CONTRIBUTIONS TO PALÆONTOLOGY

III

PERISSODACTYLA FROM THE SESPE OF THE LAS POSAS HILLS, CALIFORNIA

By Chester Stock

With four plates

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Balch Graduate School of the Geological Sciences
California Institute of Technology
Pasadena, California

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CONTENTS

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INTRODUCTION

The concentration of fossil vertebrate remains at the Kew Quarry site in the Sespe deposits of the Las Posas Hills,[1] California, furnishes one of the most varied early Tertiary mammalian faunas as yet recorded from western North America. Related in age to the John Day and upper White River, this assemblage offers for the first time an adequate basis for comparing the late Oligocene mammalian history of the Pacific Coast marine province with that determined in the Tertiary continental provinces to the east of the Cascade Range and of the Rocky Mountains.

In order to reach a fuller understanding of the stage of evolution of the Kew Quarry fauna the structural features of individual members need now to be considered and the relationships of these forms determined in greater detail than was attempted in the original statement. Brief descriptions and comparisons will be given, therefore, in this and in subsequent papers.

Among the more commonly occurring mammals in the Kew Quarry fauna are the rhinoceroses of the genus *Subhyracodon* (*Cænopus*). This type is represented by many parts of skeletons in the collections of the California Institute of Technology. In contrast, the horses are known at present by a single individual. The material, though scanty, is clearly referable to the genus *Miohippus*. While furnishing an opportunity to compare the stage of development of the Equidæ in the Sespe with that found in the John Day beds of eastern Oregon and in the White River of the western Great Plains, added interest attaches to this specimen as the first documentary evidence of the occurrence of the genus in the Pacific Coast region of North America.

DESCRIPTION OF MATERIAL

Subhyracodon kewi n. sp.

Type specimen—Skull, No. 1205, Calif. Inst. Tech. Coll. Vert. Pale., Plate 1, with complete cheek-tooth dentition P1–M3 and alveoli for the canine and two incisor teeth. The species is named for Dr. W. S. W. Kew, who discovered this important fossil locality in the Las Posas Hills.

Paratypes—Two skulls, Nos. 1221, 1222, Calif. Inst. Tech. Coll. Vert. Pale., Plate 2, figures A and B; Plate 3, figure A.

Referred specimen—An incomplete lower jaw, No. 1224, Plate 3, figure B, and a right premaxillary with second incisor, No. 1225, Plate 3, figures C and D.

Specific characters—Size, as indicated by dentition, like that of *Subhyracodon trigonodum*. Cingulum absent on upper molars. Enamel pattern of

[1] C. Stock, Proc. Nat. Acad. Sci., vol. 18, 550–554, 2 figs., 1932.

occlusal surface in P3 and P4 more like *trigonodum* than like *copei*, *occidentale* and *tridactylum*. Accessory longitudinal rib or ribs developed on inner surface of ectoloph in P4, M2 and M3.

Description—Viewed in the light of the many similar characters displayed, particularly by the superior dentition, the several skulls selected as type and paratypes of *Subhyracodon kewi* clearly belong to a single species. Taken collectively, these specimens permit of a detailed comparison with skulls of Oligocene rhinoceroses of the western Great Plains.

The skulls of the paratypes, Nos. 1221, 1222, unfortunately have the ends of the nasals as well as the premaxillaries missing, but retain their cranial portions. In the type, No. 1210, the cranial region for the most part is absent. In this specimen the antorbital foramen is situated above the anterior half of P3. The anterior end of the right nasal is present. This element is slender and shows clearly that a pedicle for a nasal horn was absent. No. 1221, in which M3 has not been fully erupted, is flattened dorso-ventrally but still displays some of the important structural features of the midcranial and basicranial regions. The postnarial notch incises the midline of the palate to a point opposite the protoloph in M2. The anterior margin of this notch is not perfectly preserved. Although the orbital wall of the cranium is badly crushed, the anterior edge of the alisphenoid is partly preserved and indicates that behind this was the recess into which the optic foramen, the foramen lacerum anterius and foramen rotundum open. The alisphenoid canal and foramen ovale are shown in No. 1221, the latter opening occurring to the antero-internal side of the postglenoid process. A postglenoid foramen is present. The space between the postglenoid and posttympanic processes is broad, in which respect *Subhyracodon kewi* is like *S. trigonodum*. Posttympanic and paroccipital processes exhibit the characters seen in the White River species of *Subhyracodon*. The latter process in skull No. 1221 is in part broken away and the posterointernal fringe is imperfect. The otic region displays the periotic mass. Posterointernal to this is the foramen lacerum posterius with the stylo-mastoid foramen clearly indicated to the outer side of the latter opening, although not shown in the illustrations of this specimen. The relatively large space to the internal and antero-internal sides of the periotic represents the foramen lacerum medius. Almost midway in an oblique direction between the paroccipital process and the condyle lies the hypoglossal foramen.

In skull No. 1222 the posttympanic and paroccipital processes are better preserved than in No. 1221. The paroccipital process is closely situated to the posttympanic and is flattened anteroposteriorly with the anterior face slightly concave transversely. This process in its downward course appears to be directed forward and slightly outward.

The occiput is best shown in skull No. 1222 although badly deformed in this specimen (see Plate 3, fig. A). The indentation of lateral borders gives prominence to the superior portion of the occiput. A median crest is sharply defined principally in the upper half and is continued below to the upper lip of the foramen magnum as a broadly rounded surface. On the upper half of the occiput a broadly rounded ridge diverges on each side from the median line and extends upward to the occipital crest. Between these diverging arms and the median crest the surface of the occiput is depressed.

In the type specimen, No. 1205, the premaxillaries show the alveoli for the incisors, although the teeth are absent. The two alveoli for the incisors are situated close together with that for I2 distinctly larger than the socket for I3. Due to displacement and some crushing at the palatal end of the premaxillary-maxillary sutures the alveoli for the canines are not perfectly pre-

served. There is, however, definite evidence that this socket was present for a portion of its posterior wall is preserved on the left side. Moreover, on the right side can still be discerned the upper portion of the canine alveolus, now filled with matrix.

A portion of a right premaxillary with I2 present and the alveolus for I3 is shown in Plate 3, figures C and D. The anterior incisor has the characteristic shape seen in *Subhyracodon*. The alveolus for I3 does not possess an anteroposterior diameter as great as that for the forward tooth, but the transverse diameter is fully as large. Although a small fragment of the maxillary adheres to this specimen, there is no trace of an alveolus for the canine. It appears probable that in at least some individuals from the Kew Quarry this tooth was absent.

In the cheek-tooth series, which is complete from P1 to M3 inclusive in No. 1205, P1 is worn considerably and M3 is not entirely erupted. P1 is separated from the alveolus for the canine by a diastema measuring 30 mm. in length. The occlusal surface of the first premolar is not so greatly worn in No. 1221 as in No. 1205. The tooth approximates a triangular shape with the ectoloph reaching forward and inward, well in front of the inner side of the protoloph. Protoloph and metaloph are distinct and the former crest is distinctly smaller than the latter. A well-developed ledge or shelf is present between the inner ends of the two cross-lophs and anterior to the protoloph, extending forward to the end of the ectoloph. While internal cingula are well defined on premolars 2-4 of the type specimen, they are entirely lacking on M1 and M2. The occlusal pattern of P2 is molariform, for the two transverse lophs are distinct, but the posterior loph at this stage of wear has established connections with the posterior cingulum. A postfossette is therefore present in this tooth.

In P3 the protoloph is broadly connected with the metaloph and this postero-internal region has fused also with the posterior cingulum. Thus a pre- and a postfossette are formed. In the third premolar, as in the second, a well-developed cingulum on the anterior side of the tooth is continuous with the internal cingulum. The antero-posterior and transverse dimensions of P2 are nearly equal. This is true also for P3, but the crown contracts more toward the inner side than in the preceding tooth. A pattern of the occlusal surface of P3, similar to that in No. 1205, is seen also in No. 1222, but in specimen No. 1221 (Plate 2, fig. B), where this tooth is not so greatly worn, no union is established, at the stage of wear indicated, between the metaloph and posterior cingulum.

P4 is compressed anteroposteriorly. A large anterior basin is formed on the crown of this tooth by union of protoloph and hypocone and by union of the latter cusp and metaconule. In view of the aspect of the crown shown in the illustration of the type specimen (Plate 1) it should be stated that the metaconule connects directly with the hypocone and not with the forward side of this cusp as might be implied from the figure. The characteristic type of union in *S. kewi* is illustrated also in the paratypes and can be clearly seen in No. 1221 (Plate 2, fig. B). A slender rib is developed on the outer wall of the forward basin and this is situated closer to the metaloph than to the protoloph.

Although an internal cingulum is lacking in M1 this tooth possesses anterior and posterior cingula and a broad ledge between the obliquely transverse lophs. Toward the outer side the valley between these lophs is somewhat constricted. M2 resembles the first molar in the development of the cingula. A slender rib on the inner wall of the ectoloph and situated close to the protoloph projects into the outer end of the median valley. Farther posteriorly

on the ectoloph is a much stronger ridge or crest which also extends into the valley. The antero-external extension of the hypocone meets the posterior face of this crest near the point of union of the latter and the ectoloph. On the anterior surface of the posterior wall of M3 are two longitudinal ribs. The rib toward the inner side is more strongly developed than the outer one.

The lower jaw, No. 1224, evidently of *Subhyracodon kewi* is shown in Plate 3, figure B. In this specimen the cheek-teeth are represented by P2-M3 and are considerably worn. No. 1224 possesses a relatively slender ramus, having a size comparable to that seen in some of the smaller species of the genus *Subhyracodon*. The symphyseal portion of the jaw, not shown in the illustration, is imperfectly preserved and the front teeth are missing. The alveolus for a lower tusk can be discerned on one side, but the wall is badly crushed. Measurements (in millimeters) of No. 1224 are: Length from anterior end of P2 to posterior end of M3, 156.6; depth of ramus behind M3 (approximate), 65; height from inferior border to condyle (approximate), 157.

COMPARISONS

Comparison with White River and John Day Rhinoceroses

The upper tooth formula (2, 1(0?), 4, 3) and the stage of evolution presented by the premolars in No. 1205 from the Sespe of the Las Posas Hills characterize a type less advanced than rhinoceroses generally grouped under the genus *Diceratherium*. The structural features seen in the Californian form are more like those found in the genus *Cænopus*. In recent years Wood[1] has come to recognize several divisions among the rhinoceroses heretofore grouped under the latter and places most of the American species of the later Oligocene within the genus *Subhyracodon*. Among the species included are *S. copei*, *S. trigonodum*, *S. occidentale* and *S. tridactylum*. Inappropriate though the name *Subhyracodon* may be, if we accept the restricted use of the genus *Cænopus* as advocated by Wood, the character of P4 in the Californian form is certainly not that seen in *C. mitis* (Cope) but comes distinctly nearer that found in the former group of rhinoceroses.

No. 1205 is larger than the type of *S. copei*, coming nearer in size to *S. trigonodum* and to *S. occidentale*. The species *tridactylum* is larger than the Californian form.

Subhyracodon kewi resembles the species *trigonodum* and differs from *copei*, *occidentale* and *gidleyi* in the character of union of the hypocone and metaconule in P4.

In the last named three species the metaconule joins the antero-external end of the hypocone, a character which Wood has pointed out distinguishes these forms from *S. trigonodum*. In *S. kewi* the union of the protoloph and metaloph tends to form a blunt V-shaped crest, and the hypocone does not form a hook-like projection behind the metaconule. In the union of the two cross-lophs, which takes

[1] H. E. Wood 2d., Bull. Amer. Pale., vol. 13, No. 50, 1927.

place at an early stage of wear, *S. kewi* differs distinctly from *Subhyracodon metalophum* and *S. tridactylum*. In the latter forms the lophs are separate.

Subhyracodon kewi differs particularly from *Amphicænopus platycephalus* in much smaller size and in the more progressive characters of the premolars. Both forms are hornless rhinoceroses of the later Oligocene.

In the absence of internal cingula on the molars of *S. kewi*, this form differs from *S. gidleyi* in which incomplete cingula are present. As in the latter, the Sespe specimens show a well-developed ledge or shelf between the lophs of $M\underline{1}$ and this may be raised at the inner end to form a low tubercle or ridge.

As in the referred specimen of *S. trigonodum*, No. 1131 A. M. N. H., mentioned by Wood, a slight posterior extension of the ectoloph in $M\underline{3}$ may occur in *S. kewi*.

In the presence of accessory ribs on the posterior premolar and molars, *S. kewi* is probably more advanced than *S. trigonodum*. In the presence of the upper canine, pattern of $P\underline{3}$ and $P\underline{4}$, absence of horn pedicles on nasals and smaller size, *S. kewi* appears to be distinctly less advanced than *S. tridactylum*.

Of the several types listed by Wood under the genus *Subhyracodon*, only *S. tridactylum* comes from the highest faunal horizon (Protoceras beds) of the White River. Although the Kew Quarry fauna of the Sespe in the Las Posas Hills may be broadly equivalent to or later than the Protoceras horizon, the rhinoceroses are evidently more primitive than those grouped under *Diceratherium* and differ also from *S. tridactylum*. Their nearest resemblance appears to be with *S. trigonodum*, while the resemblance with *copei*, *occidentale* and *gidleyi* is less marked.

In recent surveys of the John Day diceratheres by Troxell and by Wood the following species have come to be regarded as valid:

Diceratherium annectens (Marsh)
Diceratherium armatum (Marsh)
Diceratherium lobatum Troxell
Diceratherium cuspidatum Troxell

Troxell agrees with Peterson in placing *D. nanum* in a position subordinate to *armatum*. *D. hesperium* and *D. pacificum*, recognized by very fragmentary materials, are considered by Troxell and by Peterson as not adequately established in the John Day faunas.

In marked contrast to the resemblances or identity among mammalian genera found in the John Day and Kew Quarry faunas stands the dissimilarity of the rhinoceroses. It is possible that further acquisition of material from the John Day beds may demonstrate the presence of rhinoceroses currently grouped under the broad division

Cænopus. However, the extensive collections obtained from the John Day seem to have established the presence of diceratheres in the John Day fauna to the exclusion of the latter forms. On the other hand, the presence of peculiar conditions in the physical or biotic environment during the period of accumulation of the materials at the Kew Quarry site may account for the representation of one type and the apparent absence of diceratheres. At the present stage of our study of the Kew Quarry fauna it is certainly unsafe to say that the diceratheres were definitely excluded from this faunal horizon.

Comparison with Early Tertiary Rhinoceroses of the California Region

Two rhinoceroses from deposits evidently older than middle Tertiary are recorded for the Californian region. The materials obtained in Calaveras County during the Whitney Geological Survey were described by Leidy. The name *Rhinoceros hesperius* was proposed by Leidy[1] for the most complete specimen from Chili Gulch, a fragmentary lower jaw with dentition incompletely preserved, now in the collections of the Harvard Museum of Comparative Zoölogy. In a later statement[2] this jaw was again described and figured for the first time. Mention is made also of fragments of upper teeth and an unworn crown of an upper third molar from Calaveras County, which were regarded as probably belonging to *R. hesperius*. Still later, Whitney[3] quotes from Leidy a description of an additional specimen, a ramus with teeth of a young individual found at Douglas Flat. This likewise was regarded as probably of the species *R. hesperius*.

Subsequently the specimen figured by Leidy was mentioned by Osborn,[4] who referred the species to the genus *Aceratherium*. Meanwhile Leidy[5] had recorded rhinocerotid remains from the John Day basin and had determined some of this material as doubtfully of the species *R. hesperius*. In later years Loomis,[6] Peterson[7] and Troxell[8] have assigned this material either certainly or tentatively to the genus *Diceratherium*, although Peterson and Troxell regard the specimens as inadequate. Loomis has erred in regarding as type of the species *Diceratherium hesperius* the lower tooth from the John Day beds. While the lower jaw from Chili Gulch, Calaveras County, is, by inference, assigned to *Diceratherium*, definite generic determination still awaits a comparison with known representatives of this group in the John Day fauna.

[1] J. Leidy, Proc. Acad. Nat. Sci. Phila., 176–177, 1865.
[2] J. Leidy, Jour. Acad. Nat. Sci. Phila., vol. 7, 2d ser., 230–232, pl. 23, figs. 11 and 12, 1869.
[3] J. D. Whitney, Mem. Mus. Comp. Zoöl. Harvard, vol. 6, 243–244, 1879.
[4] H. F. Osborn, Mem. Amer. Mus. Nat. Hist., vol. 1, pt. 3, 144–145, fig. 42, 1898.
[5] J. Leidy, Hayden Rpt. U. S. Geol. Surv. Terr., vol. 1, 220–221, pl. 2, figs. 8 and 9, 1873.
[6] F. B. Loomis, Amer. Jour. Sci., ser. 4, vol. 26, 55 and 56, fig. 5, 1908.
[7] O. A. Peterson, Mem. Carnegie Mus., vol. 7, 411, fig. 6, 1920.
[8] E. L. Troxell, Amer. Jour. Sci., ser. 5, vol. 2, 197 and 201, 1921.

The lower jaw of *Subhyracodon kewi* is more slender than that of *Diceratherium? hesperium* and the teeth are smaller with thinner enamel walls. The symphyseal region in the former species is likewise more slender and doubtless the lower tusks were not so robust as in the latter. The rhinoceros from Calaveras County was evidently a larger type and closely approached diceratheres from the John Day in size. However, there appears to be no evidence to indicate that *D.? hesperium* was not a large representative of the genus *Subhyracodon*. In the description of an unworn M$\underline{3}$, probably belonging to *D.? hesperium*, Leidy[1] calls attention to the presence of a prominent crest which projects forward from the posterior lobe into the transverse valley. As indicated in the description of the upper dentition of *S. kewi*, two ribs or crests project into this valley, but these structures are never so prominently developed as in Leidy's specimen or in specimens of diceratheres from the John Day.

Fragmentary teeth from the Tecuya beds of Tecuya Canyon were referred tentatively to *Cænopus* or *Diceratherium* by Stock.[2] Because of the incomplete preservation of the three teeth available, comparison with *Subhyracodon kewi* is unsatisfactory. The specimens from the Tecuya belong to an individual larger than those represented by the rhinoceroses from the Kew Quarry.

Miohippus sp.

A fragment of the left ramus, No. 461, Plate 4, represents a young individual in which Dp $\overline{2}$, Dp $\overline{3}$ and Dp $\overline{4}$ are present and only very slightly worn and M$\overline{1}$ is just appearing above the alveolar border. In front of Dp $\overline{2}$ is the alveolus and single root-fragment of Dp $\overline{1}$. No. 461 approximates closely in size a ramus with teeth of a slightly older yet immature individual of *Miohippus*, No. 7279 Amer. Mus., from the Diceratherium beds of the John Day. In the latter the deciduous premolars are more worn and M$\overline{1}$ and M$\overline{2}$ are in function but M$\overline{3}$ has not appeared. The dentition available in the form from the Sespe is more nearly like that in No. 7279 in size than like that in specimens of *Miohippus* (*Mesohippus*) *intermedius* with which comparisons are made. A large jaw with permanent teeth, No. 1193 Amer. Mus., referred provisionally to *Miohippus* (*Mesohippus*) *validus*, from the Protoceras beds of South Dakota, has a M$\overline{1}$ broader but not longer than in the Sespe type. This is a large species with only a very slight indication of separation of metaconid-metastylid column.

In specimen No. 461 an external cingulum is present at the base of the protoconid in Dp $\overline{3}$ and Dp $\overline{4}$, swinging outward from the base of the paraconid ridge. The ledge extends backward and bridges the notch between protoconid and hypoconid but is not present on the external side of the latter cusp. M$\overline{1}$ is not sufficiently exposed to show the nature of the external cingulum in this tooth. All of the teeth exhibit a posterior cingulum extending outward from the entostylid (hypoconulid). In character of cingulum No. 461 resembles *Miohippus*, No. 7279. The Sespe form is also like No. 679, Amer. Mus., a fragmentary ramus of *Miohippus* (*Mesohippus*) *intermedius* from the

[1] J. Leidy, *ibid.*, 232, 1869.
[2] C. Stock, Univ. Calif. Publ. Bull. Dept. Geol., vol. 12, 271–272, figs. 4 and 5, 1920.

Comparative measurements (in millimeters)

	Subhyracodon kewi n.sp. Type, No. 1205 C.I.T.	*Subhyracodon kewi* n.sp. Paratype, No. 1221 C.I.T.	*Subhyracodon kewi* n.sp. Paratype, No. 1222 C.I.T.	*Subhyracodon trigonodum* Type, No. 528 A.M.N.H.	*Subhyracodon copei* Type, No. 522 A.M.N.H.	*Subhyracodon occidentale* Neotype, No. 114* U.S.N.M.	*Subhyracodon tridactylum*, No. 1122 A.M.N.H.	*Subhyracodon metalophum* Type, No. 1123 A.M.N.H.
Length from anterior end of P1 to posterior end of M3	*a*178.3	176.7	.....	173.4	158.4	182	214.6	195.8
Length from anterior end of P1 to posterior end of M2	157.6	149	.....	147.8	135.8	.....	176.4	168.3
Length from anterior end of P2 to posterior end of M2	141.3	136.3	.....	133	120.2	.....	162.7	149.9
Length of premolar series, through middle	86.1	79.2	.....	80.3	76	.....	98.2	93
Length of molar series, through middle	.....	99.8	99.2	95.2	83.6	.....	112	104.3
P1, anteroposterior diameter	17.9	18	.....	16.8	17.2	*a*19	20.1	20.6
P1, greatest transverse diameter	15.8	17.5	.....	16.7	16.3	.....	19.8	20.9
P2, greatest anteroposterior diameter	22.6	23	21	20.8	20.4	20.5	28.2	24.2
P2, greatest transverse diameter	23.8	23.3	22	24.1	25.2	26	35.2	31.1
P3, greatest anteroposterior diameter	28.2	26.5	23.5	24.2	21.8	22.3	29.8	27.8
P3, greatest transverse diameter	28.1	29.2	28.6	31.3	29	34.1	40.8	37.3
P4, greatest anteroposterior diameter	28.3	26.9	26	24.7	23.7	23.5	33.4	29.5
P4, greatest transverse diameter	32.2	33.3	32.7	33.7	31.7	37	45.4	40.7
M1, greatest anteroposterior diameter	36.2	36.1	30.5	35.3	31.1	30.5	40.1	40
M1, greatest transverse diameter	34.8	38	34.4	35.2	32.8	38.8	45.2	40.1
M2, greatest anteroposterior diameter	41.8	42.7	38.4	38.2	34.3	34.6	45.3	42.5
M2, greatest transverse diameter	36.3	40.4	39	37.4	35.5	41.5	46.4	43.7
M3, greatest anteroposterior diameter parallel to inner side	.....	35.4	35.2	30.7	29	.....	38.3	35.8
M3, greatest transverse diameter	.....	40.1	35.1	39.1	34.1	.....	42.1	40.4

* Measurements after Wood. *a*, Approximate.

Protoceras beds of the White River, South Dakota, and like specimens (No. 676 Amer. Mus.) referred to *Mesohippus bairdii* from the White River.

$M\bar{1}$ has a crown height similar to that in *Miohippus* from the John Day. The crown height is slightly greater in these forms than in *M. intermedius* from the Protoceras beds.

In Dp $\bar{3}$ and Dp $\bar{4}$ the metaconid and metastylid are distinct and the cleft separating the two cusps extends for a short distance below the occlusal surface. Likewise, a separation of the two cusps is evident in $M\bar{1}$. This character occurs also in *Miohippus* from the John Day, in *M. intermedius* of the White River, and is slightly less marked in *Mesohippus bairdii* from the Oreodon beds of South Dakota (No. 676 Amer. Mus.). In the permanent teeth of an adult individual of *Miohippus intermedius* (No. 681 Amer. Mus. from the Protoceras beds) no separation of the metaconid-metastylid column is evident, while in the permanent teeth of *M.* cf. *equiceps* (Cope) from the John Day (No. 7287 Amer. Mus.) a definite indication of separation is shown although much less marked than in No. 7279 from the John Day. In permanent teeth of *Mesohippus bairdii* the division is usually absent, although it may be feebly developed in some specimens, as for example in No. 8794 Amer. Mus., a lower jaw referred to this species and collected in the Oreodon beds of Cedar Creek, Colorado.

The entostylid becomes progressively larger in the posterior deciduous teeth. In $M\bar{1}$ it approximates in size or may be slightly smaller than that in Dp$\bar{4}$.

Dp$\bar{1}$ appears to have been a small tooth, in size more nearly like that in *M. intermedius* than like that in *Miohippus* (No. 7279 Amer. Mus.) from the John Day.

Dp$\bar{2}$ is particularly interesting because of the characters exhibited at the anterior end. In size and anteroposterior elongation this tooth in No. 461 is more like that in No. 7279 than like that in Nos. 682 and 679 referred to *M. intermedius* from the White River.

In Dp$\bar{2}$ of the Sespe species, as in the comparable tooth of *Mesohippus* from the White River and of *Miohippus* from the John Day, the cusps of the posterior half of the tooth are closely similar to those on the remaining deciduous teeth and on the permanent molar. The forward portion of this tooth is, however, quite differently constructed and consists of two cusps, one anterior (paraconid) and one postero-external (protoconid). From the latter cusp extend crests in three directions, namely (1) forward to the paraconid, (2) postero-internal toward the metaconid, and (3) postero-external to the ledge in front of the hypoconid. The median valley of the external side is deep and has a characteristic oblique direction. Essentially the same characters are found in the forward portion of Dp$\bar{2}$ of *Mesohippus*. In P$\bar{2}$ of *Mesohippus* and *Miohippus* no distinct metastylid is present but the postero-internal crest from the protoconid extends in front of the inner end of the antero-internal crest from the hypoconid. In both *Mesohippus* and *Miohippus* the postero-external crest from the protoconid is a striking feature of both Dp$\bar{2}$ and P$\bar{2}$, distinguishing these genera from the later anchitheriine horses.

In a specimen of *Archæohippus* from the Sheep Creek beds, Nebraska, No. 21532 Amer. Mus., slightly smaller than No. 461 from the Sespe but with the deciduous premolars somewhat more worn than in the latter, Dp$\bar{2}$ is more advanced than the comparable tooth in No. 461. In this tooth a postero-internal crest from the protoconid is well developed and terminates in a distinct metaconid. The notch between the paraconid and metaconid

is likewise more deeply incised in *Archæohippus* than in *Miohippus*. No. 21532 possesses relatively higher crowned teeth than No. 461.

Essentially the same differences in $Dp\bar{2}$ prevail between the *Miohippus* specimen from the Sespe and *Parahippus*, near *cognatus*, No. 14305 Amer. Mus. from the Miocene near Marsland, Nebraska. There is apparently less difference in the arrangement of crests and cusps between $Dp\bar{2}$ and $P\bar{2}$ in *Parahippus* than in *Miohippus*.

In the deciduous premolars of *Hypohippus osborni*, No. 8256 Amer. Mus. from the Pawnee Creek beds of Colorado an external cingulum may be present not only along the base of the protoconid but also along the base of the hypoconid. These teeth are moderately worn in No. 8256. Unfortunately the tips of the metaconid-metastylid columns are broken in $Dp\bar{3}$ and $Dp\bar{4}$. In $Dp\bar{2}$ at this stage of wear there is no indication of an indentation of the inner wall to separate metaconid from metastylid. A slight separation of the two cusps is evident in $M\bar{2}$, but is limited to the tip. In view of the size of the teeth in *Hypohippus* the separation of the metaconid and metastylid appears to be less progressive than in *Miohippus*. In *Hypohippus* the enamel patterns of $Dp\bar{2}$ and $P\bar{2}$ are similar, in which respect this genus is like *Archæohippus* and *Parahippus*. In the second deciduous premolar and in the permanent second premolar of *Archæohippus*, *Parahippus* and *Hypohippus* the more external position of the protoconid lessens in these forms the prominence of the postero-external ridge, in which respect these genera can be distinguished from *Mesohippus* and *Miohippus*.

The jaw from the Sespe evidently represents a type more advanced than typical *Mesohippus*, yet this form has not reached the stage of development represented by *Archæohippus* or by *Parahippus cognatus*. The characters displayed by the teeth are clearly those typically developed in *Miohippus*. A comparison with jaws of various species of *Miohippus* from the Protoceras beds of the White River and from the John Day indicates considerable similarity on the part of No. 461. From specimens referred to *M. intermedius* and questionably to *M. validus*, No. 461 differs in size of cheek-teeth or in the more pronounced separation of the metaconid and metastylid, or in both characters. In hypsodonty, particularly as expressed in $M\bar{1}$, the Sespe specimen appears to resemble more closely types from the John Day (*M.* cf. *equiceps*, No. 7287 Amer. Mus.). Excluding the large miohippine type, *Kalobatippus præstans* (Cope), known from the Upper John Day, no less than nine species have been described from the John Day deposits. Doubtless a revision of the latter forms would decrease the number of valid species. It would serve no particular purpose in view of the present incomplete material from the Sespe to attempt at this time a determination of the relationships with the various species recorded from the John Day.

SUMMARY

Perissodactyla in the Kew Quarry fauna from the Las Posas Hills, California, are represented by rhinoceroses of a new species for which the name *Subhyracodon kewi* is proposed, and by a horse of the genus *Miohippus*. In this late Oligocene assemblage the rhinoceroses were evidently more numerous than were the horses.

Subhyracodon kewi is more closely related to species found in the White River of the western Great Plains than to the diceratheres of the

John Day. On the basis of the characters displayed by the material available, the horse from the Sespe is closely related to species of *Miohippus* occurring in the John Day fauna.

Comparative measurements of Anchitheriine species (in millimeters)

	Miohippus sp. No. 461 C.I.T. Sespe	*Mesohippus bairdii* No. 676 A.M.N.H.	*Miohippus intermedius* No. 679 A.M.N.H.	*Miohippus intermedius* No. 682 A.M.N.H.	*Miohippus* sp. No. 7279 A.M.N.H.	*Archæohippus penultimus* No. 21532 A.M.N.H.	*Parahippus* cf. *cognatus* No. 14305 A.M.N.H.
Length from anterior end of $Dp\bar{2}$ to posterior end of $Dp\bar{4}$	48.4	35.3	38.5	44.0	47.2	44.5	59.9
$Dp\bar{2}$, anteroposterior diameter	17.0	12.3	13.5	15.1	17.0	16.4	21.1
$Dp\bar{2}$, transverse diameter across hypoconid	8.9	7.4	8.1	8.5	9.7	8.4	11.5
$Dp\bar{3}$, anteroposterior diameter	16.0	11.8	13.1	14.8	15.5	13.7	19.0
$Dp\bar{3}$, transverse diameter across hypoconid	10.2	8.9	8.9	9.6	10.5	8.7	12.1
$Dp\bar{4}$, anteroposterior diameter	16.5	12.0	12.6	14.6	14.8	14.1	19.9
$Dp\bar{4}$, transverse diameter across hypoconid	10.3	8.5	8.7	*a*9.4	10.3	8.7	11.6

a, Approximate

PLATE 1

Subhyracodon kewi n. sp.

Type, No. 1205 Calif. Inst. Tech. Coll., lateral and inferior views; x 2/3. J. L. Ridgway, del.
Sespe Oligocene, Las Posas Hills, California.

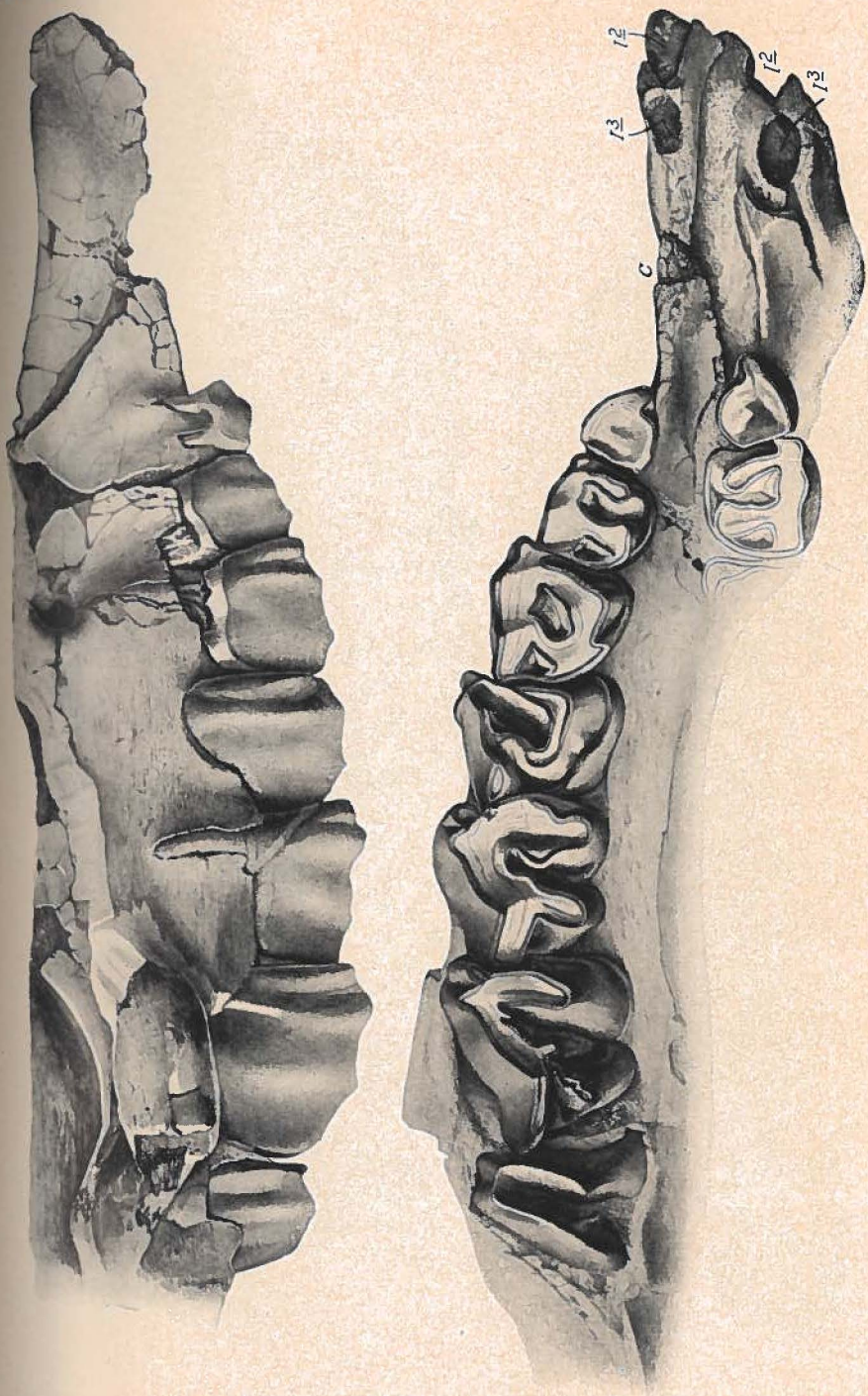

$I^{\underline{2}}$
$I^{\underline{3}}$
$I^{\underline{2}}$
$I^{\underline{3}}$
c

PLATE 2

Subhyracodon kewi n. sp.

A. Paratype, No. 1222, skull viewed from side and top.
B. Paratype, No 1221, skull in ventral view.
All figures, x 2/5 J. L. Ridgway, del. Calif. Inst. Tech. Coll. Sespe Oligocene, Las Posas Hills, California.

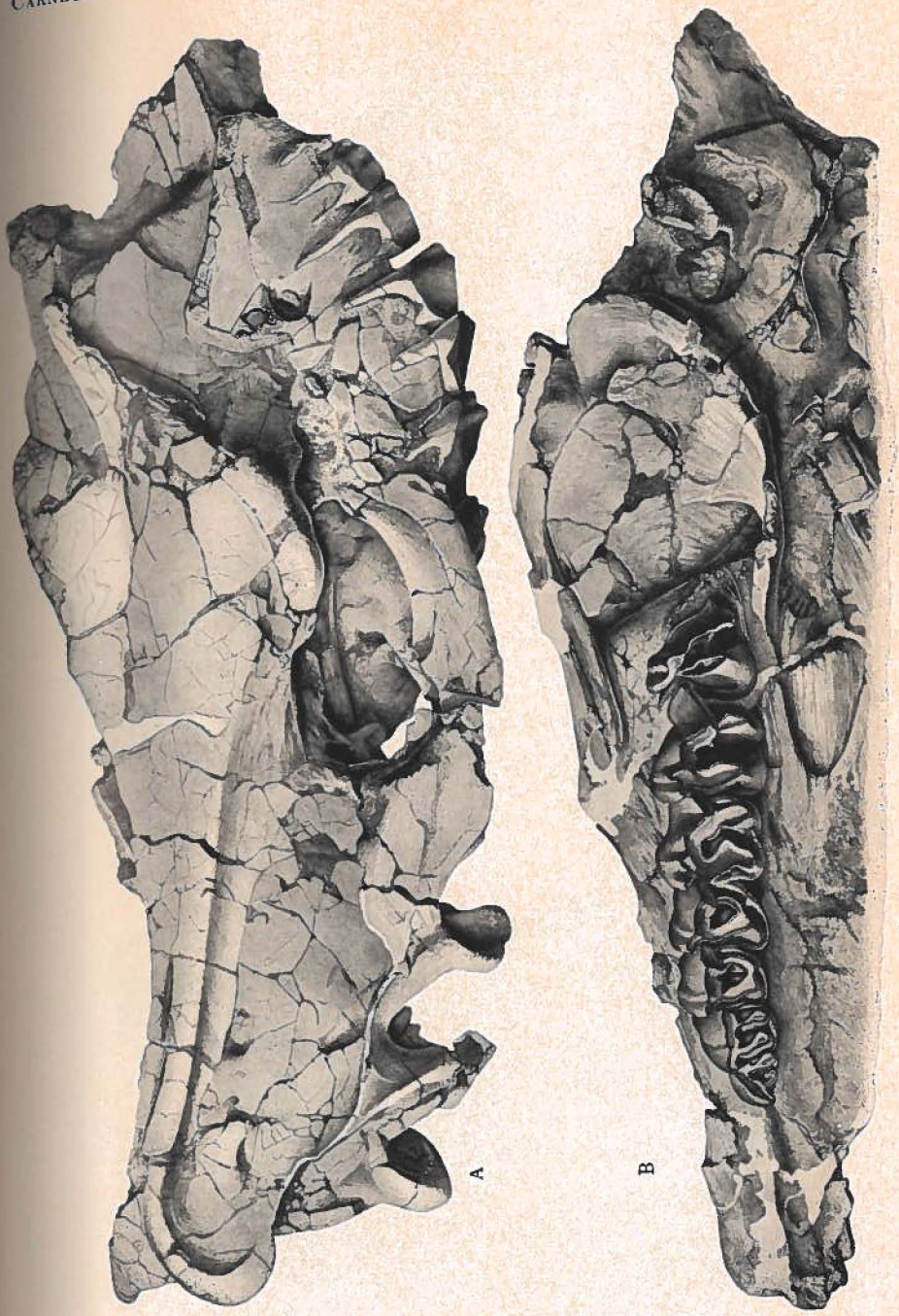

A
B

PLATE 3

Subhyracodon kewi n. sp.

A. Skull, No. 1222, view of occiput.
B. Mandible, No. 1224, lateral view.
C and D. Right premaxillary with incisor, No. 1225; C, lateral view; D, ventral view.
All figures, x 1/2. J. L. Ridgway, del. Calif. Inst. Tech. Coll. Sespe Oligocene, Las Posas Hills, California.

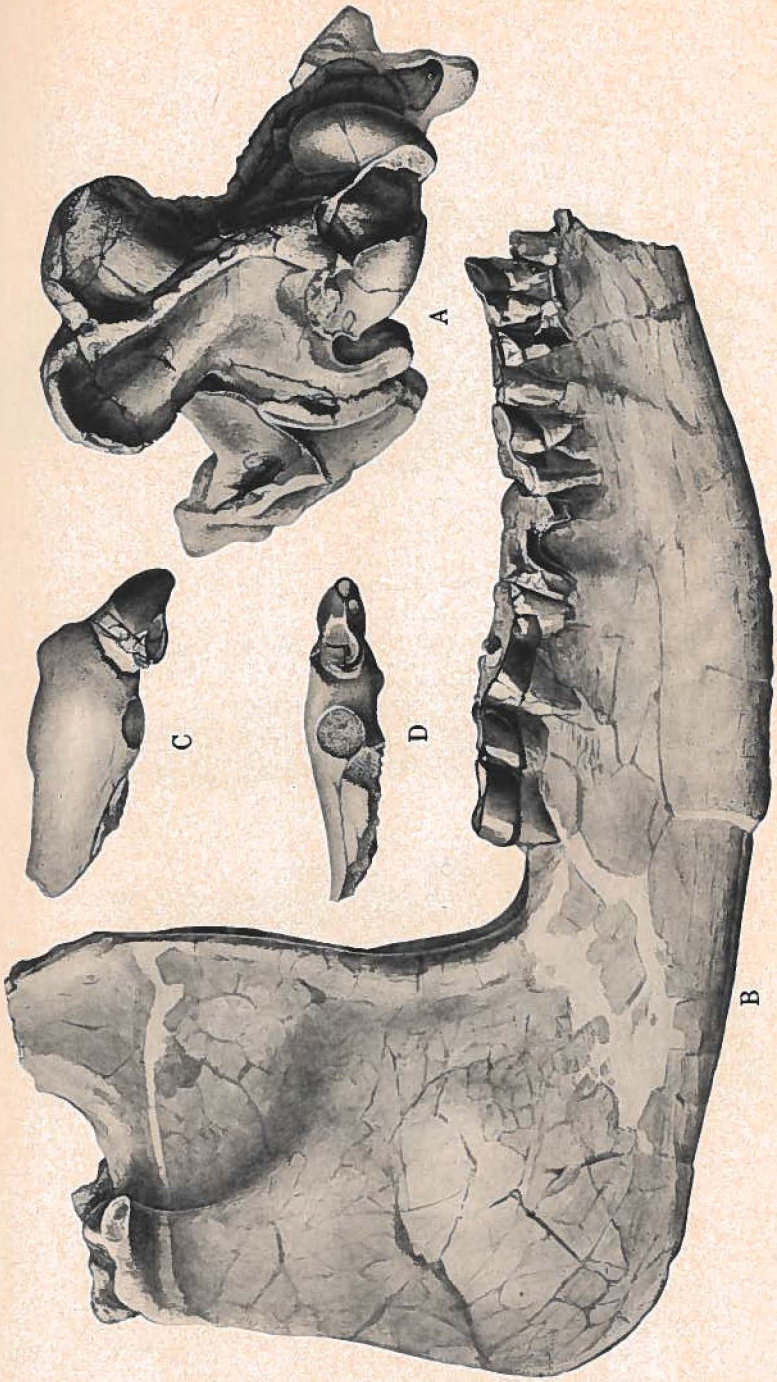
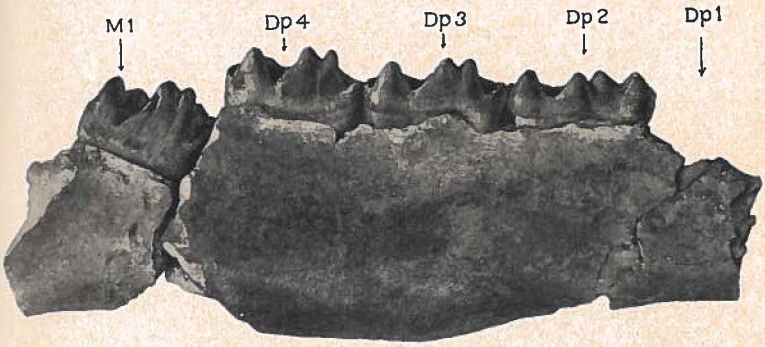

A
B
C
D

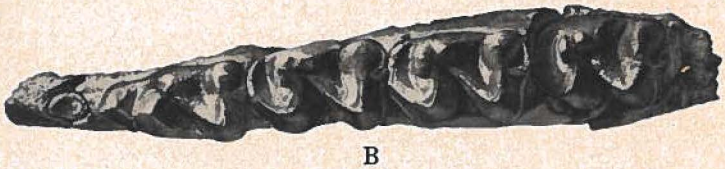
PLATE 4

Miohippus sp.

A to C. Fragment of left ramus with $Dp\overline{2}$-$Dp\overline{4}$, $M\overline{1}$, No. 461 Calif. Inst. Tech. Coll. A, inner view; B, occlusal view; C, lateral view; x 1 1/5. Sespe Oligocene, Las Posas Hills, California.



A



B

C