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## The Anatomy of *Calamaria multipunctata* (Boie)

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### INTRODUCTION

The group *Calamaria* or *Changulia* does not seem to be very well defined. De Rooij (1917) describes 46 species, including 23 from Borneo; Smith (1943) describes only 3 species while de Haas (1941) mentions 68 species, of which nearly half (29) are from Borneo, 14 are from Java, 4 are from both islands and the rest from the other islands. It seems worthwhile to investigate this group more closely.

The name *Calamaria* may be derived from the Greek *Kalamos* (reed or flute) or from the Latin *Calamus* (a pen). The word may have been chosen to describe a morphological character, i.e., the snake is small and slender like a pen. Alternatively it may have been used to indicate an ecological particularity, i.e., the animal lives among reeds or bamboo. Boie (1827) does not give an explanation. The word *Changulia* has been used by Gray (1833–35) without comment. Prof. Kuiper, whom I thank for his kind help, informs me that there is a Hindi word in a Russian dictionary spelt "changuli", *changuliya*, meaning little finger. In other sources this word is written *chungliya, chinguli* or *chungli.* It seems quite possible that this word has been chosen to indicate that it is a small snake, as big as the little finger. Other derivations, from *cangul* (claw, talon) or from *congol* (grass) and *iya* (animal) would seem less probable. This snake has a short obtuse tail, ending in a pointed scale. When taken in the hand it wriggles, pushing this scale against the palm of the hand or between the fingers, making an impression more or less similar to that made by a bird's claw. The name would then mean, the snake with the claw or the claw-like end. The combination of grass and animal could indicate the mean habitat of the animal.

The local name in the western province of Java is *oraj surapari,* which in Sundanese, is translated as, a small poisonous snake with a red point at the end of the tail.

The description given by de Rooij (1917: 174) is very clear and in her illustration (fig. 67) the two extreme types are shown. The animals I have seen were more often uniformly dark on the back, with a few coloured spots. The lower surface was mostly red, with black quadrangular spots, the darker colour being predominant.[1]

[1] Boie describes *multipunctata* as "supra e cinero et purpurascenti pallida, subtus albida, tota maculis parvis subquadratis varia . . ."

TABLE 1

*Calamaria multipunctata*, maximum lengths in mm

| | UNSEXED | | MALES | | FEMALES | |
|---|---|---|---|---|---|---|
| | Body | Tail | Body | Tail | Body | Tail |
| de Rooij, 1917 .. | 305 | 15 | .. | .. | .. | .. |
| Kopstein, 1941 .. | .. | .. | 306 | (33) | 338 | (17) |
| de Haas, 1941 .. | .. | .. | 264 | (26) | 340 | (17) |
| Bergman .. .. | .. | .. | 253 | (27) | 358 | 18 |

TABLE 2

*Calamaria multipunctata*, length of body and tail of animals longer than 150 mm

| Body Length | N | R | $M \pm \sigma_m$ | $\sigma$ | V |
|---|---|---|---|---|---|
| *Males*: | | | | | |
| Kopstein .. .. | 17 | 159–306 | 222.5±9.2 | 37.9 | 16.8 |
| de Haas .. .. .. | 181 | 153–264 | 212.6±1.8 | 24.2 | 11.4 |
| Bergman .. .. | 67 | 164–253 | 211.4±2.4 | 19.4 | 9.2 |
| *Females*: | | | | | |
| Kopstein .. .. | 48 | 164–338 | 262.4±5.0 | 34.8 | 13.3 |
| de Haas .. .. .. | 191 | 160–340 | 260.4±2.9 | 40.5 | 15.5 |
| Bergman .. .. | 55 | 222–358 | 274.4±3.9 | 29.1 | 10.6 |
| Tail Length | | | | | |
| *Males*: | | | | | |
| Kopstein .. .. | 17 | 14– 33 | 22.5±1.1 | 4.4 | 19.5 |
| de Haas .. .. .. | 181 | 12– 26 | 20.2±0.2 | 2.7 | 13.4 |
| Bergman .. .. | 67 | 14– 27 | 21.2±1.0 | 2.7 | 12.5 |
| *Females*: | | | | | |
| Kopstein .. .. | 48 | 8– 17 | 13.1±0.3 | 2.0 | 15.4 |
| de Haas .. .. | 191 | 6– 17 | 11.9±0.2 | 2.3 | 19.3 |
| Bergman .. .. | 55 | 10– 18 | 13.0±0.2 | 1.8 | 13.5 |

## MATERIALS AND METHODS

Most of our specimens came from the Bandjarwangi Estate in West Java, where Mr. de Haas, then superintendent, collected them from 1939 to 1942. They were put in small plywood boxes together with wet moss and survived the journey of some hundreds of kilometers to Surabaia very well. A few were captured near Surabaia. Altogether there were 83 males and 80 females.

The snakes were killed by occipital puncture, weighed and perfused through the aorta with isotonic saline followed for hardening by Bouin's liquid. Then the distances from snout to the top and the end of each organ were measured.

For statistical analysis the methods given by Simpson and Roe (1939) have been followed.

Furthermore, we have the data on the length of body and tail of 18 males and 48 females given by Kopstein (1941) and of 184 males, 191 females and 62 unsexed juveniles from de Haas (1941). In one of Kopstein's male specimens the tail is too short, but the sex is probably correct as the number of ventral scales indicates. In the list given by de Haas, three snakes listed as males (No. 776–834–2676) are grouped as females on account of their tail length. The measurements for these two series together with those of the group studied in Surabaia are given in Table 2.

## PATHOLOGY

In my series I noted in 8 instances that the gallbladder was filled with a clear watery liquid. This occurred in three females with a body length of 175, 200 and 268 mm. respectively, and in five males, three of 148, 195, 200 and two of 217 mm. In Kopstein's list one male with a body length of 233 mm. is noted with a broken tail, a rare occurrence in these snakes.

## SIZE

The maxima listed in the literature are summarized in Table 1. The figures in brackets do not refer to the animal whose body length is given. The figures for *Calamaria linnaei* (Boie) are taken from de Rooij (1917).

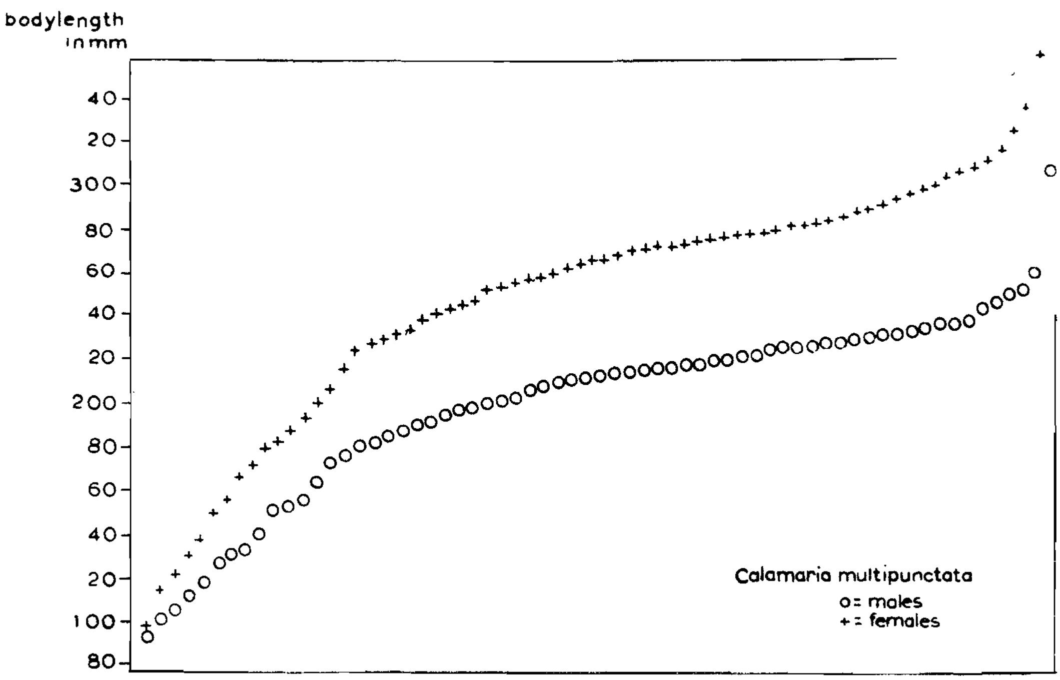


Figure 1. The series of body lengths in the male and female group.

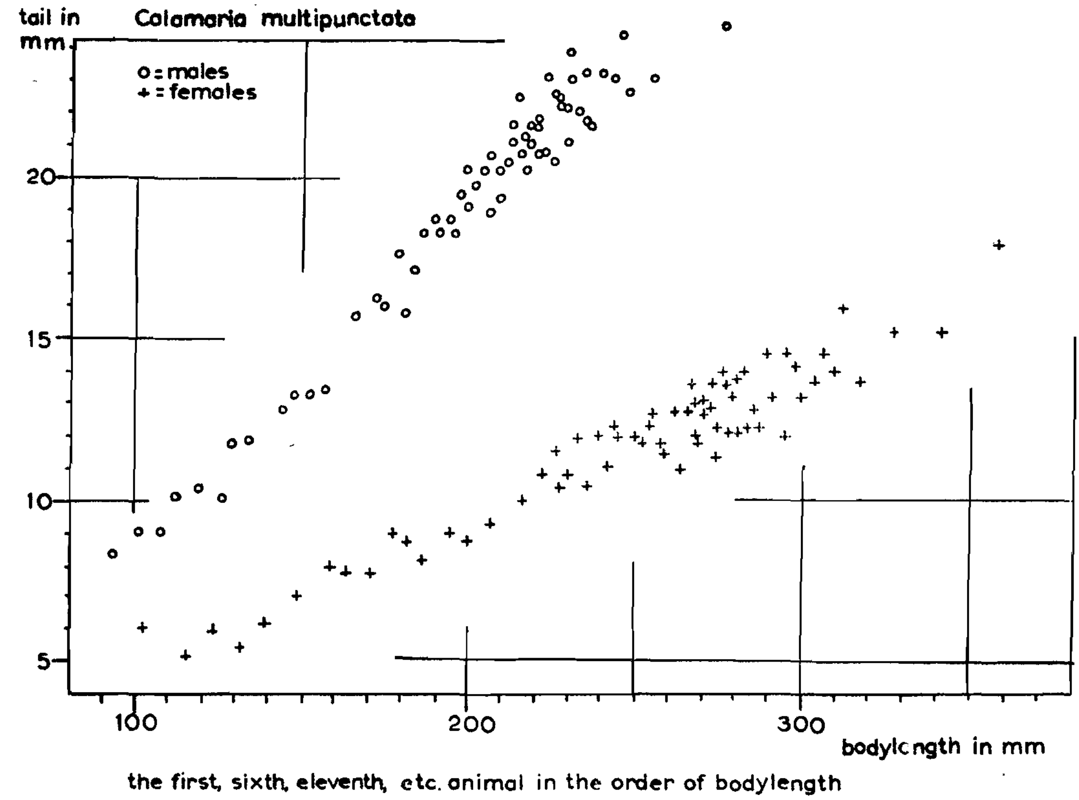


Figure 2. Scatterdiagram of the body length and the tail length in both sexes.

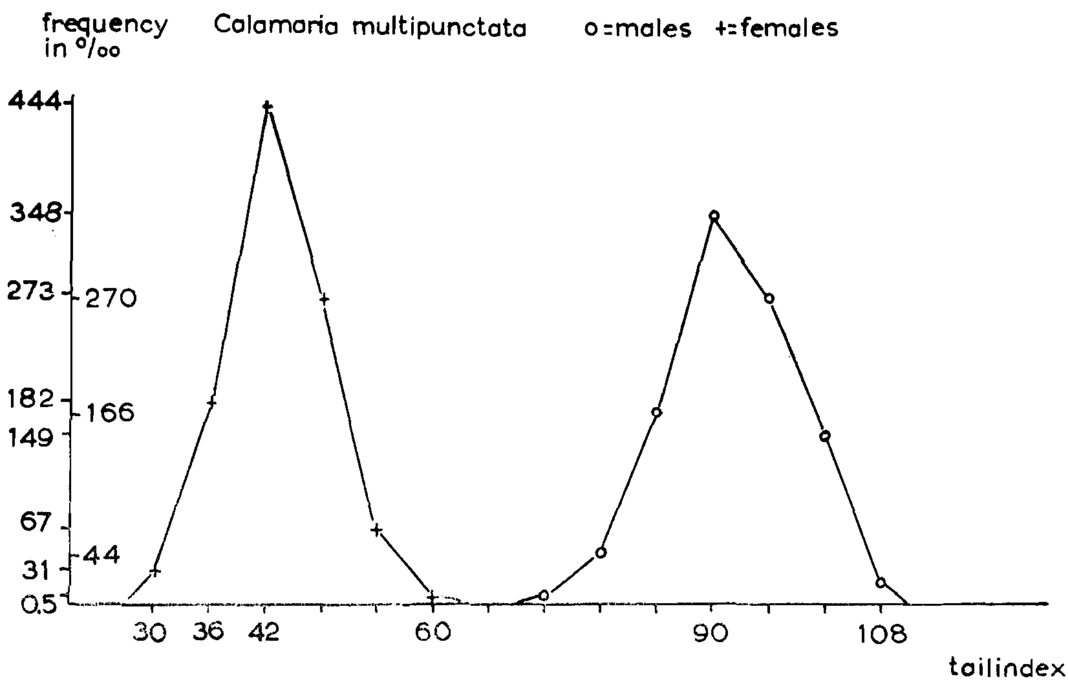


Figure 3. Frequency curve of the tail index in both sexes.

Sexual dimorphism in body length is obvious, the males being definitely shorter. In each of the three series the difference is statistically significant, D/δD for Kopstein's animals is 3.8, for de Haas' series 14.0, and 13.7 for my series. This is also demonstrated when males and females are arranged in the order of length. The lines connecting the tops of the curve of Galton have the same pattern for the three collections. Figure 1 shows the line for all the material available: the first animal in each of the successive groups of five is entered. There is also sexual dimorphism in the length of the tail, which is longer in males than in females. This holds true in absolute values notwithstanding the fact that males are shorter as regards body length. The D/δD quotient is 7.9 for Kopstein, 29 for de Haas, and 8 for my series. This dimorphism is even more obvious in the figures of the relative length of the tail: in males the tail is about 100% of the body length while in females it is a mere half, viz., 48%. Figure 2 shows the distribution of tail length and body length in the group. The frequency curve of the tail length expressed in o/oo of the body length is given in figure 3. The data for the three groups are given in Table 3. In the graph there is no overlapping of the frequency curves of both sexes. If, as the lower extreme value for the males, we take M minus three sigma, the result is 71.4, and the highest probable value in the female group being set at M plus three sigma, it is 65.1. The chance of obtaining the low value in a male specimen is slender: 96.3 − 65 = 3.78, or less than one in ten thousand, and the chance of obtaining a female with a tail index of 73 is of the order of one in thirty thousand: $\frac{46.8 - 71}{6.1} = 3.98$ The correlation between these characteristics for the three sets of data is shown in Table 4 as far as the coefficients r and Z concerned, while the full data is given in Table 10.

TABLE 3

*Calamaria multipunctata*, tail index

| —— | Males N | Tail length in o/oo | Range of bodyl. in mm | Females N | Tail length in o/oo | Range of bodyl. in mm |
|---|---|---|---|---|---|---|
| Kopstein .. .. | 17 | 73–134 | 159–306 | 48 | 39–63 | 164–338 |
| Surabaia .. .. | 83 | 81–120 | 97–253 | 80 | 29–65 | 95–376 |
| de Haas .. .. | 181 | 76–112 | 153–264 | 195 | 32–61 | 160–340 |

| —— | N | R | $M \pm \sigma_m$ | σ | V |
|---|---|---|---|---|---|
| All males .. .. .. | 281 | 73–134 | 96.3±0.5 | 8.3 | 8.6 |
| All females .. .. | 323 | 29–65 | 46.8±0.34 | 6.1 | 13.0 |

TABLE 4

*Calamaria multipunctata*, correlation coefficient between the length of body and tail

| | MALES | | FEMALES | |
|---|---|---|---|---|
| | r | $Z \pm \sigma_Z$ | r | $Z \pm \sigma_Z$ |
| Kopstein .. .. .. | 0.578 | 0.65±0.27 | 0.673 | 0.81±0.14 |
| de Haas .. .. .. .. | 0.793 | 1.05±0.07 | 0.804 | 1.08±0.07 |
| Bergman .. .. .. .. | 0.795 | 1.05±0.12 | 0.507 | 0.55±0.14 |

TABLE 5

*Calamaria multipunctata*, the length of the tail in various length (age) groups

| MALES | | | | FEMALES | | | |
|---|---|---|---|---|---|---|---|
| N | M body in mm | M tail in mm | o/oo | N | M body in mm | M tail in mm | o/oo |
| 20 | 106 | 9.2 | 86 | 23 | 128 | 5.7 | 44 |
| 19 | 136 | 11.5 | 84 | 32 | 193 | 8.5 | 44 |
| 34 | 177 | 16.2 | 92 | 32 | 240 | 10.8 | 45 |
| 36 | 201 | 18.9 | 95 | 32 | 261 | 11.7 | 45 |
| 38 | 215 | 21.0 | 97 | 32 | 274 | 12.3 | 45 |
| 37 | 226 | 21.6 | 96 | 32 | 287 | 13.3 | 47 |
| 36 | 246 | 22.6 | 92 | 32 | 310 | 14.3 | 46 |

In the group of "juvenile" animals, de Haas counted 62 snakes measuring from 90 to 150 mm. in body length. On the assumption that the animals with an index lower than 60 are females, and that the animals with a tail longer than 60% of the body length are males, there would be one group of 23 females and another of 39 males. In the group measuring 90 to 120 mm. the number of males is 19, while the females number 9; in the group of the longer animals, i.e., between 120 and 150 mm., the number of males is 20 and the number of females 14, so the females would seem to be more frequent in the longer group. The average values for the "male" category are 121 mm. body length and 10.3 mm. tail length and for the "female" group 125 mm. and 5.7 mm. respectively. In the group examined in Surabaia, 8 females and 14 males are shorter than 153 mm. and the averages for "males" are 129 and 11.8 mm., and for "females" 125 mm. and 6.1 mm. respectively. The figures for all the "males" under 153 mm. of body length are N = 53, M body length = 123, and M tail length = 10.7 (87 in o/oo; for all the "females" shorter than 153 mm., N = 31, M body length = 127, M tail length = 5.8 (45 o/oo).

Another question is whether the relation between the lengths of the body and the tail remains constant throughout the whole span of life. The animals may be divided into groups of increasing lengths, as is done in Table 5 for de Haas' series. The figures for the group examined in Surabaia show the same relations. It seems that in the females the relation tail length — body length is constant throughout the life span, the differences between the consecutive indices of the length of the tail amounting to only one or two points. In males it is not very clear. There may be a certain progression of the tail length with the onset of maturation; between the group measuring 136 mm. body length and that of 177 mm., the indices differ 8 points. For all the other classes this difference is 2 and 3.

## SEX RATIO

The numbers of males and females in the three series are given in Table 2. There is no suggestion of a deviation from the 1: 1 ratio, although Kopstein recorded a greater number of female animals.

## MATURITY

For the females, the first bend in the line of the successive body lengths occurs a little above the 230 mm. mark in Kopstein's series, while it lies between 230 and 240 mm. in both de Haas' and our series. In the data given by de Haas, we find that the smallest female carrying eggs has a body length of 239 mm., while in our series the smallest at this stage measures 243 mm. It is suggested that this is about the stage marking the transition from the juvenile to the adult. Regarding the males, no histological examination of the testes was made. If we take the bend in the curve of Galton to be a symptom, the length of attaining maturity would be around 160 mm. This figure was used in the statistical analysis of the data on the topography of the organ pattern.

## FERTILITY

The data collected by de Haas shows that pregnant animals are found throughout the year and amount to about two-thirds of the catches. The 124 females carried from one to five eggs, usually three or two, the average number (Table 6) being 2.8. The list also suggests an increase in fertility commensurate with increase in age, the latter as indicated by the length of the body. The average number of eggs increases from 1.5 to 3.4 per length class as shown in the same table.

TABLE 6

*Calamaria multipunctata*, numbers of eggs

| de Haas | | | Body length in mm | Bergman | | | | |
|---|---|---|---|---|---|---|---|---|
| Snakes | Eggs | p. cap | | Snakes | R | L | Total | p. cap |
| 2 | 3 | 1.5 | 215/234 | .. | .. | .. | .. | .. |
| 30 | 64 | 2.1 | 240/264 | 3 | 3 | 3 | 6 | 2.– |
| 53 | 144 | 2.7 | 265/289 | 9 | 13 | 6 | 19 | 2.1 |
| 32 | 99 | 3.1 | 290/314 | 3 | 4 | 2 | 6 | 2.– |
| 7 | 24 | 3.4 | 315/339 | 2 | 3 | 2 | 5 | 2.5 |
| .. | .. | .. | 340/364 | 2 | 3 | 2 | 5 | 2.5 |
| 124 | 334 | 2.8 | | 19 | 26 | 15 | 41 | 2.2 |

My own series includes 19 pregnant females, this being about a third of the females with lengths exceeding 200 mm. These numbers are however too small to be significant, but they are in accordance with the others. Furthermore, in Surabaia we checked the repartition of the eggs in both uterine tubes; out of a total of 41 eggs we found 26 on the right side and 15 on the left. The range is from 1 to 4 per animal, the average being 2.5.

Table 7 shows the frequency in the monthly catches in the collection of de Haas, tabulating for all the animals, including the juveniles, and for the males and the females separately. The lines are somewhat irregular, with two low points, one in February and one in November, and two peaks, one in March and one in August. To smoothen out the curve we may use a less subtle division, e.g., into periods of two months. The data expressed in o/oo for the male and the female group, are given in Table 8.

TABLE 7

*Calamaria multipunctata* (coll. de Haas), number of animals caught per month

| —— | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All .. | 47 | 26 | 62 | 46 | 31 | 42 | 32 | 57 | 13 | 26 | 17 | 37 |
| ♂ .. | 16 | 13 | 29 | 13 | 22 | 18 | 11 | 24 | 12 | 13 | 6 | 14 |
| ♀ .. | 19 | 9 | 25 | 18 | 12 | 19 | 19 | 20 | 14 | 11 | 6 | 11 |

TABLE 8

*Calamaria multipunctata* (coll. de Haas), frequency of bimonthly catches in o/oo of the total

| —— | Jan.–Feb. | Mar.–Apr. | May–June | July–Aug. | Sept.–Oct. | Nov.–Dec. | Total |
|---|---|---|---|---|---|---|---|
| ♂ .. | 152 | 220 | 210 | 183 | 131 | 105 | 1,001 |
| ♀ .. | 153 | 235 | 169 | 214 | 137 | 93 | 1,001 |

TABLE 9

*Calamaria multipunctata* (coll. de Haas), number of juveniles per 2 months

| —— | Dec.–Jan. | Feb.–Mar. | April–May | June–July | Aug.–Sept. | Oct.–Nov. |
|---|---|---|---|---|---|---|
| High tail index .. | 6 | .. | .. | 2 | 2 | .. |
| Low tail index .. | 3 | 2 | .. | .. | 2 | 1 |
| Total .. | 9 | 2 | .. | 2 | 4 | 1 |

The curve for the males shows one peak and one low point, while that for the females follows the same course with one additional peak; in other words, the frequencies for both sexes correspond, except in May/June when more males are caught and July/August when more females are caught. In o/oo of the total catch, the one in May/June equals 210 o/oo of the males and 169 o/oo of the females, and in July/August 183 o/oo of the males and 214 o/oo of the females (fig. 4). This may be an indication that there is a periodicity in mating, with the males coming out into the open first and the females following a little later. The dates of birth may be derived from the time when the smallest animals are caught. The smallest ones with a high tail index were caught in January (90, 91, 98, 101, & 102 mm.), June (98 mm.), July (92 mm.), August (100 mm.), September (103 mm.), and December (101 mm.), i.e. six in December/January, and four from June to September. The smallest ones with a low tail index were caught in January (116 mm.), February (118 mm.), March (96 mm.), August (109 & 112 mm.), October (115 mm.), and December (110 & 115 mm.), i.e. three in December/January, two in February/ March, and seven from June to October (Table 9). There is a peak in December/ January, a decline in April/May and another peak in August/September.

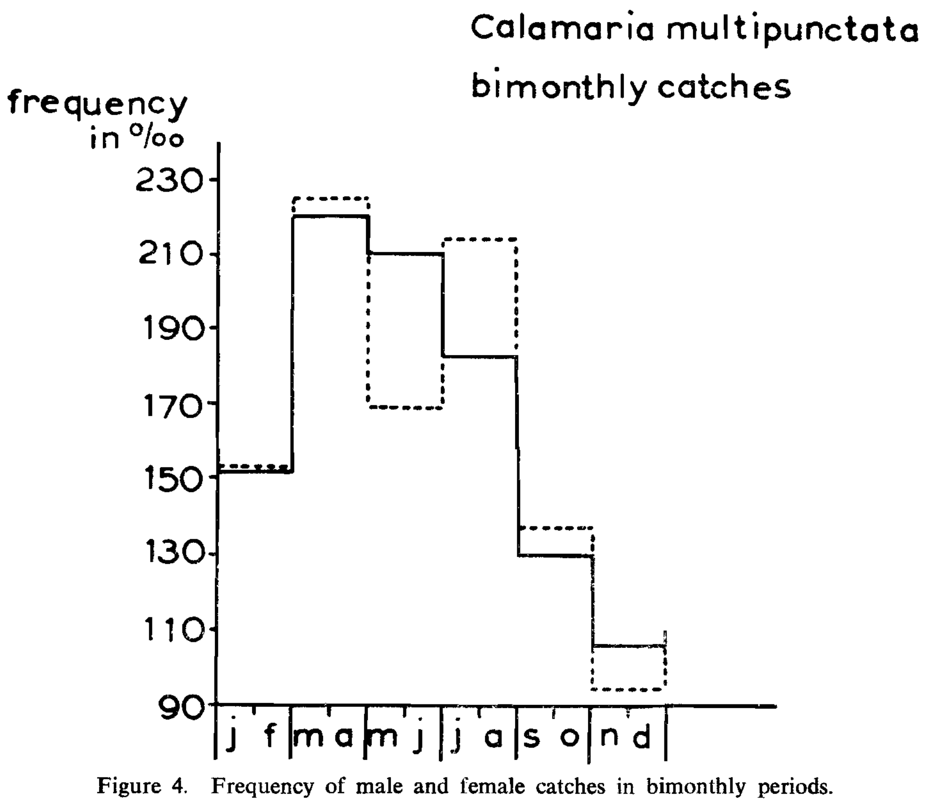


Figure 4. Frequency of male and female catches in bimonthly periods.

## TOPOGRAPHY

As there is definite sexual dimorphism in the length of the body, a corresponding difference will be found in every topographical measurement. These data are given in the Tables 10 and 11. We may get a better insight into the length of the organs and their topography when we compare the relative values of the data projected upon the body length (Table 12). The same data are elaborated on a scale map (fig. 5) for juvenile and adult animals, for both males and females. The differences between the juvenile animals of both sexes are very small indeed. In the adults however, there is some difference; the organs of the cranial half of the body are situated somewhat more cranially in females, and the kidneys seem to be located more caudally in the same group. The data on the spleen cannot be compared with those on the pancreas, since it was measured in only 19 cases out of 63. When the data for the pancreas are taken for the same group as that of which the spleen was measured, the top of the spleen proves to be practically on the same level as the top of the pancreas.

TABLE 10

*Calamaria multipunctata*, males, distances from the snout to the top and the end of the organs

| —— | N | R | $M \pm \sigma_m$ | $\sigma \pm \sigma_\sigma$ | $V \pm \sigma_v$ |
|---|---|---|---|---|---|
| Body length .. .. .. | 68 | 164–253 | 211.8±2.4 | 19.5±1.7 | 9.2±0.8 |
| Tail length .. .. .. | 68 | 14– 27 | 21.2±1.0 | 2.7±0.2 | 12.5±1.1 |
| Heart top .. .. .. | 64 | 38– 56 | 47.4±0.5 | 4.2±0.4 | 8.8±0.8 |
| Heart end .. .. .. | 64 | 45– 60 | 55.5±0.6 | 4.7±0.5 | 8.5±0.7 |
| Liver top .. .. .. | 64 | 55– 80 | 66.9±0.7 | 5.7±0.5 | 8.5±0.8 |
| Liver end .. .. .. | 64 | 98–153 | 126.7±1.4 | 11.2±1.0 | 8.9±0.8 |
| Gallbladder top .. .. | 64 | 101–172 | 137.9±1.9 | 15.3±1.4 | 11.1±1.0 |
| Gallbladder end .. .. | 64 | 103–176 | 141.9±2.0 | 15.6±1.4 | 10.9±1.0 |
| Pancreas top .. .. .. | 63 | 104–174 | 140.1±1.9 | 15.0±1.3 | 10.7±0.9 |
| Pancreas end .. .. .. | 63 | 108–178 | 145.0±1.8 | 14.6±1.3 | 10.1±0.9 |
| Spleen top* .. .. .. | 19 | 103–171 | 135.1±3.9 | 17.0±2.8 | 12.7±2.1 |
| Spleen end .. .. .. | 19 | 104–172 | 136.0±4.0 | 17.6±2.8 | 12.9±2.1 |
| Testes R top .. .. .. | 64 | 123–193 | 154.0±2.0 | 16.0±1.4 | 10.4±0.9 |
| Testes R end .. .. .. | 64 | 131–206 | 168.7±2.1 | 16.8±1.5 | 9.9±0.9 |
| Testes L top .. .. .. | 64 | 136–203 | 167.0±2.1 | 16.6±1.5 | 10.0±0.9 |
| Testes L end .. .. .. | 64 | 145–224 | 181.1±2.4 | 18.3±1.6 | 10.1±0.9 |
| Kidney R top .. .. | 64 | 146–224 | 184.2±2.1 | 16.9±1.5 | 9.2±0.8 |
| Kidney R end .. .. | 64 | 163–250 | 208.1±2.4 | 19.6±1.7 | 9.4±0.8 |
| Kidney L top .. .. | 64 | 150–220 | 187.5±2.1 | 16.9±1.5 | 9.0±0.8 |
| Kidney L end .. .. | 64 | 163–250 | 208.1±2.4 | 19.0±1.7 | 9.1±0.8 |

*In adult males the spleen has been measured in only 19 cases.

TABLE 11

*Calamaria multipunctata*, females, distances from the snout to the top and the end of the organs

| —— | N | R | M ± $ó_m$ | ó ± $ó_ó$ | V ± $ó_V$ |
|---|---|---|---|---|---|
| Body length .. .. .. | 45 | 222–358 | 274.0±4.0 | 29.1±2.8 | 10.6±1.0 |
| Tail length .. .. .. | 55 | 10– 18 | 13.0±0.2 | 1.8±0.2 | 13.8±1.3 |
| Heart top .. .. .. | 49 | 44– 71 | 55.9±0.8 | 5.6±0.6 | 10.0±1.0 |
| Heart end .. .. .. | 49 | 51– 82 | 65.3±0.9 | 6.4±0.6 | 9.8±1.0 |
| Liver top .. .. .. | 49 | 63– 99 | 79.7±1.2 | 8.2±0.8 | 10.2±1.0 |
| Liver end .. .. .. | 49 | 127–205 | 159.0±2.4 | 16.5±1.7 | 10.4±1.1 |
| Gallbladder top .. .. | 49 | 140–230 | 177.8±2.7 | 19.1±2.0 | 10.7±1.1 |
| Gallbladder end .. .. | 49 | 145–235 | 181.8±2.9 | 20.0±2.0 | 11.0±1.1 |
| Pancreas top .. .. .. | 49 | 143–232 | 180.2±2.9 | 20.2±2.0 | 11.2±1.1 |
| Pancreas end .. .. .. | 49 | 148–238 | 186.2±2.8 | 19.9±2.0 | 10.6±1.1 |
| Spleen top* .. .. .. | 21 | 145–232 | 187.4±4.8 | 22.0±3.4 | 11.7±1.8 |
| Spleen end .. .. .. | 21 | 146–234 | 189.0±4.7 | 21.6±3.3 | 11.4±1.8 |
| Ovary R top .. .. .. | 49 | 161–255 | 195.4±3.0 | 20.8±2.1 | 10.6±1.1 |
| Ovary R end .. .. | 49 | 173–276 | 213.8±3.3 | 23.3±2.4 | 10.9±1.1 |
| Ovary L top .. .. .. | 49 | 181–277 | 218.4±3.1 | 21.4±2.2 | 9.8±1.0 |
| Ovary L end .. .. .. | 49 | 188–294 | 232.4±3.5 | 24.3±2.5 | 10.4±1.1 |
| Kidney R top .. .. | 49 | 194–328 | 243.3±3.9 | 27.6±2.8 | 11.3±1.1 |
| Kidney R end .. .. | 49 | 212–352 | 268.3±4.2 | 29.3±3.0 | 10.9±1.2 |
| Kidney L top .. .. | 49 | 198–331 | 246.2±3.8 | 26.5±2.7 | 10.7±1.1 |
| Kidney L end .. .. | 49 | 215–352 | 268.5±4.2 | 29.4±3.0 | 10.9±1.1 |

* In adult females the spleen has been measured in 21 cases. For the calculation of o/oo the corresponding length have been used.

TABLE 12

*Calamaria multipunctata*, topographic pattern in o/oo of the mean body length

| —— | MALES | | FEMALES | |
|---|---|---|---|---|
| | Adults | Juveniles | Adults | Juveniles |
| N .. .. .. .. .. | 64 | 11 | 49 | 23 |
| M Body .. .. .. .. | 211.8 | 138.0 | 274.0 | 166.2 |
| Body .. .. .. .. | 1,000 | 1,000 | 1,000 | 1,000 |
| Tail .. .. .. .. | 100 | 92 | 48 | 49 |
| Heart top .. .. .. .. | 225 | 243 | 204 | 231 |
| Heart end .. .. .. .. | 264 | 292 | 238 | 268 |
| Heart length .. .. .. .. | 39 | 49 | 34 | 37 |
| Liver top .. .. .. .. | 318 | 348 | 291 | 326 |
| Liver end .. .. .. .. | 602 | 647 | 579 | 621 |
| Liver length .. .. .. .. | 284 | 299 | 289 | 295 |

TABLE 12 — *continued*

*Calamaria multipunctata*, topographic pattern in o/oo of the mean body length

| — | MALES | | FEMALES | |
|---|---|---|---|---|
| | Adults | Juveniles | Adults | Juveniles |
| Gallbl. top .. .. .. .. | 655 | 706 | 649 | 691 |
| Gallbl. end .. .. .. .. | 684 | 725 | 663 | 710 |
| Gallbl. length .. .. .. | 18 | 20 | 16 | 18 |
| Pancreas top .. .. .. .. | 664 | 717 | 657 | 666 |
| Pancreas end .. .. .. .. | 685 | 738 | 678 | 685 |
| Pancreas length .. .. .. | 22 | 20 | 21 | 19 |
| Spleen top .. .. .. .. | 634 | .. | 663 | .. |
| Spleen end .. .. .. .. | 640 | .. | 668 | .. |
| Spleen length .. .. .. .. | 6 | .. | 5 | .. |
| Sex R top .. .. .. .. | 730 | 793 | 714 | 790 |
| Sex R end .. .. .. .. | 799 | 844 | 779 | 828 |
| Sex R length .. .. .. .. | 69 | 51 | 66 | 38 |
| Sex L top .. .. .. .. | 796 | 844 | 798 | 850 |
| Sex L end .. .. .. .. | 860 | 893 | 848 | 879 |
| Sex L length .. .. .. .. | 63 | 49 | 50 | 28 |
| Both gonads .. .. .. .. | 132 | 100 | 116 | 66 |
| Kidney R top .. .. .. | 878 | 910 | 890 | 890 |
| Kidney R end .. .. .. | 984 | 1,010 | 980 | 990 |
| Kidney R length .. .. .. | 108 | 100 | 90 | 101 |
| Kidney L top .. .. .. | 893 | 925 | 900 | 906 |
| Kidney L end .. .. .. | 986 | 1,010 | 980 | 990 |
| Kidney L length .. .. .. | 94 | 85 | 78 | 85 |
| Both kidneys .. .. .. .. | 202 | 183 | 169 | 186 |
| Weight .. .. .. .. | 26.4 | 12.3 | 29.4 | 14.5 |

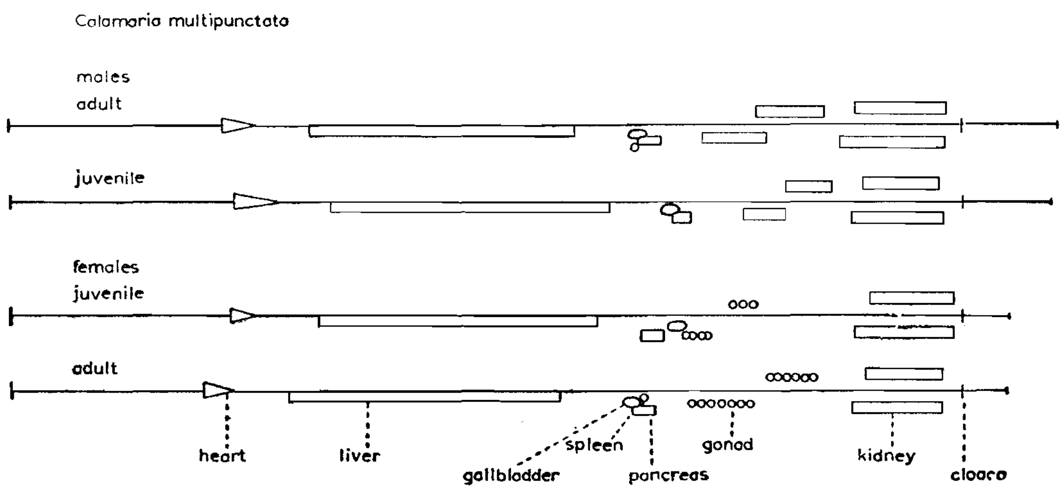


Figure 5. Scale map of average figures of the organ pattern for juvenile and adult specimens in both sexes.

## LENGTH

The data on lengths in mm. are given in Table 13. There are very few differences in the relative length of the organs. However, contrary to what we would expect, the gonads are somewhat longer in males. In addition, the kidneys are also somewhat longer in males, amounting to 200 o/oo of the body length, whereas in females they measure only 170 o/oo of the body length. In both sexes there is asymmetry, the gonads and the kidneys being shorter on the left side than on the right.

TABLE 13

*Calamaria multipunctata*, lengths of the organs in mm

| | N | R | $M \pm \sigma_m$ | $\sigma \pm \sigma_\sigma$ | $V \pm \sigma_V$ |
|---|---|---|---|---|---|
| | | | MALES | | |
| Body length | 68 | 164–253 | 211.8±2.4 | 19.5±1.7 | 9.2±0.8 |
| Tail length | 68 | 14– 27 | 21.2±0.3 | 2.7±0.2 | 12.6±1.1 |
| Heart | 64 | 5– 11 | 8.1±0.2 | 1.3±0.1 | 15.9±1.4 |
| Liver | 64 | 42– 75 | 59.8±1.0 | 7.7±0.7 | 12.9±1.1 |
| Gallbladder | 64 | 2– 6 | 3.8±0.1 | 0.9±0.1 | 25.0±2.2 |
| Pancreas | 63 | 2– 9 | 4.7±0.2 | 1.5±0.1 | 32.0±3.0 |
| Spleen | 19 | 1– 4 | 1.3±0.2 | 1.0±0.1 | 72.0±11.6 |
| Testes R | 64 | 8– 21 | 14.6±0.4 | 2.8±0.3 | 19.7±1.7 |
| Testes L | 64 | 6– 23 | 13.5±0.4 | 3.3±0.3 | 24.7±2.2 |
| R + L | 64 | 15– 41 | 27.9±0.6 | 5.0±0.4 | 18.0±1.6 |
| Kidney R | 64 | 14– 35 | 22.9±0.5 | 4.3±0.4 | 21.7±1.9 |
| Kidney L | 64 | 11– 29 | 19.8±0.3 | 3.9±0.4 | 21.0±1.9 |
| R + L | 64 | 26– 64 | 42.6±0.9 | 7.3±0.7 | 17.6±1.6 |
| Weight | 67 | 2– 9 | 5.6±0.2 | 1.6±0.1 | 25.4±2.2 |
| | | | FEMALES | | |
| Body length | 55 | 222–358 | 274.0±4.0 | 29.1±2.8 | 10.6±1.0 |
| Tail length | 55 | 10– 18 | 13.0±0.2 | 1.8±0.2 | 13.8±1.3 |
| Heart | 49 | 6– 13 | 9.3±0.2 | 1.7±0.2 | 17.7±1.8 |
| Liver | 49 | 60–106 | 79.3±1.5 | 10.5±1.1 | 13.2±1.3 |
| Gallbladder | 49 | 2– 6 | 4.3±0.1 | 1.0±0.1 | 21.5±2.2 |
| Pancreas | 49 | 2– 3 | 5.7±0.2 | 1.2±0.1 | 22.2±2.2 |
| Spleen | 21 | 1– 3 | 1.3±0.1 | 0.5±0.1 | 74.3±11.4 |
| Ovary R | 49 | 6– 41 | 18.1±0.8 | 7.8±0.8 | 42.9±4.3 |
| Ovary L | 49 | 5– 25 | 13.8±0.7 | 5.2±0.5 | 38.5±3.9 |
| R + L | 49 | 16– 66 | 31.8±1.6 | 11.0±1.1 | 34.9±3.5 |
| Kidney R | 49 | 6– 36 | 24.6±0.7 | 4.9±0.5 | 19.9±2.0 |
| Kidney L | 49 | 5– 31 | 21.5±0.7 | 4.3±0.4 | 20.0±2.0 |
| R + L | 49 | 11– 67 | 46.3±1.3 | 9.3±0.9 | 20.1±2.0 |
| Weight | 55 | 4– 16 | 8.1±0.3 | 2.5±0.2 | 30.1±2.9 |

## INTERVALS

The average values for the intervals between the organs are, as expected, smaller in males. Table 15 shows these values expressed in o/oo of the mean body length.

TABLE 14

*Calamaria multipunctata*, intervals between the organs in mm

| | N | R | $M \pm \sigma_m$ | $\sigma \pm \sigma_\sigma$ | $V \pm \sigma_v$ |
|---|---|---|---|---|---|
| | MALES | | | | |
| A1 snout-heart .. .. | 49 | 44– 71 | 55.9±0.8 | 5.6±0.6 | 10.0±1.0 |
| A2 heart-liver .. .. | 49 | 7– 21 | 14.4±0.5 | 3.6±0.4 | 25.0±2.5 |
| A3 liver-gallbladder .. .. | 49 | 2– 41 | 19.0±1.6 | 11.6±1.1 | 58.0±5.8 |
| A .. .. .. | 49 | 70– 11 | 89.5±1.6 | 11.3±1.1 | 12.7±1.3 |
| B1 pancreas-gonad R .. .. | 49 | 1– 21 | 9.5±0.8 | 5.4±0.5 | 57.0±5.7 |
| B2 gonad-kidney R .. .. | 49 | 5– 74 | 29.4±2.5 | 17.6±1.8 | 60.0±6.0 |
| B3 kidney-cloaca R .. .. | 49 | 0– 24 | 6.2±0.5 | 3.7±0.4 | 59.7±6.0 |
| B .. .. .. | 49 | 17– 88 | 45.7±2.4 | 16.9±1.7 | 37.0±3.7 |
| C1 pancreas-gonad L .. .. | 49 | 14– 58 | 32.4±1.6 | 11.3±1.1 | 34.9±3.5 |
| C2 gonad-kidney L .. .. | 49 | 1– 38 | 14.6±1.5 | 10.3±1.0 | 70.5±7.1 |
| C3 kidney-cloaca L .. .. | 49 | 0–13 | 5.8±0.3 | 2.4±0.2 | 42.9±4.3 |
| C .. .. .. | 49 | 25– 97 | 52.9±2.5 | 17.7±1.8 | 33.4±3.4 |
| A + B .. .. .. | 49 | 111–177 | 135.4±2.3 | 15.8±1.6 | 11.6±1.2 |
| A + C .. .. .. | 49 | 119–196 | 143.0±2.5 | 17.5±1.8 | 12.2±1.3 |
| DR pancreas-kidney R .. .. | 49 | 24–110 | 57.4±2.8 | 19.5±1.9 | 33.9±3.5 |
| DL pancreas-kidney L .. .. | 49 | 28–113 | 61.4±2.8 | 19.8±2.0 | 32.3±3.2 |
| | FEMALES | | | | |
| A1 snout-heart .. .. | 64 | 38– 56 | 47.3±0.5 | 4.1±0.4 | 8.7±0.8 |
| A2 heart-liver .. .. | 64 | 7– 22 | 11.5±0.4 | 2.9±0.3 | 24.8±2.5 |
| A3 liver-gallbladder .. .. | 64 | 1– 29 | 11.2±0.9 | 7.1±0.6 | 63.8±5.5 |
| A .. .. .. | 64 | 51– 98 | 70.1±1.3 | 10.1±0.9 | 14.4±1.3 |
| B1 pancreas-gonad R .. .. | 63 | 2– 18 | 9.8±0.5 | 4.1±0.4 | 41.6±3.6 |
| B2 gonad-kidney R .. .. | 64 | 5– 28 | 16.2±0.8 | 6.0±0.5 | 37.0±3.3 |
| B3 kidney-cloaca R .. .. | 64 | 0– 6 | 3.3±0.2 | 1.3±0.1 | 38.4±3.4 |
| B .. .. .. | 63 | 10– 45 | 29.2±1.1 | 8.5±0.8 | 29.2±2.6 |
| C1 pancreas-gonad L .. .. | 63 | 9– 34 | 23.3±0.8 | 6.2±0.6 | 26.2±2.3 |
| C2 gonad-kidney L .. .. | 64 | 2– 17 | 7.2±0.7 | 5.3±0.5 | 72.7±6.4 |
| C3 kidney-cloaca L .. .. | 64 | 1– 5 | 3.0±0.1 | 1.0±0.1 | 33.6±2.9 |
| C .. .. .. | 63 | 17– 49 | 33.4±1.1 | 8.7±0.8 | 25.6±2.3 |
| A + B .. .. .. | 63 | 72–132 | 99.5±1.5 | 11.5±1.0 | 11.5±1.0 |
| A + C .. .. .. | 63 | 79–140 | 103.6±1.3 | 10.7±1.0 | 10.4±0.9 |
| DR pancreas-kidney R .. .. | 63 | 18– 61 | 41.1±1.2 | 9.4±0.8 | 22.9±2.0 |
| DL pancreas-kidney L .. .. | 63 | 23– 65 | 43.6±1.2 | 9.9±0.9 | 22.7±2.0 |

TABLE 15

*Calamaria multipunctata*, length of the intervals in o/oo of the body length

| Interval | Males | Females |
|---|---|---|
| A1 | 224 | 204 |
| A2 | 54 | 52 |
| A3 | 53 | 69 |
| B1 | 46 | 35 |
| B2 | 77 | 107 |
| B3 | 16 | 23 |
| C1 | 110 | 118 |
| C2 | 34 | 53 |
| C3 | 14 | 21 |
| A | 332 | 326 |
| B | 138 | 167 |
| C | 158 | 193 |
| A+B | 470 | 494 |
| A+C | 490 | 522 |
| DR | 194 | 210 |
| DL | 206 | 224 |

The sum total of the spaces between the organs on both sides is longer in females. When measured on the right side (AB) this length is 470 o/oo of the body length in males and 494 o/oo of the body length in females. On the left side (AC) it is 490 o/oo in males and 522 o/oo in females. The differences amount to 24 o/oo on the right side and 32 o/oo on the left. In the region cranially from the pancreas, the space is perhaps a little longer in males, viz, 332 o/oo, whereas in females it is 326 o/oo, the difference being 6 o/oo. Caudally from the pancreas on the right side, these figures are 138 in males and 167 in females, with a difference of 29 o/oo, while on the left side they are 158 and 193 respectively, with a difference of 35 o/oo. The main local differences are found in the intervals B2 and C2 from the gonad to the kidney. The spaces on the right (B) and left (C) are longer in female animals, mainly because of the shorter kidney. B2 is 77 in males and 107 in females, a difference of 30 o/oo; C2 is 34 in males and 53 in females, so that on the left side the difference amounts to 19 o/oo. Perhaps the most important points, when considering the space available for growth of the eggs, are the end of the pancreas and the top of the kidney, although the topography of the complex pancreas-gallbladder-spleen seems less rigidly fixed than the liver.

## VARIABILITY

As regards the topographic data, the variability is not very great. V ranges in both sexes between 8.5 and 11.7. For the length of the various organs, there is on one hand the heart, the liver, the kidneys, the right testes and the sum of both the testes in which V varies between 12 and 20. On the other hand, for the length of the gallbladder, the pancreas, the left testes and the ovaries, V increases from 20 to 43. Only for the spleen does the value of V seem excessively high, which no doubt must be attributed to the smallness of the organ and also to the scarcity of available data.

When considering the total amount of "free spaces" of intervals both on the right and left side, we find in both sexes an identical variability which is valid not only for the values A + B and A + C, but also for the sum of the intervals in the cranial half of the body A. This is also true for the space between the heart and the liver A2, for the interval between the liver and the gallbladder A3, and for the interval C3 between the left gonad and the kidney. However, for A1, A, AB and AC the coefficient V ranges between 9 and 14; for A2 it is 25, and for A3 and C2 around 60 and 70. For all other intervals the coefficient of variability is higher in females, although the quotient D/δ D is higher than 2.50 in only 4 instances, viz., for the intervals B2 and B3, for the spaces between the gonad and the kidney, and between the kidney and the cloaca. B2 has a high coefficient and D/δD = 3.1. For the intervals from the pancreas to the kidney the coefficients are of the order of 23 and 34, with D/δD = 2.54 for the right side and D/δD = 2.51 for the left side.

## CORRELATIONS

The correlation between body length and tail length has been discussed above. The figures on these and other correlations are given in Table 16. In Figure 6 the weight is given in respect of the body length. In males r = 0.783, and in females r = 0.840, or Z = 1.03 ± 0.12 and 1.23 ± 0.14, respectively. The average weight of the males is 5.6 ± 0.2 and that of the females 8.1 ± 0.4, D/δD being 5.6, a very significant difference. When the greater body length of the female animals is taken into account, the difference diminishes although it does not disappear altogether. In males the weight is 26.4 o/oo, while in females 29.4 o/oo.

TABLE 16

*Calamaria multipunctata*, correlations

| | MALES | | | | | |
|---|---|---|---|---|---|---|
| | N | R | $M \pm \sigma_m$ | σ | V | r<br>$Z \pm \sigma_z$ |
| Body (Kopstein) .. | 17 | 159–306 | 222.5±9.2 | 37.9 | 16.8 | r = 0.578 |
| Tail .. .. | 17 | 14– 33 | 22.5±1.1 | 4.4 | 19.5 | Z = 0.66±0.27 |
| Body (de Haas) .. | 181 | 153–264 | 212.6±1.8 | 24.2 | 11.4 | r = 0.793 |
| Tail .. .. | 181 | 12– 26 | 20.2±0.2 | 2.7 | 13.4 | Z = 1.08±0.07 |
| Body (Surabaia) .. | 68 | 164–253 | 211.8±2.4 | 19.5 | 9.2 | r = 0.795 |
| Tail .. .. | 68 | 14– 27 | 21.2=1.0 | 2.7 | 12.5 | Z = 1.08±0.12 |
| Body .. .. | 49 | 222–358 | 273.2±4.4 | 30.7 | 11.2 | r = 0.628 |
| Gonads .. .. | 49 | 16– 66 | 31.5±1.6 | 11.0 | 34.9 | Z = 0.75±0.15 |
| Body .. .. | 49 | 222–358 | 273.2±4.4 | 30.7 | 11.2 | r = 0.440 |
| Kidneys .. | 49 | 11– 67 | 46.3±1.3 | 9.3 | 20.1 | Z = 0.47±0.15 |
| Body .. .. | 67 | 164–253 | 211.4±2.4 | 19.4 | 9.2 | r = 0.783 |
| Weight .. .. | 67 | 2– 9 | 5.6±0.2 | 1.6 | 30.4 | Z = 1.03±0.12 |

TABLE 16 — *continued*

*Calamaria multipunctata*, correlations

| | FEMALES | | | | | |
|---|---|---|---|---|---|---|
| | N | R | $M \pm \sigma_m$ | $\sigma$ | V | r<br>$Z \pm \sigma_Z$ |
| Body .. .. | 48 | 164–338 | 262.4±5.0 | 34.8 | 13.3 | r =0.673 |
| Tail .. .. | 48 | 8– 17 | 13.1±0.3 | 2.0 | 15.4 | Z =0.83±0.14 |
| Body (de Haas) .. | 191 | 160–340 | 260.4±2.9 | 40.5 | 15.5 | r =0.804 |
| Tail .. .. | 191 | 6– 17 | 11.9±0.2 | 2.3 | 19.3 | Z =1.08±0.07 |
| Body (Surabaia) .. | 55 | 222–358 | 274.0±3.9 | 29.1 | 10.6 | r =0.507 |
| Tail .. .. | 55 | 10– 18 | 13.0±0.2 | 1.8 | 13.5 | Z =0.55±0.14 |
| Body .. .. | 64 | 164–253 | 211.4±2.4 | 19.4 | 9.2 | r =0.615 |
| Gonads .. .. | 64 | 15– 41 | 27.9±0.6 | 5.1 | 18.3 | Z =0.73±0.13 |
| Body .. .. | 64 | 164–253 | 211.4±2.4 | 19.4 | 9.2 | r =0.510 |
| Kidneys .. | 64 | 26– 64 | 42.5±0.9 | 7.4 | 17.5 | Z =0.57±0.13 |
| Body .. .. | 55 | 222–358 | 274.0±3.9 | 29.1 | 10.6 | r =0.840 |
| Weight .. .. | 55 | 4– 16 | 8.1±0.4 | 2.5 | 30.5 | Z =1.23±0.14 |

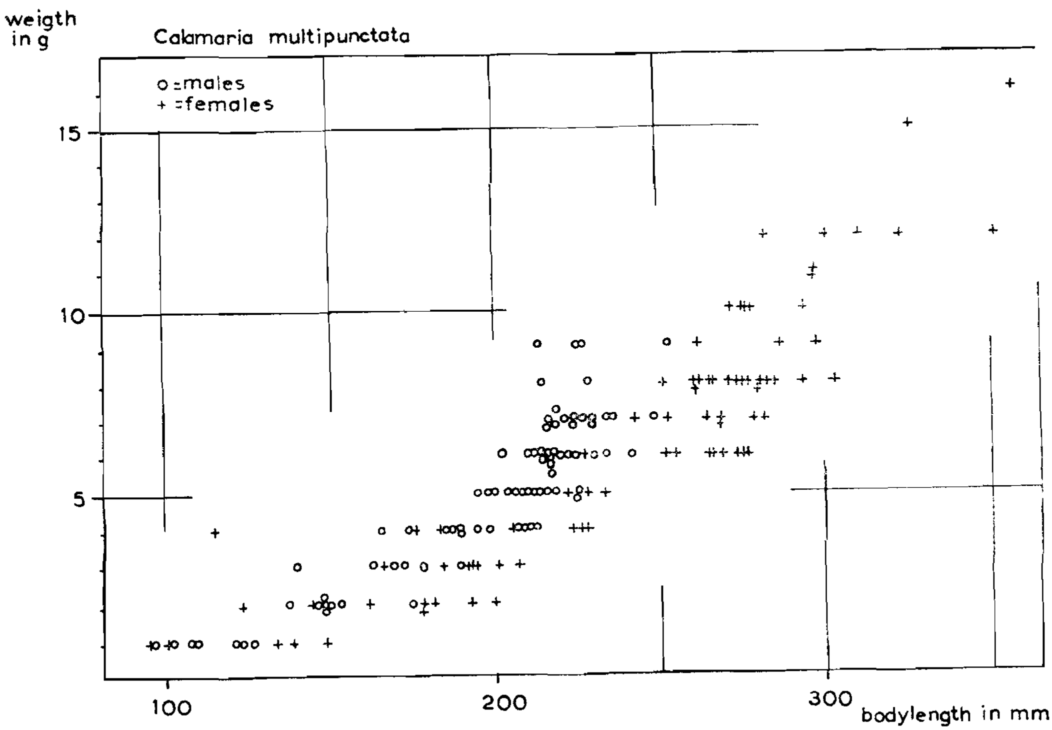


Figure 6. Scatterdiagram of the body length and the weight in both sexes.

Regarding the correlation between body length and the length of the gonads r = 0.615 in males and 0.628 in females, or Z = 0.72 ± 0.13 in males and 0.75 ± 0.15 in females (fig.7).

Between the length of the body and the length of the two kidneys r is 0.510 and Z = 0.57 ± 0.13 for males, while for females r is 0.440 and Z = 0.47 ± 0.15. In the case of the kidneys the correlation is rather low.

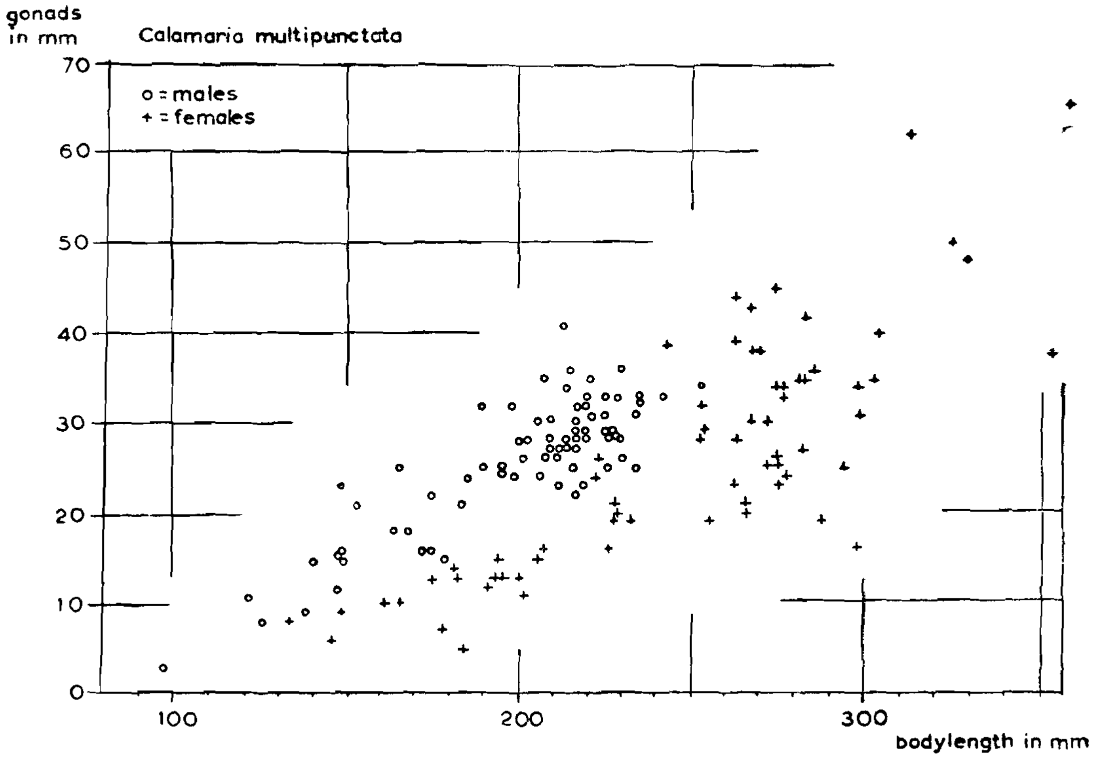


Figure 7. Scatterdiagram of the body length and the length of the gonads in both sexes.

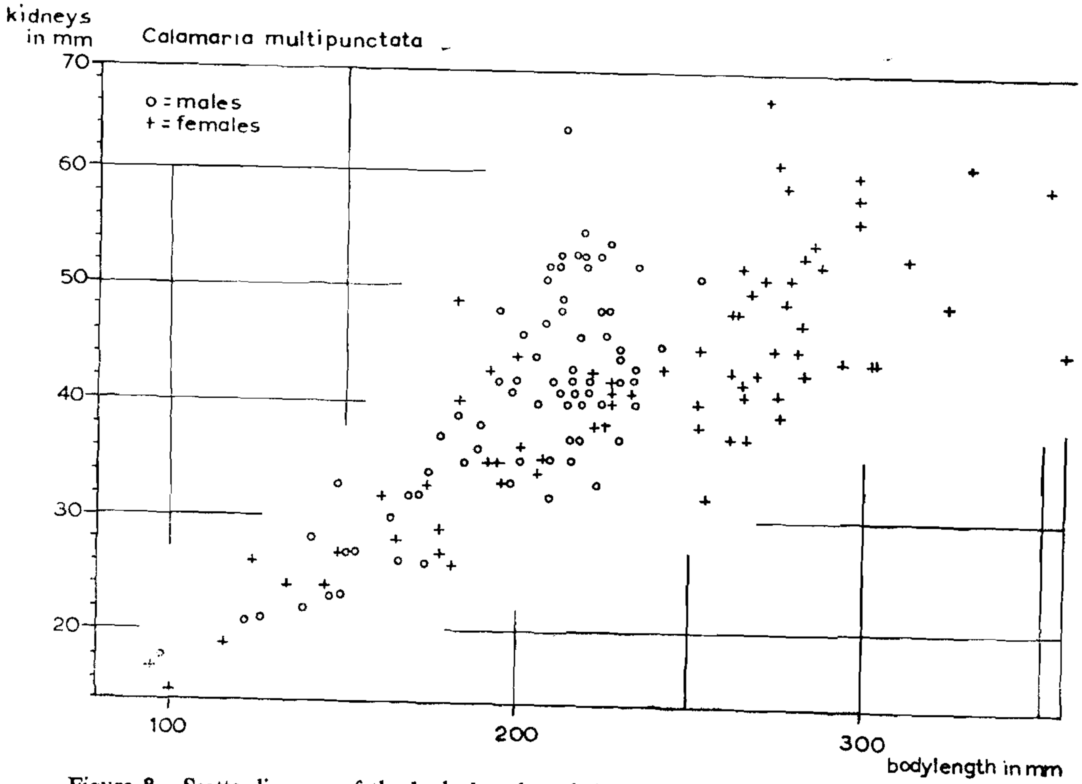


Figure 8. Scatterdiagram of the body length and the length of the kidneys in both sexes.

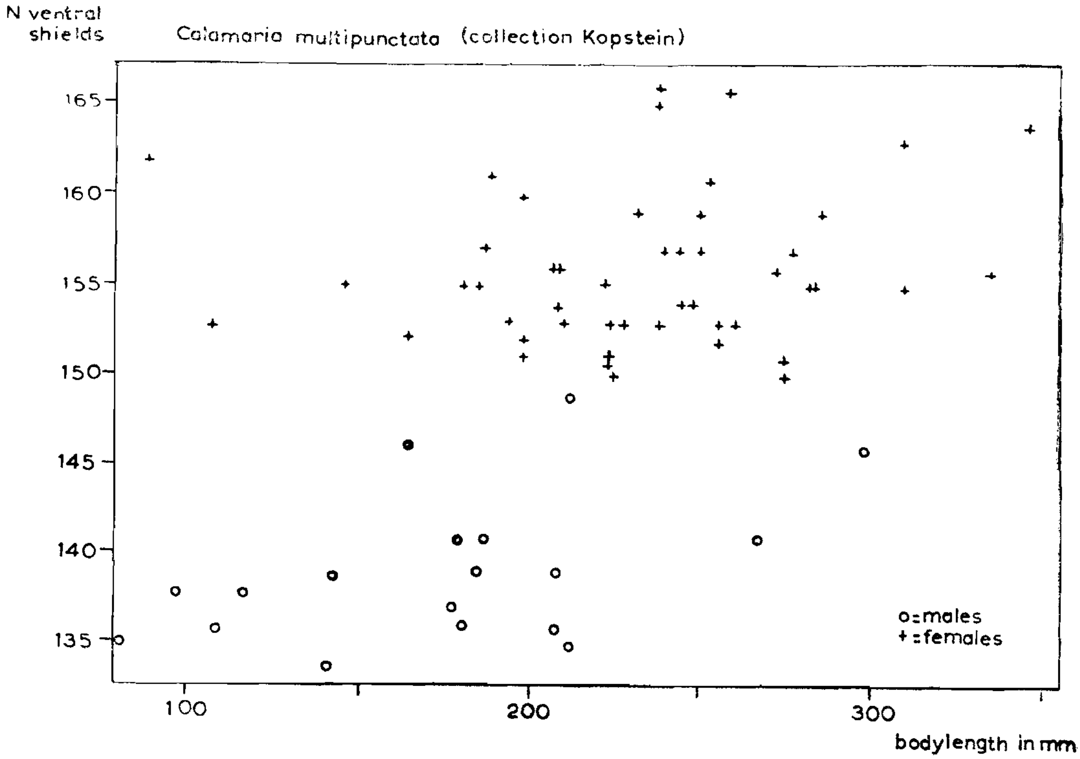


Figure 9. Scatterdiagram of the body length and the number of ventral scales in both sexes.

Kopstein has indicated that the difference between the sexes in the number of ventral scales is constant throughout life, no correlation being expected between this number and the length of the body. The figures we found are not significant (Table 17). The longer body length of the female animals may explain the higher number of ventral scales, as may be seen from Figure 9. The relative length of the ventral scales is different in males and females, but only slightly so, the difference between the averages having no statistical significance. However, as the animal grows, the relative length of the ventral scales diminishes throughout life, as is consistent with continuous growth. For males and females these lines are practically parallel to each other, the line for males lying below that for females.

When we consider the difference between the length of the smallest and that of the longest animal as an exponent of the life-span, we may use these figures as the beginning and the end of an ordinate and put the index between the number of ventral shields and the body length in the abscissa. The figures for male and female animals then coincide from a body length (in female animals) of 230 mm. upwards. Up to that length the area where the males are to be found is below that of the females. There may be an indication that this index has a fixed value at each age and for both sexes.

TABLE 17

*Calamaria multipunctata* (collection Kopstein), body length in mm and number of ventral scales

| | N | R | $M \pm \sigma_m$ | $\sigma$ | V | r | Z |
|---|---|---|---|---|---|---|---|
| **MALES** | | | | | | | |
| Body length .. | 18 | 159–306 | 222.8±8.7 | 37 | 16.2 | | |
| N ventr. scales .. | 18 | 134–149 | 139.3±1.– | 4.2 | 3.– | r= ±0.500 | Z=0.55±0.26 |
| Index .. | 18 | 48– 85 | 64.3±2.6 | 11.– | 17.1 | | |
| **FEMALES** | | | | | | | |
| Body length .. | 48 | 164–338 | 261.4±4.9 | 33.8 | 12.9 | | |
| N ventr. scales .. | 48 | 150–166 | 155.9±0.6 | 4.2 | 2.7 | r= ±0.160 | Z=0.16±0.15 |
| Index .. | 48 | 49– 98 | 62.8±1.3 | 9.1 | 14.5 | | |

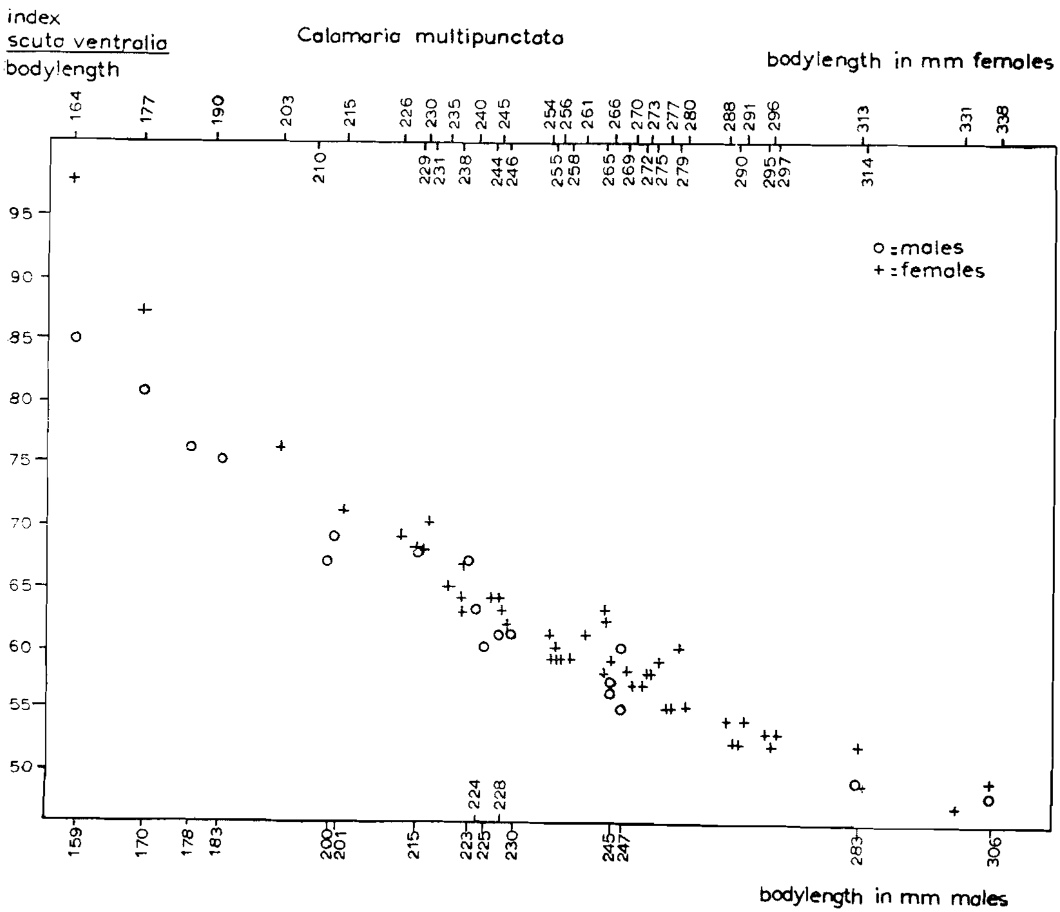


Figure 10. Scatterdiagram of the body length and the index ventral scales: body length in both sexes.

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