ARCHIDISKODON PLANIFRONS (FALCONER ET CAUTLEY) FROM THE TATROT ZONE OF THE UPPER SIWALIKS

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Although the discovery of the elephantine mentioned in the title of the present contribution dates from the early days of collecting in the Siwalik Hills (FALCONER and CAUTLEY, 1845, pl. 2 figs. 5a, 5b, as *Elephas planifrons*), the stratigraphical position of this species within the tremendously thick Siwalik series of continental deposits was first settled only in 1913, when PILGRIM wrote: "There is absolutely no trace of *Elephas* either in the Middle Siwalik or in the Tatrot zone of the Upper Siwalik. It first appears as the species *Elephas planifrons* some 2,000 feet above the base of the Tatrot zone" (PILGRIM, 1913, p. 294), that is, within the Pinjor zone. Hence, PILGRIM (l. c., pl. 26) assigns *Archidiskodon planifrons* (FALCONER et CAUTLEY) to the Pinjor zone of the Upper Siwaliks. Meanwhile, molars indistinguishable from those of the Siwalik *A. planifrons* had been discovered in Bessarabia, Southern Russia (PAVLOW, 1910, p. 27, pl. I fig. 23) and in Lower Austria (SCHLESINGER, 1912, p. 89), in strata which were then considered to be approximately of Upper and of Middle Pliocene age respectively. In accordance with this, PILGRIM (l. c., p. 323) regards the Pinjor zone as Middle to Upper Pliocene, and the underlying Tatrot zone, the basal beds of the Upper Siwaliks, as Lower Pliocene. However, he states further that, if some subsequent discovery should bring to light a specimen of *A. planifrons* in the basal beds of the Upper Siwaliks, it would then be impossible to regard the Tatrot zone as much older than the occurrences of this species in Europe (l. c., p. 295).

Unfortunately, the beautiful specimens of *Archidiskodon planifrons* collected in 1922 by BARNUM BROWN in the Upper Siwaliks around Kalka were loosely embedded in sand, occurring in gullies or depressions, and consequently are of uncertain stratigraphic position; yet OSBORN (1942, pp. 950—959) regards these molars as having been derived from the Pinjor zone.

It remained to LEWIS, during the Yale University North India Expedition of 1931—1933, to prove that the absence of *Archidiskodon* from the Tatrot zone is not a real one but due to the imperfection of the fossil record known to date, a possibility already considered by PILGRIM (1913, p. 295). "*Archidiskodon* is represented in a large collection from the type locality at Tatrot" (LEWIS, 1937, p. 198). LEWIS (l. c.) further states that his collection fails to warrant the distinction between the Tatrot and the Pinjor upheld by previous authors. He finds that the vertebrates represent a common fauna, and unites the two zones into a single stratigraphic unit which he designates as the Tatrot formation. Incidentally, LEWIS (l. c., p. 199) confirms the observations by DE TERRA and TEILHARD DE CHARDIN (1936) on the presence of a stratigraphic break between the Tatrot and the underlying Dhok Pathan, already alluded to by PILGRIM (1913, p. 275), and places the Upper Siwaliks in the Pleistocene, thereby following MATTHEW (1929, p. 447), COLBERT (1935, p. 22), and DE TERRA and TEILHARD DE CHARDIN (1936, p. 822).

MATTHEW's view on the age of the Upper Siwaliks was based on the sudden appearance of new invading elements, *Equus* and *Camelus*, which he regarded as evidence of the Pleistocene age of these beds. Already as early as 1911, HAUG, in discussing the correlation of Quaternary faunas had stressed the importance of "des types nouveaux d'origine asiatique, qui apparaissent brusquement dès le Villafranchien. Ces immigrés sont les genres *Elephas*, *Equus* et *Bos*. Leur introduction soudaine dans la faune européenne constitue un événement assez important pour justifier l'établissement d'une coupure de premier ordre. Aussi placerons-nous à la base du Quaternaire le Villafranchien ..." (HAUG, 1911, p. 1767). The revival of this idea by HOPWOOD (1935a, p. 47), who states that "there is no doubt that these three genera form convenient guide fossils for the separation of the Pleistocene from the Pliocene, and that the presence of any one of them is sufficient reason for assigning a Pleistocene age to the bed in which it is found", marks the beginning of a new period of extensive discussion of the "Villafranchian problem". To make a long story short, I would like to jump next to a pronouncement on the question by an authoritative international committee: "in order to eliminate existing ambiguities, the Lower Pleistocene should include as its basal member in the type-area the Calabrian formation (marine) together with its terrestrial (continental) equivalent the Villafranchian" (Int. Geol. Congress, Rep. 18th Session, Great Britain 1948, part IX, London, 1950, p. 6).

Having resolved to place the Villafranchian in the Lower Pleistocene, we have to consider the Villafranchian aspect of the Upper Siwaliks more in detail. The Tatrot zone fauna still possesses certain affinities to the Dhok Pathan zone fauna, which that of the Pinjor zone does not share, "the latter on the contrary indicates very clearly that it belongs to the same epoch as the Villafranchian of Europe" (PILGRIM, 1938, p. 450). It is in this zone that we find *Archidiskodon*, *Equus*, *Camelus*, and *Leptobos* [1]. Only the first of these highly characteristic Villafranchian genera occurs in the Tatrot zone [2].

It should be realized beforehand that we still do not know too much about the fauna of the Tatrot zone. Even though COLBERT and I have been able to add fourteen genera to the list of Tatrot zone mammals when studying the LEWIS collection of Siwalik mammals in the Peabody Museum, Yale University (HOOIJER and COLBERT, 1951), the faunal list of the Tatrot zone is only about one-third as long as that of the Pinjor zone. The former is conspicuously lacking in carnivores and bovids (for full lists of mammalian genera at present known to occur in these two Upper Siwalik zones, see

[1] Substitute for *Bos* (PILGRIM, 1944, p. 29, footnote).

[2] As a result of LEWIS's perhaps somewhat unfortunate choice of the name Tatrot for the formation in which he included both the Tatrot zone and the Pinjor zone, *Equus* is mistakenly stated to have been found in the Tatrot zone by PILGRIM (1938, pp. 441, 447, 449), VON KOENIGSWALD (1940, p. 74), PILGRIM (1940, p. 25), PATERSON (1941, p. 414), COLBERT (1943, p. 427), MCGREW (1944, pp. 44, 46), VON KOENIGSWALD (1950, p. 93), and STIRTON (1951, p. 81). However, the first appearance of *Equus* in the Siwalik series is in the Pinjor zone (HOOIJER and COLBERT, 1951, p. 534).

HOOIJER, 1952, p. 438). As far as our present knowledge goes, there are seven holdovers from the distinctly Pliocene Dhok Pathan zone in the Tatrot zone, while six genera in the Tatrot zone may be considered newcomers (HOOIJER and COLBERT, 1951), and it is generally agreed upon that the appearance of new elements in a fauna is a safer guide to its correlation than the persistence of old elements. The "invasion" of *Archidiskodon* at least we now know to have already taken place by Tatrot times.

Archidiskodon suddenly appears in three continents, Asia, Africa, and Europe, amidst the stegodonts of Asia and Africa, and with the last mastodonts (*Anancus*) of Europe. The general contention is that *Archidiskodon* originated somewhere in Eurasia (probably in or near to Northern India: HOPWOOD, 1938, p. 473), and sprang from primitive stegodonts. On the basis of certain fragmentary Transvaal types OSBORN (1934) defended the theory of an African center of origin of the archidiskodonts, but this idea has been refuted by ARAMBOURG (1948, p. 291). In its earliest evolutionary stage, *Archidiskodon* possessed premolars, the presence of which has not been established with certainty in any stegodont but which are of common occurrence among mastodonts.

As a matter of fact the earliest stages of *Archidiskodon,* from Asia as well as from Africa or from Europe, are remarkably alike in the structure of their molars. This great similarity between the most primitive elephantines in all of these three continents is strongly suggestive of swift dispersal of the original type, once having come into existence, over a large portion of the earth's surface without much or any opportunity for further evolution to have taken place. Subsequent development in the areas in which it became established went much along the same lines, involving mainly an increase in height and in number of the molar plates, etc.

The European species is *Archidiskodon meridionalis* (Nesti); the most primitive molars of this species are indistinguishable from those of the Upper Siwalik *A. planifrons*, and consequently have been so named by various authors (for a discussion of the European archidiskodonts, with references, see HOOIJER, 1953c). There is, indeed, a very gradual transition in molar types between the two species, without a break in the series at which the boundary line between the two species can be conveniently placed.

In Africa, the earliest archidiskodonts of the Vaal River terraces such as *A. subplanifrons* Osborn or *A. proplanifrons* Osborn have originally been considered much more primitive than *A. planifrons* of the Pinjor zone of the Upper Siwaliks (OSBORN, 1934), but in a revision of these species COOKE (1947, p. 507) writes that they "might represent an even earlier evolutionary stage than the Lower Pleistocene *A. planifrons* of India though the species may itself be a parallel survivor. It possibly lies at about the same evolutionary stage but is almost certainly of more recent date". The early archidiskodont from Ichkeul, Tunisia, described by ARAMBOURG (1952) as *Elephas africanavus*, is identical with *Archidiskodon planifrons* as I shall show below.

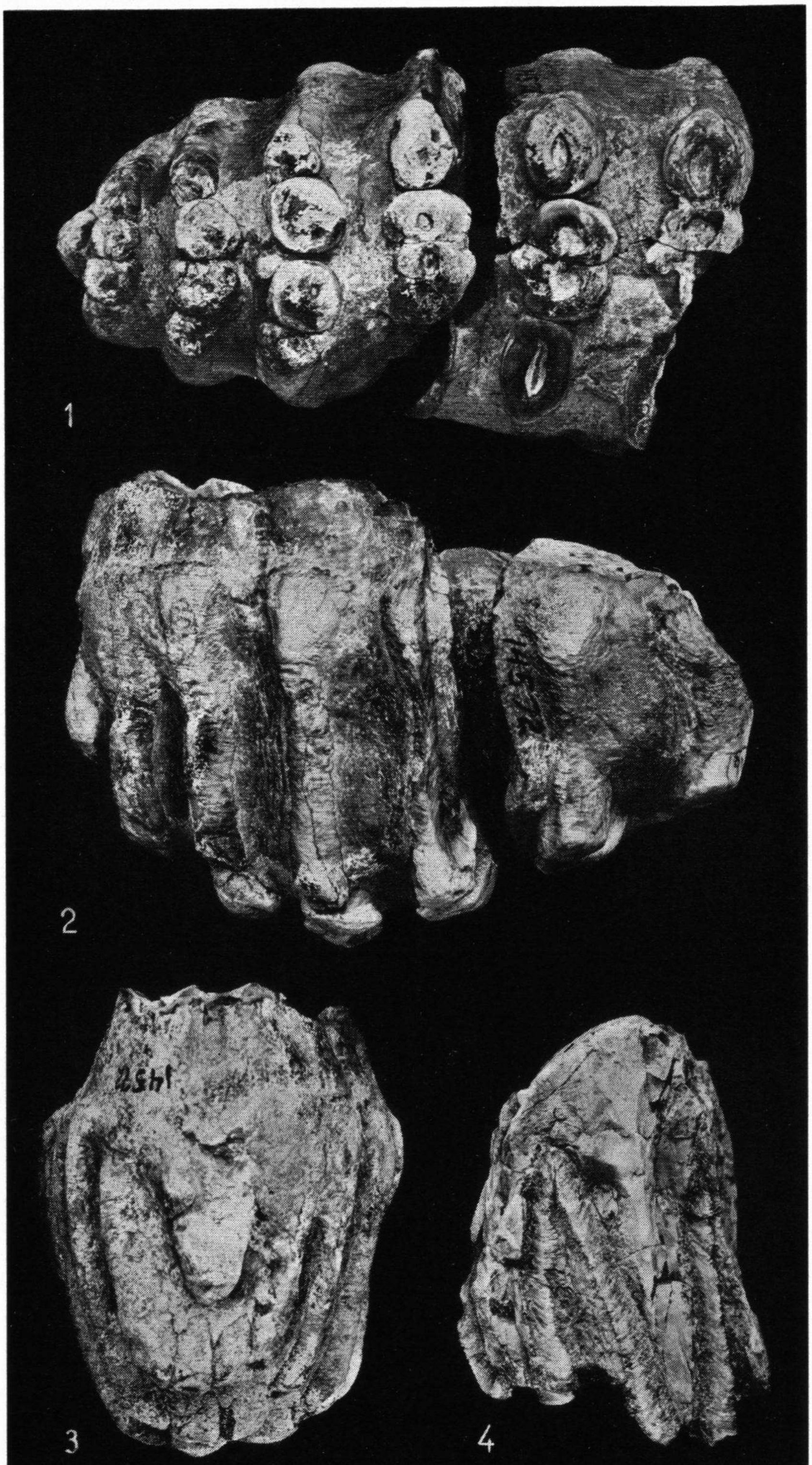
In Asia, *A. planifrons*, in addition to the Upper Siwaliks, is known from China, and Java. While HOPWOOD (1935b, p. 90) writes that on the basis of his specimen (an M^3 from the Lower Pleistocene of Shansi) one cannot say whether *A. planifrons* appeared earlier in the Siwaliks or in China, TEILHARD DE CHARDIN and TRASSAERT (1937, p. 43) mention *A. planifrons* specimens from Shansi, zone III (Villafranchian), as well as from the top of zone II, "Middle Pliocene", but with *Mastodon borsoni* which is likewise a Villafranchian type. VON KOENIGSWALD (1951, p. 273), in describing an upper milk molar and a premolar from Tjidjulang, Java, as *A. praeplanifrons*, notes the Javanese form to be "primitiver als das indische *planifrons* und somit augenscheinlich älter", but as I have already shown (Hooijer, 1953b, pp. 225, 227) there is no need for the erection of a new species of *Archidiskodon* for the Tjidjulang fauna of Java as the material is not in the least more primitive than that of the Pinjor zone species.

Although he does not appear to have seen the specimen, Pilgrim (1938, pp. 447, 449) refers to Lewis's *Archidiskodon* from the Tatrot zone as "*Elephas (Archidiscodon)* cf. *planifrons*", and Lewis's find subsequently has been cited variously as *Archidiskodon* or as *A. planifrons*. The specimen collected by Lewis is the first evidence we have of the occurrence of archidiskodonts in the Upper Siwaliks below the Pinjor zone, and it would be of considerable interest to have all the details on this specimen, as it is conceivable that it would show more primitive characters than the Upper Siwalik specimens of *A. planifrons* described by Falconer (1868) and by Osborn (1942). If it would not, there would be no valid reason to regard the Tatrot zone find as any older than the occurrences of this species elsewhere in the world. Hence, the specific identity of the Tatrot zone *Archidiskodon* is of crucial importance in connexion with the question of the correlation of the Tatrot zone fauna. However, until now Lewis's Tatrot zone *Archidiskodon* has not been described or figured.

I am very grateful to Dr. Joseph T. Gregory of the Peabody Museum, Yale University, for giving me the opportunity to study the material of *Archidiskodon* collected by Dr. G. Edward Lewis in the Upper Siwaliks during the Yale North India Expedition of 1931—1933. The specimen described in the present contribution was collected in 1932 at locality number 106, Southeast of Tatrot, Punjab (Survey of India Map 43 $\frac{H}{5}$ B 2), lat. 32° 52′ N, long. 73° 23′ E, in the Tatrot zone. It is Yale Peabody Museum no. 14572.

The specimen represents a last upper molar, of the right side. Three fragments have been collected which fortunately fit together (pl. I figs. 1—4). The largest fragment comprises the hinder end of the molar, broken off through the fourth plate from behind. The remaining two fragments are the lingual and the buccal halves of the fifth plate and most of the sixth plate from behind; the lingual fragment also holds part of the fourth plate, and fits to the remainder of the same plate on the large fragment. Thus, altogether six plates of the molar, three of which entire and unworn, are available. The root part is missing, but the base of the crown, which bulges out above the root, is preserved. As a whole, the molar is slightly curved in the horizontal plane to the effect that the buccal surface is convex from before backward, and the lingual surface flattened. The plates diverge slightly from base to top, and the worn surfaces of the plates form an occlusal surface that is convex anteroposteriorly, and that falls off toward the lingual side. The crown narrows gradually from front to back, and the plates taper to their summits; their lingual edges are slightly convex from above downward, the buccal edges are straight or (in the anterior plates) even slightly concave vertically. Cement is abundant.

The posterior talon is merely a central cone, almost twice as high as it is wide at the base. The hindmost plate (I) is not very much higher than wide, and bears four subequal conelets on the crown edge that have a combined width two-thirds as great as the basal width of the plate (full


1
2
3
4

measurements of the molar plates are contained in table 1). Cement fills the valley in front of plate I up to a few mm from the edge.

Plate II from behind is much larger but of the same build as plate I; the four conelets on the crown edge again are two-thirds the basal width. The two central conelets are larger than those on either side, and slightly higher, too. The clefts between the conelets cannot be seen in full as the cement in the valleys in front and behind covers up almost the entire plate. As far as can be ascertained, however, the plate has very much the same anteroposterior thickness over most of its height, and the valleys are as wide as the enamel plates in between.

Plate III from behind is again larger; it is the first full-sized plate. Wear has only just begun at the two large central conelets, the lingual of which has a small accessory cylinder behind, in the median line of the crown. Of the lateral conelets that on the lingual side is the larger. Again the depth to which the clefts between the conelets descend is concealed by the valley cement.

Plate IV from behind is only partially preserved; on the crown edge the lingual lateral conelet is broken off, and the anterior surface of the plate is lost except for a small portion lingually. The central conelets are three in number and slightly worn although their enamel figures have not yet coalesced; they occupy a width even less than that of the two central conelets of plate III. The lateral conelets, however, have grown relative to those in plate III, evidently at the expense of the central conelets. The fractured surfaces of plate IV permit of certain further observations: the enamel is very thick, its thickness varying from 5—7 mm, and the clefts which separate the median triplets from the lateral conelets are ca. 20 mm deep, that is, one-fourth of the height of the crown.

The ancient vertical fracture that passes through the middle of plates V and VI allows of the valleys to be seen in cross section (pl. I fig. 4). These valleys are V-shaped; the adjacent plates part immediately at the bottom of the valley.

Plate V is again complete, and has three enamel figures. In the median enamel figure the three conelets that united into it are still shown by enamel infolds; the central conelet has given off the most prominent posterior lobe. The clefts between the central enamel figure and those on either side, which latter form transverse ovals less elongated than the central figure, are still extant. Cement fills the valleys in front and behind, and does even extend upon the outer and inner sides of the plate.

Plate VI from behind is the foremost preserved plate. It is incomplete; the anterior surface is lost except for its buccal third. The central enamel figure is trilobate as in plate V, with a median posterior looped fold. The transversely elongated lingual and buccal figures, of which the lingual is the larger, have not yet coalesced with the central figure although the clefts in between are almost worn out. It is worn down to a level only 45 mm above the base of the crown.

To begin with, this specimen is not *Stegodon* as the valleys are dis-

Plate I

Archidiskodon planifrons (Falconer et Cautley), M^3 dext., Tatrot zone, Upper Siwaliks, Punjab (Yale Peabody Museum, no. 14572); fig. 1, crown view; fig. 2, buccal view; fig. 3, posterior view; fig. 4, view of fractured surface of buccal half, showing V-shaped valleys. All figures $^2/_3$ natural size.

tinctly V-shaped and not Y-shaped as in members of that genus. Further, the tapering end of this molar is quite elephantine as contrasting to the abruptly terminating molars of *Stegodon* (COLBERT, 1943, p. 403). The ridge-plates of *Stegodon* are roof-shaped, with more numerous conelets or mammillae, and less high; the worn enamel figures are more finely wrinkled,

TABLE 1

Measurements of M^3 dext. of *Archidiskodon planifrons*

Tatrot zone, Upper Siwaliks (Y. P. M. 14572)

Number of plate from behind	VI	V	IV	III	II	I	talon
Width at crown base	83	81	ca. 78	73	61	46	ca. 20
Width at 45 mm above base	70	66	64	61	49	ca. 33	—
Height of plate, unworn	—	—	—	80	70	57	35
Height of worn plate	45	55	70	—	—	—	—
Width of unworn edge	—	—	—	48	37	30	ca. 12
Width of worn edge	70	64	—	—	—	—	—
Combined width of two unworn or three worn central conelets	ca. 24	24	26	30	22	17	—

and they approach each other more closely across the valleys in advanced stages of wear than they do in an *Archidiskodon* molar.

The M^3 dext. from the Tatrot zone just described belongs to *Archidiskodon planifrons* (Falconer et Cautley), for the following reasons:

1. The unworn height of a full-sized plate (III) is only slightly greater than its basal width.

2. The valleys between the plates are V-shaped.

3. The distance from the posterior surface of plate III to the posterior surface of plate VI, covering three plates and three cement intervals, is 79 mm at the apex, only 70 mm at the base lingually, and even 81 mm at the base buccally (the convex lateral surface of the crown). This leads to a laminar frequency of 3.8 at the apex, 4.3 at the base lingually, and 3.7 at the base buccally; the average laminar frequency is just under 4, which is a figure typical of *A. planifrons* (see HOPWOOD, 1935b, p. 88; HOOIJER, 1953c, p. 196).

4. The enamel, wherever exposed in cross section, is very thick (5—7 mm), which is also characteristic of the primitive archidiskodont stage exemplified by *A. planifrons* (see HOOIJER, 1949, p. 223).

5. The enamel figures are simple but show a median posterior expansion, or even a median looped fold such as is often seen in *A. planifrons* in contradistinction to *A. meridionalis* (SCHLESINGER, 1912, pp. 101 and 106; HOOIJER, 1953a, pp. 313 and 315).

6. Cement is plentiful, and sometimes even encroaches upon the lateral surfaces of the plates.

TABLE 2

Comparative measurements of M^3 of *Archidiskodon planifrons*

	Tatrot zone	FALCONER, 1868; OSBORN, 1942, pp. 949, 954
Length	—	201—279
Width	73 (III), 81 (V)	63—123
Width-length index	—	34—47
Height	80 (III)	63—123
Height-width index	110 (III)	71—115

Although the plate formula of the Tatrot zone specimen cannot be determined, there can be no doubt about its specific identity: it belongs to *Archidiskodon planifrons* (Falconer et Cautley), of which species it is a very characteristic specimen. Comparative measurements are given in table 2. The Upper Siwalik specimens described and figured by OSBORN (1942, pp. 950—959) occasionally have higher crowns, less widely spaced plates, and thinner enamel, too; OSBORN (l. c., p. 955) considers this probably attributable to progressive evolution or to ascending mutations ranging into higher geologic levels. Be that as it may, our specimen from the Tatrot zone is a typical example of the most primitive archidiskodont stage known as *A. planifrons*.

I wish to make one more comparison, viz., with *Elephas africanavus* Arambourg from the Lower Villafranchian of North Africa. Dr. ARAMBOURG has kindly permitted me to study the type molar of his species in the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle at Paris. ARAMBOURG (1952, p. 409) states that *E. africanavus* differs from *A. planifrons* in its smaller dimensions and more brachyodont molar crowns, but these distinctions do not appear to hold good when a comparison is made

TABLE 3

Comparative measurements of M_3 of *Archidiskodon planifrons*

	Ichkeul, Tunisia (*Elephas africanavus* Aramb.)	Upper Siwaliks FALCONER, 1868; OSBORN, 1942, p. 949
Length	283	224—323
Width	95	77—105
Width-length index	34	26—43
Height	92	77—115
Height-width index	97	78—125

with FALCONER's series of *A. planifrons* M_3s (table 3). The Ichkeul type is an M_3 dext. (ARAMBOURG, 1952, pl. I fig. 2), complete with 10 plates, and a laminar frequency of 3½. The crown is very slightly lower than wide, but well within the variation limits of the Upper Siwalik M_3s. ARAMBOURG (1948, p. 291) agrees that OSBORN's *A. proplanifrons* and *A. subplanifrons* of the Vaal River gravels can be referred to *A. planifrons* proper, the primitive characters of which are of the same order as those of the Ichkeul type (ARAMBOURG, 1952, p. 409).

It is evident that the earliest archidiskodonts of Asia (India, China, Java), Africa (Transvaal, Tunisia), and Europe are so very much alike that their molars cannot be specifically distinguished. By geological standards the amount of time involved in their dispersal must have been so small as to be negligible. Therefore, *Archidiskodon planifrons* appears to represent a species of value for purposes of long distance correlation, and we may consider approximately contemporaneous, i. e., Early Villafranchian, all the beds (in Asia: the Tatrot zone of the Upper Siwaliks, top of zone II in Shansi, China, and the Tjidjulang beds in Java; cf. HOOIJER, 1952, p. 442) in which these animals do first appear.

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