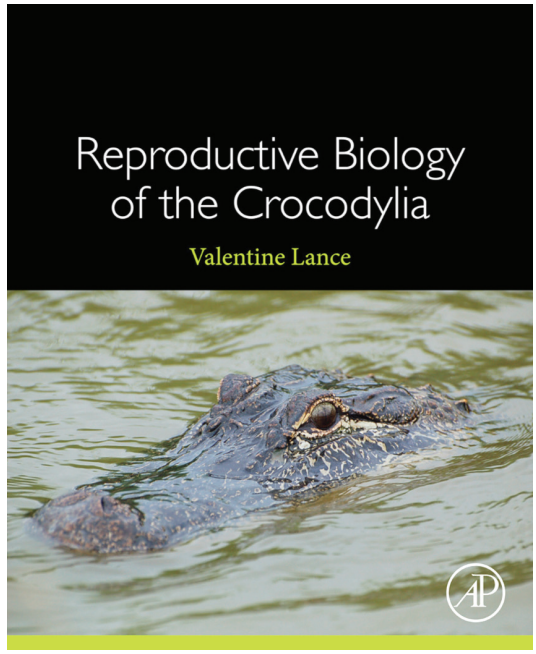
Lance, V. 2022. **Reproductive Biology of the Crocodylia.** Academic Press, Elsevier. 157 pp.



Val Lance's new book, *Reproductive Biology of the Crocodylia,* is more than a treatise on crocodilian reproduction *per se.* The 12 chapters, all well-written and easily read, track the development of knowledge about crocodilian reproduction, and the research subjects in which Val Lance has actively participated. Some research directions proved fruitful, and others not, but all have added to the steadily building knowledge base on crocodilian reproduction, and the identification of knowledge gaps where future research is likely to be rewarding. There is a strong element of research detective investigation throughout the book, which is an integral part of the motivation of dedicated researchers.

For context, Chapter 1 deals with the phylogeny and fossil history of crocodilians, and Chapter 2, with the history of reproductive research (Chapter 2), which gives true credit to pioneering researchers, going back to the times of Herodotus (484-425 BC). Fascinating and insightful, in these times, when historical research is often ignored. All aspects of crocodilian reproduction are dealt with comprehensively (Chapters 3 to 9), after which the focus shifts to how knowledge of crocodilian reproduction is linked to real life problems and opportunities, such as crocodilian farming (Chapter 10), environmental contamination (Chapter 11) and conservation (Chapter 12). For the people around the world whose lives are intertwined with crocodilians and research into them, it is a "must read" book.

Val Lance started researching alligator reproduction in Louisiana (1979), at a time when crocodilian research was starting to build globally. Virtually all wild populations had been depleted from unregulated and unsustainable historical harvests, yet knowledge of population dynamics, which is needed to improve conservation, was rudimentary. The 1970s and 1980s saw basic knowledge about crocodilians increase exponentially, with key researchers sharing their information, results and advice freely. The IUCN-SSC Crocodile Specialist Group (CSG) created an umbrella for information exchange, as it does today. But in those early days many aspects of crocodilian reproductive biology were poorly understood. Val Lance's pioneering research at that time, filled many of the gaps with which researchers were struggling. The extensive knowledge he and others have gained on crocodilian reproduction, and the enthusiasm and commitment of researchers, is addressed well in *Reproductive Biology of the Crocodylia.*

Life history parameters and ecology (Chapter 3), is more than the title suggests. It discusses issues such as biased sex ratios, multiple paternity and nest site fidelity, along with crocodilian anatomical and biochemical traits that are unique and in need of targeted research. The role played by fat bodies and peritoneal canals is still known superficially. Likewise, the endocrine system and history of research into it,

identifies major findings and gaps in current knowledge. In addressing growth, sexual maturity and senescence (Chapter 4) it is clear that as in turtles, the size and age at which maturity is reached vary geographically, and appear to be related to climate, food availability, growth rates and social triggers. The mechanism that control adaptability about when maturity is reached, in different contexts, remains unclear.

The male reproductive system is described (Chapter 4), with the single phallus, long recognised as different to the dual hemipenes of snakes and lizards. For most crocodilians (Chapter 5) there is relatively little information on testes size and its seasonal cycling outside of American alligators. The timing of their courtship is triggered by changes in ambient temperature, rather than photoperiod, which are more extreme for alligators than most crocodilian species. The scattered information available suggests other environmental cues may be used by other species in different climatic regimes.

The female reproductive system is similar to birds, but with both left and right ovaries present and functioning (Chapter 7). The vast literature on ovulation and egg production in commercially valuable poultry, such as chickens, stands in stark contrast to our limited understanding of ovulation and egg formation in crocodilians. But what we do know is well described here. Unlike birds, that lay eggs one at a time, the whole clutch of crocodilian eggs is held within the oviducts until laying. In alligators, calcium is withdrawn from bones for shell secretion, and replaced after laying. Courtship behavior may be what stimulates ovulation. Sperm storage occurs, but it is not known how long viable sperm can be held in the oviducts. Secretions from paracloacal and gular glands are associated with courtship, but their role is not understood. Nesting is described, along with the evolutionary significance of the amniotic egg, the relationships between clutch size and female size, and the history of research into most aspects of nesting.

The discussion of temperature-dependent sex determination (TSD) in crocodilians (Chapter 9), tracks its discovery in the late 1970s and explains a series of experiments to try and better understand how it operates in crocodilians. Although with alligators TSD is clearly capable of producing strongly biased sex ratios in nests, and does so, it does not as yet explain the strongly female-biased sex ratios in juveniles and subadult alligators in the wild.

The treatment of crocodilian farming (Chapter 10) describes the history of keeping crocodilians in captivity, which has been done for thousands of years. The history of alligator farming in the United States of America is comprehensive, and the problems encountered with captive breeding remain difficult to understand. Relative to many crocodilian species, captive breeding of alligators, on a commercial scale, has been difficult, and considerable research aimed at understanding why has been carried out. The problems seem to be more associated with malfunctioning of the female reproductive processes malfunctioning than with the males, although effects of ambient temperatures on spermatozoa survival cannot be discounted. Regardless, alligator farm production has switched largely to ranching (collecting wild eggs), which has proved totally sustainable. Captive breeding is one of a number of areas where alligators seem to differ from many crocodile species, although the reasons why are unclear.

That disruption of reproduction in alligators and other crocodilians can be caused by environmental pollution (Chapter 11) has been well established with alligators, in some locations, and may be implicated with die-offs of both Indian gharials and Nile crocodiles. The discussion of this issue, along with insights into heavy metal concentration in alligators is both valuable and informative.

Much of Val Lances work has been done in association with programs in which crocodilians are being managed and used sustainably for economic benefit. Hence his insights into conservation (Chapter 12) are both pragmatic and realistic. The commercial benefits derived from sustainably using crocodilians — at least

the species that have commercial value — can be used to generate incentives to conserve. Trade in skins is now mostly legal and regulated nationally and internationally, and is not the significant threat it was in the 1960s. Val Lance is correct in identifying habitat loss and spreading urbanisation as a far more insidious threats to many wild crocodilian populations than is trade.

In overview, *Reproductive Biology of the Crocodylia* is a rather unique book, directed at both researchers and crocodilian enthusiasts. It tracks Val Lance's personal interest and research into alligators, his extensive travels and research into other crocodilian species, his obvious commitment to historical research and to the reality that scientific research proceeds from corrected error to corrected error — only occasionally making a giant step forward. Of equal importance are the many areas identified where there remain significant research opportunities. The book is both a good read and an important contribution to our knowledge on crocodilian reproduction.

Grahame Webb

Wildlife Management International, PO Box 530 Karama, NT. 0812, Australia. E-mail: gwebb@wmi.com.au.

Charlie Manolis

Wildlife Management International, PO Box 530, Karama, NT 0813, Australia. E-mail: cmanolis@wmi.com.au