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Contributions to Alabama Paleontology

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A Review Of North American Basilosauridae

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ABSTRACT

Members of the family Basilosauridae represent the earliest fully aquatic cetaceans (Pelagiceti). Basilosaurids are important to studies of cetacean evolution because, in addition to being the earliest fully aquatic cetaceans, they are thought to be ancestral to modern Odontoceti and Mysticeti (Neoceti). North American basilosaurids *(Basilosaurus cetoides, Basilotritus wardii, Chrysocetus healyorum, Cynthiacetus maxwelli, Dorudon serratus, Zygorhiza kochii,* and perhaps others) are known from the Gulf Coastal Plain and southeastern Atlantic Coastal Plain, from strata of middle to late Eocene age. No basilosaurids are known with certainty from the west coast of North America, nor from the east coast north of Virginia. The taxonomy, diagnoses, and distributions in time and geography are explored, reviewed and refined herein to help clarify the origin of basilosaurids from protocetids and the origin of Neoceti form Basilosauridae.

INTRODUCTION

The earliest cetaceans in North America first appear in the middle Eocene Lutetian Stage. These animals most likely arrived in North America from Europe or North Africa where earlier middle Eocene cetaceans are known (Andrews, 1920; Cappetta and Traverse, 1988; Gingerich, 2010). Protocetids may have arrived in North America by crossing the Atlantic directly or by following a northern coastal route to stay closer to shore (Uhen, 1999). The origin of Basilosauridae from Protocetidae is not yet clear, but some protocetids, such as *Babiacetus*, *Eocetus*, and *Georgiacetus* share some characteristics with basilosaurids, and thus may be phylogenetically close to the ancestors of basilosaurids (Uhen et al., 2011). In addition, some basal basilosaurids, such as *Supayacetus* and *Basilotritus* retain some plesiomorphic characteristics of protocetids (Uhen et al., 2011: Gol'din and Zvonok, 2013).

Basilosaurids are fully aquatic archaeocetes with greatly reduced hind limbs, forelimbs modified into flippers with restricted motion at the intra-manual, carpal, and elbow joints, and most have significantly more posterior thoracic and lumbar vertebrae than protocetids. In North America, basilosaurids are known from the Gulf Coastal Plain (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, and Tennessee) and southeastern Atlantic Coastal Plain (North Carolina, South Carolina and Virginia) sediments of middle to late Eocene age.

Here, the nominal North American genera and species of Basilosauridae (*Basilosaurus cetoides*, *Basilotritus wardii*, *Chrysocetus healyorum, Cynthiacetus maxwelli, Dorudon serratus*, and *Zygorhiza kochii*) are reviewed and evaluated. In particular, the taxonomic identity of *Zygorhiza* is critically evaluated and the specimens that have been previously identified as *Zygorhiza* are re-identified where necessary, clarifying the distribution of this well-known genus. These procedures significantly improve the understanding of where different species of Basilosauridae occur and where they are missing, and how these species might be related (phylogentically, temporally, and ecologically) to other basilosaurid archaeocetes globally.

Institutional Abbreviations—The following abbreviations are used throughout the text, figures, and appendices: **AMNH**, American Museum of Natural History, New York, New York; **ANSP**, Academy of Natural Sciences,

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Philadelphia, Pennsylvania; **AUMP**, Auburn University Museum of Paleontology, Auburn, Alabama; **BCGM**, Bob Campbell Geology Museum, Clemson University, Clemson, South Carolina; **BSPG**, Bayerische Staatssammlung für Paläontologie und Geologie, Munich; **CCNHM**, College of Charleston Natural History Museum, Charleston, South Carolina; **CGM**, Cairo Geological Museum, Cairo; **ChM**, Charleston Museum, Charleston, South Carolina; **CMM**, Calvert Marine Museum, Solomons, Maryland; **FLMNH**, Florida Museum of Natural History, Gainesville, Florida; **FMNH**, Field Museum of Natural History, Chicago, Illinois; **GCNHM**, Georgia College Natural History Museum, Milledgeville, Georgia; **LSUMG**, Louisiana State University Museum of Geology, Baton Rouge, Louisiana; **MB**, Museum für Naturkunde, Berlin; **MCZ**, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; **MDLP**, Museo de La Plata, La Plata, Argentina; **MMAS**, Macon Museum of Arts and Sciences, Macon, Georgia; **MMNS**, Mississippi Museum of Nature and Science, Jackson, Mississippi; **MSC**, McWane Science Center, Birmingham, Alabama; **MUSM**, Departamento de Paleontología de Vertebrados, Museo de Historia Natural de San Marcos collections, Lima, Peru; **NCSM**, North Carolina State Museum, Raleigh, North Carolina; **NHMUK**, Natural History Museum, London; **PRI**, Paleontological Research Institution, Ithaca, New York; **RCS**, Royal College of Surgeons, London; **RMM**, Red Mountain Museum (now part of the MSC collection); **SFNM**, Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt; **SMNS**, Staatliches Museum für Naturkunde, Stuttgart; **TM**, Teyler's Museum, Haarlem; **TMM**, Texas Memorial Museum, Austin, Texas; **UAM**, University of Alabama Museum of Natural History, Tuscaloosa, Alabama; **UMMP**, University of Michigan Museum of Paleontology, Ann Arbor, Michigan; **USNM**, National Museum of Natural History, Washington, DC; **WFI**, Wagner Free Institute, Philadelphia, Pennsylvania; **YPM**, Yale Peabody Museum, New Haven, Connecticut.

MATERIALS AND METHODS

North American Basilosaurid Specimens

Most specimens of North American basilosaurids are curated in museums across the southeast and east coast (see below and Appendix 1), with the largest collection in North America curated at the U.S. National Museum of Natural History with a few additional specimens at other museums across the United States, such as the Field Museum (Chicago), the Los Angeles County Museum, and the University of California Museum of Paleontology (Berkeley). In addition, a significant number of North American basilosaurids are housed in the Teyler's Museum (Haarlem, Netherlands) and the Museum für Naturkunde (Berlin, Germany) due to the 19th century collecting efforts of A. C. Koch (see *Zygorhiza kochii* below). Almost all of these specimens have been observed by the author and all current identifications are listed in Appendix 1.

North American Basilosaurid Collecting Localities

North American basilosaurids are found along the Gulf Coastal Plain and Atlantic Coastal Plain from Louisiana to Virginia. Basilosaurids have not been found in Texas or points farther south, nor have they been discovered north of Virginia. Figure 1 shows the currently known distribution of Basilosauridae in North America. A complete and regularly updated database of all these and other fossil cetacean records can also be found in the Paleobiology Database (PaleoDB; www.paleodb.org), from which data for this map was derived. Virtually all of the occurrence records in the Paleobiology Database are derived from the primary literature on North American basilosaurids and new occurrences based on specimens in museum collections are noted here (see Appendix 1) with updated taxonomic assignments of specimens linked to this publication. Collecting localities are particularly abundant around the town of Melvin, Alabama, and areas just to the west across the state border in Mississippi. Kellogg (1936) gives an excellent resumé of North American archaeocete specimens collected prior to 1936.

Geologic Setting of North American Basilosaurids

The highest abundance of North American basilosaurid specimens overall and along the Gulf Coastal Plain are derived from the Pachuta Member of the Yazoo Formation in Mississippi and Alabama in particular, and the Yazoo Formation in general. The Yazoo Formation is a mixed siliciclastic and carbonate unit often referred to as a marl. The Pachuta Member was first distinguished and named by Murray (1947), who described it as follows:

> The Pachuta (marl) member was proposed for 6-25 feet of buff, gray, or white, partially indurated, generally glauconitic, fossiliferous marl… It is the *Zeuglodon* or *Pecten*-bryozoan bed of previous workers.

As Murray notes, the Pachuta Member was informally known as the *Zeuglodon* bed by previous authors, further emphasizing the remarkable and abundant preservation of basilosaurid archaeocetes in this unit (e.g. Clark, 1891; Lucas, 1900; Cushman, 1925). Murray (1947) also notes that as the Jackson Group strata (inclusive of the Yazoo Formation) extend east across Alabama, they become less siliciclastic, and grades into the pure limestone of the Ocala Formation.

Along the Atlantic Coastal Plain, the Castle Hayne Formation has also produced many specimens of basilosaurids. Figure 2 shows the distribution of all North Ameri-

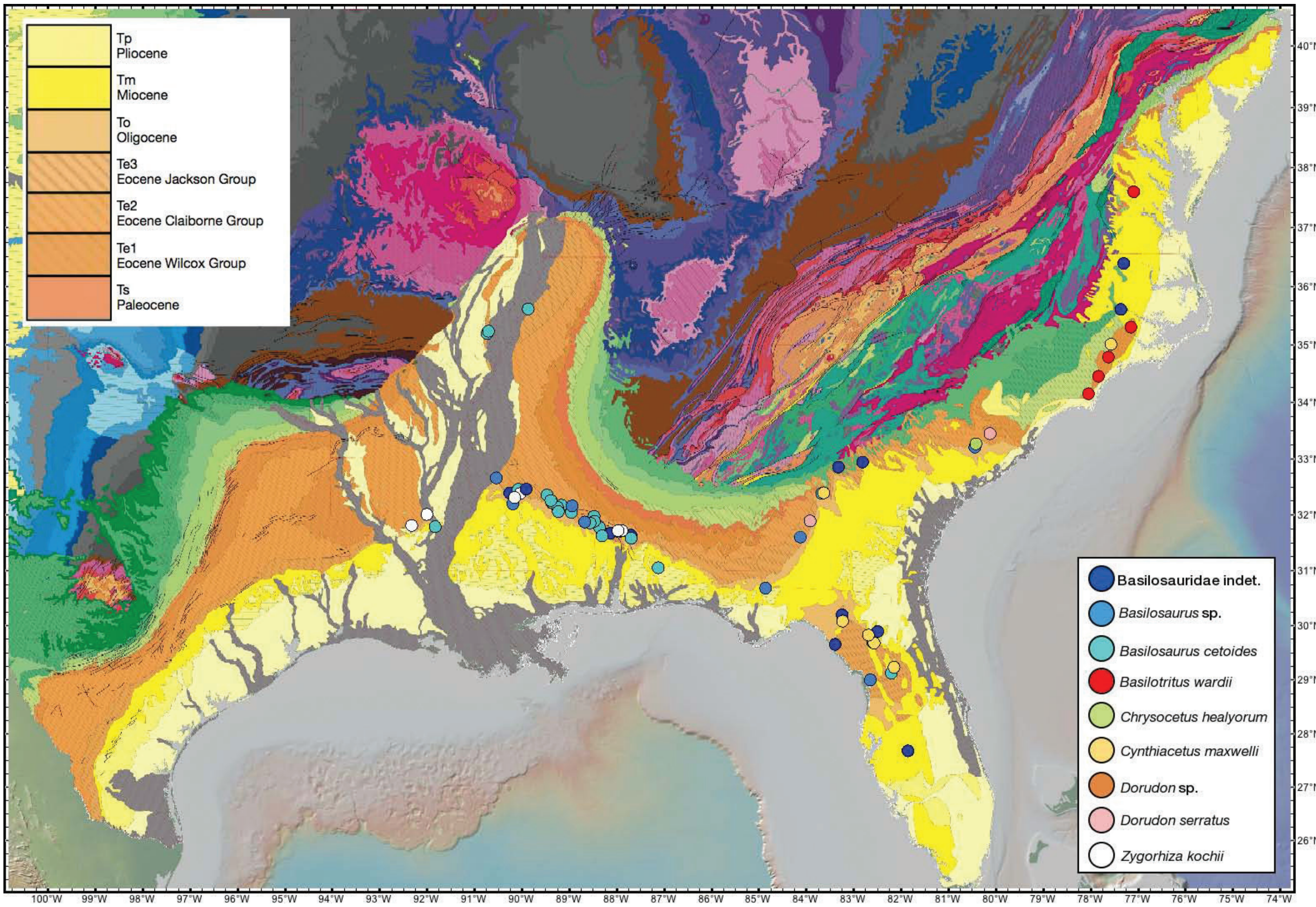

Figure 1. Map of the geology of the southeastern United States showing the sites that have produced specimens of Basilosauridae in North America. The base map was created with GeoMapApp (Ryan et al., 2009) with geology from Schruben et al. (2006). Data on fossil distributions is derived from the PaleoDB. Consult Appendix 1 and the PaleoDB for precise locality information for each taxon.

can basilosaurids in terms of geography and stratigraphy. These specimens, however tend to be more fragmentary than those from the Gulf Coastal Plain because they are recovered from more pure limestones that are exposed in quarries. The nature of quarry operations that expose the fossils (blasting and crushing) also tends to break fossil specimens into pieces. While it is difficult to tell whether specimens from these quarries were initially more or less complete than those from natural exposures of the marls from the Gulf Coastal Plain, the presence of some more complete skeletons that were clearly broken in the quarry operations (like the type specimen of *Chrysocetus healyorum*) suggest that at least some of the Atlantic Coastal Plain specimens were equally complete as the best of those from the Gulf Coastal Plain.

Phylogenetic Analysis

A cladistic analysis of most basilosaurids and related taxa was conducted using PAUP (Swofford, 2002). This analysis consisted of a branch and bound search on 25 ingroup taxa and 2 outgroup taxa (*Sus* and *Hippopotamus*) that were scored for 108 morphological characters following Geisler et al. (2005) with modifications following Uhen et al. (2011). Additional basilosaurids including *Ancalecetus*, *Basilotritus*, *Chrysocetus*, *Cynthiacetus*, *Saghacetus*, and *Zygorhiza* were also added to the matrix, which is included here as Appendix 2. The basilosaurids *Masracetus* and *Stromerius* were not included in the analysis because of the limited information available from currently known specimens of these taxa.

SYSTEMATIC PALEONTOLOGY

Cetacea Brisson 1762
Pelagiceti Uhen 2008b
Basilosauridae Cope 1868

Zeuglodontidae Bonaparte, 1849:618
Hydrarchidae Bonaparte, 1850:1
Basilosauridae Cope, 1868:144
Stegorhinidae Brandt, 1873:334

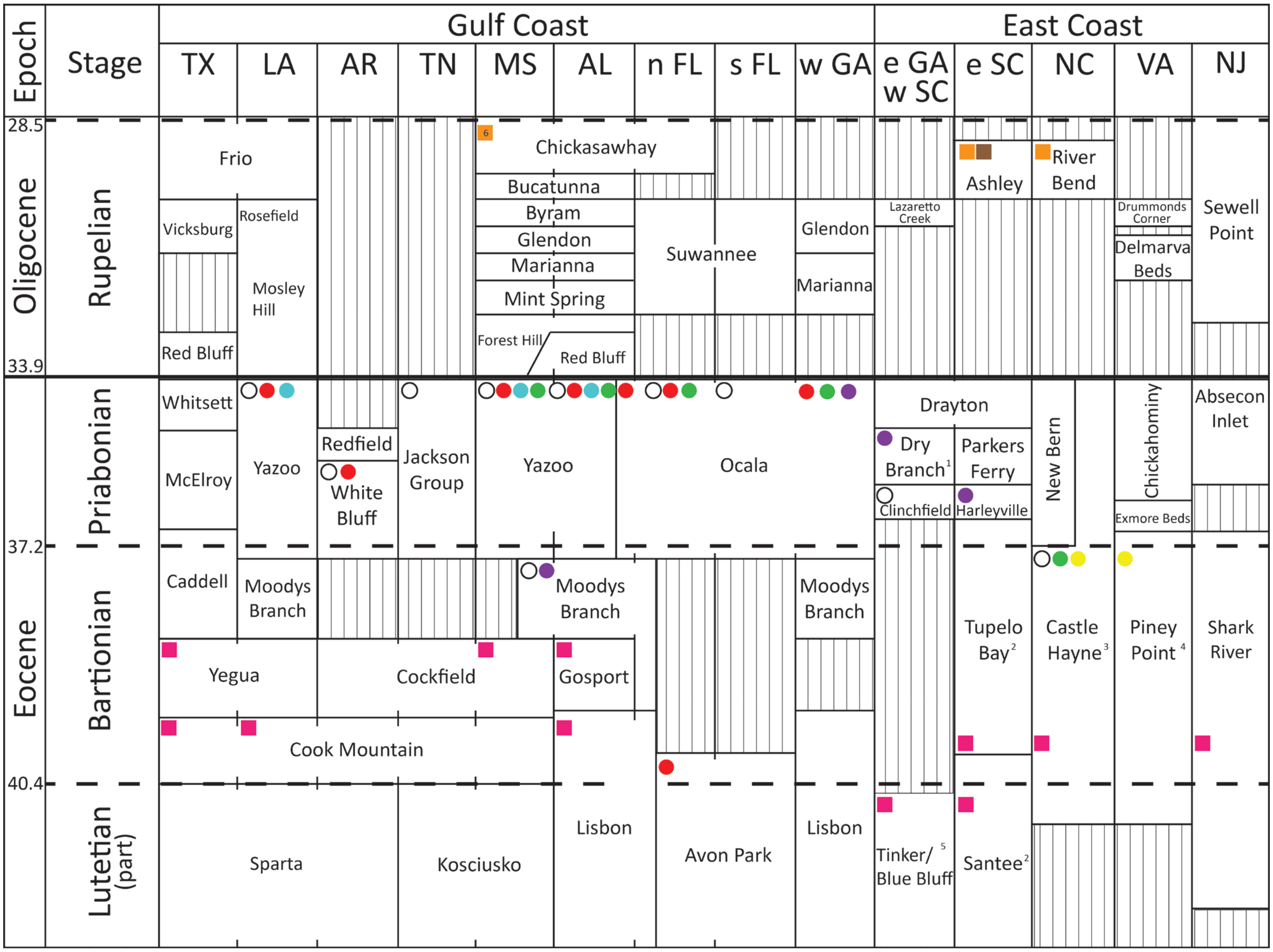

Figure 2. Stratigraphic distribution of Cetacea, focused on Basilosauridae, in southeastern North America. The base stratigraphic scheme is modified from Weems et al. (2004). Symbols are as follows: Basilosauridae indet, white circle; *Basilosaurus*, red circle; *Basilotritus*, yellow circle; *Chrysocetus*, blue circle; *Cynthiacetus*, green circle; *Dorudon*, purple circle; *Zygorhiza*, aqua circle; Odontoceti, orange square; Mysticeti; brown square, Protocetidae, pink square.

[1]Includes the Twiggs Clay (Long et al., 1986). [2]The distribution of the Tupelo Bay and Santee Formations is after Geisler et al. (2005). The Bartonian portion of the Tupelo Bay Formation is known as the Cross Member, and the Priabonian portion is known as the Pregnall Member. [3]Age and distribution of the Castle Hayne Formation and New Bern Formations is after Harris et al. (1993). [4]The age of the Piney Point Formation is after Weems et al. (2011). These authors indicate that it is Lutetian and early Bartonian, but show it extending into zone NP17, which extends in to the Priabonian. Thus, the Piney Point Formation may extend into the Priabonian. [5]The Tinker Formation is stratigraphically equivalent to the informal Blue Bluff unit, also in eastern Georgia (Hulbert et al., 1998). [6]This is a previously unreported record of an odontocete from the Chickasawhay Formation of Mississippi (USNM 186894), consisting of several fragmentary vertebrae and ribs.

Prozeuglodontidae Moustafa, 1954:87

Included Genera—*Ancalecetus* (Gingerich and Uhen, 1996), *Basilosaurus* (Harlan, 1834), *Basilotritus* (Gol'din and Zvonok, 2013), *Chrysocetus* (Uhen and Gingerich, 2001), *Cynthiacetus* (Uhen, 2005), *Dorudon* (Gibbes, 1845), *Masracetus* (Gingerich, 2007), *Ocucajea* (Uhen et al., 2011), *Saghacetus* (Gingerich, 1992), *Stromerius* (Gingerich, 2007), *Supayacetus* (Uhen et al., 2011), and *Zygorhiza* (True, 1908).

Age and Distribution—Fossils of Basilosauridae are known from Bartonian and Priabonian deposits of Austria (Uhen and Tichy, 2000); Egypt (Gingerich, 1992 and references therein); Germany (Uhen and Berndt, 2008); Italy (Pilleri and Cigala-Fulgosi, 1989); Jordan (Zalmout et al., 2000); Moroccan Sahara (Western Sahara) (Adnet et al., 2010; Field et al., 2011a, b); New Zealand (Köhler and Fordyce, 1997); Peru (Martínez-Cáceres and de Muizon, 2011; Uhen et al., 2011); ?Romania (Codrea, 2006); Russia (Kalmykov, 2012); Senegal (Élouard, 1966); Tunisia (Batik and Fejafar, 1990); Ukraine (Zvonok, 2012); United Kingdom (Halstead and Middleton, 1972); and the Gulf and Atlantic coasts of the United States (see Kellogg, 1936).

Reports of Basilosauridae from Seymour Island, Antarctica (e.g. Borsuk-Bialynicka, 1988; Fostowicz-Frelik, 2003) are difficult to assess as they may also represent fossils of early Mysticeti similar to *Llanocetus* (Mitchell, 1989) or related taxa, but some of these specimens probably represent Basilosauridae. See the Paleobiology Database for a complete listing of collections including Basilosauridae.

Emended Diagnosis—Members of the family Basilosauridae possess two upper molars rather than the three typical of other archaeocetes, as well as multiple accessory denticles on their cheek teeth. Most basilosaurids also have longer bodies than other archaeocetes due to an increased numbers of thoracic and lumbar vertebrae. The thoracic vertebral count is 16 in *Basilosaurus* (Bebej et al., 2012), 20 in *Cynthiacetus* (Martínez-Cáceres and de Muizon, 2011), 17 in *Dorudon* (Uhen, 2004) and *Zygorhiza* (pers. obs. contra (Kellogg, 1936)). The complete thoracic count is unknown for *Ancalecetus* (probably 17, see Gingerich and Uhen, 1996 for discussion), *Chrysocetus* (at least 13), *Masracetus*, *Ocucajea*, *Saghacetus* (at least 15, pers. obs.). The thoracic vertebral count for *Stromerius* and *Supayacetus* are unknown. The exception to this generalization is *Basilotritus wardii*, which has a thoracic vertebral count of 12 (Uhen, 2001), more similar to the thoracic count of protocetids than other basilosaurids (Uhen et al., 2011).

The lumbar vertebral count is 16 in *Cynthiacetus* (Martínez-Cáceres and de Muizon, 2011), 20 in *Basilosaurus* (Gingerich et al., 1990) and *Dorudon*, (Uhen, 2004). The lumbar vertebral count is unknown for *Basilotritus* (Gol'din and Zvonok, 2013). All basilosaurids also have forelimbs modified into flippers. These forelimbs include: a fan shaped scapular blade; robust humerus, radius and ulna; elbow joints with limited rotation (which exclude the ability to pronate and supinate the forearm); and carpal joints which also limit a wide range of motion. In basilosaurids for which they are known (*Basilosaurus* (Lucas, 1900; Gingerich et al., 1990), *Chrysocetus* (Uhen and Gingerich, 2001), and *Dorudon* (Uhen, 2004)), the hindlimbs are greatly reduced and do not retain a bony connection to the vertebral column. The innominate of *Basilotritus* is not as reduced as those of other basilosaurids (see Uhen, 1999). See Uhen (1998, 2009) for thorough discussions of basilosaurid characteristics.

Remarks—Previously many authors (including this author) divided the family Basilosauridae into two subfamilies, Basilosaurinae and Dorudontinae, based on the presence (Basilosaurinae) or absence (Dorudontinae) of elongate posterior thoracic, lumbar, and anterior caudal vertebrae (see e.g. Uhen, 1998). This division is not followed here because members of the Basilosaurinae are separated from the Dorudontinae based solely on the possession of elongate trunk vertebrae and because separation of the Dorudontinae from Basilosaurinae could make either one of these groups paraphyletic, depending on how the relationships within the Basilosauridae are resolved (Uhen et al., 2011).

The family Kekenodontidae was originally described as the subfamily Kekenodontinae within the family Basilosauridae by Mitchell (1989). Since then, it has been elevated to familial rank (Fordyce, 1992), and has been variably placed in the Archaeoceti (e.g. Fordyce, 2004; Bianucci and Landini, 2007), Crenaticeti (Rice, 1998), or Mysticeti (e.g. Fordyce, 1992; Fordyce and de Muizon, 2001). Additional phylogenetic analysis is necessary to determine the exact relationship of Kekenodontidae to Basilosauridae and Mysticeti.

Gingerich et al. (1995) named the genus and species *Gaviacetus razai* based on a skull from Basti Amed (GSP-UM3095; PaleoDB 28974) from the Lutetian Domanda Formation of Pakistan. These authors placed this new genus in the family Protocetidae. Bajpai and Thewissen (1998) named a new species of *Gaviacetus*, *G. sahnii* (VPL 1021) from the Lutetian Harudi Formation of Rato Nala (PaleoDB 45590) based on another incomplete skull lacking all tooth crowns except P1. Bajpai and Thewissen (1998) placed the genus *Gaviacetus* in the Basilosauridae based on its purported lack of an M3, but the portion of the maxilla that would have borne the M3 is missing. Based on the lack of clear basilosaurid synapomorphies in *Gaviacetus*, it is here retained in the Protocetidae following Uhen (2001), Uhen and Gingerich (2001), Geisler and Sanders (2003), Gingerich et al. (2005), McLeod and Barnes (2008), Bianucci and Gingerich (2011), and Uhen et al. (2011).

Basiloterus hussaini (Gingerich et al., 2001) is based on two lumbar vertebrae, a very limited and debatably diagnostic type specimen. In addition, Gingerich et al. (1997) also named a new species, *Basilosaurus drazindai*, based on a single lumbar vertebra. Because of the very limited and questionably diagnostic type specimens of each, the genus *Basiloterus,* and the species *Basiloterus hussaini*, and *Basilosaurus drazindai* are here designated *nomina dubia*, and identified as Basilosauridae indet. The specimens referred to *Basilosaurus drazindai* (NHMUK M 26552) and *Basiloterus hussaini* (NHMUK M 26553) by Gingerich et al. (1997) from the Eocene of the United Kingdom are here identified as *Basilosaurus* sp., as originally identified by Halstead and Middleton (1972).

BASILOSAURUS HARLAN 1834

Basilosaurus Harlan, 1834:397
Zygodon Owen, 1839b:35
Zeuglodon Owen, 1839a:24
Hydrargos Koch, 1845a:1
Hydrarchos Koch, 1845b:1
Zyglodon Hammerschmidt, 1848:323, typographical error (Kellogg, 1936)
Hydrarchus Müller, 1849:3
Zugodon Scudder, 1882:357, typographical error (Kellogg, 1936)
Alabamornis Abel, 1906:450

Type species—*Basilosaurus cetoides* (Owen, 1839b).

Included species—*Basilosaurus cetoides* (Owen, 1839b) and *Basilosaurus isis* (Andrews, 1904).

Age and Distribution—*Basilosaurus cetoides* is known in the United States primarily from the late Eocene of the Gulf Coast states of Alabama, Louisiana, and Mississippi. It has also been reported from the Qattara Depression of Egypt (Zalmout et al., 2011). *Basilosaurus isis* is known only from Egypt and Jordan (Gingerich, 1992; Zalmout et al., 2000). *Basilosaurus* sp. is also known from the Bartonian of the United Kingdom (Halstead and Middleton, 1972) and the Priabonian of Moroccan Sahara (Western Sahara) (Field et al., 2011a, b). See the PaleoDB for a complete listing of collections including *Basilosaurus*. Appendix 1 includes a list of all North American specimens.

Diagnosis—Members of the genus *Basilosaurus* can be distinguished from all other basilosaurids by their large size (>15 m length) and the great elongation of the posterior thoracic, lumbar, and anterior caudal vertebral bodies (length around 2 times width or height). Vertebrae assigned to members of *Basilotritus wardii* and related taxa share a somewhat similar elongation in the trunk vertebrae, but not to the same degree as seen in *Basilosaurus*. In addition, the pedicles, neural arches, neural spines, and transverse processes of the trunk vertebrae of *Basilotritus wardii* and related taxa are also greatly elongated, while in *Basilosaurus*, they are not elongated to the same degree, and the number of thoracic vertebrae in *Basilotritus wardii* is 12, like that of Protocetidae and unlike other Basilosauridae. See Remarks section below.

Remarks—Harlan (1834) originally coined the name *Basilosaurus* for the specimens now identified as ANSP 12944-12949, the type series of *Basilosaurus cetoides*, without using a specific epithet. Owen (1839b) coined the name *Zeuglodon cetoides* for these and other specimens, but the generic name *Zeuglodon* was immediately a junior objective synonym of *Basilosaurus*. Owen's specific epithet has been preserved for this species since Harlan never used one, yielding the combination *Basilosaurus cetoides* for the type species of the genus *Basilosaurus*, discussed below.

Lucas (1900) described the innominata and right femur of *Basilosaurus cetoides* that were discovered along with much of a skeleton from the Pachuta Member of Alabama (USNM 4675). Abel (1906) compared the innominata to the coracoids of *Anthropornis nordenskjoldi*, a fossil penguin from Antarctica, and concluded that they were actually the coracoids of a giant bird that he named *Alabamornis gigantea*. Lucas (1908) rather conclusively demonstrated that the elements are not coracoids of a giant bird, given their anatomy and relative positions to the skeleton of *Basilosaurus cetoides*, and they are indeed the innominata of this animal. This conclusion is further supported by the discovery of several additional innominata of *Basilosaurus isis* from Egypt in anatomical position (Gingerich et al., 1990; Gingerich, 2008). Thus, *Alabamornis gigantea* is a junior subjective synonym of *Basilosaurus cetoides* and *Alabamornis* is a junior subjective synonym of *Basilosaurus*.

Basilosaurus cetoides (Owen, 1839c)

Zeuglodon cetoides Owen, 1839c:69
Zeuglodon harlani DeKay, 1842:123
Hydrargos sillimanii Koch, 1845a:1
Hydarchos sillimanii Koch, 1845b:1
Zeuglodon ceti Wyman, 1845:654
Hydrarchos harlani, Koch, 1845a:1
Basilosaurus cetoides Geinitz in Carus, 1847:1
Basilosaurus cetoides Reichenbach in Carus, 1847:13
Basilosaurus harlani Hammerschmidt, 1848:121
Zeuglodon macrospondylus Müller, 1849:3
Alabamornis gigantea Abel, 1906:450
Basilosaurus cetoides Kellogg, 1936:15

Type specimen—ANSP 12944A (Kellogg, 1936), a vertebral centrum (type series ANSP 12944-12949, Spamer et al., 1995). See Figure 3.

Referred specimens—See Appendix 1 for a complete listing of specimens.

Type locality—A hill 200 yards from the Ouachita River, approximately 50 miles south of Monroe, in the southeastern part of Caldwell Parish, Louisiana (Harlan, 1834; Kellogg, 1936). PaleoDB collection 75638. It is difficult to pinpoint this location precisely. The rocks in this area are mapped as Jackson Group undifferentiated.

Age and Distribution—Specimens of *Basilosaurus cetoides* have been described from Alabama, Arkansas, Florida, Louisiana, Mississippi, and Tennessee. The vast

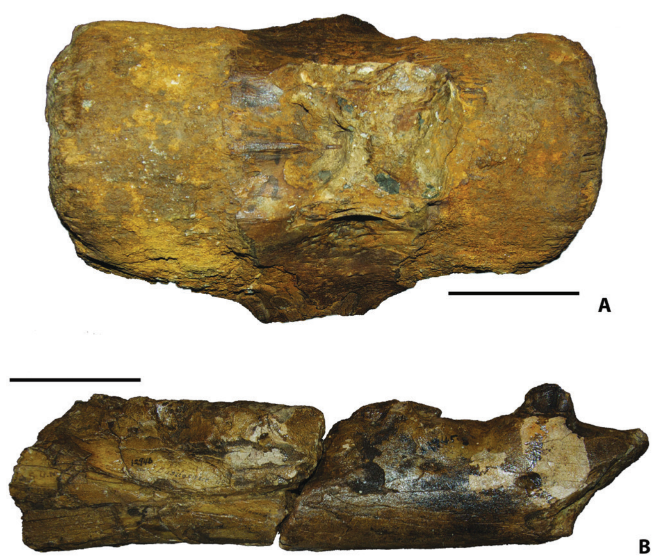

Figure 3. *Basilosaurus cetoides* type specimen, ANSP 12944. A, lumbar vertebral body in dosal view. B, *Basilosaurus cetoides*, ANSP 12946, right dentary portion in lateral view, part of the type series. Scale bar is 10 cm.

majority of specimens are from the Priabonian Yazoo Formation of Clarke County, Mississippi; and Choctaw and Clarke Counties, Alabama. No specimens of *Basilosaurus cetoides* have been positively identified from the east coast of North America. The single specimen from Tennessee (Corgan, 1976; Corgan and Breitburg, 1996) is purported to be a rib fragment that was tentatively identified by F. C. Whitmore Jr. as *Basilosaurus cetoides*, but the specimen cannot currently be located, so this identification remains unverified. Recently, *Basilosaurus cetoides* was reported from the Qattara Depression in Egypt, which marks the first time that this species has been recorded outside of North America (Zalmout et al., 2011). See the PaleoDB for a complete current listing of localities bearing *B. cetoides* and their associated references.

Diagnosis—*Basilosaurus cetoides* is distinguished from *Basilosaurus isis* by its slightly larger size (Gingerich et al., 1990).

Remarks—Additional analysis is needed to determine how *Basilosaurus cetoides* can be distinguished from *Basilosaurus isis*. Gingerich et al. (1990) stated that *B. cetoides* was slightly larger, but it is not clear if the size difference indicated allows the two species to be statistically differentiated, nor whether there are any other morphological features that could be used to distinguish the two species. Up until recently, large basilosaurids with elongate vertebrae from North America have all been called *B. cetoides*, and those from Africa have been called *B. isis*. Zalmout et al. (2011) recently noted the presence of *B. cetoides* in the Qattara Depression, but did not state how they distinguished these specimens from those of *B. isis* from the nearby Wadi Hitan. Additional supporting data will be necessary to confirm that these two species can be reliably differentiated and that this occurrence represents *B. cetoides* rather than *B. isis*.

Basilotritus Gol'din and Zvonok 2013

Basilotritus Gol'din and Zvonok 2013: 255

Type species—*Basilotritus uheni* (Gol'din and Zvonok, 2013)

Included species—*Basilotritus uheni* (Gol'din and Zvonok, 2013)

Age and Distribution—Bartonian to ?Priabonian of North Carolina, Virginia, Egypt, Germany, Russia, and Ukraine (see Gol'din and Zvonok, 2013).

Diagnosis—*Basilotritus* differs from the other basilosaurids in that: the sigmoid process of the tympanic bulla is plate-like, broad, with the poorly developed transverse rim; the transverse processes, neural arches and neural spines of posterior thoracic and lumbar vertebrae are elongated, along with the vertebral centra; the posterior thoracic and lumbar vertebrae are elongated anteroposteriorly, but less so than in *Basilosaurus*; the vertebrae have a pock-marked surface texture, with small, numerous irregularly located openings of vascular channels; the pachyostotic neural arches contain layered bone tissue located in periosteal zone; the manubrium of the sternum is T-shaped, and the broad anterior end of the mesosternum is dorsoventrally flattened; the iliac part of the innominate extends anteriorly from the acetabulum and the ischiac part is reduced to a tuberosity. *Basilotritus* further differs from most basilosaurids in the more convex medial margin of the tympanic bulla with a well-developed keel; in the steep lowering of involucrum towards the anterior part; in the blunt and rounded anterior process and in the rounded posterior part of the tympanic bulla. After Gol'din and Zvonok (2013).

Remarks—Gol'din and Zvonok (2013) identified a clade of basal basilosaurids that includes *Basilotritus uheni*, *Basilotritus wardii*, and MUSM 1443, as well as specimens from Germany and Egypt.

Basilotritus wardii (Uhen, 1999)

Eocetus wardii Uhen 1999:514
"*Eocetus*" *wardii* Geisler et al. 2005:47
"*Eocetus*" *wardii* Weems et al. 2011:273

Type specimen—USNM 310633, rostral fragment, partial right innominate, 10 partial vertebrae, and several rib fragments (Uhen, 1999). See Figure 4.

Referred specimens—See Appendix 1 for a complete listing of specimens.

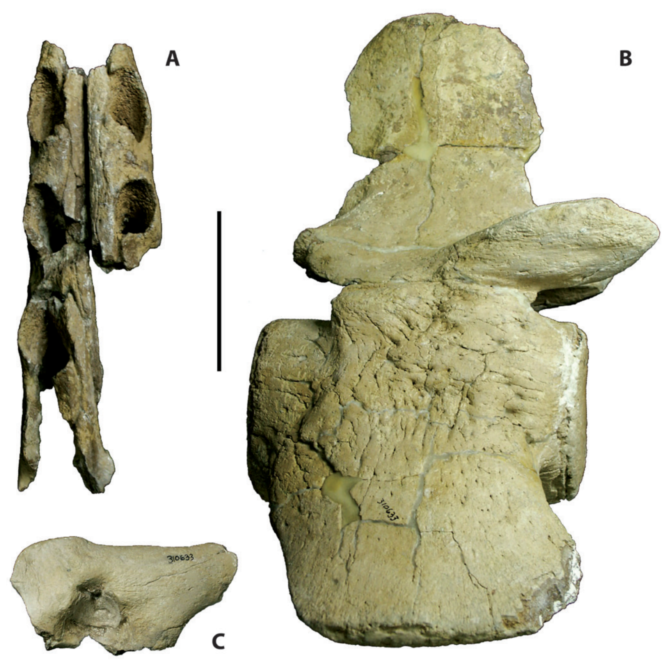

Figure 4. *Basilotritus wardii* type specimen (in part) USNM 310633. A, rostrum in ventral view. B, lumbar vertebra in right lateral view. C, right innominate in lateral view. Scale bar is 10 cm.

Type locality—Lanier Quarry, Pender County, North Carolina. PaleoDB collection 7299 (Uhen, 1999).

Age and Distribution— Bartonian Castle Hayne and Piney Point Formations, of North Carolina and Virginia, respectively (Uhen, 1999, 2001).

Diagnosis— *Basilotritus wardii* differs from *Basilotritus uheni* as it has less elongate neural spines, neural arches and transverse processes, and lesser elongation of vertebral centra. *Basilotritus wardii* also lacks the laterally swollen neural arches on the posterior thoracic vertebrae of *Basilotritus uheni*, and has much smaller body size. After Gol'din and Zvonok (2013).

Remarks—Uhen (1999) described *Eocetus wardii* as a new species of protocetid archaeocete from the Bartonian Castle Hayne Formation of North Carolina, and assigned it to the genus *Eocetus* based on similarities of the vertebrae that are part of the type specimen of *Eocetus wardii* (USNM 310633) to vertebrae that were assigned to *Eocetus schweinfurthi* by Stromer (1903) and Fraas (1904). This assignment has been questioned by subsequent authors, who have correctly emphasized the fact that none of the vertebrae referred to *Eocetus schweinfurthi* were found in direct association with the type specimen, which is a skull (Geisler et al., 2005; Weems et al., 2011), and they suggested that this species be referred to as "*Eocetus*" *wardii* until its proper generic assignment could be determined. Gol'din and Zvonok (2013) named a new genus and species of basal basilosaurid, *Basilotritus uheni,* based on a specimen from the Bartonian of Ukraine, and based on similarities of the vertebral morphology, referred "*Eocetus*" *wardii* to this new genus, creating the new combination, *Basilotritus wardii*.

The vertebrae of *Basilotritus wardii* are also quite similar to those of *Platyosphys paulsoni* (Fedorowski, 1912; Kellogg, 1936), although those of *Platyosphys* are considerably larger (Gol'din et al., 2012; Gol'din and Zvonok, 2013). *Platyosphys* was originally interpreted as being from the Oligocene of Ukraine (PaleoDB collection 48028), but these deposits are now thought to be Eocene in age (Kalmykov, 2012; Zvonok, 2012). This makes a close phylogenetic relationship between *Basilotritus wardii* and *Platyosphys paulsoni* much more plausible than if the specimens actually occurred in the Oligocene. Unfortunately, the type specimen of *Platyosphys paulsoni* is currently missing (Gol'din and Zvonok, 2013; Dimitri V. Ivanoff, pers. comm.). A new species of *Platyosphys, P. einori* was described in 2001 (PaleoDB collection 57767), but the specimens are very fragmented (Gritsenko, 2001). Given that the type specimen of *Platyosphys paulsoni* is missing and the poor quality of the type specimen of *P. einori*, both *P. paulsoni*, and *P. einori* and the genus *Platyosphys* are here considered to be *nomina dubia* belonging to Basilosauridae indet. (following Gol'din and Zvonok, 2013).

Kalmykov (2012) described a specimen from the Priabonian? Kharkov Formation at the Tsymlansk Reservoir (PaleoDB collection 123876) as *Basilosaurus* sp. The specimen consists of both vertebrae and a tooth in a fragment of bone. The figured vertebra (Kalmykov, 2012, figure 2) displays an elongate centrum and elongate transverse processes like those of *Basilotritus wardii* and "*Platyosphys paulsoni*." The tooth appears to be a large premolar with a triangular crown and fully developed accessory denticles (5 anterior and 4 posterior). The vertebra is very similar to those of *Basilotritus*, and the tooth shows that this animal is indeed a basilosaurid. It is here referred to as Basilosauridae indet. (following Gol'din and Zvonok, 2013).

Uhen et al. (2011) described a specimen of an unnamed protocetid (MUSM 1443) from the Bartonian of Peru that also displayed similar vertebral morphology to *Basilotritus wardii*, but is considerably smaller. Unfortunately, this specimen is also lacking dental material, and does not allow the identification of this specimen at the generic level. MUSM 1443 is here referred to Basilosauridae indet. (following Gol'din and Zvonok, 2013).

Given the available evidence, it is clear that *Basilotritus wardii* and related taxa were widespread during the Bartonian and perhaps the Priabonian as well. Both *Basilotritus wardii* and MUSM 1443 clearly have a small number of thoracic vertebrae (11 or 12, and 12, respectively) similar to other members of the family Protocetidae for which the complete thoracic vertebral count is known (Uhen et al., 2011; Bebej et al., 2012). This is quite different from the thoracic vertebral count of other members of the Basilosauridae, which is 16 to 20 (Uhen, 2004; Martínez-Cáceres and de Muizon, 2011; Bebej et al., 2012).

Chrysocetus Uhen and Gingerich 2001

Chrysocetus Uhen and Gingerich 2001: 2

Type species—*Chrysocetus healyorum* (Uhen and Gingerich, 2001).

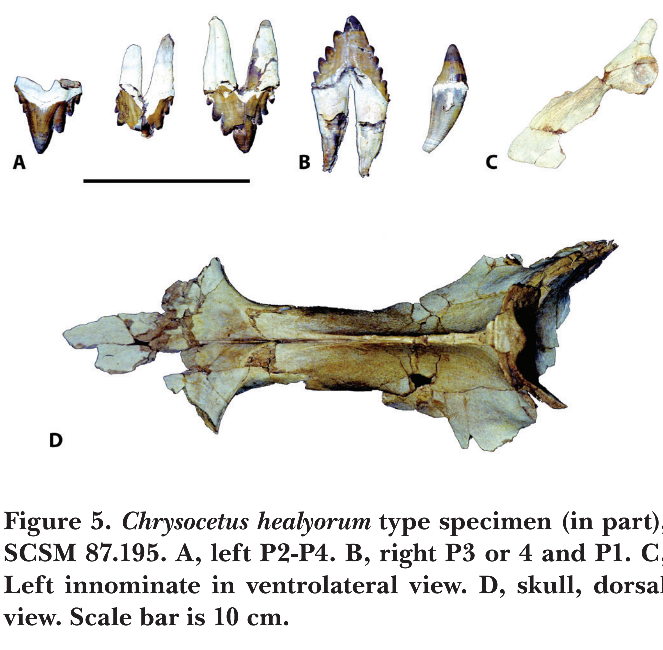

Figure 5. *Chrysocetus healyorum* type specimen (in part), SCSM 87.195. A, left P2-P4. B, right P3 or 4 and P1. C, Left innominate in ventrolateral view. D, skull, dorsal view. Scale bar is 10 cm.

Included species—The genus *Chrysocetus* currently includes only the type species, *C. healyorum.*

Age and Distribution—*Chrysocetus* is known from the Priabonian of South Carolina (Uhen and Gingerich, 2001). See the PaleoDB for a complete listing of collections. Appendix 1 includes a list of all North American specimens.

Diagnosis—As for the species.

Remarks—*Chrysocetus* is currently only known from a handful of individuals. Additional specimens will help to clarify the geographic and temporal range of this species, as well as clarify its place in the phylogeny of Pelagiceti.

Chrysocetus healyorum Uhen and Gingerich 2001

Chrysocetus healyorum Uhen and Gingerich 2001:2

Type specimen—SCSM 87.195, partial skeleton of a juvenile individual including a partial skull; hyoid apparatus; lower jaws; 10 teeth (plus additional fragments); seven cervical, 11 thoracic, and three lumbar vertebrae; ribs and sternum; left forelimb elements; and portions of the both innominata. See Figure 5.

Referred specimens—See Appendix 1 for a complete listing of specimens.

Type locality—Santee Portland Cement Company Quarry, Orangeburg County, South Carolina. PaleoDB collection 122725. Pregnall Member of the Tupelo Bay Formation. Originally, Uhen and Gingerich (2001) indicated that the type specimen of *C. healyorum* came from the late Bartonian to early Priabonian Cross Formation. More recent updates to the stratigraphy and stratigraphic nomenclature of this area indicate that the specimen came from what is now known as the Pregnall Member of the Tupelo Bay Formation, which is Priabonian in age. See (Geisler et al., 2005) for a discussion of the revised stratigraphy of this area.

Age and Distribution—*Chrysocetus healyorum* is known only from the Priabonian of South Carolina.

Diagnosis—*Chrysocetus healyorum* has vertebral bodies that lack elongation seen in members of the genus *Basilosaurus*. *C. healyorum* also has very smooth enamel and lacks vertically oriented ornamentation on the upper premolars. In addition, the premolars are more gracile than those of *Dorudon*, and the upper premolars lack crenulations on the mesial and distal cingula like those of *Zygorhiza*. Based on comparable skeletal elements, *C. healyorum* was larger than *Saghacetus osiris* and smaller than members of the genera *Dorudon*, *Cynthiacetus*, and *Basilosaurus* (after Uhen and Gingerich, 2001).

Remarks—Previously, *Chrysocetus healyorum* was only known from a single specimen. Several specimens from the CCNHM are also assignable to this species.

Cynthiacetus Uhen 2005

Cynthiacetus Uhen 2005: 159

Type species—*Cynthiacetus maxwelli* (Uhen, 2005).

Included species—*Cynthiacetus maxwelli* (Uhen, 2005) and *Cynthiacetus peruvianus* (Martínez-Cáceres and de Muizon, 2011).

Age and Distribution—*Cynthiacetus maxwelli* is known from the Bartonian and Priabonian of the Gulf and East Coasts of North America (Uhen, 2005) and *Cynthiacetus peruvianus* from the Priabonian of Peru (Martínez-Cáceres and de Muizon, 2011).

Diagnosis—Large basilosaurid lacking elongation of the posterior thoracic, lumbar and anterior caudal vertebrae seen in *Basilosaurus*; skull similar in size, but slightly shorter than *Basilosaurus* and much longer than all other basilosaurids. *Cynthiacetus* differs from all other basilosaurids in: nasal strongly tapering anteriorly; atlas with a high, massive and dome-shaped neural arch; vertebrarterial foramina on the cervical vertebrae significantly larger; absence of the ventral expansion of the transverse processes in cervical vertebrae. The supraoccipital shield of *Cynthiacetus* proportionally wider than that seen in *Saghacetus* (after Martínez-Cáceres and de Muizon, 2011).

Remarks—Several specimens consist solely of trunk vertebrae that lack elongation of *Basilosaurus*, but are even larger still than comparable vertebrae in *Cynthiacetus maxwelli* (CCNHM 127.2, 128 and FLMNH FGSV3888). These isolated vertebrae are not complete enough specimens on which to describe a new species, but perhaps indicate that

Figure 6. *Cynthiacetus maxwelli* type specimen (in part), MMNS VP 445. A, right jugal with right M2. B, right premaxilla and maxilla in lateral view. C, maxillae in ventral view.

an even larger species of *Cynthiacetus* or a related taxon existed during the late Eocene (Uhen, 1997, 2005).

Cynthiacetus maxwelli Uhen 2005

Cynthiacetus maxwelli Uhen 2005:160

Type specimen—MMNS VP 445, partial skeleton including the skull, mandibles, teeth, tympanic bullae, cervical, thoracic, and lumbar vertebrae, humerus, radius, ulna (Uhen, 2005). See Figure 6.

Referred specimens—See Appendix 1 for a complete listing of specimens.

Type locality—Cynthia Pit, Hinds County, Mississippi. PaleoDB collection 6802. Yazoo Formation.

Age and Distribution—*Cynthiacetus maxwelli* is found in Priabonian deposits of Alabama, Florida, Georgia, and Mississippi. One specimen is from the Bartonian of North Carolina. This may indicate a broader temporal range for this taxon, or may it may be misattributed to the Bartonian, as it is difficult to distinguish middle and late Eocene aged deposits in North Carolina.

Diagnosis—*C. maxwelli* differs from *C. peruvianus* in that it has one more accessory denticle on both the mesial and distal edges of p3 and p4; an anteroposteriorly longer and lower dome-shaped neural arch on the atlas; a proximodistally shorter and anteroposteriorly more robust humerus, radius and ulna (after Martínez-Cáceres and de Muizon, 2011).

Remarks—Müller (1849) named the species *Zeuglodon brachyspondylus* based on the large, but not elongate vertebrae in the Koch collection that had been assembled as *Hydrarchos*. Kellogg (1936) indicates that 27 of these vertebrae from several separate individuals were included in *Zeuglodon brachyspondylus*, but none of them were designated as the type specimen. Gingerich (2007) designated No. 6 of vertebral series II in Plate XX of Müller (1849) as a lectotype for *Zeuglodon brachyspondylus*. This specimen might be MB 43263, but unfortunately Gingerich's lectotype specimen cannot be unequivocally identified within the MB collection (Hampe, 2009; O. Hampe, pers. com.; pers. obs.). Leidy (1852) named *Pontogeneus priscus* based on a single cervical vertebra (C3, 4, or 5). Kellogg (1936) later combined these two species into one, calling it *Pontogeneus brachyspondylus* even though there were no cervical vertebrae in the 27 Koch vertebrae for comparison. Upon review, the vertebrae of *Zeuglodon brachyspondylus* are indeed large, and lack the elongation seen in the vertebrae of species of *Basilosaurus*. However, they are all poorly preserved, and since none of them were ever designated the type specimen of *Zeuglodon brachyspondylus*, and the lectotype cannot be unequivocally identified, it is best to consider this name a *nomen nudum* (following Uhen, 2005). In addition, the type specimen of *Pontogeneus priscus* is not diagnostic, and both the species and genus should be considered *nomina dubia* (Uhen, 2005).

Dorudon Gibbes 1845

Dorudon Gibbes, 1845:255

Doryodon Cope, 1868:156 (lapsus)

Durodon Gill, 1872:93, typographical error (Kellogg, 1936)

Prozeuglodon Andrews, 1906:243

Type species—*Dorudon serratus* (Gibbes, 1845).

Referred specimens—See Appendix 1 for a complete listing of specimens.

Included species—*Dorudon serratus* (Gibbes, 1845), *Dorudon atrox* (Andrews, 1906).

Age and Distribution—The genus *Dorudon* is known from the Bartonian and Priabonian of North America (*D. serratus* and *Dorudon* sp.) and the Priabonian of North and West Africa (*D. atrox*) (Uhen, 2004; Adnet et al., 2010; Gingerich, 2010; Field et al., 2011a). See the PaleoDB for a complete listing of collections.

Diagnosis—Members of the genus *Dorudon* are considerably larger than *Saghacetus* and *Chrysocetus*, and much smaller than members of the genera *Basilosaurus* or *Cynthiacetus*. Members of the genus *Dorudon* can be distinguished from members of the genus *Zygorhiza* based on the lingual cingula on P2-3. While members of both genera have cingula on the mesial and distal ends of P2-3, those of *Zygorhiza* are much better developed and more highly ornamented. *Dorudon* is slightly larger and all comparable skeletal elements are more robust than those in *Zygorhiza*.

Remarks—True (1908) attempted to differentiate between the genera *Dorudon* and his newly coined *Zygorhiza*, but he failed to recognize that the type specimen of *Dorudon serratus* (the type species for the genus *Dorudon*) was a juvenile. Thus, many of the characteristics he used to differentiate the two genera were actually characteristics distinguishing between deciduous teeth and adult teeth in basilosaurid archaeocetes. This and other factors have caused widespread confusion, and have led to most small basilosaurids in North America being identified as *Zygorhiza*. See the discussion under *Zygorhiza kochii* below for a thorough discussion on identification of specimens as *Zygorhiza*.

Dorudon serratus Gibbes 1845

Dorudon serratus Gibbes, 1845:255

Basilosaurus serratus Gibbes, 1847:5

Doryodon serratus Cope, 1868:144

Zeuglodon serratum Abel 1913:204

Type specimen—MCZ 8763, right maxilla with dP2 to dP4, left maxilla with dP2?, dI2?. The additional 12 caudal vertebrae collected at the same site (Gibbes, 1847) and believed to be from the same individual are now missing, along with some of the cranial fragments. See Uhen (2004) for additional information. See Figure 7.

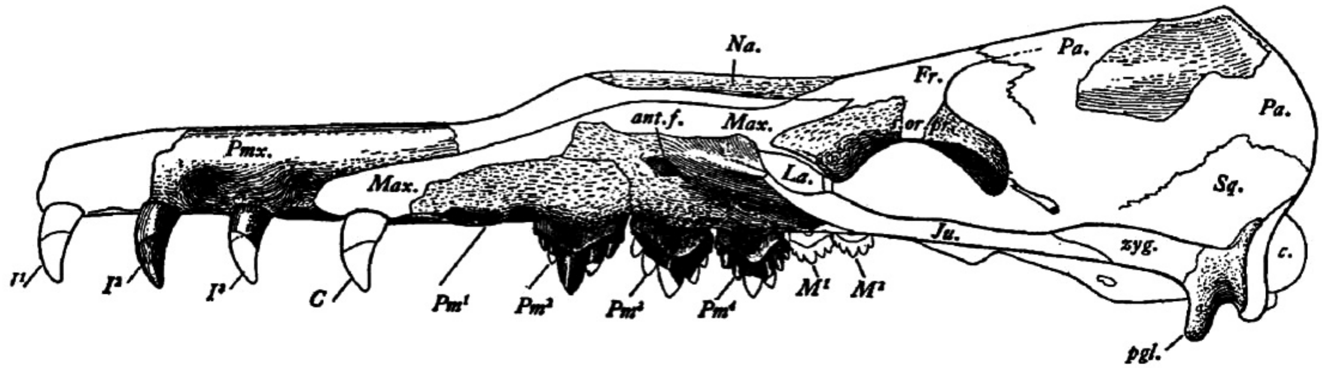

Figure 7. *Dorudon serratus* **type specimen (in part), MCZ 8763, right maxilla with dP2 to dP4, left maxilla with dP2?, dI2? in left lateral view. From Kellogg (1936).**

Type locality—Mazyck Plantation, Berkeley County, South Carolina. PaleoDB collection 13405. The type specimen is most likely from the Harleyville Formation. See Uhen (2004) for additional information.

Age and Distribution—*D. serratus* is currently known from the Priabonian of South Carolina and eastern Georgia.

Diagnosis—*Dorudon serratus* is difficult to diagnose because there is very little material included in the type specimen, and the type specimen is a juvenile individual. It appears that the posterior upper deciduous premolars of *Zygorhiza kochii* have a well-developed distal cingulum that is not highly ornamented, which the upper deciduous premolars of members of the genus *Dorudon* lack. Differences that distinguish *D. serratus* from *Dorudon atrox* include: the presence of three vs. two mesial accessory denticles on dP2; weaker mesial and distal cingula on the upper premolars; stronger vertical rib ornamentation on the upper premolars; and a weaker lingual projection (Andrew's "posterointernal buttress" of *D. atrox*) on dP3 and dP4 (after Uhen, 2004).

Remarks—Unfortunately, the type locality of *Dorudon serratus*, Mazyck Plantation, is now under the artificially created Lake Moultrie (Uhen, 2004). Thus, it is unlikely that more of the type specimen will ever be recovered, and it would be extremely difficult to verify that the type specimen was recovered from the Harleyville Formation. Most specimens from the east coast come from some type of excavation (quarry, marl pit, etc.), which tends to produce limited and/or highly fractured specimens.

Zygorhiza True 1908

Zygorhiza Kellogg 1936:100
Zygorhiza Köhler & Fordyce 1997:575
Zygorhiza Uhen 1998:38

Type species—*Zygorhiza kochii* (Reichenbach in Carus, 1847).

Included species—Only the type species is included in the genus *Zygorhiza*.

Age and Distribution—*Zygorhiza kochii* is known from the Gulf Coast states of the United States (Louisiana, Mississippi, and Alabama) and *Zygorhiza* sp. is known from Waimate, New Zealand (Köhler and Fordyce, 1997). A specimen from Antarctica (MDLP 82-IV-23-70), previously identified as *Zygorhiza* (Cozzuol, 1988), is here identified as Basilosauridae indet.

Diagnosis—As for the type species.

Remarks—Kellogg (1936) included *Balaenoptera juddi* (Seeley, 1881) and *Zeuglodon wanklyni* (Seeley, 1876) in the genus *Zygorhiza*. Based on the incompleteness and lack of diagnostic characters in the type specimens of both species, they are here considered *nomina dubia* and identified as Basilosauridae indet., following Uhen (1998) contra McLeod and Barnes (2008).

Zygorhiza kochii (Reichenbach in Carus, 1847)

Basilosaurus kochii Reichenbach in Carus, 1847:13
Zeuglodon hydrarchus Carus 1849:385
Zeuglodon brachspondylus minor Müller, 1851:240
Zeuglodon brachyspondylum Abel, 1913:203
Zygorhiza minor Kellogg, 1928:40

Type specimen—MB Ma 43248 (old number 15324), posterior portion of a skull with a partial left periotic. See Figure 8.

Referred specimens—See Appendix 1 for a complete listing of specimens.

Type locality—Collected in the vicinity of Clarksville, Clarke County, Alabama; PaleoDB collection 84754. Kellogg (1936) states that the type specimen is from the Ocala Formation, but this area is currently mapped as Jackson Group undifferentiated. The precise collecting locality is unclear.

Age and Distribution—Priabonian (late Eocene) of Alabama, Louisiana, and Mississippi. There are no specimens identifiable as *Zygorhiza kochii* from the east coast of

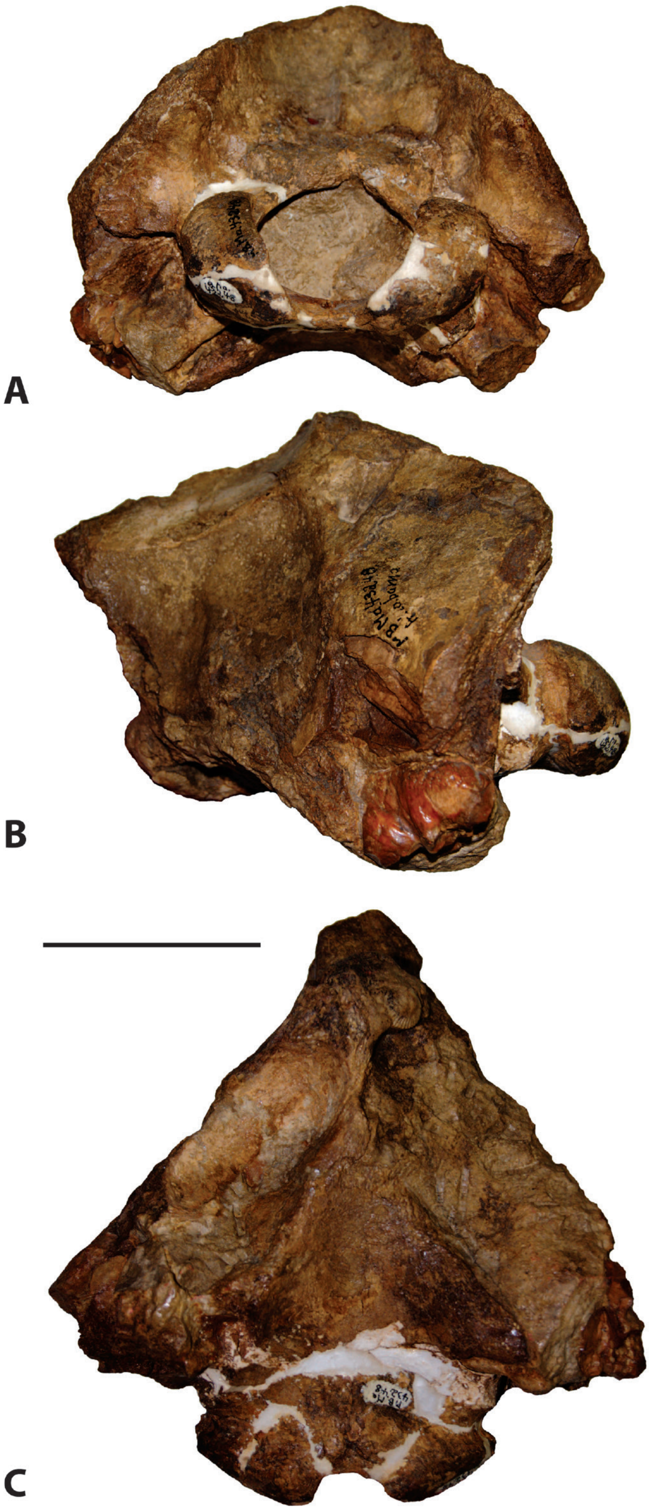

Figure 8. *Zygorhiza kochii* type specimen, MB Ma 43248, posterior portion of a skull with a partial left periotic. A, posterior view; B, left lateral view; C, ventral view. Scale bar is 10 cm.

North America. *Z. kochii* is known only from the Pachuta Member of the Yazoo Formation or its equivalents.

Diagnosis—Members of the species *Zygorhiza kochii* have strong vertical ornamentation on the enamel of the teeth, and well-developed cingula on the premolars with additional cuspules on these cingula (e.g. Kellogg, 1936; Köhler & Fordyce, 1997). These features are not shown in the type specimen, as it lacks teeth. See the discussion below regarding the replacement of the holotype with a neotype specimen, USNM 11962, which does show this diagnostic feature clearly (Kellogg, 1936, plates 10-15).

Additional cranial features were investigated as possible diagnostic characteristics of *Zygorhiza kochii*. All proved to be either too difficult to assess, or proved to be variable in nature. For instance, the periotic has proven to be a good source of diagnostic characters among taxa of Neoceti, but there are a very limited number of periotics associated with teeth and skulls for *Zygorhiza kochii*. Some small differences in the shape of the pars cochlearis and the anterior processes were observed, but it is impossible to know whether this is due to intraspecific variation or possible interspecific variation.

Also, the area of the cranial vertex was investigated, but proved to be highly variable. Among the five skulls attributed to *Zygorhiza* that preserve this area (RMM 2739, TM 8501, USNM 11962, 16638, and 16639), all have notable differences in the conformation of the sutures in this region. In RMM 2739, the premaxillae meet posterior to the external nares, excluding the anterior nasals from the narial opening. In USNM 16638, the lateral margin of the nasal presents a "notch" into which the posteriormost end of the premaxilla is sutured. TM 8501, USNM 11962 and USNM 16638 all have a large anterior process of the frontal (narial process of the frontal). RMM 2739, has a small anterior processes of the frontal, while USNM 16639 has none. Finally, in USNM 11962, the posterior end of the medial margin of the maxilla makes contact with the anterior process of the frontal, while in all of the others (this cannot be observed in TM 8501) it contacts the lateral margin of the nasal. Since none of these features seem to correlated to one another, for the time being, *Zygorhiza kochii* is considered to be a highly variable species in these respects.

Remarks—The history of *Zygorhiza kochii* begins in 1845 with the travels of Albert C. Koch in Alabama (Koch, 1847). Here, in the environs of Clarksville (Clarke County, west of modern day Grove Hill) and Washington Old Court House (Washington County; see Remington and Kallsen (1997) for these and other historical locations in Alabama), Koch collected several specimens that he later assembled into his infamous chimaera *Hydrargos sillimanii* (Koch, 1845a), which he also later dubbed *Hydrarchos harlani* (Koch, 1845b), a change made at the request of Dr. Benjamin Silliman himself (Kellogg, 1936, p. 17). The specimen was first exhibited in New York and then subsequently shipped to Europe for a tour of major cities (Kellogg, 1936).

While in New York, several American scientists studied the specimen in a somewhat cursory fashion, and were able to determine that the specimen was improperly prepared, described and exhibited. Professor Jeffries Wyman of Hampden-Sydney College, Richmond, Virginia (1845) questioned the anatomy of the skull, vertebrae, and forelimbs, stating that some of the elements exhibited as parts of the forelimb "consist not of bones, but of *casts of the cavities of a camerated shell, a species of* Nautilus" (italics original). Professor Henry D. Rogers of the University of Pennsylvania (1845) also commented on the specimen, indicating that he had discovered in amongst the bones "Cochlea of the ear... in form and structure, to the similar bone in the organ of hearing of whales." From the description, it is clear that Rodgers is referring to the tympanic bullae, and he further indicates that these two tympanic bullae are of two different sizes, indicating that the specimen was indeed a chimaera of at least two individuals, if not species. Doctor George Lister (1846), a medical doctor who lived in the area where the *Hydrarchos* specimen was discovered, also confirmed that reports of local residents indicated that Koch had collected specimens in several localities and that the head of the animal was certainly found separate from the body.

While in Germany, the material was examined by an esteemed group of scientists who attempted to determine what the bones and their geologic context meant, particularly in light of the previous publications by Harlan (1834) and Owen (1839a, c) on North American fossil cetaceans. These scholars concluded that the material included in Koch's *Hydrarchos harlani* was composed of several individuals of at least three species (Carus, 1847 and references therein).

The first species was one with a large skull and large, elongate trunk vertebrae. It was what had previously been called *Basilosaurus* by Harlan (1834), and *Zeuglodon cetoides* by Owen (1839a, c). They also correctly concluded that the proper name for this species was *Basilosaurus cetoides*, giving priority to the generic name first coined by Harlan and unjustifiably replaced by Owen (Geinitz, 1847; Reichenbach, 1847), and combining it with the specific epithet coined by Owen (1839c). This species was also subsequently called *Zeuglodon macrospondylus* by Müller (1849), a name that is considered a junior synonym of *Basilosaurus cetoides* (Kellogg, 1936).

The second species based on Koch's material was referred to as *Zeuglodon brachyspondylus* (Müller, 1849). This species exhibited large trunk vertebrae that lacked the elongation of the vertebral bodies exhibited by those of *Basilosaurus cetoides*. Because no type specimen was designated, *Zeuglodon brachyspondylus* is now considered a *nomen dubium* and is discussed at more length under *Cynthiacetus*. Also see Uhen (2005) for additional information.

The third species based on Koch's material was referred to as *Basilosaurus kochii* by Reichenbach (in Carus, 1847). This name was applied to a posterior portion of a skull now identified as specimen MB Ma 43248. This same specimen was also referred to as *Zeuglodon brachyspondylus minor* by Müller (1851). Another Koch specimen of a small basilosaurid, (the "fourth skull"; see Kellogg, 1936:102) was given the name *Zeuglodon hydrarchus* by Carus (1849). This specimen was deposited in the Teyler's Museum, Haarlem, and is now identified as TM 8501.

The nomenclatural situation remained in this state until Frederick True (1908) made an attempt to re-describe *Dorudon serratus*, a small basilosaurid from South Carolina that had been described by Gibbes (1845), and to differentiate it from other nominal North American basilosaurids. True compared the type specimen of *Dorudon serratus* (MCZ 8763) to a cast of TM 8501 which he mistakenly thought was the type specimen of *Zeuglodon brachyspondylus minor* (True, 1908:76). True coined the generic name *Zygorhiza* for this taxon, and although he did not list an etymology for the name, it is probably derived from the Greek *zygoma*, meaning yoke and *rhiza* meaning root. True never explicitly created a new combination of his generic name *Zygorhiza* with any particular specific epithet. Kellogg (1928) used the binomial *Zygorhiza minor* for this species, combining the generic name of True (1908), with the subspecific epithet of Müller (1851).

Kellogg (1936) and all subsequent authors have referred to this species as *Zygorhiza kochii* for two reasons. First, the oldest name that has been applied to a small basilosaurid from the Gulf Coast of the United States is *Basilosaurus kochii* (Reichenbach, 1847). Recall that this name had been applied to a posterior portion of a skull that was originally part of Koch's *Hydrarchos* (specimen MB Ma 43248), which is also the type specimen of *Zeuglodon brachyspondylus minor* Müller (1851). Second, True (1908) coined the generic name *Zygorhiza* for *Zeuglodon brachyspondylus minor*, implicitly creating the new combination, *Zygorhiza brachyspondylus minor*. Kellogg (1936) recognized that the appropriate combination for this species was *Zygorhiza kochii* because the type specimen of *Zeuglodon brachyspondylus minor* (MB Ma 43248) had previously been called *Basilosaurus kochii*, and the animal did not belong in the genus *Basilosaurus*, and the name *Zeuglodon* was a junior objective synonym of *Basilosaurus*. Thus, the oldest available generic name for this species is *Zygorhiza* and the oldest available specific epithet is *kochii*.

The only problem with this line of reasoning is that when True (1908) coined the generic name *Zygorhiza*, he was comparing the type specimen of *Dorudon serratus* to the Teyler's Museum specimen, TM 8501, which is actually the type specimen of *Zeuglodon hydrarchus* (Carus, 1849), not the type specimen of *Zeuglodon brachspondylus minor* as he thought at the time. Despite this mistake, the generic name *Zygorhiza* is still applicable to this taxon because True's nomenclatural act applies to the species *Zeuglodon brachyspondylus minor* (=*Basilosaurus kochii*), even if he was referring to the wrong specimen.

Unfortunately, both the type specimen of *Basilosaurus* *kochii* (MB Ma 43248) and the type specimen of *Zeuglodon hydrarchus* (TM 8501) are not diagnostic. MB Ma 43248 includes no teeth, no bones of the dorsal cranial vertex or frontal shield, no tympanic bullae and only a partial left periotic (Figure 8). TM 8501 is a much more complete skull that may benefit from additional preparation, but the teeth are not well enough preserved to determine whether or not they display the characteristics that have been historically associated with *Zygorhiza*, that is highly ornamented and rugose enamel with cingular cuspules on the upper premolars. Interestingly, Kellogg's hand-written notes on this specimen indicate that even in 1930 when he was collecting data for *A Review of the Archaeoceti*, the teeth of TM 8501 were too badly damaged to evaluate their condition even then. For this reason, a petition has been submitted to the International Commission on Zoological Nomenclature (ICZN) to designate specimen USNM 11962, a skull with periotics and teeth and partial skeleton (Kellogg, 1936:pls 10–15), to be the neotype of *Zygorhiza kochii* (Uhen, in review).

In summary, the type specimen of *Basilosaurus kochii* (MB Ma 43248) is non-diagnostic and the holotype should be replaced by a neotype USNM 11962. The type specimen of *Zeuglodon hydrarchus* (TM 8501) is also non-diagnostic, thus the name *Zeuglodon hydrarchus* should also be considered a junior synonym of *Zygorhiza kochii*.

DISCUSSION

Distribution of North American Basilosaurids

No archaeocetes have been definitively identified from the west coast of North America. Kellogg (1936) discusses an anterior lumbar vertebra, Geological Survey, Department of Mines, Canada 8748, collected from Escalante Point, British Columbia, Canada (PaleoDB 55764) that cannot currently be located. This vertebra includes no characteristics that would allow positive identification as an archaeocete. Based on a modern interpretation of the stratigraphy, it is derived from the Caramanah Group which includes the Eocene Escalante Formation and the Eocene-Oligocene Hesquiat Formation (Johns et al., 2012), and given its lack of diagnostic features, the specimen is best identified as Cetacea indet.

The earliest and most plesiomorphic members of the Basilosauridae include *Supayacetus*, *Ocucajea*, *Basilotritus* and related taxa. From what is known of these taxa, they retain thoracic vertebral counts and sternebrae like those of Protocetidae, but have basilosaurid cheek teeth with well-devloped accessory denticles. Thus, the earliest basilosaurids in North America are specimens of *Basilotritus wardii* from North Carolina and Virginia. Representatives of this basal basilosaurid radiation have yet to be discovered from the Gulf Coastal Plain.

Figure 2 shows the distribution of North American Basilosauridae in space, stratigraphy, and time. While *Basilosaurus*, *Cynthiacetus* and *Dorudon* are known across this region, a critical evaluation of known specimens indicates that *Zygorhiza* is restricted to the latest Priabonian of the Gulf Coast. *Dorudon* is for the most part restricted to the southeastern Atlantic Coast, but it also appears in the Moodys Branch Formation of Mississippi. The Moodys Branch is latest Bartonian, and the other formations that produce *Dorudon* are the Harleyville and Dry Branch, both of which are from the earlier part of the Priabonian. This appearance of *Dorudon* around the Bartonian-Priabonian boundary is similar to the temporal distribution of *Dorudon* in Egypt. This suggests that *Dorudon* may appear somewhat earlier in time, and *Zygorhiza* only appears at the end of the Priabonian, which is also the end of the Eocene. That said, the Waimate specimen (New Zealand) attributed to *Zygorhiza* sp. is considered to be Bartonian (New Zealand Bortonian stage) in age (Köhler and Fordyce, 1997).

All known occurrences of *Zygorhiza* and most specimens of *Basilosaurus* in North America are in the Yazoo Formation and its equivalents, particularly the Pachuta Member of the Yazoo Formation. These units are a mixture of carbonate and clays, while deposits farther to the east there include much less clay (Murray, 1947). From eastern Alabama, Georgia, Florida and the Atlantic coast, basilosaurids like *Dorudon* and *Chrysocetus* are found in carbonates greensands or phosphate-rich deposits. This disjunct distribution may represent a habitat preference by these closely related whales. The argillaceous sediment in the deposits from Louisiana, Mississippi, and western Alabama is derived from the proto-Mississippi river system, and localities to the east received very little continental sediment input based on a reconstruction of the river systems of the late Eocene (Galloway et al., 2011).

This distribution may also represent separate dispersal events to North America from other parts of the world. It is interesting to note that *Zygorhiza* has only been reliably identified outside of North America in New Zealand (Köhler and Fordyce, 1997), and *Dorudon* in Africa (Uhen, 2004). *Cynthiacetus* is also known from Peru (Martínez-Cáceres and de Muizon, 2011), while *Basilosaurus cetoides* has also been described from the Priabonian Dabba'a Formation of Egypt (Zalmout et al., 2011). This preliminary report may indicate that *B. cetoides* was capable of long distance migration, or that there were both Gulf Coast and Mediterranean populations of this species with occasional genetic contact across the Atlantic.

Phylogenetic Analysis Results

The phylogenetic analysis resulted in a set of 1008 equally most parsimonious trees of length 285 (Figure 9). Much of the tree is fairly well resolved, and the node delimiting the Basilosauridae is supported by several characters and character complexes of the dentition (loss of M3, accessory denticles on the cheek teeth), the vertebral

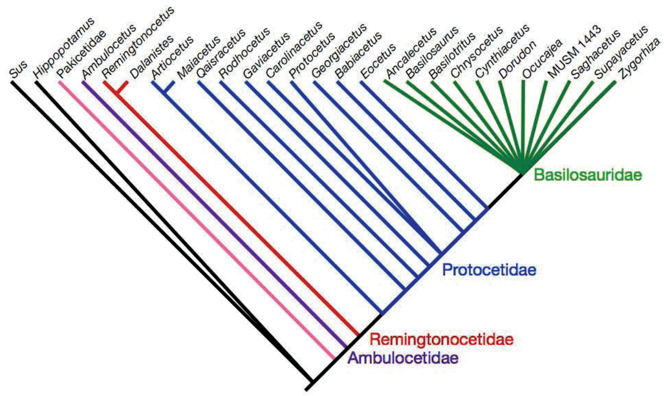

Figure 9. Phylogenetic analysis results. The cladogram is a consensus of 1008 equally parsimonious trees of length 285. Pakicetidae is in pink, Ambulocetidae is in purple, Remingtonocetidae is in red, Protocetidae is in blue, and Basilosauridae is in green. These results are similar to those of Uhen et al. (2011) in that they show a clearly delimited Basilosauridae with several synapomorphies of the dentition, cranium, vertebral column and limbs separating this group from the paraphyletic Protocetidae. It also supports a close relationship of *Eocetus* and more derived Basilosauridae. It differs from the phylogeny of Gol'din and Zvonok (2013), in that there is also no resolution within the Basilosauridae to indicate relatedness among basilosaurids.

column (high numbers of thoracic and lumbar vertebrae, loss of the sacrum, dosoventral compression of the posterior caudal vertebrae), and limbs (flattened radius and ulna, broad scapula, extreme reduction of the hindlimbs). That said, there is also no resolution whatsoever within the Basilosauridae. This result is similar to that of Uhen et al. (2011), but in contrast to that of Martínez-Cáceres and de Muizon (2011), which shows relationships completely resolved within Basilosauridae. The nature of this difference is due to the very small and select set of characters (31 characters) used in the analysis of Martínez-Cáceres and de Muizon (2011) compared to this analysis (108 characters). While the lack of resolution is disappointing, it accurately reflects the minimal morphological disparity within the group.

Among basilosaurids, the most obvious difference among the taxa is body size. *Chrysocetus* and *Saghacetus* are both quite small, *Dorudon* and *Zygorhiza* are intermediate in size, while, *Basilosaurus* and *Cynthiacetus* are both quite large. In addition, members of the genus *Basilosaurus* have elongate posterior thoracic, lumbar, and anterior caudal vertebrae that all other basilosaurids lack. Virtually all of the other basilosaurids are differentiated from one another by a series of autapomorphic features that do not assist in determining relationships among basilosaurid taxa.

Origin of Basilosauridae

Given the interpretation of *Basilotritus wardii* as a basal basilosaurid, it is interesting to note that *Eocetus* and *Georgiacetus* (and sometimes *Babiacetus*, see Figure 9) have been consistently positioned as the taxa most closely related to Pelagiceti (Basilosauridae + Neoceti) in all phylogenenetic analyses where the relevant taxa have been included (Uhen, 1999; Geisler et al., 2005; Uhen, 2008b; Uhen et al., 2011). *Georgiacetus* has a well-developed innominate that appears to lack a bony connection to the vertebral column (Hulbert, 1998). At the same time, the premolars of *Georgiacetus* have incipient accessory denticles on their crowns that are akin to those in Basilosauridae, but much more poorly developed (Hulbert et al., 1998). Uhen (2008b) also showed that *Georgiacetus* lacked a tail fluke that basilosaurids possessed based on the morphology of the caudal vertebrae.

Basilotritus wardii and related taxa retain a thoracic vertebral count similar to that of protocetids (11-12), as well as a more T-shaped manubrium of the sternum (Uhen, 2001; Uhen et al., 2011). *Basilotritus wardii* also has a greatly reduced innominate and hind limb based on the partial innominate preserved in the type specimen (Uhen, 1999), but it is clearly not reduced as much as the innominate of other basilosaurids like *Basilosaurus*, *Chrysocetus*, and *Cynthiacetus* (Uhen, 1999). This suggests that the accessory denticles on the cheek teeth of Basilosauridae evolved first, followed by reduction in the hind limb, acquisition of additional thoracic and lumbar vertebrae, and acquisition of the tail flukes. It is as yet unclear when the lingual (third) roots of the upper molars and the upper third molar were lost. Additional, more complete specimens of these and related taxa will be needed to confirm or refute this hypothesis.

Origin of Neoceti

Uhen and Gingerich (2001) demonstrated that the type specimen of *Chrysocetus healyorum* exhibited a unique combination of features regarding its ontogenetic trajectory. The osteological fusion state of the sutures from the skull, limbs, and vertebral column indicate that the animal died at a very young age, but the teeth appear to be those of an adult. This suggests that this animal presented adult teeth in a very juvenile stage of development. Uhen and Gingerich (2001) also concluded that this may be an explanation of the origin of monophyodonty in that this animal may have either quickly rushed through the deciduous dentition, or may have not developed the deciduous dentition at all, yielding a single set of adult teeth at an early ontogenetic age. If this proves to be the case, it suggests a possible origin of monophyodonty in Neoceti, and a sister-group relationship between *Chrysocetus* and Neoceti.

Figure 2 shows a dramatic break in sedimentation across regions during the entire earliest Rupelian (earliest Oligocene), presumably due to sea level drop associated with the initiation of the Oi-1 Antarctic glaciation at this time (Barker et al., 2007). Sedimentation resumed along the Gulf Coast (Texas to Florida) soon thereafter, but these well-studied units have thus far not produced any cetacean fossils. The only Rupelian (in fact the only Oligocene) cetacean fossil from the Gulf Coast is a single fragmentary specimen (USNM 186894) from the Chickasawhay Formation of Mississippi (PaleoDB collection 49871). Other specimens of Neoceti are found in the late Rupelian Ashley and River Bend Formations (Uhen, 2008a and references therein), as well as other sites on the Pacific coast of North America and around the world.

The earliest member of the Neoceti known is the mysticete *Llanocetus denticrenatus* (Mitchell, 1989) from the latest Eocene of Antarctica (PaleoDB collection 45723). *Llanocetus* has many of the features of Basilosauridae along with a few synapomorphies of Mysticeti (Mitchell, 1989; Fordyce, 2003). Given the global distribution of Basilosauridae in the Priabonian (Uhen et al., 2011), the origin of Mysticeti could have taken place anywhere, but virtually all of the most basal mysticetes occur in the Southern Hemisphere (Fordyce, 2003; Fitzgerald, 2006; Fitzgerald, 2010, 2011), indicating that is the likely place of origin of Mysticeti.

The oldest Odontoceti are all from North America, both from the East Coast localities shown in Figure 2, and several localities from the Pacific Coast as well. There are no confirmed Eocene occurrences of Odontoceti. All of the known specimens of Rupelian Odontoceti possess derived characters of the skull indicating the presence of the air sac system used to produce echolocation clicks in modern odontocetes (Fordyce, 2002). While these early odontocetes retain the heterodont dentition and accessory denticles on their cheek teeth found in basilosaurids, they are much more derived than the earliest mysticetes. Hopefully, new specimens described in the future will fill in the perceived morphological gap between derived basilosaurids and early odontocetes.

CONCLUSIONS

The history of basilosaurid discovery and description began here in North America almost 200 years ago and is still continuing today. Specimens are being discovered every year as more rock is quarried, and developments spread out across the Gulf and Atlantic Coastal Plains. Many of these new discoveries have added to our knowledge of previously described taxa (*Basilosaurus*, *Zygorhiza*, *Dorudon*), but many have not, requiring the description of new species (*Basilotritus*, *Chrysocetus*, *Cynthiacetus*). Still other less complete specimens remain that hint at even more diversity within Basilosauridae.

The following conclusions can be drawn from this review of North American Basilosauridae: 1) Despite the limited type specimen of the type species, *Basilosaurus* can be distinguished from all other basilosaurids by the characteristic morphology of the trunk vertebrae. It remains to be determined if *Basilosaurus cetoides* can be reliably distinguished from *Basilosaurus isis*. 2) *Basilotritus wardii* is the earliest basilosaurid in North America and represents a form that is transitional between earlier protocetids and more derived basilosaurids. 3) *Chrysocetus healyorum* can be readily distinguished from other basilosaurids by the distinctly smooth cheek tooth crowns and small size. Additional skeletal specimens are needed to determine if the highly derived ontogenetic trajectory described by Uhen and Gingerich (2001) is supported. 4) *Cynthiacetus* is present across the Gulf and Atlantic Coastal Plains, in a similar distribution to *Basilosaurus*. The presence of both taxa across the region indicates that size alone cannot be used to determine taxonomic identity. *Cynthiacetus maxwelli* is very similar to *Cynthiacetus peruvianus* (Martínez-Cáceres and de Muizon, 2011), and additional specimens of both will need to be investigated to see if they can be reliably distinguished from one another. 5) *Dorudon* is present in the Bartonian and early Priabonian across the region contemporaneous with its distribution in Egypt and west Africa. 6) *Zygorhiza kochii* is known only from the Gulf Coastal Plain from the Pachuta Member or its equivalents. It is highly variable in cranial morphology. Because the type specimen is not diagnostic, a new specimen, USNM 11962 needs to be designated as the neotype.

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Appendix 1. List of all North American Basilosauridae specimens and their current best identification. Many specimens have been previously identified to genus or species level based on very limited specimens that do not display diagnostic characteristics of those genera or species. Both previous identifications and current identifications are listed. Most specimens are listed with the horizon and geologic age taken directly from the museum database where the data was originally derived from. Where possible, the age and stratigraphic information has been updated, but many are still cataloged with outmoded stratigraphic nomenclature. Type specimens and casts of type specimens are in bold. Collecting localities that are underlined refer to PaleoDB collection numbers. Those without PaleoDB collection numbers could not be located precisely enough to enter into the PaleoDB. Those listed as unknown have no precise locality information.

All of the specimens from Museum für Naturkunde, Berlin were collected by Albert C. Koch in southwestern Alabama around Clarksville and Old Washington Courthouse, but the precise locality for each of the fossils is not known. This suggests that the fossils were collected from the Ocala Formation and/or the Pachuta Marl Member of the Yazoo Formation, but this cannot be confirmed. Also, the specimens from the College of Charleston Natural History Museum were purchased. They are all said to be from "Harleyville, South Carolina", and are probably from the Pregnall Member of the Tupelo Bay Formation, which is exposed in quarries in this area, but this cannot be confirmed. Specimens that lack a PaleoDB collection number could not be precisely located with the collecting information at hand. Additional information on lithology, age, and associated faunas can be found in the PaleoDB (www.paleodb.org) by searching for the appropriate collection number associated with the specimen.

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
ANSP	12944	*Basilosaurus*	*cetoides*	3 lumbar vertebrae			LA	Caldwell	75638
ANSP	12945	*Basilosaurus*	*cetoides*	R jaw frag with P/1 & P/2			LA	Caldwell	75638
ANSP	12946	*Basilosaurus*	*cetoides*	R jaw frag with P/3 & P/4?			LA	Caldwell	75638
ANSP	12947	*Basilosaurus*	*cetoides*	partial lumbar vertebra			LA	Caldwell	75638
ANSP	12949	*Basilosaurus*	*cetoides*	end of lumbar vertebra			LA	Caldwell	75638
AUMP	76	*Basilosaurus*	*cetoides*	vertebra					unknown
ChM PV	5798	*Basilosaurus*	*cetoides*	fragments of a skeleton	Pri	Pregnall	SC	Dorchester	72046
FLMNH	115000	*Basilosaurus*	*cetoides*	vertebra	Eoc	Avon Park	FL	Citrus	49882
FLMNH	146456	*Basilosaurus*	*cetoides*	partial vertebra			FL	Levy	LV028E
FMNH PM	39332	*Basilosaurus*	*cetoides*	lumbar vertebra			MS	Yazoo	unknown
FMNH PM	39333	*Basilosaurus*	*cetoides*	lumbar vertebra			MS	Yazoo	unknown
FMNH PM	39334	*Basilosaurus*	*cetoides*	lumbar vertebra			MS	Yazoo	unknown
GSM	183	*Basilosaurus*	*cetoides*	rib fragments	Pri	Harleyville	SC	Dorchester	32908
GSM	362	*Basilosaurus*	*cetoides*	partial rib	Pri	Sandersville	GA	Washington	132552
LACM	26315	*Basilosaurus*	*cetoides*	partial skeleton	Pri	Yazoo	MS	Scott	135787
LACM	26316	*Basilosaurus*	*cetoides*	partial skeleton	Pri	Yazoo	MS	Scott	55868
LACM	26317	*Basilosaurus*	*cetoides*	partial skeleton	Pri	Yazoo	MS	Scott	55868
LSUMG V	1	*Basilosaurus*	*cetoides*	skull & partial skeleton	Pri	Tullos	LA	Grant	32925
MB	28351	*Basilosaurus*	*cetoides*	posterior premolar	Pri	Pachuta?	AL		unknown
MB	28352	*Basilosaurus*	*cetoides*	partial R P/3 or P/4	Pri	Pachuta?	AL		unknown
MB	28353	*Basilosaurus*	*cetoides*	upper premolar & lower premolar	Pri	Pachuta?	AL		unknown
MB	28354	*Basilosaurus*	*cetoides*	heavily worn anterior tooth	Pri	Pachuta?	AL		unknown
MB	28355	*Basilosaurus*	*cetoides*	broken anterior tooth	Pri	Pachuta?	AL		unknown
MB	28356	*Basilosaurus*	*cetoides*	large anterior tooth	Pri	Pachuta?	AL		unknown
MB	28357	*Basilosaurus*	*cetoides*	lower P/3 or P/4, damaged	Pri	Pachuta?	AL		unknown
MB	28360	*Basilosaurus*	*cetoides*	posterior half of upper premolar	Pri	Pachuta?	AL		unknown
MB	28362	*Basilosaurus*	*cetoides*	damaged body of C345	Pri	Pachuta?	AL		unknown
MB	28364	*Basilosaurus*	*cetoides*	L tympanic bulla	Pri	Pachuta?	AL		unknown
MB	28365	*Basilosaurus*	*cetoides*	partial R bulla	Pri	Pachuta?	AL		unknown
MB	28368	*Basilosaurus*	*cetoides*	lower R M/1	Pri	Pachuta?	AL		unknown
MB	28369	*Basilosaurus*	*cetoides*	upper R M1/	Pri	Pachuta?	AL		unknown
MB	28369	*Basilosaurus*	*cetoides*	anterior half of a premolar	Pri	Pachuta?	AL		unknown
MB	28373	*Basilosaurus*	*cetoides*	partial premolar	Pri	Pachuta?	AL		unknown
MB	28374	*Basilosaurus*	*cetoides*	partial premolar	Pri	Pachuta?	AL		unknown

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
MB	28382	*Basilosaurus*	*cetoides*	fragment of R maxilla	Pri	Pachuta?	AL		unknown
MB	30339	*Basilosaurus*	*cetoides*	L dentary with roots of P/4-M/3	Pri	Pachuta?	AL		unknown
MB	43230	*Basilosaurus*	*cetoides*	partial vertebra	Pri	Pachuta?	AL		unknown
MB	43242	*Basilosaurus*	*cetoides*	partial skull	Pri	Pachuta?	AL		unknown
MB	43243	*Basilosaurus*	*cetoides*	humerus	Pri	Pachuta?	AL		unknown
MB	43244	*Basilosaurus*	*cetoides*	occiput	Pri	Pachuta?	AL		unknown
MB	43245	*Basilosaurus*	*cetoides*	intertemporal region	Pri	Pachuta?	AL		unknown
MB	43267	*Basilosaurus*	*cetoides*	rib	Pri	Pachuta?	AL		unknown
MB	43268	*Basilosaurus*	*cetoides*	group of ribs	Pri	Pachuta?	AL		unknown
MB	43270	*Basilosaurus*	*cetoides*	dentary	Pri	Pachuta?	AL		unknown
MCZ	5188	*Basilosaurus*	*cetoides*						unknown
MCZ	5788	*Basilosaurus*	*cetoides*	P/2,3, or 4	Eoc	Jackson	AL		unknown
MCZ	8515	*Basilosaurus*	*cetoides*	casts of 1 incisor and 1 premolar					unknown
MCZ	9003	*Basilosaurus*	*cetoides*	rib fragment	Eoc	Jackson	AL		unknown
MCZ	17640	*Basilosaurus*	*cetoides*	2 lumbar vertebrae & skull frags	Eoc	Jackson	AL		unknown
MMNS VP	1	*Basilosaurus*	*cetoides*	centrum, partial	Eoc		MS	Clarke	unknown
MMNS VP	446	*Basilosaurus*	*cetoides*	vertebrae, ribs and frag	Eoc	Yazoo	MS	Clarke	45634
MMNS VP	470	*Basilosaurus*	*cetoides*	bulla	Eoc	Yazoo	MS	Clarke	unknown
MMNS VP	611	*Basilosaurus*	*cetoides*	rib segment, anterior	Eoc	Yazoo	MS	Madison	6802
MMNS VP	677	*Basilosaurus*	*cetoides*	vertebra, lumbar	Eoc	Yazoo	MS	Madison	6802
MMNS VP	774	*Basilosaurus*	*cetoides*	axis	Eoc	Yazoo	MS	Hinds	45639
MMNS VP	2338	*Basilosaurus*	*cetoides*	L dentary and teeth	Eoc	Yazoo	MS		unknown
MMNS VP	2960	*Basilosaurus*	*cetoides*	partial skeleton	Eoc	Yazoo	MS	Scott	45627
MMNS VP	2961	*Basilosaurus*	*cetoides*	partial skeleton	Eoc		MS	Jasper	131913
MSC RMM	1320	*Basilosaurus*	*cetoides*	partial vertebrae, tooth frags			AL	Washington	89613
MSC RMM	1321	*Basilosaurus*	*cetoides*				AL	Washington	131804
MSC RMM	2740	*Basilosaurus*	*cetoides*	Most of a single individual		Pachuta	AL	Washington	77362
MSC RMM	3151	*Basilosaurus*	*cetoides*	Rib fragment		Pachuta	AL	Washington	131910
NHMUK M	8800	*Basilosaurus*	*cetoides*		Eoc		AL		unknown
NHMUK M	16576	*Basilosaurus*	*cetoides*	tooth roots	Eoc		AL		unknown
NHMUK M	25445	*Basilosaurus*	*cetoides*	cast of posterior 1/2 of R P/2?	Eoc		AL		unknown
NHMUK M	35642	*Basilosaurus*	*cetoides*	partial R dentary with molar roots			AL	Clarke	unknown
NHMUK M	40980	*Basilosaurus*	*cetoides*	portions of teeth	Eoc		AL	Clarke	84754
PRI	3901	*Basilosaurus*	*cetoides*	lumbar vertebra	Eoc	Jackson	AR	St. Francis	16549
TM	8506	*Basilosaurus*	*cetoides*	lumbar vertebra			AL		unknown
TM	8509	*Basilosaurus*	*cetoides*	posterior thoracic vertebra			AL		unknown
TM	8510	*Basilosaurus*	*cetoides*	C2			AL		unknown
TM	8511	*Basilosaurus*	*cetoides*	cervical			AL		unknown
TM	8515	*Basilosaurus*	*cetoides*	mesosternum			AL		unknown
TM	8521	*Basilosaurus*	*cetoides*	xiphisternum			AL		unknown
TM	8522	*Basilosaurus*	*cetoides*	vertebral processes			AL		unknown
TM	8523	*Basilosaurus*	*cetoides*	vertebral processes			AL		unknown
TM	8524	*Basilosaurus*	*cetoides*	humeral shaft			AL		unknown
TM	8532	*Basilosaurus*	*cetoides*	R dentary with premolar			AL		unknown
TM	8533	*Basilosaurus*	*cetoides*	roots of premolar			AL		unknown
TM	8547	*Basilosaurus*	*cetoides*	L premaxilla			AL		unknown
TM	8558	*Basilosaurus*	*cetoides*	anterior thoracic vertebra			AL		unknown
TM	8559	*Basilosaurus*	*cetoides*	anterior thoracic vertebra			AL		unknown

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
TM	8560	*Basilosaurus*	*cetoides*	ribs			AL		unknown
TM	8563	*Basilosaurus*	*cetoides*	sagittal crest and nuchal crest			AL		unknown
TM	8568	*Basilosaurus*	*cetoides*	manubrium			AL		unknown
TM	8569	*Basilosaurus*	*cetoides*	posterior end of xiphisternum			AL		unknown
TM	8571	*Basilosaurus*	*cetoides*	squamosal and parietal			AL		unknown
TM	8572	*Basilosaurus*	*cetoides*	squamosal/parietal			AL		unknown
TM	8573	*Basilosaurus*	*cetoides*	frontal			AL		unknown
TM	18119	*Basilosaurus*	*cetoides*	proximal radius			AL		unknown
TM	18135	*Basilosaurus*	*cetoides*	epiphysis			AL		unknown
TM	18149	*Basilosaurus*	*cetoides*	L premaxilla			AL		unknown
TM	18152	*Basilosaurus*	*cetoides*	anterior thoracic vertebra			AL		unknown
TM	18156	*Basilosaurus*	*cetoides*	humeral head			AL		unknown
TM	18157	*Basilosaurus*	*cetoides*	proximal half of R humerus			AL		unknown
TM	18191	*Basilosaurus*	*cetoides*	block with ribs etc.			AL		unknown
TM	18196	*Basilosaurus*	*cetoides*	anterior caudal vertebra			AL		unknown
TM	18197	*Basilosaurus*	*cetoides*	cervical vertebra and sternum?			AL		unknown
TM	18198	*Basilosaurus*	*cetoides*	lumbar vertebra?			AL		unknown
TM	18199	*Basilosaurus*	*cetoides*	lumbar vertebra			AL		unknown
UAM FM	27019	*Basilosaurus*	*cetoides*				AL	Choctaw	28983
UAM FM	104787	*Basilosaurus*	*cetoides*		Eoc		AL	Clarke	Claiborne
UAM FM	1985.0051.0	*Basilosaurus*	*cetoides*	partial skeleton	Pri	Shubuta/ Pachuta	AL	Washington	76685
UAM FM	1985.0056.0001	*Basilosaurus*	*cetoides*	vertebra	Eoc		AL		unknown
UAM FM	1985.0056.0002	*Basilosaurus*	*cetoides*	vertebra	Eoc		AL		unknown
UAM FM	1985.0056.0003	*Basilosaurus*	*cetoides*	vertebra	Eoc		AL		unknown
UAM FM	1985.0056.0004	*Basilosaurus*	*cetoides*	vertebra	Eoc		AL		unknown
UAM FM	1985.0072.0024	*Basilosaurus*	*cetoides*	12 bone fragments	Eoc		AL		unknown
UAM FM	1985.0077.0	*Basilosaurus*	*cetoides*	vertebrae	Pri	Shubuta Marl	AL	Choctaw?	unknown
UAM FM	1985.0078.0	*Basilosaurus*	*cetoides*	2 vertebrae	Eoc		AL		unknown
UAM FM	1988.0001.0001	*Basilosaurus*	*cetoides*	1 vertebra in 2 pieces	Eoc		AL		unknown
UAM FM	1993.0009.0001	*Basilosaurus*	*cetoides*	large rib fragment	Eoc		AL	Washington	77362
UAM FM	2000.0001.0008.001.022	*Basilosaurus*	*cetoides*	22 large bone fragments	Eoc	Pachuta	AL	Choctaw	28983
UAM FM	2000.0001.0011.001	*Basilosaurus*	*cetoides*	bone and rib fragments	Eoc	Pachuta	AL	Choctaw	28983
UCMP	140258	*Basilosaurus*	*cetoides*	cast of R+L innominate, R femur	Pri	Jackson	AL	Choctaw	86949
UMMP	10572	*Basilosaurus*	*cetoides*	vertebra	Eoc		GA?	Macon	unknown
USNM	838	*Basilosaurus*	*cetoides*	thoracic vertebra, cast	Eoc		AL	Clarke	45637
USNM	839	*Basilosaurus*	*cetoides*	maxilla fragment, cast	Eoc		AL	Clarke	45637
USNM	840	*Basilosaurus*	*cetoides*	partial mandible and humerus	Eoc		AL	Clarke	45637
USNM	4674	*Basilosaurus*	*cetoides*	partial skeleton			AL	Choctaw	28983
USNM	4675	*Basilosaurus*	*cetoides*	partial skeleton			AL	Choctaw	28983
USNM	4676	*Basilosaurus*	*cetoides*	partial skeleton	Eoc		AL	Choctaw	28983
USNM	11783	*Basilosaurus*	*cetoides*	R scapula	Eoc	Jackson	AL	Choctaw	28983
USNM	12064	*Basilosaurus*	*cetoides*	manubrium	Eoc	Jackson	AL	Choctaw	124707
USNM	12261	*Basilosaurus*	*cetoides*	skeleton with pelves & R femur	Eoc	Jackson	AL	Choctaw	86949
USNM	13681	*Basilosaurus*	*cetoides*	manubrium	Eoc	Jackson	AL	Choctaw	28983
USNM	13690	*Basilosaurus*	*cetoides*	partial skeleton	Eoc	Ocala	GA	Houston	132660
USNM	310649	*Basilosaurus*	*cetoides*	lumbar vertebra	Eoc	Jackson	MS	Hinds	45639
WFI	7548	*Basilosaurus*	*cetoides*	incisor	Eoc	Pachuta	AL	Choctaw	28983

Appendix 1 *continued*

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
WFI	7647	*Basilosaurus*	*cetoides*	premolar crown	Eoc	Pachuta	AL	Choctaw	28983
YPM PU	24932	*Basilosaurus*	*cetoides*	lumbar vertebra	Eoc		AL		unknown
AMNH FM	98055	*Basilosaurus*	sp.		Eoc		AL?		unknown
CCNHM	127.1	*Basilosaurus*	sp.	thoracic vert, T11-12?			SC	Dorchester	Harleyville
ChM PV	6762	*Basilosaurus*	sp.	partial vertebra	Pri	Pregnall	SC	Dorchester	122725
ChM PV	7637	*Basilosaurus*	sp.	lumbar vertebra			SC		unknown
MB	43232	*Basilosaurus*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43235	*Basilosaurus*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43236	*Basilosaurus*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43237	*Basilosaurus*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43238	*Basilosaurus*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43239	*Basilosaurus*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43240	*Basilosaurus*	sp.	caudal vertebral body	Pri	Pachuta?	AL		unknown
MB	43269	*Basilosaurus*	sp.	cast of jaw			AL?		unknown
NHMUK M	26552	*Basilosaurus*	sp.	thoracic vert.					unknown
NHMUK M	26553	*Basilosaurus*	sp.	anterior caudal					unknown
NHMUK M	35590	*Basilosaurus*	sp.	lower P/1?	Eoc		AL	Clarke	unknown
NHMUK M	35591	*Basilosaurus*	sp.	incisor	Eoc		AL	Clarke	unknown
NHMUK M	35592	*Basilosaurus*	sp.	P3/ or P4?	Eoc		AL	Clarke	unknown
NHMUK M	35644	*Basilosaurus*	sp.	fragments of ribs	Eoc		AL		unknown
UAM PV	1985.0072.0055.003	*Basilosaurus*	sp.	1 rib fragment	Eoc		AL		unknown
NHMUK M	40981	*Basilosaurus?*	sp.	damaged caudal vertebra	Eoc		AL		unknown
CMM	4334	*Basilotritus*	sp.	anterior thoracic vertebra	Bar	Castle Hayne	VA	King William	107512
CMM	4335	*Basilotritus*	sp.	posterior lumbar	Bar	Castle Hayne	VA	King William	107512
NCSM	11284	*Basilotritus*	*wardii*	partial skeleton		Castle Hayne	NC	Pender	75518
NCSM	11297	*Basilotritus*	*wardii*	thoracic vertebrae and fragments		Castle Hayne	NC	Pender	75518
NCSM	12531	*Basilotritus*	*wardii*	supraoccipital		Castle Hayne	NC	Pender	75518
NCSM	13434	*Basilotritus*	*wardii*	vertebral centrum		Castle Hayne	NC	Pender	75518
NCSM	13513	*Basilotritus*	*wardii*	lumbar transverse process		Castle Hayne	NC	Pender	75518
NCSM	13514	*Basilotritus*	*wardii*	thoracic vertebra centrum		Castle Hayne	NC	Pender	75518
NCSM	13676	*Basilotritus*	*wardii*	proximal end of a rib		Castle Hayne	NC	New Hanover	7297
NCSM	13678	*Basilotritus*	*wardii*	partial vertebra, caudal?		Castle Hayne	NC	Pender	75518
NCSM	15663	*Basilotritus*	*wardii*	manubrium missing anterior end		Castle Hayne	NC	Pender	75518
USNM	214429	*Basilotritus*	*wardii*	partial skull	Eoc		NC	Craven	132664
USNM	214595	*Basilotritus*	*wardii*	partial skull	Eoc		NC	Craven	132664
USNM	310633	*Basilotritus*	*wardii*	partial skeleton including pelvis	Eoc	Castle Hayne	NC	Pender	7299
CCNHM	119	*Chrysocetus*	*healyorum*	tall triangular teeth			SC	Dorchester	Harleyville
CCNHM	126	*Chrysocetus*	*healyorum*	L premax with I1-3			SC	Dorchester	Harleyville
SCSM	87.195	*Chrysocetus*	*healyorum*	partial skeleton including innom-inate	Pri	Pregnall	SC	Orangeburg	122725
FLMNH	3572	*Cynthiacetus*	*maxwelli*						unknown
FLMNH	40048	*Cynthiacetus*	*maxwelli*	lumbar vertebra			FL	Columbia	60448
FLMNH	137602	*Cynthiacetus*	*maxwelli*	lumbar vertebra	Eoc	Crystal River	FL	Marion	60449
FLMNH	137603	*Cynthiacetus*	*maxwelli*	lumbar vertebra	Eoc	Crystal River	FL	Marion	60449
FLMNH FGS V	2184	*Cynthiacetus*	*maxwelli*	vertebra	Pri	Crystal River	FL	Alachua	57123
FLMNH FGS V	3233	*Cynthiacetus*	*maxwelli*	lumbar vertebra	Pri	Crystal River	FL	Alachua	57123
FLMNH FGS V	4556	*Cynthiacetus*	*maxwelli*	1 lumbar, 1 caudal vertebra	Pri	Crystal River	FL	Alachua	unknown
FLMNH FGS V	4894	*Cynthiacetus*	*maxwelli*	lumbar vertebra	Pri		FL	Alachua	32918
FLMNH FGS V	7235	*Cynthiacetus*	*maxwelli*	partial skeleton	Pri	Crystal River	FL	Lafayette	60450
FLMNH FGS V	2603-2289	*Cynthiacetus*	*maxwelli*	vertebra	Pri	Crystal River	FL	Alachua	57123

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
MMNS VP	445	*Cynthiacetus*	*maxwelli*	skeleton, anterior portion	Eoc	Yazoo	MS	Hinds	6802
TM	8562	*Cynthiacetus*	*maxwelli*	posterior thoracic vertebra			AL		unknown
USNM	776	*Cynthiacetus*	*maxwelli*	partial lumbar	Eoc	Jackson	AL		unknown
USNM	2211	*Cynthiacetus*	*maxwelli*	5 lumbar, 1 caudal vertebrae	Eoc	Jackson	AL	Choctaw	28983
USNM	11401	*Cynthiacetus*	*maxwelli*	3 lumbar vertebrae	Eoc	Ocala	GA	Crisp	60451
USNM	310637	*Cynthiacetus*	*maxwelli*	partial skull	Eoc	Castle Hayne	NC	Jones	60452
WFI	4043	*Cynthiacetus?*	*maxwelli?*	anterior caudal vertebra	Eoc		FL		unknown
MB	43233	*Cynthiacetus?*	sp.	caudal vertebra	Pri	Pachuta?	AL		unknown
MB	43234	*Cynthiacetus?*	sp.	caudal vertebra	Pri	Pachuta?	AL		unknown
MB	43271	*Cynthiacetus?*	sp.	caudal vertebra	Pri	Pachuta?	AL		unknown
MB	43272	*Cynthiacetus?*	sp.	thoracic vertebra & tooth	Pri	Pachuta?	AL		unknown
MB	43273	*Cynthiacetus?*	sp.	vertebra	Pri	Pachuta?	AL		unknown
MB	43274	*Cynthiacetus?*	sp.	vertebra	Pri	Pachuta?	AL		unknown
MB	43275	*Cynthiacetus?*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43276	*Cynthiacetus?*	sp.	lumbar vertebral body	Pri	Pachuta?	AL		unknown
MB	43277	*Cynthiacetus?*	sp.	vertebra	Pri	Pachuta?	AL		unknown
CCNHM	123	*Dorudon*	*serratus*	8 teeth			SC	Dorchester	Harleyville
FLMNH	118687	*Dorudon*	*serratus*	skull with lower jaws, cast	Pri	Twiggs	GA	Twiggs	45640
MB	28381	*Dorudon*	*serratus*	cast of premolar	Pri	Pachuta?	AL		unknown
MCZ	8763	*Dorudon*	*serratus*	partial skull & deciduous teeth	Pri	Harleyville	SC	Berkeley	13405
MMAS A	1981.08.01	*Dorudon*	*serratus*	skull and skeleton	Eoc	Twiggs	GA	Twiggs	27508
USNM	13774	*Dorudon*	*serratus*	partial R dentary with teeth	Eoc	Ocala	GA	Crisp	60451
USNM	510828	*Dorudon*	*serratus*	skull, cast			MS	Yazoo	unknown
YPM	52999	*Dorudon*	*serratus*	deciduous premolar & incisor	Pri	Harleyville	SC	Berkeley	13405
MMNS VP	130	*Dorudon*	*serratus?*	skull and skeleton lacking flippers	Eoc	Moodys Branch	MS	Yazoo	45625
CCNHM	112	*Dorudon*	sp.	incisor			SC	Dorchester	Harleyville
CCNHM	115	*Dorudon*	sp.	incisor			SC	Dorchester	Harleyville
CCNHM	116	*Dorudon*	sp.	R M/1or 2			SC	Dorchester	Harleyville
CCNHM	117	*Dorudon*	sp.	incisor			SC	Dorchester	Harleyville
CCNHM	118	*Dorudon*	sp.	incisor			SC	Dorchester	Harleyville
CCNHM	125	*Dorudon*	sp.	R bulla with posterior process			SC	Dorchester	Harleyville
CCNHM	130	*Dorudon*	sp.	RP/1			SC	Dorchester	Harleyville
ChM PV	4824	*Dorudon*	sp.	C3-4-5			SC		unknown
ChM PV	4825	*Dorudon*	sp.	C3-4-5			SC		unknown
ChM PV	4826	*Dorudon*	sp.	C3-4-5			SC		unknown
ChM PV	4832	*Dorudon*	sp.	L dentary with P/2-P4 roots			SC		unknown
USNM	392075	*Dorudon*	sp.	molar	Eoc	Castle Hayne	NC	Jones	60452
USNM	310652	indet	indet.	4 teeth	Eoc		AL	Choctaw	32926
USNM	392078	indet	indet.	2 upper deciduous premolars	Eoc	Castle Hayne	NC	Jones	60452
AMNH FM	476	indet.	indet.	anterior L dentary	Eoc		SC	Charleston	unknown
AMNH FM	32601	indet.	indet.	lower premolar					unknown
ANSP	9948	indet.	indet.	cast of bulla					unknown
ANSP	9976	indet.	indet.	cast of lower molar					unknown
ANSP	12548	indet.	indet.	tiny piece of premolar crown			AL		unknown
ANSP	12948	indet.	indet.	large partial lumbar vertebra			LA	Caldwell	75638
ANSP	13668	indet.	indet.	vertebral body of C3, 4, or 5			LA	Caldwell	75638
AUMP	2365	indet.	indet.	cervical					unknown
AUMP	2366	indet.	indet.	cervical					unknown
AUMP	2367	indet.	indet.	rib head					unknown

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
AUMP	2369	indet.	indet.	miscellaneous fragments	Eoc		GA	Twiggs	73434
AUMP	3367	indet.	indet.	vertebra	Eoc		AL	Washington	89613
BCGM	2788	indet.	indet.	partial tympanic bulla	Pri	Harleyville	SC	Dorchester	72046
BCGM	5320	indet.	indet.	dP/1	Pri	Clinchfield	GA	Wilkinson	45640
BCGM	5474	indet.	indet.	dP3 or 4/	Pri	Clinchfield	GA	Wilkinson	45640
BCGM	6464	indet.	indet.	I/1	Eoc	Tupelo Bay	SC	Dorchester	32908
BCGM	7027	indet.	indet.	R I/2?	Pri	Clinchfield	GA	Wilkinson	45640
BCGM	7052	indet.	indet.	partial incisor or canine	Pri	Harleyville	SC	Dorchester	72046
BCGM	10004	indet.	indet.	R P/1	Pri	Harleyville	SC	Dorchester	32908
BCGM	10011	indet.	indet.	posterior portion of bulla	Pri	Harleyville	SC	Dorchester	32908
BCGM	10013	indet.	indet.	R lower or L upper incisor	Pri	Harleyville	SC	Dorchester	32908
BCGM	10014	indet.	indet.	L P/3 or P/4	Pri	Harleyville	SC	Dorchester	32908
BCGM	10015	indet.	indet.	posterior end of L P/3 or P/4	Pri	Harleyville	SC	Dorchester	32908
BCGM	10016	indet.	indet.	caudal vertebra 4, 5 or 6	Pri	Harleyville	SC	Dorchester	32908
CCNHM	110	indet.	indet.	9 assorted teeth			SC	Dorchester	Harleyville
CCNHM	111	indet.	indet.	lower P3 or 4?			SC	Dorchester	Harleyville
CCNHM	113	indet.	indet.	incisor			SC	Dorchester	Harleyville
CCNHM	114	indet.	indet.	incisor			SC	Dorchester	Harleyville
CCNHM	120	indet.	indet.	very low crowned molar? tooth			SC	Dorchester	Harleyville
CCNHM	121	indet.	indet.	L upper molar			SC	Dorchester	Harleyville
CCNHM	122	indet.	indet.	R upper molar			SC	Dorchester	Harleyville
CCNHM	124	indet.	indet.	C345, C6, T2?, rib			SC	Dorchester	Harleyville
CCNHM	127.2	indet.	indet.	lumbar			SC	Dorchester	Harleyville
CCNHM	128	indet.	indet.	lumbar			SC	Dorchester	Harleyville
CCNHM	129	indet.	indet.	incisor			SC	Dorchester	Harleyville
ChM PV	4828	indet.	indet.	incisiform teeth			SC		unknown
ChM PV	4830	indet.	indet.	supraoccipital			SC		unknown
ChM PV	4831	indet.	indet.	scrap of bone			SC		unknown
ChM PV	4833	indet.	indet.	scrap of bone			SC		unknown
ChM PV	4834	indet.	indet.	scraps of bone			SC		unknown
ChM PV	4836	indet.	indet.	frontal			SC		unknown
ChM PV	4838	indet.	indet.	scraps of bone			SC		unknown
ChM PV	4841	indet.	indet.	scrap of bone			SC		unknown
ChM PV	4842	indet.	indet.	partial lumbar vertebrae			SC		unknown
ChM PV	4843	indet.	indet.	lumbar vertebra			SC		unknown
ChM PV	6761	indet.	indet.	teeth and fragments of a skeleton	Pri	Pregnall	SC	Dorchester	72046
ChM PV	6763	indet.	indet.	caudal vertebra			SC	Dorchester	32908
ChM PV	6764	indet.	indet.	partial caudal vertebra	Pri	Pregnall	SC	Dorchester	32908
FLMNH	3458	indet.	indet.	5 vertebrae		Crystal River	FL	Alachua	32918
FLMNH	3459	indet.	indet.	axis vertebra and partial skull		Alachua	FL	Alachua	32918
FLMNH	3474	indet.	indet.						unknown
FLMNH	18001	indet.	indet.	partial skull	Pri	Crystal River	FL	Alachua	32920
FLMNH	20885	indet.	indet.	tooth	Pri	Crystal River	FL	Lafayette	73586
FLMNH	21221	indet.	indet.	tooth	Eoc		FL	Dixie	132817
FLMNH	47344	indet.	indet.						unknown
FLMNH	49046	indet.	indet.	skull element	Pri	Crystal River	FL	Lafayette	73586
FLMNH	52437	indet.	indet.						unknown
FLMNH	60100	indet.	indet.	partial skeleton	Pri	Crystal River	FL	Lafayette	60450
FLMNH	68057	indet.	indet.	partial vertebra	Pri	Crystal River	FL	Lafayette	60450
FLMNH	93083	indet.	indet.	incisor	Pri	Crystal River	FL	Lafayette	132702

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
FLMNH	93084	indet.	indet.	partial tooth	Pri	Crystal River	FL	Lafayette	132702
FLMNH	95685	indet.	indet.	R and L partial mandible	Eoc		FL	Polk	132705
FLMNH	100206	indet.	indet.	L premaxilla with I2-I3 alveoli		Crystal River	FL	Lafayette	unknown
FLMNH	114719	indet.	indet.	R dentary with roots of p4-m1	Pri	Crystal River	FL	Lafayette	unknown
FLMNH	115681	indet.	indet.	L upper M2	Eoc	Crystal River	FL	Lafayette	132702
FLMNH	115682	indet.	indet.	partial cheek tooth	Eoc	Crystal River	FL	Lafayette	132702
FLMNH	115683	indet.	indet.	partial cheek tooth	Eoc	Crystal River	FL	Lafayette	132702
FLMNH	115688	indet.	indet.	R upper cheek tooth	Eoc	Crystal River	FL	Dixie	132611
FLMNH	124694	indet.	indet.						unknown
FLMNH	129083	indet.	indet.	lower M1 or M2			FL	Jackson	132703
FLMNH	129088	indet.	indet.	lower M3			FL	Jackson	132703
FLMNH	132582	indet.	indet.	lower M2	Eoc	Harleyville	SC		32908
FLMNH	137601	indet.	indet.	cervical vertebra	Eoc	Crystal River	FL	Marion	60449
FLMNH	137604	indet.	indet.	partial rib	Eoc	Crystal River	FL	Marion	60449
FLMNH	137800	indet.	indet.	rib	Eoc	Crystal River	FL	Marion	60449
FLMNH	146396	indet.	indet.	partial tooth			FL	Levy	LV028
FLMNH	205701	indet.	indet.	vertebra			FL	Columbia	CO026E
FLMNH FGS V	2728	indet.	indet.						unknown
FLMNH FGS V	4089	indet.	indet.	huge rib					unknown
FLMNH FGS V	5233	indet.	indet.	partial rib			FL	Marion	MR000
FLMNH FGS V	3888-6132	indet.	indet.	vertebra	Pri	Crystal River	FL	Marion	57122
FLMNH TU	557	indet.	indet.						unknown
FLMNH V	2091	indet.	indet.	huge rib frag			MS	Yazoo	unknown
GCNHM VP	9938	indet.	indet.	shed incisiform deciduous tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	9939	indet.	indet.	shed incisiform deciduous tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	9940	indet.	indet.	shed incisiform deciduous tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	9941	indet.	indet.	partial premolar crown	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	9942	indet.	indet.	partial lower deciduous premolar	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	9943	indet.	indet.	partial lower? premolar crown	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	9944	indet.	indet.	large adult incisiform tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13314	indet.	indet.	broken incisiform tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13323	indet.	indet.	premolar crown fragment	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13324	indet.	indet.	posterior upper molar crown	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13325	indet.	indet.	central cusp of premolar crown	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13326	indet.	indet.	shed incisiform deciduous tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13327	indet.	indet.	shed deciduous P1/?	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13328	indet.	indet.	upper molar? roots	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13329	indet.	indet.	premolar crown fragment	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13330	indet.	indet.	shed incisiform deciduous tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13331	indet.	indet.	partial lower? premolar crown	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13332	indet.	indet.	shed incisiform deciduous tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13333	indet.	indet.	shed incisiform deciduous tooth	Pri	Clinchfield	GA	Wilkinson	45640
GCNHM VP	13334	indet.	indet.	shed deciduous premolar crown	Pri	Clinchfield	GA	Wilkinson	45640
GSM	169	indet.	indet.	LM/3?	Pri	Harleyville	SC	Dorchester	32908
GSM	170	indet.	indet.	LM/2	Pri	Harleyville	SC	Dorchester	32908
GSM	171	indet.	indet.	RM2/	Pri	Harleyville	SC	Dorchester	32908
GSM	172	indet.	indet.	RP3 or 4/?	Pri	Harleyville	SC	Dorchester	32908
GSM	173	indet.	indet.	missing from notes	Pri	Harleyville	SC	Dorchester	32908
GSM	174	indet.	indet.	RP2/?	Pri	Harleyville	SC	Dorchester	32908
GSM	175	indet.	indet.	LP1/?	Pri	Harleyville	SC	Dorchester	32908

Appendix 1 *continued*

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
GSM	176	indet.	indet.	I?	Pri	Harleyville	SC	Dorchester	32908
GSM	177	indet.	indet.	broken worn premolar	Pri	Harleyville	SC	Dorchester	32908
GSM	178	indet.	indet.	C?	Pri	Harleyville	SC	Dorchester	32908
GSM	180	indet.	indet.	vertebra	Pri	Harleyville	SC	Dorchester	32908
GSM	181	indet.	indet.	vertebra	Pri	Harleyville	SC	Dorchester	32908
GSM	182	indet.	indet.	partial vertebra	Pri	Harleyville	SC	Dorchester	32908
GSM	1344	indet.	indet.	L tympanic bulla	Pri	Harleyville	SC	Dorchester	32908
MB	28358	indet.	indet.	damaged upper premolar	Pri	Pachuta?	AL		unknown
MB	28359	indet.	indet.	partial worn premolar	Pri	Pachuta?	AL		unknown
MB	28361	indet.	indet.	upper molar	Pri	Pachuta?	AL		unknown
MB	28367	indet.	indet.	bone slide	Pri	Pachuta?	AL		unknown
MB	28372	indet.	indet.	damaged upper R premolar (P/4?)	Pri	Pachuta?	AL		unknown
MB	28375	indet.	indet.	4 bits of bulla & periotic	Pri	Pachuta?	AL		unknown
MB	28376	indet.	indet.	proximal rib frag	Pri	Pachuta?	AL		unknown
MB	28377	indet.	indet.	tooth root	Pri	Pachuta?	AL		unknown
MB	28378	indet.	indet.	tooth root	Pri	Pachuta?	AL		unknown
MB	28379	indet.	indet.	partial anterior tooth	Pri	Pachuta?	AL		unknown
MB	28380	indet.	indet.	distal rib frag	Pri	Pachuta?	AL		unknown
MB	28383	indet.	indet.	damaged atlas vertebra	Pri	Pachuta?	AL		unknown
MB	28385	indet.	indet.	beat up C7 vertebra	Pri	Pachuta?	AL		unknown
MB	28386	indet.	indet.	cast of a thoracic vertebra			AL?		unknown
MB	28387	indet.	indet.	cast of C7			AL?		unknown
MB	42347	indet.	indet.	badly preserved braincase			AL?		unknown
MB	42881	indet.	indet.	cast of a skull	Pri	Pachuta?	AL		unknown
MB	42886	indet.	indet.	humerus	Pri	Pachuta?	AL		unknown
MB	42887	indet.	indet.	humerus	Pri	Pachuta?	AL		unknown
MB	43229	indet.	indet.	partial vertebra	Pri	Pachuta?	AL		unknown
MB	43231	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43241	indet.	indet.	humerus	Pri	Pachuta?	AL		unknown
MB	43246	indet.	indet.	vertebra	Pri	Pachuta?	AL		unknown
MB	43249	indet.	indet.	caudal vertebra	Pri	Pachuta?	AL		unknown
MB	43250	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43251	indet.	indet.	partial atlas vertebra	Pri	Pachuta?	AL		unknown
MB	43252	indet.	indet.	cervical vertebra	Pri	Pachuta?	AL		unknown
MB	43253	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43254	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43255	indet.	indet.	2 vertebra fragments	Pri	Pachuta?	AL		unknown
MB	43256	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43257	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43258	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43259	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43260	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43261	indet.	indet.	vertebra	Pri	Pachuta?	AL		unknown
MB	43262	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MB	43263	indet.	indet.	vertebra	Pri	Pachuta?	AL		unknown
MB	43264	indet.	indet.	cast of neural canal	Pri	Pachuta?	AL		unknown
MB	43265	indet.	indet.	vertebra	Pri	Pachuta?	AL		unknown
MB	43266	indet.	indet.	vertebra	Pri	Pachuta?	AL		unknown
MB	43267	indet.	indet.	vertebra	Pri	Pachuta?	AL		unknown
MB	48112	indet.	indet.	anterior tooth and premolar			AL?		unknown

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
MB	48113	indet.	indet.	bulla, missing posterior end			AL?		unknown
MB	51302	indet.	indet.	rib	Pri	Pachuta?	AL		unknown
MB	51303	indet.	indet.	thoracic vertebra	Pri	Pachuta?	AL		unknown
MCZ	120	indet.	indet.	1 large canine, 1 dP1/?					unknown
MCZ	1716	indet.	indet.	bulla					unknown
MCZ	9005	indet.	indet.	bulla		Jackson	AL		unknown
MCZ	9692	indet.	indet.	3 incisors	Eoc	Jackson	AL		unknown
MCZ	16689	indet.	indet.	broken incisiform tooth			SC		unknown
MCZ	16690	indet.	indet.	broken incisiform tooth			SC		unknown
MCZ	16694	indet.	indet.	broken incisiform tooth			SC		unknown
MCZ	16695	indet.	indet.	broken incisiform tooth			SC		unknown
MMNS VP	200	indet.	indet.	skull frag, occipital portion	Eoc	Yazoo	MS	Clarke	45634
MMNS VP	285	indet.	indet.	tympanic bulla, right	Eoc	Moodys Branch	MS	Hinds	45639
MMNS VP	286	indet.	indet.	vertebra, thoracic	Eoc	Moodys Branch	MS	Hinds	45639
MMNS VP	399	indet.	indet.	vertebra, lumbar	Eoc	Yazoo	MS	Hinds	45639
MMNS VP	505	indet.	indet.	teeth, damaged, 5	Eoc	Moodys Branch	MS	Hinds	unknown
MMNS VP	612	indet.	indet.	centrum, lumbar	Eoc	Jackson	MS	Hinds	131912
MSC RMM	3093	indet.	indet.	2 thoracic vertebrae		Pachuta	AL	Washington	131914
NCSM	5612	indet.	indet.	auditory bulla		Castle Hayne	NC	New Hanover	7297
NCSM	11106	indet.	indet.	partial skeleton		Castle Hayne	NC	New Hanover	7297
NCSM	12532	indet.	indet.	patial skull		Castle Hayne	NC	Pender	75518
NCSM	15718	indet.	indet.	cervical vertebra 6		Castle Hayne	NC	Pender	75518
NHMUK M	8143	indet.	indet.	distal rib fragment	Eoc		AL		unknown
NHMUK M	23628	indet.	indet.	cast of lower premolar & incisor					unknown
NHMUK M	25443	indet.	indet.	cast of L dentary with roots of P/4	Eoc		AL		unknown
NHMUK M	25444	indet.	indet.	cast of erupting lower molar	Eoc		AL	Monroe	Claiborne
NHMUK M	25446	indet.	indet.	large incisiform tooth root	Eoc		AL		unknown
NHMUK M	25447	indet.	indet.	cast of a broken bulla	Eoc		AL		unknown
NHMUK M	25642	indet.	indet.	cast of anterior dentary P/1 root	Eoc		AL		unknown
NHMUK M	35596	indet.	indet.		Eoc		AL	Clarke	unknown
NHMUK M	35641	indet.	indet.	large incisiform tooth in bone	Eoc		AL	Clarke	unknown
NHMUK M	50387	indet.	indet.	thoracic vert.					unknown
NHMUK M	60000	indet.	indet.	lumbar vert.					unknown
TM	8502	indet.	indet.	vertebrae			AL		unknown
TM	8503	indet.	indet.	vertebrae			AL		unknown
TM	8504	indet.	indet.	vertebrae and ribs in block			AL		unknown
TM	8507	indet.	indet.	vertebrae			AL		unknown
TM	8508	indet.	indet.	vertebrae			AL		unknown
TM	8513	indet.	indet.	vertebrae in block			AL		unknown
TM	8516	indet.	indet.	manubrium, rather large			AL		unknown
TM	8517	indet.	indet.	vertebrae			AL		unknown
TM	8518	indet.	indet.	vertebrae			AL		unknown
TM	8519	indet.	indet.	vertebrae			AL		unknown
TM	8520	indet.	indet.	vertebrae			AL		unknown
TM	8525	indet.	indet.	vertebrae			AL		unknown
TM	8526	indet.	indet.	vertebrae			AL		unknown
TM	8527	indet.	indet.	vertebrae			AL		unknown
TM	8528	indet.	indet.	vertebrae			AL		unknown

Appendix 1 *continued*

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
TM	8529	indet.	indet.	vertebrae			AL		unknown
TM	8530	indet.	indet.	vertebrae			AL		unknown
TM	8531	indet.	indet.	vertebrae			AL		unknown
TM	8534	indet.	indet.				AL		unknown
TM	8535	indet.	indet.				AL		unknown
TM	8536	indet.	indet.	frontal			AL		unknown
TM	8537	indet.	indet.	atlas and axis?			AL		unknown
TM	8538	indet.	indet.	palate fragment			AL		unknown
TM	8539	indet.	indet.	sagittal crest/nuchal crest			AL		unknown
TM	8540	indet.	indet.	cast of inside of jaw			AL		unknown
TM	8541	indet.	indet.	?			AL		unknown
TM	8542	indet.	indet.	?			AL		unknown
TM	8543	indet.	indet.	?			AL		unknown
TM	8544	indet.	indet.	?			AL		unknown
TM	8545	indet.	indet.	?			AL		unknown
TM	8546	indet.	indet.	incisors			AL		unknown
TM	8547	indet.	indet.	?			AL		unknown
TM	8548	indet.	indet.	?			AL		unknown
TM	8549	indet.	indet.	?			AL		unknown
TM	8550	indet.	indet.	?			AL		unknown
TM	8551	indet.	indet.	?			AL		unknown
TM	8552	indet.	indet.	?			AL		unknown
TM	8554	indet.	indet.	sagittal crest			AL		unknown
TM	8556	indet.	indet.	vertebra			AL		unknown
TM	8557	indet.	indet.	vertebra			AL		unknown
TM	8561	indet.	indet.	?			AL		unknown
TM	8564	indet.	indet.	?			AL		unknown
TM	8567	indet.	indet.				AL		unknown
TM	8570	indet.	indet.	lower jaw?			AL		unknown
TM	8574	indet.	indet.	thoracic vertebrae			AL		unknown
TM	8575	indet.	indet.	thoracic vertebrae			AL		unknown
TM	8576	indet.	indet.	vertebra, vertebral fragments			AL		unknown
TM	8577	indet.	indet.	vertebra, vertebral fragments			AL		unknown
TM	8578	indet.	indet.	vertebra, vertebral fragments			AL		unknown
TM	8579	indet.	indet.	lumbar vertebra			AL		unknown
TM	8580	indet.	indet.	thoracic vertebra			AL		unknown
TM	8581	indet.	indet.	lumbar vertebra			AL		unknown
TM	8582	indet.	indet.	?			AL		unknown
TM	8583	indet.	indet.	?			AL		unknown
TM	8584	indet.	indet.	?			AL		unknown
TM	8585	indet.	indet.	?			AL		unknown
TM	8586	indet.	indet.	?			AL		unknown
TM	8587	indet.	indet.	glenoid of the scapula			AL		unknown
TM	8588	indet.	indet.	?			AL		unknown
TM	8589	indet.	indet.	radius fragment			AL		unknown
TM	8590	indet.	indet.	proximal ulna			AL		unknown
TM	8636	indet.	indet.	skull bone?			AL		unknown
TM	8846	indet.	indet.				AL		unknown
TM	18124	indet.	indet.				AL		unknown
TM	18129	indet.	indet.	vertebra			AL		unknown

Appendix 1 *continued*

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
TM	18131	indet.	indet.	distal humerus			AL		unknown
TM	18158	indet.	indet.	proximal radius			AL		unknown
TM	18163	indet.	indet.	mid-thoracic vertebra			AL		unknown
TM	18173	indet.	indet.	vertebra			AL		unknown
TM	18174	indet.	indet.	vertebra			AL		unknown
TM	18180	indet.	indet.	posterior thoracic vertebra			AL		unknown
TM	18192	indet.	indet.	block with ribs and vertebrae			AL		unknown
TM	18195	indet.	indet.	posterior R dentary and ribs			AL		unknown
TMM	43390-10	indet.	indet.	partial premolar	Pri	Clinchfield	GA	Wilkinson	45640
TMM	43595-1	indet.	indet.	deciduous premolar	Pri	Jackson	AR	St. Francis	16549
UAM PV	1989.0004.0154	indet.	indet.	vertebra	Eoc	Lisbon	AL	Choctaw	28983
USNM	1599	indet.	indet.	3 lumbar vertebrae	Eoc	Jackson	LA	Grant	32925
USNM	2333	indet.	indet.	cheek tooth	Eoc	Castle Hayne	NC	New Hanover	41822
USNM	4677	indet.	indet.	partial tympanic bulla	Eoc	Jackson	AL	Choctaw	28983
USNM	4680	indet.	indet.	L tympanic bulla	Eoc	Jackson	AL	Choctaw	124707
USNM	6087	indet.	indet.	partial skeleton	Eoc	Ocala	AL	Escambia	28986
USNM	6124	indet.	indet.	partial L tympanic bulla	Eoc	Jackson	AL	Choctaw	28983
USNM	6125	indet.	indet.	partial L tympanic bulla	Eoc	Jackson	AL	Choctaw	28983
USNM	10855	indet.	indet.	L periotic	Eoc		AL		unknown
USNM	10857	indet.	indet.	partial L periotic, stapes	Eoc	Jackson	AL	Choctaw	28983
USNM	11121	indet.	indet.	partial skull	Eoc	Ocala	FL	Marion	32916
USNM	11784	indet.	indet.	plaster cast of lumbar vertebra					unknown
USNM	12335	indet.	indet.	partial skeleton	Eoc	Jackson	AL	Choctaw	28983
USNM	12975	indet.	indet.	partial R periotic	Eoc	Jackson	AL	Choctaw	28983
USNM	13645	indet.	indet.	cervical vertebra	Eoc	Jackson	LA	Caldwell	75638
USNM	13773	indet.	indet.	partial skull with bulla & periotic	Eoc	Jackson	AL	Choctaw	28983
USNM	13883	indet.	indet.	lumbar vertebrae	Eoc		GA	Houston	132660
USNM	16640	indet.	indet.	vertebrae	Eoc	Jackson	AL		unknown
USNM	20660	indet.	indet.	lumbar vertebra	Eoc	Jackson	MS	Hinds	45639
USNM	214430	indet.	indet.	lumbar vertebra	Eoc	Castle Hayne	NC	Jones	60452
USNM	214433	indet.	indet.	partial L periotic	Eoc	Castle Hayne	NC	Jones	60452
USNM	214434	indet.	indet.	partial L periotic	Eoc	Castle Hayne	NC	Jones	60452
USNM	214435	indet.	indet.	partial humerus	Eoc	Castle Hayne	NC	Jones	60452
USNM	214923	indet.	indet.	incisor	Eoc	Castle Hayne	NC	New Hanover	7297
USNM	244043	indet.	indet.	partial tooth	Eoc	Castle Hayne	NC	Jones	60452
USNM	250316	indet.	indet.	partial lower jaw with teeth	Eoc	Castle Hayne	NC	Pender	32898
USNM	310635	indet.	indet.	tooth	Eoc	Castle Hayne	NC	Jones	60452
USNM	310647	indet.	indet.	2 teeth, casts	Eoc		SC	Dorchester	72046
USNM	310648	indet.	indet.	partial L lower jaw	Eoc	Jackson	MS	Rankin	132666
USNM	310650	indet.	indet.	skull element	Eoc	Jackson	AL	Clarke	124815
USNM	310651	indet.	indet.	partial rib	Eoc	Santee	SC	Dorchester	32908
USNM	310653	indet.	indet.	assorted deciduous teeth	Eoc	Jackson	MS	Clarke	132667
USNM	310654	indet.	indet.	premolar	Eoc	Jackson	MS	Jackson	unknown
USNM	310655	indet.	indet.	partial skull	Eoc	Jackson	AL	Choctaw	124707
USNM	310673	indet.	indet.	periotic	Eoc	Jackson	AL	Choctaw	124707
USNM	310674	indet.	indet.	tympanic bulla	Eoc	Jackson	AL	Choctaw	28983
USNM	310675	indet.	indet.	tooth	Eoc	Jackson	AL	Choctaw	86949
USNM	310676	indet.	indet.	partial maxilla	Eoc		SC		unknown
USNM	314765	indet.	indet.	partial tooth	Eoc	Castle Hayne	NC	New Hanover	5386
USNM	353513	indet.	indet.	partial tooth	Eoc	Castle Hayne	NC	Jones	60452

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
USNM	353514	indet.	indet.	partial tooth	Eoc	Castle Hayne	NC	Jones	60452
USNM	360561	indet.	indet.	partial tooth	Eoc	Castle Hayne	SC	Dorchester	72046
USNM	375679	indet.	indet.	partial tooth	Eoc	Castle Hayne	NC	Pitt	132701
USNM	392076	indet.	indet.	L M/1 or 2	Eoc	Castle Hayne	NC	Jones	60452
USNM	392077	indet.	indet.	canine?	Eoc	Castle Hayne	NC	Jones	60452
USNM	392079	indet.	indet.	partial adult premolar	Eoc	Castle Hayne	NC	Jones	60452
USNM	392080	indet.	indet.	partial adult premolar	Eoc	Castle Hayne	NC	Jones	60452
USNM	392081	indet.	indet.	upper R deciduous premolar	Eoc	Castle Hayne	NC	Jones	60452
USNM	392082	indet.	indet.	L M/1 or 2, very small	Eoc	Castle Hayne	NC	Jones	60452
USNM	392083	indet.	indet.	premolar	Eoc	Castle Hayne	NC	Jones	60452
USNM	449538	indet.	indet.	tympanic bulla	Eoc	Castle Hayne	NC	New Hanover	5386
USNM	449539	indet.	indet.	partial tympanic bulla	Eoc		NC	New Hanover	5459
USNM	449541	indet.	indet.	appendicular element	Eoc		NC		unknown
USNM	449542	indet.	indet.	tooth	Eoc	Castle Hayne	NC	Jones	60452
USNM	449551	indet.	indet.	partial mandible, cast	Eoc		SC	Charleston	unknown
USNM	457240	indet.	indet.	tooth	Eoc	Castle Hayne	NC	Pender	7299
USNM	460299	indet.	indet.	molar tooth, cast	Eoc	Crystal River	FL	Suwanee	132702
USNM	460300	indet.	indet.	molar tooth, cast	Eoc	Crystal River	FL	Jackson	132703
USNM	460301	indet.	indet.	molar tooth, cast	Eoc	Crystal River	FL	Jackson	132703
USNM	460371	indet.	indet.	molar tooth, cast	Eoc	Crystal River	FL	Jackson	132703
USNM	482349	indet.	indet.	partial skeleton	Eoc	Cross	SC	Dorchester	32908
USNM	510801	indet.	indet.	posterior thoracic vertebra	Eoc	Harleyville	SC	Dorchester	72046
USNM	510802	indet.	indet.	2 thoracic vertebrae	Eoc	Harleyville	SC	Dorchester	72046
USNM	510803	indet.	indet.	tooth & bone fragments	Eoc	Castle Hayne	NC	Northampton	133023
USNM	510805	indet.	indet.	partial thoracic vertebra	Eoc	Twiggs Clay?	GA	Wilkinson	133024
USNM	510806	indet.	indet.	posterior portion of premolar	Eoc	Harleyville	SC	Dorchester	72046
USNM	510807	indet.	indet.	partial deciduous premolar	Eoc	Harleyville	SC	Dorchester	72046
USNM	510808	indet.	indet.	posterior portion of premolar	Eoc	Harleyville	SC	Dorchester	72046
USNM	510809	indet.	indet.	partial thoracic vertebra, rib, etc.	Eoc	Harleyville	SC	Dorchester	72046
USNM	510810	indet.	indet.	distal rib	Eoc	Pregnall	SC	Dorchester	32908
USNM	510812	indet.	indet.	anterior caudal vertebra	Eoc	Harleyville	SC	Dorchester	72046
USNM	510813	indet.	indet.	partial vertebra	Eoc	Harleyville	SC	Dorchester	72046
USNM	510815	indet.	indet.	mesosternal element	Eoc	Santee	SC	Orangeburg	122725
USNM	510816	indet.	indet.	cervical vertebra	Eoc	Pregnall	SC	Dorchester	32908
USNM	510817	indet.	indet.	posterior half of LM1/?	Eoc	Harleyville	SC	Dorchester	72046
USNM	510818	indet.	indet.	proximal rib	Eoc	Harleyville	SC	Dorchester	72046
USNM	510822	indet.	indet.	partial bulla	Eoc	Harleyville	SC	Dorchester	72046
USNM	510823	indet.	indet.	lumbar vertebra	Eoc	Pregnall	SC	Dorchester	32908
USNM	510824	indet.	indet.	bone fragments	Eoc	Santee	SC	Dorchester	72046
USNM	510826	indet.	indet.	bone fragments	Eoc	Santee	SC	Dorchester	72046
USNM	526579	indet.	indet.	RM1/?	Eoc	Santee	SC	Dorchester	32908
USNM	526580	indet.	indet.		Eoc	Santee	SC	Dorchester	72046
USNM	526581	indet.	indet.	lumbar vertebra	Eoc		GA	Houston	132660
USNM	526582	indet.	indet.	incisor	Eoc	Castle Hayne	NC	Onslow	unknown
USNM	526584	indet.	indet.	R tympanic bulla	Eoc	Cross	SC	Dorchester	32908
USNM	526586	indet.	indet.	cervical vertebra	Eoc	Santee	SC	Dorchester	72046
USNM	526587	indet.	indet.	mesosternal element	Eoc	Cross	SC	Dorchester	32908
USNM	526588	indet.	indet.	vertebrae fragments	Eoc	Santee	SC	Orangeburg	122725
USNM	526589	indet.	indet.	lumbar vertebra	Eoc	Santee	SC	Orangeburg	122725
USNM	526590	indet.	indet.	incisor	Eoc	Santee	SC	Orangeburg	122725
USNM	526591	indet.	indet.	fragmentary skeleton and teeth	Eoc	Santee	SC	Orangeburg	122725

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
USNM	529281	indet.	indet.	shed deciduous incisor	Eoc	Cross	SC	Dorchester	32908
YPM	1745	indet.	indet.	thoracic or lumbar centrum	Eoc		AL		unknown
YPM	10498	indet.	indet.	4 verts, 1 rib	Eoc		MS	Jackson	46639
AMNH FM	39376	*Zygorhiza*	*kochii*				AL	Choctaw	28983
ANSP	9945	*Zygorhiza*	*kochii*	P1?	Eoc		AL		unknown
AUMP	2368	*Zygorhiza*	*kochii*	skull and partial skeleton	Pri	Pachuta	AL	Clarke	45637
CCNHM	109	*Zygorhiza*	*kochii*	this is a cast of USNM 11962.					unknown
ChM PV	5065	*Zygorhiza*	*kochii*	periotic	Pri	Cross (upper)	SC	Dorchester	32908
FMNH PM	170	*Zygorhiza*	*kochii*	L & R dentaries with teeth		Pachuta	AL	Choctaw	28983
FMNH PM	459	*Zygorhiza*	*kochii*	partial skull and skeleton	Pri	Pachuta	AL	Choctaw	28983
GSM	179	*Zygorhiza*	*kochii*	vertebra	Pri	Harleyville	SC	Dorchester	32908
LACM	25178	*Zygorhiza*	*kochii*	skull + vertebra	Pri	Yazoo	MS	Scott	55869
LSUMG V	160	*Zygorhiza*	*kochii*	skull and partial skeleton	Eoc	Pachuta	AL	Choctaw	28983
LSUMG VL	214	*Zygorhiza*	*kochii*	R lower deciduous premolar	Pri	Tullos	LA	Grant	32925
MB	28347	*Zygorhiza*	*kochii*	premolar	Pri	Pachuta?	AL		unknown
MB	28371	*Zygorhiza*	*kochii*	upper R P2/?	Pri	Pachuta?	AL		unknown
MB	28384	*Zygorhiza*	*kochii*	atlas	Pri	Pachuta?	AL		unknown
MB	42888	*Zygorhiza*	*kochii*	humerus	Pri	Pachuta?	AL		unknown
MB	43243	*Zygorhiza*	*kochii*	5 thoracic verts	Pri	Pachuta?	AL		unknown
MB	43247	*Zygorhiza*	*kochii*	braincase	Pri	Pachuta?	AL		unknown
MB	43248	*Zygorhiza*	*kochii*	posterior portion of a skull	Pri	Pachuta?	AL		84754
MMNS VP	398	*Zygorhiza*	*kochii*	fragmentary skeleton	Eoc	Yazoo	MS	Hinds	45639
MSC	9508	*Zygorhiza*	*kochii*	partial cranium		Tallahatta?	AL	Conecuh	131909
MSC RMM	2739	*Zygorhiza*	*kochii*	skull, dentaries & lumbar verts		Pachuta	AL	Clarke	131910
NHMUK M	3543	*Zygorhiza*	*kochii*	cast of R humerus			AL	Monroe	unknown
TM	8501	*Zygorhiza*	*kochii*	partial skeleton			AL		124707
UAM PV	1985.0035.0001	*Zygorhiza*	*kochii*	vertebra	Eoc				unknown
UAM PV	1985.0072.0025	*Zygorhiza*	*kochii*	6 rib fragments, 1 vertebra	Eoc		AL		unknown
UAM PV	1985.0072.0043.004	*Zygorhiza*	*kochii*	1 tooth	Eoc		AL		unknown
UAM PV	1989.0004.0099	*Zygorhiza*	*kochii*	tooth	Pri	Pachuta	AL	Choctaw	28983
UAM PV	1989.0004.0162.001	*Zygorhiza*	*kochii*	tooth	Eoc	Lisbon	AL	Choctaw	28983
UAM PV	2000.0001.0001	*Zygorhiza*	*kochii*	partial skull & skeleton	Pri	Pachuta	AL	Choctaw	28983
UAM PV	2000.0001.0002.001	*Zygorhiza*	*kochii*	periotic	Eoc	Pachuta	AL	Choctaw	28983
UAM PV	2000.0001.0009.001	*Zygorhiza*	*kochii*	four bone fragments (premaxilla)	Eoc	Pachuta	AL	Choctaw	28983
UAM PV	2000.0001.0012.001	*Zygorhiza*	*kochii*	tympanic bulla and fragments	Eoc	Pachuta	AL	Choctaw	28983
UAM PV	2000.0001.0025.001	*Zygorhiza*	*kochii*	humerus fragments	Eoc	Pachuta	AL	Choctaw	28983
UAM PV	2000.0001.0028.1	*Zygorhiza*	*kochii*	one vertebra fragment	Eoc	Pachuta	AL	Choctaw	28983
USNM	4673	*Zygorhiza*	*kochii*	partial skeleton	Eoc	Jackson	AL	Choctaw	28983
USNM	4678	*Zygorhiza*	*kochii*	partial skeleton	Eoc	Jackson	AL	Choctaw	45637
USNM	4679	*Zygorhiza*	*kochii*	partial skeleton	Eoc	Jackson	AL	Choctaw	28983
USNM	4748	*Zygorhiza*	*kochii*	partial skeleton	Eoc	Jackson	AL	Choctaw	28983
USNM	5943	*Zygorhiza*	*kochii*	skull, cast	Eoc		AL	Choctaw	124707
USNM	11962	*Zygorhiza*	*kochii*	partial skeleton	Eoc	Jackson	AL	Choctaw	28983
USNM	12063	*Zygorhiza*	*kochii*	partial skeleton	Eoc	Jackson	AL	Choctaw	28983
USNM	16638	*Zygorhiza*	*kochii*	skull and partial skeleton	Eoc	Jackson	MS	Hinds	45639
USNM	16639	*Zygorhiza*	*kochii*	skull and partial skeleton	Eoc	Jackson	AL	Choctaw	28983
MB	28370	*Zygorhiza*	*kochii?*	anterior tooth	Pri	Pachuta?	AL		unknown
NHMUK M	35593	*Zygorhiza*	sp.	P/2?	Eoc		AL	Clarke	unknown
NHMUK M	35594	*Zygorhiza*	sp.	P/3 or P/4?	Eoc		AL	Clarke	unknown
NHMUK M	35595	*Zygorhiza*	sp.	posterior half of lower molar	Eoc		AL	Clarke	unknown

Appendix 1 ***continued***

Museum	Specimen Number	Genus	Species	Specimen	Age	Horizon	State	County	PaleoDB
NHMUK M	40985	*Zygorhiza*	sp.	posterior thoracic vertebra					unknown
UAM FM	98069	*Zygorhiza*	sp.		Eoc		AL?		unknown
MB	28363	*Zygorhiza?*	*kochii?*	bulla missing posterior end	Pri	Pachuta?	AL		unknown

Appendix 2. Data matrix of 108 morphological characters used in the phylogenetic analysis, based on Geisler et al. (2005) and Uhen et al. (2011). The first row represents the sequential character number, the second row the brief character description. A full list of character descriptions and character state descriptions can be found in Appendix 1 of Geisler et al. (2005) and Uhen et al. (2011). Character 108 of Uhen et al. (2011) was eliminated from the matrix.

	1	2	3	4	5	6	7	8	9	10
	premaxillae	palatine fis-sures	skull length	anterior margin of external nares	posterior margin of external nares	palate	palatal pro-cess of the premaxilla	ascending process of the premaxilla	embrasure pits I1 to I3	embrasure pit C/I3
Sus scrofa	1	0	0	0	0	1	0	3	0	0
Hippopotamus	0	0	0	1&2	1	1	2	2	0	0
Pakicetidae	1	0	?	0	1	0	?	?	0	0
Ambulocetus	?	?	?	?	?	?	?	?	?	7
Rodhocetus	1	1	0&1	2	1	?	0	2	0	1
Remingtonocetus	1	1	2	1&2	1	2	?	0	1	1
Dalanistes	1	1	2	1	1	2	0	?	0	1
Gaviacetus	?	?	?	1&2&3	?	0	?	0&1&2	?	?
Carolinacetus	1	1	?	2	1	?	1	0	0	1
Protocetus	1	?	2	3	2	1	1	2	?	1
Georgiacetus	1	1	1	2	3	1	3	3	0	1
Babiacetus	1	?	?	3	3	1	2	3	?	1
Basilosaurus	1	1	2	3	4	1	3	3	1	2
Dorudon	1	1	1	3	3	1	2	3	1	2
Basilotritus	1	?	?	?	?	?	?	?	1	?
Eocetus	1	1	1&2	3	3	?	3	3	0	2
Artiocetus	1	1	1	2	1	1	1	1	0	0
Qaisracetus	1	1	-	3	1	1	2	2	0	2
Maiacetus	1	?	?	?	1	?	?	1	?	?
MUSM 1443	?	?	?	?	?	?	?	?	?	?
Supayacetus	?	?	?	?	?	?	?	?	?	?
Ocucajea	1	?	?	?	?	?	?	?	?	?
Saghacetus	1	1	2	3	3	1	?	3	1	2
Zygorhiza	1	1	1	3	4	1	3	3	1	2
Ancalecetus	?	?	?	?	?	?	?	?	?	?
Cynthiacetus	1	1	2	3	1	1	2	3	1	2
Chrysocetus	1	?	?	?	?	?	?	?	1	2

Appendix 2 ***continued***

	11	12	13	14	15	16	17	18	19	20
	embrasure pit P1/C1	**embrasure pits between upper cheekteeth**	**rostrum breadth at canine**	**palate nar-rows at :**	**nasal process of frontal**	**supraorbital process**	**orbit size**	**orbit posi-tion**	**anterior edge of orbit**	**posterior edge of postorbital process**
Sus scrofa	0	0	1	0	0	0	1	0	0	0
Hippopotamus	0	0	2	0	0	2	1	0	2	0
Pakicetidae	?	0	?	0&1	0&1	0	?	0	?	0
Ambulocetus	?	1	?	?	?	0	1	0	0	0
Rodhocetus	0	1	0	?	1	2	1	1	2	1
Remingtonocetus	3	1	0	0	1	0	0	1	0	0
Dalanistes	3	1	0	1	?	0	0	1	0	?
Gaviacetus	?	1	0	2	1	3	1	1	0&1	1
Carolinacetus	2	?	?	?	?	2&3	1	?	?	1
Protocetus	1	1	1	2	?	3	?	1	1	1
Georgiacetus	2	1	1	1	1	2	1	1	1	1
Babiacetus	3	1	?	1	2	2&3	1	1	0	2
Basilosaurus	3	1	1	4	2	3	1	1	3	2
Dorudon	3	1	1	4	2	3	1	1	3	2
Basilotritus	?	?	?	?	?	?	?	?	?	?
Eocetus	3	1	1	2&3	?	2&3	1	1	?	?
Artiocetus	?	1	1	1	1	1	1	1	1	1
Qaisracetus	1	1	1	2	1	2	1	1	2	1
Maiacetus	?	?	?	?	1	?	?	1	0	1
MUSM 1443	?	?	?	?	?	?	?	?	?	?
Supayacetus	?	?	?	?	?	?	?	?	?	?
Ocucajea	?	?	?	?	0	?	?	1	?	2
Saghacetus	3	1	1	4	1	3	1	1	2	2
Zygorhiza	3	1	1	4	0	3	1	1	2	2
Ancalecetus	?	?	?	4	1	?	?	?	?	?
Cynthiacetus	3	1	1	4	1	3	1	1	2	2
Chrysocetus	3	?	?	?	?	?	?	?	?	?

Appendix 2 ***continued***

	21	22	23	24	25	26	27	28	29	30
	foramen rotundum	**alisphenoid canal**	**foramen ovale**	**pterygoid sinus**	**preglenoid process**	**postgelnoid foramen**	**basioccipi-tal crests**	**external auditory meatus**	**lateral extent of exoccipital in ventral view**	**hypoglossal foramen**
Sus scrofa	1	1	3	0	0	2	0	4	1	1
Hippopotamus	1	1	3	0	0	2	0	4	?	0
Pakicetidae	1	1	2	0	0	1	0	3	1	1
Ambulocetus	?	?	?	?	0	?	0	3&4	?	1
Rodhocetus	?	?	?	0&1	?	?	1	1	1	?
Remingtonocetus	1	1	0&2	0	0	1	2	1	?	?
Dalanistes	?	?	?	?	0	1&2	1	1	1	?
Gaviacetus	1	1	2	1	0	1	1	3	1	1
Carolinacetus	?	?	1	?	0	1	1	4	1	1
Protocetus	1	1	1	2	0	1	1	3	1	1
Georgiacetus	1	1	1	2	0	1	1	3	1	1
Babiacetus	1	?	?	2	0	?	?	3&4	0	?
Basilosaurus	?	?	?	3	0	1	1	2	0	1
Dorudon	1	1	3	3	0	1	1	2	0	1
Basilotritus	?	?	?	?	?	?	?	?	?	?
Eocetus	?	?	?	?	0	?	?	?	?	?
Artiocetus	?	1	2	1	0	1&2	1	1	0	1
Qaisracetus	1	?	2	0	?	0&1	1	?	0	1
Maiacetus	?	?	?	?	0	?	?	2	?	?
MUSM 1443	?	?	?	?	?	?	?	?	?	?
Supayacetus	?	?	?	?	?	?	?	?	?	?
Ocucajea	?	?	?	?	?	?	?	?	?	?
Saghacetus	?	?	?	3	0	1	1	2	0	1
Zygorhiza	1	1	3	3	0	1	1	2	0	1
Ancalecetus	?	?	3	3	0	1	1	2	0	1
Cynthiacetus	1	1	?	3	0	1	1	2	0	?
Chrysocetus	?	?	?	?	?	?	?	?	?	?

Appendix 2 ***continued***

	31	32	33	34	35	36	37	38	39	40
	nuchal crests	**orientation of supra-occipital shield**	**cerebellar rete**	**nuchal tubercles**	**exoccipital in posterior view**	**fossa for insertion of rectus capitus lateralis**	**fan-shaped fossa on exoccipital dorsal to paroccipital process**	**dorsoventral row of muscular fossae on lateral edge of exoccipital**	**size of tegmen tympani**	**anterior extension of tegmen tympani**
Sus scrofa	1	1	0	1	1	0	0	0	0	0
Hippopotamus	0	0	0	0	1	?	?	?	1	0
Pakicetidae	0	0	0	1	1	1	1	0	?	1
Ambulocetus	?	?	?	1	?	?	?	?	?	?
Rodhocetus	?	?	?	1	1	2	1	0	?	?
Remingtonocetus	2	0	?	1	?	?	?	?	1	1
Dalanistes	0	1	1	1	1	2	0	0	?	?
Gaviacetus	2	0	1&2	1	1	2	1	1	?	?
Carolinacetus	2	0	2	1	1	2	1	1	1	1
Protocetus	2	0	?	0	1	1&2	1	?	?	1
Georgiacetus	2	0	?	1	1	2	1	1	?	1
Babiacetus	?	?	?	?	1	2	1	0	?	?
Basilosaurus	2	1	3	0	1	0	0	0	1	1
Dorudon	2	1	3	1	1	0	0	0	1	1
Basilotritus	?	?	?	?	?	?	?	?	?	?
Eocetus	2	0	?	?	?	?	?	?	?	?
Artiocetus	2	0	?	1	1	2	1	?	?	1
Qaisracetus	2	0	?	1	1	1	1	?	?	1
Maiacetus	2	0	?	?	?	?	?	?	?	?
MUSM 1443	2	1	?	?	?	1	?	?	?	?
Supayacetus	?	?	?	?	?	?	?	?	?	?
Ocucajea	2	1	?	1	?	?	?	?	?	?
Saghacetus	2	1	3	?	1	?	?	?	1	1
Zygorhiza	2	1	?	0	1	0	0	0	1	1
Ancalecetus	2	1	3	1	1	0	0	0	1	1
Cynthiacetus	2	1	?	1	1	0	?	?	?	?
Chrysocetus	2	1	?	?	?	?	?	?	?	?

Appendix 2 ***continued***

	41	42	43	44	45	46	47	48	49	50
	anterior process of petrosal	**epitympanic recess**	**hiatus epi-tympanicus**	**transprom-ontorial sulcus for internal carotid**	**fossa for tensor tympani**	**articulation of pars cochlearis with basi-sphenoid/ basioccip-ital**	**edge of internal acoustic meatus**	**lambdoidal exposure of mastoid process of petrosal**	**stylomastoid foramen**	**ectotympanic**
Sus scrofa	-	0	0	0	1	1	0	1	1	0
Hippopotamus	-	?	?	0	?	1	0	1	1	0
Pakicetidae	1	1	?	0	1	0	0	1	1	0
Ambulocetus	?	?	?	?	?	?	?	?	?	?
Rodhocetus	?	?	?	?	?	1	?	1	0	?
Remingtonocetus	1	1	?	0	1	1	1	1	?	?
Dalanistes	?	?	?	?	?	1	?	1	0	?
Gaviacetus	?	?	?	?	?	1	?	1	0	1
Carolinacetus	1	1	1	0	1	1	1	1	0	1
Protocetus	1	1	?	0	1	1	1	1	0	?
Georgiacetus	1	1	?	0	1	1	1	1	0	1
Babiacetus	?	?	?	?	?	1	?	1	0	?
Basilosaurus	0	1	1	0	2	1	0	1	0	1
Dorudon	0	1	1	0	2	1	0	1	0	1
Basilotritus	?	?	?	?	?	?	?	?	?	?
Eocetus	?	?	?	?	?	?	?	?	?	?
Artiocetus	?	1	?	?	0&1	1	1	1	0	1
Qaisracetus	?	?	?	0	1	1	?	1	?	1
Maiacetus	?	?	?	?	?	?	?	?	?	?
MUSM 1443	?	?	?	?	?	?	?	?	?	?
Supayacetus	?	?	?	?	?	?	?	?	?	?
Ocucajea	?	?	?	?	?	?	?	?	?	?
Saghacetus	0	1	1	0	2	1	0	1	0	1
Zygorhiza	0	1	1	0	2	1	0	1	0	1
Ancalecetus	0	1	1	0	2	1	0	1	0	1
Cynthiacetus	?	?	?	?	?	?	?	?	?	?
Chrysocetus	?	?	?	?	?	?	?	?	?	?

Appendix 2 *continued*

	51	52	53	54	55	56	57	58	59	60
	involucrum of bulla	**position of external opening of the eustachian tube**	**meatal portion of ectotympanic**	**sigmoid process**	**tip of sigmoid process**	**lateral furrow of tympanic**	**median furrow of tympanic**	**medial eminence of tympanic**	**base of posteror process of tympanic**	**entoglenoid process**
Sus scrofa	0	0	1	1&2	?	0	1	0	-	0
Hippopotamus	0	0	1	1&2	?	0	0&1	-	0	3
Pakicetidae	1	1	0	1	0	0	1	0	0	1
Ambulocetus	1	?	?	?	?	?	0&1	?	?	?
Rodhocetus	?	1	0	1&2	?	?	3	?	?	1
Remingtonocetus	1	0	0	2	?	1	3	0	?	1
Dalanistes	1	1	0	2	1	1	3	1	?	1
Gaviacetus	1	1	0	2	1	1	3	1	1	1
Carolinacetus	1	1	0	?	?	1	3	1	1	1
Protocetus	1	1	0	2	0	1	3	1	1	1
Georgiacetus	1	1	0	2	1	1	3	1	1	1
Babiacetus	?	?	0	1&2	1	1	2&3	1	1	1
Basilosaurus	1	0	0	2	1	1	2	1	1	2
Dorudon	1	0	0	2	1	1	2	1	1	2
Basilotritus	1	0	0	2	1	1	1	1	1	?
Eocetus	?	?	?	?	?	?	?	?	?	?
Artiocetus	1	1	0	2	-	1	3	1	0	1
Qaisracetus	1	1	0	2	-	1	3	1	0	?
Maiacetus	1	?	0	2	?	1	3	?	?	?
MUSM 1443	?	?	?	?	?	?	?	?	?	?
Supayacetus	1	1	?	2	1	1	2	?	?	?
Ocucajea	?	?	?	?	?	?	?	?	?	?
Saghacetus	1	0	0	2	1	1	2	1	?	2
Zygorhiza	1	0	0	2	1	1	2	1	?	2
Ancalecetus	1	0	0	2	1	1	2	1	1	2
Cynthiacetus	?	?	?	?	?	1	2	1	?	?
Chrysocetus	?	?	?	?	?	1	2	1	?	?

Appendix 2 *continued*

	61	62	63	64	65	66	67	68	69	70
	articulation of anterior part of tympanic ring or bulla to tegmen tympani of petrosal	**articulation of media ledge of the tympanic bulla with basioccipital**	**contact between ectotympanic and mastoid process of petrosal**	**posterior edge of tympanic**	**incisors**	**P1 and p1**	**accessory cusps on posterior premolars and molars**	**p1 roots**	**P1 roots**	**P3 length**
Sus scrofa	1	2	-	?	0	0	-	-	?	?
Hippopotamus	?	2	1	1	0	0	0	0	0	2
Pakicetidae	0	0	2	1	1	0	0	1	1	2
Ambulocetus	?	?	?	?	?	?	0	?	?	?
Rodhocetus	?	?	2	1	1	0	0	2	0	?
Remingtonocetus	?	?	2	1	1	?	0	2	0	1
Dalanistes	?	?	2	1	1	0	?	?	0	1
Gaviacetus	0&1	1	2	1	1	0	0	1	?	2
Carolinacetus	?	1&2	2	1	1	0	0	?	?	?
Protocetus	1	1	2	1	?	0	0	?	?	2
Georgiacetus	1	2	2	1	1	0	1	2	1	2
Babiacetus	?	?	2	1	1	1	0	2	?	2
Basilosaurus	2	2	2	0	1	1	2	2	1	2
Dorudon	2	2	2	0	1	1	2	2	0&1	2
Basilotritus	?	?	?	?	?	?	?	?	?	?
Eocetus	?	?	?	?	1	1	0	?	?	?
Artiocetus	1	1	2	1	1	0	0	1	0	2
Qaisracetus	1&2	?	?	?	?	0	0	?	0	2
Maiacetus	?	?	?	?	1	1	0	?	0	?
MUSM 1443	?	?	?	?	?	?	?	?	?	?
Supayacetus	?	?	?	?	?	?	2	?	?	?
Ocucajea	?	?	?	?	?	?	2	?	?	?
Saghacetus	2	2	2	0	1	1	2	1	1	2
Zygorhiza	2	2	2	0	1	1	2	2	1	2
Ancalecetus	2	2	2	?	?	?	2	2	?	2
Cynthiacetus	?	?	?	0	1	1	2	2	1	2
Chrysocetus	?	?	?	?	1	1	2	?	0	?

Appendix 2 ***continued***

	71	72	73	74	75	76	77	78	79	80
	paraconid on lower molars	**carnassial notch on lower molars**	**trigonid of molars**	**talonid of m1 and m2**	**M1 and M2 protocone**	**M1 roots**	**M2 roots**	**M3**	**M3 roots**	**mandibular symphysis position termination**
Sus scrofa	1	0	0	0	0	0	0	0	0	0
Hippopotamus	2	0	0	1	0	0&1	0&1	1	0&1	3
Pakicetidae	1	0	0	1	0	1	1	1	1	1
Ambulocetus	?	?	0	1	0	1	1	1	0&1	?
Rodhocetus	2	1	1	1	?	?	1	1	1	1
Remingtonocetus	2	0	-	0	2	2&3	2&3	2	2&3	4
Dalanistes	?	?	-	?	2	1	2	1	3	3
Gaviacetus	?	?	?	?	?	1	1	?	?	?
Carolinacetus	2	1	1	1	?	?	?	?	?	?
Protocetus	?	?	?	?	1&2	1	1	2	2	?
Georgiacetus	2	1	1	1	1	2	2	1	2	3
Babiacetus	2	1	1	1	2	1&2	1&2	1	1&2	2
Basilosaurus	2	1	-	1	2	3	3	3	?	1
Dorudon	2	1	-	1	2	3	3	3	?	1
Basilotritus	?	?	?	?	?	?	?	?	?	?
Eocetus	?	?	?	?	?	?	?	?	?	?
Artiocetus	?	?	?	?	0	?	1&2	?	?	?
Qaisracetus	?	?	?	?	1&2	1	1	2	1	?
Maiacetus	2	1	?	?	0&1	?	?	?	?	1
MUSM 1443	?	?	?	?	?	?	?	?	?	?
Supayacetus	?	?	?	?	?	?	?	?	?	0
Ocucajea	?	?	?	?	?	3	3	?	?	?
Saghacetus	2	1	?	1	2	3	3	3	?	1
Zygorhiza	2	1	?	1	2	3	3	3	?	1
Ancalecetus	2	1	?	1	2	3	?	3	?	1
Cynthiacetus	2	1	1	1	2	3	3	?	?	1
Chrysocetus	2	1	?	1	?	?	?	?	?	?

Appendix 2 ***continued***

	81	82	83	84	85	86	87	88	89	90
	mandibular symphysis	**mandibular foramen size**	**surface texture of posterior tho-racic and post-thoracic vertebrae**	**hypophysis of axis in ventral view**	**articulation faces on atlas for the axis**	**vertebral canal in axis**	**cervical vertebrae**	**number of thoracics**	**spinous processes of T6 and T7**	**number of lumbars**
Sus scrofa	1	0	0	0	?	0	0	3&4	0	0&1
Hippopotamus	1	0	0	?	?	?	0	0	0	0
Pakicetidae	0	0	0	?	0	?	0	?	0	?
Ambulocetus	?	?	0	?	?	?	?	4	0	2
Rodhocetus	0	1	0	0	1	0	1	2	0	1
Remingtonocetus	1	?	0	0	1	0	0	?	?	?
Dalanistes	0	?	0	?	?	?	0	?	?	?
Gaviacetus	0	1	0	?	?	?	?	?	?	?
Carolinacetus	0	1	0	0	1	0	1	1&2&3	0	?
Protocetus	?	?	0	0	0	0	?	1&2	?	2&3
Georgiacetus	0	1	0	?	?	?	?	2	0	3
Babiacetus	1	1	?	?	?	?	?	?	?	?
Basilosaurus	0	1	0	1	1	1	1	4	1	3
Dorudon	0	1	0	1	1	1	1	4	1	3
Basilotritus	?	?	1	?	?	?	1	1	0	?
Eocetus	?	?	1	?	?	?	?	?	?	?
Artiocetus	0	1	?	?	?	?	?	?	?	?
Qaisracetus	?	?	0	?	?	?	?	2	0	0
Maiacetus	1	1	0	?	?	?	1	2	0	0
MUSM 1443	?	?	1	?	?	?	1	1	0	3
Supayacetus	0	?	0	?	?	?	1	?	?	?
Ocucajea	?	?	?	?	?	?	?	?	?	?
Saghacetus	0	1	0	1	1	1	1	4	1	?
Zygorhiza	0	1	0	1	1	1	1	4	1	3
Ancalecetus	0	1	0	1	1	1	1	?	1	?
Cynthiacetus	-	1	0	1	1	1	1	4	1	3
Chrysocetus	?	1	?	1	1	1	1	?	1	?

Appendix 2 ***continued***

	91	92	93	94	95	96	97	98	99	100
	length of pose-rior lumbar or anterior sacral vertebrae	**lumbar zygapophyses**	**articulation between sacral vertebrae and illium**	**number of vertebrae fused to form sacrum**	**transverse processes of sacral vertebrae**	**number of post-lumbar vertebrae articulating via pleurapophyses**	**first five ribs**	**radius**	**olecranon process**	**distal end of ulna**
Sus scrofa	0&1	0	0	0	0	0&1	0	0	1	0
Hippopotamus	?	?	0	4	0	0&1	0	0	0	0
Pakicetidae	?	0	0	3	0	1	?	0	1	?
Ambulocetus	1	1	0	3	0	1	0	0	1	0
Rodhocetus	1	1	0	0	?	?	0	0	1	1
Remingtonocetus	0	?	0	3	0	1	?	?	?	?
Dalanistes	0	?	0	3	0	1	?	?	?	?
Gaviacetus	?	?	0	0	0	4	0	?	?	?
Carolinacetus	?	?	?	?	?	?	0	?	?	?
Protocetus	1	2	0	0	1	4	0	?	?	?
Georgiacetus	2	2	1	0	1	4	0	?	?	?
Babiacetus	?	?	?	?	?	?	?	?	?	?
Basilosaurus	3	2	1	0	1	4	1	1	1	1
Dorudon	1	2	1	0	1	4	1	1	1	1
Basilotritus	3	2	?	?	1	-	0	?	?	?
Eocetus	3	?	?	?	?	-	?	?	?	?
Artiocetus	?	?	?	?	?	?	?	0	?	?
Qaisracetus	1	1	0	1	1	2	0	?	?	?
Maiacetus	?	2	0	3	1	1	?	0	1	1
MUSM 1443	3	2	?	?	?	?	0	?	?	?
Supayacetus	?	?	?	?	?	?	0	?	?	?
Ocucajea	?	?	?	?	?	?	?	?	?	?
Saghacetus	?	2	?	?	?	?	?	?	?	?
Zygorhiza	1	2	1	0	?	4	1	1	1	1
Ancalecetus	?	?	?	?	?	?	0	1	1	1
Cynthiacetus	1	2	1	?	?	?	1	1	1	1
Chrysocetus	1	2	1	?	?	?	1	1	1	1

Appendix 2 ***continued***

	101	102	103	104	105	106	107	108
	trapezoid and magnum	**distal carpal articular surfaces**	**pelvis size**	**obturator foramen**	**dorsal edge of acetabulum**	**ventromedial expansion of pubis ventromedial to obturator foramen**	**femur**	**sternum form**
Sus scrofa	0	0	0	0	0	0	0	2
Hippopotamus	0	0	0	0	0	0&1	0	2
Pakicetidae	?	?	0	0	0	0	0	?
Ambulocetus	0	0	0	0	0	0	0	?
Rodhocetus	0	0	0	0	0	0	1	0
Remingtonocetus	?	?	?	?	?	?	?	?
Dalanistes	?	?	0	0	0	0&1	0	?
Gaviacetus	?	?	?	?	?	?	?	?
Carolinacetus	?	?	?	?	?	?	?	?
Protocetus	?	?	0	?	?	?	?	?
Georgiacetus	?	?	0	0	0	1	?	0
Babiacetus	?	?	?	?	?	?	?	?
Basilosaurus	1	1	1	1	1	2	2	1
Dorudon	1	1	?	?	?	?	?	1
Basilotritus	?	?	?	?	1	?	?	0
Eocetus	?	?	?	?	?	?	?	?
Artiocetus	?	0	0	?	?	?	0	?
Qaisracetus	?	?	0	0	0	1	?	?
Maiacetus	0	0	0	0	0	0	0	0
MUSM 1443	?	?	?	?	?	?	?	?
Supayacetus	?	?	?	?	?	?	?	0
Ocucajea	?	?	?	?	?	?	?	?
Saghacetus	?	?	?	?	?	?	?	1
Zygorhiza	?	?	?	?	?	?	?	1
Ancalecetus	1	1	?	?	?	?	?	1
Cynthiacetus	?	?	1	1	1	2	?	1
Chrysocetus	?	?	1	1	1	2	?	1