

## METABOLIC RATES OF WINTERING BLANDING'S TURTLES, *EMYDOIDEA BLANDINGII*

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**Abstract**—1. Aquatic  $\dot{V}O_2$  of three adult Blanding's turtles (*Emydoidea blandingii*) wintering at 3°C on the bottom of a small Massachusetts pond was  $0.342 \pm 0.012 \mu\text{l O}_2/\text{g/hr}$  ( $\bar{x} \pm \text{SE}$ ).

2. This moderate rate of metabolism, compared with that of other species at low water temperature, is probably correlated with the physical characteristics of the hibernation site and the amount of movement demonstrated by wintering animals.

### INTRODUCTION

Nearctic freshwater turtles at northern latitudes usually undergo forced submergence by ice cover in winter, and must consequently use extrapulmonary respiration, e.g. buccopharyngeal, cloacal, or cutaneous exchange (Jackson, 1979). Their ability to survive results from (1) their reduced  $\text{O}_2$  requirement at very low ambient temperatures, and (2) their capacity for aquatic gas exchange (Seymour, 1982). Extrapulmonary respiration has been suggested as a potentially important survival mechanism for wintering emydid turtles (Herbert and Jackson, 1985; Ultsch, 1989), but only recently have studies of aquatic  $\text{O}_2$  consumption by wintering turtles in the field been reported (Graham and Forsberg, 1991; Graham and Graham, unpubl.). Additional investigations are needed to determine the capacity of wintering turtles for aquatic gas exchange, and how it relates to their behavior in nature. This report evaluates aquatic  $\text{O}_2$  uptake by wintering Blanding's turtles on the bottom of the pond in central Massachusetts.

### MATERIALS AND METHODS

Our study was conducted from 4–7 December 1992 in a small ( $\sim 0.04$  ha) hard-bottomed pond (maximum depth  $\sim 1.1$  m) on the Fort Devens Military Reservation in Lancaster, Worcester County, Massachusetts ( $42^\circ 39' 15''\text{N}$ ;  $71^\circ 39' 35''\text{W}$ ). This pond and adjacent wetlands were created or altered by military training activity approximately 35 years ago. Surrounded by thick alder growth and mixed hardwoods, this pond contained the only open water in this small wetlands complex from September to mid-November. We observed four adult *E. blandingii* in this pond in October at  $T_w = 9^\circ\text{C}$ . Under nearly complete ice cover at the beginning of the experiment

in December,  $T_w$  was  $3^\circ\text{C}$  and ambient DO, determined by Winkler titration, was 8.4 ppm ( $P_{\text{O}_2} = 99.0$  mm Hg).

We transferred three adults underwater from their wintering sites on the pond bottom at depths of 3–110 cm to plexiglass respiration chambers (15.9–20.4 l) which we then sealed and left in place on the bottom near shore at a depth of 50 cm. Oxygen concentration within the chambers was monitored with a YSI model 57 oxygen meter and probe for 72 h to determine extrapulmonary  $\dot{V}O_2$  (Graham and Forsberg, 1991). Each chamber was equipped with a spring-loaded plunger which was used to mix the water each time readings were taken.

### RESULTS

Our adult Blanding's turtles (Table 1) had aquatic  $\dot{V}O_2$  similar to that of other nearctic freshwater species in cold water (Table 2). The higher  $\dot{V}O_2$  of males compared to females noted for hibernating common map turtles (Graham and Graham, unpubl.) was not evident in this study. Mean aquatic  $\dot{V}O_2$  of *Emydoidea* was similar to that of wintering wood turtles ( $\bar{x} = 0.371 \mu\text{l O}_2/\text{g/hr}$ ; Graham and Forsberg, 1991), but was much less than that of hibernating common map turtles (Table 2). Our results are also similar to those derived in laboratory studies of other species at low temperature (Gatten, 1980; Herbert and Jackson, 1985).

Table 1. Aquatic  $\dot{V}O_2$  at  $3^\circ\text{C}$  of three adult Blanding's turtles within a sealed respirometer on the bottom of their pond

Turtle (sex/no.)	Mass (g)	Volume (l)	$\dot{V}O_2$ ( $\mu\text{l O}_2/\text{g/hr}$ )
F8	1349	1.285	0.338
M10	1215	1.210	0.324
M18	1391	1.270	0.364
$\bar{x} \pm \text{SE}$	$1318 \pm 53$	$1.255 \pm 0.023$	$0.342 \pm 0.012$

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Table 2. Comparative values of aquatic  $\dot{V}O_2$  for selected nearctic turtles at low temperatures

Species	Mass (g)	Temp. (°C)	$\dot{V}O_2$ ( $\mu$ l $O_2$ /g/hr)	Source
<i>Chelydra serpentina</i>	3007	4	0.640	Gatten (1980)
<i>Chrysemys picta bellii</i>	953	3	0.230	Herbert and Jackson (1985)
<i>Clemmys insculpta</i>	681	5	0.371	Graham and Forsberg (1991)
<i>Graptemys geographica</i>				
Females	1899	2	0.535	Graham and Graham
Males	188	2	1.376	(unpubl.)

## DISCUSSION

Metabolic rate should to some degree reflect the amount of locomotor activity that wintering turtles demonstrate. The rather high  $\dot{V}O_2$  of male map turtles was suggested to be due to their surprising mobility at 2°C (Graham and Graham, unpubl.). In contrast, the much lower  $\dot{V}O_2$  at the slightly higher temperature for wintering wood turtles probably resulted from their almost complete lack of movement during the respirometry (Graham and Forsberg, 1991). Meeks and Ultsch (1990) reported that common snapping turtles in Ohio sometimes move during winter and were taken by muskrat traps set in runways. Other authors have reported winter movements of *Chelydra* beneath ice (Lagler, 1943; Pell, 1941) but the dates were not given. Meeks and Ultsch (1990) suggest that only movements associated with entry into hibernation or those made by animals seeking open water for air-breathing before ice-out in the early spring have been reported, therefore the level of winter mobility in *Chelydra* is essentially unknown. In view of the lack of agreement concerning the extent of winter movements in *Chelydra*, we prefer not to speculate on the relationship between their somewhat higher  $\dot{V}O_2$  (Gatten, 1980) and any tendency to move about in winter.

Ross and Anderson (1990) found that *Emydoidea* prefer ponds to marshes for overwintering, but they were unable to measure winter activity. The relatively low  $\dot{V}O_2$  for *Emydoidea* found in our study suggests that winter activity in our specimens was minimal to moderate. Kofron and Schreiber (1985) used radiotelemetry to track two adult marsh-hibernating Blanding's turtles and found that they wintered at 9–21 cm in soft mud, but changed positions weekly by as much as 13 m when the water temperature stayed at or near 6.2–7.5°C. Once the temperature dropped to 2–3°C their weekly movements were limited to only 1–2 m. On one occasion they saw a turtle under the ice sitting on top of the mud, but this animal eventually went down into the mud as the water over the mud froze. We suggest that movements of wintering mud-buried animals are related to their need to periodically leave this anoxic microhabitat. Ultsch and Jackson (1982) postulated that mud-buried turtles can use two options to avoid anoxia: (1) bury shallow enough in the substrate to allow the head to extend into open water for buccopharyngeal gas exchange; and (2) shuttle from time to time between mud and more aerated water. *Emydoidea* probably

employs both strategies when buried in winter, but our animals were not buried when captured. It appears that Blanding's turtles may bury more often when overwintering in marshes, and maintain a more exposed posture when hibernating in ponds. This behavioral dichotomy could be related to water depth (documented marsh sites are frequently shallower), because in deeper hibernacula burrowing to avoid freezing or predation may be unnecessary.

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