

## Article XII.—REVISION OF THE SPECIES OF CORYPHODON.

By CHARLES EARLE.

The recent expedition sent out by the American Museum of Natural History to the Bad Lands of the Wahsatch formation of Wyoming was successful in procuring some valuable *Coryphodon* material.

Through the kindness of Dr. H. F. Osborn, Curator, the entire collection has been placed in my hands for identification and study. In taking up the *Coryphodontidæ*, I am surprised by the great number of species which have been proposed, and I find upon studying and comparing the types that a great reduction in the number of species should be made.

Prof. Cope, with his usual liberality, has kindly allowed me to study his whole collection of *Coryphodon* material, therefore I am now prepared to revise the species approximately, and to give a fairly accurate diagnosis of each. Unfortunately nearly all the American material of *Coryphodon* has been found scattered, so that it is almost impossible to say what parts of the skeletons of the different individuals should be associated with each other.

The collection in the American Museum contains, among other specimens, the greater part of the skeleton of *Coryphodon anax* (= *Bathmodon pachypus* Cope), although there are no teeth associated with this specimen. There is also a very valuable specimen of *C. obliquus*. This latter is of importance, as it represents one individual, and contains the upper and lower dentition nearly complete.

Since Prof. Cope's original discovery<sup>1</sup> of the occurrence of the genus *Coryphodon* in America, he has described four new genera of the *Coryphodontidæ* from this country.

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<sup>1</sup> Proc. Am. Phil. Soc., 1872, p. 417.

I am especially doubtful as to the validity of the genus *Bathmodon*, and shall consider it in this paper as a synonym of *Coryphodon*. The character upon which this genus was based—namely, the presence of a tibiale facet upon the astragalus, will, I believe, be found not to be confined alone to this genus of the Coryphodontidæ, but will prove to be one of the ordinal characters of the Amblypoda in general. The presence of a tibiale facet upon the astragalus is the general rule among the other members of the Amblypoda. Marsh<sup>1</sup> has noticed the presence of this facet in the Dinocerata. He also adds, "The astragalus in *Coryphodon* is very similar in form to that in the Dinocerata, but is shorter. It has essentially the same articular faces, and the facet for the tibiale is equally well marked."<sup>2</sup> Prof. Cope<sup>3</sup> has also pointed out the existence of a tibiale facet in the astragalus of the genus *Pantolambda*.

We see from the above that in all the genera of the Amblypoda, of which we possess good examples of the astragali, there is the common character of an internal tibiale facet.

The material referable to the tarsi of *Coryphodon* and allied genera in Prof. Cope's collection is very limited. He<sup>4</sup> has described a species of *Coryphodon*, named *C. latipes*; associated with the skeleton, upon which this species is based, are two astragali. These are the only astragali in Prof. Cope's collection, which I find have been referred to the genus *Coryphodon* by him.

The two astragali above mentioned are much worn and rounded off, and as they are associated with other parts of a skeleton which shows decidedly juvenile characters, I believe that the whole skeleton belongs to an immature specimen of *Coryphodon*, in which it is impossible to form a conjecture as to the presence or absence of the tibiale facet.

I do not retain the genus *Metalophodon* Cope as a distinct genus, for the reason that all stages of transition occur, in which the posterior limb of the external crescent of the second superior molar is well developed, down to that in which the crest has

<sup>1</sup> Monograph of the Dinocerata, pp. 146 and 148.

<sup>2</sup> This description is not confirmed by Osborn.

<sup>3</sup> Tertiary Vertebrata, p. 612.

<sup>4</sup> Proc. Am. Phil. Soc., 1873, p. 33.

TABLE SHOWING ALL THE PROPOSED AMERICAN SPECIES OF CORYPHODON AND RELATED GENERA, WITH THEIR ORIGINAL NAMES, NATURE OF TYPE, AND LOCALITY.

NAME.	DATE.	TYPE.	FIGURE.	LOCALITY.
1. <i>Bathmodon radians Cope</i> ....	Proc. Am. Phil. Soc., Feb. 16, 1872, p. 417.	Sup. m. 2 & 3 with skeleton.	Tert'y Ver., pls. 45-57.	Evanston, Wy.
2. <i>Bathmodon semicinctus Cope</i> ...	" " " "	Teeth.	" " " "	" "
3. <i>Metalophodon armatus Cope</i> ....	" " " 1872, p. 542.	Superior molars.	Tert'y Ver., pl. 49.	Black Butte, "
4. <i>Metalophodon testis Cope</i> ....	" " " 1881, p. 175.	" " " "	" " pl. 44a.	Big Horn.
5. <i>Bathmodon latipes Cope</i> .....	" " " 1873, p. 33.	Skeleton.	" " pl. 48.	Evanston, Wy.
6. <i>Bathmodon elephantopus Cope</i> ..	Rep. Vert. Fos. N. M., Wheeler, 1874, p. 10.	Last sup. and inf. m. 3.	Pal. of N. M., pls. 50-54.	New Mexico.
7. <i>Bathmodon simus Cope</i> .....	" " " " p. 8.	Inferior molars.	" " pl. 55.	" "
8. <i>Bathmodon lomas Cope</i> .....	" " " " p. 9.	Inferior molar 3.	" " pl. 54.	" "
9. <i>Bathmodon molestus Cope</i> .....	" " " " "	Sup. and inf. molars.	" " pls. 56-57.	" "
10. <i>Bathmodon latidens Cope</i> .....	Syst. Cat. Vert. N. M., 1875, p. 29.	Jaw with teeth.	" " pls. 48-50.	" "
11. <i>Bathmodon cuspidatus Cope</i> ....	" " " " p. 30.	Inferior molar 3.	" " pl. 46.	" "
12. <i>Coryphodon hamatus Marsh</i> ....	Am. Jour. Sci. & Arts, 1876, p. 426.	Sup. and inf. molars.	Mon. of Dinocerata, p. 52.	Wyoming.
13. <i>Coryphodon obliquus Cope</i> ....	Pal. of New Mexico, Wheeler, 1877, p. 207.	" " " "	Vert. Pal. N. M., pl. 47.	New Mexico.
14. <i>Coryphodon lobatus Cope</i> .....	" " " " p. 209.	" " " "	" " pl. 46.	" "
15. <i>Coryphodon curvirostris Cope</i> ...	Proc. Am. Phil. Soc., 1881, p. 171.	Inferior m. 2 and 3.	Tertiary Vert., pl. 44c.	Big Horn.
16. <i>Coryphodon marginatus Cope</i> ...	" " " " p. 172.	Sup. m. 2 & mand. with teeth.	" " pl. 44c.	" "
17. <i>Coryphodon marginatus Cope</i> ...	" " " " p. 174.	Superior molar 3.	" " pl. 44e.	" "
18. <i>Coryphodon anax Cope</i> .....	" " " 1881 (1882), p. 168.	Sup. and inf. molars.	" " pls. 44a-e.	" "
19. <i>Bathmodon pachypus Cope</i> .....	Proc. Acad. Nat. Sci. Phila., 1882, p. 294.	Skeleton.	" " pls. 44d-g.	" "
20. <i>Mantodon subquadratus Cope</i> ...	Proc. Am. Phil. Soc., Dec. 16, 1881.	Last sup. m. with incisors.	" " pl. 44a.	" "
21. <i>Ectacodon cinctus Cope</i> .....	" " " " p. 167.	Superior molars.	" " "	" "

nearly disappeared.<sup>1</sup> In fact the absence or presence of the posterior limb of the crescent in *Coryphodon* is largely dependent upon the amount of abrasion, for as the tooth becomes more worn it involves the posterior limb of the crescent. This abrasion first affects the external portion of the posterior limb, and further wear will bring it into continuity with the internal apex of the crescent.

#### VARIATIONS AND HOMOLOGIES OF THE MOLAR TEETH.

Before taking up the descriptive part of this paper, I propose to treat some of the variations of the teeth and of the homologies of the molar cusps.

I have found it extremely difficult to define the limits of the specific groups in this genus, as in so many cases the species run into each other by insensible gradations. I have for that reason decided to reduce the species described to about half the number originally proposed.

The canine teeth show a great amount of variation as to size, and this is probably due partly to age and sex. The inferior canines associated with the type of *C. anax* are very much larger than those of *C. radians*, although the inferior molar series of these two species are nearly of the same size.

In no case have I been able to find two series of teeth of the same species which are even closely similar in size, etc. They always vary in their dimensions and in the characters of the crest of the last superior and inferior molars. For example, in *C. elephantopus*, Cope mentions the fact that in his specimen the last superior molar exhibits traces of the posterior limb to the crescent, whereas in the specimen in the American Museum collection this tooth is without this rudimentary limb, although in all the other characters our series of teeth correspond exactly to those of the type in the Cope collection. This same variation exists in *C. radians*, as already mentioned; now if we are to interpret all these variations as specific, the list of species in this genus would increase indefinitely. I therefore, in limiting the species, have summed up the characters in all cases when comparing related species, and have not considered slight variations as specific.

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<sup>1</sup> See Marsh's figures of *Coryphodon*, Monograph of the Dinocerata, p. 52.

The structure of the crescent in the second superior molar is an extremely variable character, and when we compare the series of species from *C. radians* through *C. elephantopus* to *C. hamatus*, I am sure we can find no generic characters between them, but must recognize the fact that we are here dealing with a phyletic series in which, in the first-named species, we have the crescent well developed, down to that where the posterior limb is completely lost. In *C. radians* the form of the second superior molar and characters of the external crescent appear to be fairly constant, but in the last upper tooth of the superior series the case is different. There is, however, one character of this tooth which appears to be diagnostic of the species, and that is the relations of the external portion of the anterior crest to the basal part of the molar; in this species the anterior crest divides into two branches running externally to the base of the crown. The fine series of teeth (No. 274) in the American Museum collection exhibits this character very well, although the form of the last superior molar is different from the type specimen.

The great variation shown by the facets of the astragalus and calcaneum will be described later, and I believe it is not possible at present to diagnose any species upon these variable characters.

The variations shown by the long bones of the skeleton are many; they chiefly affect their length and the size of their distal and proximal extremities.

HOMOLOGIES OF THE CUSPS.—The homologies of the dental elements of the superior true molars of the Coryphodontidæ are not determined without considerable difficulty, and only by a comparison of the teeth of *Coryphodon* with the most primitive member of this group, namely *Pantolambda*, are we enabled to understand the structure of the type of molar found in *Coryphodon*. Prof. Cope<sup>1</sup> has studied the question of the homologies of the cusps in the Coryphodontidæ, and it appears to me that his conclusions are satisfactory. He finds that the tritubercular form of superior molar, as found in *Pantolambda*, was the probable starting point for the *Coryphodon* molar. In the former genus (Fig. 2 A) both external crescents are well developed, and there is a prominent parastyle or antero-external buttress.

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<sup>1</sup> American Naturalist, 1884-85, pp. 1115 and 1195.

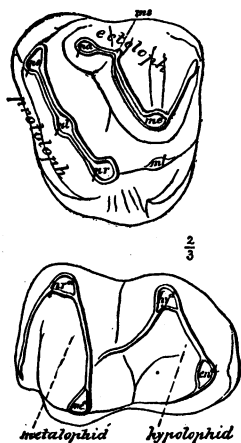


Fig. 1. The Morphology of an upper and lower Molar of *Coryphodon*. *pa*, paracone; *me*, metacone; *pr*, protocone; *ps*, parastyle; *ms*, mesostyle; *pl*, protoconule; *ml*, metacoenule; *pr<sup>d</sup>*, protoconid; *hy<sup>d</sup>*, hypoconid; *en<sup>d</sup>*, entoconid.

In some of the species of *Coryphodon* we find, as the external elements of the crown, on the first and second superior molar, a strongly-developed posterior crescent, and connected with the anterior limb of the crescent, a prominent conical cusp (Fig. 1, *pa*).

The question is: what is the homologue of this cusp in *Pantolambda* and other Ungulates? Prof. Cope believes that this cusp is the sole representative of the anterior crescent of *Pantolambda*. On the second and last superior molars of *Coryphodon* the rudimentary anterior crescent is reduced to a cusp; but on the first molar this cusp is much elongated, and forms a short crest.

The *Coryphodon* molar still retains the large parastyle which is so characteristic of the teeth of *Pantolambda*. The mesostyle

(Fig. 1, *ms*) in *Coryphodon* is only slightly developed, and is more prominent on the second superior molar than on any of the others.

The anterior transverse crest or protoloph in *Coryphodon* has probably been developed from the crest running externally from the protocone of *Pantolambda*.

It is very interesting to observe that in some species of *Coryphodon* the protoloph is enlarged at its middle, this enlargement being the homologue of the protoconule. Traces are also present of the metaconule.

The most primitive condition of the last inferior molar in *Coryphodon* is probably where the heel has a straight posterior border, for this is the condition in *Pantolambda*.

In *Coryphodon obliquus* we see the origin of the internal ridge or tubercle, which, as it increases in size, forces the entoconid to take the place of the fifth lobe of other forms, but the last inferior molar of *Coryphodon* has no element homologous with the hypoconulid or fifth lobe of the true Lophodonts.

The *Coryphodon anax* type shows the greatest specialization in the structure of the heel of the last inferior molar. In this species the three lobes of the heel are very large and equal in size.

It is interesting to note that the *Pantolambda-Coryphodon* line was first introduced by the tritubercular type of molar; later, however, in the Wahsatch period this line probably divided into two sublimes, one leading to *Manteodon*, the other to *Coryphodon*. The first subline is characterized by the quadritubercular form of molar; in the last, however, the tritubercular type persisted.

*Revised Table of Species and Synonyms.*

SPECIES.	SYNONYMS.
1. <i>Coryphodon radians</i> .....	= <i>C. repandus</i> .
2. <i>Coryphodon testis</i> .....	= <i>Metalophodon testis</i> .
3. <i>Coryphodon elephantopus</i> .....	= <i>C. simus</i> , <i>C. molestus</i> , <i>B. lomas</i> ,
4. <i>Coryphodon cuspidatus</i> .	( <i>C. latidens</i> ?), <i>C. hamatus</i> ?
5. ( <i>Coryphodon hamatus</i> .)	
6. <i>Coryphodon obliquus</i> .	
7. <i>Coryphodon curvicristis</i> .	
8. <i>Coryphodon anax</i> .....	= <i>Bathmodon pachypus</i> , <i>Coryphodon lobatus</i> .
9. <i>Manteodon subquadratus</i> .	
10. <i>Ectacodon cinctus</i> .	

***Coryphodon Owen.***

SYN.—*Bathmodon* Cope. *Metalophodon* Cope.

Premolars simpler than molars. Superior premolars, except first, consisting of an external and an internal crescent. Inferior premolars with only one crescent. Last inferior premolar much simpler than first true molar. Superior molars tritubercular, antero-external cone (parastyle) connected with protocone by a strong crest. First superior molar with well-developed postero-external crescent, second superior molar with crescent complete or incomplete. Last superior molar with crescent reduced to a posterior crest. Mesostyle well marked. Inferior true molars consisting of two crescents with anterior limb of each much reduced; trigonid raised above heel. Elements of heel of last inferior molar, entoconid and hypoconid; no cusp homologous with hypoconulid. No scapho-magnum articulation. Astragalo-cuboid contact large. Astragalus flat, with internal facet for tibiale.

*Synoptical Table of the Genera and Species of Coryphodontidae.*

- A. Last superior molar with postero-external crescent complete. Internal cones two (hypocone developed).....*Manteodon*.  
Hypocone smaller than protocone.....*M. subquadratus*.  
B. Last superior molar with postero-external crescent lacking posterior limb. Internal cones one (hypocone wanting, or rudimentary).....*Coryphodon*.

- I. Second superior molar with external crescent complete.
  - a. Heel of last inferior molar bilobate.
    1. Paracone and posterior crest of last superior molar in a straight line (type)..... *C. radians*.
    2. Paracone and posterior crest of last superior molar forming a right angle..... *C. elephantopus*.
  - b. Heel unknown. Last superior molar with postero-external cusp.  
*C. (Ectacodon) cinctus*.
  - c. Heel of last inferior molar trilobate.
    1. Accessory tubercle in posterior valley a cusp (bunoid).  
Size small..... *C. cuspidatus*.
    2. Accessory tubercle in posterior valley a lobe (lophoid).  
Size large. Sup. m. 3 subtriangular..... *C. anax*.  
Size small. Sup. m. 3 oval..... *C. obliquus*.
  - d. Heel of last inferior molar forming a crest (hypoconid and entoconid continuous)..... *C. curvirostris*.
- II. Second superior molar with external crescent incomplete.
  - e. Heel of last inferior molar unknown. Sup. m. 2 with posterior limb of crescent reduced..... *C. (Metalophodon) testis*.
  - f. Heel of last inferior molar bilobate. Sup. m. 2 with posterior limb of crescent wanting..... *C. hamatus*.

### ***Coryphodon radians* Cope.**

SYN.—*Coryphodon repandus* Cope.

Last superior molar subtriangular in outline, external termination of anterior crest generally in continuity by two ridges with basal portion of crown; postero-external crest oblique and connected with posterior cingulum by a sharp ridge (type). Last inferior molar with heel bilobate.

The type specimen of *C. radians* (Fig. 2, *B*, p. 159) consists of the last two superior molars with upper premolars, and lastly of an astragalus, femur, and other fragments of the skeleton.

The specimens in Prof. Cope's collection upon which he based his *C. repandus* are two superior molars and a portion of a jaw bearing the last two molars, all from the same individual. The measurement and character of these teeth are almost identical with the type specimen of *C. radians*, and for that reason I believe they should be referred to that species. The difference in character of the posterior crest of the last superior molar in the two types is largely due to the condition of wear, and I think are not specific.

*Coryphodon radians* was the first American species of this genus described. Prof. Cope<sup>1</sup> at the time of the discovery

<sup>1</sup> Proc. Am. Phil. Soc., 1872, p. 417.



of this species referred it to a new genus *Bathmodon*. Later he<sup>1</sup> recognized the fact that *Bathmodon* was identical with the European genus *Coryphodon*, and in his subsequent work on the 'Extinct Vertebrata of New Mexico' (1877), described this species and many others under the name of *Coryphodon*. In his 'Tertiary Vertebrata'<sup>2</sup> Prof. Cope again separated *Bathmodon* from *Coryphodon*, basing the differential characters of the genus upon the presence of an internal facet on the astragalus for the tibiale. As already mentioned, I cannot recognize this character as generic, but believe that it is common to the order Amblypoda. The original material from which *C. radians* was described came from Evanston, Wyoming. Prof. Cope states that later he procured a mandible from the same locality, which he supposed belonged to this species. I believe he is correct in associating the form of last inferior molar with a bilobate heel with the type of *C. radians*. Another reason for supposing this association to be correct, is the fact that the type specimen of *C. repandus* includes both upper and lower teeth from the same individual; also in this species the heel of the last inferior molar has a straight posterior border. If I am correct in supposing that *C. repandus* is the same species as *C. radians*, then the posterior limb of the crescent of the last superior molar is a variable character, as the type specimen of *C. repandus* shows none.

I consider also that *C. radians* and *C. anax* are very closely related species, and that *C. anax* may not be specifically distinct; this is shown by the fact that the inferior molar series of the two species are nearly of the same size. The internal tubercle, which is so characteristic of the last inferior molar of *C. anax*, is quite variable in size and position. There are three jaws in Prof. Cope's collection, two of which he refers to *C. anax*; in one (No. 2) the dimensions of the dental series are less than in the type of *C. radians*, and in this jaw the internal tubercle of the last inferior molar is not as much separated from the median tubercle as in the type specimen. The last upper molar of the type of *C. radians*, however, is smaller than that of *C. anax*.

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<sup>1</sup> Pal. Bull., No. 21, April 11, 1876, p. 2.

<sup>2</sup> Tertiary Vertebrata. 1884, p. 544.

*Measurements of Jaws.*

	<i>C. anax</i> , No. 1.	<i>C. anax</i> , No. 2.	<i>C. radians</i> .
	M.	M.	M.
Entire length of jaw.....	.420	.370	
Molar series, total.....	.195	.170	.195
Depth of jaw below m. 2.....	.085	.070	.070
Length inferior m. 3.....	.044	....	.043

The astragalus which Prof. Cope has associated with the type of *C. radians* is much smaller than that of *B. pachypus*, and it is strange that such is the case, as the teeth of *C. radians*, at least the lower ones, are nearly as large as those of *C. anax* (= *B. pachypus*). The astragalus of *C. radians* is nearly square in its dimensions; the tibiale facet is very large, and placed at right angles to the navicular face of the bone. This facet is separated by a notch from the superior face of the astragalus, although I believe this to be a variable character. Also in this astragalus the groove between the sustentacular and ectal facets is continued posteriorly into a foramen which opens above. This is probably another variable character, and will be more fully considered under the head of *C. anax*.

A few species of *Coryphodon* have been recorded from the Wind River. Prof. Cope<sup>1</sup> includes two species from this formation, namely: *C. radians* and *C. cuspidatus*. Among the collection of specimens brought from the Wind River by Dr. Wortman, there are fragments of a skeleton of a species of *Coryphodon*, including a few teeth fairly well preserved. These teeth are of the last of the lower series, and compare nearly in size and character with those of *C. radians*. I therefore provisionally refer them to this species.

***Coryphodon testis* Cope.**

SYN.—*Metalophodon testis* Cope.

Second superior molar much larger than the last; posterior limb of crescent reduced to an external cusp. Last upper molar oval in outline with posterior crest straight.

<sup>1</sup> On the Vertebrata of the Wind River Eocene Beds of Wyoming. Bull. U. S. Geol. Surv., 1881, p. 183.

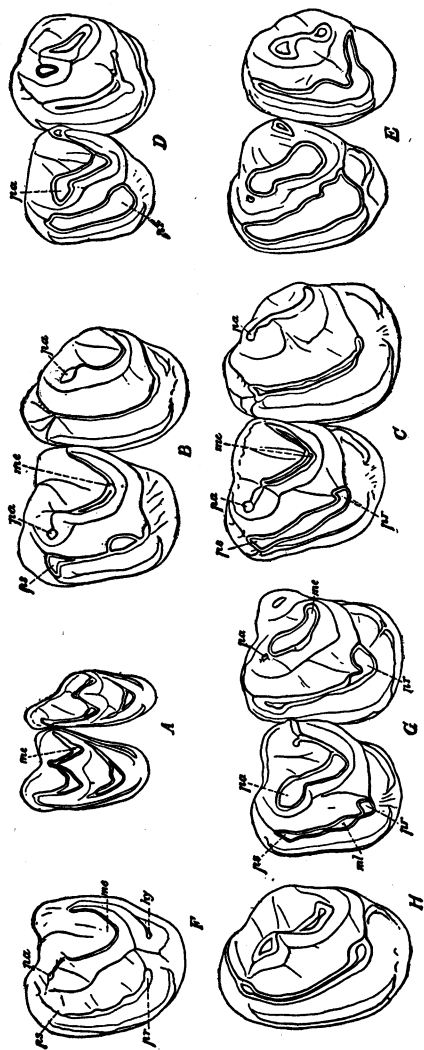


FIG. 2. Comparative view of second and third upper molars of *Coryphodon*. A, *Pantolambda*,  $\frac{1}{2}$  natural size. All others  $\frac{1}{2}$  natural size. B, C, *radians*, type. C, *C. radians*. D, *C. elephantopus*. E, *C. testis*, type. F, *Manteodon subquadratus*, type. G, *Ectacodon cinctus*, type. H, *C.anax*, type.

The type of *C. testis* is a beautiful series of the maxillary teeth of both sides in Prof. Cope's collection (Fig. 2, E). Prof. Cope<sup>1</sup> originally described the genus *Metalophodon* from two series of teeth,<sup>2</sup> one mature, the other a series of milk teeth, which were found in the same locality, although from different skulls. These teeth are in such a poor state of preservation, and as the last two upper molars of the mature specimen are of the same size and character, I cannot consider them as good types. In the *Coryphodontidæ* the second superior molar always differs widely in form and characters from the last, and I have yet to see an exception to this rule.

The exceedingly fine type specimen of *C. testis* has the second superior molar much larger, and every way different in character from the last. The posterior limb of the crescent in this molar has only its external portion worn, although further

<sup>1</sup> Proc. Am. Phil. Soc., 1872, p. 542.

<sup>2</sup> Tertiary Vertebrata, pl. xlix.

abrasion would probably have brought the whole limb in continuity internally with the apex of the crescent. The last superior molar of this species is oval in outline, with no postero-external enlargement such as is characteristic of the *C. elephantopus*.

### **Coryphodon elephantopus Cope.**

SYN.—*C. simus*, *C. molestus*, (*C. latidens* ?), *B. lomas*.

Last superior molar with postero-external portion prolonged beyond crest ; external part of posterior crest forming a right angle with the internal.

The type of *C. elephantopus* described by Prof. Cope<sup>1</sup> is a last superior and inferior molar. Later in his 'Extinct Vertebrata of New Mexico,' he described the finely-preserved skull with teeth which is figured in this work (Fig. 2, *D*).

I refer specimen No. 275 in the American Museum collection to this species, although its teeth differ in some of their characters from those described by Prof. Cope ; this difference consisting in the fact that the last superior molar shows no trace of a posterior limb to the external crescent ; otherwise the measurements and characters of the teeth are identical. I have shown elsewhere that this character is a variable one in *C. radians*, and will not suffice for specific definition.

Prof. Cope recognizes three other species of *Coryphodon* which are closely related to *C. elephantopus* ; these are the *C. simus*, *C. molestus* and *C. latidens*.

The material pertaining to *C. molestus* is abundantly represented in Prof. Cope's collection, and numerous figures are given in the work above cited.

The type of *C. simus* is a lower jaw with teeth. In this specimen the last inferior molar is preserved, whereas in the type of the lower jaw of *C. elephantopus* this tooth is wanting. The teeth of *C. simus* are slightly smaller than those of *C. elephantopus*, otherwise I see no distinction between them.

The *C. latidens* was established upon the well-preserved mandible with teeth figured in the 'Extinct Vertebrata of New Mexico.'<sup>2</sup> In this specimen the last inferior molar is also preserved, and

<sup>1</sup> Report of Vert. Fossils N. M., Wheeler, 1874, p. 10.

<sup>2</sup> Vertebrate Palæontology of New Mexico, Wheeler, 1877, pl. xlviii.

differs quite radically in form from that of the type of *C. simus*. The measurements of the lower teeth of *C. latidens* correspond exactly with the superior molars of *C. elephantopus*, and for that reason I do not give it specific rank, although further material may show that *C. latidens* is a good species.

There is another reason for referring *C. latidens* to *C. elephantopus*. In the former species the last inferior molar of the type specimen has a straight heel, with no trace of the posterior enlargement which is so characteristic of the *C. anax* and the more specialized species. Now the square form of the last superior molar of *C. elephantopus* should, I believe, be associated, as in *C. radians*, with a last inferior molar which has a bilobate heel. I have positive proof from a specimen in the American Museum collection that the oval form of last superior molar is associated with the trilobate heel.

I have labored under the disadvantage of not being able to study any of the types of *Coryphodon* from New Mexico, which have been described by Prof. Cope. Accordingly some of my conclusions as to the synonyms of the species may be incorrect; however, I can hardly appreciate the specific distinctions, made by Prof. Cope, between many of the Wahsatch species from New Mexico.

### ***Coryphodon cuspidatus* Cope.**

Last inferior molar with a prominent conical tubercle on internal side of heel.

This is a smaller species of the genus, and closely related to *C. obliquus*; it was established upon a posterior portion of a last inferior molar from New Mexico.

The tubercles and ridges on the last inferior molar of this species of *Coryphodon* are exceedingly variable characters. In the collection of the American Museum there is a series of lower molars of *C. radians*, and on the external side of each last molar there is a prominent tubercle between the lobes. I should hardly venture to refer this specimen to a new species based upon this character, and believe it to be merely a variation from the typical form of molar found in *C. radians*.

***Coryphodon hamatus* Marsh.**

Superior true molars broad and short as in *C. elephantopus*. Second superior molar with posterior limb of crescent absent.

I describe the characters of this species from the figure of its dentition given by Marsh.<sup>1</sup> If this be correct we have the most specialized species of the genus, as in this form the posterior limb of the crescent of superior *m* 2, as figured, is totally absent. The form of the last superior molar is like that of *C. elephantopus*, and it is important to notice that this specimen is associated with the bilobate form of last inferior molar. The dimensions of the teeth in *C. hamatus* are the same as in *C. elephantopus*, and it may prove to be the same species. Flower and Lydekker<sup>2</sup> in their new work on the 'Mammalia' have incorrectly given Marsh's name of *C. hamatus* priority over that of *C. elephantopus* Cope.

***Coryphodon obliquus* Cope.**

Last superior molar an elongated oval. Heel of last inferior molar trilobate; its internal enlargement a ridge.

The type of *C. obliquus* is a portion of a mandible bearing the last two molars, from New Mexico. This species has not been before recorded from the Big Horn Wahsatch. We are fortunate in having a fine specimen of it in the collection (No. 276) from this locality, consisting of the superior molar series with the mandibular dentition nearly complete.

It is exceptional to find together the superior and inferior molars of any of the species of *Coryphodon*. However, the specimens of *C. obliquus* in the American Museum collection are from one individual, and on that account they are of special value.

This is one of the few species of *Coryphodon* which can be readily distinguished by its size and dental characters from the larger species of the genus. The much smaller size of the teeth, the narrow and elongated form of the last upper molar with its long posterior crest readily distinguishes it from *C. anax*.

The second superior molar in *C. obliquus* has the posterior limb of the crescent well developed. The last lower molar is longer

<sup>1</sup> *Dinocerata*, 1884, p. 54.

<sup>2</sup> *Mammals, Living and Extinct*, Flower and Lydekker, 1891, p. 438, fig. 191.

than broad, its posterior crest is oblique to the anterior. The heel of this tooth has the entoconid large, and internally it becomes continuous with the low tuberculated ridge characteristic of the species.

The ramus of the mandible is much elongated and slender. The symphysis is long and strongly procumbent.

*Measurements of Teeth and Jaw in C. obliquus.*

	M.
Entire superior molar series.....	136
Superior molar 3. .... { ant. post.....	.024
{ trans.....	.037
Entire inferior molar series.....	152
Inferior molar 3. .... { ant. post.....	.037
{ trans.....	.022
Entire length of jaw.....	330
Depth of jaw below middle of m. 3...	.057

***Coryphodon curvicristis* Cope.**

Heel of last inferior molar with crest extending inwards from hypoconid ; no entoconid differentiated. Superior incisors with prominent external rib.

The type of *C. curvicristis* is a second superior molar, a canine and a mandible of one side containing all the true molars intact. These specimens are from the Big Horn.

This species is of the same size approximately as *C. obliquus*, and is one of the most distinct of the genus. The peculiar character of the heel of the last inferior molar exists in no other known species ; the anterior limb of the heel is strongly marked. The crowns of the lower teeth are higher in proportion to their length than in the allied species. The second superior molar, associated with the type specimens, is intermediate in size between that of *C. anax* and *C. obliquus* ; its external crescent is high and turned strongly toward the posterior border of the tooth. A canine belonging to this species is much elongated, sharp and triangular in section.

A form of *Coryphodon* described by Prof. Cope as *C. marginatus* I cannot admit as a good species. The teeth upon which it was established are probably from the milk dentition. The characters of the upper molar of this type show that it may pertain to the milk series of *C. anax*.

**Coryphodon anax** Cope.

SYN.—*Bathmodon pachypus* Cope, and *Coryphodon lobatus* Cope.

Last superior molar oval in outline; external portion of anterior crest not connected with basal part of tooth by two ridges. Heel of last inferior molar trilobate in structure, with lobes nearly equal in size.

The largest known species of *Coryphodon*, namely, the *B. pachypus*, was established<sup>1</sup> upon the characters of the skeleton alone. The type of *C. anax* has both upper and lower molars (Fig. 2, *C* and *H*) associated with parts of the skeleton. I consider, as both of these types are from the same locality, and as the differential characters pointed out by Prof. Cope<sup>2</sup> are variable, that these two species are probably identical. I have compared parts of the skeleton of the specimen of the large species of *Coryphodon* in the American Museum collection with the type of *B. pachypus*, and find they correspond.

The last upper molar of *C. anax* (Fig. 2, *H*) is large and much extended transversely; it can be distinguished from that of *C. radians* by its larger size, and also from the fact that, in the type specimen, the anterior transverse crest at its external extremity is not bifid. Although this character may be variable, as shown by the specimen (No. 267) in the American Museum collection. The valley in the last superior molar separating the paracone from the anterior crest is not as deep as in *C. radians*; also the anterior limb of the external crescent is more oblique and crescentoid than in the latter species. The form of the last inferior molar is highly characteristic of *C. anax*; its heel is strongly trilobate, and the median lobe is well separated from the laterals. The size of this tooth, as already observed, is not larger than in some specimens of *C. radians*. Prof. Cope attempts to distinguish *C. anax* from *B. pachypus*, among other characters, upon the form of the facets of the astragalus and calcaneum. In the American Museum specimen (No. 258) the astragalus is the same size as in the type specimen of *B. pachypus* in Prof. Cope's collection. In this specimen the tibiale facet of the astragalus is well marked, but is discontinuous with the navicular; in this respect it resembles *C. radians*, and differs from the type specimen. The large size of the astragalus of *C. anax*, and especially its greater transverse extent, distinguishes it from that of *C. radians*.

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., 1882, p. 294.

<sup>2</sup> Tertiary Vertebrata, pp. 551, 552.



The characters of the calcaneum mentioned by Cope as separating the two species will not hold good. In the American Museum collection there are three series of astragali and calcanea of *C. anax*; in the best-preserved specimen (No. 258) the sustentacular facet has an anterior prolongation; whereas in No. 273 the anterior portion is entirely absent. The sustentaculum in this specimen is of an oval form.

I have examined four sets of the astragali and calcanea of *C. anax*, and find that the characters of the inferior face of the astragalus are quite constant; I refer especially to the groove and foramen which are always placed on the astragalus between the ectal and sustentacular facets. In three specimens of the four the posterior opening of the groove is shut off by a bridge of bone connecting the ectal facet with the posterior median enlargement of the astragalus. In one specimen in the collection the bridge of bone is absent, and consequently there is a well-marked foramen; this specimen is associated with a calcaneum, in which the sustentacular facet is elongated.

The beautifully preserved pelvis in the American Museum collection has the same dimensions as that belonging to the type of *B. pachypus*; the femur, however, which is associated with it, is much smaller than that of *B. pachypus*. It is interesting to note that the American Museum femur has the same dimensions as that referred by Cope to the *C. anax*, thus offering more proof that *C. anax* and *B. pachypus* are the same species.

### ***Manteodon subquadratus* Cope.**

Last superior molar quadrate in form; hypocone smaller than protocone; paracone compressed and elongated.

The genus *Manteodon* was established by Prof. Cope<sup>1</sup> upon an upper true molar (Fig. 2, *F*) with fragments of teeth. I think Prof. Cope has correctly identified the single superior molar associated with the type as the last one of the superior series. We have in this tooth interesting characters which show us the modifications through which the *Coryphodon* molar has undergone. The fact that the last superior molar of *Manteodon* is quadratubercular in structure is unique, and occurs in no other genus of this family. This may indicate that *Manteodon* is not in the direct

<sup>1</sup> Proc. Am. Phil. Soc., 1881, p. 166.

line to *Coryphodon*; as in this case we should have to suppose the loss of the hypocone. The nearest approach to the rudiment of a hypocone on the superior molars of *Coryphodon* occurs in the *C. elephantopus*, although Marsh's figure of his *C. hamatus* probably indicates the presence of this cone in a rudimentary condition.

### ***Ectacodon cinctus* Cope.**

Last superior molar rectangular, larger than second; postero-external cusp widely separated from posterior crest.

The type of this genus and species is a finely-preserved series of upper molars in Prof. Cope's collection.

In the *E. cinctus* (Fig. 2, *G*) the anterior crest of the last upper molar is high, and its external termination is connected with the basal portion of the crown by only one ridge. The internal cingulum of this tooth is complete. In the second upper molar the external termination to the posterior limb of the crescent forms a prominent cusp, which is homologous with the postero-external cusp of the second superior molar of *C. testis*.

In this tooth the crescent is complete, and not reduced as in the latter.

This species is more closely related to *C. radians* than to any other, this being shown by the fact that in *C. radians* the last superior molar has traces of the posterior limb to the crescent; the postero-external cusp of *Ectacodon* being the remains of this posterior limb in the latter species.

*C. elephantopus* approaches the *E. cinctus* in the nearly square form of its last superior molar, but lacks the postero-external cusp of the latter.

I am doubtful whether *Ectacodon* should hold a generic rank, but as there are no direct transition forms as yet known between it and *Coryphodon* I retain it for the present.

In conclusion I wish to add, that owing to the material referable to the species of *Coryphodon* having been, in most cases, found so widely dissociated, it has been impossible to state accurately their number. I am convinced that the large number of species which have been founded by Prof. Cope should be greatly reduced; and that in many cases his species are to be considered merely varieties, and that often these varieties are merely individual variations in the same species due to age and sex.