SEX-SPECIFIC IDENTIFICATION OF *ASCAPHUS TRUEI* AT MATURITY

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INTRODUCTION

The Coastal Tailed Frog (*Ascaphus truei*) is a stream-associated amphibian inhabiting riparian forests from British Columbia, Canada to Northwestern California, USA. Undoubtedly the most distinctive feature of tailed frogs, and a characteristic unique within the Order Anura, is the external copulatory organ or "tail". This structure, which is a modification of the cloaca, is a penis analog used for internal fertilization (Sever et al. 2001). The obvious nature of this copulatory organ in adult males makes it a useful characteristic for sexing adults in the field. However, tailed frogs have a lengthy maturation interval, estimated to be 8-9 years (Brown 1975, 1989; Daugherty and Sheldon 1982), so how useful this "tail" may be for determining the sex of immature tailed frogs is unclear. Moreover, how well the appearance of this feature correlates with gonadal maturation is also unknown.

Our study was intended to clarify the mature segment of populations of *A. truei* and determine the size at which field researchers are able to correctly identify maturity among individuals of either sex. We wanted to determine whether the size at which sex becomes distinguishable externally parallels gonadal maturity; to assess whether females and males reached sexual maturity at the same size; and to describe trends in morphological variation as a function of size for secondary sexual characteristics (SSC) such as "tail" length, forearm width, nuptial pads, and distinctively textured patches found on the chest, chin, and digits of the front feet.

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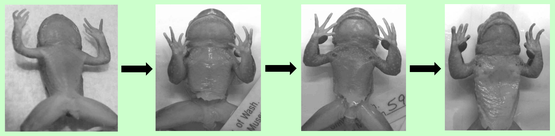
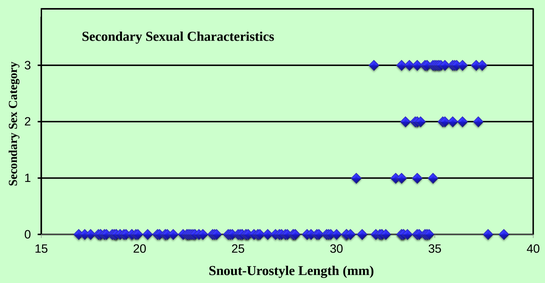


Figure 1: Distribution of the four categories of male secondary sexual characteristics (scored as 0-3; see above) across the size range of sampled males (see below).



METHODS

In the course of the Old-Growth Study conducted on the west slope of the Washington Cascades during the late summer/early fall of 1984 and 1985, Aubry and Hall (1991) collected and preserved 676 post-metamorphic Coastal Tailed Frogs. These specimens, now housed in the herpetological collection at the University of Washington Burke Museum, were available for study. We examined 332 individuals from this collection encompassing the full size range of metamorphosed individuals available, and obtained roughly equal numbers of both sexes. We processed frogs in two steps: 1) we first measured and identified the sex of individuals externally; and then 2) confirmed sex via internal examination and obtained gonadal measurements.

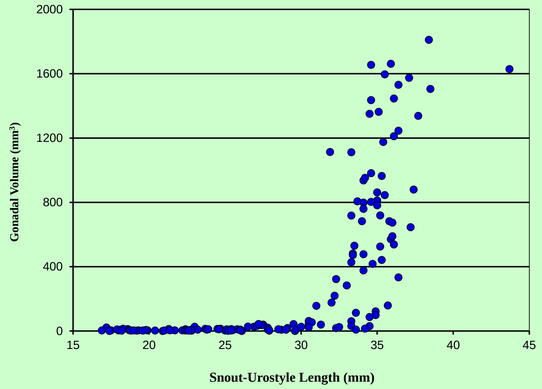


Figure 2: The relationship between gonadal volume and body size in males.

Externally, we used presence of a "tail", SSCs, eggs visible through the body wall, and abdominal shape to aid scoring sex. We measured (to the nearest 0.1 mm) snout-urostyle length, "tail" length (if present), and forearm width; and scored secondary sex characteristics (see Figure 1). The "tail" length was taken from the tip of the tail to its base. For forearm width, we measured the maximum width in the horizontal plane with the forearm pronated.

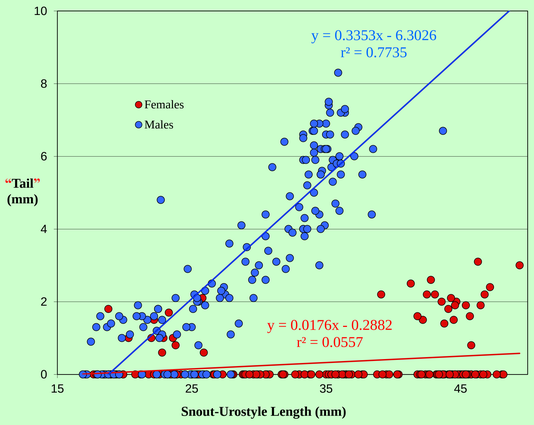


Figure 3: Relationship between "tail" presence and size in males and females.

For internal examination, we made an incision through the skin and muscle layers of the venter from the midline between the legs laterally to towards each arm. This skin was then gently folded back to expose internal organs. We then measured length and width of right and left gonads on all animals. For females, we also scored whether any eggs >2 mm in diameter (i.e., at least moderately yolked) were present.

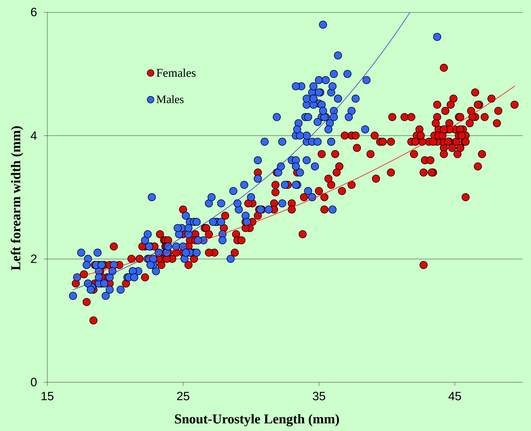


Figure 4: The relationship between forearm width and body size in males and females.

RESULTS

We found concordance between the smallest size at which males exhibit external versus internals signs of sexual maturity. Notably, the smallest males that exhibit secondary sexual characteristics of any kind were 31 mm SUL (Figure 1), which was also the same body size at which gonadal volume first showed an increase (Figure 2). Moreover, despite the fact that 18% of females possessed a "tail", the body size at which males first exhibited a "tail" larger (ca. 3.5 mm) than the largest tails of any female (3.1 mm) was about 31 mm SUL (Figure 3). Additionally, the body size at which the forearms of males begin to diverge enough in width to be recognized as significantly larger than those of females is about 30 mm SUL (Figure 4).

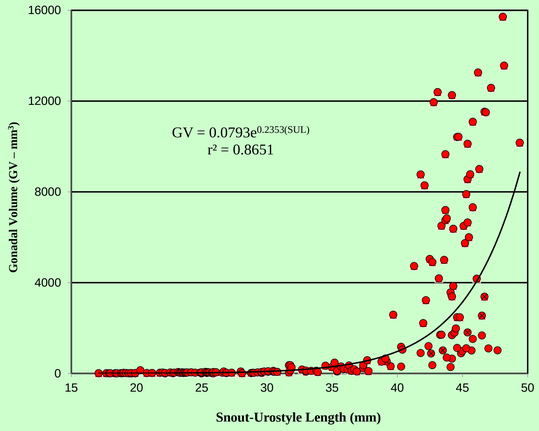


Figure 5: The relationship between gonadal volume and body size in females.

In contrast, the smallest body size at which female showed an increase in gonadal size was 39.5 mm.

Lastly, for both females and males, at sizes above the minimum size at which gonadal volume begins to increase, variation in gonadal volume is extremely large (Figures 2 and 5).

CONCLUSIONS

Assuming confidence in gonadal volume is a satisfactory indicator of reproductive maturity, females mature at a larger size than males. We caution that since our data reflect a composite population result (individuals obtained from several localities), some individuals may reach maturity at sizes larger than these minimum sizes. Nonetheless, data on minimum adult size for both males and females is within the bounds of measurement error to the minimum adult sizes that were reported by Burkholder and Diller (2007) for populations over 500 km to the south. Further, these data indicate that estimating adult sex externally based on male characteristics would overestimate adult female numbers. However, some males above the minimum size show no secondary sexual characteristics, which may reduce this error.

We also believe that the high variance in gonadal volume reflects an asynchronous pattern of biennial reproduction cycle that prior work has suggested for females of both *A. truei* (Burkholder and Diller 2007) and *A. montanus* (Metter 1964). Our data may suggest the same for males.

SELECTED LITERATURE

AUBRY, KA, AND PA HALL. 1991. Terrestrial amphibian communities in the southern Washington Cascade Range. Pp. 326-338. In: LF Ruggiero, KB Aubry, AB Carey, and MH Huff (technical coordinators), Wildlife and Vegetation of Unmanaged Douglas-Fir Forests, USFS Pacific Northwest Research Station, PNW-GTR-285.

BROWN, HA. 1975. Temperature and development of the tailed frog *Ascaphus truei*. Comparative Biochemistry and Physiology 50A:397-405.

BROWN, HA. 1989. Developmental anatomy of the tailed frog (*Ascaphus truei*): a primitive frog with large eggs and slow development. Journal of Zoology (London) 217:525-537.

BURKHOLDER, LL, AND LV DILLER. 2007. Life history of postmetamorphic Coastal tailed Frogs (*Ascaphus truei*) in northwestern California. Journal of Herpetology 41:251-262

DAUGHERTY, CH, AND AL SHELDON. 1982. Age-determination, growth, and life history of a Montana population of the tailed frog (*Ascaphus truei*). Herpetologica 38:461-468.

METTER, DE. 1964. A morphological and Ecological Comparison of two Populations of the Tailed Frog, *Ascaphus truei* Stejneger. Copeia 1964:181-195.

SEVER, DM, EC MORIARTY, LC RANIA, AND WC HAMLETT. 2001. Sperm storage in the oviduct of the internal fertilizing frog *Ascaphus truei* Journal of Morphology 248:1-21.

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