It is easily seen that the Kasner circle, mentioned in I, shrinks to a point. Thus II loses its meaning, the derivative clock being merely a point. But III″ does not become meaningless. For the associated affinity T reduces to the functional relation between the points of a neighborhood of z and the corresponding values of $w'(z)$. Thus the assertion that T is a direct similarity says exactly that the local correspondence $Z \longrightarrow w'(z)$ is conformal. This is in accord with the fact that the function $w'(z)$ is now monogenic.

Conclusion.—The derivative of any polygenic function is therefore characterized completely by our three properties: the *circle* property, the *ratio* property and the *affine-similitude* property.

[1] Presented to the Amer. Math. Soc., Feb. 22, 1930. See *Bull. Amer. Math. Soc.*, **36**, 218(1930). I wish to thank M. Richardson for his valuable assistance in writing this paper.

[2] E. Kasner, "A New Theory of Polygenic Functions," *Science*, **66**, 581–2 (1927). "General Theory of Polygenic Functions," these PROCEEDINGS, **13**, 75–82 (1928). "The Second Derivative of a Polygenic Function," *Trans. Amer. Math. Soc.*, **30**, 805–18 (1928).

[3] This circle has been called the Kasner circle in the literature of the subject. See Hedrick, "Non-Analytic Functions of a Complex Variable," *Bull. Amer. Math. Soc.*, **39**, 75–96 (1933).

[4] If the components of the polygenic function are assumed to be analytic functions of x, y, we may introduce minimal coördinates $z = x + iy$, $\bar{z} = x - iy$; then D means partial differentiation with respect to z, and P with respect to $\bar{z}$. Thus the commutativity becomes obvious.

HESPEROMERYX, A NEW ARTIODACTYL FROM THE SESPE EOCENE, CALIFORNIA

BY CHESTER STOCK

BALCH GRADUATE SCHOOL OF THE GEOLOGICAL SCIENCES, CALIFORNIA INSTITUTE OF TECHNOLOGY

Communicated January 27, 1936

Introduction.—Among the several artiodactyls collected in the Upper Sespe Eocene, the new subgenus here described, is clearly the most abundant type. In the fauna recorded at Locality 180 this form exceeds in number all other species; its representation, as a matter of fact, is greater than that of all other individuals combined. No less than 100 individuals are known on the basis of teeth, fragmentary jaws and scattered skeletal elements. While some variation is to be noted, a surprising constancy in structural features characterizes the collection as a whole. For this reason all specimens belonging to this type are referred to as single species.

Leptoreodon (Hesperomeryx) edwardsi, n. subgen. and n. sp.

Type Specimen.—An upper series of cheek-teeth, $P\underline{2}$-$M\underline{3}$, of a single individual, No. 1839, Calif. Inst. Tech. Vert. Pale. Coll., Plate 1, figure 1.

Paratype.—Incomplete left ramus of mandible with $P\overline{2}$-$M\overline{3}$, No. 1840, Plate 1, figures 2, 2*a*.

Referred Specimens.—Upper canine, No. 1841, figures 5, 5*a;* caniniform $P\overline{1}$, No. 1841, figure 6; astragalus, No. 1843, figure 3; calcaneum, No. 1844, figures 4, 4*a* and 4*b;* and numerous upper and lower teeth and fragmentary jaws.

Locality.—No. 180, Upper Sespe Eocene, north of the Simi Valley, Ventura County, California.

Subgeneric and Specific Characters.—Similar to the Uinta *Leptoreodon* and *Leptotragulus* in size.

Upper canine scimitar-shaped in side view, rounded in front and with posterior face of crown abraded by attrition with $P\overline{1}$; lateral faces each with a longitudinal groove; enamel more extensively developed on outer than on inner face.

$P\underline{2}$ three-rooted and with slight cingular enlargement at middle of inner side of crown. $P\underline{3}$ similar to $P\underline{2}$, but larger and with inner cingular enlargement better developed and appressed against principal cusp. Crown distinctly longer than wide. $P\underline{4}$ usually without internal cingulum. Brachyodont upper molars without fifth cusp; mesostyle present; external faces of outer cusps with median ribs, that on paracone particularly well developed; internal cingulum not continuous around base of antero-internal cusp; internal cingulae meet at entrance to median valley, but pillar not present as in *Leptomeryx.*

$P\overline{1}$, caniniform. $P\overline{2}$ two-rooted; crown with an external and an internal crest extending back from principal cusp. $P\overline{3}$ similar to $P\overline{2}$ but larger and with posterior crests heavier; intervening valley opens postero-internally. $P\overline{4}$ with antero-internal style more or less developed; cuspule present postero-internal to and connected with principal cusp; external crest extends posteriorly from principal cusp and swings around posterior border of crown to postero-internal corner causing valley to open on inner side of crown. $M\overline{3}$ with well developed posterior lobe, the occlusal surface of which is formed by a rim enclosing a basin.

This species is named for Dr. M. G. Edwards, geologist of the Shell Company, California.

Description.—The dentition of *Hesperomeryx* resembles most closely that of *Leptoreodon* and, as a matter of fact, would not be recognized as subgenerically distinct from the latter were it not for the presence of certain noteworthy distinguishing features. Thus the type of upper canine, the characters of the upper and lower molars, the caniniform $P\overline{1}$ and the structural features of the posterior lower premolars furnish a substantial basis for close relationship between the Sespe species on the one hand and the Uinta *Leporeodon marshi* and *L. gracilis* on the other. Interesting differences appear, however, when the teeth of these forms are compared in detail.

The upper canine resembles in form that seen in *Leptoreodon* and *Camelomeryx*. The crown portion of this tooth is worn considerably on the posterior face where occlusion is established with the anterior face of $P\overline{1}$. From the cross-section shown in figure 5 it is seen that the tooth is narrow

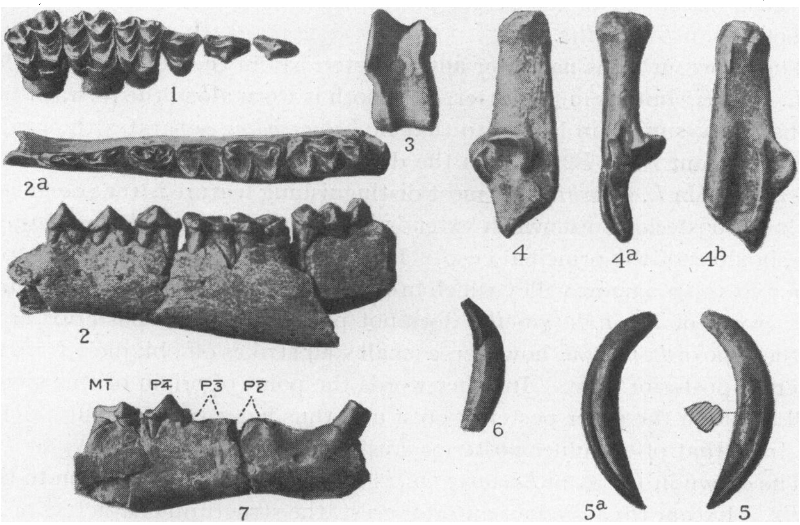

PLATE 1

***Leptoreodon* (*Hesperomeryx*) *edwardsi*, n. subgen. and n. sp.**

Figure 1, type specimen, No. 1839, upper cheek-tooth series, $P\underline{2} - M\underline{3}$; figures 2,2*a* paratype, No. 1840, left ramus with $P\overline{2} - M\overline{3}$; figure 3, astragalus, No. 1843; figures 4, 4*a* and 4*b*, calcaneum, No. 1844; figures 5, 5*a*, upper canine, No. 1841; figure 6, caniniform $P\overline{1}$, No. 1842; figure 7, fragment of right ramus with teeth, No. 1946; all figures natural size.

California Institute of Technology Collections. Sespe Upper Eocene, Calif.

in front with anterior edge rounded. The crown widens posteriorly. A groove extends longitudinally on each lateral face, fading away in its upward course in the root region. That of the outer face is shallower than the groove on the inner side. A larger covering of enamel remains on the outer face than on the inner.

$P\underline{2}$ possesses a simple type of crown with median cusp. The inner forward half of the base of this cusp is flanked by a cingulum. This ledge ends in a slight enlargement at the inner base of the median cusp and the enlargement is surmounted by a small root. Thus $P\underline{2}$ is 3-rooted. In $P\underline{3}$ the crown is similar to that in $P\underline{2}$ except that it is larger and stouter, the external enamel wall behind the principal cusp more noticeably grooved, the inner cingular cuspule larger with a cingulum present in back as well as in front of it. This tooth does not appear to be so wide for its length as in *L. gracilis.* $P\underline{4}$ is not so long anteroposteriorly as in *Leptoreodon,* and the convexity of the outer wall of the principal cusp is not so marked. The molars show the characters seen in *Leptoreodon.* Although short-crowned, they exhibit an unusually advanced feature not as a rule seen in artiodactyls of this stage of the Eocene, namely, the absence of the fifth cusp. In the posterior molar of the Sespe specimen the parastyle is not so well developed as in *L. gracilis.*

The crown in $P\overline{1}$ is narrower anteroposteriorly in the Sespe species than in *L. marshi,* but, as in the latter, this tooth is worn along the forward side. A diastema, similar in length to that in *Leptoreodon,* separates the caniniform $P\overline{1}$ from $P\overline{2}$. $P\overline{2}$ answers the description given for this tooth in *L. gracilis* and in *L. marshi.* Its most distinguishing feature is the presence of an inner posterior crest which extends backward from a point well up on the shoulder of the principal cusp. Between this crest and the outer posterior crest is a narrow valley which broadens slightly in its posterior course. The crown of $P\overline{2}$ in *L. gracilis* does not possess an inner posterior crest. In the type of *L. marshi,* however, a small spur strikes off obliquely from the external posterior crest. In other words the point of origin of this spur is well down on the outer posterior crest and thus has a position quite different from that of the inner posterior crest in *Hesperomeryx.*

The crown in $P\overline{3}$, as in *Leptoreodon,* is distinctly longer in relation to that of $P\overline{2}$. Except for a distinct anterior crest, the structural characters of the crown are similar to those in $P\overline{2}$. Thus an inner and an outer posterior crest is present, each arising high up on the shoulder of the principal cusp and enclosing a valley between them. The outlet of this valley is at or near the postero-internal corner of the crown, due to the fact that the outer posterior crest swings inward along the posterior margin of the tooth. A short cingulum of slight development is seen along the outer base of the forward half of the crown. In both *L. marshi* and *L. gracilis* the inner posterior crest takes its origin at a point on the outer posterior crest in back of the principal cusp.

In $P\overline{4}$ the anterior crest turns more abruptly inward at the forward end than does the comparable crest in this tooth in *Leptoreodon.* Postero-internal to the principal cusp and definitely connected with it is a second cusp or cuspule. This cusp is larger in *Leptoreodon gracilis* and moreover is not connected with the principal cusp. Its large size and perhaps slightly more posterior position with reference to the principal cusp in $P\overline{4}$ of *Leptoreodon* from the Uinta tends to constrict more the outlet of the posterior valley than is the case in the Sespe form. In the latter the outer posterior crest swings inward along the posterior rim of the crown, reaching the postero-internal corner, and more space prevails between the end of the crest and the inner cusp. However, an inner spur may be thrown off from the posterior crest in front of the posterior rim. A short cingulum occurs at the anterior and posterior ends of the external face of the crown.

MEASUREMENTS (IN MILLIMETERS)

	Hesperomeryx edwardsi PARATYPE NO. 1840 C. I. T.	*Hesperomeryx edwardsi* NO. 1946 C. I. T.	*Leptoreodon gracilis* NO. 11225 PRIN. UNIV.	*Leptoreodon marshi* TYPE NO. 2064 A. M. N. H.	*Leptotragulus proavus* NO. 2509 A. M. N. H.	*Leptomeryx evansi* NO. 12962 PRIN. UNIV.
Length from anterior end of $P\overline{1}$ to posterior end of $M\overline{3}$			57.9	58.1		45.3
Length from anterior end of $P\overline{2}$ to posterior end of $M\overline{3}$	41		43.9	46.4		39*
Length of diastema in front of $P\overline{2}$		6.5	10	7.6*	6.8	3.7
Length from anterior end of $P\overline{1}$ to posterior end of $P\overline{4}$		30.2	32.3	32.2		22.8
Length of molar series	23.6		25.5	26.3		22.1
Depth of ramus below anterior end of $M\overline{3}$	14		12.1*	13.7	11.5	13
Depth of ramus below anterior end of $P\overline{2}$	8.7		10	10	10.7	8.5

* Approximate.

	Hesperomeryx edwardsi TYPE NO. 1839 C. I. T.	*Leptoreodon gracilis* TYPE NO. 11225 P. U.		*Hesperomeryx edwardsi* PARATYPE NO. 1840 C. I. T.	*Leptoreodon gracilis* TYPE NO. 11225 P. U.
$P\underline{2}$, anteroposterior diameter	6.2	7	$P\overline{2}$	5.4	5
$P\underline{2}$, transverse diameter	3.2		$P\overline{2}$	2.1	
$P\underline{3}$, anteroposterior diameter	6.5	6.9	$P\overline{3}$	6.3	7
$P\underline{3}$, transverse diameter	3.7	5	$P\overline{3}$	2.9	
$P\underline{4}$, anteroposterior diameter along outer side	5.7	5.9	$P\overline{4}$	6.2	6.5
$P\underline{4}$, transverse diameter	6.2	7	$P\overline{4}$	3.6	4
$M\underline{1}$, anteroposterior diameter	6.5	6.5	$M\overline{1}$	6.2	6.5
$M\underline{1}$, transverse diameter	8.6	8.5	$M\overline{1}$	4.8	5.5
$M\underline{2}$, anteroposterior diameter	7.6	8	$M\overline{2}$	7.6	7.5
$M\underline{2}$, transverse diameter	9.7	10	$M\overline{2}$	5.9	6
$M\underline{3}$, anteroposterior diameter	8	9	$M\overline{3}$	10.3	11.5
$M\underline{3}$, transverse diameter	9.8	11	$M\overline{3}$	5.7	6.5

The lower molars are similar in all essential details to the comparable teeth in *Leptoreodon*. The posterior lobe in $M\overline{3}$ has the construction seen in the latter genus and differs noticeably, therefore, from that in *Leptotragulus*.

Two of the elements of the tarsus are illustrated in plate 1, figures 3 to 4*b*. The astragalus and calcaneum resemble the corresponding bones in *Leptoreodon gracilis* Scott.

Concluding Remarks.—*Hesperomeryx edwardsi* is more closely related to *Leptoreodon* than to *Leptotragulus*. It differs from *Leptoreodon marshi* and from *L. gracilis* in certain features of the dentition regarded as of subgeneric rank. *Hesperomeryx* appears to be in slight measure at least, more advanced than the species from the Uinta. Among the later Eocene Artiodactyla, *Leptoreodon* is unique in the advanced character of the upper molars. This genus is obviously a leptomerycid, but I am not aware of any lower Oligocene genus sufficiently close to it to be regarded as a direct descendant. The oreodonts of the Sespe Eocene show a development quite distinct from that of *Hesperomeryx*. The cleft between the latter form and the oreodonts unquestionably extends farther back in the Eocene.

ABSORPTION OF COSMIC RAYS IN THE MILKY WAY

BY F. ZWICKY

NORMAN BRIDGE LABORATORY OF PHYSICS, CALIFORNIA INSTITUTE OF TECHNOLOGY

Communicated February 4, 1936

A. Introduction.—If cosmic rays are of *extragalactic origin*, they must be partially absorbed by the gas and dust clouds which populate the interstellar spaces. This absorption will produce directional asymmetries in the intensity of the cosmic rays because of our eccentric location relative to the Milky Way. In addition to the straight absorption of energy a part of the cosmic rays will be scattered by interstellar matter without appreciable loss in total energy. Such scattering includes the formation of energetic secondaries and therefore tends to produce a change in the numbers and physical characteristics of the various constituents of the cosmic rays. Again, because of the segregating action of the earth's magnetic field, directional asymmetries will result. Although the effects to be expected are in all probability small it seems that modern instruments are sufficiently sensitive to make possible the detection of the before-mentioned asymmetries. Positive results of a search for absorption effects might furnish new information on

(1) Whether or not cosmic rays are of extragalactic origin.
(2) The problem of the total amount of interstellar matter.
(3) The analysis of the composition of cosmic rays.

B. Amount of Absorption—Most of the cosmic rays are absorbed in their passage through a layer whose thickness corresponds to one kilogram of