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European pond turtle hibernation in southeastern Slovakia: a preliminary report

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Abstract: The behavior of five European pond turtle specimens (two males and three females) just before, during and just after winter dormancy in Tajba National Nature Reserve (southeastern Slovakia) has been observed. The monitoring has been performed during winter seasons 2002 / 2003 and 2004 / 2005 by using telemetry, visual observations and by the comparison of the carapacial surface temperatures with the ambient temperatures. The last basking was recorded on 29 September in year 2002 and on 12 October in year 2004. Before the water surface is not frozen, turtles surface for air and prefer to move in water layers with the highest temperature. Beginning of dormancy stage corresponds with the freezing of water surface. Monitored turtles stay on the same place of their own closely under ice cover with temperature around 1°C. The first movement after dormancy stage was recorded on 26 March in 2003 and 24 March in 2005 but the first basking comes only a few days (4-11) thereafter.
Key words: *Emys orbicularis*, hibernation, natural history, overwintering, Slovakia.

Resumen: Hibernación del galápago europeo en el sudeste de Eslovaquia: resultados preliminares. – Se estudia el comportamiento de cinco ejemplares (dos machos y tres hembras) de galápago europeo inmediatamente antes, durante e inmediatamente después de la hibernación en la Reserva Natural Nacional de Tajba (SE de Eslovaquia). El seguimiento se llevó a cabo durante los inviernos de 2002 / 2003 y 2004 / 2005 mediante telemetría, avistamientos y comparación entre la temperatura de la superficie del caparazón y la temperatura ambiente. El último registro de asoleamiento corresponde al 29 de septiembre de 2002 y al 12 de octubre de 2004. Previamente a la congelación de la superficie, los galápagos emergen para respirar y muestran preferencia por las capas de agua con temperatura más elevada. El comienzo de la hibernación coincide con la congelación de la superficie del agua. Los ejemplares objeto de seguimiento permanecen en el sitio, a temperaturas en torno a 1ºC. El primer movimiento tras la hibernación se registró el 26 de marzo en 2003 y el 24 de marzo en 2005, mientras que el primer asoleamiento tuvo lugar algunos días después (4-11).
Palabras clave: *Emys orbicularis*, Eslovaquia, hibernación, historia natural.

Introduction

The European pond turtle (*Emys orbicularis* Linnaeus, 1758) is an aquatic turtle inhabiting marshes, ponds, lakes, and slow-moving bodies of water in western Palearctic from north Africa to northwestern Asia (Fritz, 2001, 2003). To occupy climatically so distinct areas it exhibits vast scale of ecological and physiological adaptations. One

of the so kind of adaptations is mechanism of survival of harsh winter conditions, known as hibernation.

Generally, aquatic turtles in temperate climates hibernate under ice cover of water bodies, submerged and spending for months at the bottom or buried in the mud. They must be well adapted to hypoxia due to lack of atmospheric oxygen and hence, anaerobic metabolism is very important. Their ability to cope hypoxia is due to their capability to experience of lactic acid accumulation (GATTEN, 1985, 1987).

There are broad diferences in hibernating ecology and physiology of aquatic turtles. Remarkable variability occurs in hibernacula selection, water depth, burying into bottom sediments, pre-hibernation and hibernation migration and tolerancy to different physiological stresses. Although behaviour and physiology of aquatic turtles during hibernation under natural conditions is quite well known in North American species (ERNST *et al*., 1994), only weak amount of information is disposal about this phenomenon in case of European pond turtle (FRITZ & GÜNTHER, 1996; FRITZ, 2001, 2003; THIENPONT *et al*., 2004). In this study we present detailed information on the overwintering ecology of the European pond turtle in the southeastern Slovakia.

MATERIALS AND METHODS

The Tajba National Nature Reserve is situated 1 km northeast of Streda nad Bodrogom village (48° 23' N, 21° 47' E), at an altitude of about 100 m a.s.l. The locality is created by 2 km long and 100-150 m wide oxbow of the Bodrog river with maximum depth of 1 m. Open water surface is confined only western part of oxbow, the rest of locality is covered by *Stratoides aloides* and *Nuphar lutea*. *Typha latifolia* and *Carex* sp. prevail during periods with low water level. Among trees dominate willows (*Salix cinerea*), forming in the water and along the banks loafshaped islands, and artificially planted abeles (*Populus alba*), which die from time to time during high water level periods. Deadwood is a preferred basking site of pond turtles. Microclimatic habitats of the Tajba marsh are influenced (e.g. screening of water surface) by the steep northern slopes of Roháč hill covered by secondary growth of robinias (*Robinia pseudoacacia*) and pines (*Pinus silvestris*).

Data were collected using telemetry and digital thermometers during two winter seasons. From 16 September 2002 to 15 April 2003 thermometers were fixed on carapace of two radiotracked females and from 20 September 2004 to 20 April 2005 on two males and one female. Turtle's movements and exact hibernation sites were recorded using telemetry. For telemetry, equipment of the company ATS was used, consisting of a FM 100 receiver, a three element folding Yagi antenna, and three transmitters R2030. Transmitters weight 24 g and include 14.5 cm antenna.

Thermometers and transmitters were attached to the lateral carapace by acrylic glue (Dentacryl), allowing a minimal restriction of the turtle's movements and mating activities (NOVOTNÝ *et al*., 2004).

For measuring of temperatures in standard depth of water and standard height above water level a floating device was constructed (NOVOTNÝ *et al*., 2004). This float is fixed on stable place by weight on oxbow bottom and it is following of water level movements. There are digital thermometers fixed on the axis of the float in 10 cm above water level and 10 cm under water level. All thermometers fixed on turtles and on the float recorded temperature synchronously in the intervals of 30, 60 or 120 minutes. Tempe-

ratures recorded on turtles carapaces (Tb) were compared with ambient temperatures. Turtle's seasonal activities were appointed on the base of comparison turtle's surface temperature (Tb) with water temperature in 10 cm under water level (Tw) and air temperature in 10 cm above water level (Ta).

RESULTS

It is possible to exactly recognize three different time periods from total chart of Tb from mid-September 2002 to mid-April 2003: 1) pre-hibernation period; 2) hibernation period; 3) post-hibernation period (Fig. 1). There are typical sections of recorded Tb, Tw and Ta values describing turtle's activities during individual periods and phases of overwintering designated. Beginning and duration of described phases depend on temperature conditions in season.

Pre-hibernation period

Beginning of prehibernation period was appointed artificially in this work, by the starting of temperature recording in the time of turtle's activity (16.9.2002 and 20.9.2004). The end of pre-hibernation period and the start of true hibernation is given by freezing of water surface avoiding to monitored animals breathing of air oxygen.

Pre-hibernation period is characterised by turtle activity recorded as changes of Tb. Animals are still moving and breathing air oxygen during this period. They are basking regularly in the beginning of prehibernation period (comparison of Tb with Ta). According to gradually descending turtle's activity, this period is possible to divide into three phases: 1) basking phase; 2) surfacing phase; 3) merging phase.

Basking phase. – Turtle's activity during basking phase is similar to summer activity (Fig. 2). Animals are moving and regularly leaving the water for solar basking. But there are no such rapid temperature changes recorded on thermometers than in spring and summer time. Recorded data are relatively balanced excepting basking time in midday hours. Solar basking is detected from recorded values Tb, Tw and Ta on the base of comparison maximal Tb values which significantly exceed maximal Tw and Ta values.

Surfacing phase. – It follows after basking phase and relate with decreasing of ambient temperature (Fig. 3). Temperature of upper water layers is still higher than lower layers in

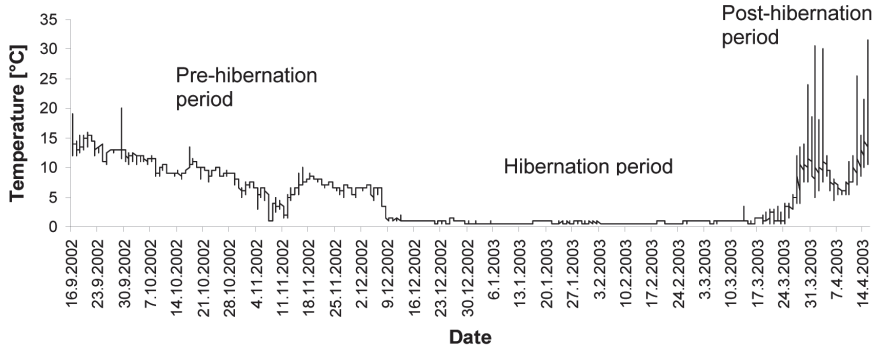

FIGURE 1. Temperature value Tb from 16 September 2002 to 14 April 2003.

FIGURA 1. Valores de la temperatura Tb desde el 16 de septiembre de 2002 al 14 de abril de 2003.

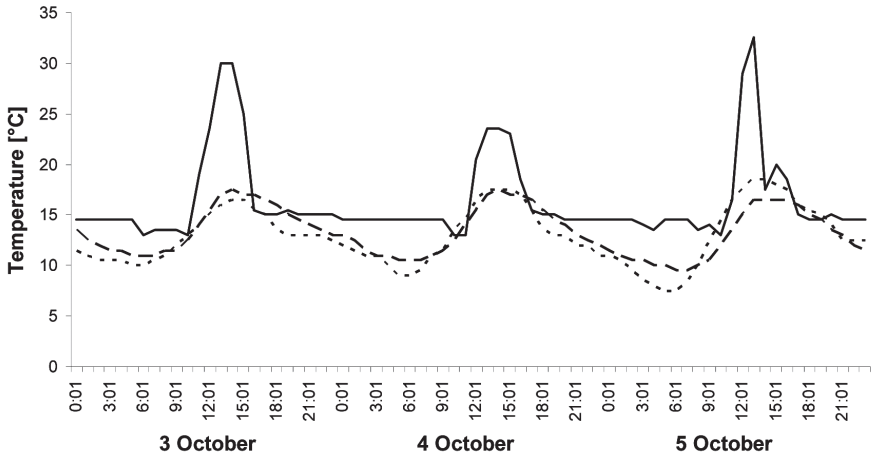

FIGURE 2. Temperature values Tb (solid line), Tw (dashed line) and Ta (dotted line) during basking phase in season 2002/2003.

FIGURA 2. Valores de la temperatura Tb (línea sólida), Tw (línea discontínua) y Ta (línea de puntos) durante el período de asoleamiento en la temporada 2002/2003.

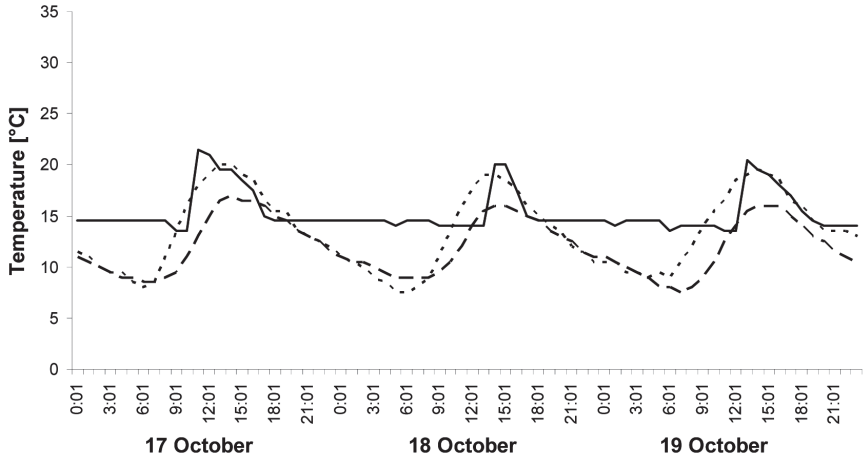

FIGURE 3. Temperature values Tb (solid line), Tw (dashed line) and Ta (dotted line) during surfacing phase in season 2002/2003.

FIGURA 3. Valores de la temperatura Tb (línea sólida), Tw (línea discontínua) y Ta (línea de puntos) durante el período de superficie en la temporada 2002/2003.

this time. Tb values exceed Tw values and sporadically also Ta values, what implies animal moving in layers close to water surface (aquatic basking). Maximum values of Tb are not yet so high than in preceding phase, turtles evidently do not already bask.

Merging phase. – During this phase turtles do not leave the water, because of lower average air temperature than the water temperature (Fig. 4). After autumn water

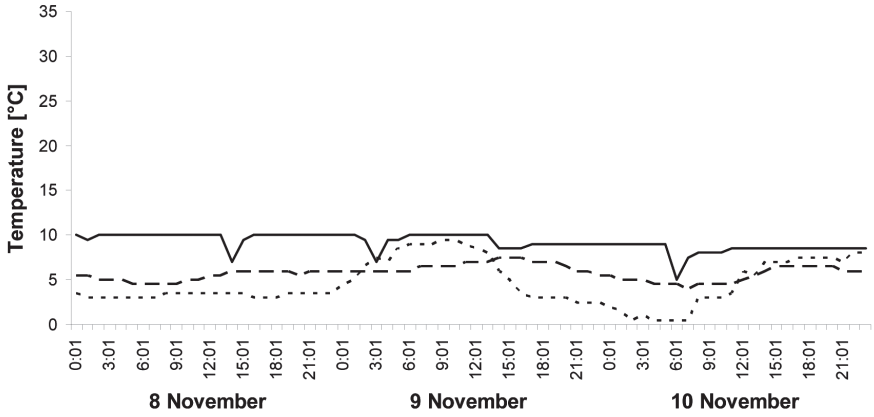

FIGURE 4. Temperature values Tb (solid line), Tw (dashed line) and Ta (dotted line) during flotation phase in season 2002/2003.

FIGURA 4. Valores de la temperatura Tb (línea sólida), Tw (línea discontínua) y Ta (línea de puntos) durante el período de flotación en la temporada 2002/2003.

temperature inversion turtles linger in deeper water spheres with higher temperature (8-10°C) than maximal Ta (5-7°C) is. They are spending most of time in water sphere with stable temperature (balanced sections of Tb course).

Monitored animals still breath air oxygen. Tb get closer to Tw just during inspiration when turtle emerge to water surface, with minimal values of Tb. Small number of these values recorded on the chart is caused by the incompatibility of two hours temperature recording period with frequency of animal surfacing for breathing.

Hibernation period (dormancy phase)

Hibernation period presents true hibernation (dormancy) when turtle find hibernaculum, stop moving and breathing air oxygen. There is beginning of dormancy phase after freezing of water surface expressed on (Fig. 5). Just before water surface freezing turtles stay in water sphere with temperature about 5°C and they still breath air oxygen (minimum Tb values on the chart of floatation phase). After freezing of water surface *T*b descended from 5°C at 9:00 to 1.5°C at 19:00 within the same day (9 December 2002 on model chart). In season 2004/2005 water surface of Tajba oxbow got frozen about 20 November and in this time all 3 monitored animals moved into water sphere with temperature 1°C and afterwards started hibernating. Every turtle spent the rest of winter in this water sphere up to spring phase of waking.

Monitored turtles (three females and two males) have never changed hibernaculum during winter. They remained on roots of willow (*Salix cinerea*) or on the layer of water vegetation in sphere with temperature approximately 1°C under ice cover. In dependency on total water depth of the hibernation site, hibernaculum is localised on the bottom (on the sites with shallow water up to 0.5 m), or in water column on the layer of water vegetation or submerged trunks (on the sites with deeper water). There was no recorded hibernaculum located deeper than 0.5 m under ice, it relates to temperature of hibernation. Burying into the mud has been never observed.

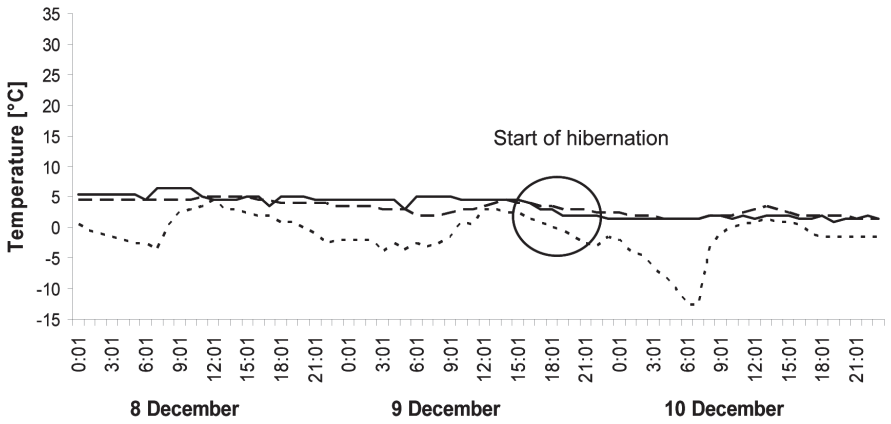

FIGURE 5. Temperature values Tb (solid line), Tw (dashed line) and Ta (dotted line) during transition from pre-hibernation periode to hibernation periode in season 2002/2003. Moment of water surface freezing and start of hibernation is emphasized.

FIGURA 5. Valores de la temperatura Tb (línea sólida), Tw (línea discontínua) y Ta (línea de puntos) durante la transición del periodo de pre-hibernación al de hibernación en la temporada 2002 / 2003. Se marca el momento en que la superficie del agua se congela y comienza la hibernación.

Post-hibernation period

Posthibernation period starts by first turtle moving after finishing of hibernation recorded as rapid changing of Tb. According to turtle's activity is possible to divide this period into two phases: 1) waking phase; 2) warming phase.

Waking phase. – The first movements of monitored animals within one season were recorded in different time in dependency on microhabitat conditions of hibernaculum (Fig. 6). The first turtle movement is established by rapid increase of Tb. During this phase, turtles are moving in deeper water

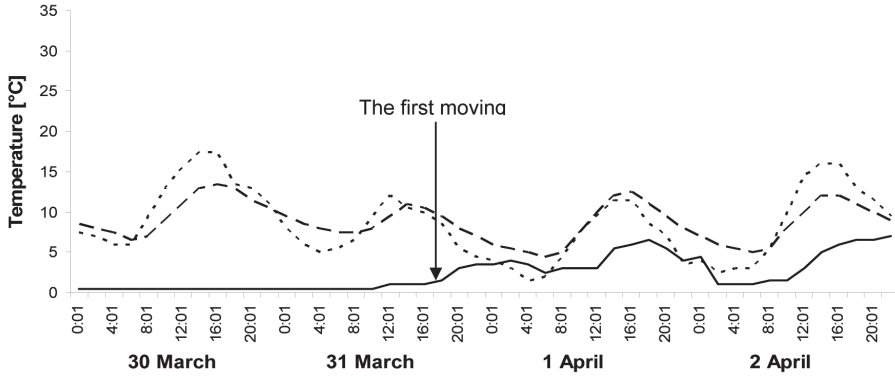

FIGURE 6. Temperature values Tb (solid line), Tw (dashed line) and Ta (dotted line) during transition from hibernation periode to post-hibernation periode in season 2004/2005. Moment of the first time turtle moving is emphasized.

FIGURA 6. Valores de la temperatura Tb (línea sólida), Tw (línea discontínua) y Ta (línea de puntos) durante la transición del periodo de hibernación al de post-hibernación en la temporada 2004/2005. Se marca el momento en que se producen los primeros movimientos de los galápagos.

spheres (Tb does not reach Tw) and they do not leave water in spite of relatively warm weather conditions (Ta about 15°C). Recorded waking phases lasted minimally four days however periods of cold weather can extend this phases. The longest waking phase lasted 11 days.

Warming phase. – During this phase turtles start solar basking - Tb exceed Ta for the first time (Fig. 7).

DISCUSSION

The literature sources concerning pond turtles hibernation in Slovakia and Hungaria determine the beginning of hibernartion from the end of October to beginning of November (LÁC, 1968; DELY, 1978). SHCHERBAK & SHCHERBAN (1980) describe turtle observation until the end of September up to end of October in Transcarpatian Ukraine, PUPIŃA & PUPIŃŚ (1996) noticed the migration of turtle in the beginning of October in Latvia.

There is registered periodic turtle moving within water level, into the colder spheres until the water surface freezing. True beginning of hibernation was appointed till after water surface freezing in every radio-tracked animals. At that time turtles move from deeper water sphere with temperature 5-8°C to the sphere under ice cover with temperature about 1.5°C. Movement takes a few hours and turtles spend rest of winter in this sphere. Low ambient temperature (around 1°C) is important for decreasing of physiological processes and reduction of oxygen consumption which difund into turtle body just trough mucous membranes during hibernation. In higher temperature conditions turtles should be active, PUPIŃA & PUPIŃŚ (1996) describe the mating of pond turtles in water with temperature 5°C. North-american turtles *Clemmys guttata* stay active in water with temperature 3°C even under ice cover (ERNST, 1982).

The hibernation sites of radio-tracked turtles in Tajba nature reserve were the same as the sites of their home range where was recorded the last summer activity. These findings are in contradiction with THIENPONT *et al*. (2004) which observed long-distance migration to a particular hibernation site in France. Migration happened during one day and then turtles moved only over short

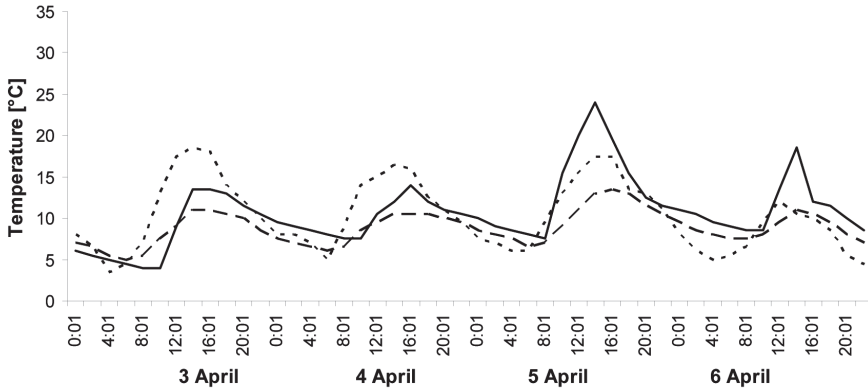

FIGURE 7. Temperature values Tb (solid line), Tw (dashed line) and Ta (dotted line) during transition from waking phase to warming phase in season 2004/2005.

FIGURA 7. Valores de la temperatura Tb (línea sólida), Tw (línea discontínua) y Ta (línea de puntos) durante la transición del periodo de activación al de termorregulación en la temporada 2004/2005.

distances until they become dormant. Hibernation with previous migration was observed in North American species *Clemmys guttata* as well, recorded migration to hibernation sites was as far as 1.5 km (LEWIS & RITZENHALER, 1997).

According to our data the total water depth is not influencing the location of hibernaculum. Monitored turtles were founded as on shallows of willow growths as on open water areas with total depth over 1 m. However, in both cases hibernaculum was situated in short distance under ice cover and recorded *T*b of monitored animals were about 1°C. What is more, FRITZ & GÜNTER (1996) described freezing of a few pond turtle specimens into the ice without any damages.

We have never observed burying of monitored turtles into the mud described by many authors (e.g. LÁC, 1968; DELY, 1978; KUZMIN, 2000; MITRUS & ZEMANEK, 2001; THIENPONT *et al*., 2004). All checked turtles remained on willow roots in shallow water and, in the case of hibernaculum located on places with bigger total depth, on submerged branches or on the water vegetation layer.

Every monitored turtles hibernated alone. We have never observed the agregation of hibernated turtles described in North American species (MEEKS & ULTSCH, 1990; ERNST *et al*., 1989; LEWIS & RITZENHALER, 1997).

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