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THE LIFE OF NATRIX VITTATA (L.)

by

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General character

Natrix vittata, the striped swimmer, is a harmless little snake, about half a meter long and as thin as a little finger, living in Java on coastal plains and in the hills up to 1200 m above see level. In a given area she will be very common but in adjacent regions, which to us may present exactly the same character of humidity, altitude, temperature, vegetation, etc., there will be only very occasionally a *Natrix vittata* among the catch (de Haas, 1941a).

Even in the field she is easily recognisable, as she will lift her head high enough to show the curious design of her ventral shields. If there is an opportunity for examining the snake more closely, the twin small white spots on the head shields will identify her. The colour of the body is light bronze with a dark stripe on the spine and two stripes running on the sides.

Although she moves gracefully and swims very well, she is easily caught but even then never tries to bite. There is some wriggling of the body in the hand and around the wrist but the head is erect and projected as far forward as possible swinging right and left in the attempt of seeking a way to escape. There is really only one disagreable feature about this natrix: when caught and especially when afraid or when too roughly gripped, she will open the cloaca and discharge the contents with a characteristic, most persistent and very unenjoyable odour. She is easy to maintain in captivity and unlike many other snakes, will take food readily. Once I saw three of these natrices in a cage, each gripping a part of the same small frog. Her inquisitiveness in the search for food makes her run big risks and her agility is only partly compensation for the lack of strong powers. This is well illustrated by the fact that in a group of 66 female adults about half of these show mutilated tails. There is no sign of regeneration of the stump which can be very short, only two or three caudal shields from the cloaca. The frailness of the tail is easily demonstrated: when one picks a *Natrix vittata* by the tail, the snake starts to screw herself round and round and very soon the tail breaks and she is free. The chances of escape out of the bad spots she runs into without losing at least part of the tail diminish with increasing age (or with the increasing number of occasions), for if we divide these snakes in a group with body length shorter than the average and a group longer than the average, we find 35 small animals with amongst them 14 with a broken tail and 31 longer animals with 22 mutilated ones. For these groups the $chi^2 = 6.1$ and P is between 0.02 and 0.01 so the difference is significant. As to the sexes in this respect the figures are in a somewhat larger group, under 75 adult females 37 mutilated and under 73 males 29 mutilated, $chi^2 = 1.52$ and P is larger than 0.1 there is no significant difference.

The preferred habitat is grassland or ricefield areas where many small ditches cross the terrain. By far the most important item on the menu is small frogs. Very often parasitic worms will be found between the skin and the underlying muscles or even deeper between the muscles of the body wall and the peritoneum. When casting her outer skin, she does it mostly in pieces and never hangs it in its entireness as a display of discarded old garments on a shrub or a stone as is the arrogant way of the cobra.

Material and problem

Apart from the description in systematic zoology, a few things are known about *Natrix vittata* by the work of Kopstein who gives data on eggs and who measured the growth of a few newborn animals during the first year of their life. For the present investigation 154 animals were used, 58 of them collected by the author from the coastal plains near Surabaia (East Java) between 1936 and 1942, and 96 caught under supervision of Mr. van Hoesel on plains in the hills of Tjimahi (West Java) at 600 m altitude [1]). Using these data together it seems possible now to find out the main points in the life history of this snake.

Method

The animals were brought alive to the laboratory and put to death by pricking with a needle through the foramen occipitale into the medulla. In

1) The original Surabaia collection was somewhat bigger but was lost through the japanese plunder. About 4/5 of the data could be saved by the help of Dr. The Tiong Hoo.

this way sensibility is instantaneously destroyed and also the coordination of the movements, which is, where poisonous snakes are used, important too.

The usual narcotics are not suitable, they take a long time to act, cause strong irritation with bleeding from the lung and kill the animal as soon as unconsciousness seems to be reached.

After decerebration, the animals are weighed, hooked on a split bamboo where the animals still wriggle, but are kept straight enough by hooking a small weight (a tin with a certain amount of sand) on the tail. Through a ventral cut in the skin, a needle is inserted into the aorta, the heart continues to beat and during one or two minutes an isotonic salt solution (Radsma, 1948) is sent into the vessels at a pressure of 180 mm Hg. Herewith a good deal of the blood is washed away, enough to prevent obstruction of the vessels by blood clots when the canula carrying the isotonic solution is changed for one carrying the fixation liquid of Bouin. The heart continues then to beat for 20 to 30 pulsations, the animals soon show fibrillar contractions while the yellow colour of the picric acid appears, they stretch and become rigid. The perfusion is continued for 15 to 20 minutes and then the animals are kept in 5 % formalin. For bigger animals the perfusion takes longer.

After one or more days, the ventral wall is cut, the animal briefly rinsed in water and put on the measuring apparatus, the snout in touch with a block. The apparatus is a board bearing a metal rule divided in mm, with a slide whereupon a square needle is mounted in a shaft. This needle is upheld by a spring and can be brought down on the object by the pressure of a finger and when released it goes up again. So the cranial and caudal end of each organ are measured, the figures dictated and repeated by the assistant who is writing them down on the forms used.

Fertility

According to Kopstein (1938), oviposition is the whole year round a more or less regular affair, except in the dry season. Out of 61 nests of eggs, 50 were collected from November till May and only 11 in the five other months. For an adult female the average number of eggs is five at a time and the next laying will occur after an interval of 36 days, this being repeated five or six times a year. It may be noted that Kopstein saw more than one nest of fertile eggs laid after one single copulation. Of the eggs about two thirds are hatched: when laid in captivity 73 came out of 108 and when collected on the field 154 out of 254 or 68 % and 66 %. The females in my series average 37 grams in weight and produce yearly about twice their own weight in eggs.

EGGS

Out of the data given by Kopstein, the averages were computed for length and width in mm and for weight in centigrams, the figures are listed in Table 1.

TABLE 1

Eggs	Length	Width	Weight wild	Weight captive
N	207	207	139	96
R	19—33	9—3	122—203	143—198
M	23.5 ± 0.2	10.7 ± 0.05	156 ± 2.0	175 ± 1.5
σ	3.0 ± 0.15	0.8 ± 0.04	23 ± 1.4	14.5 ± 1.04
V	12.8 ± 0.6	7.1 ± 0.3	15.1 ± 0.9	8.3 ± 0.6

The conclusion of Kopstein that the eggs laid in captivity are heavier than the other ones is justified as $D/\sigma_D = 7.6$.

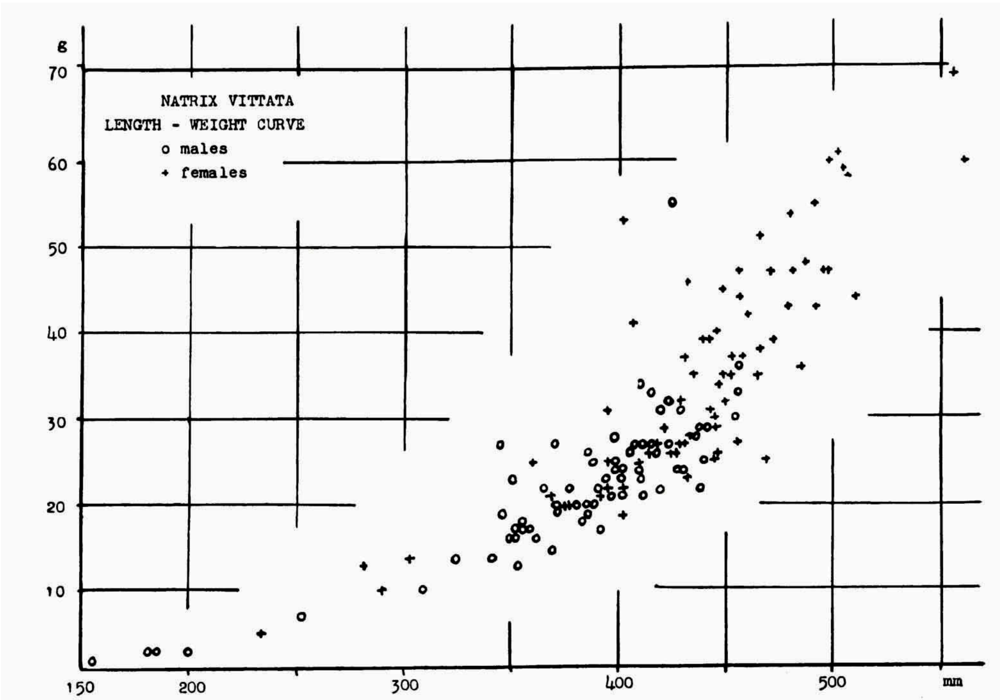

Fig. 1.

The anatomical dissection of 75 adult females (Surabaia and Tjimahi) showed that on account of the findings in the ovaries, the animals can easily be divided in two groups, one group where the ovaries bear numerous small spherical eggs of 3 to 4 mm in diameter and a second group with in each ovary a few, usually three or four elongated eggs, the long diameter from 10 up to 24 mm. These eggs remain in the ovaries until they reach this length and are then released and shoven into the uteri. The number of observations is rather small, but if we group the available data in bimonthly periods, it seems that the procentual distribution of pregnancies (long eggs in the ovaries and eggs in the uteri taken together) precedes the corresponding value in the distribution of collected nests by about one such period (Table 2).

TABLE 2. Number and % of pregnant females (eggs longer than 10 mm) and % of nests collected in bimonthly periods.

	Tjimahi		Surabaia		%	Nests
	+	—	+	—	+	%
Sept.-Oct.	7	8	1	2	10.6	8.4
Nov.-Dec.	8	12	1	3	12.0	25.—
Jan.-Febr.	9	3	3	3	16.0	25.—
Mrch.-Apr.			7	3	9.3	20.—
May-June			2	3	2.7	18.—
July-Aug.						5.—
Total	24	23	14	14	50.6	99.4

Birth

When the young snakes slip out of the egg shell, the males seem to be a little longer than the females, Kopstein supplies the data on 45 male and 60 female newborn animals. If we figure the average as is shown in the next table, the difference is not an imposing one although not clearly negligible, $D / \sigma_D = 2.3$. The fact is contradictory to what is shown in later life and the difference is of small order of magnitude, 2.5 %, in comparison with the difference between adult animals, 12.5 % (Table 3).

TABLE 3

Total length	Neonati	
	♂	♀
N	45	60
R	142—180	130—176
M	163.7 ± 1.2	159.3 ± 1.4
σ	8.07 ± 0.85	10.65 ± 0.97
V	4.93 ± 0.51	6.7 ± 0.60

Sex ratio

Amongst his 105 newborn animals Kopstein found a sex ratio of 43 % males and 57 % females and in a group of adults he found another ratio.

Looking at the figures for Surabaia and Tjimahi and using the chi^2 test we do not find a difference between these groups nor between them and the neonati of Kopstein. The same test indicates a difference between the adults of Kopstein and of our series, probably quite accidentally, as Kopstein does not present his data as collected by the method of random sampling (Table 4).

TABLE 4. Sex ratio.

	N			%	
	♂	♀	total	♂	♀
Adult Kopstein	26	57	83	31	69
Adult Surabaia	30	28	58	52	48
Adult Tjimahi	43	47	90	48	52
All adults	90	132	231	43	57
Neonati Kopstein	45	60	105	43	57

Growth

It is much more difficult to find data about the following fate met by the young *Natrix*. Once again Kopstein supplies a few data on growth.

He measured the total length of a young male and a young female at short intervals and gives the length at one year for 4 male and 6 female animals and the same for 3 male animals at two years of age. To make a comparison with the data for adult animals I had to convert the data of Kopstein to the body length, taking a quarter of the total length for the tail. I think this can be done because a nest of six very young animals, a week or ten days old, caught at Tjimahi, had an average total length of 166 mm with a tail length of 44 mm or 25 % of the total length. This was also found in adults by Kopstein (1941), who notes in his table 65 a % of 23.8 — 26.8 for males and 24.6 — 27.8 for females, and in my own series for adults the averages for total length and length of tail are for males 538 and 136 mm and for females 604 and 160 mm or 25.3 and 25 % respectively. So in this snake the same ratio between total length and length of tail is found for neonati and adults and for adults of both sexes; it persists during life.

The data on growth of Kopstein thus modified into bodylength and put together for weekly intervals appear in table 5.

TABLE 5. Body length, adapted from Kopstein's data.

	♂	♀		♂	♀
neonati	123	116	15 weeks old	234	—
1 week old	128	—	17 weeks old	—	263
2 weeks old	—	130	42 to 56 weeks old	maturity	
3 weeks old	—	158	52 weeks old	341	400
4 weeks old	146	—	104 weeks old	352	—
7 weeks old	203	218			

The length of the newborn is nearly doubled after four months and to double again it takes eight more months, whereas in the following year the gain in length is only about 3 %. The formula given by Simpson and Roe (1939) for constant growth

$$G = 2.3026 \frac{\log Y_t - \log Y_O}{t}$$

gives for the three mentioned periods the following figures in weekly procentual growth. For the first third of the first year for males 4.3 and females 4.8; for the next two thirds for males 1.02 and females 1.2; for the second year for males 0.046 and for females unknown.

Maturity

It seems obvious that at the end of the first year in Kopsteins animals the rate of growth changes abruptly to a very much slower one. The same author observed that sexual maturity was reached by a female at the age of 10½ months and by another at 13 months. These two biologically important events take place at the same moment and in *Natrix vittata* coincide with a body length of 400 mm for the female animal. As I pointed out before (Bergman, 1941) the first bend in the curve of Galton for body length gives an indication of the length of the animals at the border between youth and adult life, because in female animals 'long' eggs are never found in the ovaries of animals ranging in the first sharp rise of the curve. If for *Natrix vittata* we put together the observations of Kopstein on growth and maturity and from our series the point of inflection in the curve of Galton between the first rise and the middle part and also the body length of the smallest female bearing eggs longer than 10 mm, all these points show a very good concordance (Table 6).

TABLE 6.

	Inflexion point in the curve of Galton at		Smallest female with long eggs	Mature female	Length at one year	
	♂	♀			♂	♀
Surabaia	330—350	350—370	369	—	—	—
Tjimahi	320—340	360—390	360	—	—	—
Kopstein	—	—	—	400	340	400

Length of life

We may reasonably assume that after the first year growth will continue at practically the same rate and the length of the individual will be proportional to his age. Can these two data give us a measure for the age of *Natrix vittata*? (Fig. 2).

In the series from Surabaia and Tjimahi we find for the longest male a body length of 457 mm and Kopstein observed a value of 340 mm at the end of the first year. In the supposition that these single data are probably near to the average values for one year olds and very old animals, the figured weekly procentual growth of 0.046 will demand for the difference between

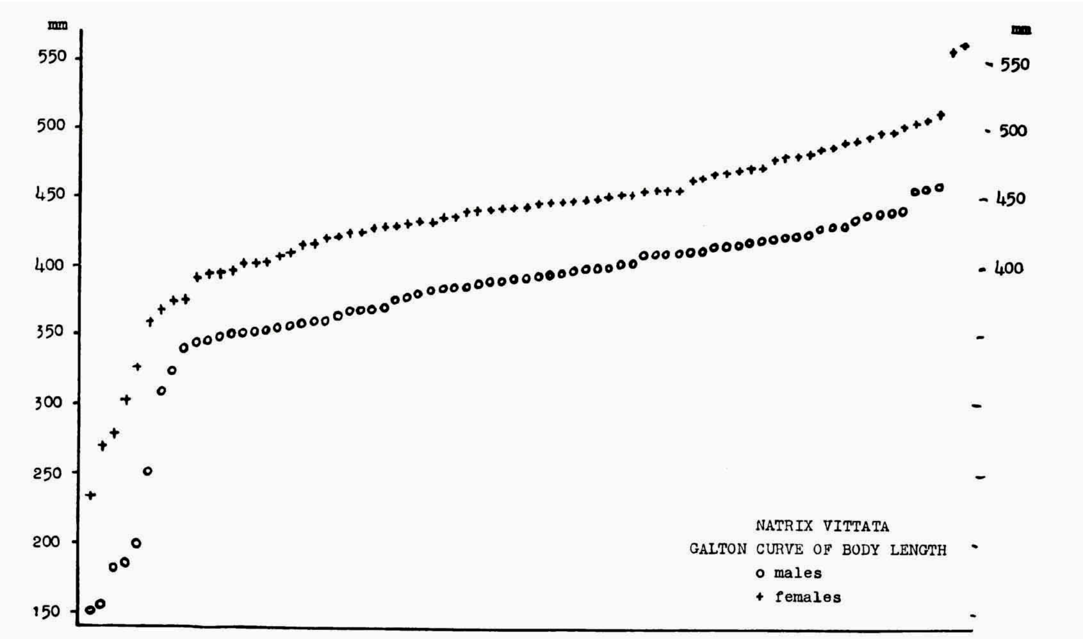

Fig. 2.

these measures a period of 440 weeks. Together with the initial 52 weeks this means a post natal span of life of round 10 years for male animals.

As there is no observation available for the growth past the first year for females, we have to try another way. In our series the longest female is much longer than the longest male, what could be explained either by a faster rate of growth in females or by a longer life. There certainly do not appear to be many biological arguments to sustain the latter probability, as a rule there will not be much difference between the length of life for male and female animals of the same species. Neither is it a priori probable that after maturity is reached, the sexual difference in growth rate has to persist.

On the other hand, comparing the curves of Galton for both sexes we will see that the curve for the male animals misses the last rise. If we look for the point in the female curve which corresponds with the last value (456 mm) of the curve for males, it will be a length of 510 mm for the female. The difference between these 510 mm and the length of the one year old female 390 mm, if to be gained in the same stretch of life as the male animals show, requires a growth rate of 0.041 in weekly %, which is about the same rate as found for adult males. This in contrast with the marked sexual difference in growth rate in the first year. In this supposition, the last value observed in the female curve (560 mm) would represent a very old animal and this maximum length of life would amount to round 17 years.

Population pyramid

The next important point is to gather information about the population pyramid and the death rate of this species. In a sample of 68 female adult animals, divided in classes with 15 mm intervals, σ is 36.9 and the theoretical distribution given by Simpson & Roe (1939) as

$$Y_O = \frac{68 \times 15}{3.69 \times 2.51} = 12.2$$

For the design of a population pyramid it is also useful to figure the theoretical year length and see the distribution of the individuals over these classes. Taking for both sexes a rate of growth of 0.046 % weekly, the values figured for every year are seen in Table 7 together with the number of animals falling within these class limits.

TABLE 7. Figured body length in mm at x years of age and number of snakes observed in these classes.

	Male			Female		Male			Female
Year	Length	N	N	Length	Year	Length	N	N	Length
1	340			390	10	450	4	4	484
2	352	8	4	399	11	463	4	4	495
3	363	5	4	409	12	477		6	507
4	374	5	3	419	13	493		1	520
5	386	6	6	429	14	507			532
6	397	9	7	440	15	523			545
7	410	9	12	450	16	537		1	558
8	423	11	7	461	17	551		1	571
9	436	5	6	472					

For females the theoretical and the observed distributions at intervals of 0.6σ are given in Table 8, together with the number of animals in corresponding two year classes.

TABLE 8. Body length. Theoretical and actual distribution with class interval 0.8 σ for males and 0.6 σ for females and the distribution according to the figured age.

		Male adults				
Interval	mm	theor.	actual	actual	age	mm
M + 2.8 σ	—484	0.3	1			
M + 2.0 σ	—459	1.7	7	7	10/11	—463
M + 1.2 σ	—434	6.1	16	16	8/9	—436
M ± 0.4 σ	386—409	12.6	17	18	6/7	387—410
M — 1.2 σ	—385	6.1	14	11	4/5	—386
M — 2.1 σ	—360	1.7	11	13	2/3	—363
M — 2.8 σ	—335	0.3			/1	—340

		Female adults				
Interval	mm	theor.	actual	actual	age	mm
M + 3.3 σ	—574	0.1	2	2	17/	—571
M + 2.7 σ	—552	0.3			15/16	—558
M + 2.1 σ	—530	1.3	1	1	13/14	—532
M + 1.5 σ	—508	4.0	10	10	11/12	—507
M + 0.9 σ	—486	8.1	9	10	9/10	—484
M ± 0.3 σ	443—464	12.2	19	18	7/8	440—461
M — 0.9 σ	—442	8.1	14	14	5/6	—439
M — 1.5 σ	—420	4.0	7	7	3/4	—419
M — 2.1 σ	—398	1.3	5	5	1/2	—399

For males the theoretical curve is figured at intervals of 0.8 and compared also with the actual distribution and the number of individuals in double year classes. The class-limits overlap only slightly, the yearly increase in length is of the order of magnitude of σ/3 and the differences between the theoretical, the observed and the age distributions do not seem to be very important.

Death rate

A general idea of the death rate in a population can be gathered from the number of females in an unselected sample and their fertility, assuming that the constitution of the population from which the sample is drawn can be considered to be constant. In the present case there has been no selection and the fact that the Surabaia and Tjimahi groups are very much alike points to the constancy of the observed distribution.

Taking the figures for the Tjimahi group alone, there are out of 47 females 42 longer than 400 mm or more than one year old and mature. They give a yearly average of 5 × 5 eggs, together 1050 eggs. 2/3 will hatch and of these 700 living young 57 % or 400 will be females. If the group is to be constant there will have to be 400 deaths too, the gross death rate for females will be 400/447 or 89 %. For males the figure is approximately the same, 300 young males added to a total group of 43 or a gross death rate of 300/343 or 87 % per year.

Djakarta, 1948.

LITERATURE

BERGMAN, R. A. M., 1937. Het fixeeren van materiaal voor anatomisch onderzoek. Geneesk. Tijdschr. Ned. Ind., vol. 77, pp. 997-1005.

——, 1938. Een nieuw orgaantje bij zeeslangen. Ibid., vol. 78, pp. 2061-2070.

——, 1941. Tumoren bij slangen. Ibid., vol. 81, pp. 571-577.

——, 1941a. Acrochordus javanicus Hornst. Treubia, vol. 18, pp. 207-211.

——, 1941b. Enhydrina schistosa. Natuurw. Tijdschr. Ned. Ind., vol. 102, pp. 9-12.

BOUIN, P. Traité d'histologie. Paris (Masson).

HAAS, C. P. J. DE, 1941 a. Het genus Natrix. Tropische Natuur, vol. 30, pp. 23-31.

——, 1941 b. Some notes on the biology of snakes and on their distribution in two districts of West Java. Treubia, vol. 18, pp. 327-375.

——, 1949. The genus Natrix in the collection of the Raffles Museum and its distribution in the Malay Peninsula. Bull. Raffles Mus., Singapore, pp. 78-97.

HOESEL, J. K. P. VAN, 1948. Snake hunting. Treubia, vol. 19, pp. 525-538.

KOPSTEIN, F., 1938. Ein Beitrag zur Eierkunde und zur Fortpflanzung der malaiischen Reptilien. Bull. Raffles Mus., Singapore, nr. 14, pp. 81-167.

——, 1941. Über Sexualdimorphismus bei malaiischen Schlangen. Temminckia, vol. 6, pp. 109-185.

RADSMA, W., 1948. Inleiding tot de physiologische chemie. Groningen, Batavia (Wolters).

ROOIJ, N. DE, 1917. The Reptiles of the Indo-Australian archipelago, vol. 2, Ophidia. Leiden (Brill).

SIMPSON, G. G. & A. ROE, 1939. Quantitative Zoology. New York & London (McGraw-Hill).

TOLEDO PIZA, S. DE J., 1930. Consideracoes a respeito da determinacao biometrica das especies en ophiologia. Rev. Agric., vol. 5, pp. 125-141.