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Larval growth and transformation size of the Green Frog, *Lithobates clamitans melanota* (Rafinesque, 1820), in south-eastern New York

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Abstract. Monthly distributions of body sizes of tadpoles from a site along the Mianus River in south-eastern New York, USA, in 2010 were used to determine larval duration and transformation size of the Green Frog (*Lithobates clamitans melanota*) from a northern site, located along the latitude approximately midway in the geographic range of the species. Tadpoles transformed in the spring and summer of the following year at an average body size of 28 mm, which were typical of populations in the central portion of its geographic range.

Keywords. *Lithobates clamitans*, tadpoles, growth rate, New York.

Introduction

The Green Frog, *Lithobates clamitans melanota* (Rafinesque 1820) is one of two recognized subspecies of the eastern North American Bronze Frog, *L. clamitans* (Latreille, 1801). Occurring throughout much of the eastern United States and south-eastern Canada, it intergrades with the Bronze Frog, *L. c. clamitans* (Latreille, 1801), along the fall line in Georgia and Alabama (Conant and Collins, 1998; Pauley and Lannoo, 2005).

Besides differences in colour pattern (Mecham, 1954), body size differences are apparent between the two forms with the northern form being larger in adult (Wright and Wright, 1949; Mecham, 1954; Meshaka et al., 2009a,b, Meshaka, Bradshaw-Wilson and Pauley, 2010; Meshaka, Marshall and Heinicke, 2011) and metamorphosling size when compared to the Bronze Frog (Wright and Wright 1949; Meshaka et al., 2009a,b, 2010, 2011). Breeding seasons follow a north-south gradient, with the shortest seasons in the northern United States (Pauley and Lannoo, 2005; Meshaka et al., 2009a,b, Meshaka, Bradshaw-Wilson and Pauley, 2010; Meshaka, Marshall and Heinicke, 2011), and metamorphoslings are likewise produced over a longer season in the southern United States (Meshaka et al. 2009a,b, Meshaka, Marshall and Heinicke, 2011). To that end, the larval period of *L. clamitans* varies geographically, with tadpoles of many northern populations overwintering the following year (Pauley and Lannoo, 2005; Meshaka, 2011). Monthly collections of tadpoles from a semi-permanent site along the headwaters of the Mianus River in south-eastern New York provided the data necessary to address larval period and body size at transformation from this nearly coastal north-eastern site.

Materials and Methods

A single site along the headwaters of the Mianus River (Fig. 1) near the town of Bedford, in Westchester County, New York,

Figure 1. A modified headwater floodplain pool of the Mianus River, Westchester County, New York, USA, that was sampled for Green Frog (*Lithobates clamitans*) tadpoles monthly during May-September 2010.

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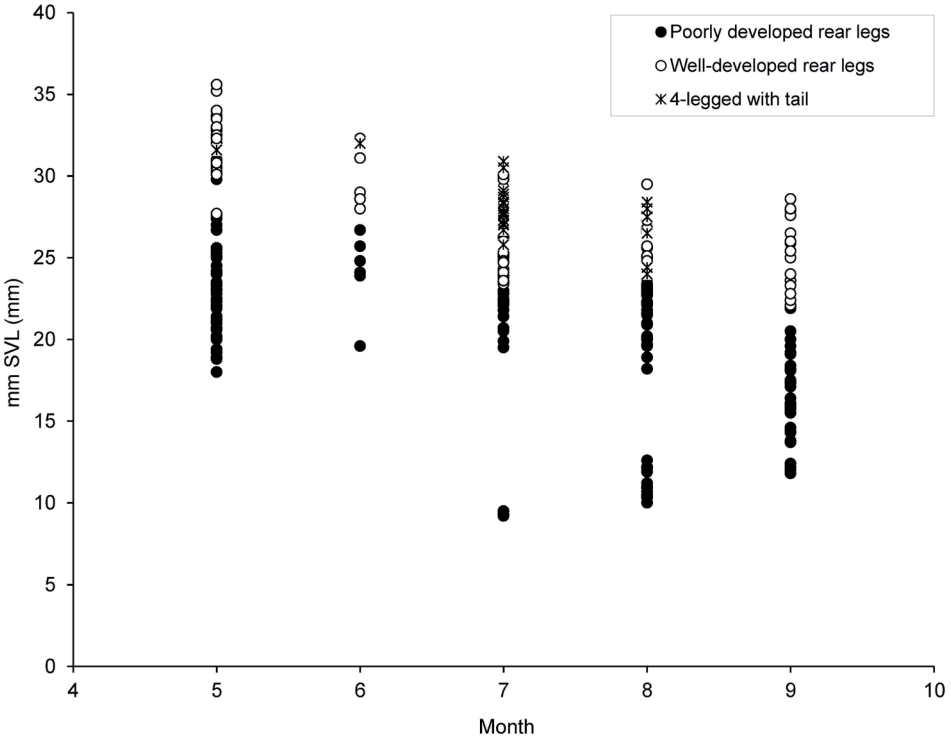

Figure 2. Monthly distribution of body sizes of 322 tadpole and metamorphosling green Frogs (*Lithobates clamitans*) from a semi-permanent aquatic site Westchester County, New York, USA, during May-September 2010.

was sampled once each month during May-September 2010. The aquatic site was a seepage area that was formally modified for a farm pond about 100 years ago. It is now an approximately 0.4 ha L-shaped woodland pool within second or third growth hardwood forest. Water depth ranges 60-120 cm seasonally. The following species of amphibians have been recorded besides *L. clamitans*: Spotted Salamander (*Ambystoma maculatum*), Eastern Newt (*Notophthalmus viridescens*), Pickerel Frog (*L. palustris*), Bullfrog (*L. catesbeianus*), Wood Frog (*L. sylvaticus*), Gray treefrog (*Hyla versicolor*) and Spring Peeper (*Pseudacris crucifer*). No fish are present. Dominant vegetation associated with the aquatic site comprises Buttonbush (*Cephalanthus occidentalis*) and Purple Loosestrife (*Lythrum salicaria*).

Aquatic samples were taken with a dipnet in the littoral zone. Samples were preserved in formalin and stored in the Section of Zoology and Botany at the State Museum of Pennsylvania, Harrisburg, Pennsylvania. Tadpoles were scored as per Gosner (1960). For practical purposes, tadpoles were in categories of having poorly-developed hind legs (less than Gosner stage 37) or well-developed hind legs (Gosner stage of at least 37). Metamorphoslings were distinguished from tadpoles by the presence of forelimbs (Gosner stage 42) and distinguished from juveniles by the presence of a tail. Body lengths of all size-classes and developmental stages of tadpoles were measured in mm snout-vent length (mm SVL). Statistical analysis was conducted with the use of Excel. Means were followed by $\pm$ 2 standard deviations, and significance was recognized at $P < 0.05$.

Results and Discussion

Tadpoles did not transform until the following year as determined by the monthly distribution of body sizes (Fig. 2). Green Frogs at the Mianus River site transformed the following May-July at a mean body size of 28.1 mm (std. dev. = 1.8; range = 24.0-32.0; n = 29). A single juvenile measuring 27.3 mm SVL was collected in August. Tadpoles with well-developed rear legs averaged 27.8 mm (std. dev. = 2.9; range = 22.1-35.6; n = 126).

Metamorphosling body sizes at our site were similar to those reported from Indiana (Minton, 2001) (range = 28-36 mm), New England (Klemens, 1993) (mean = 30.1 mm; range = 27-34), central New York (Wright, 1931) (range = 28-38 mm), south-eastern Michigan (Martof, 1956) (mean = 32.6 mm; range = 28.4-36.3), western Pennsylvania (Meshaka, 2011) (mean= 29.7 mm; range

= 26.5-33.0 and mean = 30.7 mm; range = 29.7-31.6), Rhode Island (URI web site) (mean = 33.0 mm; range = 18.0-45.0), and neighbouring West Virginia (Meshaka, Bradshaw-Wilson and Pauley, 2010) (mean = 29.4 mm; range = 18.4-34.5).

Comparatively, metamorphosling body sizes at our site were larger than those of most southern populations, as reported from Texas (Meshaka, Marshall and Heinicke, 2011) (mean = 22.1 mm; range = 18.6-27.2), southeastern Georgia (Wright, 1931) (mean = 23.3 mm; range = 20-28), Florida (WEM, unpubl. data) (mean = 24.1 mm; range = 19.1-29.6), northern Louisiana (Meshaka et al., 2009a) (mean = 26.8 mm; range = 21.2-32.4) but not southern Louisiana (Meshaka et al., 2009b) (mean = 28.3 mm; range = 19.6-47.0). From these limited comparisons, it appears that although geography may play some role in metamorphosling body size, particularly at geographic extremes, causal factors responsible for this trait are too complicated to be explained by geography alone.

The longer breeding season and warmer water temperatures in the southern United States provide the opportunities necessary for tadpoles to transform over several months in the same season as they were born. In that regard, in some southern locations larval periods were determined to range between 2-3 months (Meshaka et al., 2009a,b), and transformation was known to occur without overwintering (Collins, Collins and Taggart, 2010) or generally so (Meshaka et al., 2009a,b). In other southern sites, same-season transformation was a likely inference in light of extended or nearly continuous production of metamorphoslings (Meshaka, Marshall and Heinicke, 2011).

Not surprisingly then, a shorter breeding and growing season, as in northern populations, can only be overcome by overwintering. Experimentally, it was determined that progeny of early breeders could transform during the same season (Ting, 1951).In the context of a Michigan field study, Martof (1956) demonstrated the date on which the eggs were laid determined whether or not the tadpole would transform in the same season that it was born or the next. In West Virginia, the monthly distribution of metamorphosling body sizes (Meshaka, Bradshaw-Wilson and Pauley, 2011) was indicative of overwintering, but same-season metamorphosis could not be ruled out. For populations in the northeastern United States, such as the one described herein, it might then be expected that overwintering is the typical even if not exclusive larval response to a cool climate and intermediate breeding season. In turn, this response can lend itself to the production of larger metamorphoslings.

References

Collins, J.T., Collins, S.L., and Taggart, T.W. (2010): Amphibians, Reptiles, and Turtles in Kansas. Eagle Mountain, Eagle Mountain Publishing, LC.

Conant, R., Collins, J.T. (1998): Reptiles and Amphibians of Eastern/Central North America. 3rd edition. New York, Houghton Mifflin Co.

Gosner, K.L. (1960): A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica **16**: 183-190.

Green, N.B., Pauley, T.K. (1987): Amphibians and reptiles in West Virginia. 1987. Pittsburgh, University of Pittsburgh Press.

Hulse, A.C., McCoy, C.J., Censky, E.J. (2001): Amphibians and Reptiles of Pennsylvania and the Northeast. Ithaca, Cornell University Press.

Johnson, T.R. (1987): The Amphibians and Reptiles of Missouri. Jefferson City, Missouri Department of Conservation.

Klemens, M.W. (1993): Amphibians and Reptiles of Connecticut and Adjacent Regions. State Geol. and Nat. Hist. Survey of Conn., Bull. No. **112**. 318 pp.

Martof, B. (1956): Growth and development of the green frog, *Rana clamitans*, under natural conditions. Am. Midl. Natur. **55**: 101-117.

Mecham, J.S. (1954): Geographic variation in the green frog, *Rana clamtians* Latreille. Texas J. Sci. **1**: 1-25.

Merrell, D.J. (1977): Life history of the leopard frog in Minnesota. Occasional Papers of the Bell Mus. Nat. Hist. Univ. Minn. **15**: 1-23.

Meshaka, W.E., Jr. (2011). Overwintering by the tadpoles of the green frog, Lithobates clamitans melanota (Rafinesque, 1820), in western Pennsylvania. Herp. Notes **4**: 311-314.

Meshaka, W.E., Jr., Collins, J.T. (2010): A Pocket Guide to Pennsylvania Frogs and Toads. Newton, Mennonite Press.

Meshaka, W.E., Jr., J. Boundy, S.D. Marshall, Delahoussaye, J. (2009b): Seasonal activity, reproductive cycles, and growth of the Bronze Frog (*Lithobates clamitans clamitans*) in southern Louisiana: an endpoint in its geographic distribution and the variability of its life history traits. J. Kansas Herp. **31**: 12-17.

Meshaka, W.E., Jr., Bradshaw-Wilson, C.R., Pauley, T.K. (2010): Seasonal activity, reproductive cycles, and growth of the green frog (*Lithobates clamitans melanotus*) in West Virginia. Proc. West Virginia Acad. Sci. **81**: 41-63.

Meshaka, W.E., Jr., Marshall, S.D., Heinicke, D. (2011): Seasonal activity, reproductive cycles, and growth of the bronze frog (*Lithobates clamitans clamitans*) at the western edge of its geographic range. Bull. Maryland Herpetol. Soc. In press.

Meshaka, W.E., Jr., Marshall, S.D., Raymond, L.R., Hardy, L.M. (2009a): Seasonal activity reproduction, and growth of the Bronze Frog (*Lithobates clamitans clamtians*) in northern Louisiana: the long and short of it. J. Kansas Herp. **29**: 12-20.

Minton, S.A., Jr. (2001): Amphibians and Reptiles of Indiana. Revised 2nd edition. Indianapolis, Indiana Acad. Sci.

Pauley, T.K., Lannoo, M.J. (2005): *Rana clamitans Latreille, 1801; Green Frog*. Pp. 549-552 *In* M. Lannoo, editor, Status and Conservation of North American Amphibians. Berkeley, University of California Press.

Smith, P.W. (1961): The Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Survey Bull. **28**, Article 1.

Ting, H.P. (1951): Duration of the tadpole stage of the green frog, *Rana clamitans*. Copeia **1951**: 82.

URI Web site. http://www.uri.edu/cels/nrs/paton/#.

Vogt, R.C. (1981): Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee, Milwaukee Pub. Mus.

White, J.F. Jr., White, A.W. (2002): Amphibians and Reptiles of Delmarva. Centreville, Tidewater Publishers.

Wright, A.H. (1931): Life-Histories of the Frogs of the Okefinokee Swamp, Georgia. Ithaca, McMillan Co.

Wright, A.H., Wright, A.A. (1949): Handbook of Frogs and Toads of the United States and Canada. Ithaca, Cornell University Press.

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