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New Records and Natural History Notes for Amphibians and Reptiles from Southern Morocco

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In an historical context, Morocco has been suitably explored with herpetological expeditions dating back to Gervais (1835). The distribution of amphibians and reptiles in Morocco is thoroughly outlined in the herpetofaunal atlas by Bons and Geniez (1996); this atlas is used as a primary reference in this paper. The following is a composite of significant findings from five months of data gathered in southern Morocco during the periods of May–July 1985, October 1999, and September–October 2000. Such has resulted in notable range extensions for six species of lizards and three species of snakes and several novel comments on natural history. Voucher specimens were deposited in the Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK), Bonn, or the Hessisches Landesmuseum (HLMD), Darmstadt, Germany. Localities were determined by the use of a handheld Garmin© global positioning system (GPS) device or by the use of maps. Specimen identification relative to range extensions were confirmed by Wolfgang Böhme, Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn.

Anura

Bufo brongersmai – Tafraoute, 29°43.30'N, 8°58.76'W, 11 October 1999. At ca. 2100 h hundreds of animals were encountered in the flat-packed sand basin between the rocky hills adjacent to the town. The toads were active and orienting apparently at random, along with equally abundant *Bufo viridis* and numerous *Bufo mauritanicus*. This was after the second day of heavy rain following what locals reported as a two-year drought. No amplectant pairs were observed. No standing water was encountered. In Tafraoute on 18 June 1985, during the dry summer period, only one toad was found. It was located at night under plants which were routinely watered and was within the town limits. On 9 and 10 October 2000, two nights of searching at the Tafraoute locality revealed no toads. This was also during an extended dry period. This illustrates the periodic abundance of this reportedly rare toad species (Bons and Geniez 1996).

Lacertilia

Stenodactylus petrii – Oued Tissinnt, ca. 5 km E of Mrhimina, 29°49.14'N, 7° 08.18'W, 5 October 2000. This area is characterized by low-lying sand dunes interspersed with lava flows and large lava boulders. Two specimens were collected while searching the Oued Tissinnt dunes at night (ZFMK 73504: SVL 50 mm, TL 97 mm; ZFMK 73505: SVL 38 mm, TL 72 mm). This find extends the range of this species by ca. 100 km to the west and is the first reported locality away from major sand dunes. Dry riverbed routes may be used by this psamnophilous species as dispersal pathways.

Stenodactylus sthenodactylus – Tendrara, ca. 9 km N of the town, 33°05.05'N, 1°59.27'W, 4 October 1999. This male specimen (ZFMK SA2001:1) was found during the day, in a flat, hard-packed sand desert, under a rock. This find extends the eastern range of this species by ca. 50 km in Morocco, thus bringing it to the Algerian border.

Ptyodactylus oudrii – Oued Tissinnt, ca. 5 km E of Mrhimina, 29°49.14'N, 7°08.18'W, 5 October 2000. This gecko is cited in the literature as a dweller of steep and smooth rocks, boulders, and cliffs (Bons and Geniez 1996; Schleich et al. 1996). Here we report the use of a tree as a habitat for this species. A night search revealed two specimens ca. 1.6 m above ground in an *Acacia* tree. Ants, which are a prey item of this species, were also active on the tree at this time. The immediate surrounding habit was low-lying sand dunes with occasional volcanic rocks. In the distance, larger rock formations could be found.

Tarentola hoggarensis – Oued Drâa, ca. 20 km S of Âouïnet-Torkoz, 28°29.00'N, 9°51.17'W, 4 October 2000. This species has a lengthy and involved history of taxonomic revision (Schleich et al. 1996). Due to recent findings within the *Tarentola ephippiata* group, the taxon should be elevated from subspecific status of *Tarentola ephippiata hoggarensis* to full species rank (Böhme et al. 2001; Böhme, pers. comm.). This Oued Drâa specimen (ZFMK 73503) was found by torchlight at night on an *Acacia* tree trunk. This find represents the third discovery of this species in Morocco and is ca. 50 km east of a previously documented locality (Bons and Geniez 1996).

Lacerta andreanszkyi – Imlil, ca. 5 km NE of town, 5 July 1985. The discovery of this specimen (ZFMK 44116) at an alpine meadow at ca. 2400 m elevation confirms its presence in a questionable locality as listed in Bons and Geniez (1996).

Acanthodactylus boskianus – Taroudant, ca. 3 km S of town, 25 May 1985. This species is known to be an inhabitant of dry environments (Bons and Geniez 1996; Schleich et al. 1996). The discovery of this specimen (ZFMK 44079) resting underneath some small bushes marks its first known occurrence in a relatively moist habitat, the Souss River Valley. This report contrasts the findings of Bons and Geniez (1996) whereby they state that *A. boskianus* is absent from the western parts of Morocco, as the Anti Atlas appears to constitute an insurmountable barrier. This finding shows the species to have crossed the Anti Atlas, although the westernmost portion of the Haut Atlas lies due north as a border of this locality. This find is ca. 80 km from the nearest documented locality, though more significantly, it places the species for the first time on the north side of a significantly high mountain range.

Mesalina olivieri – Oued Torkoz – Oued Drâa confluence, 28°29.00'N, 9°51.17'W, 3 October 2000. The discovery of these specimens (ZFMK 73511–512) confirms a suspected locality (Bons and Geniez 1996) in the Oued Drâa. This population is ca. 120 km from the closest confirmed population. Some authors (e.g., Le Berre 1989) regard *Mesalina pasteuri* (Bons 1960) and *olivieri*, both taxa are reported from Southern Morocco (Bons and Geniez 1996),

as conspecific.

Eumeces algieriensis – Tafraoute, 20°43.30'N, 8°58.76'W, 22 September 2000. The diet of this large endemic Mograbin skink consists of invertebrates (Schleich et al. 1996). After hand capture, our specimen regurgitated a gecko which, although partially digested, could be identified as a *Tarentola mauretanica*.

Serpentes

Leptotyphlops macrorhynchus – Amtoudi (Id-Âïssa), 29°13.66'N, 9°13.24'W, 11 June 1985. This specimen (ZFMK 44098) was found in an area lacking vegetation within this oasis village. Though suspected to be a wideranging species in Morocco, secrecy and subterranean habits have surely restricted this species from being routinely encountered and is thus far listed from but ten localities. This discovery in the southern Anti Atlas foothills represents a distance of ca. 80 km from the closest documented record.

Macropodon cucullatus – Plage Blanche, 28°57.73'N, 10°32.89'W, 28 September 2000. According to Bons and Geniez (1996), M. cucullatus is represented by three subspecies in Morocco. The Plage Blanche specimen (ZFMK SA2001:2) keys out to the subspecies *brevis* according to head coloration (Schleich et al. 1996; Wade 1988). Our specimen falls within a ca. 160 km gap between the ranges of the subspecies *cucullatus* and *brevis*.

Bitis arietans – Plage Blanche, 28°57.73'N, 10°32.89'W, 117 m elevation, 28 September 2000. A ca. 90 cm adult female gave birth two days after capture to eight live and two dead neonates. This is a very small litter size as this species is known to commonly have litters of 20–30 with litters of up to 50–60 not being rare (Schleich et al. 1996). *Bitis arietans* from southern Morocco, however, are known to be much smaller in size than their tropical conspecifics.

Echis leucogaster – Oued Torkoz–Oued Drâa confluence, 28°22.00'N, 9°50.00W', 120 m elevation, 19 October 1999. This is one of the rarest of Moroccan snakes (Bons and Geniez 1996), and although known from the Oued Drâa, ours is only the fifth Moroccan specimen (Herrmann and Herrmann 2000). Adult female (SVL 41 cm, TL 44.5 cm) (HLMD RA2888) was found dead, killed by bedouins, and hanging in a bush.

Acknowledgments.—We thank the Philipps University, Marburg, student participants in the 2000 Moroccan Desert Ecology excursion for their participation and companionship. W. Böhme verified some of our species identifications and provided discussion on the taxonomic status of Tarentola hoggarensis. We thank our Moroccan field assistants, especially Blell with his extraordinary knowledge of the herpetofauna of southern Morocco.

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The Distribution of *Nerodia erythrogaster* in the Lower Cumberland River Basin of Kentucky and Tennessee

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Scott and Snyder (1968) reported the plain-bellied watersnake (*Nerodia erythrogaster*) from the lower Cumberland River basin (LCRB) based on specimens they collected from Montgomery Co., Tennessee, USA. This population has been shown as disjunct from the remainder of the species' geographic range (Conant and Collins 1998). Scott and Snyder (1968) described their Montgomery Co., Tennessee specimens as having the copper-bellied watersnake (*N. e. neglecta*) phenotype. Conant and Collins (1998) depict the Montgomery Co., Tennessee population as *N. e. neglecta*, even though they show the yellow-bellied watersnake (*N. e. flavigaster*) occurring further down the LCRB. McCranie (1990) mapped *N. erythrogaster* from this region as *N. e. flavigaster* x *N. e. neglecta* intergrades with a continuous distribution throughout the LCRB terminating in Montgomery Co., Tennessee, near Clarksville.

Our collecting efforts, from August 1996 to June 1999, resulted in several new voucher specimens of *N. erythrogaster* from the area within and around the distributional hiatus shown in the LCRB by Conant and Collins (1998). Cheatham Co., Tennessee, specimen APSU 4316 was collected prior to this work, but is included here to document the easternmost point of this species' distribution in the LCRB. Following are the museum numbers and latitude/longitude coordinates for the new voucher specimens, all of which were verified by David H. Snyder and deposited in Austin Peay State University's Museum of Zoology (APSU). Stewart Co., Tennessee. – APSU 5459 (36°25'48"N, 87°42'05"W), 5462 (36°32'26"N, 87°53'08"W), 5465 (36°24'31"N, 87°36'44"W), 5497 (36°24'40"N, 87°36'16"W), 5498 (36°31'14"N, 87°52'53"W). Montgomery Co., Tennessee. - APSU 5457 (36°23'37"N, 87°17'18"W), 5463 (36°29'23"N, 87°27'20"W), 5481 (offspring of APSU 5463), 5488 (1–8, offspring of APSU 5463), 5491 (1–4, offspring of APSU 5463), 5492–96 (offspring of APSU 5463), 5499 (36°25'42"N, 85°37'12"W), 5977 (36°27'15"N, 87°22'31"W), 6013–14 (36°27'00"N, 87°29'25"W). Cheatham Co., Tennessee. – APSU 4316 (36°17'35"N,

87°05'57"W), 5967 (36°17'28"N, 87°,05'58"W).

Nerodia erythrogaster occurs throughout the LCRB, from Barkley Dam in northern Land Between the Lakes (LBL, Lyon Co., Kentucky) upstream to just below Ashland City, Cheatham Co., Tennessee (Bufalino 1999). The region downstream of Barkley Dam to the confluence of the Cumberland and Ohio Rivers (Smithland, Livingston Co., Kentucky) lacks voucher specimens (Bufalino 1999). *Nerodia erythrogaster* from northern LBL (Lyon Co. and Trigg Co., Kentucky) express an intermediate phenotype, whereas specimens from southern LBL (Stewart Co., Tennessee) upstream throughout the remainder of the LCRB to Ashland City (Cheatham Co., Tennessee), express the *N. e. neglecta* phenotype (Bufalino 1999).

Acknowledgments.—We thank Edward Burchett for allowing us to collect specimens from his property and Jim Wiggington for granting us unrestricted access to Cross Creeks National Wildlife Refuge. Specimens were collected under authorization of the Tennessee Wildlife Resources Agency (permit no. 1112). Austin Peay State University's Center of Excellence in Field Biology supported this research.

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New Herpetofaunal County Records for Georgia

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Publication of *Distribution of Amphibians and Reptiles in Georgia* (Williamson and Moulis 1994) provided the basis for further study of the county by county distribution of the state's herpetofauna. Additions have been reported, mostly as accounts published in the geographic distribution section of *Herpetological Review*. The majority are from the ongoing Georgia Herp Atlas under the auspices of the Georgia Department of Natural Resources Nongame-Endangered Wildlife Program.

The following new voucher specimens are amphibians and reptiles mostly collected DOR (dead on road) from 1975 to 1999. Photograph vouchers are of live animals that were captured, photographed, and released at the place of capture. Voucher specimens have been verified by Lawrence A. Wilson and are deposited in the collection of the Fernbank Science Center, Atlanta, Georgia. For succinctness and accuracy the sites are reported as longitude and latitude acquired by GPS and/or appropriate U.S. Geological Survey topographical maps.

Caudata

Ambystoma maculatum. CHEROKEE Co: 34°14'40"N, 84°36'50"W. 6 March 1989. M. Rubio and G. Greer. FSC 98.90.155. CARROLL Co: 33°33'26"N, 84°53'8"W. 27 February 1996. M. Rubio and G. Greer. FSC 98.90.156.

Ambystoma opacum. DOUGLAS Co: 33°41'24"N, 84°53'34"W. 27 February 1997. M. Rubio and G. Greer. FSC 01.6.08 Photo.

Ambystoma talpoideum. CARROLL Co: 33°40'7"N, 84°57'53"W. 26 March 1993. M. Rubio and G. Greer. FSC 98.90.157. CHEROKEE Co: 34°18'49"N, 84°26'1"W. 5 March 1989. M. Rubio and G. Greer. FSC 98.90.420.

Eurycea guttolineata. PAULDING Co: 33°52'54"N, 85°2'6"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.113.

Hemidactylium scutatum. CHEROKEE Co: 34°15'3"N, 84°41'3"W. 14 January 1992. M. Rubio and G. Greer. FSC 01.6.01 Photo. HARALSON Co: 33°44'58"N, 85°7'17"W. 9 June 1992. M. Rubio and G. Greer. FSC 01.6.09 Photo. PAULDING Co: 33°56'3"N, 84°56'40"W. 22 February 1994. M. Rubio and G. Greer. FSC 98.90.47.

Plethodon glutinosus. PAULDING Co: 33°56'47"N, 84°54'41"W. 22 February 1994. M. Rubio and G. Greer. FSC 98.90.94.

Plethodon serratus. BARTOW Co: 34°23'29"N, 84°39'34"W. 16 February 1991. M. Rubio and G. Greer. FSC 98.90.97. CARROLL Co: 33°33'33"N, 84°54'50"W. 27 February 1987. M. Rubio and G. Greer. FSC 98.90.260. CHEROKEE Co: 34°20'40"N, 84°38'21"W. 5 March 1989. M. Rubio and G. Greer. FSC 98.90.139. COWETA Co: 33°27'25"N, 84°52'35"W. 27 February 1997. M. Rubio and G. Greer. FSC 98.90.262.

Pseudotriton ruber ruber. BARTOW Co: 34°20'44"N, 84°42'34"W. 3 May 1989. M. Rubio and G. Greer. FSC 98.90.131. CHEROKEE Co: 34°14'58"N, 84°36'28"W. 6 March 1989. M. Rubio and G. Greer. FSC 98.90.81. PAULDING Co: 33°58'39" 84°52'44"W. 22 February 1994. M. Rubio and G. Greer. FSC 98.90.458.

Notophthalmus viridescens viridescens. GORDON Co: 34°34'5"N, 84°46'2"W. 31 December 1989. M. Rubio and G. Greer. FSC 98.90.173.

Anura

Acris crepitans crepitans. WALTON Co: 33°44'49"N, 83°43'50"W. 26 June 1992. M. Rubio and G. Greer. FSC 98.90.192.

Hyla chrysoscelis. CARROLL Co: 33°47'0.8"N, 85°1'20"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.147. COWETA

Co: 33°22'5"N, 84°55'11"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.496. HEARD Co: 33°21'21"N, 85°0'6"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.488. MURRAY Co: 34°42'12"N, 84°42'41"W. 22 July 1989. M. Rubio and G. Greer. FSC 98.90.319. PAULDING Co: 33°53'44"N, 85°1'53"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.158. POLK Co: 33°58'55"N, 85°8'18"W. 24 July 1998. M. Rubio and R. T. Bryant. FSC 98.90.364.

Hyla cinerea. COWETA Co: 33°19'12"N, 84°54'27"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.497. DOUGLAS Co: 33°35'12"N, 84°51'55"W. 27 February 1997. M. Rubio and G. Greer. FSC 01.6.06 Photo. HEARD Co: 33°22'7"N, 85°0'56"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.491. PAULDING Co: 33°46'4"N, 85°2'33"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.189. ROCKDALE Co: 33°43'28"N, 84°0'40"W. 29 June 1992. M. Rubio and G. Greer. FSC 98.90.179.

Pseudacris brachyphona. CHEROKEE Co: 34°15'24"N, 84°41'34"W. 14 January 1992. M. Rubio and R. T. Bryant. FSC 98.90.460. PAULDING Co: 33°56'10"N, 84°56'32"W. 22 February 1994. M. Rubio and G. Greer. FSC 98.90.459. Southernmost record for Georgia; ca. 30 km SSW of previous Cherokee Co. record.

Pseudacris crucifer crucifer. BARTOW Co: 34°20'40"N, 84°42'34"W. 5 March 1989. M. Rubio and G. Greer. FSC 98.90.28. DOUGLAS Co: 33°36'3"N, 84°49'24"W. 15 February 1991. M. Rubio. FSC 98.90.438. HEARD Co: 33°22'6"N, 85°1'20"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.492. PAULDING Co: 33°54'48"N, 85°1'18"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.159.

Pseudacris feriarum. DOUGLAS Co: 33°39'53"N, 84°53'32"W. 27 February 1997. M. Rubio and G. Greer. FSC 98.90.53 and FSC 98.90.284.

Rana catesbeiana. CHEROKEE Co: 34°23'28"N, 84°36'37"W. 25 May 1989. M. Rubio and G. Greer. FSC 98.90.326. PAULDING Co: 33°53'7"N, 85°1'58"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.202. WALTON Co: 33°44'39"N, 83°43'52"W. 26 June 1992. M. Rubio and G. Greer. FSC 98.90.210.

Rana clamitans clamitans x *melanota.* PAULDING Co: 33°48'50"N, 85°1'5"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.143. POLK Co: 33°54'54"N, 85°91'41"W. 22 July 1998. M. Rubio and R. T. Bryant. FSC 98.90.351. GORDON Co: 34°30'29"N, 84°46'25"W. 21 July 1989. M. Rubio and G. Greer. FSC 98.90.328. HARALSON Co: 33°44'58"N, 85°7'17"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.465–467. PICKENS Co: 34°26'22"N, 84°34'60"W. 30 August 1989. M. Rubio and G. Greer. FSC 98.90.58–59.

Rana palustris. BARTOW Co: 34°19'21"N, 84°45'41"W. 9 May 1989. M. Rubio and G. Greer. FSC 98.90.320. CHEROKEE Co: 34°20'54"N, 84°36'15"W. 5 March 1989. M. Rubio and G. Greer. FSC 98.90.117. PAULDING Co: 33°55'10"N, 85°0'17"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.127. PICKENS Co: 34°26'55"N, 84°34'23"W. 30 August 1989. M. Rubio and G. Greer. FSC 98.90.322. POLK Co: 33°59'53"N, 85°5'39"W. 22 July 1998. M. Rubio and R. T. Bryant. FSC 98.90.36.

Rana sphenocephala. COWETA Co: 33°19'27"N, 84°53'7"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.499. HARALSON Co: 33°44'58"N, 85°7'17"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.468. PAULDING Co: 33°58'39"N, 84°52'35"W. 22 February 1994. M. Rubio and G. Greer. FSC 98.90.19. PICKENS Co: 34°25'23"N, 84°33'21"W. 4 June 1989. M. Rubio and G. Greer. FSC 98.90.335. POLK Co: 33°58'0"N, 85°19'7"W. 24 July 1998. M. Rubio and R. T. Bryant. FSC 01.6.10 photo.

Rana sylvatica. CHEROKEE Co: 34°15'44"N, 84°42'13"W. 14 January 1992. M. Rubio and G. Greer. FSC 98.90.451. Southernmost specimen recorded in Georgia, ca. 18 km S of nearest record (Williamson and Moulis 1994). 34°16'56"N, 84°33'49"W. 5 March 1989. M. Rubio and G. Greer. FSC 98.90.138.

Gastrophryne carolinensis. COWETA Co: 33°22'51"N, 84°59'12"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.504. PAULDING Co: 33°53'33"N, 85°1'51"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.197. PICKENS Co: 34°26'41"N, 84°34'42"W. 30 August 1989. M. Rubio and G. Greer. FSC 98.90.306. POLK Co: 33°59'29"N, 85°7'25"W. 24 July 1998. M. Rubio and R. T. Bryant. FSC 98.90.347. WALTON Co: 33°44'58"N, 83°43'53"W. 26 June 1992. M. Rubio and G. Greer. FSC 98.90.180.

Scaphiopus holbrookii holbrookii. BARTOW Co: 34°8'42"N, 84°46'15"W. 5 March 1989. M. Rubio and G. Greer. FSC 98.90.355. CHEROKEE Co: 34°23'27"N, 84°35'53"W. 7 June 1992. M. Rubio and G. Greer. FSC 98.90.21. FULTON Co: 33°35'30"N, 84°42'40"W. 22 June 1990. M. Rubio and G. Greer. FSC 98.90.211. MURRAY Co: 34°28'60"N, 84°46'55"W. 21 July 1989. M. Rubio and G. Greer. FSC 98.90.304.

Bufo americanus americanus. BARTOW Co: 34°12'53"N, 84°42'3"W. 6 March 1989. M. Rubio and G. Greer. FSC 01.6.05 photo. FULTON Co: 33°34'31"N, 84°47'51"W. 1 September 1989. M. Rubio and G. Greer. FSC 98.90.50. PAULDING Co: 34°1'5"N, 84°51'26"W. 17 May 1991. M. Rubio and G. Greer. FSC 98.90.98. GORDON Co: 34°29'39"N, 84°47'26"W. 21 July 1989. M. Rubio and G. Greer. FSC 98.90.39. HARRALSON Co: 33°51'34"N, 85°4'40"W. 7 March 1995. M. Rubio and G. Greer. FSC 98.90.206.

Bufo fowleri. HARALSON Co: 33°46'55"N, 35°3'31"W. 9 June 1992. M. Rubio and R. T Bryant. FSC 98.90.149. PAULDING Co: 34°2'14"N, 84°51'43"W. 17 May 1991. M. Rubio and G. Greer. FSC 98.90.77.

Testudines

Trachemys scripta scripta. BARTOW Co: 34°17'35"N, 84°44'25"W. 14 June 1991. M. Rubio and G. Greer. FSC 98.90.103.

Lacertilia

Eumeces inexpectatus. DEKALB Co: 33°42'41"N, 84°10'30"W. 23 May 1975. M. Rubio. FSC 98.90.430.

Eumeces laticeps. NEWTON Co: 33°30'17"N, 83°57'38"W. 18 August 1995. M. Rubio. FSC 98.90.428.

Scincella lateralis. FORSYTH Co: 34°8'57"N, 84°10'46"W. 22 July 1992. M. Rubio. FSC 98.90.431.

Sceloporus undulatus undulatus. BARTOW Co: 34°20'48"N, 84°39'37"W. 22 June 1989. M. Rubio. FSC 98.90.1.

Ophisaurus attenuatus. DOUGLAS Co: 33°34'45"N, 84°48'37"W. 7 June 1987. M. Rubio. FSC 01.6.04 photo.

Serpentes

Cemophora coccinea copei. BARTOW Co: 34°15'18"N, 84°41'31"W. 7 June 1992. M. Rubio and G. Greer. FSC 98.90.230. GORDON Co: 34°35'20"N, 84°46'4"W. 25 August 1989. M. Rubio and G. Greer. FSC 98.90.375. POLK Co: 33°55'24"N, 85°9'32"W. 22 July 1998. M. Rubio and R. T. Bryant. FSC 01.6.08 photo.

Coluber constrictor constrictor. BARTOW Co: 34°20'43"N, 84°42'24"W. 22 May 1989. M. Rubio and G. Greer. FSC 98.90.291. DOUGLAS Co: 33°38'21"N, 84°44'17"W. 29 June 1990. M. Rubio. FSC 98.90.238. GILMER Co: 34°44'28"N, 84°31'41"W. 25 August 1989. M. Rubio. FSC 98.90.311.

Diadophis punctatus edwardsii. PAULDING Co: 33°50'47"N, 84°58'28"W. 9 June 1992. M. Rubio and R. T. Bryant. FSC 98.90.424.

Diadophis punctatus punctatus x *edwardsii.* GORDON Co: 34°27'5"N, 84°41'34"W. 7 July 1989. M. Rubio and R. T. Bryant. FSC 98.90.236.

Elaphe guttata guttata. GWINNETT Co: 34°3'18"N, 84°2'7"W. 11 June 1996. M. Rubio. FSC 98.90.78. PICKENS Co: 34°26'20"N, 84°36'34"W. 29 July 1989. M. Rubio and G. Greer. FSC 98.90.273.

Elaphe obsoleta obsoleta x *spiloides.* CHEROKEE Co: 34°24'6"N, 84°38'41"W. 25 May 1989. M. Rubio and G. Greer. FSC 98.90.32. PAULDING Co: 34°0'59"N, 84°41'20"W. 17 May 1991. M. Rubio and G. Greer. FSC 98.90.70.

Lampropeltis calligaster rhombomaculata. DOUGLAS Co: 33°41'23"N, 84°50'3"W. 29 June 1990. M. Rubio. FSC 98.90.168.

Lampropeltis getula getula. PAULDING Co: 33°49'17"N, 85°1'16"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.162. DOR. *Diadophis punctatus punctatus* (FSC 98.90.163) in stomach.

Lampropeltis triangulum elapsoides. CANDLER Co: 32°22'32"N, 81°57'36"W. 28 April 1995. M. Rubio and J. Bockowski. FSC 98.90.372. JENKINS Co: 32°46'24"N, 81°52'15"W. 30 May 1991. M. Rubio. FSC 98.90.114.

Nerodia sipedon sipedon x *pleuralis.* PICKENS Co: 34°30'2"N, 84°23'58"W. 27 June 1991. M. Rubio. FSC 98.90.277.

Nerodia sipedon pleuralis. COWETA Co: 33°38'48"N, 84°46'2"W. 19 June 1990. M. Rubio and G. Greer. FSC 98.90.382. GILMER Co: 34°45'50"N, 84°31'49"W. 21 June 1989. M. Rubio. FSC 98.90.232. HARALSON Co: 33°46'57"N, 85°7'57"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.379.

Opheodrys aestivus. CHEROKEE Co: 34°20'35"N, 84°36'59"W. 23 July 1989. M. Rubio and G. Greer. FSC 98.90.29. GORDON Co: 34°30'45"N, 84°48'37"W. 6 May 1990. M. Rubio and R. T. Bryant. FSC 98.90.373. MURRAY Co: 34°38'8"N, 84°42'37"W. 22 August 1989. M. Rubio and G. Greer. FSC 98.90.31. PAULDING Co: 33°52'54"N, 85°2'6"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.110.

Regina rigida rigida. BULLOCH Co: 32°13'58"N, 81°34'12"W. 4 April 1995. M. Rubio. FSC 98.90.475.

Regina septemvittata. COWETA Co: 33°19'34"N, 84°55'11"W. 14 August 1998. M. Rubio and R. T. Bryant. FSC 98.90.502.

Storeria dekayi wrightorum. BARTOW Co: 34°21'34"N, 84°44'17"W. 2 July 1989. M. Rubio and G. Greer. FSC 98.90.34. GORDON Co: 34°34'16"N, 84°44'58"W. 27 August 1989. M. Rubio and G. Greer. FSC 98.90.238. HARALSON Co: 33°46'54"N, 85°2'33"W. 9 June 1992. M. Rubio and G. Greer. FSC 98.90.461. MURRAY Co: 34°37'36"N, 84°52'38"W. 25 August 1989. M. Rubio and G. Greer. FSC 98.90.100. PAULDING Co: 33°52'27"N, 84°51'36"W. 17 May 1991. M. Rubio and G. Greer. FSC 98.90.6. WALTON Co: 33°45'34"N, 85°43'21"W. 29 June 1992. M. Rubio and G. Greer. FSC 98.90.175.

Storeria occipitomaculata occipitomaculata. BARTOW Co: 34°18'24"N, 84°45'44"W. 4 June 1998. M. Rubio and G. Greer. FSC 98.90.5. DOUGLAS Co: 33°38'49"N, 84°46'4"W. 29 September 1990. M. Rubio. FSC 98.90.407.

Tantilla coronata. GILMER Co: 34°33'38"N, 84°33'59"W. 7 June 1990. M. Rubio. FSC 98.90.24.

Thamnophis sirtalis sirtalis. MURRAY Co: 34°42'52"N, 84°44'18"W. 4 May 1990. M. Rubio and G. Greer. FSC 98.90.406.

Virginia striatula. JENKINS Co: 32°46'24"N, 81°52'15"W. 30 May 1991. M. Rubio. FSC 98.90.244.

Virginia valeriae valeriae. BARTOW Co: 34°24'21"N, 84°40'40"W. 21 July 1989. M. Rubio and G. Greer. FSC 98.90.453. GORDON Co: 34°35'28"N, 84°44'49"W. 27 August 1989. M. Rubio and G. Greer. FSC 98.90.24. MERIWETHER Co: 33°9'22"N, 84°52'10"W. 10 May 1998. R. McCarthy. FSC 98.90.387.

Agkistrodon contortrix mokasen. GILMER Co: 34°34'42"N, 84°45'3"W. 15 June 1990. M. Rubio and G. Greer. FSC 98.90.16.

Agkistrodon contortrix contortrix x *mokasen.* FORSYTH Co: 34°8'57"N, 84°10'46"W. 18 June 1993. M. Rubio. FSC 98.90.413. PAULDING Co: 33°53'55"N, 84°55'18"W. 1 July 1998. M. Rubio and R. T. Bryant. FSC 98.90.341. POLK Co: 34°2'44"N, 85°8'13"W. 22 July 1998. M. Rubio and R. T. Bryant. FSC 98.90.338.

Crotalus horridus. BARTOW Co: 34°16'13"N, 84°43'35"W. 23 August 1989. M. Rubio and G. Greer. FSC 01.6.02 photo. POLK Co: 33°54'54"N, 85°91'41"W. 22 July 1998. M. Rubio and R. T. Bryant. FSC 01.6.03 Photo. Extends range of the species in Georgia ca. 61 km WSW of previously recorded Cherokee Co. specimen (Williams and Moulis 1994).

Sistrurus miliarius miliarius. CHEROKEE Co: 34°34'38"N, 84°37'52"W. 15 June 1990. M. Rubio and G. Greer. FSC 98.90.22. Extends range ca. 35 km N of previously reported Douglas Co. record, and ca. 77 km W of previously recorded Habersham Co. specimen (Williamson and Moulis 1994. GORDON Co: 34°34'16"N, 84°42'59"W. 14 June 1991. M. Rubio and G. Greer. FSC 98.90.65.

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BOOK REVIEWS

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The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas, by Jay M. Savage. 2002. The University of Chicago Press, Chicago and London. xx + 934 pp., 96 pp. pls., hardcover. US $75.00. ISBN 0-226-73537-0.

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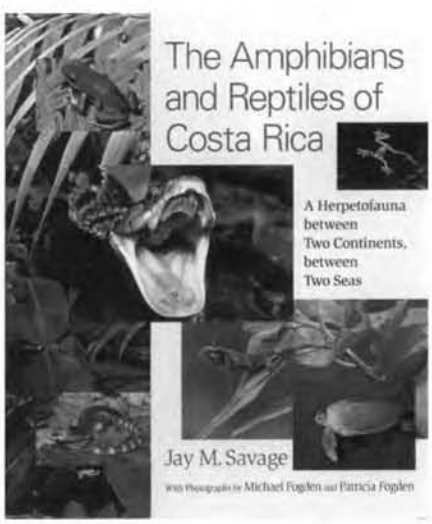

Jay M. Savage, the author of this magnificent and unparalleled book, stepped into Costa Rica in 1960, and, in the ensuing years, became a legend. Now, this legendary figure has produced a fitting culmination to his four-plus decades of research into the composition and distribution of the herpetofauna of Costa Rica.

Savage, now retired and living in San Diego, California, spent most of his career at two institutions, the University of Southern California and the University of Miami. Although his importance to the field of herpetology was apparent before beginning his tenure at USC, it was at this institution and at UM that his full measure was realized. His understanding of the Costa Rican herpetofauna took shape there, of course, but Savage also mentored and sent on their way to distinguished careers a succession of herpetologists, many of whom now hold important positions in the field. The names of some of his intellectual descendents will be familiar to anyone in herpetology: Brian Crother, Maureen Donelley, Ron Heyer, Arnold Kluge, Carl Lieb, Karen Lips, Roy McDiarmid, Norm Scott, David Wake, and Marvalee Wake. Jay Savage was also instrumental in the development and establishment of the Organization of Tropical Studies, which has been hugely influential in education and research in tropical biology. As if this work were not sufficient, Savage has also distinguished himself as a major force in modern biogeography, a talent he again demonstrates in the volume under review (see below).

Costa Rica is world-renowned for its biodiversity, for its government's commitment to protecting that biodiversity, and for its stature as a major ecotourist destination. Its herpetofaunal diversity is no less astounding, and Savage records 390 native species and six introduced ones from the country. This figure includes 172 + 2 amphibians and 218 + 4 reptiles. The area/native species figure for the country is 130.5 (50,900 km^2/390). By comparison, the figure for the much larger Honduras, the centerpiece of my research, is 338.6 (112,088 km^2/331), which is about 2.6 times larger than that for Costa Rica. Costa Rica, thus, possesses an exceedingly rich herpetofauna.

Savage's book will be a rich source of information and analysis for a very long time, not only for professional herpetologists, but for students, resource managers, and ecotourists as well. The broad range of potential users is due to several features of the book not usually seen in treatments of a country's herpetofauna.

The book is organized into four major parts, preceded by a list of keys for identification, a preface, author's acknowledgments, photographers' acknowledgments, and illustration credits. The major parts are also followed by an addendum containing discussion of eight species added to the herpetofauna while the book was in press, a glossary of 831 terms, a literature cited section of 51 pages, a systematic index, and a subject index.

The two-page preface documents Savage's involvement with the Costa Rican herpetofauna. Since 1960, he made more than sixty trips to Costa Rica, which ought to qualify him for honorary citizenship. This experience certainly positions him as the reigning authority on the herpetofauna, which is further evidenced by the number of species with which his name is associated as author. By my count, there are 21 such species, including the famous *Bufo periglenes*, the so-called "golden toad," (a misnomer, according to Savage; the males in this dichromatic species are bright orange, not "golden"), which has become a standard-bearer of amphibian population decline in Mesoamerica. Many of these 21 species were named as a result of broad-based systematic studies undertaken over the years by Savage, for example, on members of the hyperspeciose genus *Eleutherodactylus*.

Part 1, entitled "The Basics," contains three chapters of information introductory to the accounts of taxa. The first chapter (57 pages), "Discovering a Tropical Herpetofauna," is both interesting and peculiar, inasmuch as it contains information not usually seen in treatments of a country's herpetofauna. For example, Savage discusses the basics of systematics, taxonomy, phylogeny, and nomenclature, with especial reference to the cladistic approach. In addition, there is a lengthy discussion of the nature of the conduct of herpetological field research, from locating the animals to captive husbandry of them. This section is followed by two fascinating discussions of the history of Costa Rica and that of the study of its herpetofauna. Costa Rica's history is summarized from pre-Columbian times to the present, the latter characterized by Savage as *la lucha sin fin* (the endless battle). This historical summary assists readers in understanding the cauldron in which the democratic ideal for which Costa Rica is rightly famous was simmered and the stage thus set for the realization of the importance, both scientific and economic, of the immensely valuable biota and its conservation. Savage's summary of herpetological study in Costa Rica is masterful, similarly beginning in pre-Columbian times. This discussion emphasizes the relatively large number of herpetologists who have contributed to our knowledge of Costa Rica's herpetofauna, especially during the twentieth century. We are reminded, for example, of the feud between Emmett R. Dunn and Edward H. Taylor, one chapter of which involved Taylor's entrance into Costa Rica in the wake of Dunn's work there. As Savage recounts the story, Dunn had planned

to write a herpetology of lower Mesoamerica, and had amassed an outline and notes on such a work. This project was delayed, however, when Dunn received a fellowship allowing study in Colombia. Savage speculates that it is during this time that "Taylor was able to copy Dunn's outline and notes for Taylor's subsequent forays into Costa Rican herpetology." Chapter 1 also includes a short section on "Conservation and Protection," including a listing of the many protected areas in the country, which have set the stage for the surge in ecotourism, the country's major economic asset. The chapter concludes with a summary of information sources, species of possible occurrence, and erroneous records, as well as a discussion of the "challenges for readers of this book." It is in this final section of chapter 1 that Savage essentially turns over the reins of responsibility for the study and the protection of the country's herpetofauna to those who will follow him.

Chapter 2 contains a detailed summary (31 pages) of the features of the Costa Rican environment, treating physiography and hydrography, climate, and vegetation and habitats, the last primarily based on the well-known Holdridge system of forest formations.

Chapter 3 (12 pages) deals with the organization of the systematic accounts, which comprise Parts 2 and 3 of this book on the amphibians and reptiles, respectively. The topics covered are the means of identification of these creatures, the use of these sections as an introduction to the biology of the members of the herpetofauna, the purpose of the description of the major systematic groups (family and above) and the genera, the rationale and use of the dichotomous keys, the makeup of the species accounts, the abbreviations used for museums and other collections, and the key to the major groups within the Costa Rican herpetofauna.

The bulk of the book, as expected, consists of the systematic accounts. Part 2 (comprising four chapters) deals with the living amphibians, of which there are 174 species (including two introduced taxa, *Eleutherodactylus johnstonei* and *Osteopilus septentrionalis*). Chapter 4 (eight pages) introduces the class Amphibia, including the living amphibians, members of the subclass Lissamphibia. This chapter also discusses the reproductive modes practiced by Costa Rican amphibians and provides a key to the principal groups of Costa Rican anamniote eggs and developing embryos. Finally, there is a brief discussion of the phenomenon and possible causes of amphibian population decline globally and in Costa Rica. The baffling nature of these declines is alluded to by Savage, who concludes by saying, "It remains open whether anthropogenic stresses are involved and what serious consequences to the health of the global environment may be signaled by declining amphibian populations."

Chapter 5 (eight pages) covers the three genera and four species of caecilians known from the country, all members of the family Caeciliidae. The organization of this chapter is exemplary of the remainder in parts 2 and 3. Initially, the order (here the Gymnophiona) is characterized and the phylogenetic relationships of its components are discussed. Next, the matter of identification is treated and a key to the genera presented. Finally, each of the taxa below the ordinal level are presented and discussed, with identification keys provided at the appropriate points. Each of the species accounts contains the following subsections: diagnostics; description; similar species; habitat; biology; remarks; and distribution (larvae and voice are also discussed in the anuran accounts). In addition, suitably sized distribution ("spot") maps are provided for each species and several line drawings illustrate features of use in identification of taxa.

It is at this point that two of my principal adverse criticisms of Savage's book emerge. First, no synonymies are provided for the species-level taxa that would allow the reader access to the literature on these taxa in Costa Rica. Some of this literature is discussed in the Remarks section of the species accounts, but herpetologists like me who work in another region of Mesoamerica would benefit significantly from such additional knowledge for use in the construction of accounts of species also occurring in such a region. My second major concern is that none of the species accounts contains a list of locality records or specimens examined. From the perspective of one who will make major use of Savage's book in his own research in Honduras, the lack of this information is a serious concern. I understand the interest of editors and publishers (and, perhaps, authors) to contain the size of books of this nature, in order to limit the cost of production and the eventual price of the book, and to not drive off the potential purchasers of the work; however, provision of information on synonymies and available specimens and their localities would save a lot of broadcast searching of the available literature and inquiry to museum curators as to the nature of the holdings of Costa Rican material. This lack also places Savage himself in the position of having to respond to an untold number of inquiries about literature and museum material. In adopting this approach, Savage essentially asks his readers to take his identifications (and the remainder of the information in the species accounts that depends on these identifications) on faith, an approach not terribly popular in the sciences.

Chapter 6 (37 pages) deals with the three genera and 37 species of Costa Rican salamanders, all belonging to the family Plethodontidae. One of these genera, *Bolitoglossa*, is the largest genus of salamanders, with 76 species, according to Savage. The organization of these accounts is like that for the caecilians. It is within this chapter that the first of six sections of color plates is found. This set of 48 plates includes a map of the national parks, biological reserves, wildlife refuges, and other protected areas in Costa Rica, a map of the generalized distribution of Costa Rican vegetation, 16 excellent photographs of vegetation types, six mostly good to excellent photographs of caecilians (not the easiest creatures to photograph), and 24 good to excellent photographs of salamanders. Several line drawings to assist identification are also included.

Chapter 7 (247 pages) covers the anurans, of which there are 133 species in the country, including two introduced species, as noted above. The introductory section preceding the accounts of anuran species is a long one and covers much information on anurans in general and tropical anurans specifically that will be of interest to professionals and non-professionals alike. This information includes discussion of anuran reproductive patterns, ecomorphological tadpole guilds, developmental patterns in anurans based on nutritional sources, keys to adults and larvae, and an index to published illustrations of Costa Rican tadpoles. The 133 Costa Rican anurans are arranged in eight families, about 29% of the 28 families recognized worldwide. These families are the Rhinophrynidae (one species), Bufonidae (14 species), Leptodactylidae (46 species), Hylidae (43 species), Centrolenidae (13 species), Dendrobatidae (eight species), Microhylidae (three

species), and Ranidae (five species). Two sections of color plates are also found within this chapter. The first contains 13 salamander photographs and 79 anuran photographs. The second contains 92 anuran photographs and one lizard photograph. Illustrations of many tadpoles and their mouthparts also accompany this chapter, as well as several of adults indicating diagnostic features and variation in color pattern.

Part 3 (with six chapters) treats the living reptiles, of which there are 222 species (including four introduced forms, *Ctenotus cristatellus*, *Hemidactylus frenatus*, *H. garnotii*, and *Lepidodactylus lugubris*). Chapter 8 is a short (three pages) introduction to the living nonvolant (i.e., non-avian) reptiles, covering diagnostic features and some aspects of biology. Chapter 9 (of two pages) is another short introduction, this time to the squamate reptiles, covering the same subjects as in the preceding chapter.

Chapter 10 deals with the lizards in 121 pages. Seventy-three species are arranged in 22 genera and 11 families (about 39% of the 28 families currently recognized). The families are the Corytophanidae (four species), Iguanidae (three species), Phrynosomatidae (three species), Polychrotidae (27 species), Eublepharidae (one species), Gekkonidae (11 species), Xantusiidae (two species), Scincidae (three species), Teiidae (seven species), Gymnophthalmidae (six species), and Anguidae (seven species). A fourth set of 96 plates is set within this chapter, 94 of lizards and two of snakes. The quality of the photographs in this section ranges from satisfactory to excellent (one shot of a *Norops biporcatus* on a bird of paradise leaf in the forest at the La Selva Biological Station is too small to be of much use, but the understory of the forest is shown to advantage).

Chapter 11 covers the 133 species of Costa Rican snakes in 203 pages. These species are organized into 63 genera and nine families (about 58% of 19 families presently recognized). The families are the Anomalepididae (three species), Typhlopidae (one species), Leptotyphlopidae (one species), Loxocemidae (one species), Boidae (four species), Ungaliophiidae (one species), Colubridae (103 species), Elapidae (five species), and Viperidae (14 species). The final two sets of color plates are located within this chapter. The first set consists of 93 photographs of snakes; the second is of an equal number of the remainder of the snakes, the turtles, and the two crocodilians.

In general, the photographs comprising the color plates are good to excellent in execution, the animals were shot in natural or naturalistic settings, the specimens illustrated are almost all from Costa Rica (by my count, only 29 photographs of a total of 498 are of animals from outside Costa Rica or of unknown provenance), and have good locality data (but no specimen numbers). Most of the photographs were taken by the photographic team of Michael and Patricia Fogden, whose work, it must be acknowledged, will have a lot to do with the popularity this book will enjoy, as Savage himself indicates in the Acknowledgments section.

The 14 Costa Rican turtles are dealt with in Chapter 12 (34 pages) and arranged in nine genera and five families (about 42% of the 12 families currently recognized). The families are Kinosternidae (three species), Dermochelyidae (one species), Cheloniidae (five species), Chelydridae (one species), and Emydidae (four species).

The crocodilians are discussed in Chapter 13 (eight pages). The two crocodilians known from Costa Rica are placed in two genera and a single family, the Crocodylidae (not two families, as indicated in Table 3.1). Savage here regards the Alligatorinae (including *Caiman*) as a subfamily.

Part 4 (with three chapters) examines biogeographic and evolutionary patterns of the Costa Rican herpetofauna. The information and analyses in this final part of the book go significantly beyond those one generally finds in books of this nature and, as such, materially expands the usefulness the book will have to professional herpetologists, especially those working in Latin America.

Chapter 14 is an 11-page discussion of the ecological distribution of the herpetofauna, with about seven of those pages occupied by lengthy tables cataloguing distribution by elevation and forest formations. The raw distributional data found in five tables are summarized in differing ways in three additional tables and four graphs. The analyses point to patterns of distribution that are typically seen in Mesoamerica, for example that salamanders and anurans are most diverse in Premontane Rainforest, most members of the herpetofauna are found in humid lowland forests and Premontane Rainforest, and amphibians are more diverse in the Atlantic lowlands than those of the Pacific.

Chapters 15 and 16 will have broad interest to herpetologists in general and herpetogeographers in particular, inasmuch as they deal with patterns of geographic distribution and evolution of the herpetofauna of Tropical Mesoamerica as a whole, not simply Costa Rica. Savage, of course, has assayed these subjects in earlier papers, especially those published in 1966 and 1983 (see below). Savage justifies treating this subject in such an expansive fashion by indicating that Lower Mesoamerica (principally Costa Rica and Panama) constitutes an isthmian link between the continents to the north and south separating the Caribbean Sea and the Pacific Ocean, which bodies of water were in contact with one another during most of the Cenozoic, noting that "... any attempt to explain the biogeography of amphibians and reptiles in this region must recognize that the Costa Rican herpetofauna is embedded with a broader Tropical Mesoamerican faunal unit" (page 794).

In Chapter 15 (21 pages), Savage places the 215 genera and 42 families of amphibians and reptiles in Tropical Mesoamerica in four major distributional groupings, i.e., widespread tropical (eight genera), South American (62 genera), Tropical Middle American (119 genera), and Extratropical North American (34 genera, of which eight have the southern limit of their range only marginally tropical). Savage also recognizes seven major herpetofaunal assemblages, including an Eastern and Western Lowland Herpetofauna (found in humid regions), a Pacific Lowland Herpetofauna (found in semiarid to subhumid regions), a Mexican Highland Herpetofauna, a Nuclear Highland Herpetofauna (found in Nuclear Middle America), a Talamancan Herpetofauna (highlands of Costa Rica and western Panama), a Panamanian Herpetofauna (subhumid lowland habitats on the Pacific versant), and a Chocoan Herpetofauna (entering eastern Panama in lowland areas). As noted by Savage, Costa Rica is the "meeting ground" of the Eastern and Western Lowland Herpetofauna, the Pacific Lowland Herpetofauna, and the Talamancan Herpetofauna. Savage next identifies the generalized tracks and historical source units evident in tropical Mesoamerica. Four such tracks are identified, familiar to herpetogeographers working in Latin America; they are the North American-Central American track, the South

American-Caribbean track, the Middle American-Caribbean track, and the Western North American-Central American track. Genera and some sub-generic groups whose distributions correspond to a particular track are placed by Savage in a historical unit, of which there are three that have contributed to the Tropical Mesoamerican herpetofauna, i.e., an Old Northern Element (90 genera or subgenera) of largely Laurasian affinities, a South American element (64 genera or subgenera) of Gondwanan relationships, and a Middle American element (66 genera or subgenera), autochthonous in nature. The membership of these elements has been modified substantially from that established earlier by Savage ("1982" 1983), based on current phylogenetic understanding. Savage concludes this chapter with a discussion of nine faunal areas and of endemism within Costa Rica and within the faunal areas recognized. This discussion is used "as the basis for evaluation the history of the Costa Rican herpetofauna" (page 806), which evaluation is presented in the concluding chapter. The nine faunal areas fall into three groupings, viz., lowlands, foothills and uplands, and highlands. Analysis of patterns of distribution within these nine faunal areas and endemism with reference to relative representation of historical elements allows for simplification of the faunal areas recognized to five, whose separate histories are traced in Chapter 16.

Chapter 16 (23 pages) is entitled "Development of the Herpetofauna," and represents a masterful synthesis of paleogeographic, paleoclimatic, biogeographic, and biosystematic data that presents a robust and very satisfying picture of the events that have lead to the composition and distribution of the modern-day herpetofauna of Costa Rica. This type of synthesis is a particular forte of Savage, as he has demonstrated a number of times over his career. As noted above, Savage's approach is a broad-based one, such that his analysis and conclusions will be of significant use to other herpetologists working in Mesoamerica. In approaching this subject, Savage brings together an array of recent geological literature to present the complicated series of geohistorical changes that have shaped the whole of Mesoamerica and especially lower Central America. Thus is the reader introduced to the Maya, Chortis, Chorotega, and Chocó crustal blocks, the Middle American and Colombian trenches, and the five tectonic plates (North American, Caribbean, South American, Cocos, and Nazca) that were the principal players in the geohistory of this region.

Savage next deals with the available paleoclimatic data and the effect paleoclimates had on the evolution of the vegetation in Mesoamerica. Geohistorical and paleoclimatic data are integrated to form a basis for a discussion of the role of dispersal and vicariance in creating the "big picture" concerning faunal assemblages in Mesoamerica. This "big picture," as explained by Savage, has involved the alternation of vicariance (V_0 through V_3) and dispersal (D_1 through D_4) events affecting the historical elements contributing to the modern herpetofauna in complex ways. Of special interest is his exploration of the double-pulse hypothesis of the involvement of the South American Element in the present-day Mesoamerican herpetofauna, especially that of the isthmian region. This hypothesis states that two dispersals of members of the South American Element took place in the Pliocene, at intervals separated by about a million years.

The final section of this chapter provides a satisfying answer for why there are so many species between the two continents and the two seas that bracket Costa Rica. Savage presents this play in five acts. Act one introduced the Mesoamerican Element and the Central American Component of the Old Northern Element to the isthmian island chain when it became sutured to the Chortis block. Act two involved continuing uplift and vulcanism on the emerging isthmus. Act three encompassed the alternating cooling and warming cycles during the latter portion of the Cenozoic. Act four commenced with the reattachment of Central America to South America by the completed isthmian link. Act five involved the dispersal of dry-adapted taxa into northwestern Costa Rica and the Meseta Central. The conclusion of act five brings us to the present, with Savage summarizing the development of the herpetofauna by demonstrating that three historical elements arriving from different directions and at varying times have contributed 97% of the principal players in the herpetofaunal drama that has enjoyed a long run on the Costa Rican stage.

This book is very clean and I have found few errors. However, on page 44, "Stejneger's topological procedures" should read "Stejneger's typological procedures." On page 662, Fig. 11.41 of heads of species of *Leptophis* is placed near accounts of *Drymobius* instead of where it should be, about six pages beyond. The name *Tantilla supracincta* is not italicized in the legend for Plate 457. Finally, the map of the upland areas of tropical Mexico (Fig. 16.9) has a legend placing these areas to the east of the Isthmus of Tehuantepec, instead of west.

I am sure Jay Savage was asked more times than he cares to remember about when this book would see light, but it is abundantly evident that the wait was well worth it. I know of no other herpetological work that purports to cover a country's herpetofauna that is blessed with greater breadth of coverage, attention to detail, freedom from error, quality of illustration, or extent of appeal than is this one, even given my concerns about the absence of synonymies and specimen lists. For those of us who know Jay Savage, we would expect nothing less. This stupendous achievement is only the latest in a long line of distinguished contributions to the field of herpetology from his fertile mind. A copy of this book must be in the library of every person who calls himself a student of herpetology, in every university library, and in the libraries of resource managers and conservationists all over Latin America. Even well educated ecotourists with 75 bucks burning a hole in their pockets will find much of interest in this book, although it is a bit bulky to fit within a daypack. In this day of inflated book prices, this is one book that is definitely worth the monetary outlay. From this point, I can only wait with considerable anticipation to see what comes next from the hand of this talented man.

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Herpetological Review, 2003, 34(1), 85–86.

The Cuban Treefrog in Florida. Life History of a Successful Colonizing Species, by Walter E. Meshaka, Jr. 2001. University of Florida Press, Gainesville, Florida. xxiii + 191 pp., hardcover. US $69.95. ISBN 0-8130-2909-X.

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Preservation of biodiversity requires more than simply establishing preserves and protecting them from human encroachment and direct habitat degradation. Invasive species constitute a very real and present threat to biodiversity of protected areas, and nowhere is this threat more apparent than in southern Florida, where exotic species have profoundly altered the landscape and affected the region's biota.

The impact of invasive species on native forms is often assumed to be negative, but quantitative information on this point is lacking in most cases. Thus, a detailed analysis of the ecology of the Cuban Treefrog—one of the most successful of exotic vertebrates in southern Florida—and of its impact on native species, would be a welcome addition to the literature on invasive species. With this book, based largely on his doctoral dissertation, Walter Meshaka attempts to provide such an analysis. His treatment includes consideration of the geographic distribution of the Cuban Treefrog, its relationship to other members of its genus, and the history of its colonization of Florida. The environment of southern Florida is described with special reference to the Everglades, and a brief chapter outlines the author's methods and the organization of the study. The bulk of the book treats reproduction, larval development and post-metamorphic growth, behavior, habitat selection, stomach contents and diet overlap with potentially competing species, predation, and sexual size dimorphism. The book includes a one and a half page conjecture on the possibility of future geographic expansion of the Cuban Treefrog into other parts of the United States and in the Caribbean, and it concludes with an equally brief chapter on the future of the Cuban Treefrog in the Everglades.

The Cuban Treefrog in Florida is a data-rich volume, the result of the author's energetic and enthusiastic pursuit of his study of this species. He has amassed a large volume of information on this important invasive species. Sadly, the deficiencies in editing, peer review, organization, and production seriously detract from the usefulness of this slim, overpriced volume.

Substantial portions of the book are of little or no relevance to the biology of the Cuban Treefrog, or to its impact as an invasive species. For example, in describing the Everglades the author tabulates the plant communities (Table 3.1) and provides a listing of all species of amphibians and reptiles known to occur in southern Florida (Table 3.2), but this information is not clearly related to treefrog biology.

The manuscript apparently received little, if any, copyediting. How else to explain the numerous run-on sentences, incomplete sentences, awkward constructions, and pronouns with ambiguous antecedents? It is an unusual paragraph that doesn't suffer some grammatical defect. A copy editor would have detected such non-sentences as: "Resting Cuban treefrogs, and especially small individuals, wedged into folds (e.g., palm boots, roof shingles), and large ones often packed into crevices, such as tree cavities or pipes (Meshaka 1996b)" (p. 151). Likewise, a copy editor would never have allowed the following: "Even in all but the most sterile cities that are too developed and antiseptic for its existence, the Cuban Treefrog is a ubiquitous member of the new and as yet unsettled exotic and almost endemic community of the increasingly urban landscape of Florida, itself a barometer of humanity" (p. 177). Surely a copy editor would have noticed that there is much redundancy between some of the tables (e.g., Tables 2.3 and 2.4), or that in many instances the author uses the wrong word or an awkward construction in attempting to convey his meaning, as for example: "One step behind biogeography is origin, both of the genus and the species."

The manuscript cannot have been subject to rigorous peer review, for a knowledgeable reviewer would have pointed out that time should be plotted as a independent variable on the X-axis, not as a dependent variable on the Y-axis, as it is in Figure 1. A reviewer would likely have insisted that the map depicting the distribution of the Cuban Treefrog in Florida (Fig. 1A) have a north arrow, a scale, and an indication of latitude and longitude. A reviewer familiar with the literature of *Osteopilus septentrionalis* would have corrected the author's assertion that "Over the past two hundred years the Cuban treefrog has been a subject of 100 published scientific papers." In fact there have been considerably more than 100 papers published on that species during that time; among others, the author has overlooked Smith and Kohler (1987), Goldberg et al. (1994), and Bartlett and Bartlett (1996). A reviewer familiar with amphibian biology could not have failed to point out that the section entitled "larval growth" (pp. 74–76) actually deals with the duration of the larval period and size at metamorphosis. A reviewer would have advised that it is unnecessary and wasteful of space to illustrate bivariate plots of non-significant regressions (e.g., Figs. 9.3–9.5, 9.11–9.17, 9.20—some with coefficients of determination as low as 0.002!) and that many of the regressions that are reported as statistically significant are of doubtful biological significance, owing to violation of statistical assumptions and/or to the enormous leverage of a few outlying data points (e.g., Figs. 8.2, 8.3).

Overall the production values are poor. In the legends to figures, probabilities are abbreviated as uppercase "P" on some (e.g., Fig. 9.11), or as lower case "p" on others (e.g., Fig. 9.13). F-ratios are reported inconsistently to two, three, or four decimal places. Most figure legends present statistics of dispersion as ±, but in Figures 5.3 and 5.4, they are symbolized as + . Many of the 33 black-and-white photos that illustrate various habitats are repro-

duced too dark (Fig. 4.2C) , are out of focus (Fig. 4.8B), or both (Fig. 4.4B). Many of these photos provide comparison of habitats before and after Hurricane Andrew, but because most are taken from different perspectives, direct comparisons are difficult or impossible (e.g., Fig. 4.12A, B). Many graphs are defective in various ways. Some have different font sizes within a single graph (e.g., Fig. 5.5). Some include regression equations (e.g., Figs. 5.1–5.4), others do not. (e.g., Figs. 5.5, 5.6). Some have broken regression lines (e.g., Fig. 8.5), others have peculiar symbols and lines appearing on them without explanation (e.g., Figs. 8.6, 9.1, 9.24). The axis labels are miss-set on some graphs (e.g., Fig. 8.5), and others have inset labels that overlap, and thus obscure, data points (e.g., Fig. 9.7). The book is severely over-illustrated, with unnecessary graphs and tables that contain much duplicated material. In the scant space of 191 pages, there are 142 figures and tables, an average of one figure or table for every 1.3 pages.

Exacerbating the chaotic writing style are the author's misdirected attempts at humor. In the preface, for example, he sets about framing the study as a mystery in need of solving. A biological crime was committed, he asserts, when an exotic species was "... set loose in a foreign land." The culprit, he would have us believe, was the Cuban Treefrog, and humanity was an accomplice. He then asks rhetorically, "The mystery (my dear Watson) is *why*?" Indeed, as I struggled through this book and reflected on what a properly researched, written, and edited volume on the biology of the Cuban Treefrog could have been, I had the same question.

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PUBLICATIONS RECEIVED

New Perspectives on the Origin and Early Evolution of Birds: Proceedings of the International Symposium in Honor of John H. Ostrom, edited by Jacques Gauthier and Lawrence F. Gall. 2001. Peabody Museum of Natural History, Yale University, New Haven, Connecticut 06520-8118. 613 pp. Softcover. US $49.00 + $7.50 postage and handling. ISBN 0-912532-57-2.

This volume includes 31 papers derived from a symposium held at Yale University in February 1999. The symposium itself was linked to an exhibit of feathered theropod dinosaurs from China, but the book deals with broader issues of the phylogeny of theropods, the evolution of birds, the origin of feathers and flight, and the functional morphology and physiology of birds and their ancestors. The contributions range from strictly paleontological to largely neontological and many deal with inferences derived from living archosaurs and other reptiles. Of special interest are a series of papers grouped under the heading "Controversial Topics in Bird Origins." The book is illustrated by 156 black and white photos and line drawings and includes numerous tables and appendices, as well as a comprehensive index. The volume should be a valuable addition to the libraries of ornithologists, paleoherpetologists, vertebrate morphologists, and systematists.

SigmaPlot 2000/2001 for Scientists, by M. Brent Charland. 2002. Riparian House, P.O. Box 721, Merrickville, Ontario K0G 1N0 Canada. 464 pp. Softcover. US $39.95. ISBN 0-9689929-0-0.

This publication serves as a resource for users of the SigmaPlot graphics package and covers the three most recent versions of the software (2000, 2001, and 8.0). It includes information on designing graphs, creating and modifying the graph types supported by SigmaPlot, writing transforms using the built-in programming language, complex curve fitting, and a diversity of other topics. The book is designed with the needs of practicing scientists in mind and aims to maximize the utility of SigmaPlot for both the beginning and advanced user.

Turtles and Tortoises, by Vincenzo Ferri. 2002. Firefly Books, 4 Daybreak Lane, Westport, Connecticut 06880, USA. 255 pp. Softcover. US $24.95. ISBN 1-55209-631-9.

This is an English translation of an Italian book originally published in 1999. It provides an introduction to chelonians and their biology and conservation and provides color photographs of approximately 170 species. More than 150 species are treated in short species accounts consisting of small range maps and text overviewing "Distribution and habitat," "Characteristics," and, in some cases, "Situation" (conservation status). Unlike most such guides, this volume is organized geographically, with major sections on Seas and Oceans and the Palearctic, Afrotropical, Oriental, Nearctic, Neotropical and Australian regions. The book is illustrated by 400 photos of turtles and their habitats and also features partly illustrated keys to the genera of living turtles. A species index is combined with a list of all valid turtle species and, along with a glossary, short bibliography, and list of relevant journals, societies and websites, completes this compact volume. Although aimed at a general audience, the book will also serve as a handy and inexpensive guide to turtles of the world for professional herpetologists.

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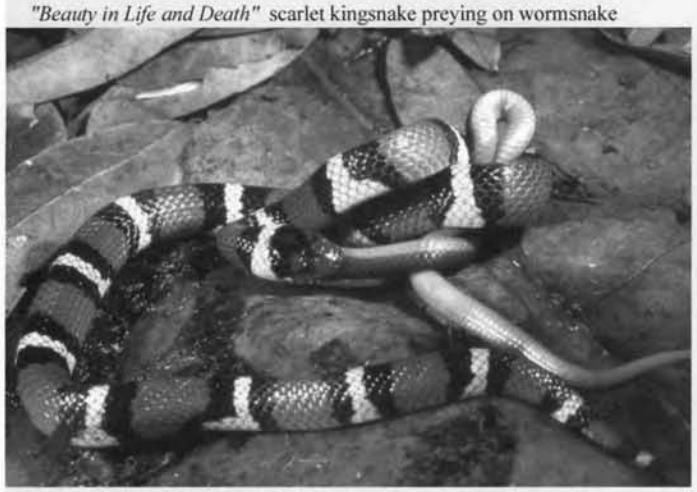

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