

Appendix 8.2

Distributional Checklist of Nonavian Reptiles and Amphibians on the Islands in the Sea of Cortés

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Biologists depend on checklists for many reasons, ranging from evolutionary studies to conservation and management of species and areas to compilations in popular guidebooks. Many uses are critically dependent on names and the information that they carry, especially when the taxonomy reflects genealogical relationships (Hull 1964; Hennig 1966; Wiley 1981). For example, in this volume alone, two chapters depend on such information for formulating hypotheses of origins and relationships and studies of evolutionary ecology. Consequently, we provide an updated checklist to the amphibians and reptiles on the islands in the Sea of Cortés. In part, this makes the volume complete, but we also clarify the taxonomic relationships of many lineages and species from a phylogenetic perspective. The distribution records are based largely on Grismer (1999b). We add the common kingsnake, *Lampropeltis getula* (documentary photos on file in the Royal Ontario Museum) and night snake *Hypsiglena torquata* (specimen deposited in the herpetological collections of the Royal Ontario Museum) to the herpetofauna of Santa Cruz. We also note that the leaf-toed gecko *Phyllodactylus tuberculosus* occurs on San Ignacio Farralon (Dixon 1966; Murphy 1983c; Murphy and Otleley 1984). Like Grismer, we have avoided referring to subspecies in this checklist (but see below).

Our taxonomy differs significantly for many groups of species, particularly for lizards. Some of the taxonomic controversy arises from different interpretations of Frost and Hillis's (1990) paper on species concepts as applied to herpetology. They recommend recognizing allopatric populations as species so long as (1) the lineage can be discretely diagnosed either anatomically or biochemically (i.e., demonstration that the independent lineages are on their own, nonephemeral evolutionary trajectory),

and (2) monophyly is maintained in the taxonomy for all taxa (see also Frost and Kluge 1994; Graybeal 1995).

Grismer (1999a) required discrete anatomical diagnosis for species recognition; in other words, there could be no overlap in at least one characteristic, and all insular populations that could be anatomically diagnosed were elevated to the status of species. He ignored all biochemical evidence. His rejection of molecular data is a problem because it precludes recognition of cryptic species as can be discovered using biochemical characters or behavior. For example, using anatomical characters only, Grismer could not recognize *Hyla chrysoscelis* and *H. versicolor* as separate species because they can only be separated based on calls, ploidy levels, and, usually, distribution (Hillis et al. 1986). Similarly, Grismer does not recognize divergent biochemical lineages on islands in the Sea of Cortés (chap. 8).

The anatomy-only operational criterion does not require history and may not reflect such. In and of itself this is not disturbing. We simply accept that mistakes will be made, and that these will be corrected if phylogenies require such (Frost and Hillis 1990). Although Grismer (1999a) claimed to apply the evolutionary species concept according to Wiley (1978, 1981) and Frost and Hillis (1990) to the herpetofauna on islands in the Sea of Cortés, he has not. History must be faithfully reflected in the taxonomy. Exceptions are not allowed.

Violation of this fundamental premise of monophyly is clear in Grismer's recognition of species of side-blotched lizards. Upton and Murphy (1997) and Grismer's student Hollingsworth (1999) showed that side-blotched lizards on Ángel de la Guarda, San Esteban, San Pedro Mártir, Santa Catalina, and Carmen and Danzante (and associated satellite islands) could be biochemically diagnosed (see chap. 8, fig. 8.12). They are genetically divergent. These insular lineages are basal in cladograms relative to those on landbridge islands. Thus, the insular lineages were isolated before those on landbridge islands. Consequently, older lineages on deep-water islands must be accorded species status in order to recognize Grismer's three landbridge island species *Uta lowei*, *U. encantadae*, and *U. tumidarostrea* on Miramar (=El Muerto), Encantada (and Islotes Blancos), and Coloradito, respectively. Grismer's species cannot be recognized without all older insular populations being accorded equal, species-level status (Upton and Murphy 1997; chap. 8, this volume). Furthermore, to maintain Grismer's species, we must also describe most other lineages on landbridge islands. Consequently, we not only reject recognition of Grismer's three species of *Uta*, we recognize *U. antiqua* and list the two side-blotched lizard lineages as undescribed species in order to maintain recognition of *U. squamata* from Santa Catalina and *U. palmeri* on San Pedro Mártir. Species descriptions are in preparation.

Grismer's use of grades (extent of anatomical divergence, and not phylogeny) is not limited to side-blotched lizards. The western whiptail lizards, *Cnemidophorus tigris*, and their associated species have identical problems. Whereas Grismer (1999a,b) relegated *C. estebanensis* to synonymy with *C. tigris*, cladogenic relationships (fig. 8.13) either require its recognition or the synonymization of *C. martyr* and *C. canus* with *C. tigris*. Thus, we recognize *C. estebanensis*. Grismer does not list the chuckwalla on Danzante as being *Sauromalus slevini*, although the DNA sequence data unambiguously demonstrate that it is a member of this lineage (app. 8.1). We include it in this taxon as being on Danzante.

We are also concerned about nomenclatorial stability. Unfortunately, for most species groups there is no phylogenetic hypothesis upon which to base the validity of Grismer's alpha taxonomic changes. However, patterns of relationships repeat because of similar histories, as evidenced by cladograms based on DNA sequence data (chaps. 8, 12). Therefore, we predict that other inappropriate changes have been made in more speciose groups, such as leaf-toed geckos (*Phyllodactylus*). Our checklist maintains previously recognized species on deep-water islands pending phylogenetic studies. In doing so, we hope to stabilize the nomenclature until the required evaluations are completed.

Based on the phylogenetic work of Kluge (1993), we have recognized the genus *Charina*, as opposed to *Lichanura*, for rosy boas. Following the International Code for Zoological Nomenclature (ICZN), Article 82.1, we use the name *Sauromalus obesus*, rather than *S. ater*, for the peninsular and landbridge island chuckwallas pending the outcome of a petition filed with the ICZN to conserve the former, more commonly used name (Montanucci et al. in press). We also recognize the name *Phyllodactylus partidus*, rather than *P. partitus*, following Article 24.2.3 of the Code. The generic name *Sator* has been retained due to extensive DNA sequence evidence that its inclusion in the genus *Sceloporus* results in a paraphyletic taxonomy (chap. 8). The inclusion of *Sator* into *Sceloporus* would also necessitate the synonymization of *Petrosaurus* and *Urosaurus* into *Sceloporus*. (The genus *Sceloporus* may remain paraphyletic with respect to some tropical Mexican species. A taxonomic correction of this problem is beyond the scope of this checklist.)

Some other taxonomic differences relate to a misunderstanding of the utility of molecular allozyme data. As noted in chapter 8, Grismer has ignored the significance of overall genetic similarity, which can provide indirect evidence of the absence of gene flow, although precise values cannot be used as arbitrators for recognizing species. Low levels of similarity (high divergence) translate to fixed allelic differences among populations. In turn, fixed allelic differences provide refutable hypotheses that gene flow is not occurring, at least within the framework of Mendelian genetics. Accordingly, some of our taxonomy is based on the largely unpublished character allozyme data summarized in Murphy (1983a) as well as our more recent unpublished data. This is especially evident in the alpha taxonomy of leaf-toed geckos (*Phyllodactylus*) and desert spiny lizards (*Sceloporus zosteromus* group), as was the taxonomy of Murphy (1983a) and Murphy and Ottley (1984). For example, in leaf-toed geckos, genus *Phyllodactylus*, Murphy's (1983a) data indicated that 7–9 (actually 8) of the 27 surveyed loci exhibited fixed allelic differences for *P. xanti* in the Cape Region and those north of there. Because the populations were not interbreeding, Murphy (1983a) recognized *P. nocticolus* as the northern species and *P. xanti* in the Cape Region. In contrast, Grismer (1994), based on similarity of scale characters (Dixon 1964), subsequently concluded that *P. xanti* occurred throughout the Peninsular Ranges from the Cape Region to San Gorgonio Pass. Similarly, in spiny lizards, *Sceloporus*, our allozyme data have no heterozygotes at five fixed loci in sympatric populations of *Sceloporus zosteromus* in the Cape Region, and *S. monserratisensis* which occurs from the Cape Region northward to the mid-peninsula. Our checklist reflects these data.

When possible, our taxonomy faithfully reflects genealogical hypotheses. Where explicit phylogenetic hypotheses are not available, we have retained the species-level

taxonomy given in Murphy and Ottley (1984). Whereas the previously noted differences center on the application of phylogenetic theory to taxonomy, and Grismer's summary on rejection of biochemical data, other issues deal with less precise aesthetics, or rather individual ideas about what alpha taxonomy should reflect to maximize its utility.

Populations on islands in the Sea of Cortés are the natural equivalents to bottles of *Drosophila*. Some populations have been altered by human intervention, and gene flow may occur via overwater colonization, as gene flow occurs among escaped *Drosophila*. The selection pressures vary among populations depending on effective population size, climate, and other variables. Bottlenecks in population size may accelerate adaptive change and quickly fix mutations in only a few generations (Waddington 1961). After all, these attributes are responsible for the considerable attention paid to the region. We believe that it is no more desirable to name all 370+ herpetological lineages distributed on 68+ islands in the Sea of Cortés as species than it is to name all of the estimated 180,000 strains of *Drosophila melanogaster* (fruit fly diversity estimate from Kathy Matthews, pers. commun., 2000 Bloomington *Drosophila* Stock Center, Indiana University).

If all insular herpetological lineages were recognized as species (undoubtedly, all can be diagnosed using microsatellites), then the alpha taxonomy will not reflect genealogical relationships, and new hierarchical levels will be required, such as recognition of new genera or subgenera (formalized species groups). We find this unappealing. This problem is particularly acute for ephemeral lineages on landbridge islands, both in the Sea of Cortés and elsewhere. Landbridge islands were frequently connected to a larger faunal source (Emslie 1998). Oxygen isotope records in marine sediments have documented at least 21 glacial cycles during the past 2.3 million years (van Donk 1976). These were rapid (10^4 – 10^5 years for the last interglacial; Cronin 1987) and glaciation occurred for 94% of the Pleistocene (Van Devender and Burgess 1985). Interglacial events, including our current condition, were short in duration. Apparently such events occurred without genetic consequences, at least following the last glacial event (Murphy 1983a,b; chap. 8, this volume) (i.e., unencumbered interbreeding continued after reunification). Therefore, we believe alpha taxonomic species names should be maintained for peninsular and insular populations of diagnosable lineages on landbridge islands. The only exceptions might include (1) preventing a paraphyletic taxonomy, and (2) demonstration of perpetual isolation (e.g., that glacial cycles have ceased). No data suggest that glacial cycles have stopped. All predict continuance. Therefore, we do not recognize any endemic species on landbridge islands that have a demonstrable recent genetic association with nearby peninsular regions. We do recognize endemic species on Carmen and Danzante because multiple cladograms suggest that they are not landbridge islands (chap. 8), as originally indicated for Carmen by Soulé and Sloan (1966).

Although we do not recognize endemic ephemeral species on landbridge islands, we recognize that anatomical divergence can occur very quickly, particularly on small islands. Subspecies names seem appropriate for such ephemeral lineages for ease of transferring information within a Linnean alpha taxonomic system. Frost and Hillis (1990, p. 94) stated that the "use of the subspecies category would necessitate the hypothesis that the subspecies *will* be subsumed into a larger species in the future, not *could* potentially be subsumed; they would necessarily be seen as temporary iso-

lated parts of the larger species” (their emphasis). Given the weight of evidence, we must assume that landbridge islands in the Sea of Cortés are ephemeral and, thus, that peripheral isolates on these islands will be subsumed in the future. We agree with the caveat that monophyly of all lineages be maintained, even for subspecies. Therefore, many insular subspecies will defy recognition, including Grismer’s three species of side-blotched lizards, unless all older populations are accorded formal alpha taxonomic recognition, at least at the subspecific level. Age of isolation can be estimated using channel depths (Wilcox 1978; Upton and Murphy 1997) and, given certain unpalatable assumptions, by the extent of genetic differentiation.

Our checklist is given in two appendixes. Appendix 8.2 lists the herpetofauna on major islands in the Sea of Cortés—islands with a relatively large number of species, or with oceanic (non-landbridge, noncontinental) origins. Appendix 8.3 provides additional data for relatively minor islands; these are landbridge islands either of the mainland or larger adjacent islands. Our tables also give the documented or presumed origins of the insular faunas, estimates of the percentage of overwater colonists, and levels of endemism calculated from the tables, which is dependent on our taxonomy. We are certain that levels of endemism on the deep-water islands will increase as knowledge accumulates, both anatomically and biochemically.

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Appendix 8.3

Distribution of Nonavian Reptiles and Amphibians on Major Islands in the Sea of Cortés

Species	Tiburón	Mejía	Ángel de la Guarda	Partida Norte	La Rаса	Salispuedes	San Lorenzo Norte	San Lorenzo Sur	San Esteban	San Pedro Mártir	San Pedro Nolasco	Tortuga	San Marcos	Coronados	Carmen	Danzante	Monserrat	Santa Catalina	Santa Cruz	San Diego	San José	San Francisco	Espíritu Santo	Partida Sur	Cerralvo
Family Colubridae																									
<i>Bogertophis rosaliae</i>																									
<i>Chilomeniscus cinctus</i>	N												C			C	C				C		C		
<i>Chilomeniscus savagei</i>																									
<i>Chilomeniscus stramineus</i>	N																								E
<i>Eridiphas slevini</i>																									
<i>Hypsigena torquata</i>	N	C	C	N/C			C	N/C																	C
<i>Lampropeltis catalinensis</i>																									C
<i>Lampropeltis getula</i>																									
<i>Masticophis aurigulus</i>																									C
<i>Masticophis bilineatus</i>	N																								
<i>Masticophis flagellum</i>	N																								C
<i>Masticophis slevini</i>									S																C
<i>Phyllorhynchus decurtatus</i>																									C
<i>Pituophis catenifer</i>	N																								C
<i>Rhinocheilus etheridgei</i>																									S
<i>Salvadora hexalepis</i>	N																								C
<i>Sonora semiannulata</i>																									C
<i>Tanilla planiceps</i>																									C
<i>Trimorphodon biscutatus</i>	N																								C

Appendix 8.4

Distribution of Nonavian Reptiles on Minor Islands in the Sea of Cortés

Species	Sonora and Sinaloa		N. Baja		Midriff		Bahía de los Angeles				Bahía Concepción		Baja California Sur				Cape Region																										
	Alcatraz	Cholludo	Dátil	Patos	San Ignacio	Fratton	Encantada Grande	Miramar	Willard	Cardonosa Este	Granito	Roca Lobos	Cabeza de Caballo	Flecha	La Ventana	Mitlan	Ptofo	Coronado	Santa Ines (S)	Cayo	El Coyote	San Indefonso	Pardo	Rocas San Cosme	El Pardino	Las Animas	Ballena	Gallina	Gallo														
Chelonia																																											
Family Emydidae																																											
<i>Gopherus agassizii</i>																																											
Reptilia, Squamata																																											
Family Iguanidae																																											
Subfamily Iguaninae																																											
<i>Ctenosaura conspicuosa</i>																																											
<i>Dipsosaurus dorsalis</i> ^a																																											
<i>Sauromalus obesus</i>																																											
<i>Sauromalus hispidus</i>																																											
<i>Sauromalus varius</i> ^b																																											
Subfamily Phrynosomatinae																																											
<i>Callisaurus draconoides</i>																																											
<i>Petrosaurus mearnsi</i>																																											
<i>Sceloporus hunsakeri</i>																																											
<i>Sceloporus orcutti</i>																																											
<i>Sceloporus zosteromus</i>																																											
<i>Urosaurus nigricaudus</i> ^c																																											
<i>Uta stansburiana</i> ^b																																											
<i>Uta</i> sp. 1																																											
Family Eublepharidae																																											
<i>Coleonyx variegatus</i>																																											

(continued)

Species	Sonora and Sinaloa			N. Baja			Midriff			Bahía de los Angeles					Bahía Concepción			Baja California Sur			Cape Region										
	Alcatraz	Cholludo	Dátil	Patos	San Ignacio	Farralon	Encantada Grande	Miramar	Willard	Cardonosa Este	Roca Lobos	Cabeza de Caballo	Flecha	La Ventana	Mitlán	Plojo	Coronado	Santa Ines (S)	Cayo	El Coyote	San Indefonso	Pardo	Rocas San Cosme	El Pardino	Las Animas	Ballena	Gallina	Gallo			
Family Gekkonidae	C	C	C			C			R																						
<i>Phyllodactylus nocticolus</i> ^a																															
<i>Phyllodactylus partitus</i>																															
<i>Phyllodactylus unctus</i>																															
<i>Phyllodactylus tuberculatus</i>																															
Family Teiidae																															
<i>Chenidophorus dickersonae</i>																															
<i>Chenidophorus tigris</i>																															
Snakes (Serpentes)																															
Family Colubridae																															
<i>Hypsigena torquata</i>																															
<i>Masticophis flagellum</i>																															
<i>Trimorphodon biscutatus</i>																															
Family Viperidae																															
<i>Crotalus atrox</i>																															
<i>Crotalus enyo</i>																															
<i>Crotalus mitchellii</i>																															
Totals	5	2	4-5	2	1	3	5	2	3	2	2	3	2	3	2	4	7	2	2	3	4	4	3	2	2	5	2	5	2	5	

C, on the peninsula of Baja California; E, of peninsular origin and endemic to one island; R, or peninsular origin and endemic to multiple islands; N, mainland Mexico taxon and origin; S, mainland Mexico origin and endemic to one island; M, mainland origin and endemic to multiple islands; I, probably introduced by Seri Indians.

^aAlso occurs on Isla Santiago.

^bAlso occurs on el Requesón, Gaviota, Islitas, San Damian, and Tijeras.

^cAlso occurs on Islas Bola, Cerraja, Colorado, Encantada, Lagartija, Las Galeras (two islands), Pata, and Islotes Blancos.

^dAlso occurs on Isla Moscas.