
BOOK REVIEWS

Biology of Whiptail Lizards (Genus *Cnemidophorus*), John W. Wright and Laurie J. Vitt (editors). 1993. The Oklahoma Museum of Natural History: i-xiv + 417 pp. Hardcover. US \$29 plus shipping. ISBN 1-883090-01-6.

This volume is the outcome of a symposium devoted to the teiid genus *Cnemidophorus*. The symposium—conceived and organized by John W. Wright and held at the University of Oklahoma in August 1984 during the joint annual meetings of the American Society of Ichthyologists and Herpetologists, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles—brought together a diverse assemblage of over 50 specialists who presented 30 papers on a broad spectrum of topics related to *Cnemidophorus*. The resulting volume (The Herpetologists' League Special Publication No. 3), containing 15 separate papers by 22 authors, is dedicated to Charles H. Lowe and Richard G. Zweifel. Contributions have been revised and updated with additional findings through September 1992. The individual papers are not grouped under subject headings, but the topics covered include systematics, reproduction, physiology, behavior, ecology, and community level analyses. Not surprisingly, a pervasive topic is the differences and similarities between unisexual and bisexual species in aspects of their biology.

The preface by John Wright and Laurie Vitt explains that the decision to produce this volume was not reached until after the symposium, and that some of the symposium presentations were already in press or committed to be published elsewhere by that time. Included in the preface is a list of the authors and titles of all 30 papers that were presented at the symposium, as well as a list of 12 symposium papers that were published elsewhere and are thus not included in the present volume.

The first chapter is an introduction by Charles H. Lowe which

provides an historical review of taxonomy and systematics of *Cnemidophorus* organized to cover three time periods from 1830 to 1990. Lowe's chronological presentation recounts the considerable difficulties and confusion experienced by workers attempting to discriminate taxa and discusses the major contributions during each time period that led to our current understanding of the genus. In the author's opinion, one of the most significant breakthroughs in discriminating *Cnemidophorus* taxa was the description of *C. neomexicanus* by Lowe and Zweifel (1952). For the first time, in addition to appearance in life and ecological information gathered in the field, discrimination of a *Cnemidophorus* species was based on statistical analysis of quantitative meristic data. The author further reviews the impact on *Cnemidophorus* research of the discovery of parthenogenesis in *Lacerta* by Darevsky, and more recently, the high level of taxonomic resolution achieved through chromosomal and molecular studies.

In Chapter 2, John W. Wright provides a summary of the evolutionary relationships of *Cnemidophorus* and a taxonomic arrangement partitioned into six species groups. The composition of each group is discussed and distribution maps and color photographs of representative taxa are provided. Wright reviews the origin and evolution of parthenogenesis in *Cnemidophorus* as well as the controversies surrounding nomenclature of parthenogenetic taxa. The lineages of parthenogenetic taxa are reviewed by species group, with particular reference to the results of mitochondrial DNA analyses. An alphabetical listing of the groups and their respective members, which contains over 100 taxa and includes over a dozen undescribed forms, differs substantially from the recent taxonomic arrangement of Maslin and Secoy (1986).

The next five papers present results of field investigations and literature reviews on the interrelated subjects of foraging ecology, thermoregulation, activity patterns, and locomotion.

Roger Anderson investigated foraging ecology of *Cnemidophorus tigris* at a six-hectare site in the Sonoran Desert of Riverside County, California, through systematic time-constrained field observations of foraging animals and quantitative assessments of vegetation, prey availability, and stomach contents. At this site, *C. tigris* was determined to be a wide forager that depended primarily on chemoreception to detect fossorial and hidden prey, but relied on vision to choose foraging pathways between and within patches of widely dispersed microhabitats. The results indicate that successful foraging in *C. tigris* is clearly not the result of opportunistic success during random wanderings.

Using experimental chambers, Richard Bowker explored questions relating to the brief daily activity periods of *C. exsanguis* and *C. velox* and the costs of their wide-foraging lifestyles by examining temperature regulation and the influence of water loss on activity times. Bowker discusses the relationships between maintaining precisely regulated body temperatures, the costs of activity, and the increase in water loss with increase in body temperature. The activity experiments indicated that water loss was proportional to length of activity, and Bowker concludes that water may be an important factor limiting daily activity in these animals.

Gustavo Casas-Andreu and Marco Gurrola-Hidalgo report on the comparative ecology of *C. communis* and *C. lineatissimus* at a tropical deciduous forest site in Jalisco, México. Average body temperatures for both species are slightly lower than those reported in a number of studies on *Cnemidophorus* from the southwestern United States, and daily activity patterns were unimodal, with greatest activity at mid-day during the entire year. Similar unimodal activity patterns have been found for other species of tropical tei-

ids, whereas bimodal activity patterns are reported for lizards from the southwestern United States.

Kay Etheridge and Lawrence Wit examine the comparatively short active season and the resulting long inactive period of adult *C. sexlineatus* in Alabama and discuss evidence from the literature and their own field work regarding the factors affecting this activity cycle. They conclude that the short annual activity period of *C. sexlineatus* can be attributed to a lack of territorial behavior, their wide-ranging foraging behavior and high foraging efficiency, avoidance of negative energy returns when food is scarce, and reduction of the risk of predation.

Locomotor performance and activity metabolism of *C. tigris* are reviewed by Theodore Garland and compared to the available quantitative data for other species of lizards. Results from the laboratory work reported here show that the endurance capacity of *C. tigris* is exceptionally high in comparison to that of other lizards, and appears to exceed what is required for foraging alone. Garland concludes that while the primary adaptive significance of high endurance capacity in *C. tigris* is unclear, a variety of activities other than foraging that may require high endurance capacities must be considered. Garland points out that the available comparative information is very limited and that additional data on other arid habitat *Cnemidophorus* are needed. Also, performance capacities demonstrated in the laboratory need to be compared to findings from the field.

The contributions by Vitt and Breitenbach, Trauth and Fagerberg, and Crews and Moore provide information on reproduction in *Cnemidophorus*. Laurie Vitt and Gary Breitenbach present an exhaustive review and synthesis of literature on reproduction and life histories of *Cnemidophorus*, emphasizing ecological aspects of reproduction. They compiled literature information on reproductive characteristics of 17 species of *Cnemidophorus* and a list of over 50 *Cnemidophorus* populations from which the reproductive data were obtained. The authors examine the available information on clutch size and egg mass, seasonality in reproduction and clutch frequency, geographic and temporal variation in reproduction, and female investment to provide support for five postulated differences in reproductive characteristics that would be expected between *Cnemidophorus* and typical wait-and-ambush lizard species.

Stanley Trauth and Wayne Fagerberg looked at eggshell ultrastructure of oviducal eggs from the hybrid species *C. laredoensis* compared with the eggshell morphology of *C. sexlineatus*, one of its parent species. In light of the results, the authors discuss the potential application of stereological methods for resolving eggshell ultrastructure in order to detect inter- and/or intraspecific differences in eggshells and as a means of correlating local environmental conditions of nest sites.

The paper by David Crews and Michael Moore provides an update on the ongoing investigations into the psychobiology of parthenogenetic whiptails and describes the relationship between pseudocopulatory behavior, hormonal correlates, and the ovarian cycle in *C. uniparens*. The authors also defend their interpretations of the causes and functions of pseudocopulatory behavior in parthenogenetic *Cnemidophorus* in light of contentions that pseudocopulation is an artifact of crowding in captivity and that reproductive condition is not associated with behavioral roles during pseudocopulation.

Thyroid activity and metabolic rate in *C. sexlineatus* were studied by Lawrence Wit and Jeffrey Sellers using animals caught from the wild over a 16-month period in Alabama and Georgia. They suggest that the lowered metabolic rate and elevated plasma thy-

roxine titers found in hibernating animals are not simply consequences of the animals becoming dormant in response to cold temperatures. The authors conclude that the increase in plasma thyroxine is due to decreased peripheral use of the hormone, as indicated by oxygen consumption, rather than increased production.

Beth Leuck's analysis of aggressive behavior between sympatric diploid and triploid *C. tessellatus* represents an insightful approach designed to investigate the effects of genetic relatedness on aggressive behavior. Under experimental conditions, lizards in mixed diploid and triploid trials had significantly more aggressive acts towards each other than those of the same ploidy level. Based on these results, Lueck concludes that diploid and triploid *C. tessellatus* appear able to distinguish genetic relatedness.

Three papers focus on competitive interactions and resource partitioning in communities with bisexual and parthenogenetic whiptail species. Joseph Schall studied a community of five *Cnemidophorus* species, two parthenogenetic and three bisexual, in southwestern Texas to test the hypothesis that all-female species should use a broader range of habitats and resources, have more patchy distributions, and live in more disturbed areas. The two parthenogenetic species, *C. exanguis* and *C. tessellatus*, had microhabitat niche breadths approximately 25% larger than the three bisexual species and were found in a much broader range of macrohabitat types, but they were most common in disturbed areas. However, he found no evidence of a difference in diet between the bisexual and parthenogenetic species.

The remaining two papers report on field studies in southern New Mexico that employed experimental population manipulations to examine mechanisms of coexistence between *C. tigris* and a sympatric unisexual whiptail. As part of a nine-year study, Orlando Cuellar monitored the immigration of *C. tigris* into an open sandy field from which *C. uniparens* was being systematically removed. The density of *C. tigris* at the site increased after removal of *C. uniparens* but decreased when the latter was no longer being removed. Cuellar concludes that the parthenogenetic species was excluding the bisexual through competition, and that parthenogenetic and bisexual whiptails coexist by inhabiting neighboring but distinct microhabitats.

Andrew Price, Joseph Lapointe, and Wirt Atmar removed *C. tigris* from one of three study grids and *C. tessellatus* from another, with the third grid serving as a control. Because there was no change in habitat use, their results indicated no microhabitat segregation between the two species. Further, there was no measurable response by the parthenogenetic *C. tessellatus* through either recruitment or increased reproduction to the removal of *C. tigris*.

The book measures 6 x 9 inches and is printed on nonreflective paper in easy-to-read, single column format. It contains numerous text figures, six distribution maps, and 48 color photographs of representative taxa in six *Cnemidophorus* species groups, including some not previously illustrated. Literature citations are placed at the end of each paper, whereas an index to subject matter and scientific names was compiled for the entire volume.

The book suffers from a number of flaws in editing and production. There are numerous typographical errors in the text. In addition, there are egregious omissions and errors with respect to tables and figures. The most obvious omissions include a reference to table 2 on p. 57 when only table 1 is present in chapter 2. Also, table 3 is absent from chapter 8 although it is referenced once on p. 221 and twice on p. 225. In chapter 2, the legends for figures 5, 7, 9, 11, and 13 all refer to figure 2 for specimen references but none are provided with figure 2; the legend for figure 3

does give information for specimens from the Natural History Museum of Los Angeles County, but does not have museum information for the acronyms listed in the other figure legends. An incorrect legend was placed with figure 8 on p. 272. The editors subsequently distributed to book purchasers a corrected legend for this figure.

These criticisms aside, I have high praise for this uniquely important book. It represents a culmination of efforts that started with John Wright's inspiration to organize and carry to fruition the first symposium on *Cnemidophorus*. The book provides superb summaries of evolutionary and ecological research that will prove indispensable for future work on whiptails, as well as especially useful to anyone doing field research on lizards in general. The extensive bibliographies will provide the reader the opportunity to become familiar with the primary literature on virtually any aspect of whiptail biology. I highly recommend the book to those interested in technical work on lizards. At \$29, it represents a welcome bargain during times of ever-increasing book prices.

LITERATURE CITED

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