakes

BERN W. TRYON
Department of Herpetology
Knoxville Zoological Park
Knoxville, Tennessee 37914

The ability of oviparous snakes to produce more than one clutch of eggs in a single reproductive season was virtually unknown until recent years. Fitch (1970), in his classic work on reproductive cycles of reptiles, summarized records of this phenomenon, listing eight instances involving colubrid snakes, drawn primarily from the oft-overlooked work of Kopstein (1938). Fitch (1970) concluded his discussion by proposing a number of other snake genera that would most probably be shown to produce more than one clutch or brood per season. Since this time, a total of 20 oviparous varieties have produced multiple egg-clutches (see Tryon and Murphy, 1982, for a review), in addition to three viviparous forms, *Eryx colubrinus loveridgei* (McLain, in preparation), *Thamnophis sirtalis* (Riches, 1980) and *Vipera aspis* (Naulleau, 1973).

These instances of reproduction have taken place under captive conditions. In recent literature there has been a divergence of opinion concerning the relative similarity of snake reproductive cycling in captivity versus that which occurs under natural conditions. Aldridge (1979) investigated reproduction in females of two temperate species in nature and concluded that vitellogenesis for each occurs at the same time of the year. Weil and Aldridge (1981) stated that vitellogenesis loses its seasonal timing in captivity. Records of specimens in captivity have shown this to be true only in cases where natural conditions of photoperiod and particularly temperature (including a hibernation period) were unavailable (Tryon and Murphy, 1982; Schuett and Tryon, in preparation).

Altering these conditions can be expected to change reproductive timing in captive specimens. A large number of species in captivity, observed over a number of years, will cycle consistently at the same time if available environmental conditions remain fixed. For example, in one group of gray-banded kingsnakes (*Lampropeltis alterna*) which were artificially hibernated from 1 December to 1 April each year, breeding behavior was consistently initiated on approximately 1 May (Murphy et al., 1978; Tryon and Murphy, 1982). Another group, hibernated from 1 November to 1 March, began breeding a month earlier, or on about 1 April (E. Wagner, personal communication). Frequently, eggs were hatching in the latter group before they

were even laid in the former, but reproductive success rates were high and multiple clutches occurred in both.

Thus, in these captive kingsnakes, reproductive timing was based upon available cycles of temperature. If natural temperature fluctuations were eliminated in these groups, it is fully expected that breeding dates would become scattered, and fertility and general reproductive success rates considerably lowered. Species which produce multiple egg-clutches in captivity while kept under more or less natural conditions should be expected to do so in nature as well, particularly in seasons of high food availability.

This note documents multiple egg-clutch production in four additional varieties of kingsnakes, *Lampropeltis calligaster calligaster, L. getulus holbrooki, L. mexicana (greeri)* and *L. triangulum polyzona,* and provides further records of this in *Elaphe guttata guttata, Lampropeltis getulus californiae* and *L. triangulum syspila.* Also described is a multiple clutch from *Calloselasma rhodostoma,* the first ever recorded in an egg-laying pit-viper. Observations in this account were recorded at the Fort Worth Zoological Park and Houston Zoological Gardens unless otherwise noted. All eggs were incubated in a vermiculite medium (Tryon, 1975). Eggs were measured with Vernier calipers and weighed on a triple-beam balance. Hatchlings were weighed on a triple-beam balance and measured using the technique of Quinn and Jones (1974).

Results

Elaphe guttata guttata. A large group of these snakes was housed in a fiberglass exhibit enclosure. One 1978 hatched female, heterozygous for albinism, bred with an albino male in early 1981 (date unrecorded). A clutch of 14 eggs was laid on 18 May 1981. Eight of these hatched on 8–10 July, 51–53 days later. Though copulation was not observed, a second clutch of eight eggs was produced on 30 June of which two hatched 60 and 61 days later on 29 and 30 August. Egg and hatchling measurements were unavailable. Clutch interval was 43 days.

E. g. guttata is without doubt one of the most frequently bred colubrid snakes in captivity (Fitch, 1970; Bechtel and Bechtel, 1978), but multiple clutches are apparently rare. Tryon and Murphy (1982) listed an occurrence of multiple clutch production in another year from the same captive group noted above, but details were unavailable. It is unknown if this female was the same specimen that produced two clutches in the earlier account. Multiple clutch production in nature is problematical, as one female apparently ready for oviposition was taken in Jasper County, South Carolina in late March, thus providing the opportunity for a second copulation during the spring breeding season.

Lampropeltis calligaster calligaster. A breeding group of these kingsnakes

was housed in various sized aquaria. Specimens were subjected to a hibernation period from 1 December to 1 March each season with temperatures ranging from approximately 10–20°C. At other times, temperatures varied from 20–32°C. One female (HZG B-39), heterozygous for albinism and hatched 4 August 1974 from the clutch of an albino gravid female taken near Pearland, Harris County, Texas, was bred to one of her albino offspring (HZG B-117) hatched on 8 July 1978. Oviposition of eight eggs occurred on 29 May 1981 with all eggs hatching on 20 July, 52 days later. Shortly after oviposition, on 9 June, this female was seen *in copulo* with the same male. A clutch of 10 eggs was laid on 24 July 1981 of which three hatched (four fertile) on 17 September after 55 days incubation. Clutch interval was 56 days.

Reproduction in *L. calligaster* is well documented (see Fitch, 1970, 1980; Tryon and Carl, 1980, for reviews). However, this report represents the first instance of a multiple egg-clutch for this species. Incomplete records for the above specimens indicate multiple clutch occurrences prior to 1981, but precise data are lacking.

Lampropeltis getulus californiae. A young female and an adult male were acquired 6 October 1977 and 28 September 1979, respectively. Both were subjected to a cooling period from 15 November to 1 March at temperatures ranging from 17–20°C. The pair was seen *in copulo* on 4 April 1980 and the female produced a clutch of seven eggs 75 days later on 18 June. Copulation again occurred on 23 June, five days after oviposition with a second clutch produced on 8 August, 46 days later. Both clutches were 100 percent fertile. Clutch interval was 51 days.

This same female produced multiple clutches in an earlier year on 20 May and 4 July 1979 with a clutch interval of 45 days (Tryon and Murphy, 1982). This subspecies, commonly bred in captive collections, has produced multiple egg-clutches in a large number of unreported instances.

Lampropeltis getulus holbrooki. A pair of specimens, heterozygous for albinism, was hatched 29 June 1978 from a captive breeding between an albino female received in April 1972 and a normal male received in January 1978. The female and male parents were collected in Dallas and Tarrant counties, Texas, respectively, shortly prior to their accession dates. Though copulation was not observed, the female offspring produced clutches of 16 and 12 eggs on 30 April and 17 June 1981, with hatching of all eggs occurring on 27 June and 3 August, respectively (G. Carl, personal communication). Clutch interval was 48 days. Accurate measurements of eggs and young were not recorded, but both appeared smaller in the second clutch. Though Zweifel (1980) described reproduction in a large captive group of *L. getulus* with no mention of multiple clutches occurring, it is probable that this will eventually be reported in most other subspecies of this form.

Lampropeltis mexicana (*Greeri*). Webb (1961) described this snake as *L.*

Table 1. Reproductive data for *Lampropeltis mexicana (greeri)*.

	Clutch 1	Clutch 2
Copulation date	23 March	1 June
Oviposition date	22 May	4 July
Female weight after oviposition (g)	158.4	140.0
Clutch interval (days)	43	
Egg number (fertile)	6 (5)	4 (4)
Hatching date (incubation, days)	28, 29 July (67, 68)	9–11 September (66–68)
$\bar{x}$ Egg-length (range) (mm)	45.6 (36–51)	44.0 (41–47)
$\bar{x}$ Egg-diameter (range) (mm)	21.2 (20–22)	20.2 (20–21)
Clutch weight ($\bar{x}$ egg weight) (g)	64.2 (12.8) $n = 5$	48.3 (12.0) $n = 4$
$\bar{x}$ Hatchling total length (range) (mm)	263.8 (251–272)	269.5 (262–284)
$\bar{x}$ Hatchling weight (range) (g)	10.8 (7.5–12.8)	9.3 (8.2–10.9)

greeri from one young specimen taken in a rodent trap on Rancho Santa Barbara, Durango, Mexico. Gehlbach (1967) allocated subspecific status (*L. mexicana greeri*) but a recent revision of the *mexicana* complex of kingsnakes (Garstka, 1982) reduced this race to a color and pattern morph of *L. mexicana*. Until recently it has remained a rare snake in collections and nothing has appeared concerning its natural history.

A pair of these snakes maintained in the author's collection bred and produced two clutches of eggs and hatchlings in a single reproductive season. The male was taken as an adult under a rock near the type locality in September 1978. The female was captive-bred and hatched in 1978 from parents taken near the above locality. The specimens were maintained separately during hibernation at 9–15°C (15 November–15 March). Weights taken on 15 March 1982 were 134.8 and 223.6 g, respectively. Each fed on three small mice on 18 March 1982 and they were placed together on 23 March. Copulation occurred shortly thereafter. The female shed her skin on 14 May, eight days prior to oviposition. Copulation for the second clutch occurred on 1 June, 10 days after oviposition. The female shed on 25 June, nine days prior to oviposition of the second clutch. Clutch interval was 43 days. Reproductive data are given in Table 1.

Sex ratio of the nine hatchlings was five males and four females as determined by hemipenial eversion. Body/tail band counts (including tail tip) for males were 37/10, 36/11, 36/10, 35/10 and 34/9. These counts for females were 36/10, 36/9, 34/10 and 33/8. Amount of red pigment within each band varied considerably in each snake and from one snake to another.

Lampropeltis triangulum polyzona. Two females (HZG B-100, 101) were received 3 April 1978, the result of a captive-breeding (Kardon, 1979). An adult male (HZG B-112), received 17 April 1978 was collected in early April

Table 2. Reproductive data for *Lampropeltis triangulum polyzona.*

	Female B-100		Female B-101	
	Clutch 1	Clutch 2	Clutch 1	Clutch 2
Copulation date	28 April	—	29 April	—
Oviposition date	15 June	1 September	15 June	10 August
Female weight after oviposition (g)	430.5	386.8	456.0	377.5
Clutch interval (days)	79		58	
Egg number (fertile)	7 (5)	3 (3)	5 (5)	6 (6)
Hatching date	22 August	31 October	22 August	11 October
(incubation, days)	(69)	(60)	(69)	(62)
$\bar{x}$ Egg-length	59.2	65.3	70.2	62.5
(range) (mm)	(53–68)	(61–70)	(66–75)	(56–68)
$\bar{x}$ Egg-diameter	25.8	22.3	24.8	24.0
(range) (mm)	(25–26)	(21–23)	(24–25)	(24)
Clutch weight	180.8	66.2	146.4	144.3
($\bar{x}$ egg weight) (g)	(25.8)	(22.0)	(29.2)	(24.0)
$\bar{x}$ Hatchling total length	330.8	316.3	367.6	335.6
(range) (mm)	(322–343)	(297–332)	(336–402)	(325–346)
$\bar{x}$ Hatchling weight	18.4	16.6	23.0	17.8
(range) (g)	(15.1–21.5)	(15.8–17.8)	(19.5–26.7)	(13.9–19.4)

1978 by R. Hubbard in Las Tuxtlas, Veracruz, Mexico. These snakes were housed together constantly once the females reached adult size. Temperature in their unit ranged from 20–32°C from March through December. From 1 January to 1 March 1981, the specimens were placed in a cooler environment maintained at approximately 18–20°C. Feeding occurred once every 2–3 weeks during cooling and weekly at all other times.

Reproductive data are given in Table 2. Both females produced two clutches of eggs in 1981 with clutch intervals of 58 and 79 days. Grand means for 21 eggs are as follows: $\bar{x}$ egg-diameter 24.5 mm (21–26 mm), $\bar{x}$ egg-length 63.6 mm (53–75 mm), $\bar{x}$ egg weight 25.6 g. Grand means for 19 hatchlings was 339.7 mm (297–402 mm) in total length and 17.4 g (13.9–26.7 g) in weight. In these snakes, $\bar{x}$ egg weights and $\bar{x}$ hatchling total lengths and weights were considerably smaller in the second clutches. First clutch grand means for 12 eggs were 25.4 mm (24–26 mm) in diameter, 63.8 mm (53–75 mm) in length and 27.2 g in weight. Hatchlings (10) from first clutches ranged from 322–402 mm ($\bar{x}$ = 349.2 mm) in total length and from 15.1–26.7 g ($\bar{x}$ = 20.7 g) in weight. Grand means for nine second clutch eggs are 23.4 mm (21–24 mm) in diameter, 63.4 mm (56–70 mm) in length and 23.3 g in weight. Nine second clutch hatchlings ranged from 297–346 mm ($\bar{x}$ = 329.2 mm) in total length and weighed from 13.9–19.4 g ($\bar{x}$ = 17.4 g).

Lampropeltis triangulum syspila. One long-term captive female copulated with a male on 4 February 1981 and produced a clutch of six eggs 31 days

later on 7 March. Two eggs hatched on 19 April and two on 20 April after an incubation period of 43 and 44 days. The remaining two eggs were determined to be infertile. This female produced a second clutch of four eggs on 21 April 1981 with a clutch interval of 45 days. These eggs desiccated and fertility status was not determined. Reproduction in *L. triangulum syspila* was summarized by Williams (1978). One multiple clutch has been reported (Tryon and Murphy, 1982).

Calloselasma rhodostoma. A juvenile female, received 13 October 1973 and an adult male, received 4 November 1979 were placed together after the arrival of the male. The specimens were housed in a room where temperatures ranged from 18–20°C year around. Though courtship and copulation were not observed, the female laid two clutches of 11 and seven eggs on 31 March and 8 September 1981, respectively, with a clutch interval of 163 days. Nine hatchlings emerged from clutch one on 21 May 1981 with total lengths of 173–185 mm ($\bar{x}$ = 177.5 mm) and weights of 5.3–7.0 g ($\bar{x}$ = 5.6 g). Seven eggs hatched from clutch two on 17 and 18 October 1981. Six hatchlings had total lengths of 179–196 mm (184.8 mm) and weights of 5.9–7.1 g ($\bar{x}$ = 6.3 g). Incubation periods were 51 and 39–40 days, respectively. Clutch two hatchlings had slightly greater mean total lengths and weights than those from clutch one. However, the lower egg number in clutch two and the extensive clutch interval which allowed the female to replace body weight between clutches may account for the greater lengths and weights of clutch two. Smith (1943) reported clutches of 13 and 30 eggs laid 1 August and 1 September from two females. Incubation periods were 42 and 47 days.

Acknowledgments

I am indebted to David A. Blody, Richard Hudson and Gary Carl of the Department of Herpetology, Fort Worth Zoological Park, for supplying data from the zoo, and to Gary Carl and Ernie Wagner for information provided from specimens under their personal care. For gift of specimens I thank Robert M. Hubbard and Randall N. Johnson. Upon death, some specimens will be placed in the vertebrate collections of The University of Texas at Arlington and Texas A&M University.

Literature Cited

Aldridge, R. D. 1979. Female reproductive cycles of the snakes *Arizona elegans* and *Crotalus viridis*. Herpetologica 35:256–261.

Bechtel, H. B., and E. Bechtel. 1978. Heredity of pattern mutation in the corn snake, *Elaphe g. guttata*, demonstrated in captive breedings. Copeia 1978:719–721.

Fitch, H. S. 1970. Reproductive cycles in lizards and snakes. Univ. Kansas Mus. Nat. Hist. Misc. Publ. (52):1–247.

Fitch, H. S. 1980. A field study of the prairie kingsnake (*Lampropeltis calligaster*). Trans. Kansas Acad. Sci. 81(4):353–363.

Garstka, W. R. 1982. Systematics of the *mexicana* species group of the colubrid genus *Lampropeltis,* with an hypothesis mimicry. Breviora Mus. Comp. Zool. No. 466:1–35.

Gehlbach, F. R. 1967. *Lampropeltis mexicana.* Cat. Amer. Amphib. Rept. Pp. 55.1–55.2.

Kardon, A. 1979. A note on captive reproduction in three Mexican milksnakes, *Lampropeltis triangulum polyzona, L. t. nelsoni* and *L. t. sinaloae.* Int. Zoo Yearb. 19:94–96.

Kopstein, F. 1938. Ein Beitrag zur Eierkunde und zur Fortpflanzung der Malaiis hen Reptilien. Bull. Raffles Mus., No. 14:81–167.

Murphy, J. B., B. W. Tryon, and B. J. Brecke. 1978. An inventory of reproduction and social behavior in captive gray-banded kingsnakes, *Lampropeltis mexicana alterna* (Brown). Herpetologica 34:84–93.

Naulleau, G. 1973. Reproduction twice in one year in a captive viper (*Vipera aspis*). British J. Herp. 5:353–357.

Quinn, H., and J. P. Jones. 1974. Squeeze box technique for measuring snakes. Herpetol. Rev. 5:35.

Riches, R. J. 1980. "Double-littering" in *Thamnophis sirtalis similis.* Herptile 5(4):12–13.

Smith, M. A. 1943. The fauna of British India. Reptilia and Amphibia. Vol. III—Serpentes. Taylor and Francis, London.

Tryon, B. W. 1975. How to incubate reptile eggs: a proven technique. Bull. New York Herp. Soc. 11:33–37.

Tryon, B. W., and G. Carl. 1980. Reproduction in the mole kingsnake, *Lampropeltis calligaster rhombomaculata* (Serpentes, Colubridae). Trans. Kansas Acad. Sci. 83(2):66–73.

Tryon, B. W., and J. B. Murphy. 1982. Miscellaneous notes on the reproductive biology of reptiles. 5. Thirteen varieties of the genus *Lampropeltis,* species *mexicana, triangulum* and *zonata.* Trans. Kansas Acad. Sci. 85(2):96–119.

Webb, R. 1961. A new kingsnake from Mexico with remarks on the *mexicana* group of the genus *Lampropeltis.* Copeia 1961:326–333.

Weil, M. R., and R. D. Aldridge. 1981. Seasonal androgenesis in the male water snake, *Nerodia sipedon.* Gen. Comp. Endocrinology 44:44–53.

Williams, K. L. 1978. Systematics and natural history of the American milk snake, *Lampropeltis triangulum.* Milwaukee Pub. Mus. Publ. Biol. Geol. 2:1–258.

Zweifel, R. G. 1980. Aspects of the biology of a laboratory population of kingsnakes. Pages 141–152 *in* J. B. Murphy and J. T. Collins (eds.), Reproductive Biology and Diseases of Captive Reptiles. SSAR Contributions to Herpetology, No. 1.