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AMBYSTOMA MAVORTIUM (Barred Tiger Salamander). BEHAVIOR UNDERNEATH THE ICE

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Larval *Ambystoma mavortium* in North Dakota spend the winter months (late October–early April) restricted underneath a thick (0.5–1.3 m) ice sheet. During February and March 2012, we observed larval *A. mavortium* in Swalls Lake, Ward Co., North Dakota, USA (48.1044°N, 101.1644°W). We drilled holes in the ice using an ice auger equipped with 20.3 cm blade. We established three ice-hole grids. Each grid had nine holes in a 3 × 3 arrangement on a 20 × 20 m square (i.e., four holes were the corners of the square). Thus, we established 27 observation holes over three locations on the lake. We could drill and observe nine holes during a four-hour observation period. We completed four, four-hour observation periods before the ice became unsafe.

To make observations, we used an Aqua-Vu underwater 760 color camera equipped with video recorder. When salamanders were viewed among vegetation, we used an average cattail stem diameter of 11.8 mm for calibration using ImageJ to estimate salamander size. Water temperatures ranged from 2.2 to 3.0°C. Observation depths ranged from 0.2 to 2 m.

Because each hole is 10 m from the nearest hole, we assumed that the number of individual salamanders observed more than once during a visit was minimal. Visibility was estimated as 0.7 m in any direction, thus a full rotation of the camera covered a circular area with a radius of 0.7 m and a circular viewing area of 1.54 m². Given this viewing area at each hole, we observed 13.86 m² during each trip to the pond (i.e., nine holes, each 1.54 m²). We viewed a total of 224 salamanders during our four observation periods (i.e., an average of 56 salamanders observed in an area of 13.85 m², or 4.04 salamanders/m²). Using a total lake area of 45,285 m² provides a coarse winter population estimate of approximately 183,102 salamanders in Swalls Lake. This estimate falls within our previous catch-per-unit effort and PIT-tag mark-recapture estimates (Poitra et al. 2007. Proc. NDAS 61:15). Salamanders measured (N = 11) averaged 128.1 mm SVL (standard deviation 17.2). All observed salamanders were large (range 99.1–151.2 mm SVL).

The Amphibian Growth Project (AGP) has been monitoring Swalls Lake as part of a long term population monitoring program since 2005. Metamorphosis of *A. mavortium* at Swalls Lake occurs during August and September at ca. 98 mm SVL. Swalls Lake is a semipermanent wetland that last dried completely in the late 1980s. This wetland is irregular in shape and is surrounded by farm fields maintained by the North Central Research Extension Office of North Dakota State University. When full of water, the maximal depth in this wetland is 2.8 m. In summer months, the *Ambystoma* population at Swalls Lake consists of a mixed population of immature larvae, sexually mature larvae (i.e.,

paedomorphs), immature transformed salamanders, and sexually mature transformed salamanders (Poitra et al. 2007. *op. cit.*). We did not observe any transformed salamanders and it is likely that these salamanders that we viewed consist of both immature and mature larvae. Both salamanders with and without swollen cloacae were observed.

Most of the salamanders observed were active. No aggression among salamanders was observed. In several cases, the salamanders are crowded such that they are nearly always in contact with another salamander. Movement up and down in the water column was very common. We often observed salamanders slowly ascending to the top of the water column (i.e., to the bottom of the ice cover) and then swimming rapidly downwards. This is a behavior seen when salamanders gulp air from the surface during ice-free months. Lung deflation in amphibians occurs during long term restriction from surface area and can be a cause of significant mortality (Ultsch et al. 2004. *Comp. Biochem. Phys. Part A* 139:111–115). However, the salamanders were able to maintain position in the water with no effort, i.e., were buoyant. Therefore we suggest that these salamanders are able to maintain inflated lungs during the winter. We are unable to determine at this time if the salamanders are gulping from pockets of air under the ice.

Amphibians often overwinter under the ice. For example, adult Northern Leopard Frogs (*Lithobates pipiens*) can spend winter months dormant in shallow pits on the pond bottom (Emery et al. 1972. *Copeia* 1972:123–126), and adult Red-spotted Newts (*Notophthalmus viridescens*) spend their lives in ponds that can freeze over (Berner and Puckett 2010. *J. Exp. Zool.* 313A:231–239). In these reports, overwintering amphibians are slow or dormant. Our observations indicate high activity levels on larval *A. mavortium* under the ice. This high activity is seen in the other organisms in Swalls Lake. Aquatic arthropods were also seen at high density and high activity. In addition, bubbles were constantly forming and releasing from the surface of cattail stems that were covered with biofilms (presumably algae and cyanobacteria).

Our video recordings are archived at amphibiangrowthproject.org and at [youtube.com/user/Kidbeachy](https://www.youtube.com/user/Kidbeachy). The AGP has been supported by grants from the National Center for Research Resources (5P20RR016471-12) and the National Institute of General Medical Sciences (8 P20 GM103442-12) from the National Institutes of Health to CKB and D. Sens. Long term access to Swalls Lake is kindly provided by the North Central Research Extension Center of North Dakota State University and its director, J. Fisher.