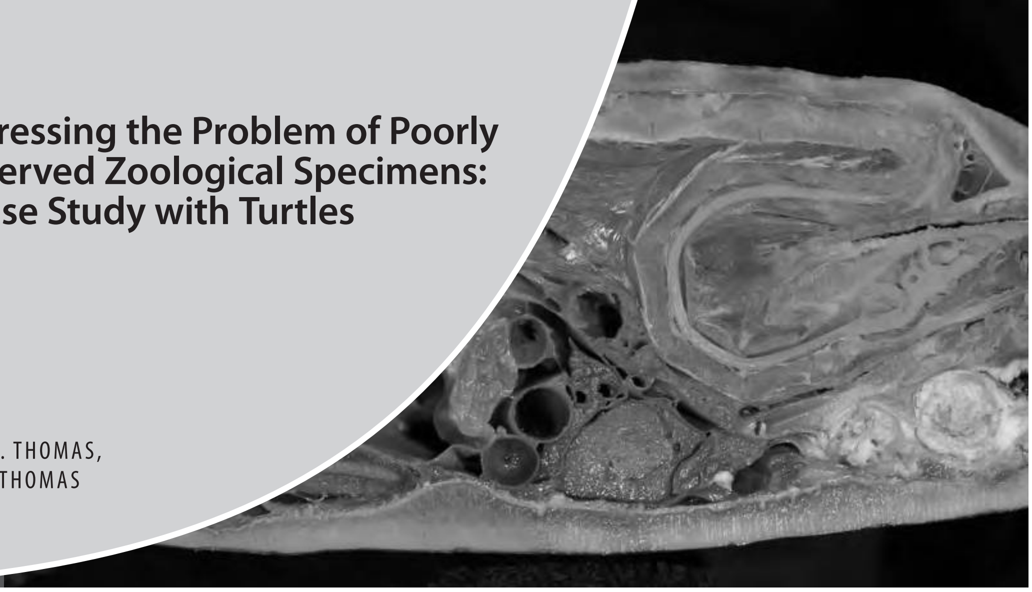
TIPS, TRICKS & TECHNIQUES

Addressing the Problem of Poorly Preserved Zoological Specimens: A Case Study with Turtles



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Abstract

We present a new use for a poorly preserved turtle specimen that teachers can easily use in demonstrating vertebrate anatomy or adaptive herpetology at the high school or college level. We give special attention to illustrating the sigmoid flexure of the neck as certain turtles withdraw their heads. This ability is anatomically and biologically important in that it protects the turtle from predators and is one of the major anatomical radiations that occurred in turtle evolution. The lesson also demonstrates how turtles, whose anatomy is confined within a rigid compartment, have their organs arranged and how adaptive strategies overcome this spatial constraint.

Key Words: *Anatomy; herpetology; sigmoid flexure; Pleurodira; Cryptodira; turtle.*

○ Introduction

Zoological teaching and research collections commonly contain specimens that are improperly preserved or that lack locality data, which renders them useless for scientific investigation. Curators and teachers dislike disposing of such specimens, so they are usually stored in containers in the corner or on cluttered shelves. Add to this the rising costs of lab specimens and the heightened attention to not killing animals unnecessarily, and it becomes a priority to find uses for such specimens.

> *We found a use for improperly preserved turtle specimens that gives educators a way to more efficiently teach internal vertebrate anatomy.*

Some years ago, we were working with our herpetology teaching collection and lamenting that we had a number of specimens of cryptodiran red-eared sliders (*Trachemys scripta elegans*) that had been preserved by students (rarely a practice today) with the turtles' heads withdrawn. Such specimens have little value as teaching tools because the head and neck patterns of this and related species and subspecies are crucial identifiers.

○ A Novel Approach

We found a use for improperly preserved turtle specimens that gives educators a way to more efficiently teach internal vertebrate anatomy, using a specimen they might easily have access to in a collection. The impetus for this work was our desire to illustrate the sigmoid flexure of the neck that allows certain turtles to withdraw their heads. This ability is anatomically and biologically important in that it protects turtles from predators and is one of the major present-day anatomical radiations that occurred in turtle evolution. The lesson also demonstrates how turtles, whose anatomy is confined within a rigid compartment, have their organs arranged and how adaptive strategies overcome this spatial constraint. This novel approach to teaching internal vertebrate anatomy is appropriate for use in anatomy and physiology, comparative anatomy, and herpetology courses at the high school or college level.

○ Turtle Anatomy

When teaching students the classification of the Order Testudines, one must define their two infraorders, Cryptodira and Pleurodira. A suite of characters make differentiation easy, chief among them the means by which turtles withdraw their heads beneath the carapace for protection – lateral folding in pleurodires and sigmoid flexure in cryptodires.

For the neck flexure in pleurodires, we have specimens of two species. One is the red side-necked turtle (*Rhinemys rufipes*; Figure 1), showing a simple bending of the neck to the side that results in the head being under the shell between the carapace and plastron, and the other is the northern Australian snake-necked turtle (*Chelodina rugosa*), which uses a more elaborate double fold to accomplish the same task. Other pleurodiran diagnostic features include transverse processes on cervical bones that afford added protection to the exposed neck; pelvis fused to the plastron and sutured to the carapace; mesoplastral bones sometimes present on the plastron; and an intergular scute present on the anterior end of the plastron.

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Figure 1. Frontal view of a pleurodire turtle from Colombia, the red side-necked turtle (*Rhinemys rufipes*), with its neck withdrawn laterally. Photo by W. W. Lamar.

Figure 2. Frontal view of a cryptodire turtle, the red-eared slider (*Trachemys scripta elegans*), with its neck withdrawn in a sigmoid flexure. Photo by Marks McWhorter.

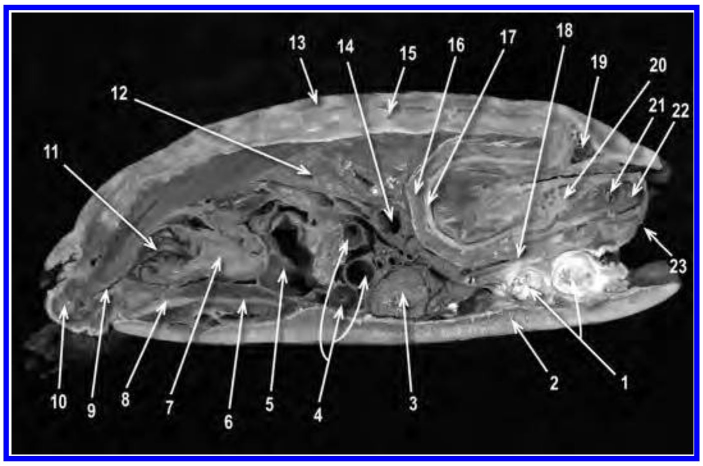

Figure 3. The sagittal section of the red-eared slider (*Trachemys scripta elegans*) brings the internal anatomy of the turtle to life for students. The section's original intent was to illustrate the sigmoid flexure of the neck as the head is retracted. 1. unidentified cysts; 2. plastron; 3. heart; 4. small intestines; 5. urinary bladder; 6. pubis; 7. testis; 8. ischium; 9. cloaca; 10. cross section of the tail showing tissue of the penis; 11. lower intestine/rectum; 12. muscle; 13. carapace; 14. stomach; 15. spine; 16. cervical bones, showing the sigmoid flexure that allows the head and neck to be completely withdrawn into the shell; 17. spinal cord; 18. trachea with cartilaginous rings visible; 19. subcarapacial sinus, from which scientists often extract blood for studies of living specimens; 20. brain; 21. eye; 22. nasal cavity; 23. tomium, the keratinized, sharpened covering of the maxilla. Photo by Shannon Fortenberry.

The cryptodires, locally represented by all the turtle species of North America and common around the world (Figure 2), pull their heads directly in, with the neck vertebrae forming a sigmoid flexure internally that is not visible from outside the shell. When one looks into the anterior opening of a cryptodire's carapace and plastron, one simply sees the face of the turtle; the withdrawal system is invisible. Additionally, the transverse processes on cervical vertebrae are absent or greatly reduced; the pelvis is free, not fused to the plastron or sutured to the carapace; and there are no mesoplastral bones or intergular scutes on the plastron.

We have always simply used the classroom blackboard to draw a skull (a circle) and a looped line to illustrate the shape of the chain of withdrawn cervical vertebrae in a sigmoid flexure. This drawing may be interpreted differently, depending on students' spatial abilities. It might help a student with good to excellent spatial perception to visualize the position of the turtle's head and neck when withdrawn, or the point might be totally missed by students with spatial challenges. We decided that it would be interesting to cut a specimen down its center-line and see if we could create a visual of the sigmoid flexing of the neck that results from the head being withdrawn.

We had specimens that were preserved by being set in 10% formalin and stored in 40% isopropyl alcohol, a standard in many research/teaching collections and biological supply companies. A specimen was selected that had been well preserved years before. We decided to use a band saw to slice the turtle, but we feared that the teeth on the circulating blade-band might flay the tissue instead of rendering a clean cut. To be cautious, we froze the turtle before making the cut. A line was drawn down the midline of the carapace, beginning with the nuchal scale (epidermal lamina), running through the centrals, and splitting the two post-centrals.

A band saw was the perfect instrument, and a herpetology student and superb technician, David Martin, made the cut with a keen eye and steady hand. The resultant sagittal section of the red-eared slider (Figure 3) gave us not only an ideal example of the sigmoid flexure, but also an excellent view of the midline internal anatomy of the turtle. We use the specimen in labs, and the photo shown in Figure 3 in lectures.

○ Internal Anatomy

This is a great opportunity for students to learn the relative positions of organs and structures inside the turtle. The various planes through which these organs and structures run add to the students' basic understanding of the turtle's anatomy and can be related to aspects of its ecology. As an example, the liver and kidneys are not visible because they are set lateral to the midline inside the shell.

Suggested Questions for Inspiring Critical Thinking

Seeing how the organs are so densely packed inside the shell makes it easy for students to understand challenges faced by turtles, such as their reproductive potential. Here are some examples of discussion questions and possible answers:

- *How do turtles deal successfully with egg production when there is limited space to store them?* They may produce more than one clutch of eggs per year, as in sea turtles, or produce smaller eggs in fewer numbers over the breeding season and lay them as they are produced, as in Mississippi mud turtles (*Kinosternon subrubrum hippocrepis*) and stinkpots (*Sternotherus odoratus*).
- *What adjustments must be made for species that feed exclusively on vegetation, thus needing larger and longer intestinal systems?* They may have large, domed shells like the Galápagos tortoise (*Chelonoidis nigra*) and Aldabra tortoise (*Aldabrachelys gigantea*).
- *What adaptations are made for species that are smaller?* They may feed more on animals, as Mississippi mud turtles and stinkpots do.

Broadening the Approach with Other Poorly Preserved Specimens

This article is focused on turtles because of the excitement elicited among our students and in professors at other universities by this sagittal view of turtle anatomy and mechanics, especially neck withdrawal. Specimens of other reptiles and amphibians that, for a variety of reasons (e.g., discoloration, damaged skin, twisted body form, or other malformations attributed to poor preservation), may seem to have little value for instruction, allow creative teachers to find new or traditional uses in the lab.

Buying skeletons is usually costly, but small preserved specimens can be easily skeletonized, using common household supplies and common laboratory tools, while giving students an exciting hands-on experience. Preserved specimens are skinned and soaked in Clorox for a few minutes. Their tissue is then easily removed using small forceps. When the tissue becomes difficult to pull away from other tissues and bones, the specimen is again soaked in Clorox, and this process is repeated until only the clean skeleton is left. The skeleton is bleached by soaking it for a couple of minutes in Clorox and then storing it in common isopropyl alcohol for a week or so to stop the destructive action of the Clorox. It may be stored in the alcohol as a wet specimen, or air dried to produce a dry specimen.

Our students, both in high school and college, have produced skulls and whole skeletons of snakes, lizards, and turtles. Large salamanders are another possibility, especially amphiumas (*Amphiuma means* and *A. tridactylum*), and smaller species might be used, though with greater difficulty. We have prepared smaller specimens using clearing and staining techniques such as those described by Weck and Miljak (1998). Also, organs can be removed from an array of taxonomic groups and used to demonstrate variation in anatomical structure among the taxa and phylogenetic improvements that open new ecological opportunities in nature. In short, there are many ways to use otherwise valueless preserved specimens to "give new life to old specimens," as stated in Weck and Miljak's (1998) title.

○ Conclusion

All research and teaching collections have "useless" specimens that are either ignored or replaced by collecting and preserving animals from the wild. Finding novel uses for such specimens serves today's conservation ethics by lessening collecting pressure on wild populations.

○ Acknowledgments

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Reference

Weck, B. & Miljak, P. (1998). Give new life to old specimens through clearing & staining. *American Biology Teacher, 60*, 699–702.

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