Biology & Conservation of North American Tortoises

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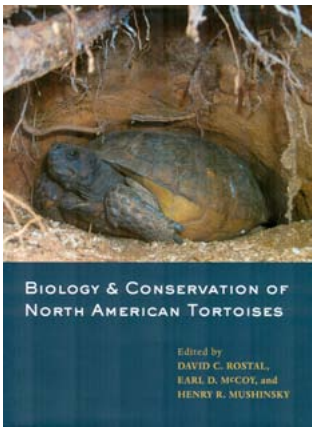

This contribution is by no less than 33 North American tortoise researchers. The book is the latest in a recent series of monographs on the biology of specific North American turtle groups. It presents an up-to-date summary of the life history of the gopher tortoise genus *Gopherus*, and continues with more extensive reviews of the five extant species *G. agassizii* (desert tortoise, Mojave [Mohave] desert tortoise, Agassiz's desert tortoise, Agassiz land-tortoise), *G. berlandieri* (Berlandier's tortoise or Texas tortoise), *G. flavomarginatus* (Bolsón tortoise, Mexican giant tortoise, or yellow-bordered tortoise), *G. morafkai* (Morafka's desert tortoise, Sonoran desert tortoise), and *G. polyphemus* (gopher tortoise) than those of the "three" United States species, *G. agassizii*, *G. berlandieri*, and *G. polyphemus*, previously presented in more condensed accounts by Ernst & Lovich (2009).

A preface explaining the reason for the book, the binomial nomenclature, and common names used is followed by 18 chapters. These can be separated into the following broad categories: 1). Morphology, fossil record, evolution, and systematics (3 chapters); 2). Thermal and reproductive physiology (2 chapters); 3). Embryology, temperature-dependent sex determination, and growth patterns (2 chapters); 4). Health problems (1 chapter) 5); Habitat characteristics and ecology (2 chapters); 6). Behaviour (3 chapters); 7). Population characteristics, status, and genetics (3 chapters); and 8). Interactions with humans and conservation (2 chapters). These are followed by a current list of references, and an adequate index.

Chapter 1 basically covers the morphology, taxonomy & distribution of gopher tortoises. Unfortunately, the photos in the chapter of the five living species are not the best, and would have been greatly enhanced if in colour. The origins, fossil record (including the extinct genus *Oligopherus*) are described and diagramed in Chapter 2. Photos of the carapacial bones of a new fossil *Gopherus* from South Carolina are presented and compared to photos of bones from G. polyphemus. It is in these first two chapters that the greatest controversy occurs; the use of the genus *Xerobates* Agassiz, 1857 for the extant species *agassizii*, *berlandieri* and *morafkai*, instead of the more familiar and precedential *Gopherus* Rafinesque, 1832, which is used for flavomarginatus and polyphemus. Use of *Xerobates* for the three western species is explained in the first chapter as due to osteological differences, especially skull and inner ear features, a more specialised hand and more robust cervical vertebrae in *Gopherus*, and molecular differences. Surprisingly, Chapter 3 covering the systematics of these tortoises still refers them to the genus *Gopherus*; and, in spite of these differences, authors of the remaining 16 chapters continue to use the name *Gopherus*. Use of *Xerobates* will probably be a "hard sell" among turtle taxonomists.

Chapters 4 & 5 give excellent reviews of the thermal energetics, including the possible role of future climate change; and reproductive cycles, physiology (including hormonal), oviductal egg development, and the effects of upper respiratory disease on reproduction. These are followed by a well illustrated Chapter 6 covering embryology, temperature sex determination, incubation temperatures, and the possible detriments of climate change. Growth patterns are covered in Chapter 7, including the allometric changes leading to sexual dimorphism, and the effects of climate and habitat quality, especially food availability. A good discussion of aging tortoises using growth rings is presented.

Various health issues (infectious diseases, noninfectious diseases, injuries, and trauma), as well as how to assess the health of a tortoise including a recommended extensive set of field data sheets, are discussed in detail in Chapter 8 by the leading North American expert on turtle diseases, Elliot Jacobson. Also, included is a helpful glossary of important definitions regarding health & disease terms. This chapter will be of interest to all researchers of turtles, and especially those keeping them in captivity.

Chapters 9 & 10 are two very good chapters covering the habitat differences of the species of *Gopherus*. The first covers the physiography, geology, plants present, rain fall, temperature regimes, availability of burrow sites, and present threats to tortoise' habitats. Chapter 10 covers the behaviour necessary to acquire food and water (including the needs of juveniles); and contains an informative diagram illustrating when during the annual cycle the various necessary behaviours (foraging, reproductive & seasonal inactivity) of five species most frequently occur. This is followed by a table listing percentages of dietary plant growth forms (annual & perennial forbs & grasses, woody plants & succulents) in the diet of *agassizii*, *berlandieri*, *morafkai*, and polyphemus.

Home range, including typical sizes and distances moved, daily activity cycles, seasonality of movement activity, burrow/shelter numbers and use, are specifically compared in chapter 11. This chapter should be of especial use to field researchers.

Chapter 12 relates the typical social behaviours of tortoises. Male-male and female-female aggression encounters are described in detail, as is female choice of mating partners. The distinctive behaviours evolved for social communications and dominance positions are discussed and illustrated; and

dispersal of individuals from their natal social group to others and its important role in genetic exchange is stressed. Observations of interspecific aggressive interactions among captives indicate that the size of the individual is important in dominance determination, with the two largest species, *flavomargiantus* and *agassizii*, being the most dominant, and the smallest, *berlandieri* and *polyphemus*, less so. The social systems of North American tortoises and ground squirrels are compared in a table.

Chapter 13 covers reproductive behaviour in *Gopherus*. It discusses reproductive output (clutch size) and its relation to female shell length and volume, choice of nest sites; and the nesting act is diagramed.

Chapters 14-16 deal with the aspects and importance of population ecology. The first chapter covers tortoise abundance and the various methods, including mathematical, of determining population size and species density, and relates current population trends and concerns to tortoise abundance. The following chapter discusses present knowledge of population genetics of *Gopherus*, and its implications for future conservation of its species. Along with a lengthy discussion of the mtDNA of each the five species is a summary table of the genetic statistics of those populations previously studied. Data are most lacking for the two Mexican species. To illustrate the use of genetic data in conservation recovery plans, a map is presented delineating the genetic recovery units of various populations of G. *agassizii*. Discussed is how habitat fragmentation by humans is detrimental to overall genetic diversity of tortoise populations, especially G. polyphemus and G. *morafkai*; and that such diversity must be maintained to ensure no further losses of population sizes. Interestingly, a genetic study by Edwards et al. (2010) of captives in the Phoenix, Arizona, area indicates tortoises there are a hybrid swarm of *agassizii*, *agassizii x morafkai* or even *berlandieri* x *morafkai* instead of the expected pure *morafkai*. Could this indicate that these taxa are merely subspecies instead of species? Chapter 16 summarises the demography of each of the five species covering population age distribution, body size and mass; sexual maturity and reproductive capacity; growth in relation to diet, the biomass of grass and forbs in their habitat; and survivorship.

A narrative of tortoise/human interactions and other threats from the Paleo-Indian and early Archaic Periods to recent; along with the current USA Federal and State, Cites and IUCN Red List status of each species is found in Chapter 17. Chapter 18 is composed of discussions of each of the present threats to the survival of *Gopherus* populations. Tables summarize these threats and assess their levels of importance to conservation of *agassizii*, *berlandieri*, *morafkai* and *polyphemus*. Following these are suggestions of how to alleviate threats by governmental protection (Federal and State), protection of habitat and migration routes, head-starting, and the role of non-governmental conservation groups.

This book is an excellent well-illustrated review of our current biological knowledge of North American tortoises, and should be a valuable addition to the libraries of all persons interested in these animals. I highly recommend it.

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