Rediscovered specimens of *Cornwallius* (Mammalia, Desmostylia) from Vancouver Island, British Columbia, Canada

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2 figures

Abstract

Specimens initially collected but not reported from the original type locality of *Cornwallius sookensis* (Mammalia, Desmostylia) have been found at the National Museum of Natural History in Washington, DC. Two femora and a partial skull were collected from the same locality as the holotype that was deposited by Ira Cornwall in the Royal British Columbia Provincial Museum in the 1920s. Though the partial skull is missing from the collection, the femora remain. They are small and lack epiphyses, possibly from breakage or immaturity. Muscle scars suggest that adductors, extensors and lateral rotators were strongly developed, indicating that their posture was of the normal mammalian upright nature. The sectioned end of USNM 11076 permits inspection of characteristics of the medullary canal and cortical bone thickness, which does not appear to be osteosclerotic.

Contents

Abbreviations

BCPM — British Columbia Provincial Museum (now known as Royal British Columbia Provincial Museum), Victoria, British Columbia, Canada.
USNM — United States National Museum (now known as National Museum of Natural History, Smithsonian Institution, Washington, DC, USA).

1. Introduction and history

The Desmostylia are an enigmatic order of large semiaquatic mammals that hold a close relationship with the Proboscidea and Sirenia, forming the Tethytheria (McKenna, 1975). Recent studies have found demonstrated that despite the north Pacific rim restricted distribution of the order as whole, several taxa are known from large portions of this range. No other desmostylian taxa exemplifies this wide distribution moreso than *Cornwallius*, who is known latitudinal distribution ranged from Unalaska Island (Beatty, in review b; Drewes *et al.,* 1961), Alaska to Baja California Sur, Mexico (Applegate, 1986; Applegate & Wilson, 1976, Beatty *et al*., 2001; Kearin *et al.,* 2001a; VanderHoof, 1941, 1942). Recently described new material from Oregon has clarified details on the cranium of this genus (Beatty, in review a), and newly discovered specimens from the type locality in British Columbia are now being found (Joan Kerik, personal communication 2005).

The first specimens described of *Cornwallius sookensis* came from Vancouver Island, British Columbia and consisted of two teeth (Cornwall, 1922; Hay, 1923). According to VanderHoof (1937: 204) and Hay (1924: 5), the holotype tooth, a left m1 (BCPM 486/USNM 15165 cast) was collected by a Miss M. Egerton and then passed along to Ira Cornwall. Another tooth, a left m3 (BCPM 491/USNM 15166 cast), was collected from the same locality by Rev. Robert Connell and also donated to Ira Cornwall. An additional tooth was collected by B. L. Clark in 1922 from very near the type locality (UCMP 32682, a fragment of a lower molar including two cusps) (VanderHoof, 1937). Since then, no further material had been identified of this taxon, or any other desmostylian, from Vancouver Island or the rest of Canada.

During investigations into specimens of this taxon from Oregon, previously unreported specimens from this same collector and collecting event were found in the collection at the Smithsonian's National Museum of Natural History in Washington, DC. These specimens have clear, accurate data confirming them as part of the same collecting locality from which the two original specimens (including the holotype) were collected, though appear to have been sent to the Smithsonian as part of some 'undetermined bones and teeth' initially considered to be from sirenians and cetaceans. In 1924 Ira Cornwall donated a collection of "12 fossil cetacean and sirenian bones from the Sooke Formation, Oligocene, British Columbia" (unpublished USNM archive accession record #84831), that he received from Rev. Robert Connell to the United States National Museum, described in a series of letters to Remington Kellogg. While only quoting 12 specimens, 14 are listed. Though none of the 14 specimens listed fits the description of the femora described below, the 'rib' fragment and missing skull fragment are listed and can be accounted for in this accession record clearly ('rib' fragment is #11, skull fragment is #10). Catalogue records of the femora described below as well as those for the 'rib' fragment and missing skull fragment indicate that all of these were indeed collected from Vancouver Island, British Columbia on the beach west of Muir Creek from the Sooke Formation. In the catalogue of specimens, the two femora are recorded as specimens #13 and #14, which were originally simply referred to as 'unidentified'. Sadly, the skull fragment, though received and catalogued (USNM 11073) cannot be found. Records and personal communication indicate that it was loaned to Edward Mitchell in the 1960s and has not been returned, found, or published. The only description of it (from USNM unpublished catalogue records) indicates that it is a "portion of a skull (squamosal and periotic of the right side)". If this specimen can be relocated or returned, it may be possible to identify it further now that crania of *Cornwallius* have been found and described (Beatty, in review a).

What follow is the description of these femora and their taxonomic assignment, as well as a discussion of the muscles scars of both femora and cross–sectional anatomy of one specimen and its palaeobiological and taxonomic implications.

2. Materials

USNM 11075 and USNM 11076, each a right femur from the beach west of Muir Creek, Vancouver Island, British Columbia, Canada.

3. Description

USNM 11075 is the most complete femur attributed to *Cornwallius* to date. The material collected from Bahia San Carlos by Barnes, Beatty, Gascon, and Kearin in April 2001, which may turn out to be a femur (or a humerus), is potentially more complete but is in an unknown state of preparation (Beatty *et al.,* 2001). Relatively short and stout, this rather small bone belonged to either a juvenile or an adult with small hindlimbs (figure 1). Since there is no known complete or even articulated skeleton of *Cornwallius*, the latter could be possible, although the lack of fused epiphyses suggest that it is indeed a juvenile. Unless *Cornwallius* has departed far from the morphology of its better–known relatives, the femur of this taxon should be considerably larger in adulthood, as it is in the larger–sized *Desmostylus hesperus* (in which a juvenile's skull [GSJ–F7743] is the same

size as that of the adult *Cornwallius*, USNM 181740). Alternatively, if the smaller specimens of *Cornwallius sookensis* from the Yaquina Formation of Oregon (USNM181738, 181741 and 244034; see Beatty, in review a) are correctly interpreted as smaller adult females (sexually dimorphic, males being larger as in USNM 181740), then these may simply be the femora of a female *Cornwallius*. This sort of sexual dimorphism would be rather extreme, on the order of what is seen in *Mirounga* (Laws, 1953). While somewhat preliminary to be certain, sexual dimorphism in the desmostylian has already been suggested for *Paleoparadoxia* (Hasegawa *et al.,* 1994, 1995).

Figure 1. Right femora of Cornwallius sookensis *from Vancouver Island. 1(a, b): USNM 11076; 2 (a,b) USNM 11075 (a = anterior view, b = posterior view). Photograph by the author.*

USNM 11075 is complete save for the missing epiphyses of the head and greater trochanter and the entire distal epiphysis. Seemingly undistorted by diagenesis, the shaft has a flattened antero–posterior cross–sectional shape much like in the specimen of *Desmostylus mirabilis*, UHR 18466. The lesser trochanter is signifcantly larger in proportion and located more distally than in UHR 18466. There is a slight gluteal tuberosity distal to the greater trochanter. The trochanteric fossa is deep and broad, with two noticeable ellipsoid depressions contributing to this depth.

The remnant of the femoral head is about the same size as the greater trochanter and it extends considerably medially via a thick, strong neck, just as is seen in *Desmostylus mirabilis* (UHR 18466). The neck extends more laterally from the head like is found on other Desmostylia. The posterior aspect of the distal end is broad and flat like in UHR 18466, though it lacks the deeply concave popliteal fossa. This is a character that has been regarded as a "semiaquatic trait" (Inuzuka, 2000), though it appears premature to associate variation in semiaquatic habits with the observed variation in relative concavity among these taxa.

USNM 11076 is a femur of the same side and size as USNM 11075, but it is broken off distal to the proximal metaphysis. It has been sectioned and polished (likely with a diamond–edged saw) at an oblique angle on the distal end, just proximal to the medial supracondylar crest and just inclusive of the proximal portion of the lateral supracondylar crest. The only noticeable difference from USNM 11075 is in the shape of the lateral supracondylar crest. That of USNM 11075 is flattened on its lateral surface, whereas that of USNM 11076 is rounded. The cross section allows us to see that the lamellar bone of the diaphysis is thickest medially, normal anteriorly and posteriorly, and somewhat thin laterally (figure 2). Though the obliqueness of the section does not affect the thickness of the section fundamentally, the appearance of the medial aspect's thickness may be exaggerated by the obliqueness of the section, since the shafts of long bones of mammals tend to be thicker in midshaft than anywhere else.

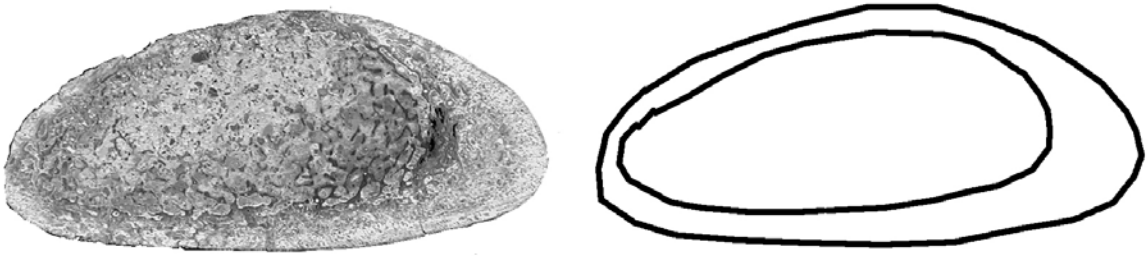

Figure 2. Cross–section of USNM 11076 in photograph (left) and line drawing (right) views, illustrating normal cortical bone thickness. Photograph and drawing by the author.

4. Palaeobiologcial implications

4.1 Muscle scars

The location of muscle scars have some implications for the palaeobiology of *Cornwallius sookensis* that were previously unknowable. M. quadratus femoris, among other muscles, inserts on the gluteal tuberosity, and this tuberosity's breadth and distal placement suggest that thigh extension and adduction were strongly developed in this taxon early on in ontogeny. If the trochanteric fossa can be assumed to mark the tendonous insertions of the obturator and gemelli muscles as in other mammals, then it should be safe to say that this animal was capable of considerable adduction and lateral rotation of the femur at the hip**.** What this means with regard to the 'herpetiform' locomotion theories by Inuzuka (Halstead, 1985; Inuzuka, 1984, 1985) remains to be more thoroughly studied, though initial study suggests that this morphology is not abnormal for a normal mammalian quadruped.

4.2 Cross section and osteosclerosis

The oblique section through the distal portion of USNM 11076 permits investigation of the nature of this taxon's cortical bone and has some paleobiological implications. Pachyosteosclerosis is common to most Sirenia (Domning & De Buffrenil, 1991), almost defining of the order, with the possible exception of some members of the Protosirenidae (Zalmout *et al.,* 2003). The earliest known members of the Sirenia were primitively pachyosteosclerotic even when retaining some degree to terrestrial locomotor ability (Domning, 2001a; Domning *et al*., 2001b). This is presumed to have been and adaptation for inactively overcoming lung buoyancy to minimize the energy expenditure during diving. This can be considered one of the key adaptations that permits sirenians to survive on plant foods despite their lower nutritional quality relative to that of animal tissues (which is the food of all other known modern marine mammals).

Osteosclerosis is not found in the femur of *Cornwallius*, USNM 11076, and suggests that this taxon lacked the physiological necessity of it. This may serve as an indicator of a lack of specialised aquatic habits (semiaquatic or terrestrial), or possibly a difference in diet (not herbivorous?). If this feature can be found in varying degrees among members of the Desmostylia, it may be possible to infer a continuum of aquatic to semiaquatic habits and serve to clarify some of the questions about terrestrial posture and aquatic habits that have been debated (Domning, 2001b, 2002; Halstead, 1985; Inuzuka, 1984, 1985, 2000). While at the present moment it seems unwise to make a broad generalisation based on one specimen, it may suggest a need for caution in estimates for the order as a whole based on single species.

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