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SOUTHERN NAMIB**

**VOLUME 2:
PALAEOONTOLOGY OF THE ORANGE RIVER VALLEY,
NAMIBIA**

by

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Orangemeryx hendeyi

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by

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New data regarding *Orangemeryx hendeyi* Morales *et al.*, 2000, from the type locality, Arrisdrift, Namibia

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Orangemeryx hendeyi is the most common large mammal at the basal Middle Miocene site of Arrisdrift, Namibia. In the new collections from the locality there are several specimens, including frontals with appendages and the brain case, which were not well represented in the previously described samples. These discoveries throw a great deal of light on the mode of insertion and orientation of the frontal appendages, as well as on the morphology of the brain case and basicranium, all of which permits a better phylogenetic interpretation of the genus, and in a wider sense, of the family Climacoceratidae. There is meagre postcranial evidence for the existence of another species of large ruminant at Arrisdrift, and a couple of smaller specimens about the size of *Walangania*, but no dentitions corresponding to these forms are known from the site.

Version française abrégée

Le Climacoceratidae *Orangemeryx hendeyi* est le grand mammifère le plus commun trouvé à Arrisdrift, avec plus d'un millier de restes représentant une grande partie des squelettes d'individus juvéniles, jeunes adultes ou séniles. Une étude préliminaire publiée par Morales *et al.*, (1999) traitait des spécimens récoltés jusqu'en 1995. Cet article complète ce travail en ajoutant les échantillons récoltés de 1996 à 2000 et insiste particulièrement sur les pièces crâniennes et dentaires les plus complètes. En particulier un frontal ayant conservé ses deux appendices *in situ* montre l'angulation de ces derniers sur le crâne. L'examen approfondi du squelette indique une forte variabilité au sein de cette espèce.

Orangemeryx hendeyi fut rattaché à la famille des Climacoceratidae par Morales *et al.*, (1999) en compagnie de *Climacoceras* et *Nyanzameryx*. Ce dernier genre érigé par Thomas (1984) allié à la fois des appendices frontaux voisins de ceux de *Climacoceras africanus* et un crâne qui possédait les caractéristiques typiques des bovidés (McCrossin *et al.*, 1998; Morales *et al.*, ce volume). *Orangemeryx* et *Climacoceras* partagent le même type d'appendices frontaux tendant à se ramifier, la même tendance à l'hypsodontie et la même morphologie postcrânienne. On ne trouve aucune canine bilobée dans la population d'*Orangemeryx* ce qui rejoint le doute exprimé par Churcher (1990) concernant la présence supposée de canines bilobées chez *Climacoceras gentryi*.

Les relations de ces deux genres avec *Prolibytherium* sont difficiles à établir car ce dernier a des protubérances crâniennes complexes dont le développement ontogénétique n'est pas connu. Cependant la denture attribuée par Hamilton (1973) est plus proche de celle des Climacoceratidae que de celle des Giraffidae. Ceci est particulièrement net pour les m/3 attribuées à *Prolibytherium* qui sont plus hypsodontes que les dents de girafe et semblables à celles d'*Orangemeryx*. De même les prémolaires de *Prolibytherium* et *Orangemeryx* sont très primitives, contrairement à celles des Giraffidae du Gebel Zelten qui montrent une tendance à la molarisation (Hamilton, 1973). De plus, la denture de *Prolibytherium* ne diffère de celle d'*Orangemeryx* que par la plus grande largeur de ses molaires inférieures. Enfin, il y a des ressemblances entre certains os de *Prolibytherium* et *Orangemeryx*. Dans l'état actuel de nos connaissances il est vraisemblable de considérer que *Prolibytherium* appartient à la famille des Clima-

coceratidae.

On peut définir les Climacoceratidae par la présence de protubérances crâniennes complexes en apophyses, associées à une denture relativement hypsodonte ayant conservé une morphologie primitive. Une parenté étroite avec d'autres Giraffidae est possible comme l'a proposé Gentry en 1994. Cependant l'existence dans les dépôts du Miocène inférieur de Namibie de formes vraisemblablement dépourvues de cornes mais dont la denture rappelle celle des Climacoceratidae telles que *Propalaeooryx austroafricanus* (Stromer, 1926; Morales *et al.*, 1999) indiquent une divergence précoce entre Giraffidae et Climacoceratidae que nous considérons comme des groupes-frères en dépit de quelques indications tirées principalement de la morphologie des appendices, et de quelques caractères de la denture et des os qui tendraient à éloigner ces deux familles. Néanmoins parmi tous les ruminants actuels, les Climacoceratidae sont plus proches des Giraffidae qu'ils ne le sont des Bovidae, Cervidae, Antilocapridae ou Tragulidae.

Introduction

Excavations From 1996-2000 at Arrisdrift, southern Namibia (Corvinus & Hendey, 1978) resulted in the collection of many more specimens of the climacoceratid ruminant, *Orangemeryx hendeyi* Morales *et al.*, (1999). Whilst many of the new specimens represent parts of the skeleton already described, some of them, notably a frontal with two appendages and a braincase, reveal new information of value for understanding the phylogenetic position of the genus, as well as that of the family Climacoceratidae.

Systematic description

Suborder Ruminantia Scopoli, 1777
Superfamily Giraffoidea Simpson, 1931
Family Climacoceratidae Hamilton, 1978
(= Climacoceridae Hamilton, 1978)

Diagnosis (in Morales *et al.*, 1999): Ruminants of medium to large size characterised by the tendency - in relation to other ruminants of the same age - to the elongation of the neck, including the atlas, and limbs. Distal epiphysis of the metatarsal with open gully. Dentition with a clear hypsodont

tendency. Lower molars with moderate or lost palaeomeryx fold, hypoconid isolated and lobe of m/3 simple.

Subfamily Climacoceratinae Hamilton 1978

Diagnosis (in Morales *et al.*, 1999): Climacoceratidae with frontal protuberances of aphophyseal nature (see Bubenik, 1990; Azanza *et al.*, this vol.). Dentition hypsodont. Premolar row shortened. Lower molars without palaeomeryx fold. Upper molars with external fusion of the lingual and buccal lobes.

Genus *Orangemeryx* Morales, Soria & Pickford, 1999

Diagnosis: The same as for the type species.

Species *Orangemeryx hendeyi* Morales, Soria & Pickford, 1999

Holotype: AD 595'94, left frontal fragment with apophysis, stored at the Geological Survey of Namibia, Windhoek (Pl. 3, fig. 1).

Locality and Age: Arrisdraft (southern Sperrgebiet, Namibia), early Middle Miocene, approximately equivalent to mammal zone MN 4 of the European scale (de Bruijn *et al.*, 1992). Pickford (1994) estimated the age of the site to be ca 17.5 Ma.

Diagnosis (in Morales *et al.*, 1999): Climacoceratinae with elongated slightly compressed truncate conical supraorbital apophyses, ornamented at the base with rounded tubercles with bifurcated or trifurcated upper termination (2 or 3 points).

Differential diagnosis (in Morales *et al.*, 1999): *Orangemeryx* differs markedly from the other genera of climacoceratines by the morphology of its frontal apophyses, which are short with a wide base which diminishes towards the apex, giving the apophysis an elongated, slightly compressed truncated conical aspect, different from the cylindrical form that occurs in *Climacoceras*.

Description of new material: Skull. The most complete specimens are AD 615'98 and AD 700'97, two calottes comprising the frontals and parietals, the former with both frontal apophyses lacking the extremities, the latter with the bases of the apophyses and part of the nuchal region. As in AD 652'94, both of the above specimens possess a deep depression in the frontals close to and in front of the zone of insertion of the frontal protuberances, which extend laterally delimited by a rounded bony ridge from the base of the apophyses to the anterior margin of the orbits. The supraorbital foramina are located on the internal border of this ridge. In AD 615 '98 it is possible to observe how the roof of the orbit is strongly expanded outwards. The postcornual *fossa* is strong and as in AD 652'94, it continues distally by way of a canal to connect with the temporal line. The temporal lines are well marked, particularly in AD 615'98, and they delimit a well developed

temporal *fossa*. In AD 700'97 (Pl. 1, Fig. 1), even though they are less well marked, it is possible to see that they run parallel to each other back to the nuchal region, where they diverge. Nevertheless, a strong V-shaped eminence is developed between them, which is probably the residue of a sagittal crest. Although the nuchal region is abraded, it does not appear to have possessed a cranial protuberance, even though it extends strongly backwards, forming a forerunner of one.

The base of the frontal apophysis is located behind the roof of the orbit, but as already mentioned, it extends by way of a rounded bony ridge to the anterior border of the orbit. In AD 615'98 (Pl. 2, Fig. 1), it is possible to see that the ossicones diverge towards their tips, but not whether they lean forwards or backwards. The right ossicone is very similar in morphology to the holotype of the species, although the anterior border above the anterior protuberance has no keel but is well rounded. The left ossicone has two anterior protuberances, and the anterior border of the ossicone is clearly rounded.

In addition to the described material, there exist three types of cranial protuberances, related to three taphonomic types; bases of protuberances with part of the frontals; protuberances with no cranial base, but with the tips broken or abraded; and complete or fragmentary apices (points). The first kind, which includes the holotype as well as AD 600'98, in which one can observe the non-pneumatized basal structure of the protuberance, and AD 173'97, which is larger but morphologically similar to the holotype. The second taphonomic type include AD 743'97 and AD 120'00, in both of which the apical termination is present, even though incomplete. In the former specimen the termination is trifurcate, whereas the second has a small additional protuberance in addition to the three main ones. These two specimens are very different from AD 594'94, figured by Morales *et al.*, (1999), despite its greater size. The third type of preservation of ossicones is represented by AD 493'98 and AD 220'95, which are simple conical points, the former specimen being of considerable size, and AD 912'97 which is an apical termination which is large and with two complete points.

In conclusion, the frontal apophyses of *Orangemeryx hendeyi* are strongly variable in size and morphology, a fact that is undoubtedly affected to some extent by taphonomic factors. Transport, fracture and abrasion of the ossicones, the bony structure of which is very solid, increase the apparent variability of the ossicones in this species. The frontal apophyses of *Orangemeryx hendeyi* are large, at least in adult males, their bases stretching over the orbit, their trunks being cylindrical, with small protuberances, some of which are sharp, others of which are rounded, comparable to those present in *Climacoceras africanus* MacInnes (1936) which are compressed transversely with a tendency to have a subtriangular section at the base. Their terminations are usually trifurcate with large, cylindrical to conical, slightly curved, pointed ends. Deeper study of the frontal apophyses of *Orangemeryx* are provided in Azanza *et al.*, (this volume).

Mandible. Mandibles of *Orangemeryx* are common at Arrisdraft, but most of the specimens lack the symphysis and ascending ramus. The most complete specimen, AD 423 '98, a right mandible with the body deformed, conserves the ascending ramus, but not the symphysis. AD 903'97, a right mandible with part of the body has a complete ascending ramus (Pl. 5, Fig. 4). AD 710'97, a left mandible (Pl. 4, Fig. 1) preserves the body and part of the symphysis, but not the

ascending ramus.

The body of the mandible is robust, the mental foramen is well developed, more so than in extant *Giraffa*. The diastema between the cheek teeth and the canine is moderate; in AD 423'98 it is 62 mm long, whereas in AD 710'97 it is 60 mm. The angle of the mandible is well defined, with a semicircular outline. The ramus is vertically oriented with respect to the body, almost at a right angle (90°), as in *Giraffa*. The coronoid process is straight and its point does not pass the condylar process posteriorly, as it does in extant *Giraffa*, in which the coronoid process is curved towards the rear. The mandibular foramen and the pterygoid fossa are located relatively low on the ramus, as in extant giraffes, and the mylohyoid groove is well marked.

Permanent lower dentition: Incisors. There is a good sample of incisiform teeth (about 50 specimens) which can be attributed to *Orangemeryx hendeyi*. As was already mentioned by Morales et al., (1999), when the sample was smaller, none of them showed the bilobed morphology which characterises the canines of Giraffidae. The third incisors are easily identified, and as in extant tragulids and most modern ruminants, the crown is widened into a spatulate shape. Other incisors have a slight tendency to widening, and their crowns are almost as tall as the third incisors, and these probably correspond to second incisors. Finally, incisors with low, narrow, crowns could represent first incisors and/or canines (Pl. 3, Fig. 9).

Lower molars/premolars (Appendix I, Table 1). A typical lower dentition is represented by the left mandible AD 710'97 which possesses a complete dental series and is near the mean of the size range. The molars are narrow, moderately hypsodont, and have no sign of the palaeomerycid fold. The m/3 has a well developed metastylid on the lingual wall which descends almost to the base of the tooth. The metaconid and entoconid are smoothly swollen. The anterior

Table 1: *Orangemeryx hendeyi*, measurement statistics of the lower dentition.

| Lower dentition | | | | | | |
|-----------------|----|------|------|------|------|-------|
| | N | Min. | Mean | Max | s.d. | C.V. |
| L_row | 14 | 92 | 100 | 109 | 5.3 | 5.3 |
| Lmm | 25 | 56 | 61.6 | 67.8 | 3.06 | 4.96 |
| Lpp | 24 | 35 | 38.6 | 45.5 | 2.57 | 6.66 |
| Lm3 | 34 | 24 | 26.6 | 29 | 1.51 | 5.68 |
| Wm3 | 32 | 8.5 | 10.4 | 11.5 | 0.71 | 6.78 |
| Lm2 | 39 | 17 | 19.3 | 23 | 1.34 | 6.94 |
| Wm2 | 39 | 10.1 | 11.3 | 13 | 0.73 | 6.45 |
| Lm1 | 37 | 14.3 | 16.5 | 20 | 1.27 | 7.67 |
| Wm1 | 37 | 9.3 | 10.6 | 12.2 | 0.62 | 5.8 |
| Lp4 | 44 | 12.5 | 14.6 | 17 | 0.9 | 6.2 |
| Wp4 | 44 | 7.2 | 8.7 | 10 | 0.77 | 8.91 |
| Lp3 | 34 | 11 | 13.3 | 15.1 | 1.01 | 7.56 |
| Wp3 | 31 | 5.5 | 7.2 | 8.6 | 0.71 | 9.85 |
| Lp2 | 20 | 8.2 | 10.3 | 12.5 | 0.94 | 9.12 |
| Wp2 | 11 | 3.9 | 5 | 6 | 0.65 | 12.89 |

cristids of the metaconid and protoconid are long and well separated from each other. In contrast the posterior cristids of these two cusps are shorter and solidly united, developing a strong, columnar metastylid at their contact in the lingual wall. The anterior cristids of the entoconid and hypoconid are also elongated and run separately without joining each other, although a small fold in the pre-entocristid tends to join them. The pre-entocristid contacts the posterior cristid of the metaconid, leaving the metastylid isolated. The posterior cristids of the entoconid and hypoconid are shorter and are united to each other, posteriorly closing off the lobule. The hypoconulid is strong and high, yet quite conical. Lingually it backs onto quite a strong but moderately high entoconulid which contacts the posterior cristid of the hypoconulid, closing it off lingually. A strong basal cingulum is developed at the base of the entoconulid and the posterior cristid of the hypoconulid. The ectostylid is weak. There is a basal cingulum at the anterior cristid of the protoconid and a very weak one at the anterior cristid of the metaconid.

The m/2 has the same basic morphology as the m/3 but without the hypoconulid. The main differences reside in the union between the posterior cristids of the entoconid and hypoconid, which although narrowly in contact do not fuse together. The entoconulid is strong and columnar. The cingula of the protoconid and metaconid are noticeably stronger and the ectostylid is better developed. The crown of m/1 is similar to that of m/2 but is smaller.

The p/4 is relatively elongated, the anterior wing is bifurcate (the stylid and anterior cusp are separated). The oblique cristid is well developed and reaches posterolingually to join the posterolingual cusp. The posterior stylid is strong and lingually it touches the posterolingual cusp. A strong incision marks the external wall between the mesiolabial and posterolingual cusps. There is a strong, quite high cingulum developed lingually between the bases of the mesiolingual and anterior cusps.

The p/3 is smaller and relatively narrower than the p/4, and differs from it by the weaker development of the oblique cristid and by the attenuation of the external incision and the internal basal cingulum.

The p/2 is quite reduced and has no anterior stylid, while the mesiolingual cristid is very reduced, as is the main cusp and the posterolingual stylid.

The lower dentition of *Orangemeryx hendeyi* is well represented in the locality, a list of specimens being presented in Appendix I. The morphological variation within the sample compared with previously described material is limited. There is a strong variation in size, which can reach 30% in some teeth. Such a degree of variation could be interpreted to mean that there is strong sexual dimorphism in the sample, but wear of the teeth could be enhancing the apparent range of variation. AD 754'97 is a mandible with unworn m/1-m/2 (Pl. 5, Fig. 1). It is the largest individual in the sample and the morphology of the molars agrees with the above description, although attention is called to the great separation between the posterior cristids of the hypoconid and entoconid. AD 610'99, a mandible with p/3-m/3 and the alveolus for p/2 (Pl. 5, Fig. 2), is one of the smallest individuals present. The differences from AD 710'97 are minimal, save for its smaller size and the greater degree of wear of the cheek teeth. There is no cingulum at the base of the entoconulid and the posterior cristid of the hypoconulid of the m/3. The posterior

separation between the entoconid and hypoconid is gently marked, and the lingual cingulum between the bases of the mesiolingual and the anterior cusps is weak. The morphological elements which comprise the dentition are attenuated, probably because of its small size. Indeed a weak line in the position of the palaeomerycid fold can be seen in the m/1 and m/2. In summary, apart from its size, the main variation occurs in the linguo-basal cingulum of the p/3 and p/4 which can range from strong to inexistent.

Deciduous lower dentition. The most complete juvenile specimens are AD 145'95, a mandible with right dm/2-m/2 and AD 631 '97 a right mandible with dm/3-dm/4 (Pl. 5, Fig. 3).

The dm/4 (19.1 x 8.1 mm) has the trilophed morphology typical of artiodactyls, and in comparison with the permanent teeth, the crown is more brachyodont. The two posterior lophs are similar in morphology to the adult molars (m/1 and m/2), but are more separated from each other. The anterior loph is formed of two strong cusps which touch each other anteriorly, with posterior cristids which are clearly elongated, and which respectively join the anterior cristids of the protoconid and metaconid. A second specimen (PQAD 2485: dm/4 = 20 x 8.5 mm) has the dm/3 (8.4 x 5.6 mm) and dm/2 (alveolus 6.1 x 4.3 mm) which possess respectively the same morphological elements as the p/3 and p/2, but differ from them by their greater transverse compression.

Permanent upper dentition (Appendix 2, Table 2). Quite a bit rarer than the lower dentition, the best specimens of the upper teeth are AD 300'99, a right maxilla with a complete set of cheek teeth in medium wear, and AD 425'98, a right maxilla with heavily worn P3/-M3/ and the alveolus for the P2/. The list of material and measurements is given in

Table 2: *Orangemeryx hendeyi*, measurement statistics of the upper dentition.

| Upper dentition | | | | | | |
|-----------------|---|------|------|------|-------|-------|
| | N | Min. | Mean | Max | s.d. | C.V. |
| L_row | 2 | 81.4 | 89.5 | 97.5 | 11.38 | 12.73 |
| LMM | 3 | 49.7 | 54.6 | 58.6 | 4.52 | 8.27 |
| LPP | 2 | 40.8 | 41.9 | 43 | 1.56 | 3.71 |
| LM3 | 8 | 17 | 19.4 | 20.4 | 1.1 | 5.67 |
| WM3 | 8 | 16.1 | 18.2 | 19.6 | 1.04 | 5.74 |
| LM2 | 7 | 18 | 19.3 | 22.4 | 1.66 | 8.57 |
| WM2 | 7 | 17.3 | 18.7 | 20.3 | 1.1 | 5.91 |
| LM1 | 4 | 15.5 | 17.3 | 18.5 | 1.47 | 8.5 |
| WM1 | 4 | 14.8 | 15.9 | 16.5 | 0.75 | 4.7 |
| LP4 | 9 | 11.5 | 12.7 | 14 | 0.79 | 6.17 |
| WP4 | 9 | 12.9 | 14.1 | 15.2 | 0.7 | 4.98 |
| LP3 | 9 | 13.2 | 14.5 | 15.8 | 0.79 | 5.45 |
| WP3 | 9 | 11 | 11.8 | 12.6 | 0.59 | 5 |
| LP2 | 2 | 14.2 | 14.3 | 14.4 | 0.14 | 0.99 |
| WP2 | 2 | 9.1 | 9.5 | 9.8 | 0.49 | 5.24 |

Table 2.

The left M3/ (AD 748'97) (Pl. 3, Fig. 3) has strong parastyle, mesostyle and metastyle which project externally. The paracone has a moderate external rib. The anterior crista of the paracone and the posterior one of the metacone unite in the mesostyle. The external cingulum joins the base of the mesostyle to that of the metastyle. The posterior crista of the metaconule is separated from the metastyle. The anterior crista of the protocone joins the parastyle. The internal crests (anterior crista of the metaconule and posterior crista of the protocone) are well separated. The anterior crista of the metaconule reaches the separation between the paracone and metacone, at the height of the mesostyle, but without making a contact between them, thereby keeping the internal cusps separate from the external ones in the central part of the tooth. There is no ectostyle. There is a weak cingulum along the anterior base of the protocone. In more worn specimens, for example AD 425'98 and AD 475'99 (Pl. 3, Fig. 4), the anterior crista of the metaconule can fuse with the paracone-metacone union, whereas the protocone remains separated centrally. The M1/ and M2/ are similar to the M3/, differing from it by the slighter development of the metastyle and the larger size of the metaconule.

The P4/ has an asymmetric external wall, with a voluminous anterior style, which joins the central cusp anteriorly (AD 26'97) (Pl. 3, Fig. 5). The posterior style is also very strongly developed, being well separated from the central cusp. The lingual cusp joins the external styles by means of high and very curved crests, closing the wall lingually. There is a medial fold which is variably developed and which disappears with advancing wear. Likewise, the basal cingulum varies from strong (for example in AD 387'00) (Pl. 3, Fig. 7) to inexistent (in AD 300'99) (Pl. 3, Fig. 8).

The P3/ is longer than the P4/ due to elongation of the anterior crista of the labial cusp. The anterior style is very weak. The posterolingual crista is less well developed than in the P4/ and is separated from the lingual cusp by a vertical incision. The lingual cingulum can be weak or is absent altogether.

The P2/ is small compared to the other premolars. It is close morphologically to the P3/, while not only the lingual cusp but also the lingual crests are weakly developed and separated from each other (AD 301'99) (Pl. 3, Fig. 6). Only in worn examples, such as AD 300'99 do the lingual elements of the P2/ join each other basally.

Upper canine. AD 499'97 (Pl. 3, Fig. 2) is considered to be an upper canine of *Orangemeryx hendeyi*. It is a uniradicate tooth with a relatively low crown (for a canine) which is transversely compressed with a sharp anterior crest, convex outer surface and a concave internal surface. The posterior edge is smoothly rounded. There is a characteristically bent labial offset of the crown on the root, similar to the canines of other ruminants including tragulids and *Propalaeoryx*.

Postcranial skeleton. The following descriptions include descriptive statistics (Tables 3-20) based on the raw data from appendices 1-23. All measurements are given in millimetres.

Vertebral column. There is a good sample of the axial skeleton of *Orangemeryx* available. In particular it is possible to observe that the cervical vertebrae are elongated, as was mentioned in the previous study (Morales *et al.*, 1999).

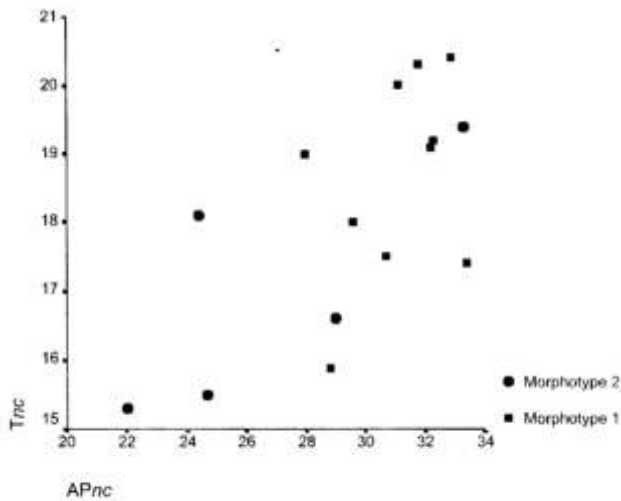


Figure 1: *Orangemeryx hendeyi*, bivariate plot of APnc and Tnc of the scapulae. (AP = anteroposterior diameter, T = transverse diameter, nc = scapular neck).

The axis is remarkable for the strength and height of the spinous process. This process is weakly developed and not as high in the extant giraffe, but it is stronger in the majority of extant bovids.

Scapula (Text Fig. 1, Appendix 3, Table 3). There are 19 scapulae in the sample, most of which consist mainly of the articular portion. The most complete specimens possess a triangular blade with acromion and a long slender neck (Pl. 6, Fig. 1), more similar to the shape observed in extant Bovidae than to those of *Giraffa* and *Okapia*. In overall size, the scapula of *Orangemeryx* is about a third of the size of those of *Giraffa* and is smaller than that of *Okapia*, being similar in dimensions to that of the extant lesser kudu *Tragelaphus imberbis* (Walker, 1985). The morphology of the glenoid is closer to that of bovids than to that of *Giraffa*. It is quite round, not squared as in *Giraffa*, and the supraglenoid tubercle is smaller and less projecting, as in most bovids.

Two morphotypes of scapula occur at Arrisdrift, each of which is variable in size. Morphotype I is characterised by having a wide and blunt supraglenoid tuberosity with no vestige of a coracoid apophysis (Pl. 6, Fig. 3). The sigmoid incision is shallow. The shape of the glenoid cavity is variable, but in most specimens it is sub-circular. The following pieces belong to this type: PQAD 2701, PQAD 1861, PQAD 1332, AD 746'97, AD 274'98, AD 401 '00.

Morphotype 2 is more variable in size than morphotype I (Table 3; Text Fig. 1). It has a narrow supraglenoid tuberosity and there is a small vestige of the coracoid apophysis (Pl. 6, Fig. 2). The sigmoid notch is more pronounced. The following specimens belong to this type: PQAD 3001, AD 607'98, PQAD 1032, AD 607'98, AD 161 '99.

The articular part of the scapula of *Prolibytherium magnieri* (Hamilton, 1973; fig. 7a) is similar to morphotype 1; *Canthumeryx sirtensis* differs from both morphotypes by the strong development of its coracoid process and its small supraglenoid tuberosity (Hamilton, 1973; fig. 7 a); and *Palaeotragus primaevus* has a greater development in both structures than *Orangemeryx* (Churcher, 1970).

Humerus (Text figs 2-3, Appendix 4, Table 4). There are 30 humeral specimens in the Arrisdrift collection. 24 of them consist of distal epiphyses, 3 are proximal fragments and 3 are fairly complete. The general aspect is one of massivity

Table 3: *Orangemeryx hendeyi*, measurement statistics of the scapula.

| Scapula | N | Min. | Mean | Max. | s.d. | C.V. |
|---------|----|------|------|------|------|-------|
| APglmx | 11 | 41.4 | 49.2 | 56.2 | 4.01 | 8.16 |
| APgl | 14 | 33.8 | 39.8 | 47.0 | 3.48 | 8.76 |
| Tgl | 11 | 28.3 | 33.5 | 39.7 | 3.42 | 10.21 |
| APnc | 16 | 22.0 | 29.1 | 33.4 | 3.89 | 13.34 |
| Tnc | 16 | 15.3 | 18.2 | 20.4 | 1.68 | 9.21 |

Table 4: *Orangemeryx hendeyi*, measurement statistics of the humerus.

| Humerus | N | Min. | Mean | Max. | s.d. | C.V. |
|---------|----|-------|-------|-------|------|------|
| L. | 1 | 222.0 | 222.0 | 222.0 | | |
| Lfc | 2 | 206.4 | 207.9 | 209.4 | | |
| APpr | 5 | 64.0 | 68.6 | 73.0 | 3.68 | 5.36 |
| Tpr | 3 | 46.0 | 52.8 | 57.5 | | |
| APdsmx | 20 | 38.0 | 44.0 | 50.0 | 3.23 | 7.34 |
| APdsht | 15 | 27.8 | 32.8 | 39.3 | 2.80 | 8.54 |
| APdsfc | 13 | 19.3 | 22.1 | 25.0 | 1.75 | 7.91 |
| Tdsmx | 21 | 40.5 | 46.4 | 51.8 | 2.93 | 6.31 |
| Tdsfc | 21 | 36.3 | 43.9 | 48.2 | 3.26 | 7.43 |

and they are slightly S-shaped in anterior view (Pl. 6, Fig. 4). The size of the humerus is less than half of that of the giraffe and is slightly larger than that of *Tragelaphus imberbis* (Table 4).

The proximal epiphysis has two low tubercles (greater and lesser tuberosities) and there is no intermediate tubercle that typifies giraffids (Morales et al., 1999). The morphology is similar to that of bovids such as *Gazella dama*, but with the greater tubercle much lower, while the *fossa* which separates the articular head from it is shallower (intra- and supraspinatus muscles) (Pl. 6, Figs 5-6).

The trochlea of the distal epiphysis is gently inclined laterally, with a large medial condyle, both proximo-distally and transversely, and occupies most of the coronoid *fossa* (Pl. 7, Fig. 1). The *capitulum* is narrow compared to the width of the trochlea, but, nevertheless, is quite well developed vertically. The radial *fossa* is closed laterally by a tubercle. In distal view the morphology is bovid-like (Heintz, 1970), with a convex medial condyle and the *capitulum* is located at the same level as the trochlea. In lateral view, the *fossa* for the insertion of the lateral extensor of the phalanges, is large and deep, and below the epicondyle there is a second *fossa* (m. ulnar radial), both of which are larger than the corresponding fossae on the medial side.

Compared with *Orangemeryx*, the distal epiphysis of the humerus of *Climacoceras gentryi* has a much wider and deeper groove, and the medial condyle is not as high proximally, making the proximal border of the articular surface horizon-

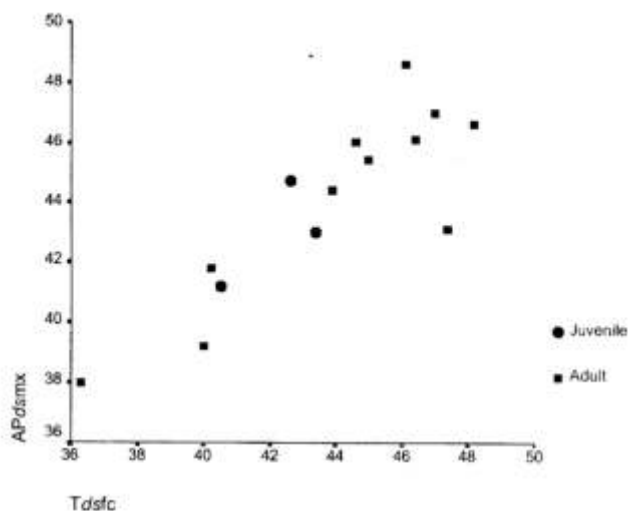


Figure 2: *Orangemeryx hendeyi*, bivariate plot of Tdsfc and APdsmx of the humeri. (AP = anteroposterior diameter, T = transverse diameter, ds = distal, fc = functional breadth, mx = maximum).

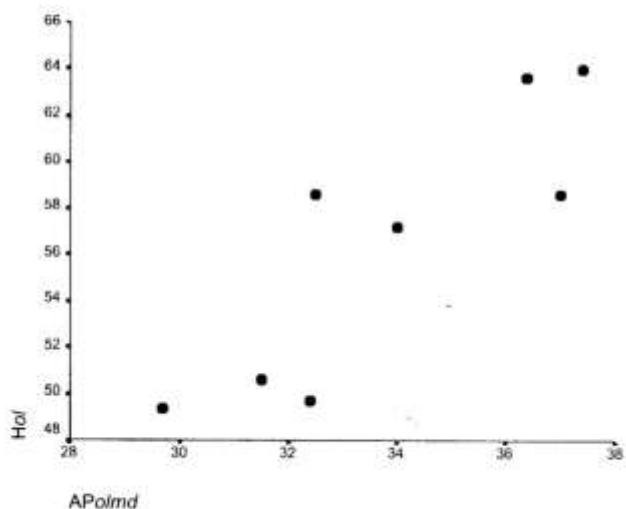


Figure 3: *Orangemeryx hendeyi*, distal humeri in cranial view, 2 morphotypes.

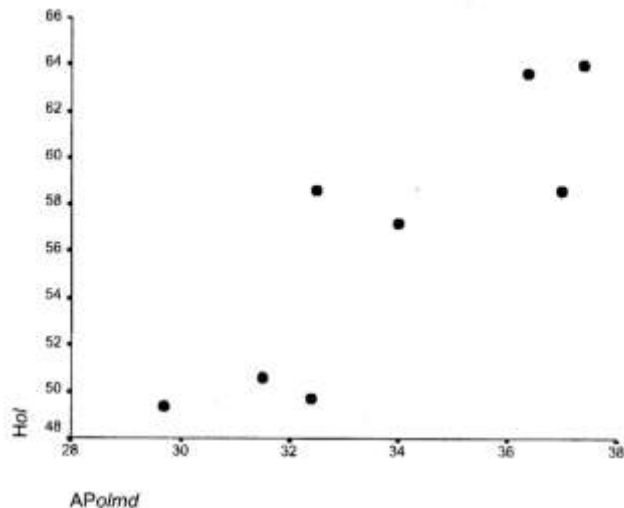


Figure 4: *Orangemeryx hendeyi*, bivariate plot of APolmd and Hol of the ulnae. (AP = anteroposterior diameter, H = height, md = medial, ol = olecranon).

Table 5: *Orangemeryx hendeyi*, measurement statistics of the ulna.

| Ulna | N | Min. | Mean | Max. | s.d. | C.V. |
|--------|----|------|-------|------|------|-------|
| L | 1 | | 323.0 | | | |
| Hol | 9 | 49.4 | 57.0 | 64.0 | 5.76 | 10.12 |
| APto | 6 | 30.1 | 34.1 | 36.3 | 2.47 | 7.25 |
| Tto | 4 | 15.2 | 16.2 | 17.3 | | |
| APolmi | 12 | 27.5 | 34.6 | 42.0 | 4.04 | 11.69 |
| Tolmi | 12 | 9.6 | 11.5 | 13.0 | 1.18 | 10.31 |
| APpa | 11 | 32.6 | 39.5 | 45.6 | 4.38 | 11.09 |
| Tpa | 16 | 11.3 | 13.1 | 14.4 | 1.05 | 8.01 |
| Tarmx | 8 | 20.1 | 22.8 | 25.7 | 1.93 | 8.45 |
| APdf | 5 | 15.0 | 16.2 | 17.6 | 1.07 | 6.58 |

tal. The same occurs in *Palaeotragus primaevus* although it has a much better developed *capitulum*.

There are indications of two size groups of humeri at Arrisdraft, the larger group containing more specimens than the smaller one, both of which include juvenile specimens. In addition, there are signs that the two groups differ in functional distal width (Tdsfc), which is relatively greater in the group of larger specimens (Text fig. 2).

Distal humeri of the small group (information about PQAD 2780 was not available) have morphological differences from those of the large group. The trochlea is more vertically oriented, the medial condyle is more convex and does not ascend as far proximally and the articular border is more horizontal (relative to the sagittal axis), the lateral condyle is larger, the groove deeper and the *capitulum* smaller (Text fig. 3). As a consequence, the distal profile is distinct leaving the *capitulum* a bit below the trochlea. The structure of the trochlea, with more distinct relief and oriented parallel to the sagittal plane, has a greater influence on restricting joint movements to the

antero-posterior plane (Pl. 7, Fig. 2).

Ulna (Text fig. 4, Appendix 5, Table 5). There are 20 ulnar fragments in the Arrisdraft collection, of which one is complete and fused to the radius, while the others are proximal ends. In general shape and length they are similar to those of large sized bovids and are about 40% the length of giraffe ulnae, from which they differ also in the morphology of the olecranon (Table 5).

The morphology of all the specimens is similar. The olecranon tuberosity is not very strong, is well set back and gives rise to two high proximal crests which unite anteriorly leaving a deep valley between them. The medial crest is parallel to the sagittal axis and the lateral one inclines towards the external surface. The dorsal border of the olecranon is convex and the palmar one smoothly concave (Pl. 7, Figs 3-4). The lateral radial facet is large and conical, and the medial one small and flat, and between them the area for the proximal interosseous ligament is large and deep (Pl. 7, Fig. 5).

Similar morphology occurs in the ulna of *Climacoceras gen-*

tryi (KNM BN 633, Hamilton, 1978), *Injanatherium arabicum* (Morales, Soria & Thomas, 1987), *Canthumeryx sirtensis* (IPP 1933/9, Hamilton, 1978) and probably *Climacoceras africanus*, a specimen from Maboko in the National Museum of Kenya showing the same features.

The styloid process of the distal epiphysis is large and sharp in the only complete specimen, AD 124'97, in which the radius and ulna are fused in its distal two thirds (Pl. 7, Fig. 6).

No significant morphological differences have been observed in the sample, but there is variability in size, especially in the height of the olecranon, which suggests the presence of two discrete groups (Text fig. 4).

Radius (Text figs 5-6, Appendix 6, Table 6). 44 radii have been recovered, 17 of which are complete with varying states of preservation. Among incomplete specimens, distal epiphyses are more abundant than proximal ones. The total length of

the radius ranges between 254 and 287 mm (11.5%; Table 6), making it about 40% of the length of the extant giraffe radius and similar to those of large sized bovids

The proximal end is morphologically homogeneous. The articular surface has a rectangular outline with parallel dorsal and palmar borders while the medial border is more acute (Pl. 8, Fig. 5). The facet for the *capitulum* of the humerus narrows anteriorly, it does not pass the height of the central keel and it is shorter (*APprmx*) than the medial facet. As a consequence, in proximal view the dorsal border is straight and the palmar one has a lateral step. The articular surface slopes towards the anterior and lateral sides. The ulnar facets are large, rounded, very concave, and present a deep dorsal notch. The medial facet is flat, square in outline and small. The lateral tubercle is moderate in size. The epiphysis is markedly variable in size, ranging up to 24% in anteroposterior diameter and 21 % in transverse diameter.

The proximal epiphysis is similar in morphology to that of *Canthumeryx sirtensis*, but with a shorter lateral facet. Basically, the morphological pattern of *Orangemeryx* is common to Giraffidae, although the latter shows differences due to the anteroposterior increase of the medial facet, as happens to a moderate extent in *Injanatherium arabicum* (Morales et al., 1987) and in a more pronounced way in *Decennatherium pachecoi* (Morales & Soria, 1981), *Honanotherium schlosseri*, *Samotherium sinense* (Bohlin, 1926) and *Okapia*.

The diaphysis is slightly curved and antero-posteriorly compressed (Pl. 7, Fig. 6). Some specimens have slender and narrow diaphyses while others have them very wide, mainly towards the distal end where there is also an increase in *APdfmi*. At the middle of the diaphysis size differences of up to 45% in anteroposterior diameter occur and 31 % in transverse breadth. The robust specimens are less curved than the gracile ones.

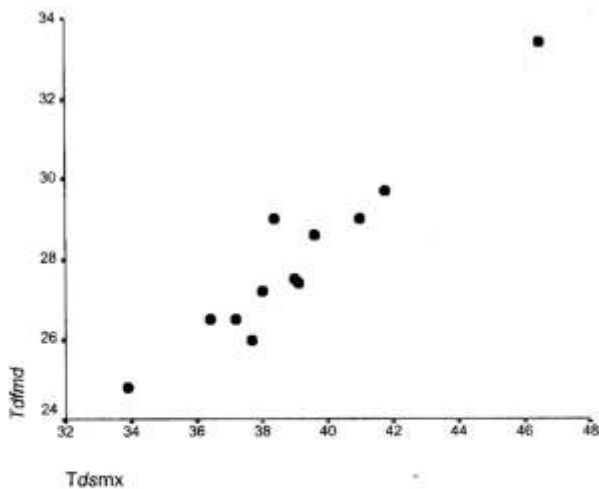


Figure 5: *Orangemeryx hendeyi*, bivariate plot of *Tdsmsx* and *Tdfind* of the radius. (T = transverse diameter, *df* = diaphysis, *ds* = distal, *md* = medial, *mx* = maximum).

Table 6: *Orangemeryx hendeyi*, measurement statistics of the radius.

| Radius | N | Min. | Mean | Max. | s.d. | C.V. |
|----------------|----|-------|-------|-------|-------|-------|
| L | 17 | 254.0 | 270.8 | 287.0 | 10.89 | 4.02 |
| <i>APprmx</i> | 19 | 20.4 | 23.1 | 26.8 | 1.68 | 7.28 |
| <i>Tprmx</i> | 21 | 37.0 | 42.2 | 46.8 | 2.61 | 6.21 |
| <i>Tprfc</i> | 19 | 35.1 | 40.7 | 45.7 | 2.73 | 6.71 |
| <i>Apdfmi</i> | 18 | 12.2 | 17.5 | 22.3 | 2.64 | 15.07 |
| <i>Tdfmi</i> | 19 | 23.0 | 27.7 | 33.4 | 2.57 | 9.30 |
| <i>APdfs</i> | 20 | 16.0 | 22.0 | 27.4 | 2.86 | 12.97 |
| <i>Tdfs</i> | 17 | 22.0 | 28.8 | 37.5 | 4.24 | 14.74 |
| <i>APdsmsx</i> | 26 | 23.5 | 28.1 | 32.9 | 22.2 | 7.90 |
| <i>Tdsmsx</i> | 25 | 33.9 | 38.6 | 46.5 | 2.78 | 7.18 |
| <i>APdsfc</i> | 24 | 20.0 | 22.4 | 25.2 | 1.48 | 6.59 |
| <i>Tdsfc</i> | 25 | 30.1 | 34.3 | 42.1 | 2.51 | 7.30 |



Figure 6: *Orangemeryx hendeyi*, distal radius, 2 morphotypes.

The distal epiphysis varies in size (APdsmx 29%, Tdsmx 27%) and shape mirroring those observed in the diaphysis (Text fig. 5; Pl. 8, Figs 3-4). The specimens with more slender diaphyses have distal epiphyses in which the dorsal groove for the radial extensor of the carpus is wide, deep, and bordered by long and strong edges (Pl. 8, Fig. 2). The lateral and medial grooves are also well developed. The styloid process is acute, and the medial condyle is low and short in palmar view. The semilunar facet is wide and long, and the one for the pyramidal is small. The palmar transverse ridge is continuous and lacks strong palmar depressions. The robust specimens have shallow grooves without sharp edges (Pl. 8, Fig. 1). The groove for the radial extensor of the carpus is wider and shallower than in slender specimens and the medial one is in many cases not visible (Text fig. 6).

The distal epiphysis of the radius in *Orangemeryx* is more antero-posteriorly compressed than in *I. arabicum* (Morales *et al.*, 1987), and even more clearly than in *Palaeotragus primaevus* (Churcher, 1970). *Orangemeryx* also differs from these two species by the presence of a smaller pyramidal facet, and by its semilunar one less extended posteriorly, a feature that is also present in *Okapia*.

Scaphoid (Text fig. 7, Appendix 7, Table 7). Ten scaphoids have been recovered from Arrisdrift. In all cases, the bone is wide and the posterior and anterior surfaces are the same height (Table 7). The proximal surface is poorly expanded on its lateral border. It does not extend medially, thus the scaphoid presents a planar medial surface. The proximal and

distal sides are wide, with gentle curves, and with less difference between the anterior and posterior widths than in bovids (Pl. 8, Fig. 6). The lateral distal platform is very reduced compared with bovids, but in a few specimens a small facet is still visible. In summary, it is very similar to the scaphoids of giraffids, but differs from them by the relatively greater width of the proximal part.

In the ten specimens under study there is a large range of size variation (21-24%) and in relative proportions. Despite the restricted sample, distribution into two groups according to the Tan can be observed (Text fig. 7).

Semilunar (Appendix 8, Table 8). The semilunar is represented by seven specimens, all of which are similar to each other except for variation in size ranging from 16 to 23% (Table 8). The articular surface for the radius has gentle curves and the medial surface is flatter proximally than in bovids. The anterior side has an inclined proximal border, which is wider than the distal one, and the lateral and medial margins converge (Pl. 8, Fig. 7). The distal lateral facet is slightly larger than the medial one, which distinguishes *Orangemeryx* from giraffids in which the opposite is the case. *Climacoceras gentryi* (KNM FT 3141, Hamilton, 1978) and *I. arabicum* (Morales *et al.*, 1987) share this feature with giraffids.

Pyramidal (Appendix 9). There are only two pyramidals in the sample (AD 785'97 and AD 476'97). The morphology of these two specimens is close to that of *Okapia*, although they are more transversely compressed. In lateral view they are subrectangular in outline; the proximal anteroposterior diameter is greater than the distal one. The facet for the pisiform is short, quite concave and is more proximally located than in bovids. The last feature is shared with giraffids, as well as the convex shape of the proximal medial border. The distal facet for the unciform is wider anteriorly than posteriorly and the distal process is short (Pl. 8, Fig. 8).

Magnotrapezoid (Appendix 10, Table 9). The sample con-

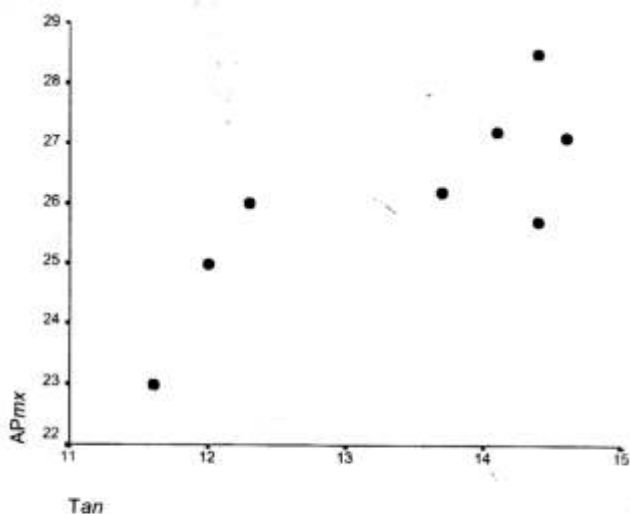


Figure 7: *Orangemeryx hendeyi*, bivariate plot of Tan and APmx of the scaphoids. (AP = anteroposterior diameter, T = transverse diameter, an = anterior, mx = maximum).

Table 7: *Orangemeryx hendeyi*, measurement statistics of the scaphoid.

| Scaphoid | N | Min. | Mean | Max. | s.d. | C.V. |
|----------|----|------|------|------|------|------|
| Hmx | 10 | 17.0 | 19.0 | 21.6 | 1.59 | 8.36 |
| Hps | 4 | 16.2 | 17.8 | 18.9 | | |
| APmx | 10 | 21.7 | 25.5 | 28.5 | 2.04 | 8.03 |
| Tan | 8 | 11.6 | 13.4 | 14.6 | 1.22 | 9.12 |

Table 8: *Orangemeryx hendeyi*, measurement statistics of the semilunar.

| Semilunar | N | Min. | Mean | Max. | s.d. | C.V. |
|-----------|---|------|------|------|------|------|
| Han | 7 | 16.1 | 18.4 | 20.3 | 1.53 | 8.31 |
| APmx | 6 | 23.5 | 25.3 | 27.9 | 1.75 | 6.89 |
| Tpr | 6 | 14.4 | 16.1 | 18.6 | 1.5 | 9.32 |
| Tds | 6 | 11.8 | 12.6 | 14.2 | 0.82 | 6.46 |

Table 9: *Orangemeryx hendeyi*, measurement statistics of the magnotrapezoid.

| Magnotrapezoid | N | Min. | Mean | Max. | s.d. | C.V. |
|----------------|---|------|------|------|------|-------|
| Han | 8 | 9.0 | 10.8 | 12.0 | 0.98 | 9.08 |
| Hps | 7 | 13.0 | 14.8 | 16.6 | 1.20 | 8.06 |
| APmx | 7 | 19.3 | 22.3 | 24.4 | 1.67 | 7.49 |
| Tan | 7 | 15.0 | 18.3 | 21.0 | 1.92 | 10.49 |
| Tpx | 7 | 15.3 | 17.4 | 19.2 | 1.31 | 7.55 |

tains six magnotrapezoids showing size variations ranging from 7 to 22% (Table 9). The morphology of all the specimens is similar and resembles most giraffids. It has a trapezoidal outline, the medial side is shorter than the lateral one. The anterior and medial sides form a more rounded surface than bovids. The posterior margin is strongly concave. The postero-lateral keel is well developed and high, especially posteriorly and distally, just as in *Palaeotragus primaevus* (Churcher, 1970). In *Orangemeryx* the anterior width is not much greater than the posterior one, so that the lateral facets are slightly inclined. The anterior one is large and rectangular, and reaches the distal border but, unlike the giraffids, there are two small independent posterior facets. The distal surface is almost flat. The lateral and distal fossae are superficial and do not communicate with each other (Pl. 8, Figs 9-10).

Climacoceras gentryi magnotrapezoid (KNM FT 3150, Hamilton, 1978) is very similar to that of *Orangemeryx*, also maintaining two posterior facets, although the proximal one is fused to the anterior facet.

Unciform (Text fig. 8, Appendix 11, Table 10). Seven specimens of unciform have been recovered from Arrisdrift showing relatively great variation in size (from 17 to 27%; Table 10). Two morphotypes could be differentiated (Text fig. 8). In morphotype 1 (Pl. 8, Fig. 11) the width of the semilunar and pyramidal facets are similar, both reaching the same maximum elevation. The semilunar facet of specimen PQAD 2512 is slightly prolonged posteriorly, but not as much as the pyramidal facet. Morphotype 2 (Pl. 8, Fig. 12), has a semilunar facet that is clearly narrower and higher than that for the pyramidal. The latter is considerably wider anteriorly than posteriorly. All these features presented by morphotype 2 are similar to those of giraffids, and particularly to *Injanatherium arabicum*, despite the size differences. Both morphotypes of unciform have three medial facets similar to the lateral ones

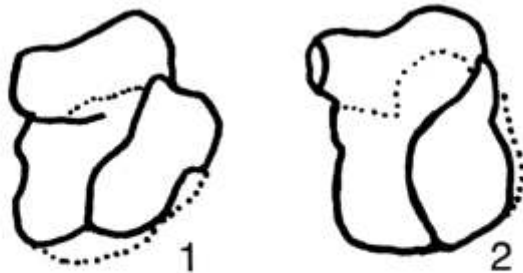


Figure 8: *Orangemeryx hendeyi*, unciform, 2 morphotypes.

Table 10: *Orangemeryx hendeyi*, measurement statistics of the unciform.

| Unciform | | | | | | |
|----------|---|------|------|------|------|-------|
| | N | Min. | Mean | Max. | s.d. | C.V. |
| Hmx | 7 | 12.2 | 14.6 | 16.7 | 1.39 | 9.53 |
| APmx | 5 | 20.0 | 22.0 | 24.0 | 1.91 | 8.70 |
| Tpr | 6 | 13.0 | 14.8 | 17.2 | 1.63 | 11.00 |
| Tps | 5 | 14.1 | 15.7 | 17.6 | 1.53 | 9.70 |

of the magnotrapezoid.

Metacarpal (Text fig. 9, Appendix 12, Table 11). There are 11 complete metacarpals in the sample the length of which ranges from 225 to 275 mm (18%; Table 11). They are approximately as long as those of the lesser kudu and less than half of the length of an adult giraffe metacarpal (about 630 mm). In addition to the complete specimens, there are 17 proximal and 13 distal ends, making a grand total of 41 specimens.

The proximal epiphysis is similar to that of the bovid morphotype illustrated by Heintz (1970). The palmar border is straight, and dorsally, the tuberosities for muscle insertions are not very strong (Pl. 8, Fig. 13).

In the diaphysis, the groove for the lateral extensor of the digits is short and shallow, the dorsal arterial groove is barely visible and proximally it does not curve towards the internal

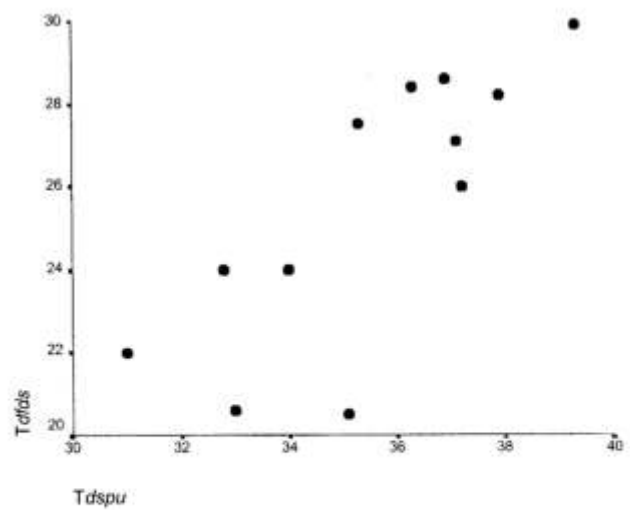


Figure 9: *Orangemeryx hendeyi*, bivariate plot of Tdspu and Tdfds of the metacarpals. (T = transverse diameter, pu = measured at the level of the pulleys, df = diaphysis, ds = measurements taken at the level of the metaphyses).

Table 11: *Orangemeryx hendeyi*, measurement statistics of the metacarpal.

| Metacarpal | | | | | | |
|------------|----|-------|-------|-------|-------|-------|
| | N | Min. | Mean | Max. | s.d. | C.V. |
| L | 11 | 225.0 | 258.5 | 275.0 | 15.87 | 6.14 |
| APpr | 25 | 18.2 | 22.4 | 27.4 | 2.00 | 8.93 |
| Tpr | 27 | 25.0 | 31.2 | 38.0 | 2.86 | 9.17 |
| APdfini | 15 | 17.0 | 19.2 | 22.6 | 1.92 | 10.02 |
| Tdfmi | 15 | 16.7 | 19.7 | 23.9 | 2.19 | 11.16 |
| APdfds | 13 | 14.7 | 16.6 | 18.7 | 1.49 | 8.94 |
| Tdfds | 14 | 20.5 | 25.3 | 29.9 | 3.12 | 12.35 |
| APds | 13 | 20.0 | 21.7 | 23.7 | 1.29 | 5.95 |
| Tds | 17 | 29.7 | 35.2 | 38.3 | 2.28 | 6.47 |
| APdspu | 18 | 21.6 | 23.7 | 26.4 | 1.46 | 6.18 |
| Tdspu | 21 | 31.0 | 35.4 | 39.3 | 2.02 | 5.71 |

side. There is no distal groove between the pulleys. All of these characters are close to type B of Köhler (1993). However, the outline of the distal diaphysis, both dorsally and laterally, correspond to type A - the pulleys are large, but are not as clearly separated from the diaphysis as in the metatarsal, and the anterior keels are blunter.

Within the sample there is some variation in both size and shape. In some specimens the diaphysis widens considerably, increasing progressively until the distal epiphysis (Text fig. 9), and there is also an increase, albeit not as marked, in the anteroposterior diameter. There are specimens which show distinct grades of increase of the diaphysis, ranging from gracile to the most extreme which are massive and columnar (Pl. 8, Figs 14-17). In the latter type, the type A morphology intensifies distally. It is especially the case that the longer specimens show the greatest differences and the most extreme development. In smaller individuals there are differences in the diaphysis, but the differences are not expressed to the extreme degree seen in the large metacarpals.

In *Climacoceras gentryi* from Fort Ternan (Hamilton, 1978) the metacarpal has a proximal epiphysis similar to that of *Orangemeryx* but relatively wider at the expense of the magnotrapezoid facet. This character is even better developed in *Palaeotragus primaevus* (Churcher, 1970, figs 43-46) and *Injanatherium arabicum* (Morales *et al.*, 1987). The section of the diaphysis in these three species is distinct from *Orangemeryx*, being more transversely compressed and possessing a very concave palmar side with prominent borders, although not as much as in the other species mentioned.

Pelvis (Text fig. 10, Appendix 13, Table 12). 18 pelvic fragments are represented in the Arrisdrift collection. The acetabular area is the best represented and its morphology resembles that of *Okapia* more than that of bovids: as in the living giraffid, it has a wide incisura, a continuous acetabular border with a smooth notch in the lateral side, and the *fossa* lacks any expansion - and thus the *facies lunata* (semi-lunar surface) is not subdivided as occurs in Bovidae. However, some features differentiate *Orangemeryx* from living *Okapia*: the caudal end of the semi-lunar surface is much larger than the cranial end and the acetabular margin does not project as much ventrally.

The iliopubic eminence is almost invisible in some specimens, while the obturator groove is almost always present. Both structures are less developed than in *Okapia*. The angle that forms the neck of the *ischium* with the cranial branch of the pubis indicates that the obturator foramen is fairly wide.

At the cranial end, the acetabulum presents two long and narrow fossae - lateral and medial - for the insertion of the *recti femoris* muscles. Both fossae can be observed in *Palaeotragus primaevus* (Churcher, 1970), but are lacking in *Okapia* and only the medial one is present in some bovids.

The body of the ilium is concave on its lateral side, grooved by several rough lines that diverge from the acetabulum to a convex and well defined sciatic spine. The lesser sciatic notch is not as deep as the greater notch. The ventral gluteal line cannot be distinguished in the specimens that partially conserve the iliac wing.

In specimens PQAD 1096, PQAD 1097 and AD 542'99 the cranial ramus of the pubis is dorsoventrally narrow, while in AD 473'99 it is very thick with an almost circular section. These differences could be due to sexual dimorphism (Text fig. 10), the former being females and the latter one a male, as in several extant mammals (Barone, 1989). Measurements of the bone (Table 12) indicate that the pelvis of *Orangemeryx* is similar in size to that of *C. sirtensis* from Muruorot (Hamilton, 1978).

Femur (Appendix 14). The sample of *Orangemeryx* femora is poor and badly preserved, comprising only two complete specimens. There are three distal extremities, four proximal ones plus a variety of incomplete condyles and femoral heads. The length of the femur is about half that of the giraffe and approximately the same as that of the lesser kudu.

The head of the femur is elongated (Pl. 9, Figs SA-B). The greater trochanter is not well preserved in any of the specimens, but it was higher than in *Giraffa*. The intertrochanteric line and the lesser trochanter are strongly developed, the latter occupying a medial position, a morphology closer to that of *Okapia* and *Giraffa*. *Canthumeryx sirtensis* from Gebel Zelten (Hamilton, 1973) has a very weak lesser trochanter which is less medially positioned.

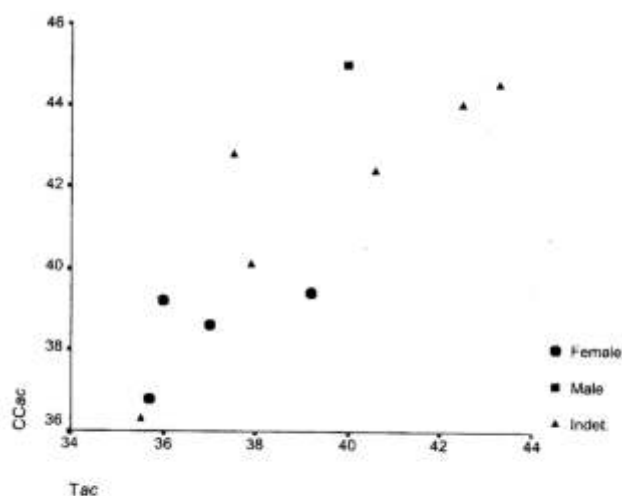


Figure 10: *Orangemeryx hendeyi*, bivariate plot of Tac and CCac of the pelvis. (T = transverse diameter, CC = cephalocaudal diameter, ac = acetabulum).

Table 12: *Orangemeryx hendeyi*, measurement statistics of the pelvis.

| Coxal | N | Min. | Mean | Max. | s.d. | C.V. |
|--------|----|------|------|------|------|-------|
| DVilnc | 12 | 24.6 | 29.5 | 34.4 | 2.84 | 9.62 |
| Tilnc | 12 | 10.8 | 13.4 | 15.9 | 1.80 | 13.43 |
| CCac | 14 | 36.3 | 41.0 | 45.0 | 2.83 | 6.89 |
| Tac | 12 | 35.5 | 38.7 | 43.3 | 2.57 | 6.65 |
| DViqsp | 7 | 52.5 | 58.6 | 70.0 | 6.09 | 10.38 |
| DViqnc | 9 | 19.7 | 26.1 | 30.3 | 3.64 | 13.96 |
| Tiqnc | 9 | 9.4 | 12.7 | 15.3 | 2.24 | 17.59 |
| DVpb | 5 | 9.6 | 12.9 | 18.1 | 3.53 | 27.40 |
| CCpd | 3 | 15.6 | 17.5 | 18.6 | | |

The femur of *Orangemeryx* does not have the massive and straight aspect seen in *Okapia* and *Giraffa*, its diaphysis being proportionally much more gracile, with a circular section, and the posterior side curved proximodistally (Pl. 9, Fig. 4). Another clear difference in the diaphysis is the pattern of the *facies aspera* which is unlike that of extant giraffids (wide and flat with parallel sides), being narrow and located laterally as in bovids, thereby resembling the condition in *Climacoceras gentryi* (KNM FT 3096, figured by Churcher, 1970 as *Palaeotragus primaevus* but identified by Hamilton, 1978, as *C. gentryi*, a determination which is more likely in view of its size). Specimens of *Canthumeryx sirtensis* from Moruorot, (Hamilton, 1978) are slightly more robust and shorter than those of *Orangemeryx*, even though in other measurements the two are comparable, and the one from Gebel Zelten (BU 20115; Hamilton, 1973) is a bit larger, its dimensions being closer to those of *C. gentryi*.

In the distal extremity of the femur (Pl. 9, Fig. 6), there is great similarity between *Orangemeryx* and *Okapia*, especially in the posterior side which has almost the same morphology. The lateral tuberosity is large as is the supra-condylar fossa which is the origin of the supedial flexor muscles of the digits. The latter structure is very deep, enlarging distally and being bordered by well-developed ridges, especially the more medially positioned one. At the end of this fossa the diaphysis swells significantly, thereby acquiring a globose aspect with a central depression, which gives it a very characteristic appearance. Both species also show a similar relative development of the two epicondyles, but *Orangemeryx* does not have the enormous development of the medial lip of the trochlea that occurs in *Okapia* (Pl. 9, Fig. 5C). Judging from the description given by Churcher (1970) of the referred specimen KNM FT 3096 (Fort Ternan, Kenya) we can deduce that *Climacoceras gentryi* did not have a particularly big supracondylar fossa, whereas it did have a better developed medial lip of the distal trochlea than *Orangemeryx*.

Tibia (Appendix 15, Table 13). There are 9 complete tibiae which range in length from 312 to 360 mm (13%; Table 13). Well preserved proximal epiphyses are rare, but numerous distal ends are preserved. In total length, the tibia of *Orangemeryx* is similar to that of the lesser kudu and half the size of the giraffe tibia, which is clearly more massively constructed than that of *Orangemeryx* in which the morphology more

closely resembles that seen in bovids (Pl. 10, Fig. 1).

The proximal epiphysis has the following features: the two condyles and the intercondylar eminences have either the same height or are slightly higher on the lateral side; the groove for the long extensor of the digits and the popliteal incision are deep. In the cranial intercondylar area there is a tuberosity and a small circular fossa. Another strong tuberosity occurs on the caudal border. The medial margin is straight. In several specimens, the postero-lateral angle has a small process which corresponds to the proximal vestige of the fibula (Pl. 10, Fig. 2).

In anterior view, the diaphysis is quite straight with parallel sides, a feature also found in *Palaeotragus primaevus* (Churcher, 1970, figs 51-56). The tibial crest is long, and below it the section is rectangular. The state of preservation of the diaphysis does not allow inspection of the popliteal line in all the specimens, but some resemble the morphology in *Palaeotragus primaevus*. In AD 577'98 the popliteal line deflects laterally parallel to the sagittal axis and fades out in the middle of the diaphysis. In general, there is another discontinuous line which runs over the medial border of the diaphysis.

The distal epiphysis is trapezoidal in outline (Pl. 10, Fig. 3), with the medial facet much less salient antero-posteriorly than the lateral one. The medial maleolus and the anterior central process are wide at the base and not very high. The maleolar groove is wide, short and not very deep. The maleolar facet is divided into two unequal parts.

Although the number of complete specimens is lower than for the other long bones, it is possible to detect a difference in the robusticity of the diaphysis independent of length, which especially affects the width (19% in width and 25% in anteroposterior diameter at the distal epiphysis).

Maleolus (Appendix 16). One left and two right specimens have been recovered. One of them (AD 252 '98) is in anatomical connection with its corresponding talus and calcaneum.

The maleolus of *Orangemeryx hendeyi* has a rectangular outline (Pl. 10, Fig. 4). Its appearance is not massive because the posterior half is not very widened relative to the proximal half. The lateral face is fairly flat and smooth. The proximal spine is short and conical, and - unlike *Okapia* and *Giraffa* - it does not occupy a lateral position; instead it is transversely expanded, dividing the articular surface for the tibia in two parts, as happens in *Injanatherium arabicum*. The posterior facet for the tibia is markedly concavo-convex, differing from the flatter one of *Okapia*.

Compared with *Orangemeryx*, the maleolus of *P. primaevus* is much more massive posteriorly and has a long and thin proximal spine.

Talus (Text Fig. II, Appendix 17, Table 14). The sample of tali is good, with about 30 complete specimens. All the specimens present a relatively short distal trochlea compared with the proximal one (Pl. 10, Fig. 5). The posterior proximal process is weak, which differentiates it from *Palaeotragus primaevus*. The proximal lateral condyle is not as well developed as in *Climacoceras gentryi* or *Canthumeryx sirtensis*. As in these two species there is a single medial process on the anterior surface. The posterior stop facets are small in most cases.

The distal trochlea has a narrow valley, a convex medial condyle and a flatter lateral one, and with one exception, both

Table 13: *Orangemeryx hendeyi*, measurement statistics of the tibia.

| Tibia | N | Min. | Mean | Max. | s.d. | C.V. |
|--------|----|-------|-------|-------|-------|-------|
| L | 9 | 312.0 | 333.6 | 360.0 | 16.73 | 5.01 |
| APprmx | 9 | 60.0 | 64.9 | 71.1 | 4.05 | 6.24 |
| Tprmx | 6 | 52.3 | 59.9 | 64.5 | 4.23 | 7.06 |
| APdf | 11 | 20.7 | 25.2 | 32.6 | 3.15 | 12.48 |
| Tdf | 10 | 25.0 | 27.6 | 30.0 | 1.60 | 5.79 |
| APdsmx | 24 | 26.3 | 30.5 | 35.0 | 2.04 | 6.70 |
| Tdsmx | 22 | 33.1 | 37.7 | 40.8 | 1.94 | 5.15 |

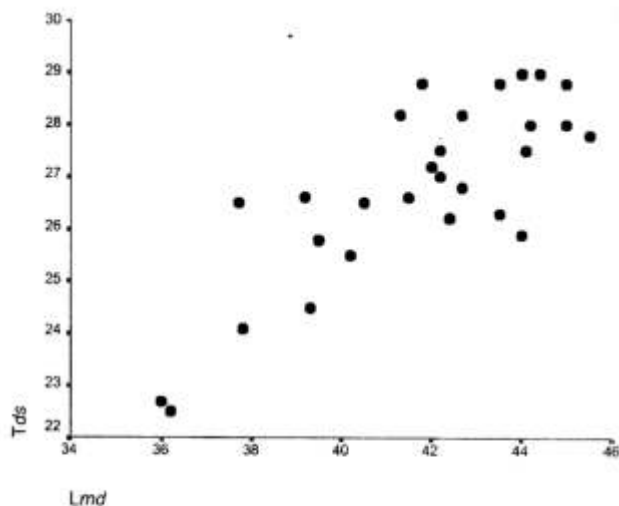


Figure 11: *Orangemeryx hendeyi*, bivariate plot of Lmd and Tds of the talus. (L = length, = transverse diameter, md = medial, ds = distal).

Table 14: *Orangemeryx hendeyi*, measurement statistics of the talus.

| Talus | N | Min. | Mean | Max. | s.d. | C.V. |
|-------|----|------|------|------|------|------|
| Lit | 29 | 37.8 | 43.8 | 49.6 | 3.07 | 7.00 |
| Lmd | 28 | 36.0 | 41.7 | 45.5 | 2.66 | 6.36 |
| Tds | 29 | 22.5 | 26.8 | 29.0 | 1.74 | 6.48 |
| Tpr | 17 | 22.8 | 27.3 | 30.9 | 1.88 | 6.89 |
| APIt | 28 | 19.7 | 23.9 | 28.2 | 1.77 | 7.43 |
| APmd | 27 | 20.7 | 24.9 | 27.7 | 1.62 | 6.50 |

reach the same height. In some examples the valley is centrally positioned, while in others it is displaced medially. These differences do not appear to be related to size. The asymmetrical disposition also occurs in *Injanatherium arabicum*, while in *Canthumeryx sirtensis* and *Climacoceras gentryi* the distal trochlea is more symmetrical but with a more prominent lateral condyle.

The sample has a size variation that ranges between 22% and 25% (Table 14). There could be two size groups, although there is not a clear gap between them. Among the smaller group there are two significantly small specimens of difficult interpretation (Text fig. 11).

Calcaneum (Text fig. 12, Appendix 18, Table 15). There are 18 complete calcanei and numerous fragmentary ones. The body is straight, especially the dorsal border, while the posterior one is gently concave (Pl. 10, Fig. 8). At the level of the *sustentaculum* there is no augmentation either of curvature, or of the dorso-planter diameter. The tuber is either symmetrical, or has a slightly greater lateral lobule; the plantar *fossa* is wide, short and shallow. The *sustentaculum* is large, especially in thickness and length (dorso-planter), but the tendinal groove is not deep (tendon for *flexor halucis longi*). The dorsal margin of the *sustentaculum* slopes upwards, towards the medial side and the coracoid process is not very strong (these characters appear in the calcaneum of *Palaeotragus primaevus* - Churcher, 1970,

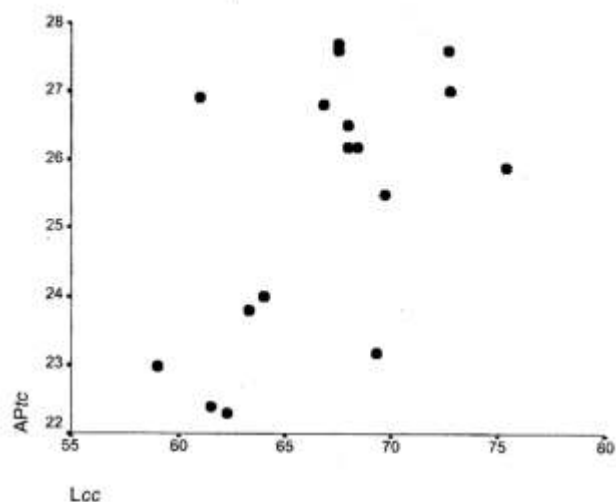


Figure 12: *Orangemeryx hendeyi*, bivariate plot of Lcc and APtc of the calcaneum. (AP = anteroposterior diameter, L = length, cc = corpus calcanei, tc = tuber calcanei).

Table 15: *Orangemeryx hendeyi*, measurement statistics of the calcaneum.

| Calcaneum | N | Min. | Mean | Max. | s.d. | C.V. |
|-----------|----|------|------|-------|------|------|
| L | 18 | 86.8 | 97.6 | 106.0 | 5.82 | 5.96 |
| Lcc | 21 | 59.0 | 66.9 | 75.4 | 4.34 | 6.49 |
| APcc | 20 | 19.3 | 24.6 | 27.8 | 2.08 | 8.45 |
| Tcc | 22 | 9.5 | 12.3 | 14.1 | 0.99 | 8.03 |
| APss | 23 | 23.0 | 29.6 | 34.8 | 2.50 | 8.45 |
| Tss | 20 | 25.0 | 28.4 | 33.4 | 1.90 | 6.70 |
| APml | 17 | 32.0 | 35.8 | 39.5 | 2.16 | 6.05 |
| APtc | 20 | 22.3 | 25.3 | 27.7 | 1.84 | 7.25 |
| Ttc | 22 | 18.6 | 21.5 | 24.0 | 1.38 | 6.43 |

figs 61-64). The maleolar facet is wide. The distal astragalar facet is oblique, as in bovids. The lateral distal groove for the muscle *longus peroneus* is gentle.

In all these characters, the calcaneum of *Orangemeryx* is very similar morphologically to that of *Palaeotragus primaevus*, with the exception of the tuber which is more symmetrical in the Arrisdrift species.

The size of the calcaneum varies between 17 and 21 % (Table 15). As in other skeletal elements, there are no differences other than biometrical. Two groups can be distinguished on the basis of the anteroposterior diameter of the tuber calcis (Text fig. 12), the smaller group being the least abundant.

Navicular-cuboid (Text figs 13-14, Appendix 19, Table 16). There are 16 navicular-cuboids, all of which have low proximal processes, especially the central one, although it is still higher than the calcaneal facet. The posterior facet for the metatarsal is very narrow, and those for the two cuneiforms are in contact with each other. The two anterior facets have a bovid-like morphology (Heintz, 1970). Despite this homogeneity, other

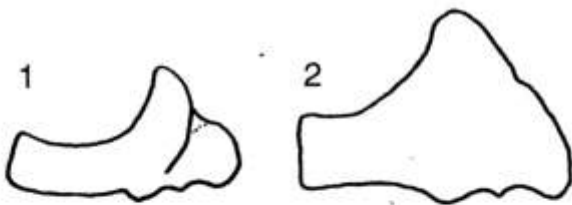


Figure 13: *Orangemeryx hendeyi*, navicular-cuboid, 2 morphotypes.

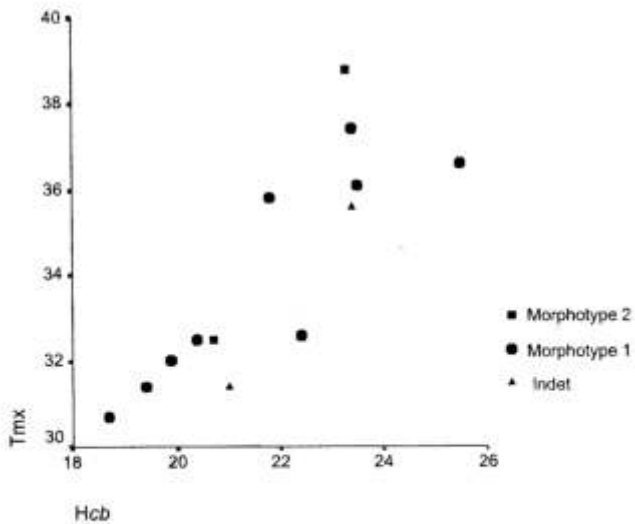


Figure 14: *Orangemeryx hendeyi*, bivariate plot of Hcb and Tmx of the navicular-cuboids. (H = height, T = transverse diameter, cb = cuboid, mx = maximum).

Table 16: *Orangemeryx hendeyi*, measurement statistics of the navicular-cuboid.

| Navicular-cuboid | | | | | | |
|------------------|----|------|------|------|------|-------|
| | N | Min. | Mean | Max. | s.d. | C.V. |
| APmx | 15 | 34.2 | 37.3 | 43.3 | 2.59 | 6.94 |
| Tmx | 14 | 30.7 | 34.3 | 38.8 | 2.72 | 7.93 |
| Ttl | 9 | 24.8 | 27.8 | 31.2 | 2.28 | 8.21 |
| Hcb | 15 | 18.7 | 21.6 | 25.5 | 1.98 | 9.17 |
| Hnv | 9 | 9.8 | 13.3 | 15.3 | 1.60 | 12.10 |
| Hptlmx | 11 | 21.6 | 27.0 | 32.6 | 3.10 | 11.50 |

features are variable and the specimens can be grouped into two morphotypes (Text fig. 13).

In AD 486'97, and AD 317'95 (morphotype 1; Pl. 10, Figs 6-7) the posterior surface has a medial crest developed only on the distal half, being more like a prominent convex process. Between the two proximal processes there is a proximal *fossa* and a variable tubercle. From this tubercle emerges a second crest which runs medially with respect to the central *fossa* but towards the distal lateral process. The latter process is poorly developed and the distal border is horizontal. There is an oblique groove on the medial surface.

In other specimens (morphotype 2; PQAD 2621, AD 161 '97; Pl. 11, Fig. 1) there is no tubercle and no proximal *fossa*; the well-developed medial crest is straight and continuous; the distal lateral process is more prominent; and the distal border has a broken outline. The medial groove is absent.

Walangania africanus has a posterior medial crest that resembles group 2, but is less developed. The rest of the posterior surface is flat and without the structures seen in morphotype 1 of *Orangemeryx*. There is no information about the navicular-cuboids of *Climacoceras gentryi* or *Prolibytherium magnieri*. A navicular-cuboid from Gebel Zelten (WUS4C 42; unpublished material from Benghazi) which, on the basis of size, is attributed to *Canthumeryx sirtensis* has morphology very similar to morphotype 2 of

Orangemeryx, with the crest more developed antero-posteriorly and proximally, and the other structures vestigial. These features of the Gebel Zelten specimen are intermediate between *Orangemeryx* and *Okapia* or *Giraffa*, with the crest continuous to the proximal process, both of which are stronger. The navicular-cuboid of *Palaeotragus primaevus* has a continuous medial crest and a short second crest without any tubercle.

As in the other postcranial bones, there is appreciable size variation (from 19 to 27%; Table 16). The metric data indicate the presence of two size groups (especially for maximal breadth; Text fig. 14) that do not correspond to the morphotypes already described.

One specimen, AD 258'00, the smallest in the sample (see appendix) has a few interesting differences from the others that are worth mentioning. These differences mainly affect the navicular part of the bone, which is lower than in the rest of the sample, the proximal process being better developed and having a larger curve of the facet for the medial condyle of the talus. In addition, the posteromedial part has a different structure, being flat. The medial crest is broken distally. In our opinion, this specimen could represent a separate ruminant distinct from *Orangemeryx*, having greater resemblances to navicular-cuboids of *Gazella dama* apart from the less well developed postero-distal process.

Metatarsal (Text fig. 15, Appendix 20, Table 17). Forty-six

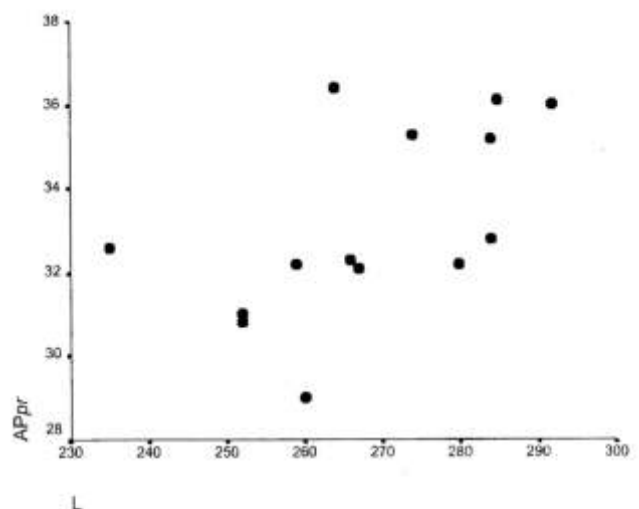


Figure 15: *Orangemeryx hendeyi*, bivariate plot of L and APpr of the metatarsal. (L = length, AP = anteroposterior diameter, pr = proximal).

Table 17: *Orangemeryx hendeyi*, measurement statistics of the metatarsal.

| Matatarsal | N | Min. | Mean | Max. | s.d. | C.V. |
|------------|----|-------|-------|-------|-------|-------|
| L | 19 | 235.0 | 269.1 | 300.0 | 16.43 | 6.11 |
| APpr | 34 | 28.5 | 32.8 | 40.0 | 2.63 | 8.00 |
| Tpr | 35 | 26.2 | 29.6 | 33.0 | 1.99 | 6.73 |
| APdfmi | 20 | 17.0 | 22.8 | 27.3 | 2.92 | 12.80 |
| Tdfmi | 21 | 15.0 | 20.0 | 23.0 | 2.41 | 12.01 |
| APdfds | 21 | 15.8 | 18.6 | 22.0 | 1.70 | 9.19 |
| Tdfds | 21 | 21.0 | 24.1 | 27.2 | 1.85 | 7.70 |
| APds | 14 | 17.0 | 22.7 | 28.0 | 3.05 | 13.48 |
| Tds | 21 | 20.0 | 34.0 | 39.7 | 4.78 | 14.08 |
| APdspu | 22 | 19.2 | 23.5 | 29.0 | 2.27 | 9.66 |
| Tdspu | 23 | 29.1 | 35.2 | 38.8 | 2.54 | 7.21 |

metatarsals have been collected from Arrisdrift, of which 19 are complete, 20 are proximal ends and the rest (7) are distal ones. The length of *Orangemeryx* metatarsals is slightly smaller than those of *Tragelaphus imberbis* and about 40% of the length of those of the giraffe.

The proximal epiphyses of the metatarsals are very constant in morphology, with a subcircular outline. The posterior margin of the articular surface is inclined because the postero-lateral tuberosity is lacking or is weak. However, the postero-medial tuberosity, where the small facet for the entocuneiform is located, is strong. The two anterior facets are large and occupy most of the surface, being delimited posteriorly by a small medial tubercle (vestige of the Mt II) and laterally by a notch which corresponds to the *fossa* with a diarthrodial facet where the Mt V lodges. Posteriorly there is another diarthroidal facet. The posterior facet for the navicular-cuboid is located on the lateral side of a triangular process, and is thus very narrow and quite inclined. It is not connected to the postero-medial tuberosity by any crest.

The morphology of the proximal epiphysis is similar to that of *Walangania Africanus* (Whitworth, 1958) and *Andegameryx andegaviensis*. The only difference from *Canthumeryx sirtensis* is that in this species the postero-lateral tuberosity is a bit better developed. The same applies to *Injanatherium arabicum* (Morales *et al.*, 1987), and to a greater degree in *Palaeotragus primaevus*. The increase in size of this tuberosity is accompanied by a more horizontal orientation of the posterior facet for the navicular-cuboid.

The diaphysis of the metatarsal has a wide arterial groove, open along its length, and progressively deeper towards its distal end. The posterior side is generally concave except in the distal third. As in the metacarpal, the groove for the lateral extensor of the digits is short. The distal epiphysis of the metatarsal has type A1 morphology of Köhler (1993) although the dorsal groove is wide and straight and the pulleys are larger and have stronger keels. These features of the pulleys restrict the lateral movement of the phalanges more than in typical A1 forms.

The length of the 19 complete metatarsals ranges from

235 mm to 300 mm (22%; Table 17), showing a more or less continuous distribution. There are differences in the diaphysis due to way it increases in width towards its distal end. Several specimens show a progressive widening of the distal half: accompanied by an increase in anteroposterior diameter. In these cases the distal part is more massive and inflated anteriorly (Pl. 11, Figs 2-3) while in others the diaphysis remains the same width throughout, increasing in width sharply towards the epiphysis. Between these two extremes there is a complete range of variation (Text fig. 15). Most of the longer specimens have the “robust” type, while the smaller individuals are more variable. Specimens in which the suture of the epiphysis is still visible, present the most gracile and homogeneous diaphyses.

AD 250'00 is a metatarsal with an unfused epiphysis, 190 mm long. It shows several differences in the morphology of the proximal end from the rest of the sample, even when compared with other young and juvenile specimens. The proximal epiphysis of this specimen has a more quadrangular outline, with the posterior margin more perpendicular to the sagittal plane and a more convex medial border. The medial anterior facet has a strong convexity posteriorly, and, in contrast to the morphology seen in *Orangemeryx*, in dorsal view it is more elevated than the anterolateral one. The Mt II is fused but forms no tubercle, and there is no vestige of the Mt V. The dorsal groove is wide, superficial and open. The presence of this specimen reinforces the impression given by the navicular-cuboid, AD 258'00, of the possible existence of another large pecoran at Arrisdrift distinct from *Orangemeryx*, the size of which is the same as the smallest individuals of *O. hendeyi*.

Phalanx I (Appendix 21, Table 18). The sample comprises 25 complete specimens plus several fragments, both proximal and distal, with different degree of preservation.

All specimens are moderately robust, having a conical shape and subcircular section (Pl. 11, Figs 4-6 and Pl. 11, Fig. 11). In lateral view, the anteroposterior diameter decreases strongly from the proximal to the distal end, and the palmar and dorsal borders are flat or slightly concave. In both lateral and dorsal view, the outline of the first phalanx is close to type B of Köhler (1993) but with a moderate degree of lateral compression. Another type B feature present in the sample is the absence of marks for the insertion of the interdigital ligaments in the internal surface.

However, they share with Köhler's type A, the presence of a groove for the interosseus muscle in the internal surface and, especially, a similar morphology of the epiphyses.

The palmar surface is convex and smooth. Some specimens present proximal tubercles for the insertion of the annular ligaments and a posterior *fossa*, although they are never very developed.

Specimen UCB V 4899/42058 of *C. sirtensis* from Moruorot is very similar in both size and shape to the first phalanx of *Orangemeryx*. The phalanges from Gebel Zelten, attributed to *Prolibitherium magnieri* by Hamilton (1973), are smaller than Arrisdrift ones and have less compressed proximal epiphyses.

Distinguishing anterior from posterior phalanges is not easy since there are no clear morphological or metrical differences between them, despite some specimens having relatively wider diaphyses and distal articular surfaces (Table 18). This homogeneity agrees with that observed in the related measurements of the distal epiphyses of both metapodials in particular those of the pulleys.

Table 18: *Orangemeryx hendeyi*, measurement statistics of the 1st phalanx.

| Phalanx I | | | | | | |
|-----------|----|------|------|------|------|------|
| | N | Min. | Mean | Max. | s.d. | C.V. |
| L | 24 | 46.3 | 51.6 | 58 | 3.32 | 6.42 |
| APpr | 24 | 18.7 | 21.1 | 23 | 1.15 | 5.45 |
| Tpr | 26 | 14.1 | 17.5 | 19.3 | 1.19 | 6.76 |
| APdf | 26 | 10.6 | 15.7 | 18 | 1.46 | 9.32 |
| Tdf | 26 | 9.8 | 13.3 | 14.8 | 1.27 | 9.54 |
| APds | 27 | 10.5 | 13.4 | 15.7 | 1.25 | 9.29 |
| Tds | 28 | 12.5 | 14.7 | 16.4 | 0.89 | 6.08 |

Table 19: *Orangemeryx hendeyi*, measurement statistics of the 2nd phalanx.

| Phalanx II | | | | | | |
|------------|----|------|------|------|------|------|
| | N | Min. | Mean | Max. | s.d. | C.V. |
| L | 24 | 24.2 | 28.1 | 30.9 | 1.74 | 6.21 |
| APpr | 20 | 17.1 | 19.8 | 22.1 | 1.37 | 6.9 |
| Tpr | 24 | 13 | 14.6 | 16.4 | 0.95 | 6.45 |
| APdf | 11 | 11.6 | 13.9 | 15.3 | 0.96 | 6.92 |
| Tdf | 11 | 9.6 | 11.7 | 13.3 | 1.16 | 9.88 |
| APds | 24 | 14.3 | 16.5 | 17.6 | 0.96 | 5.8 |
| Tds | 25 | 10 | 12.4 | 14.4 | 1.02 | 8.24 |

Phalanx II (Appendix 22, Table 19). The sample comprises 28 complete specimens plus numerous fragments that can be attributed to *Orangemeryx hendeyi*.

Second phalanges are moderately robust and have a mixture of characters of types A and B of Köhler (1993), as happens in the first phalanges (Pl. 11, Figs 7-10). They share with type A: the lateral and interdigital outlines; the gently concave proximal articular surface; the laterally expanded postarticular platform; and strong insertions for the crossed ligaments. Features resembling type B are: the outline with convergent borders seen in lateral view; the better developed dorsal extensor process and distal articular surface, which is extensive dorsally and palmarly; the weaker impressions of the flexor tendon; and the almost absent sagittal groove on the palmar side.

The second phalanges of *Canthumeryx sirtensis* (Muruorot, IPP 1933/9 and UBB V 4899/42058) have similar size and morphology that those of *O. hendeyi* (Table 19) although they have higher proximal anteroposterior diameter.

Phalanx III (Appendix 23, Table 20). Eighteen complete specimens and numerous fragments have been recovered. They are all short (Table 20; Pl. 11, Fig. 12). *Orangemeryx* third phalanges moderately resemble Köhler's (1993) type B morphology being similar to the bovid type defined by Heintz (1970, figs. 42 and 43). They have a well-developed process for the insertion of the extensor, a slightly convex dorsal border which runs towards the external side. The interdigital bor-

Table 20: *Orangemeryx hendeyi*, measurement statistics of the 3rd phalanx.

| Phalanx III | | | | | | |
|-------------|----|------|------|------|------|------|
| | N | Min. | Mean | Max. | s.d. | C.V. |
| APdorsal | 7 | 24.3 | 27.1 | 29.2 | 1.69 | 6.24 |
| APmx | 15 | 29.4 | 33.2 | 36.6 | 2.12 | 6.38 |
| Tmx | 18 | 11.4 | 12.9 | 14.8 | 1.01 | 7.89 |
| Tfc | 9 | 10.7 | 11.9 | 13.3 | 1.03 | 8.59 |
| Hmx | 12 | 22.7 | 24.9 | 28 | 1.86 | 7.49 |
| Hfc | 17 | 14.5 | 17.3 | 20.6 | 1.45 | 8.38 |

der of the plantar surface is angled. The wedge is moderate high, but it does not form a platform although it is visible in dorsal view. There is no strong plantar process for the insertion of the deep flexor tendon.

Judging from Churcher's (1970) drawings, the third phalanges of *Palaeotragus primaevus* have straighter dorsal and plantar borders as well as higher wedges than in *Orangemeryx hendeyi*.

Discussion

Morphological variability. The study of known anatomical elements has shown that there is a substantial range of variability - both in quantity and pattern - in morphological and metrical characters, being remarkable for the presence of a clear bimodal distribution. This bimodal pattern can be observed in morphometric as well as in discrete morphological characters. Since this pattern has a biological or taxonomic meaning in extant populations, we explore its possible meanings in the Arrisdrift assemblage.

The first possible explanation is the relatively small sample size and, therefore, the pattern could be due to the lack of information about intermediate morphologies and sizes. Although, it is true that the sample size for some bones is rather low, there are others with enough specimens to be representative of the range of variation in the species, but in which a bimodal distribution can be observed (as in the calcaneum; see anteroposterior diameter of the *tuber calcis* in Text fig. 12). Therefore, we think that the observed bimodality is not always due to sample scarcity and that its occurrence in elements with smaller sample sizes may be mirroring actual patterns.

Another explanation could be the presence of two morphometrically close species, a common problem in palaeontology with a difficult solution. In our opinion, however, the existence of two different, but closely related taxa in Arrisdrift is rather improbable, since differences in size do not necessarily match those in morphology when both are present, as exemplified by the navicular-cuboid that shows similar size ranges in both described morphotypes (Text fig. 14). Although we reject this hypothesis, it is possible that some of the smaller specimens - such as navicular-cuboid AD 258'00 and metatarsal AD 250'00 - belong to a different as yet undetermined taxon. Nevertheless, due to the scarce representation of such small specimens their differentiation is hazardous, which is why we maintain them in this description of *Orangemeryx*.

A third hypothesis is that the bimodal and dimorphic patterns are due to sexual dimorphism. In elements where a morphological separation of males and females is possible, such as in the pelvis (Barone, 1989), a clear size difference between sexes can be observed, the females being smaller than the males (Text fig. 10), which supports the presence of sexual dimorphism in *Orangemeryx*. Variability in other skeletal elements is analyzed to find further agreement with this hypothesis. As mentioned above, anatomical elements show different amounts and patterns of variability in size and morphology, based on which they can be grouped into 4 main types. The main criteria used to define these groups are: (1) presence or absence of morphotypes; and (2) size distributions of the measured variables.

Group 1 includes all elements having a defined morphotype with significant size differences. Two bones clearly belong to this group, the pelvis and the scapula. Correspondence between morphotypes and measurements in the pelvis were already discussed above to show sexual dimorphism in size (Text fig. 10). The scapula presents two morphotypes showing similar size ranges for most of the measured variables. Nevertheless, in the anteroposterior diameter of the neck (APnc) the mean for Morphotype 2 is significantly smaller than that for Morphotype 1 ($t = 3,32$; $p < 0.01$; Text fig. 2), despite its range being higher. In our opinion, based on the size distribution of sexes in the pelvis, morphotype 1 could be assigned to males and morphotype 2 to females due to its smaller size.

Group 2. Much more common are the elements in which morphotypes do not match size differences (Text fig. 14). Elements such as the humerus, navicular-cuboid and unciform present this pattern. In accordance with the previously discussed elements (group 1), we assign small specimens to females and larger ones to males, and if this is so, then the two morphotypes must be two stages of the same character, without any relationship to sex. Anyway, this kind of intraspecific morphological variability may have important phylogenetic meaning that is beyond the scope of the present study and which will be discussed elsewhere.

Group 3 comprises elements without clearly discrete morphological differences but having size bimodality in some of their measurements. Bones within this group are the ulna (Text fig. 4), both metapodials (Text fig. 9 for metacarpal) and the calcaneum (Text fig. 12). Studying these elements we realize that, when present, size segregation is always observed in those measurements related to articular surfaces, as for example in the metatarsals (Text fig. 15) or that have an important biomechanical meaning, such as in the ulna (Text fig. 4). This is in agreement with the proposed hypothesis of sexual dimorphism in size, since articular structures are precisely the ones that develop completely early during ontogeny, and therefore their size must correspond to the different adult size of males and females. In contrast, structures that can grow throughout life show a more continuous distribution of their measurements, as happens in the diameters of the diaphyses.

Finally, group 4 includes elements with continuous metrical variation in all measured variables and which lack morphological differences. Elements such as the dentition and the talus, despite being among the larger samples and also having high size variability, do not present clear bimodal distributions either in size or in morphology. This pattern agrees

with observations made on extant populations of bovids despite their strong sexual dimorphism (Altuna, 1978).

In summary it can be stated that: 1) The anatomical variability observed in the *Orangemeryx* population from Arrisdrift is in agreement with the proposed presence of sexual dimorphism in size, the females being slightly smaller than the males; 2) There are a few specimens within the smaller size group of *Orangemeryx* that could represent another, as yet undefined species of ruminant.

Systematics

Orangemeryx hendeyi was included in the subfamily Climacoceratidae by Morales *et al.*, (1999) along with *Climacoceras* and *Nyanzameryx*. The latter genus, defined by Thomas (1984) probably represents a mixture of material, including frontal appendages close to those of *Climacoceras africanus* and a skull that possesses morphological features typical of Bovidae (McCrossin *et al.*, 1998; Morales *et al.*, this volume). *Orangemeryx* and *Climacoceras* share the same type of apophyseal protuberances with a tendency to ramify, a similar dental pattern which shows a clear trend towards hypsodonty, and the same type of postcranial morphology. There is no sign of the presence of bilobed canines in the available sample of *Orangemeryx*, which supports the doubt expressed by Churcher (1990) concerning the supposed presence of bilobed canines in *Climacoceras gentryi*.

The relationships between these two genera with *Prolibytherium* are difficult to establish, as the latter genus has complex cranial protuberances of which the ontogenetic development is unknown. However, the dentition attributed to this form by Hamilton (1973) is much closer to those of Climacoceratidae than to those of Giraffidae. This is particularly clear for the m/3 assigned to *Prolibytherium* by Hamilton (1973, Pl. 10, fig. 3-4), which is more hypsodont than giraffe teeth, and is similar to those of *Orangemeryx*. Likewise, the premolars of *Prolibytherium* and *Orangemeryx* are quite primitive, differing from those of the Gebel Zelten Giraffidae which have a tendency to be molarized (Hamilton, 1973, Pl. 1, fig. 5). In addition, the dentition of *Prolibytherium* only differs from that of *Orangemeryx* by the greater width of the lower molars. Furthermore, there are affinities between some of the postcranial bones of *Prolibytherium* and *Orangemeryx*. In the present state of our knowledge, the most plausible phylogenetic relationship for *Prolibytherium* is to consider it to be a member of Climacoceratidae (Pickford, *et al.*, 2001; Azanza *et al.*, this volume, for further discussion of this possibility).

Climacoceratidae may be characterised by the presence of complex cranial protuberances of apophyseal type, associated with relatively hypsodont dentition of primitive morphology. A narrow phylogenetic relationship with other Giraffidae is possible, as suggested by other authors (Gentry, 1994). However, the existence, in the early Miocene deposits of Namibia, of forms which are probably hornless, but with dentitions similar to those of Climacoceratidae, such as *Propalaeoryx austro Africanus* (Stromer, 1926; Morales *et al.*, 1999) indicates a correspondingly early divergence between Giraffidae and Climacoceratidae, which we consider to be sister groups, despite some indications, mainly from the apophyseal morphology and some features of the dentition and postcranial anatomy, that they are only remotely related. Nevertheless, out

of all the extant ruminants, climacoceratids are more closely related to giraffids than they are to bovids, cervids, antilocaprids or tragulids.

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Appendix 1: *Orangemeryx hendeyi*, measurement (in mm) of the lower dentition. (L = length, W = width, m = molar, p = premolar).

| Specimen | L-row | Lmm | Lpp | Lm3 | Wm3 | Lm2 | Wm2 | Lm1 | Wm1 | Lp4 | Wp4 | Lp3 | Wp3 | Lp2 | Wp2 |
|------------|-------|------|------|------|------|------|-------|------|------|------|-----|------|-----|------|-----|
| PQ-AD-1521 | 100 | 61,5 | 38,5 | 28 | 11,5 | 19 | 12 | 16,4 | 10,6 | 15,5 | 10 | 13,4 | 8 | 10,5 | 5 |
| PQ-AD-1635 | | | 42,5 | | | 20 | 13 | 15,2 | 12 | 17 | 10 | 15,1 | 8 | 12,5 | 5,7 |
| PQ-AD-1699 | 109 | 63 | 45,5 | 26 | | 19 | 11 | 17 | 10,2 | 15 | 9 | | | | |
| PQ-AD-2269 | | 63,5 | | 26,5 | 10,2 | 19,1 | 11 | 15,5 | 10,3 | | | | | | |
| PQ-AD-1973 | | | 35 | | | | | | | 13 | 8 | 11,3 | 6,9 | 10,5 | 5 |
| PQ-AD-259 | | | | 26,5 | 11,5 | 18,5 | 12 | | | | | | | | |
| PQ-AD-270 | | 63,1 | | 27,5 | 9,5 | 19 | 10,5 | 17,8 | 10,2 | | | | | | |
| PQ-AD-269 | | | | | | | | | | 15,2 | 10 | 14 | 8,2 | | |
| PQ-AD-2859 | | | | 25,5 | 10,8 | | | | | | | | | | |
| PQ-AD-1729 | | | | | | | | | | 14,1 | 9 | | | | |
| PQ-AD-1700 | | | | | | | | | | | | 14 | 7 | | |
| PQ-AD-264 | | | | | | | | 17 | 10,5 | 12,5 | 8 | 11 | 6 | 9 | 4,5 |
| PQ-AD-612 | | | | | | | | | | | | | | | |
| PQ-AD-346 | | | | | | | | | | 14,8 | 8,5 | 13 | 7,3 | | |
| PQ-AD-1698 | 101,5 | 62 | 41 | 28 | 10,4 | 17 | 11,5 | 15,7 | 10,3 | 14,6 | 9,2 | 14 | 7,9 | 10,3 | 5,2 |
| PQ-AD-1896 | | | | | | 20,3 | 11,5 | | | 16 | 9,5 | | | | |
| PQ-AD-261 | 95 | 58 | 36 | 24,6 | 9,5 | 17,7 | 10,5 | 15,9 | 9,5 | 13,6 | 8 | | | | |
| PQ-AD-272 | | 61 | | 27 | 10,9 | 17,5 | 11,5 | 15,5 | 12,2 | 14,5 | 7,5 | | | | |
| PQ-AD-271 | 92 | 56 | 35 | 24 | 9,5 | | | | | 13,2 | 7,2 | | | | |
| PQ-AD-3041 | | | | | | 19 | 11 | 17,3 | 10,6 | 14,2 | 8,5 | | | | |
| PQ-AD-617 | | | | | | | | | | 14 | 8 | | | | |
| PQ-AD-1853 | | | | | | 20,5 | 11,5 | 17,6 | 10,5 | | | | | | |
| PQ-AD-44 | | | | 26 | 10,2 | | | | | | | | | | |
| PQ-AD-43 | | | | | | 19,4 | 12,3 | | | | | | | | |
| PQ-AD-241 | | | | | | | | | | | | 13,3 | 7,5 | | |
| AD-654'94 | | | 40 | | | 18,7 | 10,5 | 17,3 | 9,3 | 14 | 8,5 | 13,4 | 6,5 | 9,5 | |
| AD-280'94 | 95 | 58,2 | 36,1 | 25 | 11,2 | 17,4 | 10,2 | 16 | 11,5 | 13,6 | 8,4 | 12,5 | 7 | 9,8 | 5 |
| AD-368'94 | 99,5 | 61,5 | 38 | 24,2 | 10,1 | 20 | 10,5 | 17 | 10 | 14 | 8 | 13 | 6,5 | | |
| AD-369'94 | | | | | | 17,2 | 11,8 | 15,7 | 11,1 | 13,6 | 9,5 | 12 | | 10,5 | |
| AD-370'94 | 104,5 | 65,5 | 38,5 | 28 | 11 | 19,5 | 11,5 | 15,5 | 11 | 14,5 | 9 | 13 | 7,4 | 10 | |
| AD-374'94 | | | | 29 | 11 | | | | | | | | | | |
| AD-12'95 | | 59,6 | 37,5 | 26 | 10,3 | 19,3 | 11 | 16,2 | 11 | 13,9 | 7,9 | 13 | 7,1 | | |
| AD-'95 | 103 | 64,5 | 38,5 | 27 | 11 | 21 | 12 | | | 14,6 | 8,6 | | | | |
| AD-177'95 | 98 | 61,2 | 37,8 | 28,4 | 10,5 | 17,5 | 11,6 | 16,7 | 10,8 | 14 | 9,2 | 13 | 7,8 | | |
| AD-147'95 | | | | | | | | | | | | | | 8,2 | 4,1 |
| AD-152'97 | | | | 24,6 | 8,5 | | | | | | | | | | |
| AD-184'97 | | | | | | 19 | 10,7 | | | | | | | | |
| AD-177'97 | | | | | | 20 | 10,6 | | | | | | | | |
| AD-47'97 | | | | | | | | | | | | | | 10,9 | 5,4 |
| AD-706'97 | 95,5 | 61,5 | 36,2 | 26,7 | 9,5 | 19 | 10,92 | 17 | 9,9 | 14,6 | 8,1 | 12,5 | | 9,3 | |
| AD-647'97 | | | | 24,4 | 10,8 | | | | | | | | | | |
| AD-645'97 | 104,5 | 56,8 | 39,8 | 28,5 | | 20,5 | 11,3 | 17,5 | 10,6 | 15,5 | 8,8 | 14 | 7,5 | 10 | |
| AD-754'97 | | | | | | 23 | 13 | 20 | 11,6 | | | | | | |
| AD-475'97 | | | | | | | | 16,2 | 9,8 | 15,3 | 8,3 | | | | |
| AD-710'97 | 108 | 67,8 | 41,3 | 26,7 | 10 | 22 | 10,3 | 19,8 | 10 | 15,3 | 8,5 | 13,3 | 7 | 11,3 | 5,5 |
| AD-118'97 | | | | 27 | 10,5 | | | | | | | | | | |
| AD-423'98 | | 63,5 | 42 | 28,5 | 10,3 | 18,4 | 11,7 | 16 | 10,8 | 15,2 | 8,9 | 15 | 7,6 | 10 | |
| AD-573'98 | | 60,5 | | 27,4 | 11,4 | 17 | 11,5 | 16,8 | 10 | 15 | 9 | 14 | 7,5 | | |
| AD-421'98 | | 64 | | 27,7 | 10,7 | 20 | 11,8 | 15,5 | 10,5 | | | | | | |
| AD-297'98 | | | | 29 | 11,4 | | | | | | | | | | |
| AD-84'98 | | 61,5 | 37,4 | 27,6 | 10,5 | 20 | 12 | 14,7 | 11 | 15,1 | 9,2 | 12,8 | 7,9 | 10,6 | 6 |
| AD-533'98 | | | 37,3 | | | 19 | 10,7 | 15,6 | 10,2 | 15 | 7,5 | 12,5 | 5,5 | 9,6 | 3,9 |
| AD-81'98 | | | 40 | | | | | | | 15,7 | 9,8 | 13,8 | 8,6 | 10,5 | |
| SIN SIGLA | | 56,7 | 37,1 | 24 | 9,5 | 18,1 | 10,5 | 14,5 | 10,5 | 13,8 | 9,1 | 12,5 | 7,4 | 11 | |
| AD-309'98 | | | | | | | | | | | | 15 | 7,5 | | |
| AD-12'98 | | | | 26,4 | 10,5 | | | | | | | | | | |
| AD-196'98 | | | | | | | | | | 16 | 9,5 | | | | |
| AD-610'99 | 94,5 | 59,1 | 36 | 24,5 | 9,8 | 18,4 | 10,8 | 16,7 | 10,7 | 12,8 | 7,6 | 11,8 | 6,3 | 11,3 | |
| AD-608'99 | | 67 | | 28 | 10,4 | 21,2 | 11,1 | 15,4 | 10,8 | 14,5 | 9,8 | 12,8 | 7,9 | | |
| AD-160'99 | | | | | | 19 | 11,7 | 14,3 | 10,4 | 15,1 | 8,1 | 14,1 | 6,5 | | |
| AD-146'00 | | 62,4 | | 26,8 | 11 | 20 | 12 | 16,5 | 10,7 | 14,9 | 9,4 | | | | |
| AD-183'00 | | | 38,8 | | | 20,3 | 10,1 | 18,5 | 10,4 | 14,5 | 8,4 | 15 | | | |
| AD-96'00 | | | | | | 19,6 | 12,3 | 17,5 | 11 | 14,4 | 9,2 | 13,7 | 7,9 | | |
| AD-201'00 | | | | | | | | 16,2 | 10,8 | 15,5 | 9 | 14,1 | 6,4 | | |
| AD-482'00 | | | | | | | | | | 14,5 | 7,5 | 13,9 | 6,9 | | |
| AD-182'00 | | | | | | | | 17,6 | 11,2 | 15,3 | 7,7 | | | | |
| AD-53'00 | | | | | | | | | | 14,1 | 7,7 | 12,8 | 6,5 | | |

Appendix 2: *Orangemeryx hendeyi*, measurement (in mm) of the upper dentition. (L = length, W = width, M = molar, P = pre-molar).

| Specimen | L-row | LMM | LPP | LM3 | WM3 | LM2 | WM2 | LM1 | WM1 | LP4 | WP4 | LP3 | WP3 | LP2 | WP2 |
|-----------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|
| AD-229'95 | | | | | | 18 | 19 | | | | | | | | |
| AD-334'95 | | | | | | | | | | | | 14,1 | 11,8 | | |
| AD-333'95 | | | | | | | | | | 12,9 | 14,9 | | | | |
| AD-745'97 | | | | 17 | 18,2 | 18 | 18,8 | | | | | | | | |
| AD-154'97 | | | | | | | | | | | | | | | |
| AD-748'97 | | | | 20 | 19,1 | | | | | | | | | | |
| AD-262'97 | | | | | | | | | | 11,6 | 13,6 | | | | |
| AD-309'97 | | | | | | | | 18,5 | 16 | 12,6 | 14,3 | 15,8 | 12,4 | | |
| AD-910'97 | | | | | | | | | | 14 | 13,8 | 14,9 | 11,2 | | |
| AD-26'97 | | | | | | | | | | 13,3 | 14,3 | 14,1 | 12,1 | | |
| AD-56'98 | | | | | | | | | | | | 14,9 | 12,6 | | |
| AD-186'98 | | | | | | 20,7 | 19,7 | | | | | | | | |
| AD-419'98 | | | | 19 | 18,2 | | | | | | | | | | |
| AD-185'98 | | | | 19,5 | 17,6 | 19,2 | 17,6 | | | | | | | | |
| AD-425'98 | 81,4 | 49,7 | 40,8 | 19 | 16,1 | 18,1 | 17,3 | 15,5 | 14,8 | 13 | 12,9 | 13,8 | 11 | | |
| AD-424'98 | | 55,5 | | 20,4 | 19,6 | | | 16,7 | 16,2 | | | | | | |
| AD-300'99 | 97,5 | 58,6 | 43 | 20,4 | 18,5 | 22,4 | 20,3 | 18,5 | 16,5 | 13 | 15,2 | 14,6 | 12 | 14,2 | 9,8 |
| AD-301'99 | | | | | | | | | | | | 15,2 | 11,7 | 14,4 | 9,1 |
| AD-475'99 | | | | 19,5 | 18,2 | 19 | 18 | | | | | | | | |
| AD-308'00 | | | | | | | | | | 11,5 | 13,7 | | | | |
| AD-498'00 | | | | | | | | | | | | 13,2 | 11 | | |
| AD-387'00 | | | | | | | | | | 12,6 | 14,4 | | | | |

Appendix 3: *Orangemeryx hendeyi*, measurement (in mm) of the scapula. (AP = anteroposterior, T = transverse breadth, gl = glenoid cavity, nc = scapular neck, ARg/mx = anteroposterior diameter of the glenoid including the scapular tubercle.)

| SCAPULA catnum | APg/mx | APgl | Tgl | APnc | Tnc |
|-------------------|--------|------|------|------|------|
| PQAD 1332 | | | | 30,7 | 17,5 |
| PQAD 2701 | 50,7 | 41,3 | 34,9 | 32,2 | 19,1 |
| PQAD 1861 | 50,7 | 39,7 | | 33,4 | 17,4 |
| AD 746'97 | 46,1 | 37,7 | 33,3 | 28,0 | 19,0 |
| AD 662'97 | 51,2 | 44,6 | | 32,3 | 19,2 |
| AD 534'97 | | 37,5 | | 29,6 | 18,0 |
| AD 616'97 | 51,4 | 43,1 | 39,7 | 31,1 | 20,0 |
| AD 633'97 | 47,6 | 37,5 | | 32,9 | 20,4 |
| AD 428'97 | | | 32,8 | 31,8 | 20,3 |
| AD 274'98 | 45,3 | 37,8 | 31,2 | 28,8 | 15,9 |
| AD 368'99 | 56,2 | 47,0 | 37,1 | | |
| AD 92'99 | 52,2 | 37,2 | 35,5 | | |
| PQAD 3001 | | | | 33,3 | 19,4 |
| PQAD 1032 | 48,0 | 39,1 | 32,1 | 24,4 | 18,1 |
| AD 607'98 | | 42,1 | 35,2 | | 19,2 |
| AD 44'00 | | 38,3 | 28,3 | 29,0 | 16,6 |
| AD 161'99 | 41,4 | 33,8 | 28,8 | 24,7 | 15,5 |
| PQAD 3046 | | | | 22,1 | |
| AD 192'00 | | | | 22,0 | 15,3 |

Appendix 4: *Orangemeryx hendeyi*, measurement (in mm) of the humerus. (AP = anteroposterior, L = length, Lfc = functional length of the humerus as in Köhler (1993), pr = proximal, ds = distal, mx = maximum, lt = lateral).

| HUMERUS catnum | L | Lfc | APpr | Tpr | APdsmx | APdsit | APdsfc | Tdsmx | Tdsfc |
|----------------|-----------|-------|------|------|--------|--------|--------|-------|-------|
| PQAD 1915 | | | | | 44,4 | 33,3 | | 46,9 | 43,9 |
| PQAD 1631 | | | | | | 32,5 | | 46,9 | 46,4 |
| PQAD 1374 | | | | | 46,1 | 34,1 | | | 46,4 |
| PQAD 2816 | | | | | | 36,4 | | 51,8 | 47,6 |
| PQAD 490 | | | | | 46,5 | | | 47,3 | |
| PQAD 481 | | | | | 50,0 | | | 46,0 | |
| PQAD 1576 | | | | | | | | | 47,0 |
| AD 600'94 | | | | | 44,0 | 32,8 | | | |
| AD 788'99 | | | | | 45,4 | | | 46,6 | 45,0 |
| AD 474'97 | | | | | | 34,3 | 23,4 | 46,4 | 43,5 |
| AD 259'97 | | | | | 47,0 | 33,4 | 25,0 | 49,5 | 47,0 |
| AD 371'00 | | | | | 46,6 | | 23,2 | 50,0 | 48,2 |
| AD 115'99 | | | | | 44,6 | 31,0 | | 45,0 | |
| AD 691'97 | 222,0 | | 73,0 | 57,5 | 46,0 | 31,4 | 21,3 | 46,4 | 44,6 |
| AD 858'99 | | 206,4 | | | 43,1 | | | 51,0 | 47,4 |
| AD 599'94 | | 209,4 | 71,2 | | 48,6 | 39,3 | | 48,4 | 46,1 |
| AD 598'94 | | | 64,0 | | | | | | |
| PQAD 3380 | | | 68,8 | 54,8 | | | | | |
| AD 190'99 | | | 66,0 | 46,0 | | | | | |
| AD 9'99* | | | | | 44,7 | | 22,7 | 47,8 | 42,6 |
| AD 82'98* | | | | | 43,0 | 32,7 | 22,5 | 44,0 | 43,4 |
| AD 388'98* | | | | | | 31,7 | 22,6 | 44,5 | 43,4 |
| AD 370'00* | | | | | | | 24,1 | 46,6 | 43,0 |
| AD 543'95* | | | | | 41,2 | | 21,2 | 40,5 | 40,5 |
| PQAD 2780 | | | | | 41,8 | 32,9 | | 44,6 | 40,2 |
| PQAD 39 | | | | | | | | | 38,6 |
| AD 793'97 | | | | | 39,2 | | 20,0 | | |
| AD 543'99 | | | | | 40,7 | 28,5 | | 41,5 | |
| AD 253'00 | | | | | 39,2 | | 19,6 | 42,2 | 40,0 |
| AD 534'00 | *juvenile | | | | 38,0 | | 19,3 | | 36,3 |

Appendix 5: *Orangemeryx hendeyi*, measurement (in mm) of the ulna. (AP = anteroposterior, H = height, L = length, ol = olecranon, mi = middle, to = tuber olecran, pa = measured at the level of the processus anconaeus, Tarmx = maximum transverse diameter of the articular surface of the ulna, APdf = anteroposterior diameter of the diaphysis measured at the end of the fossa for the interosseous ligament.)

| ULNA catnum | L | Hol | APto | Tto | Apolmi | Tolmi | APpa | Tpa | Tarmx | APdf |
|-------------|-----------|------|------|------|--------|-------|------|------|-------|------|
| PQAD 1268 | | | | | 38,0 | 12,7 | 44,6 | 14,4 | | |
| PQAD 594 | | | | | 36,3 | 11,2 | | 12,9 | | |
| PQAD 1331 | | | | | | | | 13,7 | 24,0 | |
| PQAD 37 | | | | | | | | 11,8 | 20,7 | |
| PQAD 1597 | | | | | | | 45,6 | 12,6 | | |
| AD 603'94 | | 61,0 | | | | | | | | |
| AD 164'97 | | | | | 42,0 | 13,0 | | 14,0 | | |
| AD 478'97 | | 64,0 | 36,3 | 15,6 | 37,4 | 12,8 | 43,0 | 13,8 | | |
| AD 124'97 | 323,0 | 58,6 | 35,0 | 17,3 | 37,0 | 10,8 | | 13,6 | | |
| AD 112'00 | | 63,6 | 36,0 | 16,8 | 36,4 | 12,6 | 43,2 | 14,4 | 24,4 | |
| AD 907'97 | | 57,2 | 35,0 | 15,2 | 34,0 | 12,6 | 39,0 | 13,8 | 25,7 | 17,0 |
| AD 163'98 | | | | | | | 40,0 | 12,9 | | |
| AD 537'98 | | 58,6 | | | 32,5 | 11,0 | 40,2 | 14,0 | | 15,7 |
| AD 202'00 | | | | | | | | | 23,5 | |
| PQAD 1671 | | 50,6 | 32,0 | | 31,5 | 10,8 | 34,4 | 11,7 | 21,8 | 17,6 |
| AD 107'94 | | | | | | | | 10,6 | 16,3 | |
| AD 239'95 | | 49,7 | 30,1 | | 32,4 | 10,2 | 37,7 | 12,8 | 22,2 | 15,7 |
| AD 43'98 | | 49,4 | | | 29,7 | 10,5 | 34,5 | 11,5 | | |
| PQAD 1765 | | 30,5 | 14,0 | 7,8 | 14,5 | 7,8 | 18,7 | 10,3 | | |
| AD 171'95* | *juvenile | | | | 27,5 | 9,6 | 32,6 | 11,3 | 20,1 | 15,0 |

Appendix 6: *Orangemeryx hendeyi*, measurement (in mm) of the radius. (AP = anteroposterior, T = transverse, ds = distal, fc = functional measure, mi = middle, mx = maximum, pr = proximal, *dfds* (diaphysis distal) indicates a measure taken in the diaphyses two centimeters away from the distal metaphyses.)

| Radius catnum | L | Aprmx | Tprmx | Tprfc | Apdmi | Tdmi | Apdfs | Tdfs | Apdmx | TDsmx | Apdsfc | Tdsfc |
|---------------|-------|-------|-------|-------|-------|------|-------|------|-------|-------|--------|-------|
| PQAD 3109 | 287,0 | 26,8 | 46,8 | 45,7 | 20,8 | 33,4 | 24,8 | 30,0 | 32,9 | 46,5 | 24,9 | 42,1 |
| PQAD 3047 | 285,0 | 24,2 | 45,4 | 43,4 | 21,3 | 29,7 | 25,2 | 29,0 | 30,2 | 41,8 | 24,4 | 36,6 |
| PQAD 2783 | 284,0 | 23,8 | 43,0 | | 17,6 | 30,4 | 21,0 | 29,7 | | | | |
| PQAD 562 | 273,0 | 24,4 | 42,4 | 41,9 | | | 23,1 | 31,2 | 27,7 | 40,3 | 23,9 | 36,7 |
| AD 60294 | 265,0 | | | | | | 22,0 | | 26,0 | 35,0 | | |
| PQAD 494 | 263,0 | | | | 17,7 | 27,4 | | | | | | 31,0 |
| PQAD 1098 | 259,0 | | | | 15,1 | 26,5 | 19,8 | 24,5 | 27,8 | 36,4 | 21,3 | 33,3 |
| PQAD 527 | 258,0 | 20,8 | 37,1 | 35,1 | 14,6 | 23,0 | 16,0 | 22,0 | | | | |
| PQAD 3212 | 265,0 | | | | 17,8 | 28,2 | | | | | | |
| PQAD 3080 | | 25,4 | 44,1 | 43,1 | 22,3 | 31,5 | | | | | | |
| PQAD 979 | | 23,8 | 42,5 | 41,3 | | | | | | | | |
| PQAD 2552 | | | | | | | | | 28,8 | 40,6 | | |
| PQAD 2856 | | | | | | | | | 28,0 | 39,6 | 22,5 | 35,3 |
| PQAD 1444 | | | | | 19,5 | 27,4 | 22,0 | 25,1 | 27,3 | 39,1 | 21,9 | 35,0 |
| PQAD 484 | | | | | 17,0 | 26,0 | 21,0 | | 28,9 | | 23,6 | |
| PQAD 2978 | | | | | 15,3 | 26,5 | 20,0 | 25,2 | 26,6 | 37,2 | 22,0 | 33,0 |
| PQAD 38 | | | | | | | 20,3 | 25,0 | 29,1 | 38,3 | 22,5 | 36,0 |
| PQAD 26 | | | | | 12,2 | 23,6 | | | | | | |
| AD 70394 | | | | | | | 17,5 | 23,0 | | | | |
| AD 60194 | | | | | 19,3 | 27,5 | | | 30,5 | 39,0 | 25,2 | 33,5 |
| AD 68894 | | | | | | | | | 32,3 | 40,2 | | 37,3 |
| AD 6895 | | | 45,5 | 44,0 | | | | | | | | |
| AD 16895 | | | | | | | 27,4 | 37,5 | 30,3 | 41,0 | 21,7 | 36,7 |
| AD 20195 | | | | | | | 26,4 | 34,0 | | | 20,5 | 33,7 |
| AD 30895 | 280,0 | 23,2 | 43,2 | 43,0 | 19,0 | 28,6 | | | 30,0 | 39,6 | 23,4 | 33,9 |
| AD 90697 | 254,0 | 20,4 | 37,0 | 36,0 | 14,1 | 24,8 | | | 23,7 | 33,9 | 20,0 | 30,4 |
| AD 12497 | 268,0 | 23,5 | 42,7 | 41,4 | | 29,0 | | | 29,2 | 41,0 | 24,3 | 34,8 |
| AD 61397 | 263,0 | 22,4 | 41,7 | 40,7 | | | 23,0 | 32,0 | | | 20,3 | 32,5 |
| AD 443997 | 263,0 | 21,7 | 42,0 | 39,4 | 16,3 | 26,0 | 20,5 | 28,7 | 26,0 | 37,7 | 21,6 | 32,6 |
| AD 90497 | 282,0 | 22,2 | 40,7 | 38,4 | 18,2 | 27,2 | 21,4 | 28,8 | 28,4 | 38,0 | 21,5 | 34,0 |
| AD 81997 | 270,0 | 21,4 | 39,8 | 38,9 | | | 21,0 | 29,6 | 26,3 | 35,8 | 20,1 | 32,2 |
| AD 61597 | | 23,8 | 42,0 | 41,0 | | | | | | | | |
| AD 18097 | | 22,3 | 41,4 | 40,3 | | | | | | | | |
| AD 33097 | | 22,5 | 40,2 | 38,8 | | | | | | | | |
| AD 5797 | | | | | | | 22,6 | | 28,0 | 39,0 | 22,2 | 34,1 |
| AD 16897 | | | | | | | | | 26,4 | 35,0 | 22,3 | 30,1 |
| AD 69797 | | | | | | | | | | | 22,0 | 34,0 |
| AD 79597 | | | | | | | | | 28,3 | | 22,4 | 33,6 |
| AD 14998 | | | | | | | | | 28,6 | 40,4 | 23,4 | 35,0 |
| AD 28899 | | | | | | | | | 23,5 | 34,0 | | |
| AD 55299 | | | | | | | | | 26,7 | 38,0 | | |
| AD 53200 | 285,0 | | 44,2 | | 17,6 | 29,0 | 25,5 | 34,0 | | 38,4 | | |
| AD 12300 | | 21,4 | 38,9 | 38,4 | | | | | | | | |
| AD 71300 | | 25,3 | 45,0 | 43,0 | | | | | | | | |

Appendix 7: *Orangemeryx hendeyi*, measurement (in mm) of the scaphoid. (AP = anteroposterior, H = height, an = anterior, mx = maximum, ps = posterior).

| SCAPHOID catnum | Hmx | Hps | APmx | Tan |
|-----------------|------|------|------|------|
| PQAD 36 | 21,6 | | 26,2 | 13,7 |
| PQAD 2635 | 20,4 | | 28,5 | 14,4 |
| AD 15994 | 21,1 | | 26,0 | 12,3 |
| AD 30595 | 19,3 | | 27,1 | 14,6 |
| AD 48997 | 18,6 | 18,9 | 27,2 | 14,1 |
| AD 21297 | 18,1 | 18,0 | 23,0 | 11,6 |
| AD 38398 | 18,9 | 18,2 | 25,0 | 12,0 |
| PQAD 1632 | 17,6 | | 25,7 | 14,4 |
| AD 1895 | 17,4 | | 24,3 | |
| AD 8000 | 17,0 | 16,2 | 21,7 | |

Appendix 13: *Orangemeryx hendeyi*, measurement (in mm) of the pelvis. (CC = cephalocaudal, DV = dorsoventral, T = transverse, *ilnc* = iliac neck, *iqnc* = ischial neck, *pb* = pubis, *iqsp* = ischial spine, *ac* = acetabulum).

| FEMUR catnum | L | Lfc | APprmx | Tprmx | APhd | Thd | APdfmi | Tdfmi | APdsmd | APdsit | Tdsan | Tdspsmx |
|-----------------|-------|-------|--------|-------|-------|------|--------|-------|----------|----------|----------|---------|
| PQAD 3417 | | | >31,0 | 70,0 | >28,0 | 39,0 | | | | | | |
| PQAD 3236 | | | | | | | 28,8 | 31,0 | c.a.72,8 | c.a.63,6 | c.a.31,0 | >46,1 |
| PQAD 78 | | | | | | | 29,4 | 32,9 | | | | >47,0 |
| AD 663'94* | | 270,0 | | | | | 28,0 | 28,3 | | | | |
| AD 664'94 | | | | | | | | | | 64,2 | | |
| AD 200'95 | | | | | 31,0 | 36,6 | | | | | | |
| AD 580'99 | 275,0 | 269,0 | 36,0 | 70,0 | 30,0 | 38,3 | 24,6 | 25,0 | 71,1 | 64,9 | 32,0 | 56,0 |

* juvenile

Appendix 14: *Orangemeryx hendeyi*, measurement (in mm) of the femur. (AP = anteroposterior, L = length, T = transverse, an = anterior, df = diaphysis, ds = distal *hd* = articular head, Lfc = functional length of the femur as in Köhler (1993), lt = lateral, md = medial, mi = middle, mx = maximum, pr = proximal ps = posterior).

| FEMUR catnum | L | Lfc | APprmx | Tprmx | APhd | Thd | APdfmi | Tdfmi | APdsmd | APdsit | Tdsan | Tdspsmx |
|-----------------|-------|-------|--------|-------|-------|------|--------|-------|----------|----------|----------|---------|
| PQAD 3417 | | | >31,0 | 70,0 | >28,0 | 39,0 | | | | | | |
| PQAD 3236 | | | | | | | 28,8 | 31,0 | c.a.72,8 | c.a.63,6 | c.a.31,0 | >46,1 |
| PQAD 78 | | | | | | | 29,4 | 32,9 | | | | >47,0 |
| AD 663'94* | | 270,0 | | | | | 28,0 | 28,3 | | | | |
| AD 664'94 | | | | | | | | | | 64,2 | | |
| AD 200'95 | | | | | 31,0 | 36,6 | | | | | | |
| AD 580'99 | 275,0 | 269,0 | 36,0 | 70,0 | 30,0 | 38,3 | 24,6 | 25,0 | 71,1 | 64,9 | 32,0 | 56,0 |

* juvenile

Appendix 15: *Orangemeryx hendeyi*, measurement (in mm) of the tibia. (AP = anteroposterio, T = Transverse, df = diaphysis, ds = distql, mx = maximum, pr = proximal).

| TIBIA catnum | L | APprmx | Tprmx | APdf | Tdf | APdsmx | Tdsmx |
|-----------------|-------|--------|-------|------|------|--------|-------|
| PQAD 2292 | 360,0 | 71,1 | 64,5 | 24,7 | 28,3 | 32,1 | 39,1 |
| PQAD 1100 | 350,0 | | | 26,5 | | 29,4 | 35,6 |
| PQAD 42 | 317,0 | | 59,2 | 23,0 | 26,7 | 27,2 | 34,8 |
| PQAD 2695 | | | | | | 30,6 | |
| PQAD 1917 | | | | 26,5 | 29,9 | | |
| PQAD 41 | | | | | | 31,4 | 37,4 |
| PQAD 535 | | | | | | 26,3 | 33,1 |
| PQAD 1143 | | | | | | 31,7 | 40,8 |
| PQAD 1410 | | | | | | 30,2 | |
| PQAD 450 | | 65,0 | 59,8 | | | | |
| PQAD 3385 | | | | | | 33,8 | 40,8 |
| AD 110'94 | | | | 26,7 | 30,0 | 30,2 | 37,6 |
| AD 116'94 | 281,0 | | | 22,5 | 25,0 | | |
| AD 612'94 | | 60,0 | | | | | |
| AD 623'94 | | | | | | 32,0 | 38,3 |
| AD 689'94 | | | | | | 35,0 | 40,0 |
| AD 599'94 | | | | | | 32,2 | 40,0 |
| AD 293'95 | 350,0 | | | 26,3 | 26,9 | 30,3 | 38,0 |
| AD 112'96 | 335,0 | | | | | 29,6 | 38,7 |
| AD 229'97 | | 63,0 | | 32,6 | 28,8 | | |
| AD 467'97 | | | | | | 31,3 | 38,2 |
| AD 480'97 | | | | | | | |
| AD 637'97 | | | | | | | |
| AD 275'98 | | 66,5 | | | | | |
| AD 540'98 | | | | | | 30,0 | 35,5 |
| AD 90'98 | | | | | | 27,5 | 35,8 |
| AD 380'98 | | | | | | 32,6 | 38,4 |
| AD 381'98 | | | | | | | |
| AD 382'98 | | | | | | 25,8 | 31,0 |
| AD 577'98 | 325,0 | 62,7 | 60,6 | 23,0 | 27,0 | 28,2 | 38,2 |
| AD 207'99 | | | | | | 29,0 | 37,6 |
| AD 777'99 | 333,0 | 60,0 | 63,0 | 25,0 | 26,5 | 30,5 | 38,4 |
| AD 348'99 | | 70,7 | | | | | |
| AD 365'00 | 312,0 | 65,0 | 52,3 | 20,7 | 27,0 | 29,5 | 37,1 |
| AD 373'00 | 320,0 | | | | | 31,7 | 36,4 |

Appendix 16: *Orangemeryx hendeyi*, measurement (in mm) of the maleolus. (AP = anteroposterior, H = height, T = transverse, an = anterior, ds = distal, fc = functional measure, mx = maximum, ps = posterior).

| MALEOLUS | | | | | | | |
|-----------|------|------|--------|-------|------|------|------|
| Catnum | APmx | Tmx | APdsfc | Tdsfc | Hmx | Han | Hps |
| AD 96'97 | 21,5 | 9,7 | 17,6 | 8,2 | 17,1 | 14,6 | 13,0 |
| AD 145'98 | 20,4 | 10,6 | | | 17,0 | 13,5 | 12,6 |
| AD 252'98 | 20,5 | | | | | | |

Appendix 17: *Orangemeryx hendeyi*, measurement (in mm) of the talus. (L = length, T = transverse, ds = distal, lt = lateral, md = medial, pr = proximal).

| TALUS | | | | | | |
|-----------|------|------|------|------|------|------|
| catnum | Llt | Lmd | Tds | Tpr | APlt | APmd |
| PQAD 1628 | 44,1 | 42,2 | 27,5 | | 24,3 | 25,0 |
| PQAD 1457 | 42,6 | 42,4 | 26,2 | | 23,5 | 24,5 |
| PQAD 1634 | 38,5 | 37,8 | 24,1 | | 21,9 | 21,5 |
| PQAD 2523 | 38,6 | 36,2 | 22,5 | | 19,7 | |
| PQAD 3023 | 46,3 | 43,5 | 28,8 | | 25,7 | 24,7 |
| PQAD 1850 | 39,2 | j | 25,6 | | 22,0 | 24,3 |
| PQAD 532 | 45,0 | 41,5 | 26,6 | | 23,0 | 24,4 |
| PQAD 33 | 42,2 | 40,2 | 25,5 | | 23,3 | 24,0 |
| AD 613'94 | 44,3 | 44,0 | 25,9 | | 24,1 | 24,9 |
| AD 207'97 | 45,9 | 44,1 | 27,5 | 28,0 | 25,0 | 25,0 |
| AD 488'97 | 44,1 | 43,5 | 26,3 | 28,0 | 24,0 | 24,7 |
| AD 323'97 | 40,8 | 39,3 | 24,5 | 23,6 | 22,7 | 22,9 |
| AD 392'98 | 44,0 | 41,3 | 28,2 | 28,0 | 24,6 | 25,0 |
| AD 539'98 | 47,3 | 44,0 | 29,0 | 28,3 | 24,7 | 25,5 |
| AD 390'98 | 48,0 | 45,0 | 28,0 | 26,4 | 25,3 | 27,0 |
| AD 544'98 | 46,0 | 45,0 | 28,8 | 27,8 | 25,0 | 27,2 |
| AD 538'98 | 49,0 | 44,4 | 29,0 | 29,1 | 25,4 | 27,0 |
| AD 393'98 | 37,8 | 36,0 | 22,7 | 22,8 | 20,0 | 20,7 |
| AD 391'98 | 43,8 | 42,2 | 27,0 | 27,8 | 24,0 | 25,1 |
| AD 151'98 | 40,7 | 39,2 | 26,6 | 26,3 | 22,7 | |
| AD 252'98 | | 37,7 | 26,5 | | | 24,6 |
| AD 15'999 | 49,6 | 45,5 | 27,8 | 30,9 | 28,2 | 27,7 |
| AD 476'99 | 44,8 | 42,0 | 27,2 | 27,2 | 24,0 | 24,2 |
| AD 493'99 | 43,7 | 40,5 | 26,5 | 27,3 | 23,3 | 23,7 |
| AD 20'999 | 40,5 | 39,5 | 25,8 | 26,5 | 22,2 | 24,0 |
| AD 212'99 | 45,4 | 41,8 | 28,8 | 28,0 | 25,5 | 26,5 |
| AD sn'99 | 46,2 | 44,2 | 28,0 | 28,0 | 26,0 | 27,0 |
| AD 186'00 | 44,3 | | | | | |
| AD 526'00 | 44,0 | 42,7 | 28,2 | | 24,3 | 25,1 |
| AD 535'00 | 43,5 | 42,7 | 26,8 | | 23,6 | 25,9 |
| AD 297'00 | 29,0 | 27,8 | 17,6 | | 16,3 | 16,8 |

Appendix 18: *Orangemeryx hendeyi*, measurement (in mm) of the calcaneum. (AP = anteroposterior, L = length, T = transverse, cc = corpus calcanei, ss = corpus calcanei at the level of the sustentaculum; ml = measured at the level of the facet for the maleolus, tc = tuber calcanei).

| CALCANEUM catnum | L | Lcc | APcc | Tcc | APss | Tss | APml | APtc | Ttc |
|---------------------|-------|------|------|------|------|------|------|------|------|
| PQAD 31 | 104,0 | 68,4 | 25,3 | 12,3 | 30,7 | 28,4 | 37,8 | 26,2 | 21,0 |
| PQAD 502 | 94,0 | 63,3 | 23,6 | 12,0 | 27,3 | 26,6 | 32,0 | 23,8 | 20,8 |
| PQAD 579 | 103,8 | 75,4 | 27,8 | 12,5 | 30,4 | 28,0 | 34,2 | 25,9 | 23,2 |
| PQAD 747 | 98,0 | 67,5 | 25,8 | 12,5 | 30,7 | 29,1 | 35,7 | 27,7 | 22,1 |
| PQAD 592 | 96,3 | 63,9 | | | | 26,9 | | | 22,0 |
| PQAD 3093 | | 72,6 | | | 30,6 | | | | |
| PQAD 1501 | | | | | | | | 23,1 | 20,1 |
| PQAD 2054 | | 61,0 | 24,6 | 13,8 | | | | 26,9 | |
| AD 111'94 | 106,0 | 72,8 | | | 32,3 | | 39,5 | 27,0 | 22,6 |
| AD 135'95 | 99,7 | 66,8 | 26,8 | 12,6 | 31,2 | 30,2 | 38,1 | 26,8 | 21,5 |
| AD 824'97 | 99,8 | 67,5 | 26,1 | 12,2 | 29,6 | 28,0 | 35,0 | 27,6 | 21,0 |
| AD 210'97 | 98,0 | 68,0 | 27,2 | 14,1 | 31,4 | | | 26,2 | 24,0 |
| AD 723'97 | | | | | | | | 24,8 | 20,0 |
| AD 233'98 | 101,8 | 69,7 | 25,3 | 13,3 | 31,4 | 30,4 | 37,7 | 25,5 | 22,3 |
| AD 62'98 | 86,8 | 59,0 | 24,0 | 12,5 | 27,7 | 28,0 | | 23,0 | 22,0 |
| AD 83'98 | | | 26,3 | 13,4 | | | | 26,0 | 24,0 |
| AD 31'98 | | | 19,3 | 11,5 | 27,0 | | 33,0 | | |
| AD 281'98 | | | | | 29,2 | 27,2 | 34,5 | | |
| AD 606'98 | 89,7 | 64,0 | 22,8 | 10,7 | 27,4 | 25,0 | 34,0 | 24,0 | 19,8 |
| AD 184'00 | 106,0 | 72,7 | | 12,4 | 34,8 | 33,4 | 39,5 | 27,6 | 23,0 |
| AD 43'00 | 95,6 | 64,4 | 26,0 | 12,0 | 30,4 | 27,6 | 35,3 | | 21,7 |
| AD 75'00 | 98,8 | 69,3 | 23,2 | 12,0 | | 27,4 | 36,6 | 23,2 | 21,0 |
| AD 386'00 | 91,1 | 62,3 | 24,3 | 11,4 | 28,0 | 28,0 | | 22,3 | 18,6 |
| AD 257'00 | 88,5 | 61,5 | 23,8 | 12,3 | 25,8 | 26,3 | | 22,4 | 20,4 |
| AD 426'00 | | 66,4 | 24,3 | 12,0 | 29,0 | 31,6 | | | 21,0 |
| AD 124'00 | 99,5 | 68,0 | | 12,8 | 29,2 | 28,6 | 35,0 | 26,5 | 20,3 |
| AD 428'00 | | | | | 31,0 | 29,2 | 34,3 | | |
| AD 425'00 | | | 25,0 | 12,2 | 32,0 | 28,5 | 36,5 | | |
| AD 185'00 | | | 20,7 | 9,5 | 23,0 | | | | |

Appendix 19: *Orangemeryx hendeyi*, measurement (in mm) of the navicular-cuboid. (AP = anteroposterior, H = height, L = length, mx = maximum, tl facet for the talus, cb = cuboid, nv = navicular.)

| NAVICULAR-CUBOID catnum | Apmx | Tmx | Ttl | Hcb | Hnv | Hptmx |
|----------------------------|------|------|------|------|------|-------|
| AD 161'97 | 43,3 | 38,8 | 29,3 | 23,3 | 15,3 | 32,6 |
| AD 317'95 | 40,0 | 36,1 | 29,0 | 23,5 | 14,2 | 29,0 |
| AD 227'00 | 39,8 | 37,4 | 30,3 | 23,4 | 14,6 | 28,8 |
| AD 238'97 | 39,2 | 35,6 | 28,0 | 23,4 | 13,0 | |
| PQAD 1204 | 39,0 | 36,6 | | 25,5 | | |
| AD 74'00 | 38,4 | 37,4 | 31,2 | | | 29,3 |
| AD 234'98 | 37,5 | | | 21,0 | 13,5 | |
| AD 805'97 | 37,0 | | | | | |
| PQAD 35 | | 35,8 | | 21,8 | | |
| PQAD 1207 | 35,9 | 32,6 | | 22,4 | | 28,0 |
| AD 437'00 | 35,8 | 31,4 | 26,0 | 21,0 | 13,8 | 25,0 |
| AD 615'94 | 35,2 | 32,0 | | 19,9 | | 27,1 |
| AD 486'97 | 35,0 | 30,7 | 25,3 | 18,7 | 12,1 | 21,6 |
| AD 614'94 | 34,9 | 32,5 | | 20,4 | | |
| PQAD 2621 | 34,6 | 32,5 | 26,5 | 20,7 | 13,1 | 26,9 |
| PQAD 1851 | 34,2 | 31,4 | | 19,4 | | 25,1 |
| AD 258'00 | | | 24,8 | 19,0 | 9,8 | 23,2 |

Appendix 20: *Orangemeryx hendeyi*, measurement (in mm) of the metatarsal. (AP = anteroposterior, L = length, T = transverse, df = diaphysis, mi = middle, pr = proximal, pu = measured at the level of the pulleys, ds = measurements are taken at the level of the metatarsals.)

| METATARSAL catnum | L | Appr | Tpr | Apdfmi | Tdfmi | Apdfs | Tdfs | Apds | Tds | Apdspu | Tdspu |
|----------------------|-------|------|------|--------|-------|-------|------|------|------|--------|-------|
| PQAD 198 | 264,0 | | | 22,8 | 20,4 | 20,1 | 26,4 | | 36,4 | 21,9 | 35,4 |
| PQAD 3338 | 266,0 | 32,3 | 31,6 | 21,4 | 19,6 | 16,6 | 23,5 | | 35,3 | 23,3 | 35,5 |
| PQAD 2042 | | 40,0 | 33,0 | | | | | | | | |
| PQAD 2782 | | 29,3 | | 20,3 | 16,6 | | | | | | |
| PQAD 2947 | | 29,5 | 28,6 | | | | | | | | |
| PQAD 1138 | | 33,5 | 29,4 | | | 18,0 | 24,4 | 21,0 | 34,5 | 22,9 | 33,4 |
| PQAD 2981 | 276,0 | | 26,2 | 21,6 | 18,1 | 18,2 | 22,0 | 19,0 | 30,1 | | |
| PQAD 2946 | | | | | | | | | 39,7 | 25,3 | 37,5 |
| PQAD 3131 | | | | | | 18,8 | 23,3 | 22,0 | 32,9 | 23,9 | 34,7 |
| PQAD 485 | | 31,8 | 28,1 | | | | | | | | |
| PQAD 30 | | | | | | 21,5 | 24,4 | 23,3 | 37,1 | 23,0 | 34,9 |
| PQAD 746 | | 32,6 | 29,0 | | | | | | | | |
| PQAD 839 | | 32,0 | 30,0 | | | | | | | | |
| PQAD 82 | | 29,4 | 26,3 | | | | | | | | |
| PQAD 497 | | 30,0 | 29,4 | | | | | | | | |
| PQAD 1200 | 260,0 | 29,0 | 27,2 | 21,7 | 19,0 | | | | | | |
| PQAD 2272 | | | | | | 17,1 | 24,2 | | 30,8 | 20,4 | 30,5 |
| AD 593 | 252,0 | 31,0 | 26,2 | 21,7 | 19,4 | 17,2 | 22,5 | | 30,0 | 19,2 | 29,1 |
| AD11794 | 280,0 | 32,2 | 29,6 | 24,5 | 21,7 | | | | | | |
| AD 13394 | | 29,5 | 26,2 | | | | | | | | |
| AD 70294 | | | | 17,0 | 15,0 | 15,8 | 21,0 | 17,0 | 26,8 | | |
| AD 16795 | | 36,2 | 32,0 | | | | | | | | |
| AD 19995 | 235,0 | 32,6 | | | | 18,0 | 26,3 | 20,5 | 31,4 | 21,4 | 31,8 |
| AD 29295 | | 32,7 | 30,0 | | | | | | | | |
| AD 41196 | 300,0 | | 32,4 | 27,3 | 22,9 | | | 27,4 | 39,0 | 29,0 | 38,0 |
| AD 25696 | | 31,7 | 30,4 | | | | | | | | |
| AD 46497 | 285,0 | 36,1 | 31,0 | 24,4 | 22,0 | 20,0 | 24,0 | | | 26,3 | 37,3 |
| AD 89697 | 271,0 | | 28,6 | | 22,0 | 17,5 | 23,0 | | | 21,2 | 35,5 |
| AD 61997 | | 35,0 | 30,3 | 25,3 | 21,2 | | | | | | |
| AD 79297 | | 35,8 | 30,1 | | | | | | | | |
| AD 79697 | | | | | | 17,0 | 23,0 | | | 22,0 | 33,8 |
| AD 70597 | | | | | | 17,6 | 22,1 | | | 23,6 | 35,0 |
| AD 96297 | | 32,6 | 29,8 | 22,0 | 20,8 | | | | | | |
| AD 37798 | 284,0 | 35,2 | 30,6 | 26,8 | 22,0 | 21,2 | 26,5 | 24,4 | 38,2 | 26,0 | 38,5 |
| AD 31098 | 274,0 | 35,3 | | 23,8 | 22,4 | 20,0 | 27,2 | 23,2 | 37,8 | 25,0 | 38,8 |
| AD 57498 | 267,0 | 32,1 | 30,6 | | | 19,2 | 26,5 | 22,6 | 36,8 | | 37,4 |
| AD 57598 | 259,0 | 32,2 | 28,0 | 22,4 | 19,2 | 19,1 | 24,0 | | | 23,5 | 35,0 |
| AD 40598 | | 33,8 | 29,3 | | | | | | | | |
| AD 40298 | | 33,0 | 29,8 | | | | | | | | |
| AD 43499 | 264,0 | 36,4 | 31,8 | 26,9 | 23,0 | 22,0 | 26,5 | 25,6 | 39,1 | 26,6 | 38,3 |
| AD 50799 | 252,0 | 30,8 | 27,7 | 20,0 | 18,0 | 17,3 | 21,9 | 22,7 | 33,8 | 23,8 | 33,6 |
| AD 86099 | 292,0 | 36,0 | 33,0 | | | | | | 37,5 | 24,6 | 37,5 |
| AD 60999 | 247,0 | | 27,6 | 21,0 | 19,0 | 17,5 | 22,5 | 20,5 | 31,4 | 21,8 | 34,0 |
| AD 42700 | 284,0 | 32,8 | 32,0 | 27,1 | 22,8 | | | | 34,7 | 22,4 | 35,0 |
| AD 7600 | | 35,0 | 32,0 | | | | | | | | |
| AD 25000 | | 28,5 | 27,2 | 18,3 | 15,5 | | | 28,0 | 20,0 | | |

Appendix 21: *Orangemeryx hendeyi*, measurement (in mm) of the 1st phalanx. (AP = anteroposterior, L = length, T = transverse, df = diaphysis, ds = distal, pr = proximal).

| PHALANX I | | | | | | | |
|------------|-----------|------|------|------|------|------|------|
| Catnum | L | APpr | Tpr | APdf | Tdf | APds | Tds |
| AD 122'99 | 58,0 | 22,2 | 18,6 | 16,0 | 13,5 | 15,7 | 15,5 |
| PQAD 1980 | 57,4 | 21,8 | 17,7 | 16,6 | 13,7 | 15,0 | 14,5 |
| PQAD 2831 | 55,5 | 21,9 | 18,7 | 16,9 | 14,8 | 14,0 | 15,8 |
| AD 77'00 | 54,7 | 21,6 | 18,3 | 16,4 | 14,8 | 14,6 | 15,4 |
| AD 228'00 | 54,5 | 23,0 | 19,1 | 18,0 | 14,0 | 14,5 | 15,3 |
| AD 807'97 | 53,7 | 22,4 | 17,8 | 17,0 | 14,0 | | |
| PQAD 1095 | 53,6 | 21,4 | 17,3 | 17,0 | 13,9 | 14,3 | 14,1 |
| PQAD 501 | 53,4 | 22,0 | 17,1 | 16,1 | 14,1 | 13,8 | 15,1 |
| PQAD 28 | 52,8 | 21,0 | 18,1 | 16,4 | 14,2 | 13,4 | 15,2 |
| PQAD 2215 | 52,6 | | 17,3 | | | 13,5 | 15,3 |
| AD 152'95 | 52,3 | 21,2 | 19,3 | 16,0 | 13,0 | | 14,7 |
| AD 473'97 | 52,0 | 20,4 | 17,8 | 16,0 | 14,0 | 13,2 | 14,5 |
| AD 208'99 | 52,0 | 20,7 | 17,2 | 15,1 | 12,1 | 13,8 | 14,0 |
| AD 635'94 | 51,5 | 20,2 | 16,9 | 15,8 | 13,3 | 13,8 | 14,5 |
| AD 634'94 | 51,4 | 22,0 | 18,6 | 16,4 | 14,0 | 13,5 | 15,3 |
| AD 15'95 | 51,0 | 22,6 | 18,6 | 16,7 | 14,4 | 13,5 | 15,3 |
| AD 138'97 | 50,5 | 21,0 | 18,0 | 15,6 | 14,0 | 13,8 | 16,0 |
| AD 126'98 | 49,1 | 21,3 | 18,1 | 16,6 | 14,0 | 13,5 | 14,8 |
| AD 698'97 | 48,4 | | | 13,8 | 11,0 | | |
| AD 42'96 | 47,9 | 20,7 | 16,7 | 14,2 | 12,4 | 12,3 | 14,4 |
| PQAD 895 | 47,1 | 18,9 | 14,1 | 14,6 | 10,8 | 10,5 | 12,5 |
| AD 636'94 | 46,7 | 20,2 | 16,8 | 14,6 | 12,6 | 12,0 | 13,4 |
| AD 158'94 | 46,5 | 18,9 | 15,1 | 14,6 | 12,0 | 12,1 | 13,0 |
| AD 479'99 | 46,3 | 18,7 | 16,0 | 14,7 | 12,8 | 12,5 | 15,2 |
| AD 29'00 | | 22,0 | 17,4 | | | | |
| AD 577'99 | | 21,2 | 18,5 | | | | |
| AD 153'00 | | | 17,1 | 17,1 | 13,8 | 12,1 | 14,2 |
| AD 324'97 | | | | | | 15,7 | 16,4 |
| AD 777'97 | | | | | | 14,2 | 14,7 |
| AD 694'94 | | | | | | 13,8 | 14,4 |
| AD 155'95 | | | | | | 13,2 | 14,8 |
| AD 190'00 | | | | | | 12,7 | 13,4 |
| AD 637'94 | | | | 15,5 | 14,1 | | |
| AD 192'99* | *juvenile | | | 10,6 | 9,8 | 11,0 | |

Appendix 22: *Orangemeryx hendeyi*, measurement (in mm) of the 2nd phalanx. (AP = anteroposterior, L = length, T = transverse, df = diaphysis, ds = distal, pr = proximal).

| PHALANX II | | | | | | | |
|------------|------------|------|------|------|------|------|------|
| Catnum | L | APpr | Tpr | APdf | Tdf | APds | Tds |
| AD 28'99 | 30,9 | 22,1 | 16,4 | 15,3 | 12,5 | 17,3 | 13,2 |
| AD 536'98 | 30,6 | 21,6 | 16,1 | 14,5 | 13,3 | 17,0 | 13,0 |
| PQAD 217 | 30,5 | | | | | 17,6 | 12,4 |
| PQAD 469 | 30,2 | 21,0 | 16,0 | | | 17,2 | 14,4 |
| PQAD 27 | 29,6 | 20,9 | 16,0 | | | 17,2 | 13,4 |
| AD 639'94 | 29,4 | 20,6 | 14,8 | | | 16,7 | 12,6 |
| AD 69'98 | 29,3 | 20,7 | 15,3 | 14,3 | 13,0 | 17,4 | 13,1 |
| AD 480'99 | 29,1 | 20,0 | 14,5 | 14,0 | 11,2 | 17,0 | 12,9 |
| AD 310'97 | 29,0 | 21,1 | 15,0 | 14,8 | 13,0 | 17,3 | 13,3 |
| AD 590'99 | 28,7 | 21,2 | 15,2 | 13,6 | 10,6 | 16,9 | 13,0 |
| AD 43'96 | 28,5 | | 14,5 | | | | 12,6 |
| AD 497'99 | 28,0 | 18,1 | 15,3 | 13,7 | 11,9 | 16,8 | 13,1 |
| PQAD 3020 | 27,9 | 20,0 | 15,0 | | | 16,9 | 12,4 |
| AD 280'99 | 27,7 | 19,5 | 14,9 | 13,4 | 10,9 | 16,7 | 12,6 |
| AD 142'94 | 27,4 | 17,1 | 13,4 | | | 15,4 | 10,9 |
| AD 647'94 | 27,2 | 19,7 | 14,3 | | | 16,6 | 11,7 |
| AD 597'98 | 27,0 | 18,6 | 14,9 | 13,4 | 11,2 | 16,5 | 12,7 |
| AD 329'00 | 27,0 | | | | | 15,2 | 13,4 |
| AD 44'96 | 26,8 | 19,1 | 13,8 | | | 16,7 | 11,4 |
| AD 14'98 | 26,6 | 19,4 | 14,1 | 14,0 | 11,6 | 17,0 | 12,5 |
| AD 646'94 | 26,5 | | 13,0 | | | 15,7 | 10,2 |
| AD 151'00 | 26,0 | | 13,8 | | | 15,0 | 11,6 |
| AD 123'99 | 25,3 | 17,9 | 13,6 | 11,6 | 9,6 | 14,3 | 11,7 |
| AD 290a'99 | 24,2 | | 13,4 | | | | |
| AD 111'95 | | 19,8 | 14,7 | | | | |
| PQAD 1554 | | 18,0 | 13,5 | | | | |
| AD 808'97 | | | | | | 16,5 | 12,2 |
| AD 642'94* | * juvenile | | | | | 14,3 | 10,0 |

Appendix 21: *Orangemeryx hendei*, measurement (in mm) of the 1st phalanx. (AP = anteroposterior, L = length, T = transverse, df = diaphysis, ds = distal, pr = proximal).

| PHALANX I | | | | | | | |
|------------|-----------|------|------|------|------|------|------|
| Catnum | L | APpr | Tpr | APdf | Tdf | APds | Tds |
| AD 122'99 | 58,0 | 22,2 | 18,6 | 16,0 | 13,5 | 15,7 | 15,5 |
| PQAD 1980 | 57,4 | 21,8 | 17,7 | 16,6 | 13,7 | 15,0 | 14,5 |
| PQAD 2831 | 55,5 | 21,9 | 18,7 | 16,9 | 14,8 | 14,0 | 15,8 |
| AD 77'00 | 54,7 | 21,6 | 18,3 | 16,4 | 14,8 | 14,6 | 15,4 |
| AD 228'00 | 54,5 | 23,0 | 19,1 | 18,0 | 14,0 | 14,5 | 15,3 |
| AD 807'97 | 53,7 | 22,4 | 17,8 | 17,0 | 14,0 | | |
| PQAD 1095 | 53,6 | 21,4 | 17,3 | 17,0 | 13,9 | 14,3 | 14,1 |
| PQAD 501 | 53,4 | 22,0 | 17,1 | 16,1 | 14,1 | 13,8 | 15,1 |
| PQAD 28 | 52,8 | 21,0 | 18,1 | 16,4 | 14,2 | 13,4 | 15,2 |
| PQAD 2215 | 52,6 | | 17,3 | | | 13,5 | 15,3 |
| AD 152'95 | 52,3 | 21,2 | 19,3 | 16,0 | 13,0 | | 14,7 |
| AD 473'97 | 52,0 | 20,4 | 17,8 | 16,0 | 14,0 | 13,2 | 14,5 |
| AD 208'99 | 52,0 | 20,7 | 17,2 | 15,1 | 12,1 | 13,8 | 14,0 |
| AD 635'94 | 51,5 | 20,2 | 16,9 | 15,8 | 13,3 | 13,8 | 14,5 |
| AD 634'94 | 51,4 | 22,0 | 18,6 | 16,4 | 14,0 | 13,5 | 15,3 |
| AD 15'95 | 51,0 | 22,6 | 18,6 | 16,7 | 14,4 | 13,5 | 15,3 |
| AD 138'97 | 50,5 | 21,0 | 18,0 | 15,6 | 14,0 | 13,8 | 16,0 |
| AD 126'98 | 49,1 | 21,3 | 18,1 | 16,6 | 14,0 | 13,5 | 14,8 |
| AD 698'97 | 48,4 | | | 13,8 | 11,0 | | |
| AD 42'96 | 47,9 | 20,7 | 16,7 | 14,2 | 12,4 | 12,3 | 14,4 |
| PQAD 895 | 47,1 | 18,9 | 14,1 | 14,6 | 10,8 | 10,5 | 12,5 |
| AD 636'94 | 46,7 | 20,2 | 16,8 | 14,6 | 12,6 | 12,0 | 13,4 |
| AD 158'94 | 46,5 | 18,9 | 15,1 | 14,6 | 12,0 | 12,1 | 13,0 |
| AD 479'99 | 46,3 | 18,7 | 16,0 | 14,7 | 12,8 | 12,5 | 15,2 |
| AD 29'00 | | 22,0 | 17,4 | | | | |
| AD 577'99 | | 21,2 | 18,5 | | | | |
| AD 153'00 | | | 17,1 | 17,1 | 13,8 | 12,1 | 14,2 |
| AD 324'97 | | | | | | 15,7 | 16,4 |
| AD 777'97 | | | | | | 14,2 | 14,7 |
| AD 694'94 | | | | | | 13,8 | 14,4 |
| AD 155'95 | | | | | | 13,2 | 14,8 |
| AD 190'00 | | | | | | 12,7 | 13,4 |
| AD 637'94 | | | | 15,5 | 14,1 | | |
| AD 192'99* | *juvenile | | | 10,6 | 9,8 | 11,0 | |

Appendix 22: *Orangemeryx hendei*, measurement (in mm) of the 2nd phalanx. (AP = anteroposterior, L = length, T = transverse, df = diaphysis, ds = distal, pr = proximal).

| PHALANX II | | | | | | | |
|------------|-----------|------|------|------|------|------|------|
| Catnum | L | APpr | Tpr | APdf | Tdf | APds | Tds |
| AD 28'99 | 30,9 | 22,1 | 16,4 | 15,3 | 12,5 | 17,3 | 13,2 |
| AD 536'98 | 30,6 | 21,6 | 16,1 | 14,5 | 13,3 | 17,0 | 13,0 |
| PQAD 217 | 30,5 | | | | | 17,6 | 12,4 |
| PQAD 469 | 30,2 | 21,0 | 16,0 | | | 17,2 | 14,4 |
| PQAD 27 | 29,6 | 20,9 | 16,0 | | | 17,2 | 13,4 |
| AD 639'94 | 29,4 | 20,6 | 14,8 | | | 16,7 | 12,6 |
| AD 69'98 | 29,3 | 20,7 | 15,3 | 14,3 | 13,0 | 17,4 | 13,1 |
| AD 480'99 | 29,1 | 20,0 | 14,5 | 14,0 | 11,2 | 17,0 | 12,9 |
| AD 310'97 | 29,0 | 21,1 | 15,0 | 14,8 | 13,0 | 17,3 | 13,3 |
| AD 590'99 | 28,7 | 21,2 | 15,2 | 13,6 | 10,6 | 16,9 | 13,0 |
| AD 43'96 | 28,5 | | 14,5 | | | | 12,6 |
| AD 497'99 | 28,0 | 18,1 | 15,3 | 13,7 | 11,9 | 16,8 | 13,1 |
| PQAD 3020 | 27,9 | 20,0 | 15,0 | | | 16,9 | 12,4 |
| AD 280'99 | 27,7 | 19,5 | 14,9 | 13,4 | 10,9 | 16,7 | 12,6 |
| AD 142'94 | 27,4 | 17,1 | 13,4 | | | 15,4 | 10,9 |
| AD 647'94 | 27,2 | 19,7 | 14,3 | | | 16,6 | 11,7 |
| AD 597'98 | 27,0 | 18,6 | 14,9 | 13,4 | 11,2 | 16,5 | 12,7 |
| AD 329'00 | 27,0 | | | | | 15,2 | 13,4 |
| AD 44'96 | 26,8 | 19,1 | 13,8 | | | 16,7 | 11,4 |
| AD 14'98 | 26,6 | 19,4 | 14,1 | 14,0 | 11,6 | 17,0 | 12,5 |
| AD 646'94 | 26,5 | | 13,0 | | | 15,7 | 10,2 |
| AD 151'00 | 26,0 | | 13,8 | | | 15,0 | 11,6 |
| AD 123'99 | 25,3 | 17,9 | 13,6 | 11,6 | 9,6 | 14,3 | 11,7 |
| AD 290a'99 | 24,2 | | 13,4 | | | | |
| AD 111'95 | | 19,8 | 14,7 | | | | |
| PQAD 1554 | | 18,0 | 13,5 | | | | |
| AD 808'97 | | | | | | 16,5 | 12,2 |
| AD 642'94* | *juvenile | | | | | 14,3 | 10,0 |

Appendix 23: *Orangemeryx hendeyi*, measurement (in mm) of the 3rd phalanx. (AP = anteroposterior, H = height, T = transverse, fc = functional measure, mx = maximum).

| PHALANX III | | | | | | |
|-------------|----------|------|------|------|------|------|
| Catnum | APdorsal | APmx | Tmx | Tfc | Hmx | Hfc |
| PQAD 3116 | | 36,6 | 13,9 | | | 17,7 |
| PQAD 896 | | 36,2 | 14,1 | | 28,0 | 18,5 |
| AD 641'94 | | 35,3 | 14,8 | | 24,3 | 16,7 |
| AD 821'97 | 28,3 | 34,9 | 13,6 | 12,8 | 26,4 | 16,8 |
| AD 822'97 | 29,2 | 34,5 | 13,6 | 11,5 | 26,3 | 17,0 |
| AD 648'94 | | 33,6 | 12,6 | | | 16,6 |
| AD 305'98 | 27,7 | 33,5 | 13,8 | 13,2 | | |
| AD 175'98 | 27,7 | 33,3 | 12,9 | 12,3 | 24,7 | 17,5 |
| PQAD 567* | | 33,1 | 11,9 | | 25,5 | 18,3 |
| PQAD 1129 | | 32,7 | 11,7 | | 22,7 | 17,1 |
| AD 917'97 | 26,7 | 32,0 | 12,6 | 12,0 | | 16,4 |
| AD 227'96 | 25,5 | 32,0 | 12,3 | 10,8 | 23,5 | 14,5 |
| PQAD 2289* | | 30,8 | 12,2 | | 23,9 | 16,0 |
| PQAD 518 | | 30,1 | 11,8 | | | 18,3 |
| AD 452'00* | 24,3 | 29,4 | 11,4 | 10,7 | 23,0 | 16,1 |
| AD 152'00 | | | 11,4 | 10,9 | 22,8 | 16,2 |
| PQAD 1130* | | | 13,3 | | | 20,6 |
| AD 481'99 | | | 13,5 | 13,3 | 27,7 | 19,5 |

* eroded

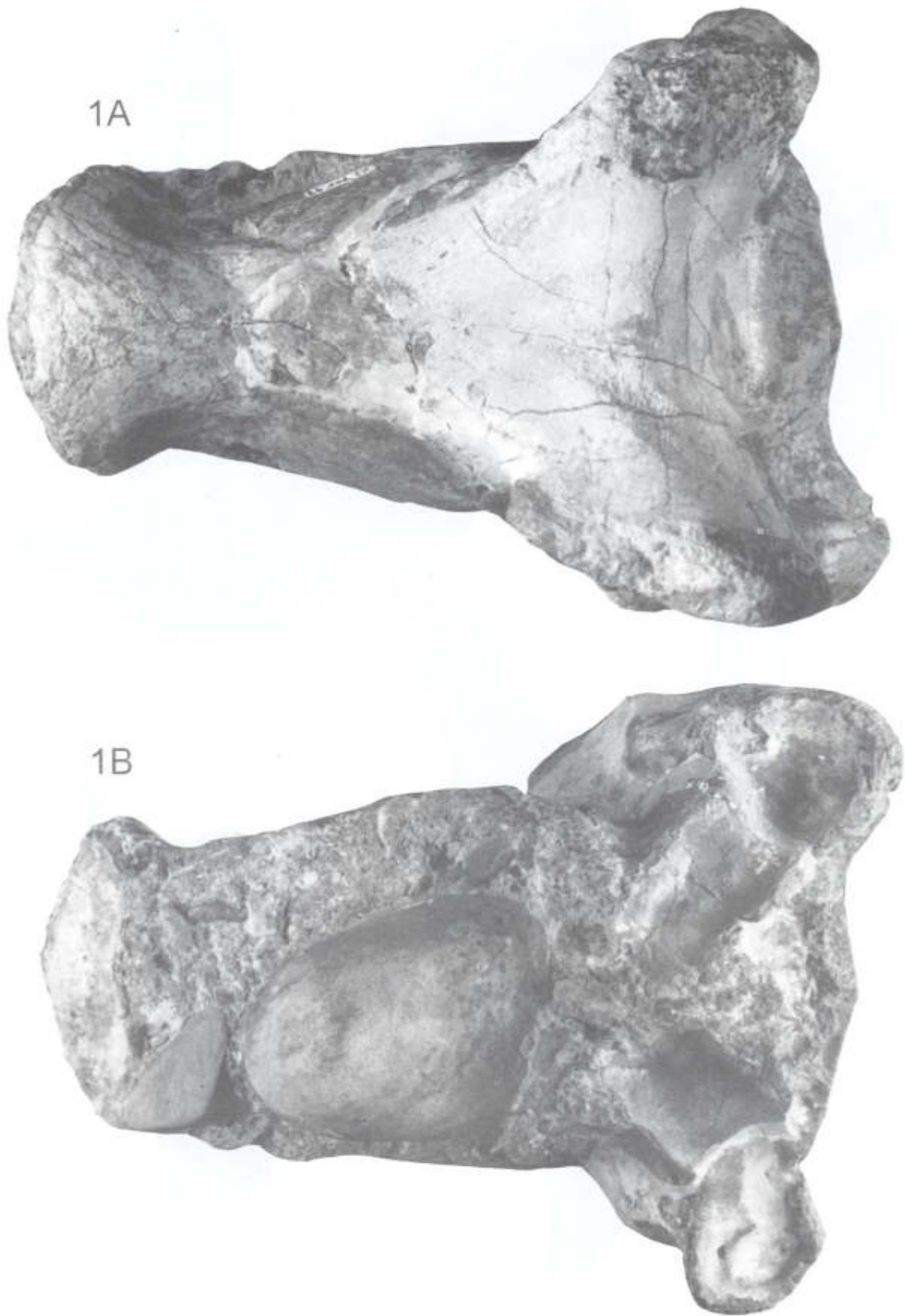


Plate 1: *Orangemeryx hendeyi* from Arrisdrift, Namibia (natural size).
Figure 1. AD-700'97. Cranial fragment, A) dorsal view; B) ventral view.



Plate 2: *Orangemeryx hendeyi* from Arrisdrift, Namibia (natural size).
Figure 1. AD-615'98. Cranial fragment, A) dorsal view; B) lateral view; C) anterior view.
Figure 2. AD-594'94. Apophysis with trifurcate tip, A) dorsal view; B) internal view.

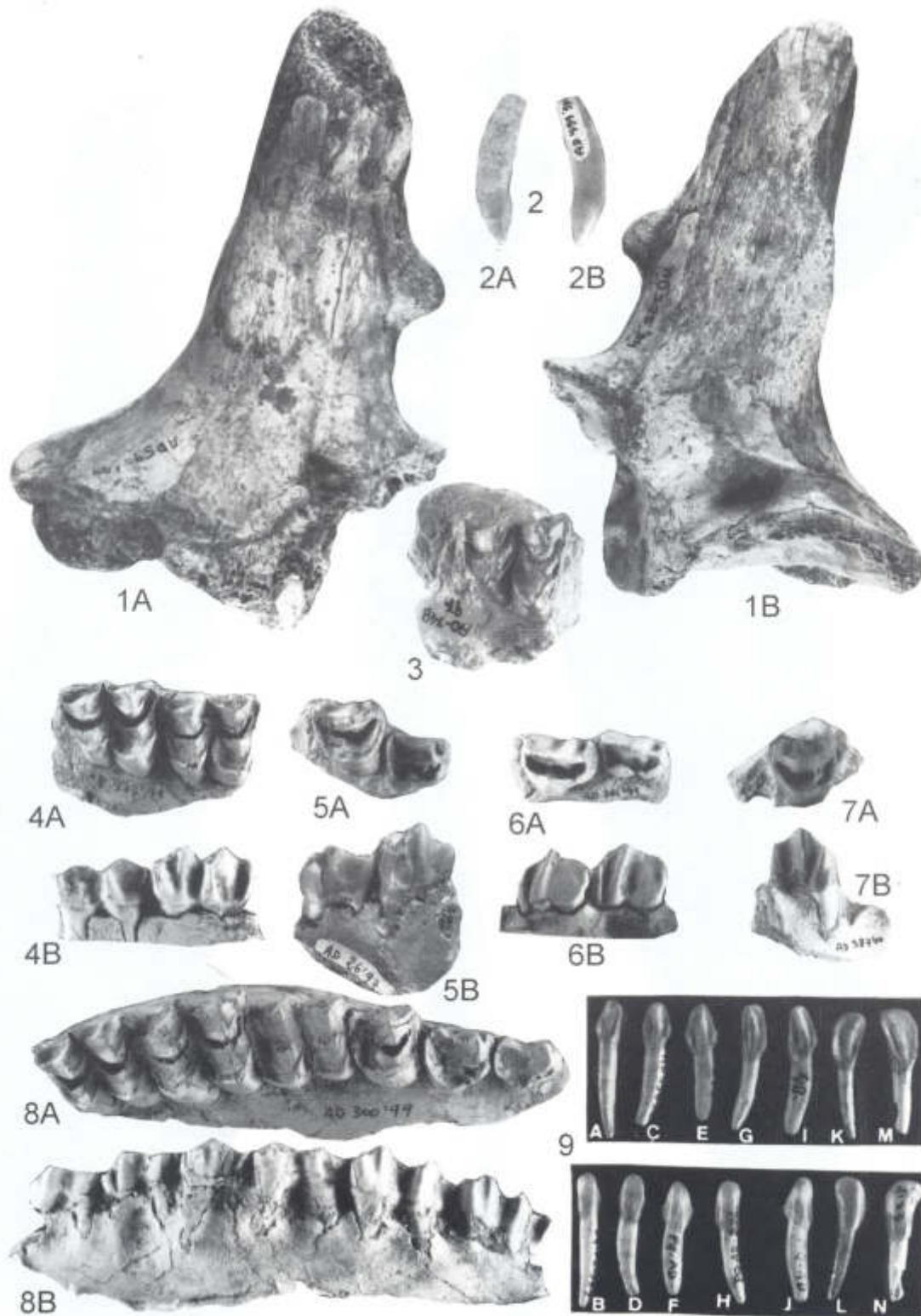


Plate 3: *Orangemeryx hendeyi* from Arrisdrift, Namibia (natural size).

Figure 1. AD-595'94. Holotype, frontal base of left aphophysis. A) internal view; B) external view.

Figure 2. AD-499'97. Upper canine, A-B) buccal and lingual views.

Figure 3. AD-748'97. Right M3/, occlusal view.

Figure 4. AD-475'99. Right M2/-M3/, A) occlusal view; B) buccal view.

Figure 5. AD-26'97. Right P3/-P4/, A) occlusal view; B) buccal view.

Figure 6. AD-301'99. Right P2/-P3/, A) occlusal view; B) buccal view.

Figure 7. AD-387'00. Left P4/, A) occlusal view; B) buccal view.

Figure 8. AD-300'99. Right P2/-M3/, A) occlusal view; B) buccal view.

Figure 9. A-N, incisiform teeth (canines + incisors) in lingual (upper row) and labial views (lower rows). A-B) PQ-AD-369; C-D) AD-559'97; E-F) PQ-AD-379; G-H) PQ-AD-236; I-J) PQ-AD-48; K-L) AD-632'97; M-N) PQ-AD-2125.

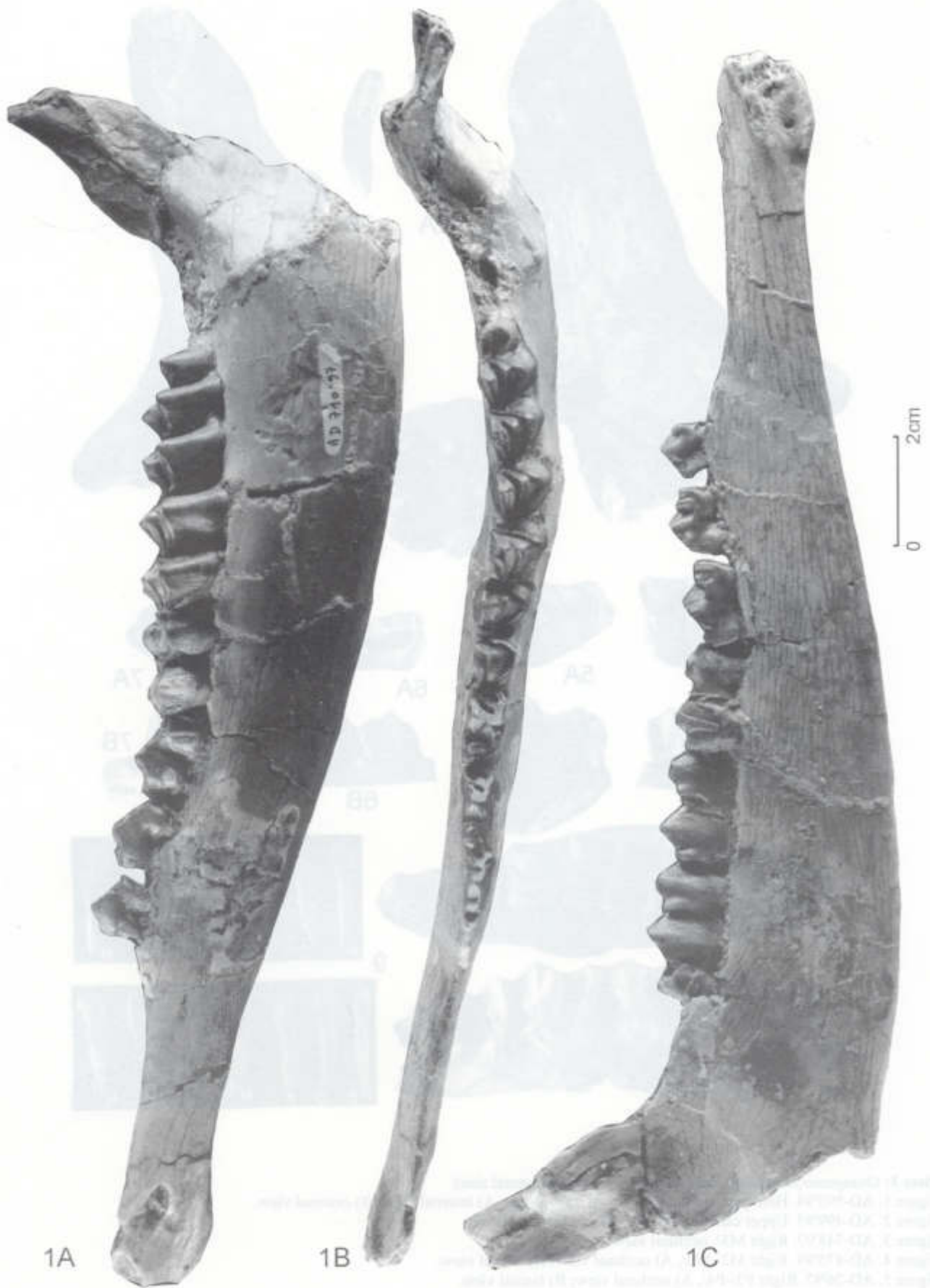


Plate 4: *Orangemeryx hendeyi* from Arrisdrift, Namibia.
Figure 1. AD-710'97. Left mandible, A) buccal view; B) occlusal view; C) lingual view.

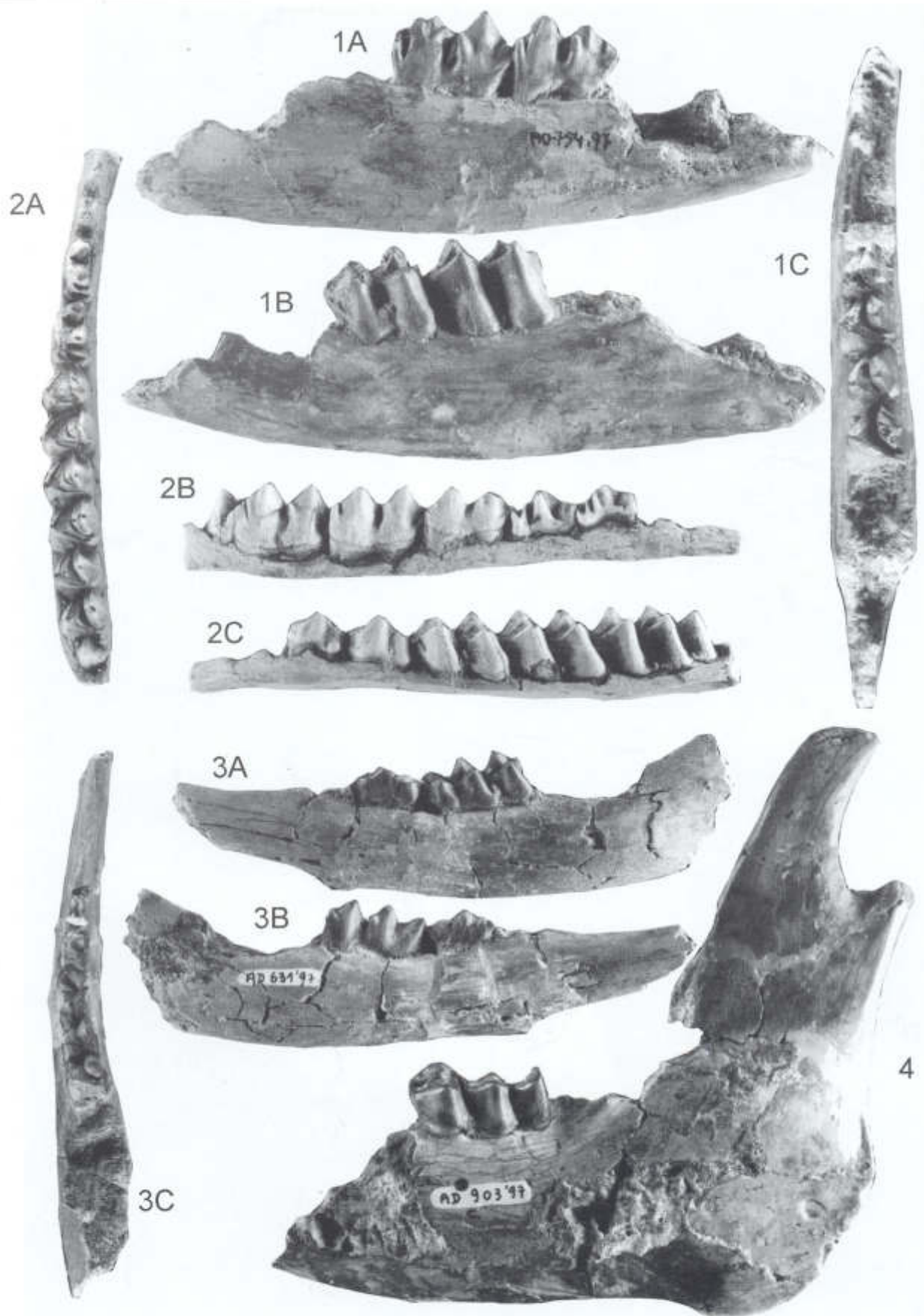


Plate 5: *Orangemeryx hendeyi* from Arrisdrift, Namibia (natural size).

Figure 1. AD-754'97. Left mandible with m/1-m/2, A) lingual view; B) buccal view; C) occlusal view.

Figure 2. AD-610'99. Left mandible with p/3-m/3, A) occlusal view; B) lingual view; C) buccal view.

Figure 3. AD-631'97. Left mandible with dm/3-dm/4, A) buccal view; B) lingual view; C) occlusal view.

Figure 4. AD-903'97. Left mandible fragment with m/3, buccal view.



Plate 6: *Orangemeryx hendeyi* from Arrisdrift, Namibia.

Figure 1. AD 782'97, Axis, lateral view.

Figure 2. AD 175'97, Vertebra C3, lateral view.

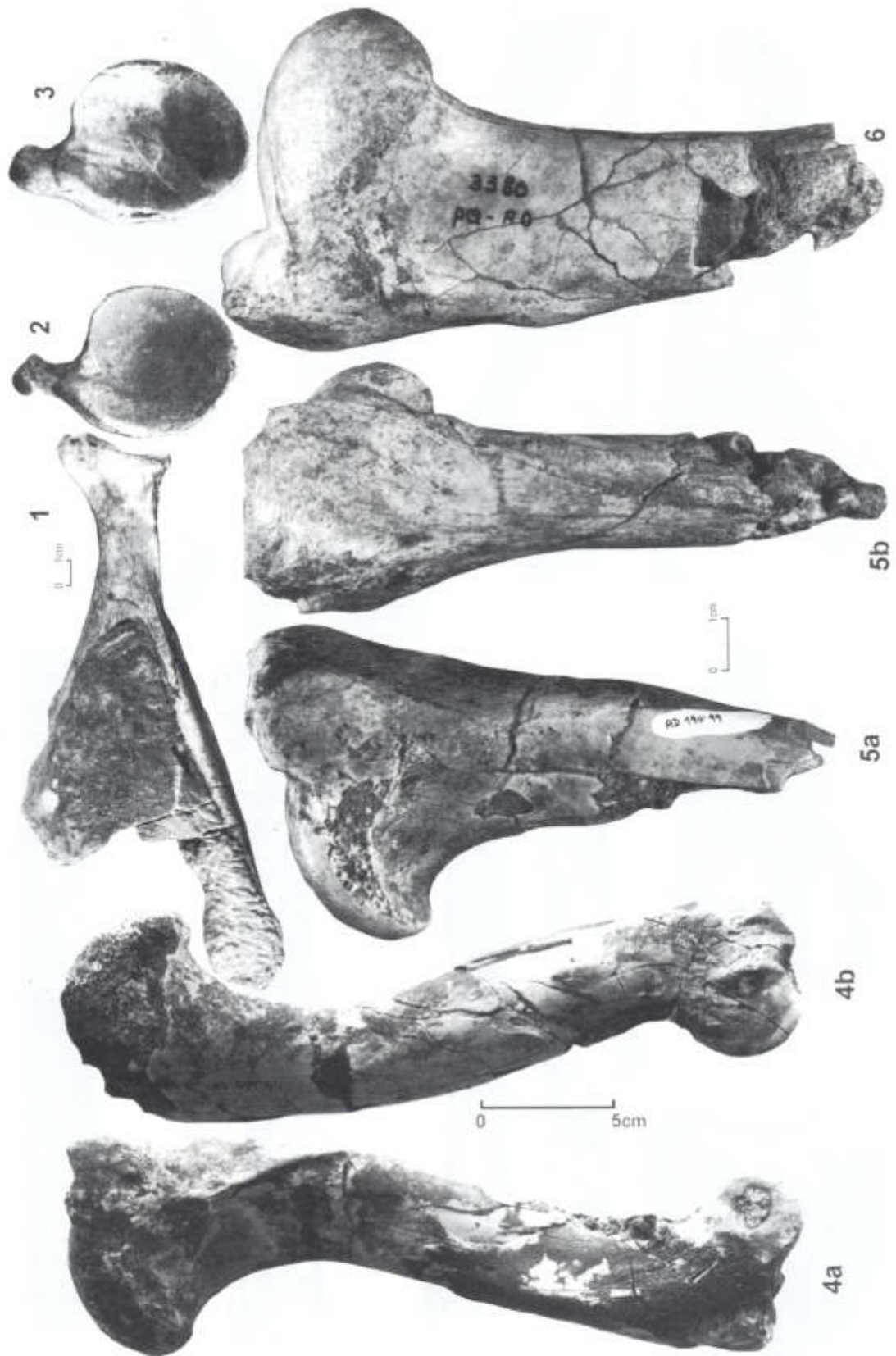


Plate 7: *Orangemeryx hendeyi* from Arrisdrift, Namibia.

Figure 1. AD 746'97. Left scapula, medial view

Figure 2. PQAD 1032. Right scapula, ventral view.

Figure 3. AD 2001. Right scapula, ventral view.

Figure 4. AD 599'94. Complete right humerus, A) lateral view; B) medial view (reduced)

Figure 5. AD 190'99. Right proximal humerus, A) lateral view; B) cranial view.

Figure 6. PQAD 3380. Left proximal humerus, lateral view.

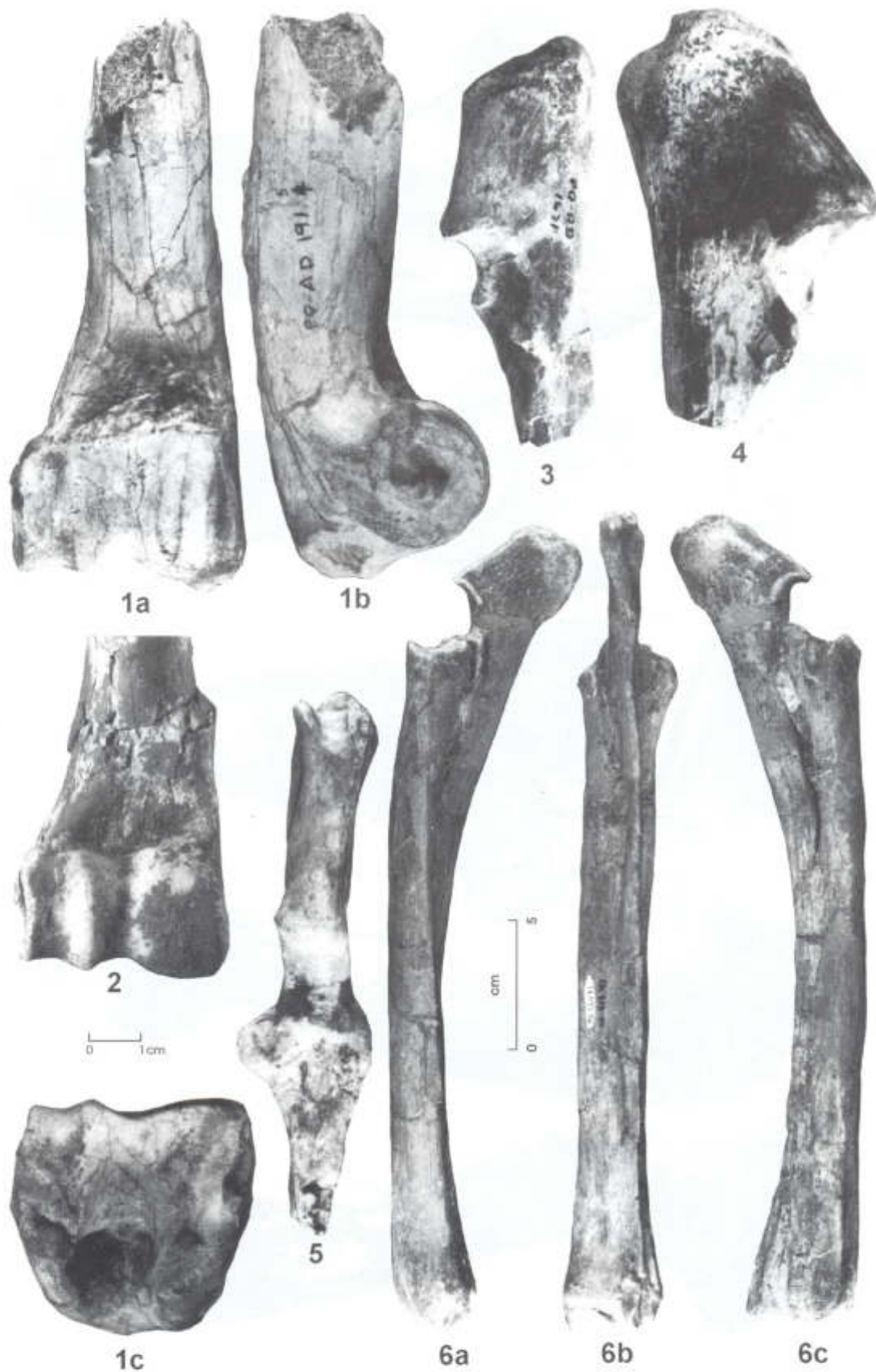


Plate 8: *Orangemeryx hendeyi* from Arrisdrift, Namibia.

Figure 1. PQAD 1915. Right distal end of humerus, A) cranial view; B) lateral view; C) distal view.

Figure 2. AD 253'00. Right distal end of humerus, cranial view.

Figure 3. PQAD 1671. Left proximal end of ulna, lateral view.

Figure 4. PQAD 1268. Right proximal end of ulna, lateral view.

Figure 5. AD 907'97 (Figured in Morales *et al.*, 1999 with catalog number AD-00'95). Right proximal end of ulna, dorsal view.

Figure 6. AD 124'97. Complete right radio-ulna, A) medial view; B) palmar view; C) lateral view.

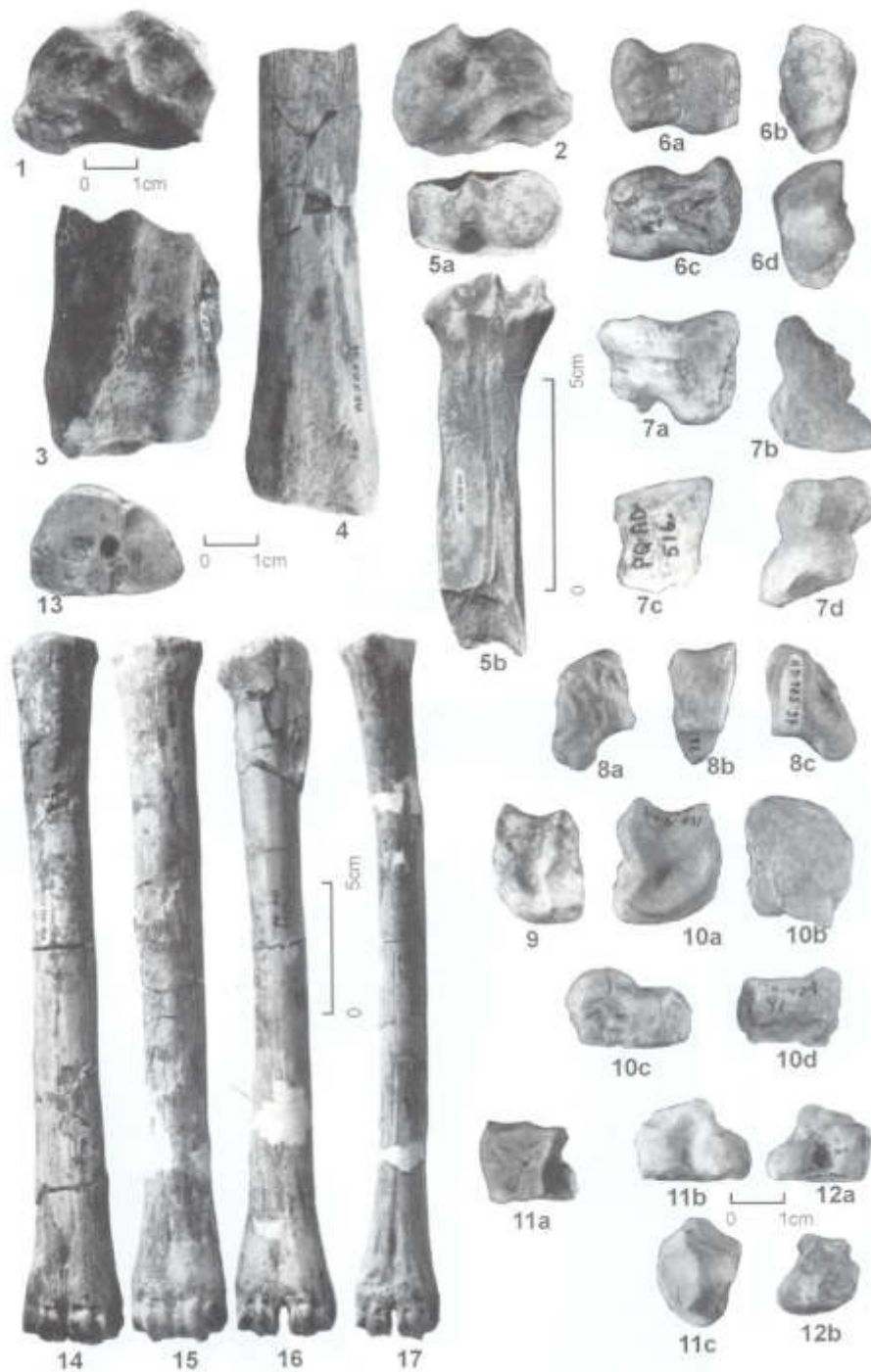


Plate 9: *Orangemeryx hendeyi* from Arrisdrift, Namibia.

Figure 1. PQAD 3047. Complete right radius, distal view.

Figure 2. AD 906'97. Complete left left radius, distal view.

Figure 3. AD-688'94. Left distal end of radius, dorsal view.

Figure 4. AD 703'94. Right distal end of radius, dorsal view.

Figure 5. AD-123'00. Right proximal end of radius, A) proximal view; B) palmar view.

Figure 6. PQAD 1632. Left scaphoid, A) medial view; B) proximal view; C) lateral view; D) distal view.

Figure 7. PQAD 516 Left semilunar, A) medial view; B) proximal view; C) dorsal view; D) distal view.

Figure 8. AD 785'97. Left pyramidal, A) medial view; B) dorsal view; C) lateral view.

Figure 9. PQAD 2574. Left magnotrapezoid, proximal view.

Figure 10. AD 909'97. Right magnotrapezoid, A) proximal view; B) distal view; C) lateral view; D) palmar view.

Figure 11. PQAD 510. Right unciform, A) dorsal view; B) medial view; C) proximal view.

Figure 12. AD 187'96. Left unciform, A) medial view; B) proximal view.

Figure 13. AD 373'97. Complete right metacarpal, proximal view.

Figure 14. PQAD 2216. Complete right metacarpal, dorsal view.

Figure 15. PQAD 199. Complete right metacarpal, dorsal view.

Figure 16. PQAD 2519. Complete left metacarpal, dorsal view.

Figure 17. PQAD 2810. Complete left metacarpal, dorsal view.



Plate 10: *Orangemeryx hendeyi* from Arrisdrift, Namibia.

Figure 1. PQAD 1096. Right pelvis, lateral view.

Figure 2. AD 473'99. Right pelvis, acetabular view, male individual.

Figure 3. AD 542'99. Right pelvis, acetabular view, female individual.

Figure 4. AD 580'99. Complete left femur, caudal view.

Figure 5. AD 580'99. Left femur, A) caudal view of proximal end; B) cranial view of proximal end; C) cranial view of distal end.

Figure 6. PQAD 3236. Distal end of left femur, caudal view.

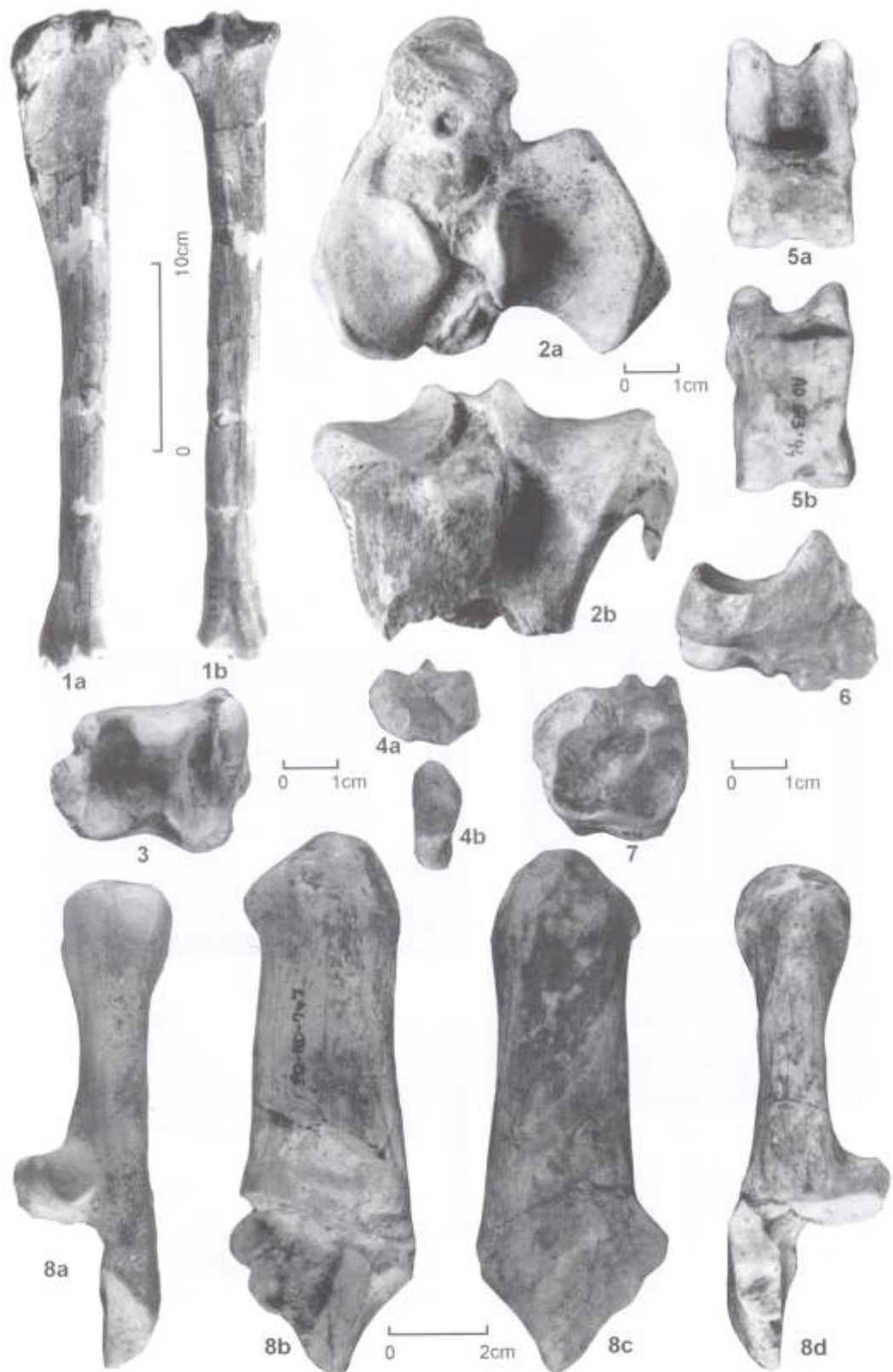


Plate 11: *Orangemeryx hendeyi* from Arrisdrift, Namibia.

Figure 1. PQAD 2292, Complete left tibia, A) lateral view; B) caudal view.

Figure 2. AD 348'99. Right proximal end of tibia, A) proximal view; B) cranial view.

Figure 3. AD 467'97. Right distal end of tibia, distal view.

Figure 4. AD 96'97. Left maleolus, A) medial view; B) distal view.

Figure 5. AD 613'94. Right talus, A) dorsal view; B) plantar view.

Figure 6. AD 317'95. Right navicular-cuboid, medial view.

Figure 7. AD 486'97. Right navicular-cuboid, proximal view.

Figure 8. PQAD 747. Right calcaneum, A) plantar view; B) medial view; C) lateral view; D) dorsal view.

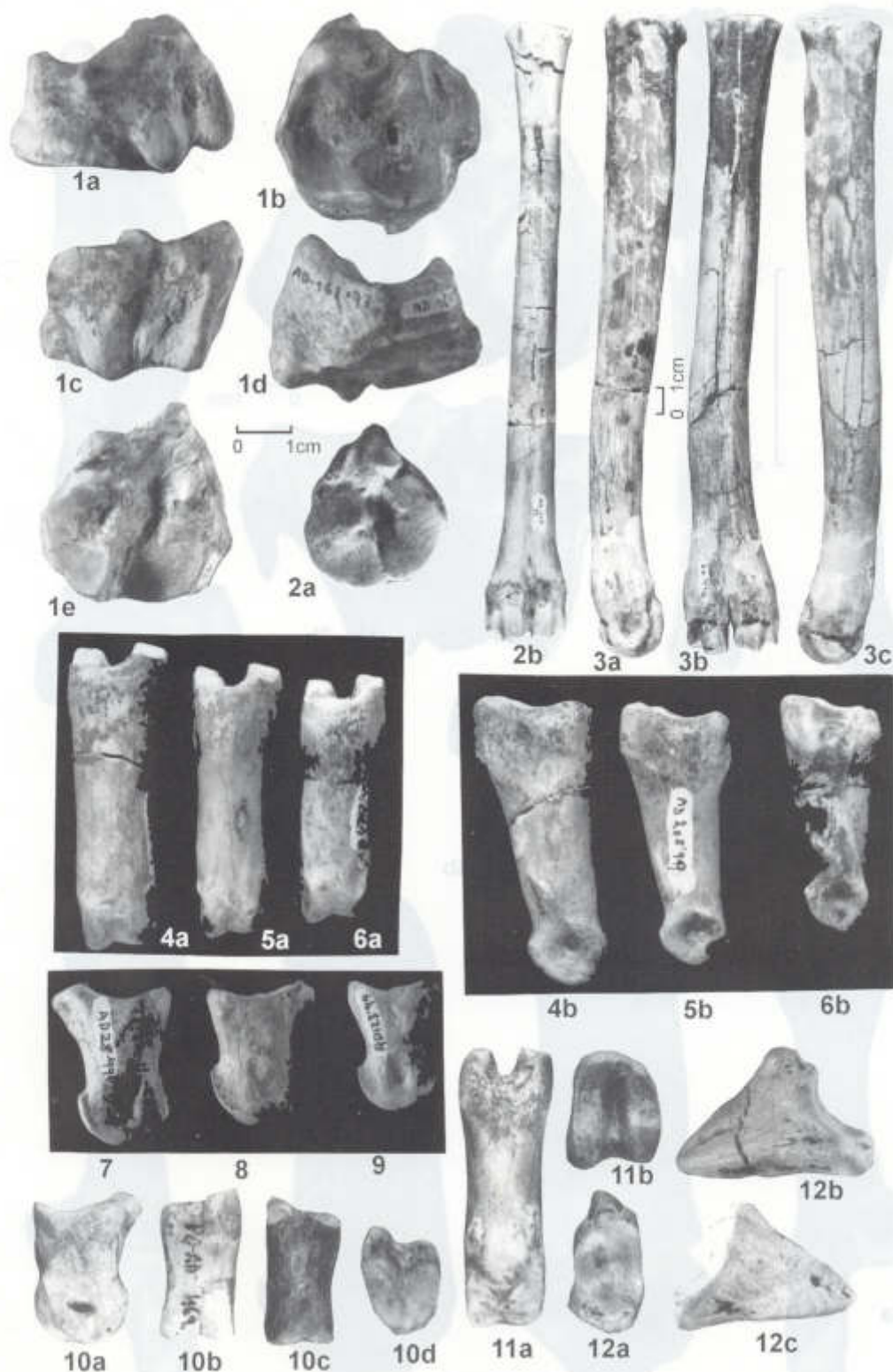


Plate 12: *Orangemeryx hendeyi* from Arrisdrift, Namibia.

Figure 1. AD 161'97. Left navicular-cuboid, A) lateral view; B) proximal view; C) plantar view; D) medial view; E) distal view.

Figure 2. AD 507'99. Complete right metatarsal, A) proximal view; B) dorsal view.

Figure 3. AD 434'99. Complete left metatarsal, A) lateral view; B) dorsal view; C) medial view.

Figure 4. AD 122'99. 1st phalanx, A) dorsal view; B) interdigital view.

Figure 5. AD 208'99. 1st phalanx, A) dorsal view; B) external view.

Figure 6. AD 479'99. 1st phalanx, A) dorsal view; B) interdigital view.

Figure 7. AD 28'99. 2nd phalanx, external view.

Figure 8. AD 530'99. 2nd phalanx, external view.

Figure 9. AD 123'99. 2nd phalanx, external view.

Figure 10. PQAD 469. 2nd phalanx, A) interdigital view; B) volar view; C) dorsal view; D) proximal view.

Figure 11. PQAD 501. 1st phalanx, A) volar view; B) proximal view.

Figure 12. PQAD 896. 3rd phalanx, A) proximal view; B) interdigital view; C) external view.