

Variations in the Vertebrae and Pelvis of *Necturus*¹

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In most specimens of *Necturus*, the nineteenth vertebra serves as the sacrum; the iliac processes of the pelvic girdle articulate with it. In a number of specimens, Vertebra XX or (less frequently) Vertebra XVIII serves as the sacrum. But not always do the two iliac processes join the same vertebra. The iliac process of the left side may join the XVIII, XIX, or XX vertebra. The converse may also occur.

Parker (1896), Bumpus (1897), Waite (1897), and Wilder (1903) reported some of the above conditions in *Necturus*. Lucas (1886) has reported similar conditions in *Menopoma*, and Frances (1934) cites Lucas (1876) to show similar conditions in *Salamandra*. Other amphibia, as well as other animals, show similar variations.

Parker (1896) examined the skeletons of 27 *Necturus*. Nineteen of the 27 specimens had Vertebra XIX as the sacrum, while six had Vertebra XX. In one specimen the left ilium joined XIX, and the right ilium, XX; in the remaining specimen, the left ilium joined XX, the right joined XXI.

Bumpus (1897) examined the skeletons of 100 *Necturus* by x-rays. Of his specimens, 64 had Vertebra XIX as the sacrum and 28 specimens employed Vertebra XX. The iliac processes were obliquely joined in 8 specimens. As far as his oblique specimens were concerned, Bumpus said that only his Number 62 was "dextro-sinistral" (*i.e.*, ilium of right side was attached to the vertebra anterior to that of the left side), and was the only specimen to use segment XVIII. As Bumpus mentioned no attachments to Vertebra XXI, I surmise that in all his other oblique specimens, the sacrum was attached to Vertebra XIX on the left, and to Vertebra XX on the right side.

Waite (1897) dissected the lumbo-sacral plexus of 30 *Necturus* and studied the relation of the nerves to the sacral variations. Twenty of his specimens had Vertebra XIX as the sacrum; seven had Vertebra XX as the sacrum; three

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had the ilia obliquely joined. Of the oblique specimens, one had the left sacral rib on XX, and the right sacral rib on XIX; while two specimens had the left sacral rib on XIX, and the right sacral rib on XVIII.

Wilder (1903) did not tell how many specimens he examined, but did mention finding one oblique specimen in which right Vertebra XIX and left Vertebra XX served as the sacrum.

I have examined by x-ray 132 *Necturus*. Two individuals had the sacrum on Vertebra XVIII; 98 individuals had the sacrum on Vertebra XIX; and 17 individuals had the sacrum on Vertebra XX. In 15 individuals, the sacra were obliquely joined. The obliquity was "dextro-sinistral" in 5, and "sinistro-dextral" in 10 individuals. (Table 1). In one specimen, the iliac process of both right and left side were joined to two vertebrae (XX and XXI). It is interesting to note that Huxley (1875) [working apparently on an abnormal individual] described *Menopoma* as having typically two vertebra in the sacrum—an error that was corrected by Lucas (1886).

The total number of segments in the vertebral column of *Necturus* varies. In the 100 specimens studied by Bumpus, the number of vertebrae varied from 43 to 51, with the average 46.7. Total length of the specimens ranged from 193 mm. to 390 mm. In the 132 specimens which I examined, the number of vertebrae ranged from 34 to 43, with the average at 38.9. Total length of my specimens varied from 220 mm. to 370 mm.

Larger specimens do not necessarily have more vertebrae than shorter ones. I found 38 present in both my shortest and longest specimens. The three specimens with 34 vertebrae measured 249 mm., 270 mm., and 272 mm., respectively; the two specimens with 43 vertebrae measured 260 mm., and 280 mm., respectively. Nevertheless, extra length does tend to indicate the presence of more vertebral segments, as is shown by the fact that the correlation-coefficient for body-length and number of vertebrae is 0.66.

Attachment of the pelvic girdle to Vertebra XX seems to be associated with larger size. Conversely, those animals using Vertebra XVIII for the attachment of the hip-girdle seem to be of smaller size, though data are too few to be

conclusive. The mean length of all my specimens was 287.6 mm. The mean length of those specimens using Vertebra XIX as the sacrum was 285.5 mm. The mean length of the specimens using Vertebra XX as the sacrum was 295.1 mm. Specimens with oblique sacra had a mean length of 287.3 mm. Of the two specimens using Vertebra XVIII as the sacrum, one measured 248 mm., the other measured 260 mm.

Variations in the sacrum are more common in the male than in the female. Ignoring those individuals in which sex could not readily be determined, my collection had 49 males and 59 females. In this group of 108 specimens, 19 females and 9 males had abnormal sacra.

Males appear to be larger than the females, both in actual length and in number of vertebrae. The mean length of the 108 specimens in which the sex could be determined externally was 289 mm.; and the mean number of vertebrae was 39.1. My 49 males of this group had a mean length of 294 mm., and a mean vertebra-number of 39.4. The 59 females had a mean length of 285 mm., and a mean vertebra-number of 39.0. It is interesting to note that with a difference in mean vertebra-number of only 0.4, there was a difference of 9 mm. in the mean lengths of males and females.

A range of 150 mm. (from 220 mm. to 370 mm.) in length of my specimens has been previously mentioned. Since the maximum length of any vertebra in any specimen did not exceed 10 mm., it is obvious that increase in length is not due solely to addition of vertebrae, but also (perhaps primarily) to interstitial growth of individual segments. Within limits, then, the longer specimens should also be the older specimens. An attempt to discover the age of *Necturus* by a study of their otoliths has, however, been fruitless.

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TABLE I. SUMMARY SHOWING VERTEBRAL ATTACHMENT OF ILIAC PROCESSES IN NECTURUS

	18	19	20	21	18L 19R	19L 18R	19L 20R	20L 19R	20L 21R	
Parker (1896)										
27 Specimens.....		19	6				1		1	
Bumpus (1897)										
100 Specimens.....		64	28			1	7			
Waite (1897)										
30 Specimens.....		20	7			2			1	
Harris (1950)										
132 Specimens.....		2	98	17	1	1	8	4		
Total Specimens = 289.....		0.6%	69.5%	20.0%	0.3%	0.3%	5.5%	1.7%	0.3%	99.5%