**Current Names: A Guide to Recent Name**

**Changes of Horned Lizard Species**

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*Introduction*

When I first started writing about our horned lizard species in the United States and Canada in 1981, there were seven species (Sherbrooke 1981). When I considered all the species of horned lizards in North America (including Mexico) in 2003, there were 13 species: eight in the United States and Canada, and five additional species in Mexico (Sherbrooke 2003). Today, by some accounts (see discussion below), there are 17 species. How have these increases in numbers of recognized species of horned lizards come about?

During this period there have been significant changes in the tools used by taxonomists in determining the relationships between populations of horned lizards. In the past morphological and behavioral characteristics as well as geographic and ecological distributions were strong components for making decisions. For several decades now the power of examining gene structure of lizards, through their mitochondrial and nuclear DNA, has gained a very significant role in helping scientists to make taxonomic decisions. These techniques have been widely applied, although how they are applied is sometimes controversial.

Names are how we categorize the complexity of the world surrounding us. In science the naming of living organisms, taxonomy, is done collectively and in part with international rules, so that we may understand species names across all cultures and languages. There is a general consensus that all horned lizard species are closely related and are best categorized as representing a single genus, *Phrynosoma*. With scientific names the first letter of a genus (genera is the plural of genus) is always capitalized, but not that of species names, and both genus and species names are italicized (e.g. *Phrynosoma asio*).

If we find several horned lizards in one location, and they have very similar features,

we may assume they belong to a single species (species is both singular and plural). This is true even if we encounter some differences between individuals, between the two sexes, and between juveniles and adults. If we encounter other horned lizards at the same location that are not similar in appearances to those already identified, we might assume they belong to another species, though that conclusion may require further careful study. If we go to another locality and find similar looking horned lizards, which differ somewhat, we might wonder if they are of the same species we have seen or are of still another species not yet encountered. It is the role of taxonomists to study these situations and make informed judgments as to how names should be applied, taking into account established procedures and the evolutionary history of the species and their close relatives.

Considering the task of naming all of evolved life on earth, taxonomists have had a very long, difficult and constantly evolving endeavor, naming nearly a million species to date (Mayr et al. 1953; Hennig 1966; Mayr 1982). The field continues to evolve as technology advances and concepts change. This all affects the naming and name changes of horned lizard species. A major historic shift was accepting species names as applying to populations of interbreeding individuals that are actually or potentially reproductively isolated from other such populations. But we find geographically isolated populations of very similar animals that have minor morphological or other differences, and it is often nearly impossible to determine how far these populations have evolved towards being reproductively isolated from one another.

Other complications arise as well, such as hybridization between populations considered to

be two separate species. This situation has required informed judgments. Taxonomists use

varied data to reach their conclusions and do not always agree. When morphological differences between populations have been judged to be real, but not evolutionarily significant (still within the same species), taxonomists have sometimes applied subspecies names. Over time new information may come to light and this may result in a revision of prior judgments.

After a new species, similar to species X, has been described and named species Y, there are

two species. Years later Y may be judged to not really be a species distinct from the earlier

described populations named species X. Then the new species Y may be changed to be a

subspecies Y, or the name Y may be removed from use. Later, taxonomists with still more

new data may choose to resurrect the name Y again as a full species name for the population, distinct from the population(s) of species X. Thus, over time, one species X became 2 species X and Y, and then reverted to all being 1 species X. Still later newer data may suggest populations of subspecies Y, of species X, or populations of species X that included what was species Y, are again recognized as a full species Y, resulting again in 2 species, X and Y.

In this listing of horned lizards, I will not consider the history of all subspecies or list them,

but subspecies names may come into consideration as taxonomic changes bring them into

judgments in correctly applying established scientific names to populations.

A modern innovation in considering the relationships of species, like among horned lizards,

is a taxonomic methodology known as cladistics (Hennig 1966). In cladistics all species are

seen as pairs derived from another single ancestral species and the two new ones are considered sister species. This establishes monophyletic (single) lines of evolution. These

species relationships are presented as cladograms, branching diagrams that summarize extensive character data that have been statistically analyzed for each species. They illustrate closeness of relationships between species (sister species, a clade) and older bifurcating groups of species also referred to as clades.

The tools used in determination of relationships between species and groups of organisms

have been greatly enhanced by access to genetic codes incorporated in the mitochondrial

and nuclear DNA of species. Nevertheless, groupings of morphological data and of molecular data regarding species may not always provide identically clear resolutions between relationships of species or groups of species (Losos et al. 2012). This has led some

taxonomists of horned lizards to have different judgments concerning the naming of different horned lizard species. Those focused on morphological data have frequently used subspecies as subunits of species, whereas those using molecular data designate subdivisions as clades. Thus, the literature is mixed as to how many species there are, according to different scientists. In general, species described from morphological data are easier to identify in the field (morphological characters are often easy to see), than are species determined from laboratory molecular data. I will review recent publications of taxonomic changes of horned lizard scientific names resulting from both approaches.

Common names have been applied for centuries to horned lizards across many languages,

cultures and geographical areas. Often these broadly applied names are used without recognizing scientific species differences. Widely used English common names are often applied to multiple species, e.g. horny toads, horned lizards, horned frogs, and in Spanish

camaleón and tapayaxin. With modern standardizations, common names are being applied

to specific species throughout their ranges and are becoming more useful (Liner and Casa-

Andreu 2008; Crother et al. 2017), especially for non-scientists. But for species not well

known they are often not in common use by the general public. Common names have no

formal scientific recognition but are widely being incorporated to clarify informal names of

scientifically determined species. Their descriptive value varies greatly. I will incorporate

these in the listing of scientific names for horned lizards, with comments (Table 1).

*Review*

Reviewing the extensive earlier literature on horned lizards for a popular booklet in 1981, I

found the following seven species to occur in the United States and Canada: *Phrynosoma*

*cornutum*, *P. coronatum*, *P. douglassi*, *P. m’calli*, *P. modestum*, *P. platyrhinos*, and *P. solare*,

(Sherbrooke 1981). In 1987 Montanucci published a taxonomic review of the entire genus,

including species in Mexico, and made decisions concerning species relationships and

names based on skeletal and external morphological features. He suggested that there were

12 species of horned lizards in two lineages, a “southern radiation” consisting of *Phrynosoma asio*, *P. braconnieri*, *P. ditmarsi*, *and P. taurus*, and a “northern radiation” consisting of *Phrynosoma douglassii*, *P. cornutum*, *P. coronatum*, *P. mcallii*, *P. modestum*, *P. orbiculare*, *P. platyrhinos* and *P. solare*. His analysis differed somewhat from another earlier skeletalstudy that recognized 14 species of horned lizards (Presch I969). Baur and Montanucci(1998) utilized the same 12 names as Montanucci in 1987 and presented a taxonomic history of names for those species. (Note: Throughout this review I will use the spelling ofspecies names as they appear in each publication. Minor variations in spellings of speciesnames are due to various taxonomic issues, including linguistic considerations, or errors,but not to changes in species recognized.)

In 1997, utilizing mitochondrial DNA data, Zamudio et al. published a review of the widespread short-horned horned lizards (*Phrynosoma douglasi*; with six subspecies) of the western United States, southwestern Canada, and northern Mexico. They clearly determined that one clade (subspecies) in the NW corner of the U.S. has an evolutionary history distinct from all other clades and is a separate species. Since those populations had previously been recognized as *Phrynosoma douglasi douglasi* those populations then became the species *Phrynosoma* *douglasi*. The other clades (subspecies) were all considered to be a single species and were given the name of the oldest (first) named, which was *hernandezi*, of the other named populations/subspecies or clades. Thus, they were all *Phrynosoma hernandezi*.

Therefore when I published on horned lizards in 2003 (Sherbrooke 2003) I recognized two

species of short-horned horned lizards, *P. douglasii* and *P. hernandesi* (following Zamudio et al. 1997). That resulted in a total of 13 species in the genus, including five species found only in Mexico, *P. asio*, *P. braconnieri*, *P. ditmarsi*, *P. orbiculare*, and *P. taurus* (Sherbrooke 2003).

Further study of mitochondrial genes of these 13 species suggested they are grouped into five clades (Hodges and Zamudio 2004). However, somewhat earlier studies (Reeder and Montanucci 2001) had found difficulty in arriving at congruous grouping of 12 species (including *P. douglasi* but not *P. hernandesi*) into clades due to conflicting morphological or mitochondrial DNA data analyses. Mitochondrial DNA strongly placed *P. ditmarsi* with short-horned *P. orbiculare* and *P. douglasi*, whereas morphological data strongly suggested its exclusion from that clade and placed it near the southern species *P. braconnieri* and *P. taurus*.

In 2004 Montanucci published a paper based on morphological and color pattern data that focused on geographic differences in populations of a species formerly considered *Phrynosoma* *coronatum*, a single species with six subspecies (Brattstrom 1997). Its range extended from coastal northern California to the southern end of the Baja California peninsula in Mexico. Over the years various populations throughout the range had received numerous names. Not recognizing all these populations as valid species, Montanucci concluded that three named populations were distinct species, *P. blainvillii*, *P. cerroense*, and *P. coronatum*. He then described another population, of the formerly recognized widespread *P. coronatum*, as a distinct, previously undescribed species, *Phrynosoma wigginsi*. His designation of the name *coronatum* to populations at the southern end of Baja California, from where that name was originally applied, left the next oldest name *blanvillii* to be applied to more northern populations, in the state of California and northern Baja California.

Overall, this arrangement added three species (two incorporating preexisting names, *blainvillii* and *cerroense*, and one with a new name, *wigginsi*) to his former taxonomic listings of 12horned lizard species (Montanucci 1987; Baur and Montanucci 1998; neither publication recognizing *P. hernandesi* as distinct from *P. douglasii*). The separation of those two had led to 13species (Zamudio et al. 1997). Thus, the count of horned lizard species was raised to 16.

In 2006 Mulcany et al. published a paper in which they used mitochondrial DNA data to analyze and reexamine the status of populations of *Phrynosoma platyrhinos* previously designated as having three subspecies. They concluded that one former subspecies is a separate and distinct species, apart from the other two. So they resurrected it as a species, with its former given name of *Phrynosoma goodei*. Thus, it became recognized as a 17th species of horned lizard.

Also, in 2006, Leaché and McGuire, recognizing the difficulties arising from some conflicts

between morphological and mitochondrial DNA data, reexamined the relationships of the

17 species using mitochondrial and nuclear DNA evidence. In analyzing the data, they discovered misleading mitochondrial gene tree problems. Their resulting cladogram of relationships of the 17 species in the genus suggested four clades of related species which they named in a phylogenetic taxonomy of the genus *Phrynosoma*: (1) clade Tapaja (*P. ditmarsi*, *P.* *hernandesi*, *P. douglasii*, *P. orbiculare*), (2) clade Doliosaurus (*P. goodei, P. platyrhinos*, *P. modestum*), (3) clade Anota (*P. solare*, *P. mcalli*, *P. cerroense*, *P. wigginsi*, *P. blainvillii*, *P. coronatum*), and (4) clade Brevicauda (*P. taurus*, *P. braconnieri*), with *P. cornutum* and *P. asio* being basal to the four clades.

In 2009 Leaché et al. studied ecological, morphological, and genetic variation in four

species of horned lizards previously studied morphologically by Montanucci (2004) and assigned by Leaché and McGuire (2006) to the Anota clade. These populations occur from

northern California to the southern cape region of Baja California. They found only three

taxonomically well-defined populations. From north to south these are *Phrynosoma blanvillii*, *P. cerroense*, and *P. coronatum*. Thus, the name *P. wigginsi* was no longer recognized as a distinct species. This brought the number of horned lizard species down to 16 (Leaché et al. 2009).

Then a paper published in 2014 described a newly discovered population of horned lizards

in Mexico. After careful study of nuclear and mitochondrial genetic data, and morphological

data, it was determined to be a new species from Guerrero, Mexico, *Phrynosoma sherbrookei* (Nieto-Montes de Oca et al. 2014). This new species resulted in there again being a total of17 species of horned lizards. Later Leaché and Linkem (2015), using new DNA sequencingtechniques for a scaled-up analysis of the 17 species of horned lizards (without *P. wigginsi*,but with *P. sherbrookei*) confirmed the four clades described earlier (Leaché and McGuire2006), and placed *P. sherbrookei* in the clade Brevicauda.

Central Mexico is a topographically complex home, including the Trans-volcanic Belt, to

widely distributed populations of horned lizards that have received numerous names over

decades by various taxonomists (six subspecies, Baur and Montanucci 1998). They are currently known collectively as *Phrynosoma orbiculare* (Montanucci 1979; Bryson et al. 2012; Morano Barajas et al. 2013). Bryson et al. used mitochondrial DNA to examine the history of *P. orbiculare* and to estimate the timing and tempo of lineage diversification. Their study supported 11 geographic lineages or clades, variously associated with the earlier described subspecies. The authors suggested that further studies would be advisable prior to alterations in scientific species names that might be suggested by their initial findings.

Then in 2015 Montanucci used comparative morphological traits and color patterns in a

massive taxonomic revision of short-horned horned lizards in the *Phrynosoma douglasii*

complex, five subspecies that occur throughout the Inter-montane West and Great Plains of

western North America, southward into Mexico. The separation of *P. douglasii* as a species

apart from *P. hernandesi* (Zamudio et al. 1997) was confirmed. But two of the five subspecies, *P. douglasii brevirostris* and *P. douglasii ornatissimum*, were resurrected as full species (*P. brevirostris* and *P. ornatissimum*), being considered distinct from *P. hernandesi*. In addition, two new species were named from populations not formerly designated with

names. They were named *P. bauri* and *P. diminutum*. These taxonomic changes, two of revised status of former subspecies to species and two as new descriptions of populations not formerly recognized as distinct, raised the number of species of horned lizards from 17 to 21.

But at odds with that view of the taxonomy of the *P. douglasii* complex, Crothers et al. 2017,

in a review of common and scientific herpetological names, suggested that this arrangement by Montanucci (2015) exhibits both conflicts with inferred phylogenetic relationships based on mitochondrial and nuclear DNA studies and internal inconsistencies. Therefore, they relegated the four species newly recognized by Montanucci (2015) to subspecies status, pending an analysis of explicit species delimitations based on multilocus genetic data (Crothers et al. 2017). Accepting that conclusion leaves the short-horned species complex with two species, *P. douglasii* and *P. hernandesi*. And, it brings our list of current horned lizard species in the genus *Phrynosoma* back to 17 species (Table 1).

I have accepted the published and most recent conclusions regarding valid species names

without changes. These are discussions of scientists who have been expending great effort

to understand the history and evolution of horned lizards. As they continue their efforts

and engage others, we will learn more. A careful reading of the taxonomic literature will

clearly reveal there are still lingering issues not fully resolved in determining the current

limits of relationships between populations and species of horned lizards. This leaves me

with acceptance that further studies, some in progress, will continue to alter some of the

species designations that have been presented here. I will present below my understanding

of current scientific names of the various populations of horned lizards of North America. I

look forward to future contributions to our understanding of horned lizard evolution.

*Current Scientific and Common Names of Horned Lizards*

Current scientific names are presented alphabetically. These species and common names

follow those established by Crother et al. (2017) and Liner and Casas-Andreu (2008) (all in

bold in Table 1), with my addition of the latest new species, *Phrynosoma sherbrookei*, not

considered by those authors. In some cases of common names, I have suggested alternatives (added, not in bold) to those listed from Liner and Casas-Andreu (2008) and Crother et al. (2017). I do not include names of currently recognized subspecies.

These additions carry superscripts 1-9 to notations at the end of the list where I append my

reasons for future herpetological common name reviewers to consider changes. I do not expect all, perhaps none, to be accepted. Standardizing common names for scientific horned lizard species, a very worthy pursuit, is somewhat difficult as the scientific understanding of the species change. A change of a scientific name of a species or its application to populations in different geographic areas may cause incongruent use of a previously assigned common name, or in some wider context, descriptive common names may be inappropriate in relation to another species’ common name.

Table 1. Scientific and Common Names of 17 Horned Lizards, genus *Phrynosoma*, with notations of countries of occurrence (United States, US; Mexico, MX, Canada, CAN). There are 9 species in the United States, 16 in Mexico, and 1 + 1 (?) in Canada (with *P. douglasii* apparently extirpated in Canada; Powell and Russell 1998). Those not in bold font are suggested alternatives.

|  |  |  |
| --- | --- | --- |
| ***Phrynosoma asio*** | **Giant Horned Lizard** | **MX** |
| ***Phrynosoma blainvillii*** | **1Blainville’s Horned Lizard** | **US, MX** |
|  | 1Pacific Coast Horned Lizard |  |
| ***Phrynosoma braconnieri*** | **Short-tailed Horned Lizard** | **MX** |
| ***Phrynosoma cerroense*** | **3Cedros Island Horned Lizard** | **MX** |
|  | 3Baja Horned Lizard |  |
| ***Phrynosoma cornutum*** | **Texas Horned Lizard** | **US, MX** |
| ***Phrynosoma coronatum*** | **4Coast Horned Lizard** | **MX** |
|  | 4Baja-Cape Horned Lizard |  |
| ***Phrynosoma ditmarsi*** | **Rock Horned Lizard** | **MX** |
|  | 5Ditmars’ Horned Lizard |  |
| ***Phrynosoma douglasii*** | **Pygmy Short-horned Lizard** | **US, CAN (?)** |
| ***Phrynosoma goodei*** | **6Goode’s Horned Lizard** | **US, MX** |
|  | 6Sonoran Horned Lizard |  |
| ***Phrynosoma hernandesi*** | **Greater Short-horned Lizard** | **US, MX, CAN** |
| ***Phrynosoma mcallii*** | **Flat-tailed Horned Lizard** | **US, MX** |
| ***Phrynosoma modestum*** | **Round-tailed Horned Lizard** | **US, MX** |
| ***Phrynosoma orbiculare*** | **Mountain Horned Lizard** | **MX** |
|  | Mexican-plateau Horned Lizard |  |
| ***Phrynosoma platyrhinos*** | **Desert Horned Lizard** | **US, MX** |
| ***Phrynosoma sherbrookei*** | 8Guerrero Horned Lizard | **MX** |
|  | 8Sherbrooke’s Horned Lizard |  |
| ***Phrynosoma solare*** | **Regal Horned Lizard** | **US, MX** |
| ***Phrynosoma taurus*** | **9Mexican Horned Lizard** | **MX** |
|  | 9Bull Horned Lizard |  |

1 The resurrection of the name *P. blainvillii*, introduces an unfamiliar and non-descriptive common name to populations in California and northern Baja California long known as Coast Horned Lizards. Until recently all populations of *P. coronatum* carried that common name. Using that old common name (Coast Horned Lizard) does not seem to clearly apply solely to populations of *P. coronatum* now limited to parts of southern Baja California in Mexico (see 4 *P. coronatum* below). Retaining the relationship of populations of this species to areas broadly adjacentto the ocean and adding some uniqueness to the common name, I suggest Pacific Coast Horned Lizards for *P. blainvillii*. This name seems more geographically expansive than Cape Horned Lizard used for *P. blainvillii* (Edley and Nossaman 2015).

2 The common name Short-tailed Horned Lizard for *P. braconnieri* has not been widely used. Descriptively, Short-tailed Horned Lizard could apply to several other species (e.g. *P. ditmarsi*, *P. sherbrookei*, *P. taurus*). Short-tailed Horned Lizard has been used by Liner and Casas-Andreu 2008, Jiménez-Arcos et al. 2014, and Edley and Nossaman 2015. Perhaps a more distinctive common name is not available?

3 The use of the scientific name *P. cerroense* has been expanded from a population on a small Pacific coastal island (Cedros Island) to populations on a significant portion of the Baja California peninsula. Thus, naming it the Cedros Island Horned Lizard seems misleading. The name Baja Horned Lizard corresponds to its wide geographic distribution throughout the mid-Baja peninsula. This name seems more appropriate, but its use would result in instability for the current common name.

4 The common name of *P. coronatum* has a history as the Coast Horned Lizard (see 1 above; *P. blainvillii*), but with the restriction of the scientific name to populations in southern Baja California, with other former populations of that species now located to the north (*P. cerroense* and *P. blainvillii*), *P. coronatum* should have a more restrictive common name. Based on biogeography (Grismer 2002; Bezy et al. 2019), I suggest Baja-Cape Horned Lizard for these populations (*P. coronatum*) on the southern end of the peninsula.

5 The common name of *Phrynosoma ditmarsi* has been Ditmars’ Horned Lizard for some time (Roth 1971, 1997; Lowe and Howard 1975; Sherbrooke 1997), but more recently has been called Rock Horned Lizard (Lowe and Howard 1975; Liner and Casas-Andreu 2008; Edley and Nossaman 2015; Rorabaugh and Lemos-Espinal 2016; Molina-Padilla et al. 2019). Unfortunately, its descriptive nature could be applied to several other species of horned lizards considered stone or rock mimics (e.g. *P. modestum*). Additionally, in discussions people frequently refer to *P. ditmarsi* as Ditmars’ Horned Lizard. In part this is due to its over half century disappearance and interesting history of rediscovery (Lowe et al. 1971; Roth 1971, 1997; Sherbrooke 1997). Such a change in common name would disrupt name stability, but might reflect real “common name” usage.

6 The resurrection of the scientific name *Phrynosoma goodei* has lead to the coining of common names for the species. Two sources have simply incorporated the species name honoring a person, Goode’s Horned Lizard, thus giving no information about distribution or

features (Liner and Casas-Andreu 2008; Crother et al. 2017). Liner and Casas-Andreu (2008) give a Spanish common name of Camaleón de Sonora, but an English common name of Goode’s Desert Horned Lizard. Mulcahy et al. (2006) refer to “The Sonoran horned lizard

(*Phrynosoma goodei* Stejneger 1893)….” They did not capitalize it as a common name. Given

the distribution of the species within the Sonoran Desert and within the Mexican state of

Sonora, I think the common name of Sonoran Horned Lizard is most appropriate.

7 The name Mexican-plateau Horned Lizard (Sherbrooke 2003; Edley and Nossaman 2015;

Van Devender et al. 2015) has been used for *Phrynosoma orbiculare*, as has Mountain Horned Lizard (Beltrán-Sánchez et al. 2000; Liner and Casas-Andreu 2008). Unfortunately, Mountain Horned Lizard might seem to apply to other horned lizard species living at higher elevations, both in the United States and Mexico. This species, living in the northern and central highlands of Mexico, might better be called Mexican-plateau Horned Lizard, or Mexican Mountain Horned Lizard.

8 Edley and Nossaman (2015) used the common name of Sherbrooke’s Horned Lizard for

*Phrynosoma sherbrookei* described in 2014 (Nieto-Montes de Oca et al. 2014). But a note reporting a new location for the species, also in the Mexican state of Guerrero, has used the

common name Guerrero Horned Lizard (Bautista-del Moral et al. 2019). A “formal” common name awaits selection.

9 *Phrynosoma taurus* has long been known by the common name of Bull Horned Lizard

(Sherbrooke 2003; Edley and Nossaman 2015), reflecting its spectacular horn arrangement. Therefore, it seems strange that its Spanish common name is given as Camaleón Toro, and its common name in English is given as Mexican Horned Lizard in Liner and Casas-Andreu (2008), and by García-Vázquez and Canseco-Marquez (2006). I would hope that the very descriptive name Bull Horned Lizard would be used in place of a name that could be applied to 16 species of horned lizard occurring in Mexico, eight exclusively.

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