# THE RELATIONSHIP OF THE POSITION OF THE VISCERAL ORGANS TO THE VENTRAL SCALE NUMBER IN THREE SPECIES OF SNAKES


By

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# CHAPTER I

## INTRODUCTION

Snakes have been the object of much research, especially in the area of venom and venom transmission. However, little has been published about the anatomical arrangement and position of internal organs, particularly with reference to external landmarks that can be used to indicate their position in the living animal. This paper will present evidence that there is a relationship between the number of ventral scales and the position of some of the visceral organs, and compare these relationships between species of different size and in different families.

Ventral scale counts have often been used as a means of identification in snakes. The taxonomic significance of this character is established and accepted by Thompson, Schmidt, Davis, Dowling and others. Thompson (1914), Schmidt and Davis (1941) and Dowling (1951) proposed standard systems of counting ventral scales to eliminate the possibility of error, especially in the throat region.

Klauber (1956) listed the measurements in millimeters of the lung, heart, liver, stomach, gallbladder, spleen, kidney and testis in <u>Crotalus mitchelli pyrrhus</u>. He also listed in millimeters the position of these organs within the body cavity and calculated the percentage lengths of these organs in relationship to the number of ventral scales.

Tyson, as cited in Ahrenfeldt (1955), noted that the number of vertebrae and ribs of the rattlesnake equalled the number of scales on the underside from the neck to the anus. If the relationship of vertebrae and ribs to ventral scales is consistent, one could theorize that a relationship could also be demonstrated in the position of the visceral organs. The recognition of such a relationship is important, especially in animals without limbs or other external indications of division of the trunk into neck, thorax and abdomen.

Knowing the position of an organ by scale number should prove more useful than knowing its position by percentage of body length for it is difficult to derive accurate linear measurements either from moving, live specimens or from hardened, preserved specimens that have been coiled in jars.

A system that permits precise location of the position of various visceral organs could aid in studies of many sorts. With a knowledge of organ position, physiological, histological and morphological studies could be attempted with less possibility of death to the snake.

## CHAPTER II

## GENERAL DESCRIPTION OF SPECIES

The species of snakes used were *Natrix rhombifera rhombifera*, the diamond-backed water snake, *Haldea striatula*, the rough earth snake and *Ancistrodon contortrix laticinctus*, the broad-banded copperhead.

*N. rhombifera rhombifera*, often mistaken for the cottonmouth, ranges from southeast Iowa to the Gulf and from west central Alabama to central Texas. This snake belongs to the family Colubridae, subfamily Natricinae. It is large and bulky, ranging up to 63 inches in length. It frequents varying types of aquatic habitats where it feeds nocturnally on fish, frogs, small turtles and other aquatic animals. In late August these snakes give birth to live young averaging 30 young per litter.

The small secretive snake, *H. striatula* belongs to the family of harmless snakes, Colubridae, subfamily Colubrinae. Its distribution extends from Virginia to northern Florida and west to Kansas and Texas. It ranges from seven to ten inches in length, is nocturnal and hides in moist places under rocks and debris. Being small, it feeds on insects and other small invertebrates. It measures about four inches in length at birth and the average litter size is seven.

*A. contortrix laticinctus* belongs to the family of venomous snakes, Viperidae, subfamily Crotalinae. It is found in southern Kansas through Oklahoma and central Texas to the Gulf of Mexico. Its length may reach

53 inches but average is 22 to 30 inches. This snake prefers moist areas but does not frequent ponds. Its diet consists mainly of small mammals and occasionally birds and insects. Two to ten live young per litter are born in late August to early September.

These three species of snakes were chosen because they differ from one another taxonomically, in size and in habitat. If a relationship does exist between the position of visceral organs and the number of ventral scales in each species of snake studied, the knowledge derived from it would be more valuable if based on widely separated taxa.

## CHAPTER III

## ANATOMICAL DISCUSSION

The visceral organs, heart, liver, gallbladder, pancreas, gonads, and kidneys were considered in the order of their appearance in the snake (anterior to posterior). For clarity, a brief and general anatomical discussion of the organs considered follows.

The entire pleuroperitoneal cavity and the relationship of the organs within it, is quite unique in snakes due to the attenuated body form and the consequent necessity for a linear arrangement of the organs. Thus there is a marked asymmetry of the viscera, particularily of the paired organs, those of the right side being anterior to, as well as larger than those of the left (Smith, 1954).

Due to the compression of the organs within such a small, cylindrical space the organs are elongated, diminished in size or in some cases eliminated entirely. For example, one finds two lungs in the more primitive snakes but the more advanced snakes have only one functional lung, the right, and a rudimentary left lung.

The lung is divided into three regions: the tracheal, bronchial and reservoir regions. The tracheal lung, which is the most anterior region, fills the anterior part of the body cavity and terminates opposite the center of the heart. This lung tissue is filled directly with air from the trachea that lies below it. The trachea is split dorsally from the beginning of the tracheal lung to its entrance into the bronchial lung (Klauber, 1956).

The bronchus or terminus of the trachea supplies air to the bronchial lung tissue. The boundary between the posterior tracheal and anterior bronchial portions is often not precisely definable. The bronchial portion, also called the respiratory or vascular lung, terminates anterior to the gallbladder (Varde, 1951). Its total length depends upon the length of the snake.

The final section of the lung is a bladderlike tube with a thin, translucent wall which serves as an air reservoir. The length of the reservoir lung varies in different species, often extending as far as the anterior end of the gonads.

The heart is three-chambered in all snakes and lies in the anterior part of the body with the lung dorsal and to the right of it and the esophagus to the left of it. The muscular ventricle is the most apparent part of the heart when viewed ventrally. The ventricle is partially divided by an incomplete interventricular septum which extends from the apex toward the center. The conus arteriosus no longer exists as a separate part. The conus arteriosus, as well as the ventral aorta, is split into three main trunks.

The esophagus is a thin walled membranous tube lying to the left of the heart and opening into the cardiac part of the stomach at the level of the middle of the liver. The anatomical distinction between the esophagus and stomach is not easily seen unless the stomach is distended with food. The stomach which can be greatly distended, ends posteriorly with a small pyloric portion, much narrower than the body, and terminating with a sphincter. This sphincter divides the stomach from the coiled small intestine, with the small intestine leading into a short large intestine which terminates in a cloaca.

The accessory organs of the digestive system, the liver and pancreas, are very distinctive. The liver is the most conspicuous organ, being reddish-brown in color. Its anterior end lies posterior to the heart and the posterior end is found in the middle of the body cavity some distance anterior to the gallbladder. The common bile duct, which appears to divide the single lobe of the liver, lies in the ventral midline of the liver and courses through the mesentery to the gallbladder and pancreas posteriorly. After giving off a branch to the gallbladder, it opens into the anterior end of the small intestine.

A membranous, greenish gallbladder is found at the level of the entrance of the bile duct into the small intestine. It is posterior to and completely separate from the liver. The ducts of the pancreas, a globular gland adhering closely to the posterior end of the gallbladder, enter the small intestine just anterior to the bile duct.

The gonads adhere to the lateral walls of the pleuroperitoneal cavity on either side of the small intestine. They are always found posterior to the pancreas but the exact position cannot be predicted precisely because the gonads vary in size and position depending upon the state of the sexual cycle, especially in the female. The gonads are solid structures with the right gonad being larger and situated farther forward.

The metanephric kidneys which are similar in both sexes and situated behind the gonads, are composed of a series of irregular lobes adhering to the lateral walls of the coelom. The kidneys, like the gonads, are asymmetrically placed. One kidney may lie entirely behind the other or they may overlap to a varying extent. The mesentery extending from the kidney to the coelomic wall is the same mesentery that supports the gonads. In gravid females the developing young tend to displace the kidneys and gonads by stretching the mesentery. A urinary bladder is lacking in all snakes.

## CHAPTER IV

## MATERIALS AND METHODS

Twenty preserved specimens of *N. rhombifera rhombifera*, 30 specimens of *H. striatula* and 16 specimens of *A. contortrix laticinctus* were obtained from the Oklahoma State University Museum. Ten *N. rhombifera rhombifera* and five *A. contortrix laticinctus* were collected alive near the University of Oklahoma Biological Station at Lake Texoma. All of the snakes under consideration were females. The snakes were chosen because of their diversity in size, habitat and taxonomic position.

Live specimens were killed with an injection of sodium nebutal through the foramen magnum into the brain. This killed quickly and caused the muscles to relax, thus insuring the natural position of the organs.

Although the sample tested was restricted to females the relationship could also be applied to males. Most variability occurs in females according to Smith (1954) who noted that gigantism, the presence of abnormally large animals in a population, is usually restricted to females.

Studies by Boyer (1957) and Klauber (1943) present evidence that females have a greater number of ventral scales and fewer subcaudals than males. The males have longer tails than the females and the retracted hemipenes are accommodated in the tail. Being longer the tail requires more scales to sheathe them. The females, on the other hand, must carry eggs and young that represent a considerable proportion of the body bulk, and so are favored with additional ventral scales (Klauber, 1956).

Klauber found that the coefficient of sexual dimorphism in the ventrals, with the females invariably higher, varied from 0.5 to 4.0%, with an average of 2.3%. This indicated a higher count of about four or five ventral scales in the females of most species. These ranges were found to be constant. Thus, if there is a definite relationship of the ventrals to the position of visceral organs in the female population, one could by adjusting percentages, apply this relationship to male populations.

Schmidt and Davis' (1941) method of counting ventrals was employed. They recommended starting the count with the first ventral scale which is distinctly wider than long, and proceeding to the scale immediately before the anal plate (Figs. 1 and 2). The ventrals were counted twice, once from anterior to posterior and once from posterior to anterior, to eliminate error. The total length of the snake was measured to the nearest inch.

A midventral incision from throat to vent was made to reveal the organs of the pleuroperitoneal cavity. Specific counts for the anterior and posterior ends of the heart, liver, gallbladder, pancreas and the anterior ends of the gonads and kidneys were taken randomly to lessen the possibility of error (Fig. 3). After the random count was taken for each organ the count was taken again beginning at the anterior end of the body and progressing to the vent. To avoid bias, no two members of the same species were counted consecutively, except in unavoid-

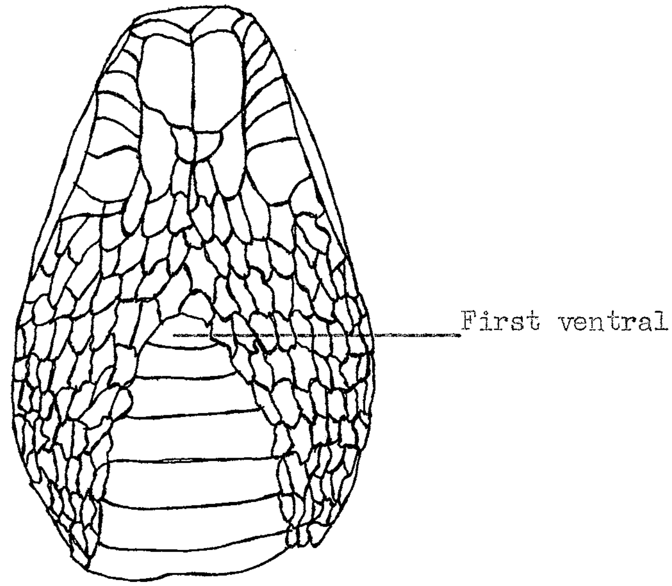


Figure 1. Determining the First Ventral Scale

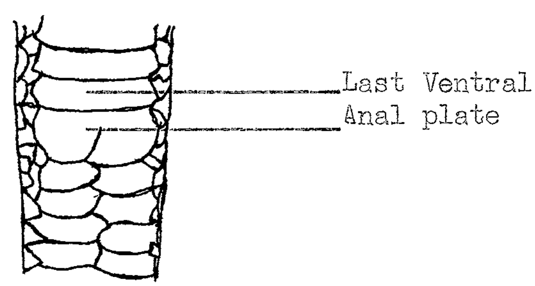


Figure 2. Determining the Last Ventral Scale

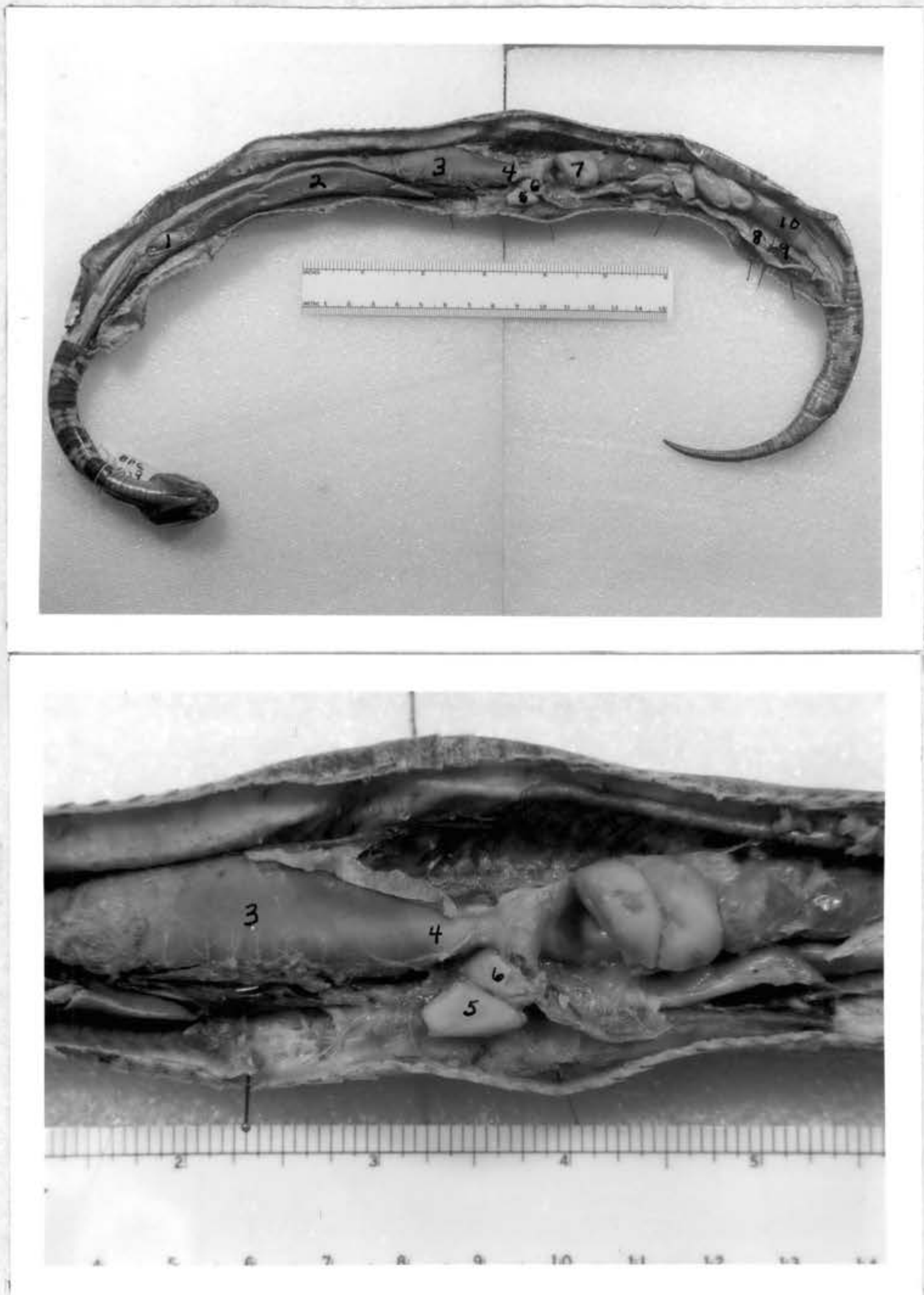

Fig. 3. Internal anatomy of A. contortrix laticinctus
1. heart. 2. liver. 3. body of stomach. 4. pyloric stomach. 5. gallbladder. 6. pancreas. 7. small intestine 8. oviduct. 9. kidney 10. large intestine.

circumstances. If the organ in question was located within less than one half of one scale length of the adjoining scale, the scale was not included in the count.

The scales marking the posterior ends of the gonads and kidneys were not counted because the length and position of these organs in the coelom varied due to differing degrees of sexual activity.

Mean ventral scale positions of organs and their confidence intervals for each species of snake were calculated using methods given in Steel and Torre (1960), by use of 7040 type IBM data-processing machine.

CHAPTER V

RESULTS AND DISCUSSION

It was presumed from the beginning of this study, that at birth a snake has its full complement of ventral scales, and that these scales increase in length and width at a rate proportionate to the increase in size of the visceral organs. The basis for this assumption was the fact that the number of ventral scales are relatively constant for a given species (Dowling, 1951), and Tyson's (1683) observation that the number of vertebrae-bearing ribs of the rattlesnake equalled the number of scales on the belly.

The data listed in Table I, III and II show the mean values and confidence intervals as derived from the means and standard deviations for the anterior and posterior ends of each organ in each species. A 90% confidencewinterval was derived using 30 observations for *Natrix* and *Haldea* and 20 observations for *Ancistrodon*. According to the data obtqined, a relationship does exist between ventral scale count and organ location, but variation is greater in *Natrix* than in *Haldea* and *Ancistrodon*.

The relationships, as found in this study, may not be applicable to other snakes of the same species for several reasons. Klauber (1956) demonstrated variation in thè number of ventral scales in snakes of the same species from different geographical regions. The snakes considered in this study were taken from a limited geographical area, thus the data

TABLE I

MEAN VENTRAL SCALE COUNTS FOR POSITION OF ORGANS AND THEIR CONFIDENCE INTERVALS FOR 30 SPECIMENS OF *NATRIX RHOMBIFERA RHOMBIFERA*

| | Abbrev. | | 90% Confidence Interval | |
|---|---|---|---|---|
| Organ | of organ | Mean | Lower limit | Upper limit |
| Heart begins | HB | 24.5 | 22.4 | 26.6 |
| Heart ends | HE | 30.2 | 27.7 | 32.5 |
| Liver begins | LB | 40.3 | 36.9 | 43.7 |
| Liver ends | LE | 69.9 | 66.6 | 73.0 |
| Gallbladder begins | GBB | 77.6 | 71.9 | 83.3 |
| Gallbladder ends | GBE | 80.1 | 73.8 | 86.2 |
| Pancreas begins | PB | 80.9 | 75.3 | 86.5 |
| Pancreas ends | PE | 82.4 | 76.0 | 88.0 |
| Left gonad begins | LGB | 107.9 | 102.0 | 113.8 |
| Right gonad begins | RGB | 99.2 | 92.6 | 105.8 |
| Left kidney begins | LKB | 117.3 | 111.2 | 123.2 |
| Right kidney begins | RKB | 108.6 | 102.9 | 114.3 |

TABLE II

MEAN VENTRAL SCALE COUNTS FOR POSITION OF ORGANS AND THEIR CONFIDENCE INTERVALS FOR 30 SPECIMENS OF *HALDEA STRIATULA*

| | | 90% Confidence Intervals | |
|---|---|---|---|
| Organ | Mean | Lower limit | Upper limit |
| Heart begins | 20.7 | 19.2 | 22.2 |
| Heart ends | 24.6 | 23.1 | 26.1 |
| Liver begins | 31.0 | 29.6 | 32.4 |
| Liver ends | 66.2 | 62.5 | 69.9 |
| Gallbladder begins | 78.6 | 74.1 | 82.9 |
| Gallbladder ends | 79.6 | 75.3 | 83.9 |
| Pancreas begins | 80.6 | 76.3 | 84.9 |
| Pancreas ends | 81.6 | 77.3 | 85.9 |
| Left gonad begins | 97.4 | 92.9 | 101.9 |
| Right gonad begins | 89.3 | 82.9 | 95.7 |
| Left kidney begins | 106.8 | 102.8 | 110.8 |
| Right kidney begins | 101.5 | 97.5 | 105.5 |

TABLE III

MEAN VENTRAL SCALE COUNTS FOR POSITION OF ORGANS AND THEIR CONFIDENCE INTERVALS FOR 20 SPECIMENS OF *ANCISTRODON CONTORTRIX LATICINCTUS*

| | | 90% Confidence Intervals | |
|---|---|---|---|
| Organ | Mean | Lower limit | Upper limit |
| Heart begins | 46.3 | 44.6 | 47.9 |
| Heart ends | 51.0 | 49.0 | 53.0 |
| Liver begins | 52.1 | 49.8 | 54.4 |
| Liver ends | 81.9 | 78.9 | 84.9 |
| Gallbladder begins | 90.7 | 87.2 | 94.2 |
| Gallbladder ends | 93.8 | 90.5 | 97.1 |
| Pancreas begins | 94.2 | 91.0 | 97.4 |
| Pancreas ends | 95.8 | 93.0 | 98.6 |
| Left gonad begins | 109.5 | 107.3 | 111.7 |
| Right gonad begins | 101.8 | 99.0 | 104.6 |
| Left kidney begins | 120.8 | 118.4 | 123.6 |
| Right kidney begins | 116.5 | 113.8 | 119.2 |

may not apply perfectly to snakes from other localities.

Variability in these particular data may be due to the fact that there was no way of determining the conditions under which these snakes developed embryologically. Fox (1948) performed some important experiments showing the effect of prenatal temperature conditions on scale counts of young. He procured gravid female garter snakes from a limited locality, and, having divided them into two groups, he subjected one group to a higher temperature than the other during the period of embryonic development of their young. The young born to the mothers in the cooler room had significantly fewer ventrals than those whose mothers had been kept warmer during gestation.

At the 90% level of confidence one can expect to find the front end of the heart within a three-scale range in <u>Ancistrodon</u> and <u>Haldea</u> and a four-scale range in <u>Natrix</u>. The heart in all species was at least four scales in length. The means obtained for both ends of the heart indicated that in the three species studied the heart lies adjacent to four or five ventral scales, regardless of age or size of the snake. The size of the organ therefore, seems to increase at a rate equal to the rate of increase in the size of the scales.

According to the data, the confidence intervals for the anterior and posterior ends of the liver show variation in the position of the organs. Table IV, V, and VI list the length of the liver in ventral scales taken up by the liver. Even though the placement of the organ is not consistent the data show that the liver on the average, covers 29 scales in <u>Ancistrodon</u> and <u>Natrix</u> and 33 scales in <u>Haldea</u>. This suggests a precise length of the liver relative to number of ventral scales.

TABLE IV

THE LENGTH OF THE LIVER IN NUMBER OF SCALES
AND PERCENTAGE OF TOTAL VENTRAL SCALES
IN *NATRIX RHOMBIFERA RHOMBIFERA*

| Total number of ventral scales under liver | Total number of ventral scales | Percentage of total ventral scales under liver |
|---|---|---|
| 30 | 146 | 20% |
| 29 | 150 | 19% |
| 26 | 145 | 18% |
| 30 | 150 | 20% |
| 33 | 149 | 22% |
| 30 | 145 | 21% |
| 28 | 149 | 19% |
| 30 | 149 | 20% |
| 35 | 149 | 23% |
| 27 | 143 | 18% |
| 32 | 143 | 22% |
| 32 | 146 | 21% |
| 27 | 143 | 18% |
| 28 | 146 | 19% |
| 33 | 146 | 22% |
| 20 | 145 | 13% |
| 32 | 148 | 21% |
| 28 | 143 | 19% |
| 27 | 143 | 18% |
| 30 | 146 | 20% |
| 31 | 148 | 20% |
| 27 | 146 | 19% |
| 30 | 149 | 20% |
| 28 | 145 | 19% |
| 30 | 150 | 20% |
| 30 | 150 | 20% |
| 31 | 146 | 21% |
| 32 | 147 | 21% |
| 30 | 145 | 21% |
| 31 | 149 | 20% |

TABLE V...

THE LENGTH OF THE LIVER IN NUMBER OF SCALES AND PERCENTAGE OF TOTAL VENTRAL SCALES IN <u>HALDEA STRIATULS</u>

| Total number of ventral scales under liver | Total number of ventral scales | Percentage of total ventral scales under liver |
|---|---|---|
| 38 | 122 | 31% |
| 35 | 120 | 29% |
| 36 | 125 | 29% |
| 33 | 120 | 28% |
| 34 | 126 | 27% |
| 36 | 121 | 29% |
| 36 | 125 | 29% |
| 34 | 120 | 28% |
| 39 | 120 | 32% |
| 36 | 126 | 29% |
| 35 | 120 | 29% |
| 34 | 124 | 27% |
| 34 | 120 | 29% |
| 38 | 122 | 31% |
| 36 | 120 | 30% |
| 34 | 125 | 27% |
| 33 | 125 | 27% |
| 38 | 126 | 30% |
| 32 | 124 | 26% |
| 32 | 121 | 26% |
| 33 | 120 | 28% |
| 35 | 122 | 29% |
| 35 | 123 | 28% |
| 32 | 124 | 25% |
| 33 | 123 | 27% |
| 37 | 121 | 31% |
| 37 | 128 | 28% |
| 36 | 127 | 28% |
| 37 | 124 | 29% |
| 36 | 123 | 29% |

TABLE VI

THE LENGTH OF THE LIVER IN NUMBER OF SCALES AND PERCENTAGE OF TOTAL VENTRAL SCALES IN *ANCISTRODON CONTORTRIX LATICINCTUS*

| Total number of ventral scales under liver | Total number of ventral scales | Percentage of total ventral scales under liver |
|---|---|---|
| 25 | 149 | 18% |
| 28 | 148 | 19% |
| 33 | 151 | 21% |
| 26 | 148 | 18% |
| 29 | 150 | 19% |
| 29 | 150 | 19% |
| 29 | 148 | 19% |
| 27 | 148 | 19% |
| 30 | 151 | 20% |
| 29 | 148 | 19% |
| 31 | 150 | 20% |
| 28 | 149 | 19% |
| 31 | 149 | 20% |
| 31 | 147 | 20% |
| 32 | 148 | 21% |
| 30 | 150 | 20% |
| 31 | 149 | 20% |
| 32 | 150 | 21% |
| 30 | 148 | 20% |
| 35 | 151 | 23% |

for each species.

The positions of the gallbladder and pancreas are variable according to the confidence intervals values shown. Upon further analysis, it was found that the average position of the gallbladder was nine scales behind the posterior end of the liver in Ancistrodon, twelve scales in Haldea and eight scales in Natrix. The average size of the gallbladder in Natrix was 2.46 scale lengths, 1.0 scale lengths in Haldea and 3.2 scale lengths in Ancistrodon with very little deviation from the mean. Several specimens had large gallbladders due to distention with bile at the time of dissection. The gallbladder increased in length, when distended, thus spanning more ventral scales.

In all cases the pancreas was found adhering closely to the posterior end of the gallbladder, therefore its location was dependent upon the position of the gallbladder. The average size of the pancreas in Natrix was 1.46 scale lengths, 1.0 scale lengths in Haldea and 1.6 scale lengths in Ancistrodon.

It was presumed at the beginning of this study that the gonads would vary in position because of differing degrees of sexual activity, especially since all of the specimens were female. It was presumed also that the added bulk of the developing young would push the kidneys out of their usual position. Both assumptions were found to be true in Natrix and Haldea but not in Ancistrodon.

The range of variation in the position of the gonads and kidneys in Natrix and Haldea studied was great, but not in the Ancistrodon (Table III), due to the fact that only two specimens of Ancistrodon were gravid, while most specimens of Natrix and Haldea were.

the gonads in Ancistrodon were 2.0 scales on either side of the mean for the left gonad (mean 109.5 scales) and 2.8 scales for the right gonad (mean 101.8 scales). The lower and upper limits of variation for the kidneys were 2.4 scales for the anterior end of the left kidney (mean 120.8 scales) and 2.7 scales for the right kidney (mean 116.5 scales). The frequency distribution table for Ancistrodon further indicates the lack of variability in this area.

The frequency distribution tables VII, VIII, and IX also show a relationship between the staggered position of the right gonad and kidney to the left gonad and kidney, with the right being situated anterior to the left.

From the analysis of data, it was evident that the relationship of ventral scales to the position of visceral organs is proximate but not absolute. The relationship of the size of the organ to the number of ventral scales is evident. The data support the theory that the scales increase in length at a rate proportionate to the increase in size of visceral organs, and the size and rate is constant for a given species.

An organ can be located with accuracy by number of ventral scales and by percentage of total ventral scales. The relationship of position of organs to number of ventral scales is constant as derived for each of the three species of snakes studied but can be applied only to that one species. It cannot be said, for example, that the heart begins at the 20% level of total ventral scales in all species of snakes nor can this means of definition be used for other visceral organs.

TABLE VII

FREQUENCY DISTRIBUTION FOR POSITION OF VISCERAL ORGANS IN NATRIX RHOMBIFERA RHOMBIFERA

| No. Scales | *HB | HE | LB | LE | GBB | GBE | PB | PE | LGB | RGB | LKB | RKB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18-20 | | | | | | | | | | | | |
| 21-23 | 8 | | | | | | | | | | | |
| 24-26 | 20 | | | | | | | | | | | |
| 27-29 | 2 | 11 | | | | | | | | | | |
| 30-32 | | 17 | | | | | | | | | | |
| 33-35 | | 2 | | | | | | | | | | |
| 36-38 | | | 6 | | | | | | | | | |
| 39-41 | | | 17 | | | | | | | | | |
| 42-44 | | | 6 | | | | | | | | | |
| 45-47 | | | 1 | | | | | | | | | |
| 48-50 | | | | | | | | | | | | |
| 51-53 | | | | | | | | | | | | |
| 54-56 | | | | | | | | | | | | |
| 57-59 | | | | | | | | | | | | |
| 60-62 | | | | | | | | | | | | |
| 63-65 | | | | | | | | | | | | |
| 66-68 | | | | 6 | | | | | | | | |
| 69-71 | | | | 18 | | | | | | | | |
| 72-74 | | | | 6 | 5 | 2 | | | | | | |
| 75-77 | | | | | 9 | 8 | 5 | 3 | | | | |
| 78-80 | | | | | 10 | 7 | 6 | 7 | | | | |
| 81-83 | | | | | 6 | 7 | 10 | 9 | | | | |
| 84-86 | | | | | | 6 | 9 | 7 | | | | |
| 87-89 | | | | | | | | 4 | | | | |
| 90-92 | | | | | | | | | | | | |
| 93-95 | | | | | | | | | | 4 | | |
| 96-98 | | | | | | | | | | 9 | | |
| 99-101 | | | | | | | | | | 10 | | |
| 102-104 | | | | | | | | | 5 | 3 | | 2 |
| 105-107 | | | | | | | | | 9 | 2 | | 8 |
| 108-110 | | | | | | | | | 12 | 1 | 3 | 15 |
| 111-113 | | | | | | | | | 1 | 1 | 11 | 3 |
| 114-116 | | | | | | | | | | | 11 | 0 |
| 117-119 | | | | | | | | | | | 2 | 2 |
| 120-122 | | | | | | | | | | | 3 | |
| 123-125 | | | | | | | | | | | 1 | |
| 126-128 | | | | | | | | | | | | |

*Refer to Table I for abbreviation of organs

TABLE VIII

FREQUENCY DISTRIBUTION FOR POSITION OF VISCERAL ORGANS IN HALDEA STRIATULA

| No. scales | *HB | HE | LB | LE | GBB | GBE | PB | PE | LGB | RGB | LKB | RKB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18-20 | 11 | | | | | | | | | | | |
| 21-23 | 19 | 3 | | | | | | | | | | |
| 24-26 | | 27 | | | | | | | | | | |
| 27-29 | | | 1 | | | | | | | | | |
| 30-32 | | | 28 | | | | | | | | | |
| 33-35 | | | 1 | | | | | | | | | |
| 36-38 | | | | | | | | | | | | |
| 39-41 | | | | | | | | | | | | |
| 42-44 | | | | | | | | | | | | |
| 45-47 | | | | | | | | | | | | |
| 48-50 | | | | | | | | | | | | |
| 51-53 | | | | | | | | | | | | |
| 54-56 | | | | | | | | | | | | |
| 57-59 | | | | | | | | | | | | |
| 60-62 | | | | | | | | | | | | |
| 63-65 | | | | 1 | | | | | | | | |
| 66-68 | | | | 12 | | | | | | | | |
| 69-71 | | | | 10 | | | | | | | | |
| 72-74 | | | | 7 | 3 | | | | | | | |
| 75-77 | | | | | 9 | 6 | 4 | 3 | | | | |
| 78-80 | | | | | 10 | 12 | 11 | 9 | | | | |
| 81-83 | | | | | 7 | 10 | 11 | 10 | | | | |
| 84-86 | | | | | 1 | 2 | 4 | 7 | | 7 | | |
| 87-89 | | | | | | | | 1 | | 13 | | |
| 90-92 | | | | | | | | | | 4 | | |
| 93-95 | | | | | | | | | 9 | 4 | | |
| 96-98 | | | | | | | | | 11 | 1 | | 2 |
| 99-101 | | | | | | | | | 8 | 1 | | 14 |
| 102-104 | | | | | | | | | 2 | | 4 | 11 |
| 105-107 | | | | | | | | | | | 12 | 2 |
| 108-110 | | | | | | | | | | | 11 | 0 |
| 111-113 | | | | | | | | | | | 0 | 1 |
| 114-116 | | | | | | | | | | | 1 | |
| 117-119 | | | | | | | | | | | | |
| 120-122 | | | | | | | | | | | | |
| 123-125 | | | | | | | | | | | | |
| 126-128 | | | | | | | | | | | | |

*Refer to Table I for abbreviation of organs

TABLE IX

FREQUENCY DISTRIBUTION FOR POSITION OF VISCERAL ORGANS IN ANCISTRODON CONTORTRIX LATICINCTUS

| No. Scales | *HB | HE | LB | LE | GBB | GBE | PB | PE | LGB | RGB | LKB | RKB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18-20 | | | | | | | | | | | | |
| 21-23 | | | | | | | | | | | | |
| 24-26 | | | | | | | | | | | | |
| 27-29 | | | | | | | | | | | | |
| 30-32 | | | | | | | | | | | | |
| 33-35 | | | | | | | | | | | | |
| 36-38 | | | | | | | | | | | | |
| 39-41 | | | | | | | | | | | | |
| 42-44 | | | | | | | | | | | | |
| 45-47 | 18 | | | | | | | | | | | |
| 48-50 | 2 | 6 | 2 | | | | | | | | | |
| 51-53 | | 13 | 16 | | | | | | | | | |
| 53-56 | | 1 | 1 | | | | | | | | | |
| 57-59 | | | 1 | | | | | | | | | |
| 60-62 | | | | | | | | | | | | |
| 63-65 | | | | | | | | | | | | |
| 66-68 | | | | | | | | | | | | |
| 69-71 | | | | | | | | | | | | |
| 72-74 | | | | | | | | | | | | |
| 75-77 | | | | | | | | | | | | |
| 78-80 | | | | 5 | | | | | | | | |
| 81-83 | | | | 12 | | | | | | | | |
| 84-86 | | | | 3 | | | | | | | | |
| 87-89 | | | | | 7 | | | | | | | |
| 90-92 | | | | | 9 | 6 | 5 | | | | | |
| 93-95 | | | | | 4 | 11 | 11 | 11 | | | | |
| 96-98 | | | | | | 3 | 4 | 7 | | 1 | | |
| 99-101 | | | | | | | | 2 | | 6 | | |
| 102-104 | | | | | | | | | | 12 | | |
| 105-107 | | | | | | | | | 1 | 1 | | |
| 108-110 | | | | | | | | | 14 | | | |
| 111-113 | | | | | | | | | 5 | | | 1 |
| 114-116 | | | | | | | | | | | | 9 |
| 117-119 | | | | | | | | | | | 5 | 9 |
| 120-122 | | | | | | | | | | | 13 | 1 |
| 123-125 | | | | | | | | | | | 2 | |
| 126-128 | | | | | | | | | | | | |

*Refer to Table I for abbreviation of organs

# CHAPTER VI

## SUMMARY

Counts were taken of the number of ventral scales and the position of the heart, liver, gallbladder, pancreas, gonads and kidneys relative to the ventral scales in females of three species of snakes. Thirty specimens of Natrix rhombifera rhombifera and Haldea striatula and 20 specimens of Ancistrodon contortrix laticinctus were examined.

The data were treated statistically to derive confidence intervals and to plot frequency distributions. From the analysis, it was evident that the relationship of ventral scales to the position of visceral organs while not absolute, is sufficiently precise to enable most organs to be located with considerable accuracy. The relationship of the size of the organs to the number of ventral scales is evident. The data indicate that during growth the scales increase in length at a rate proportionate to the increase in size of the visceral organs so that the relationship between scale size and organ size is constant for a given species.

### Conclusions

1. The position of visceral organs in relationship to the number of ventral scales can be located with considerable accuracy.
2. The position of these organs is specific for a given species and cannot be applied to other species.

3. The number of ventral scales was constant within a five scale range.

4. The ventral scales increase in length at a rate proportionate to the increase in size of the visceral organs, and the size and rate is constant for a given species.

5. Variation in the number of ventral scales in snakes of the same species from different geographical regions was noted by Klauber (1956). The snakes considered in this study were taken from a limited geographical area, thus the data may not apply perfectly to snakes from other localities.

6. Variability in the number of ventral scales in these particular data may be due to the fact that there was no way of determining the conditions under which these snakes developed embryologically. Fox (1948) performed an experiment showing that temperature effects the number of ventral scales during embryonic development.

7. Dissection and statistical data showed that the position of the gonads and kidneys varied in gravid females. The position of these organs varied little in non-gravid females. Since a common mesentery supports the gonad and kidney the enlarged state of the gonad could displace the kidney by stretching the mesentery.

8. Although the kidneys were found to vary in position in females, this may not be true in males, which were not studied.

9. That the gallbladder, in all snakes studied, was found to be completely separated from the liver. It was supported by a ligament which extended from the liver to the gallbladder and pancreas.

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