

## Quantitative External Relationships in Two Species of Small Plethodons

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Interest in the relationships discussed herein was aroused initially when some routine field work resulted in our observing some cases of *Plethodon dorsalis* Cope which appeared to be unusually large. Measurements of these were compared with published records, and this led to an extension of the study to include additional collecting, a more comprehensive and thorough program of measuring, and expansion of the study to include *Plethodon cinereus* (Green) because of its general similarity to *P. dorsalis*. In characterizing and describing both groups, the standard systematic works make use of characteristics which are at basis quantitative (head length, tail length, etc.) and our interest lay in comparing such records with the actual data obtained from a substantial though not large sample of each salamander group. In his classical work of 1926, Dunn (3) considered these two taxonomic entities to be separate species, but Bishop (1) treated them both as subspecies of *P. cinereus*. Because of their very considerable resemblance to each other, and the consequent possibility of confusion concerning them, Thurow (5, 6) has presented a careful and extensive comparison of the two groups, based on very large samples; his account does not stress quantitative anatomical aspects, however. In his recent revision of the genus *Plethodon*, Highton (4) treated them as separate species.

Our data are based on 93 specimens of the zigzag salamander, *P. dorsalis* and 66 specimens of the red-backed salamander, *P. cinereus*, all collected in Putnam County, Indiana. Collecting was non-selective, but for this study no "dark phase" or unstriped animals were included; the salamanders discussed herein manifested either the zigzag yellow or red dorsal stripe of *dorsalis* or the similar but straight-edged stripe of *cinereus*. Measurements were made with micrometer calipers under uniform conditions in which the animals were under light chloretone anesthesia and posed in a natural but unstretched position. A number of calculations were made with the resulting information to produce for each animal index values that might be helpful in investigating certain anatomical relationships; methods of calculation are indicated in Table 1. Head lengths were measured from the tip of the snout to the gular fold of the salamander's neck region, trunk length extended from the gular fold to the anterior angle of the vent, and tail length from the latter point to the tip of the tail; only complete tail lengths were measured, however. The widths of both head and trunk were measured where these dimensions were maximal.

### 1. Body Size.

Conant (2) gave the "record" for *P. cinereus* as 125.0 mm (5 inches), while Bishop (1) gave the "extreme length" as 122.0 mm; Dunn (3) in his 1926 account cited total lengths of the order of 82 to 88 mm. In our series, among the 55 animals with tails of sufficient completeness

to measure a total length, the largest was a male of 106.0 mm. Five more specimens (3 females, 2 males) were 90.0 mm or more in total length. In the case of *P. dorsalis*, Bishop (1) credited Dunn (3) with recording the largest specimen at 87.0 mm; Conant (2) however gives the "record" as 3 3/8 inches or 90.6 mm. In our series, 88 salamanders had complete tails and of these six exceeded Dunn's 87.0 mm. record. Two females and one male measured 87.5 mm, one female measured 88.5 mm, one male measured 90.0 mm, and one female exceeded Conant's record at 97.0 mm. Based on the six largest animals in the two species, the data just reviewed does not unequivocally support Bishop's (1) generalization that *dorsalis* is a smaller species than *cinereus*. Information in terms of means exhibited in Table 1 does not offer much additional clarification: Item 1 records a mean total length in *cinereus* some 4 mm greater than in *dorsalis*, while Item 7 records a mean snout-vent length in *dorsalis* some 4 mm greater than in *cinereus*.

TABLE 1  
Quantitative Aspects of Salamander External Morphology

	<i>P. cinereus</i>		<i>P. dorsalis</i>	
	Mean	N	Mean	N
1. Total length, all cases	74.5	55	70.5	88
2. Total length, males	79.8	17	69.7	28
3. Total length, females	72.8	38	70.6	60
4. Trunk length, all cases	30.1	66	30.96	93
5. Trunk length, males	31.5	20	31.1	31
6. Trunk length, females	29.5	46	30.9	62
7. Snout-vent length, all cases	37.7	66	41.6	93
8. Tail length, all cases	36.5	55	33.8	88
9. Index = $\frac{\text{Snout-vent length}}{\text{Head width}}$	7.5	66	7.6	93
10. Index = $\frac{\text{Trunk length}}{\text{Trunk width}}$	6.4	66	6.1	93
11. Index = $\frac{\text{Trunk length}}{\text{Head length}}$	3.96	66	3.9	93

All values except index values are in millimeters

## 2. Tail Size.

That *P. dorsalis* has a shorter tail than *P. cinereus* has been recorded by both Dunn (3) and Thurow (5). The latter author makes a point of the fact that the shorter tail of *dorsalis* necessarily implies a more rapid taper which would make the tail constitute relatively a smaller proportion of the total mass of the organism. Reference to Table 1, Item 8, will show that in our series the *dorsalis* tail averaged about 3 mm less in length than the *cinereus* tail. The tail size in reference to the rest of the body presented interesting differences. In our *dorsalis*, of the 88 salamanders having complete tails, only 8 animals or 9% were exceptions to the rule that the snout-vent length exceeded the tail length. Such a degree of consistency was not observed, however, among the 55 specimens of *cinereus* which had complete tails; of these, 31 cases or 56% showed tail lengths less than snout-vent lengths,

a situation not to be expected in this long-tailed species where tail length may exceed snout-vent length by as much as 30%, according to Thurow (5).

### 3. Trunk Slenderness.

Our interest in the relative slenderness of the trunks of these two salamander groups stemmed from Bishop's (1) characterization of *P. dorsalis* as "smaller and more slender than its near relative, *P. c. cinereus*." Item 10 in Table 1 indicates the manner by which a slenderness index was calculated for each salamander. In *P. cinereus*, the six smallest and youngest specimens exhibited index values of 3.4 to 5.9, while the six largest and presumably oldest had values of 6.7 to 7.0, and the greatest value in any of the 66 *cinereus* was 7.9. With respect to *dorsalis*, the six smallest showed indices of 3.66 to 6.0, while the six largest had indices of 6.00 to 8.65, the latter being the greatest value seen in any of the 93 specimens. These data indicate that both species exhibit slenderization as an accompaniment of the growth process. This is verified by a case-by-case inspection of the data when all data are arranged in sequence in order of salamander size. Such an inspection, however, does not strongly suggest any material difference in the relative slenderness of one species as compared to the other. Index values in terms of means recorded in Table 1, Item 10, show very little difference, with *cinereus* being indicated as slightly more slender than *dorsalis*, if an index value difference of 0.3 is of any significance.

### 4. Head-Trunk Relationships

Dunn's (3) descriptions of both species gave the trunk length as four times the head length. For each of our specimens an index was calculated as given in Item 11 of Table 1. For all specimens of both species, the means of these indices, 3.96 for *cinereus* and 3.90 for *dorsalis*, are in essential agreement with Dunn's value of 4.0. In both species this index gives an additional measure of the allometric growth of the trunk as compared to the head. The smaller and younger specimens of both species exhibit indices as low as 2.4 to 3.0, while the older and larger specimens exhibit indices as high as 4.3 to 4.6.

Another of Dunn's (3) body-proportion characterizations gave the snout-vent length as  $7 \frac{1}{3}$  times the head width in *dorsalis*, seven times the head width in *cinereus*. Both of these values are too low as judged by our two series; Item 9 of Table 1 records this relationship as an index, the mean value of which is 7.5 for *cinereus*, 7.6 for *dorsalis*, so our data indicate very little difference between the two species in this relationship. This index also emphasizes the allometric nature of trunk growth: smaller *cinereus* have index values of 5.3 to 5.7, while the 11 largest have index values of 8.0 or more; in *dorsalis*, the smaller specimens evince indices of 4.6 to 4.7, while the largest specimens again have indices of 8.0 or more.

### 5. Sex Differences.

This facet of our study was provoked by Bishop's (1) comment that the *cinereus* male was usually shorter in body length, and in general smaller, than the female. In Table 1, Items 2, 3, 4, and 6 are pertinent

to this point, and our data do not support Bishop's statement; in terms of means, trunk length of males was about 2 mm greater than that of females, and in total length the discrepancy is even more marked, males some 7 mm longer than females. Our collecting was completely non-selective, yet the character of our sample may have biased these data. The smallest male *cinereus* was 28.5 mm in total length, 21.5 mm in trunk length, and our sample included six females which were smaller than this smallest male. Little comment need be made concerning *P. dorsalis*, since a glance at Table 1 will show that our data reveal little difference between the sexes in the attributes measured.

#### Literature Cited

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