

On the classification of the order Glires / by Edward R. Alston.

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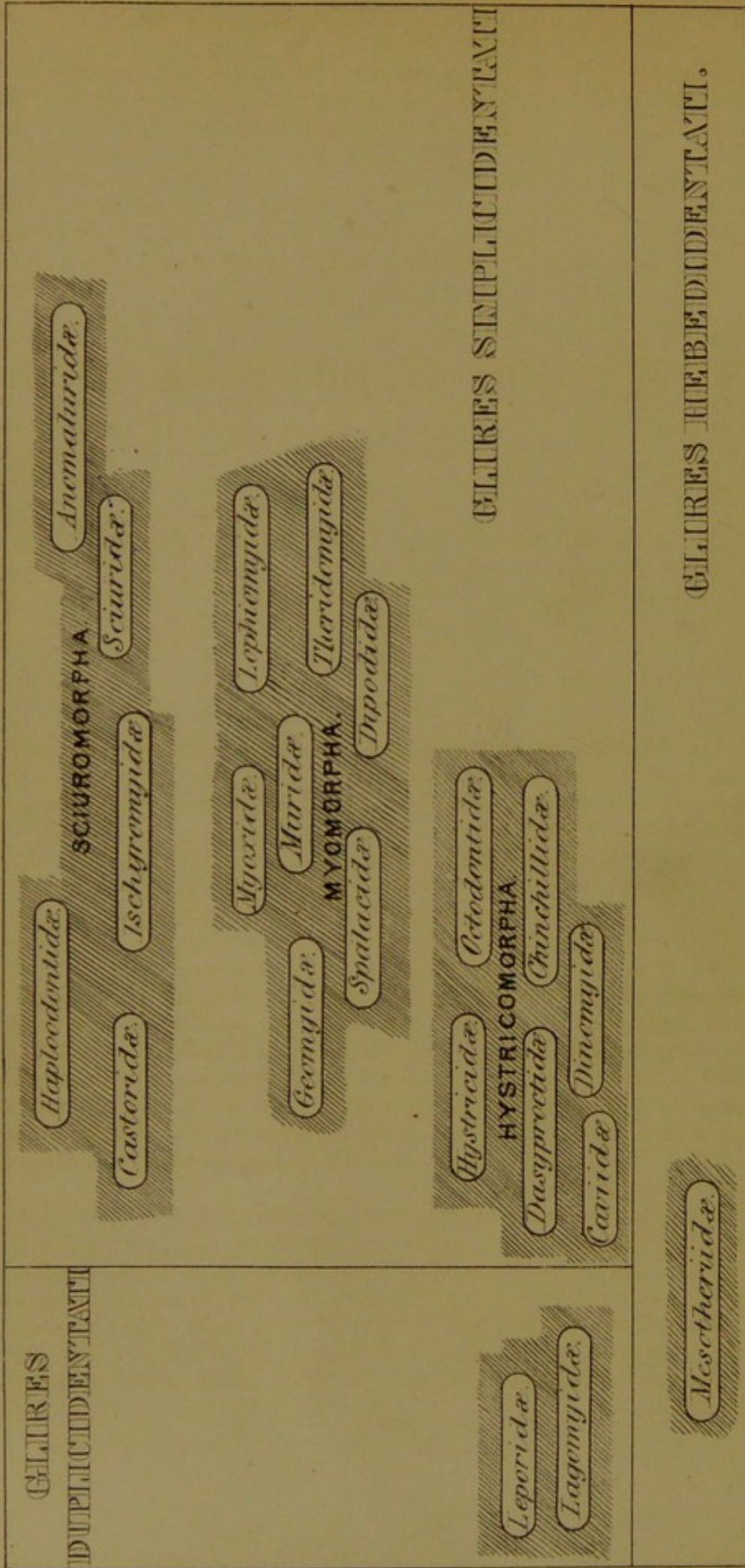
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CHART OF FAMILIES OF THE ORDER GLIRES.

A. Doran Esq.
With the Author's Compts
June 1876

[From the PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON,
January 18, 1876.]

H.

ON THE
CLASSIFICATION OF THE ORDER GLIRES.

BY

EDWARD R. ALSTON, F.G.S., F.Z.S.

did much 14/1881, aged 35.



(Plate IV.)

The following attempt at a natural arrangement of the gnawing mammals is the result of a revision of the genera of that order, undertaken at the suggestion of Professor Flower, on which I have been for some time engaged.

In laying it before the Society it may be well to say at once that the proposed classification has few claims to novelty, being in fact a modification of that first suggested by Mr. Waterhouse, and since improved by Professors Gervais, Brandt, and Lilljeborg. Nevertheless I have found it necessary to propose several changes in the arrangement of the families and subfamilies, as well as rectifications in their nomenclature. I have also taken the fossil forms into consideration, and have thereby been compelled to propose the establishment of a new suborder. Lastly; I have endeavoured to bring the whole up to a level with the improved state of our knowledge, which has gained much of late years from the labours of Milne-Edwards, Gray, Günther, Leidy, Coues, and others, but, above all, from those of Dr. Peters.

The order *Glires* has always been a stumbling-block to naturalists, owing to the immense number and variety of the forms which it includes, and to their puzzling cross-relationships to one another. Nor has palæontology here yielded, save in a few instances, the same help which she has lent the student of some other orders of mammals; for most of the fossil rodents yet discovered are referable to families which still exist, and are often closely allied to recent genera.

These difficulties were insuperable as long as zoologists placed their trust in outward appearances; and when sounder principles gained ground it was some time before the necessary anatomical data could be collected. Without detailing all the classifications which have been proposed within the last fifty years, I must briefly mention the memoirs of the four zoologists on whose labours, as already stated, the following proposed arrangement is chiefly based.

In 1839, Mr. G. R. Waterhouse, then Curator of this Society, published the first of a series of essays in which he may confidently be said to have laid down the groundwork of a natural arrangement of this order*. Unfortunately, as the mammalogist must think, this accurate and thoughtful zoologist has long since turned his attention to other departments, and only a small portion of his great work on the Rodentia ever appeared†. In his first papers Mr. Waterhouse, taking the characters of the skull and mandible as his chief guides, arranged the Rodents into three great families, the *Murina*, *Hystricina*, and *Leporina*, with twelve subfamilies. Continuing his labours for ten years, his views were naturally changed on many points. Latterly he separated the *Sciuridæ* as a group equal in value to the other two, the following being the arrangement of families and subfamilies adopted in his later writings:—

RODENTIA.

- | | |
|----------------------------|--------------------------|
| I. <i>Sciuridæ</i> . | III. <i>Hystricidæ</i> . |
| II. <i>Muridæ</i> . | 1. <i>Hystricina</i> . |
| 1. <i>Sacomyina</i> . | 2. <i>Dasyproctina</i> . |
| 2. <i>Dipodina</i> . | 3. <i>Echimyina</i> . |
| 3. <i>Ctenodactylina</i> . | 4. <i>Octodontina</i> . |
| 4. <i>Murina</i> . | 5. <i>Chinchillina</i> . |
| 5. <i>Spalacina</i> . | 6. <i>Caviina</i> . |
| 6. <i>Arvicolina</i> . | IV. <i>Leporidæ</i> . |
| 7. <i>Bathyergina</i> . | |

In 1848 Professor Gervais published an arrangement of this order, in which he instituted two principal sections or suborders‡. The first of these included the ordinary Rodents with only one pair of incisors above and below; the second consisted of those with two pairs in the upper jaw, and was consequently equivalent to Illiger's group *Duplicidentæ*§. The following was Professor Gervais's arrangement of the families:—

* "Observations on the Rodentia," Mag. Nat. Hist. iii. pp. 90-96, 184-188, 274-279, 593-600; Ann. Nat. Hist. viii. pp. 81-84, x. pp. 197-203 (1839-42). "On the Geographical Distribution of the Rodentia," P. Z. S. 1839, pp. 172-174. "Order Rodentia," Keith Johnston's Physical Atlas, Phytology and Zoology, map. 5, letterpress (1849).

† Natural History of the Mammalia, vol. ii. "Rodentia." London 1848 (includes only the families *Leporidæ* and *Hystricidæ*).

‡ Dict. Univ. d'Hist. Nat. xi. p. 202 (1848); Ann. Scien. Nat. 3^{me} sér. t. xx. pp. 245, 246 (1853).

§ Prod. Syst. Mamm. p. 91 (1811).

GLIRES.

- | | |
|--------------------------------|------------------------------------|
| I. <i>Rongeurs ordinaires.</i> | 6. Lagostomidæ. |
| 1. Sciuridæ. | 7. Hystricidæ. |
| 2. Pseudostomidæ*. | 8. Caviadæ. |
| 3. Muridæ. | |
| 4. Dipodidæ. | II. <i>Rongeurs duplicidentés.</i> |
| 5. Ctenomydæ. | 9. Leporidæ. |

In 1855 appeared Professor J. F. Brandt's learned and elaborate review of the cranial structure and classification of recent Rodents†. On the whole he adopted Mr. Waterhouse's arrangement; but recognizing the fact that his four groups were of more than family value, he raised them to the rank of suborders. He also made several changes in the arrangement of the families and the position of some of the more doubtful forms, and imposed new names on all the divisions, which he arranged in the following order:—

GLIRES.

- | | |
|-------------------------|-----------------------------|
| I. <i>Sciuiomorphi.</i> | III. <i>Hystricomorphi.</i> |
| 1. Sciuroïdes. | 8. Hystricoïdes. |
| II. <i>Myomorphi.</i> | 9. Spalacopodoïdes§. |
| 2. Myoxoïdes. | 10. Eriomyoïdes . |
| 3. Castoroïdes. | 11. Hemionychoïdes¶. |
| 4. Sciurospalacoïdes‡. | IV. <i>Lagomorphi.</i> |
| 5. Myoïdes. | 12. Lagoïdes. |
| 6. Spalacoïdes. | |
| 7. Dipodoïdes. | |

Eleven years later Professor Lilljeborg published his admirable systematic review of this order**. Appreciating the great importance of the characters which separate the *Leporidæ* and *Lagomyidæ* from all other rodents, he adopted Gervais's two suborders under the names *Glires Simplicidentati* and *Glires Duplicidentati*. In the arrangement of the former he pointed out a well-marked and constant character which separates the *Myomorphi* of Brandt from both the *Sciuiomorphi* and the *Hystricomorphi*, namely the complete ankylosis in the former of the lower part of the tibia and fibula. Although Professor Lilljeborg does not retain these divisions in his tabular arrangements, he observes that the *Myomorphi* include the

* *Sacommyina*, Waterhouse.

† J. F. Brandt, "Untersuchungen über die craniologischen Entwicklungsstufen . . . und Classification der Nager der Jetztwelt," *Mém. de l'Acad. Imp. de St. Pétersbourg*, 6^{me} série (Sciences Naturelles), vii. pp. 127-336, 12 pls. (1855).

‡ Containing *Geomys* and *Thomomys*.

§ Equal to *Echimyina* and *Octodontina* of Waterhouse.

|| *Chinchillina*, Waterh.

¶ Equal to *Dasyproctina* and *Caviina*, Waterh.

** Systematisk Öfversigt af de Gnagande Däggdjuren, *Glires*. 4to. Upsala, 1866.

first *six*, the *Sciuromorphi* the *seventh*, and the *Hystricomorphi* the *eighth* to *eleventh* families in the following Table:—

GLIRES.

- | | |
|-----------------------------|-----------------------------|
| I. <i>Simplicidentati</i> . | 8. Haploodontidæ. |
| 1. Muridæ. | 9. Chinchillidæ. |
| 2. Spalacidæ. | 10. Spalacopodidæ. |
| 3. Dipodidæ. | 11. Hystricidæ. |
| 4. Myoxidæ. | II. <i>Duplicidentati</i> . |
| 5. Saccomyidæ. | 12. Lagomyidæ. |
| 6. Castoridæ. | 13. Leporidæ. |
| 7. Sciuridæ. | |

In his recent work on Scandinavian mammals*, Professor Lilljeborg retains the above arrangement, adding a new family, allied to the Muridæ, for the reception of Milne-Edwards's genus *Lophiomys*.

As it became clear that the cranial characters of the groups proposed by Waterhouse and Brandt are liable to exceptions, and that they are connected by more or less intermediate forms, they have not been regarded with favour by recent systematic writers; nevertheless the affinities which they indicate have been very generally accepted in the arrangement of the families. But if a group is a natural one, it should not, I think, be rejected because it is difficult to characterize. The Insectivora may be taken as an example of a very natural order, of which, in Professor Huxley's words, "it is exceedingly difficult to give an absolute definition." Even if it were not possible to separate the first three of Waterhouse's great families by perfectly constant characters, they ought, as it appears to me, to be recognized as indicating three distinct lines of development. But by the help of the characters of the leg-bones, pointed out by Professor Lilljeborg, the difficulty is overcome. In the few cases in which the cranial differences fail us in separating the sciurine rodents from the murine, and the latter from the hystricine, the complete ankylosis of the lower part of the tibia and fibula in the second group comes to our aid. As far as I am aware, there is no real exception to this rule; for the union between these bones sometimes observed in the genus *Pteromys*, in aged individuals of *Castor*, and in several of the hystricine series, is totally different from the true fusion which we meet with in all the known *Myomorphi*. The first and third groups, which agree with one another in this point, are at once separated from each other by the form of the mandible, as well as by the whole type of cranial structure.

But while recognizing these groups as true and natural, I cannot consider them to have any thing like the rank of Brandt's *Lagomorphi*, and rather treat them as sections of Lilljeborg's suborder *Glires Simplicidentati*, of somewhat similar value to the sections instituted by Turner and Flower in the *Carnivora fissipedia*.

Before proceeding to some general remarks on these various divisions, it should be premised that an absolutely equal value is not

* Sweriges och Norges Rygggradsdjur, I. Däggdjuren. Upsala, 1874.

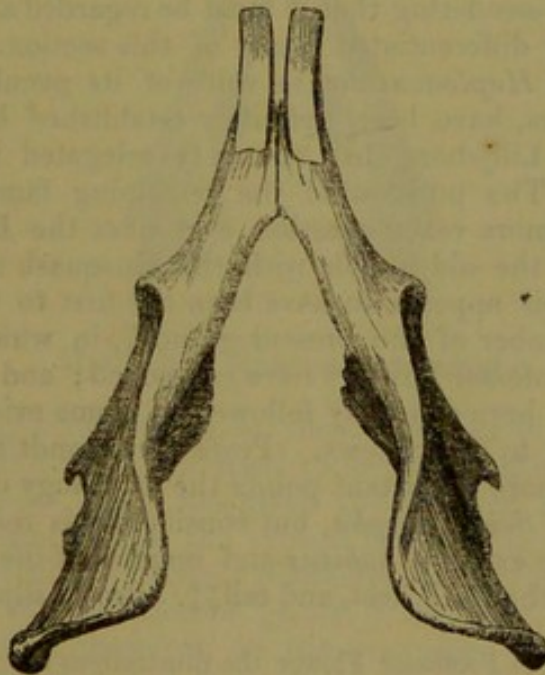
here claimed for all the families and subfamilies. Such is the variety of the extent of differentiation that it appears to me that no Procrustean standard can be applied. Either we must load our memories with tribes, legions, cohorts, series, superfamilies, &c., or we must be content with divisions pretending only to an *approximate* equality of value.

General Remarks.

The first suborder of Rodents, GLIRES SIMPLICIDENTATI, contains an enormous majority of both the recent and extinct forms, and is at once proved by its dentition to be the most highly specialized division of the order. There is only one pair of incisors above and below at all ages; and their enamel is restricted to their front surface. In the skull, the incisive foramina are moderate and separate, the optic foramina are very rarely confluent, and there is an alisphenoid canal*. The fibula is either ankylosed below to the tibia or free, and does not articulate with the calcanium. Vesicular glands are present; and the testes are usually abdominal, only temporarily descending into the scrotal pouches†.

Of this suborder the first section, *Sciuromorpha*, has for constant characters the combination of a peculiar form of mandible with

Fig. 1.



Mandible of *Arctomys marmotta*.

the persistence of the fibula as a distinct bone throughout life. The former character at once separates it from the *Hystricomorpha*, the latter from the *Myomorpha*. In the mandible the angular portion springs from the lower edge of the bony covering of the inferior incisor, not from its outer side; and its outline is more or less rounded.

* Cf. Turner, P. Z. S. 1848, p. 65. † Cf. Owen, Anat. of Vert. iii. p. 649.

The difference between the mandible characteristic of the *Sciuromorpha* and *Myomorpha* and that peculiar to the *Hystricomorpha* will be best shown by a comparison of the figures*. In the more typical forms the infraorbital opening is not enlarged to give passage to a portion of the masseter muscle; and in all the malar extends far forward, and is not supported below by a continuation backwards of the maxillary zygomatic process. The incisive foramina are small, and confined to the intermaxillaries; the foramina of the base of the skull are proportionally small; and there is no interpterygoid canal†. The clavicles are always perfect, the posterior ridge of the scapula is strongly developed, and the acromion is broad and flattened. Externally the muffle is naked, the upper lip usually cleft, the nostrils rounded above and comma-shaped, the ears hairy, and the tail cylindrical and well haired, except in *Castor*, in which it is flattened and scaly.

The typical family, the *Sciuridæ*, easily distinguished by their postorbital frontal processes, has been divided for convenience into two subfamilies, the long-tailed arboreal Squirrels (*Sciurinae*), and the short-tailed terrestrial Marmots (*Arctomyinae*), though it must be confessed that their differences are merely adaptive and not very striking. The other families are all more or less aberrant, and their true affinities have been the subject of much discussion.

The first of these is the *Anomaluridæ*; and I have already‡ given my reasons for considering that it must be regarded as an undoubted though specially differentiated family of this section. The sciurine affinities of the *Haplodontidæ*, in spite of its peculiar dental and cranial characters, have been definitely established by Dr. Peters§, although Prof. Lilljeborg has strangely relegated it to the *Hystricomorpha*||. The position of the remaining family, *Castoridæ*, has been a still more vexed question, ever since the Beaver has been extricated from the old jumble with the Musquash and the Coypu. Professor Gervais appears to have been the first to treat *Castor* as an aberrant member of the present group¶, in which Mr. Waterhouse** and Professor Baird†† have concurred; and although these writers have not been generally followed, it seems evident to me that we must revert to their views. Professor Brandt fully recognized that in all the more important points the osteology of *Castor* agrees with that of the *Sciuromorpha*, but considers this resemblance to be negated by the external *habitus* and manner of life, as well as by the structure of the teeth, feet, and tail‡‡. Prof. Lilljeborg places the

* By permission of Professor Flower the illustrations have been drawn from specimens in the Museum of the Royal College of Surgeons.

† This name was proposed by Mr. Waterhouse for the fissure which in some rodents leads from the bottom of the pterygoid fossa into the orbit. Cf. Turner, P. Z. S. 1848, p. 63.

‡ "On *Anomalurus*, its Structure and Position," P. Z. S. 1875, pp. 88-97.

§ Monatsb. Ak. Berlin, 1864, p. 177. || *Op. cit.* p. 9.

¶ Dict. Univ. d'Hist. Nat. xi. p. 203.

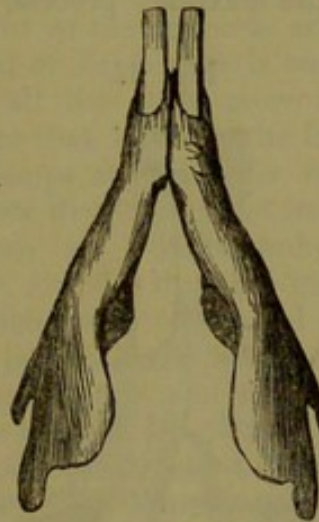
** Physical Atlas, Zool. map, 5 (letter-press).

†† North-American Mammals, p. 350.

‡‡ *Op. cit.* pp. 149, 150.

Castoridae among the *Myomorpha*, but on the boundary between them and the *Sciuromorpha*, remarking that the fibula is stout, and remains long separate from the tibia*. But the characters of these bones seem to me to be strictly sciurine; for though they are more or less firmly attached to one another in aged individuals, yet they always appear to remain essentially distinct throughout their length. Less weight is now generally given to external characters than was the case when Prof. Brandt wrote; and the purely adaptive differentiation of the teeth, feet, and tail cannot be allowed to outweigh the numerous and important characters which are at once evident on a careful comparison of the skulls and skeletons of a Beaver and a Marmot. These external peculiarities, coupled with those of the digestive, excretory, and generative organs, certainly show that the *Castoridae* is a very isolated and aberrant family; but they do not appear to indicate any specially murine affinities.

Fig. 2.

Mandible of *Cricetomys gambianus*.

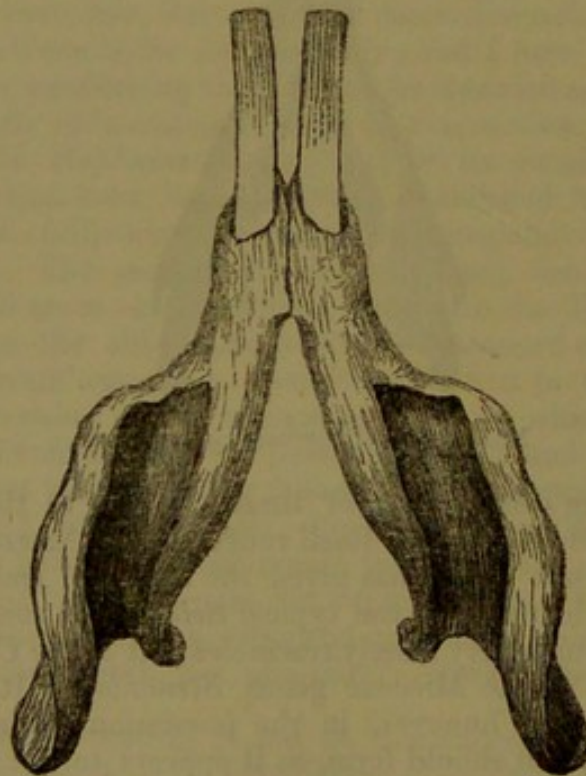
An interesting confirmation of these views as to the position of the Beaver is afforded by the fossil rodent of the American Miocene, to which Professor Leidy has given the name of *Ischyromys*. In this form the dentition of the typical *Sciuridae* is combined with a form of skull which very closely resembles that of the *Castoridae*, and especially that of the Miocene genus *Stenofiber*. It differs from both these groups, however, in the possession of a large infra-orbital opening, and should form, as it appears to me, a fifth family of the *Sciuromorpha*, under the name of *Ischyromyidae*†.

The second section, *Myomorpha*, is at once separated from either of the others by the single character of the complete fusion in the adult of the lower part of the tibia and fibula. Externally, the muffle and upper lip are as in the last section; and the tail is cylin-

* *Op. cit.* pp. 7, 35.† *Cf. Leidy, Journ. Acad. Philadelphia*, 2nd ser. vol. vii. pp. 335-338, pl. xxvi.; *Cope, Report U.S. Geol. Survey*, 1873, p. 477.

drical, either covered with scales arranged in rings, or more or less hairy. The *Myomorpha* contains such a variety of forms, many of them much specialized, that it is only by allowing for exceptions that its definition can be carried further; still many and important distinctions are common to the vast majority. The form of the mandible, by which the section was first separated from the *Hystriomorpha*, agrees with the last section, the angular portion springing from the lower edge of the bony covering of the lower incisor, excepting in the subfamily *Bathyerginæ*, in which it has exactly the form so characteristic of the hystricine rodents. The other cranial characters are very varied. In the more typical forms the infra-orbital opening has a peculiar shape, which may be termed *murine*; it is high, perpendicular, narrow, wider above than below; and the lower root of the maxillary zygomatic process is perpendicular and flattened into a thin plate with a rounded anterior edge. The zygoma is comparatively slender; the malar seldom advances far forward (except in the *Dipodidæ*), and is usually supported below by a continuation backwards of the maxillary process, being reduced in some

Fig. 3.

Mandible of *Bathyergus maritimus*.

of the typical genera to a mere splint between the latter and the squamosal process. The outer walls of the pterygoid fossæ are generally obsolete; and they have no direct fissure at the bottom, except in the aberrant subfamily named above. The clavicles are perfect except in the *Lophiomyidæ*.

Of the seven well-marked families into which this section may be divided, the typical one, the *Muridæ*, comprises a great number of genera. The best classification of these with which I am acquainted is that of Dr. Peters, which is here adopted with some little modification, his groups being ranked as subfamilies, and a slight alteration being made in their arrangement*. M. A. Milne-Edwards having clearly proved that the genera *Ellobius* and *Siphneus* really belong to this family†, the subfamily *Siphneinæ* is now placed alongside of the *Arvicolinæ*, with which it is so nearly allied.

Of the other families, the *Myoxidæ* bear a very strong outward resemblance to the *Sciuromorpha*, which, however, is not markedly confirmed by their anatomy. Dr. Peters having shown that *Platacanthomys* must be removed to the *Muridæ*‡, the remaining genera of Dormice are all very closely allied, and are isolated from all other known rodents by the complete absence of the cæcum. The next family, *Lophiomyidæ*, contains a single form differing in structure not only from all the rest of the order, but even from all the known members of the mammalian class§. Nevertheless, if the extraordinary development of the temporal and malar regions be overlooked, the whole skull of *Lophiomys* is truly murine in type; and this is confirmed by all the other more important points in its anatomy. It is strange that, although its habits appear to be at least partly arboreal, *Lophiomys* should differ from all the rest of the section in the incomplete development of its clavicles.

The *Spalacidæ*, even when disencumbered by the removal of *Siphneus* and *Ellobius*, are still divisible into two subfamilies—the typical *Spalacinæ*, which have the normal mandible of the section, and the *Bathyerginæ*, in which are found the hystricine characters already mentioned (*suprà* p. 68), and which were hence named *Spalaces subhystriciformes* by Prof. Brandt. The next family, which includes the American rodents with cheek-pouches which open *outside* the mouth, was founded by Mr. Waterhouse under the name of *Sacomymidæ*, and subsequently divided by Prof. Baird into two subfamilies, *Geomyinæ* and *Sacomycinæ*. Dr. E. Coues, in a recent valuable memoir, has contended that these latter divisions should rank as separate though allied families||—a view in which I cannot agree. The diversity in their outward form may be paralleled by that in the Squirrels and Marmots; and the differences in their cranial structure are, as Dr. Coues himself observes, of a superficial nature. In any case, Mr. Waterhouse's name must be changed; for Dr. Peters has shown¶ that the genus *Sacomys* of Frederic Cuvier is in all probability, a synonym of Desmarest's *Heteromys*. The oldest and best-

* The names only of these divisions appeared in the Monatsb. Ak. Berlin, 1866, pp. 13, 14.; for access to Dr. Peters's hitherto unpublished characters I am indebted to the courtesy of the author.

† Recherches pour servir à l'Hist. Nat. des Mammifères, pp. 71–129.

‡ P. Z. S. 1865, pp. 397–399.

§ Cf. A. Milne-Edwards, Nouv. Arch. du Mus. iii, pp. 81–118.

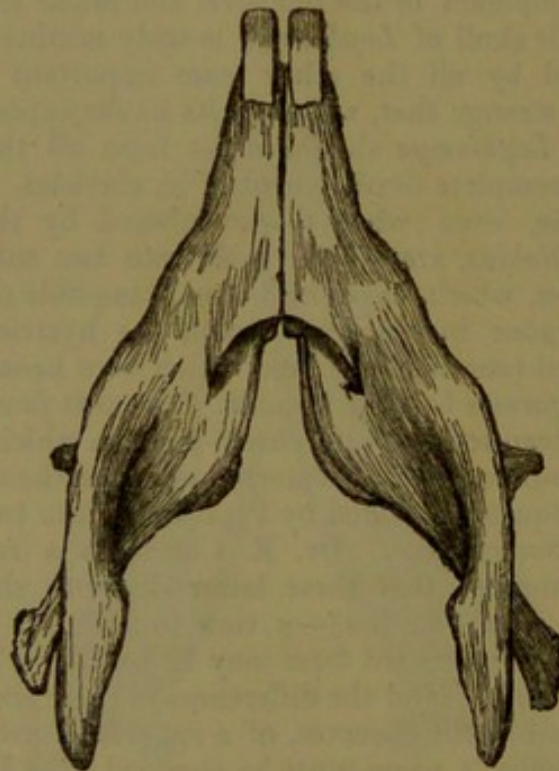
|| Rep. Explor. Colorado River, p. 215; Bull. U.S. Survey of Territories, 2nd ser. no. 2, pp. 81–90.

¶ Monatsb. Ak. Berlin, 1874, p. 354–359.

known genus will therefore legitimately give name to the family *Geomyidæ*, the subfamilies standing as *Geomyinæ* and *Heteromyinæ*.

Here I am inclined to place, at least provisionally, a family of Rodents which flourished in Europe in the later Eocene and Miocene periods, and of which three genera are known. Each of these was at first ascribed to a distinct family of the *Hystricomorpha*—namely, *Theridomys* to the *Octodontidæ*, *Archæomys* to the *Chinchillidæ*, and *Issiodoromys* to the *Caviidæ*. M. Gervais was the first to remove them entirely from that section, uniting the first two in his tribe *Théridomins* of the family *Myoxidés* (which also included *Anomalurus*). He placed *Issiodoromys* in his *tribu des Pédétins* of the *Dipodidæ*, but with the remark that it might have to be relegated to the *Théridomins**. That these animals were strictly myomorphine is clearly shown by the form of their mandibles. Now that *Anomalurus* has been definitely separated from the *Myoxidæ*, there seems to be nothing to unite these ancient rodents with that

Fig. 4.

Mandible of *Capromys pilorides*.

family; and, both in their very varied dentition and in what we know of their cranial characters, they appear to me to be very nearly related to the *Dipodidæ*—the two former to the true *Dipodinæ*, and the last to the *Pedetinæ*. Meantime it may be best to allow them to stand as a distinct family under the name of *Theridomyidæ*.

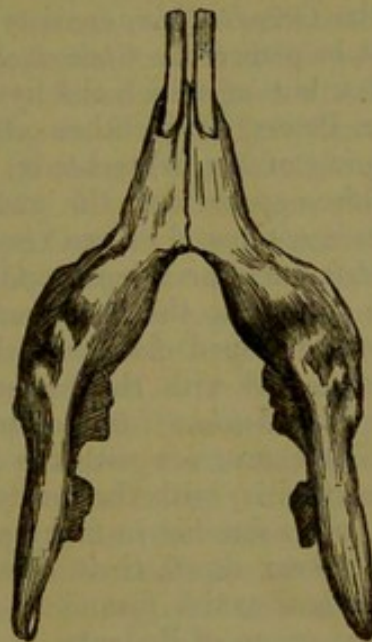
The last family of the *Myomorpha*, the *Dipodidæ*, is divisible into three plainly marked subfamilies—*Jaculinæ*, *Dipodinæ*, and

* Zool. et Paléont. Franç. (2^{me} ed.), pp. 31-36.

Pedetinae, of which the first is the most murine, and the second the most highly specialized, while the third shows more than superficial resemblances to the *Chinchillidae*.

The third section, *Hystricomorpha*, is characterized by the form of the mandible, combined with persistence of the fibula as a distinct bone throughout life. In the mandible the ascending ramus and coronoid process are low, and the angular portion does not spring from the lower edge of the bony covering of the lower incisor. In the great majority of forms in which that tooth is long, the angular portion springs from the outer side of its bony sheath, so that when viewed from below there is a longitudinal groove between the angular and dental portions. In the *Caviidae*, in which the incisors are short, "the direction of the incisor is such that, were it prolonged

Fig. 5.



Mandible of *Cavia aperea*.

backwards, the alveolus of the tooth and the angular portion of the jaw would hold the same relative positions" as in the other members of the section*. This difference in the form of jaw will be best understood by a comparison of figures 4 and 5. In the skull the infraorbital opening is always large, oval or subtriangular, an interpterygoid fissure is present, and the foramina of the base of the skull are proportionally large, while the incisive foramina are small. The frontals have no distinct postorbital processes (except in *Chaetomys*); and the malar, which is rarely continued far forward, is not supported below by a continuation of the maxillary zygomatic process. The clavicles are either perfect or imperfect; and one premolar is present above and below (except in *Ctenodactylus*). The upper lip is rarely cleft, the muffle is usually clad with very fine hairs, and the

* Waterhouse, Nat. Hist. Mamm. ii. p. 149.

nostrils pointed above, sigmoid or linear. The ears are very generally emarginate behind; and the tail, when present, is cylindrical, hairy, scaly, or subnaked.

In the division of the hystricine Rodents into families much diversity of opinion has prevailed. Mr. Waterhouse, laying too great stress on dental characters, entirely separated the *Dasyproctina* from the *Caviina*, and placed them between the *Hystricina* proper and the *Echimyina**. Prof. Brandt reunited the two former in his family *Hemionychoides*, equivalent to the *Subungulata* of Illiger†. But the group thus formed is so ill defined that Prof. Lilljeborg found it impossible to separate it from the *Hystricidæ*‡. It seems to me that, although Mr. Waterhouse was certainly misled in entirely separating the Agoutis and Pacas from the Cavies and Capybara, they must still be ranked as distinct but allied families, and that the same value must be given to the curious form named *Dinomys* by Dr. Peters§. Accordingly I would recognize six families of the *Hystricomorpha*.

Of these the first, the *Octodontidæ*, consists of three subfamilies; for here, I think, must be placed the *Ctenodactylinæ*, formerly associated with the Jerboas, but of which the hystricine affinities have been established by Dr. Peters||. The other subfamilies are the *Octodontinæ* and *Echinomyinæ* of Mr. Waterhouse. Some of the genera of the latter make a close approach to the next family, the *Hystricidæ*, which in its turn is composed of two very distinct subfamilies, *Sphingurina* and *Hystricina*; for I cannot follow Professor Lilljeborg in relegating the former to the *Octodontidæ*¶, principally on account of their better-developed clavicles, which are probably an adaptive peculiarity connected with their arboreal habits. Of the remaining families the *Chinchillidæ* form a small but very natural group, connected in some characters with the *Dinomyidæ*; and the latter, again, has close affinities with the nearly allied *Dasyproctidæ* and *Caviidæ*. These latter families in many points, as in the mode in which their incisors wear down, their emarginated palates, and the large size of their basicranial foramina, show a striking approach to the next great group of Rodents.

The second suborder, GLIRES DUPLICIDENTATI, containing only two families, is clearly less specialized than the first, and appears to be a survivor, representing a comparatively early stage in the development of the Rodent type. At birth, the upper jaw contains the normal number of incisors; but only the two inner pairs are retained; and of these the second remain very small, and are placed directly behind the large middle pair. In the mandible there is never more than one pair. Another important proof of the inferior degree of specialization in the *Glires duplicidentati* is the fact that the enamel of the incisors may be traced round to their posterior surface, though it is here much thinner than in front**. Of cranial characters, it may be

* Nat. Hist. Mamm. ii. p. 360.

† Prod. Syst. Mamm. p. 92.

‡ Op. cit. p. 54.

§ Festschrift. Gesellsch. nat. Freunde, pp. 227-234 (1873).

|| Tr. Z.S. vii. pp. 397-409.

¶ Op. cit. p. 51.

** Cf. Owen, Comp. Anat. Vert. iii. p. 296.

noted that they have no true alisphenoid canal, but a carotid canal is present in the tympanic*. The optic foramina are confluent; and the bony palate is reduced to a mere bridge between the molar series, being bounded in front by the large confluent incisive foramina, and behind by the deep posterior emargination. The fibula is ankylosed below with the tibia, and articulates with the calcaneum. There are no vesicular glands; and the testes are permanently external.

The two families *Leporidae* and *Lagomyidae* are certainly very nearly allied, but differ in several important characters; and I have therefore followed Professor Lilljeborg in keeping them distinct. The absence of postorbital frontal processes, the posterior continuation of the zygoma towards the auditory meatus, the absence of reticulation in the facial portion of the maxillary, and the full development of the clavicles in the Pikas are among the points in which their anatomy confirms their distinction from the Hares, outwardly indicated by the different proportion of their ears and tails.

The remark has been made above that palæontology has hitherto not yielded much of interest to the student of this order. A striking exception, however, is to be found in certain wonderful forms from the South-American Miocene and Pliocene, of which the true position has been much disputed. Of these the most striking is the huge animal whose skull, discovered by Mr. Darwin, was described by Professor Owen under the name of *Toxodon*†, and since more fully investigated by Dr. Burmeister‡. Its Ungulate characters, however, much overweigh in importance those which it has in common with the Rodents; and it may therefore be dismissed from present consideration.

Another animal presenting an extraordinary combination of characters is that discovered by M. Bravard, and placed by him, under the name of *Typotherium*, among the Pachydermata§. Almost every part of its skeleton has been obtained; and the whole has been well described by M. Serres|| under the name of *Mesotherium*, and by Professor Gervais¶ under Bravard's name**. The last-named zoologist considers that it must be regarded as a link between the Rodents and the Perissodactyles, and that its nearest affinities are with the *Leporidae*.

The most important characters in which *Mesotherium* differs from existing Rodents are, briefly, the transversely hollowed crowns of the incisors (which have not the chisel-edge so characteristic of

* Cf. Turner, P. Z. S. 1848, p. 65.

† Zoology of the 'Beagle,' pt. 1, pp. 16-35.

‡ Ann. Mus. Pub. de Buenos Aires, i. pp. 254-286.

§ Catalogue des espèces d'anim. foss. recueillies dans l'Amér. du Sud, 4to. Parana, 1860.

|| Comp. Rend. Ac. Paris, xlv. p. 961 (1857); lxxv. pp. 6, 17, 140-148, 273-279, 429-437, 593-599, 740-748, 841-848.

¶ Zool. et Paléont. Générales, pp. 134-137, pls. xxii.-xxv.

** M. Gervais regards Bravard's name as having priority; on what grounds I cannot discover. It does not appear whether or not it was used in the latter writer's paper on the Geology of La Plata, published in the 'Registro Estadístico' of Buenos Ayres in 1857 (which M. Gervais was unable to find in Paris, and which is not in the British Museum); but even if it was it would only be contemporary with M. Serres's very appropriate name.

the order), their number in the lower jaw (as in *Hyrax*), the curvature of the molars, of which the convexity is not inwards but outwards (as in *Toxodon*), the transverse form of the condyle of the mandible and the glenoid fossa, and the articulation of the ischia with some of the caudal vertebræ (as in some Edentates). With regard to the first of these characters, we have seen that the enamel is present, though very thin, on the back as well as the front of the incisors of the *Glires duplicidentati*; and a side view of these teeth in the Hares and in some of the lower *Hystricomorpha* shows a sort of gradation between the acute edge of the more highly specialized forms and the hollowed crown of *Mesotherium*. Of the condyle and glenoid cavity also it is to be noted that, although they are not transverse in any existing Rodent, yet their shape is much less clearly defined in the less-specialized forms. In other respects the whole skeleton of *Mesotherium* presents so many resemblances to the Rodents that it seems to me that we must follow Professor Gervais in placing it in that order rather than in any other. Its affinities with the more aberrant Ungulates, and especially with *Toxodon*, cannot, however, be overlooked; and it appears to have been a survivor, to Pliocene times, of a much earlier type, which represented an era at which the Rodents were not yet clearly marked off from their allies*. In fact *Mesotherium* seems to continue into the order *Glires* that line of affinity which Prof. Flower has pointed out as extending from the typical Ungulates through *Hyracodon*, *Homalodontotherium*, *Nesodon*, and *Toxodon*†.

As to the affinities of *Mesotherium* within the Order *Glires*, they do not appear so exclusively leporine to me as to M. Gervais. While agreeing with the Hares in many important points, as in the form of the mandible (which, however, is still more like that of *Hyrax*), in that of the brain, as indicated by a cast of the cranial cavity, and in the articulation of the fibula with the calcaneum, *Mesotherium* rather inclines in other particulars to the *Glires simplicidentati*, and especially to *Hydrochærus*. Among these may be enumerated the comparative shortness of the incisors, the smallness of the incisive foramina, the development of the bony palate and of the paroccipital processes, the depth of the malar, the form of the scapula, &c. Some at least of the toes seem to have been subungulate; and the terminal phalanx figured by Gervais (pl. xxv. fig. 34) very closely resembles the same bone in the Capybara.

As *Mesotherium* thus appears to present relationships to each of the existing suborders, combined with peculiarities which forbid its admission into either, I venture to propose the establishment of a third for its reception. It might be named GLIRES HEBETIDENTATI‡, and characterized by the incisors being two above and four below, the molars curved inwards and the condyles placed transversely.

Before ending this paper, with a Table of the characters of the various divisions here adopted, attention may be drawn to the accom-

* We have seen that in Europe the Rodents were fully differentiated in the Eocene period (*antèa*, p. 70).

† Phil. Trans. 1874, p. 181.

‡ *Hebes -tis*, blunt; *dentatus*, toothed.

panying chart (Plate IV.), on which I have endeavoured to indicate approximately the relationship of the different families to one another.

Arrangement.

Order GLIRES.

Suborder I. GLIRES SIMPLICI- DENTATI.	Sec. 3. <i>Hystricomorpha</i> . Fam. 1. Octodontidæ.
Sec. 1. <i>Sciuromorpha</i> . Fam. 1. Anomaluridæ. " 2. Sciuridæ. " 3. Ischyromyidæ. " 4. Haplodontidæ. " 5. Castoridæ.	" 2. Hystricidæ. " 3. Chinchillidæ. " 4. Dasyproctidæ. " 5. Dinomyidæ. " 6. Caviidæ.
Sec. 2. <i>Myomorpha</i> . Fam. 1. Myoxidæ. " 2. Lophiomyidæ. " 3. Muridæ. " 4. Spalacidæ. " 5. Geomyidæ. " 6. Theridomyidæ. " 7. Dipodidæ.	Suborder II. GLIRES DUPLICI- DENTATI. Fam. 1. Lagomyidæ. " 2. Leporidæ.
	Suborder III. GLIRES HEBETI- DENTATI. Fam. 1. Mesotheriidæ.

Table of Characters.

Order GLIRES.

The middle pair of incisors long, curved, rootless, and constantly growing, their points more or less chisel-edged (except in *Mesotherium*), the other pairs very small or absent; no canines, a large space intervening between the incisors and the grinding-teeth, which are variously formed; premolars present or absent; three molars above and below (except in *Hydromys*). Skull with the temporal fossæ continuous with the orbits, within which the lachrymal foramen opens; an interparietal almost always distinct; the periotic and tympanic ankylosed to one another, but not to any other bone; and the auditory bullæ moderately or largely developed. Scapula narrow with a deep notch, a well-developed more or less bifurcated acromion, and a small coracoid. Clavicles perfect or imperfect. Scaphoid and lunar usually combined. Manus with five or four digits. Tibia and fibula either separate or ankylosed below. Pes with five, four, or three digits. Intestinal canal long; cæcum large (except in *Myoxidæ*). Liver with a bifid Spigelian lobe (except in *Anomalurus*). Placenta deciduate and discoidal.

Suborder I. GLIRES SIMPLICIDENTATI.

Incisors $\frac{2}{2}$ only, even at birth, their enamel confined to the front surface. Skull with both a true alisphenoid and an external alisphenoid canal*; optic foramina rarely confluent; incisive foramina separate; and bony palate well developed. Fibula either ankylosed

* Cf. H. N. Turner, P. Z. S. 1848, p. 65.

with the tibia below or free, not articulating with the calcaneum. Testes abdominal, descending periodically; vesicular glands present*.

Section I. *Sciuromorpha*.

Premolars present; when there is more than one in the upper jaw the first is smaller than the others; grinding-teeth rooted or rootless. Postorbital frontal processes present or absent, infraorbital opening various. Zygomatic arch mainly composed of the malar, which is not supported below by a continuation of the maxillary zygomatic process. Outer walls of pterygoid fossæ obsolete; no inter-ptyergoid fissure. Incisive foramina small or moderate, not extending into the maxillaries. Mandible with the angular portion springing from the lower edge of the bony covering of the lower incisor, its outline more or less rounded, not pointed; coronoid process high and falcate. Clavicles perfect. Fibula persistent as a distinct bone through life, and usually perfectly free. Upper lip usually cleft, muffle small and naked; nostrils comma-shaped, rounded above. Tail cylindrical and hairy (except in *Castoridae*). Five families:—

Family I. ANOMALURIDÆ.

One premolar above and below; grinding-teeth subequal, not tuberculate, with flat crowns and transverse enamel loops. Skull with postorbital processes obsolete; infraorbital opening large, sub-ovate; palate contracted in front, deeply emarginate behind. Sixteen pairs of ribs. Limbs connected by a flying expansion of the skin, supported by a chondrified fascia articulating with the olecranon. Tail long, hairy, with a series of large scales on the lower basal portion. Distribution Ethiopian. Recent genus:—

Anomalurus, Waterhouse, P. Z. S. 1842, p. 124 . . . (1842).

(Characters those of the family.)

Family II. SCIURIDÆ.

Two premolars above, and one below; the first upper premolar very small, sometimes deciduous; grinding-teeth rooted, tubercular (at least in youth). Skull with distinct postorbital processes; infra-orbital opening small, usually placed in front of the maxillary zygomatic process; palate broad, flat. Twelve or thirteen pairs of ribs. Tail cylindrical, hairy. Two subfamilies:—

A. SCIURINÆ. Incisors compressed. Limbs either free or united (*Pteromys*) by an expansion, whose fascia articulates with the carpus. Form slender, tail long. Cosmopolitan (exc. Australasian region). Recent genera:—

1. *Pteromys*, G. Cuvier, Leçons d'Anatomie (1800).

Limbs united by a flying expansion, the supporting fascia of which articulates with the carpus; tail long, bushy. Grinders usually soon ground flat, in some tuberculate through life.

* Cf. Owen, Comp. Anat. Vert. iii. p. 649.

2. *Sciurus*, Linnæus, Syst. Nat. i. p. 86 (1766).

Limbs free, form agile, tail long, bushy. No cheek-pouches; three or four pairs of teats. First upper premolar sometimes soon lost. Frontals ankylosed with parietals; postorbital processes moderate; infraorbital opening in front of anterior root of zygoma. Palate broad, flat.

3. *Xerus*, Hemprich & Ehrenberg, Symbol. Phys., Mamm. i., 99 (1832).

Ears very short or rudimentary, tail short, fur sparse, harsh, with flattened spines. No cheek-pouches, two pairs of teats. Nasals and palate narrower, and postorbital processes much smaller than in *Sciurus*.

4. *Tamias*, Illiger, Prod. Syst. Mamm. p. 83 (1811).

Ears short, fore feet with the fourth digit longest, limbs subequal, tail short. Large internal cheek-pouches. First upper premolar soon lost. Skull slender; infraorbital opening in anterior root of zygoma, not in front of it.

B. ARCTOMYINÆ. Incisors not compressed. Limbs free, form usually stout, tail short. Palæarctic and Nearctic. Recent genera:—

5. *Spermophilus*, F. Cuvier, Mém. du Mus. vi. p. 293 . (1822).

Form somewhat slender; tail short or moderate. Claw of pollex rudimentary or absent. Large cheek-pouches. Series of grinding-teeth nearly parallel. Skull with no marked ridges; postorbital processes slender, directed backwards.

6. *Cynomys*, Rafinesque, Amer. Monthly Mag. ii. p. 45 (1817).

Form thickset, tail short, claws of fore feet long on all the digits, shallow cheek-pouches. Series of grinding-teeth strongly convergent behind. Skull short and broad; postorbital processes long, directed backwards; parietals narrow, parallelogrammatic.

7. *Arctomys*. Schreber, Säugethiere, iv. p. 721 (1792).

Form thickset, tail short; pollex rudimentary, with a flat nail. Cheek-pouches rudimentary or absent. Series of grinding-teeth nearly parallel. Skull broad; postorbital processes large, triangular, standing out at right angles; parietals narrow, parallelogrammatic.

Fossil genera. The following genera, characterized from details of dentition, seem to be referable to this family:—*Plesarctomys*, Bravard, in Gervais's 'Zool. et Pal. Franç.' pl. xlvi. (1852), Eocene of France; *Pseudosciurus*, Hensel, Z. Deutsch. geol. Ges. 1856, p. 660, bone-beds of Württemberg; *Sciuravus*, Marsh, Am. Journ. Sc. 1871, p. 120, Eocene of North America; *Paramys*, Leidy, Geol. Survey, Montana, 1871, p. 363 (perhaps the same as the last); *Gymnotrichus*, Cope, Pal. Bulletin, i. p. 6 (1874), Miocene of North America.

Family III. ISCHYROMYIDÆ (fam. nov.)*.

Dentition as in *Sciuridæ*. Skull resembling *Castoridæ*, but with the infraorbital opening large, a sagittal crest, no postorbital processes, palate broad, basioccipital keeled. Miocene of North America. Fossil genus:—

Ischyromys, Leidy, Proc. Acad. Philad. 1856, p. 89 . . (1856).
(Characters those of the family.)

Family IV. HAPLODONTIDÆ.

Two premolars above and one below, the first upper premolar small; grinding-teeth rootless, simple, and prismatic. Skull much depressed, no postorbital processes, infraorbital opening small, angular portion of mandible much twisted. Tail short, cylindrical, hairy. Nearctic. Recent genus:—

Haplodon = *Aplodontia*, Richardson, Zool. Journ. iv. p. 334
(1829).

(Characters those of the family.)

Family V. CASTORIDÆ.

One premolar above and below; grinding-teeth subequal, semi-rooted or rootless, with reentering enamel-folds. Skull massive, no postorbital processes, infraorbital opening small and placed low, a sagittal crest, angle of mandible rounded. Carpus with a large accessory ossicle. Stomach with a glandular appendage, excretory and generative organs opening into a common cloaca. Tail broad, flattened, spatulate and reticulated. Hind feet fully webbed. Palæarctic and Nearctic. Recent genus:—

1. *Castor*, Linnæus, Syst. Nat. i. p. 78 (1766).

(External characters those of the family.) Upper grinding-teeth subequal, each with one internal and three external enamel-folds; the lower similar but reversed; the subsidiary folds not soon isolated from the exterior. Parietals narrow, parallelogrammatic; interparietal triangular; basioccipital concave.

Fossil genera:—

2. *Diobroticus*, Pomel, Arch. Bibl. Univ. Genève, ix. p. 167 †.
(1848).

Skull much as in *Castor*. Third upper molar and lower premolar elongate, with four enamel folds, the rest with only two; all the folds soon isolated.

3. *Stenofiber*, Is. Geoffroy, Revue Encyclopédique. . . . (1833).

Parietals not parallelogrammatic; interparietal subhexagonal; basioccipital not concave. Grinding-teeth as in *Castor*, the subsidiary folds sooner isolated.

* It seems probable that *Pseudotomys*, Cope, Proc. Am. Phil. Soc. 1872, p. 467, from Eocene of North America, may prove to belong to this family.

† = *Trogotherium* Owen (nec Fischer), Brit. Foss. Mamm. p. 184; Geol. Mag. vi. pp. 49-56 (cf. Gervais, Zool. et Paléont. Générales, pp. 80-84).

4. *Castoroides*, J. W. Forster, 2nd Rep. Geol. Ohio, p. 81 (1838).

Parietals not parallelogrammatic; interparietal very small; basi-occipital concave. Incisors with numerous longitudinal grooves; grinding-teeth with the enamel-folds extending quite across their crowns, completely separated and united only by cement; the last upper molar and lower premolar with four folds, the rest with three only.

More doubtful fossil genera are:—*Trogontherium*, Fischer, Mém. Soc. Imp. Nat. Mosc. ii. p. 260 (1809); *Palæomys*, Kaup, Isis, 1832, p. 992; *Chalicomys*, Kaup, *op. cit.* p. 994; *Chelodus*, Kaup, *op. cit.* p. 995; *Palæocaster*, Leidy, Journ. Ac. Philad. vii. p. 338 (1869).

Section II. *Myomorpha*.

Premolars present or absent; grinding-teeth rooted or rootless. No postorbital frontal processes; infraorbital opening various. Zygomatic arch slender; the malar rarely extending far forward, and being usually supported below by a continuation of the maxillary zygomatic process. Incisive foramina usually long, and extending into the maxillaries. Outer walls of pterygoid fossæ often obsolete, no inter-ptyergoid fissure (except in *Bathyerginæ*). Angular portion of mandible springing from the lower edge of the bony covering of the lower incisor (except in *Bathyerginæ*). Clavicles perfect (except in *Lophiomyidæ*). Tibia and fibula completely ankylosed in the adult for at least their lower third. Upper lip usually cleft; muffle small and naked; nostrils comma-shaped, rounded above. Tail cylindrical, either hairy or covered with scales arranged in rings. Seven families:—

Family I. MYOXIDÆ.

One premolar above and below, which is rather smaller than the molars; all the grinding-teeth rooted, with transverse enamel-folds. Skull with frontals much contracted, clasped by the parietals; interparietal broad, articulating with the squamosals. Infraorbital opening moderate, high, narrow. Mandible with the angle rounded or subquadrate, coronoid long and slender. No cæcum. Form gracile; eyes and ears large; fore limbs small; tail long, hairy. Palæarctic and Ethiopian. Recent genera:—

1. *Myoxus*, Schreber, Säugeth. iv. p. 824 (1792),

Tail bushy and distichous throughout. Stomach simple. Angular portion of mandible not perforate. Premolars small; molars large, with well-marked enamel-folds.

2. *Muscardinus*, Kaup, Entw. europ. Thierw. p. 139 . . . (1829).

Tail bushy and cylindrical throughout. Stomach complicated. Mandible not perforate. Grinding-teeth large; their crown flat, with well-marked and numerous folds.

3. *Eliomys*, Wagner, Abhand. baierisch. Akad. iii. p. 179 (1843).

Tail with short hairs at base, tufted and distichous towards its

end. Stomach simple. Angular portion of the mandible perforate. Grinding-teeth smaller; their crowns concave, with few and faintly marked folds.

4. *Graphiurus*, F. Cuvier & Geoffroy, Mammifères, 60^{me} livr. (1845).

Tail short, cylindrical, ending in a pencil. Mandible not perforate. Grinding-teeth very small; their crowns flat, with hardly a trace of enamel-folds.

Family II. LOPHIOMYIDÆ.

No premolars; molars rooted and tuberculate. Skull as in the typical *Muridæ*, but with the temporal fossæ completely arched over by thin plates developed from the temporal ridge and the malar, articulated with one another; surface of skull granulated. Clavicles imperfect. Cæcum small. Form thickset. Hair long, forming a crest along the back and tail. Ethiopian. Recent genus:—

- Lophiomys*, A. Milne-Edwards, L'Institut, xxxv. p. 46 . (1867).
(Characters those of the family.)

Family III. MURIDÆ.

Lower incisors compressed; no premolars (except in *Sminthinæ*); molars rooted or rootless, tuberculate or with angular enamel-folds. Frontals contracted. Infraorbital opening in typical forms high, perpendicular, wide above and narrowed below, with the lower root of the maxillary zygomatic process more or less flattened into a perpendicular plate; very rarely the opening is either large and oval or small and subtriangular. Malar short and slender, generally reduced to a splint between the maxillary and squamosal processes. External characters very variable. Pollex rudimentary, but often with a small nail. Tail generally subnaked and scaly, rarely densely haired. Cosmopolitan. Ten subfamilies*:—

(a Molars rooted.)

A. SMINTHINÆ. Premolars $\frac{1}{1}$, molars $\frac{3}{3}$. Infraorbital opening subtriangular, widest below. Incisive foramina long. Palæartic. Recent genus:—

1. *Sminthus*, Keyserling & Blasius, Wirbelth. Europ. p. 38 (1840).
(Characters those of the subfamily.)

B. HYDROMYINÆ. Molars $\frac{2}{2}$, divided into transverse lobes. Infraorbital opening crescentic, scarcely narrowed below. Incisive foramina and auditory bullæ very small. Hind feet partly webbed. Australasian. Recent genus:—

2. *Hydromys*, Geoffroy, Ann. du Mus. vi. p. 81 (1805).
(Characters those of the subfamily.)

* *Suprà*, p. 69.

C. PLATACANTHOMYINÆ. Molars $\frac{3}{3}$, divided into transverse laminae. Infraorbital opening typical; incisive foramina and auditory bullae small. Form myoxine; fur mixed with flattened spines; tail densely haired. Indian. Recent genus:—

3. *Platacanthomys*, Blyth, Proc. As. Soc. Bengal, xxviii. p. 289 (1859).

(Characters those of the subfamily.)

D. GERBILLINÆ. Incisors narrow; molars divided into transverse laminae. Infraorbital opening typical; pterygoid fossae short; auditory bullae usually large. Hind limbs elongated; tail long, hairy. Palæarctic, Indian, and Ethiopian. Recent genera:—

4. *Gerbillus*, Desmarest, Nouv. Dict. d'Hist. Nat. xxiv. p. 22 (1804).

Form murine; muzzle pointed; ears moderate, sparsely haired; tail long, hairy, slightly tufted. Skull with occipital region broad; auditory bullae large. Incisors grooved or plain. First molar with three laminae, the second with two, the third with one only.

5. *Mystromys*, Wagner, Wieg. Arch. 1841, p. 132 . . (1841).

Ears large and broad; tail moderately long, truncated, not tufted. Auditory bullae smaller. Incisors plain. First molar with three laminae, the second and third with two each; these are alternated, and the last is very small.

6. *Otomys*, F. Cuvier, Dents des Mamm. p. 168 (1825).

Ears large, hairy; tail moderate, clad with scales and short hairs, not tufted. Nasal profile more arched than in *Gerbillus*. Incisors grooved. Molars with their laminae completely separated and united by cement; the third the longest, with from three to seven laminae.

7. *Dasymys*, Peters, Monatsb. Akad. Berlin, 1875, p. 12 (1875).

Ears moderate, hairy; fur somewhat coarse; tail moderate, scaly, and sparsely haired. Skull intermediate between *Gerbillus* and *Mus*. Lower branch of maxillary zygomatic process produced forward in a hook-shape. Incisors plain. Front molars the longest; the posterior lamina of the first and the anterior laminae of the second and third upper molars large and complicated.

E. PHLÆOMYINÆ. Incisors broad; molars divided into transverse laminae. Infraorbital opening typical. Claws large. Indian. Recent genera:—

8. *Phlæomys*, Waterhouse, P. Z. S. 1839, p. 108 (1839).

Muzzle blunt; lip imperfectly cleft; ears moderate, hairy externally; tail moderately long, densely haired. Skull ovate; frontals not contracted, with a rudimentary postorbital process at their junction with the squamosals; auditory bullae very small. Incisors very broad. First upper molar with three laminae; second and third with two; first lower with four, second with three, and third with two laminae.

9. *Nesokia*, Gray, Ann. and Mag. Nat. Hist. x. p. 264 . (1842).

Muzzle blunt; ears moderate; claws long; fur rather harsh; tail short, scaly, sparsely haired. Palate narrow; incisive foramina short; auditory bullæ rather small. Incisors broad. First molars with three laminae; the rest with two only.

F. DENDROMYINÆ. Incisors convex in front; molars tuberculate. Infraorbital opening not narrowed below; coronoid process very small. Ears hairy. Claws long. Ethiopian. Recent genera:—

10. *Dendromys*, A. Smith, S. African Q. Journ. ii. p. 158 (1834).

Form slender; tail long, scaly, and sparsely haired. Three middle digits of each foot much longer than the first and fifth. Incisors grooved. Molars parallel in series; the first as long as the second and third taken together; their tubercles arranged in pairs.

11. *Steatomys*, Peters, Reise n. Mossambique, i. p. 162 . (1852).

Form plump; tail rather short, finely scaled and densely haired; claws of fore feet the longest. Incisors grooved. Molars converging behind; the first longer than the second and third taken together; their tubercles arranged in twos and threes.

12. *Lophuromys*, Peters, Monatsb. Ak. Berlin, 1874, p. 234
(1874).

Form as in *Steatomys*, but fur developed into fine flattened bristles, pterygoid fossæ longer, and coronoid process better-developed. Incisors plain. Molars nearly parallel in series; the third upper with only two anterior tubercles.

G. CRICETINÆ. Molars tuberculate. Infraorbital opening subtypical, not much narrowed below, and the perpendicular plate little developed. Large internal cheek-pouches. Palæarctic and Ethiopian. Recent genera:—

13. *Cricetus*, G. Cuvier, Règne Animal (1^{re} éd.), i. p. 198 (1817).

Form thickset; limbs short; claws large; tail short, not scaly, sparsely haired. Cheek-pouches large. Skull with marked but rounded supraorbital ridges continued into temporal ridges; coronoid process high and falcate. Incisors plain. Molars with tubercles arranged in pairs, of which the first has three and the rest two only; these entirely disappear in aged specimens.

14. *Saccostomus*, Peters, Monatsb. Ak. Berl. 1846, p. 258 (1846).

Form as in *Cricetus*, but feet and claws weaker and more murine. Cheek-pouches moderate. Supraorbital ridges more parallel, and infraorbital opening more typically murine; incisive foramina longer. Incisors plain. Molars with tubercles arranged in threes, one of each row being smaller than the other two.

15. *Cricetomys*, Waterhouse, P. Z. S. 1840, p. 2 (1840).

Form more murine; muzzle pointed; tail long, scaly, and very

sparsely haired. Cheek-pouches large. Skull most like that of *Saccostomus*, but incisive foramina much smaller. Upper incisors grooved. Molars as in *Saccostomus*.

H. MURINÆ. Molars tuberculate, at least in youth. Infraorbital opening typical; pterygoid fossæ lengthened; auditory bullæ moderate. Cheek-pouches absent or very small. Tail scaly, more or less naked. Cosmopolitan. Recent genera:—

16. *Mus*, Linnæus, Syst. Nat. i. p. 79 (1766).

Muzzle pointed; eyes prominent; ears rather large, subnaked; fur soft (rarely mixed with spines); pollex rudimentary; claws short; tail moderate or long, scaly, with scattered hairs. No cheek-pouches. Skull elongate, narrow; temporal ridges nearly parallel; palate compressed; incisive foramina long; auditory bullæ moderately large; coronoid process high, falcate. Incisors rarely grooved. Molars with transverse ridges, each composed in youth of three tubercles.

17. *Pelomys*, Peters, Reise n. Mossambique, i. p. 157 . (1852).

Middle three digits of each foot longer than the first and third; fur bristly; tail short, scaly. Palate much compressed. Incisors grooved. Molars broader than in *Mus*.

18. *Echinothrix* (= *Echiothrix*), Gray, P. Z. S. 1867, p. 599 (1867).

Head elongate, muzzle produced; fur mixed with flattened spines; tail long, scaly. Facial portion of skull greatly elongated; nasals very narrow; palate much compressed; incisive foramina long; coronoid process small. Incisors grooved. First upper molars large, with three ridges, second with one only; third small, simple, subcircular.

19. *Uromys*, Peters, Monatsb. Ak. Berlin, 1867, p. 343 (1867).

External characters as in *Mus*; but the caudal scales thick, polygonal, and not overlapping, auditory bullæ and incisive foramina smaller, and pterygoid processes more like those of *Hapalotis*.

20. *Hapalotis*, Lichtenstein, Darst. neu. Säugeth. Th. iv. pl. 29 (1829).

Muzzle produced; ears long, tapered, sparsely haired outside; hind limbs elongated; fur soft; tail long, hairy, terminating in a pencil. Skull with no distinct occipital crest or supraorbital ridges; incisive foramina very large; coronoid process obsolete. Incisors plain. Molars as in *Mus*.

21. *Acomys*, Is. Geoffroy, Ann. Sc. Nat. 2^{me} sér. x. p. 126 (1840).

Fur mixed with flattened spines, especially on the head and back; tail short, scaly. Skull as in *Mus*, but the pterygoid fossæ more shallow, and the incisive foramina extremely small; coronoid process little developed. Teeth as in *Mus*.

22. *Nesomys*, Peters, Sitzungs-Ber. Gesell. nat. Freunde, 1870, p. 54 (1871).

Form murine; upper lip grooved, not cleft; ears and eyes large;

feet as in *Mus*; tail long, scaly. Skull as in *Mus*; the infraorbital foramen lower and wider. Incisors plain. Molars like those of *Hesperomys*; the first upper, when worn, with one internal and two external indenting folds; the first lower with one external and two internal, the rest with one external and one internal fold.

23. *Brachytarsomys*, Günther, P. Z. S. 1875, p. 79 . . (1875).

Upper lip grooved, not cleft; eyes small; ears short; hind feet much shorter than the lower leg; tail long, scaly. No supraorbital ridges; auditory bullæ moderate. Incisors plain. Molars with two or three indenting folds on each side, one of which in the upper molars passes quite across the crown.

24. *Drymomys*, Tschudi, Fauna Peruana, p. 178 . . (1844-6).

Form murine; muzzle pointed; upper lip cleft; ears large; tail long, scaly. Incisors furrowed on the sides. Molars small; the first with three pairs of tubercles, the second with two, the third with one pair only.

25. *Holochilus*, Brandt, Mém. Ac. St. Pétersb. (6^{me} sér.) iii. p. 428 (1835).

Muzzle obtuse; upper lip not fully cleft; fore feet small; hind limbs large and strong; tail long, sparsely haired. Skull short, strong; supraorbital ridges well marked. Incisors broad, flat, plain. Molars large, the third as large as the second, with tubercles arranged in pairs, which soon wear away, leaving the crown flat with indenting folds.

26. *Hesperomys*, Waterhouse, Zool. Voy. Beagle, i. p. 75 (1839).

Upper lip cleft; ears large or moderate; tail sparsely haired. Small internal cheek-pouches in a few species. Skull murine, with or without marked supraorbital ridges. Incisors plain. Molars as in the last genus, but narrower; the third smaller than the second, and the first upper with three roots.

27. *Ochetodon*, Coues, Proc. Acad. Philad. 1874, p. 184 (1874).

As in the last genus; tail moderate. Upper incisors grooved. First upper molar with four roots.

28. *Reithrodon*, Waterhouse, P. Z. S. 1837, p. 29 . . . (1837).

Profile arched; eyes large; ears hairy; hind feet with first and fifth digits very short; tail moderate, hairy. Skull with nasal portion large, supraorbital ridges well marked, posterior nares narrowed by the approximation of the pterygoids. Upper incisors grooved. Molars as in *Hesperomys*, their indenting folds deep.

29. *Sigmodon*, Say & Ord, Journ. Acad. Philad. iv. p. 352 (1825).

Muzzle blunt; upper lip partially cleft; ears large, but nearly concealed in the long fur; hind feet with first and fifth digits very short; tail moderate, nearly naked. Skull with supraorbital ridges sharp, perpendicular plate of zygoma emarginate in front, incisive

foramina large. Incisors plain. Molars never tuberculate, the indenting folds deep and closed, those of the second and third lower molars sigmoid.

30. *Neotoma*, Say & Ord, Journ. Acad. Philad. iv. p. 346 (1825).

Ears large, nearly naked; tail long, either sparsely haired or bushy. Upper incisors broad, plain. Molars never tuberculate, with open angular indenting folds, giving them a very arvicoline appearance.

(β . *Molars semirooted or rootless*.)

I. ARVICOLINÆ. Molars composed of triangular prisms placed alternately. Skull with brain-case rhomboidal, frontals much contracted, infraorbital opening typical. Limbs moderate; tail moderate or short, hairy. Palæarctic and Nearctic. Recent genera:—

31. *Fiber*, G. Cuvier, Leçons d'Anatomie (1800).

Form thickset; muzzle blunt; limbs short, subequal; hind feet fringed with long stiff hairs; tail moderate, compressed, clad with scales and short hairs; supraorbital ridges united in a sagittal crest. Palate and lower surface of maxillaries minutely perforated. Incisors plain. Molars semirooted, separated into prisms, which are placed alternately.

32. *Arvicola*, Lacépède, Tableau (1803).

Muzzle blunt; fore feet small, with short claws, soles naked; tail longer than the hind foot, clad with short hairs. Skull as in *Fiber*; but the supraorbital ridges diverge after meeting, and converge again on the interparietal; palate not perforated. Incisors plain. Molars as in *Fiber*, rootless (rarely semirooted).

33. *Myodes*, Pallas, Zoogr. Rosso-Asiat. i. p. 173 . . . (1811).

Muzzle blunt; fore feet moderate, with strong hooked claws; soles hairy; tail not longer than hind foot, hairy. Skull as in *Arvicola*, but the brain-case broader and the zygomatic arches stronger. Molars rootless, as in *Arvicola*, but the prisms of the posterior teeth usually compressed and twisted.

K. SIPHNEINÆ. Molars as in the *Arvicolinæ*; infraorbital opening small and subtriangular. Form cylindrical; ear-conch rudimentary; limbs and tail very short. Palæarctic. Recent genera:—

34. *Ellobius*, Fischer, Zoognosia, iii. p. 72 (1814).

Body subcylindrical; limbs very short, upper lip cleft; eyes small; no external ear-conch; fore feet with short claws, but stronger than the hind feet; tail very short. Skull as in *Arvicola*, but the profile more arched and the facial portion shorter. Upper incisors arched forward.

35. *Siphneus*, Brants, Het Geslacht der Muizen, p. 20 . . (1827).

Eyes small; ears rudimentary; fore feet with long, strong claws,

that of the fifth digit being longer than the toe itself; tail short, hairy. Skull broader and more truncated behind than in *Ellobius*; supraorbital ridges nearly parallel; occipital crest sharp; infraorbital foramen subtriangular. Upper incisors perpendicular.

Fossil genera. The following genera will probably prove to be referable to this family:—*Cricetodon*, Lartet, Notice, p. 20 (1851); *Eumys*, Leidy, Proc. Ac. Philad. 1856, p. 90; *Heliscomys*, Cope, New Vert. Colorado, p. 3 (1873), Miocene of North America; *Mysops*, Leidy, U.S. Geol. Surv. Terr. i. p. 111 (1873), Eocene of America.

Family IV. SPALACIDÆ.

Incisors large; premolars present or absent; grinding-teeth rooted, not tuberculate, with reentering enamel-folds. Infraorbital opening moderate or small, with no perpendicular plate; occipital plane high, often sloped boldly forward; palate narrow. Form cylindrical; eye and ear-conch very small, sometimes rudimentary; limbs short and stout; claws large; tail short or absent. Two sub-families:—

A. SPALACINÆ. Palate between the molars broader than one of the alveoli. No interpterygoid fissure. Mandible of normal myomorphine form (the angular portion springing from *the edge* of the bony covering of the lower incisors). Palæarctic, Indian and Ethiopian. Recent genera:—

1. *Spalax*, Gldenstdt, Nov. Comment. Petrop. xiv. i. p. 409 (1770).

Head broad, flat, with a ridge of long stiff hairs on each side; eyes rudimentary, covered by the skin; no ear-conch or external tail; feet broad, claws short. Skull depressed, occipital plane high and sloped boldly forward; parietals and interparietal small and soon ankylosed; infraorbital opening moderate, suboval. Upper incisors plain, nearly perpendicular. No premolars. Molars with curved enamel-folds in youth only.

2. *Rhizomys*, Gray, P. Z. S. 1830, p. 95 (1830).

Form robust; eyes very small; ears very short, naked; pollex rudimentary; tail rather short, partially haired. Skull broad, occipital plane only slightly sloped forward; infraorbital opening small, subtriangular. Upper incisors arched forward. No premolar. Upper molars with one deep internal and two or more external enamel-folds; the lower molars reversed.

3. *Heterocephalus*, Rppell, Mus. Senkenb. i. Sugeth. p. 99 (1834).

Eyes very small; no ear-conch; pollex short, not rudimentary; tail short; whole body almost hairless. Skull as in *Rhizomys*, but broader, occipital plane more perpendicular, and infraorbital foramen larger. Dentition similar, but the upper molars with an external indenting fold only, the lower with one external and one internal fold.

B. *BATHYERGINÆ*. Palate between the molars not broader than one of the alveoli; an interpterygoid fissure; mandible hystricine in form (the angular portion springing from *the side* of the bony covering of the lower incisor). Ethiopian. Recent genera:—

4. *Bathyergus*, Illiger, Prod. Syst. Mamm. p. 86 . . . (1811).

Eyes small; no ear-conch; fore feet with very long claws; hind feet with the third digit longest; tail short, hairy. Skull massive, occipital plane perpendicular; nasals very narrow; parietals very small; infra-orbital foramen very small, subcircular; angle of mandible pointed. Upper incisors enormously large, broad, grooved. One premolar above and below. Molars with indenting enamel-folds in youth only.

5. *Georychus*, Illiger, Prod. Syst. Mamm. p. 87 . . . (1811).

Externally like *Bathyergus*, but the claws, especially of the fore feet, shorter and weaker, skull with the profile more arched, the occipital plane slightly sloped forward, and the angle of the mandible rounded. Upper incisors long, arched forwards, plain. Grinding-teeth as in *Bathyergus*.

6. *Heliophobius*, Peters, Monatsb. Ak. Berlin, 1846, p. 239
(1846).

Differs externally from *Georychus* in the second digit of the hind feet being the longest. Skull with the infraorbital opening smaller, the bony palate shorter, and the coronoid process larger. Incisors plain. Three premolars above and below; but sometimes two only are developed.

Family V. GEOMYIDÆ.

One premolar above and below. Grinding-teeth rooted or rootless. Malar extending forward to the lachrymal. Squamosals extremely large. Angular portion of mandible strongly twisted. Large cheek-pouches, opening on the cheeks *outside* the mouth. Upper lip not cleft. Other external characters very variable. Nearctic and Neotropical. Two subfamilies:—

A. *GEOMYINÆ*. Incisors broad. Skull massive; infraorbital opening very small; mastoid not appearing on the top of the skull; malar stout. Form thickset; eyes small; ear-conch rudimentary; limbs short, subequal; fore claws very large. Recent genera:—

1. *Geomys*, Rafinesque, Am. Monthly Mag. ii. p. 45 . . (1817).

Fore feet large, with very large compressed curved claws; tip of tail naked; cheek-pouches large. Skull very massive; zygomatic arches stout. Upper incisors deeply grooved. Crowns of premolars divided into two subequal lobes.

2. *Thomomys*, Max. Prinz zu Wied, Nov. Act. Ac. Car. Leop. xix. i. p. 383 (1839).

Fore feet comparatively small, with moderate claws; cheek-pouches moderate. Skull less massive; zygoma more slender. Upper incisors plain, or with merely a fine groove near their inner edge. An-

terior lobes of premolars small. A third upper molar small, sub-circular.

B. HETEROMYINÆ. Incisors narrow. Skull more delicate, with the mastoid appearing largely on its top; infraorbital opening not defined, through the non-development of the lower root of the maxillary zygomatic process; malar slender. Cervical vertebræ sometimes ankylosed (as in *Dipodinae*). Form slender; hind limbs and tail elongated; eye and ear moderate or large. Recent genera:—

3. *Dipodomys*, Gray, Ann. & Mag. Nat. Hist. vii. p. 521 (1840).

Ear large, rounded; tail long, densely haired, tufted; soles hairy; pollex very small, with a small claw. Cheek-pouches large. Skull with nasals produced in front; upper part of zygoma produced into a flat plate articulating with the frontals; interparietal very small, narrow; auditory bullæ enormous, projecting far beyond the occipital plane. Incisors plain. Grinding-teeth rootless, at first with slight indenting enamel-folds, afterwards simple.

4. *Perognathus*, Max. Prinz zu Wied, Nov. Act. Ac. Car. Leop. xix. i. p. 369 (1839).

Ears shorter; tail thinly haired; soles more or less naked; pollex with a flat nail. Skull less modified; nasals not so much produced; zygoma not developed into a flat plate; interparietal broad; auditory bullæ not projecting behind the occipital plane. Incisors grooved. Grinding-teeth rooted, tuberculate in youth, afterwards with isolated enamel-loops.

5. *Heteromys*, Desmarest, Mammalogie, p. 313. (1820).

Like *Perognathus*, but the fur bristly, mixed with flattened spines; tail shorter, clad with large scales and scattered hairs. Skull with sharp supraorbital ridges; interparietal very broad. Upper incisors plain. Grinding-teeth as in *Perognathus*.

Family VI. THERIDOMYIDÆ.

One premolar present above and below. Grinding-teeth rooted or rootless, not tuberculate, with more or fewer transverse enamel-folds. Infraorbital opening large, suboval. Palate somewhat contracted in front and emarginate behind. Eocene and Miocene of Europe. Fossil genera:—

1. *Theridomys*, Jourdan, Compt. Rend. Ac. Paris, v. p. 483 (1837).

Grinding-teeth rooted, with three or four reentering enamel-folds, which become isolated enamel-loops in the worn teeth.

2. *Archæomys*, De Laizer et De Parieu, C. R. Ac. Paris, viii. p. 206 (1839).

Grinding-teeth rootless, the enamel-folds continued diagonally across the crowns, which are thus divided into laminæ, of which the anterior is the largest above, while they are subequal below.

3. *Issidioromys* (Croizet), De Blainville, C. R. Ac. Paris, x. p. 932 (1840).

Grinding-teeth rootless, with open reentering folds dividing their crowns into heart-shaped lobes; the subsidiary folds only represented here and there by a minute isolated enamel-loop.

Family VII. DIPODIDÆ.

Incisors compressed. Premolars present or absent. Grinding-teeth rooted or rootless, not tuberculate, with more or fewer transverse enamel-folds. Skull with the brain-case short and broad; infraorbital opening rounded, very large (often as large as the orbit); zygomatic arch slender, curved downwards; the malar ascending in front to the lachrymal in a flattened perpendicular plate; facial surface of maxillaries minutely perforated; mastoid portion of auditory bullæ usually greatly developed. Metatarsal bones greatly elongated, often fused into a cannon bone. Form gracile; front portion of body and fore limbs very small; hind limbs long and strong, with from three to five digits; tail long, hairy. Three subfamilies:—

A. JACULINÆ*. One premolar above. Grinding-teeth rooted. Cervical vertebræ free, metatarsals separate. Hind feet with five developed digits. Tail sparsely haired. Nearctic. Recent genus:—

1. *Jaculus*, Wagner, Syst. Amph. &c. p. 23 (1830).
(Characters those of the subfamily).

B. DIPODINÆ. Premolars present or absent. Grinding-teeth rooted. Cervical vertebræ more or less ankylosed. Metatarsals united in a cannon-bone. Hind feet with only three digits functionally developed. Tail thickly haired, often tufted. Palæarctic and Ethiopian. Recent genera:—

2. *Dipus*, Gmelin, Syst. Nat. ed. 13, i. p. 157 (1788).

Hind feet with three digits only; tail cylindrical, tufted. Skull with occipital region very broad, auditory bullæ enormously developed, infraorbital opening with a separate canal for the nerve. Incisors grooved. Premolars absent or almost rudimentary, and found above only.

3. *Alactaga*, F. Cuvier, P. Z. S. 1836, p. 141 (1836).

Hind feet with five digits, of which the first and fifth do not reach the ground; tail cylindrical, tufted. Skull with the occipital region less broad, auditory bullæ smaller, infraorbital opening with no separate canal for the nerve. Incisors plain. One very small premolar present above only.

4. *Platycercomys*, Brandt, Bull. Ac. St. Pétersb. p. 209 . (1844).

As in *Alactaga*, but the hind limbs proportionally shorter, and

* Since the above went to press, Dr. E. Coues has published a paper in which he rejects the generic names *Jaculus* and *Meriones* as preoccupied, substitutes *Zapus*, and regards the form as the type of a distinct family, *Zapodidæ* (Bull. U.S. Geol. Surv. v. pp. 253-262).

the tail flattened, lancet-shaped, covered with short hairs and not tufted. No premolars.

C. PEDETINÆ. One premolar above and below. Grinding-teeth rootless. Cervical vertebræ free. Metatarsals separate. Hind feet with four well-developed digits, with short broad hoof-like nails. Tail bushy throughout, not tufted. Ethiopian. Recent genus:—

5. *Pedetes*, Illiger, Prod. Syst. Mamm. p. 81. (1811).
(Characters those of the subfamily.)

Section III. *Hystricomorpha*.

One premolar above and below (except in *Ctenodactylus*). Grinding-teeth rooted or rootless, not tuberculate. Frontals with no distinct postorbital processes (except in *Chætomys*). Infraorbital opening large, subtriangular, or oval. Zygomatic arch proportionally stout; malar not advancing far forward (except in *Ctenodactylinae* and *Chinchillidæ*), and not supported below by a continuation of the maxillary zygomatic process. Incisive foramina small; foramina in base of skull proportionally large; an interpterygoid fissure. Mandible with its angular portion springing from the *outer side* of the bony covering of the lower incisor, triangular, usually pointed behind; coronoid process small, and condyle low. Clavicles perfect or imperfect. Fibula persistent as a distinct bone throughout life. Upper lip rarely cleft. Muffle clad with fine hairs. Nostrils pointed above, sigmoid or linear. Ears usually emarginate behind. Tail hairy, subnaked, or scaly.

Family I. OCTODONTIDÆ.

Grinding-teeth with external and internal enamel-folds. Malar with an inferior angle; incisive foramina usually long, extending into the maxillaries; clavicles perfect. Both hind and fore feet usually with five digits, rarely with four; claws curved. Teats placed high on the flanks. Tail clad with short hairs or with scales. Three subfamilies:—

A. CTENODACTYLINÆ. Grinding-teeth semirooted. Malar extending to the lachrymal (as in the last family) in a flattened perpendicular plate. Hind feet with the claws of the two inner digits covered by comb-like series of bristles. Ethiopian. Recent genera:—

1. *Ctenodactylus*, Gray, Spicilegia Zoologica, p. 10 . . (1830).

Ears very small, with no antitragus. Tail rudimentary. Interparietal and auditory bullæ large; coronoid process reduced to a ridge. No premolars. Molars with single external and internal enamel-folds.

2. *Pectinator*, Blyth, J. A. S. B. xxiv. p. 294 (1855).

Ears with a small antitragus. Tail half as long as the body, bushy. Interparietal smaller, auditory bullæ larger, and palate more contracted than in *Ctenodactylus*. Premolars present, but very small. Third upper molar with two external folds.

B. OCTODONTINÆ. Grinding-teeth semirooted or rootless, with short and simple enamel-folds. Fur soft. Tail usually short. Ethiopian and Neotropical. Recent genera :—

3. *Petromys*, A. Smith, S. African Quart. Journ. ii. p. 2 (1831).

Ears short. Fur rather harsh. Pollex very short, with a small nail. Claws short. Tail moderate, rather bushy. Infraorbital opening with a small groove for the nerve. Grinding-teeth semirooted, with single external and internal folds, which nearly meet in the middle.

4. *Ctenomys*, De Blainville, Bull. Soc. Philomath. 1826, p. 62 (1826).

Eye and ear very small. Fur soft. Claws longer than the toes, those of the hind feet with comblike bristles (as in *Ctenodactylinæ*). Tail rather short, clad with short hairs. Skull and mandible very massive; auditory bullæ long and pear-shaped; malar with strong superior and inferior angles; infraorbital opening with no groove for the nerve. Incisors very broad. Grinding-teeth rootless, with kidney-shaped crowns; the third molar above and below small and sub-circular.

5. *Schizodon*, Waterhouse, P. Z. S. 1841, p. 91 (1841).

External characters much as in *Ctenomys*, but the ears larger and the claws, though strong, not longer than the digits themselves. Skull less massive; the superior and inferior angles of the malar weaker; infraorbital opening with a groove for the nerve. Incisors broad, convex. Grinding-teeth placed transversely, with single external and internal folds, which meet in the middle.

6. *Spalacopus*, Wagler, Isis, 1832, p. 1219 (1832).

Ear rudimentary; tail short; claws of fore feet shorter than the digits. Skull shorter than in *Schizodon*; superior and inferior angles of malar obsolete; infraorbital opening smaller, with no separate canal for the nerve. Incisors broad, the upper arched boldly forward, the lower very long. Grinding-teeth like those of *Schizodon*; but the external and internal folds do not meet in the middle line.

7. *Octodon*, Bennett, P. Z. S. 1832, p. 46 (1832).

Ears rather large. Claws small, that of the pollex truncated. Tail long, hairy, bushy at the tip. Skull similar to that of *Spalacopus*, but with a separate canal in the infraorbital opening for the nerve. Incisors narrow. Molars like those of *Spalacopus*, but placed diagonally, and the posterior lobe smaller than the anterior in the upper teeth.

8. *Habrocoma* (= *Abrocoma*), Waterhouse, P. Z. S. 1837, p. 30 (1837).

Ears very large. Fur very soft. Tail moderate, clad with short hairs, not tufted. Pollex obsolete. Skull with the facial portion elongated; malar with moderate superior and inferior angles; auditory bullæ very large. Incisors narrow. Upper grinding-teeth with single exter-

nal and internal enamel-folds; the lower with one external and two internal folds, dividing them into narrow angular lobes.

C. ECHINOMYINÆ. Grinding-teeth semirooted or rooted, with deep, curved enamel-folds. Fur more or less harsh, often mixed with spines. Tail usually long. Neotropical and Ethiopian. Recent genera:—

9. *Carterodon*, Waterhouse, Nat. Hist. Mamm. ii. p. 351 (1848).

Muzzle blunt; ears moderate; tail short, clad with scales and rather long hairs. Skull broad, with no marked crests; frontals with delicate supraorbital ridges. Incisors broad, with longitudinal furrows and raised ridges. Upper grinding-teeth with one internal and two external enamel-folds; the lower similar but reversed.

10. *Myopotamus*, Geoffroy, Ann. du Mus. vi. p. 81 . . . (1805).

Muzzle blunt; pollex with a truncated nail; hind feet large, with the first four digits fully webbed and the fifth free; tail moderate, cylindrical, scaly. Skull elongated, with sharp occipital and sagittal crests; auditory bullæ small; paroccipital processes very long. Incisors flat, plain. Grinding-teeth as in *Carterodon*, but the lower with three internal folds.

11. *Cercomys*, F. Cuvier & Geoffroy, Mammifères, 6^{me} livr. (1829).

Muzzle pointed; ears rather large; fur without bristles or spines; pollex very small, with a short nail; hind feet not webbed; tail long, scaly. Skull ovate; frontals contracted, with sharp supraorbital ridges, coronoid process small. Incisors flat. Grinding-teeth with nearly circular crowns; the upper with one internal and three external enamel-folds; the lower similar but reversed.

12. *Loncheres*, Illiger, Prod. Syst. Mamm. p. 90 (1811).

Muzzle blunt; ears rather short; fur in most species mixed with flattened lanceolate spine; toes subequal; second digit of fore feet with a broad truncated nail; tail long, clad with scales and hairs. Skull like that of *Cercomys*. Incisors narrow. Upper grinding-teeth like those of *Cercomys*, but longer, with the middle folds usually meeting in the middle; the lower with one external and two internal folds.

13. *Mesomys*, Wagner, Wieg. Arch. 1845, Th. ii. p. 145 (1845).

External characters as in *Loncheres*; but pollex with a short curved claw, fur without spines, and tail short, thickly haired. No distinct supraorbital ridges. Incisors broad. Upper grinding-teeth with one or two external folds; the lower similar but reversed.

14. *Echinomys* (= *Echimys*), Desmarest, Nouv. Dict. d'Hist. Nat. x. p. 45 (1817).

Muzzle pointed; ears larger than in *Loncheres*; feet narrower, the toes more uneven in length, fur usually mixed with spines. Palate shorter and broader. Incisors narrow. Grinding-teeth as in *Mesomys*.

15. *Dactylomys*, Is. Geoffroy, Ann. Sc. Nat. (2^{me} sér.) x. p. 126 (1838).

Ears short; tail long, scaly; fore feet with the pollex obsolete, and the third and fourth digits elongated, with short convex nails. Skull with proportionally small orbits and high occiput. Incisors flat. Grinding-teeth (except the lower premolar) each divided into two lobes, each of which has a single enamel-fold.

16. *Plagiodon* (= *Plagiodontia*), F. Cuvier, Ann. Sc. Nat. (2^{me} sér.) vi. p. 347 (1836).

Form stout; muzzle blunt; pollex rudimentary; outer hair coarse; under-fur silky; tail short, scaly. Grinding-teeth rootless, the upper with a deep enamel-fold running diagonally forward from near the internal posterior angle, and another running back from near the outer anterior angle; the lower with one external and two internal folds.

17. *Capromys*, Desmarest, Mém. Soc. d'Hist. Nat. i. p. 44 (1822).

External characters much as in *Plagiodon*; fur long and harsh; tail moderate or long, scaly, sparsely haired. Liver divided into minute lobules. Skull elongate, with no marked crests; malar deep; paroccipital process long. Incisors small, convex. Upper grinding-teeth with one internal and two external folds; the lower similar but reversed.

18. *Aulacodus*, Temminck, Monogr. de Mamm. i. p. 245 (1827).

Form stout; muzzle blunt; fur harsh; tail moderate, sparsely haired; fore feet with the pollex rudimentary and the fifth digit very short; hind feet with four digits, of which the outer is rudimentary. Skull with the facial portion much inflated; the brain-case small, with strong sagittal and occipital crests; parietals small; infraorbital opening with a separate canal for the nerve. Incisors very broad, the upper with three deep grooves. Grinding-teeth rooted, with folds arranged as in *Capromys*.

Family II. HYSTRICIDÆ.

Grinding-teeth with external and internal enamel-folds. Skull ovate, often greatly inflated by large air-sinuses in the bones; facial portion short and broad; malar with no inferior angle; occipital plane perpendicular, with a median ridge. Form robust; limbs subequal; fur more or less modified into spines and hollow quills. Two subfamilies:—

A. SPHINGURINÆ. Grinding-teeth rooted. Skull short; lachrymal bone not bounding the canal. Clavicles perfect. Upper lip unfurrowed. Tail moderate or long, usually prehensile. Soles of feet tuberculated. Four teats. Nearctic and Neotropical. Recent genera:—

1. *Chaetomys*, Gray, P. Z. S. 1843, p. 21 (1843).

Head and body clad with stout wavy bristles; feet with four

digits; the hind feet with a nailless tubercle instead of the first digit, and an internal lobe, supported by two accessory tarsal ossicles. Skull short; the frontal and malar with large postorbital process, which almost meet; walls of auditory meatus produced. Upper grinding-teeth each divided into three lobes, of which the anterior and posterior have deep single enamel-folds; lower teeth with one external and two internal folds.

2. *Sphingurus* (= *Sphiggurus*), F. Cuvier, Dents d. Mamm. p. 256 (1825)*.

Nostrils far apart; head and body clad above with short stiff spines, or with mixed spines and bristly hair; feet as in *Chætomys*; tail long, prehensile at its tip. Skull short; the air-sinuses greatly developed in some species; no postorbital processes; walls of auditory meatus not produced; interparietal broad; angle of mandible pointed. Grinding-teeth subequal, like those of *Sphingurus*, but with two lobes only.

3. *Erythizon*, F. Cuvier, Dents d. Mamm. p. 256 . . . (1825).

External characters as in *Sphingurus*, but the nostrils nearer together, the quills more concealed by hair, the hind feet with five toes and hardly any internal lobe; the tail short, thick, and non-prehensile. Skull with walls of auditory meatus slightly produced; angle of mandible rounded. Grinding-teeth like those of *Sphingurus*, but the anterior much longer than the posterior.

B. HYSTRICINÆ. Grinding-teeth semirooted. Skull more elongate; lachrymal partly bounding the canal. Clavicles imperfect. Upper lip furrowed; tail not prehensile; soles of feet smooth; six teats. Palæarctic, Indian, and Ethiopian. Recent genera:—

4. *Atherura*, G. Cuvier, Règne Animal (2^{me} éd.), i. p. 215 (1829).

Spines flattened, channelled; tail long, scaly, with a tuft of compressed bristles at the point. Nasal part of skull moderate. Upper grinding-teeth with one internal and three or four external folds, the latter soon separated as enamel-loops; the lower teeth similar, but reversed.

5. *Hystrix*, Linnæus, Syst. Nat. i. p. 76 (1766).

Spines cylindrical; tail short, covered with spines and slender-stalked open quills. Nasal cavity usually very large. Air-sinuses of frontals greatly developed. Teeth as in *Atherura*.

Family III. CHINCHILLIDÆ.

Incisors short; grinding-teeth divided by continuous folds into transverse laminæ. Malar extending forward to lachrymal, with no inferior angle, and only a rudimentary superior angle. Optic foramina confluent. Auditory bullæ moderate or very large. Palate contracted in front, and deeply emarginate behind. Clavicles perfect.

* = *Syntheres* and *Sphiggurus*, F. Cuvier (1825) = *Cercolabes*, Brandt (1835).

Fore limbs small; hind limbs elongate, with four or five toes. Fur very soft. Tail moderate or long, bushy. Neotropical. Recent genera:—

1. *Chinchilla*, Bennett, Gardens &c. Zool. Soc. pt. i. p. 1 (1829).

Ears broad, not elongated. Fore feet with five digits; the pollex very small, but bearing a claw; hind feet with four digits. Tail long, bushy. Skull with the auditory bullæ enormous, appearing on the top of the skull between the supraoccipital, interparietal, and squamosals. Grinding-teeth rootless, with their enamel-folds nearly straight, each with three laminæ; the two anterior laminæ of the lower premolar imperfectly separated.

2. *Lagidium*, Meyer, Nov. Act. Acad. Nat.-Cur. xvi. p. 576 (1833).

Ears elongated. Both fore and hind feet with four digits. Skull as in *Chinchilla*, but the auditory bullæ more moderate, articulating on the top of the skull with the supraoccipital and squamosals only. Grinding-teeth similar, but their folds curved; all three laminæ of the lower premolar perfectly separated.

3. *Lagostomus*, Brooks, Tr. Linn. Soc. xvi. p. 102 . . . (1828).

Ears moderate. Fore feet with four digits, and hind feet with three; the tarsus elongated. Tail moderate, bushy, tufted. Skull more massive than in the other genera, with well-marked sagittal and occipital crests; auditory bullæ smaller, not appearing on the top of the skull; infraorbital opening with a separate canal for the nerve. Grinding-teeth with two laminæ, except the last upper molar, which has three.

Fossil genera:—

4. *Amblyrhiza*, Cope, Proc. Amer. Phil. Soc. xi. p. 183 . (1869).

Grinding-teeth semirooted, each with either four or five laminæ.

5. *Loxomylus*, Cope, *op. cit.* p. 187 (1869).

Grinding-teeth as in *Amblyrhiza*, but each with three laminæ only, their crowns obliquely sloped both longitudinally and laterally.

Family IV. DASYPROCTIDÆ.

Incisors long. Grinding-teeth semirooted, with external and internal enamel-folds. Milk-teeth long retained. Optic foramina separate; palate broad; incisive foramina short; mandible with the masseteric ridge obsolete. Clavicles rudimentary. Form somewhat slender, limbs moderate; upper lip entire; ears short; tail short and naked or rudimentary. Fore feet with five digits; hind feet with five or three; claws short and hoof-like. Neotropical. Recent genera:—

1. *Dasyprocta*, Illiger, Prod. Syst. Mamm. p. 93 . . . (1811).

Form compact; limbs long; hind feet with three digits only; tail either obsolete or short and subnaked. Skull elongate, smooth; infraorbital opening with no separate canal; malar simple; parocci-

pital processes short. Upper grinding-teeth with one internal and three or four external folds, the latter soon separated as isolated enamel-loops; the lower teeth similar but reversed.

2. *Cælogenys*, F. Cuvier, Ann. du Mus. x. p. 203 . . . (1807).

Muzzle obtuse; skin of cheeks reflected below the zygoma; hind feet with five digits; tail reduced to a tubercle. Skull with the zygoma enormously inflated, the anterior two thirds composed of the maxillary zygomatic process, which is hollowed out below into a great chamber, lined with mucous membrane and communicating with the mouth; infraorbital opening with a canal for the nerve; paroccipital processes long. Upper grinding-teeth with two internal and three external folds, except the third molar, which is reversed; lower teeth with one external and three internal folds.

Family V. DINOMYIDÆ.

Incisors broad. Grinding-teeth rootless, with folds dividing them into transverse lobes. Optic foramina confluent. Paroccipital processes short. Palate broad. Clavicles imperfect. Manubrium broad. Upper lip cleft. Hair harsh. Tail rather long, bushy. Both fore and hind limbs with four digits; claws as in the last family. Neotropical. Recent genus:—

1. *Dinomys*, Peters, Monatsb. Ak. Berlin, 1873, p. 551 (1873).
(Characters those of the family.)

Family VI. CAVIIDÆ.

Incisors short. Grinding-teeth with folds dividing them into transverse lobes. Milk-teeth shed during foetal life. Optic foramina separate; paroccipital processes long and curved; palate contracted in front; mandible with a strong masseteric ridge. Clavicles imperfect. Upper lip entire; ears short or long; fur moderately soft; tail very short or absent. Fore feet with four digits, hind feet with three only; claws as in last family. Neotropical. Recent genera:—

1. *Cavia*, Pallas, Misc. Zool. p. 30 (*ex* Klein, 1751) . . (1766).

Body plump; limbs very short, subequal; ears short; hind feet not palmated; no external tail. Skull much depressed; malar slender; palate much contracted in front, deeply emarginate behind, exposing the præspenoid; incisive foramina long. Grinding-teeth each divided into two angular lobes.

2. *Dolichotis*, Desmarest, Mammalogie, p. 360 (1822).

Limbs and ears long; tail very short or rudimentary. Skull less depressed than in *Cavia*, and the facial portion comparatively larger; palate still more deeply emarginate, exposing the vomer; incisive foramina long. Grinding-teeth each divided into two angular lobes, except the third upper molar and the lower premolar, which have each three lobes.

3. *Hydrochærus*, Brisson, Règn. An. p. 116 (1756).

Body massive; limbs moderate; muzzle very blunt; eyes and ears small; tail obsolete; hair coarse and sparse; all the feet fully webbed. Skull massive; malar very deep; palate produced behind the last molar; incisive foramina short; paroccipital processes very large and long. Upper incisors grooved in front; upper grinding-teeth each with two lobes, united only by cement, except the third molar, which has twelve narrow transverse plates; lower premolar and first molar with three narrow lobes, the second and third with four.

Suborder II. GLIRES DUPLICIDENTATI.

Incisors $\frac{4}{2}$, at birth $\frac{6}{2}$; the outer upper incisors soon lost; the next pair very small, placed directly behind the large middle pair; their enamel continuous round the tooth, but much thinner behind. Skull with the optic foramina confluent, with no true alisphenoid canal; incisive foramina usually confluent; bony palate reduced to a bridge between the alveolar borders. Fibula ankylosed to tibia below, and articulating with the calcaneum. Testes permanently external; no vesicular glands. Two families:—

Family I. LAGOMYIDÆ.

Either one or two premolars above and below; grinding-teeth rootless, with transverse enamel-folds dividing them into lobes. Skull depressed; frontals contracted, with no postorbital processes; facial surface of maxillary with a single perforation; posterior angle of malar produced almost to the auditory meatus; basisphenoid not perforate, nor separated by a fissure from the vomer; coronoid process in the form of a tubercle. Clavicles complete. Ears short. Hind limbs not markedly elongated. No external tail. Palæarctic and Nearctic. Recent genus:—

1. *Lagomys*, G. Cuvier, Tabl. Elém. de l'Hist. Nat. p. 132 (1798).

External characters those of the family; two premolars above and below.

Fossil genus:—

2. *Titanomys*, Von Meyer, Jahrb. für Mineralog. 1843, p. 393 (1834).

One premolar only, both above and below.

Family II. LEPORIDÆ.

Three premolars above, and two below; grinding-teeth as in last family. Skull compressed; frontals with large wing-shaped postorbital processes; facial portion of maxillaries minutely reticulated; basisphenoid with a median perforation and separated by a fissure from the vomer; coronoid process represented by a thin ridge of bone. Clavicles imperfect. Ears and hind limbs elongated. Tail short, bushy, recurved. Cosmopolitan (except Australasian region). Recent genus:—

1. *Lepus*, Linnæus, Syst. Nat. i. p. 77 (1766).

External characters those of the family; all the grinding-teeth with three narrow laminæ, except the last lower molar, which is small and simple.

Fossil genus:—

2. *Palæolagus*, Leidy, Proc. Acad. Philad. 1856, p. 89 . (1856).

Incisors longer than in *Lepus*, first lower premolar with only two laminæ.

Suborder III. GLIRES HEBETIDENTATI (subord. nov.).

Incisors $\frac{2}{4}$; the second lower pair very small, and placed rather behind the middle pair, their enamel continuous round the tooth, and their crowns transversely hollowed, not chisel-edged. Grinding-teeth rootless, curved, with their convexity directed outwards. Mandibular condyles and glenoid cavity transverse. Fibula articulating with the calcaneum. One family:—

Family I. MESOTHERIIDÆ.

Two premolars above and one below; grinding-teeth rootless, with single reentering enamel-folds. Skull massive, with sagittal and occipital crests enormously developed, the latter running forwards at the sides to the zygoma; frontals with large postorbital processes; infraorbital opening small; malar very deep, running forward to the lachrymal; auditory bullæ moderate; paroccipital processes long; bony palate perfect, produced behind the molars; mandible resembling in form that of *Leporidae*. Clavicles perfect; scapular and humerus resembling those of *Castoridae*. Both fore and hind limbs with five digits, claws probably short and hoof-like. Ischia articulated with two of the caudal vertebræ. Pliocene of South America. Fossil genus:—

1. *Mesotherium*, Serres, Compt. Rend. Ac. Paris, xlv. p. 961
(1857).

(Characters those of the family.)

P.S. Since this paper was written I have been much pleased to find that the researches of my friend Mr. A. Doran, of the Royal College of Surgeons, into the form of the auditory ossicles of mammals, essentially confirm the views of affinity here adopted. Mr. Doran's observations are yet unpublished; and it will be sufficient here to indicate their more general result. He finds in the auditory ossicles of the more typical Sciuromorpha a different type from that presented in the typical Myomorpha. *Castor*, though aberrant, approaches nearest to *Arctomys*; and *Anomalurus* is very close to *Sciurus*. Among the Myomorpha, *Bathyergus* has the characteristic type of the Hystricomorpha, in which, with few or no exceptions, the malleus and incus are ankylosed together; and *Dipus* inclines in the same direction. The ossicles of the GLIRES DUPLICIDENTATI present a distinct and less specialized type.