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LENS MORPHOLOGY AS AN IDENTIFICATION TOOL IN THE SALAMANDER SUBFAMILY DESMOGNATHINAE

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ABSTRACT

The lenses of desmognathine salamanders contain radii which are grooves running from one pole of the lens to the other. The number of radii per quadrant of the lens was counted for all species in the subfamily, and appears to be a useful taxonomic character. The range in number per quadrant varied from a low of from 11 to 13 in *Desmognathus wrighti* to a high of from 36 to 49 in *D. quadramaculatus*. The variation within each species does not seem to be related to age, sex, or geographical location. Considerable overlap in some ranges exists. However, the use of lens radii allows separation of such difficult forms as *D. monticola* and *D. fuscus*, and should be valuable in allocating some immature specimens which have yet to develop other distinctive characteristics.

INTRODUCTION

Included in the salamander subfamily Desmognathinae are the genera *Desmognathus, Leurognathus,* and *Phaeognathus. Leurognathus* and *Phaeognathus* are monotypic genera and are easily identifiable. *Desmognathus,* on the other hand, has historically been variously interpreted to represent from 5 to 11 species. No features thus far used allow complete separation of all the forms.

Most problems are encountered in separating members of the *D. ochrophaeus* and *D. fuscus* complexes, and in separating *D. fuscus* from *D. monticola*. Coupled with characters currently used and locality information, a character involving lens structure was found to offer a valuable adjunct in differentiating the species.

Appearing on the lenses of vertebrates are the *lentis radii,* suture lines created where the ends of the lens fibers come together. The pattern of polar suture lines is variable among the vertebrates (Prince 1956); in desmognathine salamanders it takes on a stellate appearance, making counts of the radii possible (Fig. 1).

METHODS AND MATERIALS

The right lenses of all specimens were removed, placed in a watch glass with the posterior surface up, and covered with alcohol. An ocular was fitted with crosshairs to facilitate counting the radii of one quadrant. Numbers per quadrant were determined using a dissecting microscope at powers ranging from 25X to 100X, depending on the size of the specimen. Best results were obtained using substage illumination. Light must be directed up through the lens to best demonstrate the radii. Sometimes adhering tissue must be removed from the lens with fine needles or by rubbing the lens between the thumb and forefinger. Sex, snout-vent length, and locality were recorded for each specimen. Species were surveyed throughout their geographic range. The number of specimens of each species examined is given in Table 1. Totally, lens radii of 355 specimens were counted.

RESULTS AND DISCUSSION

The lenses of all desmognathine larvae are spherical. Those of adults are subspherical (Fig. 1), except in *Leurognathus,* in which the lens remains spherical into adulthood. With this exception, and interspecific differences in the number of radii per quadrant, all species exhibited similar lens morphologies. The number of lens radii was not sexually dimorphic, nor was it found to vary geographically.

Table 1 gives the range of lens radii per quadrant exhibited by the various specimens. *Desmognathus quadramaculatus* had the highest range in number of radii per quadrant (36-49), and *D. aeneus* the lowest (11-12). *Phaeognathus hubrichti* and *Leurognathus marmoratus* cannot be separated from all other species using lens radii number. However, *L. marmoratus* differs from other desmognathines in having a spherical lens as an adult. Since the aforementioned forms are readily identifiable, no further mention of them will be made. Also, determination of the number of lens radii is unnecessary in identifying *D. quadramaculatus, D. aeneus,* and *D. wrighti.*

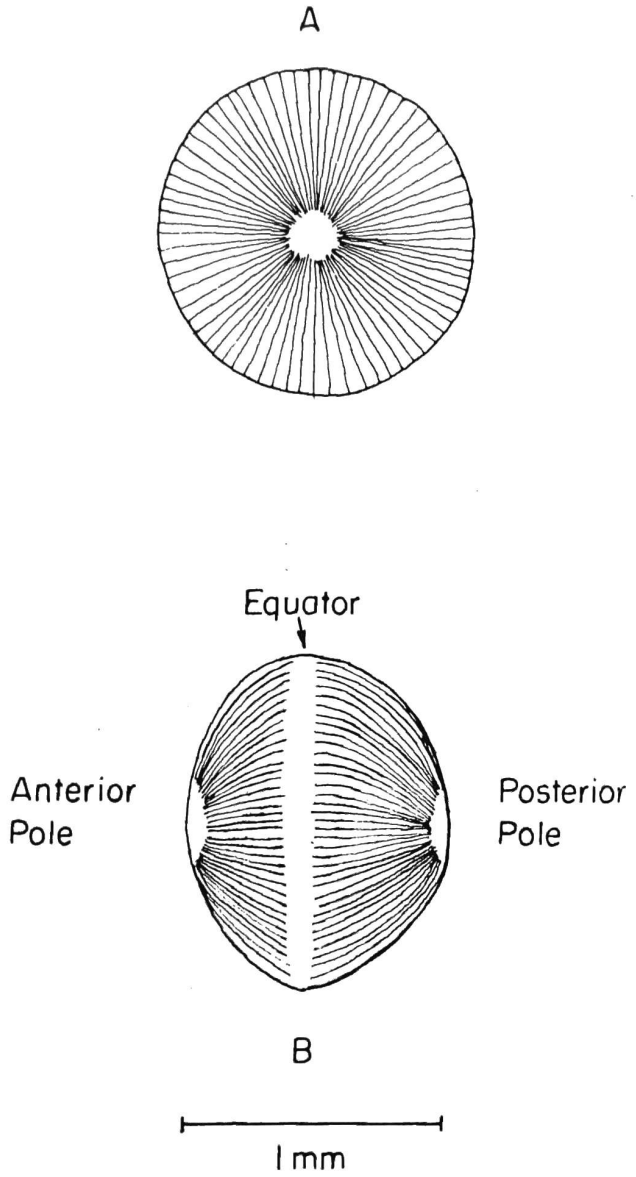

FIG. 1. A). Desmognathus fuscus *(54mm SVL) lens diagrammatically illustrating lens radii as they appear from a posterior polar view. B). Equatorial view illustrating the subspherical nature of a typical lens.*

The ranges in number of radii in *D. ochrophaeus* and *D. fuscus* overlap; hence, reliable separation of the forms using the character cannot be made. However, *D. ochrophaeus* does have a smaller minimum number than *D. fuscus*. The character is most useful in separating *D. fuscus* (range: 17-23) from *D. monticola* (range: 24-30). Specimens were examined from throughout the geographic range of the two species, and no overlap in radii number was detected.

TABLE 1. *Number of lens radii per quadrant and maximum adult size in certain desmognathine salamanders.*

Species	N	X	Range	Mode	Max. SVL (mm)
Phaeognathus hubrichti	12	36	34-40	35	134
Desmognathus quadramaculatus	20	44	36-49	42	107
D. welteri	33	26	23-29	26	89
D. brimleyorum	20	24	23-26	24	83
D. monticola	44	26	24-30	25	80
Leurognathus marmoratus	20	20	19-22	20	78
D. fuscus (nom. + *conanti*)	55	19	17-23	19	65
D. f. auriculatus	21	19	17-23	20	65
D. ochrophaeus	90	16	14-22	15	55
D. wrighti	20	12	11-13	13	30
D. aeneus	20	12	11-12	12	30

Desmognathus welteri cannot be separated from *D. monticola* using lens radii. However, external characters can usually be used to differentiate those species. Also, these species exhibit different tooth morphologies in the region of sympatry (Caldwell 1977). *Desmognathus welteri* has a blunt rounded tooth with the labial and lingual cusps being of relatively equal height. *Desmognathus monticola* has a piercing type tooth which is pointed, the labial cusp being much lower than the lingual.

Desmognathus brimleyorum is not known to occur sympatrically with *D. fuscus* (Conant 1975). However, if the two species should be found together, they will probably be separable using lens radii counts. Although radii counts in the two species overlap at 23, the number of individuals involved amounted to only approximately 6 percent of each sample. *Desmognathus brimleyorum* cannot be separated from *D. monticola* using radii counts, but these species do not occur together.

As an identification tool, lens radii counts appear to be particularly valuable in separating *D. fuscus* and *D. monticola*. Also, the character should be useful in distinguishing small specimens of most species of *Desmognathus* in which other useful characteristics have not developed.

Data on larvae of three species (*D. quadramaculatus, D. monticola,* and *D. fuscus*) suggest that ontogenetic variation during larval development precludes the use of radii in identifying larvae. Only after the stage when the gills have been absorbed and functional eyelids develop can the character be used. After this stage, the radii number in an individual does not

change, and no further ontogenetic variation occurs, making the character useful in post-metamorphic individuals of any size.

The significance of the differences in radii number among species of *Desmognathus* does not appear to be directly related to differences in optical physics. Rather, there appears to be a direct relationship between radii number and the maximum adult size attained by a particular species. Table 1 shows the modal number of radii per quadrant and maximum adult size attained by a particular species. Maximum adult sizes were obtained from the literature (Barbour and Hays 1957, Martof 1963, Huheey 1966, Folkerts 1968, Schwaner and Mount 1970, and Valentine 1974). As can be seen from the table, species with larger maximum adult sizes tend to have a larger number of radii. No relationship between individual specimen size and number of lens radii could be seen from the data. The hypothesis was further tested using two non-desmognathine plethodontids, *Plethodon glutinosus* and *P. cinereus*. Fifteen specimens of both species were examined. Radii count ranges were 26-36 for *P. glutinosus* and 14-16 for *P. cinereus*. Maximum snout-vent lengths of *P. glutinosus* and *P. cinereus* respectively, were given at 76mm and 52mm by Highton (1962). These data support the hypothesis that the radii number is related to maximum adult size attained by the particular species.

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