



A new species of *Cernictis* (Mammalia, Carnivora, Mustelidae) from the Late Miocene Bidahochi Formation of Arizona, USA

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ABSTRACT

Cernictis repenningi is a new species of mustelid carnivore from the middle Hemphillian (late Miocene) Bidahochi Formation of northeastern Arizona. *Cernictis* is a late Miocene immigrant from the Old World, where it apparently is represented by undescribed material from China. The upper dentition of this material indicates that *Cernictis* is a primitive member of the tribe Galictini, which includes one or two extant Neotropical genera, five extinct New World genera, and three or four extinct Old World genera.

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KEY WORDS: Bidahochi Formation; Hemphillian; Mustelidae; *Cernictis*; new species

INTRODUCTION

Cernictis hesperus was described as an unusual mustelid carnivore from the Pinole Tuff Local Fauna of California (Hall 1935). The Pinole Tuff has been dated radiometrically at 5.3-5.5 Ma (Tedford et al. 2004), making the fauna latest Hemphillian (Hh4, latest Miocene) in age. Hall's new genus and species was based on a mandibular fragment with p4-m1. The new species of *Cernictis* described here is named from a mandible with p2-m1 from the Bidahochi Formation at White Cone Peak in northeastern Arizona. White Cone Peak, a prominent topographic feature on the Hopi Indian Reservation (formerly Hopi-Navajo joint-use land) in Navajo County, Arizona, approximately 70 km north of Holbrook, has produced a diverse fossil assemblage (Stirton 1936; Taylor 1966; Uyeno

and Miller 1965; Baskin 1978, 1979; Parmley and Peck 2002; Hodnett 2010). The White Cone Local Fauna was collected from the upper member of the Bidahochi Formation (Repenning and Irwin 1954), approximately 20 m above the base of the volcanic middle member. A basalt flow, which can be traced into the middle member of the Bidahochi Formation at Roberts Mesa, approximately 10 km northwest of White Cone peak, was dated at 6.85 ± 0.16 Ma (Damon and Spencer 2001), which places the White Cone fauna in the late Hemphillian (Hh3).

The holotype of *Cernictis repenningi* n. sp. was collected by C. Repenning during a geologic investigation of the Bidahochi Formation by the USGS (Repenning and Irwin 1954). He (Repenning et al. 1958, p.129) described the specimen as belonging to a "marten-like animal." It is in the col-

lections of the University of Arizona Laboratory of Paleontology (UALP). Two additional specimens collected from White Cone Peak in 1974 are referred to *C. repenningi* because they are of the appropriate size. They are designated by the prefix UALP wc.

SYSTEMATIC PALEONTOLOGY

Family MUSTELIDAE Fischer de Waldheim, 1817
Subfamily GALICTINAE Reig, 1956
Tribe GALICTINI Baskin, 1998

Diagnosis (From Baskin 1998, p. 164). "Small mustelines with a deep jaw, crowded premolars, and p1 absent; P4 primitively with a small anterior protocone and narrow lingual cingular shelf, that is more expanded in derived forms; M1 with an expanded hypocone and a more separate protocone-metacone; and m1 with an open bladeli-like trigonid, a lingually expanded and basined talonid with a posterolingual cingulum extending from the base of the reduced metaconid to the hypoconid, and hypoconid separated from the protoconid by a small notch."

Included genera. New World: *Galictis*, *Stipanicia*, *Trigonictis*, *Sminthosinis*, *Lutravus*, *Cernictis*, and possibly *Lyncodon*; Old World: *Enhydriectis*, *Pannonictis*, *Oriensictis*, and possibly *Trochictis*.

Discussion. Pocock (1921) established the Grisoninae as a subfamily of Recent Mustelidae for the Neotropical *Grison* (= *Galictis vittata*) and *Grisonnella* (= *Galictis cuja*), the greater and lesser grison. Pilgrim (1933) added the fossil European genera *Trochictis*, *Enhydriectis*, and *Pannonictis*; the late Miocene "Mustelide gen. indet. sp. n." from China (Zdansky 1927; Ficarelli and Torre 1967); and the Neotropical Pleistocene and Recent *Tayra* (= *Eira*) to the Grisoninae. Subsequently, Schreuder (1935) excluded both *Eira* and *Trochictis* from the Grisoninae, because of the characteristics of their upper carnassials. Furlong (1932) described *Lutravus halli* as a new genus and species of otter (Lutrinae). Gazin (1934) added two species to *Lutravus* (?), based on two lower jaws from Idaho. Although he described the three species as otter-like, Gazin (1934) noted the many similarities of the lower dentitions of *Lutravus* to the grisonines *Enhydriectis*, *Pannonictis*, and *Galictis*. After recovering upper carnassials of one of his two species, Gazin (1937) transferred the Idaho species to *Canimartes?*, a genus known only from a few isolated teeth and tooth fragments (Baskin 1998). Repenning (1967) suggested that Gazin's (1934)

two species could be derived from the European *Trochictis*. Zakrzewski (1967) assigned the two species to *Trigonictis* (Hibbard 1941), which had been recognized as a galictine by Reig (1956), but left Furlong's species as the sole member of *Lutravus*.

Reig (1956) emended the subfamily name to Galictinae and added the North American Neogene *Lutravus* and *Trigonictis*, and two Neotropical genera, *Lyncodon* (the extant Patagonian weasel) and the Pleistocene *Stipanicia*. Reig (1957) placed *Lutravus* in the Galictinae because of the grison-like features, especially of the lower dentition as noted by Gazin (1934). Reig (1957) also included *Cernictis*, the subject of the present paper. Bjork (1970) included *Trochictis*, *Enhydriectis*, *Trigonictis*, *Sminthosinis*, *Galictis*, and *Grisonnella* in the Galictinae.

The systematic positions of *Trochictis* and *Eira* have been debated. The early to middle Miocene (MN4-MN5) *Trochictis* has been considered the most primitive galictine (e.g., Pilgrim 1933; Ficarelli and Torre 1967; Bjork 1970). More recently, it has been assigned to the Melinae, the Old World badgers (e.g., Petter 1971; Ginsburg and Morales 2000), although some still treat it as a galictine (e.g., Ogino and Otsuka 2009). Pilgrim (1933) concluded that *Eira* retained primitive characters of the skull and P4 similar to *Trochictis* and therefore was a galictine. Reig (1957) agreed with this reference, but Ficarelli and Torre (1967) excluded *Eira* from the Galictinae, because of differences in the dentition and auditory bulla from other members of the subfamily. As suggested by the upper cheek teeth (Baskin 1998) and confirmed by molecular phylogeny (Fulton and Strobeck 2006), *Eira* is not a galictine, but is more closely related to *Martes*. In *Eira*, the P4 has a well developed protocone on a spur opposite the paracone and lacks a lingual shelf.

Molecular phylogeny not only supports the subfamilial status of *Galictis*, but also indicates that the Old World Ictonychini (zorillas, etc.) are galictines (Fulton and Strobeck 2006; Koepfli et al. 2008). Other recent discussions of the contents and characteristics of fossil and recent Galictini can be found in Ray and others (1981), Baskin (1998), Morlo and Kundrát (2001), and Ogino and Otsuka (2008).

Genus *CERNICTIS* Hall, 1935

Type species. *Cernictis hesperus* Hall, 1935.

Type and only specimen. UCMP 22968, left mandible with p4-m1.

TABLE 1. Measurements in mm on *Cernictis repenningi* and *C. hesperus*. L = length; W = width; m1tr = m1 trigonid length, length from anterior edge of paraconid to notch at posterior side of protoconid; depth p2 and depth p4 = depth of mandible below p2 and p4, respectively.

	<i>C. repenningi</i>		<i>C. hesperus</i>	
	L	W	L	W
p2	4.7	2.6		
p3	5.4	3.4		
p4	7.3	4.2	8.5	3.9
m1	10.6	5.1	11.5	4.9
m1tr	7.5		8.3	
p4-m1	17.4		18.8	
p2-m1	36.8			
depth p2	11.8			
depth m1	11.5		12.0	

Type locality. Pinole Junction, Site 1, Pinole Tuff Formation, Contra Costa County, California. Late Hemphillian North American Land Mammal Age

Included species. *Cernictis hesperus*, *C. repenningi* n. sp.

Emended diagnosis. There are three crowded lower premolars. The p2 is two rooted. The p4 possesses a posterior accessory cusp. The m1 is relatively short relative to the p4; the talonid is less than half the length of the trigonid; the talonid is semi-basined, and the metaconid is moderately developed.

Comparisons. The deep jaw, crowded premolars, and internally expanded talonid with a posterolingual cingulum extending from the base of the reduced metaconid to the hypoconid on m1 are diagnostic of the galictin affinities of *Cernictis*. *Cernictis* differs from *Trochictis* in loss of p1, having a more crowded dentition, and having the mandible deep, especially anteriorly. It differs from *Galictis*, *Enhydriactis*, *Pannonictis*, *Trigonictis*, *Sminthosinis*, *Lutravus*, and *Oriensictis* in possessing a posterior cusp on the p4 and in having a shorter and less well basined talonid on the m1. It differs from *Galictis* and *Eira* in having a two rooted p2, and a larger metaconid, more trenchant hypoconid, and more basined talonid on the m1. *Eira* also lacks a posterior cusp on the p4.

Hall (1935) described the lower jaw of his new genus and species, *Cernictis hesperus*, as having some similarities to marten-like forms such as *Martes* or *Gulo*, but not being closely related to either. Reig (1957) concluded that the p4 and m1 of *Cernictis* were most similar to those of *Eira*, and

included both in the Galictinae. In contrast to other galictins, *Cernictis*, possesses a relatively short talonid on m1, a feature also present in *Eira*. Characteristics of the upper dentition, especially the P4, have been important for assigning genera to the Galictini. *Enhydriactis*, *Pannonictis*, *Trigonictis*, and *Galictis* are characterized by a P4 with a triangular occlusal outline, a lingual shelf and a small protocone. *Sminthosinis* (Bjork 1970) has P4 with a relatively large protocone and unexpanded lingual cingulum.

Undescribed material from the late Miocene (Turolian) of China in the collections of the AMNH adds support that *Cernictis* is a primitive galictin, because the upper dentition is otherwise unknown in *Cernictis*. Information with a skull and lower jaw indicate it is from the Baodean (MN 12, ca 8 Ma) locality Ma Chia Liang Kou in northern Shanxi Province. The lower jaw and dentition have characteristics of *Cernictis*, but with more slender premolars and a better developed metaconid on m1. The P4 has a small anteriorly placed protocone and a very weakly developed internal cingulum. The M1 is not expanded internally. The lower dentition resembles the figures of *Baranogale adroveri* from the Turolian (MN12) of Spain (Petter 1964). *Baranogale* is an extinct member of the Ictonychini. Spassov (2001) questioned the assignment of Petter's species to this genus.

Cernictis repenningi n. sp.

Table1, Figure 1

Holotype. UALP 8079, left mandibular fragment with p2-m1, alveolus for the m2.

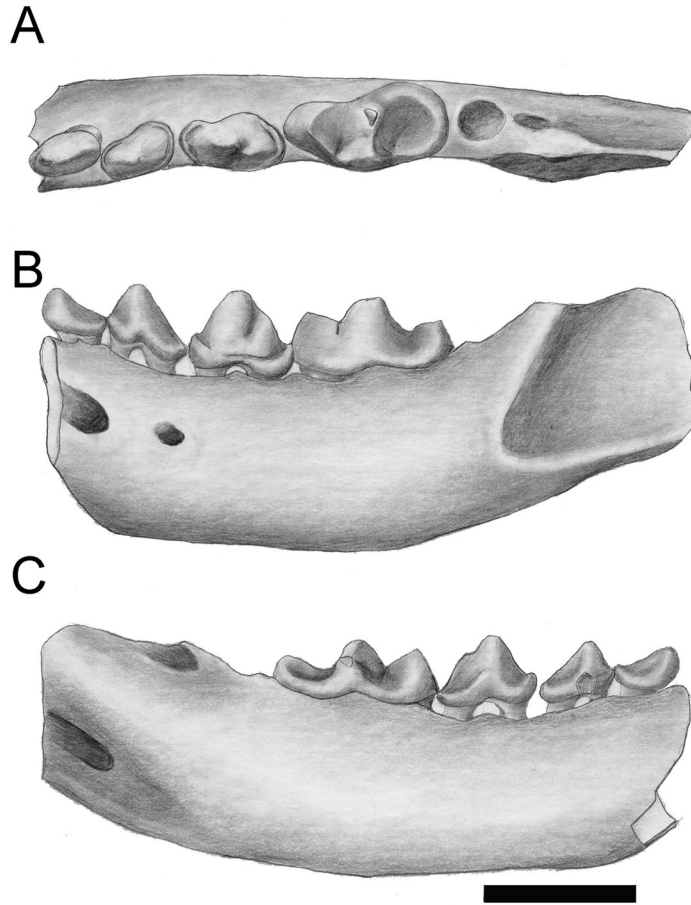


FIGURE 1. *Cernictis repenningi*, sp. nov. UALP 8079, left mandible with p2-m1. A, dorsal; B, external; and C, internal views. Scale equals 10 mm.

Referred material. UALP wc 251/6, right M1 fragment; 260/6, m2.

Distribution. White Cone (UALP locality 6). Bida-hochi Formation, northeastern Arizona; Hemphillian North American Land Mammal Age.

Etymology. Named for C.A. Repenning, collector of the holotype.

Diagnosis. A species smaller than *Cernictis hesperus* Hall. There are three laterally compressed, crested, and crowded premolars. The p4 is relatively wide posteriorly. The protoconid of the m1 is only slightly higher than the paraconid and is lower than the main cusp of p4. The entoconid is absent.

Description. There is no alveolus for a p1, between the p2 and the alveolus for the c1. The p2 is set obliquely in the jaw and has a single anteriorly directed cusp. A slight crest extends antero-posteriorly along the midline of the tooth, terminating in a small cuspile. The p3 has a single

anteriorly directed cusp. There is a narrow anterior cingulum and a broader posterior cingulum. The anterior-posterior crest terminates in a small cuspile.

On p4, the posterior accessory cusp is located slightly labial to the midline of the tooth. The anterior cingulid is low and very short and is connected to the wide and low posterior cingulid by a narrow external cingulid.

The m1 is a relatively narrow, blade-like tooth. The protoconid is the tallest and most prominent cusp, with a weak antero-external cingulid. The apex of the paraconid is situated on the midline of the tooth. The metaconid is a robust cup situated on the posterior margin of the protoconid and connected to it by a weak ridge. It is nearly equal in height to the paraconid. Internally, the valley between the paraconid metaconid is open and indented at its base. On the external side, a narrow notch separates the posterior margin of the

protoconid from the hypoconid. The talonid is short, semibasined, and slightly expanded internal to the metaconid. The hypoconid is trenchant and internal to the protoconid. A low posterointernal crest runs from the hypoconid to the base of the metaconid, closing the basin.

The mandible is deep, especially anteriorly. There are two mental foramina; one below the p2, the other below a point between p3 and p4.

The external half of a worn M1 and an isolated m2 are tentatively assigned to *C. repenningi*. The M1 has a metacone slightly smaller than the paracone. The two cusps are joined by a short loph. The m2 is small (L = 2.9, W = 3.0), single rooted, and circular in occlusal outline. The tooth is divided into anterior and posterior basins, plus a labial shelf. There is a low lingual cusp and a smaller labial cusp.

Comparisons. *Cernictis hesperus* Hall (1935) from the Hemphillian Pinole Formation of California is known from a mandibular fragment with p4 and m1. It is larger than *C. repenningi* (Table 1). The p4 is much narrower posteriorly and has a better developed anterior cingulid cusp. The m1 is shorter relative to the p4 and has a smaller metaconid. The internal wall of the talonid is better developed than in *C. repenningi*. In *C. hesperus*, the protoconid of m1 is much higher than the paraconid of m1 and slightly taller than the main cusp of p4. In *C. repenningi*, the protoconid of m1 is somewhat higher than the paraconid of m1 and lower than the main cusp of p4. *Lutravus halli* (Furlong 1932) is much larger than *Cernictis repenningi*. The metaconid of the m1, as illustrated, appears to be smaller, more separated from the protoconid, and situated more posterior to the protoconid than in *Cernictis*. The mandible is not as deep relative to the cheek teeth as in *Cernictis*.

Remark. Repenning et al. (1958) noted the presence of a “marten-like animal” from the Bidahochi Formation at White Cone Peak. Because the Bidahochi specimens were described in my unpublished Master’s thesis (Baskin 1975) as belonging to *Martes (Plionictis)*, this misidentification was repeated in subsequent publications (e.g., Lindsay and Tessman 1974; Lindsay et al. 1984; Morgan and White 2005; Hodnett 2010). Correct attribution to *Cernictis* was first published by Baskin (1998) and used in a faunal list of the Bidahochi Formation by Morgan and White (2005).

Discussion. Immigration events are used as biostratigraphic markers to delineate and subdivide North American Land Mammal Ages (Tedford et al.

1987). The late Miocene in particular was marked by dispersal of carnivorans, including galictins, across the Bering Strait into North America (Repenning 1967; Qiu 2003). *Trochictis* has been considered the earliest galictine, making galictines distinct from other mustelids since perhaps the early Miocene (Pilgrim 1933; Reig 1957). If *Trochictis* is a meline, the earliest galictine may be *Cernictis* sp. from China, discussed above and dated at about 8 Ma. However, an occurrence of ?*Lutravus* from the late Miocene (ca 8 Ma) in the Ukraine is cited in Vangengeim and Tesakov (2008). In the New World, the earliest galictines are *Lutravus halli* and *Cernictis repenningi*, at about 8 Ma and 6.5 Ma, respectively.

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I was first introduced to the jaw of *Cernictis repenningi* as a Master’s student at the University of Arizona, under the supervision of E. Lindsay, where I did my thesis on the small mammals of the Bidahochi Formation (Baskin 1978, 1979). Although I briefly mentioned the specimen in my thesis, at that time I had limited familiarity with mustelids and did not include it in my publications on the Bidahochi Formation. While a graduate student at the University of Florida, I met with C. Repenning at the National Museum of Natural History where he had an office for the Paleontology and Stratigraphy Branch of the USGS. He was very forthcoming with information about the stratigraphy and paleontology of the Bidahochi Formation and gave me free access to specimens that he had collected that were in the USNM collections. My doctoral dissertation was a study of late Miocene carnivorans from Florida. At that time, I began a productive relationship with R. Tedford at the American Museum of Natural History, which led to my publication on North American Tertiary mustelids (Baskin 1998). It was during my time at the AMNH that I became better acquainted with the identification of the White Cone mustelid named in this paper. I thank L. Jacobs and L. Taylor for inviting me to participate in this volume and giving me the opportunity to finally describe the specimen. Figure 1 was drawn by W. Korth. Two anonymous reviewers provided comments that helped improve the manuscript.

REFERENCES

- Baskin, J.A. 1975. Small vertebrates of the Bidahochi Formation, White Cone, northeastern Arizona. Unpublished M.S. Thesis. University of Arizona, Tucson, Arizona, USA.

- Baskin, J.A. 1978. *Bensonomys*, *Calomys*, and the origin of the phyllotine group of Neotropical cricetines (Rodentia, Cricetidae). *Journal of Mammalogy*, 59:125-135.
- Baskin, J.A. 1979. Small mammals of the Hemphillian age White Cone Local Fauna, northeastern Arizona. *Journal of Paleontology*, 53:695-708.
- Baskin, J.A. 1998. Mustelidae, p. 152-173. In Janis, C., Scott, K.M., and Jacobs, L.L. (eds.), *Evolution of Tertiary Mammals of North America*. Cambridge University Press, Cambridge, United Kingdom
- Bjork, P.R. 1970. The Carnivora of the Hagerman Local Fauna, (late Pliocene) of southwestern Idaho. *Transactions of the American Philosophical Society, new series*, 60 (7), 1-54.
- Damon, P.E. and Spencer, J.E. 2001. K-Ar geochronologic survey of the Hopi Buttes volcanic field, p. 53-56. In Young, R.A. and Spamer, E.E. (eds.), *Colorado River, Origin and Evolution*. Grand Canyon Association, Monograph Number 12, Grand Canyon, Arizona.
- Ficcarelli, G. and Torre, D. 1967. Il mustelide *Enhydrictis galictoides* del Pleistocene della Sardegna. *Palaeontographia Italica*, 33:139-160.
- Fischer von Waldheim, G. 1817. *Adversaria Zoologica. Mémoires de la Société Impériale des Naturalistes de Moscou*, 5:357-446.
- Fulton, T.L. and Strobeck, C. 2006. Molecular phylogeny of the Arctoidea (Carnivora): effect of missing data on supertree and supermatrix analyses of multiple gene data sets. *Molecular Phylogenetics and Evolution*, 41:165-181.
- Furlong, E.L. 1932. A new genus of otter from the Pliocene of the northern Great Basin Province. *Carnegie Institution of Washington Publication*, 418:93-103.
- Gazin, C.L. 1934. Upper Pliocene mustelids from the Snake River Basin of Idaho. *Journal of Mammalogy*, 15:137-149.
- Gazin, C.L. 1937. Notes of fossil mustelids from the upper Pliocene of Idaho and Texas, *Journal of Mammalogy*, 18:363-364.
- Ginsburg, L. and Morales, J. 2000. Origine et évolution des Melinae (Mustelidae, Carnivora, Mammalia). *Comptes Rendus de l'Académie des Sciences, Series IIA*, 330:221-225.
- Hall, E.R. 1935. A new mustelid genus from California. *Journal of Mammalogy*, 16:137-138.
- Hibbard, C.W. 1941. New Mammals from the Rexroad Fauna, Upper Pliocene of Kansas. *American Midland Naturalist*, 26:337-368.
- Hodnett, J-P. 2010. A machairodont felid (Mammalia; Carnivora; Felidae) from the latest Hemphillian (Late Miocene/Early Pliocene) Bidahochi Formation, northeastern Arizona. *PaleoBios*, 29:64-79.
- Koepfli, K.P., Deere, K.A., Slater, G.J., Begg, C., Begg, K., Grassman, L., Lucherini, M., Veron, G., and Wayne, R.K. 2008. Multigene phylogeny of the Mustelidae: Resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. *BMC Biology*, 6:10.
- Lindsay, E.H. and Tessman, N.T. 1974. Cenozoic vertebrate localities and fauna in Arizona. *Journal of the Arizona Academy of Science*, 9:3-24.
- Lindsay, E.H., Opdyke, N.D., and Johnson, N.M. 1984. Blancan-Hemphillian Land Mammal Ages and late Cenozoic mammal dispersal events. *Annual Review of Earth and Planetary Sciences*, 12:445-488.
- Morgan, G.S. and White, R.S. 2005. Miocene and Pliocene vertebrates from Arizona, In Heckert, A.B. and Lucas, S.G. (eds.), *Vertebrate Paleontology in Arizona. New Mexico Museum of Natural History and Science Bulletin*, 29:115-136.
- Morlo, M. and Kunderát, M. 2001. The first carnivoran fauna from the Ruscium (Early Pliocene, MN 15) of Germany. *Paläontologische Zeitschrift*, 75:163-187.
- Ogino, S. and Otsuka, H. 2008. New middle Pleistocene Galictini (Mustelidae, Carnivora) from the Matsugae cave deposits, northern Kyushu, West Japan. *Paleontological Research*, 12:159-166.
- Parmley, D. and Peck, D.L. 2002. Amphibians and reptiles of the Late Hemphillian White Cone local fauna, Navajo County, Arizona. *Journal of Vertebrate Paleontology*, 22:175-178.
- Petter, G. 1964. Deux mustélidés nouveaux du pontien d'Espagne orientale. *Bulletin du Muséum national d'Histoire naturelle*, 36:270-278.
- Petter, G. 1971. Origine, phylogénie et systématique des blaireaux. *Mammalia*, 35:567-597.
- Pilgrim, G.E. 1933. The genera *Trochictis*, *Enhydrictis*, and *Trocharion*, with remarks on the taxonomy of the Mustelidae. *Proceedings of the Zoological Society of London*, 1932:845-867.
- Pocock, R.I. 1921. On the external characters and classification of the Mustelidae. *Proceedings of the Zoological Society of London*, 1921:803-837.
- Qiu, Z-x. 2003. Dispersals of Neogene carnivorans between Asia and North America. *Bulletin of the American Museum of Natural History*, 279:18-31.
- Ray, C.E., Anderson, E., and Webb, S.W. 1981. The Blancan carnivore *Trigonictis* (Mammalia: Mustelidae) in the eastern United States. *Brimleyana*, 5:1-36.
- Reig, O.A. 1956. Note préliminaire sur un nouveau genre de mustélidés fossiles du Pléistocène de la République Argentine. *Mammalia*, 20:223-230.
- Reig, O.A. 1957. Un mustélido del género *Galictis* del Eocuartario de la provincia de Buenos Aires. *Ameghiniana*, 1:33-47.
- Repenning, C.A. 1967. Palearctic-Nearctic mammalian dispersal in the late Cenozoic, p. 288-311. In Hopkins, D.M. (ed.), *The Bering Land Bridge*. Stanford University Press, Stanford, California.

- Repenning, C.A. and Irwin, J.H., 1954, Bidahochi formation of Arizona and New Mexico. *American Association of Petroleum Geologists Bulletin*, 38:1821-1826.
- Repenning, C.A., Lance, J.F., and Irwin, J.H. 1958. Tertiary stratigraphy of the Navajo Country, p. 123-192. In Anderson, R.Y. and Harshberger, J.W. (eds.), *Guide Book of the Black Mesa Basin, Northeastern Arizona*. New Mexico Geological Society Field Conference 9.
- Schreuder, A. 1935. A note on the Carnivora of the Tege-len Clay, with some remarks on the Grisoninae. *Archives Néerlandaises de Zoologie*, 2:73-94.
- Spassov, N. 2001. Zorillas (Carnivora, Mustelidae, Ictonychini) from the Villafranchian of Bulgaria with a description of a new species of *Baranogale* Kormos, 1934. *Geodiversitas*, 23:87-104.
- Stirton, R.A. 1936. A new beaver from the Pliocene of Arizona, with notes on the species of *Dipoides*. *Journal of Mammalogy*, 17:279-281.
- Taylor, D. 1966. Summary of North American Blancan non-marine mollusks. *Malacologia*. 4:1-172.
- Tedford, R.H., Skinner, M.F., Fields, R.W., Rensberger, J.M., Whistler, D.P., Galusha, T., Taylor, B.E., Macdonald, J.R., and Webb, S.D. 1987. Faunal succession and biochronology of the Arikareean through Hemphillian interval (late Oligocene through earliest Pliocene Epochs) in North America, p. 153-210. In Woodburne, M.O. (ed.), *Cenozoic mammals of North America*. University of California Press, Berkeley and Los Angeles.
- Tedford, R.H., Albright, L.B. III, Barnosky, A.D., Ferrusquia-Villafranca, I., Hunt, R.M. Jr., Storer, J.E., Swisher, C.C. III, Voorhies, M.R., Webb, S.D., and Whistler, D.P. 2004. Mammalian biochronology of the Arikareean through Hemphillian interval (late Oligocene through early Pliocene epochs), p. 169-231. In Woodburne, M.O. (ed.), *Late Cretaceous and Cenozoic mammals of North America: biostratigraphy and geochronology*. Columbia University Press, New York.
- Uyeno, T. and Miller, R.R. 1965. Middle Pliocene cyprinid fishes from the Bidahochi Formation, Arizona. *Copeia*, 1965:28-41.
- Vangengeim, E.A. and Tesakov, A.S. 2008. Maeotian mammalian localities of eastern Paratethys: magnetostratigraphy and position in European continental scales. *Stratigraphy and Geological Correlation*, 16:437-450.
- Zakrzewski, R.L. 1967. The systematic position of *Canimartes?* from the upper Pliocene of Idaho. *Journal of Mammalogy*, 48:293-297.
- Zdansky, O. 1927. Weitere Bemerkungen über fossile Carnivoren aus China. *Palaeontologia Sinica* ser. C, 4 (4):1-30.