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THE RABBITS *(HYPOLAGUS* AND *PRATILEPUS)* FROM THE UPPER PLIOCENE, HAGERMAN LOCAL FAUNA OF IDAHO

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INTRODUCTION

In 1956, when I visited the area of the United States National Museum Horse Quarry (Gazin, 1936), west of Hagerman in Twin Falls County, Idaho, with Dwight W. Taylor, I discovered that the Glenns Ferry Formation (Malde and Powers, 1962) contained numerous remains of small vertebrates. It was observed at this time that the microtine rodent *(Cosomys)* did not occur in the upper part of the section but was replaced by *Ophiomys* (Hibbard and Zakrzewski, 1967).

It was evident that careful collecting in the area would yield a much larger fauna for this time interval and that numerous remains of the more common vertebrates could be recovered for population studies.

Since the project was started, Evernden, *et al.* (1964, p. 14), have dated basalt within the Glenns Ferry Formation from Elmore County, Idaho, which lies at a stratigraphic position approximately 90 feet below the Horse Quarry in Twin Falls County. The basalt gave a potassium-argon date of 3.48 ± 0.27 million years old. "This basalt directly overlaps another lava flow that extends to the area of the Horse Quarry. They dated a volcanic ash taken 70 feet below this lower basalt. It gave a potassium-argon date of 3.3 million years (Sample KA 831). Another volcanic ash taken 80 feet above the lower basalt, hence at about the same stratigraphic position as the Horse Quarry, gave a potassium-argon date of 3.2 million years (Sample KA 832). These dates, as well as the fauna, establish a late Pliocene age for this part of the Glenns Ferry Formation." (The stratigraphy of these dated deposits was explained to us by H. E. Malde, written communication, January 19, 1968, and is based on unpublished maps prepared by him and H. A. Powers.)

Only the three rabbits *Hypolagus,* near *vetus, H. limnetus* and *Pratilepus vagus* reported by Gazin (1934) were recovered from the deposits. The specimens included in this study are in the United States National Museum collections and The University of Michigan collections. They came from the west side of the Snake River from the Glenns Ferry Formation in Secs. 16, 17, 20, 21, 28, 29, 32 and 33, T.7S., R.13E., and Secs. 5 and 8, T.8S., R.13E., Twin Falls County, Idaho.

They were recovered from 34 localities over an area of approximately 6 square miles ranging in elevation from 2950 feet to 3350 feet.

The rabbits from the Hagerman local fauna have been studied to determine their relationship with the earlier rabbits from the Rexroad local fauna from Kansas. The variations found in the dentitions of the three species of rabbits from the Hagerman local fauna are discussed and compared with those of *Hypolagus* and *Pratilepus* from Kansas.

Two partial skeletons with skull and associated lower jaws collected by the United States National Museum field party in 1934 have helped greatly in the study. Kenneth Campbell, Jr. has made a careful analysis of the skeletal structure of the three species of rabbits.

Catalogue numbers not otherwise identified are those of The University of Michigan, Museum of Paleontology and are preceded by the letter V. Names of other collections are abbreviated as follows: KUMNH, University of Kansas, Museum of Natural History; UMMZ, The University of Michigan, Museum of Zoology; and USNM, United States National Museum.

Hypolagus sp. *aff. H. vetus* (Kellogg) (Figs. 1A-B; 2A, E-F, and H-I; 3F-G)

Hypolagus, near *vetus* (Kellogg); Gazin, 1934, Proc. U.S. Natl. Mus., 83 (2976): 112–114, figs. 1a-b

Material.—In The University of Michigan collection there are parts of eight right and four left lower jaws with $P_{\bar{3}}$, or more teeth; also 62 right and 51 left $P_{\bar{3}}$s. These specimens were recovered in an area of 6 square miles, from 21 localities in the Glenns Ferry Formation ranging in elevation from 2950′ to 3295′. From these localities and others in the area were taken parts of the postcranial skeleton of this rabbit.

In addition to the above specimens, there are included those reported by Gazin (1934), and a skull, lower jaws and part of an associated skeleton, USNM 23573, which was taken in the embayment south of the Horse Quarry, June 12, 1934.

The associated lower jaws and skull (Figs. 1A-B; 3F) of a young adult *Hypolagus* are the best known in North America.

Skull, USNM 23573.—The braincase is more arched anteroposteriorly than in Recent skulls examined of the genera *Brachylagus, Lepus, Oryctolagus, Pentalagus, Pronolagus, Romerolagus* and *Sylvilagus*. The size and shape of the skull is more like a male skull (UMMZ 102219) of *Oryctolagus cuniculus* (Linnaeus) from Bremen, Germany.

The external occipital protuberance is directed ventrally at a much more acute angle in relation to the occipital condyles than in Recent specimens of the above genera. The parietal-frontal suture is straight and ends on the side of the skull dorsal to the zygomatic process of the squamosal. The parietals are 21.2 mm in length, measured along the midsuture.

The frontals are broken in the area of the supraorbital processes. There is a slight upward flexure of the frontals in this area. The anteroposterior length of the orbit from the posterior

side of the zygomatic process of the maxillary to the anterior face of the zygomatic process of the squamosal is 22.4 mm. The vertical height is 17.0 mm. Only part of the right postorbital process is present. There is a small piece of bone missing from both sides of the skull at the squamosal-frontal suture where the postfrontal projection could have attached to the skull. The right zygomatic arch is complete. The temporal fossa is better developed than in *Sylvilagus floridanus* (J. A. Allen) and approaches the condition observed in *Oryctolagus*.

The left bulla and left side of the skull have been flexed anteriorly 2.5 mm as shown by the relation of the zygomatic process of the squamosal to that of the jugal. This flexure does not account for the arched outline of the braincase.

The suture between the anterior part of the frontals where they join the median sides of the nasals is like the condition observed in *Sylvilagus floridanus* and *Oryctolagus cuniculus*.

The relation of the intermaxillary to the nasal (Fig. 1A) is as shown by Sych (1965, fig. 2a) in *Hypolagus brachygnathus* Kormos and as observed in *Sylvilagus floridanus*.

The reticulated surface of the maxillaries has been destroyed but the reticulated area does not appear to have been as large as in *Oryctolagus*.

The anterior edge of the incisive foramina is 3.0 mm posterior to the alveolar borders of the posterior incisors. The foramina end posteriorly on a line with the anterior alveolar border of P^3. The maxillopalatine suture is fractured but it appears to cross the palatal bridge approximately in line with the middle of P^4 as observed by Dawson (1958) in *Hypolagus vetus*.

The posterior nasal opening is narrower transversely than that of *Sylvilagus floridanus* and is more like that observed in *Oryctolagus cuniculus*.

The tympanic bullae are intermediate in size between those of *Sylvilagus floridanus* and *Oryctolagus*. The bullae have an anteroposterior length of 16.0 mm and a transverse width of 8.0 mm. The basioccipital is 7.9 mm long and has a median ridge. The exoccipitals are larger than those of *S. floridanus* and *O. cuniculus*. The greatest distance across the condyles is 15.0 mm. The paroccipital (jugular) process is strongly developed and is closer to the exoccipitals than observed in Recent rabbits. For measurements of the skull and dentition, see Tables 1 and 2.

Dentition.—The transverse width of the first upper incisor is 2.8 mm. The P^2 (Fig. 2A) has a shallow labial groove. The deep anterior groove is located three-fifths of the transverse width in from the labial side of the tooth. The groove swings labially and is not crenulated. The deep anterior groove of P^2 in *Pratilepus* is more centrally located and contains more cement than that of *Hypolagus*. The labial side of P^2 of *Pratilepus* is more acute than that of *Hypolagus*.

Lower Jaw.—It resembles that of *Sylvilagus palustris* (Bachman) and *S. aquaticus* (Bachman) in that the condyloid process supporting the articular surface is more nearly vertical than in *S. floridanus* and *Oryctolagus cuniculus*. The articular surface has a greater transverse width (4.0 mm) than that of *Oryctolagus* (3.5 mm). The

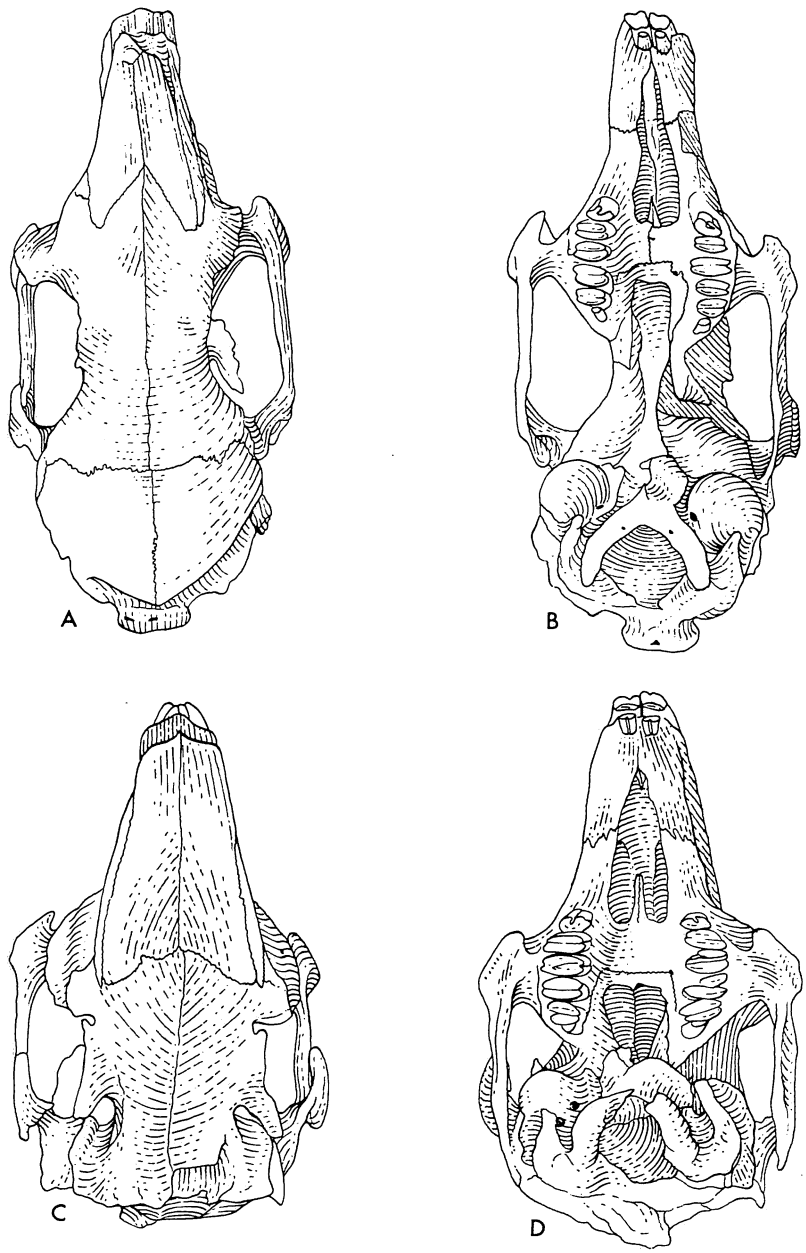

FIG. 1. *Hypolagus* and *Pratilepus*: A and B dorsal and ventral views, skull of *Hypolagus* sp. *aff. H. vetus*, USNM 23573. C and D dorsal and ventral views, skull of *Pratilepus vagus*, USNM 23574. All views X1. Drawn by Alice R. Ballard.

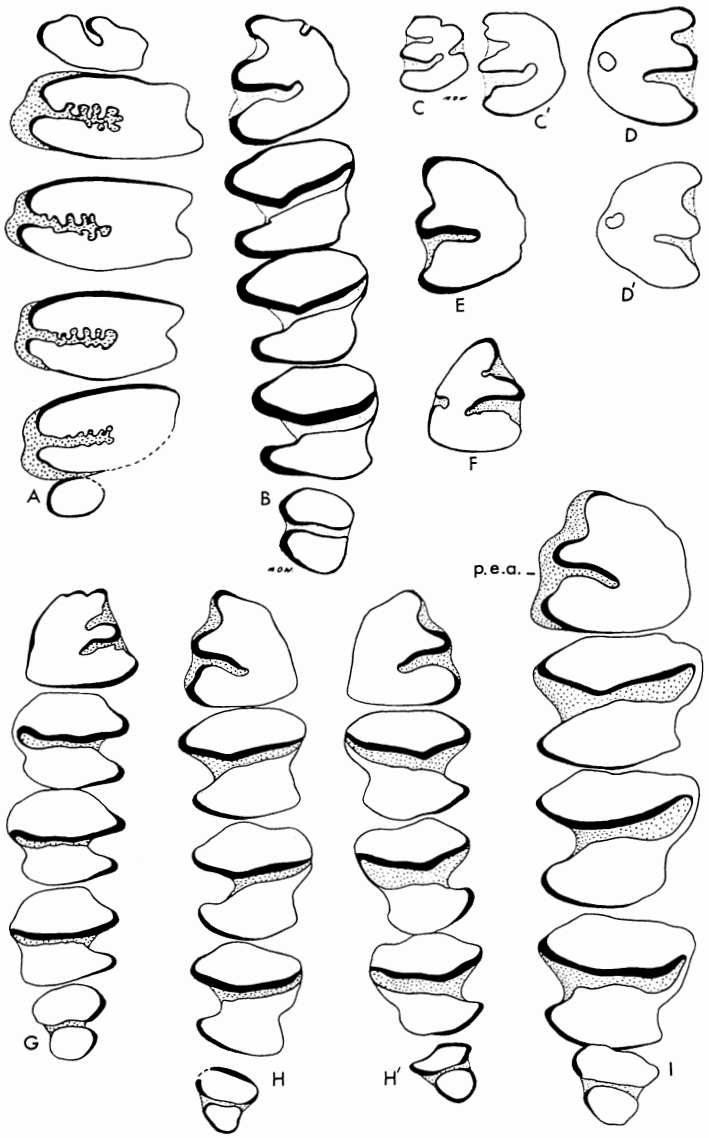

FIG. 2. *Hypolagus*, occlusal views: A, *Hypolagus* sp. *aff. H. vetus*, USNM 23573, left P^2 – M^3. B – D, *H. regalis*, Rexroad fauna: B, left $P_{\bar{3}}$ – $M_{\bar{3}}$, V29678; C-C′ immature left $P_{\bar{3}}$, V39783, C′ base view reversed; D-D′ right $P_{\bar{3}}$, V42635; D′ base view reversed. E – F, *Hypolagus aff. H. vetus*, Hagerman fauna: E, left $P_{\bar{3}}$, V49713; F, $RP_{\bar{3}}$, V55053. G, *H. limnetus*, right $P_{\bar{3}}$ – $M_{\bar{3}}$, V54782; *Hypolagus aff. H. vetus*, H and H′, USNM 23573, left and right $P_{\bar{3}}$ – $M_{\bar{3}}$, lower jaws united. I, left $P_{\bar{3}}$ – $M_{\bar{3}}$, V48946. All times 6.

Abbreviation: p.e.a., posterior external reentrant angle. Figures B, C and C′ drawn by Michael O. Woodburne (M.O.W.) the other drawings by Alice R. Ballard.

TABLE I
MEASUREMENTS IN MILLIMETERS OF *HYPOLAGUS*, NEAR *VETUS*, *PRATILEPUS VAGUS*, *SYLVILAGUS FLORIDANUS* AND *ORYCTOLAGUS CUNICULUS*.

	HYPOLAGUS USNM # 23573	*PRATILEPUS* USNM # 23574	*SYLVILAGUS* UMMZ # 58264	*ORYCTOLAGUS* UMMZ # 102219
Condylobasal length	65.5	—	62.5	70.0
Basilar length of Hensel	57.0	—	54.0	60.0
Length of incisive foramen	17.5	18.4 approx.	17.6	29.2
Diastemal length, $I^{\frac{2}{2}}$ to $P^{\frac{2}{2}}$	18.0	20.0 approx.	19.0	21.5
Depth of rostrum in front of premolars	15.8	—	13.5	15.8
Anteroposterior diameter of bulla	11.2	9.5	11.0	11.0
Transverse diameter from median edge	9.1	8.7	6.5	7.3
Width across anterior roots of zygomatic arches	35.0	38.9	33.0	35.5
Length of palate	7.5	8.0	8.0	7.3
Length of palatine on palate	2.9	1.9	2.8	1.8
Length of maxilla on palate	4.6	6.1	5.2	5.5
Interorbital constriction	14.6	14.0	12.2	12.0
Greatest length of nasal	27.0	29.5	31.0	29.6
Diastemal length, $I - P_{\frac{3}{3}}$	15.5	15.8	14.4	16.5
Alveolar length of $P_{\frac{3}{3}} - M_{\frac{3}{3}}$	15.0	15.4	14.0	14.5
Occlusal length of $P_{\frac{3}{3}} - M_{\frac{3}{3}}$	12.9	13.6	11.7	12.8
Transverse width of lower incisor	2.7	3.2	2.5	2.5

TABLE II
MEASUREMENTS IN MILLIMETERS OF *HYPOLAGUS* SP. *H. AFF. VETUS*, USNM 23573

$LP^{\bar{2}}$	
anteroposterior length	1.50
transverse width	2.80
$LP^{\bar{3}}$	
anteroposterior length	2.20
transverse width	4.20
$LP^{\bar{4}}$	
anteroposterior length	2.30
transverse width	4.20
$LM^{\bar{1}}$	
anteroposterior length	2.20
transverse width	3.80
$LM^{\bar{2}}$	
anteroposterior length	2.00
transverse width	3.30
$LM^{\bar{3}}$	
anteroposterior length	0.97
transverse width	1.60
$LP^{\bar{2}} - M^{\bar{3}}$	
alveolar length	15.20
$LP^{\bar{2}} - M^{\bar{3}}$	
occlusal length	12.00
$LP_{\bar{3}}$	
anteroposterior length	2.90
transverse width	2.70
$LP_{\bar{4}}$	
anteroposterior length	2.70
transverse width	3.00
$LM_{\bar{1}}$	
anteroposterior length	2.80
transverse width	2.80
$LM_{\bar{2}}$	
anteroposterior length	2.80
transverse width	2.70
$LM_{\bar{3}}$	
anteroposterior length	1.60
transverse width	1.58

vertical distance from the dorsal surface of the articular to the bottom of the angle is 37.0 mm. The greatest length of the jaw from the edge of the alveolus of the incisor to the posterior edge of the angle is 54.6 mm. The diastemal length from the anterior border of the alveolus of $P_{\bar{3}}$ to the alveolus of the incisor is 15.5 mm. The mental foramen is on the labial side of the jaw and 4.5 mm anterior to $P_{\bar{3}}$. The depression for the external pterygoid muscle is very shallow. The shelf on the lingual side of the angle of the jaw in the area of the insertion of the internal pterygoid muscle is poorly developed. The lower jaws are united at the symphysis. The transverse width of the lower incisor is 2.7 mm.

Remarks.—I have followed Gazin (1934) in considering the specimens as being near *Hypolagus vetus* Kellogg. I have been unable to study the holotype of *Hypolagus vetus* or the specimens reported by Dawson (1958). The species of *Hypolagus* from the Hagerman local fauna are quite distinct from *Hypolagus regalis* Hibbard (1939) from the Rexroad local fauna. The specimens from Hagerman belong to the *Hypolagus vetus* group as is shown by the posteriorly directed posterior external reentrant angle of $P_{\bar{3}}$ (Figs. 2H-I). All of the $P_{\bar{3}}$s except two from the Hagerman local fauna have the posterior external reentrant angle directed posteriorly. In the other two $P_{\bar{3}}$s the reentrant angle is straight (Fig. 2E).

One $P_{\bar{3}}$ (No. V55053, Fig. 2F) from the Hagerman local fauna has a shallow, internal reentrant angle anterior to the posterior external reentrant

angle (Fig. 2I, p.e.a.). The lack of variation in the dental pattern is in contrast to the variation observed in *Hypolagus regalis* from the Rexroad local fauna of Kansas.

There are 28 left and 36 right $P_{\bar{3}}$s of *Hypolagus regalis* from KU Locality 3, and two right and two left $P_{\bar{3}}$s from Locality UM-K3-53 (Woodburne, 1961) of the Rexroad local fauna of Meade County, Kansas. The external posterior reentrant angle swings forward in 38 of the $P_{\bar{3}}$s (Fig. 2B). In 13 of the $P_{\bar{3}}$s this angle is straight and in 13 $P_{\bar{3}}$s it curves backward.

The $P_{\bar{3}}$ (No. V29678) from KU Locality 3 has an anterolingual reentrant angle filled with cement (Fig. 2B). There is a left $P_{\bar{3}}$ (No. V49633) of *Hypolagus furlongi* Gazin from the Grand View local fauna of Idaho that has a lingual reentrant filled with cement. If I am correct, the $RP_{\bar{3}}$ (No. V42635, Fig. 2D-D′) from KU Locality 3, is that of *Hypolagus regalis,* where a lingual reentrant has become isolated as an enamel island (see Hibbard, 1963, fig. 2U-U′). This tooth has a posterior internal enamel lake as in *Hypolagus browni* (Hay) USNM 10201a (fig. 10 of Dice, 1932). The $P_{\bar{3}}$ (V42635) has the general shape of the $P_{\bar{3}}$ of *Hypolagus* as well as a shallow anterior external reentrant angle in contrast to the deep and generally trefoiled reentrant of *Pratilepus kansasensis.* The occlusal and reversed ventral patterns of an immature $P_{\bar{3}}$ of *Hypolagus regalis* are shown in Figure 2C and C′ from KU Locality 3.

The specimens of *Hypolagus* sp. *aff. H. vetus* from the Hagerman local fauna taken through a vertical section of 345 feet represent a homogenous species of rabbit when based on the occlusal pattern of $P_{\bar{3}}$. No evolutionary trends were observed among the specimens examined.

Hypolagus limnetus Gazin

(Fig. 2G)

Hypolagus limnetus Gazin, 1934, Proc. U.S. Natl. Mus., 83(2976): 114–117, figs. 3a and b.

Material.—In The University of Michigan collection there are 8 right and 7 left $P_{\bar{3}}$s and a right lower jaw with $P_{\bar{3}} - M_{\bar{3}}$ (Fig. 2G). These were taken from 10 localities, ranging in elevation from 3000 feet to 3350 feet in the Glenns Ferry Formation in the area of the U.S. National Museum Horse Quarry.

The dental pattern and size of $P_{\bar{3}}$ is like that of the holotype (USNM 12619). No variation was observed in the dental pattern. The deep, narrow anteroexternal angle of $P_{\bar{3}}$ distinguishes this small species of *Hypolagus.* The occlusal length of the right $P_{\bar{3}} - M_{\bar{3}}$ (No. V54782) is 12.27 mm (Fig. 2G). Parts of skeletons were found at two of the localities where teeth were recovered.

Remarks.—The few isolated $P_{\bar{3}}$s recovered of *Hypolagus furlongi* (Fig. 3A) from the area of the late Blancan Grand View local fauna are all slightly smaller than the $P_{\bar{3}}$ of *H. limnetus. Hypolagus furlongi* has a shallow anteroexternal reentrant angle. The same condition is observed in the small *Hypolagus* sp. (Fig. 3b) from the Deer Park local fauna of Kansas (Hibbard, 1956). The small *Hypolagus* from the later Borchers local fauna of Meade

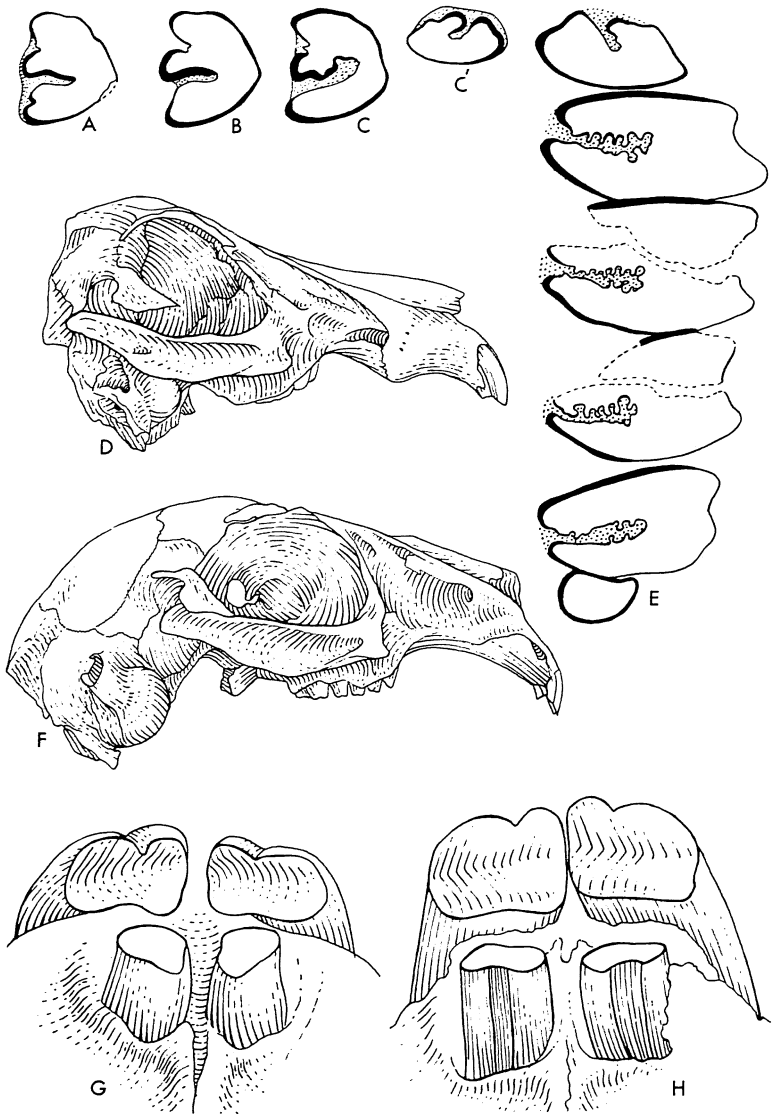

FIG. 3. *Hypolagus* and *Pratilepus*: A, *Hypolagus furlongi*, Grand View fauna, left $P_{\bar{3}}$, V49414. B, *Hypolagus* sp. Deer Park fauna, left $P_{\bar{3}}$, V31955. C – C′, *Hypolagus* sp. Borchers fauna, left $P_{\bar{3}}$ and right $P^{\underline{2}}$, V51338. All occlusal views. X6. D, E and H, *Pratilepus vagus*, Hagerman fauna; D, lateral view of skull, USNM 23574. X1. E, left $P^{\underline{2}}$ – $M^{\underline{3}}$, occlusal view, USNM 23574. X6. H, occlusal view of anterior and posterior incisors, USNM 23574. X6. F and G, *Hypolagus* sp. *aff. H. vetus*, F, lateral view of skull, USNM 23573. X1. G, occlusal view of anterior and posterior incisors. X6. Drawn by Alice R. Ballard.

County is distinct in that the postero-external reentrant angle extends nearly three-fourths of the distance across the occlusal surface of the $P_{\bar{3}}$ and turns sharply anterior (Hibbard, 1941, Pl. 1, figs. 4 and 5) and (Fig. 3C-C′). These teeth represent a new species of small *Hypolagus*.

Pratilepus vagus (Gazin)

(Figs., 1C-D; 3D-E & H; 4A-C; 5A-D)

Alilepus? vagus Gazin, 1934, Proc. U.S. Nat. Mus., 83(2976): 119–120, fig. 5.

Alilepus? vagus Gazin; Dawson, 1958, Univ. Kans. Paleont. Contrib., Vertebrata, Art. 6, p. 61.

Alilepus? vagus Gazin; Hibbard, 1959, Papers Mich. Acad. Sci., Arts and Letters, 44 (1958): 15.

Pratilepus vagus (Gazin); Taylor, 1966, Malacologia, 4 (1): 75.

Pratilepus vagus (Gazin); Dawson, 1967, in Essays in Paleo. and Strat., Univ. Kans. Dept. Geol. Spl. Publ. 2: 287–316.

Material.—The holotype and other specimens in the United States National Museum which includes the associated lower jaws, a good skull and approximately 50 parts of an associated skeleton of *Pratilepus vagus* (USNM 23574) taken by C. Lewis Gazin on July 23, 1934, from the north part of the main Horse Quarry, are included in this study.

In The University of Michigan collection there are parts of 4 right and 4 left lower jaws bearing $P_{\bar{3}}$ or more teeth. Also there are 29 left $P_{\bar{3}}$s and 20 right $P_{\bar{3}}$s. These remains were recovered from 9 localities in the area of the USNM *Plesippus* Quarry from an elevation of 3012 feet, to 3295 feet in an area of approximately 4 square miles. Parts of the skeleton of *Pratilepus* were found at 4 of the sites where the teeth were taken.

Skull, USNM 23574.—The posterior portion of the skull is badly crushed forward, the basioccipital and bullae resting against the posterior part of the maxillaries. The premaxillaries are flexed upward at the sutures with the maxillaries (Figs. 1C-D; 3D). All comparisons of *Pratilepus vagus* to *Hypolagus* are with *Hypolagus* sp. *aff. H. vetus*, USNM 23573.

Pratilepus vagus possesses a broader and larger skull than *Hypolagus*, for measurements see Table 1. The supraorbital processes are present. Neither the anterior nor the posterior projections are fused to the skull (Fig. 1C). The width across the skull including the supraorbitals is 16.5 mm. The temporal fossa is as large as that of *Hypolagus*. The posterior root of the zygoma where it comes off the squamosal is larger and thicker than that of *Hypolagus*.

The frontals do not extend as far anteriorly between the nasals as in *Hypolagus* (Fig. 1A and C). The intermaxillaries are wider than those of *Hypolagus* and extend just posterior to the nasals. The reticulated areas of the maxillaries appear to have been smaller than those of *Hypolagus*. It is not possible to get an accurate measurement of the orbit since the skull is distorted.

The anterior edge of the incisive foramina is 2.8 mm posterior to the alveolar borders of the posterior in-

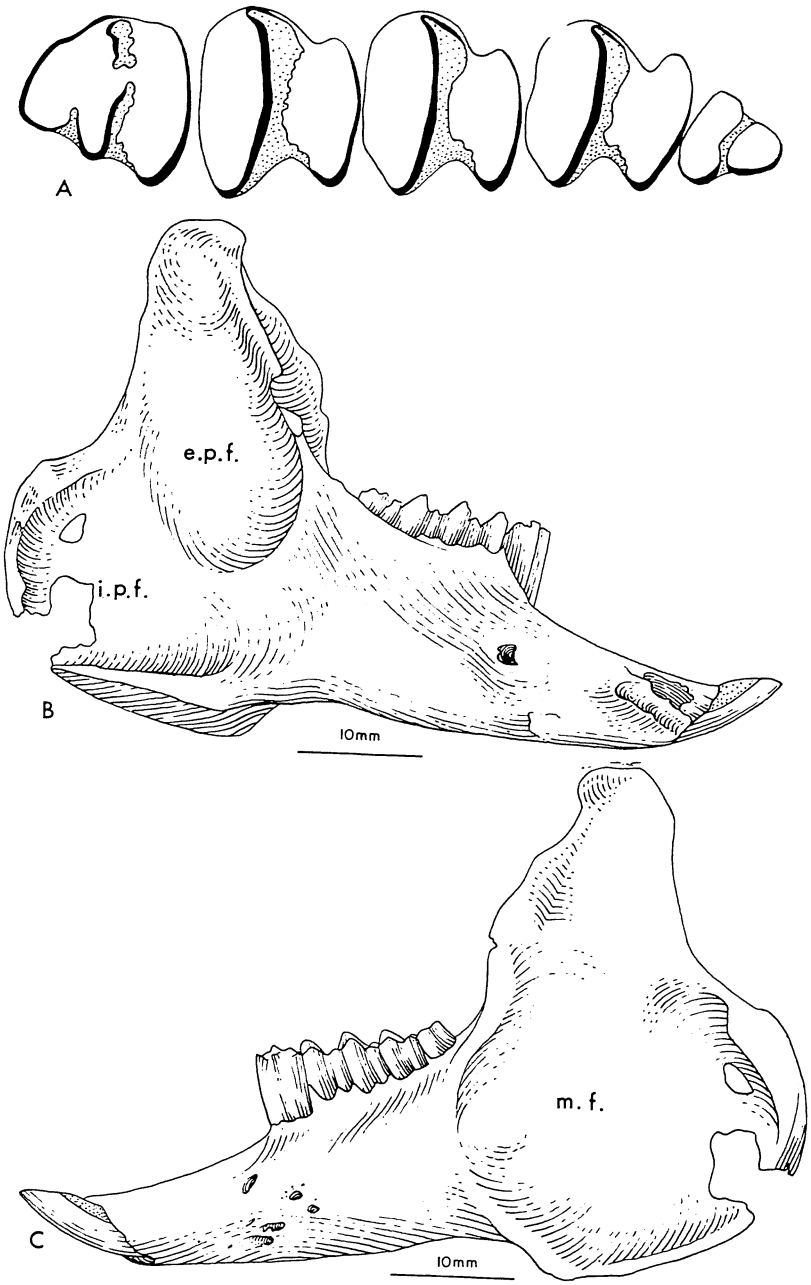

FIG. 4. *Pratilepus vagus*, left lower jaw, V55050, Hagerman fauna: A, occlusal view, $LP_{\bar{3}} - M_{\bar{3}}$. X6. B, lingual view. C, labial view. X scale given. Drawn by Alice Ballard.

Abbreviations: e.p.f., external pterygoid depression or fossa; i.p.f., internal pterygoid fossa; m.f., masseteric fossa.

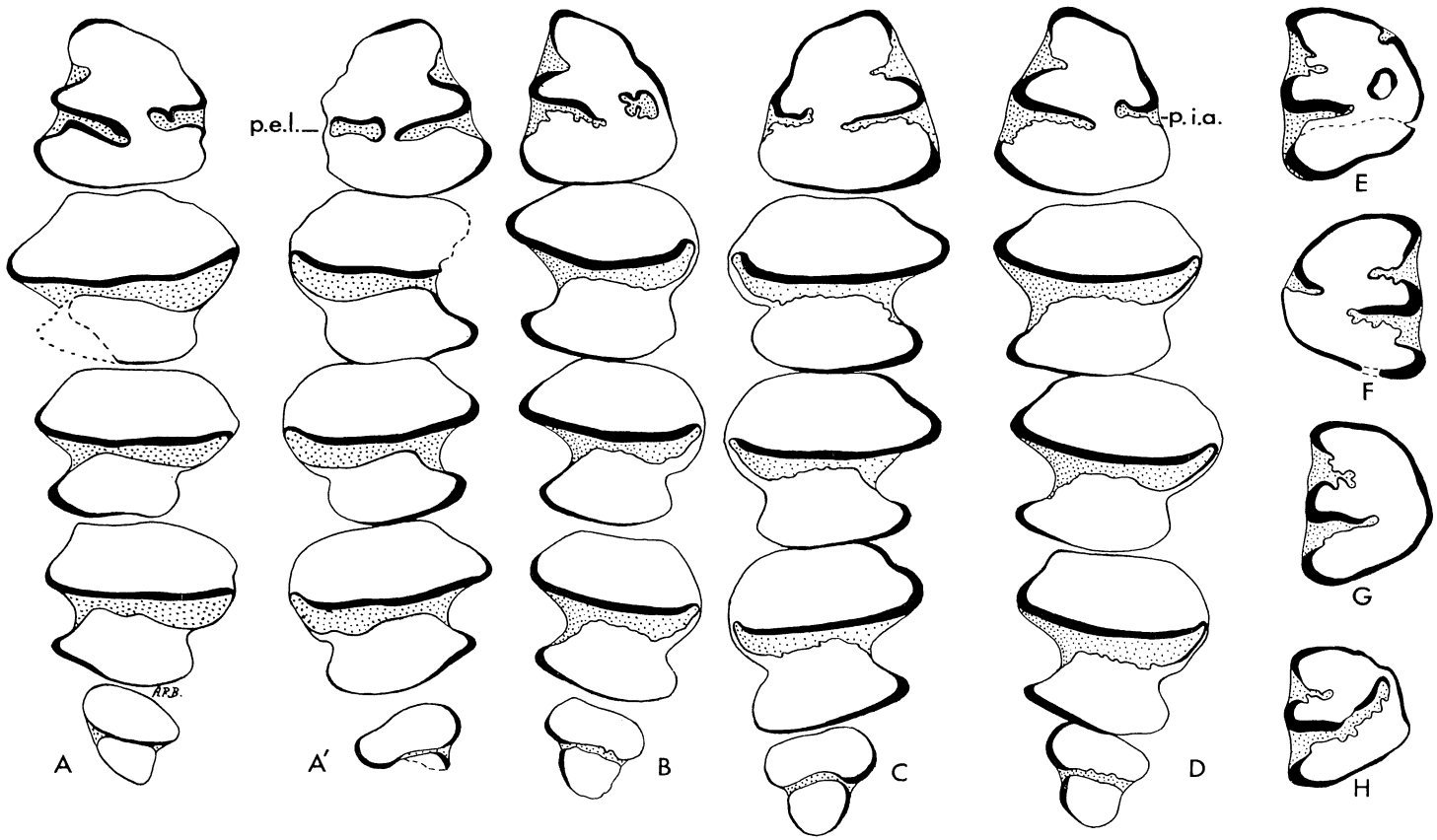

FIG. 5. *Pratilepus vagus*, Hagerman fauna, and *P. kansasensis*, Rexroad fauna: Occlusal views. A – D, P. *vagus*; A – A′, $LP_{\bar{3}}$ – $M_{\bar{3}}$, and $RP_{\bar{3}}$ – $M_{\bar{3}}$, USNM 23574, jaws united. B, $LP_{\bar{3}}$ – $M_{\bar{3}}$, V48943; C, $RP_{\bar{3}}$ – $M_{\bar{3}}$, V52754; D, $LP_{\bar{3}}$ – $M_{\bar{3}}$, V55051. E – H, *P. kansasensis*; E, $LP_{\bar{3}}$, V29634; F, $RP_{\bar{3}}$, V29642; G, $LP_{\bar{3}}$, V56576; H, $LP_{\bar{3}}$, V42603. All X6. Drawn by Alice R. Ballard (A.R.B.).
Abbreviations: p.i.a., posterior internal reentrant angle; p.e.l., posterior internal enamel lake or island.

cisors. The foramina end posteriorly on a line with the lingual side of $P^{\frac{2}{2}}$. The maxillopalatine suture crosses the palatal bridge just anterior to a line with the middle of $P^{\frac{4}{4}}$ (Fig. 1D).

Only the right tympanic bulla is present. It is approximately the size of the bullae observed in *Sylvilagus floridanus* UMMZ 58264) and slightly smaller than those of *Hypolagus* sp. *aff. H. vetus*. The anteroposterior length is 9.5 mm, and transverse width is 8.7 mm.

The exoccipitals are crushed but they are thicker than those of *Hypolagus*. The distance separating the exoccipitals and the broader and slightly larger paroccipital processes is as narrow as in *Hypolagus*.

The lower jaws are united at the symphysis. The condyloid process supporting the articular surface is much like that of *Hypolagus* except that the articular process is wider (5.0 mm) and tapers posteriorly for a distance of 9.3 mm. The medial edge of the condyloid process curves medially forming the posterior boundary of the external pterygoid depression or fossa (Fig. 4B, e.p.f.) which is very distinct but not well developed in *Hypolagus*. A distinct ridge marks the lower boundary of the fossa. The internal (lower) pterygoid depression, or fossa, (Fig. 4B, i.p.f.) is large and deep. It is bounded by a distinct ridge on the ventral part of the medial surface of the angle where the internal pterygoid muscle inserts. The area for the attachment of the internal pterygoid muscle is more pronounced than in *Hypolagus*. The vertical distance from the articulation surface to the bottom of the angle is 39.9 mm. The masseteric fossa (Fig. 4C, m.f.) on the labial side of the angle is more deeply developed than that of *Hypolagus*. The strong development of the areas of attachment of the masseter, internal pterygoid and the external pterygoid muscles in *Pratilepus vagus* indicates that it fed on harsher vegetation than *Hypolagus* sp. *aff. H. vetus*.

The diastemal length from the anterior border of the alveolus is 15.8 mm. The alveolar length of $P_{\bar{3}} - M_{\bar{3}}$ is 15.6 mm and the occlusal length is 14.0 mm. The lower incisor has a transverse width of 3.2 mm. The right incisor has been broken and is flexed upward.

Dentition.—The associated upper and lower dentition of *Pratilepus* has contributed greatly to our understanding of this group of rabbits.

The posterior incisors have a shallow and broad groove on their posterior surfaces (Fig. 3H). The upper premolars and molars are broken (Fig. 3E) so that accurate measurements of the tooth row and individual teeth are not possible as in *Hypolagus*.

When I described *Pratilepus kansasensis* (Hibbard, 1939, fig. 1b), I assigned part of a maxillary (KUMNH 4566) that contained the $LP^{\frac{2}{2}} - M^{\frac{2}{2}}$ and $RP^{\frac{2}{2}} - M^{\frac{1}{1}}$ of a rabbit to *Pratilepus kansasensis* because it was found in a small flour sand pocket with a lower jaw of *P. kansasensis*. They were not in occlusion. The $P^{\frac{2}{2}}$ of the above maxillary had three anterior reentrant angles. It was assumed that this was one of the generic characters. At that time I was unable to explain the type of deposition at KU Locality 3 in Meade County, Kansas. Erosion in

the Spring of 1959 exposed a large sand tube of an artesian spring that accounted for pockets and lenses of flour sand that contained fossils in the overlying sandy silt and clay.

When we started collecting in the Glenns Ferry Formation, I could not explain why we were getting lower jaws of *Hypolagus* and *Pratilepus* and only P^2s with a single anterior reentrant angle until I saw the associated skull and lower jaws of *Pratilepus vagus* in December, 1965. I am unable to definitely separate isolated P^2s of *Hypolagus* and *Pratilepus* from the Hagerman local fauna, nor have I been able to separate the isolated P^2s from the Rexroad local fauna into three groups for the larger species of rabbits. The P^2 of the maxillary (KUMNH 4566) that has the three anterior reentrant angles is in all probability a maxillary of *Nekrolagus*.

It is fortunate that the lower jaws (USNM 23574) of *Pratilepus vagus* are fused since the left P_3 has an open lingual reentrant angle in the area of the enamel lake (Fig. 5A, p.i.a.). The right P_3 has the closed internal enamel lake (Fig. 5A′, p.e.l.) This type of pattern in a single individual supports the variation observed in the P_3 pattern of *Pratilepus kansanensis* (Hibbard, 1963).

Six of the 57 P_3s of *Pratilepus vagus* taken at 9 localities in the area of the Horse Quarry had an open posterior internal reentrant angle that extends to the base of the tooth. The variations in the P_3 pattern are shown in Figures 4A and 5A-D. The posterior internal reentrant angle or the enamel lake in *Pratilepus*, as a rule, is slightly more anterior to the lingual edge of the posterior external reentrant angle than in *Nekrolagus*.

Remarks.—In The University of Michigan collection from KU Locality 3, Meade County, Kansas, there are parts of 6 right and 4 left lower jaws with P_3 and other teeth. There are also 48 left and 30 right isolated P_3s with an internal enamel lake or a posterior internal reentrant angle (Fig. 5E-F). Twelve of the 88 P_3s have an open posterior internal reentrant angle. There are also 9 P_3s with the *Sylvilagus? bensonensis* Gazin (1942) pattern (Hibbard, 1963, figs. 1d-e; and Fig. 5H, of this paper). Figure 5H is the left P_3 (fig. 2d, Hibbard, 1963) which was incorrectly drawn. Note the thickened enamel along part of the anterior edge of the posterior reentrant angle in contrast to the continuous thickened enamel in some P_3s. Whether this pattern is a variation within the *Pratilepus* population of the Rexroad local fauna or whether it represents an undescribed rabbit is not known. The dental pattern is developed from that of *Pratilepus*.

There are 5 isolated P_3s not included in the above count that are teeth of *Pratilepus kansasensis* which lack either the posterior internal reentrant angle or the internal enamel lake (Fig. 5G). These teeth possess the characteristic deep trefoiled anterior external reentrant angle, the same as the P_3s with the *Sylvilagus? bensonensis* pattern.

Pratilepus vagus lacks the deep trefoiled anterior external reentrant angle and the crenulated pattern of P_4 – M_2 of *P. kansasensis*. Not all of the teeth of *P. kansasensis* are crenu-

lated, two of the 10 jaws (Nos. V29643 and V44545) lack crenulation on the $P_{\bar{4}} - M_{\bar{1}}$. $M_{\bar{2}}$ and $M_{\bar{3}}$ are missing in these specimens.

SUMMARY

The most abundant rabbit in the Hagerman local fauna is *Hypolagus* sp. *aff. H. vetus.* Its occurrence is based upon the number of $P_{\bar{3}}$s whether isolated or associated with other teeth in the lower jaw. A minimum number of 75 individuals were studied. This number is based on the right $P_{\bar{3}}$s. The largest sample (38 $RP_{\bar{3}}$s) was recovered at United States Geological Survey, Cenozoic Locality 20765 in Sec. 28, T.7S., R.13E., at an elevation of 3025 feet. Only one left $P_{\bar{3}}$ of *Pratilepus vagus* was taken at this locality. *H.* sp. *aff. H. vetus* decreases in abundance as one works upward in the geological section. Only one specimen, an isolated $P_{\bar{3}}$, was taken at an elevation of 3295 feet. This rabbit occurs higher in the geological section in the Sand Point local fauna in association with *Pratilepus vagus* from the Glenns Ferry Formation in Owyhee County, Idaho, down the Snake River from Hagerman.

Hypolagus limnetus is poorly represented in the fauna. A minimum number of eleven individuals was recovered. This number is based upon the number of right $P_{\bar{3}}$s. It is found throughout the geological section from an elevation of 3000 feet to 3350 feet. The largest number of individuals, 4 left and 2 right $P_{\bar{3}}$s, was recovered from Localities UM-Ida.1–65 and UM-Ida.1a–65, at an elevation of about 3260 feet in association with some upland forms such as *Citellus* and *Perognathus.* Its habitat is considered as that of the surrounding upland region coming into the area only for water.

Pratilepus vagus is the second most abundant rabbit in the fauna. Based on the collection in the United States National Museum and The University of Michigan, a minimum number of 37 individuals ($LP_{\bar{3}}$s) has been recovered from this area. The lowest elevation at which its remains were taken was 3025 feet. It is scattered throughout the next 225 feet of the Glenns Ferry Formation. The concentration of the remains is from an elevation of 3250 feet to 3300 feet. Of the 37 left $P_{\bar{3}}$s recovered, 20 were taken at United States Geological Survey Cenozoic Locality 19216, at an elevation of 3295 feet. Associated with this sample of *P. vagus* was an isolated $P_{\bar{3}}$ of *Hypolagus* sp. *aff. H. vetus.* The other concentration of *P. vagus* come from Localities UM-Ida.1–65 and UM-Ida.1a–65, at an elevation of about 3260 feet. At these localities 2 right $P_{\bar{3}}$s and 5 left $P_{\bar{3}}$s were taken in association with 4 left and 2 right $P_{\bar{3}}$s of *H. limnetus.* At these two localities the sediments were deposited by a stream carrying fine to medium fine sand.

The decrease in abundance of *Hypolagus* sp. *aff. H. vetus* in the upper part of the geological section near the Horse Quarry appears to be related to a shift from a more marshy habitat at the elevation of 3025 feet to a gradual development of a better drained area with the presence of larger streams at the elevations of 3200 feet to 3300 feet in this area. This decrease in numbers of individuals of *Hypolagus* coincides

with the observation concerning the abundance of *Cosomys primus* Wilson in the lower part of the geological section, and its absence at the elevation of 3295 feet at the United States Geological Survey Cenozoic Locality 19216 (Hibbard, 1959). At this locality *Cosomys* is replaced by *Ophiomys taylori* (Hibbard and Zakrzewski, 1967).

Teeth of the above three species of rabbits, based on the pattern of $P_{\bar{3}}$, were recovered from 34 localities in approximately 6 square miles ranging throughout a vertical section of 400 feet of the Glenns Ferry Formation.

Hypolagus sp. *aff. H. vetus* $P_{\bar{3}}$s or lower jaws with $P_{\bar{3}}$ were taken at 16 localities but not in association with the $P_{\bar{3}}$ of the other two species of rabbits. *H.* sp. *aff. H. vetus* and *H. limnetus* were found in association at two localities. *H.* sp. *aff. H. vetus* was found associated with *Pratilepus vagus* at 5 localities.

Hypolagus limnetus was found by itself at 6 localities. It was taken in association with *Pratilepus* at two localities. *Pratilepus vagus* was taken by itself at three localities. I consider the absence of all three species at any one locality as purely chance in collecting because *Hypolagus limnetus* is not a common fossil.

Hypolagus sp. *aff. H. vetus* appears to be a very homogenous population throughout the Hagerman local fauna. No change was detected in the dental pattern throughout the vertical section. It belongs to the distinct *vetus* group of *Hypolagus* and is not closely related to *H. regalis* from the older Rexroad local fauna. *Hypolagus limnetus* shows no evolutionary change in the fauna.

Pratilepus vagus also represents a very homogenous population in the Hagerman local fauna. No evolutionary trends were detected in the dental patterns. It is quite distinct from *Pratilepus kansasensis* from the Upper Pliocene Rexroad local fauna from Kansas.

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