Short Note

Growth rings in young turtles *Emys orbicularis* – marking is the only reliable criterion for distinguishing between wild and headstarted animals

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In 2006, 11 wild and 16 headstarted European pond turtles *Emys orbicularis*, that hatched in the years 1997–2001 and were marked during previous studies, were recaptured in central Poland. Wild turtles produced one growth ring per year, although variations were observed in headstarted individuals. Some headstarted turtles presented a pattern in which some of the growth rings were composed of false rings. Such a pattern was not observed in wild individuals. However, the growth ring pattern alone is not a reliable criterion for distinguishing between wild and headstarted turtles after being released into the wild.

Key words: age estimation, European pond turtle, freshwater turtles, headstarting

Many species of reptiles are endangered (Gibbons et al., 2000). Thus, for such species many protection programmes (e.g. headstarting), are currently in place. Headstarting involves raising young animals in captivity for a few months to several years and then releasing them back into the wild. The technique has been used for different species of freshwater turtles, as well as for sea turtles, snakes and iguanas (e.g. Haskell et al., 1996; Bell et al,. 2005; King, 2006; Alberts, 2007). However, using headstarting as a management tool remains controversial, due in part to a lack of empirical data on its effectiveness. Recent analyses of headstarting programmes for freshwater and sea turtles suggest these programmes could be inefficient as a tool for increasing population size (Heppell et al., 1996; Heppell, 1998; Mitrus, 2005). It has been suggested that released headstarted animals could have a negative impact on wild animals of the same species – for example, because they may behave abnormally (Meylan & Ehrenfeld, 2000; Alberts, 2007). Thus, empirical data on the survival rates and growth rates of headstarted animals are necessary. Headstarted animals are typically marked before being released, but the marks can be difficult to recognize after a long period of time. The aim of this study was to determine if young wild and headstarted European pond turtles *Emys orbicularis* (L.) produced the same number of growth rings per year, and whether the pattern of growth ring formation was similar in the two groups.

I captured turtles in the Borowiec Nature Reserve, located in the Zwolenka river valley, Radom district, central Poland (for more details, see Zemanek, 1992; Mitrus & Zemanek, 2004), during field trips from May to August 2006. Individual turtles were captured by dip netting in reservoirs for 4–6 consecutive days on each field trip. In this reserve, intensive studies on turtles were conducted from 1997 to 2001, and many turtles were individually marked by marginal scute notching (Plummer, 1989; Mitrus & Zemanek, 2004).

The easiest and most popular technique for estimating the age of turtles and tortoises is to count the growth rings formed on the scutes of the carapace and plastron (Zug, 1991). The growth rings are formed by the successive deposition of epidermal scute layers during periods of intensive growth, alternated with grooves or lines of arrested growth (LAGs) formed during periods of decreased growth (Zug, 1991; Germano & Bury, 1998; Wilson et al., 2003). However, the usefulness of this method for aging turtles should be tested for each population studied (Wilson et al., 2003). In this study I used only data for young turtles. Also, I considered only recaptured headstarted animals that were marked before one year of age, and wild animals that had been marked previously up to three years of age (determined through growth ring counts; see Mitrus, 2005). I counted the rings on the plastron using the left pectoral scute. All rings on the scute were counted and the pattern of the rings (colour of the youngest ring, width, intensity of LAGs) was recorded.

I began capturing turtles during the first half of May 2006. The new growth ring for 2006 was not yet visible in individuals captured at this time of year, owing to the sigmoidal growth pattern of temperate zone chelonians (Lindeman, 1997). Thus, for turtles caught in May and the first half of June, information about sigmoidal patterns of growth was taken into consideration in the analyses.

I captured 11 wild (hatched 1998–2001) and 16 headstarted turtles (hatched 1997–2001) that had been previously marked. The scute notches of wild turtles hatched in 1998 and 1999 and marked as yearlings were difficult to see in 2006, although it was still possible to read them. The notches of headstarted turtles made before their release (in age about nine months) in 1998 were readily discernible in 2006. Variation in the number of LAGs produced per year is evident for headstarted individuals: in seven headstarted turtles, either one more or one less ring was observed than would have been expected based on their age, and one individual had two rings more than would have been expected for its age (Fig.

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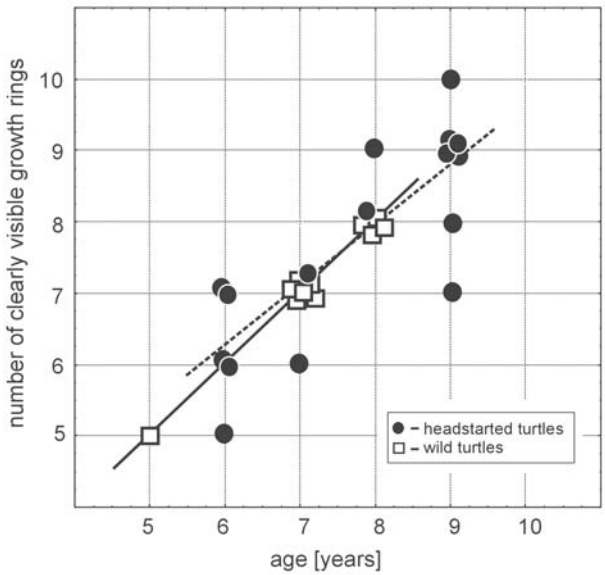

Fig. 1. Relationship between the number of observed growth rings on the left pectoral scute and age in years of turtles *Emys orbicularis* captured in central Poland. The solid line indicates the theoretical relationship (1:1), which was observed for eleven wild turtles; the dotted line indicates the relationship observed for headstarted individuals (regression lines: for wild turtles, y = x; for headstarted turtles, y = 0.83x + 1.38; there are no statistical differences between the lines).

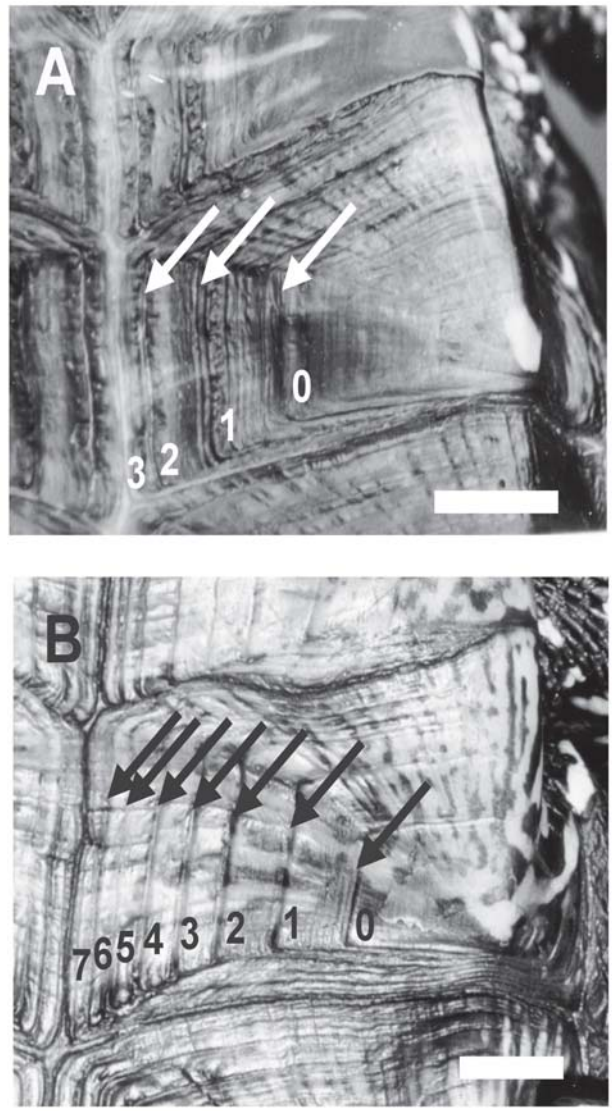

Fig. 2. Frequently observed patterns of growth rings in young headstarted (A) and wild (B) turtles Emys orbicularis. In headstarted turtles, the first growth rings may consist of several "false rings"; thus, sometimes it is difficult to say how many growth rings are on a scute. Bar = 1 cm. Arrows = LAGs; 1–7 denote the LAGs formed during subsequent growing seasons.

1). Eight of the 16 headstarted turtles, as well as all 11 wild turtles, produced one growth ring per season (Fig. 1). However, there were no differences found between wild and headstarted turtles in the average number of LAGs produced per year (test for difference between two population regression coefficients, Zar 1999: t=0.63, P>0.5).

It has been shown that in artificial rearing subsidized with good food and a continuous growth season, turtles can produce more than one ring per year (Tracy & Tracy, 1995; Germano, 1998). I observed a similar pattern in our headstarted turtles. In eight of the 16 headstarted turtles in the study, the first growth rings were composed of a series of "false rings" (Fig. 2A). False rings are shallower than annual growth rings and are frequently incomplete (Germano & Bury, 1998; Wilson et al., 2003; Stone & Babb, 2005). I observed no such pattern in the wild individuals (cf. Fig. 2B). A new ring for the 2006 growth season was first observed in June, and had a lighter colour which made it readily distinguishable from older rings. In June and the first half of July, the new growth ring was lighter than the older ones, with the youngest ring typically whitish in tone, in contrast to the older rings which were grey, yellow or black. In the second half of July and August no differences in the colour of the growth rings were detected. Similar data on the colour of the new scute rings were presented for the red eared slider *Trachemys scripta elegans* (Stone & Babb, 2005).

A good method of recognizing wild and headstarted animals that have not been marked, or in which markings are not discernible, would help in the long-term monitoring of the efficiency of headstarting. Notches on the marginal scutes of young turtles may not be clearly visible after longer periods in natural conditions – for example in juveniles of species such as *Trachemys scripta* and *Kinosternon subrubrum*, the notches were readily discernible after more than six years (Gibbons, 1990), but there is no information how long the notches could be readable. Likewise, in headstarted European pond turtles marked just before release, the notches were

clearly visible after eight seasons, yet in wild individuals marked as yearlings or younger it was difficult (but – at least in some of the individuals – still possible) to read the markings after six or seven years.

Some of the rings in the headstarted turtles in my study were composed of several narrow false rings. False rings may be a consequence of feeding captive turtles *ad libitum*. Some of the headstarted turtles did not produce growth rings annually after their release into the wild, which may be a consequence of problems adapting to conditions in the wild after release (e.g. difficulty in finding food). However, pattern of growth alone cannot be used to differentiate between wild and headstarted individuals. Thus, during studies on the efficiency of headstarting programmes, animals should be recaptured frequently and marked, with the marking improved.

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