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Animal biodiversity:
An outline of higher-level classification and survey of taxonomic richness

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Class Amphibia Gray, 1825\(^{2,3}\)

Amphibia incertae sedis

†Albanerpetontidae Fox & Naylor, 1982 (†4)\(^{5}\)

Order Anura Fischer von Waldheim, 1813 (frogs and toads) (410–466 genera; 6090 species; †=84)\(^{4}\)

Family Allophyllidae Goin, Goin, & Zug, 1978 (1 genus; 1 species)\(^{1}\)

Family Alsodidae Mivart, 1869 (3 genera; 32 species)\(^{3}\)

1. By D.C. Blackburn & D.B. Wake (for full contact details, see the list after References). The title of this contribution should be cited as “Class Amphibia Gray, 182, In: Zhang, Z.-Q. (Ed.) Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness”.

2. The Amphibian Species of the World website (Frost, 2011), a continuation of Frost (1985), has guided our work; this site provides detailed information on the taxonomic history of the names we discuss here. Our decisions on which taxa to recognize and at what level are based on current literature and our assessment of current usage. Numbers of species used in our classification are based on the AmphibiaWeb website (www.amphibiaweb.org; Accessed 13 October 2011).

3. Linnaeus (1758) used Amphibia for a different assemblage of taxa than currently recognized, and authorship for the currently understood taxon is uncertain (Anderson et al., 2008, Ruta et al., 2003). Many extinct anuran generic-level taxa exist, but most cannot be assigned with confidence to the families recognized here. A few are demonstrably monophyletic. Frost (1985) listed the taxa in the Batrachylinae and Telmatobiinae. Heinicke et al. (2006) extended the taxonomy of Frost & Naylor (1982; Milner, 2000; McGowan, 2002). Phylogenetic analyses have reaffirmed a close relationship between †Albanerpetontidae, comprising four extinct genera (for recent summary see Sweetman & Gardner, in press), and the extant orders Anura and Caudata, although the precise relationships remain uncertain (Anderson et al., 2008, Ruta et al., 2003).

4. Transcriptions of the new names of extinct taxa, as listed, followed by the number of extinct (†) genera.

5. Historically, the †Albanerpetontidae has been allied to the extant orders of amphibians (Fox & Naylor, 1982; Milner, 2000; McGowan, 2002). Phylogenetic analyses have reaffirmed a close relationship between †Albanerpetontidae, comprising four extinct genera (for recent summary see Sweetman & Gardner, in press), and the extant orders Anura and Caudata, although the precise relationships remain uncertain (Anderson et al., 2008, Ruta et al., 2003).

6. Many extinct anuran generic-level taxa exist, but most cannot be assigned with confidence to the families recognized here. A few are demonstrably outside of crown-group Anura (e.g., †Czekobobatracus, †Mesophryne, †Notobatracus, †Prosalirius, †Triobatracus, †Vieraella, †Yizhoubatrachus, Baez & Basso, 1996; Gao & Wang, 1998; Gao & Chen, 2004). When phylogenetic analyses or other evidence allow placement of an extinct genus with some confidence within the crown-group of a family of living species, we have opted to include that extinct taxon within that family. However, because of either a lack of thorough analyses or changing concepts of families, we cannot place many of these extinct taxa within currently recognized families. These extinct taxon include †Aluimna, †Aralobatracus, †Arariphytone, †Anitbatracus, †Avgoura, †Comobatracus, †Cordicephalus, †Cratia, †Elkobatracus, †Eobatracus, †Eopelobates, †Esophryne, †Euribeta, †Estiesia, †Estesia, †Eurycephala, †Hatzegobatracus, †Hemirella, †Kiyhillum, †Latonia, †Lobatobatracus, †Litobatracus, †Livorotobatracus, †Macropelobates, †Messelobatracus, †Neoocrocoela, †Nerobatracus, †Nepocius, †Ophistocelis, †Palaeophryne, †Paralatonia, †Pelophylus, †Plitobatracus, †Proceratobatracus, †Ramomorphus, †Ranavus, †Schoevoerderbergia, †Sunnybatracus, †Thaumastosaurus, †Theotonius, †Thraciculiasis, and †Udecania; see Sanchiz (1998) for a review of most extinct anuran taxa.

7. Frost et al. (2006), avoiding families with only one genus, treated Allophyllinae and Centroleniinae as subfamilies of Centrolenidae. Phylogenetic analyses support a sister relationship among these clades (Austin et al., 2002; Farvich et al., 2005; Wiens et al., 2003; Frost et al., 2006; Guayasamin et al., 2008), but the revision by Guayasamin et al. (2009) maintained Allophyllinae and Centroleniinae as separate families. We see either as acceptable and viable taxonomies.

8. Pyron & Wiens (2011) were unable to obtain a robust topology of several genera once considered leptodactylids (see also Correa et al., 2006; Frost et al., 2006; Grant et al., 2006) and recognized eight small families: Alsodidae, Batrachylidae, Ceratophryidae, Cycloramphidae, Hylididae, Ödontophrynidae, Rhinodermatidae, and Telmatobiidae. Previously, Grant et al. (2006) refined the taxonomy of Frost et al. (2006) by recognizing Hylididae as distinct from the Cyclorhaphidae. Correa et al. (2006) resolved different relationships among these taxa, but used less comprehensive sampling. Both Nuin and do Val (2005) and Heinicke et al. (2009), with limited taxon sampling, showed that Cyclorhaphidae was likely not monophyletic. Frost et al. (2006) showed that Rhinoderma is nested within their Cyclorhaphidae; this was also suggested by Correa et al. (2006) who found Rhinoderma to be the sister taxon of Insetopterynidae. Relationships among some of these genera based on morphological data were discussed by Diaz & Valencia (1985), who included Caudivelvera (now Calyptocephelaea) in this lineage, and Diaz (1989), with further details on potentially useful diagnostic features within this group provided by Alcalde & Blotto (2006), Cárdenas-Rojas et al. (2007), and Ruban & Formas (2009). Grant et al. (2006) extended the taxonomy of Frost et al. (2006) by recognizing three subfamilies of Ceratophryidae. However, while several phylogenetic studies have suggested that these subfamilies form a clade (Faivovich et al., 2005; Frost et al., 2006; Grant et al., 2006), others have not (Darst & Cannatella, 2004; Wiens, 2005; Correa et al., 2006; Roelants et al., 2007; Heinicke et al., 2009; Pyron & Wiens, 2011; see also Ruane et al., 2011). Other studies are consistent with monophyly but did not include taxa from all three subfamilies (Wiens et al., 2005). While reporting monophyly, Frost et al. (2006) and Grant et al. (2006) differed in assessments of relationships among the subfamilies: Grant et al. (2006) found a sister relationship between Telmatobatrace and Ceratophryinae whereas Frost et al. (2006) reported a sister relationship between Batrachylinae and Ceratophryinae. Roelants et al. (2007) did not resolve Ceratophryidae as monophyletic, but reported a sister relationship between taxa in the Batrachylinae and Telmatobatrace. Heinicke et al. (2009) also did not resolve Ceratophryidae as monophyletic, but instead found a sister relationship between taxa in the Telmatobatrace and Ceratophryinae. Roelants et al. (2007) did not resolve Ceratophryidae as monophyletic, but reported a sister relationship between taxa in the Batrachylinae and Telmatobatrace. Heinicke et al. (2009) also did not resolve Ceratophryidae as monophyletic, but instead found a sister relationship between taxa in the Telmatobatrace and Ceratophryinae. Bossuyt & Roelants (2009) recognized two families, Telmatobiidae and Ceratophryidae, yet did not specify the content of these families, which is crucial given the uncertainty in relationships among the subfamilies. Given that Pyron & Wiens (2011) is the analysis to date with the most complete taxonomic sampling of taxa previously placed in the Ceratophryidae, Cycloramphidae, and Hylididae, we follow their elevation to family level of the three subfamilies of Ceratophryidae of Grant et al. (2006).

9. Cortes & Descudecaux (2005) provide a cladistic analysis of karyotypic data suggesting that Telmatobius is paraplytic with respect to Batrachophryinae. For the families Alsodidae and Batrachylidae, we follow the genus-level revision of Pyron & Wiens (2011) that resulted in placing Hylorhina and several Batrachyla species in Euphylidae.
Analyses of molecular data support a clade containing Alytes, Barbouroura, Bombina, and Discoglossus (Hay et al., 1995; Hoegg et al., 2004; San Mauro et al., 2004a, 2005; Roelants & Bossuyt, 2005; Frost et al., 2006; Giissi et al., 2006; Roelants et al., 2007; Wiens, 2007; Blackburn et al., 2010). Aromobatidae and Discoglossidae have long been recognized as closely related from morphological and phylogenetic analyses (e.g., Cannatella, 1985; Gao & Wang, 2001) and molecular phylogenetic analyses agree. Historically, the taxon containing these genera has been referred to as Discoglossidae. Sanchíz (1998) and Dubois (2005) noted the nomenclatural priority of Alytidae. Bossuyt & Roelants (2009) recognize Alytidae and Discoglossidae as separate families based on the extent of “evolutionary time” separating these clades, and this remains an appropriate alternative taxonomy, as would an alternative more inclusive family containing Barbouroura and Bombina (and thus the Bombinatoridae, see below). We tentatively include six extinct taxa in the Alytidae (†Callobatrachus, †Enneabatrachus, †Eudiscoglossus, †Prodiscoglossus, †Scotiochryse, †Wealdenabatrachus, †Zaphrissa), although their phylogenetic relationships remain unclear (Sanchíz, 1998; Gao & Wang, 2001; Gao & Chen, 2004; Marjanoviæ & Laurin, 2007).

Grant et al. (2006) separated a family Aromobatidae (with three subfamilies: Allobatinae, Anomaloglossinae, Aromobatinae) from the Dendrobatidae. While some have rejected this partitioning (Santos et al., 2009; Santos & Cannatella, 2011; Pyron & Wiens, 2011), many in the research community (e.g., Verdone & Rodrigues, 2007; Manzanilla et al., 2009; Brown & Twomey, 2009) have found this partitioning useful and follow the taxonomy of Grant et al. (2006). We view either family-level taxonomy as a viable taxonomy. A supplementary document associated with Santos et al. (2009) disputes the higher-level taxonomy of Grant et al. (2006), but monophyly of the Dendrobatidae and Aromobatidae and the proposed subfamilies of Dendrobatidae receive strong support. The basic topology of generic relationships within Aromobatidae recovered by Santos et al. (2009), as well as by Pyron & Wiens (2011), differs little from that of Grant et al. (2006). Santos et al. (2009) find no support for the Anomaloglossinae. One composite taxon, which combined molecular data for Allocates alagoanus with morphological data from A. olsiferoides, was resolved as sister to the remaining species of Allocates by Grant et al. (2006). Verdone & Rodrigues (2007) synonymized these two species, with A. olsiferoides having priority. Santos et al. (2009) found this species (referred to in Supplementary Materials as Colostethus alagoanus) to be the sister-taxon of all other species of Aromobatidae. This result renders Allocates, and thus Allobatinae, paraphyletic. Pending further analysis of intramural relationships, we list no subfamilies for the Aromobatidae. Grant et al. (2006) and Santos et al. (2009) provide conflicting views on the number of genera recognized and allocated to the Aromobatidae and Dendrobatidae (see also Brown et al., 2011).

The Arthroleptidae (sensu Frost et al., 2006) has been recognized as a morphologically distinctive lineage for decades (Laurent 1941, 1942, 1951; see also Dubois, 1981). This includes recognition that Leptopolis may be more closely related to genera in the Arthroleptidae than to those in the Hyperoliidae, a hypothesis supported by a variety of molecular phylogenetic studies (Emerson et al., 2000; Biju & Bossuyt, 2003; Vences et al., 2003b; Bossuyt et al., 2006; Frost et al., 2006; Roelants et al., 2007). Frost et al. (2006) recognized two subfamilies: Leptopelinae (Leptopelis) and Arthroleptinae (Arthrolepis, Astylosternus, Cardiglossa, Leptodactylodon, Nyctibates, Scotobleps, and Trichobatrachus). However, uncertainty remains in the placement of Leptopolis, including the possibility that the Arthroleptinae sensu Frost et al. (2006) is paraphyletic with respect to Leptopolis (Vences et al., 2003b; Scott, 2005; Frost et al., 2006; Blackburn, 2008), and thus we do not recognize subfamilies of Arthroleptidae.

Frost et al. (2006) recognized Asciaphidae and Leiopelmidae as subfamilies of Leiopelmatidae. Morphology-based hypotheses of phylogeny have either separated these two families as successively branching lineages at the base of anuran phylogeny (e.g., Cannatella, 1985) or resolved them as sister taxa (e.g., Baez & Basso, 1996; Wang et al., 2001). Green et al. (1989) found these taxa to be genetically divergent and suggested that Asciaphus could be more closely related to other clades of anurans than to Leiopelma, though recent molecular phylogenetic analyses have recognized these as sister taxa (e.g., Frost et al., 2006; Roelants et al., 2007; Irisarri et al., 2010; Pyron & Wiens, 2011). Bossuyt & Roelants (2009) maintained two families because of the degree of genetic divergence, as did Pyron & Wiens (2011).

See footnote 8.

14. Monophyly of Bombinatoridae is supported by both molecular (Blackburn et al., 2010) and morphology-based (Cannatella, 1985; Gao & Wang, 2001) phylogenetic studies. We include †Paradiscoglossus in the Bombinatoridae (Estes & Sanchíz, 1982). See also footnote 9.

15. Hedges et al. (2008) restricted Brachycephalidae to Brachycephalus and Ischnocnema. Brachycephalidae is one of four recognized families in the unranked taxon Terrana (Hedges et al., 2008; Heinicke et al., 2009). A viable alternative taxonomy that avoids reliance on unranked taxa would be to recognize the families of Terrana as subfamilies of Brachycephalidae.

16. Brevicipitidae (sensu Frost et al., 2006), long included in Microhylidae, is now recognized as a member of a larger clade endemic to sub-Saharan Africa (e.g., van der Meijden et al., 2004; Frost et al., 2006; Roelants et al., 2007; Wiens, 2007; Kurabayashi et al., 2011). Dubois (2005) enlarged the Brevicipitidae to also contain the taxa recognized here as Arthroleptidae, Hemisotidae, and Hyperoliidae, which is a viable alternative taxonomic arrangement that would produce a taxon with nearly 400 species.
Family Ceratobatrachidae Boulenger, 1884 (5 genera; ~86 species)
Family Ceratophryidae Tschudi, 1838 (3 genera; 12 species; 3)*
Family Cethomantidae Heinicke, Duellman, Trueb, Means, MacCulloch & Hedges, 2009 (1 genus; 4 species)
Family Conrauaidae Dubois, 1992 (1 genus; 6 species)
Family Craugastoridae Hedges, Duellman, & Heinicke, 2008 (2 genera; 115 species)
Family Cycloramphidae Bonaparte, 1850 (2 genera; 33 species)
Family Dendrobatidae Cope, 1865 (13 genera; 182 species)
Subfamily Colostethinae Cope, 1867 (4 genera; 64 species)
Subfamily Dendrobatinae Cope, 1865 (8 genera; 59 species)

17. Generic-level taxonomy within Bufonidae is in a state of flux (Frost et al., 2006; 2009; Pauly et al., 2009). Controversy arises because the many species historically referred to Bufo do not form an exclusive clade with respect to morphologically distinct satellite taxa (e.g., Ansonia, Capensibuso, Neckrophrynoides, Pedostibes, Schismaderma, Stegophryades). In the interests of taxonomic stability, some workers prefer to maintain Bufo for readily recognized “toad”-like taxa, even to the point of reducing morphologically divergent taxa long recognized as genera to subgenera. This would result in a very large genus Bufo, with more than 450 species. Alternatively, approximately 50 genera would be recognized (Frost et al., 2006; Frost, 2011), with many species long placed in Bufo and having extensive literature references being placed in newly (or recently) created genera. Many of the generic-level taxonomic changes have been embraced already by much of the community of amphibian taxonomists (Pramuk et al., 2007; Van Bocxlaer et al., 2009, 2010; Macel et al., 2010). Pyron & Wiens (2011) recognize 35 genera.

18. Calyptocephalellidae is recovered as monophyletic and a sister taxon of our Myobatrachidae (San Mauro et al., 2006; Wiens et al., 2005; Correa et al., 2006; Frost et al., 2006; Pyron & Wiens, 2011). Frost et al. (2006) referred to the clade containing Calyptocephalella and Telmatobufo as the Batrachophryinae because it was not yet clear that Batrachophryinae is likely embedded within the genus Telmatobius (Aguilar & Pacheco, 2005; Córdova & Descaillaux, 2005; Aguilar & Valencia, 2009).

19. Guayasamin et al. (2009) recognized two subfamilies within the Centrolenidae. We follow Pyron & Wiens (2011) in placing the monotypic Hikogori in the Centrolenidae. See also footnote 7.

20. Multiple phylogenetic studies have revealed complicated relationships among clades variously assigned to the Ranidae (see Dubois, 1981, 1983, 1992, 2005; Duellman & Trueb, 1986), including clades recognized here as the Arthroleptidae, Mantellidae, and Rhacophoridae (Emerson et al., 2000; Vences et al., 2003b; Roelants et al., 2004, 2007; Scott, 2005; van der Meijden et al., 2005; Wiens et al., 2006; Wiens, 2007; Wiens et al., 2009; Pyron & Wiens, 2011; see also Ford, 1990; Ruvinsky & Maxson, 1996; Biju & Bossuyt, 2003; Haas, 2003). Dubois (2005) suggested recognizing fourteen subfamilies of Ranidae (Ceratobatrachinae, Conrauinae, Dicroglossinae, Lankanectinae, Mantellinae, Micrixalinae, Nictibatrachinae, Petropedetinae, Phrynobatrachinae, Psychadennia, Pyxicephalinae, Raninae, Ranixalinae, and Rhacophorinae); for a summary of the taxonomic history of “ranid” frogs, see Frost et al. (2006). The subfamilial taxa of Dubois (2005) were elevated to the family level by Frost et al. (2006), although several were combined into single families; Lankanectinae and Nictibatrachinae were combined into the Nictibatrachidae, and Conrauinae, Petropedetidae, and Ranixalinae were combined into the Petropedetidae (although Ranixalinae is recognized as a separate family by subsequent authors; Van Bocxlaer et al., 2006; Bossuyt & Roelants, 2009; Wiens et al., 2009). Some authors (Bossuyt et al., 2006; Wiens et al., 2009) follow the concept of Ranidae advocated by Dubois (2005), but there is growing use of the family-level taxonomy advocated by Frost et al. (2006). As pointed out by Frost et al. (2006), their unranked taxon Natatanura roughly corresponds to what previous workers have referred to as “ranids”. There is high support for the Natatanura of Frost et al. (2006) from a variety of phylogenetic studies, although the relationships among these families remain unresolved (Vences et al., 2003b; Roelants et al., 2004, 2007; Scott, 2005; Bossuyt et al., 2006; Wiens, 2007; Wiens et al., 2009; Pyron & Wiens, 2011). Ceratobatrachidae is supported as monophyletic (Bossuyt et al., 2006; Frost et al., 2006; Van Bocxlaer et al., 2006; Roelants et al., 2007; Wiens et al., 2009; Ruane et al., 2011; Pyron & Wiens, 2011; see also Brown, 2004).

21. Based on recent phylogenetic studies (Evans et al., 2008; Ruane et al., 2011), we include three extinct genera in the Ceratophryidae († Baurubatrachus, † Beezlebufo, † Wavelia). See also footnote 8.

22. Heinicke et al. (2009) described the Cethomantidae, as well as its sole genus Cethomantis, and showed that it is sister to a clade containing other families placed in the unranked taxon Terrarana.

23. The monophyly of a clade containing Conraua and Petropedetes (including taxa formerly placed in Arthroleptidae) is supported in several phylogenetic analyses (Bossuyt et al., 2006; Van Bocxlaer et al., 2006; Roelants et al., 2007; Wiens et al., 2009; Ruane et al., 2011), but not others (van der Meijden et al., 2005; Zimkus et al., 2010; Pyron & Wiens, 2011). Frost et al. (2006) resolved this clade to also contain the taxon here recognized as Ranixalidae, but this is not supported by subsequent analyses. Dubois (1992) considered the Conrauina to be a tribe within his subfamily Dicroglossinae (Ranidae of Dubois, 1992) and, by implication, included Petropedetes within the Phrynobatrachidae; Dubois (2005) later treated both Conrauinae and Petropedetinae as subfamilies of the Ranidae (sensu Dubois, 2005). In light of the uncertain sister relationship between these two clades and their likely deep divergence (Roelants et al., 2007), we recognize these as two distinct families, Conrauaidae and Petropedetidae. For further details on taxonomy of taxa placed in the Ranidae of Dubois (2005), see footnote 20.

24. Hedges et al. (2008) proposed the Craugastoridae for the diverse Craugastor and its sister taxon, a new genus Haddaclus. The Craugastoridae is one of four families in the unranked taxon Terrarana (Hedges et al., 2008; Heinicke et al., 2009; Pauly et al., 2009). Pyron & Wiens (2011) found Craugastoridae sensu Hedges et al. (2009) to be embedded within the Strabomantidae sensu Hedges et al. (2009), and expanded the Craugastoridae to include all taxa previously assigned to Strabomantidae. However, because of low support values among basal nodes in this larger clade, the analysis of Pyron & Wiens (2011) does not reject the hypothesis that Craugastoridae is sister to the Strabomantidae. Higher-level relationships among these clades require further study.

25. See footnote 8.

26. Grant et al. (2006) recognize three subfamilies of Dendrobatidae (for discussion regarding taxa in the Aromobatidae, see footnote 10). The phylogenetic relationships resolved in other studies (Vences et al., 2000, 2003a; Roberts et al., 2006; Santos et al., 2009; Santos & Cannatella, 2011) support the tree topology on which the subfamily taxonomy of Grant et al. (2006) is based. Santos et al. (2009; see also Santos & Cannatella, 2011) argued that the partitioning of Dendrobates into six genera was unnecessary (Adelphobates, Dendrobates, Eubatobates, Minyobates, Oophaga, Ranitomeya). Brown et al. (2011) discuss this matter at length and elect to recognize all six genera and describe a seventh genus, Andinobates.
Subfamily *Hyloxalinae* Grant, Frost, Caldwell, Gagliardo, Haddad, Kok, Means, Noonan, Schargel & Wheeler, 2006 (1 genus; 59 species)

Family *Dicroglossidae* Anderson, 1871 (12–14 genera; 177 species)\(^{27}\)

Subfamily *Dicroglossinae* Anderson, 1871 (10–12 genera; 155 species)

Subfamily *Occidozyginae* Fei, Ye, & Huang, 1990 (2 genera; 22 species)

Family *Eleutherodactylidae* Lutz, 1954 (4 genera; 202 species)\(^{34}\)

Subfamily *Eleutherodactylinae* Lutz, 1954 (2 genera; 195 species)

Subfamily *Phyzelaphryninae* Hedges, Duellman, & Heinicke, 2008 (2 genera; 7 species)

Family †*Gobiatiidae* Roček & Nesov, 1993 (†3)\(^{39}\)

Family *Helophrynidae* Noble, 1931 (2 genera; 6–7 species)\(^{30}\)

Family *Hemiphractidae* Peters, 1862 (6 genera; 95 species)\(^{31}\)

Family *Hemisotidae* Cope, 1867 (1 genus; 9 species)\(^{32}\)

Family *Hylidae* Rafinesque, 1815 (42–46 genera; 904 species; †1)\(^{33}\)

Subfamily *Hylineae* Rafinesque, 1815 (36–39 genera 647 species;)

Subfamily *Pelodyrininae* Günther, 1858 (1–2 genera; 198 species)

Subfamily *Phyllomedusinae* Günther, 1858 (5 genera; 59 species)

Family *Hylodidae* Günther, 1858 (3 genera; 42 species)\(^{34}\)

Family *Hyperoliidae* Laurent, 1943 (18 genera; 214 species)\(^{35}\)

Family *Leiopelmatidae* Mivart, 1869 (1 genus; 4 species)\(^{36}\)

Family *Leiuperidae* Bonaparte, 1850 (7 genera; 85 species)\(^{37}\)

Family *Leptodactylidae* Werner, 1896 (6 genera; 105 species)\(^{38}\)

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27. Phylogenetic analyses of molecular data support monophyly of the Dicroglossidae (Kosuch et al., 2001; Roelants et al., 2004, 2007; Kurabayashi et al., 2005; van der Meijden et al., 2005; Bossuyt et al., 2006; Frost et al., 2006; Van Bocxlaer et al., 2006; Che et al., 2007; Wiens, 2007; Wiens et al., 2009; Ruane et al., 2011). Two clades, the subfamilies Dicroglossinae and Occidozyginae, also receive strong support (Kosuch et al., 2001; Roelants et al., 2004; Bossuyt et al., 2006; Frost et al., 2006; Che et al., 2007; Wiens et al., 2009; Ruane et al., 2011; Pyron & Wiens, 2011). Generic-level taxonomy and phylogenetic relationships within the Dicroglossidae remain unresolved (Dubois et al., 2001; Jiang et al., 2005; Che et al., 2007, 2009, 2010; Pyron & Wiens, 2011). For further details on taxonomy of taxa placed in the Ranidae of Dubois (2005), see footnote 20.

28. Hedges et al. (2008) recognized two well-supported clades within the Eleutherodactylidae, one including *Diasporus* and the mega-diverse genus *Eleutherodactylus* and the other including the species-poor *Adelophrynus* and the monotypic *Phylaphrynodes*. Of this family, only the *Hylineae* are recognized as a distinct family. The *Pelodyrininae* and *Phyllomedusinae* are considered monophyletic by molecular analyses (Frost et al., 2006), whereas others resolve it to be paraphyletic (Wiens, 2007; Guayasamin et al., 2008; Heinicke et al., 2009; Pyron & Wiens, 2011). Frost et al. (2006) recognized three families (Amphignathodontidae, Cryptobatrachidae, Hemiphractidae). Because more recent studies have resolved this family as monophyletic, we maintain the family *Hemiphractidae* for *Hemiphryctus, Cryptobatrachus, Hadromophryne, and Stefania*, as well as the resurrected *Fritziana* (Duellman et al., 2011).


30. Molecular phylogenies have resolved the *Hylidae* as the sister taxon of all other Neobatrachia (e.g., Hoegg et al., 2004; Frost et al., 2006; Roelants et al., 2007; Wiens, 2007). Van Dijk (2008) erected *Hadromorphynyrus*, the validity of which is further supported by Pyron & Wiens (2011).

31. Monophyly of the *Hemiphractidae* has been controversial. Based on molecular phylogenetic analyses, some authors have found the Hemiphractidae to be paraphyletic (Darst & Cannatella, 2004), or polyphyletic (Faivovich et al., 2005; Frost et al., 2006), whereas others resolved it to be monophyletic (Wiens, 2007; Guayasamin et al., 2008; Heinicke et al., 2009; Pyron & Wiens, 2011). Frost et al. (2006) recognized three families (Amphignathodontidae, Cryptobatrachidae, Hemiphractidae). Because more recent studies have resolved this family as monophyletic, we maintain the family *Hemiphractidae* for *Cryptobatrachus, Flectonotus, Gastrotheca, Hemiphractus,* and *Stefania*, as well as the resurrected *Fritziana* (Duellman et al., 2011).

32. The family *Hemisotidae*, containing only the genus *Hemisotus*, is assumed to be monophyletic, though we know of no explicit test. *Hemisotus* is the sister taxon of the *Brevicipitidae* (Frost et al., 2006; Roelants et al., 2007; van der Meijden et al., 2007b; Wiens, 2007), a relationship previously suggested by morphological phylogenetic studies (Blemmers-Schlosser, 1993; Channing, 1995). One viable alternative taxonomic arrangement would be to include *Hemisotidae* as a subfamily of the *Brevicipitidae*.

33. The content of the *Hylidae* has been extensively modified in recent years. Those frogs recognized above as the *Hylidae* were previously considered part of the *Hylidae* (Duellman, 1970), but they are not necessarily closely related (Darst & Cannatella, 2004; Frost et al., 2006; Wiens, 2007; Heinicke et al., 2009). Most analyses agree in resolving a monophyletic lineage containing three subfamilies (Darst & Cannatella, 2004; Faivovich et al., 2005; Wiens et al., 2005; Frost et al., 2006; Pyron & Wiens, 2011), two of which (Pelodyrininae and *Phyllomedusinae*) form a clade sister to the third (Hylineae). However, there is some disagreement on the monophyly of *Hylidae* (Roelants et al., 2007), which, combined with deep genetic divergences, has led some authors to recognize each subfamily as a distinct family (Bossuyt & Roelants, 2009). We recognize a single family with three subfamilies. Faivovich et al. (2005) extensively revisited the generic-level taxonomy of *Hylinae*. Generic-level taxonomy of the *Pelodyrininae* remains in flux with authors recognizing one or two genera (Faivovich et al., 2005; Frost et al., 2006; Rosauer et al., 2009; Tyler et al., 2009; Pyron & Wiens, 2011). For the *Phyllomedusinae*, Faivovich et al. (2010) synonymized *Hylomantis* and *Pachymedusa* with *Agalychnis*. There are relationships with *Australobatrachus* to currently recognized clades remains unclear.

34. The three genera of *Hylodidae* form a clade (Nuin & do Val, 2005; Frost et al., 2006; Grant et al., 2006; see also Pyron & Wiens, 2011) that Grant et al. (2006) resolved as the sister taxon of the *Dendrobatidae* + *Aromobatidae* (also suggested by morphological and karyological data; e.g., Lynch, 1971; Bogart, 1991; Augier et al., 2004) and thus removed it from the *Cyclorhaphidae*, where it had been placed by Frost et al. (2006). Pyron & Wiens (2011) resolved *Hylodidae* as the sister taxon of *Alsodidae*, and not near the *Dendrobatidae* + *Aromobatidae*.

35. The *Hyperoliidae* is a diverse clade of seventeen genera, many of which have long been recognized as sharing morphological features (Laurent 1986; Drewes, 1984) and both morphological (Drewes, 1984) and molecular phylogenetic analyses support monophyly (Vences et al., 2003b; Frost et al., 2006; Vieith et al., 2009). As detailed in footnote 11, the genus *Leiopeltes* is now considered part of the *Arthroleptidae*, which is the sister taxon to *Hyperoliidae*.

36. See footnote 12.
42. Following recognition of the Brevicipitidae (see footnote 16), there is strong support for the monophyly of the Microhylidae (Ford & Cannatella, 1993; Frost et al., 2006).

39. Phylogenetic analyses provide strong support for the monophyly of the Mantellidae (Emerson et al., 2006).

38. Ruvinsky & Maxson (1996) showed that Leptodactylidae sensu lato is paraphyletic with respect to the Lemuridae. The monophyly of the Micrixalidae, containing only the genus Micrixalus, is supported by phylogenetic analyses (Bossuyt et al., 2006; Van Bocxlaer et al., 2006; Wiens et al., 2009; see also Dubois et al., 2001). For further details on taxonomy of taxa placed in the Ranidae of Dubois (2005), see footnote 20.

40. The monophyly of the Megophryidae is widely accepted (e.g., Ford & Cannatella, 1993; Frost et al., 2006). The most significant recent taxonomic change is the recognition that Leptobrachium is paraphyletic with respect to *Vibris supported by phylogenetic analyses (Bossuyt et al., 2006; Van Bocxlaer et al., 2006; Wiens et al., 2009; see also Dubois et al., 2001). For further details on taxonomy of taxa placed in the Ranidae of Dubois (2005), see footnote 20.

41. The monophyly of the Microhylidae is elevated to family would lead to many genera of unclear affinities being orphaned. Thus, we advocate recognizing the family Microhylidae with multiple subfamilies and leaving certain genera without subfamily designation. Based on Greenbaum (2006), we suggest that *Albignus, *Melanophryn, *Myriopterus, and *Scaphiophryne be included in the Gastrophrynidae. Following Pyron & Wiens (2011) and Trueb et al. (2011), we tentatively include *Symphryus in the Otophrynidae.
Family Pelobatidae Bonaparte, 1850 (1 genus; 4 species)\(^{46}\)
Family Pelodytidae Bonaparte, 1850 (1 genus; 3 species; \(\approx 7^{29}\)  
Family Petropedetidae Noble, 1931 (1 genus; 12 species)\(^{36}\)  
Family Phrynobatrachidae Laurent, 1941 (1 genus; 84 species)\(^{31}\)  
Family Pipidae Gray, 1825 (4–5 genera; 33 species; \(\approx 17^{52}\)  
Family Ptychadenidae Dubois, 1987 (3 genera; 51 species)\(^{33}\)  
Family Pyxicephalidae Bonaparte, 1850 (13 genera; 67 species)\(^{34}\)  
Subfamily Cacosterninae Noble, 1931 (11 genera; 61 species)  
Subfamily Pyxicephalinae Bonaparte, 1850 (2 genera; 6 species)  
Family Ranidae Rafinesque, 1814 (10–16 genera; 369 species)\(^{49}\)  
Family Ranixalidae Dubois, 1987 (1 genus; 10 species)\(^{36}\)  
Family Rhacophoridae Hoffman, 1932 (15 genera; 333 species)\(^{37}\)  
Subfamily Buergeriinae Channing, 1989 (1 genus; 5 species)\(^{38}\)

43. From one to three families of myobatrachids (Myobatrachidae, Limnodynastidae, Rheobatrachidae) have been recognized. Ford & Cannatella (1993) questioned the monophyly of a single family (e.g., Heyer & Liem, 1976) and proposed that \(\text{T}Rhoeobatrachus\) may be most closely related to the Myobatrachinae (sensu Heyer & Liem, 1976). Several molecular phylogenetic analyses did not test the monophyly of each family (e.g., Read et al., 2001; Morgan et al., 2007). Frost et al. (2006) found that twenty genera variously assigned to the three families form a clade, yet chose to recognize two families (Limnodynastidae and Myobatrachidae, the latter containing \(\text{Mixophyes}\) and \(\text{T}Rhoeobatrachus\)). Much of the uncertainty of higher-level taxonomy in this clade relates to \(\text{Mixophyes}\) and \(\text{T}Rhoeobatrachus\), the relationships of which remain uncertain (Heyer & Liem, 1976; Farris et al., 1982; Frost et al., 2006; Roelants et al., 2007; Ruane et al., 2011; Pyron & Wiens, 2011). In several analyses, \(\text{Mixophyes}\) and \(\text{T}Rhoeobatrachus\) are not sister taxa and the relationships of these two genera to the other taxa in the Limnodynastidae and Myobatrachidae (sensu Frost et al., 2006) remain unclear (Roelants et al., 2007; Pyron & Wiens, 2011; Ruane et al., 2011). Bossuyt & Roelants (2009) recognized Rheobatrachidae, Limnodynastidae, and Myobatrachidae but mentioned neither \(\text{T}Rhoeobatrachus\) nor \(\text{Mixophyes}\) explicitly. To date, the most complete relevant analyses are those of Frost et al. (2006) and Pyron & Wiens (2011), which largely agree with one another, yet disagree on whether \(\text{T}Rhoeobatrachus\) and \(\text{Mixophyes}\) form a clade. Because of remaining uncertainties in the placement of \(\text{T}Rhoeobatrachus\) and \(\text{Mixophyes}\), we follow Pyron & Wiens (2011) by using two subfamilies for the single family Myobatrachidae. The genus \(\text{T}Rhoeobatrachus\) became extinct in the late 20th century.

44. The monotypic family Nasikabatrachidae (Biju & Bossuyt, 2003) is nearly universally accepted, although Frost et al. (2006) included the sole genus in the Sooglossidae. We follow the generally accepted practice of maintaining these as two distinct families (e.g., Frost, 2011; Pyron & Wiens, 2011).

45. Frost et al. (2006) subsumed the Lankanectinae and Nyctibatrachinae of Dubois (2005) into a single family, Nyctibatrachidae. The monophyly of this family, containing the two genera \(\text{Lankanectes}\) and \(\text{Nyctibatrachus}\), receives high support from phylogenetic analyses (van der Meijden et al., 2005; Bossuyt et al., 2006; Frost et al., 2006; Van Bocxlaer et al., 2006; Roelants et al., 2007; Wiens, 2007; Wiens et al., 2009; Ruane et al., 2011; Pyron & Wiens, 2011; see also Dubois & Ohler, 2001). For further details on taxonomy of taxa placed in the Ranidae of Dubois (2005), see footnote 20.

46. Pyron & Wiens (2011) found strong support for the monophyly of a clade of three genera (\(\text{Macroemugiella}, \text{Odontophrynus}, \text{and Proceratophrys}\)), which they recognized as the Odontophysyidae. See also footnote 8.

47. \(\text{T}Palaeobatrachidae\) contains four recognized extinct genera (\(\text{T}Albionobatrachus\), \(\text{T}Messelobatrachus\), \(\text{T}Palaeobatrachus\), and \(\text{T}Pliobatrachus\)) and is generally accepted as the sister of the extant Pipidae although the phylogenetic relationships of this family remain obscure (Sanchíz, 1998). The phylogenetic analyses of Gao & Wang (2001) and Gao & Chen (2004), which included \(\text{T}Palaeobatrachus\), suggest that \(\text{T}Palaeobatrachidae\) may nest within the Pipidae, but a phylogenetic analysis with greater taxonomic sampling of extinct pipoid taxa supports the monophyly of Pipidae to the exclusion of \(\text{T}Palaeobatrachus\) (Trüeb & Bätz, 2006; see also Roček, 2003).

48. The well-supported Pelobatidae contains a single genus (\(\text{Pelobates}\)) with four species (Cannatella, 1985; Ford & Cannatella, 1993; Lathrop, 1997; García-Pérez et al., 2003; Roelants & Bossuyt, 2005; Frost et al., 2006; Veith et al., 2006). Based on the morphological phylogenetic analysis of Cannatella (1985), Ford & Cannatella (1993) defined Pelobatidae to include \(\text{Pelobates}\) as well as \(\text{Scaphiopus}\) and \(\text{Spea}\) (see also, e.g., Noble, 1925). Analyses of molecular data by Lathrop (1997), Henrińi & Haynes (2006), and Henrińi (2009) further support this result as well as including the extinct taxa \(\text{Elkoelobatrachus}\), \(\text{Macroleobatobates}\), \(\text{Eполненobates}\) in the Pelobatidae. However, subsequent molecular phylogenetic analyses, as well as a combined analysis of larval and adult morphology (Pugener et al., 2003) indicate that \(\text{Pelobates}, \text{Scaphiopus}, \text{and Spea}\) do not form a clade exclusive of Pelodytidae and Megophryidae (see also footnote 39). We follow the results of these recent studies by recognizing Pelobatidae and Scaphiopodidae to be distinct families, although the relationships of the extinct taxa now remain uncertain and we consider these \(\text{Anura incertae sedis}\).

49. The monophyly of the Pelodytidae, which contains a single genus (\(\text{Pelodytes}\)) with three species, is supported by phylogenetic analysis of mitochondrial DNA sequence data (García-Pérez et al., 2003). Analyses of both morphological and molecular data support the Pelodytidae as a member of a larger clade containing the Pelobatidae, Scaphiopodidae, and Megophryidae (Cannatella, 1985; Ford & Cannatella, 1993; Hay et al., 1995; García-Pérez et al., 2003; Pugener et al., 2003; Roelants & Bossuyt, 2005; San Mauro et al., 2005; Frost et al., 2006; Veith et al., 2006; Roelants et al., 2007; Wiens, 2007; Ruane et al., 2011). \(\text{T}Mixoleobates\) and \(\text{T}Eполненobates\) have been included in the Pelodytidae based on the fusion of the tubial and fibulare (unique among archaeobatrachians; Cannatella, 1985), but the precise relationships of these two genera to \(\text{Pelodytes}\) remains unclear (Taylor, 1941; Henrińi, 1994).

50. See footnote 23.

51. The monophyly of the Phrynobatrachidae, containing the single diverse genus \(\text{Phrynobatrachus}\), is well supported by phylogenetic analyses (Scott, 2005; Bossuyt et al., 2006; Van Bocxlaer et al., 2006; Roelants et al., 2007; Wiens et al., 2009; Ruane et al., 2011; Zimkus et al., 2010). While combined molecular and morphological data of Scott (2005) suggested paraphyly of \(\text{Phrynobatrachus}\) with respect to \(\text{Natalobatrachus}\), the recent phylogenetic analysis of van der Meijden et al. (2011) demonstrate \(\text{Natalobatrachus}\) to be within the Pyxicephalidae. For further details on taxonomy of taxa placed in the Ranidae of Dubois (2005), see footnote 20.
Subfamily Rhacophorinae Hoffman, 1932 (14 genera; 327 species)
Family Rhinodermatidae Günther, 1858 (2 genera; 3 species)\(^{58}\)
Family Rhinophrynidae Günther, 1859 (1 genus; 1 species; \(\ddagger\)–3)\(^{39}\)
Family Scaphiopodidae Cope, 1865 (2 genera; 7 species)\(^{60}\)
Family Sooglossidae Noble, 1931 (2 genera; 4 species)\(^{61}\)
Family Strabomantidae Hedges, Duellman, & Heinicke, 2008 (17–19 genera; 572 species)\(^{62}\)
Subfamily Holoadeniinae Hedges, Duellman, & Heinicke, 2008 (6 genera; 47 species)
Subfamily Strabomantinae Hedges, Duellman, & Heinicke, 2008 (11–13 genera; 525 species)
Family Telmatobidae Fitzinger, 1843 (2 genera; 60 species)\(^{63}\)

Order Caudata Fischer von Waldheim, 1813 (salamanders) (67–68 genera; 614 species; \(\ddagger\)–66)\(^{44}\)
Family **Ambystomatidae** Gray, 1850 (1 genus; 32 species; †2)

Family **Amphiumidae** Gray, 1825 (1 genus; 3 species; †1)

Family **Batrachosauroididae** Auffenberg, 1958 (†7)

Family **Cryptobranchidae** Fitzinger, 1826 (2 genera; 3 species; †6)

Family **Dicamptodontidae** Tilden, 1958 (1 genus; 4 species; †5)

Family **Hynobiidae** Cope, 1859 (9 genera; 53 species; †1)

Family **Karaauridae** Ivachnenko, 1978 (†2–3)

Family **Plethodontidae** Gray, 1850 (27 genera; 418 species)

Subfamily **Hemidactyliinae** Hallowell, 1856 (20 genera; 322 species)

Subfamily **Plethodontidinae** Gray, 1850 (7 genera; 96 species)

Family **Proteidae** Gray, 1825 (2 genera; 6 species; †2)

Subfamily **Proteinae** Gray, 1825 (1 genus; 1 species; †2)

64. We consider Caudata and Urodela to be synonyms and follow the argumentation of Frost *et al.* (2006) by recognizing Caudata as the appropriate name (for a contrasting view, see Dubois, 2004). Family-level assignment is currently not possible for ~25 extinct genera. Of these, †Karaaurus and †Kokartos may be outside crown-group Caudata. Unassigned taxa, some of which are based on very limited material (e.g., †Galverpeton), are †Aproicosiren, †Batrachosauroids, †Bishara, †Chrysotriton, †Chunerpeton, †Comonectoridae, †Galverpeton, †Hemitrypo, †Hylaeobatrachus, †Iridotriton, †Jeholotriton, †Kiyatriot, †Lacotroutriton, †Marmorpeton, †Mynablakia, †Nesovtriton, †Paleosamphyina, †Pangerpeton, †Prosiren, †Ramoolius, †Regalerpeton, †Sminobatrachus, †Simerpeton, †Triassaurus (possibly not within Caudata; Estes, 1981; Milner, 2000), and †Valdorriton.

65. The monophyly is well established for Ambystomatidae and Dicamptodontidae, and the clades are sister taxa (Larson, 1991; Larson & Dimmick, 1993; Frost *et al.*, 2006; Roelants *et al.*, 2007; Vieites *et al.*, 2007, 2009; Wiens, 2007; Zhang & Wake, 2009a; Pyron & Wiens, 2011). Frost *et al.* (2006) reduced Dicamptodontidae to a subfamily of Ambystomatidae to avoid two taxa each with only one genus. Significantly, the decision by Frost *et al.* (2006) to place the Dicamptodontidae in the Ambystomatidae because “each contains a single genus” (p. 118) disregards the long recognition of extinct genera as belonging to these families (e.g., Estes, 1981). In light of the deep separation of the taxa (probably in excess of 100 my: Roelants *et al.*, 2007; Zhang & Wake, 2009a; Vieites *et al.*, 2009), the long fossil record of dicamptodontids, documentation of their former occurrence in Europe (Venczel, 2008), and substantial biological differences between the two clades, we recognize these as two distinct families. We follow Estes (1981) by including five extinct genera (†Ambystomichnus [an ichnotaxon; Peabody, 1954], †Bargmannia, †Chrysotriton, †Geyeriella, and †Wolterstorfiellia) in the Dicamptodontidae. While we agree with Milner (2000) that the inclusion of these in Dicamptodontidae is based on very limited data (i.e., vertebral morphology; Estes, 1981), it is the only evidence at hand and serves as a hypothesis to be tested with additional data. Rogers (1976) described †Ambiptirin as an extinct genus of Ambystomatidae; Estes (1981) and Milner (2000) have shown that the morphological features of this extinct taxon fall within the diversity observed in Ambystoma.

66. The monophyly of Amphiumidae contains three extant species of *Amphiuma*. Amphiumidae is the sister-taxon to the Plethodontidae (Larson & Dimmick, 1993; Frost *et al.*, 2006; Roelants *et al.*, 2007; Vieites *et al.*, 2007, 2009; Wiens, 2007; Zhang & Wake, 2009a; Pyron & Wiens, 2011). We include †Promamphiuma, and refrain from including †Paleosamphyina because of disagreements as to its affinities (Rippe1 & Grande, 1998; Gardner, 2003).

67. The †Batrachosauroididae is an extinct, enigmatic family of uncertain phylogenetic affinity with seven currently recognized genera (†Batrachosauroids, †Mynablakia, †Opistsotriton, †Paleosoanops, †Pattisia, †Peratosauroids, and †Prodesmodon; Estes, 1989; Denton & O’Neill, 1998; Milner 2000). Estes (1981) considered batrachosauroidids to be closely related to extant prosk Redirect to /encyclopedia/article?title=Blackburn%20%26%20Wake%3A%20Class%20Amphibia%20Gray%2C%201825 68. The monophyto-branchioid clade (e.g., Wiens, 2007; Zhang & Wake, 2009a; Pyron & Wiens, 2011) contains two extant genera (Andrias and Cryptbranchus) and two extinct genera (†Aviturus and †Ulanurus). Gubin (1991) placed †Aviturus and †Ulanurus in the subfamily Avituirinae within the Cryptbranchiidae, but we refrain from recognizing this subfamily taxonomy pending cladistic analyses. Four other extinct genera (†Chunerpeton, †Jeholotriton, †Pangerpeton, and †Regalerpeton) form a clade with extant cryptbranchiids exclusive of other salamanders but these have not been formally included within the Cryptbranchiidae (Zhang *et al.*, 2009; Skutschas & Gubin, in press; see also Wang & Evans, 2006). Estes (1981) provides details on other taxa considered junior synonyms of *Andrias*. Skutschas (2009) also includes both †Eoscaphepeton and †Horecmia in the Cryptbranchiidae.

69. See footnote 65.

70. Hynobiidae is monophyletic (e.g., Frost *et al.*, 2006; Zhang & Wake, 2009a; Zheng *et al.*, 2011; Pyron & Wiens, 2011) and sister to the Cryptbranchiidae (Larson, 1991; Larson & Dimmick, 1993; Frost *et al.*, 2006; Roelants *et al.*, 2007; Vieites *et al.*, 2007, 2009; Wiens, 2007; Zhang & Wake, 2009a; San Mauro, 2010; Pyron & Wiens, 2011). A close relationship between the Hynobiidae and Cryptbranchiidae is supported by morphological data (Noble, 1925; Larsen, 1963; Larson & Dimmick, 1993). Molecular phylogenetic analysis of the recently rediscovered *Protohynobius puxionensis* reveals that it is closely related to *Pseudohynobius* and nested well within Hynobiidae (Peng *et al.*, 2010), thus invalidating the former subfamily *Protohynobius* (Fei & Ye, 2000). We follow Venczel (1999) by including the extinct †Parahynobius in the Hynobiidae.

71. †Karaauridae is an extinct family comprising two genera (†Karaaurus and †Kokartos) from the Jurassic of middle Asia (Ivachnenko, 1978; Nessov, 1988). The †Karaauridae is believed to be the sister taxon of extant salamanders (Evans & Milner, 1996; Evans *et al.*, 2005; Skutschas & Martin, 2011; Skutschas & Gubin, in press). Another extinct genus, †Marmorerpeton, may be allied to the †Karaauridae (Milner, 2000).

72. Evidence for two major clades within the Plethodontidae is strong (Vieites *et al.*, 2007, 2011; Camp *et al.*, 2009) and two subfamilies, Hemidactyliinae and Plethodontinae, are recognized (contra Pyron & Wiens, 2011). Vieites *et al.* (2011) recognized four tribes in the Hemidactyliinae and five in the Plethodontinae; their Bolitoglossini and Schepertiini were treated as subfamilies by Chippindale *et al.* (2004) and Pyron & Wiens, 2011). Each subfamily and each tribe is well resolved as monophyletic in molecular phylogenetic analyses (e.g., Chippindale *et al.*, 2004; Mueller *et al.*, 2004; Macey, 2005; Min *et al.*, 2005; Frost *et al.*, 2006; Wiens, 2007; Kozak *et al.*, 2009; Vieites *et al.*, 2011, Pyron and Wiens, 2011). However, inferred relationships among the tribes have changed over time with increases in phylogenetic data (Hedges & Maxson, 1993; Hay *et al.*, 1995; Chippindale *et al.*, 2004; Mueller *et al.*, 2004; Macey, 2005; Min *et al.*, 2005; Frost *et al.*, 2006; Roelants *et al.*, 2007; Wiens, 2007; Kozak *et al.*, 2009; Vieites *et al.*, 2011).
Subfamily Necturinae Fitzinger, 1843 (1 genus; 5 species)
Family Rhyacotritonidae Tiiten, 1958 (1 genus; 4 species)
Family Salamandridae Goldfuss, 1820 (21–22 genera; 86 species; †9)
  Subfamily Pleurodelinae Tschudi, 1838 (16–17 genera; 69 species; †7)
  Subfamily Salamandrinae Goldfuss, 1820 (4 genera; 15 species; †1)
Subfamily Salamandriniinae Fitzinger, 1843 (1 genus; 2 species)
Family Scapherpetontidae Auffenberg & Goin, 1959 (†3)
Family Sirenidae Gray, 1825 (2 genera; 4 species; †3)
Order Gymnophiona Müller, 1832 (caecilians) (31 genera; 188; †3)
  Family Caeciliidae Rafinesque, 1814 (2 genera; 42 species)
  Family Dermophiidae Taylor, 1969 (4 genera; 14 species; †1)
  Family Herpetidae Laurent, 1984 (2 genera; 9 species)
Family Icthyophiidae Taylor, 1968 (3 genera; 50 species)
Family Indotyphlidae Lesecure, Renous & Gasc, 1986 (7 genera; 21 species)
Family Rhinatrematidae Nussbaum, 1977 (2 genera; 11 species)
Family Scolecomorphidae Taylor, 1969 (2 genera; 6 species)

73. Monophyly of the Proteidae has long been debated (e.g., Larsen & Guthrie, 1974; Hecht & Edwards, 1976). Molecular phylogenetic studies recover a monophyletic Proteidae but with very long internal branches and a split likely in excess of 120 my (Frost et al., 2006; Roelants et al., 2007; Wiens, 2007; Zhang & Wake, 2009a). While we recognize a single family, there are distinct taxa assigned to Proteinae and a reasonable alternative would be to raise the subfamilies (Proteinae and Necturinae) to family level (Zhang & Wake, 2009a). The extinct taxa †Miopterus and †Orthophyia are morphologically similar to Proteus (Estes, 1981; Milner, 2000) and we place these genera in the Proteinae.

74. The Rhyacotritonidae, containing only the genus Rhyacotriton, is sister to the clade comprising the Amphiumidae and Pseudobranchidae (Mueller et al., 2004; Min et al., 2005; Frost et al., 2006; Wiens et al., 2005; Roelants et al., 2007; Vieites et al., 2007, 2011; Wiens, 2007; Zhang & Wake, 2009a; Pyron & Wiens, 2011; Zheng et al., 2011).

75. Monophyly of the Salamandriniinae is well established based on morphological and molecular evidence (Wake & Özeti, 1969; Titus & Larson, 1995; Pyron & Wiens, 2011), although Zhang & Wake (2009a), using complete mitochondrial genomes, found monophyly of the Salamandriniinae to be sister to all other salamanders. We follow Evans et al. (2011) to recognize only three families: Caeciliidae, Typhlonectidae, and Rhinatrematidae. In order to resolve apparent paraphyly, Wilkinson et al. (2011) recognized nine families. Their classification is compatible with the results of the most comprehensive molecular phylogenetic analyses (Roelants et al., 2007; Zhang & Wake, 2009b; Pyron & Wiens, 2011), yet many taxa remain unsampled. We adopt the classification of Wilkinson et al. (2011), which identifies major clades and presents detailed justifications for recognizing these as families (rather than subfamilies as in Pyron & Wiens, 2011); because of this recent presentation, we do not go into detailed summaries for each family of caecilians. The Caeciliidae (sensu Nussbaum & Wilkinson, 1989; see also Wilkinson & Nussbaum, 2006) is the family-level taxon most affected by changes proposed by Wilkinson et al. (2006; Loader et al., 2007; Roelants et al., 2007; Gower et al., 2008; Gower & Wilkinson, 2009; Zhang & Wake, 2009b), although most of these studies are based on a single representative of each taxon. Frost et al. (2006) subsumed the Uraeotyphlidae within the Ichthyophiidae based on data for three specimens, one of which was unidentified to species. In studies with richer taxon sampling, Gower et al. (2002), Zhang & Wake (2009b), and Pyron & Wiens (2011) found Ichthyophis to be paraphyletic with respect to Uraeotyphlus, and Ichthyophis is parasynaplectic with respect to Caudicaecilia (Roelants et al., 2007; Zhang & Wake, 2009b; Pyron & Wiens, 2011). The validity of genera in the Ichthyophiidae requires further research (i.e., Wilkinson et al., 2011).

See footnote 78.
Family Siphonopidae Bonaparte, 1850 (7 genera; 22 species)
Family Typhlonectidae Taylor, 1968 (4 genera; 13 species)

Cited References


84. Rhinatrematidae is monophyletic (Wilkinson & Nussbaum, 1996; Frost et al., 2004; Roelants et al., 2007; Zhang & Wake, 2009b) and is the sister taxon of all other living gymnophiona (Hedges et al., 1993; Wilkinson & Nussbaum, 1996; San Mauro et al., 2004b, 2009; Frost et al., 2006; Loader et al., 2007; Roelants et al., 2007; Gower et al., 2008; Gower & Wilkinson, 2009; see also Wake, 1993).

85. The Scolecomorphidae is a morphologically distinctive clade (Frost et al., 2006; Pyron & Wiens, 2011; Wilkinson et al., 2011).

86. See footnote 77.

87. While Pyron & Wiens (2011) suggest paraphyly of the aquatic Typhlonectidae with respect to the terrestrial Caeciliidae of Wilkinson et al. (2011), their analysis includes but two typhlonectid genera. The morphological similarities among typhlonectids and their distinctiveness in relation to other caecilians are well established (Wilkinson & Nussbaum, 1997, 1999).


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