ART. XLIV.—*Hyopsodidae of the Wasatch and Wind River Basins*; by F. B. LOOMIS.

DURING the early summer of 1904, Amherst College sent a party into the Wasatch along the Big Horn River, where an unusually complete collection was obtained: later, collecting was continued in the Wind River beds, a new and rich locality having been found on the east side of Bridger Creek, about ten miles northwest of Lost Cabin Post Office, Wyoming. In the latter basin, the fauna of which has been but meagerly known, some 400 specimens, distributed among about 50 species, were found. As a large number of the species are new, the material, together with that of the Wasatch, has been used in a study of the families represented; reference also having been made to other collections from these horizons, especially those of Cope and the American Museum of Natural History, both being in that museum.

Order INSECTIVORA.

Family *Hyopsodidae*, Schlosser.

This family as now known includes two genera, *Hyopsodus* and *Sarcolemur*, both from the North American Eocene. The genera were originally classed among the Primates; and so in Cope's* and Osborn's† papers are placed under the suborder Mesodonta; or by Schlosser‡ under the equivalent Pseudolemuroidae. Wortman,§ however, has classed them among the Insectivora, giving the following reasons: 1, the incisors are 3/3; 2, the tympanic bulla is not ossified; 3, the structure of the molars is not Primate; 4, the enterocarotid circulation is that typical of the Insectivora; 5, the limb bones differ from those of any known Primate; 6, the metapodials are not Primate; 7, the phalanges are short; 8, the hallux is not opposable. The writer too would place the *Hyopsodidae* among the Insectivora and in the neighborhood of the genus *Erinaceus*.

The family may be defined as follows: teeth in a continuous series, cusps more or less pointed; superior molars with intermediate cusps (protoconule and metaconule); posterior internal cusp (hypocone) less developed than the other cusps; the lower molars with a low anterior buttress (protolophid) connecting the two anterior cusps; a second buttress behind the first, connecting the same cusps posteriorly (metalophid) more or less developed; the entoconid feebly developed (see fig. 1).

* Rep. U. S. Geol. Surv., iii, 738, 1884.

† Bull. Amer. Museum Nat. Hist., 178, 1902.

‡ Die Affen, Lemuren, Chiropteren N. S. W., 21, 1890.

§ This Journal, xv, 400, 1903.

Two genera are distinguished by Cope and Osborn on the condition of the metaconid: when simple, *Hyopsodus*; if bifid, *Sarcolemur*. The two genera are certainly distinct but further characters are required to separate them; for several jaws, which, in all other features, are most closely related to *Hyopsodus*, still have the metaconid bifid. This character has also been noticed as occurring in the genus *Eohippus*, *Phenacodus*, and *Systemodon*, and is not, therefore, considered alone enough to separate the two genera. The bifid metaconid is used below to distinguish some of the species of *Hyopsodus*.

Hyopsodus is characterized by lower wider teeth, the cusps being blunter; the fourth premolar is wide and not compressed, having fewer and less developed cusps. It occurs in the Wasatch, Wind River and Bridger horizons. In several species there is a tendency to have the metaconid bifid, but it is never as marked as is characteristic of *Sarcolemur*.

Sarcolemur is characterized by narrow trenchant teeth, with pointed cusps; the fourth premolar is much compressed and has the anterior cusps well developed. It is as yet known only from the Bridger, and of the promolars only the fourth is known.

HYOPSODUS Leidy

Lemuravus Marsh, *Stenacodon* Marsh, *Microsus* Leidy, *Diacodexis*, Cope.

The genus was founded by Leidy* on an imperfect lower jaw of *H. paulus* from the neighborhood of Ft. Bridger. The name *Microsus*† was given the same year to a second species differing only in the proportionate depth of the mandibular ramus. *Stenacodon*‡ was founded by Marsh on what proves to be a last lower molar, the genus being separated on the ground that there was no cingulum. *Lemuravus*§ was proposed for a species on the basis of the incisor formula being 3/3 which, later, proved to be true for *Hyopsodus*. *Diacodexis*|| was proposed by Cope for a specimen, including premolars of *Eohippus*. As yet the only members of the family found in the Wasatch and Wind River horizons belong to the genus *Hyopsodus*, the skeletal features of which are as follows:

The skull is elongate with a level top terminating abruptly behind, the rear of the cranium overhanging the occipital condyles, somewhat as in Rodent skulls. The zygomatic arches are slender but widely arched. On the deep lower jaw, the anterior border of the surface for attachment of the masseter

* Proc. Acad. Nat. Sci., Phila., 110, 1870.

† Same cit., p. 113.

‡ This Journal, ii, 210, 1892.

§ Same cit., vol. iv, p. 239, 1875.

|| Proc. Amer. Phil. Soc., vol. xxi, 181, 1883.

muscle lies just under the last molar. The teeth are in a continuous series but without crowding. In the upper jaw, the hypocone of the last molar is merely a rudiment, indicated by a slightly raised portion of the cingulum. Molars one and three have a small but distinct hypocone, the cingulum running to it. The first and second premolars have a single cusp while the third and fourth each have inner cusps. The canines are moderate and the three incisors simple. Specific characters are found only in the cingulum and size of the form. The lower teeth are more varied, especially the last molar. The general topo-

FIG. 1. A typical *Hyopsodus* lower molar. $\times$ nat. size.

graphy of a lower tooth with the nomenclature here used is given in fig. 1. On the front part of the tooth the protoconid and metaconid are the principle cusps, connected anteriorly by a low curved protolophid. The inner end of this is in some species developed into a tiny cusp, the possible equivalent of the paraconid. Behind, these same two cusps are usually united by a metalophid, and the hypoconid is connected to the metaconid by a more or less developed ridge (hypolophid). The entoconid is always feebly developed, and between it and the hypoconid there is a strong hypoconulid. The fourth premolar has the protoconid and deutoconid well developed, and from the former a ridge runs to the front, while a second ridge runs from the same cusp to the rear, developing in some species one or two cusps on the margin. The third premolar is similar but simpler.

Of the milk dentition I have seen nothing which is worthy of note among so many specimens.

The skeletal material, while rather fragmentary, gives many of the characters which determine the ordinal position of genus. The stout humerus is widened at the distal end and pierced by a supratroclear foramen (similar to *Erinaceus*).

The olecranon process of the ulna is long (distinctly an Insectivor character), and the greater sigmoid cavity is very wide, the less sigmoid cavity being also well marked. The femur is short, thick and flattened, and has a strong third trochanter. (This is not found in Primates, but is especially well marked in *Erinaceus*.) Finally, according to Wortman, the metapodials are short and stout, and the hallus not opposable (both Insectivor features).

Hyopsodus simplex sp. nov.

The specimens of this, the smallest and at the same time most abundant of the Wasatch species, were referred by Cope to *H. vicarius* and *H. paulus*, both of the Bridger horizon. Osborn* provisionally referred them to *H. miticulus* Cope, from the New Mexico Wasatch, but differing from *H. simplex* in being somewhat larger and having a low ("Esthyonyx-like") heel and in having the posterior cusps more developed.

For a type, a lower jaw of the left side carrying the fourth premolar and the molars is chosen. All the teeth of the lower jaw are short and wide with obtuse cusps. On each there is a trace of a cingulum about the rounded anterior outer corner of the tooth and also externally between the cusps. On the wide fourth premolar the protoconid is better developed than the deutoconid, and behind there is a wide basin, the posterior margin of which is crenulated. On molars one and two the protolophid is well developed, while there is not more than a trace of a metalophid. A strong ridge runs from the hypoconid to the metaconid. The entoconid is weak and has a small tubercle in front of it, very characteristic of the species. On the last molar the heel region consists of a basin bounded behind by a high crenulated rim, on which the hypoconulid and entoconid appear as crenulations, scarcely larger than the others.

FIG. 2. *Hyopsodus simplex*. Left ramus. $\times 4$.

Each of the upper molars has the cingulum in front, outside and behind. The last of these molars is much reduced and is without a true hypocone. Promolars three and four have each an internal cusp, while the front two are simply cusps.

Affinities—*H. simplex* is about the same size as *H. vicarius* from the Bridger, but the molars are shorter and more robust, while the hypoconulid is less developed and has an extra tubercle in front of it. *H. paulus* is a much larger and better developed species. *H. miticulus* is the nearest form, the more specialized and low talonid, and the superior size distinguishing it from *H. simplex*.

* Bull. Amer. Museum Nat. Hist., xvi, 183, 1902.

Locality—27 specimens were collected from both the upper and lower beds of the Wasatch on Gray Bull River.

They run very uniform in size, the length of the three lower molars being between 10 and 11^{mm}. In a few cases the last lower molar was considerable smaller than the normal.

Hyopsodus miticulus Cope.*

This form from the New Mexico Wasatch is thus described by Cope: "Parts of several specimens of this species show that the molars are similar in size to *H. paulus*, but that it has a much smaller last inferior molar, which has such a low heel as to resemble the corresponding tooth of the species of *Esthonyx*."

The species seems to resemble *H. simplex* most, but is larger and differs in the heel being low, and more developed. The last molar is also proportionally smaller. The two cannot in the writer's opinion be included in one species.

Hyopsodus lemoinianus Cope.†

This species presents several difficulties on account of the large amount of variation in size, and in the development of both the metaconid and the metalophid; but in as much as these variations do not seem to be constant, and as intermediate forms are found between the widest variations, all these related forms have been assigned to the one species. *H. lemoinianus* was established by Cope, who figured a left ramus with the molars, on which the metaconid is but slightly bifid. Osborn figures a second specimen with the metaconids also but little twinned. Most of the Amherst specimens have this cusp markedly bifid, as is seen in the specimen figured.

FIG. 3. *Hyopsodus lemoinianus*.
× $\frac{2}{1}$.

The species may be described as follows: There is a cingulum on the front of the tooth, and between the external cusps of the moderately stout teeth. On molars one and two, there is developed on the inner end of the protolophid a small but distinct paraconid, which makes the metaconid appear bifid. The metalophid is either entirely wanting or but moderately developed. The entoconid is small, as is also the hypoconulid. The last lower molar is longer, and similar except that the hypoconulid is developed into a prominent heel. On the upper molars the cingulum is well marked and the cusps fairly high.

The three lower molars measure 13 to 15^{mm}, there being considerable variation in size. The nine specimens collected all occurred in the basal beds along the Gray Bull River, Wyoming.

* Rep. Vert. Fossils of New Mexico, Appen. F.F., Rep. Chief. Eng., 8, 1874.

† Proc. Amer. Phil. Soc., xx, 148, 1881.

Hyopsodus powellianus Cope.*

This, the largest species of the *Hyopsodidae*, occurs but infrequently, being known by parts of the lower jaw only. The teeth are low and wide with stout, low cusps and no cingulum. The metaconid is simple and widely separated from the protoconid. The hypoconulid is small, even on the last molar. The protolophid is low and the metalophid lacking. On the last molar the entoconid region is occupied by two small cusps.

FIG. 4. *Hyopsodus powellianus*. $\times \frac{2}{1}$.

The three lower molars measure together 18^{mm}. In the Amherst collection the species occurs but twice, both specimens coming from the basal beds of the Wasatch of the Gray Bull River, Wyoming.

Hyopsodus laticuneus Cope.†

A single specimen represents this species, on which the genus *Diacodexis* also hangs. The specimen included both upper and lower teeth, but Matthew has removed the lower premolars and assigned them to *Eohippus index*, leaving the upper molars which are characteristic of the genus *Hyopsodus*, and a last lower molar which is distinguished by low broad crown with obtuse cusps, lack of an external cingulum and the entoconid region occupied by two small cusps, and lastly by the metaconid being bifid. This last character alone distinguishes the species from *H. powellianus* to which it is equal in size. The specimen came from the Wasatch in the neighborhood of Gray Bull River.

In the Wind River horizon, four species are known, three of which are here described for the first time. This horizon is marked by a slight advance in the development of the genus. The hypoconulid is stronger, especially on the last molar, and in the entoconid region there is only a single strong cusp, the entoconid. The metalophid is universally present.

In the locality found by the Amherst party the specimens of *Hyopsodus* formed fully a third of the collection.

Hyopsodus wortmani Osborn.‡

The type specimen (including an upper and a lower jaw) was first figured by Cope among *H. vicarius* specimens, and was later by Osborn removed and used as the type of this species, the description however being very meager.

The teeth are moderately wide with rather low cusps and a cingulum along the front only. On the fourth premolar the protoconid and deutoconid are connected by a sharp ridge; the basin behind is wide, and on the outer side of the rim is a

* Rep. U. S. Geol. Surv., iii, 235, 1884.

† Proc. Amer. Phil. Soc., xx, 181, 1881.

‡ Bull. Amer. Museum Nat. Hist., xvi, 185, 1902.

small cusp. The protolophid and metalophid are both well developed on the first and second molars but on molar three the latter is very weak. The hypoconulid is small on the first two molars but developed into a prominent heel on the last, the entoconid being tiny. The upper molars are those typical of the genus, having a cingulum in front, outside and behind.

FIG. 5. *Hyopsodus wortmani*. $\times \frac{2}{1}$.

The specimens run uniform in size, the three inferior molars measuring 12^{mm}. On Bridger Cr., 37 specimens were collected and the species occurs also in the other Wind River localities.

Hyopsodus minor sp. nov.

Though but one example of this tiny form was found, it differs so materially from *H. wortmani* that it is impossible to include it in that species. The type specimen is part of the right ramus with the three molars measuring together 10^{mm}.

The teeth are short, with obtuse but well-separated cusps, and have a cingulum in front and a trace of it between the external cusps. The proto- and meta-conids are set close together and united by both a protolophid and metalophid. The hypoconid has a strong ridge running to the metaconid, while the hypoconulid and entoconid are both strongly developed.

FIG. 6. *Hyopsodus minor*. $\times \frac{2}{1}$.

The species is distinguished by its small size, presence of a cingulum externally and the strength of the ento- and hypoconulid. The locality is Bridger Cr., Wyoming, in the Wind River horizon.

Hyopsodus browni sp. nov.

This, the most abundant species in the Wind River beds, is named in recognition of the successful work of Mr. T. C. Brown in collecting these forms. The type is a left ramus with the molars and fourth premolar; while an upper jaw with premolars three and four is associated with it as co-type. A less complete specimen has both upper and lower dentition.

The teeth of the lower jaw are short and stout with obtuse cusps, and a cingulum along the front only. On the fourth premolar the deuterioconid is merely indicated by a small cusp, and behind on the proterior margin of the basin, there is a small external cusp. On all the molars the proto- and meta-conids are set close together and united by both a proto- and meta-lophid. The hypoconid is large and connected the metaconid by a wide ridge. The hypoconulid is rather large on all the molars but does not make a strong heel on the third molar.

The upper molars have a cingulum in front, outside and behind; on the which, where it meets the ridge from the para-

cone, there is a strong parastyle. The protoconule is closely united to the protocone. The last molar is large, but still lacks the hypocone. The third and fourth premolars have the parastyle but lack the intermediates and hypocone.

The species includes the medium sized individuals of the Wind River, the three lower molars measuring 15^{mm}. It compares in size to *H. lemoinianus* but lacks the external cingulum, and has a simple metaconid as well as having much more obtuse cusps. There are 45 specimens in the Amherst collection all from Bridger Cr., Wyoming.

FIG. 7. *Hyopsodus browni*. $\times \frac{2}{3}$.

Hyopsodus jacksoni sp. nov.

In many ways this is the most specialized of the *Hyopsodidae*, and it has been named in recognition of the interest and coöperation of Mr. E. E. Jackson in the Amherst expeditions. The type is a right ramus with the molars and the fourth premolar, and a third premolar from the left side. The co-type contains three upper molars.

The lower molars are rather narrow with moderately high cusps and a cingulum along the front side only. The metaconid is bifid, strongly so on the first molar, and just visibly so on the last. The protoconid and metaconid are widely separated and connected by the protolophid only. The hypoconulid is throughout small; and on the third molar connected by a ridge to the entoconid. The fourth premolar is complex, the protoconid and deutoconid being connected by a ridge; and there are two well-developed cusps behind on the posterior rim. The third premolar is similar but lacks the two posterior cusps. The upper molars are those typical of the genus, with the cingulum well developed on the outside. A distinct parastyle is formed on the anterior external angle of the cingulum. The posterior intermediate is isolated while the anterior one is connected to the protocone.

The three lower molars measure together 16^{mm}. 26 specimens were found along Bridger Cr., Wyoming.

FIG. 8. *Hyopsodus lawsoni*. $\times \frac{2}{3}$.

HYOPSODUS.

	H. simplex.	H. miticulus.	H. lemoinianus.	H. powellianus.	H. laticuneus.	H. wortmani.	H. minor.	H. browni.	H. lawsoni.
Lower premolar 4	Deuteroconid strong: posterior margin of basin crenulated without cusps		Deuteroconid strong and bifid: posterior margin of basin with two tiny cusps			Deuteroconid smaller than protoconid: connected by ridge: posterior margin with external cusp		Deuteroconid very small: with external cusps	Deuteroconid connected to protoconid by ridge: posterior margin with two cusps
Lower molars 1 & 2	External cingulum, traces: hypoconulid large: no metalophid: entoconid with tubercle in front: metaconid simple	No external cingulum: hypoconulid medium: no metalophid: entoconid simple: metaconid simple	External cingulum, traces: hypoconulid strong: no metalophid: entoconid medium simple: metaconid bifid	No external cingulum: hypoconulid small: no metalophid: entoconid small: metaconid simple	No external cingulum: hypoconulid large: metalophid: entoconid medium: metaconid simple	No external cingulum: hypoconulid small: metalophid: entoconid small: cusps alternating: metaconid simple	No external cingulum: hypoconulid large: metalophid: entoconid medium: metaconid simple	No external cingulum: hypoconulid large: metalophid: entoconid medium: cusps alternating: metaconid simple	No external cingulum: hypoconulid small: metalophid: entoconid weak: entoconid small: metaconid bifid
Lower molar 3	External cingulum, traces: metaconid simple: entoconid one of several small tubercles: heel not prominent	No external cingulum: metaconid simple: entoconid with a small tubercle in front of it: heel fairly prominent	External cingulum, traces: metaconid bifid: entoconid with small tubercle in front: heel prominent	No external cingulum: metaconid simple: entoconid with large tubercle in front of it: heel not prominent	No external cingulum: metaconid bifid: entoconid with small tubercle in front of it: heel fairly prominent	No external cingulum: metaconid simple: entoconid with small tubercle in front of it: heel prominent	No external cingulum: metaconid simple: entoconid simple: heel prominent	No external cingulum: metaconid simple: entoconid simple: heel prominent	No external cingulum: metaconid simple: entoconid simple: heel prominent
Length of 3 lower molars	10-11 mm	12 mm	13-15 mm	18 mm	About 18 mm	12 mm	10 mm	15 mm	16 mm
Horizon	Wasatch	Wasatch (New Mexico)	Wasatch	Wasatch	Wasatch	Wind River	Wind River	Wind River	Wind River
No. of specimens	27	0	9	2	0	37	1	45	26