Supplementary data from Asher and Hofreiter, submitted.

MS in progress (July 2005). Do not cite or distribute. Send questions/comments to robert.asher[at]museum.hu-berlin.de

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1. Guide to files in "asher_hofreiter_suppdata.zip"

This zipped file contains input/output files from MrBayes 3.1 and PAUP 4.0 b10. After decompression, the "combined" folder contains alignments, character matrices, and resulting trees for both Bayesian and MP analyses of the 23-taxon, morphology+GHR dataset. The "partitions" folder contains alignments, character matrices, and resulting trees for the 43-taxon GHR-only and the 23-taxon morphology-only datasets. These are readable with text editors such as bbedit or PAUP. For MrBayes "runN.p" files, a spreadsheet such as openoffice or excel is recommended.

Characters are numbered according to anatomical region following Asher (2000), with one addition (interincisal gap, #126). We make no claims of polarity or order in the following character descriptions. The symbol "0" has neither more nor less significance than any other character-state symbol. References to figures listed below refer to the PhD dissertation of Asher (2000); these plus literature cited from Asher (2000) are included at the end of this document.

**Cranial vasculature**

1) **Posterior stapedial ramus:** When present in adult taxa, this artery arises from the proximal stapedial medial to the stapes, and runs posterolaterally into the stapes fossa (e.g., *Echinops*, state 0). In some taxa the proximal stapedial artery gives off no branches immediately medial to the stapes (e.g., *Tenrec*, state 1).

2) **Superior stapedial ramus:** In adult *Echinops*, the proximal stapedial bifurcates into superior and inferior rami after passing through the obturator foramen of the stapes; and the superior ramus courses in the sinus canal within the braincase along the surface of the lateral cranial wall (state 0). Several other taxa (e.g., *Potamogale*) show varying levels of involution of the superior stapedial ramus, all of which result in a small or absent superior ramus with supply of cranial structures such as eyes and meninges taken over by other arterial sources (state 1).

3) **Inferior stapedial ramus:** This inferior branch of the stapedial bifurcation, with target structures in the jaw, upper dentition, and/or face, is either present (e.g., *Echinops*, state 0) or absent (e.g., *Tenrec*, state 1).

4) **Origin of ophthalmic artery:** In *Setifer*, the ophthalmic artery arises from the internal carotid (state 0), and is apparent passing through the bony optic canal accompanied by the optic nerve. Several taxa show an ophthalmic artery originating from the superior stapedial
ramus as it leaves the sinus canal (e.g., *Echinops*, state 1). Bugge (1974) described the ophthalmic artery in *Talpa* and *Erinaceus* as originating from the inferior stapedial-supplied ramus infraorbitalis (state 2). This pattern was also observed in the *Erinaceus concolor* specimen described above. Carnivorans such as *Nandinia* show an ophthalmic artery supplied by a branch of the external carotid (state 3). Polymorphisms are occasionally apparent in the origin of optic vasculature; hence, a given taxon may be coded as having arterial supply from multiple sources.

5) **Origin of ramus mandibularis:** In most taxa (e.g., *Echinops*), the arterial supply to the jaw is provided by the inferior stapedial ramus (state 0). Alternatively, the ramus mandibularis supplying the jaw may originate from the external carotid artery (e.g., *Elephantulus*, state 1).

6) **Internal carotid relation to anterior cochlea:** As the promontory branch of the internal carotid approaches the point at which it enters the braincase, it may be medial (e.g., *Microgale*, state 0; Fig. A-13) or lateral (*Chrysochloris*, state 1; Fig. A-20) to the anterior pole of the pars cochlearis of the inner ear.

7) **Bifurcation of stapedial artery:** Typically (e.g., *Echinops*), the proximal stapedial artery bifurcates into inferior and superior rami after passing through the obturator foramen of the stapes, within the tympanic cavity (state 0). *Geogale* is one of a few taxa studied here to show a stapedial bifurcation above the roof of the middle ear, within the braincase (state 1).

8) **Proximal course of ramus infraorbitalis:** Posterior to the exit of the ophthalmic and maxillary divisions of the trigeminal nerve from the cranium, the ramus infraorbitalis may travel within the cavum epiptericum, ventral to trigeminal nerve bundles (e.g., *Echinops*, state 1); or it may be extracranial (e.g., *Blarina*, state 0).

9) **External carotid relation to thyropharyngeus muscle:** In *Echinops* (Fig. A-16) the external carotid passes medial to a slip of thyropharyngeus muscle, just proximal to its division into lingual, facial, and temporal trunks (state 0). Other taxa (e.g., *Micropotamogale*; Fig. A-7)
show the external carotid artery consistently lateral to thyropharyngeal musculature (state 1).

**Cartilaginous nasal skeleton**

10) **Anterior relation of vomeronasal duct**: *Solenodon* and *Dasypus* differ from other animals examined here in possessing a vomeronasal duct that empties directly into the nasal fossa (state 1) rather than into the nasopalatine duct (e.g., *Tenrec*, state 0).

11) **Paraseptal cartilage and anterior vomeronasal organ"outer bar")**: Among marsupials, a strut of paraseptal cartilage consistently encloses the vomeronasal organ anterolaterally (e.g., *Didelphis*, state 0; Sánchez-Villagra, in press). This is variably present among placental mammals; in many taxa the paraseptal cartilage is laterally open along its anterior half (e.g., *Micropotamogale*, state 1).

12) **Oral opening of nasopalatine duct**: The nasopalatine duct opens into the oral region via a single, unpaired channel in *Echinops* and *Setifer* (state 1; Hofer, 1982a). In other taxa, the nasopalatine duct is paired, and opens into the mouth on either side of the palatine papilla (e.g., *Tenrec*, state 0).

13) **Presence of nasopalatine duct cartilage**: Broom (e.g., 1898) noted that marsupials consistently lack cartilaginous support for the nasopalatine duct as it passes ventrally from the nasal fossa into the oral cavity (e.g., *Didelphis*, state 0). Some placentals, on the other hand, often show a cartilage medial and/or lateral to the nasopalatine duct (e.g., *Tenrec*, state 1). Many authors assign the medial (nasopalatine) and lateral (palatine) components different names (e.g., Maier, 1980); however, as mentioned above, Kuhn (1971) noted that these cartilages may be continuous and difficult to distinguish from one another. Due to this ambiguity, all cartilaginous support for the nasopalatine duct is here labeled "nasopalatine duct cartilage."

14) **Connection of nasopalatine duct and paraseptal cartilages**: When present, the nasopalatine
duct cartilage may show a connection to the paraseptal cartilage posterior to the nasopatine duct (e.g., Tenrec, state 1). Alternatively, it may appear adjacent to the duct with no connection to the paraseptal cartilage (e.g., Microgale, state 0).

15) **Presence of nasolacrimal duct:** Most taxa show a glandular duct running from the anteromedial margin of the eye, along the sidewall of the cartilaginous nose ventral to the maxilloturbinal, and opening anteriorly within the nasal cupola adjacent to the external nares (e.g., Tenrec, state 0). Potamogalines, on the other hand, show no trace of any such duct (state 1).

16) **Lateral cover of nasolacrimal duct:** The extent to which the nasolacrimal duct is shielded laterally by cartilage varies (W. Maier, personal communication). In Echinops, there is no cartilaginous barrier lateral to the duct at any point except for its anterior extreme, when it opens into the nasal cupola (state 0). Erinaceus, on the other hand, shows a lateral extension of the anterior transverse lamina dorsal to the anterior margin of the premaxilla that shields the nasolacrimal duct laterally, well before it empties anteriorly into the nasal cupola (state 1).

17) **Papillary cartilage:** Some taxa exhibit a cartilaginous structure within the palatine papilla (e.g., Elephantulus, state 0). Broom (1896) and Sánchez-Villagra (in press) note the presence of a papillary cartilage in most marsupials; however, such a structure is lacking in a Didelphis individual examined in this study and in those examined by Wöhrmann-Repennig (1984), although it appears to be present in others (Sánchez-Villagra, personal communication). Most eutherians lack a papillary cartilage (e.g., Tenrec, state 1).

18) **Vomeronal organ blood vessels:** In several taxa, a single, prominent blood vessel travels anteroposteriorly along with the vomeronasal organ tucked into its lateral side, giving the vomeronasal organ a kidney-shaped appearance when viewed coronally (e.g., Didelphis, state 0). Other animals show blood vessels scattered throughout the vomeronasal epithelium that do not travel in any single, well-defined fossa in the vomeronasal organ (e.g., Potamogale,
19) **Inferior nasal septum**: Sánchez-Villagra (in press) notes that a parallel-sided nasal septum (when viewed coronally) is ubiquitous among marsupials (e.g., *Didelphis*, state 0), and contrasts with the ventrally ovoid septum present in many placentals (e.g., *Echinops*, state 1).

20) **Zona annularis**: Anterior to the premaxilla, the nasal cartilages may form a complete, uninterrupted ring of cartilage around the nasal fossa, joining the anterior transverse lamina with the nasal sidewall and roof (e.g., *Echinops*, state 0). Alternatively, these structures may not be fully continuous at any point anterior to the premaxilla (e.g., *Solenodon*, state 1).

**Middle ear**

21) **Tympanic process of basisphenoid** (N86: #49; M88: #3): The basisphenoid medial and anterior to the middle ear is typically flat (e.g., *Nandinia*, state 0). Alternatively, it may make a significant contribution to the anterior and/or medial floor of the ossified auditory bulla (e.g., *Potamogale*, state 1; Fig. O-1).

22) **Piriform fenestra** (M88: #9): This character is present when the petrosal, alisphenoid, and/or squamosal fail to ossify anterior to the promonitory in the roof of the middle ear in a fully grown individual (e.g., *Microgale*, state 1; Fig. O-2). Adults of other taxa have a solid tympanic roof anterior to the middle ear promontory (e.g., *Erinaceus*, state 0).

23) **Caudal tympanic process of the petrosal** (N86: #55; M88: #2): This outgrowth from the posterior part of the petrosal may be absent or cover only the fenestra cochleae ventrally (e.g., *Hemicentetes*, state 0), or it may be larger and shield the fenestra cochleae and the entrance of the internal carotid artery as it enters the middle ear, contributing to the posterior wall of the ossified auditory bulla (e.g., *Potamogale*, state 1; Fig. O-2).

24) **Rostral tympanic process of petrosal** (M88: #1): A ventromedial flange of petrosal may
be present, extending up to the ventral apex of the promontory, contributing to the entrance foramen for the internal carotid in the posterior bulla, and/or articulating with the basisphenoid (e.g., *Potamogale*, state 0; Fig. O-2). Alternatively, the petrosal may exhibit a medial process that either does not extend to the apex of the promontory or is absent altogether (e.g., *Hemicentetes*, state 1).

25) **Tympanic roof** (M88: #8, 9; F91: #33): The squamosal and alisphenoid differ in the degree to which they are exposed on the tympanic roof. Although the squamosal consistently comprises the tympanic roof in the region of the epitympanic recess (housing the articulation of the incus and malleus), it may be more restricted medially. In some taxa the alisphenoid is widely exposed on the anterior roof of the middle ear (e.g., *Erinaceus*, state 2). *Potamogale*, on the other hand, has a squamosal that extends medially to articulate with the promontory, and is exposed broadly on the middle ear's anterior roof (state 1; Fig. O-1). Some taxa with a large piriform fenestra lack any bony roof in the anterior middle ear (e.g., *Blarina*, state 0).

26) **Epitympanic recess** (M88: #10; F91: #39): The articulation between malleus and incus is housed in the epitympanic recess. In most taxa examined here, this space is continuous with, or only slightly recessed from, the rest of the middle ear (e.g., *Erinaceus*, state 0). Certain other taxa possess an epitympanic recess that is greatly enlarged, housing hypertrophied middle ear ossicle(s) (e.g., *Chrysochloris*, state 1).

27) **Tubal canal** (M88: #4): In most examined taxa, the auditory tube exits the anterior part of the middle ear through a sulcus defined by the alisphenoid dorsally and basisphenoid medially (e.g., *Microgale*, state 0; Fig. O-2). Other taxa have one or two completely closed foramina, defined by the alisphenoid dorsally and basisphenoid ventrally, through which pass the auditory tube and/or inferior ramus of the stapedial artery (e.g., *Potamogale*, state 1; Fig. O-1).

28) **Ectotympanic exposure** (N86: #47, 48; M88: #5): The ectotympanic bone, to which the
tympanic membrane attaches, is often widely exposed, or phaneric, among mammals (e.g., *Tenrec*, state 2; Fig. O-2). In other taxa it is partially occluded (semiphaneric), with only the apex of the ectotympanic visible (e.g., *Potamogale*, state 1), or completely occluded (phaneric; e.g., *Leptictis*, state 0) by other elements of the middle ear. I follow MacPhee (1981: 151) in coding the ectotympanic of *Tupaia* as phaneric.

29) **Ectotympanic expansion**: Most taxa possess a simple, ring-shaped ectotympanic (e.g., *Tenrec*, state 0). In others, this element is mediolaterally expanded so as to contribute significantly to at least the lateral part of the bony auditory bulla (e.g., *Procavia*, state 1).

30) **Entotympanic** (N86: #49; M88: #7): Many mammals lack an independently ossified entotympanic contribution to the auditory bulla (e.g., *Erinaceus*, state 0; see MacPhee, 1981). Other taxa (e.g., *Leptictis*, state 1) possess one or more ossified entotympanic elements that comprise some or all of the tympanic floor (MacPhee, 1979). The presence of a small rostral entotympanic in *Amblysomus* as described by MacPhee and Novacek (1993) is acknowledged; however, in this case the element does not contribute significantly to the tympanic floor, and is coded as state "0."

31) **Inferior stapedial foramen** (M88: #4): As the inferior stapedial arterial ramus leaves the middle ear in *Echinops*, it passes through a bony foramen within the alisphenoid contribution to the anterior wall of the middle ear (state 1), dorsal to and distinct from the exit point of the auditory tube. Other taxa show no distinct arterial foramina dorsal to the tubal canal in the alisphenoid contribution to their anterior bullar wall (e.g., *Tenrec*, state 0).

**Basicranium**

32) **Alisphenoid canal, presence** (N86: #34): In *Echinosorex*, the alisphenoid canal consists of a foramen in the alisphenoid just anterior and medial to foramen ovale, an anteriorly directed sulcus on the internal aspect of the alisphenoid, and a foramen in the alisphenoid just posterior
to the lateral margin of the sphenorbital fissure (state 1; see Cartmill and MacPhee, 1980: fig. 2). In *Orycteropus*, no such canal exists (state 0).

33) **Alisphenoid canal, position:** When present, the alisphenoid canal may have an anterior opening lateral to the sphenorbital fissure, as in *Echinosorex* described above (state 0); or it may be "elongate" and anteriorly continuous with the exit foramen(ina) of the ophthalmic and/or maxillary trigeminal divisions (e.g., *Tenrec*, state 1; see Butler, 1988: 119).

34) **Basisphenoid pit** (F91: #30): At the dorsal and posterior margin of the nasopharynx, medial and slightly anterior to the middle ear, a marked concavity (when viewed ventrally) may occur in the basisphenoid (e.g., *Tenrec*, state 1). Alternatively, most taxa examined here possess a flat basisphenoid continuous with the basioccipital (e.g, *Potamogale*, state 0).

35) **Fenestrate basioccipital:**
Some tenrecids are unique among all taxa examined in possessing fenestrae larger than the jugular foramen (approaching the size of the sphenorbital fissure in *Potamogale*) within the basioccipital just anterior to both occipital condyles, corresponding to the hypoglossal foramina (e.g., *Potamogale*, state 1; Fig. O-1). Other taxa have unremarkable, solid basioccipital bones containing pin-sized hypoglossal foramina (e.g., *Erinaceus*, state 0).

36) **Suboptic foramen** (Butler, 1956: 473): In *Micropotamogale*, an opening is evident ventral to the optic foramina, passing transversely through the body of the sphenoid, ventral to the sella turcica, that connects the sphenorbital fissures on each side of the skull (state 1). In most other taxa this communication between the opposite orbitotemporal regions is not apparent in the anterior aspect of the sphenorbital fissure (e.g., *Erinaceus*, state 0). It is possible, through the large optic foramina of certain taxa, to view the opposite orbitotemporal region (e.g., *Tupaia*); however, this is not necessarily associated with possession of an anteriorly placed suboptic foramen that connects both orbitotemporal fossae.

37) **Petromastoid contribution to mastoid tubercle** (N86: #46, 58): In some taxa the
petromastoid bone shows an enlarged ventrolateral process posterior to the jaw joint and anterior to the paroccipital process that provides an attachment for sternomastoid musculature (e.g., *Erinaceus*, state 1). In other taxa this process does not provide a major surface area for muscular attachment (e.g., *Didelphis*, state 0).

38) **Squamosal contribution to mastoid tubercle** (N86: #46): In some taxa the squamosal bone provides a ventrally projecting surface posterior to the jaw joint and anterior to the paroccipital process (the posttympanic process of Novacek, 1986: 48-49) to which sternomastoid muscles attach (e.g., *Potamogale*, state 1; Fig. O-1). In other taxa the squamosal contribution to a mastoid tubercle is reduced (e.g., *Tupaia*, state 0).

39) **Squamosal length on basicranium**: Soricids possess a mastoid "tubercle" that is an anteroposteriorly elongate extension of the squamosal on the lateral margin of the basicranium (e.g., *Blarina*, state 1). This process extends from the jaw joint to posterior margin of the middle ear, and is at least as long as the transverse width of the mandibular condyle. In other taxa, the squamosal does not extend along the basicranium a great distance posterior to the jaw joint (e.g., *Erinaceus*, state 0).

40) **Dual ectopterygoid** (N86: #36): Most taxa possess a single pair of laminae made up primarily of the sphenoid and palatine bones that laterally border the nasal choana (e.g., *Nandinia*, state 0). Other taxa possess prominent ectopterygoid processes of the alisphenoid that form a pair of laminae on each side of the choana, and create a large fossa for attachment of pterygoid musculature (e.g., *Erinaceus*, state 1).

41) **Maxillary process on pterygoid** (McDowell, 1958: 184): The maxilla posterior to the upper toothrow is not extensive in most taxa (e.g., *Erinaceus*, state 0). *Potamogale*, on the other hand, shows a process of the maxilla extending well posterior to the upper toothrow along the inferior margin of the ectopterygoid lamina (state 1; Fig. O-3).

42) **Post-palatine spine** (N86: #18): The posterior margin of the palate may be smooth or
have only a minor tubercle at its midpoint (e.g., Potamogale, state 0; Fig. O-3), or it may possess a large process extending caudally or caudo-dorsally at its midpoint (e.g., Erinaceus, state 1).

43) **External position of petromastoid** (N86: #60): The petromastoid is the dorsal part of the petrosal, housing part of the inner ear. It may be best exposed on the posterior aspect of the skull, posterior to the nuchal crest (e.g., Leptictis, state 0), or it may be located anterior to nuchal muscle scars and appear broadest when viewed laterally (e.g., Potamogale, state 1; Fig. O-5). The petromastoid of Procavia is completely occluded by the squamosal and occipital bones, and shows no external exposure (state 2).

**Orbitotemporal region**

44) **Optic foramen, presence** (N86: #30): Taxa in which the optic nerve leaves the braincase via an ossified optic canal (e.g., Canis, state 0) possess an optic foramen. Several taxa (e.g., Didelphis) lack a distinct canal through which the optic nerve passes (state 1).

45) **Optic foramen, size** (N86: #30; MacPhee 1994: 164): Several mammals possess an optic foramen that is similar in size to foramina associated with the first two divisions of the trigeminal nerve (e.g., Orycteropus, state 0). Most insectivorans have an optic foramen of very small caliber, a fraction of the size of trigeminal exit foramina (e.g., Tenrec, state 1).

46) **Position of ethmoidal foramen**: In Solenodon, one or more foramina within the anterior cranial (= olfactory) fossa open bilaterally into the orbitotemporal fossa well anterior to the sphenorbital fissure (state 0; Fig. O-4). Alternatively, Tenrec shows a condition in which the ethmoidal foramen opens up within the superior part of the sphenorbital fissure (state 1). Ethmoidal foramina provide passage for an artery (called the ethmoidal by McDowell, 1958 and Gregory, 1910) typically continuous with the superior stapedial ramus supplying the posterior nasal region, eye, and anterior meninges.
47) Sinus canal, presence (N86: #38): Most taxa possess an anteroposteriorly running sulcus on the interior of the squamosal, most prominent dorsal and anterior to the petromastoid. Within this sulcus courses the superior ramus of the stapedial artery (e.g., Solenodon, state 0; Fig. O-4). Some taxa (e.g., Canis) lack this sulcus (state 1). All specimens of Potamogale examined here (Table 2) lack a sinus canal, contra McDowell (1958: 187).

48) Sinus canal foramen: When present, considerable variation exists in the anterior relations of the sinus canal. It may open into the orbitotemporal region via a foramen confluent with the sphenorbital fissure (e.g., Tenrec, state 0), or with ethmoidal foramina (e.g., Nesophontes, state 2). The sinus canal may also enter the orbitotemporal region via a distinct foramen anterior to the sphenorbital fissure and posterior to the ethmoidal foramen (e.g., Echinosorex state 1; Fig. O-4).

49) Common recess for sphenopalatine and dorsal palatine foramina (N86: #20): Erinaceids have distinct sphenopalatine and dorsal palatine foramina for the vessels and nerves of the posterior nasal fossa and palate, respectively (state 1). In tenrecines, the sphenopalatine and dorsal palatine canals share a common recess proximally along their respective paths (state 0). Novacek (1986) suggested that Leptictis shares the morphology seen among tenrecs; however, my own observations of Leptictis skulls (e.g., AMNH 38920) and of specimens figured in Novacek (1986: 33, 34, 36) indicate that this "common recess" differs sufficiently between these groups to merit distinct coding. In Tenrec the sphenopalatine and dorsal palatine foramina share a single sulcus that opens into the orbit; these foramina are distinct on the orbital wall of Leptictis (cf. Novacek, 1986: figs. 9, 11).

50) Entoglenoid process, presence (N86: #39, M88: #6; McDowell, 1958: 143-144, 170): At the medial margin of the glenoid fossa for the mandible, adjacent to foramen ovale, a ventrally projecting process of alisphenoid and/or squamosal may be present (e.g., Procavia, state 1). Alternatively, this region just medial to the cranial glenoid fossa may be flat (e.g., Canis,
51) **Entoglenoid process, jaw articulation** (N86: #39, M88: #6; McDowell, 1958: 143-144, 170): Some taxa considered here (e.g., *Leptictis*) possess both a true postglenoid process (posterior to the mandibular fossa and anterior to the postglenoid foramen) and a small entoglenoid process (posterior to foramen ovale and well medial to the mandibular fossa). In these taxa the entoglenoid process plays little or no role in defining the jaw joint (state 0). In other taxa (e.g., *Potamogale*) this process comprises most of the bony process defining the glenoid fossa posteriorly (state 1; Fig. O-1).

52) **Entoglenoid process, composition**: Tenrecines possess an entoglenoid process comprised of the squamosal laterally and the alisphenoid medially (state 1); other taxa possess a large, mediolaterally expanded entoglenoid process comprised completely of the squamosal (e.g., *Potamogale*, state 0; Figs. O-1, O-2). *Didelphis* shows an entoglenoid process comprised entirely of the alisphenoid bone (state 2).

53) **Lacrimal foramen, presence**: Most taxa show a bony entrance foramen for the nasolacrimal duct in the vicinity of the anterior margin of the orbit and posterior margin of the infraorbital canal (e.g., *Erinaceus*, state 1). A few taxa do not show this foramen (e.g., *Potamogale*, state 0; Fig. O-5).

54) **Lacrimal foramen, position** (N86: #23): Many taxa examined here possess a lacrimal foramen that opens laterally, anterior to the orbit, within the bridge of bone that forms the infraorbital canal (e.g., *Tenrec*, state 1). In *Solenodon*, this foramen opens in a posterior direction, into the orbit (state 0), and is situated on the posterior margin of the infraorbital canal (Fig. O-4).

55) **Orbital wing of the maxilla** (N86: #14): Most insectivorans are remarkable among mammals in possessing a broad process of the maxilla that extends dorsocaudally into the medial orbital wall, reducing the contribution of the palatine to the orbital mosaic (e.g.,
Erinaceus, state 2). Novacek (1986: 31) notes that Leptictis possesses a maxilla that partially excludes the palatine from the orbit, but does not contact the frontal (state 1). Most non-insectivorans possess a maxilla restricted to the anteroinferior margin of the orbit (e.g., Nandinia, state 0).

56) Reduction of zygomatic arch (N86: #25): Many insectivorans have a zygomatic arch in which the jugal bone is vestigial, leaving the arch incomplete lateral to the mandibular coronoid process (e.g., Tenrec, state 1). Most other mammals have a robust zygomatic process and a persistent jugal (e.g., Canis, state 0).

57) Robusticity of zygomatic arch: When present, the zygomatic arch may consist of robust squamosal, jugal, and maxillay components (e.g., Didelphis, state 0). Alternatively, moles and golden moles show a slender, but complete, zygomatic arch (state 1)--the bony constituents of which are unclear (MacPhee and Novacek, 1993).

58) Origin of maxillary zygoma: Some taxa possess a maxillary root of the occasionally hypertrophied zygomatic arch that is relatively rostral, originating at or near the last upper premolar or the M1 (e.g., Erinaceus, state 0). It may also originate adjacent to M2 (e.g., Blarina, state 1), or M3 (e.g., Hemicentetes, state 2). In taxa possessing a broad maxillary zygoma (e.g., Desmana), the anterior-most part of the zygoma was used to code this character.

59) Size of maxillary zygoma: Soricids possess a highly reduced rudiment of the maxillary root of the zygoma, barely extending lateral to the upper dentition (e.g., Crocidura, state 1). Other taxa possess a larger maxillary zygoma, which extends posterolaterally (e.g., Potamogale, state 0; Fig. O-5).

Rostrum

60) Length of infraorbital canal (N86: #10, F91: #6): The length of the canal transmitting the infraorbital vessels and nerve and passing dorsal to posterior cheek teeth can be longer than
the maximum mesiodistal length of an upper molar (e.g., *Geogale*, state 0), or similar in size or shorter (e.g., *Solenodon*, state 1; Figs. O-4, O-5).

61) **Frontal proportions:** Most taxa examined have a frontal bone that has a maximum rostrocaudal length similar to that of the parietal bone (e.g., *Tenrec*, state 1). *Potamogale* has a rostrocaudally reduced frontal, less than half the length of the parietal (state 2; Fig. O-5); *Nandinia* has an elongate frontal bone, more than 25% longer than the parietal (state 0).

62) **Shape of nasals** (N86: #2): The posterior margin of the nasal bones is sometimes broader transversely than is the anterior margin (e.g., *Didelphis*, state 0). Other taxa possess nasal bones that taper to a point posteriorly (e.g., *Potamogale*, state 1; Fig. O-5).

63) **Length of nasals** (F91: #1): The posterior edge of the nasal bones may lie at or anterior to the anterior margin of the orbit (e.g., *Tenrec*, state 0). Alternatively, they may extend posterior to the antorbital rim (e.g., *Erinaceus*, state 1).

64) **Lacrimal flange:** The area of the rostrum dorsal to the lacrimal foramen is typically smooth (e.g., *Tenrec*, state 0). Some taxa possess a marked muscle scar on the rostrum, dorsal to the lacrimal foramen (e.g., *Erinaceus*, state 1). *Procavia* shows a lacrimal process directed posteriorly into the orbit (state 2).

**Braincase**

65) **Crista galli** (N86: #5): Some mammals possess a plate of bone projecting dorsally along the midline of the cribiform plate (e.g., *Leptictis*, state 0). Insectivorans and some metatherians lack this process, having instead a flat or depressed region along the midline of the cribiform plate (e.g., *Erinaceus*, state 1).

**Upper dentition**

66) **Size of anterior upper incisor:** In some taxa the anterior-most upper incisor is longer and
more robust than other anterior teeth (e.g., Potamogale, state 0); in other taxa the upper incisors are homogenous in size (e.g., Talpa, state 1).

67) **Premaxillary dentition**: The number of teeth on each half of the premaxilla ranges from 5 (e.g., Didelphis, state 4) to 0 (e.g., Orycteropus, state 0), with intermediate states numbered accordingly. No taxon in this data set exhibits 4 teeth in each half of its premaxilla; therefore, this character state is omitted.

68) **Upper antemolars, excluding incisors**: The number of upper premolars and canines in each dental quadrant varies in the taxa examined from 5 (e.g., Echinosorex, state 0) to 4 (e.g., Tenrec, state 1) to 3 (e.g., Echinops, state 2) to 2 (e.g., Crocidura, state 3).

69) **Upper canine**: The upper canine of certain taxa varies from being similar in shape and size to the anterior premolars (e.g., Erinaceus, state 0), trenchant and more than twice the root-apex length of adjacent teeth (e.g., Nesophontes, state 2), to squat, bulbous structures nearly as large as the molar toothrow (e.g., Cuban Solenodon, state 1).

70) **Molariform P3**: P3 may be three-rooted with a lingually-projecting protocone and be similar in size to more posterior cheek teeth (e.g., Leptictis, state 1); or it may be smaller and more closely resemble anterior premolars (e.g., Microgale, state 0).

71) **Molariform P4**: P4 may possess a lingually-projecting protocone and be similar in size and shape to more posterior cheek teeth (e.g., Tenrec, state 1), or buccolingually compressed like more anterior premolars, without a prominent lingual cusp (e.g., Talpa, state 0).

72) **Carnassial P4**: P4 may be larger than other cheek teeth, and show a particularly long crest running posteriorly from the main cusp that occludes with a similarly enlarged trigonid of the lower first molar (e.g., Canis, state 1). Alternatively, it may be similar in size and resemble other upper cheek teeth in its level of shearing occlusion with its lower counterpart (e.g., Tupaiia, state 0).

73) **Metacone**: Some taxa possess a prominent metacone on the posterobuccal aspect of M1
and M2 (e.g., *Echinosorex*, state 0). *Potamogale* possesses a metacone that is closely situated (or "connate") to the paracone (state 1). Other taxa have a reduced or absent metacone (e.g., *Tenrec*, state 2).

74) **Protocone**: In some taxa the mesiolingual cusp of the upper cheek teeth is restricted to the cingulum and less than half the size of the paracone (e.g., *Tenrec*, state 1). In other mammals the protocone is similar in size to the paracone (e.g., *Echinosorex*, state 0).

75) **Hypocone**: Some taxa possess a prominent hypocone on the posterolingual aspect of M1 and M2 (e.g., *Echinosorex*, state 0). In other taxa this cusp is reduced or absent (e.g., *Tenrec*, state 1).

76) **Parastyle on M1**: On the mesiobuccal margin of M1, *Solenodon* displays a large, anteriorly projecting parastyle (state 1; Fig. O-6). Other taxa show a flat mesial border to M1 with no anterior projections (e.g., *Erinaceus*, state 0).

77) **Centrobuccal cleft on upper molars**: The buccal margin of the upper molars (particularly M2) may be mesiodistally flat (e.g., *Echinosorex*, state 0). Alternatively, a cleft extending lingually may separate the mesial and distal stylar regions, giving the buccal margin of the tooth a "V" shape (e.g., *Solenodon*, state 1; Fig. O-6 and MacPhee, 1987: fig. 7b). McDowell (1958: 151-152) discussed this character as a possible synapomorphy of *Solenodon* and *Nesophontes*, but he underestimated its ubiquity among other insectivorans.

78) **M3 presence**: Adults of most taxa possess a permanent M3 (e.g., *Echinosorex*, state 0); in others the M3 is absent (e.g., *Canis*, state 1).

79) **M3 stylar shelf**: When present, the M3 may show an elongate stylar region with a distinct stylocone, meso-, and/or metastyles (e.g., *Didelphis*, state 1). Alternatively, this region may be reduced, and little or no occlusal surface may be present buccal to the para- and/or metacone (e.g., *Echinosorex*, state 0).

80) **M3 mesostyle**: When present, the mesostyle (i.e., the second anterior-most stylar cusp,
posterior to the parastyle and/or stylocone) may reach the buccal margin of the tooth (e.g., *Didelphis*, state 1) or be located lingually at the end of a distally running centrocrista, adjacent to the paracone (e.g., *Solenodon*, state 0; Fig. O-6).

**Lower dentition**

81) **Size of lower anterior teeth** (F91: #46): The anterior-most lower incisor is either larger than the immediately adjacent teeth (e.g., *Erinaceus*, state 0), smaller (e.g., *Potamogale*, state 2), or equal in size to other lower incisors (e.g., *Leptictis*, state 1).

82) **Lower antemolars**: The number of lower premolars, canines, and incisors in each jaw of taxa examined varies from 8 to 5, comprising character states 0-3, respectively. Some soricids possess 3 antemolar lower teeth in each jaw, and are coded as state 4 (e.g., *Blarina*).

83) **Molariform p3**: p3 may have a distinct metaconid and short heel posterior to the trigonid, contributing to a molariform appearance (e.g., *Tenrec*, state 1). In most taxa, p3 lacks a metaconid and resembles more anterior premolars (e.g., *Potamogale*, state 0).

84) **Molariform p4**: Many taxa examined show a p4 with a molariform trigonid with three major cusps (para-, meta-, and protoconids; e.g., *Potamogale*, state 1). Other taxa possess a p4 that lacks multiple trigonid cusps and is buccolingually narrow, as in more anterior premolars (e.g., *Blarina*, state 0).

85) **Talonid**: Lower molars of several taxa may have a talonid with a well defined basin surrounded by ridges comprised of, or continuous with, the entoconid, hypoconid, and/or hypoconulid (e.g., *Echinosorex*, state 0). In other taxa the talonid basin is reduced or altogether absent (e.g., *Chrysochloris*, state 1).

86) **Hypoconulid**: The first two lower molars may show a well-defined posteriormost cusp, situated on the distal talonid and abutting the adjacent tooth (e.g., *Pholidocercus*, state 1). Alternatively, a well-defined cusp may be absent (e.g., *Microgale*, state 0).
87) **Hypoflexid-paracone occlusion**: In *Potamogale*, the paracone has a large occlusal area in the area buccal to the talonid and distal to the trigonid, or the hypoflexid (state 1; Fig. O-6). In most other taxa (e.g., *Erinaceus*, state 0) the hypoflexid of the lower cheek teeth provides little or no occlusal surface for upper molars. The term "hypoflexid" follows Van Valen (1966: 8) and Szalay (1969: 202). The term "ectoflexid" has been used for this same structure by McKenna (1975: 35) and Asher (1999a).

88) **Secondary hypoflexid basin**: Among taxa with hypoflexid-paracone occlusion, the paracone of the M3 may occlude with the m3 in a basin comprised of the hypoflexid bounded laterally by a cingulum (e.g., *Solenodon*, state 0; Fig. O-6). Alternatively, the lower m3 hypoflexid may be buccally open (e.g., *Tenrec*, state 1).

89) **m3 presence**: Adults of some taxa lack a permanent m3 (e.g., *Nandinia*, state 1), whereas most others have one (e.g., *Tenrec*, state 0).

90) **m3 length**: When present, considerable variability in m3 length relative to more anterior cheek teeth exists: it may be shorter (e.g., *Erinaceus*, state 2), equal in length (e.g., *Leptictis*, state 1), or longer (e.g., *Solenodon*, state 0) than each of the first lower two molars.

**Dentary**

91) **Mental foramina**: Foramina for branches of the mandibular nerve and vessels appear in a number of places on the exterior of the mammalian jaw. States observed here include ventral to p4 (e.g., *Echinosorex*, state 0), p3 (e.g., *Microgale*, state 1), or m1 (e.g., *Crocidura*, state 3). Many taxa exhibit two or more mental foramina (e.g., *Tenrec*, state 2).

92) **Mandibular condyle length**: Some taxa have a globular, ball-shaped mandibular condyle (e.g., *Tenrec*, state 0). This contrasts with pronounced mediolateral expansion conspicuous in other taxa (e.g., *Solenodon*, state 1), in which the condyle is 50-100% wider transversely than m1.
93) **Mandibular condyle, number**: Extant soricids possess a dual craniomandibular articulation (state 1), showing two distinct articular surfaces and synovial capsules between jaw and cranium (Fernhead et al., 1954). Other taxa show a single synovial articulation between jaw and cranium (e.g., *Erinaceus*, state 0).

94) **Mandibular condyle, height**: Some taxa have a mandibular condyle that is situated well above a transverse plane contacting major cusps on unworn lower molars (e.g., *Desmana*, state 1). In others, the condyle is level with this plane (e.g., *Canis*, state 0).

95) **Internal coronoid fossa**: The internal aspect of the coronoid process of the jaw in most taxa examined is smooth and continuous with the mandibular condyle and the jaw angle (e.g., *Erinaceus*, state 0). Many soricids, in contrast, show a state in which a deep fossa is present on the coronoid process internally (e.g., *Blarina*, state 1).

**Axial skeleton**

96) **Posteroventral keel on axis** (F91: #69): The posterior aspect of the second cervical vertebral centrum may be smooth ventrally or show only a reduced tuberosity close to its midpoint (e.g., *Tenrec*, state 1). The axis of other taxa shows a prominent spine projecting posteroventrally from the centrum (e.g., *Echinosorex*, state 0).

97) **Number of vertebrae in sacrum**: Most taxa possess between two and four vertebrae in the sacrum (e.g., *Tenrec*, state 0). A few taxa possess at least five well-ossified vertebrae in their sacra (e.g., *Talpa*, state 1).

98) **Number of vertebrae contributing to the sacroiliac articulation**: The sacral vertebrae articulating with the ilium may include S1 alone (e.g., *Blarina*, state 0), S1-S2 (e.g., *Potamogale*, state 1), or S1-S3 (e.g., *Talpa*, state 2).

99) **Fusion of sacral neural spines** (F91: #72): Most taxa show sacral neural spines that lack consistent fusion among each other (e.g., *Tenrec*, state 0). In a few taxa sacral spines arches
form a well-fused longitudinal plate (e.g., Echinosorex, state 1). Bradypus lacks sacral neural spines (state 2).

**Forelimb**

100) **Clavicle**: Most mammals possess a membranous bone of the shoulder girdle, or clavicle, articulating with the scapular metacromion and sternum (e.g., Tenrec, state 0). In some moles it is greatly shortened, wider than it is long (e.g., Talpa, state 1; see Grassé 1955: 1596). Some taxa lack this bone altogether (e.g., Potamogale, state 2).

101) **Scapular shape**: Most taxa possess a scapula that is broadly quadrangular or triangular in shape (e.g., Tenrec, state 0; Fig. O-7). Talpids and some shrews, on the other hand, show a transversely elongate scapula with a craniocaudally narrow medial scapular margin (e.g., Talpa, state 1).

102) **Scapular spine, metacromion presence** (F91: #71; Fig. O-7): Most taxa possess a laterally bifid scapular spine, made up of two processes extending laterally from the scapular spine and dorsal to the scapular glenoid fossa: the acromion (directed laterally) and metacromion (directed posteriorly). Variation in this region occurs in several ways: first, the posteriorly directed metacromion may be absent (e.g., Potamogale, state 1), or present (e.g., Tenrec, state 0; Fig. O-7).

103) **Scapular spine, metacromion shape** (F91: #71): Second, when present, the metacromion may be elongate (e.g., Desmana, state 1; Fig. O-7), or blunt (e.g., Tenrec, state 0; Fig. O-7).

104) **Scapular spine, acromion presence**: Third, the laterally directed acromion may be absent (e.g., Desmana, state 1; Fig. O-7), or present (e.g., Canis, state 0).

105) **Scapular spine, acromion shape**: Fourth, when present, the acromion may be elongate (e.g., Blarina, state 1; Fig. O-7) or blunt (e.g., Tenrec, state 0; Fig. O-7).

106) **Scapular spine, length**: Finally, the scapular spine itself may be elongate, extending well
lateral to the scapular glenoid fossa (e.g., *Amblysomus*, state 1; Fig. O-7), or it may be shorter and extend only up to the glenoid fossa laterally (e.g., *Tenrec*, state 0; Fig. O-7).

107) **Entepicondylar foramen of humerus:** The distal humerus of most taxa examined here is pierced on its medial epicondyle by the entepicondylar foramen (e.g., *Echinosorex*, state 0). Other animals show no foramen medially (e.g., *Potamogale*, state 1).

108) **Medial epicondyle of humerus, presence:** Most taxa possess a mediadly projecting epicondyle that makes up at least 25% of the distal humeral margin medial to the trochlea (e.g., *Solenodon*, state 1). Others show a reduced or absent medial epicondyle (e.g., *Erinaceus*, state 0).

109) **Medial epicondyle of humerus, shape:** When present, the medial epicondyle may be greatly enlarged, comparable in lateral extent as the entire length of the humeral shaft (e.g., *Chrysochloris*, state 1). However, most taxa possess an epicondyle that extends only slightly lateral to the distal humerus (e.g., *Echinops*, state 0).

110) **Olecranon fenestra of humerus:** Distally, the humerus may have a fenestra or a very thin lamina of bone within the olecranon fossa (e.g., *Erinaceus*, state 1); in most taxa the olecranon process of the ulna sits in a well-ossified fossa of the humerus (e.g., *Potamogale*, state 0).

111) **Distal ulna:** Elephant shrews possess an ulna that tapers to a distal end by the radial midshaft, with no articular surface for the carpus (state 1). Other taxa possess an ulna that articulates with both the humerus and carpus (e.g., *Erinaceus*, state 0).

112) **Ulnocarpal articulation:** In many taxa the distal ulna has a restricted articulation with the carpus, reaching the triquetrum and pisiform only via an elongate styloid process (e.g., *Tenrec*, state 1; see Kielan-Jaworowska, 1977: 72). Other taxa show a distal ulna with a broader articulation with the carpus, comparable in size to the radial articular surface (e.g., *Erinaceus*, state 0).
113) **Number of bones in forearm:** Golden moles display a condition in which one bone (probably a sesamoid) is elongate and has a variably developed tendinous articulation with the carpus and the medial epicondyle of the humerus (state 1)--effectively forming a third long bone of the forearm (see GrassŽ, 1955: 1597). Other taxa (e.g., *Tenrec*, state 0) possess two forearm longbones: the radius and ulna.

**Hindlimb**

114) **Orientation of iliac blades:** The cranial margin of each iliac blade usually has a rounded or sagittally oriented long axis (e.g., *Erinaceus*, state 0). In a few taxa, the cranial margin of each iliac blade is oriented coronally (e.g., *Tenrec*, state 1).

115) **Cranial extent of ilia:** Most taxa possess ilia that extend cranially past the sacro-iliac articulation (e.g., *Erinaceus*, state 0). Certain others show ilia that are even with the cranial margin of the sacrum (e.g., *Tenrec*, state 1).

116) **Iliopectineal tubercle, presence:** In *Potamogale*, a prominent, single, ventrally projecting tuberosity is present immediately ventral to the acetabulum (state 1; Fig. O-8). Most other taxa show only a mild rugosity or a smooth surface ventral to the acetabulum (e.g., *Echinops*, state 0; Fig. O-8).

117) **Iliopectineal tubercle, shape:** When present, the iliopectineal tubercle may be medially directed, crestiform, and continuous with the pubis (e.g., *Echinosorex*, state 0). Alternatively, it may be a ventrally directed process with a well-defined shape distinct from the pubis (e.g., *Potamogale*, state 1; Fig. O-8).

118) **Internal pelvic shape:** The region internal to the acetabulum is typically smooth, showing no concavities (e.g., *Canis*, state 0). Several taxa possess a marked concavity internal to the acetabulum (e.g., *Echinosorex*, state 1).

119) **Pubic symphysis:** insectivorans have been characterized as having either narrow or no
contact between each pubis at the symphysis (e.g., Tenrec, state 1). Most other mammals have a craniocaudally broad pubic symphysis, similar in length to ischiopubic rami framing the obturator foramina of each os coxae (e.g., Tupaiia, state 0). Following Allen (1910: 39), all of the specimens of Solenodon paradoxus observed during the course of this study show a reduced pubic symphysis, contra Leche (1907: 82).

120) **Pubis length:** Variation is present in the relative lengths of the pubis and ischium (Leche, 1907: 81). In some taxa the distance from the midpoint of the acetabulum to the symphysis (pubis) is longer than the distance from the same point to the caudal extent of the ischium (e.g., Potamogale, state 1; Fig. O-8). In other taxa the pubis is similar in length or slightly shorter than the ischium (e.g., Echinops, state 0; Fig. O-8).

121) **Angle of pubic ramus:** The pubis typically joins the acetabulum making an angle with the ischium and ilium of 15° or greater (e.g., Echinops, state 0; Fig. O-8). In some taxa the pubis is parallel with the long axis of the ilium and ischium (e.g., Chrysochloris, state 1; Fig. O-8).

122) **Third trochanter of femur:** In most taxa, this process is relatively small and proximally situated on the lateral surface of the femoral diaphysis (e.g., Tenrec, state 0). A few taxa show a more distally placed third trochanter that reaches the middle of the femoral diaphysis (e.g., Erinaceus, state 1).

123) **Fusion of distal tibia and fibula:** The distal tibia and fibula may be completely fused or synostosed at the ankle (e.g., Erinaceus, state 1). Some taxa possess a distal tibia-fibula that approximate each other but show no fusion (e.g., Tenrec, state 0).

124) **Distal fibula:** Golden moles have a socket in the distal fibula that receives a ball-like condyle on the lateral margin of their calcaneus (state 1). In contrast, Bradypus shows a ball-like process on their distal fibula that fits into a socket on the astragalus (state 2). In other taxa the distal fibula shows a simple, ventrally projecting, and internally flat process that
covers the astragalus laterally (e.g., *Didelphis*, state 0).

125) **Calcaneal (= peroneal) tubercle** (Gregory, 1910: 250): In some taxa the distolateral margin of the calcaneus shows a blunt rugosity (e.g., *Erinaceus*, state 0) for attachment of abductor digiti quinti and, following Gregory (1910: 250), a tarso-metatarsal ligament. In others this rugosity is elongate and similar in size to the sustentaculum tali, extending laterally and/or distally past the distal margin of the calcaneus (e.g., *Microgale*, state 1).

126) **Interincisal gap** (Butler and Hopwood, 1958). Taxa with space between the anterior upper incisors equal to or greater than the width of each incisor's alveolus are coded here as having a "wide" interincisal gap (e.g., *Geogale*, state 1). Taxa with an interincisal gap smaller than the transverse distance of each anterior incisor alveolus (e.g., *Potamogale*) are coded with state 0. Taxa lacking premaxillary teeth (e.g., *Orycteropus*) are coded as inapplicable for this character.

Literature Cited
suggest a sister group relationship between Xenarthra (Edentata) and Ferungulates. Molecular Biology and Evolution 14: 762-768.


Fitch, W. M. 1979. Cautionary remarks on using gene expression events in parsimony


Lillegraven, J. A., M. C. McKenna and L. Krishtalka. 1981. Evolutionary relationships of middle Eocene and younger species of Centetodon (Mammalia, Insectivora,
Geolabididae) with a description of the dentition of Ankylodon (Adapisoricidae).
and palate. Thieme, Stuttgart.
study based on DNA sequence data in Cetaceans. Genetics 144: 1817-1833.
Milinkovitch, M. C., A. Meyer and J. R. Powell. 1994. Phylogeny of all major groups of
cetaceans based on DNA sequences from three mitochondrial genes. Molecular Biology
and Evolution 11: 939-948.
methods with congruence. Systematic Biology 44: 64-76.
Montgelard, C., F. M. Catzefflis and E. Douzery. 1997. Phylogenetic relationships of
artiodactyls and cetaceans as deduced from the comparison of cytochrome b and 12S
estimation: a case study of 18S rDNAs of Apicomplexa. Molecular Biology and
Evolution 14: 428-441.
Naylor, G. P. and W. M. Brown. 1998. Amphioxus mitochondrial DNA, chordate phylogeny,
and the limits of inference based on comparisons of sequences. Systematic Biology 47:
61-76.
Nedbal, M. A., R. L. Honeycutt and D. A. Schlitter. 1996. Higher level systematics of rodents
(Mammalia, Rodentia): evidence from the mitochondrial 12SrRNA gene. Journal of
Mammalian Evolution 3: 201-237.
Novacek, M. J. 1980. Cranioskeletal features in tupaiids and selected Eutheria as phylogenetic
evidence; pp. 35-93 in P. Luckett (ed.), Comparative Biology and Evolutionary
Novacek, M. J. 1986. The skull of leptictid insectivorans and the higher level classification of
Novacek, M. J. 1992b. Fossils, topologies, missing data, and the higher level phylogeny of
and B. K. Hall (eds.), The Skull: Patterns of Structural and Systematic Diversity (vol.
Diego.
Press, Baltimore.
O'Leary, M. O. 1999. Parsimony analysis of total evidence from extinct and extant taxa and
O'Leary, M. O. and J. H. Geisler. 1999. The position of Cetacea within Mammalia:


Patterson, B. 1956. Early Cretaceous mammals and the evolution of mammalian molar teeth.


Springer, M. S. and E. Douzery. 1996. Secondary structure and patterns of evolution among...
Thompson, J. D., T. J. Gibson, F. Plewniak, F. Jeanmougin and D. G. Higgins. 1997. The
CLUSTAL-X windows interface: Flexible strategies for multiple sequence alignment
 xenarthran (edentate) monophyly supported by a unique deletion in A-crystallin.
Systematic Biology 48: 94-106.
Voss, R. S. 1988. Systematics and ecology of ichthyomyine rodents (Muroidea): patterns of
morphological evolution in a small adaptive radiation. Bulletin of the American
Museum of Natural History 188: 260-493.
Die Affen, Zahnflücker, Beutelthiere, Hausthiere, Insektenfresser, und Handflügler.
Leipzig.
Press, New York.
Wheeler, W. C. 1993. The triangle inequality and character analysis. Molecular Biology and
Wheeler, W. C. 1996. Optimization alignment: the end of multiple sequence alignment in
Museum of Natural History, New York.
Whidden, H. P. and R. J. Asher. in press. The origin of the Greater Antillean Insectivorans; in
C. A. Woods (ed.), West Indian Biogeography. CRC Press, Boca Raton, FL.
Wible, J. R. and K. P. Bhatnagar. 1996. Chirotean vomeronasal complex and the
Wiens, J. J. 1998a. Does adding characters with missing data increase or decrease
Wiens, J. J. 1998b. Combining data sets with different phylogenetic histories. Systematic
Biology 47: 568-581.
Winge, H. 1941. The interrelationships of the mammalian genera, vol. 1 (translated from
Danish). C.A. Reitzels Forlag, Copenhagen.


Figure A-1. Hypothesized pattern of cranial arterial supply in the eutherian common ancestor (after Cartmill and MacPhee, 1980 and Wible, 1984). Abbreviations are on pp. 186-187. "*" indicates artery commonly found among tenrecids, but not necessarily inferred as part of primitive eutherian pattern by authors cited above.

Fig. A-2. Reconstruction of cranial vasculature in Potamogale velox, (ZIUT HL 17mm). Specimen viewed from ventral aspect; lateral is left, anterior top.
Fig. A-3
Coronal section through basicranium of *Potamogale velox*, slice 43.3.4

Fig. A-4
Coronal section through basicranium of *Potamogale velox*, slice 37.2.3
Fig. A-5. Reconstruction of cranial vasculature in *Micropotamogale lamottei* (IZEA 939)

Figure A-6. Coronal section through basicranium of *Micropotamogale lamottei* (IZEA 939), slice 181.2.2
Figure A-7. Coronal section through basicranium of *Micropotamogale lamottei* (IZEA 939), slice 177.2.1

Figure A-8. Reconstruction of cranial vasculature in *Geogale aurita* (MCZ 45499)
Fig. A-9. Coronal section through basicranium of *Geogale aurita* (MCZ 45504), slice 106.2.1

Fig. A-10. Coronal section through basieranium of *Geogale aurita* (MCZ 45504), slice 96.1.2
Fig. A-11. Reconstruction of cranial vasculature in *Microgale dobsoni* (MPIH 1964/103)

Figure A-12. Coronal section through basicranium of *Microgale dobsoni*, slice 1190
Figure A-13. 
Coronal section through basicranium of *Microgale dobsoni*, slice 1080

Figure A-14. 
Reconstructed cranial vasculature of *Echinops telfairi* (ZIUT HL 18)
Figure A-15. Coronal section through basicranium of *Echinops telfairi* (ZIUT), slice 68.1.1

Figure A-16. Coronal section through basicranium of *Echinops telfairi* (ZIUT), slice 63.4.2
Figure A-17. Reconstruction of cranial vasculature in *Tenrec ecaudatus* (ZIUT HL 20mm). Specimen is figured in ventral aspect, lateral is left anterior top.

Fig. A-18. Coronal section through basicranium of *Tenrec ecaudatus* (ZIUT HL 20mm), slice 67.1.4
Fig. A-19. Coronal section through basicranium of *Tenrec ecaudatus* (ZIUT 20mm), slice 61.2.4

Fig. A-20. Coronal section through basicranium of *Chrycoschloris asiatica* (ZIUT 25 mm HL), slice 97.3.2. Note entrance of promontory artery into braincase lateral to anterior cochlea; contrast to Fig. A-13 of *Microgale*. 
Fig. N-1a. Model of *Potamogale* anterior nasal region, lateral view. Arrow represents approximate plane of coronal section in Fig. N-2.

Fig. N-1b. Model of *Potamogale* cartilaginous nose, lateral view. Region in box is magnified at left without external ossifications of maxilla and premaxilla.

Fig. N-2. Coronal section through nasal region of *Potamogale velox* (ZIUT), slice 12.1.6.
Fig. N-3. Coronal section through *Micropotamogale lamottei* (IZEA 939) nasal region, slice 32.1.2.

Fig. N-4. Coronal section through *Microgale dobsoni* (MPIH 1964/103) nasal region, slice 250.
Fig. N-5. Model of *Geogale aurita* (MCZ 45499) anterior nasal region, lateral view. Arrow represents approximate plane of coronal section in Fig. N-6.

Fig. N-6. Coronal section through nasal region of *Geogale aurita* (MCZ 45499), slice 8.1.4.
Fig. N-7. Coronal section through nasal region of *Echinops telfairi* (ZIUT), slice 8.4.4.

Fig. N-8. Model of *Tenrec ecaudatus* (ZIUT) anterior nasal region, lateral view. Arrow shows approximate plane of coronal section in Fig. N-9.
Fig. N-9. Coronal section through nasal region of *Tenrec ecaudatus* (ZIUT), slice 8.2.4.

Fig. N-10. Coronal section through nasal region of *Solenodon paradoxus* (ZIUT), slice 100.3.1.
Fig. N-11. Coronal section through nasal region of *Solenodon paradoxus* (ZIUT), slice 102.1.2.

Fig. N-12. Coronal section through nasal region of *Erinaceus europaeus* (ZIUT), slice 14.2.4
Fig. O-1. Right basicranial region of *Potamogale velox*, MCZ 23174. Ectotympanic, tympanic petrosal processes, and tympanohyal are not shown in this specimen. Sutures are shown with dashed lines. Arrow passes through tubal canal.

Fig. O-2. Left middle ear of *Microgale dobsoni* (redrawn from MacPhee, 1981: 209). Arrow passes through tubal canal.

Fig. O-3. Ventral view of posterior palate and choanae in *Potamogale* (left) and *Sorex* (right) (after McDowell, 1958: 184).
Fig. O-4. Lateral view of *Solenodon cubanus* skull, FMNH 134. Arrow passes through infraorbital canal.

Figure O-5. Skull of *Potamogale velox* BMNH 26.11.1.62, showing sutures among dermal cranial bones, including an antero-posteriorly shortened frontal. Arrow passes through infraorbital canal.

Fig. O-6. Upper and lower M1-3 of *Solenodon paradoxus* in occlusion (after McDowell 1958:161). Darker outline represents lower teeth, lighter outline represents uppers.
Fig. O-7. Left scapulae from photographs of AMNH specimens. From top, *Blarina* (207018), *Amblysomus* (169149; reversed right scapula), *Tenrec* (170511), and *Desmana* (206). Medial is at right, cranial at top; specimens are not to scale.

Fig. O-8. Right os coxae from photographs of USNM specimens. From top, *Echinops* (464980), *Chrysochloris* (49896), and *Potamogale* (266897). Cranial is at right, dorsal at top. Specimens are not to scale.
Table S1. Overlap in base pairs between amplified fragments, excluding primers. If the overlapping region is unique to a species it is labeled “d” for diagnostic; in cases when two or more species are identical for an overlapping region, it is denoted “n” for non-diagnostic. In cases when a fragment was determined from more than one primer pair, the longer overlap was used at each end, as the extensive overlap between alternative PCR products for one fragment always resulted in highly diagnostic overlap between such alternative fragments (see also Fig. 3)

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Table S3. Alignment alternatives (number of parsimony informative sites listed in parentheses in first row). Full alignments have been provided to the editor and will be placed online upon publication. Autapomorphic insertions were deleted in aligns 1 and 3. Numbers in parentheses represent approximate position in respective alignment file. Each row represents a putatively homologous region of GHR. Asterisks indicate autapomorphic indels.

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