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COMPARATIVE POSTCRANIAL OSTEOMORPHOLOGY AND OSTEOMETRY OF SPRINGBOK, *ANTIDORCAS MARSUPIALIS* (ZIMMERMAN, 1780) AND GREY RHEBOK, *PELEA CAPREOLUS* (FORSTER, 1790) (MAMMALIA: BOVIDAE).

by

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(with 19 figures)

ABSTRACT

Peters, J. & Brink, J.S. 1992. Comparative postcranial osteomorphology and osteometry of springbok, *Antidorcas marsupialis* **(Zimmerman, 1780) and grey rhebok,** *Pelea capreolus* **(Forster, 1790) (Mammalia: Bovidae). Navors. nas. Mus., Bloemfontein 8(4): 161-207.** A key for the osteomorphological distinction between the postcranial skeleton of springbok, *Antidorcas marsupialis* (Zimmerman, 1780) and grey rhebok, *Pelea capreolus* (Forster, 1790) has been developed and is presented here. Bone remains of these medium sized bovids are often encountered in late Quaternary archaeological sites in southern Africa, but their specific identification poses considerable problems for archaeozoologists. It is demonstrated that measurements on postcranial bones are also useful to separate *Antidorcas* and *Pelea*. In addition, measurements taken on springbok specimens from the Kalahari and from the interior of southern Africa have provided the opportunity of evaluating the subspecific status of *A. m. marsupialis* and *A. m. hofmeyri* on the basis of size variation in the postcranial skeleton. (**Southern Africa, Osteology, Bovidae,** *Antidorcas*, *Pelea*).

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INTRODUCTION

The identification of bovid remains from archaeological sites in Africa and elsewhere often poses serious problems to the archaeozoologist. This is to a large extent due to our limited knowledge of the osteology of the postcranial skeleton of many bovids. The problem of identification is especially acute for the postcranial skeleton of similar sized species with overlapping distributions. Recent studies by Van Neer (1981, 1989), Gabler (1985), Peters (1988, 1989), Plug & Peters (1991) and others have provided valuable keys for identifying fragmented fossil bone material from a number of wild bovid species which are widely distributed throughout Africa, for example oribi (*Ourebia ourebi*) common duiker (*Sylvicapra grimmia*), bushbuck (*Tragelaphus scriptus*), bohor reedbuck (*Redunca redunca*) and African buffalo (*Syncerus caffer*). For the domesticated bovids, cattle, sheep and goat, distinctive morphological features can be found in Boessneck, Müller, & Teichert (1964) and Peters (1988). Nevertheless, much osteomorphological research still needs to be done, not least because of the richness of the African bovid fauna and the associated identification problems, but also because of the possible extinction in the near future of osteologically unstudied species.

This study focuses on the osteomorphology and osteometry of two medium sized southern African bovid species: the springbok, *Antidorcas marsupialis* (Zimmerman, 1780) (Fig.1) and the grey rhebok, *Pelea capreolus* (Forster, 1790) (Fig.2). Both *A. marsupialis* and *P. capreolus* are commonly found in fossil assemblages in South Africa (*cf.* summary by Klein 1984; Brink 1987), and their identification is generally based on dental material and on horncores. Because faunal samples from archaeological sites often consist mainly of postcranial remains, we thought it necessary to develop a key to distinguish between the postcranial bones of the two species mentioned. This would enable the recognition of *A. marsupialis* and/or *P. capreolus* in small samples, or in samples with only postcranial remains.

Both species are endemic to southern Africa and their ranges overlap. The springbok survives mainly in nature reserves and on private farms, except in less populous areas (Meester, Rautenbach, Dippenaar, & Baker 1986). Its present-day distribution, excluding

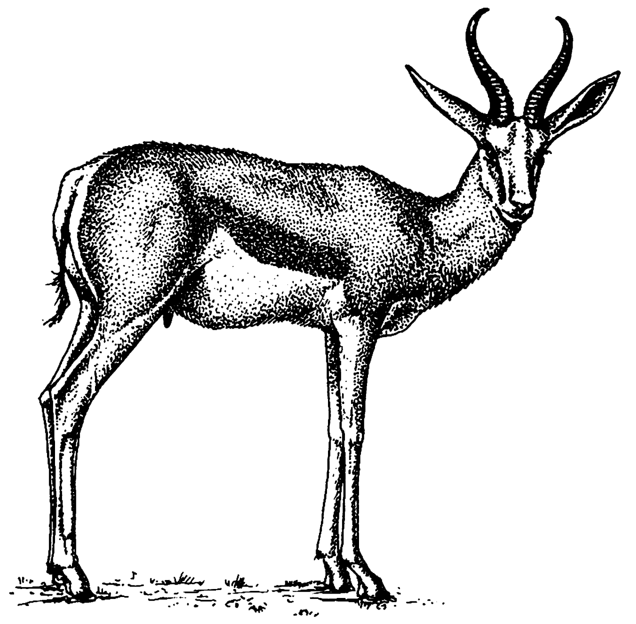

Figure 1: *Antidorcas marsupialis* (Zimmerman, 1780).

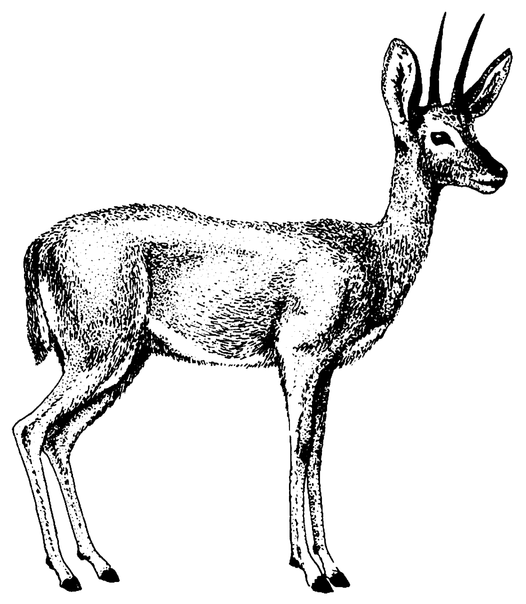

Figure 2: *Pelea capreolus* (Forster, 1790).

translocated populations, is given in Smithers (1983; see Fig.3). The historic range of the species, excluding Angola, has been compiled by Du Plessis (1969) (Fig.4). A comparison of the two maps indicates that the area inhabited by natural populations of *A. marsupialis* has been reduced considerably in recent times. However, recent introductions of springbok into nature reserves and farms have resulted not only in the reoccupation of its former range, but also in its presence in areas well outside of it. The introduction of springbok into the Cape of Good Hope Nature Reserve is a good example of this (Ansell 1972).

Meester *et al.* (1986) follow Ansell (1972) and Groves (1981) in recognising three subspecies: *A.m. marsupialis*, *A.m. hofmeyri* and *A.m. angolensis*. The geographic range of the subspecies is given in Meester *et al.* (1986). *A.m. marsupialis* occurs in the Cape Province, the Orange Free State and southern Transvaal, whereas *A.m. hofmeyri* inhabits northern Transvaal, the northern Cape, Botswana and Namibia. *A.m. angolensis* is confined to Angola, north to the latitude of Benguela. Smithers (1983) on the other hand quotes a study by Robinson (1975), who came to the conclusion, after a comparison of the size of the skulls and by karyological and electrophoretic examination, that little support exists for the continued recognition of subspecies.

The grey rhebok, a monotypic species, has a more restricted distribution compared to the springbok (Meester *et al.* 1986). Its present-day and historical distributions are given respectively in Smithers (1983; see Fig.5) and in Du Plessis (1969; see Fig.6). A comparison of the two maps reveals the changes in distribution of the species. However, considering the present-day distribution of grey rhebok in the Orange Free State (Ferreira & Bigalke 1987), it appears that the past distribution of the species in this province was not accurately evaluated by Du Plessis (1969).

A. marsupialis and *P. capreolus* can be classified as mixed feeders. The springbok, however, is arid-adapted and occurs in open grassland and semi-desert scrub, avoiding thick woodland, extensive areas of tall grass and rocky hills. Springbok both browse and graze, shifting their diet to dicotyledonous material when grass becomes unpalatable in the winter months. During the summer months newly-grown grass and herbs are predominantly utilised (Bigalke 1972; Brink & Lee-Thorp 1992; Liversidge 1972). In arid regions, where rainfall is sporadic and localised, the herds move to areas where rain has fallen, to utilise the fresh, green vegetation. There they form aggregations which may number up to thousands of individuals of all ages and sexes (Smithers 1983). Such larger aggregations of animals moving in a set direction, the so-called "treks", were observed up to the end of the last century (Cronwright-Schreiner 1925). Today, these mass movements still continue, although they never reach the proportions seen in past years (Smithers 1983).

Throughout the greater part of their range grey rhebok are associated with rocky hills, rocky mountain slopes and mountain plateaux. As it is a highly selective feeder with a preference for dicotyledonous material, it can inhabit widely varying environments, ranging from the Cape Fynbos to the Drakensberg escarpment (Ferreira & Bigalke 1987). This preference for forbs and shrubs is in contrast to earlier reports (*vide* Smithers 1983)

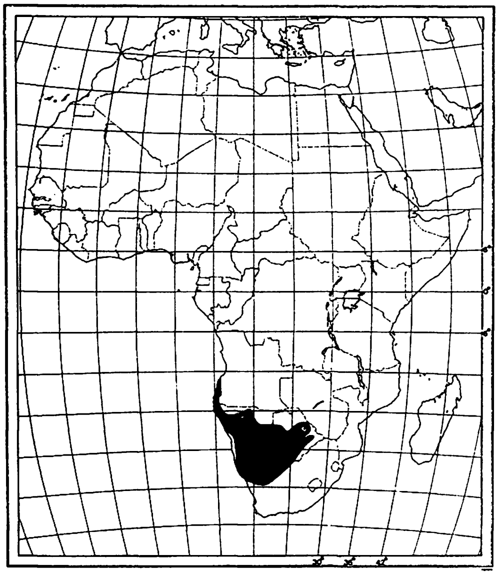

Figure 3: Present geographic distribution of *Antidorcas marsupialis*; after Smithers 1983.

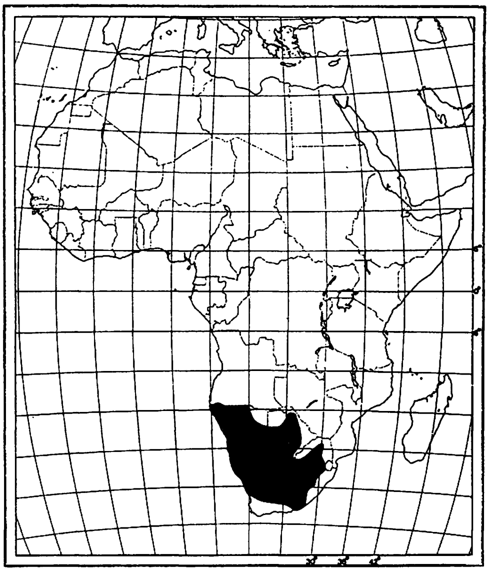

Figure 4: Historic geographic distribution of *Antidorcas marsupialis*; after Du Plessis 1969.

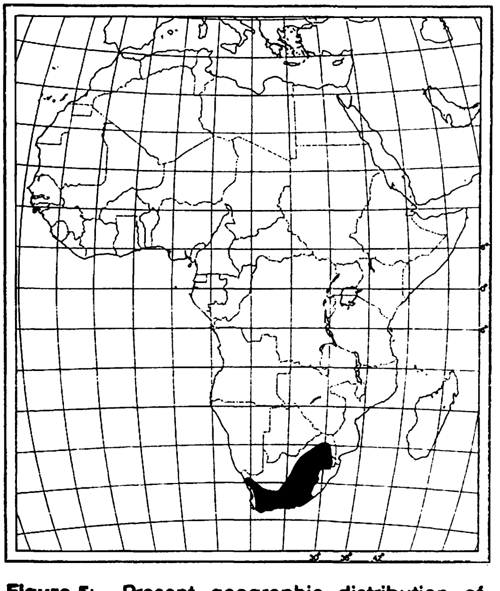

Figure 5: Present geographic distribution of *Pelea capreolus*; after Smithers 1983.

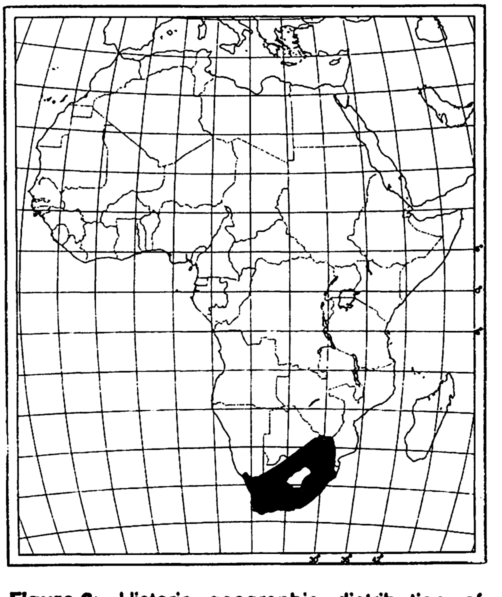

Figure 6: Historic geographic distribution of *Pelea capreolus*; after Du Plessis 1969.

which suggested that the grey rhebok is mainly a grazer. Grey rhebok live in small family parties that remain within a defined home range throughout the year. Such parties may sometimes join up to form larger temporary aggregations (Smithers 1983).

Niche and habitat requirements often have a functional response which becomes manifested in the osteomorphology of a species. In the following sections we explore the osteomorphological and osteometrical differences between the springbok and the grey rhebok.

MATERIAL AND METHODS

Material examined is housed in the following institutions: IPM: Institut für Palaeoanatomie, München; KMMA: Koninklijk Museum voor Midden-Afrika, Tervuren; MMK: McGregor Museum, Kimberley; NMB: National Museum, Bloemfontein; SAM: South African Museum, Cape Town; TMP: Transvaal Museum, Pretoria; ZSM: Zoologische Staatssammlung, München.

Appendix 1 includes the following information about the specimens examined: Collection numbers, sex and the locality where the animals have been obtained. Unfortunately, many specimens were kept in zoological gardens before ending up in osteological collections. As far as we could ascertain, the skeletons of these zoo animals do not differ osteomorphologically from those of free ranging individuals. However, the skeletal measurements of zoo specimens should be treated with caution because dwarfism is known in bovids bred in captivity.

Our results are based on a detailed osteomorphological and osteometrical analysis of some bones of the axial (atlas, axis and sacrum) and, with the exception of the sesamoids and the bones of the dew claws, of all bones of the appendicular skeleton of adult springbok and grey rhebok. The skeletons of 21 male and 30 female *A. marsupialis*, as well as a number of metapodials from unsexed individuals, were carefully examined. We examined skeletons of four male and three female *P. capreolus*. Where complete skeletons were available, we used the pelvic bone to check the sex of the specimen.

For the osteomorphological descriptions, we have strictly followed the nomenclature proposed by the International Committee on Veterinary Gross Anatomical Nomenclature in their *Nomina Anatomica Veterinaria* (3rd. ed., 1983). The figures illustrate the left limb bones with the light source positioned top left of the specimens. Each segment of a scale bar represents 10 mm. The relevant diagnostic features are indicated by a number in the text which is also given on the figures. Arrows on these figures indicate morphological features, lines refer to differences in proportions.

Tables 1 and 2 give the standard statistics of the measurements taken on the postcranial elements of the two species. The measurements are taken according to the standard method of Von den Driesch (1982), except for a few measurements defined by the first author (Peters 1986a). Smaller skeletal elements were measured according to 0,1mm intervals, while measurements of larger elements were rounded off at 0,5mm or at 1mm.

COMPARATIVE OSTEOMORPHOLOGY

Atlas

1 The size and the proportions of the atlas differ in the two genera: large and craniocaudally elongated in *Antidorcas*, small and squarish in *Pelea* (Figs 7A--H, char.1).

2 In *Pelea* the alae atlantis project slightly beyond the fovea articularis caudalis. The atlas of *Antidorcas* has well developed alae atlantis, which project clearly beyond the caudal articular surface (Figs 7A--H, char.2).

3 The attachment surface for the neck muscles becomes larger with the increasing weight of the head. Therefore, it is to be expected that marked sexual dimorphism between the heads of male and female antelope is also expressed in the morphology of the atlas. This is the case in *Antidorcas*, where the size dimorphism observed in the heads and horns of males and females is almost always reflected in the morphology and size of the alae atlantis (Figs 7C--D and 7G--H, char.3).

Axis

1 In *Antidorcas* the body of the second cervical vertebra is robust and exhibits well developed processus transversi. In *Pelea*, the axis is gracile with relatively small transverse processes (Figs 7I--L, char.4).

2 On the ventral surface of the dens epistrophei a distinct protrusion is found in *Pelea*, which is absent in *Antidorcas* (Figs 8B, D, F, H, char.5).

3 Ventrally of the dens, the fusion area of the processus articulares craniales is broader in the axis of *Antidorcas* compared with *Pelea* (Figs 8B, D, F, H, char.6).

4 In *Antidorcas* the processus spinosus of the axis is generally better developed (Figs 8A, C, E, G, char.7).

Sacrum

1 In dorsal view, the sacrum of *Antidorcas* has a more triangular shape than of *Pelea* which is more rectangular. (Figs 8I, J, L, M, char.8). The distinction between the sacrum of males and females of the two genera is based on the more sagittal position of the alae ossis sacri in males, and the fact that the wings do not extend as far laterally in males as in females (*cf.* Boessneck & Meyer-Lemppenau 1966).

2 In *Antidorcas* the margo craniodorsalis is set back about two thirds of the length of the first sacral vertebra. In *Pelea* this margin is not set back (Figs 8I, L, char.9).

3 Proportionally seen, the foramina sacralia pelvina primum to quartum are often larger in *Pelea* (Figs 8J, M, char.10).

4 In *Pelea* the ventral side of the sacrum is rather flat, whereas in *Antidorcas* it is more rounded (Figs 8J, M, char.11).

5 In *Pelea* the processus spinosus of the first sacral vertebra is well developed, whereas it is much reduced in *Antidorcas* (Figs 8K, N, char.12). Consequently, the course of the crista sacralis mediana differs in the two species.

Scapula

1 The scapula of *Antidorcas* tends to be more elongated proximodistally compared to that of *Pelea* (Figs 9A--B, char.13).
2 In *Pelea* the form of the cavitas glenoidalis is oval with no particular features, whereas in *Antidorcas* the cavitas is circular with a synovial groove which extends caudally inwards (Figs 9C, E, char.14 and 15).
3 The position and general appearance of the tuberculum supraglenoidale and the processus coracoideus differ in the two genera: the tuberculum supraglenoidale projects cranially in *Antidorcas* and craniomedially in *Pelea* (Figs 9C, E, char.16). Consequently, the margo cranialis has a different outline in *Antidorcas* (Figs 9A--B, char.17).
4 In *Antidorcas* the spina scapulae projects further distally and forms an acute angle with the collum scapulae. In *Pelea* the distance between spina and cavitas is larger and the angle between spina and collum is less acute (Figs 9D, F, char.18).
5 The caudal margin of the collum is characterised by a tuberosity, which is much more prominent in *Antidorcas* than in *Pelea* (Figs 9D, F, char.19).

Humerus

1 The pars cranialis of the tuberculum maius extends further proximally and is more slenderly built in *Pelea* (Figs 9G--H, 10A--B, char.20).
2 The caput humeri is more flattened in *Antidorcas* (Figs 9G--H, char.21).
3 The humerus shaft is slender and straight in *Pelea*, whereas in *Antidorcas* the shaft is robust and slightly curved (Figs 10A--B, char.22).
4 The rough ridge for the muscle attachment situated on the distal portion of the shaft medioproximally of the trochlea is less pronounced in *Pelea* (Figs 10A--B, char.23).
5 The two species can also be separated on the basis of the form of the trochlea humeri: rectangular in *Pelea* and trapeziform in *Antidorcas* (Figs 10A--D, char.24).
6 The verticillus of the trochlea humeri is rounded in *Pelea* and sharp in *Antidorcas* (Figs 10A--D, char.25).
7 The lateral condylus of the trochlea projects further distally in *Antidorcas* (Figs 10E--F, char.26).

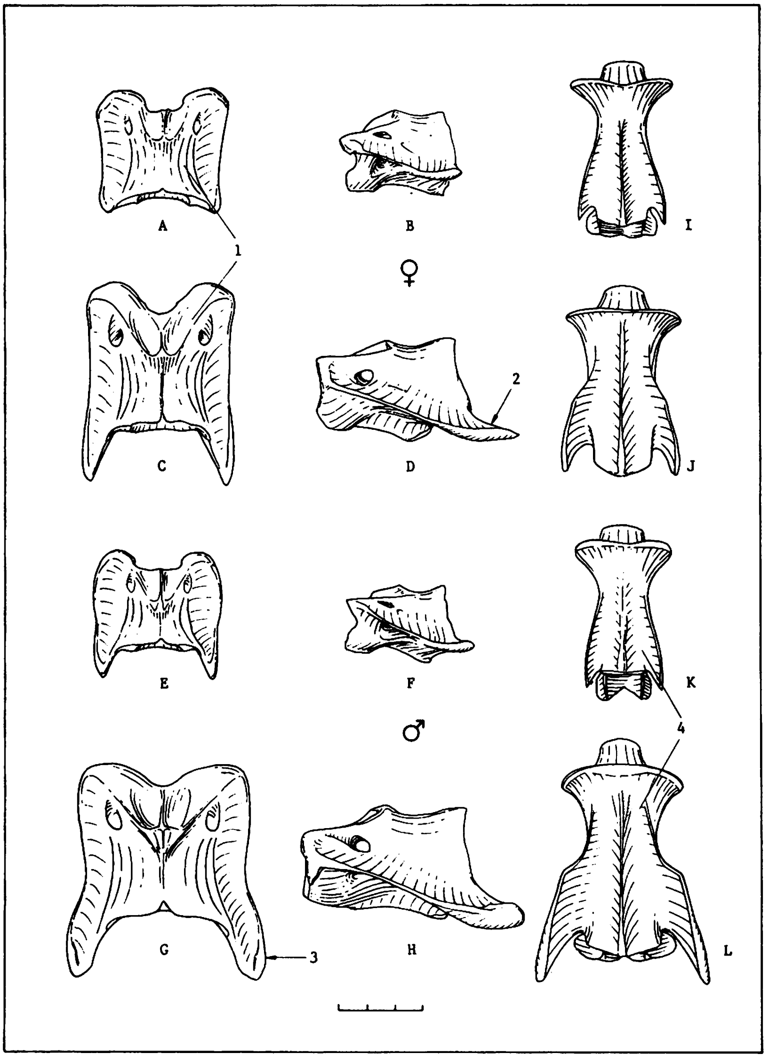

Figure 7: A: *Pelea capreolus*, Atlas ♀, dorsal view; B: *Pelea capreolus*, Atlas ♀, lateral view; C: *Antidorcas marsupialis*, Atlas ♀, dorsal view; D: *Antidorcas marsupialis*, Atlas ♀, lateral view; E: *Pelea capreolus*, Atlas ♂, dorsal view; F: *Pelea capreolus*, Atlas ♂, lateral view; G: *Antidorcas marsupialis*, Atlas ♂, dorsal view; H: *Antidorcas marsupialis*, Atlas ♂, lateral view; I: *Pelea capreolus*, Axis ♀, ventral view; J: *Antidorcas marsupialis*, Axis ♀, ventral view; K: *Pelea capreolus*, Axis ♂, ventral view; L: *Antidorcas marsupialis*, Axis ♂, ventral view.

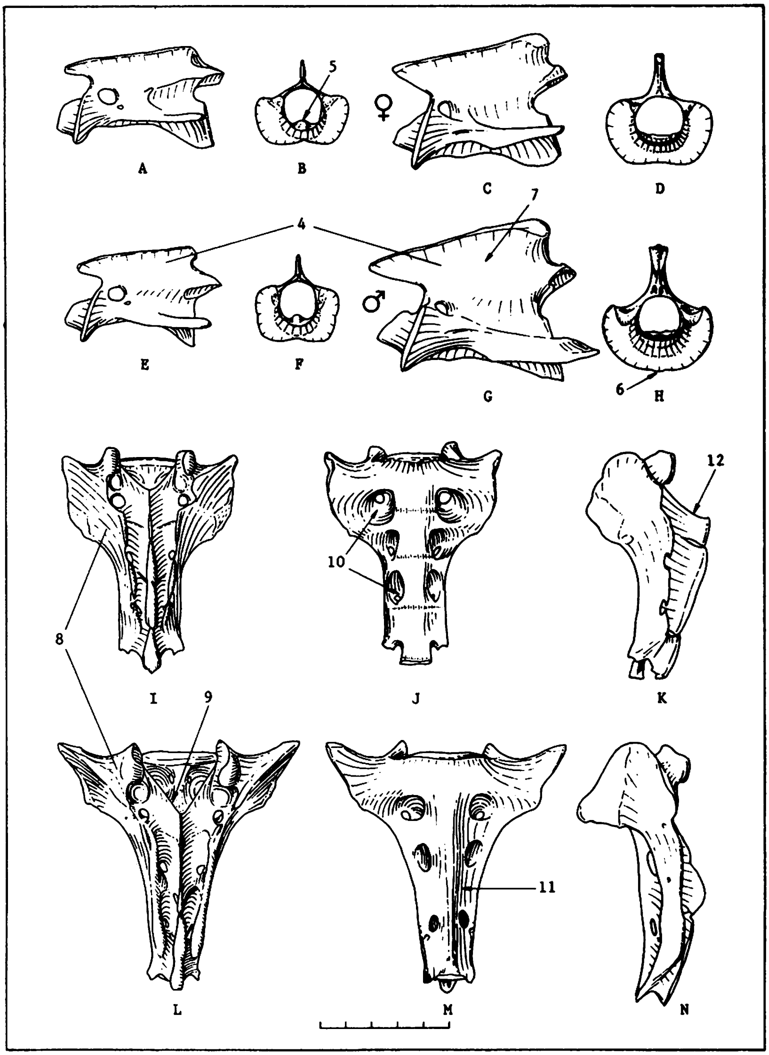

Figure 8: A: *Pelea capreolus*, Axis ♀, lateral view; B: *Pelea capreolus*, Axis, ♀, cranial view; C: *Antidorcas marsupialis*, Axis ♀, lateral view; D: *Antidorcas marsupialis*, Axis ♀, cranial view; E: *Pelea capreolus*, Axis ♂, lateral view; F: *Pelea capreolus*, Axis ♂, cranial view; G: *Antidorcas marsupialis*, Axis ♂, lateral view; H: *Antidorcas marsupialis*, Axis ♂, cranial view; I: *Pelea capreolus*, Sacrum ♀, dorsal view; J: *Pelea capreolus*, Sacrum ♀, ventral view; K: *Pelea capreolus*, Sacrum ♀, lateral view; L: *Antidorcas marsupialis*, Sacrum o, dorsal view; M: *Antidorcas marsupialis*, Sacrum ♀, ventral view; N: *Antidorcas marsupialis*, Sacrum ♀, lateral view.

Ulna

1 The ulnar olecranon is long with a slightly curved dorsal margin in *Antidorcas*, whereas in *Pelea* it is shorter and dorsally more concave (Figs 10G--H, char.27).
2 In *Antidorcas* the tuber olecrani exhibits a distinct notch which is less pronounced in *Pelea* (Figs 10G--H, char.28).
3 The lateral side of the olecranon exhibits a muscle attachment in *Antidorcas* which is absent in *Pelea* (Figs 10G--H, char.29).
4 In *Antidorcas* the processus coronoideus lateralis protrudes in a strong V-shape, whereas in *Pelea* it is much more flattened (Figs 9I--J, char.30).

Radius

1 In order to match the processus on the ulna, the incision for the lateral coronoid process at the caudal side of the caput radii is V-shaped in *Antidorcas*. In *Pelea* this incision is so shallow that it is almost absent (Figs 9I--J, char.31).
2 The fovea capitis radii is more sculptured in *Antidorcas*. This is related to the differences in morphology of the verticillus on the trochlea humeri (Figs 9I--J, char.32).
3 The proportions and morphology of the facets of the facies articularis carpea differ in the two species. Typical for *Antidorcas* is the palmaromedial extension of the lateral margin of the radial articular facet (Figs 10I--J, char.33) and the somewhat more indented intermedial facet (Figs 10I--J, char.34).

Ossa carpi

Os carpi radiale

1 The relative proportions of the os carpi radiale differ between the two species. The palmarodorsally elongated form of the radial carpal of *Antidorcas* is especially very typical (Figs 11A--C, E--G, char.35).
2 Other features typical for *Antidorcas* are the prominent tuberosity at the mediopalmar side, the more indented proximal articular surface and the angular aspect of the distal articular surface (Figs 11A--C, E--G, char.36--38).

Os carpi intermedium

1 The os carpi intermedium of *Pelea* is less elongated in a dorsopalmar direction compared with *Antidorcas* (Figs 11J, N, char.39).
2 The mediodorsal part of the distal articular facet often projects further distally in *Antidorcas* than in *Pelea* (Figs 11D, H, char.40).
3 In *Antidorcas* the medial part of the distal articular surface is more developed in a palmar direction compared to that of *Pelea* (Figs 11I, M, char.41).

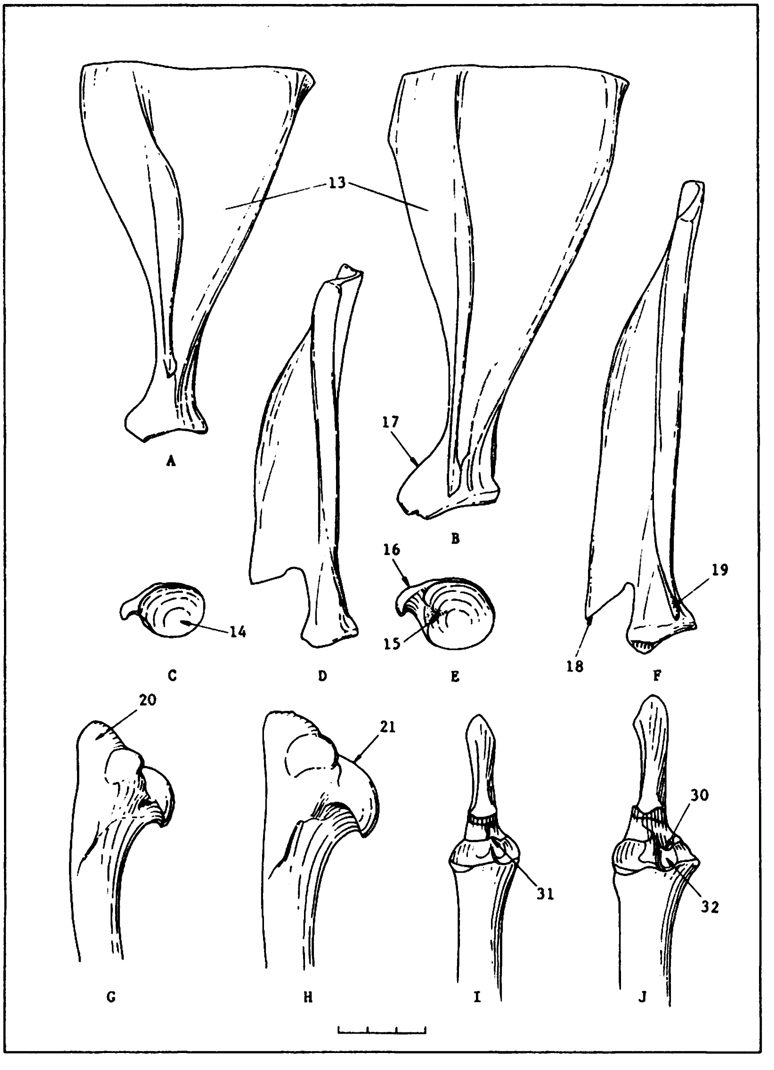

Figure 9: A: *Pelea capreolus*, Scapula, lateral view; B: *Antidorcas marsupialis*, Scapula, lateral view; C: *Pelea capreolus*, Scapula, distal extremity, distal view; D: *Pelea capreolus*, Scapula, caudal view; E: *Antidorcas marsupialis*, Scapula, distal extremity, distal view; F: *Antidorcas marsupialis*, Scapula, caudal view; G: *Pelea capreolus*, Humerus, proximal extremity, lateral view; H: *Antidorcas marsupialis*, Humerus, proximal extremity, dorsal view; I: *Pelea capreolus*, Radius-Ulna, proximal extremity, dorsal view; J: *Antidorcas marsupialis*, Radius-Ulna, proximal extremity, dorsal view.

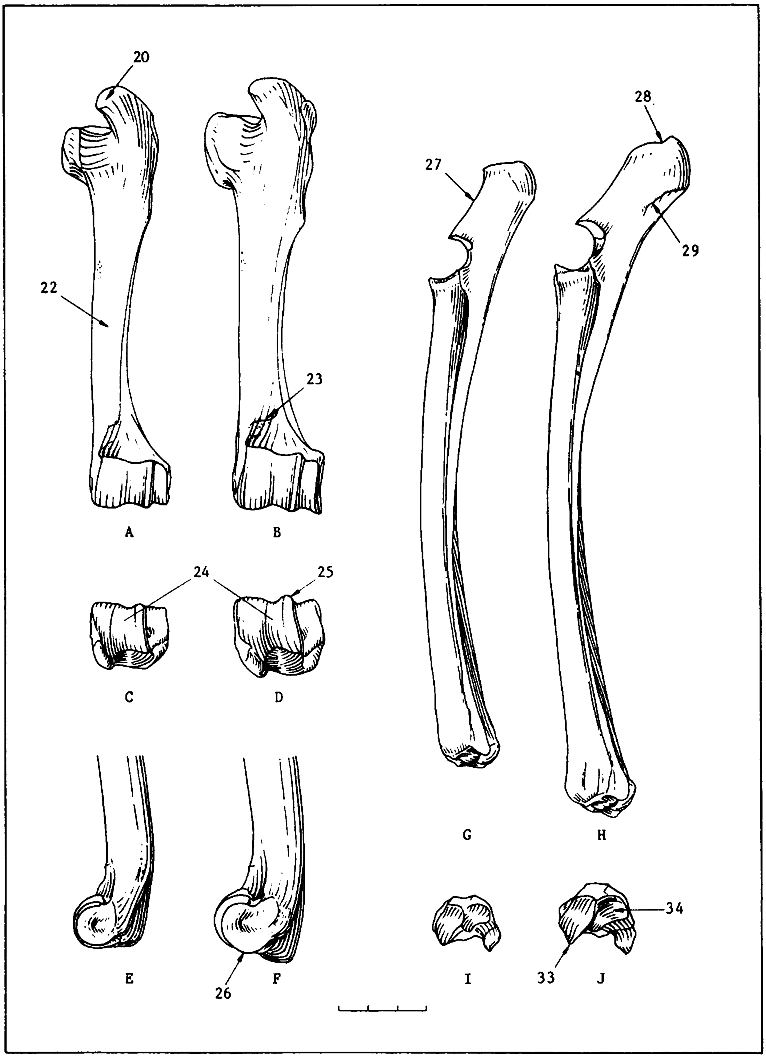

Figure 10: **A**: *Pelea capreolus*, Humerus, cranial view; **B**: *Antidorcas marsupialis*, Humerus, cranial view; **C**: *Pelea capreolus*, Humerus, distal extremity, distal view; **D**: *Antidorcas marsupialis*, Humerus, distal extremity, distal view; **E**: *Pelea capreolus*, Humerus, distal extremity, lateral view; **F**: *Antidorcas marsupialis*, Humerus, distal extremity, lateral view; **G**: *Pelea capreolus*, Radius-Ulna, lateral view; **H**: *Antidorcas marsupialis*, Radius-Ulna, lateral view; **I**: *Pelea capreolus*, Radius-Ulna, distal extremity, distal view; **J**: *Antidorcas marsupialis*, Radius-Ulna, distal extremity, distal view.

Os carpi ulnare

1 In *Pelea*, the distal articular surface is less indented than in *Antidorcas* (Figs 11K, O, char. 42).
2 The proximal articular surface is relatively broad in *Antidorcas*, whereas in *Pelea* it tends to be small (Figs 11L, P, char.43).

Os carpi accessorium

No constant morphological differences were found.

Os carpale II + III

1 A proximal view of the *os carpale II + III* of *Antidorcas* shows its angular aspect. In *Pelea*, this carpal bone is more rounded (Figs 11Q, U, char.44).
2 In *Antidorcas* the palmar part of the crista sagittalis projects further proximally than in *Pelea* (Figs 11R, V, char.45).
3 The lateral articular facets in *Pelea* are almost always separate, whereas in *Antidorcas* they are adjoining (Figs 11R, V, char.46).

Os carpale IV

1 The os carpale IV is more sculptured in *Antidorcas* (Figs 11T, X, char.47).
2 At the distopalmar side, the articular surface extends further distally in *Antidorcas*. (Figs 11T, X, char.48).

Os metacarpale III + IV

1 In proximal view the os metacarpale III + IV shows a more angular aspect in *Antidorcas* (Figs 14, A--B, char.49).
2 The palmar side of the metacarpal shaft is concave in *Pelea*, whereas in *Antidorcas* it is relatively flat with a distinct sagittal muscular attachment on the medial half of the bone (Figs 14, C--D, char.50).
3 The trochleae ossis metacarpalis III + IV of *Antidorcas* are deep and exhibit well pronounced, sharp sagittal ridges. In *Pelea*, these trochleae are less deep and have more rounded sagittal ridges (Figs 14E--F, char. 51-52).

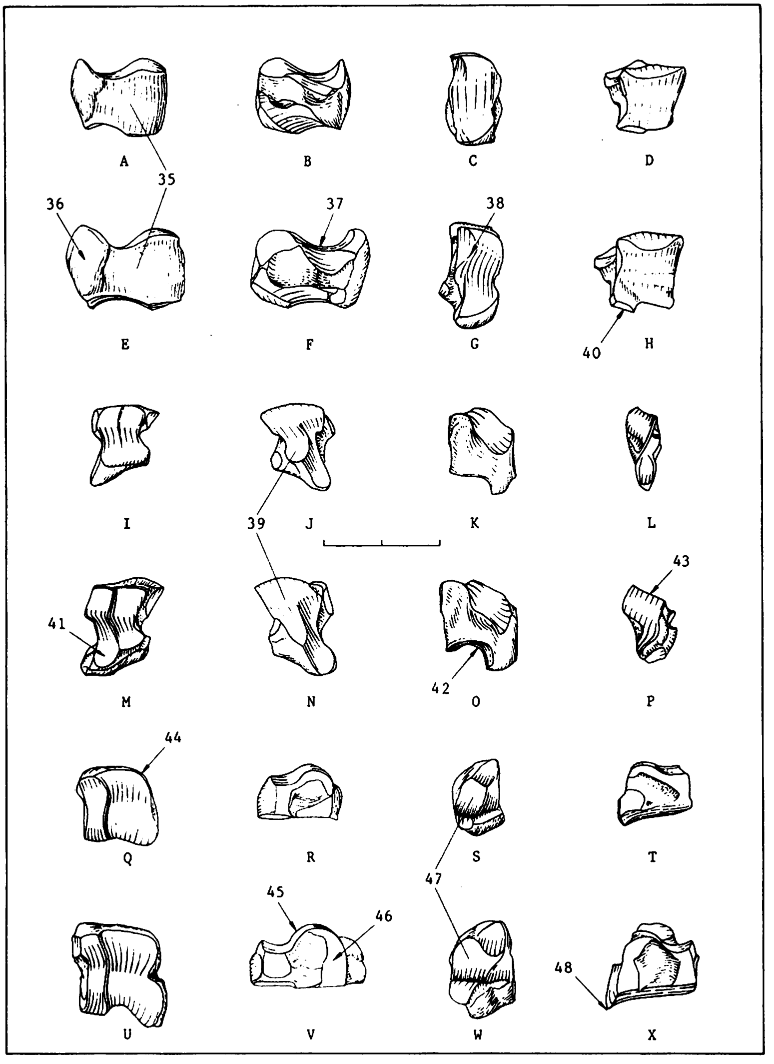

Figure 11: **A**: *Pelea capreolus*, Os carpi radiale, dorsomedial view; **B**: *Pelea capreolus*, Os carpi radiale, lateropalmar view; **C**: *Pelea capreolus*, Os carpi radiale, proximal view; **D**: *Pelea capreolus*, Os carpi intermedium, dorsal view; **E**: *Antidorcas marsupialis*, Os carpi radiale, dorsomedial view; **F**: *Antidorcas marsupialis*, Os carpi radiale, lateropalmar view; **G**: *Antidorcas marsupialis*, Os carpi radiale, proximal view; **H**: *Antidorcas marsupialis*, Os carpi intermedium, dorsal view; **I**: *Pelea capreolus*, Os carpi intermedium, distal view; **J**: *Pelea capreolus*, Os carpi intermedium, proximal view; **K**: *Pelea capreolus*, Os carpi ulnare, dorsolateral view; **L**: *Pelea capreolus*, Os carpi ulnare, proximal view; **M**: *Antidorcas marsupialis*, Os carpi intermedium, distal view; **N**: *Antidorcas marsupialis*, Os carpi intermedium, proximal view; **O**: *Antidorcas marsupialis*, Os carpi ulnare, dorsolateral view; **P**: *Antidorcas marsupialis*, Os carpi ulnare, proximal view; **Q**: *Pelea capreolus*, Os carpale II + III, proximal view; **R**: *Pelea capreolus*, Os carpale II + III, lateral view; **S**: *Pelea capreolus*, Os carpale IV, proximal view; **T**: *Pelea capreolus*, Os carpale IV, medial view; **U**: *Antidorcas marsupialis*, Os carpale II + III, proximal view; **V**: *Antidorcas marsupialis*, Os carpale II + III, lateral view; **W**: *Antidorcas marsupialis*, Os carpale IV, proximal view; **X**: *Antidorcas marsupialis*, Os carpale IV, medial view.

Pelvis

In artiodactyls, marked sexual differences exist in the size and the form of the pelvis (e.g. Boessneck *et al.* 1964; Lemppenau 1964; Getty 1975; Smuts & Bezuidenhout 1987). A description of these distinctive features is not repeated in this study, but figures of the pelvis of both sexes are included.

1 In *Antidorcas* the crista iliaca is more concave (Figs 12A--D, char.53).
2 On the lateroventral side of the os ilium, one observes in *Antidorcas* a well developed muscle attachment, which tends to be absent in *Pelea* (Figs 12A--D, char.54).
3 In *Antidorcas* the spina ischiadica is rather convex and very rugose with many lineae musculares. In *Pelea* the spina is less convex and only occasionally rugose (Figs 12A--D, char.55)
4 In *Antidorcas* the incisura ischiadica minor curves strongly upward towards the tuber ischiadicum. This incisura is only moderately curved in *Pelea* (Figs 12A--D, char.56).
5 The processus lateralis of the tuber ischiadicum projects further laterally in *Antidorcas* (Figs 13A--D, char.57)
6 The lateroconcave muscle attachment at the ventral side of the ischium is often more prominent in *Antidorcas* (Figs 13A--D, char.58).

Os femoris

1 The caput ossis femoris is conical in *Pelea* but cylindrical in *Antidorcas* (Figs 14G--H, char.59). Also typical of *Antidorcas* is the "saddle" form of the femur head (Figs 14I--J, char.60)
2 The trochanter maior is somewhat lower in relation to the caput in *Antidorcas*, while it is more proximally extended in *Pelea* (Figs 14I--J, char.61).
3 In *Pelea* the lateral side of the trochanter maior is divided by a craniocaudal muscle attachment. In *Antidorcas* this muscle attachment is limited to the cranial half of the lateral side (Figs 15A--B, char.62).
4 The trochlea femoris is narrower in *Pelea* (Figs 14K--L, char.63).
5 In *Antidorcas* the proximal part of the medial trochlear ridge forms a "nose" which is absent in *Pelea* (Figs 14K--L, 15C--D, char.64).

Patella

1 In *Pelea* the patella is proximodistally elongated, whereas in *Antidorcas* there is a well developed processus cartilagenius (Figs 16A--D, char.65).
2 The facies cranialis is more sculptured in *Antidorcas* (Figs 16A--B, char.66).

Tibia

1 The tuberculi intercondylares of the eminentia intercondylaris project further proximally in *Antidorcas* (Figs 15E--F, char.67).
2 The small articular facet medially of the incisura poplitea is somewhat larger in *Antidorcas* than in *Pelea* (Figs 15E--F, char.68).
3 In *Pelea* the tibia shaft is more slender and has a less marked sulcus malleolaris, whereas the tibia of *Antidorcas* is more robust and exhibits a well defined sulcus malleolaris (Figs 15G--H, char.69; Figs 15I--J, char.70).
4 The muscle attachment at the malleolus medialis projects further proximally in *Antidorcas* (Figs 15I--J, char.71).
5 The fossa synovialis of the cochlea tibiae is deeper and more prominent in *Antidorcas*. As a consequence, the lateral and medial articular surfaces are clearly separated in the tibia of *Antidorcas* (Figs 15K--L, char.72).
6 In *Pelea* the muscle attachment proximal of the distal articular surface on the dorsal side of the tibia differs. It lies closer to the distal articulation and bends laterally. In *Antidorcas* it lies more towards the proximal end and bends medially (Figs 15G--H, char.73).
7 The dorsal facet of the articular surface for the os malleolare extends towards the dorsal side of the tibia in *Antidorcas*, which is not the case in *Pelea* (Figs 15G--H, char.74)
8 In size (GL) male *Antidorcas* and female *Pelea* can be separated easily, but there is overlap between female *Antidorcas* and male *Pelea*.

Os malleolare

1 The spine of the os malleolare projects further proximally in *Antidorcas* (Figs 16O, Q, char.75).
2 In *Pelea* the lateral side of the os malleolare is rather flat. In *Antidorcas* this side of the bone is characterized by a tuberosity (Figs 16P--R, char.76).

Ossa tarsi

Talus

1 The talus of *Pelea* generally is more slender (Figs 17A--H, char.77). The ratio length of the trochlea tali to caput tali is about 2 to 3 in *Pelea* and 1 to 2 in *Antidorcas* (Figs 17B, F, char.78).
2 The position and morphology of the medial muscle attachment at the collum tali differs between the two species (Figs 17B, F, char.79).
3 The fossa synovialis of the trochlea tali is relatively smooth in *Pelea* but rugose in *Antidorcas* (Figs 17B, F, char.80).
4 The facies articularis medialis, which articulates with the malleolus medialis, is proportionally larger in *Antidorcas* than in *Pelea* (Figs 17C, G, char.81).
5 In *Antidorcas* the articular surface for the calcaneus is more arched, whereas in *Pelea* this surface is flatter (Figs 17D, H, char.82).

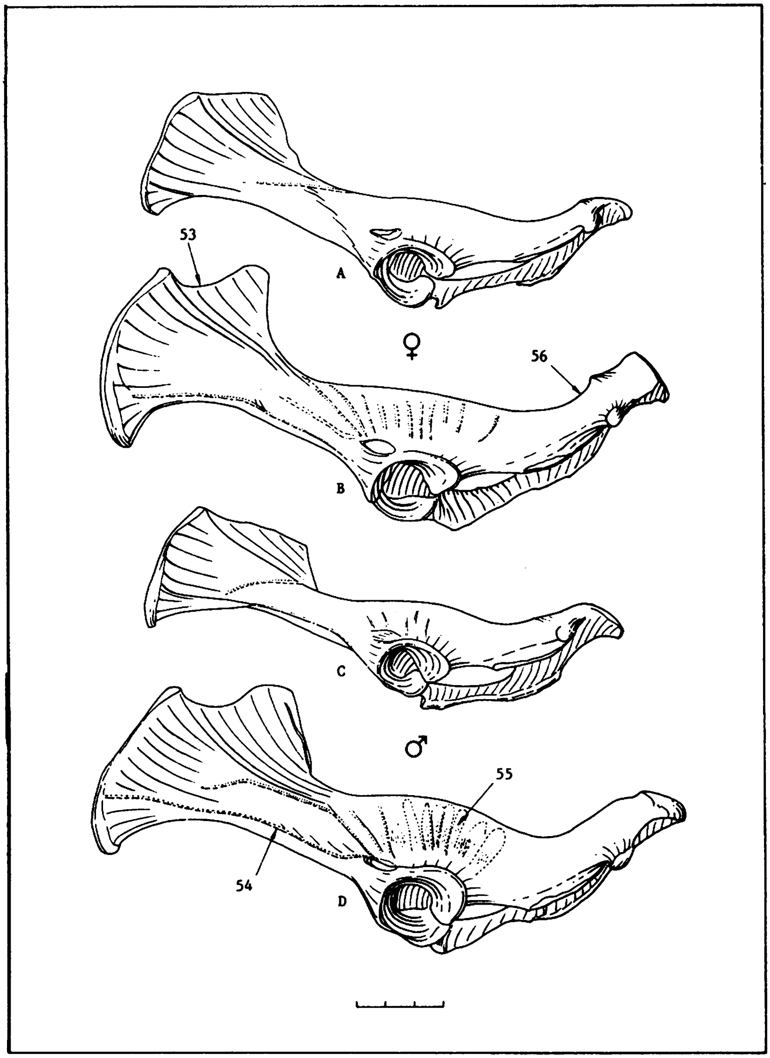

Figure 12: A: *Pelea capreolus*, Pelvis ♀, lateral view; B: *Antidorcas marsupialis*, Pelvis ♀, lateral view; C: *Pelea capreolus*, Pelvis ♂, lateral view; D: *Antidorcas marsupialis*, Pelvis ♂, lateral view.

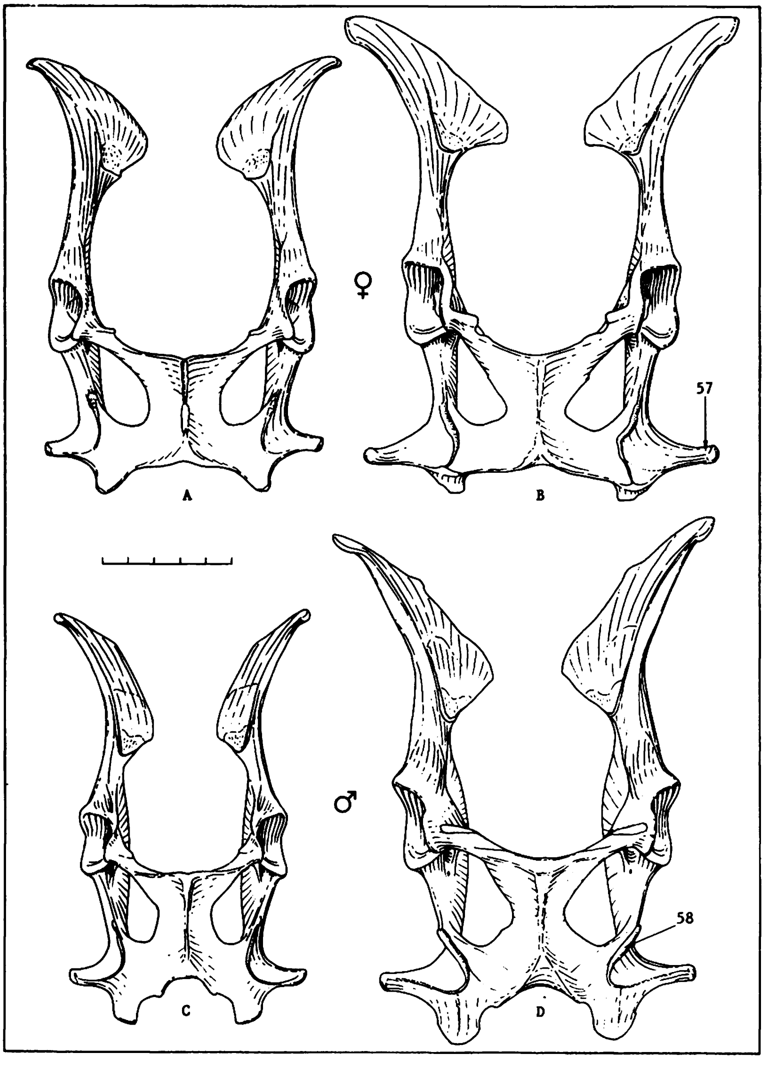

Figure 13: **A**: *Pelea capreolus*, Pelvis ♀, ventral view; **B**: *Antidorcas marsupialis*, Pelvis ♀, ventral view; **C**: *Pelea capreolus*, Pelvis ♂, ventral view; **D**: *Antidorcas marsupialis*, Pelvis ♂, ventral view.

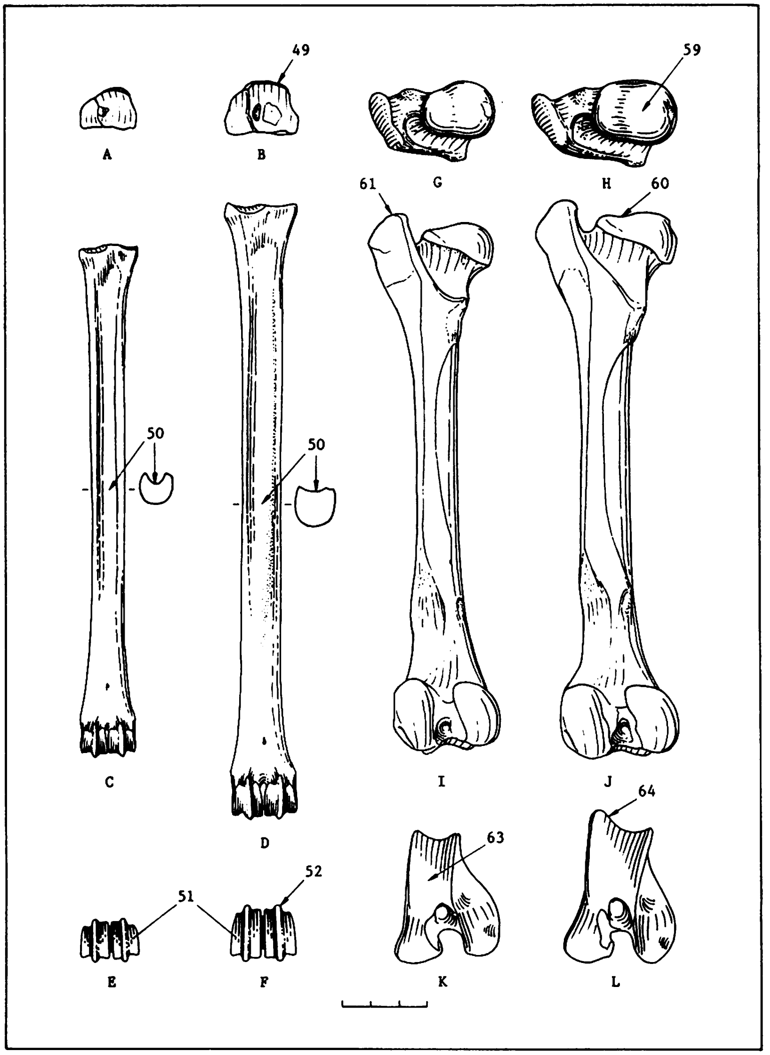

Figure 14: **A**: *Pelea capreolus*, Os metacarpale III + IV, proximal view; **B**: *Antidorcas marsupialis*, Os metacarpale III + IV, proximal view; **C**: *Pelea capreolus*, Os metacarpale III + IV, palmar view; **D**: *Antidorcas marsupialis*, Os metacarpale III + IV, palmar view; **E**: *Pelea capreolus*, Os metacarpale III + IV, distal view; **F**: *Antidorcas marsupialis*, Os metacarpale III + IV, distal view; **G**: *Pelea capreolus*, Os femoris, proximal view; **H**: *Antidorcas marsupialis*, Os femoris, proximal view; **I**: *Pelea capreolus*, Os femoris, caudal view; **J**: *Antidorcas marsupialis*, Os femoris, caudal view; **K**: *Pelea capreolus*, Os femoris, distal view; **L**: *Antidorcas marsupialis*, Os femoris, distal view.

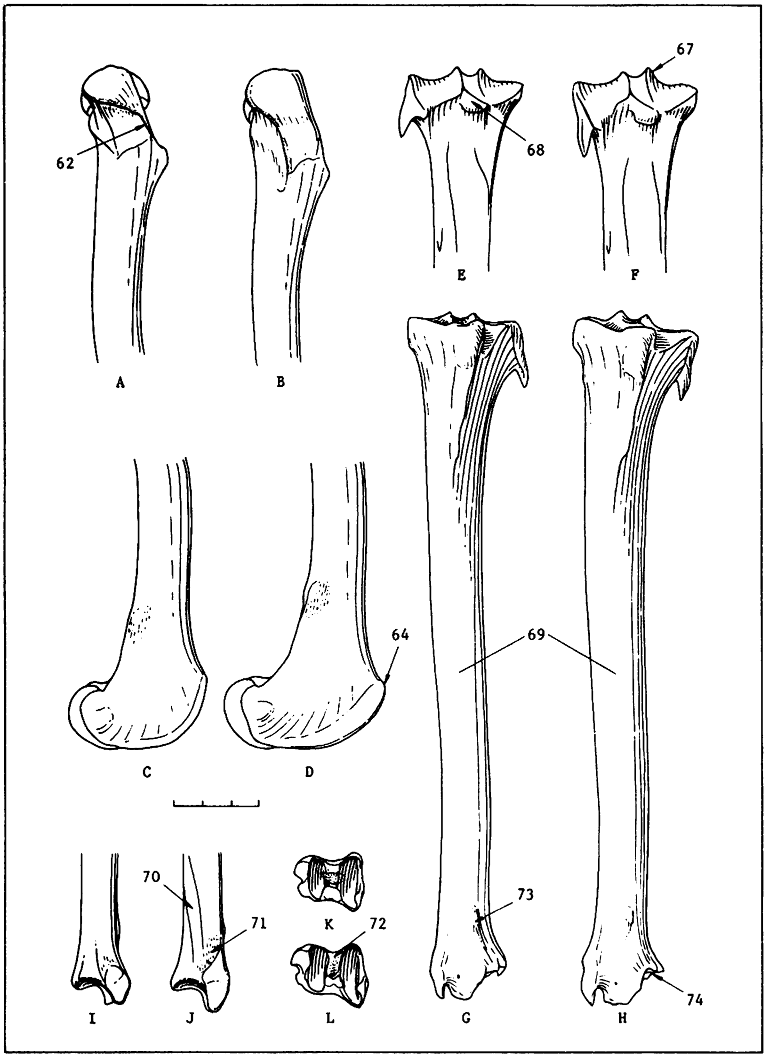

Figure 15: **A:** *Pelea capreolus*, Os femoris, proximal extremity, lateral view; **B:** *Antidorcas marsupialis*, Os femoris, proximal extremity, lateral view; **C:** *Pelea capreolus*, Os femoris, distal extremity, medial view; **D:** *Antidorcas marsupialis*, Os femoris, distal extremity, medial view; **E:** *Pelea capreolus*, Tibia, proximal extremity, plantar view; **F:** *Antidorcas marsupialis*, Tibia, proximal extremity, plantar view; **G:** *Pelea capreolus*, Tibia, dorsal view; **H:** *Antidorcas marsupialis*, Tibia, dorsal view; **I:** *Pelea capreolus*, Tibia, distal extremity, medial view; **J:** *Antidorcas marsupialis*, Tibia, distal extremity, medial view; **K:** *Pelea capreolus*, Tibia, distal view; **L:** *Antidorcas marsupialis*, Tibia, distal view.

Calcaneus

1 In *Pelea* the plantar part of the sustentaculum tali extends further proximally and plantarly. In *Antidorcas*, the sustentaculum tali is less developed in both directions and therefore looks more flattened (Figs 17I, K--M, O--P, char.83).

2 In *Pelea* the processus coracoideus projects more dorsally (Figs 17I, M, char.84). and is also less sculptured (Figs 17L, P, char.85).

3 In *Antidorcas* the transition between the plantar margin of the calcaneus and the articular facet for the os centroquartale is characterized by an angular protrusion, which is absent in *Pelea* (Figs 17I, M, char.86).

4 In *Antidorcas* the rugose muscle attachments on the lateral side of the distal half of the calcaneus are more prominent (Figs 17J, N, char.87).

5 In *Pelea* the calcaneus is less flattened and exhibits a more rounded dorsal margin (Figs 17L, P, char.88).

Os centroquartale

1 The lateroplantar portion of the os centroquartale exhibits in *Antidorcas* a well developed prominence, which is less pronounced in *Pelea* (Figs 16E--H, char.89).

Os tarsale I

No constant morphological features were found.

Os tarsale II + III

No constant morphological features were found.

Os metatarsale III + IV

1 The proximal end of the os metatarsale III + IV extends more plantaromedially in *Antidorcas* (Figs 16I--J, char.90).

2 The lateroplantar articular facet is more proximally developed in *Antidorcas* (Figs 16K--L, char.91).

3 The os metatarsale III + IV of *Antidorcas* is much more lateromedially compressed than that of *Pelea* (Figs 16K--L, char.92).

4 In *Pelea* the lateral and medial margins of the plantar side of the os metatarsale III + IV are not so sharp-edged as in *Antidorcas* (Figs 16K--L, char.93).

5 The trochleae ossis metatarsalis III + IV of *Antidorcas* are deep and exhibit well pronounced, sharp sagittal ridges. In *Pelea* these trochleae are less deep and have more rounded sagittal ridges (Figs 16M--N, char.94).

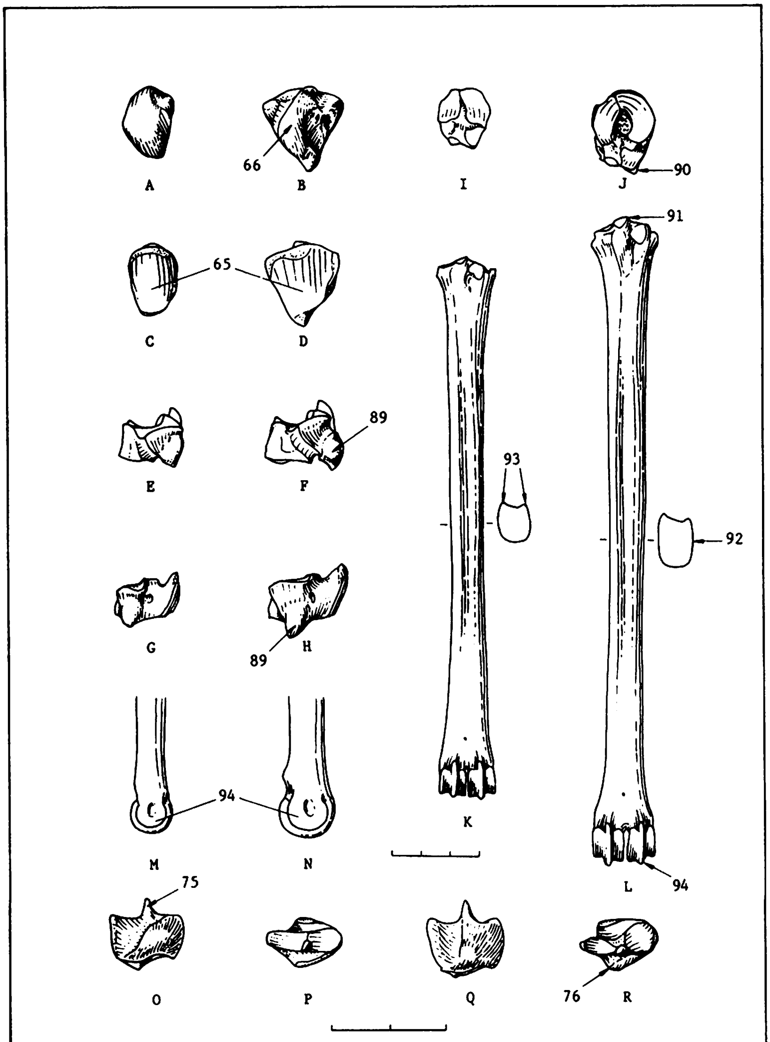

Figure 16: **A**: *Pelea capreolus*, Patella, cranial view; **B**: *Antidorcas marsupialis*, Patella, cranial view; **C**: *Pelea capreolus*, Patella, caudal view; **D**: *Antidorcas marsupialis*, Patella, caudal view; **E**: *Pelea capreolus*, Os centroquartale, lateral view; **F**: *Antidorcas marsupialis*, Os centroquartale, lateral view; **G**: *Pelea capreolus*, Os centroquartale, plantar view; **H**: *Antidorcas marsupialis*, Os centroquartale, plantar view; **I**: *Pelea capreolus*, Os metatarsale III + IV, proximal view; **J**: *Antidorcas marsupialis*, Os metatarsale III + IV, proximal view; **K**: *Pelea capreolus*, Os metatarsale III + IV, plantar view; **L**: *Antidorcas marsupialis*, Os metatarsale III + IV, plantar view; **M**: *Pelea capreolus*, Os metatarsale III + IV, distal extremity, lateral view; **N**: *Antidorcas marsupialis*, Os metatarsale III + IV, distal extremity, lateral view; **O**: *Pelea capreolus*, Os malleolare, lateral view; **P**: *Pelea capreolus*, Os malleolare, proximal view; **Q**: *Antidorcas marsupialis*, Os malleolare, lateral view; **R**: *Antidorcas marsupialis*, Os malleolare, proximal view.

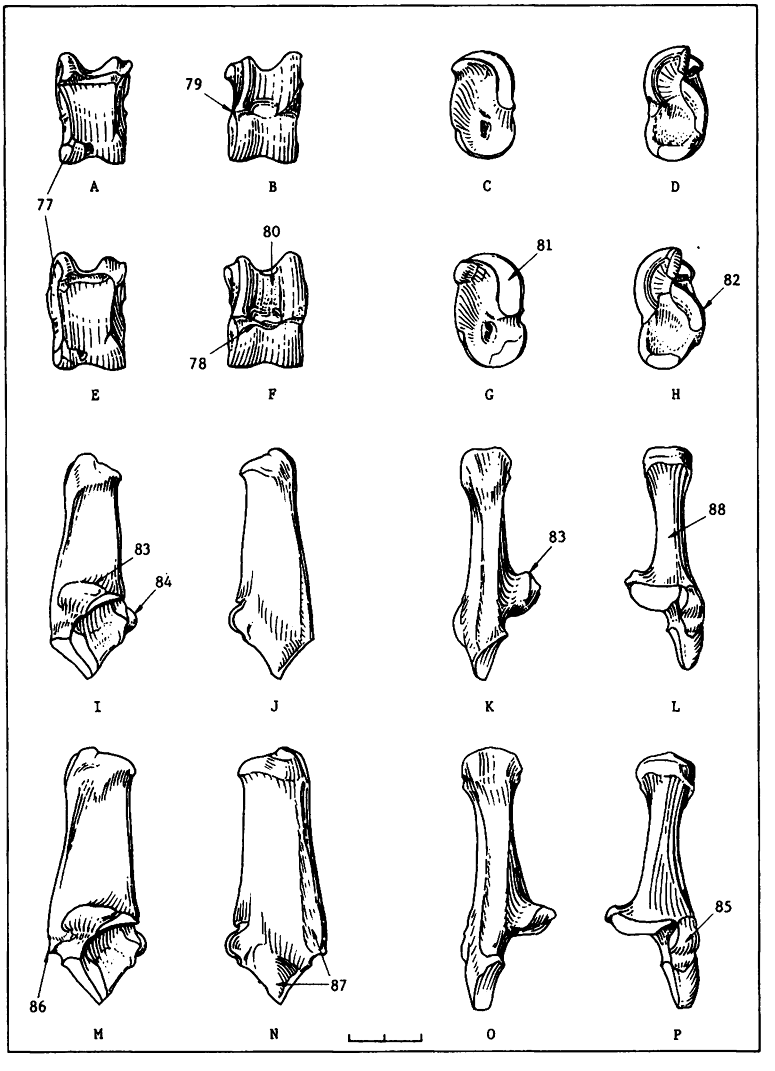

Figure 17: **A**: *Pelea capreolus*, Talus, plantar view; **B**: *Pelea capreolus*, Talus, dorsal view; **C**: *Pelea capreolus*, Talus, medial view; **D**: *Pelea capreolus*, Talus, lateral view; **E**: *Antidorcas marsupialis*, Talus, plantar view; **F**: *Antidorcas marsupialis*, Talus, dorsal view; **G**: *Antidorcas marsupialis*, Talus, medial view; **H**: *Antidorcas marsupialis*, Talus, lateral view; **I**: *Pelea capreolus*, Calcaneus, medial view; **J**: *Pelea capreolus*, Calcaneus, lateral view; **K**: *Pelea capreolus*, Calcaneus, plantar view; **L**: *Pelea capreolus*, Calcaneus, dorsal view; **M**: *Antidorcas marsupialis*, Calcaneus, medial view; **N**: *Antidorcas marsupialis*, Calcaneus, lateral view; **O**: *Antidorcas marsupialis*, Calcaneus, plantar view; **P**: *Antidorcas marsupialis*, Calcaneus, dorsal view.

Ossa digitorum

A. Criteria to distinguish the ossa digitorum manus from the ossa digitorum pedis in *Pelea* and *Antidorcas*:

Phalanges proximales

1 In *Pelea* the first phalanges of the fore limb are similar sized to those of the hind limb. Apparently, the only distinctive feature to be found lies in the somewhat different shape of the proximal articular surface and in the length of its synovial groove (Figs 18I--J, char.95).

2 In *Antidorcas* the P. proximales manus are longer and generally more slenderly built than the P. proximales pedis (Figs 18C--D, char.96). The proximal articular surface of all first phalanges is rectangular, though the articular surface of those of the fore limb is more elongated in a palmarodorsal direction (Figs 18K--L, char.97).

Phalanges mediae

1 In *Pelea* the P. mediae manus are in most cases a bit shorter than the P. mediae pedis (Figs 18Q--R, char.98). The proximal articular surface is somewhat more rectangular in the P. mediae manus compared to that in the P. mediae pedis (Figs 19E--F, char.99).

2 In *Antidorcas* the P. mediae manus are somewhat longer than the P. mediae pedis (Figs 19C--D, char.100). Both have triangular proximal surfaces but the dorsal margin of the articular surface is more pointed in those of the fore limb and more rounded in those of the hind limb (Figs 19G--H, char.101).

3 In the second phalanges of both species, the palmar/plantar part of the proximo-abaxial articular facet extends further proximally in the P. mediae manus than in the P. mediae pedis (Figs 18Q--T, 19E--H, char.102). Furthermore, and especially in *Antidorcas*, the abaxiopalmar part of the trochlea phalangis mediae manus is more developed proximally compared with its analogue in the P. mediae pedis (Figs 19I--L, char.103).

Phalanges distales

1 No constant morphological differences were found between the fore and hind distal phalanges of *Pelea*.

2 In *Antidorcas* the P. distales manus have a more elongated facies articularis than the P. distales pedis (Figs 19U--X, char.104).

B Criteria to distinguish between the ossa digitorum of *Pelea* and *Antidorcas*:

Phalanges proximales

1 The overall shape and form of the P. proximales differs between the two species. The P. proximalis manus of *Antidorcas* is especially very typical (Figs 18A--H, M--P, char.105).
2 The abaxial epicondylus is more pronounced in *Antidorcas* (Figs 18A--D, M--P, char.106).
3 The intermediate groove at the proximal articular surface is somewhat deeper in *Antidorcas* (Figs 18M--P, char.107).
4 In *Antidorcas* the palmar/plantar articular surface of the trochlea phalangis proximalis extends more proximally compared to its analogue in *Pelea* (Figs 18A--H, M--P, char.108).
5 The trochlea phalangis proximalis is deeper in *Antidorcas* than in *Pelea* (Figs 18A--H, char.109).

Phalanges mediae

1 The proportions of the second phalanges differ between the two species, those of *Pelea* being shorter than those of *Antidorcas* (Figs 18Q--T, 19A--D, I--L, char.110).
2 The palmar/plantar articular surface of the trochlea phalangis media extends less proximally in *Pelea* than in *Antidorcas* (Figs 19I--L, char.111).

Phalanges distales

1 In *Pelea* there is a large nutrient foramen on the palmar/plantar half of the facies axialis, just above the planum cutaneum. In *Antidorcas* this foramen is barely visible (Figs 19N, Q, T, W, char.112).
2 The distal phalanges of *Antidorcas* are characterized by a prominent processus extensorius (Figs 19M--X, char.113).
3 At the basis of the processus extensorius, one observes two smaller, similar sized foramina nutritia in *Pelea*, whereas in *Antidorcas* there is a large axial and a smaller abaxial nutrient foramen (Figs 19O, R, U, X, char.114).
4 The facies articularis of the third phalanges of *Antidorcas* is more elongated and has a more developed tuberculum flexorium compared with its analogue in *Pelea* (Figs 19M--X, char.115).

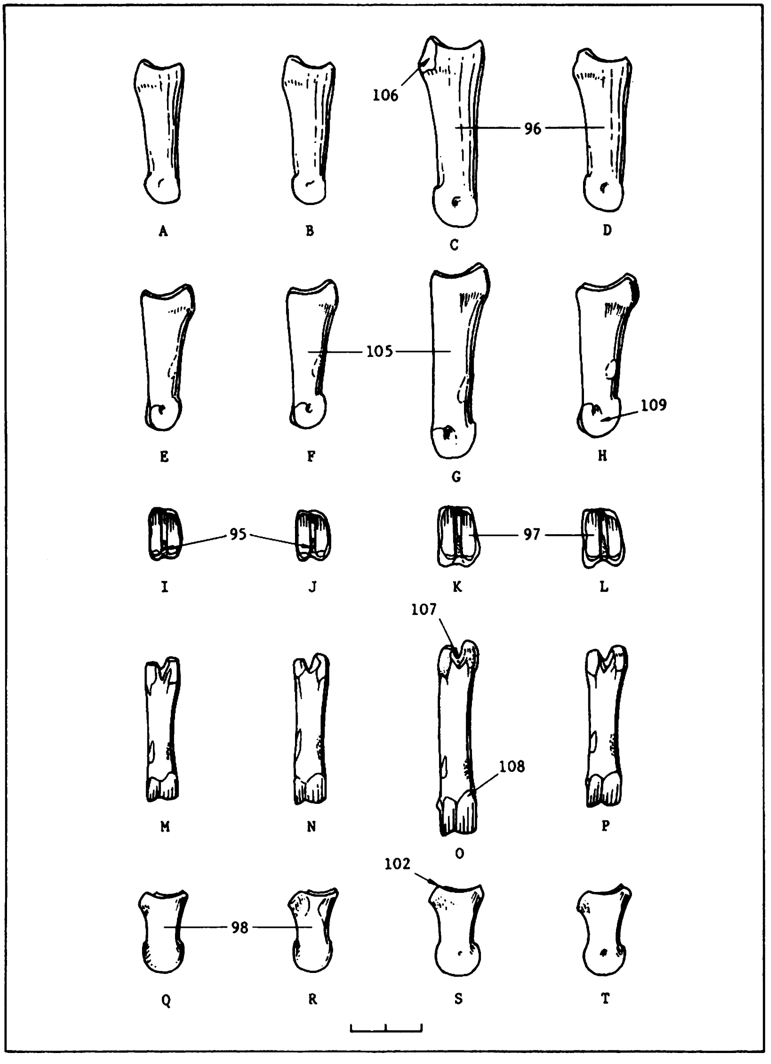

Figure 18: **A**: *Pelea capreolus*, P. proximalis manus, abaxial view; **B**: *Pelea capreolus*, P. proximalis pedis, abaxial view; **C**: *Antidorcas marsupialis*, P. proximalis manus, abaxial view; **D**: *Antidorcas marsupialis*, P. proximalis pedis, abaxial view; **E**: *Pelea capreolus*, P. proximalis manus, axial view; **F**: *Pelea capreolus*, P. proximalis pedis, axial view; **G**: *Antidorcas marsupialis*, P. proximalis manus, axial view; **H**: *Antidorcas marsupialis*, p. proximalis pedis, axial view; **I**: *Pelea capreolus*, P. proximalis manus, proximal view; **J**: *Pelea capreolus*, P. proximalis pedis, proximal view; **K**: *Antidorcas marsupialis*, P. proximalis manus, proximal view; **L**: *Antidorcas marsupialis*, P. proximalis pedis, proximal view; **M**: *Pelea capreolus*, P. proximalis manus, palmar view; **N**: *Pelea capreolus*, P. proximalis pedis, plantar view; **O**: *Antidorcas marsupialis*, P. proximalis manus, palmar view; **P**: *Antidorcas marsupialis*, P. proximalis pedis, plantar view; **Q**: *Pelea capreolus*, P. media manus, abaxial view; **R**: *Pelea capreolus*, P. media pedis, abaxial view; **S**: *Antidorcas marsupialis*, P. media manus, abaxial view; **T**: *Antidorcas marsupialis*, P. media pedis, abaxial view.

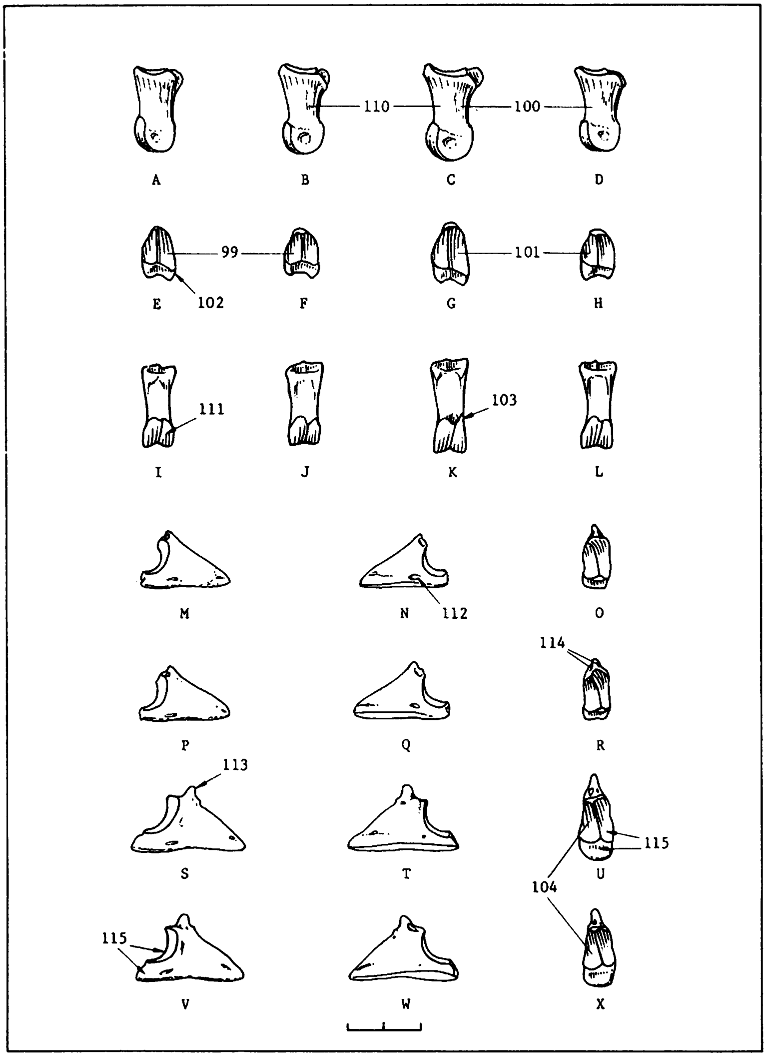

Figure 19: **A**: *Pelea capreolus*, P. media manus, axial view; **B**: *Pelea capreolus*, P. media pedis, axial view; **C**: *Antidorcas marsupialis*, P. media manus, axial view; **D**: *Antidorcas marsupialis*, P. media pedis, axial view; **E**: *Pelea capreolus*, P. media manus, proximal view; **F**: *Pelea capreolus*, P. media pedis, proximal view; **G**: *Antidorcas marsupialis*, P. media manus, proximal view; **H**: *Antidorcas marsupialis*, P. media pedis, proximal view; **I**: *Pelea capreolus*, P. media manus, palmar view; **J**: *Pelea capreolus*, P. media pedis, plantar view; **K**: *Antidorcas marsupialis*, P. media manus, palmar view; **L**: *Antidorcas marsupialis*, P. media, pedis, plantar view; **M**: *Pelea capreolus*, P. distalis manus, abaxial view; **N**: *Pelea capreolus*, P. distalis manus, axial view; **O**: *Pelea capreolus*, P. distalis manus, proximal view; **P**: *Pelea capreolus*, P. distalis pedis, abaxial view; **Q**: *Pelea capreolus*, P. distalis pedis, axial view; **R**: *Pelea capreolus*, P. distalis pedis, proximal view; **S**: *Antidorcas marsupialis*, P. distalis manus, abaxial view; **T**: *Antidorcas marsupialis*, P. distalis manus, axial view; **U**: *Antidorcas marsupialis*, P. distalis manus, proximal view; **V**: *Antidorcas marsupialis*, P. distalis pedis, abaxial view; **W**: *Antidorcas marsupialis*, P. distalis pedis, axial view; **X**: *Antidorcas marsupialis*, P. distalis pedis, proximal view.

COMPARATIVE OSTEOMETRY

If one compares the shoulder height of *Antidorcas* (males: 75-90cm; females: 70-80cm; Haltenorth, Diller & Smeenk 1979) and *Pelea* (70-80cm; *ibid.*), one can expect a considerable overlap in size between the bones of the two species. Tables 1 and 2 indeed show that the measurements obtained on postcranial bones of *Pelea* fall to a large extent within the lower range of those of *Antidorcas*, although the degree of overlap differs from bone to bone. We agree with Oboussier (1970) that the osteometrical differences observed between the proportions of the fore- and hindlimb bones of *Pelea* and *Antidorcas* are related to the different habitats which the species occupy. In *Pelea* more emphasis will be laid on the forelimb because the animal climbs rocky hills and inhabits mountain slopes, whereas in *Antidorcas*, a fast running, plains-living species, the hindlimbs become more important for locomotion. Certain skeletal modifications in *Antidorcas* may also represent an adaptation to stotting behaviour.

Osteometrical data often allow an almost immediate separation between *Pelea* and *Antidorcas*. This is for example the case with the greatest length measurement (GL) of the metacarpus (168-188/185-239mm) and the metatarsus (175-196/196-254mm; for additional length measurements on metapodials of the two species see Oboussier, 1970). Other bones for which osteometrical data are characteristic include the atlas (GB; GL) axis (BFcr), sacrum (GB), scapula (HS; BG), humerus (Dmd), radius (Bp, Dp), ulna (LO), os femoris (BT, Dmd), patella (GB) and phalanx proximalis (GLpe).

DISCUSSION AND CONCLUSIONS

As is clear from the foregoing, many diagnostic osteomorphological features exist which allow a distinction between the postcranial skeleton of *Antidorcas* and *Pelea*. Only a few smaller skeletal elements including the os carpi accessorium, the os tarsale I and the os tarsale II + III cannot be separated as yet. Many osteomorphological characteristics are located at or near the articular surfaces of the bones. Hence incomplete specimens, for example bone fragments found in archaeological deposits, can now in many cases be identified to the species level.

The osteometrical analysis of the postcranial skeleton of *Antidorcas* and *Pelea* reveals that the values of the latter fall to a large extent within the lower range of the former. However, a number of particular measurements on certain skeletal elements allow an immediate separation into springbok or grey rhebok.

The osteometry of the small sample of *Pelea* skeletons illustrates a degree of size variation which has been noted in other medium sized antelopes (e.g. Peters 1986b). The opposite is true for *Antidorcas*, since a greater variation in size than expected has been observed. This is due to the fact that two discrete populations, one from the Kalahari and one from the central part of southern Africa, are included in the study sample.

The number of subspecies of *Antidorcas* is still a subject of discussion. According to Groves (1981) the three subspecies of *A. marsupialis* cannot be separated only on the basis of their external characters, but also because there is a sharp break between them in size as measured by skull length. Although his study material was very scanty, he notes that skull measurements indicate a size cline through *A. m. hofmeyri* from south (N. Transvaal, N. Cape Province) to north (Namibia). The smaller members of *A. m. hofmeyri* are found therefore in the southern part of its range, closest to populations of the smaller subspecies, *A. m. marsupialis*. The largest members of *A. m. hofmeyri* occur at the northwestern end of the range of the subspecies. There is, furthermore, a discontinuity between *A. m. hofmeyri* and *A. m. angolensis*, which resembles the small southern *A. m. marsupialis* in size. This discontinuity presumably coincides with the Cunene River.

If the localities of the museum specimens are fitted into the geographical range of the three subspecies *sensu* Groves (1981), it is clear that our study sample must yield skeletons of at least two subspecies of *Antidorcas*, namely *A.m. marsupialis* and *A.m. hofmeyri*. On the basis of a comparison of specimens collected in the Kimberley area with specimens collected in the Kalahari, in the vicinity of the Nossob rest camp, it is possible to demonstrate that there is indeed a size difference between the springbok south of the lower Orange River and Vaal River and those from the northern Cape in the Kalahari Gemsbok Park. We illustrate this with measurements on metacarpals and metatarsals from individuals of the two populations (Table 3). The GL values obtained by Oboussier (1970) on *Antidorcas* metapodials from the Cape Province (1 specimen) and from Namibia (2 specimens) confirm this observation. The difference in size between the two populations can be seen as an argument to maintain a subspecific status for the *Antidorcas* populations north and south of the lower Orange and Vaal Rivers.

Although the sharp size differentiation of springbok at the subspecies boundaries could itself function nowadays as an isolating mechanism (*cf.* Groves, 1981), it remains an open question whether this was also the case in the past. In the first place, mass movements of springbok along migration routes across the supposed subspecies boundaries, such as for example the Orange River during the 19th century (Shortridge 1934), which enabled the populations to interbreed, do not take place anymore. Secondly, it is known that within historical times, springbok have been almost exterminated in the Orange Free State and the Transvaal and, to a large extent in the Cape Province.

It is probably unlikely that domestic stock would have affected the size of the southern springbok populations directly by means of food competition, since it is known that a feeding niche separation exists between small domestic ruminants and the springbok. This seems to be supported by the archaeozoological record, since, in spite of the presence of Khoi sheep from about 2 000 years ago in southern Africa (Von den Driesch & Deacon 1985), fairly large springbok were still present in considerable numbers in the Karoo before the 19th century (I. Plug pers. comm. 1990). However, the fencing of huge tracts of land and hunting with firearms over the past 150 years, together with rinderpest at the end of the last century contributed to the reduction in numbers of springbok (Smithers 1983). By reintroducing springbok from a limited stock or gene pool into areas with an impoverished vegetation due to overgrazing by increased numbers of livestock in modern times, it remains possible that man is indirectly responsible for the smaller size of the present day "southern" springbok (*A.m. marsupialis sensu* Groves 1981).

Whatever taxonomic point of view is favoured - subspecies or not - substantial evidence could come from archaeozoological research in the near future. A comparison of measurements on springbok remains from Late Pleistocene to Holocene archaeological sites in South Africa may help to establish whether to the two different sized springbok populations existed in the past north and south of the Lower Orange-Vaal River system.

Table 1

Standard measurements for male and female *A. marsupialis* according to sample size (n), mean (x), standard deviation (s), minimum values (min.) and maximum values (max.).

♂

Atlas	n	x	s	min.	max.
GB	19	71,4	7,15	57,0	86,4
GL	19	73,8	6,76	62,0	83,5
BFcr	19	48,1	3,90	41,0	58,0
BFcd	19	43,3	3,43	39,5	55,5
H	19	37,9	2,50	32,5	44,0

Axis	n	x	s	min.	max.
LCDe	19	71,0	4,64	62,5	78,4
LAPa	19	72,5	8,55	56,0	85,6
BFcr	19	43,6	3,41	40,0	55,5
BFcd	18	22,9	2,16	18,6	26,9
SBV	19	23,6	1,74	20,8	27,5
H	19	59,6	6,01	45,0	68,2

Sacrum	n	x	s	min.	max.
GL	14	97,9	13,94	76,0	126,5
PL	13	90,2	13,44	66,0	115,6
GB	16	82,3	8,17	67,0	96,5
No. of vertebrae	16	4,3	0,57	3	5

♀

Atlas	n	x	s	min.	max.
GB	24	54,4	4,12	47,7	63,5
GL	24	62,1	5,32	50,5	70,3
BFcr	24	43,6	2,95	38,0	49,0
BFcd	24	38,2	1,90	35,5	42,0
H	24	33,7	2,75	27,0	38,5

Axis	n	x	s	min.	max.
LCDe	24	64,9	3,74	59,5	73,5
LAPa	25	59,1	7,22	49,0	73,5
BFcr	26	39,4	2,27	35,0	43,7
BFcd	24	19,6	1,03	17,4	21,7
SBV	25	21,0	1,58	18,9	25,0
H	24	45,0	3,76	40,0	51,5

Sacrum	n	x	s	min.	max.
GL	25	94,2	8,22	80,0	118,0
PL	25	84,5	6,38	72,0	100,0
GB	25	85,6	7,06	67,0	94,8
No. of vertebrae	25	4,2	0,40	4	5

Scapula

	n	x	s	min.	max.
HS	20	169,2	18,21	144,0	229,0
Ld	20	85,6	8,29	74,0	113,0
GLP	20	36,2	3,14	31,0	42,5
LG	20	29,6	2,15	26,0	33,0
BG	20	26,9	2,30	22,5	30,6

Humerus

	n	x	s	min.	max.
GL	19	157,4	11,41	140,0	174,4
BT	19	29,4	1,72	26,0	32,8
Bd	19	32,6	1,56	30,0	36,0
Dmd	19	29,2	1,97	25,5	32,4

Radius & Ulna

		n	x	s	min.	max.
R & U:	GL	18	242,4	20,74	204,0	273,0
Radius:	GL	19	196,8	16,13	173,0	225,0
	BFp	19	28,7	1,78	24,0	31,1
	Bp	19	32,6	1,71	28,5	34,9
	Dp	19	18,3	1,10	16,1	19,8
	Bd	19	29,4	1,93	25,5	32,4
Ulna:	LO	19	46,7	4,20	39,2	53,5
	DPA	19	26,3	1,45	24,0	29,2
	BPC	19	17,3	1,43	14,0	20,0
	BIT	19	12,0	0,74	10,9	13,3

Os carpi radiale

	n	x	s	min.	max.
GD	20	21,1	1,46	18,2	23,7
GH	20	14,3	1,17	12,3	17,3
BFd	20	10,7	0,93	4,2	12,6

Os carpi intermedium

	n	x	s	min.	max.
GD	18	20,4	1,36	18,2	23,1
GH	18	13,7	1,11	11,7	15,4

Os carpi ulnare

	n	x	s	min.	max.
GL	18	20,1	1,33	17,8	22,2

Scapula

	n	x	s	min.	max.
HS	26	154,1	12,30	135,0	190,0
Ld	26	77,3	6,22	68,0	88,4
GLP	26	33,3	2,47	28,5	37,0
LG	26	27,1	1,74	23,5	29,5
BG	26	23,0	1,78	19,5	26,3

Humerus

	n	x	s	min.	max.
GL	28	146,1	9,56	129,0	162,7
BT	28	27,3	1,68	23,0	30,0
Bd	28	30,5	1,49	26,5	33,0
Dmd	28	26,8	1,90	22,5	29,7

Radius & Ulna

		n	x	s	min.	max.
R & U:	GL	27	224,8	15,13	201,0	252,0
Radius:	GL	27	183,7	13,52	162,0	209,0
	BFp	27	27,0	1,73	23,0	29,5
	Bp	27	30,5	1,99	26,0	34,0
	Dp	27	16,9	1,27	14,5	19,6
	Bd	27	27,5	1,83	23,5	30,5
Ulna:	LO	27	43,2	2,75	38,5	51,0
	DPA	27	24,2	1,57	20,0	26,9
	BPC	27	16,7	1,33	13,8	19,2
	BIT	27	10,9	0,77	9,7	12,4

Os carpi radiale

	n	x	s	min.	max.
GD	26	19,7	1,21	17,5	22,5
GH	26	13,4	1,00	12,0	15,6
BFd	26	9,8	0,64	8,5	11,2

Os carpi intermedium

	n	x	s	min.	max.
GD	25	19,0	1,32	15,6	21,1
GH	25	12,7	1,09	10,5	14,4

Os carpi ulnare

	n	x	s	min.	max.
GL	26	18,4	1,06	16,3	20,0

Os carpale II + III

	n	x	s	min.	max.
GB	19	15,7	1,13	13,7	17,4
GD	19	16,9	1,32	14,5	19,3

Os carpale IV

	n	x	s	min.	max.
BFd	18	10,8	2,66	9,8	13,0
GH	18	11,1	2,67	10,5	13,0

Os metacarpale III + IV

	n	x	s	min.	max.
GL	19	220,6	14,55	189,0	239,0
Bp	19	26,1	1,64	21,9	29,1
Dp	19	18,9	1,25	16,8	20,9
SD	19	14,5	0,91	12,9	15,7
DD	19	10,5	1,03	8,6	12,2
Bd	19	10,5	1,60	21,1	27,6
Dd	19	24,3	1,08	16,9	21,3

Pelvis

	n	x	s	min.	max.
GL	17	211,1	15,74	179,0	230,0
GBTC	9	135,9	11,29	122,0	155,0
GBA	9	98,9	4,53	91,0	104,0
SBI	9	71,2	5,24	64,0	80,0
GBTi	9	124,4	11,61	110,0	143,0
LS	17	65,6	5,33	58,0	73,7
LA	17	34,1	1,93	29,5	37,2

Os femoris

	n	x	s	min.	max.
GL	21	205,0	17,43	171,0	242,0
Bp	21	51,9	4,23	44,0	62,5
SD	21	18,0	1,56	15,5	21,1
BT	21	24,8	2,13	21,0	28,6
Bd	21	41,7	3,39	35,5	49,0
Dld	21	47,8	4,04	40,5	60,0
Dmd	21	56,9	5,01	47,0	69,5

Tibia

	n	x	s	min.	max.
GL	20	254,3	20,03	218,0	285,0
Bp	20	44,4	2,93	38,5	48,6
Dp	20	48,7	4,07	40,0	54,5
Bd	19	29,1	2,06	25,5	32,5
Dd	20	22,3	1,78	19,2	25,5

Os carpale II + III

	n	x	s	min.	max.
GB	25	14,6	0,96	13,0	16,1
GD	25	15,9	0,96	13,6	17,1

Os carpale IV

	n	x	s	min.	max.
BFd	25	10,4	0,73	9,1	12,2
GH	25	10,9	0,89	8,5	12,2

Os metacarpale III + IV

	n	x	s	min.	max.
GL	26	206,0	13,89	185,0	236,0
Bp	26	24,3	1,59	21,4	26,6
Dp	26	17,7	1,32	15,5	19,5
SD	26	12,9	0,81	11,4	14,1
DD	26	9,6	0,83	8,0	10,5
Bd	26	22,4	1,43	19,7	24,8
Dd	26	18,0	1,32	16,0	19,9

Pelvis

	n	x	s	min.	max.
GL	22	195,7	10,79	174,0	213,0
GBTC	20	140,9	8,62	123,0	157,0
GBA	20	104,3	5,83	91,0	113,0
SBI	20	77,2	5,88	63,0	85,0
GBTi	20	128,9	10,54	109,0	147,0
LS	22	56,5	4,52	47,5	66,7
LA	23	32,1	1,70	28,5	34,5

Os femoris

	n	x	s	min.	max.
GL	29	192,4	13,12	166,0	223,0
Bp	29	48,6	3,42	41,5	56,5
SD	29	16,5	1,25	13,8	19,0
BT	29	23,5	1,90	18,5	27,0
Bd	29	39,1	2,55	34,0	43,0
Dld	29	45,3	3,15	38,5	50,0
Dmd	29	53,8	3,57	46,5	60,0

Tibia

	n	x	s	min.	max.
GL	28	239,8	14,58	212,0	267,0
Bp	28	42,4	2,33	37,0	46,5
Dp	28	46,4	3,54	38,5	53,0
Bd	28	27,7	2,10	23,5	31,0
Dd	28	21,7	1,91	18,9	28,3

Patella

	n	x	s	min.	max.
GL	20	30,0	2,21	25,5	33,0
GB	20	26,1	3,35	20,5	32,5

Os malleolare

	n	x	s	min.	max.
GD	19	16,0	1,25	13,8	18,2

Talus

	n	x	s	min.	max.
GLl	20	31,7	2,53	27,5	36,2
GLm	20	29,5	2,08	26,0	33,2
Dl	20	18,3	1,48	15,5	21,0
Bd	20	19,6	1,43	17,1	22,5

Calcaneus

	n	x	s	min.	max.
GL	20	72,0	5,67	62,0	80,8
GB	20	24,1	1,73	21,3	27,0
Bp	19	16,4	1,12	14,3	18,1
DS	20	20,5	1,64	17,1	23,2
Dd	20	27,6	2,27	24,0	31,2

Os centroquartale

	n	x	s	min.	max.
GB	20	25,5	1,71	22,5	28,3
GD	20	27,6	1,99	24,0	30,6

Os tarsale II + III

	n	x	s	min.	max.
GD	20	18,5	1,97	15,6	22,1

Os metatarsale III + IV

	n	x	s	min.	max.
GL	19	234,4	15,06	207,0	254,0
Bp	19	23,8	1,52	20,6	26,2
Dp	19	26,9	3,69	15,6	31,7
SD	19	12,8	0,97	11,1	14,4
DD	19	12,2	1,11	9,5	13,9
Bd	19	25,2	1,57	21,6	28,0
Dd	19	19,7	0,98	17,4	21,0

Patella

	n	x	s	min.	max.
GL	26	28,5	2,15	24,0	33,0
GB	26	25,1	2,05	21,5	29,0

Os malleolare

	n	x	s	min.	max.
GD	23	15,4	1,16	13,2	17,3

Talus

	n	x	s	min.	max.
GLl	29	30,5	1,98	27,0	33,5
GLm	29	28,7	1,82	25,0	31,5
Dl	29	17,6	1,10	15,2	19,6
Bd	29	18,9	1,22	16,5	20,9

Calcaneus

	n	x	s	min.	max.
GL	28	69,5	4,54	61,5	79,0
GB	28	23,3	2,21	20,0	29,5
Bp	28	15,7	1,00	14,0	17,6
DS	28	20,5	1,75	17,0	24,2
Dd	28	26,6	1,89	22,5	30,5

Os centroquartale

	n	x	s	min.	max.
GB	27	24,3	1,57	21,0	26,2
GD	27	26,1	1,61	23,5	30,5

Os tarsale II + III

	n	x	s	min.	max.
GD	24	17,7	1,52	15,0	20,6

Os metatarsale III + IV

	n	x	s	min.	max.
GL	26	217,6	14,34	196,0	247,0
Bp	26	22,3	1,48	19,5	24,7
Dp	26	25,2	2,21	21,0	28,8
SD	26	11,7	0,81	10,0	13,0
DD	26	11,7	1,06	9,4	13,5
Bd	26	23,4	1,43	21,0	25,7
Dd	26	18,5	1,63	15,8	24,3

Phalanx proximalis

		n	x	s	min.	max.
Manus:	GLpe	19	55,8	4,92	47,0	64,4
	Bp	19	12,1	1,48	9,9	16,8
	SD	19	9,2	0,69	7,9	10,6
	Bd	19	10,8	0,99	8,9	12,6
Pedis:	GLpe	19	46,1	4,10	39,0	53,4
	Bp	19	12,3	0,89	9,9	13,8
	SD	19	9,3	0,75	7,6	10,4
	Bd	19	10,6	0,80	8,9	12,0

Phalanx proximalis

		n	x	s	min.	max.
Manus:	GLpe	25	52,2	3,48	45,5	60,0
	Bp	25	11,3	0,70	10,0	12,7
	SD	25	8,4	0,67	7,3	9,4
	Bd	25	10,0	0,76	8,8	11,5
Pedis:	GLpe	25	43,4	2,89	37,5	49,0
	Bp	25	11,9	0,78	10,6	13,6
	SD	25	8,8	0,78	7,7	10,4
	Bd	25	10,1	0,79	8,9	11,4

Phalanx media

		n	x	s	min.	max.
Manus:	GL	19	27,2	2,51	23,0	33,0
	Bp	19	10,9	0,89	8,9	12,1
	SD	19	7,7	0,61	6,7	8,8
	Bd	19	9,2	0,67	7,6	10,3
Pedis:	GL	19	26,3	2,23	22,0	30,6
	Bp	19	11,0	2,03	9,4	19,3
	SD	19	7,6	0,61	6,1	8,7
	Bd	19	9,0	0,71	7,9	10,4

Phalanx media

		n	x	s	min.	max.
Manus:	GL	23	25,5	1,72	21,5	28,2
	Bp	23	10,1	0,64	8,8	11,1
	SD	23	7,1	0,51	6,2	8,1
	Bd	23	8,6	0,63	7,5	9,6
Pedis:	GL	24	25,0	1,68	21,0	27,8
	Bp	24	10,1	0,70	8,8	11,3
	SD	24	7,2	0,55	6,2	8,1
	Bd	24	8,6	0,73	7,4	10,0

Phalanx distalis

		n	x	s	min.	max.
Manus:	DLS	18	33,0	3,99	27,0	37,6
	Ld	18	28,2	3,76	23,5	33,4
	HP	18	19,0	1,35	16,6	21,5
	BFp	18	8,8	0,62	7,5	10,1
Pedis:	DLS	18	32,3	4,25	26,0	37,6
	Ld	18	27,5	4,00	22,5	33,1
	HP	18	18,6	1,40	16,0	22,0
	BFp	18	8,8	0,63	7,7	9,8

Phalanx distalis

		n	x	s	min.	max.
Manus:	DLS	20	30,2	3,21	25,5	35,0
	Ld	20	25,4	2,94	20,5	30,0
	HP	20	17,5	1,40	14,8	19,9
	BFp	20	8,4	0,68	7,3	9,7
Pedis:	DLS	21	30,0	3,32	24,5	35,0
	Ld	21	25,3	3,06	20,5	31,3
	HP	21	17,6	1,31	14,6	20,3
	BFp	21	8,3	1,32	7,2	9,2

Table 2

Standard measurements for male and female *P. capreolus* according to sample size (n), mean (x), standard deviation (s), minimum values (min.) and maximum values (max.).

Atlas

	♂ n	x	s	min.	max.	♀ n	x	s	min.	max.
GB	4	45,8	2,25	44,0	49,0	3	47,2	1,15	46,5	48,5
GL	4	46,3	1,44	44,5	48,0	3	46,2	2,52	43,5	48,5
BFcr	4	38,5	2,27	36,0	41,5	3	40,3	1,76	38,5	42,0
BFcd	4	34,3	0,65	33,5	35,0	3	34,5	0,50	34,0	35,0
H	4	28,3	2,72	26,0	32,0	3	26,7	1,16	26,0	28,0

Axis

	♂ n	x	s	min.	max.	♀ n	x	s	min.	max.
LCDe	3	55,8	4,13	50,0	59,0	3	59,0	1,87	56,5	61,0
LAPa	3	48,3	1,65	46,0	49,5	2	53,0	1,0	52,0	54,0
BFcr	3	33,2	0,94	32,5	34,5	3	35,3	0,85	34,5	36,5
BFcd	3	15,4	0,62	14,5	15,9	3	15,4	0,36	15,4	16,2
SBV	3	15,0	0,33	14,6	15,4	3	15,6	0,37	15,0	15,9
H	3	37,2	0,85	36,0	38,0	3	38,0	1,03	17,0	39,5

Sacrum

	♂ n	x	s	min.	max.	♀ n	x	s	min.	max.
GL	4	82,5	5,17	76,0	90,0	3	93,0	5,35	86,0	99,0
PL	4	75,5	5,60	71,0	85,0	3	86,7	5,44	81,0	94,0
GB	4	58,0	474	54,0	66,0	3	71,0	2,16	68,0	73,0
No. of vertebrae	3	4,25	0,43	4	5	3	4,3	0,47	4	5

Scapula

	♂ n	x	s	min.	max.	♀ n	x	s	min.	max.
HS	3	130,0	1,41	129,0	132,0	3	140,7	6,94	132,0	149,0
Ld	3	78,7	3,85	75,0	84,0	3	84,7	8,18	77,0	96,0
GLP	3	27,2	1,25	25,5	28,5	3	28,2	0,24	28,0	28,3
LG	3	22,2	1,43	20,5	24,0	3	23,7	1,03	22,5	25,0
BG	3	18,7	1,25	17,0	20,0	3	19,3	1,18	18,5	21,0

Humerus

	♂ n	x	s	min.	max.	♀ n	x	s	min.	max.
GL	4	145,8	2,95	141,0	149,0	3	151,7	6,94	143,0	160,0
BT	4	26,1	0,41	25,5	26,3	3	26,3	0,85	25,5	27,5
Bd	4	28,3	0,91	27,0	29,5	3	28,5	0,41	28,0	29,0
Dmd	4	23,5	0,5	23,0	24,0	3	23,8	0,47	23,5	24,5

Radius & Ulna

		n	x	s	min.	max.
R & U:	GL	4	200,5	5,17	194,0	208,0
Radius:	GL	4	161,5	3,50	158,0	167,0
	BFp	4	25,4	0,41	25,0	26,0
	Bp	4	26,5	0,35	26,0	27,0
	Dp	4	14,3	0,98	12,6	15,0
	Bd	4	23,6	1,47	21,5	25,0
Ulna:	LO	4	37,4	0,41	37,0	38,0
	DPA	4	23,3	0,56	22,3	24,0
	BPC	4	14,6	0,90	13,1	15,4
	BIT	4	10,1	0,28	9,6	10,3

Os carpi radiale

	n	x	s	min.	max.
GD	3	17,3	0,75	16,5	18,3
GH	3	12,9	0,57	12,2	13,6
BFd	3	9,1	0,29	8,8	9,5

Os carpi intermedium

	n	x	s	min.	max.
GD	3	18,1	0,34	17,6	18,4
GH	3	12,5	0,54	11,9	13,2

Os carpi ulnare

	n	x	s	min.	max.
GL	3	17,4	0,12	17,2	17,5

Os carpale II + III

	n	x	s	min.	max.
GB	3	13,5	0,16	13,3	13,7
GD	3	14,5	0,12	14,4	14,7

Os carpale IV

	n	x	s	min.	max.
BFd	2	9,1		8,4	9,7
GH	2	11,1		11,0	11,1

Radius & Ulna

		n	x	s	min.	max.
R & U:	GL	3	213,7	3,30	210,0	218,0
Radius:	GL	3	175,0	2,45	172,0	178,0
	BFp	3	23,5	0,41	25,0	26,0
	Bp	3	26,7	0,47	26,0	27,0
	Dp	3	15,0	0,33	14,8	15,5
	Bd	3	25,2	0,94	24,5	26,5
Ulna:	LO	3	37,5	1,08	36,5	39,0
	DPA	3	23,8	1,25	22,5	25,5
	BPC	3	15,6	1,34	14,4	17,5
	BIT	3	10,6	0,43	10,0	11,6

Os carpi radiale

	n	x	s	min.	max.
GD	3	17,0	0,60	16,4	17,8
GH	3	13,3	0,49	12,7	13,9
BFd	3	9,3	0,22	9,0	9,5

Os carpi intermedium

	n	x	s	min.	max.
GD	3	17,6	0,12	17,4	17,7
GH	3	12,0	0,12	11,9	12,2

Os carpi ulnare

	n	x	s	min.	max.
GL	3	17,1	0,24	16,8	17,3

Os carpale II + III

	n	x	s	min.	max.
GB	3	13,9	0,28	13,5	14,1
GD	3	14,1	0,36	13,8	14,6

Os carpale IV

	n	x	s	min.	max.
BFd	3	8,8	0,21	8,6	9,1
GH	3	10,3	0,36	10,0	10,8

Os metacarpale III + IV

	n	x	s	min.	max.
GL	3	174,3	4,64	168,0	179,0
Bp	3	21,8	0,29	21,4	22,1
Dp	3	15,7	0,28	15,3	15,9
SD	3	12,3	0,49	11,7	12,9
DD	3	8,9	0,37	8,4	9,3
Bd	3	20,6	0,68	19,6	21,1
Dd	3	15,7	0,05	15,7	15,8

Pelvis

	n	x	s	min.	max.
GL	4	170,3	4,76	165,0	178,0
GBTC	4	104,3	5,93	98,0	114,0
GBA	4	86,5	3,91	81,0	92,0
SBI	4	62,5	3,91	59,0	69,0
GBTi	4	96,0	6,44	91,0	107,0
LS	4	50,5	3,30	46,5	54,0
LA	4	28,4	1,71	25,5	30,0

Os femoris

	n	x	s	min.	max.
GL	4	185,0	5,10	179,0	193,0
Bp	4	43,6	1,63	42,0	45,5
SD	4	15,1	1,12	13,4	16,3
BT	4	18,4	0,54	17,5	19,0
Bd	4	37,2	1,52	35,5	39,0
Dld	4	43,5	1,37	41,5	45,0
Dmd	4	47,6	1,52	45,0	48,5

Tibia

	n	x	s	min.	max.
GL	4	231,3	5,12	227,0	240,0
Bp	4	39,8	1,03	38,5	41,0
Dp	4	43,9	1,39	42,5	45,5
Bd	4	26,0	0,94	25,0	27,5
Dd	4	19,6	0,26	19,3	20,0

Patella

	n	x	s	min.	max.
GL	3	27,3	0,47	27,0	28,0
GB	3	19,4	0,40	18,8	19,7

Os malleolare

	n	x	s	min.	max.
GD	4	13,8	0,36	13,3	14,3

Os metacarpale III + IV

	n	x	s	min.	max.
GL	3	182,0	4,32	178,0	188,0
Bp	3	21,4	0,60	20,6	22,0
Dp	3	16,3	0,83	15,2	17,2
SD	3	12,7	0,17	12,5	12,9
DD	3	9,3	0,53	8,7	10,0
Bd	3	20,8	0,85	19,6	21,5
Dd	3	15,3	0,28	14,9	15,5

Pelvis

	n	x	s	min.	max.
GL	3	185,3	7,93	177,0	196,0
GBTC	3	128,0	7,79	118,0	137,0
GBA	3	97,7	6,13	90,0	105,0
SBI	3	78,7	3,09	76,0	83,0
GBTi	3	114,3	8,58	104,0	125,0
LS	3	53,3	2,66	50,0	56,5
LA	3	30,0	0,82	29,0	31,0

Os femoris

	n	x	s	min.	max.
GL	3	192,0	6,16	185,0	200,5
Bp	3	44,7	1,55	42,5	46,0
SD	3	15,8	0,54	15,0	16,2
BT	3	19,3	0,85	18,5	20,5
Bd	3	38,3	1,25	37,0	40,0
Dld	3	43,7	1,31	42,5	45,5
Dmd	3	48,2	1,25	46,5	49,5

Tibia

	n	x	s	min.	max.
GL	3	246,7	6,18	238,0	252,0
Bp	3	41,5	2,16	39,5	44,5
Dp	3	44,7	1,43	43,0	46,5
Bd	3	26,5	0,71	26,0	27,5
Dd	3	20,1	0,09	20,0	20,2

Patella

	n	x	s	min.	max.
GL	3	26,0	1,78	24,3	28,5
GB	3	18,5	1,60	16,7	20,6

Os malleolare

	n	x	s	min.	max.
GD	2	14,7		14,2	15,2

Talus

	n	x	s	min.	max.
GLl	4	30,13	0,89	29,0	31,5
GLm	4	28,4	0,41	28,0	29,0
Dl	4	16,5	0,35	16,1	16,8
Bd	4	17,6	0,20	17,3	17,8

Calcaneus

	n	x	s	min.	max.
GL	4	62,1	1,64	59,5	64,0
GB	4	20,8	0,84	19,5	21,7
Bp	4	14,5	0,53	13,8	15,2
DS	4	18,3	0,83	17,5	19,4
Dd	4	23,6	0,65	23,0	24,5

Os centroquartale

	n	x	s	min.	max.
GB	4	21,9	0,65	21,0	22,5
GD	4	21,2	1,30	19,8	22,5

Os tarsale II + III

	n	x	s	min.	max.
GD	4	15,4	1,11	13,9	17,0

Os metatarsale III + IV

	n	x	s	min.	max.
GL	4	185,5	5,32	175,0	188,0
Bp	4	20,2	0,23	20,0	20,6
Dp	4	21,9	0,96	20,8	22,9
SD	4	11,3	0,86	9,9	12,1
DD	4	10,3	0,58	9,3	10,8
Bd	4	21,6	0,54	21,0	22,3
Dd	4	16,7	0,61	15,6	17,0

Phalanx proximalis

		n	x	s	min.	max.
Manus:	GLpe	3	39,7	1,03	38,5	41,0
	Bp	3	10,6	0,25	10,3	10,9
	SD	3	7,8	0,17	7,6	8,0
	Bd	3	9,5	0,29	9,1	9,8
Pedis:	GLpe	4	38,9	1,43	37,0	40,5
	Bp	4	11,2	0,25	10,8	11,4
	SD	4	7,3	0,25	6,9	7,5
	Bd	4	9,6	0,29	9,2	10,0

Talus

	n	x	s	min.	max.
GLl	3	30,7	0,24	30,5	31,0
GLm	3	28,5	0,41	28,0	29,0
Dl	3	16,7	0,47	16,0	17,0
Bd	3	18,2	0,33	17,8	18,6

Calcaneus

	n	x	s	min.	max.
GL	3	64,2	2,49	61,5	67,5
GB	3	21,3	0,94	20,2	22,5
Bp	3	14,6	0,37	14,2	15,1
DS	3	18,9	0,81	17,8	19,6
Dd	3	24,7	0,42	24,1	25,0

Os centroquartale

	n	x	s	min.	max.
GB	3	23,3	0,24	23,0	23,5
GD	3	22,3	0,62	21,5	23,0

Os tarsale II + III

	n	x	s	min.	max.
GD	3	15,9	0,33	15,5	16,3

Os metatarsale III + IV

	n	x	s	min.	max.
GL	3	191,3	3,68	187,0	196,0
Bp	3	21,0	0,90	19,8	22,0
Dp	3	22,1	0,34	21,8	22,6
SD	3	12,5	0,12	12,4	12,7
DD	3	10,2	0	10,2	10,2
Bd	3	21,7	0,60	20,9	22,3
Dd	3	16,7	0,43	16,1	17,2

Phalanx proximalils

		n	x	s	min.	max.
Manus:	GLpe	3	40,3	1,31	38,5	41,5
	Bp	3	10,8	0,57	10,1	11,5
	SD	3	7,7	0,36	7,4	8,2
	Bd	3	9,6	0,39	9,1	10,0
Pedis:	GLpe	3	40,5	1,08	39,5	42,0
	Bp	3	11,4	0,26	11,0	11,6
	SD	3	8,0	0,39	7,6	8,5
	Bd	3	10,0	0,37	9,5	10,4

Phalanx media

		n	x	s	min.	max.
Manus:	GL	3	23,8	0,85	23,0	25,0
	Bp	3	9,8	0,40	9,2	10,1
	SD	3	6,6	0,31	6,3	7,0
	Bd	3	8,5	0,21	8,3	8,8
Pedis:	GL	2	23,5	0,82	22,5	24,5
	Bp	3	10,2	0,31	9,8	10,5
	SD	3	6,9	0,52	6,5	7,6
	Bd	3	8,3	0,23	8,2	8,8

Phalanx distalis

		n	x	s	min.	max.
Manus:	DLS	3	25,3	0,47	25,0	26,0
	Ld	3	21,7	0,60	21,1	22,5
	HP	3	15,5	0,46	15,0	16,1
	BFp	3	8,1	0,09	8,0	8,2
Pedis:	DLS	3	25,8	0,62	25,0	26,5
	Ld	3	21,8	0,45	21,4	22,4
	HP	3	15,3	0,40	15,0	15,9
	BFp	3	8,1	0,24	7,8	8,3

Phalanx media

		n	x	s	min.	max.
Manus:	GL	2	22,4	-	22,5	22,3
	Bp	2	9,9	-	9,3	10,5
	SD	2	6,8	-	6,7	6,9
	Bd	2	8,5	-	8,4	8,5
Pedis:	GL	2	23,5	-	23,0	24,0
	Bp	2	10,2	-	9,7	10,7
	SD	2	7,0	-	6,9	7,1
	Bd	2	8,7	-	8,7	8,7

Phalanx distalis

		n	x	s	min.	max.
Manus:	DLS	1	24,0	-	-	-
	Ld	1	21,5	-	-	-
	HP	1	15,5	-	-	-
	BFp	1	7,6	-	-	-
Pedis:	DLS	1	24,5	-	-	-
	Ld	1	21,5	-	-	-
	HP	1	15,5	-	-	-
	BFp	1	7,8	-	-	-

Table 3

A comparison of male and female *A. marsupialis* metacarpals and metatarsals from the Kalahari Gemsbok Park with those from the Kimberley area. Measurements are given according to sample size (n), mean (x), standard deviation (s), minimum values (min.) and maximum values (max.).

KALAHARI

Os metacarpale III + IV

	n	x	s	min.	max.
GL	16	228,2	8,15	213	239
Bp	16	26,6	1,17	25,2	29,1
Dp	16	19,3	0,94	18,2	20,9
SD	16	14,7	0,75	13,8	15,7
DD	16	10,8	0,76	9,8	12,2
Bd	16	24,8	1,19	22,9	27,6
Dd	16	20,0	0,65	18,7	21,3

Os metatarsale III + IV

	n	x	s	min.	max.
GL	16	242,8	7,87	227	254
Bp	16	24,5	1,06	22,5	26,2
Dp	16	28,8	1,42	26,7	31,7
SD	16	13,2	0,61	12,0	14,4
DD	16	12,8	0,74	11,5	13,9
Bd	16	25,7	1,09	23,8	28,0
Dd	16	20,1	0,53	19,2	21,0

KIMBERLEY

Os metacarpale III + IV

	n	x	s	min.	max.
GL	23	196,7	5,50	188,0	206,0
Bp	23	23,7	0,85	22,4	25,2
Dp	23	17,4	0,58	16,2	18,4
SD	23	13,8	0,82	12,1	15,3
DD	23	10,0	0,51	8,8	10,9
Bd	23	22,3	0,86	20,8	24,1
Dd	23	17,9	0,52	16,8	18,8

Os metacarpale III + IV

	n	x	s	min.	max.
GL	15	210,2	4,28	201,0	219,0
Bp	15	21,7	0,56	20,8	22,5
Dp	15	24,2	0,66	22,9	25,1
SD	15	12,1	0,45	11,0	12,9
DD	15	11,9	0,52	10,9	12,8
Bd	15	23,4	0,91	21,8	25,4
Dd	15	18,2	0,37	17,7	18,8

OPSOMMING

'n Sleutel vir die osteomorfologiese onderskeiding tussen die postkraniale skelet van die springbok, *Antidorcas marsupialis* (Zimmerman, 1780), en die vaalribbok, *Pelea capreolus* (Forster, 1790), is daargestel en word hier voorgelê. Beenreste van medium-groot boksoorte word dikwels in laat-Kwaternêre argeologiese vindplekke in suidelike Afrika gevind, maar die onderskeiding tussen hierdie naas-verwante spesies is dikwels problematies. Dit word hier aangedui dat die afmetings van die postkranial skeletdele van *Antidorcas* en *Pelea* ook bruikbaar is vir die onderskeiding tussen die twee. Verder is gepoog om die stand van die subspesifieke status van *A. m. marsupialis* en *A. m. hofmeyri* te evalueer op grond van die variasie in grootte van postkraniale skeletdele soos af te lei uit afmetings op springbokbevolkings van die Kalahari en van die binneland van suidelike Afrika.

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APPENDIX 1
SPECIMENS EXAMINED

ANTIDORCAS MARSUPIALIS

Institut für Palaeoanatomie, München: IPM 2, male, Zoo Hellabrunn, München; IPM 4, female, provenance unknown; IPM 6, female, provenance unknown; IPM 10, male, provenance unknown; IPM 11, female, provenance unknown; IPM 14, female, Zoo Hellabrunn; IPM 15, female, Gift Faculty of Veterinary Medecine, Onderstepoort; IPM 17, female, Zoo Hellabrunn.

Koninklijk Museum voor Midden-Africa, Tervuren: KMMA-77-45-M 10, female, imported from Pretoria Zoo to Zoo Antwerpen; KMMA 78-73-M 4, female, imported from Pretoria Zoo to Zoo Antwerpen.

McGregor Museum, Kimberley: MMK M 1374, female, Benfontein Farm, SE of Kimberley, Orange Free State; MMK M 193-1 to 23 and MMK M 194-2 to 16, Magersfontein Farm, Cape Province.

National Museum, Bloemfontein: NMB 6019, female, Soetdoring Nature Reserve, Orange Free State; NMB 6020, male Soetdoring Nature Reserve, Orange Free State; NMB 7418, male, Nossob, Kalahari Gemsbok National Park; NMB 7419, male Nossob, Kalahari Gemsbok National Park; NMB 7422, male, Nossob, Kalahari Gemsbok National Park; NMB 7423, male, Nossob, Kalahari Gemsbok National Park; NMB 7424, male, Nossob, Kalahari Gemsbok National Park; NMB 7432, male, Nossob, Kalahari Gemsbok National Park; NMB 7433, male, Nossob, Kalahari Gemsbok National Park; NMB 7433, male, Nossob, Kalahari Gemsbok National Park; NMB 7434, male, Nossob, Kalahari Gemsbok National Park; NMB 7435, male, Nossob, Kalahari Gemsbok National Park; NMB 7436, male, Nossob, Kalahari Gemsbok National Park; NMB 6096, female, Nossob, Kalahari Gemsbok National Park; NMB 7421, female, Nossob, Kalahari Gemsbok National Park; NMB 7420, female, Nossob, Kalahari Gemsbok National Park; NMB 7425, female, Nossob, Kalahari Gemsbok National Park; NMB 7426, female, Nossob, Kalahari Gemsbok National Park; NMB 7431, female, Nossob, Kalahari Gemsbok National Park.

South African Museum, Cape Town: SAM 36034, female, acquired through Vrolijkheid Predator Control Farm, Robertson, Cape Province; SAM 36290, female, Cape Point Nature Reserve, Cape Province; SAM 36299, male, Tijgerberg Zoo, Cape Province; SAM 37117, male, provenance unknown; SAM 37166, female, Cape Point Nature Reserve, Cape Province, SAM 38732, female, provenance unknown, SAM 39798, female, provenance unknown; SAM 40438, female, provenance unknown.

Transvaal Museum, Pretoria: TMP AZ 179, female, Pretoria Zoo; TMP AZ 477, female, Pretoria Zoo; TMP AZ 1032, male Pretoria Zoo; TMP AZ 1496, male Pretoria Zoo; TMP 14175, male Mata Mata, Kalahari Gemsbok Park, Cape Province; TMP 16428, male, provenance unknown; TMP 16445, female, provenance unknown; TMP 16448, female, provenance unknown, TMP 18750, female, S.A. Lombard Nature Reserve, Transvaal Province.

Zoologische Staatssammlung, München: ZSM 1963 64, female, Zoo Hellabrunn, München; ZSM 1973 277, female, Zoo Hellabrunn; 1973 278, female, Zoo Hellabrunn; ZSM 1976 32, male, Zoo Hellabrunn.

PELEA CAPREOLUS

Institut für Palaeoanatomie, München: IPM 1, female, Gift Faculty of Veterinary Medecine, Onderstepoort; IPM 2, male, Bontebok National Park, Cape Province.

South African Museum, Cape Town: SAM 39319, male, Cape Point Nature Reserve, Cape Province; SAM 40069, male, Cape Point Nature Reserve; SAM 40630, female, provenance unknown.

Transvaal Museum, Pretoria: TMP 479, male, provenance unknown; TMP 526, female, provenance unknown.

Orders to: National Museum, PO Box 266, Bloemfontein 9300, Republic of South Africa