

An Initial Estimation of the Numbers and Identification of Extant Non-Snake/Non-Amphisbaenian Lizard Kinds: Order Squamata

Tom Hennigan, Truett-McConnell College, Cleveland, Georgia.

Abstract

Biosystematics is in great flux today because of the plethora of genetic research which continually redefines how we perceive relationships between organisms. Despite the large amount of data being published, the challenge is having enough knowledge about genetics to draw conclusions regarding the biological history of organisms and their taxonomy. Consequently the biosystematics for most taxa is in great flux and not without controversy by practitioners in the field. Therefore, this preliminary paper is meant to produce a current summary of lizard systematics, as it is understood today. It is meant to lay a groundwork for creation systematics with the goal of estimating the number of baramins brought on the Ark. Based on the analyses of current molecular data, taxonomy, hybridization capability, and statistical baraminology of extant organisms, a tentative estimate of 43 extant non-snake, non-amphisbaenian lizard kinds were taken on board the Ark. It is hoped that this paper will encourage future research into creationist biosystematics.

Keywords: Ark Encounter, biosystematics, taxonomy, reptiles, squamata, kind, baraminology, lizard

Introduction

Creation research is guided by God's Word, which is foundational to the scientific models that are built. The biblical and scientific challenge is to investigate several questions surrounding what the kind is, how to recognize it, and the mechanisms involved with organismal diversification (Brophy and Kramer 2007; Lightner et al. 2011; Sanders and Wise 2003; Turner 2009; Williams 1997; Wise 1992; Wood 2003; Wood et al. 2003; Woodmorappe 1996).

In previous papers, the current understanding of most herptile systematics was overviewed and numbers of kinds estimated (Hennigan 2013a, 2013b, 2014a, 2014b). The purpose of this paper is to survey the current understanding of lizard biosystematics and taxonomy (excluding snakes and amphisbaenas) and use available information to make a preliminary estimate of the identification and numbers of extant lizard kinds. The conclusions brought forth will no doubt change with future data as our understanding of creation biosystematics improves.

The State of Biosystematics and Taxonomy Today

Biosystematics is the science of discovering, classifying, and organizing biological diversity. The science of identifying taxa and naming organisms is taxonomy. There is no universally accepted procedure for classifying organisms and currently these disciplines are in great flux as researchers are placing more importance on accumulating new genetic and molecular data for phylogeny development; much is being changed accordingly. Therefore, how organisms are named and organized

today may change tomorrow, depending on the data and assumptions about that data. For example, naturalists assume randomness and universal common descent. In keeping with these assumptions, they are gradually moving away from Linnaean hierarchies and toward the PhyloCode system (Vitt and Caldwell 2009, pp.20–25). See Ross (2014) for an in-depth discussion regarding taxonomic hierarchy assumptions and methodologies within Linnaean and cladistic systems. In contrast, creation biologists recognize the God of Scripture as the Creator of all "kinds" and assume "forest," rather than "tree" thinking, when interpreting biological diversity and disparity. Instead of the tree (or trees) of life that represent evolutionary random processes and universal common descent, the creationist may visualize individual trees in a forest as the originally created kinds. The separation of each tree represents the discontinuity between kinds and the degree of branching represents the diversification of that kind over time since the creation. Specifically, creationists are interested in how creatures have diversified from the originally created baramins and the archetypes that left the Ark. While anatomical, genetic, and molecular data will be incorporated in this taxonomic analysis, and taxonomic categories will be based on Uetz (2014), there is not enough knowledge about biochemistry to draw universal conclusions regarding the biological history and taxonomy of organisms. Adding to the complexity, little hybridization data is available and statistical baraminology data has only been done for a few squamate taxa (Brophy and Kramer 2007; Wood 2005). Therefore, it is important

to consider the following precautions and perspectives. Baraminologists tend to equate kinds with the family and for many cases with good reason (Wood 2006). However, we should carefully analyze the structures, behaviors, and physiologies of members of a putative kind and look at the genetic reasons why a certain member of a kind doesn't have characters that other members possess (Wilson 2010). Within his Trinitarian character God is diverse and we would expect that his creation would reflect that diversity. When we better understand what mechanisms are involved in the production of differences, we should be better able to infer whether they are traits produced by direct creation, post-Flood diversification through unknown/known designed genetic mechanisms, and/or random mutations.

Suborder Squamata: Lizards

Lepidosaurids, based on Linnaean taxonomy, are currently classified accordingly: Class Reptilia; Subclass Diapsida; Superorder Lepidosauria; and two Orders: Rhyncocephalia (Suborder Sphenodontida—tuataras) and Squamata (“lizards” that also include snakes and amphisbaenas). Squamates have the greatest diversity of all reptile taxa and representatives can be found on all continents except Antarctica (Uetz 2014; Vitt and Caldwell 2009, pp. 4, 514–515).

Based on evolutionary assumptions, squamates have more than 50 shared-derived traits that include a single, fused premaxillary and single parietals, reduced nasals, no vomerine teeth, specialized wrist and ankle joints, hooked fifth metatarsal, paired copulatory organs (hemipenes), saccular ovaries, vomeronasal organ separated from the nasal capsule, lacrimal duct joined to the vomeronasal duct, femoral and preanal glands, and an egg tooth in hatchlings (Vitt and Caldwell 2009, p.514). Though amphisbaenas and snakes are nested within lizards according to the philosophical/material naturalist paradigm, I infer from the biblical creation paradigm that they are separate kinds and therefore not related to one another. Any traits in common can also be interpreted as sharing a common Creator, rather than a common ancestor. Therefore, for the rest of this paper lizards will refer to the non-snake and non-amphisbaena members of squamata.

As of August 2014 there are 5987 known lizard species, making them the most speciose extant reptile group, even without considering snakes and amphisbaenas, with new ones being discovered every year (Uetz 2014; Vitt and Caldwell 2009, p.514). What follows are brief descriptions of each lizard group as per Uetz (2014), the estimated kinds as tentatively identified at the family level as per Wood (2006), Lightner (2012, 2013), and Ross (2014). Other

information includes average snout to vent length (SVL) or average total length (TL) as estimated by Vitt and Caldwell (2009). At times descriptions may be reminiscent of a herpetological field guide, they are meant to compare and contrast behaviors and processes that may be relevant for distinguishing continuity and discontinuity between kinds.

Infraorder Iguania

1. Dragon Lizard Kind—Family Agamidae— 56 genera—445 species—SVL=198 mm (7.7 in)



Fig. 1. *Agama mwanzae*. Photograph: Chmehl. <http://en.wikipedia.org/wiki/Agamidae>.



Fig. 2. *Sitana ponticeriana*. Photograph: J.N. Garg. <http://en.wikipedia.org/wiki/Agamidae>.

Found in Africa, Asia, and Australia, dragon lizard general characteristics include: pleurodont teeth. (Note, while most non-amphisbaena/non-snake lizard clades have pleurodont teeth, or teeth that come from the side of the jaw, Agamidae (and Chamaeleonidae) have acrodont teeth which connect to the bone surface). Other dragon lizard characters include no teeth on the pterygoid bone, juxtaposed scales cover the body dorsoventrally, and intraspecific hybrids producing parthenogenic offspring (Hartman, Geissler, and Böhme 2011; Uetz

2014; Vitt and Caldwell 2009, p.516). It has been suggested that some species of *Phrynocephalus* and *Cophotis ceylanica* are viviparous while most are oviparous (Vitt and Caldwell 2009, p.517). Viviparity is thought to have evolved from oviparity but some lizards, such as skinks, can alternate between birth modes depending on environmental conditions (Handwerk 2010). Among the most well known members of Agamidae are the gliding lizards of genus *Draco*.

2. Chameleon Kind—Family Chamaeleonidae—
12 genera—200 species—SVL = 195 mm (7.6in)



Fig. 3. *Bradypodion pumilum*. Photograph: Chiswick Chap. <http://en.wikipedia.org/wiki/Chameleon>.



Fig. 4. Malagasy giant chameleon. Photograph: Bernard Gagnon. <http://en.wikipedia.org/wiki/Chameleon>.

Distributed from the Middle East, Africa, and Madagascar to India, southern Spain, and Sri Lanka, chameleons are unique in many ways. Characters include: strong, laterally compressed bodies,



Fig. 5. *Brookesia micra*. Photograph: F. Glaw, J. Köhler, T.M. Townsend, and M. Vences. http://commons.wikimedia.org/wiki/File:Brookesia_micra_on_a_match_head.jpg.

prehensile tails, head casque (“helmet”) around neck, zygodactylous-like feet forming two-digitated mitten-like fore and hind feet, projectile tongues, independently (binocular-like) moveable eyes, and ability to adjust body colors with their environmental setting (Uetz 2014; Vitt and Caldwell 2009, pp.518–520). Intraspecific hybrids are sold in the pet trade, but there is little information concerning interspecific hybridization either in captivity or the wild. *Brookesia micra* (a tiny “leaf” chameleon) may be one of the smallest reptiles in the world with lengths as small as 25 mm (0.98in) (Vitt and Caldwell 2009, p.519).

Superfamily Iguanidae

Historically, the taxonomy of iguanids has been difficult and not without controversy (Frost 1992; Frost and Etheridge 1989; Frost et al. 2001; Macey et al. 1997; Schulte, Valladares, and Larson 2003). From a baraminological perspective it is important to note that intergeneric hybridization between the land iguana (*Conolophus subcristatus*) and the marine iguana (*Amblyrhynchus cristatus*) minimally connects the two genera into a monobaramin (Rassmann, Trillmich, and Tautz 1997) and therefore, it is not surprising that iguanid taxonomy and origins has piqued creationist interest (Hennigan 2009; Hennigan, Purdom, and Wood 2009; Wood 2005). Wood (2005) did statistical baraminology (baraminic distance and 3-D Multi-Dimensional Scaling analysis) on data obtained by Frost and Etheridge (1989) and Frost (1992) and found that Frost’s subfamilies (Crotaphytinae, Corytophaninae, Hoplocercinae, Iguaninae, Oplurinae, Phrynosomatinae, Polychrinae, and Tropicurinae) have significant positive correlation with each other and significant negative correlation with acrodont lizards, which defines the group as a holobaramin. Wood proposed that Iguanids in Frost’s biosystematics (including Galápagos members of Tropicuridae (e.g. lava lizards) and the land and marine iguanas) are a holobaramin and can trace

their ancestry from the original pair of iguanids that dispersed from the Ark.

Systemetists that tend to lump taxa would not necessarily have a problem with that conclusion, especially since the conclusion was derived by quantitative means. However, there are limits to statistical analysis and one of the most glaring is that the characters that were analyzed were few (when compared to the total number of possible characters) and data were not completely holistic.

Systemetists who tend to split taxa may argue that more genetic mechanisms for various character expressions need to be better understood before lumping organisms together from limited statistical data. So it is possible that our current understanding may favor these eight families as one kind, but we may also have anywhere from one to eight or more kinds within the iguanid taxon and that assumes the kind is at the Family level. There is still much research required to understand iguanid relationships and many of Frost's identified subfamilies have been upgraded to families by other researchers (Uetz 2014). These questions are a good illustration of the difficulty surrounding organism continuity and discontinuity from both evolutionary and creationary perspectives. Below, each iguanid family will be treated as a separate created kind, with the understanding that these categories will change as our understanding gets better.

3. Casquehead Lizard Kind—

Family Corytophanidae—3 genera—
9 species—SVL=145 mm (5.7 in)



Fig. 6. *Basiliscus vittatus*. Photograph: Benjamins444. <http://en.wikipedia.org/wiki/Corytophanidae>.

Casquehead lizards are endemic from southern Mexico to northern South America (Vitt and Caldwell 2009, p.521). Shared characters include lacrimal foramen of skull not enlarged, absent palatine teeth, pterygoid teeth present, largely arboreal, long limbed and long tailed (Uetz 2014; Vitt and Caldwell 2009, p.521). Though they are good tree climbers, basilisks (*Basiliscus sp.*) are an exception to an exclusively

arboreal niche. Omnivorous, they are active forest ground dwellers and have rapid bipedal running speed. Known as the “Jesus Christ lizard,” they can run across water at speeds of 1.5 m/s (Nat. Geo. 2014).

4. Collared Lizard Kind—

Family Crotaphytidae—2 genera—12 species—
SVL=120 mm (4.7 in)



Fig. 7. *Crotaphytus collaris*. Photograph: Daniel Schwen. <http://en.wikipedia.org/wiki/Crotaphytidae>.

Found in the southwestern United States and northern Mexico, collared lizards share characters that include: palatine and pterygoid teeth present, stout bodies, long and strong limbs, long tails, mostly diurnal predators, and capable of bipedal running (Uetz 2014; Vitt and Caldwell 2009, p.522).

5. Anole Kind—Family Dactyloidae—1 genus (*Anolis*)—391 species—SVL=80 mm (3.1 in)

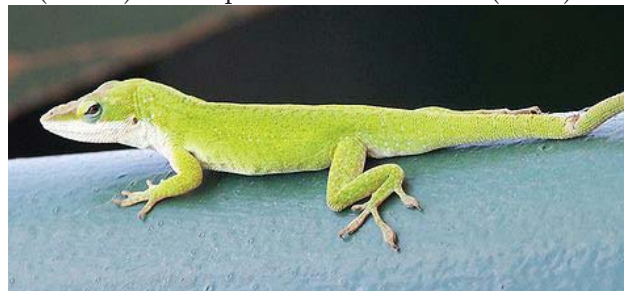


Fig. 8. *Anolis carolinensis*. Photograph: DanielCD. <http://en.wikipedia.org/wiki/Anolis>.

Anoles can be found in the southeastern USA, southern South America, and the West Indies. Generally considered monotypic, *Anolis* is the most species rich of the amniote tetrapods. Although they are morphologically similar, they exhibit considerable biochemical diversity, generating considerable discussion of their biosystematics (Glor, Losos, and Larson 2005; Uetz 2014). As a group they are being used as models for studying adaptive radiation and phenotypic plasticity in the context of island biogeography. In island habitats they tend to partition resources by diversifying into several ecological niches. Some have identified

several clades that could represent different genera, but this is not universally accepted (Nicholson et al. 2012). There has been some interspecific hybridization reported in Trinidad (Hailey, Quesnel, and Boos 2009). Called ecomorphs, rapid morphological changes may take place such as longer limbs on those who occupy tree trunks and shorter limbs on those who live on twigs. Experimental introductions of *Anolis* to islands have allowed researchers to predict how they will diversify (Losos et al. 1998; Losos 2007). Diversification into differing niches is not necessarily based on morphological differences but can be based on their thermal biology as they have been found to be quite adaptable to temperature differences, a unique ability when compared to other lizard taxa (Hertz et al. 2012; Leal and Gunderson 2012; Losos 2009). Most are sexually dimorphic and females have a unique reproductive physiology. Egg production is continuous, alternating between left and right ovaries that, when under ideal conditions, will allow a female to lay one egg at a time every 7–20 days (Vitt and Caldwell 2009, p. 524). In the natural world this egg production would not be continuous all year because seasonality and food resources affect egg production.

6. Bush Anole Kind—Family Polychrotidae—
1 genus (*Polychrus*)—7 species—
SVL=70 mm (2.7 in)



Fig. 9. *Polychrus acutirostris*. Photograph: Bolivar R. Garcete-Barrett. <http://en.wikipedia.org/wiki/Polychrotidae>.

The family used to be considered part of Anolidae, but recent molecular studies suggest that they may not be closely related at all (Uetz 2014). This family may be connected to Dactyloidae. Until more data are available, I distinguish Polychrotidae and Dactyloidae as two kinds.

7. Wood Lizard Kind—Family Hoplocercidae—
3 genera—16 species—SVL=120 mm (4.7 in)
From the isthmus of Panama to northern South



Fig. 10. *Enyalioides palpebralis*. <http://en.wikipedia.org/wiki/Hoplocercidae>.

America and the upland Amazon basin, wood lizards are moderately large and robust, diverse in their morphology, and insectivorous (Uetz 2014; Vitt and Caldwell 2009, p. 522).

8. Iguana Kind—Family Iguanidae—8 genera—
39 species—SVL=200 mm (8 in)

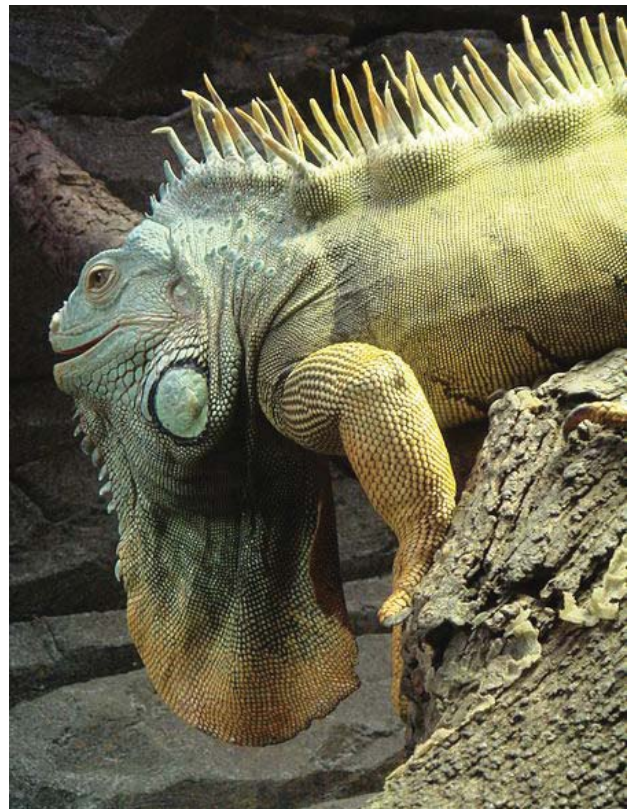


Fig. 11. *Iguana iguana*. Photograph: Manuel de Corselas. <http://en.wikipedia.org/wiki/Iguanidae>.

Distributed from the southwestern USA, South America, Galápagos, West Central Pacific Islands, and the West Indies and, with the exception of the marine iguana who feeds on algae under water, most iguanas are large terrestrial herbivores. (*Iguana* and *Brachylophus* are almost exclusively arboreal). Iguanans are oviparous with many of the larger species migrating to special nesting locations to lay their clutches of 12–88 eggs (Vitt and Caldwell 2009, p. 522).



Fig. 12. *Amblyrhynchus cristatus cristatus*. Photograph: D. Gordon E. Robertson. http://en.wikipedia.org/wiki/Marine_iguana.



Fig. 13. *Conolophus subcristatus*. Photograph: Charlesjsharp. http://en.wikipedia.org/wiki/Galapagos_land_iguana.

9. Curly-Tailed Lizard Kind—Family Leiocephalidae—1 genus (*Leiocephalus*)—29 species—SVL=70 mm (2.7 in)



Fig. 14. *Leiocephalus carinatus armouri*. Photograph: Ianaré Sévi. http://en.wikipedia.org/wiki/Curly-tailed_lizards.

Found throughout the Caribbean, curly-tailed lizards have not been studied in depth.

10. Tree Lizard Kind—Family Leiosauridae—6 genera—32 species—SVL=80 mm (3.1 in)

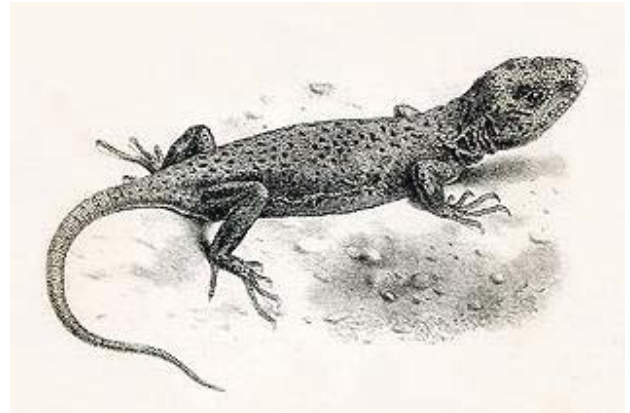


Fig. 15. *Urostrophus scapulatus*. Artist: Peter Smit. http://en.wikipedia.org/wiki/File:Urostrophus_scapulatus.jpg.

Tree lizards are endemic to South America and many are known for their triangular heads and strong jaws.

11. Snow Swift Kind—Family Liolaemidae—3 genera—286 species—SVL=73 mm (2.8 in)

Snow swifts are distributed throughout South America.



Fig. 16. *Liolaemus tentuis* male (left) and female. Photograph: Lycaon.cl. <http://en.wikipedia.org/wiki/Liolaemidae>.

12. Madagascar Iguanid Kind—Family Opluridae—2 genera—7 species—SVL=75 mm (2.9 in)



Fig. 17. *Oplurus cuvieri*. Photographer: JialiangGao. <http://en.wikipedia.org/wiki/Opluridae>.

These lizards are native to Madagascar and the Comores.

13. Horned Lizard Kind—Family

Phrynosomatidae—9 genera—148 species—
SVL=75 mm (2.9 in)



Fig. 18. *Phrynosoma platyrhinos*. Photograph: Pierre Fidenci. <http://en.wikipedia.org/wiki/Phrynosomatidae>.

These are the dominant iguanid lizards of Mexico and North America and have the following characters; xeric environment design, most oviparous with *Phrynosoma* and *Sceloporus* being oviviviparous, birthing 6–30 neonates (Vitt and Caldwell 2009, pp. 523–524). The desert horned lizard (*Phrynosoma platyrhinos*), sometimes called the “horned toad” is a well-known member of this taxon.

14. Neo-Tropical Ground Lizard Kind—

Family Tropiduridae—8 genera—125 species—
SVL=80 mm (3.1 in)



Fig. 19. *Microlophus peruvianus*. Photograph: Acatenazzi. <http://en.wikipedia.org/wiki/Tropiduridae>.

Infraorder Gekkota

Gekkota is a highly speciose taxon and may be a holobaramin because of its strong cognita, anatomy, behavior, and life histories. Based on genetic and molecular characters, I break this Infraorder down by family as per Uetz (2014).

15. Gecko Kind—Family Gekkonidae—

51 genera—996 species—SVL=194 mm (7.6 in)

Distributed pantropically on all land masses, they are small to large pleurodont lizards with short to long tails and no osteoderm occurring on their trunks (Vitt and Caldwell 2009, p. 525). They are unique among lizards in that 60% of them have complex adhesive mechanisms that use van der Waals forces

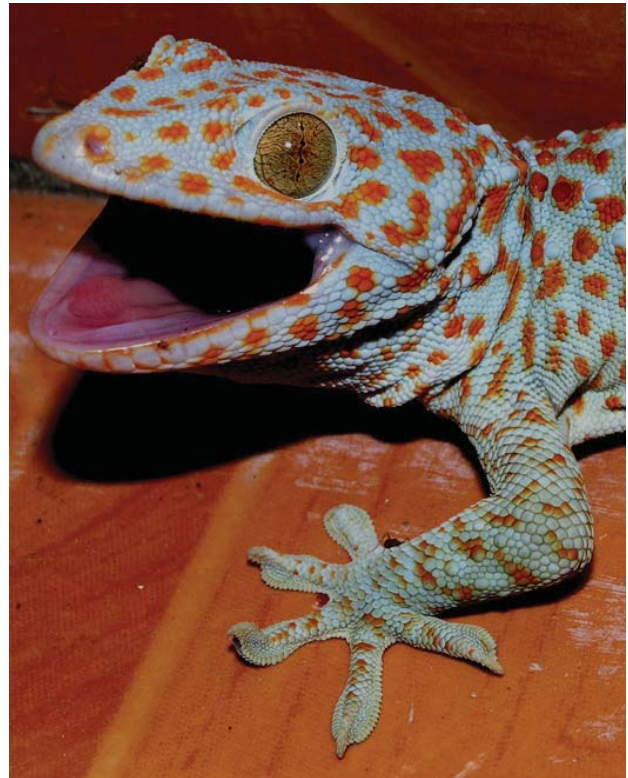


Fig. 20. *Gekko Gecko*. Photograph: Nick Hobgood. <http://en.wikipedia.org/wiki/Gekkonidae>.

to enable them to climb all kinds of environmental substrates (Gamble et al. 2012). Gamble et al. (2012) hypothesize that the taxon has gained and lost this unique climbing physiology several times throughout its evolutionary history. Though the loss of traits is possibly compatible with a creation paradigm, the complex adhesive design and toe morphology that enable the van der Waals forces to give most geckos extraordinary climbing abilities has garnered the attention of biomimetic researchers (Mahdavi et al. 2008). This gecko trait has been studied in order to improve human adhesive technology which is quite consistent with engineering design predicted within a biblical creation paradigm.

16. Australian Knob Tailed Gecko Kind—

Family Carphodactylidae—7 genera—
30 species—SVL=175 mm (6.8. in)



Fig. 21. *Phyllurus platurus*. <http://en.wikipedia.org/wiki/Phyllurus>.

17. New Caledonian Gecko Kind—

Family Diplodactylidae—25 genera—
125 species—SVL= 130 mm (5.1 in)



Fig. 22. *Oedura lesueurii*. <http://en.wikipedia.org/wiki/Diplodactylidae>.

18. Leopard Gecko Kind—

Family Eublepharidae—6 genera—
32 species—SVL= 35 mm (1.4 in)



Fig. 23. *Eublepharis macularius*. <http://en.wikipedia.org/wiki/Eublepharidae>.

Ranging from North America, South Asia, and sub-Saharan Africa, these geckos are moderately large and, unlike most geckos, have moveable eyelids and no adhesive pad physiology (Uetz 2014).

19. Leaf-Toed Gecko Kind—

Family Phyllodactylidae—10 genera—
134 species—SVL= 35 mm (1.4 in)



Fig. 24. *Phyllodactylus xanti*. http://en.wikipedia.org/wiki/Xantus_Leaf-toed_Gecko.

20. Croaking Gecko Kind—

Family Sphaerodactylidae—13 genera—
209 species—SVL= 35 mm (1.4 in)



Fig. 25. *Teratoscincus keyserlingii*. Photograph: Andrew S. Gardner. <http://en.wikipedia.org/wiki/Sphaerodactylidae>.

21. Pygopod Kind—Family Pygopodidae—

7 genera—44 species—SVL= 125 mm (4.9 in)



Fig. 26. *Lialis burtonis*. Photograph: Smacdonald. <http://en.wikipedia.org/wiki/Pygopodidae>.

From Australia and southern New Guinea, characters include: elongate, snake-like bodies with no evidence of forelimbs and flap-like hind limbs, large, overlapping scales for skin, ear holes, unforked tongues, 2-egg clutches per year, and evidence of communal nesting (Vitt and Caldwell 2009, p.527). Pygopods of Genus *Delma* have unique hearing apparatus that enable them to hear frequencies of 14kHz to greater than 20kHz, much higher than other reptiles (Manley and Kraus 2010).

Infraorder Scincomorpha**22. Spinytailed Lizard Kind—**

Family Cordylidae—10 genera—64 species—
SVL= 180 mm (7.1 in)



Fig. 27. *Cordylus tropidosternum*. Photograph: deror avi. <http://en.wikipedia.org/wiki/Cordylidae>.

From sub-Saharan Africa and Madagascar, characters of this family include: mostly keeled scales, autotomous tails (a defense tactic where tails can break off and move when attacked by a predator), and designed for semi-arid and arid environments (Vitt and Caldwell 2009, p. 537).

23. Plated Lizard Kind—

Family Gerrhosauridae—6 genera—
37 species—SVL=180 mm (7.1 in)



Fig. 28. *Gerrhosaurus major*. <http://en.wikipedia.org/wiki/Gerrhosauridae>.

From sub-Saharan Africa and Madagascar plated lizard characteristics include: two parietal scales on head and nostrils enclosed in 3–4 scales (Vitt and Caldwell 2009, p. 538).

24. Spectacled Lizard Kind—

Family Gymnophthalmidae—40 genera—
244 species—SVL < 60 mm (2.3 in)



Fig. 29. *Lepsosoma rugiceps*. Photograph: Esteban Alzate. <http://en.wikipedia.org/wiki/Gymnophthalmidae>.

Distributed from southern Central America and southern South America east of the Andes, they are also called microteiids and some are capable of parthenogenesis (Vitt and Caldwell 2009, p. 534).

25. Whiptail Lizard Kind—Family Teiidae— 15 genera—146 species—SVL=220 mm (8.7 in)



Fig. 30. *Tupinambis teguixin*. Photograph: Factumquintus. <http://en.wikipedia.org/wiki/Teiidae>.

Members in the Family Teiidae range from the southern United States to Chile and Argentina (Vitt and Caldwell 2009, pp. 535–536). Interspecific hybridization has been reported to produce parthenogenic offspring (Reeder, Dessauer, and Cole 2002).

26. Wall Lizard Kind—Family Lacertidae—

42 genera—321 species—SVL=140 mm (5.5 in)



Fig. 31. *Lacerta agilis*. Photographer: Stanislaw Szydlo. <http://en.wikipedia.org/wiki/Lacertidae>.

Found in most of Africa, Europe, and Asia they are diverse, mostly oviparous, but a few are viviparous such as *Lacerta vivipara* from northern Europe, which is capable of surviving six months of freezing temperatures (Vitt and Caldwell 2009, pp. 532–534).

Family Scincidae

7–9 Subfamilies (or families)—depending on the researchers—154 genera—1582 species

With a nearly worldwide distribution, skinks have historically been an extensive group belonging to one family (Scincidae) made up of 154 genera and 1582 species (Hedges 2014; Uetz 2014). Recently a



Fig. 32. *Tiliqua scincoides*. Photograph: Benjamint444. <http://en.wikipedia.org/wiki/Skink>.

seven-family classification system has been devised; Acontidae (26 species), Egerniidae (58 species), Eugongylidae (419 species), Lygosomidae (52 species), Mabuyidae (191 species), Sphenomorphidae (559 species), and Scincidae (277 species) based on molecular data (Hedges 2014; Uetz 2014). Two proposed families Ateuchosauridae (East Asian skinks) and Ristellidae (Indo-Sri Lanka skinks) have been proposed but are unaccepted taxa at this time and not counted in the list below (Uetz 2014). Though it is possible they all descend from an original Ark kind, representatives from “125 (84%) of the 154 genera of skinks are available in the public sequence databases and have been placed in molecular phylogenies that support the recognition of these families” (Hedges 2014). Until more data are available, I have tentatively identified these new family taxa with the biblical kind.

27.Limbless Skink Kind—Family Acontidae—
2 genera—26 species—SVL= 190 mm (7.5 in)



Fig. 33. *Ophiomorus punctatissimus*. Photograph: Benny Trapp. http://en.wikipedia.org/wiki/Limbless_skink.

28.Social Skink Kind—Family Egerniidae—
9 genera—58 species—SVL 190 mm (7.5 in)



Fig. 34. *Egernia stokesii*. Photograph: Mark Marathon. <http://en.wikipedia.org/wiki/Egernia>.

29.Eugongylid Skink Kind—
Family Eugongylidae—40 genera—
419 species—SVL= 190 mm (7.5 in)



Fig. 35. *Morethia boulengeri*. Photograph: Donald Hobern. http://en.wikipedia.org/wiki/Morethia_boulengeri.

30.Lygosomid Skink Kind—
Family Lygosomidae—5 genera—
52 species—SVL=190 mm (7.5 in)



Fig. 36. Unidentified skink. Photograph: L. Shyamal. <http://en.wikipedia.org/wiki/Lygosominae>.

31. Mabuyid Skink Kind—Family Mabuyidae—
22 genera—191 species—SVL=190 mm (7.5 in)



Fig. 37. *Spondylurus powelli*. Photograph: U.S. Army Corps of Engineers. http://en.wikipedia.org/wiki/Anguilla_Bank_Skink_Lizard.

32. Sphenomorphid Skink Kind—
Family Sphenomorphidae—36 genera—
559 species—SVL=190 mm (7.5 in)



Fig. 38. *Ctenotus robustus*. Photograph: Quartl. <http://en.wikipedia.org/wiki/Ctenotus>.

33. Typical Skink Kind—Family Scincidae—
34 genera—277 species—SVL=190 mm (7.5 in)



Fig. 39. *Eumeces schneideri*. <http://en.wikipedia.org/wiki/Eumeces>.

Family Xantusiidae

34. Night Lizard Kind—Family Xantusiidae—
3 genera—34 species—SVL=80 mm (3.1 in)



Fig. 40. *Xantusia vigilis*. http://en.wikipedia.org/wiki/Night_lizard.

From the western United States, to eastern Mexico, to northern South America, characters include: non-retractable foretongue, secretive, viviparous, and the tropical, forest dwelling *Lepidophyma* consist of parthenogenic and bisexual individuals (Uetz 2014; Vitt and Caldwell 2009, pp.531–532).

Infraorder Dibamia

Dibamia is a new taxon containing the one family Dibamidae, as per Uetz (2014).

35. Blind Lizard Kind—Family Dibamidae—
2 genera—23 species—SVL=125 mm (4.9 in)

Distributed disjunctly from Mexico, the West Indies, and Indochina, characters include: no forelimbs, flap-like hind limbs, snake-like morphology, short with autotomous tail, and fossorial (Uetz 2014; Vitt and Caldwell 2009, p. 528).

Infraorder Diploglossa

36. Glass-Alligator Lizard Kind—
Family Anguillidae—10 genera—73 species—
SVL=300 mm (11.8 in)



Fig. 41. *Anguis fragilis*. Photograph: pl:user:Marek_bydgoski. <http://en.wikipedia.org/wiki/Anguinae>.

Anguinae used to consist of four subfamilies (Anguinae, Anniellinae, Diploglossinae, and Gerrhonotinae). Diploglossinae and Anniellinae have been upgraded to the family level, Diploglossidae and Anniellidae respectively (Uetz 2014) and are distributed in North America, Eurasia, and western Panama. Glass lizard and slow worm (Anguinae) characteristics include: robust, limbless, and tail length twice the body (Uetz 2014). Glass lizards like *Ophisaurus sp.* get their name not only because they can autotomize tails, but also because the tail can break into several pieces (Vitt and Caldwell 2009, p. 542). Alligator lizards (Gerrhonotinae) characters include: stout bodies, well-developed limbs, heavily armored bodies, and live in variable habitats depending on the species (Vitt and Caldwell 2009, pp. 541–542).

37. Galliwasp Kind—Family Diploglossidae—
3 genera—51 species—SVL= 170 mm (6.7 in)



Fig. 42. *Diploglossus monotropis*. Photograph: Sahaquiel9102. <http://en.wikipedia.org/wiki/Diploglossus>.

Found in the West Indies, central America, and central South America this group has elongate

bodies, well-developed limbs, tail autotomy, and can be very small to very large, depending on species (Vitt and Caldwell 2009, p. 543).

38. American Legless Lizard Kind—

Family Anniellidae—1 genus (*Anniella*)—
6 species—SVL= 157 mm (6.1 in)



Fig. 43. *Anniella pulchra*. http://en.wikipedia.org/wiki/American_legless_lizard.

Found in California characters include, tail two-thirds of the body length, small, elongate, snake-like morphology, mainly fossorial, and capable of accessing interstitial water when soil moisture content exceeds 7% (Vitt and Caldwell 2009, p. 543).

39. Knob-Scaled Lizard Kind—

Family Xenosauridae—1 genus
(*Xenosaurus*)—10 species—SVL= 125 mm (4.9 in)



Fig. 44. *Xenosaurus grandis*. Photograph: Tim Burkhardt. <http://en.wikipedia.org/wiki/Xenosauridae>.

With disjunct distribution found in southern China and eastern Mexico into Guatemala, characters include: dorsal covering of granular, juxtaposed scales, osteoderm present ventrally but not dorsally, and requires moist surroundings (Vitt and Caldwell 2009, pp. 543–544). The Chinese crocodile lizard (*Shinisaurus crocodilurus*) used to be included in this group and has since been placed in the Infraorder Platynota; Superfamily Shinisaurioidea; Family Shinisauridae (Uetz 2014). See below.

Infraorder Platynota

40. Beaded Lizard Kind—

Family Helodermatidae—1 genus
 (*Heloderma*)—2 species—SVL= 400 mm
 (15.7 in)



Fig. 45. *Heloderma suspectum*. Photograph: L. A. Dawson. <http://en.wikipedia.org/wiki/Heloderma>.

Located in southwestern North America from the Sonoran desert south to Guatemala, these are large lizards and the only non-snake squamates with well-developed venom glands (Vitt and Caldwell 2009, p. 545). Other characters include: thick skin, rows of rounded scales giving them a beaded look, and large home ranges where they may move 1.5km (0.9mi) per day (Vitt and Caldwell 2009, pp. 545–546).

41. Earless Monitor Lizard Kind—Family—

Lanthanotidae—1 genus (*Lanthanotus*)—
 1 species (*borneensis*)—SVL= 375 mm (14.7 in)



Fig. 46. *Lanthanotus borneensis*. <http://reptile-database.reptarium.cz/species?genus=Lanthanotus&species=borneensis>.

Located in Borneo, this species lacks a parietal eye and a hemibaculum, adults and juveniles may be semiaquatic (Vitt and Caldwell 2009, p. 546).

42. Monitor Lizard Kind—Family Varanidae—

1 genus (*Varanus*)—77 species—
 TL= 1615 mm (63.5 in)

Distributed from sub-Saharan Africa to Asia, Australia, and islands in the southwest Pacific, characters include distinctive morphology with



Fig. 47. *Varanus komodoensis*. <http://en.wikipedia.org/wiki/Varanidae>.



Fig. 48. *Varanus komodoensis*. Photograph: Mark Dumont. http://en.wikipedia.org/wiki/Komodo_dragon.

small head and long neck, long and robust bodies, and strong jaws (Vitt and Caldwell 2009, pp. 546–547). In terms of size, varanids can be as small as the pygmy goanna, *Varanus brevicauda*—TL=230mm (9in), to the largest known lizard, the Komodo dragon, *V. komodoensis*—maximum TL=3.1 m (10.1 ft) (Vitt and Caldwell 2009, p. 546). Parthenogenesis has been observed in komodo females and they may produce venom, but further research is required to substantiate this as there is still debate about this topic (Bradford 2014; Fry et al. 2009; Zimmer 2009).

Superfamily Shinisauroidea

- 43. Chinese Crocodile Lizard Kind**—Family Shinisauridae—1 genus (*Shinisaurus*)—1 species (*crocodilurus*)—SVL=420 mm (16.5 in)



Fig. 49. *Shinisaurus crocodilurus*. Photograph: Tiermotive.de. http://en.wikipedia.org/wiki/Chinese_crocodile_lizard.

A semi-aquatic lizard, it is found in cool montane forested streams of China and Vietnam, they forage on fish, tadpoles, and other animals and rest on branches overhanging streams at night (Vitt and Caldwell 2009, p. 544).

Summary

The challenge of using a biblical worldview to determine Ark kinds is distinguishing whether similar characters are products of a common designer or common ancestry within a kind, and when discontinuities indicate a separate kind. The challenge of using a philosophical naturalist worldview is the large amount of discontinuity in reptiles and the difficulty in delineating universal common ancestry. The fact that lizards are marvelously designed and are well endowed with structures that surpass human technology is consistent with a wise and all-powerful engineer behind their origins. After carefully reviewing the molecular, hybridization, and statistical baraminology data, but recognizing that there is much that we do not know or even understand, I tentatively suggest that 43 extant lizard kinds may have been brought on the Ark. Since their exit from the Ark, they have diversified into the plethora of species we marvel at today. The data, interpreted within a biblical worldview, suggests that diversification was rapid (Lightner 2008). This overview is meant to be a starting place for future creationist systematics and identification of amphibian and reptile baramins. The challenge for future creationist research will be investigating genetic mechanisms that could produce rapid diversification responses with changing environmental variables as in the case of *Anolis*. No

matter how many were included on the Ark, reptile diversity and persistence are a reminder of an all-powerful Creator who is both just and merciful.

Acknowledgments

As this paper brings to a close the most current taxonomic reviews of extant amphibians and reptiles from a creation perspective, I would like to thank the Ark Encounter Team: Dr. Jean Lightner, Dr. Georgia Purdom, Dr. Marcus Ross, and Dr. Andrew Snelling for the encouragement, expertise, and patience they offered throughout this research process. I would also like to thank Dr. Gordon Wilson and the anonymous reviewers for their critical feedback on earlier drafts.

References

- Bradford, A. 2014. Komodo dragon facts. Accessed December 2, 2014. <http://www.livescience.com/27402-komodo-dragons.html>.
- Brophy, T.R., and P.A. Kramer. 2007. Preliminary results from a baraminological analysis of the mole salamanders (Caudata: Ambystomatidae). *Occasional papers of the BSG* 10:10–24.
- Frost, D.R. 1992. Phylogenetic analysis and taxonomy of the *Tropidurus* group of lizards (Iguania: Tropiduridae). *American Museum Novitates* 3033:1–68.
- Frost, D.R., and R. Etheridge. 1989. A phylogenetic analysis and taxonomy of iguanian lizards (Reptilia: Squamata). *University of Kansas Natural History Museum Miscellaneous Publication* 81:1–65.
- Frost, D.R., R. Etheridge, D. Janies, and T.A. Titus. 2001. Total evidence, sequence alignment, evolution of polychrotid lizards and a reclassification of Iguania (Squamata Iguania). *American Museum Novitates* 3343:1–38.
- Fry, B.G., S. Wroe, W. Teeuwisse, M.J.P. van Osch, K. Moreno, J. Ingle, C. McHenry, T. Ferrara, et al. 2009. A central role for venom in predation by *Varanus komodoensis* (Komodo dragon) and the extinct giant *Varanus (megalania) priscus*. *Proceedings of the National Academy of Sciences USA*: 106, no. 22:8969–8974. Accessed December 2, 2014. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2690028/>.
- Gamble, T., E. Greenbaum, T.R. Jackman, A.P. Russell and A.M. Bauer. 2012. Repeated origin and loss of adhesive toe pads in geckoes. *PLoS ONE* 7, no. 6:e39429. Accessed November 28, 2014. http://www.academia.edu/2246700/Repeated_Origin_and_Loss_of_Adhesive_Toepads_in_Geckos.
- Glor, R.E., J.B. Losos, and A. Larson. 2005. Out of Cuba: overwater dispersal and speciation among lizards in the *Anolis carolinensis* subgroup. *Molecular Ecology* 14, no. 8:2419–2432. Accessed November 26, 2014. http://lacertilia.com/research/PDF/Glor_etal_2005.pdf.
- Hailey, A., V.C. Quesnel, and H.E.A. Boos. 2009. The persistence of *Anolis trinitatis* as a naturalized lizard in Trinidad against hybridization pressure with *Anolis aeneus*. *Applied Herpetology* 6:275–294.
- Handwerk, B. 2010. Evolution in action: Lizard moving from eggs to live birth. *National Geographic News*. Accessed November 25, 2014. <http://news.nationalgeographic.com/news/2010/09/100901-science-animals-evolution-australia-lizard-skink-live-birth-eggs/>.

- Hartmann, T., P. Geissler, and W. Böhme. 2011. *Leiolepis* (Squamata: Agamidae) farming in southern Vietnam and a new size record in butterfly lizards. *Herpetological Bulletin* 117:15–18. Accessed on November 24, 2014. http://www.academia.edu/4039201/Leiolepis_Squamata_Agamidae_farming_in_southern_Vietnam_and_a_new_size_record_in_butterfly_lizards.
- Hedges, S.B. 2014. The high-level classification of skinks (Reptilia, Squamata, Scincomorpha). *Zootaxa* 3765, no.4: 317–338. Accessed November 29, 2014. <http://www.hedgeslab.org/pubs/258.pdf>.
- Hennigan, T. 2009. Darwin’s “imps of darkness”: the marine iguanas of the Galápagos. *Creation* 31, no. 2:28–30. Accessed November 27, 2014. <http://creation.com/galapagos-iguanas>.
- Hennigan, T., G. Purdom, and T.C. Wood. 2009. Creation’s hidden potential. *Answers Magazine* 4, no. 1:70–75. Accessed November 27, 2014. <https://cdn-assets.answersingenesis.org/doc/articles/pdf-versions/hidden-potential.pdf>.
- Hennigan, T. 2013a. An initial estimate toward identifying and numbering amphibian kinds within the orders caudata and gymnophiona. *Answers Research Journal* 6:17–34. Accessed November 29, 2014. <http://www.answersingenesis.org/articles/arj/v6/n1/amphibian-kinds>.
- Hennigan, T. 2013b. An initial estimate toward identifying and numbering the frog kinds on the Ark: Order anura. *Answers Research Journal* 6:335–365. Accessed November 29, 2014. <http://www.answersingenesis.org/articles/arj/v6/n1/frog-kinds-on-ark>.
- Hennigan, T. 2014a. An initial estimate toward identifying and numbering the Ark turtle and crocodile kinds. *Answers Research Journal* 7:1–10. Accessed November 29, 2014. <http://www.answersingenesis.org/articles/arj/v7/n1/turtle-crocodile-kinds>.
- Hennigan, T. 2014b. An initial estimate toward identifying and numbering extant tuatara, amphisbaena, and snake kinds. *Answers Research Journal* 7: 31–47. Accessed November 29, 2014. <http://answersingenesis.org/creation-science/baraminology/an-initial-estimate-toward-identifying-and-numbering-extant-tuatara-amphisbaena-and-snake-kinds/>.
- Hertz, P.E., Y. Arima, A. Harrison, R.B. Huey, J.B. Losos, and R.E. Glor. 2012. Asynchronous evolution of physiology and morphology in *Anolis* lizards. *Evolution* 67, no. 7:2101–2113.
- Leal, M., and A.R. Gunderson. 2012. Rapid change in the thermal tolerance of a tropical lizard. *The American Naturalist* 180, no. 6:815–822.
- Lightner, J.K. 2008. Life: designed by God to adapt. Accessed November 25, 2014. <https://answersingenesis.org/evidence-for-creation/life-designed-by-god-to-adapt>.
- Lightner, J.K. 2012. Mammalian Ark kinds. *Answers Research Journal* 5:151–204. Accessed November 29, 2014. <https://answersingenesis.org/creation-science/baraminology/mammalian-ark-kinds/>.
- Lightner, J.K. 2013. An initial estimate of avian Ark kinds. *Answers Research Journal* 6:409–466. Accessed November 29, 2014. <https://answersingenesis.org/creation-science/baraminology/an-initial-estimate-of-avian-ark-kinds/>.
- Lightner, J.K., T. Hennigan, G. Purdom, and B. Hodge. 2011. Determining the Ark kinds. *Answers Research Journal* 4:195–201. Accessed November 29, 2014. <https://answersingenesis.org/noahs-ark/determining-the-ark-kinds/>.
- Losos, J.B., T.R. Jackman, A. Larson, K. de Queiroz, and L. Rodriguez-Schettino. 1998. Contingency and determinism in replicated adaptive radiations of island lizards. *Science* 279, no.5359:2115–2118.
- Losos, J.B. 2007. Detective work in the West Indies: Integrating historical and experimental approaches to study island lizard evolution. *BioScience* 57, no. 7:585–597.
- Losos, J.B. 2009. *Lizards in an evolutionary tree: Ecology and adaptive radiation of anoles*. University of California Press: Berkley, California.
- Macey, J.R., A. Larson, N.B. Ananjeva, and T.J. Papenfuss. 1997. Evolutionary shifts in three major structural features of the mitochondrial genome among iguanian lizards. *Journal of Molecular Evolution* 44, no. 6:660–674.
- Mahdavi, A., L. Ferreira, C. Sundback, J.W. Nichol, E.P. Chan, D.J. Carter, C.J. Bettinger, et al. 2008. A biodegradable and biocompatible gecko-inspired tissue adhesive. *Proceedings of the National Academy of Sciences USA* 105, no. 7:2307–2312. Accessed November 28, 2014. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2268132/>.
- Manley, G.A., and J.E.M. Kraus. 2010. Exceptional high-frequency hearing and matched vocalizations in Australian pygopod geckos. *Journal of Experimental Biology* 213, no.11:1876–1885. Accessed November 29, 2014. <http://jeb.biologists.org/content/213/11/1876.full.pdf+html>.
- Nat. Geo. 2014. Green basilisk lizard. Accessed November 26, 2014. <http://animals.nationalgeographic.com/animals/reptiles/green-basilisk-lizard/>.
- Nicholson, K.E., B.I. Crother, C. Guyer, and J.M. Savage. 2012. It is time for a new classification of anoles (Squamata: Dactyloidae). *Zootaxa* 3477:1–108. Accessed november 26, 2014. <http://www.mapress.com/zootaxa/2012/zt03477p108.pdf>.
- Rassmann, K., F. Trillmich, and D. Tautz. 1997. Hybridization between the Galápagos land and marine iguanas (*Canolophus subcristatus* and *Amblyrhynchus cristatus*) on Plaza Sur. *Journal of Zoology* 242, no. 4:729–739.
- Reeder, T.W., C.J. Cole, and H.C. Dessauer. 2002. Phylogenetic relationships of whiptail lizards of the genus *Cnemidophorus* (Squamata: Teiidae): A test of monophyly, reevaluation of karyotypic evolution, and review of hybrid origins. *American Museum Novitates* 3365:1–61.
- Ross, M.R. 2014. Fossil baramins on Noah’s Ark: The “amphibians.” *Answers Research Journal* 7:331–355. Accessed November 29, 2014. <https://answersingenesis.org/creation-science/baraminology/fossil-baramins-noahs-ark-amphibians/on> November 29, 2014.
- Sanders, R.W., and K.P. Wise. 2003. The cognitum: A perception-dependent concept needed in baraminology. In *Proceedings of the fifth International Conference on Creationism*, ed. R.L. Ivey, 445–456. Pittsburgh, Pennsylvania: Creation Science Fellowship.
- Schulte, J.A.II, J.P. Valladares, and A. Larson. 2003. Phylogenetic relationships within Iguanidae inferred using molecular and morphological data and a phylogenetic taxonomy of iguanian lizards. *Herpetologica* 59:399–419.
- Turner, K.J. 2009. The kind-ness of God: A theological reflection of *min*, “kind.” In *CORE Issues in Creation* no. 5, ed. T.C. Wood and P.A. Garner, 31–64. Eugene, Oregon: Wipf and Stock.
- Uetz, P. 2014. ed. Reptile database. Accessed November 29, 2014. <http://www.reptile-database.org/db-info/taxa.html>.

- Vitt, L.J., and J.P. Caldwell. 2009. *Herpetology: An introductory biology of amphibians and reptiles*. 3rd ed. Burlington, Massachusetts: Academic Press.
- Williams, P.J. 1997. What does *min* mean? *Creation Ex Nihilo Technical Journal* 11, no. 3:344–352.
- Wilson, G. 2010. Classic multidimensional scaling isn't the *sine qua non* of baraminology. <http://www.answersingenesis.org/articles/aid/v5/n1/cmds-baraminology>.
- Wise, K.P. 1992. Practical baraminology. *Creation Ex Nihilo Technical Journal* 6, no. 2:122–137.
- Wood, T.C. 2003. Mediated design. *Impact Article #363*. Institute for Creation Research: El Cajon, California. Accessed on November 29, 2014. <http://www.icr.org/i/pdf/imp/imp-363.pdf>.
- Wood, T. C., K. Wise, R. Sanders, and N. Doran. 2003. A refined baramin concept. *Occasional Papers of the BSG* 3:1–14.
- Wood, T.C. 2005. A creationist review and preliminary analysis of the history, geology, climate, and biology of the Galápagos Islands. In *CORE issues in creation*, no. 1, ed. T. C. Wood, 82–97. Eugene, Oregon: Wipf and Stock.
- Wood, T. C. 2006. The current status of baraminology. *Creation Research Society Quarterly* 43, no. 3:149–158.
- Woodmorappe, J. 1996. *Noah's Ark: A feasibility study*. Santee, California: Institute for Creation Research.
- Zimmer, C. 2009. Chemicals in dragon glands stir venom debate. *New York Times*. p.D2. Accessed on December 2, 2014. <http://www.nytimes.com/2009/05/19/science/19komo.html>.