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Captive Breeding of the Durango Mountain Kingsnake (Lampropeltis mexicana greeri) and the Arizona Mountain Kingsnake (Lampropeltis pyromelana)

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Introduction

My interest in reptiles began when I was a youth collecting reptiles for my own collection. After a few years I expanded the scope of my collecting to capture extras that I could trade with other collectors for non-local species. Eventually, I collected commercially in addition to exporting and importing reptiles. In those days, quantities of reptiles were available at a reasonable price. However, in the mid 1970's, I noticed and became affected by a gradual trend. There were more and more laws and restrictions "getting in the way", and specimens were getting more expensive and difficult to obtain. Because reptiles have never been my

primary source of income, I started to feel that the hassles and problems might be more trouble than the rewards were worth. I began looking for alternatives for my needed "reptile fix". There were several acquaintances of mine who were just beginning to captive breed some snakes. I could see a need developing for captive produced reptiles and the concept was very appealing to me.

Durango Mountain Kingsnake (*Lampropeltis mexicana greeri*)

In 1979, I purchased my first captive hatched juvenile breeding stock. I also purchased a few wild caught adults for this purpose. Among these were a few Durango Mountain Kingsnakes (*Lampropeltis mexicana greeri*). The holotype *greeri* was collected July 18, 1958 at a reported elevation of 7400 feet by Robert G. Webb and J. Keever Greer. The location was Rancho Santa Barbara (Weicher Ranch), 29 miles west southwest of Ciudad Durango, Durango, Mexico. The area is described by Kemnitz and Kruse (1986) as "very rugged rocky terrain high up on the hills which face South and West...Vegetation consists mainly of fir, pine, and scrub oak; however, cactus plants can be found all around where rock is exposed to large amounts of sunlight. Snow covers the area much of the year, and this accounts for the short activity period for most of the animals." Webb wrote the paper describing *greeri*, and Greer has the honor of having the snake named after him.

My *greeri* originated at or near Rancho Santa Barbara. The hatchlings were housed in gallon jars and the adults were maintained in 5 and 10 gallon slide top aquariums. I was influenced by the scientific community and decided to keep individual records on each snake. On the front of a 5" x 8" file card, I kept a record of the purchase or hatch date, source, who the parents were, biannual weights, and every feed and shed date. Later, on the back of the card, I would keep a record of every breeding, whether or not sperm were found in the sample taken, the date of egg laying, the number of eggs and clutch weight, the post egg laying weight of the female, egg hatching date, and the sex ratio of the hatchlings. I also recorded any special problems, parasites, disease, medications, etc.

In 1980, my "bedroom snakeroom" was ready for occupancy and my adult *greeri* were moved in. These condominium style cages are illuminated by a single 4' power twist Vita-lite® above one square foot of 1/8" wire mesh. Each cage unit measures 18"W x 24"D x 16"H. There is a hole in each floor allowing access to the inside of a drawer underneath each cage. The drawer has approximately the same floor dimensions as the upper cage, minus the back 3", with a 3" height. There is a heat tape passing behind the drawer in the created airspace under the back 3" of the floor of the cage the entire length of each cage row. This allows the snakes to go from cooler to warmer areas by going towards the rear of the cage or drawer. Each heat tape is connected to its own rheostat for heat control. The lights are on timers and I attempt a day/night light cycle during the spring breeding time. Later in the summer, my background

temperature becomes too hot; therefore, power to the lights are turned off early in the day by a master thermostat incorporated into the system to prevent the room from overheating.

The juveniles were kept warm and feeding for the first year in the "Tropical Room". On November 1st, I stopped feeding the adult *greeri* and waited approximately two weeks for complete digestion and elimination of feces. Then over a period of one to two weeks,the rheostats on the heat tapes were gradually turned down until they were off. I also turned off the lights. There is indirect light coming into the room through a plastic covered exterior window. Once every two weeks I would enter the room, check each snake, and change the water. On March 1, I would reverse the process until the heat tapes and lights were on by the 10th. I would begin feeding both sexes, but give the females extra meals. Most breeding took place in April, when the room background temperatures were 65-86°F, but there was additional warmth over or against the heat tape end of the cage or drawer.

The breeding itself was easy (see Figure 1). Put opposite sexes together and they would do the rest. Sometimes a new sex partner, or some male combat would enhance performance in this area. The average copulation time was 7-10 minutes. Being a novice I made some errors. I had no knowledge about the pre-egg-laying shed (i.e. Most colubrids will shed a specific number of days before egg-laying), or what a ready to lay *greeri* should look like. They were very different from the California mountain kingsnakes (*L. zonata*) that I was used to from past experience. I was soaking what I thought was an egg-impacted female in warm water two days before she was due to lay. When the two females looked "lumpy", I would remove any cage mates and put in a container of damp sphagnum moss for the eggs. It still surprises me how stretched and "bad" a gravid *greeri* will look prior to egg-laying. I was very please with my 1980 results: 2 clutches, 9 eggs, 4.5 sex ratio, and 100% hatch ratio.

In August of 1980, I felt the two 1979 hatchling female *greeri* I was raising should be large enough to breed in 1981 so I moved them into the "Adult Breeding Room" (Note the confidence, in 1979 the same room was the Bedroom Snake Room). Except for short-cutting the cooling and warming part (heat and lights on or off all in one day) I followed the same procedures as the year before and in 1981, before they reached their second birthday, both my "raised babies" produced 2 clutches of eggs each. Between my four adult females, I produced 6 clutches, 26 eggs, and an 8.14 sex ratio for an 85% hatch ratio. Not perfect, but since one of the younger females had produced the only 4 bad eggs (out of 7 in two clutches) and the other three females had 100% hatch ratios, I could live with it!

In 1982, adding three more females (from my 1980 hatch) I produced 46 eggs, a 16.12 sex ratio, and a 61% hatch ratio. I was not upset with these results. At the time, I rationalized somewhat towards optimism and, by looking at the records, determined that the younger females were smaller for a first breeding than the 1981 year. I was not as thrilled with *greeri* as when they were new to me, I was raising and breeding several other species of snakes, and

I had a mouse shortage. Frankly, I had neglected my *greeri* in favor of some of the other species. I felt I could fatten everybody up and in 1983 produce my best "crop" of *greeri* ever. I was so confident that I felt captive breeding of *greeri* was easy. Other people I knew were having problems with *greeri* and I was often asked for advice and it was suggested that I should do an article or paper on captive propagation of *greeri*. It felt good to be "an expert" and I said I would do a paper.

DURANGO MOUNTAIN KINGSNAKE

Female Identification Number	100% 1980				85% 1981				61% 1982				2% 1983				0% 1984				49% 1985				0% 1986			
	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H
5					4	Y	4	1.2	?	?	7	4.2	?	?	8	0	36	N	6	0	16	N	8	2.2	16	N	9	0
					?	?	3	0	?	?	5	0					16	N	?	0	36	Y	3	0				
																	4	N			?	?						
3	1	?	5	3.2	4	Y	7	2.5	1	Y	8	3.1	?	?	9	0	36	N	6	0	36	Y	7	5.0	36	N	?	0
									4	Y			?	?	?	0					?	?	2	0				
2	1	?	4	1.3	1	?	3	1.2	1	Y	4	1.2																
14									?	?	4	1.2	?	?	8	0	4	N	5	0			7	1.4	?	?	8	0
																							7	0				
13									16	Y	4	.1	?	?	5	1.0	?	?	4	0	4	Y	7	1.4	?	?	0	0
									4	Y											16	N						
6					4	?	5	2.3	4	Y	5	4.1	4	N	6	0	4	N	6	0	?	?	8	1.4	?	?	8	0
					?	?	4	2.2	?	?	4	2.2					?	?	4	0	?	?	3	0				
15									?	?	5	1.1	?	?	4	0	36	N	5	0	4	Y	7	2.3	?	?	8	0
																	7	N										
			9	4.5			26	8.14			46	16.12			40	1.0			36	0			59	12.17			33	0

249 Eggs Total, 89 Hatched=36%

ARIZONA MOUNTAIN KINGSNAKE

	0%				36%				66%				85%				36%				85%				85%			
	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H	M	S	E	H
11																									4	Y	4	3.1
1	?	?	3	0	2	?	5	4	2	?	6	2.3	2	Y	7	7.0	2	Y	5	1.3	2	Y	5	3.2	2	Y	7	3.4
3					4	N	6	0	4	N	3	.1	4	Y	6	1.3	4	Y	5	1	4	Y	4	2.2	4	Y	5	3.1
									2	Y									4	0								
5																					2	Y	3	1.2	2	Y	5	1.4
6																					2	Y	2	0	2	Y	4	.1
8																									13	Y	6	3.3
14																									4	Y	6	2.4
16																					4	Y	3	.2	13	Y	3	0
9																									4	Y	4	2.2
15																					?	?	3	1.2	12	Y	4	2.2
			3	0			11	4			9	2.4			13	8.3			14	1.3.1			20	7.10			48	19.22

118 Eggs Total, 84 Hatched=71%

Figure 1: Breeding results of Durango and Arizona mountain kingsnakes from 1980-1986. M = Identification Number of male parent; S = Good Sperm (yes or no); E = Number of eggs; H = Sex ratio of hatchlings (Male.female)

You might ask, "Why did it take 5 years to do that paper?" In 1983, I produced 40 eggs (I sold some of my wild-caught females), hatched 1.0 (deformed at that) and lost all that confidence. It was replaced by humility. What did I do wrong? I went to other breeders with notebook in hand. I tried vitamin supplements, cuttlebone in the water, feeding "vitamin balanced" fresh captured lizards. What could the problem be? The females were in good condition as far as I could tell, mated with the males, and produced plenty of eggs. The males looked good, but I couldn't find any living sperm in their semen samples. Could they "wear out" in captivity? I had males of several age groups, so I didn't think that was it. Could I have exhausted some natural vitamin reservoir that I hadn't been replenishing? Possibly, but doubtful because some of my offspring were producing for others while being fed the same food. In a chance conversation with my sister about my utility bill (she is a non-reptile oriented employee of our local power company), I felt I was given a free clue. She said that the 1982-83 winter was one of the warmest on record (see Figure 2).

My cages had a certain amount of a thermal gradient, and the way I hibernated my animals was to turn off all the heat and let mother nature do my cooling. Could this have been the problem? I kept several species and subspecies in the same room. They had been arranged by species in horizontal rows. After a marathon cage cleaning session I rearranged them vertically by species, and kept the males in the lower cages, figuring the lower cages should be cooler than the upper ones. My grandiose plans were to see if the males in the lower cages produced sperm more dependably than those in the middle cages, and to eventually be able to arrange

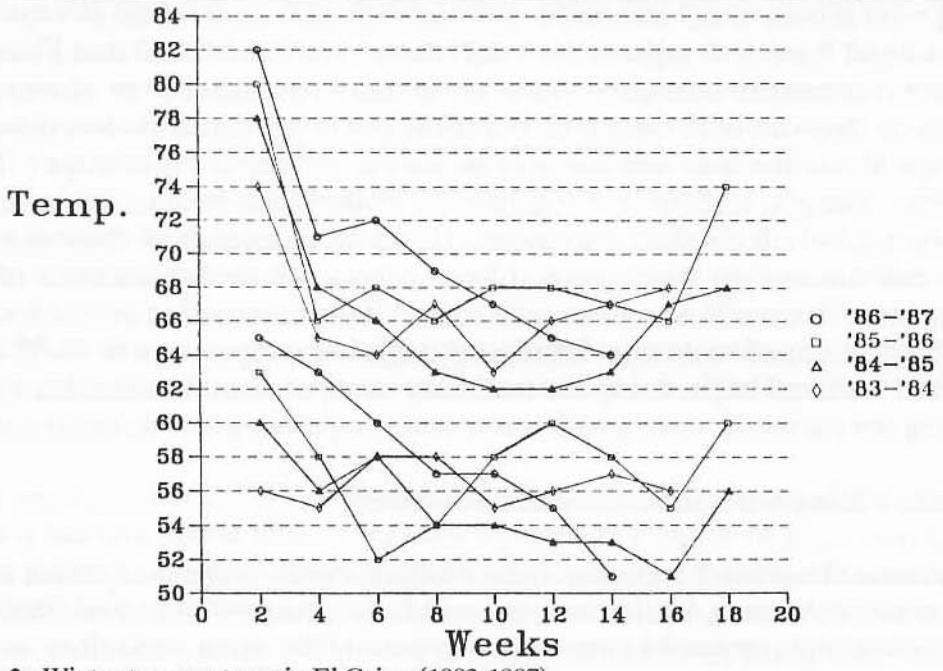

Figure 2: Winter temperatures in El Cajon (1983-1987)

the species in the room with the more temperature tolerant species in the top cages. I also bought a high/low thermometer and began recording, at two week intervals, the high and low temperatures reached during that period of time (more records to keep, ugh).

In 1984, I produced 36 eggs and none hatched. I converted the Tropical Room to a Colubrid room, with the addition of 48 more drawer type cages. These measured 12" x 24" x 10" high, with a 1.5" deep drawer under each. There is no light over each cage, and no heat in each cage. The room temperature is controlled, and the back of the cages are against a cool north wall, so there is a little temperature variance in each cage. There is no consistant light cycle. The heat in the room is produced by incandescent lights on a thermostat. They tend to be on at night when it is cooler. An overhead fluorescent light is on when I turn it on for illumination and is often on or off for days at a time. There is indirect light filtering in through outside windows, through the cage glass and screen of the cages that make up two of the outer walls of this room, before reaching the inner cages. This room is on the north side of my house and averages a few degrees cooler than the Bedroom Snakeroom (southwest corner of the house). I have continued to record the bedroom temperatures for comparative year to year purposes.

In late 1984, I moved the entire *greeri* colony into the garage colubrid room. In 1985, I produced 59 eggs, 29 of which hatched with a 12.17 sex ratio. In 1986, I produced 33 eggs and again none hatched. The 85-86 winter was warmer than the 84-85 winter.

Figures 1 and 2 seem to support my "cool" theory, but I don't feel that I have enough data, or consistent success to announce to the world that I have solved the mystery. I never did like graphs, as they can look complete, but leave out important considerations. For instance, the graph shows the high and low for two weeks. Where did it average? The graph and I don't know. The graph also doesn't include the snakes ages, weights, parasite load, and general condition, all of which affect the results. However, in spite of all these disclaimers, I believe that I will successfully hatch *greeri* if I can keep a relatively consistent hibernation temperature of 50-55°F from November 1 to March 1. If the hibernation period is successfully controlled then all I need to do after increasing the room temperature to 75-85°F is to get the *greeri* to feed well and begin doing the necessary manipulation for breeding (combating males, switching sex partners, misting with warm water, separating and reintroducing etc.).

Arizona Mountain Kingsnake (*Lampropeltis pyromelana*)

The Arizona Mountain Kingsnake is also a higher elevation snake reported to frequent mountainous areas of Arizona, Utah, Nevada, and Mexico from 4500' to over 7500' in elevation. I have maintained my *pyromelana* colony in exactly the same conditions as the *greeri* colony. I believe the *pyromelana* can breed and produce eggs at higher temperatures than the *greeri*. Part of this belief is based on the following occurrences within my breeding colony.

When I first started with *pyromelana*, I had two pairs of adults. One of the males was sold to me as a captive born "proven breeder." For several years he mated, but failed to produce living sperm. The second male, in the adjoining cage on the same level mated and fathered young during this period. The "sterile" male was a particularly attractive animal; therefore, I kept him around, even though, I felt that I had made a bad purchase, and he was useless as a breeder. When I moved the *greeri* and *pyromelana* colonies into the garage (cooler) snake room, the "sterile" *pyromelana* male began to produce sperm the following spring and hasn't missed since.

Over the years, I have had a few male *pyromelana* that have not produced viable sperm, but no "all or nothing" mass male sterility as was noted with the *greeri*. When a female *pyromelana* has mated with a "sterile" male, I have followed that up with a second male who produced sperm and good eggs have followed. This fact supports my hypothesis that the problems I have been having with fertile egg production is centered in the males. Occasionally, I have had bad eggs from a female that mated with a "good" male, but I have never had a good egg from a female who mated with a "sterile" male unless the mating was followed by a mating with a good male.

Differences Between The Species

One would expect higher elevation snakes, closely related, to have similar habits. There are some notable differences. The most obvious difference I have seen is their feeding habits. The *greeri* will usually feed well right up to time to hibernate. It is usual for the *pyromelana* to feed sporadically or refuse to eat altogether as early as August or September, even though they are kept warm until November. The females usually refuse food earlier than males. I have had to really concentrate on putting weight on the *pyromelana* early in the year with extra feedings to successfully breed this species. The weight records kept on each snake have really helped me determine if a *pyromelana* has attained optimum weight. When my charts show I have been successful putting full weight, or additional weight back on a female, I have usually been rewarded with larger clutches of eggs. My smaller, or thin snakes have produced good clutches with as few as 2 eggs, my larger females have produced up to 7 eggs in a clutch. I would suggest cooling the *pyromelana* soon after they become "finicky" eaters to help conserve the weight.

At one time, I entertained the thought that I could breed to produce babies that would aggressively feed on pinkie mice. One year I produced a clutch of *greeri* that fed voraciously on pinkies, no tricks needed. I thought this would be a great combination, so I bred the same adults and produced another clutch the following year. All the second year babies refused normal pinkies and had to be tricked into accepting them. I have no explanation for this. Fortunately, both *greeri* and *pyromelana* are easy to trick into accepting normal pink mice and are growing rapidly.

The *pyromelana* breed early in the year. Mine have been observed breeding as early as March 30. I have records that show eggs being produced as early as 25 days after an observed mating to 58 days after a mating. It is important to remember that some of my animals are kept as pairs and probably mated unobserved. This could explain the 25 day period. Based upon a large sample average time between fertilization and egg-laying is probably 40-45 days.

One tip on raising *pyromelana* I feel I should mention concerns parasites. When I first obtained or raised my breeder stock of various species to adult size, I wanted a colony free of parasites. Several of my wild caught, or captive hatched snakes that I had fed on wild lizards (yes, feeding wild parasite laden lizards was dumb, but this was during the "vitamin sterility" crisis) had *Trichomonas*. I read several veterinary sources that suggested using metronidazole (Flagyl®) in doses varying from 100 mg/kg to 250 mg/kg to kill these protozoans. I decided a dose of 125 mg/kg would be a compromise and dosed all the infected snakes. Out of a total of about 40 snakes, one milksnake (*L. triangulum*) died, and several of the *pyromelana* showed an adverse reaction. They acted like they had a nervous disorder, twitching about the head and neck. One female had difficulty maintaining her balance and would partially roll over when crawling. All the *pyromelana* recovered (the worst female twitched for two years), but I have since discovered that a dose of 50 mg/kg is plenty to kill *Trichomonas*. None of the other snakes I treated were visibly affected by the treatment, and the colony was apparently free of *Trichomonas*.

Another difference is egg-laying. It is common for a *greeri* to lay two good clutches in a season. I have never had a *pyromelana* lay two good clutches. In fact, I have seen only one double clutch from a *pyromelana* and all eggs of the second clutch were yellow, hard, and obviously infertile.

Conclusion

Both the *greeri* and the *pyromelana* are hearty captives, and thrive with a minimum of care. If you can convince the babies to feed on pinkie mice through their first winter, they can and will produce their own babies at two years of age.

At what could have been a conclusion of this paper, you might be wondering, "Why doesn't he air condition the room?" That is a very good question, and I might, but with my present set-up it would be very expensive and it raises other questions. Could air conditioning dehydrate the snakes? Do snakes need some sort of fluctuation to clue them in to when it is Spring? Could it cause some other unanticipated problem? There are still too many questions unanswered for a private, unfunded individual (me) to risk a major change to a large, and overall successful breeding collection of snakes. I have lots of data, and if there is any institutional or other person/group willing to accept the challenge and do a really "Scientific Method"

type work-up on the problem, all my data is available to you, IF you share the progress and results with me.

References Cited

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Acknowledgments

I would like to thank many unnamed individuals who have helped me, over the years, in obtaining the knowledge I have. You know who you are. I would also like to thank my customer/friends for purchasing my offspring and preventing a major over-crowding situation.

Addendum

The temperatures stayed low in February and March 1987 and during the spring of 1987 I have many fertile male *greeri*, which have produced many good *greeri* eggs in the incubator at the time of editing this paper (7-14-87).