THE VARIATIONS EXHIBITED BY THAMNOPHIS ORDINOIDES (BAIRD AND GIRARD), A GARTER-SNAKE INHABITING THE SAUSALITO PENINSULA, CALIFORNIA.

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INTRODUCTION.

The garter-snakes of the Pacific coast found west of the Sierra-Nevada-Cascade Range, from Vancouver in the north to the Tehachapi Mountains in the south, have been assembled in the Memoir of Dr. A. G. Ruthven, under the one name of *Thamnophis ordinoides* (Baird and Girard).[1]

This species presents a remarkably large series of variations, is equaled by no other in the genus, and is only approached by *T. elegans* and *T. radix* which occupy regions five to eight times greater in extent.

The specimens upon which this study is based were captured on the Sausalito Peninsula, which forms the northern boundary of the Golden Gate, the entrance to San Francisco Bay. They were all taken within a radius of 3 kilometers.

METHODS.

In addition to enumerating the number of scale rows on the various parts of the body, it has been found that most instructive records may be obtained if note is taken of the exact gastrostege level at which an added row begins or a suppressed row ends.

Assuming that a normal specimen is being examined, the following is about what may be expected: At the beginning of the neck there may be counted 10 rows of scales on each side of the median, a total of 21 rows; a little further back there are 9 rows and the median, a total of 19 rows; where this reduced count begins it will be seen that it is caused by the IV row (counting the row next to the gastrostege as the first row) being suppressed, and this occurs usually at the level of the sixth gastrostege. From this point on there are 19 rows until about the twenty-fifth gastrostege, where the count is increased to 21 rows; this is brought about by the addition of a row on each side, the added row being the V. This V row, with the accompanying total of 21 rows, continues to about the sixty-fifth gastrostege, when the V row is suppressed and the count of 19 rows is resumed. The 19 rows continue to the level of the eighty-fifth gastrostege, when the

[1] Bull. 61, U. S. National Museum, 1908, p. 147.

IV row is suppressed, leaving 17 rows, which continue throughout the rest of the body.

A specimen such as just described would have the scale rows recorded as—

Neck, 19. Body, 19–21–19–17;

the sequence of addition and suppression of the scale rows as—

Neck, —IV. Body, +V, —V, —IV;

and the complete data showing the gastrostege level at which the added rows begin and the suppressed rows end may be presented as follows:

Neck.		Body.							
21—IV.		19+V.		21—V.		19—IV.		17 cont'd.	
rt.	lt.	rt.	lt.	rt.	lt.	rt.	lt.	rt.	lt.
6	6	25	25	65	65	85	85	......	......

One of the variations in the scale formulæ is where the body instead of having 19–21–19–17 rows, has only 19–17, that is, 19 rows anteriorly and 17 posteriorly. In this type it is the fourth row in actual counting which is lost.

In order that the data be correctly coordinated the scale rows must be given permanent numbers on that part of the body on which the highest count occurs in the species. In this case it is 21 rows, and the series are numbered from I to X in addition to the median. A specimen in which the highest count is 19 rows must be assumed to have the V rows suppressed constructively. It will have 9 rows on each side of the median; for these to be recorded in terms of the maximum number for the species they must be counted as I, II, III, IV (V suppressed constructively), VI, VII, VIII, IX, and the median row.

Another variation is where the count is 19–17–15. In this type the 19 rows become reduced to 17 by the suppression of the IV row, and occasionally the 17 rows become 15 by the loss of the fifth row in actual count, but this row when recorded in terms of the maximum rows for the species must be counted as the VI row.

Behind the posterior pair of geneials there are usually one or two pairs of small gular shields; these are followed by from one to three shields in the median line which increase in width in pyramidal fashion. The shield that is regarded as the first gastrostege is the first one that is nearly the standard width; it is usually distinguished by being colored similarly to the rest of the ventrals and not white or cream-colored like the throat.

VARIATION IN NUMBER OF DORSAL SCALE ROWS.

Combining the records obtained by Doctor Ruthven[1] with the data secured from the present series it appears that there are eight dis-

[1] Bull. 61, U. S. Nat. Mus., p. 148.

tinct scale formulæ for *T. ordinoides.* The reduced counts prevail in specimens from the northern part of the range. These formulæ and the frequency of occurrence of the five types found on the Sausalito Peninsula are as follows:

	Per cent.
21-19-17	6
19-21-19-17	66
19-17	10
19-17-15	12
19-17-15-13	2
17-19-17-15	0
17-15	0
15-17-15	0
Bilaterally asymmetrical	4

SCALE FORMULA 21-19-17 (—V, —IV).

U.S.N.M. No.	Sex.	Ventrals.	Neck.	Body.		
			23—IV.	21—V.	19—IV.	17 cont.
50283	Male......	159	—III. 6 7	79 80	115 114	....
50304	Female....	154	6 5	75 72	110 109	....
50309	...do......	154	5 5	71 74	121 123	....

SCALE FORMULA 19-21-19-17 (+ V, —V, —IV).

This combination was found in 66 per cent of the specimens; of these, 61 per cent were males and 39 per cent females. It may be regarded as the normal count for this immediate region.

Male.

U.S.N.M. No.	Ventrals.	Neck.	Body.			
		21—IV.	19+V.	21—V.	19—IV.	17 cont.
50254	153	4 4	35 38	44 44	86 86	....
50259	150	7 7	24 26	59 61	91 85	....
50263	159	8 7	25 23	65 70	87 86	....
50264	155	5 5	32 36	—IV 53 53	—V 80 79	....
50265	164	Cont. 8	Cont. 20	69 71	95 93	....
50266	156	—V 8 8	23 23	62 67	83 86	....
50267	155	5 5	22 24	—IV 59 58	—III 76 78	....
50268	159	6 6	35 34	42 48	85 86	....
50269	156	4 5	28 29	58 59	84 85	....
50270	157	9 8	—VI 24 35	54 53	82 83	....
50271	155	7 7	34 35	—IV 50 60	—V 85 87	....
50272	156	6 6	28 31	59 63	89 91	....
50276	157	—V 11 11	29 31	63 64	93 94	....
50278	159	12 16	20 23	61 67	88 89	....
50296	160	7 6	29 23	57 55	84 84	....
50297	160	7 8	35 40 35	35 40 36	84 86	....
50310	162	—V 7 7	28 35	69 73	89 93	....
50312	152	6 6	19 20	71 75	90 91	....
50314	159	13 13	25 23	65 70	87 86	....
50306	158	5 4	27 29	56 66	87 91	....
50284	164	—V 7 6	24 27	—IV 66 64	—V 94 93	....

Female.

U.S.N.M. No.	Ventrals.	Neck.	Body.			
		21+IV.	19+V.	21—V.	19—IV.	17 cont.
50253	150	7 7	29 28	58 55	86 86	....
50257	153	8 9	23 23	72 72	90 91	....
50261	152	10 10	19 20	73 75	90 91	....
50262	150	8 7	24 26	64 62	84 85	....
[1]	157	6 4	26 32	62 57	88 90	....
50273	161	6 6	35 36	56 57	89 89	....
50279	156	7 4	22 24	74 74	96 93	....
50292	150	6 5	23 22	62 65	85 86	....
50295	157	6 6	—VI 32 38	52 50	86 87	....
50298	152	Irregular.	20 26	54 51	85 87	....
50308	154	6 5	46 45	55 53	89 85	....
50315	157	8 7	26 24	72 72	87 90	....

[1] Leiden Museum.

SCALE FORMULA 19-17 (—IV).

U.S.N.M. No.	Sex.	Ventrals.	Neck.	Body.	
			21—IV.	19—IV.	17 cont.
50256	Male......	157	7 6	88 88	....
50274	...do.......	154	6 5	82 82	....
50293	Female....	145	7 7	84 83	....
50294	...do.......	150	6 7	84 85	....
50305	...do.......	149	6 6	91 90	....

SCALE FORMULA 19-17-15 (—IV, —III).

U.S.N.M. No.	Sex.	Ventrals.	Neck.	Body.		
			21—IV.	19—IV.	17—III.	15 cont.
50258	Male......	153	2 2	77 81	—VI 129 142	....
50299	...do.......	159	7	82 83	132 136	....
50302	...do.......	156	—5 —II 5	84 85	141 140	....
50311	...do.......	155	5 5	77 77	115 117	....
50289	Female....	145	6 6	80 82	122 121	....
50303	...do.......	149	6 6	73 77	125 136	....

SCALE FORMULA 19-17-15-13-15 (—IV, —III RT. —VI LT., —X, +X).

No. 50275, female, ventrals 150. On the neck the IV row on the right and the V row on the left are suppressed at the level of the seventh ventral. On the body the IV row is suppressed on the right at the seventy-third, and the left at the seventy-fifth ventral, leaving 17 rows; the III row on the right at the one hundred and fifth, and the VI row on the left at the one hundred and fifteenth ventral are suppressed, leaving 15 rows; the row on either side of the median, the X, is suppressed on each side at the one hundred and tenth ventral, leaving 13 rows; these 13 rows continue to a little before the end of the body, when the X row reappears, on the right at the one hundred and thirty-eighth, and on the left at the one hundred and thirty-ninth ventral.

This specimen varies from the normal in four additional characters, the shields involved being the postoculars, the posterior temporals, the supralabials, and the urosteges. This is the largest number of variations found in a single specimen. It also possesses the lowest number of scale rows, 13, that has been recorded in this species. The reduction is brought about by the suppression of the scale row adjoining the median. Doctor Ruthven has demonstrated that the normal sequence of suppression in *Thamnophis,* in terms of the maximum number of rows, 23, for the genus is the V, VI, IV, and VII rows.[1] These are adjoining rows, whereas the reduction in this specimen from 15 to 13 rows was brought about not by the suppression of an adjoining row, but by that of one several series away, the one next to the median. Some 10 species of Dipsadomorphinæ have been examined and where the scale formula was 21–19–17, 19–17–15, or 17–15–13 the sequence of suppression was first a lateral row, the IV, and then the row adjoining the median; or the sequence was reversed, and the row adjoining the median was the first to be suppressed followed by the row on the flank.

BILATERALLY ASYMMETRICAL.

No. 50260, male, ventrals 163. Anteriorly there are 19 rows. On the right side the V row is absent; on the left side it is very short, as it begins at the level of the thirty-ninth gastrostege and is suppressed at the forty-second. Over this segment of the body there are 20 rows, and posterior to it the count of 19 is resumed. The IV row is suppressed on the right at the eighty-sixth and on the left at the eighty-fifth gastrostege, leaving 17 rows, which are continued throughout. It will be noted that this series of three scales in the V row on the left side is an intermediate condition between the normal 19–21–19–17 type and the reduced 19–17 type.

No. 50313, male, ventrals 157. On the neck the IV row is suppressed on the right at the fifth and on the left side at the sixth ventral. Anteriorly there are 19 rows; on the right side the V row is absent, on the left it begins at the thirty-fifth, and is suppressed at the forty-first ventral; over this short segment of the body there are 20 rows. Posteriorly the IV row is suppressed on the right at the eighty-third and on the left at the eighty-second ventral, leaving 17 rows which are continuous throughout. It will be noted that this specimen closely approaches the 19–17 type except for the short series of scales in the V row on the left side, which extends over the space of but 6 ventrals.

OTHER VARIATIONS.

Besides the variations in the scale formulæ the specimens vary in eight additional dermal characters. The shields involved are the preoculars, the postoculars, the anterior temporals, the posterior temporals, the supralabials, the infralabials, the anal, and the urosteges.

[1] Bull. 61, U. S. Nat. Mus., p. 17.

VARIATION IN PREOCULARS.

The normal condition is a single preocular. Where two exist it is due to the fragmentation of the lower one-third of the normal shield. In many normal specimens the lower one-third of the shield is indented at the margins and is lighter in color.

	Per cent.
1 normal	86
1–2 asymmetrical	10
2 bilateral	4

VARIATION IN POSTOCULARS.

The normal condition is three shields. Where two exist it is due to the fusing of the normal middle and lower shields and where there are four it is due to the normal lower shield being horizontally divided. In some normal specimens the lower shield is enlarged and shows traces of a tendency to become divided.

	Per cent.
3 normal	80
3–2 asymmetrical	10
3–4 asymmetrical	6
2 bilateral	2
4 bilateral	2

VARIATION IN ANTERIOR TEMPORALS.

	Per cent.
1 normal	94
1–2 asymmetrical	4
2 bilateral	2

VARIATION IN POSTERIOR TEMPORALS.

	Per cent.
2 normal	82
2–3 asymmetrical	12
3 bilateral	6

VARIATION IN SUPRALABIALS.

The normal condition is to have 8 supralabials with the fourth and fifth entering the eye. Where the number is reduced to 7 it is due to the fusing of the normal second and third shields; in this type the third and fourth enter the eye. Where the count is increased to 9 it is due to the dividing of the normal eighth shield into 2 in which the posterior is the smaller.

	Per cent.
8 normal	94
8–7 asymmetrical	4
8–9 asymmetrical	2

VARIATION IN INFRALABIALS.

The normal condition is to have 10 infralabials. Where the number is increased to 11 it is due to the normal fourth shield being divided. Where it is decreased to 9 it is due to the normal third and fourth shields (33 per cent), the normal seventh and eighth shields (16 per cent), or the normal eighth and ninth shields (50 per cent) being fused. Where the count has been still further reduced to 8, it has been due to the normal third and fourth shields and the normal eighth and ninth shields being fused.

	Per cent.
10 normal	74
10–11 asymmetrical	6
10–9 asymmetrical	12
10–8 asymmetrical	2
9 bilateral	4
9–8 asymmetrical	2

VARIATION IN ANAL.

	Per cent.
Entire	90
Divided	10

VARIATION IN UROSTEGES.

The normal condition is for the urosteges to be paired throughout. Many occur in which there are from one to four entire shields; another peculiarity is that these are confined to the first half dozen at the base of the tail.

	Per cent.
Paired	72
1 to 4 entire	28

Extracting from these data shows that the following may be assumed to be the normal conditions:

		Per cent.
Scale rows	19–21–19–17	66
Preocular	1	86
Postoculars	3	80
Anterior temporals	1	94
Posterior temporals	2	82
Supralabials	8	94
Infralabials	10	74
Anal	entire	90
Urosteges	paired	72

The following table shows the percentage of normal individuals and the percentage of those that are abnormal in one or more characters:

	Per cent.
Normal in all characters	14
Abnormal in one character	44
Abnormal in two characters	20
Abnormal in three characters	14
Abnormal in four characters	6
Abnormal in five characters	2

An inspection of the above tables does not evidence any grouping of the variations. There is apparently no tendency for a variation from the normal in one character to be associated with a variation in another character.

SUMMARY OF VARIATIONS.[1]

U.S.N.M. No.	Sex.	Scales.	Oculars.		Temporals.		Labials.		Anal.	Urosteges.
			Pre.	Post.	Ant.	Post.	Supra.	Infra.		
50283	Male	21-19-17	2					10-11	÷	
50304	Female	do								III-IV
50309	do	do								
50254	Male	19-21-19-17				2-3				
50259	do	do		2-3			8-7	10- 9		III-V
50263	do	do								
50264	do	do						10- 9	÷	II-IV
50265	do	do				3				
50266	do	do	1-2							
50267	do	do						9- 8		
50268	do	do								
50269	do	do				2-3				
50270	do	do	1-2						÷	
50271	do	do		3-2				9		III
50272	do	do								
50276	do	do		3-2						
50278	do	do								II-III
50284	do	do					8-7	9		III-IV
50296	do	do								
50297	do	do								III
50310	do	do								
50312	do	do								
50314	do	do		3-4						
50306	do	do								III
50253	Female	do			2				÷	
50257	do	do	1-2	3-4		3		10-11		
50261	do	do		4				10-11		
50262	do	do								
(2)	do	do	1-2					10- 9		
50273	do	do	1-2		1-2				÷	III-IV
50279	do	do								III-V
50292	do	do		2						
50295	do	do			1-2					
50298	do	do	2							
50308	do	do		3-2		2-3				
50315	do	do		3-4			8-9			
50256	Male	19-17						10- 9		III-IV
50274	do	do						10- 9		IV-VI
50293	Female	do								
50294	do	do								
50305	do	do								
50258	Male	19-17-15				2-3				
50299	do	do				3				
50302	do	do				2-3		10- 8		
50311	do	do								
50289	Female	do								
50303	do	do								II-III
50275	do	19-17-15-13		3-2		2-3		9- 8		II
50313	Male	Asymmetrical								
50260	do	do								

[1] For the sake of clearness the normal records are indicated by dashes.
[2] Specimen in the Leyden museum.

POSITION OF THE VISCERA.

The external landmarks of the principal viscera, in terms of gastrosteges, are as follows:

Sex	Male.							Female.							
Scale rows	19–21–19–17							19–21–19–17							
Gastrosteges	157	153	150	163	159	155	164	150	153	152	150	161	156	147
Heart apex	29	29	26	27	28	28	27	27	28	27	26	28	26	29
Liver, tip	38	40	32	35	36	36	37	36	36	35	35	37	34	39
Liver, end	72	73	60	67	69	66	70	71	69	65	59	71	62	69
Gall bladder	83	85	78	82	87	80	86	82	86	84	79	86	79	86
Kidney, right tip	109	106	92	101	104	98	111	107	107	110	108	109	111	107
Kidney, right end	128	127	104	127	131	127	127	129	126	128	125	131	131	125
Kidney, left tip	120	114	120	116	116	131	120	116	117	121	120	120	124	117
Kidney, left end	138	139	136	144	142	141	142	129	135	137	133	144	141	134
U.S.N.M. number	50256	50258	50259	50260	50263	50264	50265	50253	50257	50261	50262	50273	50279	50291

In this table are recorded specimens in which the scale formula is 19–21–19–17, the normal for this particular geographical region. If compared with the two previous tables for the normal scale formula several points of interest may be elicited. The V row is usually added, giving the maximum count of 21 rows, at the level of the base of the heart, and becomes suppressed beyond the posterior half of the liver where that organ begins to taper. The IV row is very constantly suppressed, leaving 17 rows, just posterior to the gall bladder.

There is no variation from the normal position of the viscera in specimens with the abnormal or less frequently occurring scale formulæ. Where the count is 19–17, the IV row is usually suppressed, exactly as in those with the normal formula, a little behind the gall bladder.

As to the length of the spinal column, it is clear that whatever increase or decrease in the number of dorsal vertebræ that takes place in an individual specimen is brought about by the addition or subtraction of vertebræ in that part of the column that is between the posterior end of the left kidney and the base of the tail.

HABITAT.

The Sausalito Peninsula is bounded on the east by San Francisco Bay and on the west by the Pacific Ocean; it is about 10 km. long and 5 km. wide. The hills, many of which reach an altitude of from 200 to 300 meters, are almost bare of trees. The valleys are deeply eroded and are clothed with fairly dense groves of laurel, scrub oaks, manzanita, and willows. In all the canyons the brooks cease to flow during the dry season, but in places water continues to trickle and there are many damp spots and a few water holes.

FOOD.

There is a big salamander population, but the frogs and toads are very scarce. As the garter-snakes do not eat the salamanders, and as there are not enough frogs to support them, it proved instructive to look into their food supply. This was found to consist almost entirely of large slugs, of the genus *Ariolimax*. One specimen had eaten a small rodent, and another had devoured two young of its own species.

This diet of slugs, eked out with an occasional indulgence in cannibalism, is an interesting example of the straits a species may be brought to when its normal food supply is not obtainable.