CLASSIFICATION OF THE HARES AND THEIR ALLIES

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CONTENTS

I. INTRODUCTION

The object of this paper is to give an account of the principal osteological features of the hares, rabbits, and pikas or duplicidentate rodents, the Duplicidentata, and to determine their family, generic, and subgeneric relationships.

The subject is treated in two ways. First, there is a discussion of each part of the skeleton and of the variations that are found in that part throughout the various groups of the existing Duplicidentata. Second, each of these groups is separately considered, and the characters of its skeleton described. The treatment of the osteology in these two ways is followed by three keys to the genera and subgenera, one based on cranial characters, one on dental characters, and one on skeletal characters aside from those of the skull.

Before taking up the osteological discussion, however, I give the histories of the various generic and subgeneric names that have been applied to the existing hares, rabbits, and pikas.

As the geographical distribution of the various groups shows some interesting correlations with zoogeographic areas, a few remarks are made on that subject.

I have had at my disposal the following skeletons:

1048[1] *Lepus (Lepus) timidus*.....Sweden.
1049[1] *Lepus (Lepus) timidus*.....Sweden.
49622[1] *Lepus (Lepus) campestris*.....Nebraska.
49623[1] *Lepus (Lepus) campestris*.....Kansas.
2276[1] *Lepus (Lepus) bangsii*.....Newfoundland.
2277[1] *Lepus (Lepus) bangsii*.....Newfoundland.
18303[2] *Lepus (Lepus) gichiganus*.....Northeast Siberia.
836[1] *Lepus (Pœcilolagus) americanus*[3].....Fort Pierre, British America.
969[1] *Lepus (Pœcilolagus) americanus virginianus*[4].....New York.
7577[1] *Lepus (Pœcilolagus) americanus dalli*[6].Alaska.
21805[1] *Lepus (Macrotolagus) callotis*.....Locality unknown.
94198[5] *Lepus (Macrotolagus) texianus*.....Newark valley, Nevada.
49621[1] *Lepus sp*.....India; Jumna river.
49586[1] *Sylvilagus floridanus*.....Florida.
49587[1] *Sylvilagus floridanus*.....Florida.
49588[1] *Sylvilagus floridanus*.....Florida.

[1] United States National Museum.
[2] American Museum of Natural History.
[3] Very young, of little use.
[4] Skeleton incomplete.
[5] United States National Museum, collection Biological Survey, Department of Agriculture.
[6] Incomplete.

49589[1] *Sylvilagus floridanus*.....Florida.
89514[2] *Sylvilagus floridanus mallurus*.....Four Mile Run, Virginia.
16248[1] *Sylvilagus floridanus mallurus*.....Carlisle, Pennsylvania.
49624[1] *Sylvilagus floridanus transitionalis*.....Monroe county, New York.
11644[1] *Sylvilagus nuttallii*.....Fort Bridger, Wyoming.
92965[2] *Sylvilagus truei*.....Metlaltoyuca, Mexico.
113432[1] *Sylvilagus minensis*.....Chapada, Brazil.
49665[1] *Sylvilagus minensis*, young.....Chapada, Brazil.
74883[2] *Sylvilagus sp*.....Lewiston, Idaho.
94197[2] *Sylvilagus sp*.....Monitor valley, Nevada.
49580[1] *Limnolagus paludicola*.....Florida.
49645[1] *Oryctolagus cuniculus*.....Germany.
49648[1] *Oryctolagus cuniculus*.....England.
49386[1] *Oryctolagus cuniculus*, lop-eared.....Domestic.
49677[1] *Oryctolagus cuniculus*, Belgian hare....United States.
57954[2] *Romerolagus nelsoni*.....Mt. Popocatepetl, Mexico.
22972[1] *Pronolagus crassicaudatus*.....South Africa.
93695[2] *Brachylagus idahoensis*.....Ione valley, Idaho.
93596[2] *Brachylagus idahoensis*.....Ione valley, Idaho.
91188[2] *Ochotona (Pika) saxatilis*.....Cabinet mts., Idaho.
30990[2] *Ochotona (Pika) saxatilis*.....Salmon River mts., Idaho.
49620[1] *Ochotona (Pika) saxatilis*.....Oregon.
49500[1] *Ochotona (Ochotona) ladacensis*.....Hanlé district, Ladak.

Besides these, I have had access to a large number of skulls, mostly of American species. These are indicated at the end of the description of each genus or subgenus.

The material examined has been altogether too limited for anything like complete work on this interesting group of rodents and much more must be compared before a satisfactory determination of various relationships can be made. Yet, in the course of study so many interesting points have been disclosed, some already published and some apparently never before recorded, that it seems advisable to set forth our present knowledge in as complete a manner as can now be done.

As an aid to a clearer understanding of the text, the following outline of the classification therein adopted is here given:

The existing Duplicidentata are considered as composed of two distinct families, the Leporidæ, hares and rabbits, and the Ochotonidæ, pikas.

The Leporidæ are regarded as containing the following ten distinct genera, most of which have heretofore been recognized as subgenera. Two are here described as new.

[1] United States National Museum.

[2] United States National Museum, collection Biological Survey, Department of Agriculture.

1. *Lepus,* with the largest number of species and the most extensive geographical distribution. It contains three well-marked subgenera and a number of species which from lack of available material cannot now be satisfactorily classified.

(*a*) Subgenus *Lepus,* represented by the well-known species, *timidus, arcticus, europæus, campestris,* and their allies.

(*b*) Subgenus *Macrotolagus,* containing the jackass hares of Mexico and southwestern United States.

(*c*) Subgenus *Pœcilolagus* (new), containing *Lepus americanus* and the related species.

2. *Sylvilagus,* with two subgenera.

(*a*) *Sylvilagus* proper, containing the wood rabbits or cottontails of North and South America.

(*b*) *Microlagus,* containing a few small forms from western and southwestern United States.

3. *Oryctolagus,* represented by the rabbit of the Old World, *O. cuniculus.*

4. *Limnolagus,* containing the swamp rabbits and water hares of southern United States.

5. *Brachylagus,* a small short-tailed rabbit of western United States, *B. idahoensis.*

6. *Pronolagus* (new), containing the cape hare of South Africa.

7. *Romerolagus,* the peculiar little rabbit of Mount Popocatepetl, Mexico.

8. *Nesolagus,* from Sumatra.

9. *Caprolagus,* from the southern foothills of the Himalayas.

10. *Pentalagus* (new), from the Liu Kiu islands south of Japan.

The family Ochotonidæ contains but one existing genus, *Ochotona,* with a number of species inhabiting the northern parts or high mountain ranges of the Northern Hemisphere. It contains three well-marked subgenera.

(*a*) *Ochotona,* containing *ladacensis,* and allied forms from central Asia.

(*b*) *Pika,* containing *alpina* and the North American species.

(*c*) *Conothoa* (new), represented by *roylii* and related species.

In the preparation of this paper I have received from Mr. Gerrit S. Miller, Jr., many valuable suggestions and generous criticisms, which are here gratefully acknowledged. My thanks are due also to Dr. C. Hart Merriam for the use of all the skeletons and many separate skulls of the Duplicidentata in the collection of the Biological Survey of the United States Department of Agriculture; to Dr. Milton J. Greenman for the use of two specimens of *Pentalagus*

furnessi in the Wistar Institute of Anatomy, Philadelphia, and to Dr. J. A. Allen for the use of a skeleton of *Lepus gichiganus* and skull of *Ochotona kolymensis* in the American Museum of Natural History, New York. I have also to thank Mr. Oldfield Thomas, who presented to the U. S. National Museum a skeleton of *Oryctolagus cuniculus* and two young skeletons of *Sylvilagus minensis;* Dr. E. A. Mearns, who collected for the National Museum a series of skeletons of *Sylvilagus floridanus* and the only available skeleton of *Limnolagus;* and Messrs. Witmer Stone and James A. G. Rehn for furnishing references and copies of Blyth's figures of *Caprolagus*.

II. LIST OF NAMES APPLIED GENERICALLY OR SUBGENERICALLY TO THE EXISTING HARES, RABBITS, AND PIKAS

ABRA

Proposed by Gray (Cat. Mammals, Birds, etc., presented by B. H. Hodgson to Brit. Mus., 2d ed., p. 11, 1863) as a subgenus of *Lagomys*.

Type *Lagomys* (*Abra*) *curzoniæ* Hodgson from the Himalayas of Sikkim, India.

Preoccupied by *Abra* Leach, 1818, a genus of Mollusca, fide Palmer, North American Fauna, No. 23, pp. 71, 860, January 23, 1904.

BRACHYLAGUS

Proposed by Miller (Proc. Biol. Soc. Washington, XIII, p. 157, June 13, 1900) as a subgenus of *Lepus* for *L. idahoensis* Merriam, the only species and the type. In the present paper it is considered a distinct genus.

CAPROLAGUS

Proposed by Blyth (Journ. Asiatic Soc. Bengal, XIV, 1845, p. 247) as a genus to include *Lepus hispidus* Pearson.

Blyth (Cat. Mam. Mus. Asiat. Soc. Calcutta, 1863, p. 133) subsequently replaced *Caprolagus hispidus* in the genus *Lepus*.

Gray (Ann. Mag. Nat. Hist., XX, 3d ser., 1867, p. 225) under the misprinted name *Carpolagus* regarded it as a distinct genus for *Lepus hispidus* Pearson.

Trouessart (Catalogus Mammalium, vol. I, fasc. iii, p. 664, 1897) places two species under *Caprolagus* as a subgenus of *Lepus*, *hispidus* Pearson, and *netscheri* Schlegel, the latter being regarded in this paper as the type of the genus *Nesolagus* Major.

Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 514, November, 1899) regards *Caprolagus* as a distinct genus containing the three species *sivalensis* Major, *valdarnensis* Weith, and *hispidus* Pearson, the first two extinct. He also uses the name in a larger sense for a group, including (1) *Caprolagus*, (2) *Nesolagus*, (3) *Oryctolagus*, (4) *Sylvilagus* (the last containing (*a*) *Limnolagus*, (*b*) *Romerolagus*, (*c*) *Tapeti*, and (*d*) *Sylvilagus*), contrasted with a *Lepus* group containing the one genus *Lepus* (this the same as the genus *Lepus* of the present paper).

Stone (Proc. Acad. Nat. Sci. Philadelphia, 1900, p. 462) regards *Caprolagus* as a distinct genus containing the following species: *hispidus* PEARSON, *netscheri* SCHLEGEL, *furnessi* STONE. The last two are considered in the present paper as the types of the genera *Nesolagus* and *Pentalagus* respectively.

CARPOLAGUS

Used by Gray (Ann. Mag. Nat. Hist., XX, 3d ser., 1867, p. 225), typographical error, for *Caprolagus* BLYTH.

CHIONOBATES

Used by Kaup (Entw. Gesch. und Natür. Syst. Europ. Thierwelt, I, p. 170, 1829) as a genus for two species, *variabilis* and *borealis*. It is antedated by *Lepus* LINNÆUS.

CUNICULUS

First used as a name for rabbits by Meyer (Mag. f. Thiergesch., I, pt. i, 52–53, 1790) applied to *Oryctolagus cuniculus* (renamed by Meyer *campestris*) and *domesticus, angorensis, argenteus, russicus,* and *dauricus* Europe, and to *brasiliensis* Brazil.

The name is synonymous with *Lepus* LINNÆUS, containing the same three genera, *cuniculus* representative of *Oryctolagus, dauricus* = *tolai* (Erxleben) a member of the genus *Lepus,* and *brasiliensis* a member of the genus *Sylvilagus.*

Cuniculus was next used by Gloger (Hand- u. Hilfsbuch Naturgesch., I, p. 104, 1841) for *Oryctolagus cuniculus* renamed *Cuniculus dasypus.*

It was proposed again by Gray (Ann. Mag. Nat. Hist., XX, 3d ser., 1867, p. 224) as a genus for "*Lepus* Section C" Baird (Mammals of North America, 1857, p. 575). The only species included by Gray in the genus is *fodiens* KLEIN which he considered the correct name for *Lepus cuniculus* LINNÆUS, which is accordingly the type.

The name is preoccupied (*Cuniculus* BRISSON, Regn. Animal, 1762, p. 13, and *Cuniculus* WAGLER, Nat. Syst. d'Amphibian, 1830, p. 21) and was replaced by *Oryctolagus* LILLJEBORG (Sveriges och Norges Ryggradsdjur, I, 1874, p. 417).

EULAGOS

Used by Gray (Ann. Mag. Nat. Hist., XX, 3d ser., 1867, p. 222) as a genus for *Lepus mediterraneus* WAGNER, and *Eulagus judææ* "the Holy Land Buneas, Tristram." The word has apparently not been used by subsequent writers, who have placed these species under the subgenus *Lepus* of the genus *Lepus.* I have seen no material of either.

HYDROLAGUS

Used by Gray (Ann. Mag. Nat. Hist., XX, 3d ser., 1867, p. 221) as a generic term for "*Lepus,* Section F" of Baird (Mammals of North America, p. 575). Gray places in it two species: *aquaticus* BACHMAN, and *palustris* BACHMAN. The former, the first named species and the one from which the word *Hydrolagus* was evidently derived, may be considered the type.

Trouessart (Catalogus Mammalium, I, fasc. iii, pp. 657, 658, 1897) uses the name as a subgenus of *Lepus* for the following species: *aquaticus* BACHMAN, *aquaticus attwateri* ALLEN, *palustris* BACHMAN, *paludicola* MILLER and

BANGS, and *truci* ALLEN. In the present paper the last named species is referred to the genus *Sylvilagus.*

As shown by Mearns (Science, n. s., v, March 5, 1897, p. 393) *Hydrolagus* GRAY, 1867, is antedated by *Hydrolagus* GILL, 1862, for a genus of fishes. (See *Limnolagus.*)

LAGOMYS

Proposed by Cuvier (Leçons d'Anat. Comp., Table, 1800, characterized in Table élémentaire de l'histoire naturelle des animaux, p. 132, 1798) as a genus to include the animal previously known as *Lepus alpinus,* the only named species and the type.

From 1800 up to 1896 *Lagomys* was in general use among systematists as the generic term of the pikas. At the latter date Thomas (Proc. Zool. Soc. Lond., 1896, p. 1026) adopted the older name *Ochotona* LINK (Beyträge Naturgeschichte, I, pt. II, p. 74, 1795).

Under *Lagomys,* Gray (Ann. Mag. Nat. Hist., XX, 3d ser., p. 220, 1867) included the following species: Asia: *alpinus* CUVIER, *pusillus* DESMAREST, *rufescens* GRAY, *hodgsoni* BLYTH, *nepalensis* HODGSON, *roylii* OGILBY, *hyperboreus* WAGNER; America: *princips* RICHARDSON, *minimus* LORD.

Lagomys CUVIER is preoccupied by *Lagomys* STORR, 1780 (Prodromus Methodi Mammalium, p. 39), a substitute for the name *Arctomys* (fide Miller, North American Fauna, No. 12, p. 13, July 23, 1897).

LAGOPSIS

Used by Rafinesque (Analyse de la Nature, 1815, addendum, p. 219) as an emendation of *Lagopsys* used on p. 58. Nomen nudum.

Used by Schlosser 1884, and Major 1899, for fossil forms.

LAGOPSYS

Used by Rafinesque (Analyse de la Nature, 1815, p. 58). Nomen nudum, 'Lagopsys R. *Lepus sp.;* name emended to *Lagopsis,* ibid., p. 219.

LAGOS

Used in a sales catalogue by Brookes. "Cat. Anat. & Zool. Mus. of Joshua Brookes, London, p. 54, 1828."

Type: *Lagos arcticus* (=*Lepus arcticus* Ross), fide Palmer, North American Fauna, No. 23, pp. 361, 850, January 23, 1904.

This questionable name is a synonym of the restricted genus *Lepus.*

LEPUS

Used by Linnæus, 1758 (Syst. Nat., 10th ed., I, p. 57, 1758), as a genus for four species, representing three modern genera, as follows:

Timidus, Chionobates KAUP 1829.

Brasiliensis, Tapeti GRAY = part of *Sylvilagus* GRAY 1867.

Capensis, Chionobates KAUP, 1829.

Cuniculus, Cuniculus GLOGER, 1841 (not of BRISSON, 1862) = *Oryctolagus* LILLJEBORG, 1874.

In accordance with the code of nomenclature of the American Ornithologists' Union, the species *cuniculus* would become the type, as it represents the last of the non-exotic groups to be removed.

On the other hand, by a slight extension of the rule recommended in Science, n. s., XVI, pp. 114, 115, July 18, 1902, *timidus* may be fixed as the type of the genus *Lepus,* and no radical changes in the generic names of the Leporidæ would result, as would occur by a strict application of the principle of elimination.

This rule is as follows:

"A generic name which is the same as that of an explicitly included species (or a cited post-Linnæan synonym of such species) takes that species as its type regardless of subsequent elimination."

Since Linnæus could cite no post-Linnæan synonym, the rule can rationally be extended to include, in the case of Linnæus, the names used by earlier writers. Under *timidus,* Linnæus cites *Lepus* GESNER.

In the present paper, *timidus* is regarded as the type of the genus *Lepus,* and the word *Lepus* is retained for the species to which it has been commonly applied.

Pallas (Glires, 1778, pp. 1–70), Gmelin (Linnæus, Syst. Nat., I, 1788, pp. 164–166), Schreber (Saügthiere, VII, pp. 906–918, 1792), use *Lepus* as the generic name of the pikas as well as of the hares and rabbits.

The pikas were placed in separate genera, *Ochotona* LINK, 1795 (Beyträge Naturgesch., I, pt. ii, p. 74, 1795) and later *Lagomys* G. CUVIER, 1798 (Leçons d'Anat. Comp. Table, 1800; characterized in Tab. Élémentaire de l'Hist. Nat. des Animaux, p. 132, 1798).

From the time of Link and Cuvier until Gray in 1867, the generic name *Lepus* was used for both hares and rabbits and as the equivalent of the family Leporidæ. Gray, however, divided the genus into the following genera: *Hydrolagus, Sylvilagus, Eulagos, Lepus, Tapeti,* and *Cuniculus.* At the same time he revived Blyth's genus *Caprolagus* (under the misprint *Carpolagus*) which had been proposed in 1845 and subsequently withdrawn by Blyth.

Gray included in the genus *Lepus* the following species:

European.—*timidus* LINNÆUS, *hybridus* DESMAREST, *aquilonius* BLASIUS, *variabilis* PALLAS, *canescens* NILSSON.

African.—*ægyptius* GEOFFROY, *hebessinicus* HEMPRICH and EHRENBERG, *isabellinus* RÜPPELL, *capensis* LINNÆUS, *saxatilis* F. CUVIER, *crassicaudatus* I. GEOFFROY.

Asiatic.—*arabicus* HEMPRICH and EHRENBERG, *syriacus* HEMPRICH and EHRENBERG, *sinaiticus* HEMPRICH and EHRENBERG, *nigricollis* F. CUVIER, *ruficaudatus* I. GEOFFROY, *tolai* PALLAS, *tibetanus* WATERHOUSE, *pallipes* HODGSON, *brachyurus* TEMMINCK, *sinensis* GRAY, *altaicus* BRANDT.

American.—*arcticus* LEACH, *americanus* ERXLEBEN, *washingtonii* BAIRD, *campestris* BACHMAN, *callotis* WAGNER, *californicus* GRAY, *longicaudatus* GRAY, *audubonii* BAIRD, *trowbridgii* BAIRD.

Of these *crassicaudatus* is regarded in this paper as the type of the genus *Pronolagus* and *audubonii* and *trowbridgii* as members of the genus *Sylvilagus.*

From 1867 to 1896 not much attention was paid to Gray's division of *Lepus,* but in 1896 Mearns revived *Sylvilagus* and *Hydrolagus* as subgenera of *Lepus.*

In the same year, 1896, Merriam described *Romerolagus* as a new genus of the Leporidæ, regarding all the other members of the family as congeneric. From that time on the idea has rapidly spread that the family Leporidæ no longer could be regarded as composed of but a single genus. In 1899 Major

revived Gray's names and Blyth's *Caprolagus* and gave one new name, *Nesolagus*.

Trouessart (Catalogus Mammalium, I, fasc. iii, 1897, pp. 649–664) gives two genera of the Leporidæ, *Romerlagus* and *Lepus*. *Lepus* contains the following subgenera: *Lepus, Hydrolagus, Sylvilagus, Microlagus, Macrotolagus, Tapeti, Oryctolagus,* and *Caprolagus*. All of these except *Lepus* are discussed elsewhere.

Under *Lepus* as a subgenus Trouessart includes the following species: *timidus* LINNÆUS, *europæus* PALLAS, *mediterraneus* WAGNER, *tolai* PALLAS, *mandschuricus* RADDE, *yarkandensis* GÜNTHER, *oiostolus* HODGSON, *pallipes* HODGSON, *dayanus* BLANFORD, *nigricollis*, F. CUVIER, *ruficaudatus* IS. GEOFFROY, *peguensis* BLYTH, *sinensis* GRAY, *hypsibius* BLANFORD, *swinhoei* THOMAS, *hainanus* SWINHOE, *brachyurus* TEMMINCK, *omanensis* THOMAS, *arabicus* HEMPRICH and EHRENBERG, *judeæ* GRAY, *sinaiticus* HEMPRICH and EHRENBERG, *ægyptius* AUDOUIN and GEOFFROY, *somalensis* HEUGLIN, *berberanus* HEUGLIN, *tigrensis* BLANFORD, *microtis* HEUGLIN, *capensis* LINNÆUS, *whytei* THOMAS, *victoriæ* THOMAS, *crassicaudatus* IS. GEOFFROY, *saxatilis* F. CUVIER, *salæ* JENTINK, *arcticus* LEACH, *grœnlandicus* RHOADS, *tschuktschorum* NORDQUIST, *americanus* ERXLEBEN, *campestris* BACHMAN.

Of these, *crassicaudatus* is regarded as the type of a new genus *Pronolagus* in the present paper. Many of the others I have not examined, nor seen figures of them, but those of which specimens and figures are available undoubtedly belong to the genus *Lepus* as defined further on.

Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 541, November, 1899) uses *Lepus* as a genus for evidently the same species that Trouessart includes in his subgenera *Lepus* and *Macrotolagus*.

Miller and Rehn (Proc. Boston Soc. Nat. Hist., XXX, pp. 177–180, December 27, 1901) have included under the subgenus *Lepus,* the following: *americanus* ERXLEBEN, *americanus bairdii* HAYDEN, *americanus columbiensis* RHOADS, *americanus dalli* MERRIAM, *americanus macfarlani* MERRIAM, *americanus phæonotus* ALLEN, *americanus struthopus* BANGS, *americanus virginianus* HARLAN, *arcticus* ROSS, *arcticus bangsii* RHOADS, *bishopi* ALLEN, *campestris* BACHMAN, *grœnlandicus* RHOADS, *klamathensis* MERRIAM, *labradorius* MILLER, *othus* MERRIAM, *poadromus* MERRIAM, *washingtonii* BAIRD.

In the present paper the genus *Lepus* corresponds in general with Trouessart's and Miller and Rehn's subgenera *Lepus* and *Macrotolagus*. I regard it as composed of a number of species whose relationships cannot be determined at the present time, and at least three distinct subgenera, (*a*) *Lepus*, including *arcticus, arcticus bangsii, campestris, grœnlandicus, labradorius, othus,* and *poadromus* of Miller and Rehn's list, together with *europæus, timidus,* and related forms of the Old World; (*b*) *Pœcilolagus,* containing *americanus* and its subspecies, together with *bishopi, klamathensis,* and *washingtonii;* and (*c*) *Macrotolagus,* with the species included under that name by Trouessart and by Miller and Rehn.

LIMNOLAGUS

Proposed by Mearns (Science, n. s., v, March 5, 1897, p. 393) to replace *Hydrolagus* GRAY (Ann. Mag. Nat. Hist., XX, 3d ser., 1867, p. 221) preoccupied in ichthyology by *Hydrolagus* GILL (Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 331). Type designated as *Lepus aquaticus* BACHMAN.

Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., November, 1899, p. 514) uses it as a subgenus of *Sylvilagus* for "*S. palustris, aquaticus,* &c."

Miller and Rehn (Proc. Boston Soc. Nat. Hist., XXX, pp. 183–184, December 27, 1901) have included under *Limnolagus* as a subgenus of *Lepus* the following species: *aquaticus* BACHMAN, *aquaticus attwateri* ALLEN, *palustris* BACHMAN, *palustris paludicola* MILLER and BANGS, *telmalemonus* ELLIOT, and *truei* ALLEN.

I consider *Limnolagus* as a genus embracing all the species just mentioned as found in Miller and Rehn, except *truei* ALLEN which is a member of the genus *Sylvilagus.*

MACROTOLAGUS

Proposed by Mearns (Sci., N. S. I., p. 698, June 21, 1895; Proc. U. S. N. M., XVIII, p. 552, June 24, 1896) as a subgenus of *Lepus* for the jackass hares of southwestern United States and Mexico. *Lepus alleni* MEARNS is designated as the type. The following species are included by him in this subgenus: *callotis, gaillardi, alleni* (type), *merriami, melanotis, griseus, texianus, eremicus, deserticola,* and *californicus.*

Trouessart (Catalogus Mammalium, I, fasc. iii, 1897, pp. 660–662) includes under *Macrotolagus* as a subgenus of *Lepus,* the following species: *alleni* MEARNS, *callotis* WAGLER, *gaillardi* MEARNS, *merriami* MEARNS, *melanotis* MEARNS, *texianus* WATERHOUSE (including the subspecies *eremicus* ALLEN, *griseus* MEARNS, and *deserticola* MEARNS) *californicus* GRAY, *martirensis* STOWELL, *insularis* BRYANT.

The term is used by Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., pp. 468, 469, November, 1899) as a subgenus of *Lepus,* for apparently the same group of hares that Mearns applied it to.

Miller and Rehn (Proc. Boston Soc. Nat. Hist., XXX, pp. 180–183, December 27, 1901) place in the subgenus *Macrotolagus* the following species: *alleni* MEARNS, *alleni palitans* BANGS, *asellus* MILLER, *californicus* GRAY, *californicus xanti* THOMAS, *callotis* WAGLER, *gaillardi* MEARNS, *insularis* BRYANT, *martirensis* STOWELL, *melanotis* MEARNS, *merriami* MEARNS, *texianus* WATERHOUSE, *texianus deserticola* MEARNS, *texianus eremicus* ALLEN, *texianus griseus* MERRIAM.

It is used in the present paper in the same sense as by Miller and Rehn.

It is interesting to note that the hares of this subgenus were recognized by Baird (Mammals of North America, p. 574, 1857) as forming a distinct group and constituting his "*Lepus* Section B."

MAMLEPUS

Used by A. L. Herrera (Sinonimia vulgar y cientifica de los principales vertebrados mexicanos, p. 11, 1899) as a name in a new system of nomenclature for the broad genus *Lepus* of Linnæan nomenclature.

MICROLAGUS

Proposed by Trouessart (Catalogus Mammalium, I, fasc. iii, p. 660, 1897) as a subgenus of *Lepus* for *Lepus cinerascens* ALLEN, on characters defined by Mearns (Proc. U. S. Nat. Mus, XVIII, pp. 552, 553, June 24, 1896). *Cinerascens* ALLEN, the only species named by Trouessart, is the type.

It is used by Miller and Rehn (Proc. Bost. Soc. Nat. Hist., XXX, pp. 188, 189) as a subgenus of *Lepus* for the following species: *bachmani* WATER-

HOUSE, *bachmani ubericolor* MILLER, *cerrosensis* ALLEN, *cinerascens* ALLEN, *peninsularis* ALLEN.

In the present paper it is regarded as a subgenus of *Sylvilagus,* and includes the species just mentioned as recorded by Miller and Rehn.

Baird (Mammals of North America, p. 575, 1857) recognized that the members of this subgenus formed a distinct group included under his section E.

MICROTOLAGUS

A curious misprint for *Macrotolagus* MEARNS found in Elliot (Synopsis of Mammals of North America and adjacent Seas, Field Columbian Mus., Zool. Ser. II, pp. 269, 288, 1901), repeated by Allen (Bull. Amer. Mus. Nat. Hist., p. 607, 1903).

MNUOLAGUS

Billberg (Syn. Faunæ Scandinaviæ, I, Mamm., Conspectus A. (before p. 1), 1828). Nomen nudum, occurring only in a table between *Lagomys* and *Lepus,* fide Palmer, North American Fauna, No. 23, January 23, 1904, pp. 850, 951.

NESOLAGUS

Proposed by Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 514, November, 1899) as a genus under the *Caprolagus* group (or a subgenus of the genus *Caprolagus;* Major does not definitely state) for *Lepus netscheri* SCHLEGEL (Notes Leyden Museum, II, 1880, pp. 59–65).

Netscheri is the only mentioned species and the type.

Nesolagus is here regarded as a well-marked genus.

OCHOTONA

First used by Link, 1795 (Beyträge Naturgeschichte, I, pt. ii, p. 74, 1795) as the generic name of the pikas. The following species are given: *pusilla, alpina,* and *minor* (*Lepus Ochotona*) Linnæus, of which *ochotona* is the type, *dauricus* is an earlier name, however, for the same species. (See Palmer, N. A. Fauna, No. 23, p. 468, January 23, 1904.)

It is the proper generic name of the pikas, for nearly a century called *Lagomys* CUVIER (Leçons d'Anat. Comp. Table, 1800) owing to ignorance of Link's rare work. Thomas (Proc. Zool. Soc. Lond., 1896, p. 1026) seems to have been the first to have brought forward Link's name.

It is used in the present paper as a genus for the pikas and also as a subgeneric name for *Ochotona ladacensis* and related species.

OGOTOMA

First used by Gray in 1867 (Ann. Mag. Nat. Hist., XX, 3d ser., p. 220, 1867) as the generic name for *Lagomys ogotoma* of Cuvier and of Waterhouse, the *Lepus ogotoma* PALLAS. Gray changes the specific name to *pallasii.* As this is the only species placed in the genus by Gray, it is the type.

The term is antedated by *Ochotona* LINK (Beyträge Naturgesch., I, pt. ii, p. 74, 1795), which has the same species for the type.

ORYCTOLAGUS

Proposed by Lilljeborg (Sveriges och Norges Ryggradsdjur, I, p. 417, 1874) as a subgeneric name for *Lepus cuniculus* LINNÆUS which is designated as the type. It was used to replace *Cuniculus* GRAY (Ann. Mag. Nat. Hist., 3d ser., XX, p. 225) which is preoccupied by *Cuniculus* WAGLER (Nat. Syst. d'Amphibian, p. 21, 1830), and BRISSON (Regn. Animal, 1762).

Trouessart (Catalogus Mammalium, I, fasc. iii, p. 663, 1897) uses it as a subgenus for *Lepus cuniculus* LINNÆUS, the only existing species.

Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., November, 1899, p. 514) regards it as a genus containing two species "*O. cuniculus* (LINN.); *O. crassicaudatus* (GEOFFR.)." In the present paper the latter is regarded as the type of the genus *Pronolagus*.

Recently Thomas (Ann. Mag. Nat. Hist., ser. 7, XI, January, 1903, pp. 78, 79) following Major has used *Oryctolagus* in a generic sense.

In the present paper it is regarded as a genus for the rabbits, heretofore commonly known as *Lepus cuniculus*.

PICA

Proposed by Fischer (Das National Museum Naturgesch. zu Paris, II, 126, 1803) as a correction of *Pika* LACÉPÈDE, fide Palmer (North American Fauna, No. 23, January 23, 1904, p. 537).

PIKA

Used by Lacépède in 1799 (Tableau des Divisions de Mammifères, 1799, p. 9) for the Alpine pika, called *Pika alpinus*, the only mentioned species, and accordingly the type.

It is used in the present account as a subgeneric term to include *Ochotona* (*Pika*) *alpina* and its related species, embracing all the North American forms.

ROMEROLAGUS

Proposed by Merriam (Proc. Biol. Soc. Washington, X, December 29, 1896, p. 173) as a genus for a remarkable rabbit found on the west slope of Mount Popocatepetl, Mexico. The type and only species in the genus is *Romerolagus nelsoni* MERRIAM.

Herrera (Mem. Revista de la Soc. Cient. Antonio Alzate, XIV, 1899–1900, p. 380; La Naturaleza, 2d ser., tomo III, 1898, p. 80) considers *Romerolagus nelsoni* to be a member of the genus *Lagomys*, a view which is entirely untenable (Nelson, Soc. Científica Antonio Alzate Mex., Revista Científica y Bibliográfica, num. 3, 1901, p. 33, figs. 1–6).

Major (Trans. Linn. Soc. London, 2d ser. VII, Zool., November, 1899, p. 514) regards *Romerolagus* as one of four subgenera of *Sylvilagus*, the other three being *Tapeti*, *Limnolagus* and true *Sylvilagus*.

Stone (Proc. Acad. Nat. Sci. Philadelphia, 1900, p. 462) regards it as one of three genera forming the Leporidæ, the other two being *Caprolagus* and *Lepus*.

Romerolagus is here recognized as a well-marked genus of the family Leporidæ.

SYLVILAGUS

This was first proposed by Gray (Ann. Mag. Nat. Hist., 3d ser., XX, 1867, p. 221) as a generic term for "*Lepus* Section D" of Baird (Mammals of North America, 1857, p. 578). The species first mentioned by Gray is *Sylvilagus nanus* (SCHREBER), a synonym of *Sylvilagus sylvaticus* (BACHMAN), whose specific name was undoubtedly the origin of the word *Sylvilagus*. It is evident that Gray had Baird's account in mind and merely copied the synonymy of *Sylvilagus sylvaticus* as given by Baird, and in this way he happened to use Schreber's name *nanus*. As the animal formerly known as *Sylvilagus*

sylvaticus has had to be renamed *Sylvilagus floridanus mallurus* (Thomas, Ann. Mag. Nat. Hist., 7th ser., II, October, 1898, p. 320; Allen, Bull. Amer. Mus. Nat. Hist., XII, March 4, 1899, p. 13), the latter becomes the type of the genus *Sylvilagus*.

Two other species were placed in this genus by Gray, *artemesia* BACHMAN, and *bachmani* WATERHOUSE.

The name has generally been used by subsequent writers as the subgeneric term for the cottontail rabbits (*Sylvilagus floridanus* and its allies) of North America.

Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., November, 1899, p. 514) uses it in a generic sense for *Limnolagus* MEARNS, *Romerolagus* MERRRIAM (both regarded as separate genera in the present account), *Tapeti* GRAY (which I regard as a part of *Sylvilagus*), and *Sylvilagus* GRAY, which according to Major embraces "*S. sylvaticus*, etc."

Trouessart (Catalogus Mammalium, I, fasc. ii, pp. 658–660, 1897) uses it in a subgeneric sense for the following species: *sylvaticus* BACHMAN (with the subspecies: *transitionalis* BANGS, *bachmani* WATERHOUSE, *alacer* BANGS, *mearnsi* ALLEN, *floridanus* ALLEN, *pinetis* ALLEN, *arizonæ* ALLEN, *holzneri* MEARNS, *nuttali* BACHMAN, *auduboni* BAIRD, *aztecus* ALLEN), *grangeri* ALLEN, *trowbridgei* BAIRD, *artemisia* BACHMAN, *arizonæ* ALLEN (with the subspecies *major* MEARNS and *minor* MEARNS), *veræcrucis* THOMAS, *insolitus* ALLEN, *orizabæ* MERRIAM, *graysoni* ALLEN, *idahoensis* MERRIAM.

Of these the last I regard as the only member of the genus *Brachylagus* proposed by Miller as a subgenus, and *trowbridgii* BAIRD as a member of the subgenus *Microlagus* of the genus *Sylvilagus*.

Miller and Rehn (Proc. Boston Soc. Nat. Hist., XXX, December 27, 1901, 184–188) have included under *Sylvilagus*, as a subgenus of *Lepus*, the following species: *arizonæ* ALLEN, *arizonæ confinis* ALLEN, *arizonæ major* MEARNS, *arizonæ minor* MEARNS, *baileyi* MERRIAM, *floridanus* ALLEN, *floridanus alacer* BANGS, *floridanus audubonii* BAIRD, *floridanus aztecus* ALLEN, *floridanus caniclunis* MILLER, *floridanus chapmani* ALLEN, *floridanus holzneri* MEARNS, *floridanus mallurus* THOMAS, *floridanus mearnsi* ALLEN, *floridanus pinetis* ALLEN, *floridanus rigidus* MEARNS, *floridanus sanctidiegi* MILLER, *floridanus subcinctus* MILLER, *floridanus transitionalis* BANGS, *floridanus yucatanicus* MILLER, *grangeri* ALLEN, *graysoni* ALLEN, *insolitus* ALLEN, *nuttallii* BACHMAN, *orizibæ* MERRIAM, *veræcrucis* THOMAS.

Recently Thomas (Ann. Mag. Nat. Hist., ser. 7, VIII, December, 1901, pp. 534, 539) following Major has raised *Sylvilagus* to generic rank.

I consider *Sylvilagus* a distinct genus, embracing all the forms given by Miller and Rehn under their subgenera *Sylvilagus*, *Microlagus*, and *Tapeti* (also including *Lepus truei* ALLEN, which is found in their list under the subgenus *Limnolagus*) and all the South American Leporidæ. It is also used in the present paper as a subgeneric term for all the species of *Sylvilagus* just mentioned, except the group embracing *Microlagus* here regarded as another subgenus of *Sylvilagus*.

TAPETI

Proposed by Gray (Ann. Mag. Nat. Hist., 3d ser., XX, 1867, p. 224) as a generic term for *Lepus brasiliensis* LINNÆUS, which, as the only named species, is the type.

Trouessart (Catalogus Mammalium, 1, fasc. iii, 1897, pp. 662–663) places the following species under it used as a subgenus, *gabbi* ALLEN, *defilippii* CORNELIA, *nigronuchalis* HARTERT, *brasiliensis* LINNÆUS.

Miller and Rehn (Proc. Boston Soc. Nat. Hist., XXX, p. 190, December 27, 1901) have included under it (as a subgenus of *Lepus*) *brasiliensis* LINNÆUS and *gabbi* ALLEN.

Major (Trans. Linn. Soc. London, 2d ser., VII, Zool., November, 1899, p. 514) regards *Tapeti* as one of four subgenera (the other three being *Limnolagus, Romerolagus,* and true *Sylvilagus*) forming the genus *Sylvilagus.*

Gray describes *Tapeti* as follows: "Skull like *Lepus,* but with hinder supraorbital notch narrow, the lobes short, with a sharp inner edge; the front of the lower edge of the zygoma dilated, sharp-edged, porous above, hinder nasal opening rather narrower. Tail, none. Ears short." This description of the skull does not agree with the skulls of *Sylvilagus minensis, paraguensis* or *gabbi* at hand, and I am at a loss to understand the true status of *Tapeti.* The available material shows that *Tapeti* is nothing else than a part of *Sylvilagus,* and it is so here regarded.

III. LIST OF THE EXISTING SPECIES OF THE DUPLICIDENTATA ARRANGED BY GENERA AND SUBGENERA

The species under each group are arranged alphabetically. The list includes all the names that are found in Trouessart's Catalogus Mammalium, 1897, and in Miller and Rehn's Systematic Results of the Study of North American Land Mammals to the Close of the Year 1900 (Proc. Boston Soc. Nat. Hist., XXX, December 27, 1901) together with the names that have appeared since these two works. Those species of which the writer has seen skulls or skeletons are printed in small capitals, those of which he has seen figures of the skulls or skeletons are in italic, and those of which he has seen neither specimens nor figures are in ordinary type.

LEPUS (LEPUS) ARCTICUS Ross.
LEPUS (LEPUS) ARCTICUS BANGSII Rhoads.
LEPUS (LEPUS) ARCTICUS CANUS Preble.
LEPUS (LEPUS) CAMPESTRIS Bachman.
Lepus (Lepus) corsicanus de Winton.
Lepus (Lepus) creticus Barrett-Hamilton.
Lepus (Lepus) cyprinus Barrett-Hamilton.
LEPUS (LEPUS) EUROPÆUS Pallas.
LEPUS (LEPUS) GICHIGANUS Allen.
LEPUS (LEPUS) GRŒNLANDICUS Rhoads.
LEPUS (LEPUS) LABRADORIUS Miller.
Lepus (Lepus) lilfordi de Winton.
LEPUS (LEPUS) OTHUS Merriam.
LEPUS (LEPUS) PARNASSIUS Miller.
LEPUS (LEPUS) POADROMUS Merriam.
LEPUS (LEPUS) TIMIDUS Linnæus.
Lepus (Lepus) timidus ainu Barrett-Hamilton.
Lepus (Lepus) timidus lutescens Barrett-Hamilton.
Lepus (Lepus) transylvanicus Matschie.
LEPUS (LEPUS) VARRONIS Miller.

LEPUS (PŒCILOLAGUS) AMERICANUS Erxleben.

Lepus (Pœcilolagus) americanus bairdii (Hayden).
Lepus (Pœcilolagus) americanus columbiensis Rhoads.
Lepus (Pœcilolagus) americanus dalli Merriam.
Lepus (Pœcilolagus) americanus macfarlani Merriam.
Lepus (Pœcilolagus) americanus phæonotus Allen.
Lepus (Pœcilolagus) americanus struthopus Bangs.
Lepus (Pœcilolagus) americanus virginianus (Harlan).
Lepus (Pœcilolagus) bishopi Allen.
Lepus (Pœcilolagus) klamathensis Merriam.
Lepus (Pœcilolagus) saliens Osgood.
Lepus (Pœcilolagus) washingtonii Baird.

Lepus (Macrotolagus) alleni Mearns.
Lepus (Macrotolagus) alleni palitans Bangs.
Lepus (Macrotolagus) asellus Miller.
Lepus (Macrotolagus) californicus Gray.
Lepus (Macrotolagus) californicus xanti Thomas.
Lepus (Macrotolagus) callotis Wagler.
Lepus (Macrotolagus) gaillardi Mearns.
Lepus (Macrotolagus) gaillardi battyi Allen.
Lepus (Macrotolagus) insularis Bryant.
Lepus (Macrotolagus) martirensis Stowell.
Lepus (Macrotolagus) melanotis Mearns.
Lepus (Macrotolagus) merriami Mearns.
Lepus (Macrotolagus) texianus Waterhouse.
Lepus (Macrotolagus) texianus deserticola Mearns.
Lepus (Macrotolagus) texianus eremicus Allen.
Lepus (Macrotolagus) texianus griseus Mearns.
Lepus (Macrotolagus) texianus micropus Allen.

Lepus ægyptius Audouin and Geoffroy.
Lepus arabicus Hemprich and Ehrenberg.
Lepus atlanticus de Winton.
Lepus berberanus Heuglin.
Lepus brachyurus Temminck.
Lepus capensis Linnæus.
Lepus capensis centralis Thomas.
Lepus capensis ochropus Wagner.
Lepus crawshayi de Winton.
Lepus dayanus Blandford.
Lepus etruscus Bosco.
Lepus fagani Thomas.
Lepus hainanus Swinhoe.
Lepus harterti Thomas.
Lepus hawkeri Thomas.
Lepus hypsibius Blanford.
Lepus judeæ Gray.
Lepus kabylicus de Winton.
Lepus mandschuricus Radde.
Lepus mediterraneus Wagner.
Lepus microtis Heuglin.
Lepus monticularis Thomas.
Lepus nigricollis F. Cuvier.
Lepus oiostolus Hodgson.
Lepus omanensis Thomas.
Lepus pallidor Barrett-Hamilton.
Lepus pallipes Hodgson.
Lepus peguensis Blyth.
Lepus ruficaudatus Is. Geoffroy.
Lepus salae Jentink.
Lepus saxatilis F. Cuvier.
Lepus schlumbergeri St. Loup.
Lepus sechuensis de Winton.
Lepus siamensis Bonhote.

Lepus sinaiticus Hemprich and Ehrenberg.
Lepus sinensis Gray.
Lepus somalensis Heuglin.
Lepus swinhoei Thomas.
Lepus syriacus Hemprich and Ehrenberg.
Lepus tigrensis Blanford.
Lepus tolai Pallas.
Lepus tunetæ de Winton.
Lepus victoriæ Thomas.
Lepus whitakeri Thomas.
Lepus whytei Thomas.
Lepus yarkandensis Günther.
Lepus zechi Matschie.

Oryctolagus cuniculus (Linnæus).

Sylvilagus (Sylvilagus) andinus (Thomas).
Sylvilagus (Sylvilagus) arizonæ (Allen).
Sylvilagus (Sylvilagus) arizonæ confinis (Allen).
Sylvilagus (Sylvilagus) arizonæ major (Mearns).
Sylvilagus (Sylvilagus) arizonæ minor (Mearns).
Sylvilagus (Sylvilagus) baileyi (Merriam).
Sylvilagus (Sylvilagus) braziliensis (Linnæus).
Sylvilagus (Sylvilagus) cumanicus (Thomas).
Sylvilagus (Sylvilagus) defilippii (Cornalia).
Sylvilagus (Sylvilagus) durangæ (Allen).
Sylvilagus (Sylvilagus) floridanus (Allen).
Sylvilagus (Sylvilagus) floridanus alacer (Bangs).
Sylvilagus (Sylvilagus) floridanus auduboni (Baird).
Sylvilagus (Sylvilagus) floridanus aztecus (Allen).
Sylvilagus (Sylvilagus) floridanus caniclunis (Miller).
Sylvilagus (Sylvilagus) floridanus chapmani (Allen).
Sylvilagus (Sylvilagus) floridanus holzneri (Mearns).
Sylvilagus (Sylvilagus) floridanus mallurus (Thomas).
Sylvilagus (Sylvilagus) floridanus mearnsi (Allen).
Sylvilagus (Sylvilagus) floridanus persultator (Elliot).
Sylvilagus (Sylvilagus) floridanus pinetis (Allen).
Sylvilagus (Sylvilagus) floridanus rigidus (Mearns).
Sylvilagus (Sylvilagus) floridanus sanctidiegi (Miller).
Sylvilagus (Sylvilagus) floridanus subcinctus (Miller).
Sylvilagus (Sylvilagus) floridanus transitionalis (Bangs).
Sylvilagus (Sylvilagus) floridanus yucatanicus (Miller).
Sylvilagus (Sylvilagus) gabbi (Allen).
Sylvilagus (Sylvilagus) grangeri (Allen).
Sylvilagus (Sylvilagus) graysoni (Allen).
Sylvilagus (Sylvilagus) incitatus (Bangs).
Sylvilagus (Sylvilagus) insolitus (Allen).
Sylvilagus (Sylvilagus) laticinctus (Elliot).
Sylvilagus (Sylvilagus) laticinctus rufipes (Elliot).
Sylvilagus (Sylvilagus) margaritæ (Miller).
Sylvilagus (Sylvilagus) minensis Thomas.
Sylvilagus (Sylvilagus) nigronuchalis (Hartert).
Sylvilagus (Sylvilagus) nuttallii (Bachman).
Sylvilagus (Sylvilagus) orinoci Thomas.
Sylvilagus (Sylvilagus) orizabæ (Merriam).
Sylvilagus (Sylvilagus) paraguensis Thomas.
Sylvilagus (Sylvilagus) parvulus (Allen).
Sylvilagus (Sylvilagus) russatus (Allen).
Sylvilagus (Sylvilagus) simplicanus (Miller).
Sylvilagus (Sylvilagus) superciliaris (Allen).
Sylvilagus (Sylvilagus) surdaster Thomas.
Sylvilagus (Sylvilagus) truei (Allen).
Sylvilagus (Sylvilagus) verækrucis (Thomas).

Sylvilagus (Microlagus) bachmani (Waterhouse).

Sylvilagus (Microlagus) bachmani ubericolor (Miller).
Sylvilagus (Microlagus) cerrosensis (Allen).
Sylvilagus (Microlagus) cinerascens (Allen).
Sylvilagus (Microlagus) peninsularis (Allen).

Limnolagus aquaticus (Bachman).
Limnolagus aquaticus attwateri (Allen).
Limnolagus palustris (Bachman).
Limnolagus palustris paludicola (Miller and Bangs).
Limnolagus telmalemonus (Elliot).

Brachylagus idahoensis (Merriam).

Caprolagus hispidus (Pearson).

Pronolagus crassicaudatus (Is. Geoffroy).
Pronolagus crassicaudatus curryi (Thomas).
Pronolagus crassicaudatus nyikæ (Thomas).

Romerolagus nelsoni Merriam.

Nesolagus netscheri (Jentink).

Pentalagus furnessi (Stone).

Ochotona (Ochotona) curzoniæ (Hodgson).
Ochotona (Ochotona) daurica (Pallas).[1]
Ochotona (*Ochotona*) *koslowi* Büchner.
Ochonota (Ochotona) ladacensis Günther.
Ochotona (Ochotona) melanostoma Büchner.

Ochotona (*Pika*) *alpina* (Pallas).
Ochotona (Pika) collaris (Nelson).
Ochotona (Pika) cuppes Bangs.
Ochotona (Pika) hyperboreus (Pallas).
Ochotona (Pika) kolymensis Allen.
Ochotona (Pika) littoralis (Peters).
Ochotona (Pika) princeps (Richardson).
Ochotona (Pika) pusilla (Pallas).
Ochotona (Pika) saxatilis Bangs.
Ochotona (Pika) schisticeps (Merriam).

Ochotona (*Conothoa*) *erythrotis* Büchner.
Ochotona (Conothoa) roylei (Ogilby).

Ochotona rufescens (Gray).
Ochotona rutila (Severzow).

IV. GENERAL CONSIDERATION OF THE SKELETON AND TEETH OF THE DUPLICIDENTATA

SKULL

The skulls of the two families Ochotonidæ and Leporidæ are widely different in nearly every respect, and were it not for the structure of the teeth and the number of the upper incisors there would be little to indicate that the two groups were closely related. The skulls of members of both of these families have so often been described and figured that there is here no need of a general description of that important part of their osteology, which will be given later in regard to less well known parts.

[1] An earlier name for *ochotona* the type.

LEPORIDÆ

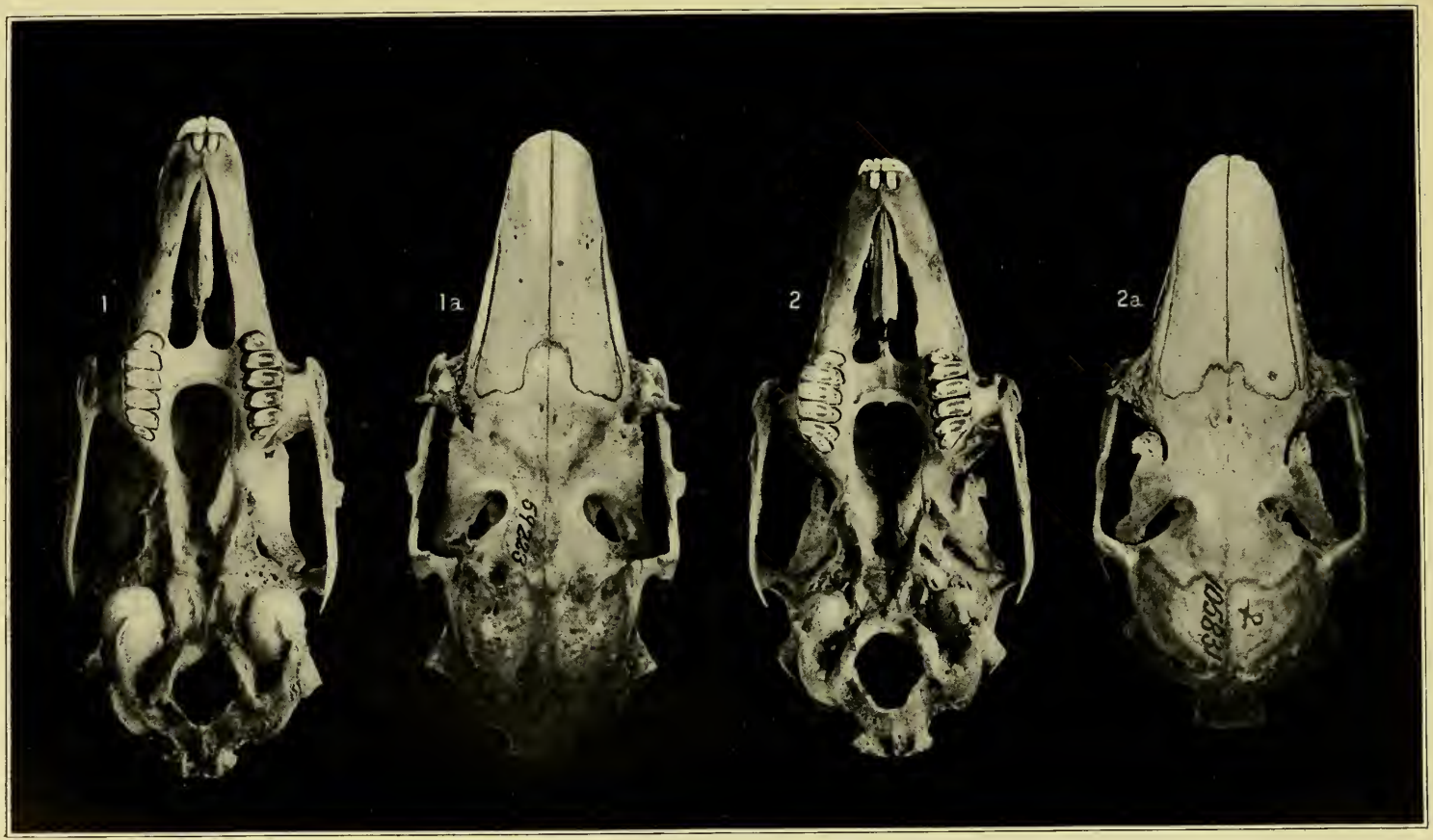
(PLATES LXXIV–LXXXIX)

The skulls of the Leporidæ fall into several groups, each distinct from the other, and no specimens have been seen which show intermediate conditions between any two of the divisions. The variations upon which these groups are founded consist principally in the shape, size, and method of the attachment of the postorbital processes, the distinctness of the interparietal bone, the distance between the two vertical portions of the palate bones, or width of the choanæ, and the relative heaviness of the zygoma. Each of these points will be considered in detail.

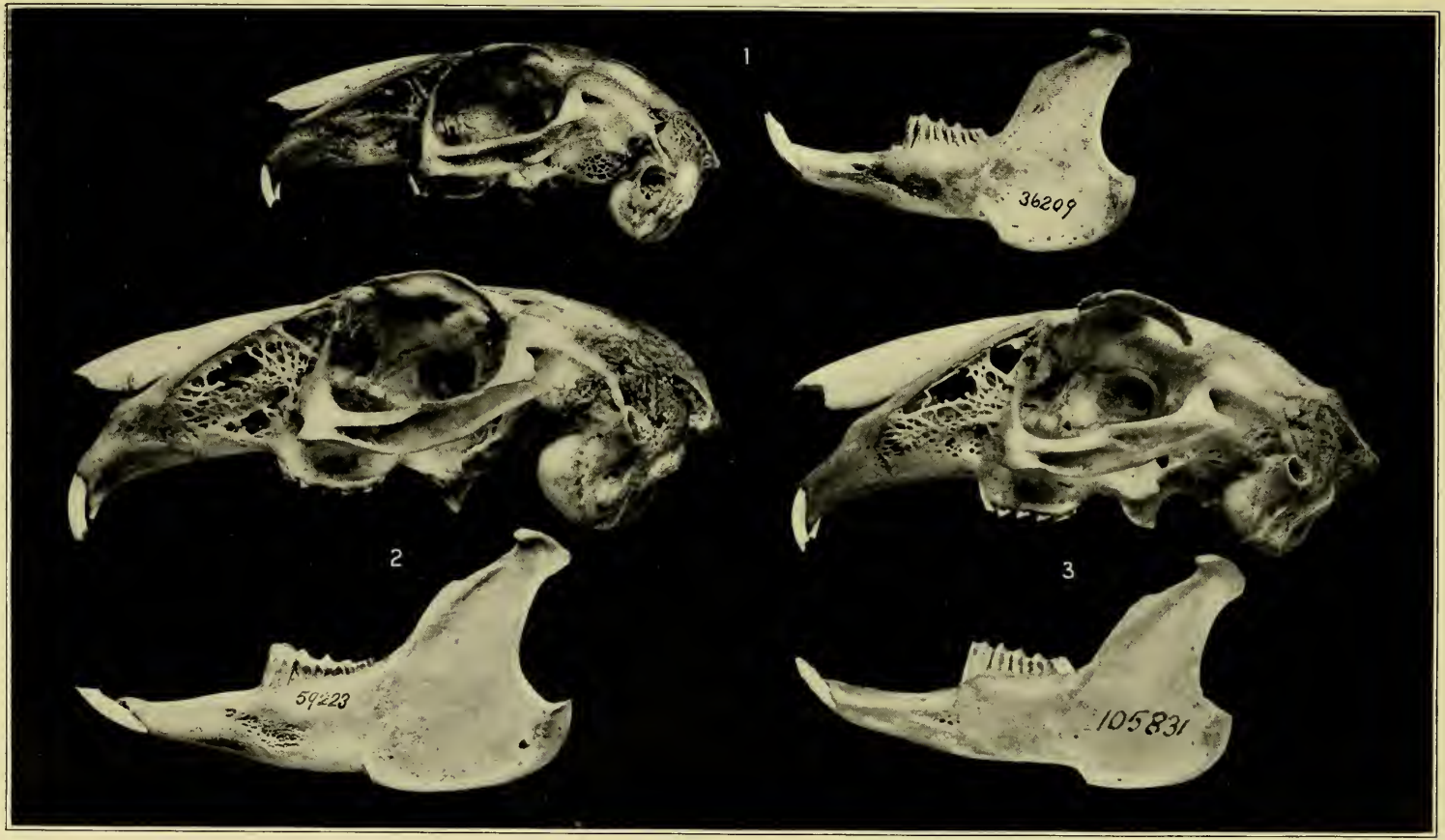
POSTORBITAL PROCESSES

The postorbital processes are conspicuously developed in all of the Leporidæ. In general and typically the process is triradiate, one arm being attached to the skull and forming the pedicle of the process, the other two arms or angles being toward the outside, one directed anteriorly, the other posteriorly. The following seven forms of postorbital processes are found:

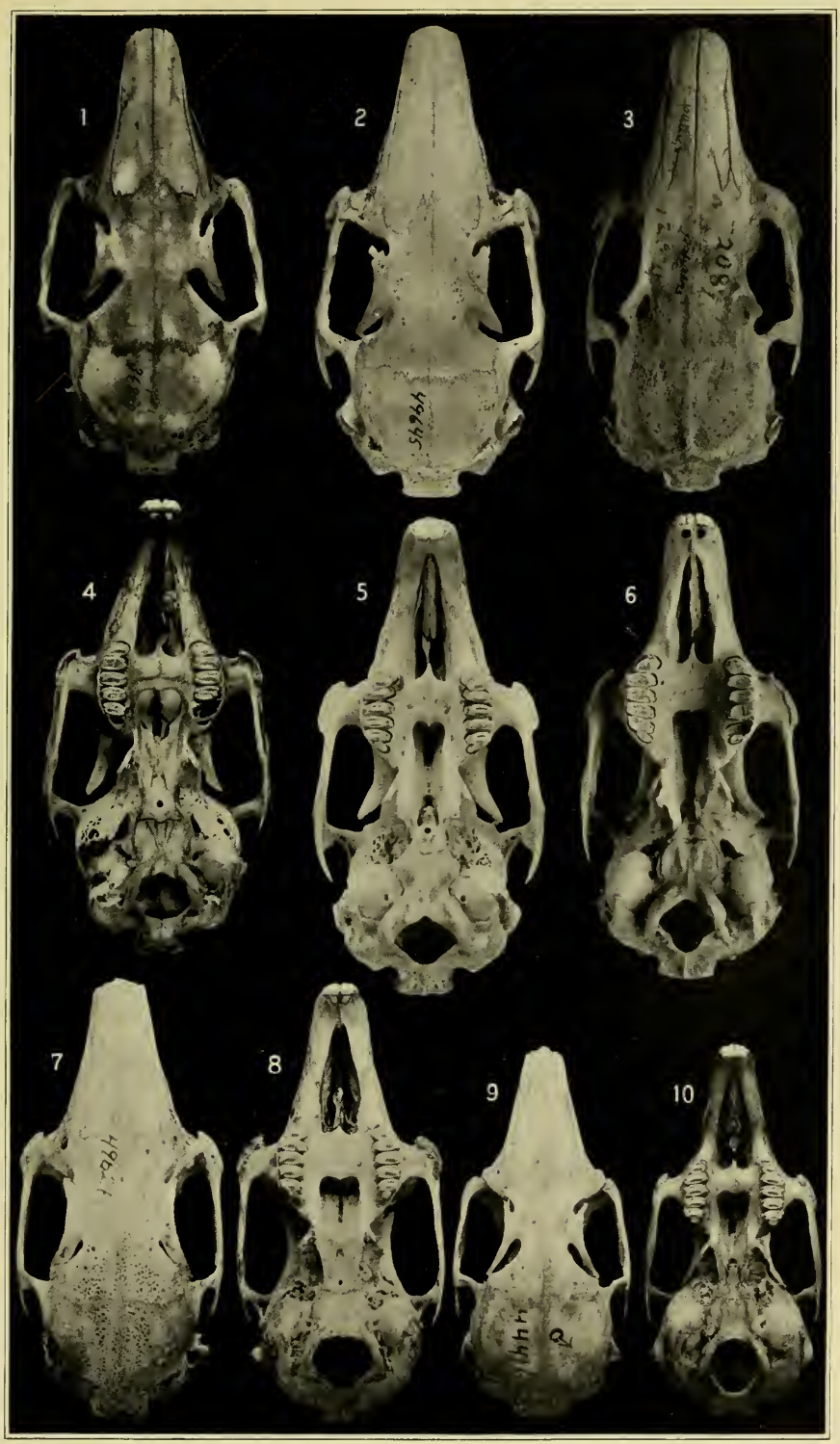
1. Postorbital processes large and triangular, standing out from the side of the head and considerably arched from before backward. This form is best developed in the subgenus *Lepus,* where the process is a conspicuous triangle, one angle of which is attached to the skull, the other two angles of which are entirely free, the anterior subtending a large anterior notch, and the posterior subtending a larger posterior notch. Occasionally in some specimens the anterior angle of the postorbital process is directed inward, its apex meets the frontal bone and a distinct foramen is formed instead of a notch. In the subgenus *Macrotolagus* the posterior angle of the postorbital process is always directed inward to meet the side of the cranium and in this way forms the outer boundary of a conspicuous foramen. Some of the Old World specimens resemble *Macrotolagus* in this respect; such are *Lepus sp.* Jumna river, India; *L. ochropus,* East Africa; *L. hypsibius,* Ladak, and *L. tibetanus,* central Asia. In the hares belonging to the subgenus *Pœcilolagus* the postorbital processes, while of the same general form, are much slenderer, the outer angles are not so wide, and the process is not so arched as it is in its best developed form in the subgenus *Lepus.* Both anterior and posterior angles are free, and help to form corresponding notches with the rest of the skull. The posterior angle and notch are larger than the anterior angle and



SKULLS OF HARES (about $\frac{4}{5}$ natural size). 1, 1*a*, subgenus *Macrotolagus*. 2, 2*a*, subgenus *Lepus*. For explanation see page 443.

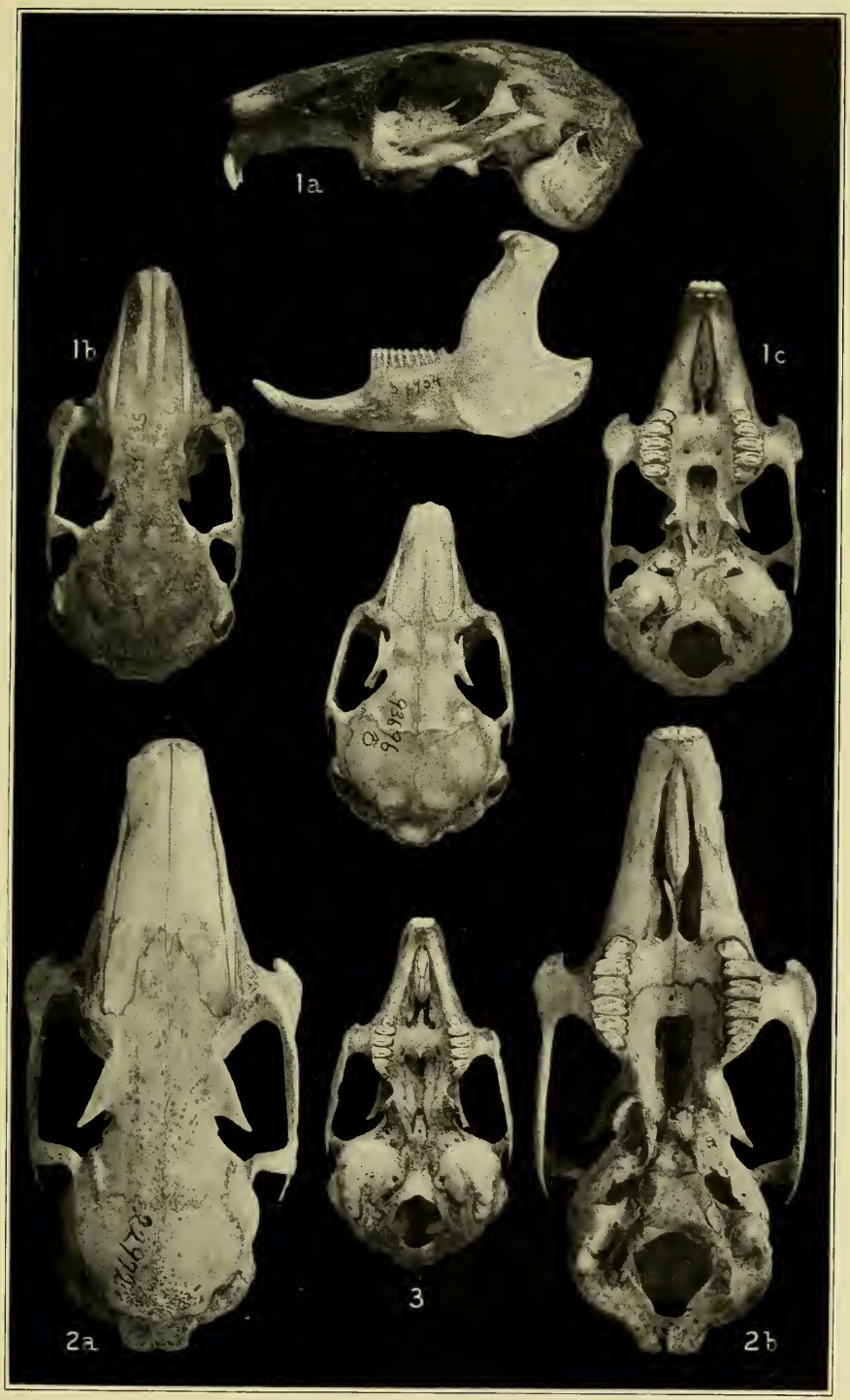


SKULLS OF HARES (about $\frac{5}{6}$ natural size). 1. Subgenus *Pœcilolagus*. 2. Subgenus *Macrotolagus*. 3. Subgenus *Lepus*. For explanation see page 443.



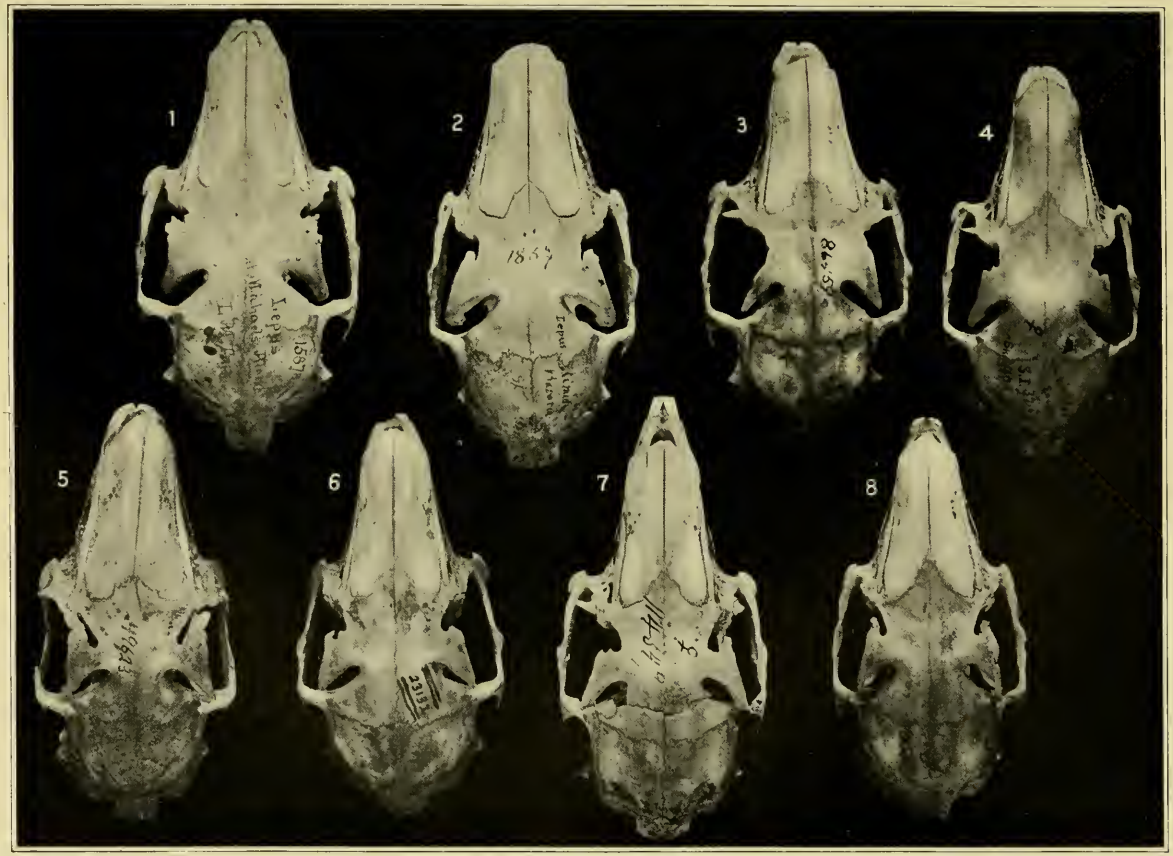
SKULLS OF HARES AND RABBITS (about $\frac{3}{8}$ natural size). For explanation see page 43.

SKULLS OF RABBITS (about $\frac{5}{6}$ natural size). For explanation see page 443.

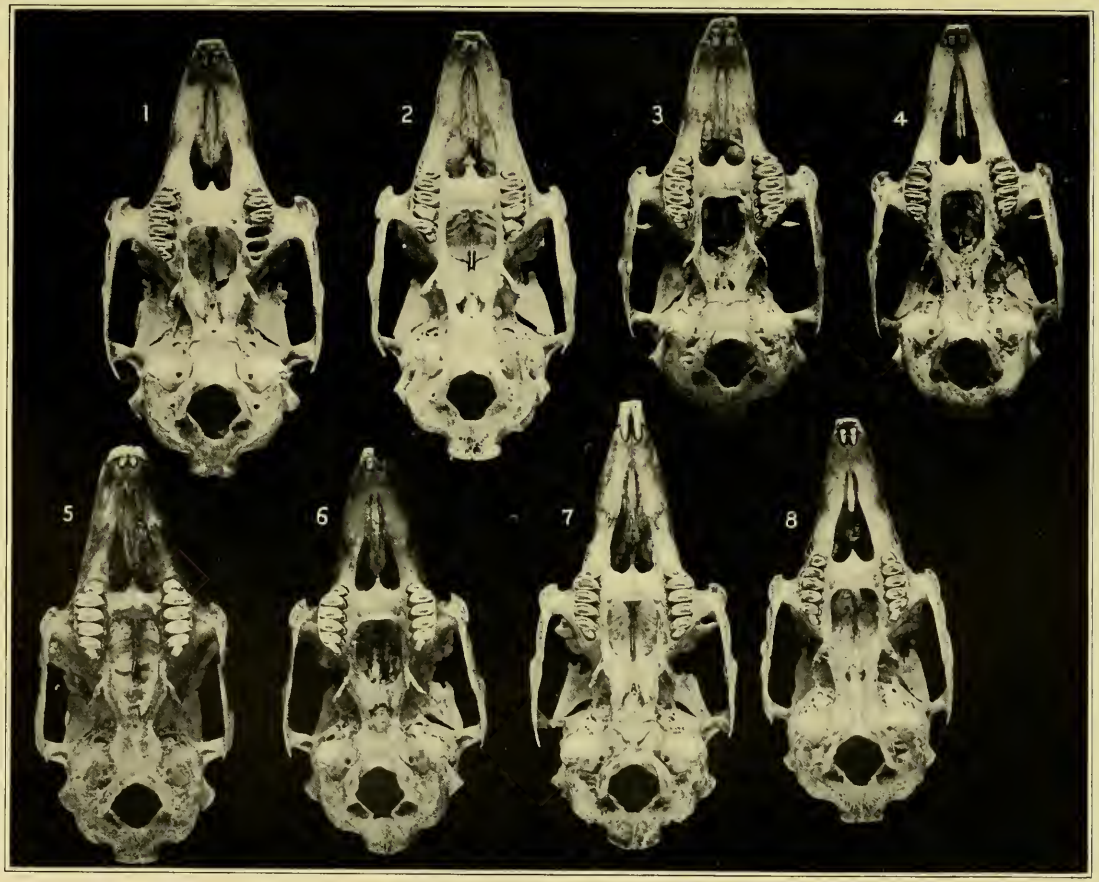


SKULLS OF RABBITS (natural size). 1. *Romerolagus*. 2. *Pronolagus*. 3. *Brachylagus*.

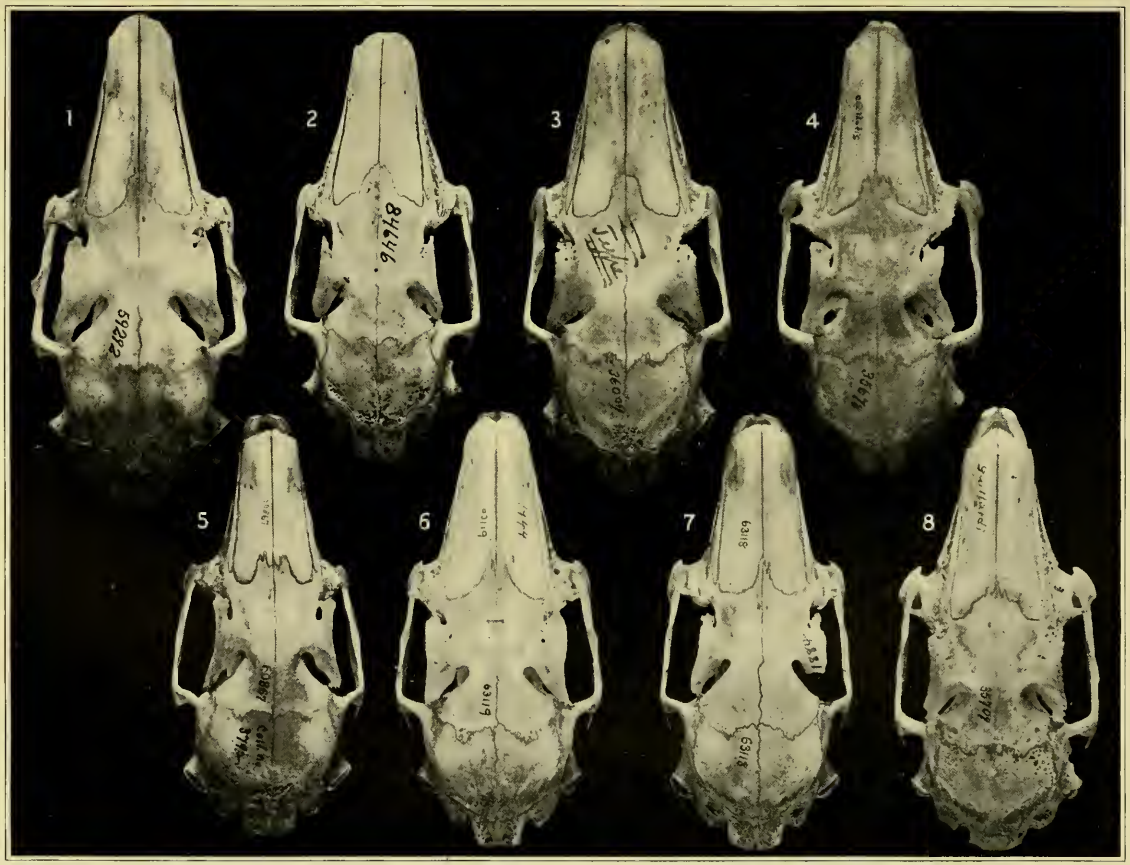
SKULLS OF RABBITS (natural size). 1, *Brachylagus*. 2*a*, 2*b*, 2*c*, *Pentalagus*.



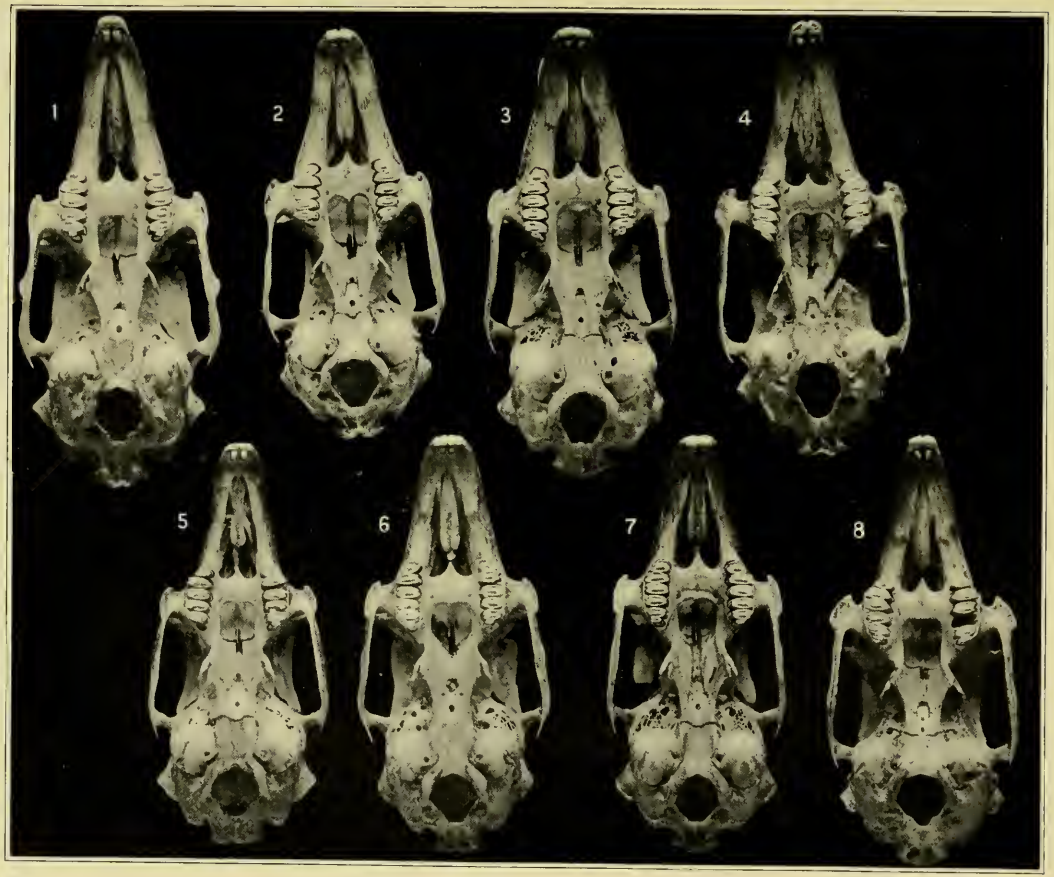
SKULLS OF HARES, subgenus *Lepus* (about $\frac{3}{8}$ natural size). For explanation see page 444.



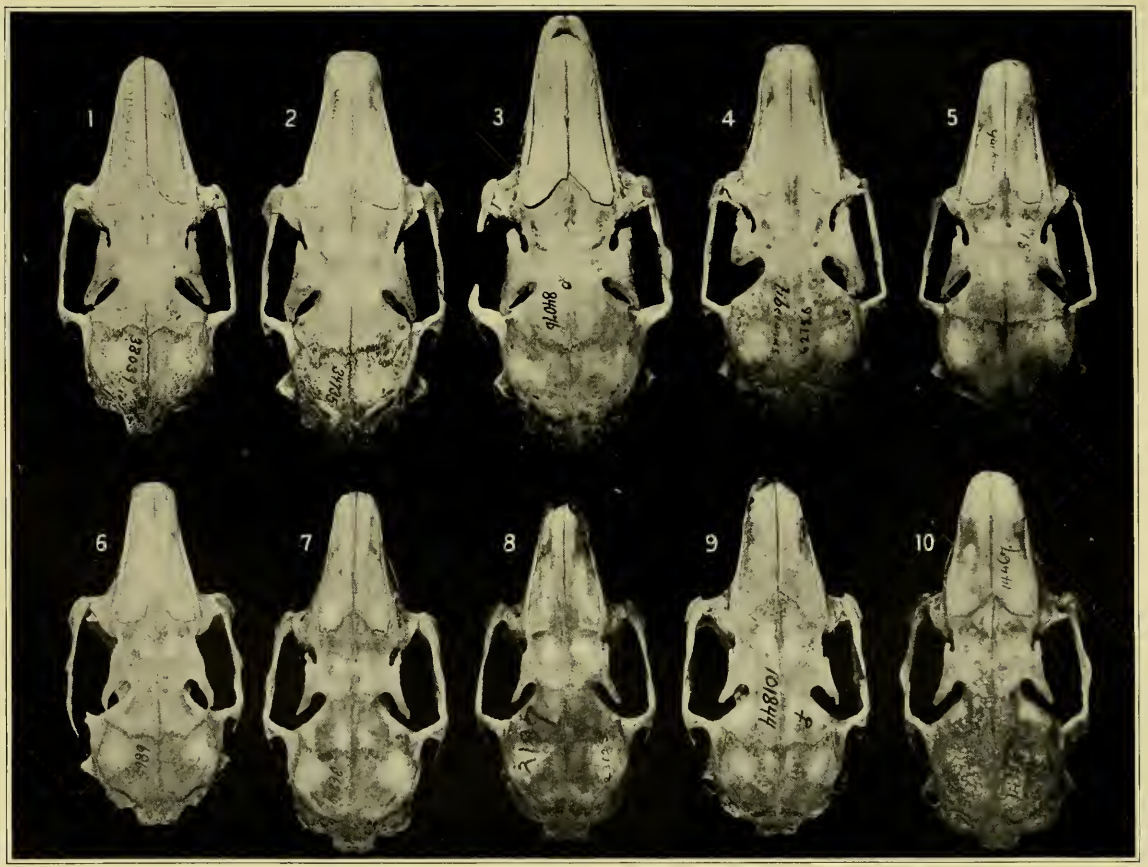
SKULLS OF HARES, subgenus *Lepus* (about $\frac{3}{8}$ natural size). For explanation see page 444.



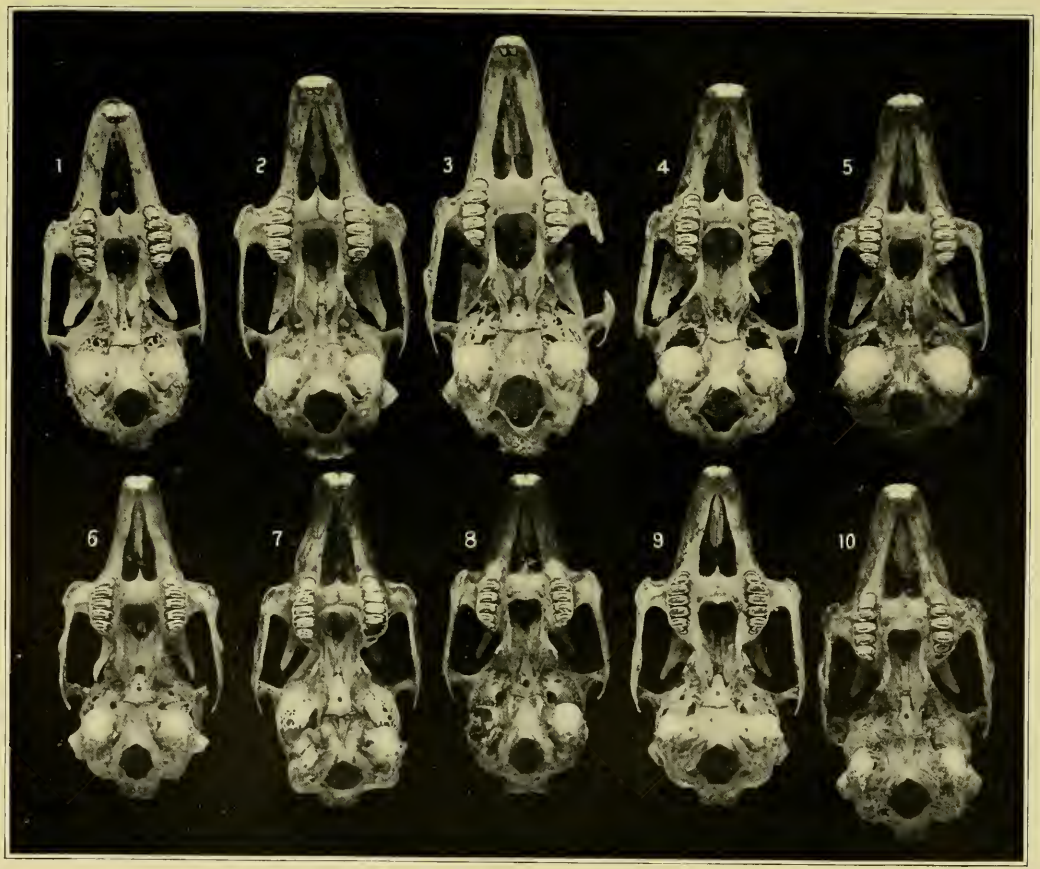
SKULLS OF JACKASS HARES, subgenus *Macrotolagus* (about $\frac{2}{3}$ natural size). For explanation see page 444.



SKULLS OF JACKASS HARES, subgenus *Macrotolagus* (abont $\frac{2}{3}$ natural size). For explanation see page 444.

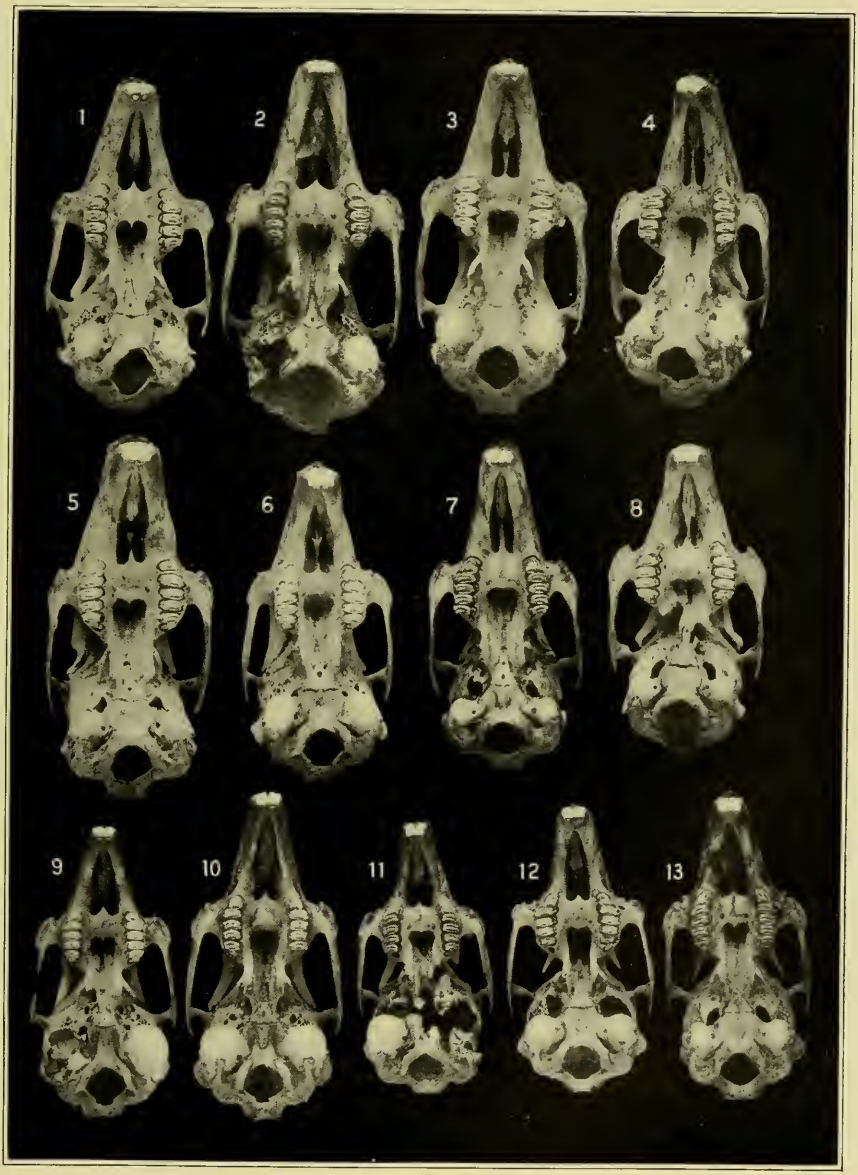


SKULLS OF HARES (about $\frac{2}{3}$ natural size). For explanation see page 444.



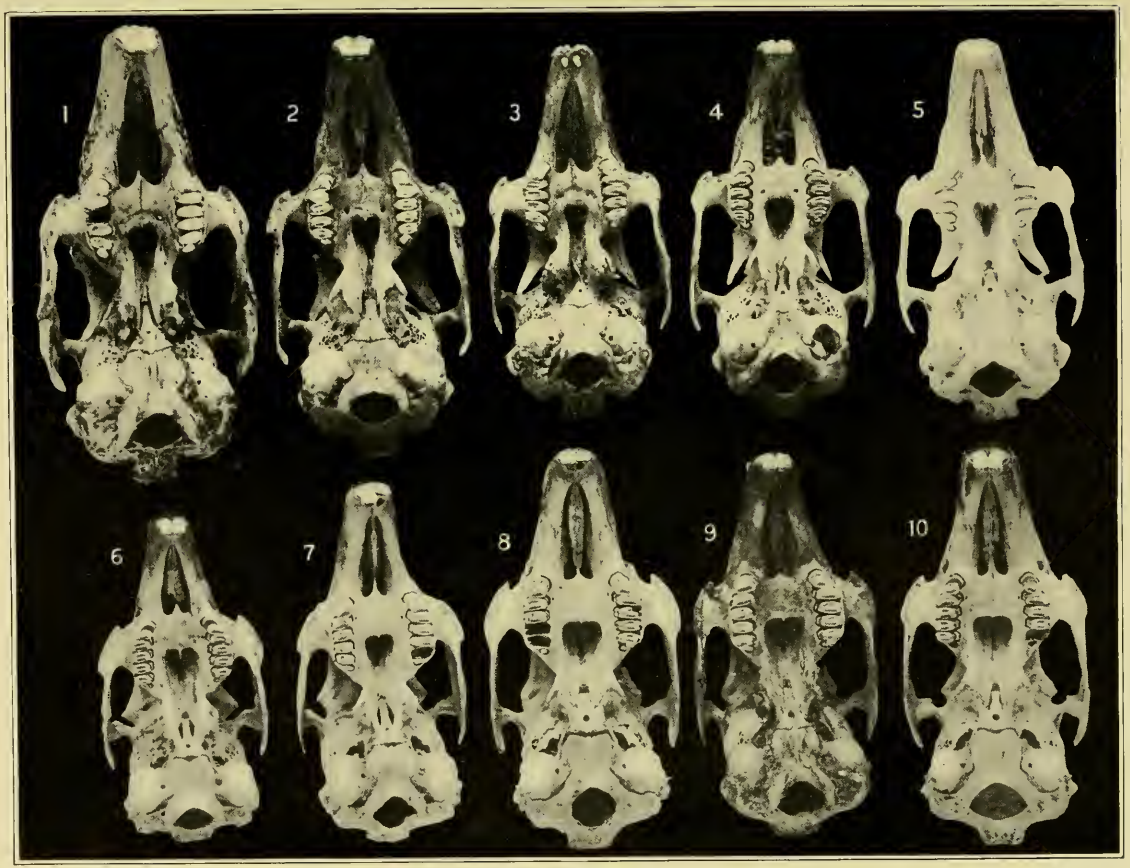
SKULLS OF HARES (about $\frac{5}{8}$ natural size). For explanation see page 444.

SKULLS OF COTTONTAILS, genus *Sylvilagus* (about $\frac{9}{14}$ natural size). For explanation see pages 444, 445.



SKULLS OF COTTONTAILS, genus *Sylvilagus* (about $\frac{9}{14}$ natural size). For explanation see pages 444, 445.

SKULLS OF EUROPEAN RABBITS, *Oryctolagus*, 1–5; SWAMP RABBITS, *Limnolagus*, 6–10 (about $\frac{5}{8}$ natural size).



SKULLS OF EUROPEAN RABBITS, *Oryctolagus*, 1–5; SWAMP RABBITS, *Limnolagus*, 6–10 (about $\frac{5}{8}$ natural size).

notch. *Lepus yarkandensis* from central Asia has postorbital processes agreeing with those of *Pœcilolagus*.

2. The skulls having postorbital processes most nearly resembling those of typical *Lepus*, belong to the genus *Oryctolagus*. The processes are here large, but are not wide and triangular and they do not project out laterally from the sides of the skull as they do in *Lepus*. The process is arched. The anterior portion does not meet the frontal bone and thus subtends a notch, and a larger posterior notch is formed by the posterior angle which also does not meet the cranium. In two skulls of domestic rabbits at hand, a lop-eared and a Belgian hare, the anterior angle or limb of the postorbital process meets the frontal bone, and in the lop-eared forms the outer boundary of an irregular foramen, while in the Belgian hare the whole anterior angle is fused to the cranium, so that even the foramen is obliterated. In both these specimens posterior notches are present.

3. In the third form of postorbital process, the anterior limb is entirely lacking or else so intimately associated with the cranium that the process appears as a triangle, one whole side of which is attached to the cranium, the second side directed outward and somewhat forward, while the third side is directed obliquely inward and backward, forming the outer boundary of a posterior notch. This type of postorbital is found in the genera *Romerolagus, Pronolagus, Caprolagus, Pentalagus,* and probably in *Nesolagus*. The process is larger and blunter in *Pentalagus* than it is in the others.

4. Postorbital processes long and narrow, strongly arched, attached to the skull by a very broad and short pedicle. The whole anterior part of the process, with the exception of a millimeter or two, is attached to the skull, so that only a very small notch is subtended. The posterior part of the process is long and narrow, not triangular as it is in skulls of the preceding type. Its inner posterior edge touches the side of the cranium, and a narrow clavate slit is thus formed between the inner edge of the process and the side of the skull. In its typical form this slit or clavate foramen is much narrower than the process which helps to make it. In one skull of *Sylvilagus floridanus mearnsi*, No. 22,409, from Illinois, complete fusion of the postorbital process with the side of the skull takes place, and the clavate foramen is obliterated. The opposite extreme is found in the group of *Sylvilagus arizonæ* and its subspecies, where the clavate foramen is relatively wider and passes gradually over into the next style of postorbital. In these atypical forms the anterior notch is also relatively larger than it is in typical *Sylvilagus*.

5. In many respects the postorbital processes included in this division resemble the postorbital processes found in that section of the genus *Lepus* which forms the subgenus *Pœcilolagus,* but on the whole they are rather slenderer, and do not project so far outward from the side of the skull. The typical form is seen in *Sylvilagus* (*Microlagus*) *bachmani.* The postorbital process is attached by a comparatively narrow pedicle. A large posterior notch is formed between the sides of the skull and the slender posterior portion of the postorbital process. In No. 63,957, *Microlagus* from Posts, California, the posterior extremity of the postorbital almost touches the cranium. *Sylvilagus* (*Microlagus*) *cinerascens* shows conditions of the postorbital ranging all the way from those found in No. 63,957 to conditions almost identical with those found in typical *Sylvilagus,* but the posterior clavate foramen is always wider in *Microlagus.*

6. The postorbital processes of the skulls of the genus *Brachylagus* are small and slender, free both in front and behind. They bear considerable resemblance to the postorbitals of the subgenus *Pœcilolagus.*

7. The genus *Limnolagus* possesses postorbital processes of a form quite different from any of the others. The process is completely fused to the side of the frontal bone so that only a notch is found anteriorly and no notch or slit is found posteriorly except in rare and anomalous cases where a small foramen is sometimes seen. The fused postorbital process has about the same general shape as has the unfused process of the genus *Sylvilagus.* An atypical specimen, No. 64,029, Kissimmee, Florida, shows the manner in which the process is attached. The posterior end of the process, instead of meeting the skull directly as it does in those genera where the posterior end of the process is in contact with the side of the skull, is met by an outgrowing process from the cranium. In this specimen, No. 64,029, a small foramen is inclosed between the posterior part of the postorbital process and the above outgrowing process from the cranium. A more or less prominent blunt projection is formed by the union of the postorbital process with the outgrowing process from the cranium. This blunt projection above, together with the root of the zygomatic process just below, forms a rather conspicuous notch.

INTERPARIETAL BONE

The interparietal bone of the Leporidæ is always present in the very young, and in most cases remains perfectly distinct in the adult.

On the other hand, in certain hares, the distinctness of the interparietal is lost at an early age, when the animal is but little more than half grown. Judging from rather limited material in cases where its distinctness is lost in the adults, it appears that the upper borders of the bone become obliterated, each half fusing with the parietal above, and the sagittal suture between the two parietals pushing down to meet the interparieto-supraoccipital suture. The distinctness or the obliteration of the interparietal is very constant, for the different groups of the Leporidæ. It is found as an independent bone in *Sylvilagus, Brachylagus, Limnolagus, Oryctolagus, Romerolagus.* In the genus *Lepus,* the interparietal loses its distinctness before adult life is reached. In the single available skull of *Pronolagus* from South Africa, the inferior suture of the interparietal is distinct, as it always is; the right latero-superior suture is partially obliterated, and the left latero-superior suture is entirely obliterated. As the specimen is a young adult, it seems reasonable to say that the interparietal is obliterated in this case. In the genus *Pentalagus* the interparietal is not present as a distinct bone.

PALATE AND POSTERIOR NARES

The bony palate of all the Leporidæ has its antero-posterior dimension very short, while the side-to-side dimension is considerable, so that the length of the bony palate is usually less than its width. The palatal portion of the bony palate is the part most reduced, and in some cases the horizontal plates of the palate bones form only the extreme posterior edge of the bony palate. The incisive foramina are very large, especially at the posterior ends, and extend from the anterior edge of the bony palate almost to the alveoli of the incisors. The roof of the narial cavity is usually high, so that the sides of the posterior nares form a wall of considerable height, composed mostly of the vertical portion of each palate bone. All of these structures vary in several ways and constantly for certain groups.

Variations in bony palate.—In *Brachylagus* the bony palate is very short, shorter than in any other genus of the Leporidæ. The horizontal plates of the palate bones form only the posterior border of it. In *Lepus* also the palate is short, but not so short as it is in *Brachylagus.* The horizontal plates of the palate bones form between a fourth and a third of the bony palate. Very similar to this arrangement is the bony palate of the genus *Sylvilagus,* which is typically a little longer than it is in *Lepus,* but in the rabbits of the *Sylvilagus arizonæ* group the bony palate has about the same relative

length that it has in *Lepus*. In *Sylvilagus* (*Microlagus*) *cinerascens* the bony palate is short, but in *S.* (*M.*) *bachmani* it is distinctly longer. In *Limnolagus* and *Oryctolagus* the bony palate lengthens, relatively speaking; the horizontal plate of the palate bone is better developed and enters into the formation of the bony palate to a slightly greater extent than in the case of the preceding genera, but to a less extent than it does in *Romerolagus*. The portion of the palate bone that borders the maxilla caudad of the posterior edge of the bony palate is better developed in *Limnolagus* and *Oryctolagus* than it is in *Lepus, Sylvilagus,* or *Brachylagus,* and thus forms part of the roof of the mouth along the posterior dental alveoli. This development of the palate bone just internal to the dental alveoli is better developed in *Oryctolagus* than in *Limnologus,* and it is still further developed in the genera *Romerolagus* and *Pronolagus*. The last has the longest and narrowest bony palate of any of the Leporidæ at hand, though *Romerolagus* has one nearly as long relatively. The horizontal plates of the palate bones in these two genera form about the posterior half of the bony palate. *Pentalagus* and *Nesolagus* have long palates resembling those of *Romerolagus* and *Pronolagus,* but the horizontal plates of the true palate bones form only the posterior fifth or fourth of the bony palate. The palate of *Caprolagus* is apparently similar, but the horizontal plates of the palate bones form its posterior third.

In most of the Leporidæ the posterior palatine foramina are of moderate size and are located between the palatine plate of the maxilla and the horizontal plate of the palate bone, at the anterior outer angles of the horizontal plate. In *Romerolagus,* however, the posterior palatine foramina are relatively very large and in the usual position. In *Pronolagus* the posterior palatine foramina are very small, and are scarcely visible except for two grooves leading from them. They are situated not at the anterior outer angles of the horizontal plate of the palate bones, but are found near the median line, toward the anterior internal angles of the horizontal plates of the palate bones.

Variations about the posterior nares or choanæ, and width of the incisive foramina.—Certain variations are found in the degree of approximation of the vertical plates of the palate bones, the height of the pharyngeal vault, and the width of the incisive foramina, and when compared with the length of the bony palate measured half-way between the median line and the dental alveoli, there are found ratios which are seen to be fairly constant for the different groups of the Leporidæ.

Wide choanæ are found in *Lepus* and *Brachylagus*. They are remarkably wide when compared with the narrow choanæ of *Oryctolagus*. In both of the former the length of the bony palate, measured midway between the median line and the dental alveoli, is decidedly less than the least distance between the two vertical plates of the palate bones. In the same two genera the incisive foramina are wide, especially so in *Brachylagus*, where the greatest width of each incisive foramen nearly equals in length the bony palate measured midway between the median line and the dental alveoli. In *Lepus*, the greatest width of the incisive foramina taken together is much greater than the length of the bony palate.

The choanæ are wide in *Sylvilagus*, but not quite so wide as they are in *Lepus* and *Brachylagus*. In certain species of *Sylvilagus*, *arizonæ* and its allies, the lateral walls of the choanæ are more approximated than they usually are in most rabbits, and approach the narrow choanæ seen in *Oryctolagus*. The length of the bony palate taken midway between the median line and dental alveoli equals the greatest width of the incisive foramina as well as the distance between the choanal walls. In the *Sylvilagus arizonæ* group this palatal length is less than the width of the incisive foramina, but equals the distance between the choanal walls.

In *Limnolagus* the length of the palate taken between the median line and the dental alveoli about equals the greatest width of the incisive foramina taken together, and the distance between the vertical plates of the palate bones. The choanæ are narrower than they are in *Lepus*, but are not so extensively narrowed as they are in *Oryctolagus*.

The length of the relatively long bony palate of *Romerolagus* is very much greater than the greatest width of the two incisive foramina and also very much greater than the choanal width.

In the genus *Pronolagus* the incisive foramina are long and narrow, less triangular in outline than they are in most of the Leporidæ. Their greatest width is much less than the length of the bony palate. The choanæ are rather narrowed, being almost as narrow as they are in *Oryctolagus*, but the pharyngeal vault is not so high as it is in the latter genus.

In the skull of *Caprolagus*, as figured by Blyth, the incisive foramina are narrow, elongated-triangular, the choanæ are moderately wide, about as wide as the greatest width of the narrow incisive foramina taken together. The bony palate is long, decidedly longer than the choanal width.

In *Pentalagus* the incisive foramina are narrow, their sides nearly

parallel. The choanæ are wide, much wider than the greatest width of the incisive foramina taken together. The bony palate is long, exceeding in length the rather wide choanæ. The pharyngeal vault is low.

In *Nesolagus* the incisive foramina are rather narrow, about as wide as they are in *Caprolagus;* but instead of being triangular, their sides are nearly parallel, in this respect resembling the incisive foramina of *Pentalagus* and *Pronolagus.* Their greatest width taken together is a little less than the choanal width and much less than the length of the bony palate.

In *Oryctolagus* the distance between the vertical plates of the palate bones is less in proportion to size than in any other member of the family Leporidæ. The incisive foramina are narrow, their greatest width not quite equal to the length of the bony palate taken half-way between the median line and the dental alveoli, and much greater than the distance between the lateral choanal walls. The pharyngeal vault is high.

Following is a summary of the relative sizes of the greatest width of the incisive foramina, the length of the palate measured between the median line and the dental alveoli, and the distance between the two vertical portions of the palate bones:

In *Limnolagus* and typical *Sylvilagus* the width of the incisive foramina, the length of the palate, and the width of the choanæ all about equal one another.

In *Romerolagus* the width of the incisive foramina and the choanal widths are subequal to one another and each is less than the length of the palate.

In *Lepus* and *Brachylagus* the width of the incisive foramina and the width of the choanæ are much greater than the length of the palate.

In *Pentalagus* the width of the incisive foramina is less than half the length of the bony palate; the width of the choanæ is not much less than the length of the bony palate.

In *Oryctolagus* the width of the incisive foramina about equals the length of the palate, while the width of the choanæ is less than the palatal length.

In *Pronolagus* the width of the incisive foramina is a little less than the length of the palate; the width of the choanæ is less than the palate length.

In *Caprolagus* and *Nesolagus* the width of the incisive foramina taken together is less than the length of the palate, and the length of the palate is greater than the choanal width.

ZYGOMATIC ARCH

The zygomatic arch of the Leporidæ is well developed. Seen from above or below it is very narrow, and is much flattened when seen from the side. In the adult but two bones seem to make it up, viz., the zygomatic process from the squamosal, and what is apparently a very long backwardly projecting zygomatic process of the maxilla, but this latter consists of the true malar or jugal bone, which forms most of the zygoma and fuses at a very early age with a small zygomatic process of the maxilla. The zygomatic process of the squamosal is a triangular foot-like structure attached to the squamosal by a narrow pedicle. The squamoso-zygomatic suture remains distinct throughout old age. The malar projects caudad of the zygomatic process of the squamosal, to a greater or less extent. In the family Leporidæ the antero-inferior angle of the zygoma is usually enlarged and flares outward to a greater or less extent.

The heaviest zygomata are seen in *Romerolagus* and *Limnolagus,* in each of which it is thick and deep, especially deep in *Romerolagus.* In *Lepus* and *Brachylagus* the zygoma is deep but not thickened. In *Oryctolagus* the anterior half of the zygoma is deep, but in the posterior half it is shallower. *Sylvilagus* and *Pronolagus* have zygomata that are rather thin and shallow when compared with the zygomata of the other genera.

The foot-like extremity of the zygomatic process of the squamosal is shorter in *Lepus* than it is in most of the other Leporidæ. The external lateral length of the squamoso-malar suture is contained about two times in the superior border of the malar, measured from the anterior end of the squamoso-malar suture to the antero-inferior angle of the orbit. In *Oryctolagus Pentalagus,* and *Caprolagus,* on the other hand, the foot-like extremity of the zygomatic process of the squamosal is considerably enlarged, so that the lateral length of the squamoso-malar suture is contained between one and one and a half times in the superior border of the malar, measured from the anterior end of the squamoso-malar suture to the antero-inferior angle of the orbit. In *Romerolagus* the foot-like extremity of the zygomatic process of the squamosal is moderately enlarged; in *Brachylagus* it is relatively slightly larger than it is in *Lepus.* In *Sylvilagus* and *Pronolagus* the size of the foot-like extremity of the zygomatic process of the squamosal has about the same relation to the rest of the zygoma that it has in *Lepus.* In *Limnolagus,* the foot-like extremity of the zygomatic process of the squamosal is short.

The antero-inferior end of the zygoma is much expanded and flared outward in *Limnolagus, Nesolagus,* and *Romerolagus.* It is also enlarged, but not quite to the same degree in *Oryctolagus.* In *Pronolagus* is is moderately enlarged. In *Lepus, Sylvilagus, Brachylagus,* and *Pentalagus* the antero-inferior angle of the zygoma is only slightly enlarged. In the last the deep fossa seen just in front of the antero-inferior angle of the zygoma in the other genera except *Limnolagus* is lacking. In *Caprolagus* the antero-inferior angle of the zygoma is apparently not enlarged at all.

The posterior free projecting extremity of the malar is very large and long in *Romerolagus,* and is nearly as large in *Limnolagus, Oryctolagus,* and *Caprolagus.* It is moderately enlarged in *Pentalagus* and in *Brachylagus;* in the remaining genera, *Lepus, Sylvilagus,* and *Pronolagus* the posterior free extremity of the malar is short.

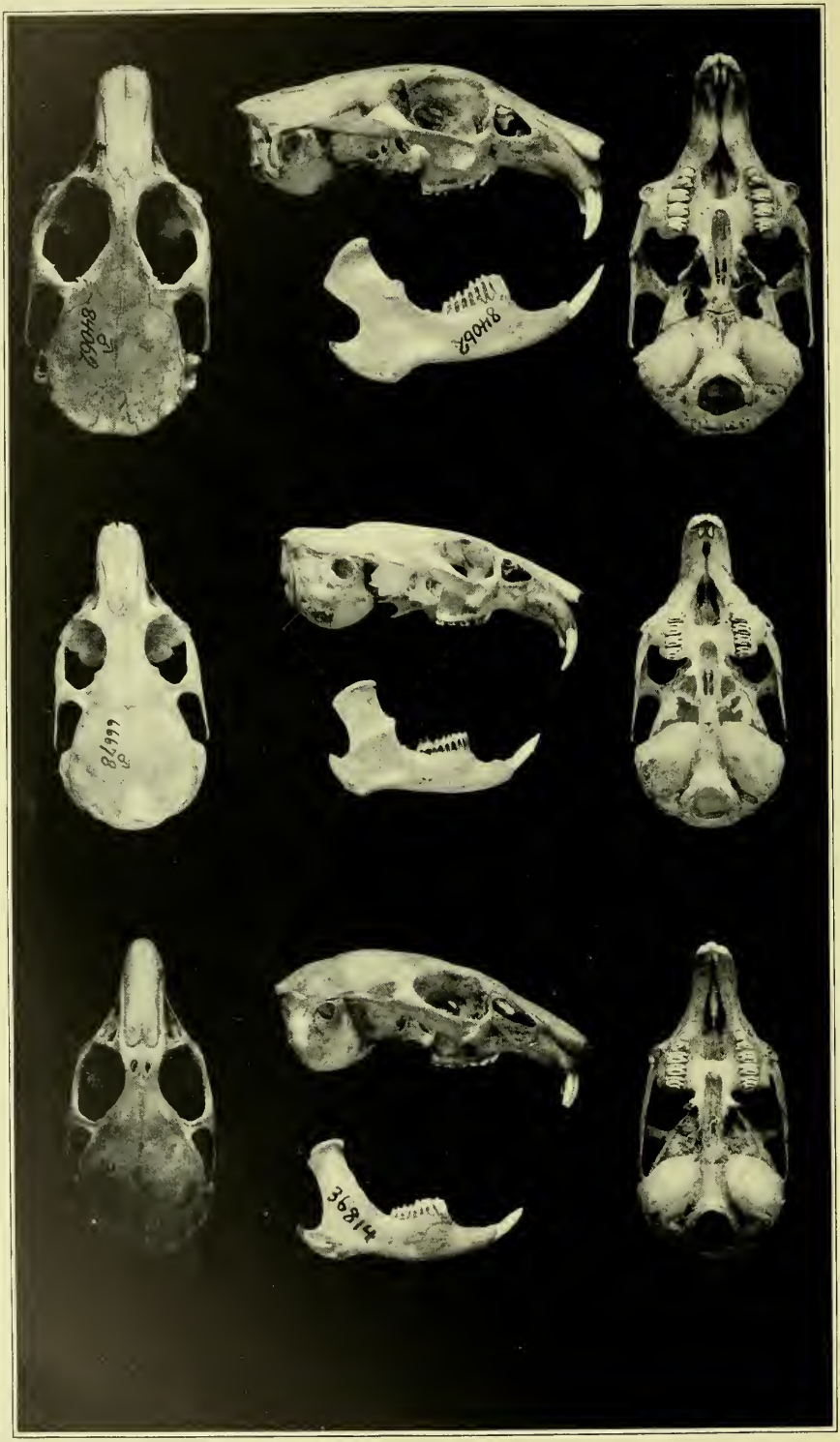
AUDITAL BULLÆ

Most of the Leporidæ have well-developed audital bullæ, but the degree of development is subject to some variations. The external auditory meatus is prolonged upward and backward into a tubular or spout-like structure. The bulla and this tube combined much resemble a flask, the external auditory meatus being the neck.

In *Brachylagus* the audital bulla is very much enlarged, the external auditory meatus large and rounded. *Pronolagus, Caprolagus,* and *Pentalagus* have very small audital bullæ. The external auditory meatus in the last is not at all spout-like; it has the form of an irregular oval bony ring, rather closely applied to the side of the skull. *Romerolagus* has the external auditory meatus relatively larger than in any of the other genera, and decidedly oval in outline, instead of simply circular. The rest of the Leporidæ present nothing unusual in respect to the audital bullæ or the external meatus.

FENESTRATION OF MAXILLÆ

The sides of the maxilla are fenestrated in nearly all the Leporidæ. In certain groups, however, this fenestration is less marked than in others. In *Pentalagus* there is practically none. In *Limnolagus, Pronolagus,* and *Romerolagus* the degree of fenestration is much less than it is in all the other genera, which may be said to have a normal degree of fenestration. In the genera with the least degree of fenestration, the infraorbital foramen is most marked and attains its largest size.



SKULLS OF PIKAS, *Ochotona* (natural size). Subgenera: *Ochotona* 84,062, *Pika* 66,678, *Conothoa* 36,814.

MANDIBLE

The mandible of the Leporidæ is characterized by the great development of the angular process and of the condyloid process and by the almost complete absence of the coronoid process. It does not show very many variations, but there are a few which are constant for some of the genera.

In *Lepus* and *Oryctolagus* the mandibles resemble one another closely, and may be said to possess the typical form.

In *Pronolagus* the angular process of the mandible is rather straighter along the lower edge than it is in the mandible of the *Lepus* type. The mandible of *Caprolagus* apparently resembles it.

The mandible in *Limnolagus* has a very large, rounded, angular process. The ascending ramus is rather wider than it is in the genus *Lepus*. The notch between the condyle and the angular process is much smaller than it is in *Lepus*. The condyle has a greater antero-posterior dimension.

The mandible of *Nesolagus* is similar, but the angular process is smaller.

The mandible of *Sylvilagus* very closely resembles that of *Lepus*, but the angular process is relatively larger, and the notch between the condyle and the angular process is shorter. In this respect it resembles the mandible of *Limnolagus*.

Brachylagus has a mandible resembling a small one of the *Lepus* style, but the angular process is relatively as well as absolutely smaller, and its edge is nearly straight.

The mandible of *Romerolagus* possesses wide ascending rami, which are nearly vertical. The angle is well developed and its edge moderately rounded. The notch between the ascending ramus and the angular process is larger than it is in any of the other genera.

The mandible of *Pentalagus* has a very large, rounded, angular process, which is separated from the condyle by a small, shallow notch. The antero-posterior dimension of the ascending ramus and of the condyle is much greater relatively than it is in the other Leporidæ. It is an exaggeration of the mandible of *Limnolagus*.

OCHOTONIDÆ

(PLATE XC)

The skull in the Ochotonidæ is so entirely different in form and structure from that of the Leporidæ, that it is almost superfluous to point out differences. The most conspicuous points in the skulls of the Ochotonidæ that serve to separate them from the Leporidæ

are, the absence of postorbital processes, the general flatness of the brain-case, the much greater development of the posterior free extremity of the malar, the shortness and slenderness of the rostrum, the greater interorbital construction, and the differences in the shape of the palate, all of which are best seen in the figures. The fenestration of the maxillary bone in the Leporidæ is replaced in the Ochotonidæ by a single large opening in the side of the bone.

The mandible of the Ochotonidæ, although presenting many differences from that of the Leporidæ, is built on the same general plan. In *Ochotona* the ascending ramus is relatively much wider. The groove on the anterior surface of the ramus and the thin plate of bone forming the outer border of this groove in the hares is not found in the pikas. Just below the middle of the anterior surface of the ascending ramus of the mandible of *Ochotona* is a more or less prominent tubercle that is lacking in *Lepus* and its allies.

Corresponding to the shorter rostrum of the pikas, that portion of the mandible between the series of grinding teeth and the incisors is relatively shorter than it is in the hares.

The mental foramen in the Leporidæ is situated on the side of the mandible just anterior to the insertion of the first cheek tooth; in the Ochotonidæ the mental foramen is located on the side of the mandible situated as far posteriorly as the last lower molar. The few skulls of the genus *Ochotona* that are available for study show striking differences among themselves and may be placed in three groups, which will be described further on as subgenera.

The brain-case is generally flat and not rounded in *Ochotona*, especially so in the North American species, where the whole skull is also flat. In the group represented by *Ochotona ladacensis* the skull as a whole is not flattened, although the brain-case is; the interorbital region is much constricted and highly arched. In the group containing *Ochotona roylii*, the brain-case is less flattened than in the other and more typical forms; it is somewhat rounded, suggesting the brain-case of the Leporidæ.

Two general styles of incisive foramina are found in the Ochotonidæ: (*a*) incisive foramina resembling those of the Leporidæ in general shape, but at the same time encroaching much farther back on the bony palate, represented by *Ochotona roylii;* (*b*) incisive foramina constricted into two unequal portions by the approximation, if not actual union, in the median line, of the posterior ventral portions of the premaxillæ, the anterior portions of the foramina being very small, and the posterior portions very large

and wide, represented by the American species and *Ochotona ladacensis.*

In the *Ochotona roylii* group all the available skulls have an oval foramen between one and two millimeters in length in the anterior and superior part of each frontal bone. This foramen is not seen in any of the other skulls, although some of the American specimens, notably 36298, *O. collaris,* Fort Yukon, Alaska, show light spots in the anterior part of the frontal bone, evidently the equivalent of the two above mentioned foramina.

In *Ochotona roylii* the single large opening in the side of the maxilla is less rotund than in the other species at hand, is more elongated, and immediately beneath it there is a small amount of fenestration.

TEETH

Leporidæ

(Plate XCI, 2–9)

The dental formula of most of the Leporidæ is I $\frac{2}{1}$, C $\frac{0}{0}$, Pm $\frac{3}{2}$, M $\frac{3}{3}$. In the genus *Pentalagus* the molars are reduced to $\frac{2}{3}$. As there are no differences in structure between some of the premolar and the molar teeth, in what follows in regard to the teeth, the premolars and molars taken together will be called the molariform teeth.

Incisors.—The first upper incisors are large and heavy, being typical rodent incisors in general form. The second upper incisors are minute teeth placed directly behind the first incisors. The anterior surface of each front incisor is marked by a longitudinal groove, extending more or less deeply into the tooth, and which may or may not be filled with cement.

The lower incisors are perfectly plain rodent incisors.

Cheek Teeth.—All the upper molariform teeth are built on the plan of a cylinder, filled up with cement and dentine. The cylinder, however, is not circular in section, and the enamel undergoes certain infoldings, except in the last tooth of the series. The greatest diameter of each tooth is from side to side.

The first upper molariform tooth has enamel variously infolded on its anterior face; most commonly there is a deep median reentrant angle, and two smaller reentrant angles, one on each side of the median one. On the other three faces of the tooth the enamel is not infolded.

The second, third, fourth, and fifth upper molariform teeth have each a single deep reentrant angle on the inner side, the sides of

which angle are more or less crenated. The enamel is well marked in this loop and on the anterior and posterior faces of the teeth, but it is scarcely discernible on the outer sides.

The last upper molariform tooth is very small, subterete, and without reentrant angles.

The lower molariform teeth, while built essentially on the same plan as the upper molariform teeth, are more difficult to understand, owing to the greater extent of the infolding of enamel which takes place in all the teeth, even the last small tooth. The infolding of the enamel is on the outer side of these teeth, and not the inner side, as in the case of the upper molariform teeth.

The first lower molariform tooth is divided into an anterior and a posterior portion in most Leporidæ by a single deep reentrant angle extending across the tooth from the external face. In three genera, however, *Romerolagus, Pronolagus,* and *Pentalagus* (and perhaps *Nesolagus*), this tooth is divided into anterior and posterior portions by two reentrant angles, each extending half-way across the tooth, one from the external face and one from the internal. The anterior portion of this tooth has various minor reentrant angles on the anterior or lateral surfaces, or on both. Each of the second, third, and fourth lower molariform teeth appears like a double tooth of two compressed parts, of which the more anterior is the larger and stands higher up.

The last lower molariform tooth is much reduced in size, but similar to the others in structure, with a larger elliptic anterior portion and a smaller rotund posterior portion.

Following are the tooth variations in different genera of the Leporidæ:

Incisors.—The groove on the anterior surface of the first upper incisor is shallow and is not filled with cement in *Pœcilolagus, Oryctolagus, Brachylagus, Pentalagus,* nearly all the members of *Sylvilagus* (where, however, the groove is deep and in some Mexican specimens it is filled with cement), *Romerolagus* (where the groove is still deeper), and *Pronolagus. Lepus* (*Macrotolagus*) *californicus* has a shallow unfilled groove. Most members of the subgenus *Lepus* have deep grooves, usually without cement.

The groove is shallow and filled with cement in *Limnolagus* and in *Lepus tibetanus.*

The groove is rather deep but simple and filled with cement in *Lepus* (*Lepus*) *campestris,* in *Lepus yarkandensis,* in *Lepus ochropus,* in *Lepus* (*Macrotolagus*) *texianus,* and in *Caprolagus.*

FIG. 44.—Enamel pattern of first right upper incisor of Hares, Rabbits, and Pikas, enlarged nearly four times. 1, *Brachylagus idahoensis,* No. 93696, Ione valley, Idaho. 2, *Sylvilagus* (*Microlagus*) *bachmani,* No. 98466, Bridgeville, California. 3, *Sylvilagus* (*Sylvilagus*) *floridanus,* No. 49586, Florida. 4, *Limnolagus paludicola,* No. 64029, Kissimmee, Florida. 5, *Romerolagus nelsoni,* No. 57954, Mt. Popocatepetl, Mexico. 6, *Lepus tibetanus,* No. 62126, Ladak. 7, *Lepus ochropus,* No. 34735, Kilima-njaro, Africa. 8, *Lepus yarkandensis,* No. 62132, eastern Turkestan. 9, *Lepus ruficaudatus,* No. 38039, Inda. 10, *Lepus sp.,* No. 49621, Jumna river, India. 11, *Lepus* (*Macrotolagus*) *alleni,* No. 59292, Sonoyta, Mexico. 12, *Lepus* (*Macrotolagus*) *merriami,* No. 84643, Fort Clark, Texas. 13, *Lepus* (*Macrotolagus*) *gaillardi,* No. 35709, Chihuahua, Mexico. 14, *Lepus* (*Macrotolagus*) *asellus,* No. 36009, San Luis Potosi, Mexico. 15, *Lepus* (*Macrotolagus*) *callotis,* No. 8982, Chihuitan, Mexico. 16, *Lepus* (*Macrotolagus*) *texianus,* No. 63118, northeastern Mexico. 17, *Lepus* (*Macrotolagus*) *californicus,* No. 60867, southern California. 18, *Lepus* (*Pœcilolagus*) *americanus,* No. 4325, Fort Liard, British America. 19, *Lepus* (*Lepus*) *campestris,* No. 61367, Madison, Minnesota. 20, *Lepus* (*Lepus*) *timidus,* No. 37137, Sweden. 21, *Lepus* (*Lepus*) *europœus,* No. 105828, Switzerland. 22, *Oryctolagus cuniculus,* No. 3124, England. 23, *Pronolagus crassicaudatus,* No. 22972, South Africa. 24, *Pentalagus furnessi,* No. 5583, Liu Kiu islands. 25, *Ochotona ladacensis,* No. 84062, Ladak.

The groove is bifurcated internally, deep and filled with cement in *Lepus* (*Macrotolagus*) *gaillardi*, in *Lepus* (*Macrotolagus*) *alleni*, in *Lepus* (*Macrotolagus*) *merriami*, in *Lepus ruficaudatus*, in *Lepus sp.* from Jumna river, India. The groove is deep, filled with cement, and trifurcated in *Lepus* (*Macrotolagus*) *callotis* and *Lepus* (*Macrotolagus*) *asellus*.

It is rather difficult to make any general statement about the character of the groove, so far as groups go. In certain members of the genus *Lepus* this groove attains the greatest development, but at the same time in the subgenus *Pœcilolagus* the groove is shallower than in any of the specimens at hand, and is not filled with cement. Even in the subgenus *Macrotolagus* the same extremes are met.

Check Teeth.—In *Brachylagus* the anterior surface of the first upper molariform tooth presents a single shallow reentrant angle. In all the other genera the anterior surface of the tooth presents a relatively deep median reentrant angle, and two shallower lateral reentrant angles, one on each side of the main median one. There is more or less individual variation in the depth and form of these folds, and occasionally the median fold itself is slightly crenated. In the genera *Pronolagus, Caprolagus, and Pentalagus* these reentrant angles are deeper than they are in any of the other genera. In *Pentalagus* the main reentrant angle of this tooth is much crenated.

The first lower molariform tooth has the simplest folding of enamel in *Brachylagus*, there being only a shallow reentrant angle on the outer surface of the anterior half.

The genera *Lepus, Oryctolagus,* and *Sylvilagus* all have a small reentrant angle on the anterior face of the first lower molariform tooth, and a broader one on the anterior half of the external surface. Some skulls of *Sylvilagus* from Mexico show two reentrant angles on the anterior surface, resembling *Limnolagus* in this respect.

In *Limnolagus* are found two or more reentrant angles which may be somewhat crenate on the anterior surface, and a broad crenated, reentrant angle on the anterior half of the external surface of the tooth. The whole anterior half of the tooth is more solid looking and more quadrilateral than it is in the other genera.

There are two deep simple reentrant angles in front on the first lower molariform tooth of *Pronolagus* and a broad shallow one on the external surface of the anterior half of the tooth. Unlike any other genus except *Romerolagus* and *Pentalagus, Pronolagus* has a deep reentrant angle on the internal face of the first lower molari-

form tooth, which, extending to the middle of the tooth and meeting the reentrant angle from the external surface, divides the tooth into an anterior and a posterior portion.

In *Romerolagus* there is a broad shallow infold of the enamel on the external surface of the anterior half of this tooth, but the anterior and internal surfaces of this part of the tooth are smooth. The main infold as in *Pronolagus* extends but half-way across the tooth, while a corresponding reentrant angle comes in from the internal surface, both angles contributing to the division of the tooth into an anterior and a posterior portion.

In *Pentalagus* the first lower molariform tooth is very long. It is divided by two well-marked reentrant angles, one from the internal and one from the external face, into two portions, a narrower longer anterior portion, and a broader shallower posterior portion. The anterior portion of this tooth has two reentrant angles on its anterior face, and one each on the internal and external faces.

In *Caprolagus* the anterior portion of the first lower molariform tooth is separated from the posterior portion by a single reentrant angle from the external surface. The anterior portion considerably exceeds in size the posterior portion; it has two narrow reentrant angles on its anterior face, a broad shallow one on the external face, and a similar one on the internal face. (Major '99, pl. 37, fig. 23.)

The reentrant angle of the second, third, fourth, and fifth upper molariform teeth of *Brachylagus* extends but half-way across the tooth; it is not crenated.

The second upper molariform tooth of *Nesolagus* has a short non-crenated reentrant angle extending about a third the distance across the tooth (Major '99, pl. 37, fig. 17). Probably the third, fourth, and fifth upper molariform teeth are similar.

In *Pronolagus* the reentrant angle of the second, third, fourth, and fifth upper molariform teeth extends nearly all the way across the tooth and is crenated. The internal half of the angle is rather wide and open.

In *Pentalagus* the reentrant angle of the second, third, fourth, and fifth upper molariform teeth extends completely across the tooth. The crenation of its sides is more marked than it is in any other genus of Leporidæ. The sides of the angle are almost in contact throughout their entire extent.

In *Romerolagus* the crenated reentrant angle of the second, third, fourth, and fifth upper molariform teeth does not extend quite so far across the tooth as it does in *Pronolagus*, but at the same

time farther than it does in the remaining genera. The internal third of the reentrant angle is rather wide, as it is in *Pronolagus*.

In the remaining genera, *Lepus, Oryctolagus, Sylvilagus,* and *Limnolagus,* the reentrant angle of the second, third, fourth, and fifth upper molariform teeth is crenated and extends about three-quarters of the distance across the tooth. In *Limnolagus* the internal fourth of the fold is rather wide, resembling the condition seen in *Romerolagus* and in *Pronolagus*. In *Lepus, Oryctolagus,* and *Sylvilagus* the sides of the reentrant angles are almost in contact with one another throughout their whole extent.

In the second, third, and fourth lower molariform teeth of *Brachylagus* the single external reentrant angle divides the tooth into the usual anterior and posterior portions, but the latter portion has only about half the side-to-side diameter that the anterior portion has.

In *Pronolagus, Romerolagus,* and *Pentalagus* the posterior portions of the second, third, and fourth lower molariform teeth have lateral diameters equaling those of the anterior portions, but in *Pentalagus* the fold of enamel dividing these teeth into anterior and posterior portions is very deeply convoluted, very much more than it is in any other genus of the Leporidæ.

In *Lepus, Oryctolagus, Sylvilagus, Limnolagus,* and *Caprolagus* the lateral diameters of the posterior portions of the second, third, and fourth lower molariform teeth are about four-fifths the lateral diameters of the anterior portions.

In all the genera the third upper molar is much reduced in size and is elliptic in section, and in *Pentalagus* it is not found at all. It is larger in *Pronolagus,* however, and is somewhat diamond-shaped. In *Caprolagus* it is relatively much smaller than it is in the rest of the Leporidæ.

The last lower molar has the appearance of a double cylinder in all the genera, the anterior portion of which is larger and more elliptical in section, the posterior portion smaller and more terete. In *Pronolagus,* the reentrant angle, which divides this tooth into the two mentioned portions, is more marked than it is in the other genera, and the posterior face of the anterior cylinder is slightly indented.

Ochotonidæ

(Plate XCI, 1)

The dental formula of the Ochotonidæ is I $\frac{2}{1}$, C $\frac{0}{0}$, Pm. $\frac{3}{2}$, M $\frac{2}{3}$, being the same as that of the Leporidæ with the exception of the small last upper molar, which has been so reduced in *Ochotona* as to have disappeared, as is also the case with *Pentalagus* of the

TEETH OF HARES, RABBITS AND PIKAS (enlarged three times). For explanation see page 445.

Leporidæ. This is Forsyth Major's view on the relative number of premolars and molars in *Ochotona*. No. 84,064, *O. ladacensis* from Ladak, a young individual bears out this view, for it shows the third maxillary tooth in process of replacement by the permanent premolar.

The teeth of *Ochotona* are simpler in every way than the teeth of *Lepus* and its allies; they lack the more complicated infolding of enamel and its beautiful crenation.

Incisors.—The first upper incisors of the Ochotonidæ have each a simple groove. Their cutting edge is very sharp; the portion external to the groove much produced downward, the internal portions slightly so produced. In this manner an unequally sided V-like notch is seen on the front cutting edge of each tooth, with the groove at the point of the V.

The second upper incisors are small slender teeth placed behind the first pair as in the case of the Leporidæ.

The single pair of lower incisors of the Ochotonidæ are longer, slenderer, and more pointed than the corresponding teeth in the Leporidæ.

Cheek Teeth.—The first upper premolar is relatively much smaller than the corresponding tooth in the Leporidæ. It has a single reentrant angle, on its anterior face toward the inner edge.

The second upper premolar has a reentrant angle on its anterior face, extending to the middle of the tooth, and thence toward the outer edge. There is also a broad shallow angle on the internal face of this tooth.

The third, fourth, and fifth upper cheek teeth possess each a single reentrant angle on the internal face, extending all the distance across the tooth, very much like the reentrant angles of the Leporidæ, but lacking the crenation usually seen in that family. The last of these teeth has a projecting loop of enamel from the posterior aspect of the tooth, thus differing from the others.

The first lower premolar much resembles the anterior half of the first lower premolar of *Lepus*. It has two reentrant angles on the external face, and one on the internal.

The second, third, and fourth mandibular cheek teeth in *Ochotona* are much like the corresponding teeth of the Leporidæ, but the division into anterior and posterior portions is more marked, and the two portions are subequal.

The last lower molar is small, irregularly ovate in section, its pointed end being toward the external side. A posterior portion to this tooth is completely lacking.

VERTEBRAL COLUMN

LEPORIDÆ

The vertebral column in the different members of the Leporidæ, while of the same general type throughout, presents several peculiarities, constant for the various genera. The vertebral column in the Ochotonidæ, on the other hand, is different in many ways from that of the Leporidæ, as will be detailed below. The different sections of the vertebral column will be taken up successively, beginning with a general account of the structures of each series, followed by a discussion of the variations each series presents in the various genera.

Cervical Vertebræ (pl. XCII, 2–10).—The first cervical or atlas is large, with conspicuous wing-like transverse processes.

The second cervical or axis has a well-developed cylindric odontoid process. Its centrum is long, its neural spine well developed, the antero-posterior length of the neural spine being greater than the corresponding length of the centrum. Transverse processes are present as caudad projecting spines on each side.

The third, fourth, and fifth cervical vertebræ have practically no neural spines; on the sixth there is a small neural spine and on the seventh a larger one.

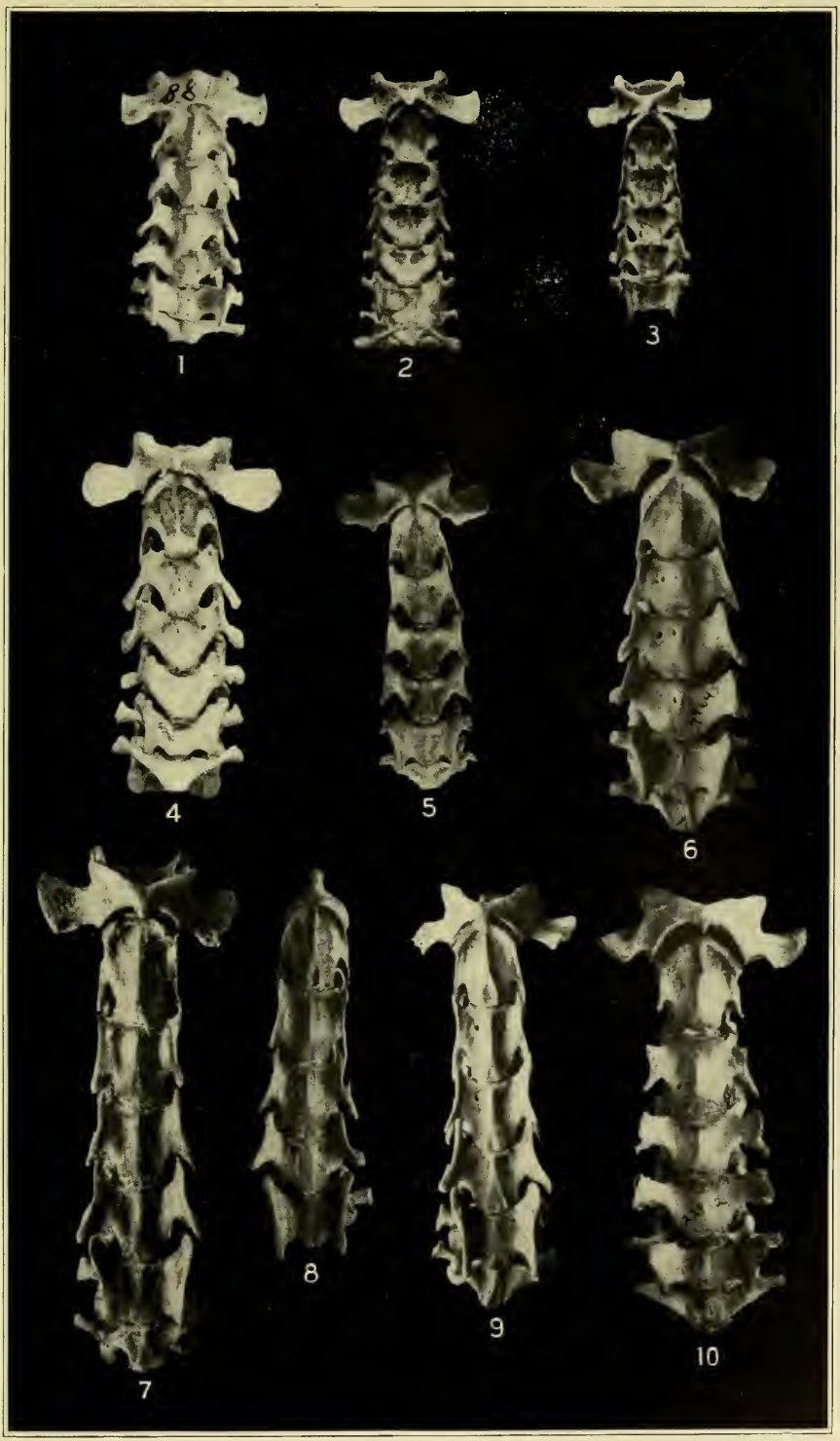
The third, fourth, and fifth have spine-like transverse processes directed backward. The sixth and seventh have well-developed transverse processes, not so spine-like as they are in the third, fourth, and fifth, and they project outward.

In the fourth, fifth, and sixth, the costal process is well developed as an expanded plate projecting laterally from the centrum and extending farther both cephalad and caudad than the centrum to which it is attached. With the true transverse process, this plate encloses the vertebral foramen. This plate-like expansion is largest in the sixth cervical, steadily decreases in size in each further cephalad vertebra, is merely indicated in the third cervical, and in the axis is seen only as the ventral wall of the vertebral foramen.

The seventh cervical is very similar to the first dorsal, differing from it in that it has on each side a vertebral foramen and no facets for the articulation of ribs.

The articulating surfaces of the centra are oblique, sloping from above downward and backward.

The laminæ of the axis, of the third, and of the fourth are well developed, forming a complete roof for the spinal canal. The laminæ of the fifth are less extensively developed, and of the sixth



CERVICAL VERTEBRÆ OF HARES, RABBITS, AND PIKAS. For explanation see page 445.

and seventh still less so, forming only a narrow arch over the vertebral canal.

Not many variations are found in the cervical vertebræ in the different genera of the Leporidæ, but in general two forms occur:

First, large rabbits, in which the individual vertebræ are uniformly lengthened, and in which the costal process does not project laterally from the centrum to a marked extent, and the anterior and posterior spines of the costo-transverse process are more elongated. Cervical vertebræ of this type are found in all the skeletons belonging to the genus *Lepus.*

Second, rabbits averaging smaller in size in which the individual cervical vertebræ are uniformly shortened and in which the costal process projects further laterally from the centrum than it does in the first group, the anterior and posterior spines of which are less pronounced. The true transverse process is slightly more conspicuous here, and often begins to project laterally from the vertebra, beginning with the fifth cervical instead of with the sixth as in the case of the more elongated type of cervical vertebræ. All the genera of the family Leporidæ, with the exception of the genus *Lepus,* belong to this section.

The most extreme development of the shortened type of cervical vertebræ is seen in *Pronolagus,* in which the costal process stands out still farther from the body of the vertebra. The process is narrower, that is, its antero-posterior dimensions are relatively much less than they are in the other genera. The cephalad and caudad projecting spines of the costal processes are apparently not well developed, but they have a somewhat worn or damaged look in the only specimen examined. The general appearance of the cervical vertebræ in *Pronolagus,* when viewed from below, is much as it is in *Ochotona.*

Thoracic Vertebræ.—There are twelve thoracic vertebræ, of which the more anterior are wider from side to side than they are long, while the reverse is true of the posterior vertebræ. The general size of each individual vertebra increases as one passes from before backward.

The centra, often at the beginning of the thoracic series and nearly always toward the end of it, have a low ventral median ridge, which on some of the anterior lumbar vertebræ is produced into a spine, the hypophysis.

In the first eight vertebræ of the thoracic series, the transverse processes are well developed and each is furnished with a large facet for articulating with the tubercle of the rib. In the ninth,

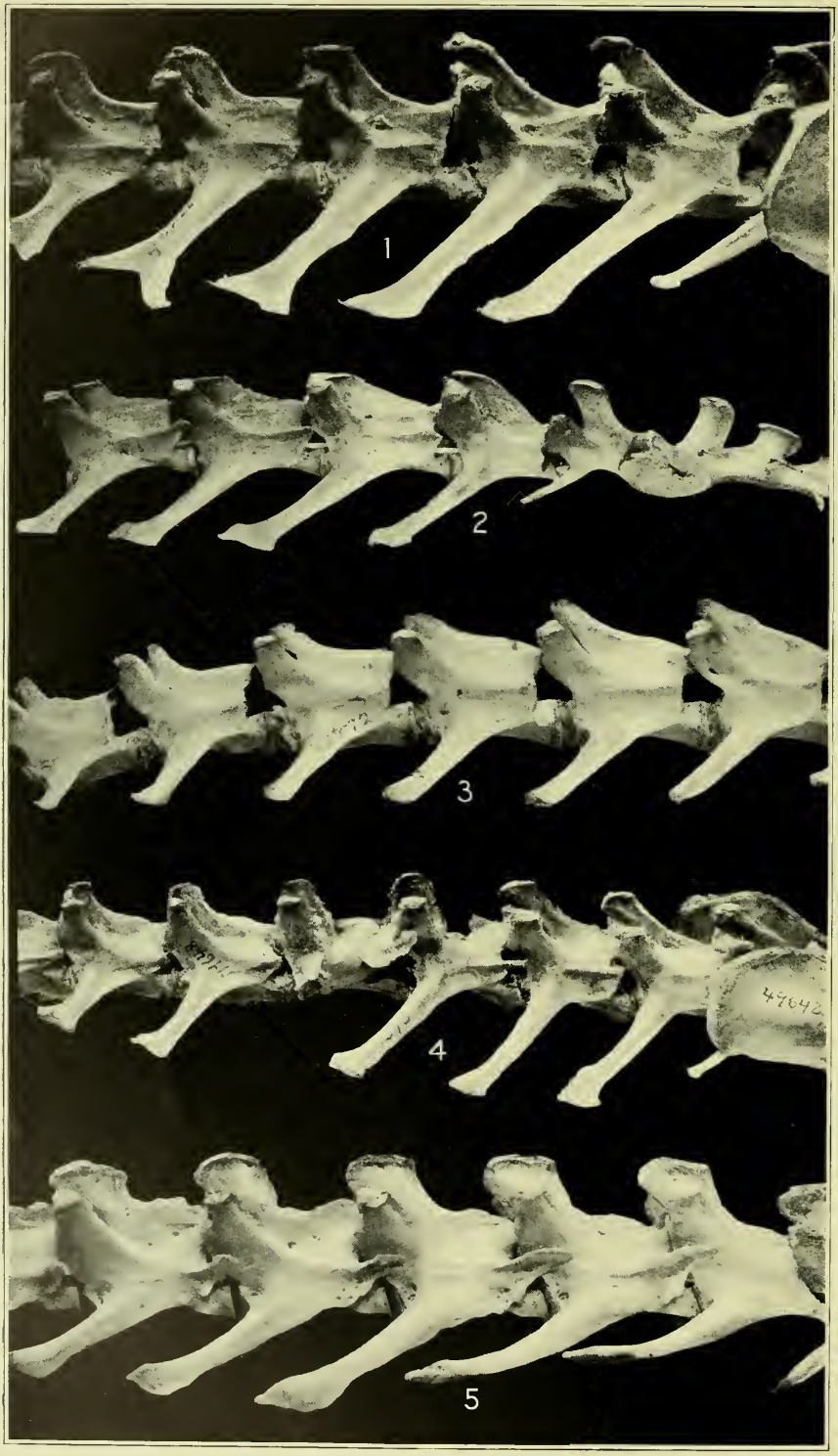
tenth, eleventh, and twelfth thoracic vertebræ, as a rule, the transverse process is absent, the ribs attached to these vertebræ articulating with the facets on the sides of the bodies only. In each of the last four thoracic vertebræ, each transverse process is replaced by a metapophysis on the anterior part of the vertebra, usually indicated by a tubercle on the eighth thoracic, and steadily increasing in size through the twelfth thoracic and still further increasing in size on the lumbar vertebræ. On the side of each of the four above vertebræ posteriorly, there is found another process, smaller than the above, the anapophysis. It is first seen in the ninth thoracic, is usually largest on the tenth, and decreases in size on the eleventh and twelfth. The large transverse processes which are found on the lumbar series are represented on the eleventh and twelfth thoracic by low lateral ridges.

The spinous or neural process of the first thoracic vertebra is very short and broad, inclined slightly backward. The neural spines of the succeeding eight vertebræ are all broad at the base, but spine-like at the free extremity, all are strongly directed backward. The spine of the ninth thoracic is broader than the spines of the vertebræ in front of it. The spine of the tenth thoracic vertebra is still broader from before backward, and usually the spine of this vertebra is inclined neither forward nor backward, that is, as the rule, it is the anticlinal vertebra. The spines of the eleventh and twelfth are still broader, and like the spinous processes of the lumbar vertebræ are directed forward.

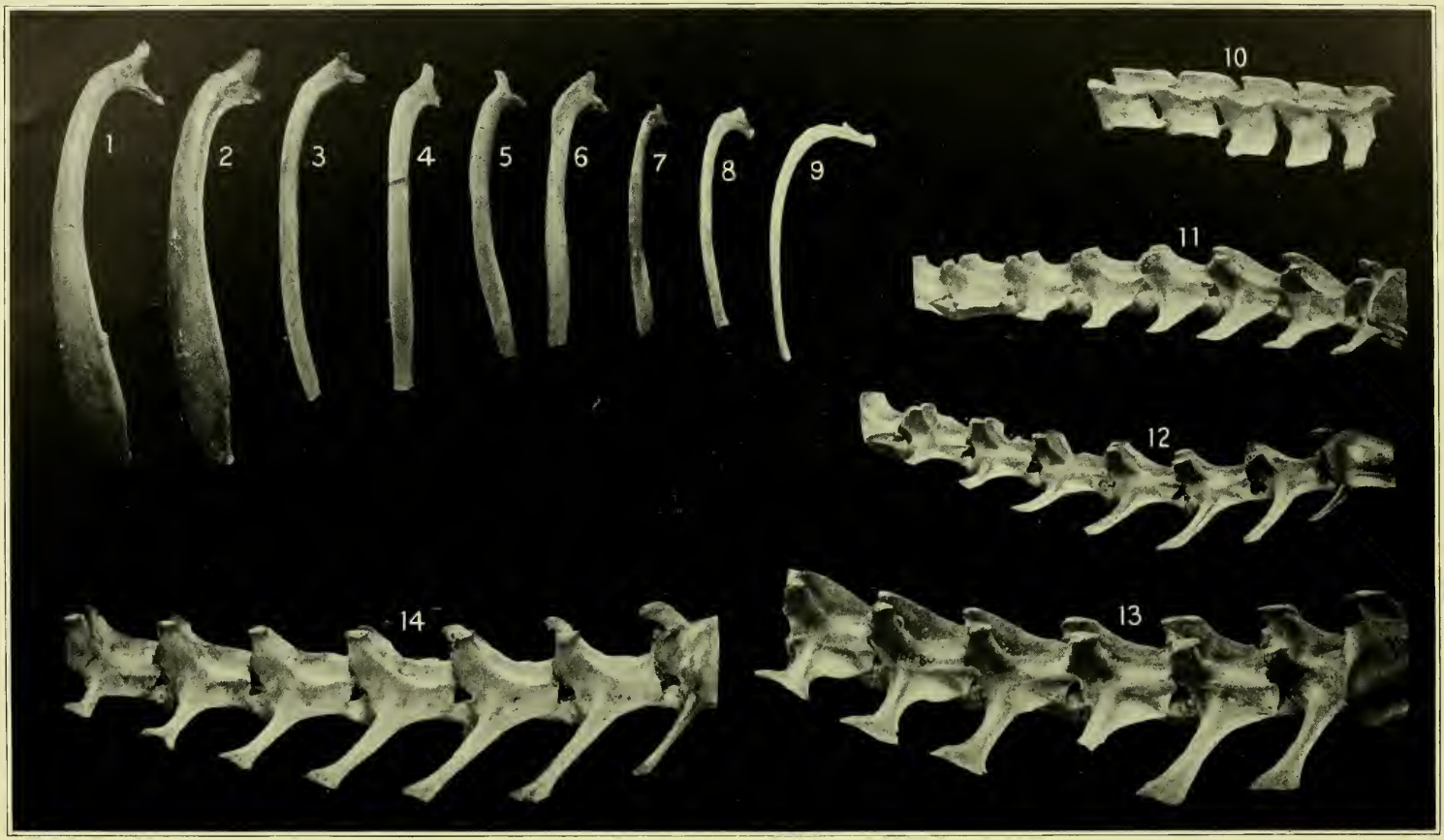
The first vertebra presents a whole facet at the anterior edge of the centrum for the head of the first rib, a half facet at the posterior edge of the centrum for half of the head of the second rib. From the second to the eighth thoracic vertebræ, inclusive, there is a half facet at the anterior edge and another half facet at the posterior edge of the centrum. The ninth thoracic vertebra has only a half facet at the anterior edge of the centrum. The tenth, eleventh, and twelfth have a whole facet each on the centrum anteriorly.

The transverse process of the first thoracic vertebra has a small concave facet for articulating with the tubercle of the rib. All the other vertebræ to and including the ninth have similar facets which increase in size up to the fifth and then decrease in size again. The tenth, eleventh, and twelfth thoracic vertebræ have no transverse processes.

Variations in the thoracic vertebræ are fewer than they are in the cervical vertebræ of the Leporidæ. Some of the variations do not



LUMBAR VERTEBRÆ OF HARES AND RABBITS (natural size). For explanation see page 446.



RIBS AND LUMBAR VERTEBRÆ OF HARES, RABBITS, AND PIKAS. For explanation see page 446.

seem to be more than individual, and the most that can be said is that they are tendencies rather than fixed characters.

The relative length of the neural spines in the anterior part of the thoracic series of vertebræ varies fairly constantly as follows: In *Romerolagus,* the length of an anterior neural spine is about twice the length of the centrum of the vertebra to which it is attached; in *Sylvilagus, Brachylagus, Limnolagus, Lepus* (*Pœcilolagus*), and *Pronolagus,* the spine equals about two and a half times the centrum; in true *Lepus* it is about three times the length of the centrum, and in *Macrotolagus* and *Oryctolagus* it is a trifle over three times.

The position of the anticlinal vertebra varies between the tenth and eleventh thoracic as follows: It is the tenth in *Brachylagus, Limnolagus,* and *Romerolagus;* it is usually the eleventh in *Lepus, Sylvilagus, Oryctolagus,* and *Pronolagus,* but in some cases it is the tenth.

Metapophyses are always found well developed on the last three thoracic, but in *Pronolagus, Limnolagus,* and most of the members of *Lepus,* a well-developed metapophysis is also found on the ninth thoracic; this also happens frequently in the case of the genus *Sylvilagus.*. But even those cases when the metapophysis is well developed on the tenth and eleventh thoracic only, it is always indicated by an ill-defined tubercle on the ninth.

Lumbar Vertebræ (pls. XCIII, XCIV).—The seven lumbar vertebræ are large and elongated. Each is provided with a stout, broad, spinous process, much shorter than the spines of the thoracic vertebræ. The metapophysis is well developed in all the lumbar vertebræ, and in the lumbar series nearly equals the spinous process in size. Like the spinous processes, the metapophyses are directed forward. On the anterior five lumbar vertebræ the anapophysis is represented by a horizontal line ending posteriorly, usually, in a small projecting spine. In some cases this little spine is practically absent, while in others it is very well developed.

The transverse processes of the lumbar vertebræ are very large and long, projecting downward and forward. The proximal end arises from the anterior third or half of the side of the centrum. The free extremity is usually enlarged, and in the more anterior vertebræ of the lumbar series it is usually bifurcated. The total length of a transverse process in the middle of the lumbar series is usually equal to one and one-half times the length of the centrum to which it is attached.

Each of the second and third lumbar vertebræ has a prominent ventral spine, the hypophysis. A smaller hypophysis is found in the first lumbar, and on the twelfth thoracic and the fourth lumbar vertebræ the hypophysis is usually indicated by a low ventral ridge on the centrum.

The zygopophyses are prominent in the lumbar vertebræ, and the articulating surfaces are directed laterally instead of horizontally as is the case with the cervical and thoracic series of vertebræ.

The last lumbar vertebra is peculiar in being shorter than any of the others and in having shorter and more slender transverse processes.

The lumbar vertebræ of the Leporidæ possess several well-marked variations, constant for certain groups and making good characters by which to determine them. The most important variations occur in the length, shape, and attachment of the transverse processes, and they may be outlined as follows:

1. Large rabbits having wide and long transverse processes with the free extremity expanded. The length of the longest process equals the length of the centrum to which it is attached and half the length of the centrum in front. The attached portion of the transverse process rises abruptly from the anterior half of the side of the centrum. All the members of the genus *Lepus* have the transverse processes of the lumbar vertebræ of this form.

2. Medium sized rabbits having the lumbar transverse processes of the same relative length and width as in the above group. Instead, however, of arising abruptly from the anterior half of the lateral aspect of the centrum, each process has a rather long posterior root coming from nearly the whole of the posterior half of the centrum, sharply sloping into the process itself. The skeletons having such transverse processes on the lumbar vertebræ belong to the genera *Sylvilagus* and *Oryctolagus*.

3. Medium-sized rabbits with the transverse processes slightly shorter than they are in the two preceding groups, the longest process equaling the length of the centrum to which it is attached and a fourth of the centrum in front. The processes are much broader than they are in the former groups, so that they appear much shorter than they really are. The free extremities are more expanded than they are in any of the genera except *Romerolagus*. The attached bases are very wide, coming from the whole side of the centrum, and the angle between the main axis of the transverse process and the side of the centrum is filled in with thin bone especially marked in the anterior part of the lumbar series, approach-

ing the condition found in *Romerolagus*. These processes are characteristic of the genus *Limnolagus*.

4. Small rabbits having the lumbar transverse process slightly more concave anteriorly than in the other rabbits. Each process is marked by a prominent longitudinal ridge. But for this pronounced ridge the lumbar transverse process resembles that found in the genus *Sylvilagus*. While this ridge is found to a greater or less extent in the other groups of the Leporidæ, yet it is never so narrow nor so sharply marked off from the rest of the process. The transverse processes of this type are peculiar to the genus *Brachylagus*.

5. Small rabbits with the lumbar transverse processes short, the longest equaling the length of the centrum to which it is attached. The process of the first lumbar vertebra is very short and almost rudimentary. All the processes are wide and have triangular outlines in general. The base is broad, coming from the whole side of the centrum, and the angle between the main axis of the process and the side of the centrum is completely filled with thin bone. It is an exaggeration of the condition found in *Limnolagus*. Even the transverse process of the last lumbar vertebra, which is usually slender in other rabbits, is here very broad, but not so broad as the transverse processes on the other lumbar vertebræ. Transverse processes of this type are characteristic of the genus *Romerolagus*.

6. Medium-sized rabbits with lumbar transverse processes of medium length, the longest equaling the length of the centrum to which it is attached. The process is not so much expanded at the free extremity as in the case of the above groups. It is wide however at the base, where it comes from the whole side of the centrum, resembling in this respect *Limnolagus,* but the posterior border of the transverse process is not so strongly concave as in that genus, and the process itself is more slender. Transverse processes of this type are found in the genus *Pronolagus*.

The other variations in the lumbar vertebræ are of less importance and not so well defined as are the variations of the transverse processes.

The spinous processes and metapophyses are always well developed. In the anterior part of the lumbar region the spinous processes are usually a little longer than the metapophyses on the same vertebra and they are always longer in the posterior region. The spinous process is of variable shape and there are marked differences in individuals of the same species. This process is, in general, bluntly triangular, sloping obliquely anteriorly, the basal

side attached to the rest of the vertebra, with a long sloping or usually concave posterior edge, and a more nearly vertical and shorter anterior edge.

In the following hares the spinous processes are perfectly triangular, and are relatively not so high as in the typical form: *Romerolagus, Limnolagus, Pronolagus, Pœcilolagus.* One skeleton of the genus *Sylvilagus* (No. 94,197, from Monitor valley, Nevada) also has neural spines of this shape, although in the other members of this genus which I have noted they are of the typical form.

The anapophyses are very slightly developed on the lumbar vertebræ of all hares. Their presence is usually indicated by a mere ridge on the side of the vertebræ, which ends in a small caudad projecting tubercle. They are least developed in the skeleton of *Pronolagus* and are longest in the skeleton of a lop-eared domestic rabbit, *Oryctolagus cuniculus.* Here they are very large, and in the three middle vertebræ of the lumbar series, viz., third, fourth, and fifth, the anapophysis extends as far posteriorly as the posterior border of the metapophysis of the next succeeding vertebra. In the wild *Oryctolagus,* however, this great development of the anapophysis is not so pronounced, but it is much larger than on the lumbar vertebræ of any of the other skeletons.

Ventral spines, or hypophyses, or ridges indicating them, are found on the first three lumbar vertebræ. The spines usually occur in three lengths: In the genera *Sylvilagus* and *Brachylagus* the hypophysis on the second lumbar is the longest, that on the first lumbar is next in length, and the shortest hypophysis is found on the third. Occasionally in *Sylvilagus* the first hypophysis is reduced to a ridge and the last is sometimes lacking. In all the skeletons of the genus *Lepus* the third lumbar vertebra bears the longest hypophysis; the first bears the shortest. In *Romerolagus* the first hypophysis is the shortest, the second and third are subequal, the third being a trifle the larger. In the skeletons of *Limnolagus, Pronolagus,* and *Oryctolagus* the hypophyses are more or less injured. It would appear, however, in these genera that the second hypophysis is the longest.

Sacral Vertebræ.—The number of sacral vertebræ in the Leporidæ varies from three to five, according to the age of the individual, four being the usual number. The two anterior vertebræ of the sacrum are the only ones entering into the formation of the sacroiliac joint. The remaining vertebræ are progressively smaller and resemble in shape the anterior caudal vertebræ.

The first sacral has a large neural spine, vertical or inclined

slightly forward like the spines of the lumbar vertebræ. The neural spines of the remaining sacral vertebræ become progressively smaller from before backward and they are directed caudad. In some cases the spine of the fourth sacral is very small. In nearly all cases the spines of the sacral vertebræ are distinct and not fused with one another.

The outline of the sacrum as a whole is triangular, the base being in front, the apex behind. The greatest width, which is at the anterior part of the massive fused transverse processes of the first and second sacral vertebræ, is nearly equal to the greatest antero-posterior diameter.

In all the rabbits the sacrum presents very few variations. The differences found in the different sacra seem to be due entirely to age and individual variations. The only sacrum showing any marked deviation from the type is in *Lepus sp.* No. 49,621, from Jumna river, India. The posterior part of this sacrum is very narrow from side to side. The expanded wing-like portions to which the ilia are attached are very narrow from before backward. In general, the shape of this peculiar sacrum, as seen from below, is like a T. The adjacent tips of the first and second, and of the third and fourth of its sacral neural processes are in contact.

The usual number of vertebræ in the sacrum is four; in some old individuals it is raised to five, and in some younger ones it is only three. In what follows with reference to the caudal vertebræ, four vertebræ will be considered as entering into the formation of the sacrum.

Caudal vertebræ.—The caudal series always includes vertebræ of three different though not sharply defined forms.

1. The first one or two vertebræ following the sacrum are long, and in general appearance resemble the last sacral vertebra.

2. The next three to seven cadual vertebræ are shortened, have wing-like anteriorly directed transverse processes and the neural arches become progressively less developed caudad.

3. The remaining vertebræ of the caudal series, four to nine in number, are merely small elongated centra without processes or neural arches.

The accompanying table (page 364) shows the number of the different forms throughout the caudal series in the available skeletons. From this table the following groups may be picked out:

1. *Nesolagus,* with a total of eight caudal vertebræ.

2. *Romerolagus,* with a total of nine caudals, of which one is of the first form, five of the second, and three of the third.

Genera and Species.	Locality.	Number.	No of 1st Form	No. of 2d Form	No. of 3d Form.	Total Number.
Lepus (*Lepus*) *timidus*	Sweden	1,048[1]	1	7	5	13
" " "	"	1,049[1]	1	7	5	13
" " *campestris*	Kansas.	43,623[1]	1	7	6	14
" " "	Nebraska.	49,622[1]	1	7	6	14
" " *gichiganus*	Siberia.	18,303[2]	2	5	5	12
" (*Macrotolagus*) *texianus*	Nevada.	94,198[3]	1	7	7	15
" (*Pœcilolagus*) *americanus virginianus*	New York.	969[1]	1	7	*	*
" *sp*	India: Jumna river.	49,621[1]	1	6	7	14
Sylvilagus floridanus	Florida.	49,586[1]	1	6	7	14
" "	"	49,587[1]	1	7	6	14
" "	"	49,588[1]	1	5*	*	*
" "	"	49,589[1]	2	6	7	15
" " *mallurus*	Virginia.	89,514[3]	1	6	6*	13*
" " *transitionalis*	New York.	49,624[1]	2	6	7	15
" " subspecies	Nevada.	94,197[3]	1	6	5*	13*
" *nuttallii*	Wyoming.	11,644[1]	1	6	6	13
" *truei*	Mexico.	92,965[3]	1	6	*	*
" *minensis*	Brazil; Chapada.	113,432[1]	2	5	4	11
" "	" "	49,665[1]	2	5	4	11
Brachylagus idahoensis	Idaho.	93,695[3]	2	3	4	9
" "	"	93,596[3]	2	3	4	9
Nesolagus netscheri[4]	Sumatra.		?	?	?	8
Romerolagus nelsoni	Mexico.	57,954[3]	1	5	3	9
Limnolagus paludicola	Florida.	49,580[1]	1	5	5	11
Oryctolagus cuniculus, lop ear	domestic.	49,386[1]	1	7	9	17
" "	Germany.	49,645[1]	1	6	9	16
" "	England.	49,648[1]	1	8	8	17
" " Belgian hare	domestic.	49,677[1]	1	7	9	17
Pronolagus crassicaudatus	South Africa.	22,972[1]	2	*	*	*

3. *Brachylagus,* with a total of nine caudals, of which two are of the first form, three of the second, and four of the third.

4. *Limnolagus,* with a total of eleven, of which one is of the first form and five each of the second and third.

The other genera containing a larger number of species than the above do not show such sharply defined results, but they roughly fall into these groups.

5. *Sylvilagus,* having a total of eleven to fifteen caudals, of which usually the first one or two are of the first form, the next five or seven, usually six, of the second form, and the terminal four or seven of the third form.

[1] United States National Museum.

[2] American Museum of Natural History.

[3] United States National Museum, Collection of Biological Survey, United States Department of Agriculture.

[4] No specimen seen, taken from original description. (Schlegel, '80, p. 64.)

[5] Series incomplete.

6. *Lepus,* having a total of thirteen to fifteen caudals, of which the first only is of the first form, the next five to seven, usually seven, of the second form, and the remaining five to seven of the third form.

7. *Oryctolagus,* with a total of sixteen to seventeen caudals, of which the first is of the first form, the next six or eight of the second, and about the remaining eight or nine of the third form.

Ochotonidæ

The vertebral column of the Ochotonidæ presents nearly as many and as marked differences from that of the Leporidæ as do the skulls of the former from those of the latter.

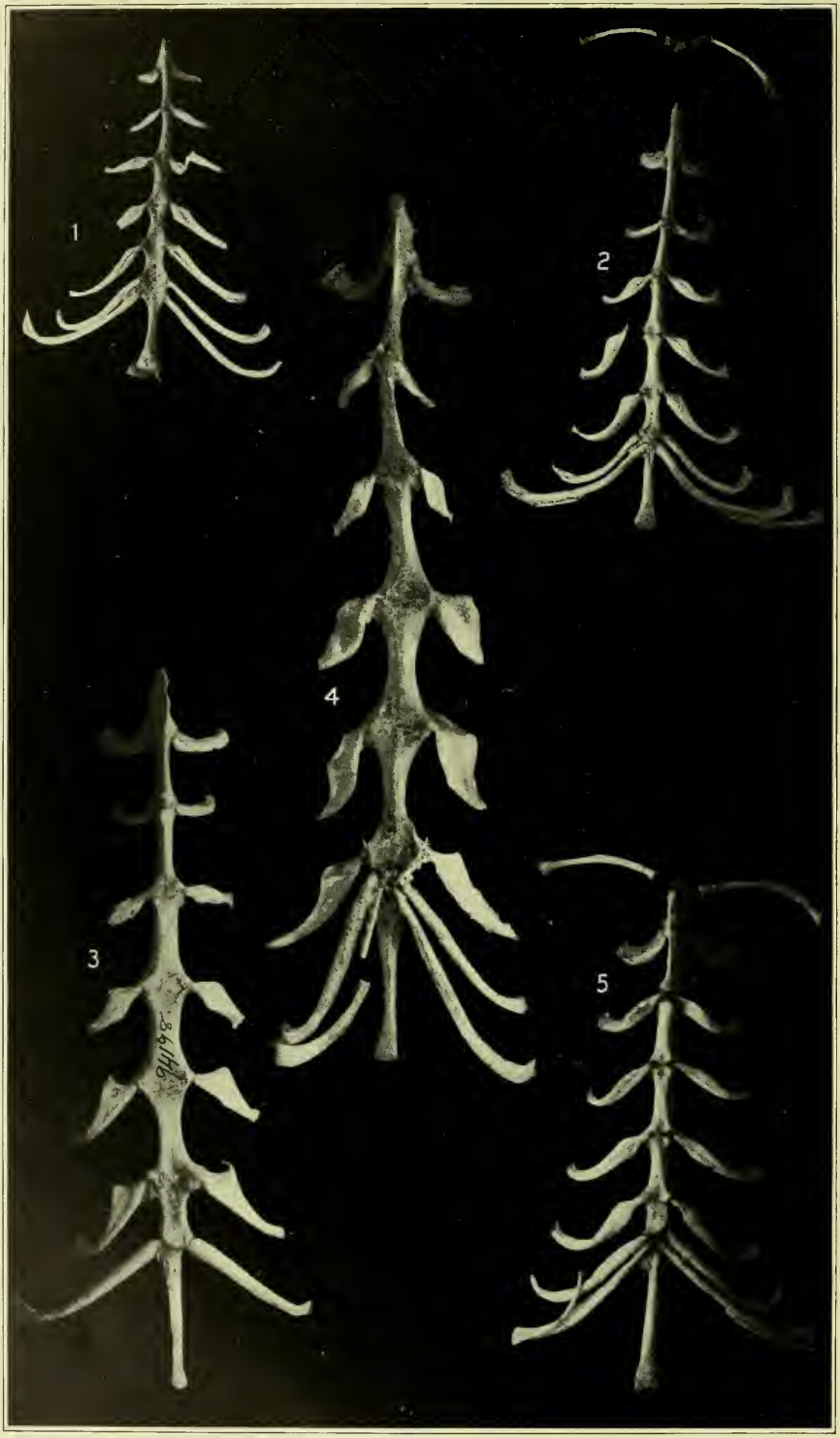
Cervical Vertebræ (pl. xcii, 1).—The cervical vertebræ of the Ochotonidæ have the same general characteristics as in the Leporidæ. They are decidedly shortened antero-posteriorly, the laminæ of the posterior ones being very narrow. This shortening involves the axis but not the atlas. The latter has the free extremity of the transverse processes moderately expanded. The costo-transverse processes of the third, fourth, and fifth cervicals are placed more obliquely to the axis of the vertebral column than the same processes are in the Leporidæ. In the sixth they become horizontal as they do in the hares. The transverse process of the seventh cervical differs from that in the Leporidæ in not being pierced by a costo-transverse or vertebral foramen.

Thoracic Vertebræ.—The thoracic vertebræ of the Ochotonidæ are entirely different from the same series of vertebræ in the Leporidæ, they are 17 in number instead of 12, the thoraco-lumbar vertebræ in the two groups being 22 and 19 respectively. The first 12 of the thoracic vertebræ in the Ochotonidæ are exactly homologous with the 12 thoracic vertebræ of the Leporidæ. The arrangement of the facets for the heads and the tubercles of the ribs is entirely similar. The five remaining rib-bearing vertebræ of the Ochotonidæ are practically indistinguishable from one another as well as from the twelfth, except by the slightly greater size of each succeeding vertebra.

The spinous processes are relatively shorter in the Ochotonidæ, and this is especially true in the posterior thoracic region from the twelfth onward where the spines are all low and slightly inclined forward. Each neural spine of these posterior thoracic vertebræ arises by a broad base from the whole length of the neural arch; the free extremity of the process is nearly as long as the base, the posterior edge being slightly concave.

That part of the transverse process of the thoracic vertebra which articulates with the tubercle of the rib is the same in form in the two families. Associated with this transverse process in the Ochotonidæ are the metapophysis and the anapophysis. Both these processes are first seen on the third thoracic as mere tubercles. The anapophysis grows larger on each successive vertebra, attaining its greatest size on the last thoracic. From the eleventh thoracic onward, the anapophysis is a well-marked process directed upward, backward, and outward. The metapophysis remains little more than a tubercle until the tenth thoracic vertebra is reached, where it is a well-marked process. On the eleventh it is slightly larger, and on the twelfth still larger but closely associated with the prezygopophysis. The metapophysis scarcely increases in size through the rest of the series and continues closely asociated with the prezygopophysis throughout. No ventral spines or hypophyses are found on any of the vertebræ. Some of the posterior thoracic have a slight ventral ridge which is also found on all the lumbar vertebræ.

Lumbar Vertebræ (pl. XCIV, 10).—Corresponding to the greater number of the thoracic vertebræ in the Ochotonidæ, there is a diminution in the number of the lumbar vertebræ, from 7 to 5, but this is not sufficient to make the number of thoraco-lumbar vertebræ the same in the two families. The lumbar vertebræ of *Ochotona* are very different in form as well as in number from those of *Lepus* and its allies. Each vertebra is compact, with the processes broader and more closely applied to the body instead of the slenderer processes extending to a distance from the centrum such as occurs in the Leporidæ. The neural process is low, with the free edge as long as the whole length of the vertebra and parallel with the axis of the vertebra. The metapophyses are well developed and more closely associated with the prezygopophyses than they are in the Leporidæ. Anapophyses are well developed on the first and second lumbar vertebræ and are a direct continuation of the thoracic series of anapophyses. These processes are slightly indicated on the third lumbar vertebra, after which point they disappear. The transverse process is little more than a tubercle on the first and second lumbar vertebræ, but on the third and fourth it is a wide quadrilateral plate of bone coming from the whole side of the vertebræ, sloping downward and outward. The transverse process of the fifth and last lumbar is a trifle longer than the other transverse processes and only about half as wide, the narrowing taking place chiefly at the expense of the posterior half of the process. There are no hypophyses, but all the lumbar vertebræ (as is the case of those lumbar vertebræ of



STERNA OF HARES AND RABBITS (natural size). For explanation see page 446.

the Leporidæ which do not bear ventral spines) possess a median ventral ridge.

Sacral Vertebræ.—The sacrum in the pikas is entirely different in form from the corresponding structure in the hares and rabbits. It is long and narrow, its greatest breadth being contained in its length about twice. The lateral masses that are attached to the ilia, instead of being expanded into wing-like processes with the greatest width anteriorly, are much less expanded and have nearly parallel sides. The neural spines so distinct and conspicuous on the sacra of the Leporidæ are reduced in the Ochotonidæ to form a low dorsal ridge, the separate spines having fused with one another. The number of vertebræ entering into the formation of the sacrum of the Ochotonidæ is four, the same as in the case of the Leporidæ.

Caudal Vertebræ.—The caudal vertebræ in the Ochotonidæ are eight in number in all the skeletons at hand except one, which has nine. In three American specimens, Nos. 91,188 and 30,990 from Idaho, and No. 49,620 from Oregon, the first caudal is somewhat narrowed, the next two are slightly wider, with faint indications of lateral projections; the rest of the series consists of short flattened bodies. The single Asiatic skeleton, No. 49,500, *Ochotona ladacensis*, central Asia, has mainly the same character of the caudals, but the individual vertebræ are relatively wider throughout.

STERNUM

Leporidæ

(Plates XCV, 1–5; XCVI, 1, 3–5)

The sterna of the Leporidæ are formed of the usual three portions, presternum or manubrium, mesosternum or gladiolus, and xiphisternum.

The presternum consists of one piece which is usually longer than any other single segment of the sternum excepting the xiphisternum. It is usually compressed from side to side and marked by a more or less evident ventral keel. At or anterior to its middle the first pair of sternal ribs is attached.

The mesosternum consists of four usually distinct segments. A sternal rib is attached at the point of articulation of each segment with the other, as well as at the point of articulation of the presternum with the mesosternum. At the posterior outer aspect of the last mesosternal segment near the articulation of the xiphisternum two sternal ribs are usually attached.

The xiphisternum is usually the longest single segment. It is attached anteriorly to the last mesosternal segment. Its posterior end is free and is terminated by a thin rounded piece of cartilage.

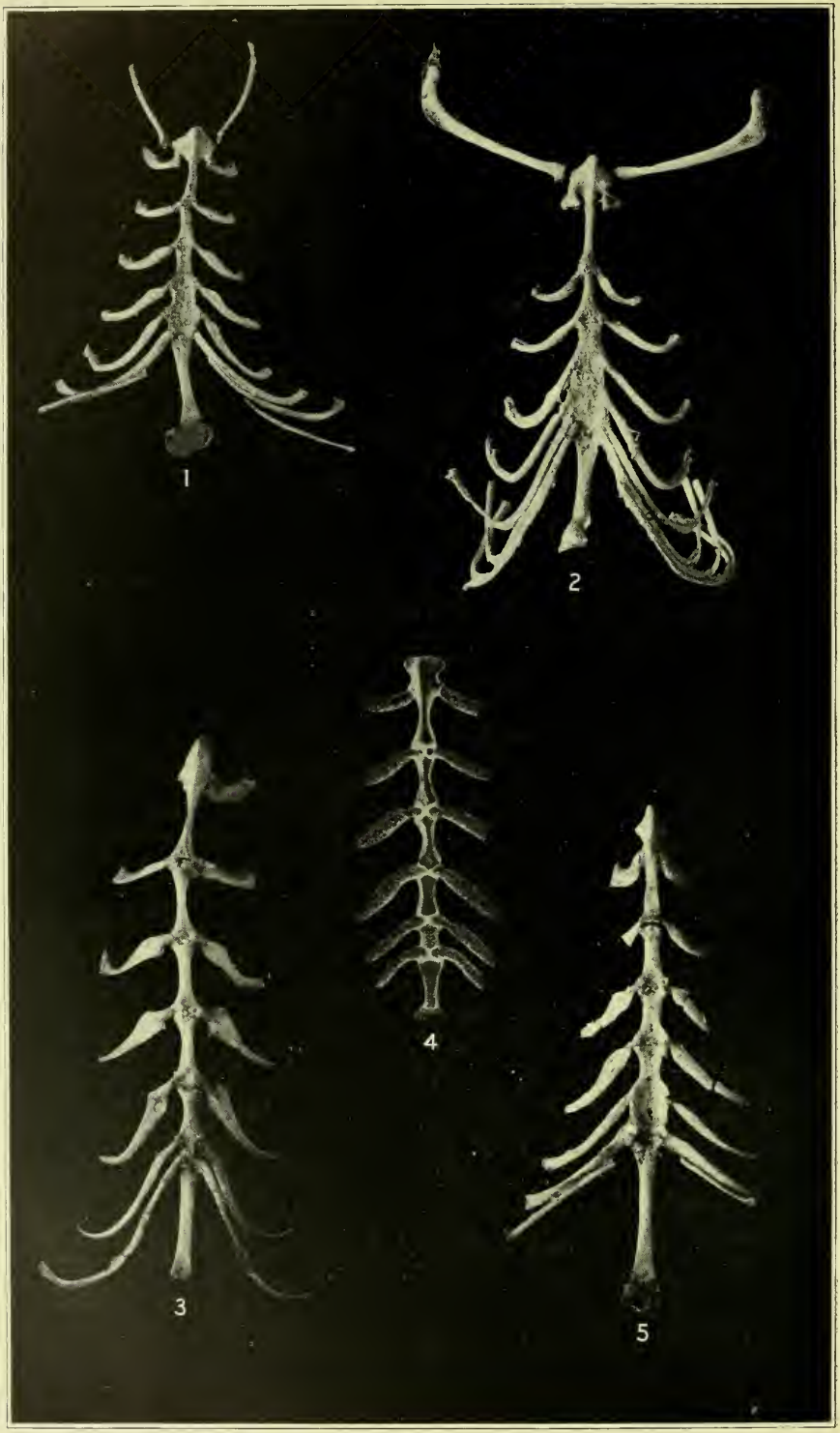
Eight different types of sternum are found among the Leporidæ; some of which are characteristic of certain genera, while the others are not so sharply defined and might better be considered tendencies rather than actual developments. A greater number of skeletons may show that some of the types amount to nothing, as there seems to be a certain amount of variation in individuals of the same species. The different types of sterna are as follows:

1. Presternum long and narrow, much compressed laterally into a keel which is most prominent anteriorly; the first rib is attached at the junction of the first and second fourths or first and second thirds. Mesosternum of four distinct segments, of which the first is narrow and compressed, the others not compressed or even flattened dorso-ventrally. All the mesosternal segments in general are subequal and each successive one grows wider from before backward. The xiphisternum about equals the presternum in length. The anterior end is considerably enlarged where it articulates with the last mesosternal segment. Its posterior and free extremity is rather pointed or only slightly larger than the narrowest portion of the xiphisternum. One skeleton (*Lepus texianus,* No. 94,198), belonging in this section, has an anomalous mesosternum composed of five distinct segments, the last of which is only slightly smaller than the other segments. At the articulation of the mesosternum with the xiphisternum, but one pair of ribs is attached instead of the usual two pairs in sterna where the fifth mesosternal segment is normally suppressed.

The hares possessing sterna like the above are all large and belong to the genus *Lepus.* (Pl. xcv, 3, 4.)

2. Sternum in general very similar to the above, presternum relatively longer, its keel less prominent anteriorly. The first pair of ribs is attached just anterior to its middle. The mesosternal segments have a tendency to be less flattened. Xiphisternum shorter than the presternum, its posterior end more enlarged than it is in the case of the preceding section. Such sterna are more or less characteristic of the genus *Sylvilagus.* (Pl. xcv, 2.)

3. Sterna similar to those of the genus *Lepus;* presternum more conspicuously keeled, the first rib attached just anterior to its middle. Mesosternal segments more compressed from side to side than they are in *Lepus.* The last is much shorter than any of the other mesosternal segments. Xiphisternum large and stout, longer than the



STERNA OF RABBITS AND PIKA. For explanation see page 446.

presternum, its posterior extremity about as much expanded as its anterior. These sterna are found in the genus *Oryctolagus*. (Pl. XCV, 5.) One skeleton of *Oryctolagus* (No. 49,648) shows the peculiarity of five segments in the mesosternum, the fifth being very small and short. As in the case of the abnormal sternum of *Lepus texianus*, No. 94,198, also with five mesosternal segments, only one pair of ribs is attached to the junction of the fifth mesosternal segment with the xiphisternum.

4. Presternum compressed with low keel all along ventral border, dorsal portion somewhat expanded just anterior to the attachment of the first pair of ribs which takes place at the junction of the anterior and middle thirds. Mesosternum of four distinct segments, the first compressed laterally with a low keel continuing that of the presternum, the succeeding mesosternal segments becoming successively wider and more dorso-ventrally flattened. The last segment is much wider than any of the others, with a well-marked postero-lateral angle for the attachment of the last two sternal ribs. The xiphisternum is decidedly longer than the presternum; it is slender in the middle, but the ends are considerably expanded, especially the posterior end. This type of sternum is found in the genus *Brachylagus*. (Pl. XCV, 1.)

5. Posterior two thirds of the presternum much compressed, but not keeled. The anterior third is somewhat expanded, resembling that portion of the presternum of *Limnolagus*. The first pair of ribs is attached at the junction of the first and second fourths. The mesosternal segments are more compressed laterally than they are in the other skeletons and each succeeding one is a little shorter than the one immediately in front of it. The xiphisternum is a trifle shorter than the presternum, is comparatively short, and about equally widened at each end. This type of sternum is found in the single skeleton of *Pronolagus*. (Pl. XCVI, 3.)

6. The anterior portion of the presternum is considerably expanded laterally, having a tendency to be intermediate in form between the presterna of *Lepus* and those of *Romerolagus* and *Ochotona*. The mid-ventral line of this expanded part bears a low keel which is not extended backward on the posterior portion of the presternum. The first pair of ribs is attached to the middle of the presternum. The mesosternum as a whole is wider than are the mesosterna previously mentioned. It is also shorter, so that its length is but little greater than that of the presternum or of the xiphisternum, both of which are about equal in length. The first, second, and third mesosternal segments are about equal in length; each

succeeding segment is wider than the one in front. The third and fourth mesosternal segments are completely ankylosed so that the whole mesosternum is composed of but three separate pieces instead of the usual four. The xiphisternum is long and slender and about equally expanded at each end. In all the preceding sections the sixth and seventh pairs of ribs are attached to the last piece of the mesosternum in the angle between it and the xiphisternum. In case of the form of sternum just described the sixth rib is the last attached directly to the sternum, the seventh being attached to the cartilage of the sixth near the point where the latter joins the mesosternum. This type of sternum is found in the skeleton of *Limnolagus paludicola*. (Pl. XCVI, 5.)

7. In this section the sternum is very characteristic and resembles almost exactly that of *Ochotona*. The anterior portion of the presternum is very much expanded and flattened dorso-ventrally. To the outer posterior angles of this expanded portion the first pair of ribs is attached. The rest of the presternum is long and narrow, as it is throughout the Leporidæ, but devoid of any ventral keel. A slight ridge indicating a keel is seen on the ventral face of the expanded portion. The mesosternum in general is very much like the same structure in *Limnolagus* just described. The first and second segments, however, are subequal and relatively narrower, the third and fourth segments are subequal in length, but the fourth is broader, both are relatively wider than they are in *Limnolagus* and as in that genus are firmly ankylosed. The xiphisternum is long and rather stout; it is about equally enlarged at either end. It is but a trifle shorter than the whole mesosternum and decidedly longer than the presternum. As in *Limnolagus* the seventh pair of ribs does not articulate with the sternum, but with the cartilages of the sixth pair. The above is the sternum of *Romerolagus*. (Pl. XCVI, 1.)

8. In this group the presternum is considerably enlarged in its anterior third, to about the same extent that it is in *Romerolagus*. Its different shape is best seen by consulting figures 1 and 4, plate XCVI. The mesosternum consists of four distinct segments, the first two subequal in length, compressed laterally; the third segment is slightly shorter, not laterally compressed; the fourth segment is very short and cartilaginous. The xiphisternum is very short, much shorter than the presternum; its anterior end is considerably enlarged. Apparently six pairs of ribs only articulate directly with the sternum. This type of sternum is found in *Nesolagus* (Major, '99, pl. 39, fig. 18).

OCHOTONIDÆ

(PLATE XCVI, 2)

The material for making generalizations concerning the sterna of the Ochotonidæ is far from being satisfactory. Out of four skeletons but one is fully adult and there is a certain amount of variation among them. It may be that more material would show that there are two or three different types of sterna among the Ochotonidæ. Aside from a few minor details the sternum of the only adult *Ochotona* at hand, No. 91,188, is almost exactly like the sternum of *Romerolagus* just described, so that the genus *Romerolagus* can be briefly described as a rabbit with the sternum of a pika. The expanded portion of the manubrium is less developed in *Ochotona* than in *Romerolagus,* and rather triangular in outline instead of pentagonal. In other respects the two sterna are similar. The *Ochotona* presternum is nearly as long as the mesosternum and slightly longer than the xiphisternum.

The mesosternum of *Ochotona* is in general very similar to that of *Romerolagus.* The first and second segments are subequal in length, the second being broader however. The third segment is the longest and broadest of the mesosternum. The fourth segment is the shortest and nearly as broad as the third. Both the third and fourth mesosternal segments are completely ankylosed as they are in *Romerolagus* and *Limnolagus.*

The xiphisternum is considerably expanded at the proximal end, but the distal extremity is not much enlarged. It is decidedly shorter than the presternum.

The seventh rib is attached along with the sixth rib to the sternum at the point of union of the mesosternum with the xiphisternum.

No. 30,990 *Ochotona saxatilis,* Idaho, is very similar to the above; it is young, however, and the third and fourth pieces of the mesosternum are not yet fused.

No. 49,620, from Oregon, has the entire mesosternum narrow and its last two segments separate.

No. 49,500 *Ochotona ladacensis,* Ladak, central Asia, has the enlarged portion of the presternum less expanded; the mesosternum is relatively longer and decidedly narrower than is the mesosternum of *O. saxatilis,* the third and fourth mesosternal segments are not fused. The mesosternum as a whole bears considerable resemblance to some of the mesosterna of *Sylvilagus.* The xiphisternum is rather short.

RIBS

LEPORIDÆ

(PLATE XCIV, 1–8)

Corresponding to the number of thoracic vertebræ there are twelve pairs of ribs of which seven are normally attached to the sternum by means of well developed, ossified, costal cartilages. The last three or four pairs of ribs have no ventral attachments. The ribs intervening between the sternal and floating ribs are attached by their costal cartilages to the costal cartilages of the sternal ribs.

The typical rib has a head attached to the centra of two adjoining vertebræ, a well-marked tubercle a portion of which articulates with the transverse process of the more anterior vertebra and another portion of which projects superiorly, forming a spine. The most posterior ribs lack the tubercle. The first rib has the articular portion of the tubercle well developed but the spine-like part is lacking. Its place, however, is taken by a dorsally projecting spine from the transverse process of the first thoracic vertebra. The rest of the rib is made up of a long, thin, flattened shaft.

In the genus *Lepus* the non-articular portion of the tubercles are very well developed, the eighth pair of ribs is the last pair bearing them. The second, third, fourth, fifth, and sixth ribs are very flat and broad in the ventral half of the shaft; the greatest width of the rib just behind the tubercle is very much less than the width of the shaft in the lower portion. The sternal costal cartilages in *Lepus* are very short and wide, as compared with the sternal costal cartilages of the other genera.

In *Oryctolagus* conditions similar to those found in *Lepus* exist regarding the ribs, but the shafts of the anterior ribs are relatively less widened.

The genus *Sylvilagus* closely resembles *Lepus* with respect to the form of the ribs, but like *Oryctolagus* the shafts of the ribs are less expanded and in some of the species, notably *S. minensis,* the non-articular portions of the tubercles are not so well developed and are last seen on the seventh pair of ribs.

Brachylagus closely resembles *Sylvilagus,* especially *S. minensis;* the non-articular portions of the tubercles are not very well developed and are last seen on the eighth pair of ribs.

In *Limnolagus* the tubercles are well developed but are not conspicuous, owing to the fact that the angle between the tubercle and the posterior edge of the rib is filled up with bone, making that part distinctly the widest portion. In the single skeleton at hand

the last rib to bear a spine-like tubercle on the right side is the seventh, while on the left side it is the sixth. The shafts of the anterior ribs are not widened ventrally.

The spines of the tubercles are very small in *Pronolagus,* and are last found in the seventh pair of ribs. The shafts of the ribs are relatively narrow and there is no indication of the wide expansion found in *Lepus.* Decidedly the widest part of the rib is just behind the spine.

Romerolagus very closely resembles *Pronolagus* in regard to the ribs, but the spines of the tubercles are last found on the sixth pair.

Ochotonidæ

(Plate XCIV, 9)

In the Ochotonidæ there are seventeen pairs of ribs of which the first seven are attached to the sternum by means of costal cartilages, the last seven pairs or about that number have no ventral attachments, while the three intermediate pairs are attached to the costal cartilages of the ribs in front. The ribs are all slender and weak compared with the ribs of the Leporidæ and none of them possesses spine-like, non-articular portions of tubercles, but just behind the tubercles the more anterior ribs are quite broad and heavy.

CLAVICLE

Leporidæ

(Plates XCV, 2, 5; XCVI, 1)

In the Leporidæ the clavicle is probably always present as a small curved, slender bone, about fifteen millimeters long. In most of the skeletons, however, the clavicles are wanting, undoubtedly the result of faulty preparation. In only four of the skeletons at hand have these bones been found. The uncleaned skeletons show that the clavicle does not articulate with either the sternum or the scapula as it does in those animals where it is well developed. Ligamentary tissue extends from its inner end to the presternum, while the outer end is attached to a piece of cartilage placed on the summit of the greater tuberosity of the humerus. In his account of the genus *Romerolagus* (Proc. Biol. Soc. Washington, x, 1896, December 29, p. 171) Dr. Merriam says: "The clavicle is complete and articulates directly with the sternum (fig. 33)—a thing that never happens in the genus *Lepus.*" Whether that is the case with any of the other genera of the Leporidæ can not be told, owing to the faulty methods of cleaning the skeletons. It might be thought

that *Romerolagus* with the enlarged presternum would have clavicles much larger than those in the other genera of the Leporidæ, but measurements show that the ratios of length of humerus to length of clavicle in *Romerolagus* is 3.20, in *Oryctolagus* 3.16, in *Sylvilagus* 4.00.

Ochotonidæ

(Plate XCVI, 2)

In the Ochotonidæ the clavicle is very well developed, the ratio of its length to that of the humerus is $\frac{1}{2}$. The outer end, enlarged and flattened, is connected by a ligament to the greater tuberosity of the humerus. The inner end articulates directly with the extreme anterior portion of the presternum.

SCAPULA

Leporidæ

(Plate XCVII, 1–4, 6–9)

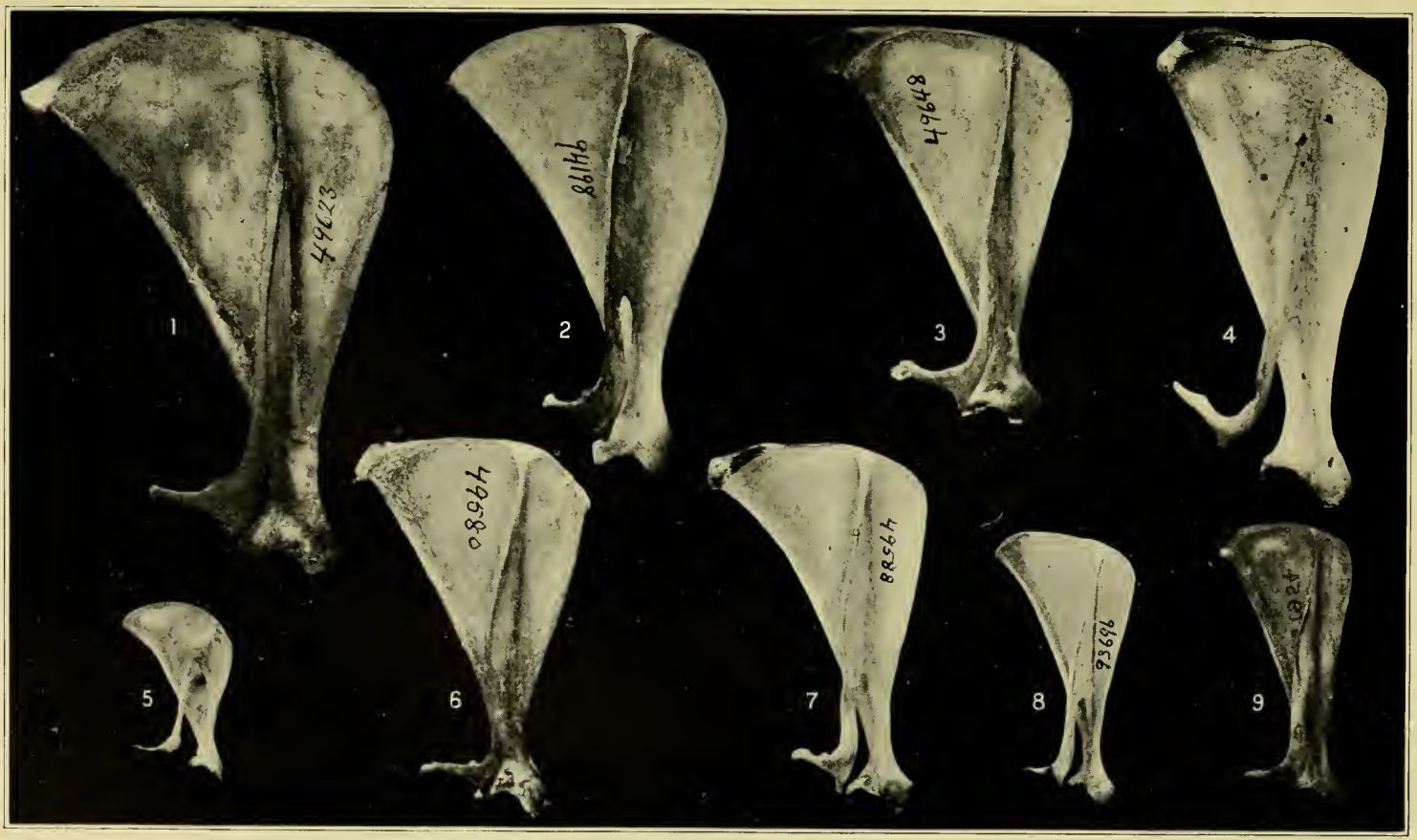
The general shape of the scapula of the Leporidæ is roughly that of a right triangle, with the right angle rounded off, and directed upward and forward. The acromion process is long and slender and about half the length of the actual scapular spine. Coming off at right angles to the acromion process and directed caudad is a well developed pointed metacromion.

The scapulæ of the Leporidæ fall into three not very strongly marked groups:

1. Large rabbits, members of the genus *Lepus* in which the scapula is relatively broad, the superior border rather more convex, the antero-superior angle more rounded, and the supraspinous fossa relatively wider.

2. Rabbits averaging smaller in size, members of the genera *Sylvilagus, Oryctolagus, Brachylagus,* and *Limnolagus,* in which the scapula is relatively narrower, the superior border straighter and less convex, the antero-superior angle more pronounced and not so gradually rounded off as in the genus *Lepus*. The supraspinous fossa is relatively narrower.

3. *Romerolagus* and *Pronolagus* have scapulæ much alike and differing from the scapulæ of the other genera in being longer and narrower. The posterior border is more nearly straight instead of being concave as in the other two groups. The superior border is straighter. The distance between the antero-superior and the postero-superior angles is contained twice in the length of the scapula measured along the inner surface at the attachment of the



SCAPULÆ OF HARES, RABBITS, AND PIKAS (natural size). For explanation see pages 446, 447.

spine, from the superior border to the edge of the glenoid cavity. In the other rabbits the distance between the two superior angles is contained but one and one-half times in the scapular length.

Ochotonidæ

(Plate XCVII, 5)

The scapula of the Ochotonidæ is of a quite different type from that of the Leporidæ. The general outline of the bone is also that of a right triangle, but the right angle is very much rounded off and the general appearance of the scapula is more oblique. The acromion process is very long and slender, about twice the length of the actual scapular spine. The metacromion is well developed, and has about the same general proportion that it has in the Leporidæ. The posterior border of the scapula is long and more concave than in the Leporidæ; the superior border is relatively longer and very much rounded off, so that it gradually merges into the anterior border. The distance between the antero-superior and the postero-superior angles is relatively greater in the pikas than it is in the hares and rabbits, being contained but little more than once in the length of the scapula taken along the attachment of the spine. The supraspinous fossa in the Ochotonidæ is relatively much narrower, when compared with the infraspinous fossa, than it is in the Leporidæ.

The scapula of *Ochotona ladacensis* differs somewhat from that of the American species. The superior border is shorter and does not merge so gradually into the anterior border, so that the antero-superior angle is more pronounced.

HUMERUS

Leporidæ

The humeri of the Leporidæ are all much alike in form and proportions, and the humeri of the Ochotonidæ differ but slightly from them in these respects. The variations in this bone in the different genera are few, hard to define, and apparently of little significance. They are as follows:

The groove that subtends the internal condyle is best marked in members of the genus *Lepus*. It is well marked also in *Sylvilagus*, *Oryctolagus*, and *Pronolagus*, but in *Limnolagus* and *Romerolagus* is much less developed and in *Pentalagus* it is very slight. *Brachylagus* occupies an intermediate position between these last two degrees of development. In *Pentalagus* the double trochlear surface at the distal extremity of the humerus differs from the same structure

in the other genera in having its two portions very unequally developed, the main one being very broad and shallow, and the external portion much reduced.

Brachylagus and *Romerolagus* have the slenderest humeri; *Oryctolagus* and especially *Pentalagus* have rather thick, heavy ones. All the other groups may be said to have moderately developed humeri.

The external condyloid ridge is very short and poorly developed in all the hares. *Romerolagus* has the most prominent external condyloid ridge; *Brachylagus* has a ridge as wide but not so long; *Limnolagus* has a short and comparatively wide ridge, but only a trifle more conspicuous than the ridge in *Sylvilagus* or in the other genera.

Ochotonidæ

The humeri of the Ochotonidæ have a strong resemblance to those of the Leporidæ. The head of the bone is more globular in the former, the bicipital groove does not encroach on its anterior surface.

The tuberosities of the humeri of *Ochotona* bear about the same general proportions to one another that they do in the hares and rabbits. The greater tuberosity does not project so far upward in *Ochotona* as it does in the *Leporidæ,* so that the head of the humerus is the highest point of the bone, while in the hares and rabbits the greater tuberosity is the highest point.

When viewed from the side, the head of the humerus in the pikas is seen to project farther backward than in the hares, and to form a sort of hook with the shaft of the bone.

The double trachlear surface at the distal end of the humerus is shallow and wider in *Ochotona* than in any of the Leporidæ.

The groove subtending the internal condyle is rather shallow and inconspicuous in *Ochotona;* it is developed to about the same degree that it is in *Romerolagus.*

RADIUS AND ULNA

Leporidæ

(Plate XCVIII, 1–10)

The bones of the forearm of the Leporidæ show some interesting differences among the various genera, in regard to their relative development and the length of the radius compared with the length of the humerus.

The radius and ulna are always perfectly distinct, but they are in contact with one another throughout the greater part of their extent. At the point of contact there is a certain amount of fusion, but at the same time each bone maintains its individual distinctness.

BONES OF THE FOREARM OF HARES, RABBITS, AND PIKAS (natural size)

For explanation see page 447.

In the upper part of the forearm, the radius lies in front of the ulna, while at the distal extremity the radius is found toward the inner side.

The radius in general is flattened antero-posteriorly, presenting a rather flattened posterior surface and a convex anterior one. The upper extremity of the radius forms the inferior portion of the sigmoid notch for articulating with the double trachlear surface of the lower end of the humerus. The lower extremity of the radius is rather enlarged and its distal surface is concave, the concavity inclining to be double for articulating with the scaphoid and semilunar bones of the wrist.

The ulna in general lies behind the radius and toward the outer side. In some cases the shaft of the ulna is more heavily built than the shaft of the radius, while in other cases it is very much reduced. The outer part of the lower end of the ulna is prolonged downward into a convex articular surface which fits into a corresponding concavity formed jointly by the cuneiform and pisiform bones. This projecting part of the ulna is the only part of that bone which articulates with the carpus in the case of the Leporidæ. In the case of the Ochotonidæ, however, there is a concave facet internal to this projection which articulates with a corresponding convexity on the cuneiform. A condition approaching this is found in *Pentalagus, Romerolagus, Brachylagus,* and in some skeletons of *Sylvilagus* and *Lepus.*

In the genus *Lepus* the ulna is much reduced in size along the middle of the shaft, and except at the lower extremity it is placed almost entirely behind the radius. The radius itself is rather long and slender. The humerus and radius are usually subequal in length. In the subgenus *Macrotolagus,* at least so far as the limited material shows, the radius is slenderer than it is in the two other subgenera, *Lepus* and *Pœcilolagus,* and it is decidedly longer than the humerus.

In the genera *Sylvilagus, Pronolagus,* and *Limnolagus* the radius and ulna are subequal in size, the ulna not being reduced in the middle part of the shaft. The ulna is situated external to the radius rather than behind it as in *Lepus.* Both radius and ulna as a rule are moderately slender. The radius equals the humerus in length.

The condition of the bones of the forearm in *Brachylagus* is very similar to that just described, but the humerus is distinctly longer than the radius.

In *Pentalagus,* in *Romerolagus,* and to a less extent in *Oryctolagus* the radius is slenderer than the ulna, except at the articular ends of the radius, where normal conditions exist. The humerus is distinctly longer than the radius, except in *Oryctolagus* where their lengths are subequal.

Ochotonidæ

(Plate XCVIII, 11)

In the Ochotonidæ the bones of the forearm resemble the ulna and radius of the Leporidæ in general form and position. The ulna is distinctly the larger of the two bones of the forearm throughout its whole extent. As noted in the description of that bone under the Leporidæ, the ulna has an extra facet at its distal surface for articulating with the carpus. The proximal articulating extremity of the radius maintains about the same relative size that it does in the Leporidæ, but the distal end is conspicuously reduced and the lower end of the ulna is correspondingly increased. The radius is distinctively shorter than the humerus.

CARPUS

Leporidæ

(Figure 45, 1–3)

The full number of carpal bones (nine) is found in the Leporidæ. An understanding of their form and position is best obtained from consulting the figures. In all the skeletons the bones have the same relative shapes, sizes, and positions.

The pisiform is one of the largest carpal bones and has considerable dorso-palmar depth, except in *Pentalagus* where this depth is less and has about the same relative proportions that it has in *Ochotona.*

In the cuneiform, together with a small portion of the pisiform, is a cup-shaped depression into which fits the small rounded projecting head of the ulna. The internal and median portion of the proximal aspect of the cuneiform in most hares is scarcely at all developed, but in some of the skeletons (*Pentalagus, Romerolagus, Pronolagus, Brachylagus,* and rarely in *Sylvilagus* and *Lepus*) there is found internal to the cup-shaped cavity for the ulna, a small convex surface which articulates with the ulna internal to the projecting convexity.

The os centrale is a flask-shaped bone, only the neck of which appears in an undissected carpus. The distal aspect of the neck-like process articulates with the outer portion of the proximal end of the second metacarpal.

In some of the skeletons (and probably in all had they been carefully cleaned), in the angle between the unciform and the fifth meta-

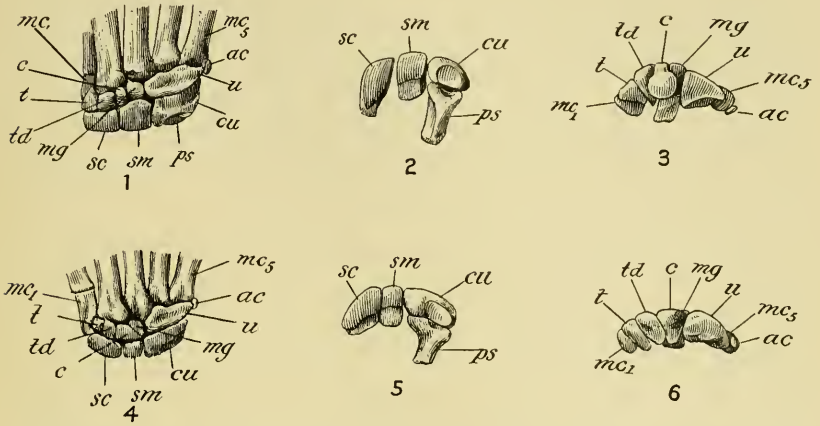


FIG. 45.—Carpus of the *Leporidæ* and *Ochotonidæ*. 1. Dorsal view of right carpus of *Sylvilagus floridanus mallurus*, No. 16,248, Carlisle, Pennsylvania, enlarged nearly twice. 2. Proximal view of proximal row of carpal bones of same. 3. Proximal view of distal row of carpal bones of same. 4. Dorsal view of right carpus of *Ochotona saxatilis*, No. 49,620, Oregon, enlarged nearly four times. 5. Proximal view of proximal row of carpal bones of same. 6. Proximal view of distal row of carpal bones of same. *ac*, accessory ossicle; *c*, os centrale; *cu*, cuneiform; mc_1, first metacarpal; mc_5, fifth metacarpal; *mg*, os magnum; *ps*, pisiform; *sc*, scaphoid; *sm*, semilunar; *t*, trapezium; *td*, trapezoid; *u*, unciform.

carpal, is a small bone which Forsyth Major calls the carpale 5. He regards the unciform as carpale 4 only, instead of the fused carpalia 4 and 5. This small bone is otherwise known as the os vesalianum.

OCHOTONIDÆ

(FIGURE 45, 4–6)

The carpus of the Ochotonidæ differs in several respects from the carpus of the Leporidæ. The pisiform has less dorso-palmar depth; the lunare is narrower; the internal half of the cuneiform is more largely developed, making up for the narrower lunare, and presents a well-developed convex facet for articulating with the ulna, in addition to the cup-shaped cavity formed by the cuneiform and pisiform jointly. The centrale is much larger than it is in the Leporidæ, and is not flask-shaped. The os magnum is reduced in size. A small os vesalianum is present.

METACARPUS

There are few points of interest about the metacarpus of either the Leporidæ or the Ochotonidæ; both have metacarpi of a generalized mammalian type. The first metacarpal is very short in both families. The fifth metacarpal is about twice or about two and a half times the length of the first. The middle metacarpal is the longest, but not much longer than the two subequal adjacent ones. The middle metacarpal is relatively longer in the Leporidæ than in the Ochotonidæ, with respect to the two metacarpals on either side of it.

The metacarpus, as a whole, is longer in the Leporidæ than it is in the Ochotonidæ. The width of the three middle metacarpals at their bases is contained about two and one-half times the length of the middle metacarpal in all the genera except *Pentalagus*. In the Ochotonidæ, however, and in *Pentalagus* of the Leporidæ the basal width of the three middle metacarpals taken together is contained only about one and one-half times in the length of the middle metacarpal.

PHALANGES

The phalanges are relatively longer in the Leporidæ than in the Ochotonidæ. In both families the length of the three phalanges of the middle digit about equals the length of the middle metacarpal, which bone, as noted above, is relatively longer in the hares and rabbits than in the pikas.

OS INNOMINATUM

Leporidæ

The os innominatum in all the genera of the Leporidæ is generally uniform in shape, differences being slight and apparently of not much importance, yet they are fairly constant for some genera or groups of genera.

In the genus *Lepus*, the ilium is broad and shovel-like; the anterosuperior angle of the crest is rounded off, but not obliquely so as in the case of the other genera. The distance from the anterior edge of the acetabulum to the most anterior point of the ilium, is less than the distance from the same point to the most distant part of the ischium, while in all the other genera the distance from the anterior edge of the acetabulum to the most distant point of the ilium is equal to or a little greater than the distance measured from the same point to the most distant part of the ischium.

The obturator foramen is more rotund in *Lepus* than in most other genera.

In *Oryctolagus, Sylvilagus,* and *Brachylagus* the ossa innominata have about the same general form. There is nothing to distinguish these bones in the first two genera, but the innominate bone of *Brachylagus* can be distinguished by its smaller size and the greater prominence of the tubercle in front of the acetabulum and by a slenderer descending ramus of the pubis and shorter distance from the tuberosity of the ischium to nearest point of the obturator foramen. In the above three genera the ilium is not so wide and shovel-like as it is in *Lepus*. The anterior edge of the acetabulum is about equidistant between the extreme anterior and posterior points of the os innominatum, or just a little posterior to the equidistant point. The antero-superior angle of the ilium is obliquely rounded off. The thyroid foramen is usually less rotund than it is in *Lepus*.

The genus *Limnolagus* has wide ilia, much like those of *Lepus,* but the antero-superior angle is not obliquely rounded off. The antero-ventral angle is produced into a blunt, very short spine. The horizontal rami of the pubic bones slope backward more than they do in the other genera except *Romerolagus*.

The os innominatum of *Romerolagus* closely resembles that of *Limnolagus*. The only marked differences, aside from its slender formation, is the more pronounced development of the short, blunt spine at the antero-ventral angle, and the straightness of the ventral edge of the ilium. In all the other groups except the genus *Pronolagus* the ventral edge of the ilium has a more or less pronounced concavity on its posterior half.

The genus *Pronolagus* has an os innominatum resembling in most respects that of *Sylvilagus* and *Oryctolagus,* but the ilium is even narrower than it is in them. Its ventral edge is straight, in this respect being like the ventral edge of the ilium of *Romerolagus*.

Ochotonidæ

The pelvis of the Ochotonidæ is very different from the pelvis of the Leporidæ. The most notable difference is the absence of the symphysis pubis. As none of the few available skeletons is sexed, it is impossible to say whether the difference is sexual or not. The pubic bones are widely separated from one another, but are connected by a ligament.

The os innominatum of the Ochotonidæ as a whole is longer and more slender than that bone in the Leporidæ. The ilium is less ex-

panded, thicker, its ventral third separated from the dorsal two-thirds by a well-marked ridge, which terminates anteriorly and ventrally in a well-marked, recurved, pointed spine. The tuberosity of the ischium is not so heavy and it lacks the processes seen in the Leporidæ. The thyroid foramen is egg-shaped, the small end of the egg being directed forward toward the acetabulum.

The horizontal ramus of the pubis is very short, the descending ramus long, directed obliquely backward and downward.

FEMUR

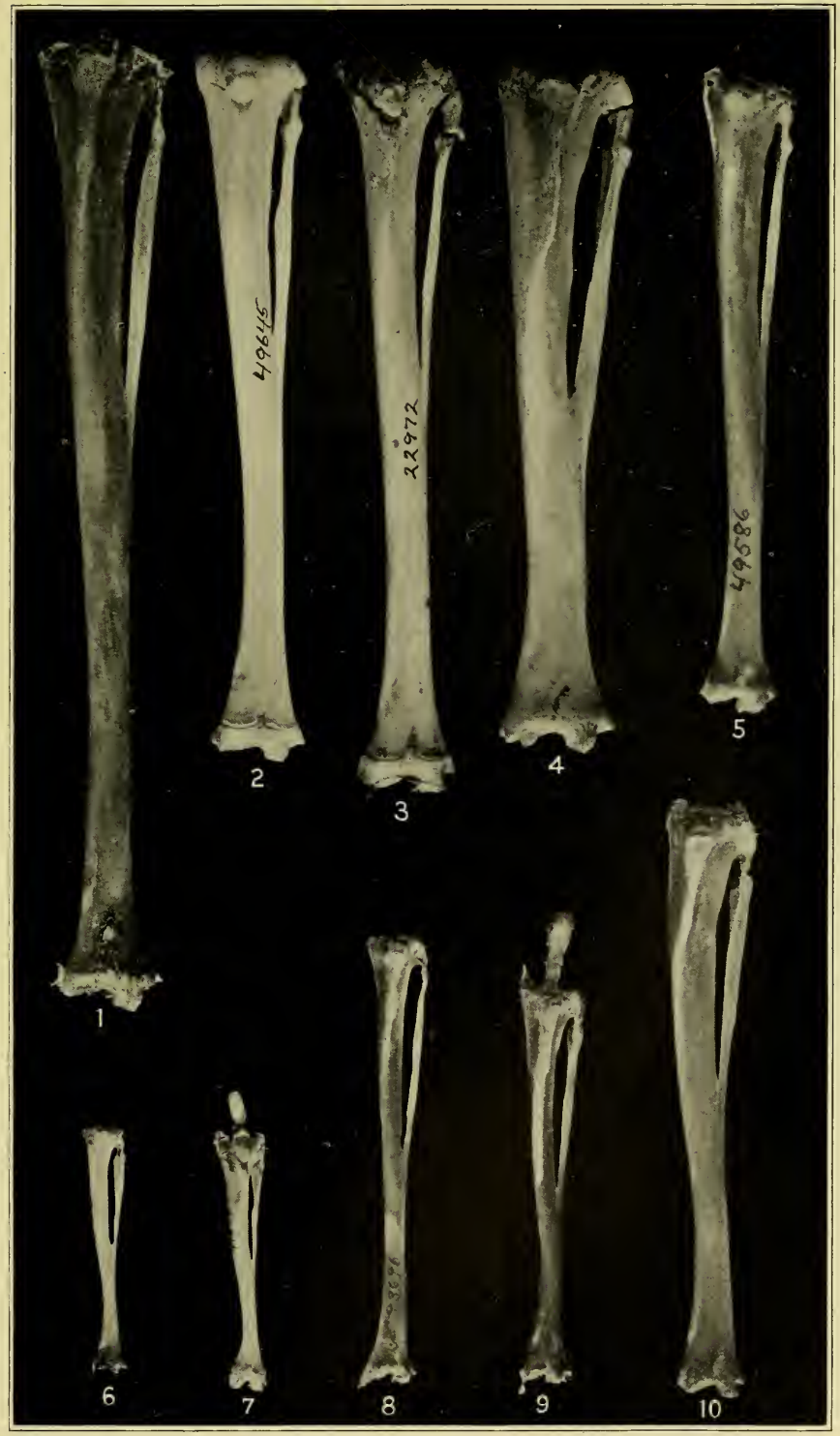
The femora in all the Leporidæ resemble one another very closely. The bone is stout and heavy in *Pentalagus,* it is relatively thicker in *Oryctolagus* than in the remaining genera, and it is slenderest in *Brachylagus,* but individuals vary much in this respect. Of two *Lepus campestris,* one from Nebraska and the other from Kansas, one is relatively thicker than the other. The same individual variation is found in the series of skeletons of *Sylvilagus floridanus.* In most of the skeletons the femur is a little shorter than the tibia. In *Lepus (Macrotolagus) texianus,* however, it is decidedly shorter, in *Pentalagus* the two bones are subequal in length.

The femur in the Ochotonidæ has the same general characteristics that it has in Leporidæ, but it is a relatively thicker and heavier bone; the third trochanter is much reduced in size, the lesser trochanter is relatively larger, and the fossa behind the great trochanter is not so deep. Its length is a trifle less than that of the tibia.

TIBIA AND FIBULA

(Plate XCIX)

The tibia and fibula show about as few variations in the different groups of the Leporidæ as do the femora. The fibula is a free, distinct bone above, but at a point somewhat above the middle of the tibia it becomes intimately fused with the bone and its identity is lost sight of from there on, in all the genera except *Romerolagus* and *Pentalagus,* in which genera the fusion of fibula and tibia occurs at the middle of the latter bone. The point of fusion is highest in *Lepus,* next highest in *Sylvilagus, Oryctolagus, Pronolagus,* and *Limnolagus,* and in *Brachylagus* it is just above the middle point of the tibia. In *Pentalagus* the tibia and fibula are relatively much heavier than they are in the other genera. In *Romerolagus* and *Limnolagus* also the tibia is relatively heavier than in the remaining



LEG BONES OF HARES, RABBITS, AND PIKAS (natural size). For explanation see page 447.

genera. In both *Romerolagus* and *Limnolagus,* especially the former, the tibia is more curved than it is in the other rabbits, the inner surface of the lower part of the shaft of the tibia being concave, as it is in *Ochotona.*

In most of the skeletons the greatest length of the foot is about equal to the length of the tibia. In *Brachylagus* and *Sylvilagus floridanus subsp.* No. 94,197, from Nevada, the foot is longer than the tibia. In the subgenus *Macrotolagus* and in the genus *Romerolagus* the foot is shorter than the tibia.

The tibia and fibula in the Ochotonidæ are similar in form to the same bones in *Romerolagus.*

TARSUS

(Plate C)

The tarsal bones in all the skeletons show few differences among the Leporidæ, except as to size. The middle cuneiform is not fused to the base of the second metatarsal.

The tarsus of the Ochotonidæ is in general like that of the Leporidæ. The middle cuneiform, however, is entirely fused with the base of the second metatarsal. The foot, as a whole, is relatively shorter than it is in the Leporidæ.

In the Ochotonidæ there are some small sesamoid bones, on the plantar surface of the tarsus, which are apparently lacking in the feet of the Leporidæ. These bones are discussed by Major at considerable length. Their true significance and functions cannot be well determined without the dissection of fresh material. The largest of these sesamoid bones is situated on the plantar surface of the base of the fifth metatarsal. In the Leporidæ this bone seems to have become fused with the base of the fifth metatarsal, where it forms a prominent tubercle.

METATARSUS

The metatarsals in both the Leporidæ and the Ochotonidæ are four in number, the first being suppressed. According to their relative lengths the metatarsi in the two families fall into four groups, as follows: The basal width of the metatarsus, measured from the tuberosity of the fifth to an opposite point on the second is contained about three times in the length of the third metatarsal in *Lepus.* It is contained about two and a half times in *Sylvilagus, Oryctolagus, Limnolagus, Brachylagus,* and *Pronolagus.* It is contained two times in *Romerolagus.* In *Pentalagus* and *Ochotona* it is contained one and a half times.

PHALANGES

Little can be said regarding the toes. The two lateral digits are relatively longer in the Ochotonidæ than they are in Leporidæ. In *Ochotona, Romerolagus, Pronolagus, Limnolagus, Oryctolagus,* and *Brachylagus* the combined lengths of the three phalanges approximately equals the length of the metatarsal to which they belong. In the other genera, *Lepus* and *Sylvilagus,* this is true of the middle digits only; in the case of the lateral digits the metatarsals are decidedly longer than the combined length of the corresponding phalanges.

V. OSTEOLOGICAL DIFFERENCES BETWEEN OCHOTONIDÆ AND LEPORIDÆ

The principal osteological differences between the two families Ochotonidæ and Leporidæ, discussed in the foregoing pages, are briefly set forth in the following table:

OCHOTONIDÆ	LEPORIDÆ
Skull	
Not arched, flat, much constricted between the orbits.	More or less arched, not flat, only moderately constricted between the orbits.
Rostrum short and slender.	Rostrum long and stout.
Nasals widest in front.	Nasals not wider in front than behind.
Palate very short.	Palate moderately short.
Postorbital processes lacking.	Postorbital processes well developed.
Posterior free edge of malar very long.	Posterior free edge of malar only moderately long.
Maxilla not conspicuously fenestrated.	Maxilla more or less conspicuously fenestrated.
Mental foramen of mandible far posterior to its usual position.	Mental foramen of mandible anterior, in its usual position.
Teeth	
Dental formula $I\ \frac{2}{1}\ C\ \frac{0}{0}\ Pm\ \frac{3}{2}\ M\ \frac{2}{3}$	Dental formula $I\ \frac{2}{1}\ C\ \frac{0}{0}\ Pm\ \frac{3}{2}\ M\ \frac{3}{3}$ (In one genus, *Pentalagus,* $M\ \frac{2}{3}$).
Enamel not crenated in reentrant angles of upper cheek teeth.	Enamel usually crenated in reentrant angles of upper cheek teeth.
Cutting edge of first upper incisor V-shaped.	Cutting edge of first upper incisor straight.
Third upper molar entirely wanting.	Third upper molar small but usually present (absent in *Pentalagus* only).
Second and fifth upper cheek teeth unlike third.	Second and fifth upper cheek teeth entirely similar to third.
Last lower molar simple.	Last lower molar double.

HIND FEET OF HARES, RABBITS, AND PIKAS (natural size). For explanation see page 447.

Vertebral Column

Transverse process of the seventh cervical not pierced by a vertebral foramen.

Thoracic vertebræ seventeen in number.

Thoraco-lumbar vertebræ twenty-two in number.

Spinous processes of thoracic vertebræ relatively short.

Spinous processes of lumbar vertebræ relatively low.

Transverse processes of lumbar vertebræ very short and wide.

No hypophyses on any of the lumbar vertebræ.

Sacrum long and narrow, twice as long as wide.

Transverse process of the seventh cervical pierced by a vertebral foramen.

Thoracic vertebræ twelve in number.

Thoraco-lumbar vertebræ nineteen in number.

Spinous processes of thoracic vertebræ relatively long.

Spinous processes of lumbar vertebræ relatively high.

Transverse processes of lumbar vertebræ long and slender.

Hypophyses found on the anterior three lumbar vertebræ.

Sacrum wide and triangular about as wide as long.

Shoulder Girdle and Upper Extremity

Clavicle well developed.

Scapula with antero-superior angle much rounded off.

Acromion very long, three times the length of actual scapular spine.

Supraspinous fossa of scapula narrow.

Dorso-palmar depth of pisiform not pronounced.

Internal half of cuneiform more largely developed, presenting a well developed convex facet for articulation with the ulna, in addition to the cup-shaped cavity formed by the cuneiform and pisiform together.

Centrale larger, not flask-shaped.

Os magnum smaller.

Width of three middle metacarpals at base contained about one and a half times into length of the middle metacarpal.

Clavicle small and rudimentary.

Scapula with antero-superior angle not much rounded off.

Acromion long, about half the length of the actual scapular spine.

Supraspinous fossa of scapula much wider.

Dorso-palmar depth of pisiform very great, except in *Pentalagus*.

Internal half of cuneiform not largely developed nor presenting a well developed convex facet for articulation with the ulna, though sometimes such a condition is indicated.

Centrale smaller, flask-shaped.

Os magnum larger.

Width of three middle metacarpals at base contained about two and a half times into length of the middle metacarpal, except in *Pentalagus*.

Pelvis and Lower Extremity

Pubic symphysis absent.

Antero-ventral angle of ilium with a well-marked recurved spine.

Middle cuneiform bone of the foot intimately fused with the base of the second metatarsal.

Basal width of the metatarsals taken together contained less than twice into the length of the metatarsals.

A large sesamoid bone on the plantar surface of the fifth metatarsal.

Pubic symphysis well marked.

Antero-ventral angle of ilium without a well-marked recurved spine.

Middle cuneiform of foot not fused with the base of the second metatarsal.

Basal width of the metatarsals contained two or more times into the length of the metatarsals, except in *Pentalagus* one and a half times.

A prominent tubercle on the base of the plantar surface of the fifth metatarsal.

VI. KEYS TO FAMILIES, GENERA, AND SUBGENERA OF THE DUPLICIDENTATA, BASED ON DENTAL, CRANIAL, AND OTHER SKELETAL CHARACTERS

A. Key to the Families and Genera of Existing Hares, Rabbits, and Pikas, Based Mainly on Dental Characters

a) Dental formula: I $\frac{2}{1}$, C $\frac{0}{0}$, Pm $\frac{3}{2}$, M $\frac{2}{3}$, second upper molariform tooth unlike third in form. Family Ochotonidæ, genus *Ochotona*, p. 431.

a') Dental formula usually I $\frac{2}{1}$, C $\frac{0}{0}$, Pm $\frac{3}{2}$, M $\frac{3}{3}$ (in *Pentalagus* the molars are $\frac{2}{3}$), second upper maxillary tooth like third in form. Family, Leporidæ, p. 389.

b) Reentrant angle of second upper maxillary tooth short and not crenated.

c) Reentrant angle extends one-third way across the tooth, genus *Nesolagus*, p. 425.

c') Reentrant angle extends half way across the maxillary teeth, genus *Brachylagus*, p. 411.

b') Reentrant angles of second, third, fourth, and fifth maxillary teeth with sides crenated.

d) First lower premolar divided into an anterior and a posterior portion by two reentrant angles, one extending from the external, the other from the internal face to the center of the tooth.

e) Anterior face of first lower premolar without reentrant angles. Genus *Romerolagus*, p. 420.

e') Anterior face of first lower premolar with two reentrant angles.

f) Posterior limb of reentrant angles of second, third, and fourth mandibular cheek teeth with antero-posterior convolutions nearly as long as the antero-posterior diameter of the posterior portions of the teeth. Genus *Pentalagus*, p. 428.

f') Posterior limb of reentrant angles of second, third, and fourth mandibular cheek teeth with normal convolutions, not nearly so long as the antero-posterior diameter of the posterior portions of the teeth. Genus *Pronolagus*, p. 416.

d') First lower premolar divided into an anterior and posterior portion by a single deep reentrant angle extending entirely across the tooth from its external surface.

g) First lower premolar with but one reentrant angle on its anterior face. (Some Mexican *Sylvilagus* have two.)

h) Sutures of the interparietal obliterated in the adult, genus *Lepus*, p. 389.

i) Groove on incisors not filled with cement. Subgenus *Pœcilolagus*, p. 395. Also some *Lepus* and *Macrotolagus*.

i') Groove on incisors filled with cement.

j) Groove deep and simple. Mostly subgenus *Lepus*, p. 394.

j') Groove deep and bi- or tri-furcated. Mostly subgenus *Macrotolagus*, p. 395.

h') Sutures of the interparietal distinct throughout life.

k) Choanæ narrow. Genus *Oryctolagus,* p. 402.

k') Choanæ not narrowed. Genus *Sylvilagus,* p. 396.

g') First lower premolar with two crenated reentrant angles on its anterior face.

l) Internal face of anterior portion of first lower premolar without reentrant angle. Genus *Limnolagus,* p. 406.

l') Internal face of anterior portion of first lower premolar with reentrant angle. Genus *Caprolagus,* p. 426.

B. Key to the Families, Genera, and Subgenera of Existing Hares, Rabbits, and Pikas, Based on Cranial Characters

a) Postorbital process absent, skull flat, much constricted between orbits, rostrum short and slender, nasals widest in front, bony palate very short, posterior free edge of malar very long, maxilla not conspicuously fenestrated, mental foramen of mandible situated under last lower molar. Family Ochotonidæ, genus *Ochotona,* p. 431.

b) Interorbital region very narrow and pinched up and strongly arched from before backward. Subgenus *Ochotona,* p. 438.

b') Interorbital region moderately broad, not compressed laterally nor arched from before backward.

c) Brain case and whole skull very flat, rostrum slender, its origin abrupt, no foramen in the anterior part of the frontal bone. Opening in maxilla single, roundly triangular. Incisive foramina constricted into two unequal portions. Subgenus *Pika,* p. 438.

c') Brain case rather rounded, whole skull moderately arched from before backward, rostrum relatively long and heavy, its origin not abrupt, a small oval foramen in frontal bone. Opening in maxilla elongated triangular with a small amount of fenestration just beneath it. Incisive foramina triangular in outline, not constricted into two unequal portions. Subgenus *Conothoa,* p. 438.

a') Postorbital process well developed, skull arched from before backward, moderately constricted between the orbits, bony palate only moderately short, rostrum long and stout, nasals widest behind, posterior free edge of malar only moderately long, sides of maxilla more or less conspicuously fenestrated, mental foramen of mandible situated under first lower cheek tooth. Family Leporidæ.

d) Postorbital process attached to the side of the skull for its whole length. Genus *Limnolagus,* p. 406.

d') Postorbital process not attached to the side of the skull for its whole length, bounding well marked foramina or notches.

e) Postorbital process small, without anterior limb, the single posterior limb pointed, directed outward and backward, bounding a distinct notch. Bony palate long.

f) Nasals relatively short, as broad in front as behind.

g) Incisive foramina elongated triangle in outline, postorbital process smaller and pointed. Genus *Caprolagus,* p. 426.

g') Incisive foramina, not triangular in outline, small, their sides approximately parallel, postorbital process larger and blunter. Genus *Pentalagus*, p. 428.

f') Nasals relatively larger, wider behind than in front.

h) Audital bulla much reduced in size, smaller than foramen magnum. Genus *Pronolagus*, p. 416.

h') Audital bulla normal, as large as the foramen magnum. Genus *Romerolagus*, p. 420.

e') Postorbital process large with distinct anterior and posterior limbs, bony palate relatively shorter, usually less than its posterior third formed by the horizontal plates of the palate bones.

i) Interparietal not present as a distinct bone in adult life. Genus *Lepus*, p. 389.

j) Skull shortened and arched, posterior limb of postorbital not touching the sides of the cranium.

k) Size large, postorbital process wide and heavy, nasals and rostrum wider and heavier. Spines of lumbar vertebræ well marked. Subgenus *Lepus*, p. 394.

k') Size medium, postorbital process rather slenderer, nasals and rostrum narrower. Spines of lumbar vertebræ low and triangular. Subgenus *Pœcilolagus*, p. 395.

j') Skull elongated, less arched, posterior limb of postorbital meeting side of cranium and enclosing a large foramen. Subgenus *Macrotolagus*, p. 395.

i') Interparietal present as a distinct bone in adult life.

l) Choanæ very narrow, pharyngeal vault high, distance bebetween vertical plates of palate bones less than least length of bony palate. Posterior limb of postorbital not meeting side of skull. Genus *Oryctolagus*, p. 402.

l') Choanæ not remarkably narrow, the distance between the vertical plate of palate bones equal to or greater than the least length of bony plate.

m) Skull and rostrum shortened, arched, audital bullæ very large. Postorbitals slender, neither its anterior nor its posterior limb touches the side of the skull. Genus *Brachylagus*, p. 411.

m') Skull and rostrum not relatively shortened, audital bullæ not greatly enlarged, posterior limb of postorbital usually in contact with side of the cranium, rostrum heavier. Genus *Sylvilagus*, p. 396.

n) Posterior limb of postorbital always meeting side of cranium, and inclosing a clavate slit narrower than the process itself. Subgenus *Sylvilagus*, p. 401.

n') Posterior limb of postorbital not meeting the side of the cranium, or if it does, enclosing a clavate slit as wide or wider than the process itself. Rostrum slenderer. Subgenus *Microlagus*, p. 402.

C. Key to the Families and Genera of Hares, Rabbits, and Pikas, Based on Skeletal Characters Other than Cranial

(Because of insufficient material, the genera *Caprolagus, Pentalagus,* and *Nesolagus* can not be incorporated in this key.)

a') Transverse process of 7th cervical vertebra, with no vertebral foramen, thoracic vertebræ 17, lumbar vertebræ 5, sacrum much longer than wide. Acromion about 3 times the length of actual scapular spine, foot short, basal width of metatarsals contained 1½ times into length of longest metatarsal. Family Ochotonidæ. Genus *Ochotona,* p. 431.

a) Transverse process of 7th cervical vertebra, with no vertebral foramen, thoracic vertebræ 12, lumbar 5, sacrum as wide as long. Acromion process about half the length of the actual scapular spine, foot long, basal width of metatarsals contained at least 2 times and usually 2½ times into the length of longest metatarsal. Family Leporidæ.

b) Cervical vetrebræ lengthened individually, ulna much reduced in size, smaller than radius and behind that bone, ventral half of anterior ribs much broadened. Genus *Lepus,* p. 394.

b') Cervical vertebræ individually shortened, ulna and radius subequal in size, the ulna toward the outer side of radius. Ventral half of anterior ribs not broadened.

c) Transverse processes of the lumbar vertebræ not conspicuously ridged, and the angle between the process and the side of the centrum not conspicuously filled in with thin bone.

d) Tubercles of anterior ribs not well marked. Genus *Pronolagus,* p. 416.

d') Tubercles of anterior ribs usually well marked.

e) Presternum with well marked keel, xiphisternum large and stout, equally enlarged at both ends, longer than presternum. Genus *Oryctolagus,* p. 402.

e') Presternum with keel not well marked, xiphisternum shorter than presternum. Genus *Sylvilagus,* p. 396.

c') Transverse processes of lumbar vertebræ conspicuously ridged or else angle between the process and the side of centrum conspicuously filled in with thin bone.

f') Anterior portion of presternum conspicuously enlarged, like presternum of *Ochotona.* Genus *Romerolagus,* p. 420.

f) Anterior portion of presternum not conspicuously enlarged.

g) Size small, each transverse process of the lumbar vertebræ with a well marked longitudinal ridge. Genus *Brachylagus,* p. 411.

g') Size larger, angle between transverse process and side of centrum of lumbar vertebræ filled in with thin bone. Genus *Limnolagus,* p. 406.

VII. DETAILED ACCOUNT OF THE GENERA AND SUBGENERA OF THE EXISTING HARES, RABBITS, AND PIKAS

Family LEPORIDÆ

Genus LEPUS Linnæus

1758. *Lepus* Linnæus, Syst. Nat., 10th ed., 1, p. 57.

1829. *Chionobates* Kaup, Entw. Gesch. und Natur. Syst. Europ. Thierwelt, 1, p. 170.

1867. *Lepus* GRAY, Ann. Mag. Nat. Hist., XX, 3d ser., p. 222.
1900. *Lepus* MAJOR, Trans. Linn. Soc. London, 3d ser., VIII, Zool., p. 514, November, 1899.

Type.—*Lepus timidus* Linnæus.

Geographical Distribution.—The genus *Lepus* is found throughout nearly every portion of the world except Australia, Madagascar, and South America.

Diagnosis.—Pelage soft, a patch on throat different in color and texture from surrounding fur, ears as long as or longer than head, tail short but plainly evident. Hind feet long, heavily clothed with hair, claws not conspicuous. Sutures of interparietal obliterated in the adult, postorbital processes large and triangular, with distinct anterior and posterior limbs. Palate short, its least length two and one-half or less times the length of M^1, choanæ wide, about four times length of M^1. Teeth normal as described on page 391.

Skull (pls. LXXIV, LXXV, LXXX–LXXXV).—The postorbital processes are large and spreading, usually distinctly triangular, standing out from the side of the head and considerably arched from before backward.

The sutures of the interparietal are obliterated at an early age, so that in adult life the interparietal is not distinguishable as a separate bone. Apparently the only other genera of the Leporidæ in which this condition occurs are *Pronolagus* and *Pentalagus*.

The bony palate is very short, but not relatively so short as it is in *Brachylagus*. The horizontal plates of the palate bones form between a fourth and a third of the bony palate. The posterior portion of the palate bone, bordering the edge of the maxilla, caudad of the posterior edge of the bony palate, is very slightly developed and scarcely enters into the formation of the roof of the mouth.

The posterior palatine foramina are of moderate size and located between the palatine plate of the maxilla and the horizontal plate of the palate bone, at the anterior outer angle of the horizontal plate.

As in *Brachylagus,* the choanæ are wide in the genus *Lepus*. The length of the bony palate, taken at a point midway between the median line and the dental alveoli, is decidedly less than the least distance between the vertical plates of the palate bones.

The incisive foramina are wide; their greatest width much exceeds the length of the bony palate, measured midway between the median line and the dental alveoli.

The zygoma is deep, but not thickened. The foot-like extremity of the zygomatic process of the squamosal is shorter in *Lepus* than

in most of the other genera. The external lateral length of the squamoso-malar suture is contained about twice in the superior border of the zygoma, measured from the anterior end of the squamoso-malar suture to the antero-inferior angle of the orbit. The antero-inferior angle of the zygoma is only slightly enlarged in *Lepus*. The posterior free projecting extremity of the malar is short.

The audital bullæ, the fenestration of the maxillæ, and the shape of the mandible throughout the genus show nothing distinctive and may be said to represent normal degrees of development.

Teeth (pl. XCI, 6).—The following are the dental characters of the genus *Lepus:* Front upper incisor with longitudinal groove in anterior face, more or less deep, simple or branched internally, filled or unfilled with cement. First upper maxillary tooth has typical folding of enamel on the anterior surface, a deep median reentrant angle, on either side of which is a smaller reentrant angle. The first lower molariform tooth, divided into two portions by a single reentrant angle from the external face, has a small reentrant angle on its anterior surface, and a shallow broader reentrant angle on the external surface of the anterior half of the tooth. The second, third, fourth, and fifth upper molariform teeth show each a deep reentrant angle extending from the internal face about three-quarters the distance across the tooth; the adjacent edges of this angle are almost in contact with one another throughout their whole extent. The enamel of the reentrant angles is beautifully crenated. The lateral diameter of the posterior half of each of the second, third, and fourth lower molariform teeth is about four-fifths the lateral diameter of the anterior half of the tooth. The last upper molar is a small elliptic cylinder; the last lower molar is a small double cylinder in form, the anterior half of which is larger and elliptical, the posterior half terete.

Vertebral Column.—The cervical vertebræ (pl. XCII, 7–9) of *Lepus* have a form characteristic for the genus and are uniformly lengthened as compared with the same series of vertebræ in the other genera. The costo-transverse process does not project laterally from the centrum to a marked extent, and the anterior and posterior spines of the same are more elongated.

The thoracic vertebræ show practically nothing characteristic of *Lepus*. The neural spines in the anterior part of the series equal about two and a half to three times the length of their centra. The anticlinal vertebra is usually the eleventh, but it may be the tenth. A well-developed metapophysis is found on the ninth thoracic.

The lumbar vertebræ (pl. XCIII, 1, 2) have transverse processes peculiar to this genus. They are wide and long with the free extremity considerably expanded. The length of the longest process equals the length of the centrum to which it is attached and half the length of the centrum in front. The attached portion of the transverse process arises abruptly from the anterior half of the side of the centrum. The anapophyses are indicated by a mere ridge or tubercle. Hypophyses are developed on the first three lumbars, the first being the shortest and the third the longest.

Except in absolute size the sacra in all the skeletons but one differ in no respect from the sacra of the other genera. The single exception is No. 49,621, from the Jumna river, India. The narrow posterior part of this sacrum is very narrow from side to side. The expanded wing-like portion to which the ilia are attached is very narrow. In general its shape, as seen from below, is like a T. The adjacent edges of the first and third, and of the third and fourth sacral neural processes are in contact.

The total number of caudal vertebræ varies from thirteen to fifteen; of these the first is long and with a complete neural arch, the next five or seven, usually seven, are of the form having more or less evident broad transverse processes, the remaining five to seven are small rudimentary centra, without processes.

Sternum and Ribs (pls. XCIV, 1, 2; XCV, 3, 4).—The sternum of the genus *Lepus* is not very characteristic. The presternum is long and narrow, compressed laterally into a keel, which is most prominent anteriorly. The first rib articulates with it at the junction of the first and second fourths, or first and second thirds. The mesosternum consists of four distinct segments, of which the first is narrow and compressed, the remaining three are not compressed, and are often flattened dorso-ventrally. All the mesosternal segments in general are subequal in length, and each successive one grows wider. The xiphisternum is about equal to the presternum in length; its anterior end is considerably enlarged where it articulates with the last segment of the mesosternum. Its posterior free extremity is rather pointed and only slightly larger than its narrowest portion.

The form of the ribs is quite characteristic for the genus *Lepus*. The spine-like portions of the tubercles of the ribs are well developed and prominent. The eighth pair of ribs is the last pair bearing these tubercles. The second, third, fourth, and fifth ribs are very flat and broad on the ventral half of their shafts. The greatest width of one of these ribs, just behind the spine and tubercles, is very much less than the width of the shaft in its lower portion. Seven pairs of ribs

articulate with the sternum. The sternal costal cartilages are very short and wide as compared with the same structures in the other genera.

Shoulder Girdle and Upper Extremity.—The scapula (pl. XCVII, 1, 2) in *Lepus,* especially in the larger members, has a tendency to be relatively broad, with the superior border rather more convex than it is in the other genera, with the antero-superior angle more rounded, and with the supra-spinous fossa relatively wide.

The radius and ulna (pl. XCVIII, 1–3) show characteristics peculiar to the genus. The ulna is much reduced in size along the middle of the shaft, and except at the lower extremity it is placed almost entirely behind the radius. The radius itself is rather long and slender. The humerus and radius are usually subequal in length.

The carpus, the metacarpus, and the phalanges of *Lepus* are entirely similar in form and position to these same bones in any of the Leporidæ as detailed in the general account of the wrist and the hand.

Pelvis and Lower Extremity.—The ilium is broad and shovel-like in the genus *Lepus;* its antero-superior angle is rounded off, but not obliquely so, as in the case of the other genera. The distance from the anterior edge of the acetabulum to the extreme anterior point of the ilium is less than the distance from the former point to the most distant point of the ischium. In all the other genera the former distance is usually equal to or a little greater than the latter. The obturator foramen is usually more rotund in *Lepus* than in the rest of the family.

The femur and the tibia and fibula (pl. XCIX, 1) of *Lepus* are typical for the family, as detailed in the general account and show nothing that is peculiar to the genus.

The basal width of the metatarsus is contained two and a half or more often three times into the length of the third metatarsal, as is commonly the case among the Leporidæ (pl. C, 6).

The combined length of the phalanges of the two lateral digits is less than the length of the metatarsal to which they belong. The combined length of the phalanges of the middle two digits approximately equals the lengths of the metatarsals to which they belong.

The genus *Lepus* possesses a number of skeletal characters quite peculiar to itself and serving to separate it at once from all the other genera of the Leporidæ. Among these are form of postorbital processes, shortness of palate, reduced size of ulna, shape of anterior ribs, shape of transverse processes of lumbar vertebræ, and the elongated form of the cervical vertebræ. Not one of these charac-

ters is found in any of the other genera. To these might also be added the obliteration of the sutures of the interparietal in the adult, which is nearly as characteristic.

Thus there is considerable foundation for Major's view that the existing hares and rabbits fall into two supergeneric groups, one containing *Lepus,* and one containing the other genera, which he designates as *Caprolagus.* It is the writer's opinion, however, that Major's group, *Caprolagus,* contains many genera as well defined as *Lepus.*

The genus *Lepus* has the most extensive geographic distribution and the greatest number of species of any of the Leporidæ. As would be expected, there are several groups of these species, constituting at least three well-marked subgenera for forms from North America and northern Eurasia described below. There are a number of skulls at hand, however, from central and eastern Asia and from Africa, which it is impossible to classify satisfactorily, owing to lack of material, and no provision is made for these in the present discussion. For a list of these specimens see page 335.

Subgenus LEPUS Linnæus

1758. *Lepus* Linnæus, Syst. Nat., 10th ed., I, p. 57.

1900. *Lepus* Major, Trans. Linn. Soc. London, 2d ser., VIII, Zool., p. 514, November, 1899.

Type.—*Lepus timidus* Linnæus.

Geographical Distribution.—Mainly the northern portions of the New and Old Worlds.

Diagnosis.—Size large, ears moderate, greatest length of skull nearly 100 mm.; skull broad, postorbital broader than notch it subtends, its posterior limb not touching side of cranium.

The skull is broad and strongly arched. The rostrum is shorter and broader and the brain case is broader and the nasals shorter and broader than they are in the other members of the genus *Lepus.* The postorbital processes are broad and triangular, neither the anterior nor the posterior limbs touch the sides of the cranium, but help to bound well-marked anterior and posterior notches.

Teeth (figure 44, 19–21).—The groove on the front of the incisors is fairly deep, is simple and usually filled with cement.

This subgenus apparently possesses no other skeletal character.

Species included in this subgenus, see p. 334.

Subgenus PŒCILOLAGUS, new

Type.—*Lepus americanus* ERXLEBEN.

Geographical Distribution.—The Canadian, Hudsonian, and Transition zones of North America.

Diagnosis.—External, cranial, and dental characters essentially as in subgenus *Lepus,* but size smaller, greatest length of skull about 75 mm., portorbital process slenderer than in *Lepus,* its posterior limb free behind, rostrum more pointed, groove on incisors simple, shallow, and without cement. Spinous processes of lumbar vertebræ low and triangular in form.

Skull (pls. LXXV, 1; LXXVI, 1, 4; LXXXIV; LXXXV, 6–12).—The members of this subgenus are hares of medium size, the skull being about 75 mm. long. The skull is less strongly arched than it is in the true *Lepus,* but not so flat and long as in *Macrotolagus.* The nasals and rostrum are narrower than they are in *Lepus.* The postorbital processes are much slenderer, less triangular than they are in *Lepus* or *Macrotolagus,* free both in front and behind. They bear considerable resemblance to the postorbital seen in *Oryctolagus.*

Teeth (figure 44, 18).—The first upper incisors bear each a simple shallow groove not filled with cement. The remaining teeth are as in true *Lepus.*

Vertebral Column.—The spines of the anterior dorsal vertebræ are relatively shorter than they are in true *Lepus,* being equal to about two and a half times the length of the centra, instead of three times. The spinous processes of the lumbar vertebræ (pl. XCIII, 2) are also relatively lower in *Pœcilolagus* than in *Lepus;* they are triangular in outline, with the posterior edge nearly straight, while in the other subgenera the posterior edge is much cut out.

Species included in this subgenus, see pp. 334 and 335.

Subgenus MACROTOLAGUS Mearns

1896. *Macrotolagus* MEARNS, Proc. U. S. Nat. Mus., XVIII, p. 552, June 24, 1896.

1899. *Macrotolagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., pp. 468, 469, November, 1899.

Type.—*Lepus alleni* MEARNS.

Geographical Distribution.—Mexico and the southwestern United States.

Diagnosis.—Size large, as in subgenus *Lepus,* ears longer than head or hind foot, skull narrow, posterior limb of postorbital touching side of cranium, enclosing an oval foramen.

Skull (pls. LXXIV, 1; LXXV, 2; LXXXII; LXXXIII).—The skull of *Macrotolagus* is large and slender. It is not arched as in the subgenus *Lepus*. The nasals are larger and narrower, the brain case is narrower, and the choanæ somewhat narrower. The postorbital processes are larger, rather longer than they are in the true *Lepus*, and their posterior angles are always attached to the side of the cranium enclosing large foramina.

Teeth (figure 44, 11–17).—The groove on the front of the incisor teeth in this subgenus may be perfectly simple and not filled with cement as it is in *Lepus* (*Macrotolagus*) *californius*, but more often it is deep and filled with cement as in *L.* (*M.*) *texianus*, where the groove is simple, and in *gaillardi, alleni, merriami*, where the groove is bifurcated internally, and in *callotis* and *asellus* where the grove is trifurcated internally. This is the only group of the Leporidæ in North America that shows this complicated folding of the groove internally, but at the same time some members of it do not show it. When found in a North American rabbit this folding of the groove on the incisor is diagnostic of the subgenus, but when not found it is without significance.

Vertebral Column.—The length of the neural spines is a little greater than it is in either the subgenus *Lepus* or *Pœcilolagus*. In the latter two it is about three times the length of the centrum in the anterior part of the thoracic series of vertebræ; in *Macrotolagus* it is a little over three times the length of the centrum.

Upper Extremity (pl. XCVIII, 2).—The radius is slenderer than in the other members of the genus *Lepus* and longer than the humerus, while in the other subgenera, the humerus and radius are about equal in length.

Species belonging to this subgenus, see p. 335.

Genus SYLVILAGUS Gray

1867. *Sylvilagus* GRAY, Ann. Mag. Nat. Hist., XX, 3d ser., p. 221.
1896. *Sylvilagus* MEARNS, Proc. U. S. Nat. Mus., XVIII, p. 551, June 24, 1896.
1899. *Sylvilagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 514, November, 1899.

Type.—*Sylvilagus floridanus mallurus* (THOMAS).

Geographical Distribution.—In general, North America south of the northern border of the United States and in South America.

Diagnosis—External and dental characters as in *Lepus*. Skull essentially like that of *Lepus* except that sutures of interparietal are always distinct; the postorbital process is long and narrow, its

posterior limb touching the side of the cranium and helping to bound a clavate foramen. Rarely the process fails to meet the cranium.

Skull (pls. LXVI, 7–10; LXVII, 1, 2; LXXXVI; LXXXVII).—The postorbital processes are long and narrow, attached to the skull by a very broad pedicle. The whole anterior part of the process, with the exception of a millimeter or two, is attached to the skull and a very small anterior notch is thus formed. The posterior part of the postorbital process is long and narrow, not triangular. Its inner posterior edge usually touches the cranium and the process thus forms a narrow clavate slit. The amount of fusion of the postorbital process is subject to considerable variation. In one individual, *Sylvilagus floridanus mearnsi,* from Illinois, complete fusion of the postorbital with the side of the skull takes place and the usual clavate slit is obliterated. In *Sylvilagus arizonæ* and its forms the anterior portion of the postorbital process is not so extensively fused with the frontal bone and a larger anterior notch is found than in the more typical forms. In the most highly differentiated forms of the subgenus *Microlagus,* viz., *bachmani,* the postorbital process is attached by a comparatively narrow pedicle, a large notch is found in front, and as the posterior end of the postorbital does not meet with the cranium a large notch is found posteriorly instead of the usual clavate slit. In No. 63,957, *Sylvilagus bachmani,* from Posts, California, the posterior extremity of the postorbital almost touches the cranium. Skulls of *S.* (*Microlagus*) *cinerascens* show conditions ranging from those seen in No. 63,957 to conditions very similar to those found in typical *Sylvilagus,* but the posterior clavate slit is always relatively wider. Intermediate conditions are thus found from the extreme freedom of the postorbital seen in *S. bachmani,* No. 35,131, Nicasio, California, passing through *S. cinerascens* and then *S. arizonæ* and normal typical *Sylvilagus,* to the atypical skull, from Illinois, No. 22,409, where the postorbitals are entirely fused to the sides of the cranium.

The bony palate in true *Sylvilagus* is rather short, slightly larger relatively than it is in *Lepus* or *Brachylagus,* but shorter than in any of the other genera. Its length half-way between the median line and the dental alveoli about equals the greatest width of the incisive foramina and also the distance between the vertical plates of the palate bones. In the *Sylvilagus arizonæ* group the palate is shorter than in typical *Sylvilagus;* its length half-way between the median line and the dental alveoli is less than the width of the incisive foramina and about equals the distance between the vertical plates of the palate bones, which are here closer together than in

any of the rabbits except those of the genus *Oryctolagus*. The portion of the palate bone that borders the maxilla caudad of the posterior edge of the bony palate is poorly developed in *Sylvilagus*.

The posterior palatine foramina are of moderate size and located between the palatine plate of the maxilla and the horizontal plate of the palate bone, at the anterior outer angles of the horizontal plate.

The zygoma of *Sylvilagus* is thin and shallow. The foot-like extremity of zygomatic process of the squamosal is short, the external lateral length of the squamoso-malar suture is contained about two times into the superior border of the malar measured from the anterior end of the squamoso-malar suture to the antero-inferior angle of the orbit. The antero-inferior end of the zygoma is only slightly enlarged. The posterior free extremity of the malar is short.

The audital bullæ, the external auditory meatus and the fenestration of the maxillæ in *Sylvilagus* show nothing distinctive and may be said to represent normal degrees of development.

The angular process of the mandible is rather larger and more rounded, as compared with *Lepus*. The ascending ramus is of moderate development, resembling that of *Lepus*.

Teeth (pl. XCI, 9; figure 44, 2 and 3).—The following are the characters of the teeth of the genus *Sylvilagus*, which, with the exception of the front upper incisors and first lower premolar, and smaller size throughout, are not different from those of the teeth of *Lepus:* First upper incisors with longitudinal groove in anterior face always simple, usually shallow and filled with cement only in a few specimens from Mexico. The first upper maxillary tooth has typical folding of enamel on the anterior surface, a deep median reentrant angle on either side of which is a smaller reentrant angle. The first lower molariform tooth has a small reentrant angle on its anterior surface and a shallow, broader reentrant angle on the external surface of the anterior half of the tooth. In some of the specimens of *Sylvilagus*, from Mexico, the anterior face of this tooth is marked by two reentrant angles, instead of the usual one, the tooth in this case resembling the first lower premolar of *Limnolagus*. The second, third, fourth, and fifth upper molariform teeth show each a deep reentrant angle extending from the internal face about three-quarters the distance across the tooth; the adjacent edges of this angle are almost in contact with one another throughout their whole extent. The enamel of the reentrant angle is crenated. In the second, third, and fourth lower molariform teeth the lateral diameter of the posterior half of each tooth is about four-fifths of the lateral diameter

of the anterior half of the tooth. The last upper molar is small with an elliptic cross section. The last lower molar is a small double cylinder in form, the anterior half of which is larger and elliptic in section, the posterior half terete.

Vertebral Column.—The cervical vertebræ (pl. XCII, 5) of *Sylvilagus* have nothing to distinguish them from the same vertebræ of many other genera, being noticeably different from those of *Lepus* and *Pronolagus* only. The cervicals are uniformly shortened, the costal processes project laterally farther from the sides of the centrum, the anterior and the posterior spines of these processes are less prominent, than in *Lepus*. The true transverse process is more conspicuous and is often found to project laterally from the side of the fifth vertebra.

The length of a neural spine in the anterior thoracic region is about twice the length of the centrum, to which it is attached. The anticlinal vertebra is usually the eleventh, but often the tenth. Metapophyses are usually seen only on the tenth, eleventh, and twelfth thoracic vertebræ, sometimes on the ninth.

The lumbar vertebræ (pl. XCIV, 14) are scarcely distinguishable from the same in *Oryctolagus*. The transverse processes instead of arising abruptly from the anterior half of the lateral aspect of the centra as they do in *Lepus*, arise from the whole side, so that the angle between the process and the centrum is partly filled in with bone, but this is not comparable to the filling in that takes place in *Limnolagus* and in *Romerolagus*. True anapophyses are lacking, the neural spines and metapophyses show nothing of interest. The hypophysis on the second lumbar is the longest, that on the first is next in length, and the shortest is found on the third. Sometimes the first hypophysis is reduced to a ridge and the third is lacking.

The sacrum differs in no way from the description given in the general account.

The caudal vertebræ vary from eleven to fifteen in number. The larger number is the more usual. Of the different forms (see p. 363) of vertebræ in this region, one, or often two, is of the first form; five to seven of the second, usually six; four to seven of the last form, usually six or seven. The skeleton with the lowest number of caudals, eleven, is *Sylvilagus minensis* THOMAS. The decrease takes place in the last form, which is here reduced to four in number.

Sternum and Ribs.—The sternum (pl. XCV, 2) of *Sylvilagus* is not very characteristic. In general it resembles the sternum of *Lepus*. The presternum is relatively larger, the keel less prominent anteriorly. The first pair of ribs is attached just in front of its

middle. The mesosternal segments have a tendency to be less flattened than they are in *Lepus*. The xiphisternum is shorter than the presternum, its ends moderately enlarged, the posterior end being more enlarged, relatively, than in *Lepus*.

The ribs (pl. XCIV, 5) are somewhat peculiar, but there is nothing to distinguish them from the ribs of *Oryctolagus*. The shafts of the anterior ribs are only moderately enlarged in their ventral portions. The spine-like portion of tubercles is well developed on all the skeletons except that of *Sylvilagus minensis* where the spines are poorly developed and are last seen on the seventh pair of ribs instead of on the eighth as in the others.

Shoulder Girdle and Upper Extremity.—The scapula (pl. XCVII, 7) of *Sylvilagus* is different in form from the same bone of *Lepus, Romerolagus,* and *Pronolagus,* but shows nothing tangible by which it can be distinguished from the scapulæ of the other genera. It is relatively narrow, the superior border relatively less convex, the antero-superior angle moderately pronounced, and the supraspinous fossa relatively narrow, when compared with the scapula of *Lepus*.

Regarding the humerus of *Sylvilagus* there is nothing peculiar by which it can be distinguished from the humeri of many of the other genera.

The forms, relations, sizes, and positions of the radius and ulna (pl. XCVIII, 4) are alike in *Sylvilagus* and in *Limnolagus*. These bones are subequal in size; the ulna is not reduced in the middle of its shaft, and is situated external to radius rather than behind it. Both bones are moderately slender. The radius is equal to the humerus in length.

The carpus, the metacarpus, and the phalanges of *Sylvilagus* are entirely similar in form and position to these bones in any of the Leporidæ, as detailed in the general account of the wrist and hand (p. 378).

Pelvis and Lower Extremity.—The os innominatum has about the same general form in *Sylvilagus* and in *Oryctolagus*. The ilium is not wide and shovel-like. The anterior edge of the acetabulum is about midway between the extreme anterior and posterior points of the os innominatum or just a little posterior to the middle point. The antero-superior angle of the ilium is rather obliquely rounded off. The obturator foramen is apparently less rotund than is the case with *Lepus*.

The femur, the tibia, and the fibula of *Sylvilagus* are typical for the family, as detailed in the general account (p. 382), and show nothing that is peculiar to the genus.

The greatest length of the foot about equals the length of the tibia, but in one skeleton, No. 94,197, from Nevada, the foot is longer than the tibia, in this respect resembling the foot and tibia of *Brachylagus*.

The basal width of the metatarsus is contained two and a half times into the length of the third metatarsal, as is commonly the case among other Leporidæ.

The combined length of the phalanges of the two lateral digits, as well as of the two middle ones, is usually approximately equal to the length of the metatarsals to which they belong.

The genus *Sylvilagus* stands second to *Lepus* in point of number of species and extent of geographic distribution. It is a fairly homogeneous group. A few forms have been classed as a separate subgenus, an arrangement which is here retained. The teeth on the whole are formed as they are in typical *Lepus*. Certain of the Mexican species, however, have the first lower premolar as it is in *Limnolagus*.

In the form of the cervical vertebræ and the shape of the transverse processes of the lumbar vertebræ, the relative size of the radius and ulna, and in the shape of the pelvis and the ribs, sternum, and scapula, *Sylvilagus* seems to be generally similar to *Oryctolagus*. The teeth in these two genera are essentially alike.

There are two subgenera of *Sylvilagus*—*Sylvilagus* proper and *Microlagus*. No skeletons of the latter are available for examination.

Subgenus SYLVILAGUS Gray

1867. *Sylvilagus* Gray, Ann. Mag. Nat. Hist., xx, 3d ser., p. 221.
1896. *Sylvilagus* Mearns, Proc. U. S. Nat. Mus., xviii, p. 551. June 24, 1896.
1899. *Sylvilagus* Major, Trans. Linn. Soc. London, 2d ser., vii, p. 514, November, 1899.

Type.—*Sylvilagus floridanus mallurus* (Thomas).

Geographical Distribution.—Same as for the genus.

Diagnosis and Description.—Size larger, skull (pls. lxxvi, 7, 8; lxxvii, 2; lxxxvi; lxxxvii, 1–10) heavier, rostrum often heavier and not so pointed. Postorbital processes long and narrow, attached to skull by a very broad pedicle. The anterior part of the process short, attached to the side of the skull for nearly its whole length. Posterior part of the process long and narrow, the posterior edge touching the cranium, the process thus enclosing a very narrow clavate slit, much narrower than the width of the postorbital, which helps to form it.

Species in this subgenus, see p. 336.

Subgenus MICROLAGUS Trouessart

1897. *Microlagus* TROUESSART, Catalogus Mammalium, I, fasc. iii, p. 660.

Type.—*Sylvilagus (Microlagus) cinerascens* (ALLEN).

Geographical Distribution.—Western and southwestern United States and northern Mexico.

Diagnosis and Description.—Externally like *Sylvilagus,* size small, skull (pls. LXXVI, 9, 10; LXXVII, 1; LXXXVI; LXXXVII, 11–13) light, rostrum rather straight, narrow, pointed; postorbital process attached to skull by a narrow pedicle, the anterior portion of the postorbital more or less free from the skull, and helping to form a well-marked notch. Posterior portion of postorbital rather slender. It may or may not touch the side of the cranium; when it does, it incloses a clavate foramen, fully as wide as the posterior limb of the process.

For the species belonging to this subgenus, see pp. 336, 337.

Genus ORYCTOLAGUS Lilljeborg

1867. *Cuniculus* GRAY, Ann. Mag. Nat. Hist., 3d ser., XX, p. 225.

1874. *Oryctolagus* LILLJEBORG, Sveriges och Norges Ryggradsdjur, I, p. 417.

1899. *Oryctolagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., November, 1899, p. 514.

Type.—*Lepus cuniculus* LINNÆUS.

Geographical Distribution.—Southern and western Europe and northern Africa.

Diagnosis.—Externally similar to *Lepus,* but ears and hind feet relatively shorter. Postorbital process large but not wide and triangular; its posterior limb does not touch side of cranium. Sutures of the interparietal distinct. Choanæ very narrow, incisive foramina and least length of palate subequal, width of choanæ much less than either. Teeth essentially as in *Lepus.*

Skull (pls. LXXVI, 2, 5; LXXVII, 5; LXXXVIII; LXXXIX, 1–5).—The postorbital processes are large, but not wide and triangular; they do not stand out from the side of the skull to a marked extent. The process is arched. Neither the anterior nor the long and rather pointed posterior portions meet the side of the cranium in the wild rabbits. Anterior and posterior notches are thus formed. In two of the skulls of domestic rabbits at hand, a lop-eared and a Belgian hare, the anterior angle of the postorbital meets the frontal bone, and in the lop-ear forms the outer boundary of an irregular foramen, while in the Belgian hare the whole anterior angle is fused to the cranium so that even the foramen is obliterated. In both these specimens posterior notches are present.

The interparietal is present as a distinct bone in *Oryctolagus*.

The bony palate is relatively long. The horizontal plate of the palate bone well developed. It enters into the formation of the bony palate to a greater extent than it does in *Lepus,* where it forms a fourth to a third of the bony palate, and to a less extent than it does in *Romerolagus* where it is about half of the bony palate. The portion of the palate bone that borders the maxilla caudad of the posterior edge of the bony palate is moderately developed and thus helps to form part of the roof of the mouth along the posterior dental alveoli. The distance between the vertical plates of the palate bones, that is the width of the choanæ, is very slight, less than it is in any other genus. The pharyngeal vault is high. The length of the bony palate, measured midway between the median line and the inner edge of the dental alveoli, is about equal to the greatest width of the incisive foramina, which are narrow in this genus, and it is much greater than the least distance between the two vertical plates of the palate bones.

The posterior palatine foramina are of moderate size and situated in the usual position at the anterior outer angles of the horizontal plates of the palate bones.

The anterior portion of the zygoma is deep, as it is in *Lepus,* but the under edge of the posterior portion is cut away, rendering it shallower. The antero-inferior angle of the zygoma is enlarged and flares outward to a rather marked extent. The foot-like extremity of the zygomatic process of the squamosal is enlarged. The lateral length of the squamoso-malar suture is contained between one and one and a half times in the superior border of the malar, measured from the anterior edge of that suture to the antero-inferior angle of the orbit. The posterior free extremity of the malar is long.

The audital bullæ, the fenestration of the maxillæ, and the shape of the mandible in *Oryctolagus* show nothing distinctive of the genus, and may be said to represent normal degrees of development.

Teeth (pl. XCI, 5; figure 44, 22).—First upper incisors, with longitudinal groove on anterior face, always simple, moderately shallow and unfilled with cement. First upper maxillary tooth has typical folding of enamel on the anterior surface, a deep median reentrant angle, on either side of which is a smaller reentrant angle. The first lower molariform tooth has a small reentrant angle on its anterior face, and a shallow broader reentrant angle on the external surface of the anterior half of the tooth which is separated from the posterior half by a single reentrant angle. The second, third, fourth, and fifth upper molariform teeth show each a deep reentrant angle

extending from the internal face about three-quarters the distance across the tooth. The adjacent edges of this angle are almost in contact with one another throughout their whole extent and crenated. In the second, third, and fourth lower molariform teeth the lateral diameter of the posterior half of each tooth is about four-fifths the lateral diameter of the anterior half of the tooth. The last upper molar is very small, with an elliptical outline. The last lower molar is also small, consisting of a larger anterior elliptic portion and a smaller posterior portion, circular in outline.

Vertebral Column.—The cervical vertebræ (pl. XCII, 6) of *Oryctolagus* have nothing to distinguish them from the same series of vertebræ of several other genera, being noticeably different only from the two extremes, *Lepus*, with elongated cervicals on the one hand, and *Pronolagus*, with more shortened ones, on the other. The cervicals are uniformly shortened, the costal processes project relatively far from the sides of the centrum; the anterior and the posterior spines of these processes are less prominent than they are in *Lepus*. The true transverse process is more conspicuous and is often found to project laterally from the side of the fifth vertebra.

The length of the neural spines in the anterior thoracic region is about three times the length of a centrum. The anticlinal vertebra is the eleventh, on the lop-eared domestic it is the tenth, however. Metapophyses are well developed on the tenth, eleventh, and twelfth thoracic and are indicated on the ninth by small tubercles.

The lumbar vertebræ (pl. XCIII, 4, 5) are scarcely distinguishable from the same series of vertebræ in *Sylvilagus*. The transverse processes do not arise abruptly from the anterior half of the lateral aspect of the centra, but from the whole side, so that the angle between the process and the centrum is partly filled in with bone, but in no way comparable to the filling in that takes place in *Limnolagus* and in *Romerolagus*. Anapophyses are best developed in this genus of all the Leporidæ. In the skeleton of the lop-eared domestic, these processes are very large; in the three middle vertebræ of the lumbar series, the third, fourth, and fifth, the anapophyses extend as far caudad as the posterior border of the metapophyses of the next succeeding vertebra. In the two skeletons of wild *Oryctolagus*, however, this great development of the anapophyses is not so pronounced, but they are much larger than they are on the lumbar vertebræ of any of the other skeletons.

The hypophyses are injured in the skeletons of the wild animals, but from what remains of them it would appear that the second hypophysis is the longest, as it is in the lop-eared domestic.

The sacrum of *Oryctolagus* differs in no way from the description given in the general account, p. 362.

The caudal vertebræ are about seventeen in number, one being of the first form (see p. 363), six to eight of the second, and the last eight or nine are the rudimentary elongated centra, without neural canal or processes.

Sternum and Ribs.—The sternum (pl. XCV, 5) in *Oryctolagus* is in general as in *Lepus*. The presternum is more conspicuously keeled; the first pair of ribs attached just anterior to its middle. The mesosternal segments are more compressed from side to side than they are in *Lepus*. The last is much shorter than any of the other mesosternal segments. The xiphisternum is large and stout, longer than the presternum, its posterior end about as much enlarged as its anterior.

There is nothing by which the ribs of *Oryctolagus* can be distinguished from the ribs of *Sylvilagus*. The shafts of the anterior ribs are scarcely enlarged in their ventral portion. Spine-like portions of the tubercles of the ribs are well developed, and are last seen in the eighth pair.

Shoulder Girdle and Upper Extremity.—The scapula (pl. XCVII, 3) of *Oryctolagus* is different in form from the same bone in *Lepus, Romerolagus,* and *Pronolagus,* but shows nothing tangible by which it can be distinguished from the scapulæ of the other genera. It is relatively narrow, the superior border relatively convex, the antero-superior angle moderately prominent, and the supraspinous fossa relatively narrow, as compared with the scapula of *Lepus*.

Regarding the humerus of *Oryctolagus* there is nothing by which it can be distinguished from the humeri of many of the other genera.

The form, relative sizes, and positions of the radius and ulna are nearly alike in *Oryctolagus, Sylvilagus, Pronolagus,* and *Limnolagus;* that is, the ulna is not reduced in the middle of its shaft and is situated external to the radius rather than behind it. In *Oryctolagus* the ulna is somewhat heavier than the radius and both bones are rather heavier than they are in the other genera mentioned above. The radius is equal to the humerus in length.

The carpus, the metacarpus, and the phalanges of *Oryctolagus* are entirely similar in form and position to these same bones in any of the Leporidæ, as detailed in the general account of the wrist and hand (p. 378).

Pelvis and Lower Extremity.—The os innominatum has about the same general form in *Oryctolagus* and in *Sylvilagus*. The ilium is not wide and shovel-like except in the lop-eared domestic. The

antero-superior angle is rather obliquely rounded off. The anterior edge of the acetabulum is about midway between the extreme anterior and the extreme posterior points of the bone. The obturator foramen is less rotund than it is in *Lepus*.

The femur, the tibia, and the fibula of *Oryctolagus* are typical for the family Leporidæ, as detailed in the general account (p. 382), and show nothing that is peculiar to the genus.

The greatest length of the foot about equals the length of the tibia.

The basal width of the metatarsus is contained two and a half times in the length of the third metatarsal, as is commonly the case among the Leporidæ.

The combined length of the phalanges of the two lateral digits, as well as of the two middle ones, is approximately equal to the length of the metatarsals to which they belong.

Species in the genus. One, *O. cuniculus* (LINNÆUS).

Oryctolagus is a well-marked genus. In spite of a rather extensive geographic distribution, only one species has been recognized. It seems to have few relationships with the other Old World genera. With *Sylvilagus* in America, it has certain points of resemblance, in the shape of the transverse processes of the lumbar vertebræ, of the scapula, in the relative size of the radius and ulna, in the shape of the pelvis and of the ribs and sterna. The skulls of the two genera taken as a whole are not markedly different, and the teeth are essentially alike.

Oryctolagus has been extensively domesticated, and many stable varieties produced, among them the Belgian hare, but the true generic characters are never lost, and some of them, as the keeled presternum and the large anapophyses of the lumbar vertebræ are even better marked in the domestic rabbits than they are in the wild ones.

Genus LIMNOLAGUS Mearns

1867. *Hydrolagus* GRAY, Ann. Mag. Nat. Hist., XX, 3d ser., 1867, p. 221.
1897. *Limnolagus* MEARNS, Science, n. s., V, March 5, 1897, p. 393.
1899. *Limnolagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., November, 1899, p. 514.

Type.—*Limnolagus aquaticus* (BACHMAN).

Geographical Distribution.—Austro-riparian faunal area of North America, in general the South Atlantic and Gulf states.

Diagnosis.—Externally similar to *Sylvilagus*, but pelage harsher; ear, tail, and hind foot relatively shorter, the latter scantily haired. Skull much as in *Sylvilagus*, but postorbital process fused to side of cranium for its whole length, forming neither notch nor foramen.

Teeth essentially as in *Lepus,* except first lower premolar which has two or more reentrant angles on anterior face.

Skull (pls. LXXVI, 3, 6; LXXXVII, 4; LXXXVIII; LXXXIX, 6–10).—The genus *Limnolagus* possesses postorbitals quite different in form and attachment from the postorbitals of any of the other genera of the Leporidæ. The whole process is fused to the side of the frontal bone, so that only a very minute notch is found anteriorly, and no notch, foramen, or slit is found posteriorly, except in rare and anomalous cases, in which a small foramen may be formed by incomplete fusion of the postorbital with the side of the skull. The fused postorbital process has about the same general shape as has the unfused process in the genus *Sylvilagus.* An atypical specimen (No. 64,029, Kissimmee, Florida) shows the manner in which the process is attached. The hind-end of the process, instead of meeting the skull directly as it does in those genera where the posterior end of the process is in contact with the side of the skull, is met by an outgrowing process from the cranium. In this specimen a small foramen is enclosed between the posterior part of the postorbital process and the above outgrowing process from the cranium. A more or less prominent blunt projection, not seen in the other genera, is formed by the union of the postorbital process with the outgrowing process from the cranium. The blunt projection above, together with the root of the zygomatic process just below, forms a rather conspicuous notch.

The interparietal is present as a distinct and separate bone.

The bony palate is relatively long, about as it is in *Oryctolagus,* longer than in *Lepus* or *Sylvilagus,* shorter than in *Pronolagus* or *Romerolagus.* The horizontal plate of the palate bone is relatively well developed, to about the same extent as in *Oryctolagus,* forming between a third and a half of the bony palate. The portion of the palate bone bordering the maxilla caudad of the posterior edge of the bony palate is moderately well developed, much better than it is in *Lepus,* much less than it is in *Romerolagus.* The posterior palatine foramina, of moderate size, are located at the anterior outer angles of the horizontal plates of the palate bones. The choanæ are moderately wide, narrower than in *Lepus,* but not approaching the extreme narrowness seen in *Oryctolagus.* The length of the bony palate taken midway between the median line and the dental alveoli is about equal to the width of the choanæ and to the greatest width of the incisive foramina taken together.

The zygoma is heavy, thick, and deep, its antero-inferior angle is much expanded and flares outward, more so than it does in any

other genus except *Romerolagus*. The foot-like extremity of the zygomatic process of the squamosal is short, about as it is in *Lepus*, but the posterior free extremity of the malar is long.

The audital bullæ and the external auditory meatus are typical for the family as detailed in the general account (page 346).

The fenestration of the maxillæ is reduced to a small degree, being about as it is in the genera *Pronolagus* and *Romerolagus*.

The mandible of *Limnolagus* has a very large, rounded, angular process, similar to the form in *Sylvilagus*, but the ascending ramus is relatively wider.

Teeth (pl. XCI, 4; figure 44, 4).—The first upper incisor in *Limnolagus* has a shallow, simple groove in front, filled with cement. The first upper molariform tooth has the three usual reentrant angles, a deeper median one and two lateral shallower ones. The first lower molariform tooth, divided into an anterior and a posterior portion by a single deep reentrant angle from the external face, presents on its anterior face two deep crenated reentrant angles and one or two smaller ones, and a broad crenated reentrant angle on the anterior half of the external surface. The whole anterior half of the tooth is rather solid looking, and more quadrilateral in outline than is usually the case with this tooth in other genera. The second, third, fourth, and fifth upper molariform teeth have each a deep, internal reentrant angle, extending about three-quarters the distance across the tooth as in *Lepus*, *Oryctolagus*, and *Sylvilagus*, but unlike them the internal fourth of the reentrant angle is rather wide, that is, its adjacent edges are not in contact for that fourth. The second, third, and fourth lower molariform teeth have each the lateral diameter of the posterior half of the tooth equal to about four-fifths the lateral diameter of the anterior portion. The last upper molar is small, elliptical in section. The last lower molar is also small, consisting of anterior and posterior portions which are more nearly subequal in size than they are in most of the genera. The anterior part is the larger and more elliptical, the posterior smaller and more rotund in outline.

Vertebral Column.—The cervical vertebræ (pl. XCII, 4) of *Limnolagus* have nothing to distinguish them from the same vertebræ of several other genera, being noticeably different only from the two extremes, *Lepus* with elongated cervicals, and *Pronolagus* with more shortened ones. The individual vertebræ are uniformly shortened, the costal processes project relatively far from the sides of the centrum, the anterior and posterior spines of these processes are less prominent than they are in *Lepus*. The true transverse process is

more conspicuous and is found to project laterally from the side of the fifth vertebra.

The length of a neural spine in the anterior thoracic region is about equal to twice the length of a centrum. The tenth thoracic is the anticlinal vertebra. Well developed metapophyses are found on the last four thoracic vertebræ.

The lumbar vertebræ (pl. XCIV, 13) of *Limnolagus* are quite peculiar. The transverse processes are shorter and much broader than they usually are in the Leporidæ, the longest being equal to the length of the centrum to which it is attached and a fourth of the centrum in front. Their breadth makes them appear shorter than they really are. The free extremity of the transverse process is more expanded than it is in any other genus except *Romerolagus*. The attached base is very wide, coming from the whole side of the centrum, so that the angle between the main axis of the transverse process and the side of the centrum is filled in with thin bone, approaching the condition found in *Romerolagus*. This character of the transverse process is especially marked in the anterior part of the lumbar series. The spinous processes of the lumbar vertebræ are low, triangular in outline, and directed forward. True anapophyses are lacking. The hypophyses are injured in the single available skeleton, but it is probable that the second was the longest.

The sacrum differs in no way from the description given in the general account (page 362).

The total number of caudal vertebræ in *Limnolagus* is eleven, of which the first is long with a complete neural arch, the next five are shorter, wider, with more or less evident transverse processes, and the terminal five consist of small rudimentary centra without neural arches or processes.

Sternum and Ribs (pls. XCVI, 5; XCIV, 6).—The anterior portion of the presternum of *Limnolagus* is considerably enlarged laterally, having a tendency to be intermediate in form between the presternum of *Lepus* and that of *Romerolagus* and *Ochotona*. The mid-ventral line of this expanded part bears a low keel which is not extended backward on the posterior portion of the presternum. The first pair of ribs is attached to the middle of the sides of the presternum. The mesosternum of *Limnolagus* as a whole is wider than it is in most of the other genera. It is also shorter, so that its length is but little greater than that of the presternum or of the xiphisternum, both of which are subequal. The first, second, and third mesosternal segments are about equal in length, the fourth is shorter. Each successive segment is wider than the one immediately in front. The third

and fourth segments are completely ankylosed so that the whole mesosternum is composed of but three separate pieces instead of the usual four. The xiphisternum is long and slender and about equally expanded at each end.

In all the other genera except *Romerolagus,* the sixth and seventh pairs of ribs are attached to the last piece of the mesosternum. In these two genera the last rib attached directly to the sternum is the sixth, the seventh rib being attached to the cartilage of the sixth near the point where the latter joins the mesosternum.

The spine-like portions of the tubercles of the ribs in *Limnolagus* are well developed, but are not conspicuous, owing to the fact that the angle between the tubercle and the posterior edge of the rib is filled in with bone, making that part of the rib very wide, so that it is distinctly the widest portion of the rib. In the single skeleton at hand the last rib to bear a spine-like tubercle on the right side is the seventh, while on the left side it is the sixth. The shafts of the anterior ribs are not widened ventrally.

Shoulder Girdle and Upper Extremity.—The scapula (pl. XCVII, 6) of *Limnolagus* is different in form from the same bone in *Lepus* and in *Romerolagus* but shows nothing tangible by which it can be distinguished from the scapulæ of the other genera. It is relatively narrow, the superior border relatively convex, the antero-superior angle moderately pronounced, and the supraspinous fossa relatively narrow.

There is little about the humerus of *Limnolagus* by which it can be distinguished from the humeri of many of the other genera, but the groove subtending the internal condyle is rather less marked than in any of the Leporidæ except *Romerolagus.* The external condyloid ridge is short but comparatively wide, a trifle more conspicuous than it is in the other genera except *Romerolagus.*

The form, relative sizes, and positions of the radius and ulna (pl. XCVIII, 5) are quite alike in *Limnolagus* and in *Sylvilagus.* These bones are subequal in size; the ulna is not reduced in the middle of its shaft; it is situated external to the radius, rather than behind it. Both bones are moderately slender. The radius is equal to the humerus in length.

The carpus, the metacarpus, and the phalanges of *Limnolagus* are entirely similar in form and position to these same bones in any of the Leporidæ, as mentioned in the general account of the wrist and hand (page 378).

Pelvis and Lower Extremity.—*Limnolagus* has wide ilia, much like those of *Lepus,* but the antero-superior angle is not obliquely

rounded off. The antero-ventral angle is produced into a blunt, very short spine. The horizontal rami of the pubic bones slope backward more than in the other genera with the exception of *Romerolagus*.

The femur and the fibula of *Limnolagus* are typical for the family Leporidæ, as detailed in the general account (page 382). The tibia (pl. XCIX, 10) of *Limnolagus* however is relatively heavier than in the other genera excepting *Romerolagus*. It resembles that of the latter genus in the fact that it is rather curved, the inner surface of the lower part of the shaft being concave.

The foot (pl. C, 5) is about equal in length to the tibia. As in the other genera, the basal width of the metatarsals is contained about two and a half times in the length of the third metatarsal. The combined lengths of the phalanges of each toe is about equal to the length of the metatarsal of that toe.

Species in the genus *Limnolagus*, see page 337.

Limnolagus is a well-marked genus. It has a number of characters associating it with *Sylvilagus* on the one hand and with *Romerolagus* on the other. The radius, the ulna, the hind foot, the pelvis, and the scapula are much alike in *Limnolagus* and *Sylvilagus*. Occasionally abnormal individuals show postorbital processes somewhat alike in the two genera.

The palatal region of *Limnolagus* shows some resemblance to the same region in *Romerolagus*, while the whole sternum and the shape of the transverse processes on the lumbar vertebræ and the degree of development of the tail are intermediate in character between these structures in *Romerolagus* and *Sylvilagus*.

Genus BRACHYLAGUS Miller

1900. *Brachylagus* MILLER, Proc. Biol. Soc. Washington, XIII, p. 157, June 13, 1900.

Type.—*Brachylagus idahoensis* (MERRIAM).

Geographical Distribution.—Upper Sonoran faunal area, in southern Idaho, in northern Nevada and California, and in eastern Oregon and Washington.

Diagnosis.—Externally similar to Lepus, except that the tail is unusually short. Skull essentially like that of *Lepus* but with interparietal distinct; audital bullæ relatively larger than in any of the related genera. First upper premolar with only one reentrant angle on anterior face. Reentrant angles of upper molariform teeth extending only half-way across the tooth and not crenate.

Skull (pl. LXXVIII, 3; LXXIX, 1).—*Brachylagus* is the smallest of

all the rabbits examined and consequently has the smallest skull. As a whole the skull is short and wide, arched antero-posteriorly. The brain-case is inflated.

The postorbital processes are small and slender, free both in front and behind, forming anterior and posterior notches with the cranium proper.

The interparietal bone is distinct.

The bony palate is shorter than in any other genus, its least length being equal to twice the length of M^1. Its extreme posterior edge only is formed by the horizontal plates of the palate bones. The incisive foramina are wide, the widest part of each one nearly equaling the length of the bony palate. The distance between the vertical plates of the palate bones is relatively as great as it is in *Lepus*, and much exceeds the length of the bony palate.

The zygoma is deep and thin, only slightly expanded at the antero-inferior angle. The posterior free extremity of the malar is moderately enlarged. The foot-like extremity of the zygomatic process of the squamosal is rather short, but not relatively so short as it is in *Lepus*.

The audital bullæ are much inflated and the external auditory meatus is very large and rounded.

The mandible has the general form of the mandible of *Lepus*, but the angular process is relatively smaller and its edge is nearly straight.

Teeth (pls. XCI, 1; fig. 44, 1).—*Brachylagus* has the simplest teeth of any of the Leporidæ available for examination. The enamel lacks much of the folding and the crenation found in the other genera. The first upper incisor has a simple groove, not filled with cement. The first upper premolar is very simple, presenting a single reentrant angle instead of the usual three on the anterior face. The infolding of the enamel on the inner sides of the four upper molariform teeth extends as far as the middle of each tooth only and lacks the crenation so distinctly seen in the case of the other genera. The anterior lower premolar is also simple. It is divided into an anterior and a posterior portion by a single deep reentrant angle extending in from the external face. It has no infolding of the enamel in front, none on the inner side of the anterior half of the tooth, and a single wide, shallow infolding on the outer side of the anterior portion of the tooth. The posterior transverse portions of the three lower molariform teeth are relatively much shorter than they are in any of the other Leporidæ. The lateral length of each posterior portion is equal to about half the lateral length of the anterior

portion to which it belongs. In all the other genera the anterior and posterior portions of the three lower molariform teeth are subequal or nearly so. The enamel between the two portions of these teeth is not crenated as in the other groups.

Vertebral Column.—The cervical vertebræ (pl. XCII, 3) of *Brachylagus* have practically the same form that they have in the large genus *Sylvilagus,* that is, they belong to the shorter type.

In the anterior part of the thoracic series of vertebræ, the length of the neural spine is about equal to three times the length of the centrum to which it is attached. The tenth thoracic is the anticlinal vertebra; its spine is abruptly broader than any of the spines in front and is concave on its anterior and also on the posterior edge. The anterior edge of the eleventh is slightly concave and is perpendicular in its general direction; the posterior edge is concave and slopes backward and downward from above. The spine of the last thoracic is smaller than that on the eleventh and resembles in form the spines of the lumbar series. Well developed metapophyses are found on the last three thoracic vertebræ, and on the ninth this process is distinctly indicated by a small spine. The last two vertebræ of this series have rather well marked ventral ridges.

The lumbar series of vertebræ (pl. XCIV, 12) in *Brachylagus* is quite different in some respects from the same series in the other genera. The best distinguishing character is a prominent longitudinal rounded ridge extending the length of the long axis of the transverse processes. The process itself is rather long and slender, is rather more curved and concave anteriorly than the lumbar transverse process in the other genera. The longest process has a length of one and a half times that of the centrum to which it is attached. The process does not rise abruptly from the side of the centrum, but slopes gently into it at the posterior angle of its attachment, as in *Sylvilagus* and in *Oryctolagus.* The neural spines are low, especially anteriorly. Anapophyses are slightly more developed on the anterior three or four vertebræ of this series than they are in other genera, except *Oryctolagus.*

The sacral vertebræ are four in number and differ in no essential respects from the same vertebræ in other genera.

The caudal series of vertebræ is very short in *Brachylagus,* the total number being nine, the smallest that occurs in any genus except *Romerolagus,* which has the same number, and *Nesolagus* which has eight. The first two caudal vertebræ are long, with complete neural arches, and resemble the last sacral vertebræ, the next three are shorter, with rather wide transverse processes, the last four are

small, rudimentary centra, longer than wide and without processes of any kind.

Sternum and Ribs (pls. XCV, 1; XCIV, 7).—The structure of the sternum of *Brachylagus* is fairly characteristic of the genus. The presternum is compressed, bearing a low keel along the whole ventral border. The dorsal portion of the presternum is somewhat enlarged laterally just anterior to the attachment of the first pair of ribs, which takes place at the junction of the anterior and middle thirds. The mesosternum consists of four distinct segments, of which the first is compressed laterally, with a low keel continuing that of the presternum. The succeeding mesosternal segments become successively wider, and more flattened dorso-ventrally. The last segment is much wider than any of the others, with well marked postero-lateral angles, for the attachment of the sixth and seventh pairs of ribs. The xiphisternum is decidedly longer than the presternum, is slender in the middle but considerably expanded at the ends, especially the posterior one.

The ribs are not very characteristic in *Brachylagus*. In general they resemble those of *Sylvilagus*. The spine-like portion of the tubercles are but moderately developed and are last seen on the seventh pair of ribs. The lower part of the shafts of the anterior ribs is but slightly broadened.

Shoulder Girdle and Upper Extremity.—There is apparently nothing about the shoulder blade (pl. XCVII, 8) of *Brachylagus* except the smaller size by which to distinguish it from the scapulæ of several other genera. It belongs to the moderately narrow type with a relatively straighter and less convex vertebral border, with the antero-superior angle of the more pronounced type, and the supraspinous fossa relatively narrower.

There is little in the humerus of *Brachylagus* that is peculiar. It is small and relatively more slender than in other genera except *Romerolagus*. The groove subtending the internal condyle is moderately developed. The external condyloid ridge is rather wide for one of the Leporidæ, like that of *Romerolagus*, but not quite so long.

In *Brachylagus* the radius and ulna (pl. XCVIII, 6) are subequal in size, and in general resemble those bones in *Sylvilagus, Oryctolagus, Pronolagus*, and *Limnolagus*. Unlike any of those skeletons, however, with bones of the foramen equally developed, the radius is distinctly shorter than the humerus, in the other cases the humerus and radius are subequal in length.

The carpal bones, the metacarpals, and the phalanges of *Brachy-*

lagus are entirely similar in form and position to these bones in any of the Leporidæ, as detailed in the general account of the wrist and the hand (page 378).

Pelvis and Lower Extremity.—The innominate bone in *Brachylagus* is smaller than it is in other genera. The anterior part of the ilium is of the narrow type with the antero-superior angle obliquely rounded off, in these respects resembling *Sylvilagus* and *Oryctolagus*. A tubercle in front of the acetabulum is more prominent in *Brachylagus* than in the other genera. The descending ramus of the pubis is slenderer, and the distance from the tuberosity of the ischium to the nearest edge of the obturator foramen is relatively shorter than it is in other Leporidæ. The anterior edge of the acetabulum is about equidistant between the extreme anterior and posterior points of the os innominatum.

The femur, tibia, and fibula (pl. XCIX, 8) of *Brachylagus* are typical for the family as detailed in the general account (page 382) and show nothing that is peculiar for the genus, but the fibula fuses with the tibia at a point relatively nearer the middle than it does in most of the genera. The femur is apparently relatively more slender than in the other genera.

The greatest length of the foot (pl. C, 3) in *Brachylagus*, unlike that of most of the skeletons except *Sylvilagus*, No. 94,197 from Nevada, is greater than the greatest length of the tibia. The basal width of the metatarsals is contained about two and one-half times in the length of the third metatarsal. The combined lengths of the three phalanges approximately equal the length of the metatarsal to which they are attached.

So far as known the genus *Brachylagus* contains but a single species, *B. idahoensis*, represented by two skeletons and several skulls.

Brachylagus is a very well marked genus. Its peculiar teeth and the ridge on the transverse process of the lumbar vertebræ are quite unlike anything else among the Leporidæ, although it would appear from the published figures (Major, '99, pl. 37, fig. 17) of the teeth of *Nesolagus* from Sumatra that the latter has teeth resembling those of *Brachylagus*. Aside from that, however, the two genera have little in common. Apart from the structure of the teeth, *Brachylagus* appears somewhat related to *Microlagus*, judging from the skulls as a whole. The skeleton in general, aside from the reduced number of caudal vertebræ and the ridges on the transverse processes of the lumbar vertebræ, is much like the skeleton of *Sylvilagus*.

Genus PRONOLAGUS new

1867. *Lepus* GRAY, Ann. Mag. Nat. Hist., 3d ser., XX, p. 223.
1899. *Oryctolagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 514, November, 1899.

Type.—*Pronolagus crassicaudatus* (GEOFFROY).

Geographical Distribution.—South Africa.

Diagnosis.—Externally similar to *Lepus*. Skull and teeth essentially like those of *Romerolagus* except that audital bullæ are smaller than foramen magnum, and anterior face of first lower premolar has two reentrant angles.

Skull (pls. LXXVIII, 2*a*, 2*b*; LXXVII, 3).—The skull as a whole is long and narrow. The anterior angle of the postorbital process is entirely lacking or else is so intimately associated with the cranium that the process appears as a triangle, one whole side of which is attached to the cranium. Of the two other sides one is directed outward and somewhat forward and the other obliquely inward and backward, forming the outer boundary of a posterior notch. The posterior and only angle of the postorbital is pointed. The process, as a whole, closely resembles that of *Romerolagus*, but it is relatively as well as absolutely larger.

It cannot be definitely stated whether the interparietal of *Pronolagus* is obliterated in adult life or not. In the single available skeleton, which has evidence of being young, the sutures of this bone are partially obliterated.

The bony palate of *Pronolagus* is longer and narrower than in most of the Leporidæ, its least length equaling four times the length of M^1, though the palate of *Romerolagus* approaches it closely. The incisive foramina are long and narrow, less triangular in outline than they are in most of the other genera. Their greatest width, taking both together, is much less than the length of the bony palate. The horizontal plates of the palate bones are large, and form a little less than half of the bony palate. The portion of the palate bone that borders the maxilla caudad of the posterior edge of the bony palate is developed to a greater degree than in any other genus except *Romerolagus*, and aids in forming to a considerable extent the lateral portion of the roof of the mouth just internal to the dental alveoli and posterior to the bony palate. The choanæ are considerably narrowed, almost approaching the narrowness seen in *Oryctolagus*, but the pharyngeal vault is only moderately high. The posterior palatine foramina are very small and would be scarcely noticeable were it not for the well-marked grooves leading from them. These foramina are located near the median line and not at the anterior external angles

of the horizontal plates of the palate bones, as in the case of the other genera of Leporidæ.

The zygoma is rather thin and shallow; its antero-inferior angle is moderately enlarged. The foot-like extremity of the zygomatic process of the squamosal is rather short, about as it is in the genus *Lepus*. The posterior free extremity of the malar is short. The root of the zygomatic process takes its origin close to the squamoso-frontal suture, closer than in any other genus, although *Romerolagus* and *Limnolagus* show an approach to this condition.

The audital bullæ in *Pronolagus* are remarkably small.

The fenestration of the maxillæ is developed to a small extent only, about as in *Romerolagus* and *Limnolagus*.

The mandible in general is quite like that of *Lepus*, but the lower edge of the angular process is decidedly straight.

Teeth (pl. xci, 8; fig. 44, 23).—First upper incisor has the groove simple, very shallow, and unfilled with cement. The first upper molariform tooth has the three usual reentrant angles on the anterior surface very deep, deeper than they are in the other genera, except *Pentalagus*. The first lower molariform tooth, like the same tooth in *Romerolagus*, departs from the typical form. The tooth is divided into anterior and posterior portions not by a single reentrant angle extending inward from the external face, but by two reentrant angles, one from the internal, one from the external face, which meet near the center of the tooth. The external angle is the broader and shallower of the two. The internal is deeper and the adjacent sides of the angle are nearly in contact. The anterior limbs of both the reentrant angles are plain and heavy, the posterior limbs relatively narrower and decidedly convoluted. On the anterior face of the first lower molariform tooth are two deep, simple, reentrant angles. On the external face of the anterior portion of the tooth is a broad, shallow, reentrant angle. In the second, third, fourth, and fifth upper molariform teeth the reentrant angles extend nearly the whole distance across the teeth. The internal half of the angle is rather wide and open, differing in this respect from the other genera except *Romerolagus*. The enamel of the reentrant angles is crenated. The second, third, and fourth lower molariform teeth are divided by the usual deep reentrant angle, into anterior and posterior portions, the lateral diameters of which are equal to one another. The last upper molar is relatively larger in *Pronolagus* than in the other genera and its grinding surface is somewhat lozenge-shaped. The last lower molar has the reentrant angle which divides the tooth into a larger elliptical anterior portion and a smaller circular pos-

terior portion well marked. Owing to an extra fold of the reentrant angle the posterior face of the anterior portion of this tooth has a slight indentation not seen in the other genera.

Vertebral Column.—The greatest development of the shortened type of cervical vertebræ (pl. XCII, 10) is seen in *Pronolagus*. The costal process stands out very far from the body of the vertebra; the process itself is narrow, that is, its antero-posterior dimensions are relatively much less than they are in the other genera. The cephalad and caudad projecting spines of the costal processes are apparently not well developed, but they have a somewhat worn or damaged look in the only skeleton. The general appearance of the cervical vertebræ in *Pronolagus,* seen from below, is much the same as in *Ochotona.*

The spines of the anterior thoracic vertebræ are equal to about two and a half times the length of their centra. The eleventh thoracic is the anticlinal vertebræ. Metapophyses are developed in the last four thoracic.

The transverse process of the lumbar vertebræ (pl. XCIII, 3) of *Pronolagus* is of medium length, the longest equaling the length of the centrum to which it is attached. It is not so much enlarged at the free extremity as it is in other genera. It is wide at the base where it comes from the whole side of the centrum, resembling *Limnolagus* in this respect, but the posterior border of the process is not so strongly concave as in that genus and the process itself is more slender. The spinous processes are low and triangular, like those of *Limnolagus, Romerolagus,* and *Pœcilolagus.* The hypophyses are injured in the only available skeleton. Probably the second was the longest.

The sacrum differs in no way from the description given in the general account, page 362.

All but two of the caudal vertebræ are missing. These two resemble the sacral vertebræ in form.

Sternum and Ribs (pls. XCVI, 3; XCIV, 3).—The posterior two-thirds of the presternum is much compressed, but not keeled; its anterior third is somewhat enlarged, resembling that portion of the presternum of *Limnolagus.* The first pair of ribs is attached at the junction of the first and second fourths. The mesosternal segments are more compressed laterally than they are in any of the other skeletons and each succeeding one is a trifle shorter than the one immediately in front. The xiphisternum is a little shorter than the presternum, is comparatively stout and about equally enlarged at each end.

The spine-like portions of the tubercles of the ribs are very small

and are last seen on the seventh pair of ribs. The shafts of the ribs are relatively narrow and there is no indication of the wide expansion found in *Lepus*. Decidedly the widest part of the rib is just behind the spine.

Shoulder Girdle and Upper Extremity (pl. XCVII, 4).—The scapula of *Pronolagus* is different in form from the same bone in *Lepus* and in *Sylvilagus,* and has relative proportions about the same as are found in *Romerolagus*. It is relatively long and narrow, the superior border relatively less convex, the antero-superior angle moderately pronounced, and the supra-spinous fossa relatively narrow.

Regarding the humerus of *Pronolagus* there is nothing peculiar by which it can be distinguished from the humeri of many of the other genera.

The form, relative sizes, and positions of the radius and ulna (pl. XCVIII, 7) are much alike in *Pronolagus* and in *Oryctolagus*. The bones are about subequal in size; the ulna is not reduced in the middle of its shaft, and is situated external to the radius rather than behind it. Both bones are moderately slender. The radius is equal to the humerus in length.

The carpus, the metacarpus, and the phalanges of *Pronolagus* are entirely similar in form and position to these same bones in any of the Leporidæ as detailed in the general account of the wrist and the hand (page 378).

Pelvis and Lower Extremity.—The os innominatum of *Pronolagus* resembles, in most respect, the same bone in the genera *Sylvilagus* and *Oryctolagus,* but the ilium is even narrower than it is in them, and its ventral edge is straight, in this respect resembling the ilium of *Romerolagus*.

The femur, the tibia, and the fibula (pl. XCIX, 3) of *Pronolagus* are typical for the family as detailed in the general account (page 382) and show nothing that is peculiar for the genus.

The basal width of the metatarsus is contained about two and a half times in the length of the third metatarsal.

The combined lengths of the three phalanges of each of the hind toes approximately equal the length of the metatarsal to which they are attached.

The genus is represented by a single skeleton, *Pronolagus crassicaudatus* from South Africa.

Pronolagus is a peculiar genus, first classed as *Lepus* and later as *Oryctolagus*. It has not much to associate it with the former, and but little with the latter. In the structure of its teeth, postorbital processes, palate, and zygoma, it appears related to *Romerolagus*.

The sternum, however, is very similar to that of *Lepus*. The hind foot is nearly as short relatively as it is in *Romerolagus*. While I have seen no skins of *Pronolagus*, yet the fact that it has always been associated with *Lepus* or *Oryctolagus* makes it appear that its external features are not peculiar, which is all the more interesting, as the genus with which it has the most skeletal resemblances, *Romerolagus*, externally, bears certain resemblances to the pikas.

Genus ROMEROLAGUS Merriam

1896. *Romerolagus* MERRIAM, Proc. Biol. Soc. Washington, x, p. 173, December 29, 1896.
1898. *Lagomys* HERRERA, La Naturaleza, 2d ser., III, p. 80.
1899. *Romerolagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 514, November, 1899.

Type.—*Romerolagus nelsoni* MERRIAM.

Geographical Distribution.—West slope of Mount Popocatepetl, Mexico.

Diagnosis.—Externally, like *Pentalagus;* tail none; ears and hind feet short. Skull entirely leporine, palate long, postorbital process small, consisting of posterior limb only, nasals as in *Lepus*, audital bullæ normal, equal to foramen magnum in size. First lower premolar divided into an anterior and a posterior portion by two reentrant angles, one extending from the external and the other from the internal face to the center of the tooth; anterior face of first lower premolar without reentrant angles. Sternum essentially as in *Ochotona*.

Skull (pls. LXXVIII, 1*a*, 1*b*, 1*c*).—The postorbital processes are small, of similar form and position to those of *Pronolagus* and *Caprolagus*, but relatively as well as absolutely smaller. The anterior angle is entirely lacking, so that the process appears as a triangle, one entire side of which is attached to the cranium. The second side is directed outward and somewhat forward. The third side is directed obliquely inward and backward, forming the outer boundary of a posterior notch.

The interparietal is present as a distinct, separate bone.

The bony palate in *Romerolagus* is very long, its least length nearly equaling four times that of M^1 and equaled in proportional development only by *Pronolagus*. Its length measured half-way between the median line and the inner edge of the dental alveoli is very much greater than the greatest width of the two incisive foramina taken together, and also very much greater than the distance between the vertical plates of the palate bones or width of the choanæ. The

latter is not narrowed as in the case of *Oryctolagus*. The horizontal plates of the palate bones are extensively developed and form about half of the bony palate. The portion of the palate bone bordering the maxilla, caudad of the posterior edge of the bony palate, reaches its greatest development in *Romerolagus, Pentalagus,* and *Pronolagus*, about equally developed in each, where it helps to form the lateral posterior part of the roof of the mouth. The posterior palatine foramina are very large in *Romerolagus;* they are in the usual position at the anterior outer angles of the horizontal plates of the palate bones.

The zygoma of *Romerolagus* is very thick and deep. The antero-inferior angle is much enlarged and flares outward to a considerable degree. The foot-like extremity of the zygomatic process of the squamosal is moderately enlarged. The posterior free projecting extremity of the malar is large and long, being proportionally more so than in any of the other genera.

The audital bullæ show nothing peculiar, but the external auditory meatus is relatively larger than in the rest of the Leporidæ, and its outline is oval instead of circular.

The fenestration of the maxilla is much reduced, about as it is in *Pronolagus* and *Limnolagus*.

The mandible of *Romerolagus* possesses wide ascending rami, which are nearly vertical instead of sloping backward as in other Leporidæ. The angle is well developed and its edge is moderately rounded. The notch between the ascending ramus and the angular process is much larger than in any of the other genera.

Teeth (pl. XCI, 3; fig. 44, 5).—The teeth of *Romerolagus* in a general way resemble those of *Pronolagus*. The first upper incisor has the groove rather deep but not filled with cement. The first upper molariform tooth presents the three usual reentrant angles on the anterior face, a deep median one and a shallower one on each side. The first lower molariform tooth has a broad shallow reentrant angle on the external surface of its anterior half. The main reentrant angle extends but half way across the tooth, while a corresponding reentrant angle comes in to meet this from the internal surface, both angles contributing to the division of the tooth into anterior and posterior portions.

The second, third, fourth, and fifth upper molariform teeth show reentrant angles that extend nearly across the teeth, but not quite so far as they do in *Pronolagus*. The internal third of the reentrant angles is rather wide; for the external two thirds, the adjacent sides are almost in contact. The posterior portions of the second,

third, and fourth lower molariform teeth have their lateral diameters equal to those of the anterior portions, like these teeth in *Pronolagus*. The last upper molar is small and narrowly elliptic in section. The last lower molar consists of the two usual portions, the anterior larger and elliptic, and the posterior smaller and circular.

Vertebral Column.—The cervical vertebræ (pl. XCII, 2) of *Romerolagus* belong to the shortened type. The costal process projects laterally from the centrum; its anterior and posterior spines are only moderately pronounced. The true transverse process is rather conspicuous and projects laterally from the fifth cervical onward through the rest of the series.

The length of a neural spine in the anterior part of the series of thoracic vertebræ is about twice the length of its centrum, relatively shorter than in other genera. Metapophyses are found in the last three vertebræ of this series. The tenth is the anticlinal vertebra.

The transverse processes of the lumbar vertebræ (pl. XCIV, 11) of *Romerolagus* are very characteristic. The processes are short and wide, the longest equaling the length of the centrum to which it is attached. The process on the first lumbar is very short and almost rudimentary. All the processes are wide and, in general, have triangular outlines. The base is broad, coming from the whole side of the centrum, so that the angle between the main axis of the process and the side of the centrum is completely filled up with thin bone. It is an exaggeration of the condition found in *Limnolagus*. The spinous processes of the lumbar vertebræ are low, triangular in outline. Anapophyses are very slightly developed. The first three lumbar vertebræ bear hypophyses, the first of which is the shortest; the second and third are nearly the same length, but the latter is a trifle longer.

The sacrum consists of the usual four vertebræ and does not differ in form from the sacra of the other genera of the Leporidæ.

The caudal vertebræ of *Romerolagus* are only nine in number, this being the smallest number of any genus except *Brachylagus* which also has nine, and *Nesolagus* with eight. One vertebra is of the first form, like the last sacral, five are of the second form bearing more or less wing-like processes, the last three are merely centra without processes.

Sternum and Ribs.—The sternum (pl. XCVI, 1) of *Romerolagus* is very characteristic, being like that of *Ochotona*. The anterior portion of the presternum is very much expanded and flattened dorsoventrally. To the outer posterior angles of this enlarged portion the first pair of ribs is attached. The rest of the presternum is long

and narrow, as it is throughout the other Leporidæ, but devoid of any ventral keel. A slight ridge indicating a keel is seen on the ventral face of the expanded portion however. The mesosternum in general is very like the same structure in *Limnolagus*. The first and second segments are subequal, the third and fourth segments are subequal in length, but the fourth is broader. Both of the latter are relatively wider than they are in *Limnolagus* and as in that genus are firmly ankylosed. The xiphisternum is long and rather stout. It is but a little shorter than the whole mesosternum and decidedly longer than the presternum. The seventh pair of ribs does not meet the sternum, but articulates only with the cartilages of the sixth pair.

The ribs (pl. XCIV, 8) of *Romerolagus* are very similar in structure to the ribs of *Pronolagus;* the only marked difference is that the poorly developed spine-like portion of the tubercles is last found on the sixth pair of ribs instead of on the seventh pair. The shafts of ribs are relatively narrow, and there is no indication of the wide expansion found in *Lepus*. Decidedly the widest part of the ribs is behind the spine.

Shoulder Girdle and Upper Extremity.—The ratio of the length of the humerus to the length of the clavicle (pl. XCVI, 1) in *Romerolagus* is 3.2, in *Oryctolagus* 3.15, in *Sylvilagus* 4, in *Ochotona* 2. In the skeletons representing the other genera the clavicles have been lost, due to faulty preparation. In the original account of the genus *Romerolagus,* the description reads (Merriam '96, p. 171): "The clavicle is complete and articulates directly with the sternum (fig. 33), a thing that never happens in the genus *Lepus.*" In the present condition of the skeleton of *Romerolagus,* the clavicle has been cleaned from all its attachments. An examination of uncleaned skeletons of *Oryctolagus* and *Sylvilagus* showed that the clavicle did not articulate directly with the sternum. In the articulation of the clavicle *Romerolagus* resembles *Ochotona,* and not the other genera of the Leporidæ.

The scapula (pl. XCVII, 9) of *Romerolagus* differs in form from the scapulæ of the other Leporidæ, except *Pronolagus,* with which it has many points of similarity. It is long and narrow, its posterior border is practically straight instead of being concave, as in the other genera; its superior border is straight rather than convex. The distance between the antero-superior angle and the postero-superior angle is contained twice in the length of the scapula measured along the inner surface at the attachment of the spine. In the other genera with the exception of *Pronolagus* the distance be-

tween the two superior angles is contained but one and a half times in the scapular length.

There is little that is peculiar about the humerus. Like that of *Brachylagus* it is slenderer than in most of the other genera. The groove subtending the internal condyle is not well marked. The external condyloid ridge is better developed than in the other genera. The humerus of *Romerolagus* is distinctly longer than the radius.

Unlike the other genera, except *Oryctolagus* and especially *Pentalagus,* the radius of *Romerolagus* is slenderer than the ulna (pl. XCVIII, 9); at its articular ends the usual degree of development takes place.

The carpus, the metacarpus, and the phalanges of *Romerolagus* are entirely similar in form and position to these same bones in any of the Leporidæ as detailed in the general account of the wrist and the hand (page 378).

Pelvis and Lower Extremity.—The os innominatum of *Romerolagus* closely resembles that of *Limnolagus.* The only marked difference, aside from its slenderer formation, is the more pronounced development of the short, blunt spine at the antero-ventral angle, and the straightness of the ventral edge of the ilium. The ilia are wide, but their antero-superior angles are not obliquely rounded off. The horizontal rami of the pubic bones slope backward to a greater extent than they do in other genera with the exception of *Limnolagus.*

The femur of *Romerolagus* is entirely similar to the same bone in any of the Leporidæ and needs no special mention.

The fusion of the fibula with tibia (pl. XCIX, 9) in *Romerolagus* takes place at the middle of the latter bone, thus resembling *Ochotona.* In other genera of the Leporidæ, except *Pentalagus,* it occurs just above the middle. The tibia of *Romerolagus,* like that of *Limnolagus* and *Pentalagus,* is relatively heavier and also more curved than in the other genera, the inner surface of the lower part of its shaft being concave as in *Ochotona.*

The basal width of the metatarsus is contained twice in the length of the third metatarsal.

The combined lengths of the three phalanges approximately equal the length of the metatarsals to which they belong.

Romerolagus nelsoni, the only species of the genus, is represented by a single complete skeleton and several separate skulls.

Romerolagus is one of the best marked genera of the Leporidæ. Externally it appears much like *Pentalagus.*

The skull, as a whole, and in particular the postorbital processes and the palate, strongly suggests the skull of *Pronolagus*. The structure of the first lower premolar also associates *Romerolagus* with *Pronolagus* and with *Pentalagus* as well. Its external characters also associate it with *Pentalagus* but not with *Pronolagus*. In the shortness of its hind foot, *Romerolagus* approaches *Pentalagus* and *Ochotona*. The sternum of *Romerolagus* has almost exactly the same form as in *Ochotona*.

Genus NESOLAGUS Major

1897. *Caprolagus* TROUESSART, Catalogus Mammalium, vol. I, fasc. iii, p. 664.
1899. *Nesolagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 514, November, 1899.
1900. *Caprolagus* (in part) STONE, Proc. Acad. Nat. Sci. Philadelphia, 1900, p. 462.

Type.—*Nesolagus netscheri* (SCHLEGEL).

Geographical Distribution.—Sumatra.

Diagnosis.—Externally essentially as in *Caprolagus* (Schlegel, '80, pp. 61, 62). Reentrant angle of second upper cheek tooth extending little more than a third across the tooth, not crenated, but resembling the same tooth in *Brachylagus*. (Major, '99, pl. 37, fig. 17.)

No specimens of this interesting rabbit have been seen by the writer, and the following description is based on the figures given by Major and the description by Schlegel.

Skull.—Postorbital processes probably like those of *Romerolagus*, *Pronolagus*, *Caprolagus*, and *Pentalagus*.

The bony palate is long, the true palate bones forming about its posterior third, its length is greater than the width of the choanæ or incisive foramina. The incisive foramina are rather small, their sides approximately parallel, their greatest width less than the width of the choanæ. The choanæ are wide. The antero-inferior angle of the zygoma is enlarged. (Major, '99, pl. 39, fig. 38.)

Teeth.—The reentrant angle of the second upper molariform tooth extends but little more than a third of the distance across the tooth; its sides are not crenated. (Major, '99, pl. 37, fig. 17.)

Vertebral Column.—Sacro-caudal series of vertebra twelve (Schlegel, '80, p. 64). By considering four vertebræ as forming the sacrum, eight caudal vertebræ are left, a smaller number than is found in any other genus of the Leporidæ.

Sternum and Ribs (pl. XCVI, 4).—Presternum considerably enlarged in its anterior third, to about the same extent as in

Romerolagus. Its different shape is shown in figs. 1 and 4, pl. XCVI. The mesosternum consists of four distinct segments, the first two subequal in length, compressed laterally; the third segment is slightly shorter, not laterally compressed; the fourth segment is very short and cartilaginous. The mesosternum, strangely enough, is quite unlike that of *Romerolagus*, and closely resembles the mesosternum of *Sylvilagus*. The xiphisternum is very short, much shorter than the presternum, its anterior end considerably enlarged, its posterior end not enlarged at all. Apparently only six pairs of ribs articulate directly with the sternum. (Major, '99, pl. 39, fig. 18.)

Upper Extremity.—Radius and ulna subequal. (Major, '99, pl. 38, fig. 28.)

Species in the genus.—One, *Nesolagus netscheri* (SCHLEGEL).

Nesolagus is apparently a well-marked genus, but unfortunately I have seen no examples of it. The general structure of its skull, radius, and ulna seems to associate it with *Caprolagus*. The anterior portion of its presternum is enlarged quite as in *Romerolagus* and *Ochotona*. The upper cheek teeth apparently resemble those of *Brachylagus* in the short non-crenate reentrant angles.

Genus CAPROLAGUS Blyth

1845. *Caprolagus* BLYTH, Journ. Asiatic Soc. Bengal, XIV, 1845, p. 247.
1863. *Lepus* BLYTH, Cat. Mam. Mus. Asiat. Soc. Calcutta, p. 133.
1867. *Carpolagus* GRAY, Ann. Mag. Nat. Hist., XX, 3d ser., p. 225.
1899. *Caprolagus* MAJOR, Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 514, November, 1899.
1900. *Caprolagus* STONE, Proc. Acad. Nat. Sci. Philadelphia, 1900, p. 462.

Type.—*Caprolagus hispidus* (PEARSON).

Geographical Distribution.—Along the foot-hills of the Himalayas in northeastern India.

Diagnosis.—Fur harsh, ears much shorter than head, tail short. Skull short and heavy, rostrum stout, postorbital process represented by small posterior limb only. Teeth essentially as in *Lepus* except that the first lower premolar has two reentrant angles on anterior face and one on the internal face of the anterior portion of the tooth.

I have seen no members of this genus, and the following account has been taken from the published figures of the skull and teeth. (Blyth '45, Major '99.)

Skull.—The skull, as a whole, is rather short and heavy, moderately arched, rostrum short and stout, nasals about as wide in front as behind.

Postorbital process small, represented by the posterior limb only, which forms the outer border of a well-marked posterior notch.

The bony palate is long, its length equaling four times the length of M^1, its posterior third is formed by the horizontal plates of the palate bones. Its length is greater than the width of the choanæ, and is greater than the greatest width of the incisive foramina taken together.

The incisive foramina themselves are smaller than in any other genus except *Pentalagus;* their shape taken together is that of an elongated triangle.

The zygoma is deep, its posterior free extremity long. Its antero-inferior angle is not enlarged.

The audital bullæ are small, resembling those of *Pronolagus* and *Pentalagus*.

Teeth.—First upper incisor, groove on anterior face, deep, simple, and filled with cement (Major '99, p. 468, No. VIII). The first upper molariform tooth has the usual three reentrant angles on its anterior surface very deep, much as they are in *Pronolagus;* the sides of the angle are not crenated. The second, third, fourth, and fifth upper molariform teeth have each the usual deep reentrant angle on the internal face extending about four-fifths of the distance across each tooth. The sides of these reentrant angles are close together throughout their whole extent, and are strongly crenated in the first two of these teeth, moderately crenated in the third, and scarcely at all in the fourth. The last upper molar is very small, elliptic in outline, with a transverse diameter between a fourth and a fifth of the transverse diameter of the other upper jaw teeth.

The first lower molariform tooth is divided, by the usual deep reentrant angle from the external face, into an anterior and a posterior portion. The anterior face of the anterior portion has two narrow reentrant angles, and the external and internal faces of this portion have a single broad reentrant angle each. The second, third, and fourth lower molariform teeth are divided into the usual anterior and posterior portions by a well-marked reentrant angle extending from the external face across the tooth, the posterior limb of the angle being crenated. The posterior portion of the second lower molariform tooth has a transverse diameter about five-sixths the transverse diameter of the anterior portion; the transverse diameter of the posterior portion of the fourth lower molariform tooth is little more than half of the same dimension of the anterior portion of the tooth. The last lower molar is small, composed of a larger anterior portion, elliptic in section, and a smaller posterior portion, more nearly circu-

lar, which is very small in comparison with the anterior portion. (Major '99, pl. 36, fig. 33; pl. 37, fig. 23.)

Upper Extremity.—The radius and ulna are subequal in size, apparently shorter than they are in most of the Leporidæ. (Major '99, p. 490, figs. XXXVI–XL.)

Species in the genus.—One, *Caprolagus hispidus* (PEARSON).

Caprolagus is apparently a well-marked genus of the Leporidæ. It was the first member of the family to be separated as a genus distinct from *Lepus*. The structure of its teeth associate it with *Lepus*, *Sylvilagus*, and *Oryctolagus*, while the general shape of the skull make it appear related to *Nesolagus* and *Pentalagus*, as do also the external characters.

Genus PENTALAGUS new

1900. *Caprolagus* STONE, Proc. Acad. Nat. Sci. Philadelphia, p. 460.

Type.—*Pentalagus furnessi* (STONE).

Geographical Distribution.—Liu Kiu islands.

Diagnosis.—Ears and hind feet unusually short, similar to proportions in *Romerolagus*, pelage harsh, throat patch not well marked. Skull and teeth of leporine build, but molars $\frac{3}{3}$ instead of $\frac{3}{3}$.

Skull (pl. LXXIX, *2a*, *2b*, *2c*).—The skull as a whole is low and flat, not so much arched as is usual among the Leporidæ, broad between the orbits, rostrum shorter and heavier than in the other Leporidæ. Nasals very short and broad, as wide in front as behind; their most posterior point is on a line just anterior to the anteroinferior angle of the zygoma; in most of the other genera of the Leporidæ, the nasals are on a line just posterior to the anteroinferior angle of the zygoma.

The postorbital process consists of the posterior limb only, as is the case with *Pronolagus*, *Caprolagus*, and *Romerolagus*. It is well developed, heavier and more blunt than in the genera just mentioned.

The sutures of the interparietal are obliterated.

The bony palate is long, being four times the length of M^1; its posterior fourth is formed by the horizontal plates of the palate bones.

The incisive foramina are narrow, their sides approximately parallel, resembling in shape those of *Pronolagus*, but very much smaller. Their greatest width taken together is about half the length of the bony palate and much less than the width of the choanæ. The choanæ are wide, but their width is less than the length of the bony palate. The pharyngeal vault is low. The posterior palatine foramina are well developed and are situated at the outer anterior angles of the horizontal plates of the palate bones.

The zygoma is moderately heavy, its posterior free extremity moderately long, its antero-inferior angle slightly enlarged but considerably flared outward. The fossa, which is found usually in the Leporidæ on the anterior surface of the antero-inferior angle, is lacking in *Pentalagus* as it also is in *Limnolagus*. The foot-like extremity of the zygomatic process is large.

The audital bullæ are very small, being even more reduced in size than they are in *Pronolagus*. The external auditory meatus does not have the form of a rounded tube, but is an oval ring of bone closely applied to the side of the skull, just above and slightly behind the audital bulla. The paramastoid process of the exoccipital, which is in relation with the audital bulla posteriorly, is very large and heavy, and projects below the lowest point of the bulla about six millimeters. In all the other rabbits at hand, the paramastoid process projects not more than one or two millimeters below the bulla.

The sides of the maxilla are scarcely at all fenestrated, being pierced by a few small foramina only. The infraorbital foramen is large and distinct.

The premaxillæ are relatively shorter than in the other genera and their nasal processes do not extend so far caudad.

The mandible of *Pentalagus* shows an exaggeration of the condition found in *Limnolagus*. The angular process is large and rounded, extends high up on the ascending ramus, which is relatively thick. The condyle has a long antero-posterior dimension. The notch between the condyle and the angular process is very short and shallow.

Teeth (pl. XCI, 7; fig. 44, 24).—*Pentalagus* differs from all the other known genera of the Leporidæ in lacking the third upper molar.

The upper incisors are large and heavy, each with a broad sulcus on its anterior face, not filled with cement.

The first upper molariform tooth has the three usual reentrant angles, of which the middle and largest one is very deep and has its sides distinctly crenated. The second upper molariform tooth is the largest of the maxillary teeth; the third, fourth, and fifth are nearly subequal in size. The reentrant angles on all the teeth are well marked and extend almost completely across the tooth. The sides of these angles are almost in contact throughout their whole extent and more distinctly crenated than they are in the rest of the Leporidæ.

The first lower molariform tooth is very long. It is divided into two portions, a narrower, longer, anterior one, and a broader, shorter, posterior one, by two well-marked reentrant angles, one from the external and the other from the internal face. The anterior portion

of the tooth has two reentrant angles on its anterior face, and one each on its internal and external faces. The second, third, and fourth lower molariform teeth have their posterior portions as well developed as their anterior portions, and the posterior limb of the reentrant angle which divides these teeth into two portions is very much more convoluted than in any of the other Leporidæ examined. The last lower molar has the appearance of a double cylinder, the anterior portion of which is larger and elliptic in outline, and the posterior portion smaller and more terete.

Upper Extremity.—The bones of the upper extremity, like those of the lower, are relatively shorter and stouter than in the other genera. The double trochlear surface of the humerus has its main portion very broad and shallow, while the outer portion is much reduced in size. The groove subtending the internal condyle is very shallow.

The radius and ulna (pl. XCVIII, 10) are short, heavy bones, the ulna being the larger of the two. The radius is distinctly shorter than the humerus.

The carpal bones resemble those of the Leporidæ as described in the general account (page 378), but the pisiform is considerably reduced in size, and has almost the same form that it has in *Ochotona.*

The metacarpals are short and heavy, resembling those of *Ochotona,* and the basal width of the three middle ones is contained but one and a half times in the length of the middle metacarpal.

Lower Extremity.—The femur is very stout and heavy.

The tibia and fibula are also very stout and heavy, in marked contrast to the same bones in the other genera. As in the case of *Romerolagus* the fibula fuses with the tibia at its middle point (pl. XCIX, 4).

The hind foot (pl. C, 4) is short and stout, the tarsal bones being relatively wider than in the other genera of the Leporidæ, having about the same general proportion as in the Ochotonidæ.

The metatarsals are especially short and heavy, and their basal width is contained but one and a half times in the length of the longest, as in the case of the Ochotonidæ.

Pentalagus is the most marked of any of the genera of the Leporidæ, the tooth formula, the structure of the teeth, the relative size of the radius and ulna, and the very short tarsus and metatarsus being peculiar to the genus and unlike anything in the rest of the family. A complete skeleton would probably show that it has still further points of differentiation from the typical leporine form.

Its general build of skull seems to associate it with *Caprolagus* and *Nesolagus*. But *Caprolagus* has typical leporine teeth and the upper cheek teeth of *Nesolagus* seem to resemble those of *Brachylagus*. In the structure of the first lower premolar, *Pentalagus, Romerolagus,* and *Pronolagus* are very similar.

The dental formula, the relation between radius and ulna, and the extremely short hind foot associate *Pentalagus* with *Ochotona*, but the general structure of its skull is entirely leporine.

Family OCHOTONIDÆ

Genus OCHOTONA Link

1778. *Lepus* (in part) Pallas, Glires, pp. 1–70.
1795. *Ochotona* Link, Beyträge Naturgesch., I, pt. ii, p. 74.
1800. *Lagomys* Cuvier, Leçons d'Anat. Comp., I, Table.
1867. *Ogotoma* Gray, Ann. Mag. Nat. Hist., XX, 3d ser., p. 220.
1867. *Lagomys* Gray, Ann. Mag. Nat. Hist., XX, 3d ser., p. 220.
1897. *Ochotona* Trouessart, Catalogus Mammalium, I, fasc. ii, p. 645.
1899. *Lagomys* Major, Trans. Linn. Soc. London, 2d ser., VII, Zool., p. 435, November, 1899.

Type.—Ochotona ochotona (Pallas).

Geographical Distribution.—In the mountain ranges of eastern Europe, central Asia, Siberia, and the Boreal Zone of the mountains of western North America.

Diagnosis.—Same as for the family Ochotonidæ. Duplicidentate rodents without postorbital processes, and the second upper cheek tooth different in structure from the third. See also page 384.

Skull (pl. XC).—As a whole the skull of *Ochotona* is small, flat, not arched, brain case not rounded or inflated, rostrum short and moderately slender, the greatest width of the nasals being anterior and not posterior as in the case of the typical Leporidæ.

Postorbital processes are lacking.

The interparietal is present as a distinct bone.

The bony palate is very short, and the incisive foramina in front and the choanæ behind are separated only by a very narrow bridge of bone. The sutures of the horizontal plates of the palate bones and of the horizontal plates of the maxilla are obliterated in adult skulls. Young individuals show that more than half of the bony palate is formed by the horizontal plates of the palate bones. The horizontal plate of the palate is largely developed between the dental alveoli and the outer border of the choanæ, each such portion of the horizontal plate of the palate bone being approximately equal to the width of the choanæ.

The incisive foramina are variously shaped; they may have an elongated, triangular form, as in *Ochotona roylii,* but more usually they are divided into two portions—a smaller anterior one just behind the upper incisors, and a larger, rather pyriform one, just anterior to the bony palate—by the uniting to a greater or less extent of the posterior ventral portions of the two premaxillary bones.

The zygoma is moderately heavy; at its antero-inferior angle is a well-marked tubercle; its posterior free extremity is very long.

The maxilla of *Ochotona* is not fenestrated as it is in the Leporidæ. Instead there is a single large, roughly triangular opening in the upper part of the nasal portion of the maxilla. In *Ochotona roylii,* however, the triangular opening is more elongated than in the other species, and just inferior to it there is a very slight amount of fenestration.

The mandible of *Ochotona* has a very wide ascending ramus and long condyle; the notch between the ascending ramus and the angular process is large. No groove or thin plate of bone is found on the anterior surface of the ascending ramus of the mandible, as in the Leporidæ, but a prominent tubercle occurs there which is lacking in the latter family. The mental foramen is situated on the side of the horizontal ramus, directly under the last lower molar.

Teeth (pl. XCI, 2; fig. 44, 25.)—The first upper incisors of *Ochotona* have each a single, simple groove. Their cutting edge is very sharp; that portion external to the groove is much produced downward, the internal portion only moderately so produced. In this manner an unequally sided V-like notch is seen on the front cutting edge of each tooth, with the groove at the point of the V.

The second upper incisors are small slender teeth placed directly behind the first. The lower incisors, a single pair, are longer, slenderer, and more pointed than the corresponding teeth in *Lepus* and its allies.

The first upper premolar is small, with a single reentrant angle on the inner half of the anterior face.

The second upper premolar has a reentrant angle on its anterior face, extending to the middle of the tooth and thence toward the outer edge. There is also a broad, shallow angle on the internal face of this tooth.

The three remaining upper jaw teeth possess each a single reentrant angle on the internal face, extending all the distance across the tooth, very much like the reentrant angles of the Leporidæ, but without any crenation. The last tooth has a projecting loop of enamel, from its posterior aspect, thus differing from the two teeth immediately in front of it.

The first lower premolar much resembles the anterior half of the first lower premolar of *Lepus*. It has two reentrant angles on the external face and one on the internal.

The second, third, and fourth mandibular cheek teeth of *Ochotona* are quite like the corresponding teeth of the Leporidæ, but the division into anterior and posterior portions is more marked and the two portions are entirely subequal.

The last lower molar is small, irregularly oval in outline, its pointed end being toward the external side. A posterior portion to this tooth is completely lacking.

Vertebral Column.—The cervical vertebræ (pl. XCII, 1) of the Ochotonidæ have the same general characteristics as in the Leporidæ. They are decidedly shortened antero-posteriorly, the laminæ of the posterior ones being very narrow. This shortening involves the axis but not the atlas. The latter has the free extremities of the transverse processes moderately expanded. The costo-transverse process of the third, fourth, and fifth cervicals are placed more obliquely to the axis of the vertebral column than the same processes in the Leporidæ. In the sixth they become horizontal as they do in the hares. The transverse process of the seventh cervical differs from the same process on the same vertebra in the Leporidæ in not being pierced by a costo-transverse or vertebral foramen.

The thoracic vertebræ of the Ochotonidæ are seventeen in number. The first twelve of the thoracic vertebræ, in *Ochotona,* are exactly homologous with the twelve thoracic vertebræ of the Leporidæ. The arrangement of the facets for the heads and the tubercles of the ribs is entirely similar. The five remaining rib-bearing vertebræ of *Ochotona* are practically indistinguishable from one another, as well as from the twelfth, except by the slightly greater size of each succeeding vertebra.

The spinous processes are relatively shorter in *Ochotona*, and this is especially true in the posterior thoracic region from the twelfth onward, where the spines are all low and slightly inclined forward. Each neural spine of these posterior thoracic vertebræ arises by a broad base from the whole length of the neural arch; the free extremity of the process is nearly as broad as the base, the posterior edge being slightly concave.

That part of the transverse process of the thoracic vertebra which articulates with the tubercle of the rib is of the same form in the two families. Associated with this transverse process in *Ochotona* are the metapophysis and the anapophysis. Both of these processes are first seen on the third thoracic as mere tubercles. The anapo-

physis grows larger on each succeeding vertebra, attaining its greatest size on the last thoracic. From the eleventh thoracic onward the anapophysis is a well-marked process, directed upward, backward, and outward. The metapophysis remains little more than a tubercle until the tenth thoracic vertebra is reached, where it is a well-marked process. On the eleventh it is slightly larger and on the twelfth still larger, closely associated with the prezygopophysis. The metapophysis scarcely increases in size through the rest of the series and continues closely associated with the prezygopophysis throughout.

No ventral spines or hypophyses are found on any of the vertebræ. Some of the posterior thoracic have a slight ventral ridge, which is also found on all the lumbar vertebræ.

There are five lumbar vertebræ (pl. XCIV, 10) in *Ochotona,* each of which is compact, with the processes broad and closely applied to body. The neural process is low, with the free edge as long as the whole length of the vertebra and parallel with its axis. The metapophysis is well developed and is more closely associated with the prezygopophysis than it is in the Leporidæ. Anapophyses are well developed on the first and second lumbar vertebræ and are a direct continuation of the thoracic series of anapophyses. These processes are slightly indicated on the third lumbar vertebra, after which point they disappear. The transverse process is little more than a tubercle on the first and second lumbar vertebræ, but on the third and fourth it is a wide quadrilateral plate of bone coming from the whole side of the vertebræ, sloping downward and outward. The transverse process of the fifth and last lumbar is a trifle longer than the other transverse processes and only about half as wide, the narrowing taking place chiefly at the expense of the posterior half of the process. There are no hypophyses, but all the lumbar vertebræ, as is the case of those lumbar vertebræ of the Leporidæ which do not bear ventral spines, possess a median ventral ridge.

The sacrum in the pikas is long and narrow, its greatest breadth being contained in its length about twice. The lateral masses that are attached to the ilia have sides that are nearly parallel. The neural spines, so distinct and conspicuous on the sacra of the Leporidæ, are reduced in the Ochotonidæ to form a low dorsal ridge, the spines having fused with one another. The number of vertebræ entering into the formation of the sacrum of the Ochotonidæ is four, the same as in the Leporidæ.

The caudal vertebræ in *Ochotona* are eight in number in all the skeletons at hand except one, which has nine. In the three American specimens, the first caudal is somewhat narrowed; the next two are

slightly wider, with faint indications of lateral projections; the rest of the series consists of short, flattened bodies. The single Asiatic skeleton has mainly the same character of the caudals, but the individual vertebræ are relatively wider throughout.

Sternum and Ribs (pls. XCVI, 2; XCIV, 9).—The material for making generalizations of the sterna of *Ochotona* is far from satisfactory. Among four skeletons but one is fully adult and there is a certain amount of variation among them. It may be that more material would show that there are two or three different types of sterna in the Ochotonidæ. Aside from a few minor details the sternum of the only adult *Ochotona* at hand, No. 91,188, is almost exactly like the sternum of *Romerolagus*. The expanded position of the manubrium is less developed in *Ochotona* than in *Romerolagus*, and rather triangular in outline instead of pentagonal. In other respects the two sterna are similar. The presternum is nearly as long as the mesosternum and slightly longer than the xiphisternum.

The mesosternum of *Ochotona* is, in general, very similar to that of *Romerolagus*. The first and second segments are subequal in length, the second, however, being broader. The third segment is the longest and broadest of the mesosternum. The fourth segment is the shortest and nearly as broad as the third. Both the third and fourth mesosternal segments are completely ankylosed as they are in *Romerolagus* and *Limnolagus*.

The xiphisternum is considerably expanded at the proximal end but the distal extremity is not much enlarged. It is decidedly shorter than the presternum.

The seventh rib is attached, along with the sixth rib, to the sternum at the point of union of the meso- and xiphi-sternum.

No. 30,990 *Ochotona saxatilis*, from Idaho, is very similar to the above; it is young, however, and the third and fourth pieces of the mesosternum are not yet fused.

No. 49,620, from Oregon, has the entire mesosternum narrow, and its last two segments separate.

No. 49,500 *Ochotona ladacensis*, has the enlarged portion of the presternum less expanded, the mesosternum is relatively longer and decidedly narrower than is the mesosternum of *O. saxatilis*, the third and fourth mesosternal segments are not fused. The mesosternum, as a whole, bears considerable resemblance to some of the mesosterna of *Sylvilagus*. The xiphisternum is rather short.

In *Ochotona* there are seventeen pairs of ribs, of which the first seven are attached to the sternum by means of costal cartilages; the

last seven, or about that number, have no ventral attachments, while the intermediate three pairs are attached to the costal cartilages of the ribs in front. The ribs are all slender and weak compared with the ribs of the Leporidæ, and none of them possesses well-developed spine-like tubercles, but between the heads and tubercles the anterior ribs are rather broad and heavy.

Shoulder Girdle and Upper Extremity.—In *Ochotona,* the clavicle (pl. XCVI, 2) is well developed; its outer end is enlarged, flattened, and connected by a ligament to the greater tuberosity of the humerus. The inner end articulates directly with the extreme anterior portion of the presternum.

The scapula (pl. XCVII, 5) has the general outline of a right-angled triangle with the right angle very much rounded off. The acromion process is very long and slender and about three times the length of the actual scapular spine. The metacromion is well developed. The posterior border of the scapula is long and concave; the superior border is relatively long and much rounded, so that it gradually passes into the anterior border. The distance between the antero-superior and postero-superior angles is contained a little more than once in the length of the scapula, taken along the attachment of the spine.

The humerus of *Ochotona* is in general very much like the same bone in *Lepus* and its allies. The head of the bone is rather more globular, and the bicipital groove does not encroach on its anterior surface. The anterior tuberosity does not project above the head of the bone, so that the latter point is its highest part. When viewed from the side, the head of the humerus is seen to project rather backward, so as to form a sort of hook with the shaft of the bone. The double trochlear surface, at the distal end of the bone, is rather wide and shallow. The groove subtending the internal condyle is poorly developed.

The bones of the forearm (pl. XCVIII, 11) in *Ochotona* are similar to the forearm bones of *Pentalagus* (page 430). The ulna is distinctly larger than the radius throughout its whole extent. The outer portion of the distal extremity of the ulna is prolonged downward into a convex articular surface which fits into a corresponding concavity formed by the cuneiform and pisiform bones. There is also a concave facet just internal to this projection which articulates with a corresponding convexity on the cuneiform.

The structure of the carpus of *Ochotona* is best understood by an examination of the figures (page 379). Compared with the carpus of *Lepus* and its allies the dorso-palmar depth of the pisiform is

relatively small, the lunare narrow, the internal half of the cuneiform larger, which presents a well-developed convex facet for articulation with the ulna, as mentioned above. The os centrale is quite large, and not flask-shaped. The os magnum is rather small. A small os vesalianum is present.

The metacarpus and phalanges of *Ochotona* are quite like the same structures in *Lepus*. The second and fourth metacarpals are nearly as long as the third. The width of the three middle metacarpals is contained about one and a half times in the length of the third metacarpal.

Pelvis and Lower Extremity.—The most striking feature of the pelvis of *Ochotona* is the absence of the symphysis pubis. The pubic bones are widely separated from one another but are connected by a ligament. As none of the few available skeletons are sexed, it is barely possible that this character is sexual. The os innominatum is rather long and slender, the ilium rather thick, its ventral third separated from the dorsal two-thirds by a well marked ridge, which terminates anteriorly and ventrally in a well-marked, recurved, pointed spine. The thyroid foramen is ovoid, its narrow end directed forward toward the acetabulum. The horizontal ramus of the pubis is very short, the descending ramus long, directed obliquely backward and downward.

The femur of *Ochotona* has the same general character that it has in *Lepus,* but is relatively thicker and heavier. The third trochanter is much reduced in size, the lesser trochanter relatively larger. The fossa behind the great trochanter is not so deep as in *Lepus*. The length of the femur is a trifle less than that of the tibia.

The tibia and fibula (pl. XCIX, 6, 7) of *Ochotona* are similar in all respects, except in absolute size, to these bones in *Romerolagus*. The fibula fuses with the tibia at the middle of the latter bone. The inner surface of the lower part of the shaft of the tibia is concave.

The tarsus of *Ochotona* is generally like that of *Lepus*. The middle cuneiform, however, is fused with the base of the second metatarsal. The basal width of the metatarsals is contained one and a half times in the greatest length of the metatarsals. There is a large sesamoid bone at the platar surface of the base of the fifth metatarsal. This bone is lacking in the Leporidæ, but is represented by a prominent tubercle on the fifth metatarsal in the same situation.

The skulls of *Ochotona* available for study are a heterogeneous lot, capable of being placed in three distinct groups, described below as subgenera.

Subgenus OCHOTONA Link

1795. *Ochotona* Link, Beyträge Naturgesch., 1, pt. ii, p. 74.
1867. *Ogotona* Gray, Ann. Mag. Nat. Hist., xx, 3d ser., p. 220.

Type.—*Ochotona ochotona* (Pallas).

Geographical Distribution.—Mountains of central Asia.

Diagnosis and Description.—Brain-case rather flattened, resembling that in subgenus *Pika*. Skull (pl. xc, 84,062) itself rather strongly arched, especially between the orbits. Interorbital region very narrow and pinched up. Incisive foramina constricted into two unequal portions as they are in subgenus *Pika*.

Represented by several skulls of *Ochotona ladacensis*. The figures published by Büchner, show that *O. koslowi* also belongs to this subgenus.

Subgenus CONOTHOA new

Type.—*Ochotona roylii* Ogilby.

Geographical Distribution.—Mountains of central Asia.

Diagnosis and Description.—Brain-case rather rounded, whole skull (pl. xc, 36,814) moderately arched from before backward, rostrum relatively long, its origin less abrupt than in the other subgenera. A small oval foramen, between one and two millimeters long, is found in the antero-superior part of each frontal bone; interorbital region moderately wide. The opening in the maxilla is elongated triangular; just beneath this large opening there is a small amount of fenestration. The incisive foramina together are triangular in outline, usually not constricted into an anterior and posterior portion.

This subgenus is represented by several skulls of *Ochotona roylii*. The figures of *O. erythrotis*, published by Büchner, show that it undoubtedly belongs in this subgenus, although the incisive foramina are constricted into two portions.

Subgenus PIKA Lacépède

1799. *Pika* Lacépède, Tableau de Divisions de Mammifères, p. 9.

Type.—*Ochotona alpina* (Cuvier).

Geographical Distribution.—Same as for the genus.

Diagnosis and Description.—Brain-case and whole skull (pl. xc, 66,678) very flat, interorbital region rather broad and flat, not pinched up or arched. No foramina in the anterior part of the frontals. Opening in the maxilla roundly triangular, single. Incisive foramina constricted into two unequal portions.

Ochotona alpina illustrated by Waterhouse (pl. 11), and all the American species belong to this subgenus.

VIII. GEOGRAPHICAL DISTRIBUTION

The family Leporidæ is widely distributed. Members of it are found in every portion of the world except the general regions embraced by Australia and neighboring islands, and by Madagascar and neighboring islands. In the terms of zoogeographers they are found throughout the Arctogæic realm (Lydekker '96) with the exception of the Malagasy region, and one genus is found in the Neogæic realm. No member of the family is found in the Notogæic realm, nor in the Malagasy region of the Arctogæic realm.

The genus *Lepus* has the same general distribution that the family has, except that no members so far as known are found in the Neogæic realm. This genus is found most abundantly in the Holarctic region.

The subgenus *Lepus* is mainly confined to the Holarctic region, but in North America one species, *Lepus campestris,* extends into the Sonoran region (Lydekker '96) or Arid Transition faunal area (Merriam '98).

The subgenus *Pœcilolagus,* so far as known, is found in that portion of North America which belongs to the Holarctic region, the Canadian, Hudsonian, and Transition zones.

The subgenus *Macrotolagus* is chiefly confined to the western arid portion of the Sonoran region of Lydekker or the arid portion of Merriam's Austral region embracing the Upper and Lower Sonoran.

The genus *Sylvilagus* is restricted entirely to the New World, where it extends throughout the Sonoran region of the Arctogæic realm of Lydekker, and southward more or less extensively throughout the Neogæic realm, or it may be said to occur throughout the Transition zone of Merriam and all the zones southward.

Brachylagus has a rather small distribution in the Upper Austral, called Upper Sonoran faunal area, in southern Idaho, northern Nevada and California, and eastern Oregon and Washington.

Limnolagus is found, in general, throughout the Austroriparian faunal area, occupying the greater part of the South Atlantic and Gulf states.

The genus *Oryctolagus* occurs in southern and western Europe and northern Africa, in general, the southwestern portion of Lydekker's Holarctic region in the Old World.

The genus *Pronolagus,* so far as known, is confined to the southern portion of Africa or the Ethiopian region.

The remaining genera of the Leporidæ contain but a single species each, and have a very limited distribution.

Caprolagus is found along the foothills of the Himalayas in northeastern India.

Nesolagus is found only in Sumatra.

Romerolagus is known only from Mount Popocatepetl, Mexico.

Pentalagus is known only from the Liu Kiu islands, south of Japan.

The family Ochotonidæ has a much less extensive distribution than the Leporidæ. Members of it are found in the Canadian zone of the Rocky mountains of western North America. They also occur in the mountain ranges of eastern Europe, central Asia, and in Siberia. They are thus confined to the Holarctic region of the Arctogæic realm.

IX. BIBLIOGRAPHY

The following bibliography gives the titles of the works which are referred to in, and have been of most service in the preparation of, the present paper, with the exception of those that are mentioned in the tables of synonomy, or incidentally in the text, where full references are given.

Baird, S. F., '57.

Mammals of North America, 1857, pp. 572–620, pls. LVI–LIX.

The following groups of the genus *Lepus* are recognized, designated by letters: A, corresponds to the genus *Lepus* exclusive of the subgenus *Macrotolagus;* B, corresponding to the subgenus *Macrotolagus;* C, to the genus *Oryctolagus;* D, to the subgenus *Sylvilagus;* E, to the subgenus *Microlagus,* and F, to the genus *Limnolagus.*

Excellent figures of skulls of *Lepus, Sylvilagus, Macrotolagus* and *Limnolagus* are given.

Blyth, Edward, '45.

Description of *Caprolagus,* a new genus of Leporine Mammalia.

Journal of Asiatic Society of Bengal, XIV, 1845, pp. 247–249.

Caprolagus proposed as a genus to include *Lepus hispidus* PEARSON.

Figures of the skull, dorsal, ventral and lateral views are given.

Büchner, Eug., '94.

Wissenschaftliche Resultate der von N. M. Przewalski nach Central-Asien Reisen Zool. Theil, Band I., Säugethiere. St. Petersburg, 1894.

Contains excellent photographic reproductions of the skulls of *Ochotona (Ochotona) ladacensis, Ochotona (Ochotona) koslowi, Ochotona (Conothoa) erythrotis. Ochotona (Pika) daurica. Lepus oistolus,* and *Lepus pallipes,* on plates XXIV and XXV.

Flower, William Henry, and Lydekker, Richard, '91.

Mammals, living and extinct, London, 1891, pp. 491–495.

Brief descriptions of the two families of the Duplicidentata, Lagomyidæ, and Leporidæ, each with a single existing genus, *Lagomys* and *Lepus,* are given.

Gray, J. E., '67.

Notes on the skulls of Hares (Leporidæ) and Picas (Lagomyidæ) in the British Museum. Annals and Magazine of Natural History, 3d series, vol. xx, 1867, pp. 219–225.

Lagomyidæ divided into two genera: *Ogotoma* and *Lagomys.*

Leporidæ divided into the following genera: *Hydrolagus, Sylvilagus, Eulagus, Lepus, Tapeti, Cuniculus, Carpolagus.*

Krause, W., '84.

Die Anatomie des Kaninchens in topographischer und operativer Rücksicht, Zweite Auflage, 1884, pp. 1–383.

It contains a complete anatomy of the common rabbit *Oryctolagus cuniculus;* pp. 36–46, general osteology; pp. 75 to 135, a detailed description of all the bones of the rabbit, illustrated by woodcuts, figs. 28 to 64; pp. 197–199, embracing figs. 80–82, devoted to the teeth. In the introduction, pp. 1–35, many of the differences between the hares *Lepus* and the rabbits *Oryctolagus* are pointed out, figs. 3–13. The skulls and bones of the forearm of each are figured.

Lilljeborg, '74.

Sveriges och Norges Ryggradsdjur, 1, 1874.

Describes *Lepus* with two subgenera, true *Lepus* represented by *timidus, Oryctolagus* (new name to replace Gray's *Cuniculus*) for *Lepus cuniculus.* The cranial characters of the two subgenera are carefully set forth.

Lydekker, Richard, '96.

A geographical History of Mammals, 1896.

A work of 400 pages with a map of the mammalian geographical realms and regions in the front.

Major, C. I. Forsyth, '99.

On Fossil and Recent Lagomorpha. Transactions of the Linnean Society of London, 2d ser., vii, Zoology, November, 1899, pp. 433–530, plates 36–39.

An elaborate account of recent and fossil forms, with excellent figures, especially of the teeth. The characters for the groups are not well defined and are rather obscured in the mass of general discussion.

Mearns, Edgar A., '96.

Preliminary description of a new subgenus and six new species and subspecies of hares from the Mexican border of the United States. Proc. U. S. Nat. Museum, xviii, pp. 551–565, June 24, 1896.

Macrotolagus described as a new subgenus of *Lepus.* Diagnoses of *Hydrolagus, Sylvilagus,* and *Macrotolagus* given.

Merriam, C. Hart, '96.

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The genus *Romerolagus* is described. Its sternum is figured.

Merriam, C. Hart, '98.

Life and Crop Zones of the United States. Bull. No. 10, U. S. Dept. Agric., Div. of Biol. Survey, 1898, pp. 1–79.

Map of the life zones of the United States in front.

Miller, Gerrit S., Jr., 1900.

A new subgenus for Lepus idahoensis. Proc. Biol. Soc. Washington, XIII, p. 157, June 13, 1900.

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Miller, Gerrit S., Jr., and Rehn, James A. G., '01.

Systematic Results of the Study of North American Land Mammals to the close of the year 1900. Proc. Boston Soc. Nat. Hist., XXX, No. 1, pp. 175–190, December 27, 1901.

It gives a complete list of all the North American Duplicidenta known up to the close of 1900 and places them in their several genera and subgenera, according to the views of modern workers.

Pallas, 1778.

Novæ Species Quadrupedum e Glirium Ordine. 1778, pp. 1–70, pls. I–IV.

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The external and internal anatomy of *Ochotona pusilla, alpina,* and *ogotona* is given with considerable detail. Figures of the skull and a figure of the entire skeleton of *pusilla* are given. *Lepus variabilis* and *L. tolai* are also described at some length.

Palmer, T. S., '04.

North American Fauna No. 23. Index Generum Mammalium. January 23, 1904.

On pp. 850–851, a list of the generic and subgeneric terms that have been applied to the Leporidæ; on p. 860, those that have been applied to the Ochotonidæ. In the body of this invaluable work, each of these terms is treated by itself.

Schlegel, H., '80.

On an anomalous species of Hare discovered in the Isle of Sumatra; *Lepus netscheri.* Notes from the Leyden Museum, II, 1880, pp. 59–65, February.

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Stone, Witmer, 1900.

Description of a new rabbit from the Liu Kiu islands, and a new flying squirrel from Borneo. Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 460–463.

External and cranial characters of *Pentalagus furnessi* (STONE) described. *Pentalagus* not recognized as distinct but considered a part of *Caprolagus,* which is regarded as a good genus.

Trouessart, E-L., '97.

Catalogus Mammalium, Vol. I, fasc. iii, 1897, pp. 644–664.

A list, with references, of all known hares, rabbits, and pikas is given. It aims to be a compilation of what has been published in a systematic way on the subject, up to its date of publication, together with the geographic distribution.

Microlagus is named on p. 660 as a subgenus for *Lepus cinerascens* ALLEN.

Waterhouse, G. R., '48.

A Natural History of the Mammalia, Vol. II, Rodentia, 1848, pp. 9–147, pls. I and II.

Contains an excellent account of the structure and characters of the two families Leporidæ and Ochotonidæ. All the species known at that time are described. On plate II good figures are given of the skulls of *Lepus timidus* and *Ochotona alpina.*

EXPLANATION OF PLATES

PLATE LXXIV (About four-fifths natural size)

1 and 1*a*. *Lepus* (*Macrotolagus*) *alleni*, No. 59,223, Sonora, Mexico.
2 and 2*a*. *Lepus* (*Lepus*) *europæus*, No. 105,831, Switzerland.

PLATE LXXV (About five-sixths natural size)

1. *Lepus* (*Pœcilolagus*) *americanus dalli*, No. 36,209, Alaska.
2. *Lepus* (*Macrotolagus*) *alleni*, No. 59,223, Sonora, Mexico.
3. *Lepus* (*Lepus*) *europæus*, No. 105,831, Switzerland.

PLATE LXXVI (About five-sixths natural size)

1, 4. *Lepus* (*Pœcilolagus*) *americanus dalli*, No. 36,209, Alaska.
2, 5. *Oryctolagus cuniculus*, No. 49,645, Germany.
3, 6. *Limnolagus palustris*, No. 2,089, Society Hill, South Carolina.
7, 8. *Sylvilagus* (*Sylvilagus*) *floridanus transitionalis*, No. 49,624, Monroe county, New York.
9, 10. *Sylvilagus* (*Microlagus*) *bachmani*, No. 44,416, San Luis Obispo, California.

PLATE LXXVII (About five-sixths natural size)

1. *Sylvilagus* (*Microlagus*) *bachmani*, No. 44,416, San Luis Obispo, California.
2. *Sylvilagus* (*Sylvilagus*) *floridanus transitionalis*, No. 49,634, Monroe county, New York.
3. *Pronolagus crassicaudatus*, No. 22,972, South Africa.
4. *Limnolagus palustris*, No. 2,089, Society Hill, South Carolina.
5. *Oryctolagus cuniculus*, No. 49,645, Germany.

PLATE LXXVIII (Natural size)

1*a*, 1*b*, 1*c*. *Romerolagus nelsoni*, No. 57,954, Mt. Popocatepetl, Mexico.
2*a*, 2*b*. *Pronolagus crassicaudatus*, No. 22,972, South Africa.
3. *Brachylagus idahoensis*, No. 93,696, Ione valley, Idaho.

PLATE LXXIX (Natural size)

1. *Brachylagus idahoensis*, No. 93,696, Ione valley, Idaho.
2*a*, 2*b*, 2*c*. *Pentalagus furnessi*, No. 5,583 (Wistar Institute), Liu Kiu islands.

PLATES LXXX, LXXXI (About three-fifths natural size)

1. *Lepus* (*Lepus*) *othus*, No. 15,878, St. Michaels, Alaska.
2. *Lepus* (*Lepus*) *europæus*, No. 1,857, Bavaria.
3. *Lepus* (*Lepus*) *tschuktschorum*, No. 86,459, Petropaulski, Kamschatka.
4. *Lepus* (*Lepus*) *variabilis*, No. 37,137, Sweden.
5. *Lepus* (*Lepus*) *campestris*, No. 49,623, Kansas.
6. *Lepus* (*Lepus*) *labradorius*, No. 23,132, type, Labrador.
7. *Lepus* (*Lepus*) *grœnlandicus*, No. 114,849, Bache peninsula, Greenland.
8. *Lepus* (*Lepus*) *varronis*, No. 105,834, Switzerland.

PLATES LXXXII, LXXXIII (About two-thirds natural size)

1. *Lepus* (*Macrotolagus*) *alleni*, No. 59,292, Sonoyta, Mexico.
2. *Lepus* (*Macrotolagus*) *merriami*, No. 84,646, Fort Clark, Texas.
3. *Lepus* (*Macrotolagus*) *asellus*, No. 36,009, type, San Luis Potosi, Mexico.
4. *Lepus* (*Macrotolagus*) *callotis*, No. 35,678, Guadalajara, Mexico.
5. *Lepus* (*Macrotolagus*) *californicus*, No. 60,867, U. S. and Mexican boundary line at Pacific ocean.
6. *Lepus* (*Macrotolagus*) *texianus eremicus*, No. 63,119, U. S. and Mexican boundary line, monument No. 77.
7. *Lepus* (*Macrotolagus*) *texianus*, No. 63,118, U. S. and Mexican boundary line, monument No. 64.
8. *Lepus* (*Macrotolagus*) *gaillardi*, No. 35,709, White Water, Chihuahua, Mexico.

PLATES LXXXIV, LXXXV (About five-eighths natural size)

1. *Lepus ruficaudatus*, No. 38,039, India.
2. *Lepus ochropus*, No. 34,735, Kilima-njaro, Africa.
3. *Lepus hypsibius*, No. 84,076, Rupshu, Ladak.
4. *Lepus tibetanus*, No. 62,126, Ladak.
5. *Lepus yarkandensis*, No. 62,132, Yarkand river, eastern Turkestan.
6. *Lepus* (*Pœcilolagus*) *washingtonii*, No. 6,865, Washington.
7. *Lepus* (*Pœcilolagus*) *americanus dalli*, No. 36,209, Alaska.
8. *Lepus* (*Pœcilolagus*) *americanus struthopus*, No. 23,123, Labrador.
9. *Lepus* (*Pœcilolagus*) *americanus virginianus*, No. 101,844, Massachusetts.
10. *Lepus* (*Pœcilolagus*) *americanus macfarlani*, No. 14,467, type, Fort Anderson, British America.

PLATES LXXXVI, LXXXVII (Nine-fourteenths natural size)

1. *Sylvilagus* (*Sylvilagus*) *floridanus mallurus*, No. 1,227, District of Columbia.
2. *Sylvilagus* (*Sylvilagus*) *floridanus yucatanicus*, No. 37,772, type, Merida, Yucatan.
3. *Sylvilagus* (*Sylvilagus*) *floridanus mearnsi*, No. 22,409, Illinois.
4. *Sylvilagus* (*Sylvilagus*) *truei*, No. 112,787, Mexico.
5. *Sylvilagus* (*Sylvilagus*) *margaritæ*, No. 63,217, type, Margarita island.
6. *Sylvilagus* (*Sylvilagus*) *subcinctus*, No. 35,663, Hacienda El Molino, Mexico.
7. *Sylvilagus* (*Sylvilagus*) *brasiliensis gabbi*, No. 37,794, type, Talamanca, Costa Rica.

8. *Sylvilagus (Sylvilagus) paraguensis,* No. 121,423, Sapucay, Paraguay.
9. *Sylvilagus (Sylvilagus) arizonæ,* No. 58,863, Fort Lowell, Arizona.
10. *Sylvilagus (Sylvilagus) auduboni,* No. 60,921, Coast Range mountains, U. S. and Mexican boundary line.
11. *Sylvilagus (Microlagus) cinerascens,* No. 60,871, Tecate river, U. S. and Mexican boundary line.
12. *Sylvilagus (Microlagus) bachmani,* No. 35,131, Nicasio, California.
13. *Sylvilagus (Microlagus) bachmani ubericolor,* No. 35,371, type, Beaverton, Oregon.

PLATES LXXXVIII, LXXXIX (About five-eighths natural size)

1. *Oryctolagus cuniculus,* domestic, Belgian hare, No. 105,402.
2. *Oryctolagus cuniculus,* common domestic, No. 62,704.
3. *Oryctolagus cuniculus,* common domestic, No. 36,831.
4. *Oryctolagus cuniculus,* wild, No. 3,124, England.
5. *Oryctolagus cuniculus,* wild, No. 49,645, Germany.
6. *Limnolagus paludicola,* No. 64,029, Kissimmee, Florida.
7. *Limnolagus palustris,* No. 2,089, Society Hill, South Carolina.
8. *Limnolagus aquaticus,* No. 3,779, Warren county, Mississippi.
9. *Limnolagus aquaticus,* No. 84,109, Mississippi.
10. *Limnolagus attwateri,* No. 97,031, Richmond, Texas.

PLATE XC (Natural size)

1. *Ochotona (Ochotona) ladacensis,* No. 84,063, Ladak, central Asia.
2. *Ochotona (Pika) princeps,* No. 66,678, Nelson, British Columbia.
3. *Ochotona (Conothoa) roylei,* No. 36,814, Baltistan.

PLATE XCI (Enlarged three times)

LOWER AND UPPER CHEEK TEETH, RIGHT SIDE

1. *Brachylagus idahoensis,* No. 23,104, Goose lake, California.
2. *Ochotona ladacensis,* No. 84,062, Ladak, central Asia.
3. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.
4. *Limnolagus paludicola,* No. 64,029, Kissimmee, Florida.
5. *Oryctolagus cuniculus,* No. 49,648, England.
6. *Lepus campestris,* No. 61,367, Madison, Minnesota.
7. *Pentalagus furnessi,* No. 5,583 (Wistar Institute), Liu Kiu islands.
8. *Pronolagus crassicaudatus,* No. 22,972, South Africa.
9. *Sylvilagus floridanus,* No. 49,588, Florida.

PLATE XCII (Natural size except Figure 1, which is enlarged twice)

VENTRAL VIEWS OF CERVICAL VERTEBRÆ

1. *Ochotona saxatilis,* No. 91,188, Cabinet mountains, Idaho.
2. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.
3. *Brachylagus idahoensis,* No. 93,595, Ione valley, Idaho.
4. *Limnolagus paludicola,* No. 49,580, Florida.
5. *Sylvilagus floridanus,* No. 49,587, Florida.
6. *Oryctolagus cuniculus,* No. 49,645, Germany.
7. *Lepus (Lepus) campestris,* No. 49,623, Kansas.
8. *Lepus (Pœcilolagus) americanus virginianus,* No. 969, New York.
9. *Lepus (Macrotolagus) texianus,* No. 94,198, Newark valley, Nevada.
10. *Pronolagus crassicaudatus,* No. 22,972, South Africa.

PLATE XCIII (Natural size)

LUMBAR VERTEBRÆ, SEEN FROM THE SIDE.

1. *Lepus (Lepus) campestris,* No. 49,622, Nebraska.
2. *Lepus (Pœcilolagus) americanus virginianus,* No. 969, New York.
3. *Pronolagus crassicaudatus* No. 22,972, South Africa.
4. *Oryctolagus cuniculus,* No. 49,648, England.
5. *Oryctolagus cuniculus,* lop-ear, domestic, No. 49,386.

PLATE XCIV (Natural size, except 9 and 10 enlarged twice)

RIBS AND LUMBAR VERTEBRÆ

1. *Lepus texianus,* No. 04,198, Newark valley, Nevada.
2. *Lepus campestris,* No. 49,623, Kansas.
3. *Pronolagus crassicaudatus,* No. 22,972, South Africa.
4. *Oryctolagus cuniculus,* No. 49,645, Germany.
5. *Sylvilagus floridanus mallurus,* No. 89,514, Four-mile Run, Virginia.
6. *Limnolagus palustris,* No. 49,580, Florida.
7. *Brachylagus idahoensis,* No. 93,595, Ione valley, Idaho.
8. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.

9 and 10. *Ochotona saxatilis,* No. 91,188, Cabinet mountains, Idaho.

11. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.
12. *Brachylagus idahoensis,* No. 93,595, Ione valley, Idaho.
13. *Limnolagus paludicola,* No. 49,580, Florida.
14. *Sylvilagus floridanus mallurus,* No. 89,514, Four-mile Run, Virginia.

PLATE XCV (Natural size)

STERNA AND COSTAL CARTILAGES, VENTRAL VIEW.

1. *Brachylagus idahoensis,* No. 93,595, Ione valley, Idaho.
2. *Sylvilagus floridanus,* No. 49,587, Florida—clavicles shown.
3. *Lepus (Macrotolagus) texianus,* No. 94,198, Newark valley, Nevada.
4. *Lepus (Lepus) campestris,* No. 49,622, Nebraska.
5. *Oryctolagus cuniculus,* No. 49,645, Germany—clavicles shown.

PLATE XCVI

STERNA AND COSTAL CARTILAGES, VENTRAL VIEW.

1. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico—clavicles shown. Natural size.
2. *Ochotona saxatilis,* No. 91,188, Cabinet mountains, Idaho—clavicles shown. Twice natural size.
3. *Pronolagus crassicaudatus,* No. 22,972, South Africa, natural size.
4. *Nesolagus netscheri,* copied from Pl. 39, fig. 18, Major '99.
5. *Limnolagus paludicola,* No. 49,580, Florida, natural size.

PLATE XCVII (Natural size)

SCAPULÆ.

1. *Lepus (Lepus) campestris,* No. 49,623, Kansas.
2. *Lepus (Macrotolagus) texianus,* No. 94,198, Newark valley, Idaho.
3. *Oryctolagus cuniculus,* No. 49,648, England.
4. *Pronolagus crassicaudatus,* No. 22,972, South Africa.
5. *Ochotona saxatilis,* No. 91,188, Cabinet mountains, Idaho.
6. *Limnolagus paludicola,* No. 49,580, Florida.

7. *Sylvilagus floridanus,* No. 49,588, Florida.
8. *Brachylagus idahoensis,* No. 93,696, Ione valley, Idaho.
9. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.

PLATE XCVIII (Natural size)

BONES OF THE FORE ARM

1. *Lepus (Lepus) campestris,* No. 49,623, Kansas.
2. *Lepus (Macrotolagus) texianus,* No. 94,198, Newark valley, Nevada.
3. *Lepus (Pœcilolagus) americanus virginianus,* No. 969, New York.
4. *Sylvilagus floridanus,* No. 49,586, Florida.
5. *Limnolagus paludicola,* No. 49,580, Florida.
6. *Brachylagus idahoensis,* No. 93,696, Ione valley, Idaho.
7. *Pronolagus crassicaudatus,* No. 22,972, South Africa.
8. *Oryctolagus cuniculus,* No. 49,648, England.
9. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.
10. *Pentalagus furnessi,* No. 5,583 (Wistar Institute), Liu Kiu islands.
11. *Ochotona saxatilis,* No. 91,188, Cabinet mountains, Idaho.

PLATE XCIX (Natural size)

BONES OF THE LEG

1. *Lepus campestris,* No. 49,622, Nebraska.
2. *Oryctolagus cuniculus,* No. 49,645, Germany.
3. *Pronolagus crassicaudatus,* No. 22,972, South Africa.
4. *Pentalagus furnessi,* No. 5,583 (Wistar Institute), Liu Kiu islands.
5. *Sylvilagus floridanus,* No. 49,586, Florida.
6. *Ochotona saxatilis,* No. 91,188, Cabinet mountains, Idaho.
7. *Ochotona ladacensis,* No. 49,500, Ladak, central Asia.
8. *Brachylagus idahoensis,* No. 93,696, Ione valley, Idaho.
9. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.
10. *Limnolagus paludicola,* No. 49,580, Florida.

PLATE C (Natural size)

HIND FEET

1. *Ochotona ladacensis,* No. 49,500, Ladak, central Asia.
2. *Romerolagus nelsoni,* No. 57,954, Mt. Popocatepetl, Mexico.
3. *Brachylagus idahoensis,* No. 93,696, Ione valley, Idaho.
4. *Pentalagus furnessi,* No. 5,583 (Wistar Institute), Liu Kiu islands.
5. *Limnolagus paludicola,* No. 49,580, Florida.
6. *Lepus campestris,* No. 49,623, Nebraska.
7. *Pronolagus crassicaudatus,* No. 22,972, South Africa.
8. *Oryctolagus cuniculus,* No. 49,645, Germany.
9. *Sylvilagus floridanus,* No. 49,586, Florida.