**FIGURE 4.12:** Bovid size class I - IV: Minimum and maximum index values for the femur.

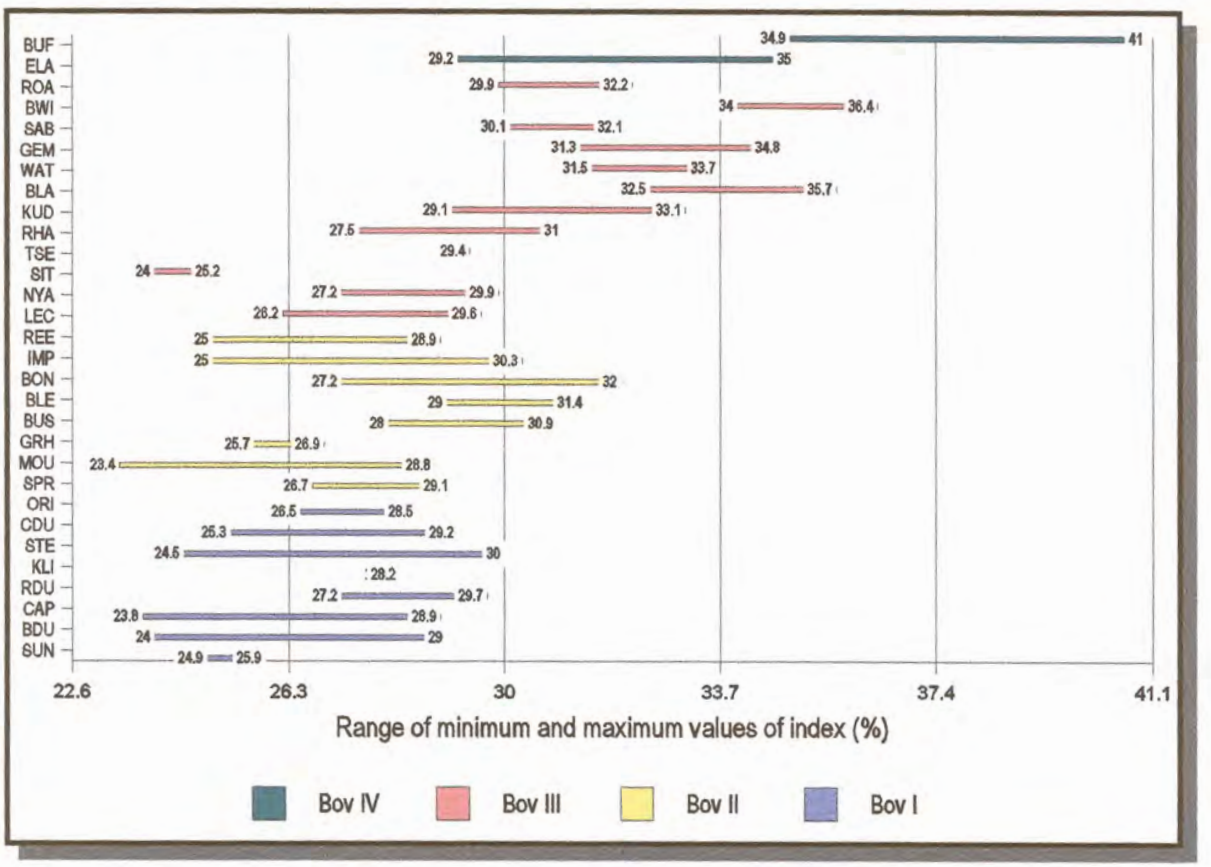


**FIGURE 4.13:** Bovid size class I - IV: Minimum and maximum index values for the tibia.

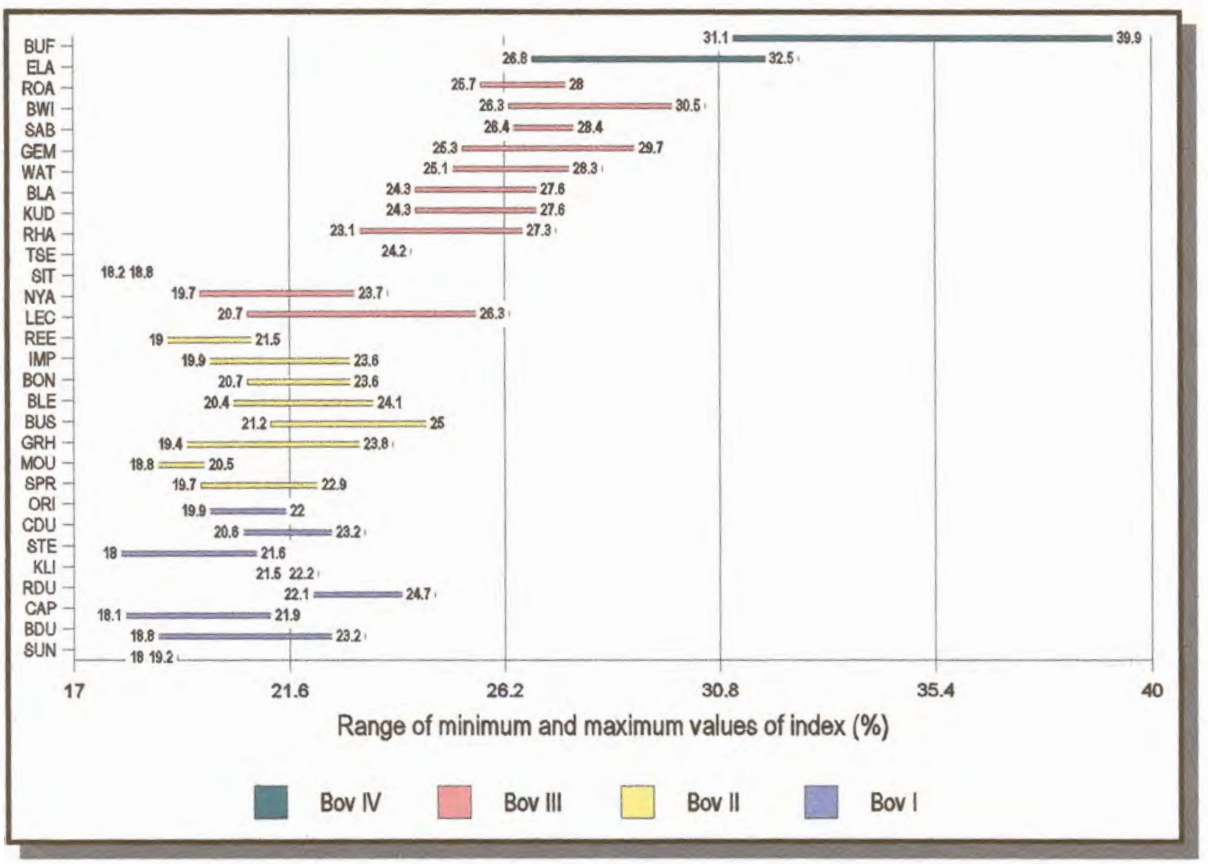
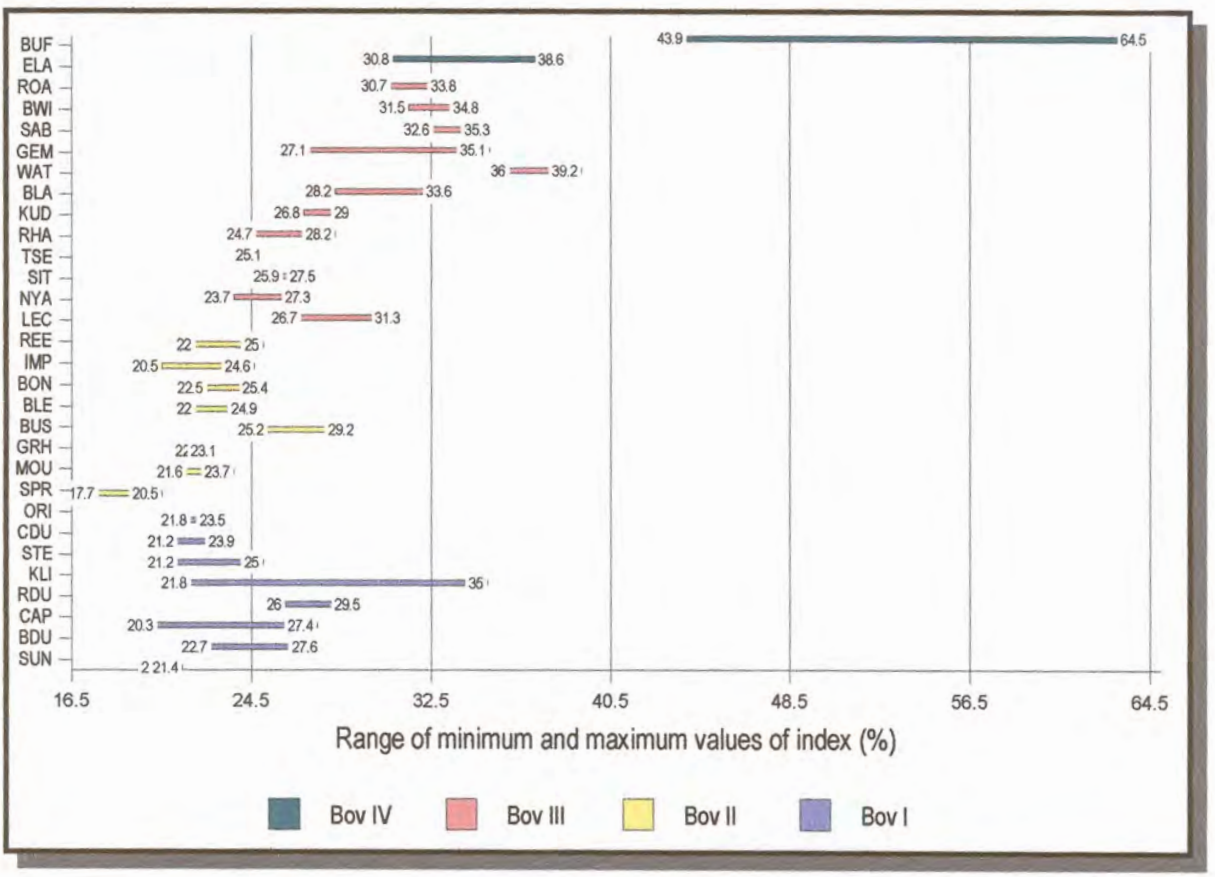


**FIGURE 4.14:** Bovid size class I - IV: Minimum and maximum index values for the metatarsal.



## 2.2 Development of programme

The programme was developed using the 97 version of Lotus Smartsuite. A copy of the Osteo-ID programme is available form the department of Anatomy, University of Pretoria or the author. Three different database identification files for the femur, tibia and metatarsal are on the Osteo - ID CD. The following steps should be taken to utilize the programme:

Step 1: If Lotus Smartsuite is not accessible, then obtain and install.

Step 2: When Lotus is up and running, insert Osteo-ID CD in CD-Rom Drive.

Step 3: From the CD, open either femur, tibia or metatarsal file (as required).

Step 4: Click on navigation icon (button) located on the upper left hand side of the screen.

Navigation icon ➜ 

Step 5: Select "Identification"

Step 6: Enter values measured on the bone that needs to be identified.

If unsure about measurement descriptions and methods, use Materials and Methods chapter as reference. With the further development of the programme these measurements will be available on the computer programme for reference.

Identification will automatically be displayed on the SPECIMEN - ID CHART the moment a value is entered. Every time a new value is entered, the graph will change according to identification. Although the graph will react even on one value entered, the identification will obviously be more accurate with additional values.

The database is protected with a password, to ensure the integrity of data and that no values are accidentally altered.

Three values are calculated by the programme. These are:

**The *Identification percentage probability* (IPP) =**

$$\frac{\text{Total amount of measurements falling within a species median X100}}{\text{Total measurements of respectively femur(14), tibia(15) or metatarsal(16)}}$$

This is a calculation of the number of measurements (median values of specific species) which fall within the range of the entered measurement values, expressed as a percentage. It is very important to note that this percentage is *weighted*, as it will return a percentage indicative of the number of measurements entered by the user against the total number of measurements available in the database on respectively the femur (14 measurements), the tibia (15 measurements) and the metatarsal (16 measurements).

**The *Fractional percentage probability* (FPP) =**

$$\frac{\text{Individual IPP value X100}}{\text{Sum of IPP values of all species identified with IPP value}}$$

This is the percentage chance the specimen measured has of being one of the species that had a positive IPP. The FPP is therefore a fractional expression of the IPP, as a percentage. The highest FPP value is then the most probable species.

**The *Element percentage probability* (EPP) =**

$$\frac{\text{Total number of measurements falling within range of species median X100}}{\text{Total number of measurements entered}}$$

This is a calculation of the number of measurements that shows correlation with the database measurements expressed as a percentage of the measurements that had been entered by the user. This percentage is not *weighted* and may be misleading on the basis of the overall accuracy of the database. The reason is that it

may disregard some measurements unique to this species, but are similar in other. The following example explains all three values:

Example: The user enters 5 measurements of the 15 tibial measurements available for identification on the programme. Only 3 of these measurements fall within the median of Springbok, and 2 within the median values of Impala. The three calculated values returned by the programme will be:

| Springbok: | Impala: |
|---|---|
| **IPP:** 3 / 15 X 100 = 20% | **IPP:** 2 / 15 X 100 = 13.3% |
| **EPP:** 3 / 5 X 100 = 60% | **EPP:** 2 / 5 X 100 = 40% |
| **FPP:** 20 / (20 + 13.3) X 100 = 60% | **FPP:** 13.3 / (20 + 13.3) = 40% |

If the number of measurements entered are equal to that of the number of measurements available on the specific bone, the IPP and EPP will have the same value.

The Identification chart graphically shows the FPP value, but both the IPP and EPP values can be accessed. Although it is essential to enter as many of the measurements available on the specific bone, it is not mandatory. The Identification graph will react on one entry only. In such instance the user must realize that the computer will only return species which shows correlation with that one element, which will necessitate further study.

Figure 4.15 shows the Identification chart of the programme as seen on the computer screen.

MASTERS PROJECT STUDY - "FEMUR IDENTIFICATION" - by E.J.Swanepoel

Please type in the actual sizes of your specimen, in the blocks provided below, under their corresponding headings.

Not all measurements need be supplied, but it will enhance the chances of correctly identifying the species.

The computer will then attempt to identify the specimen, based on a line-of-regression-analysis, by species.

| F(GL) | F(GLH) | F(SBD) | F(SCD) | F(GBP) | F(GDH) | F(GBH) | F(GBD) | F(GLDD) | F(GMDD) | F(GBCF) | F(SBCF) | F(GBT) | F(GL-GLH) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 232.0 | 218.0 | 19.7 | 62.0 | 59.9 | 24.7 | 33.0 | 49.5 | 54.2 | 61.3 | 11.9 | 9.8 | 25.8 | 2.0 |

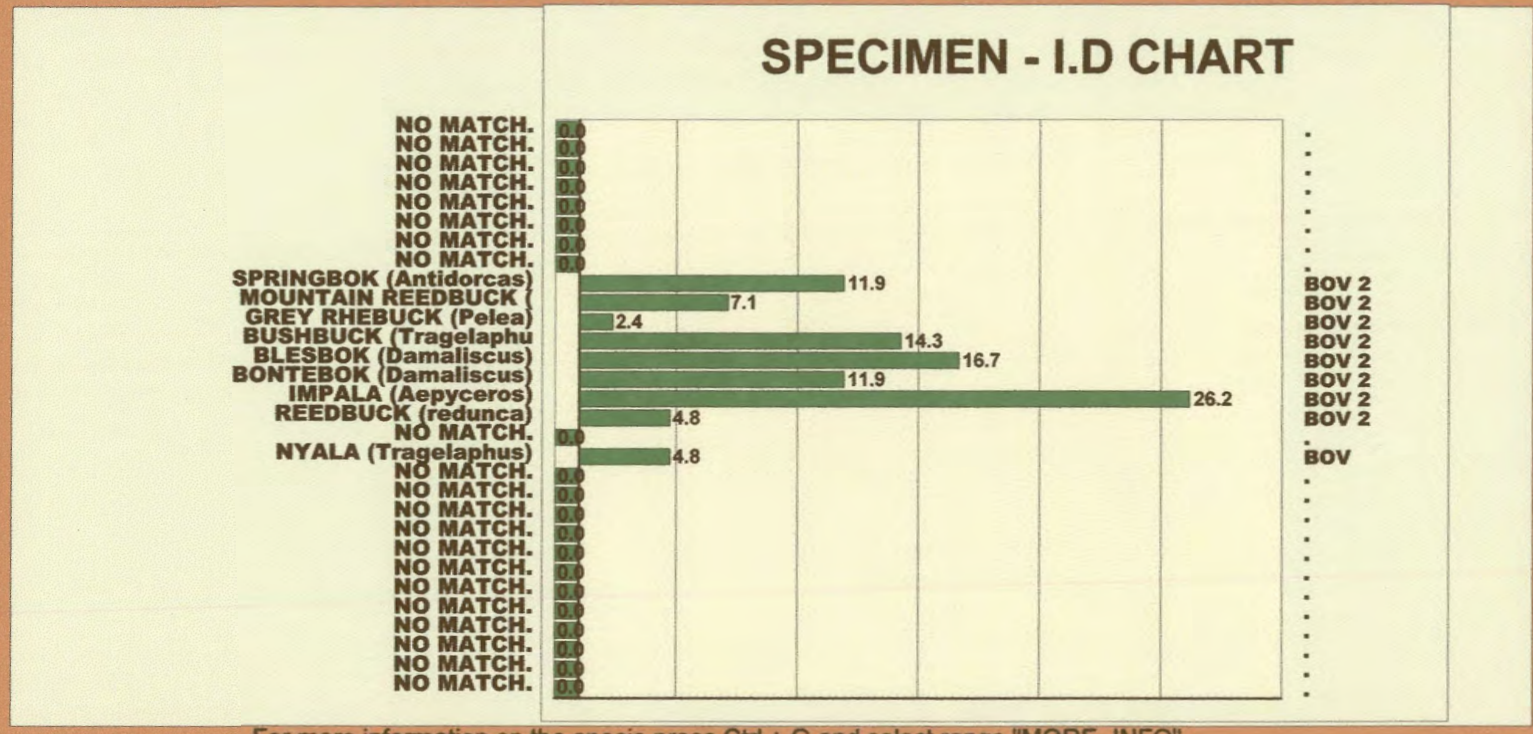



**FIGURE 4.15:** Identification chart as seen in the computer programme.

The identification chart also supplies the Bovid size class, if the FPP values are too close in value and are therefore of little use. As in conventional faunal analysis, the Bovid size class can at least be captured if no species can be assigned to the specimen.

The navigation icon can also be used to acquire additional detail of a specific species by selecting the "MORE INFO" option. This information may be used to further identify a species. Although only four examples (Cape Grysbok, Springbok, Red Hartebeest, Buffalo) is available at present, it indicates how the programme may be further developed. "MORE INFO" data includes the following:

❶ Minimum and maximum live weight of males and females.

❷ Distribution description.

❸ Description of species

❹ Habitat & Diet

❺ Smithers' mammal number [51]

The distribution map, for example, can be used to distinguish between similar size species, with different distributions in the Southern African region. This may assist in further identification. Blesbok and Bontebok, for example, are skeletally very similar, but have diverse natural distributions in the Southern African region. The habitat and diet of these species are of importance in the process of faunal analysis.

The navigational icon can further be used to view the EPP, IPP and FPP values of the species identified in the graph. This can be accessed by selecting the "ADDITIONAL VALUES" option.

Figure 4.16 shows the additional information that can be accessed by selecting the "MORE INFO" option at the navigation button or Ctrl + G.

# SPECIES DATABASE (more info)

| COMMON NAME | SUBFAMILY | DIET |
|---|---|---|
| SPRINGBOK (Antidorcas marsupialis) | Antilopinae | Mixed |

**HABITAT**

* Arid regions and open grassland.
* In areas where surface water is unavailable.
* They avoid mountainous, rocky areas as well as thick woodland and tall grass.

**DISTRIBUTION (in S.A.)**

Namibia: Widespread, except in N and NE

Botswana: N,S and W parts

South Africa: Game Reserves

**DESCRIPTION**

* Sleek and trim , medium built.
* Back is bright brown with dark reddish-brown horizontal band from foreleg to hip. Under parts are white.
* Face is white with reddish brown line from front eye to mouth angle.

(description continued)

* Horns in both male and female
* Ears are extremely long, narrow and pointed.
* Tail is white with terminal tuft of black hair.

| LIVE WEIGHT (M) | LIVE WEIGHT(F) | SIZE (class) |
|---|---|---|
| 31.2 - 41 kg | 26.5 - 37.1 kg | II |

| F(GL) | F(GLH) | F(SBD) | F(SCD) | F(GBP) | F(GDH) | F(GBH) | F(GBD) | F(GLDD) | F(GMDD) | F(GBCF) | F(SBCF) | F(GBT) | F(GL-GLH) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 208.25 | 201.25 | 18.3 | 56.75 | 52.3 | 21.9 | 29 | 42.1 | 48.55 | 57.8 | 10.6 | 8.55 | 25.4 | 8.25 |

NO: 314

**FIGURE 4.16:** Additional information as seen in the computer programme.

# 3. STAGE 3 - TESTING

Stage 3 comprised of a test of accuracy and reliability of the programme developed in this study. The test included specimens from the Kemp's Cave collection which were identified as either femur, tibia or metatarsal of a specific species. Only ten specimens fulfilled these criteria. One of these specimens (LKC/93/23) were a non-fused epiphyses, which indicated that it belonged to a sub-adult or juvenile. All modern collection measurements taken for this study were that of adult individuals. Although the results obtained from testing this juvenile specimen with the developed programme may therefore be negative, it's identification graphs are also included here. The ten identified specimens of the Kemp's Cave collection were identified by an independent expert to verify accuracy.

Ten modern specimens from the National Flagship Institution, with known identifications, were also used for the testing stage. The reasons for including the extra specimens were that 1) the sample size (femur, tibia and metatarsal specimens of bovids) from Kemp's Caves was too small and 2) the accuracy of the identification of the fragmented specimens of Kemp's Cave could be doubted. Specimens that could not be utilised for various reasons in the original data collection, were measured. These included a femur, tibia and metatarsal from each of Bovid size class I, II and III, as well as a metatarsal from Bov IV.

## 3.1 Kemp's Caves specimens

Figures 4.17 to 4.26 show the results of the different specimens from the Kemp's Cave collection. These specimens were in various stages of fragmentation, thus only certain measurements could be taken from each. The original identification was done, by the author, by comparing the specimen to the modern collection of the

National Flagship Institution collection.

The results of the test include the specimen number, the measurements taken (Tables 4.10 - 4.19), the specimen - ID chart (with FPP values) as well as the IPP values for each of the species calculated by the developed programme.

The IPP value is a calculation which indicates how many of the entered measurements , fall within the range of the database medians, expressed as a percentage.

The Identification Percentage Probability (IPP) values shown with the ID results of the Kemp's Caves specimens, are mostly very low values. The reason being that these fragmented specimens could only supply a few measurements. These values give a good indication of the fact that identification with only a few measurements may be less accurate. The Fractional Percentage Probability (FPP) values are also shown on the ID chart. These values give an indication of the probability of the specimen measured as being one of all the species that showed positive IPP values.

**LKC/94/27 (Fig 4.17) Conventionally identified as Red Hartebeest:**

Although Red Hartebeest had a 14.3% probability, the ID chart showed a higher probability for it to be either Lechwe or Sitatunga. Lechwe, however, does not naturally occur in this area. The Sitatunga sample size was also very small and the results of this ID might change with a larger sample. The IPP values were relatively low, but correlated with the fact that only two measurements were available for identification testing.

**LKC/92/38 (Fig 4.18) Conventionally identified as Springbok:**

The ID chart showed a 20% probability for both Springbok and Oribi, but the highest probability with 60% is Grey Rhebuck. Oribi and Springbok showed a low 7% IPP value, whereas Grey Rhebuck showed higher (20%) IPP value. These results may however, change drastically if proximal measurements values are entered.

**LKC/93/23 (Fig 4.19) Conventionally identified as Impala:**

The only three species that showed a probability is Oribi (40%), Mountain Reedbuck (20%) and Grey Rhebuck (40%). The IPP values of all three species were, however, relatively low, as only three measurements were entered. This specimen, however, was an unfused distal extremity. No juveniles or sub-adults were measured and utilised in the database which might explain the absence of the probability of Impala on the ID chart.

**LKC/93/70 (Fig 4.20) Conventionally identified as Blesbok:**

A combination of four species showed the highest probability percentage at 16% which included Blesbok. The IPP values ranged form 20% - 27% which is relatively high if one takes into account that only a third of the measurements were entered. One of the measurements available was the T(SCD), smallest circumference of the tibial shaft. As can be seen in Figure 4.13, the robusticity values of all four species overlaps completely which correlates with the identification results.

**LKC/93/302 (Fig 4.21) Conventionally identified as Reedbuck:**

All measurements could be taken on this specimen as it was a complete metatarsal. Although sixteen species showed varied percentage probabilities, Reedbuck had the third highest FPP (12.7%) and a 63% IPP. Bontebok had the highest probability with a 17.7% FPP and a 88% IPP value.

**LKC/93/126 (Fig 4.22) Conventionally identified as Impala:**

Grey Rhebuck showed the highest (42.9%) percentage probability, while Oribi, Mountain Reedbuck and Bushbuck were also identified as possible species. Impala did not have a positive IPP and therefore did not show on the ID chart. All species showed relative low IPP values (6% to 19%), which correlates with the fact that only three measurements could be entered.

**LKC/94/328 (fig 4.23) Conventionally identified as Blesbok:**

Springbok and Reedbuck had the highest (22.7%) FPP values. Although Blesbok had a positive IPP value, its fractional probability was only 4.5%. Again it can be seen in Figure 4.14 that all the identified species show overlap in the metatarsal robusticty value (which includes the M(SCD). This may explain the large amount species that was identified in this specific test.

**LKC/93/40 (Fig 4.24) Conventionally identified as Blesbok:**

All five species that showed percentage probabilities, had a 20% FPP value. The only measurement available was the M(SCD). The IPP values of all four species was extremely low (6%). This is obviously due to the fact that only the smallest circumference measurement of this bone was available. In Figure 4.14 these species show great overlap in the robusticity values and thus these results correlates with the metatarsal robusticity index. Bontebok, however, does not naturally occur in the Kemp's cave area, which might be useful information in further identification.

**LKC/93/35 (Fig 4.25) Conventionally identified as Blesbok:**

Although Blesbok showed a high (15.7%) FPP vlaue, Reedbuck was identified as being the most (21.8%) probable species. Eight different species showed positive IPP values, which ranged between 6% and 44%. Blesbok showed an IPP value of 31%, which is relatively high when less than half the measurements were available for identification.

**LKC/92/34 (Fig 4.26) Conventionally identified as Blesbok:**

Blesbok, Springbok, Bushbuck, Reedbuck and Nyala each had a 14.3% fractional probability value, while Impala had the highest FPP value at 28.6%. Only two measurements were available (M(SBD) and M(GBP) which might explain that Blesbok did not have a higher FPP value.

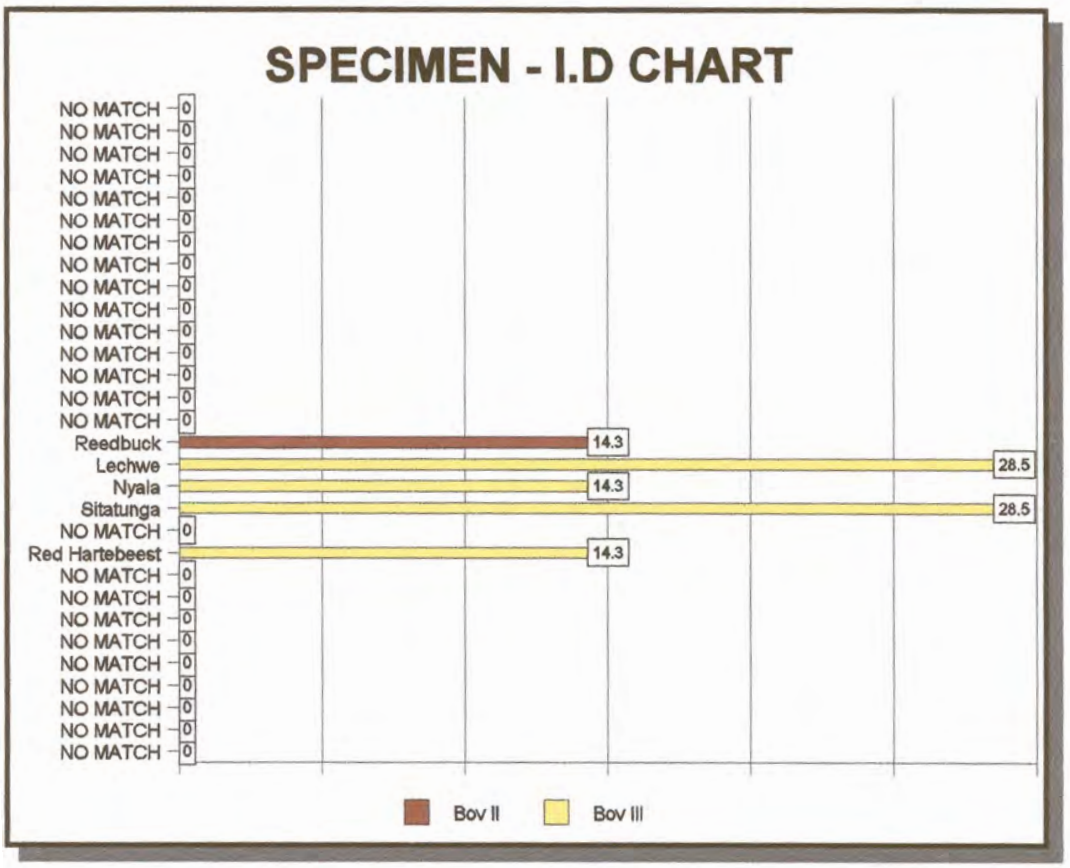
Only 20% of the identification tests was correctly identified (having the highest FPP value) as being the species which was conventionally identified during faunal analysis. In 90% of the tests the species had a positive IPP value and featured on the identification graph. Reasons for the low success rate might be 1) the small number of measurements available because of fragmentation 2) possible inaccurate conventional identification and 3) the inaccuracy of the computer programme, resulting from the small number of specimens in the database used for the development of the programme.

## KEMP'S CAVE SPECIMEN (LKC/94/27) Red Hartebeest femur

**TABLE 4.10:** Measurements of specimen LKC/94/27.

| F(GL) | F(GLH) | F(SBD) | F(SCD) | F(GBP) | F(GDH) | F(GBH) | F(GBD) | F(GLDD) | F(GMDD) | F(GBCF) | F(SBCF) | F(GBT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | 24.2 | 76.0 | - | - | - | - | - | - | - | - | - |

**FIGURE 4.17:** Identification chart of LKC/94/27 - FPP (%).



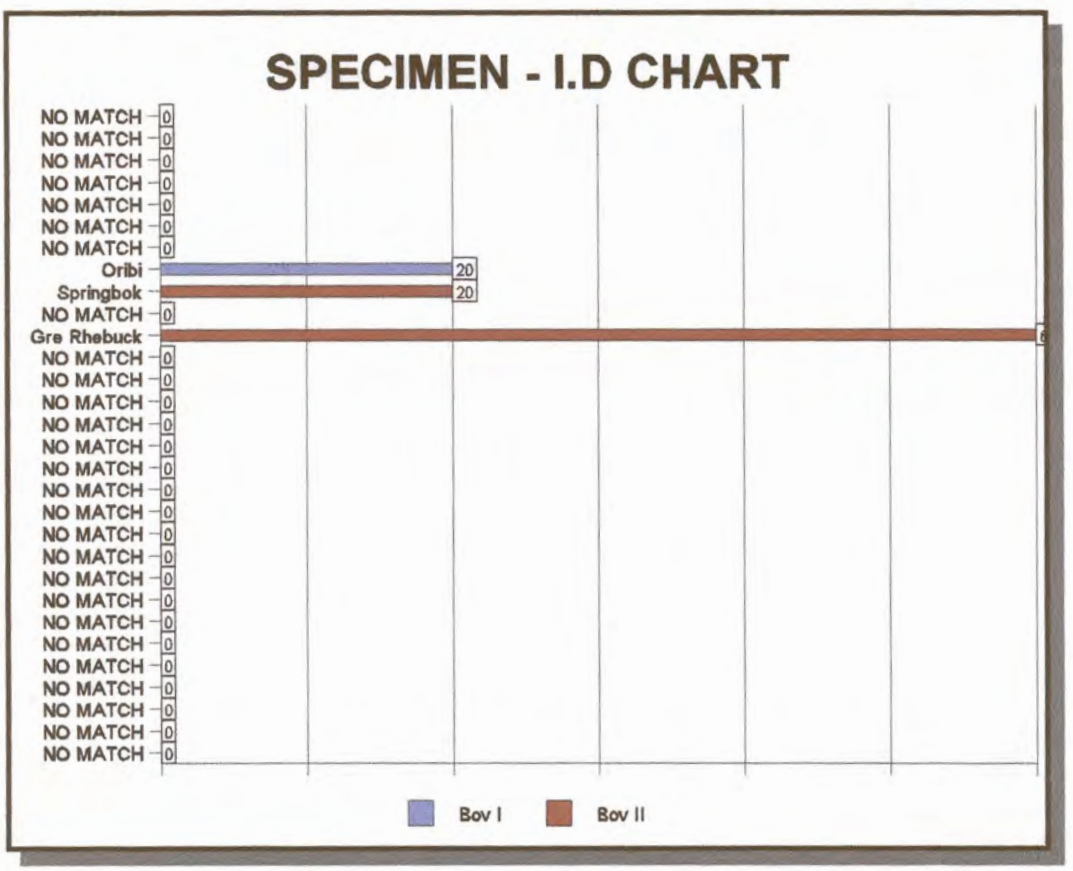

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Reedbuck | 8% | Sitatunga | 15% |
| Lechwe | 15% | Red Hartebeest | 8% |
| Nyala | 8% | | |

## KEMP'S CAVE SPECIMEN (LKC/92/38) Springbok tibia

**TABLE 4.11:** Measurements of specimen LKC/92/38.

| T(GL) | T(GML) | T(GLL) | T(SBD) | T(SCD) | T(GBP) | T(GDP) | T(GDLC) | T(GDMC) | T(GDT) | T(GDTN) | T(SBIE) | T(GBD) | T(GDD) | T(SDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | 15.6 | 47.0 | - | - | - | - | - | - | - | 24.6 | 20.5 | 13.8 |

**FIGURE 4.18:** Identification chart of LKC/92/38 - FPP (%).



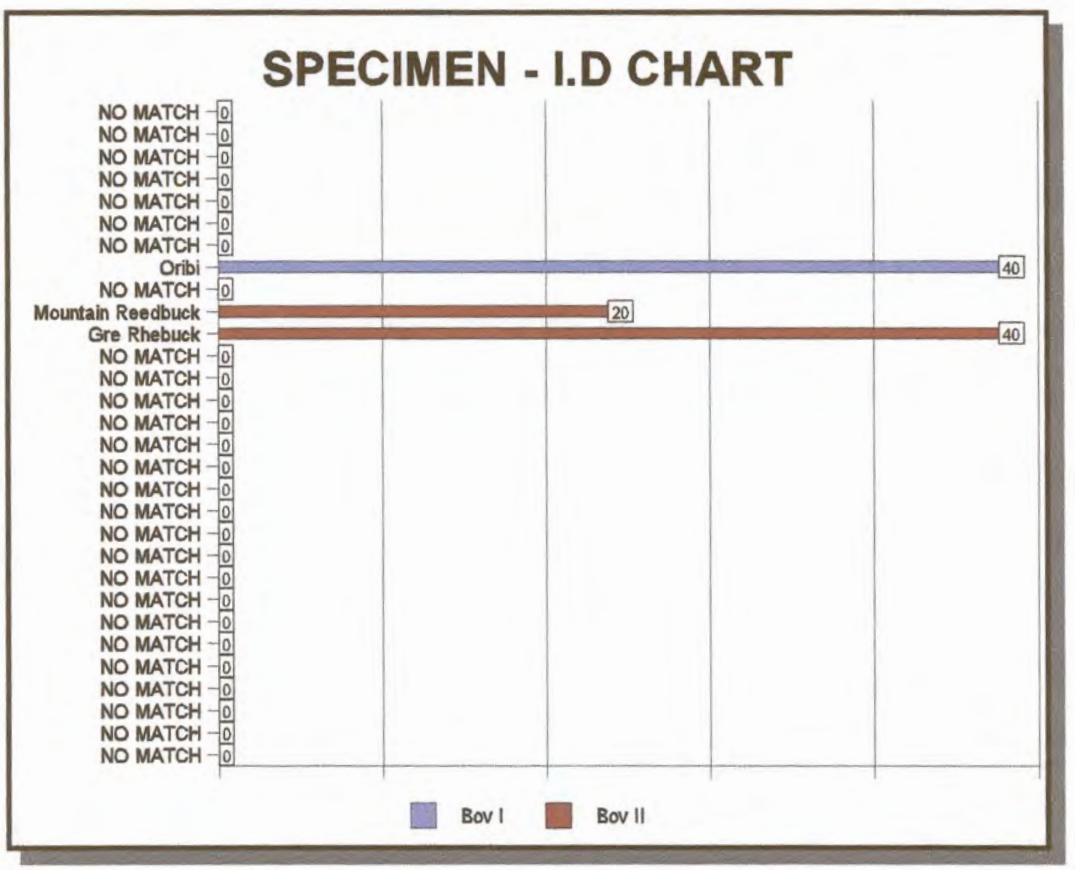

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Oribi | 7% | Grey Rhebuck | 20% |
| Springbok | 7% | | |

## KEMP'S CAVE SPECIMEN (LKC/93/23) Impala tibia

**TABLE 4.12:** Measurements of specimen LKC/93/23.

| T(GL) | T(GML) | T(GLL) | T(SBD) | T(SCD) | T(GBP) | T(GDP) | T(GDLC) | T(GDMC) | T(GDT) | T(GDTN) | T(SBIE) | T(GBD) | T(GDD) | T(SDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | - | - | - | - | - | 26.4 | 19.9 | 13.5 |

**FIGURE 4.19:** Identification chart of LKC/93/23 - FPP (%).



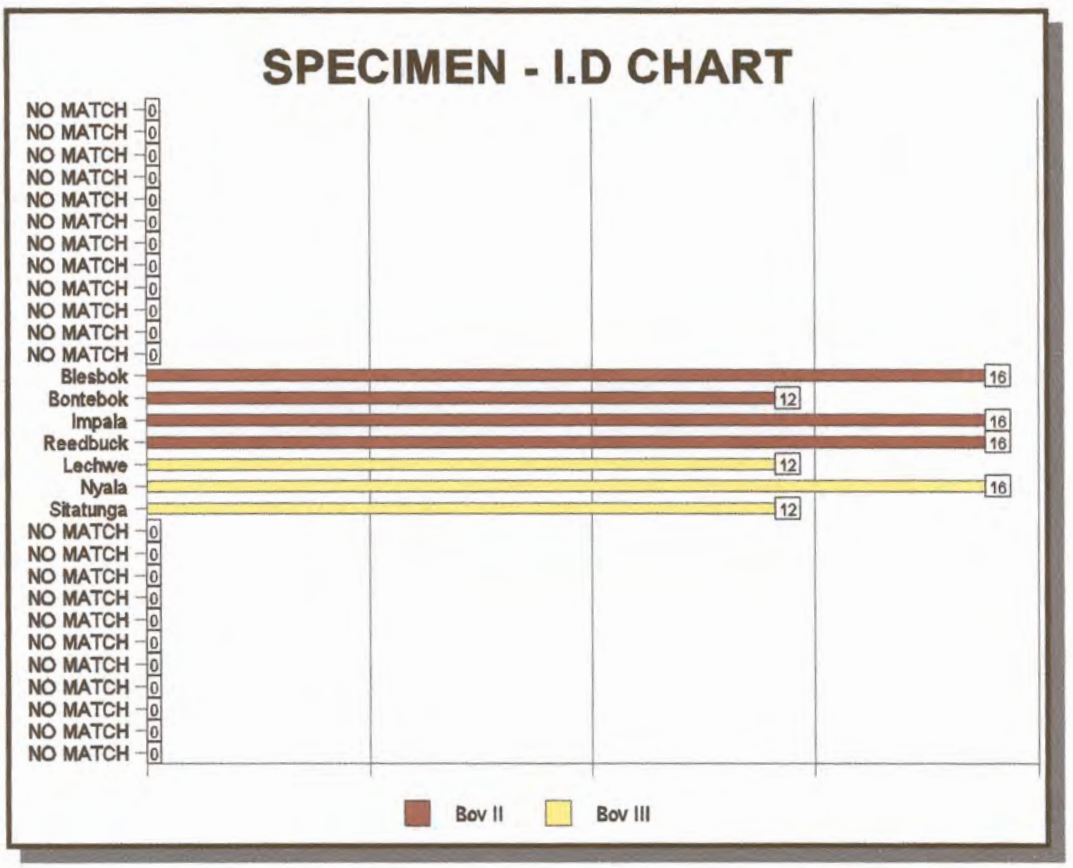

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Oribi | 13% | Grey Rhebuck | 13% |
| Mounatin Reedbuck | 6% | | |

## KEMP'S CAVE SPECIMEN (LKC/93/70) Blesbok tibia

**TABLE 4.13:** Measurements of specimen LKC/93/70.

| T(GL) | T(GML) | T(GLL) | T(SBD) | T(SCD) | T(GBP) | T(GDP) | T(GDLC) | T(GDMC) | T(GDT) | T(GDTN) | T(SBIE) | T(GBD) | T(GDD) | T(SDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | 22.5 | 66.0 | - | - | - | - | - | - | - | 34.5 | 27.8 | 20.4 |

**FIGURE 4.20:** Identification chart of LKC/93/70 - FPP (%).



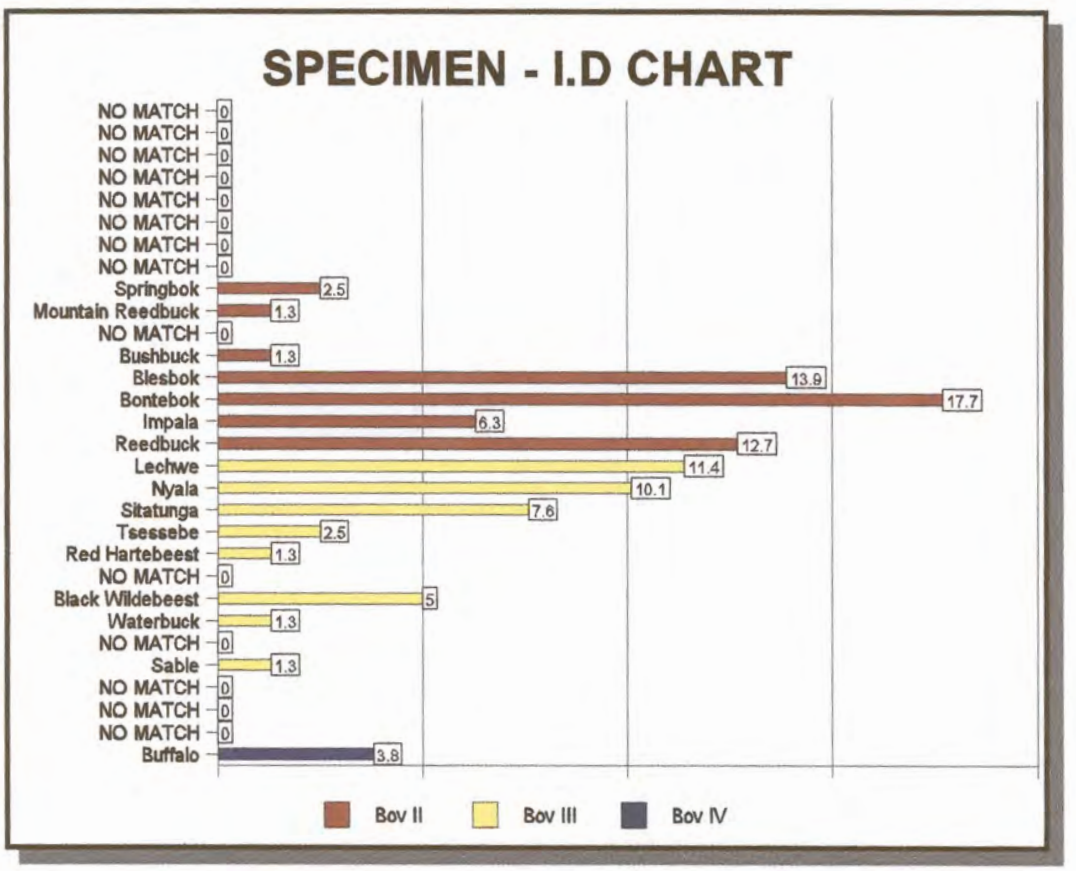

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Blesbok | 27% | Lechwe | 20% |
| Bontebok | 20% | Nyala | 27% |
| Impala | 27% | Sitatunga | 20% |
| Reedbuck | 27% | | |

## KEMP'S CAVE SPECIMEN (LKC/93/302) Reedbuck metatarsal

**TABLE 4.14:** Measurements of specimen LKC/93/302.

| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 225.0 | 220.0 | 222.0 | 15.0 | 57.0 | 29.5 | 32.3 | 23.4 | 13.5 | 21.2 | 12.1 | 32.1 | 21.9 | 15.0 | 14.9 | 14.8 |

**FIGURE 4.21:** Identification chart of LKC/93/302 - FPP (%).



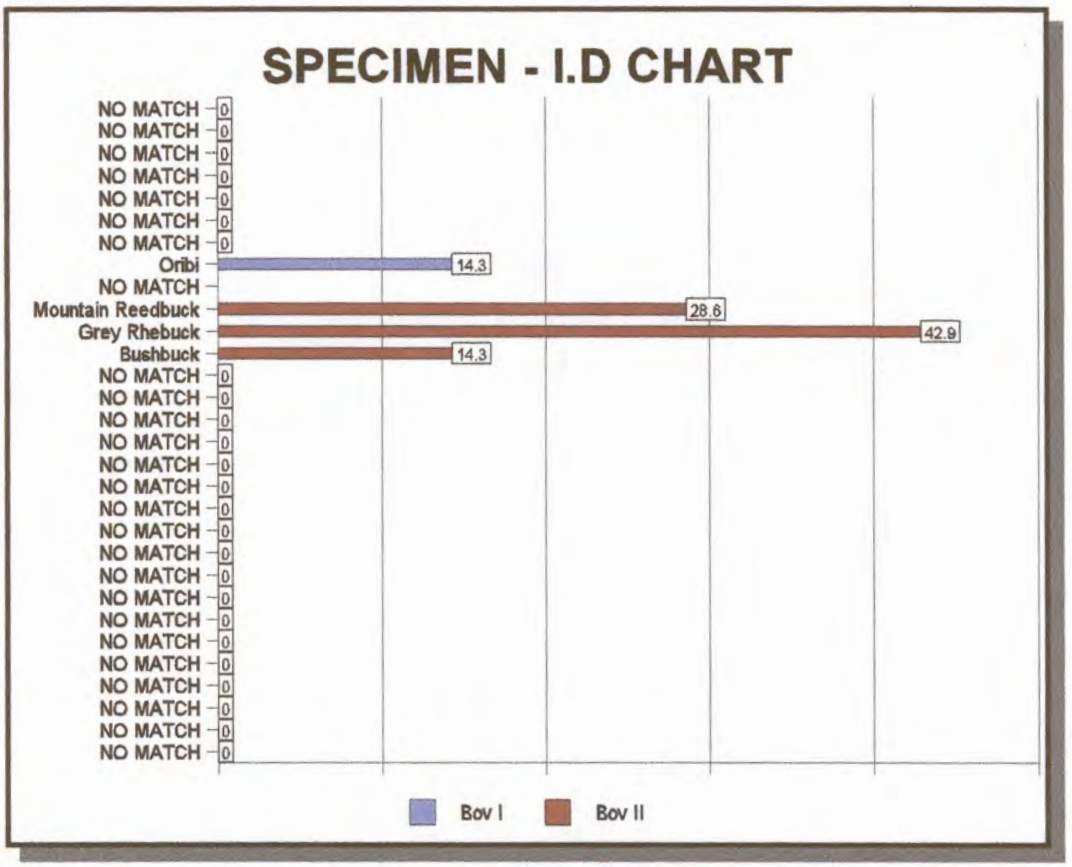

| SPECIES | IPP | SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|---|---|
| Sprinbok | 6% | Reedbuck | 63% | Red Hartebeest | 6% |
| Mounatin Reedbuck | 6% | Lechwe | 56% | Black Wildebeest | 25% |
| Bontebok | 88% | Nyala | 50% | Waterbuck | 6% |
| Blesbok | 69% | Sitatunga | 44% | Sable | 6% |
| Impala | 25% | Tsessebe | 13% | Buffalo | 19% |

## KEMP'S CAVE SPECIMEN (LKC/93/126) Impala metatarsal

**TABLE 4.15:** Measurements of specimen LKC/93/126.

| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | 11.9 | - | 21.0 | 23.0 | - | - | - | - | - | - | - | - | - |

**FIGURE 4.22:** Identification chart of LKC/93/126 - FPP (%).



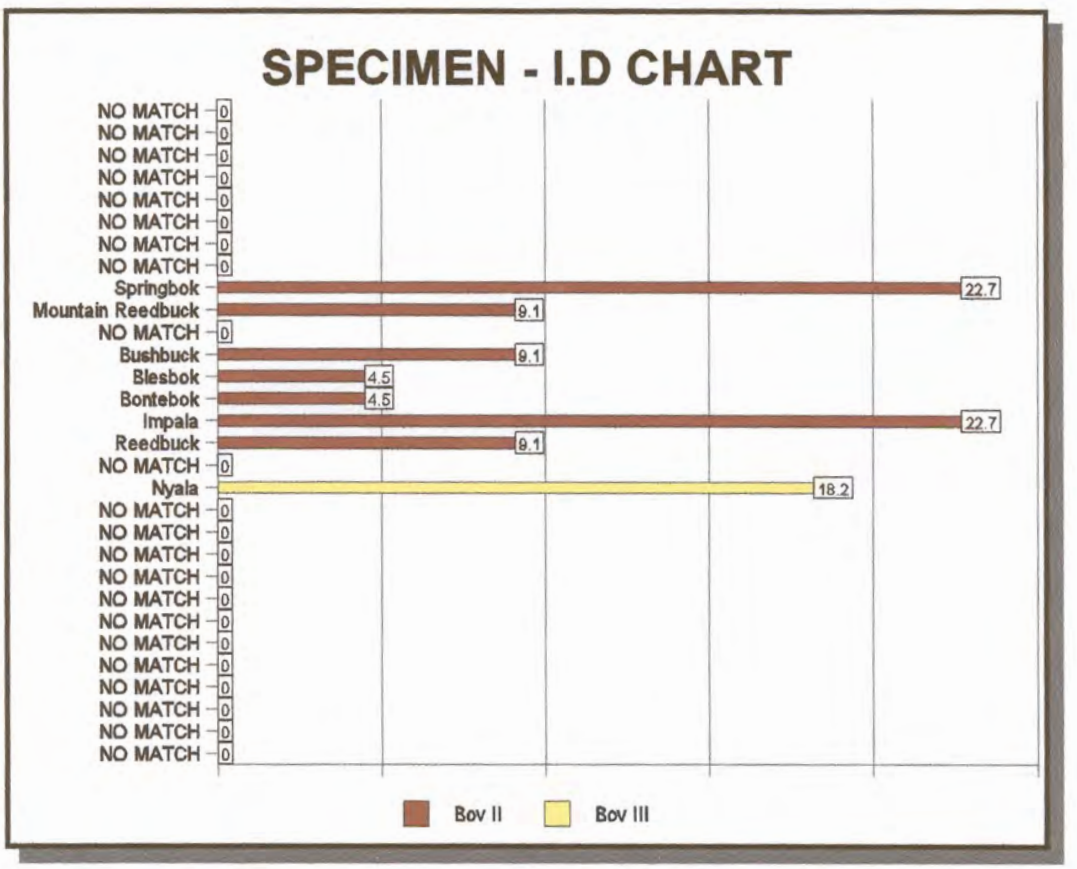

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Oribi | 6% | Grey Rhebuck | 19% |
| Mountain Reedbuck | 13% | Bushbuck | 6% |

## KEMP'S CAVE SPECIMEN (LKC/94/328) Blesbok metatarsal

**TABLE 4.16:** Measurements of specimen LKC/94/328.

| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | 15.0 | 49.5 | - | - | - | - | - | - | 26.9 | 18.9 | 12.7 | 12.2 | 12.9 |

**FIGURE 4.23:** Identification chart of LKC/94/328 - FPP (%).



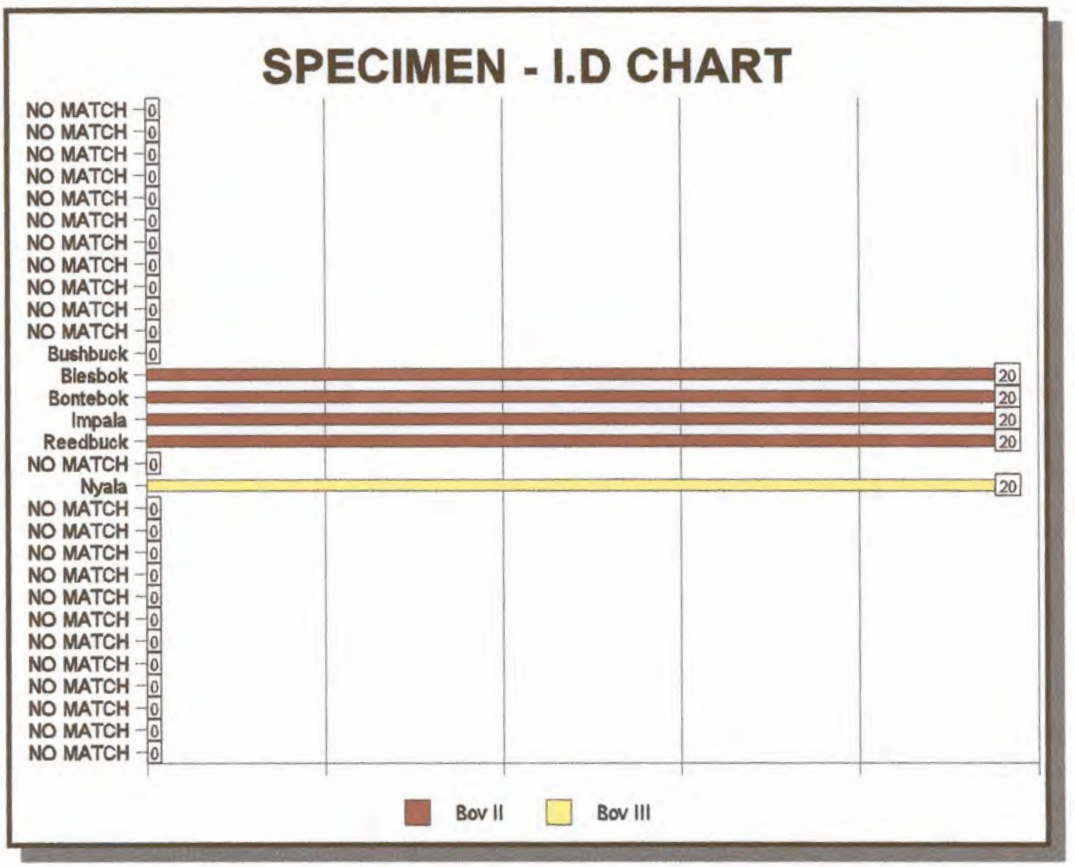

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Springbok | 31% | Bontebok | 6% |
| Mountain Reedbuck | 13% | Impala | 31% |
| Bushbuck | 13% | Reedbuck | 13% |
| Blesbok | 6% | Nyala | 25% |

## KEMP'S CAVE SPECIMEN (LKC/93/40) Blesbok metatarsal

**TABLE 4.17:** Measurements of specimen LKC/93/40.

| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | - | 57.0 | - | - | - | - | - | - | - | - | - | - | - |

**FIGURE 4.24:** Identification chart of LKC/93/40 - FPP (%).



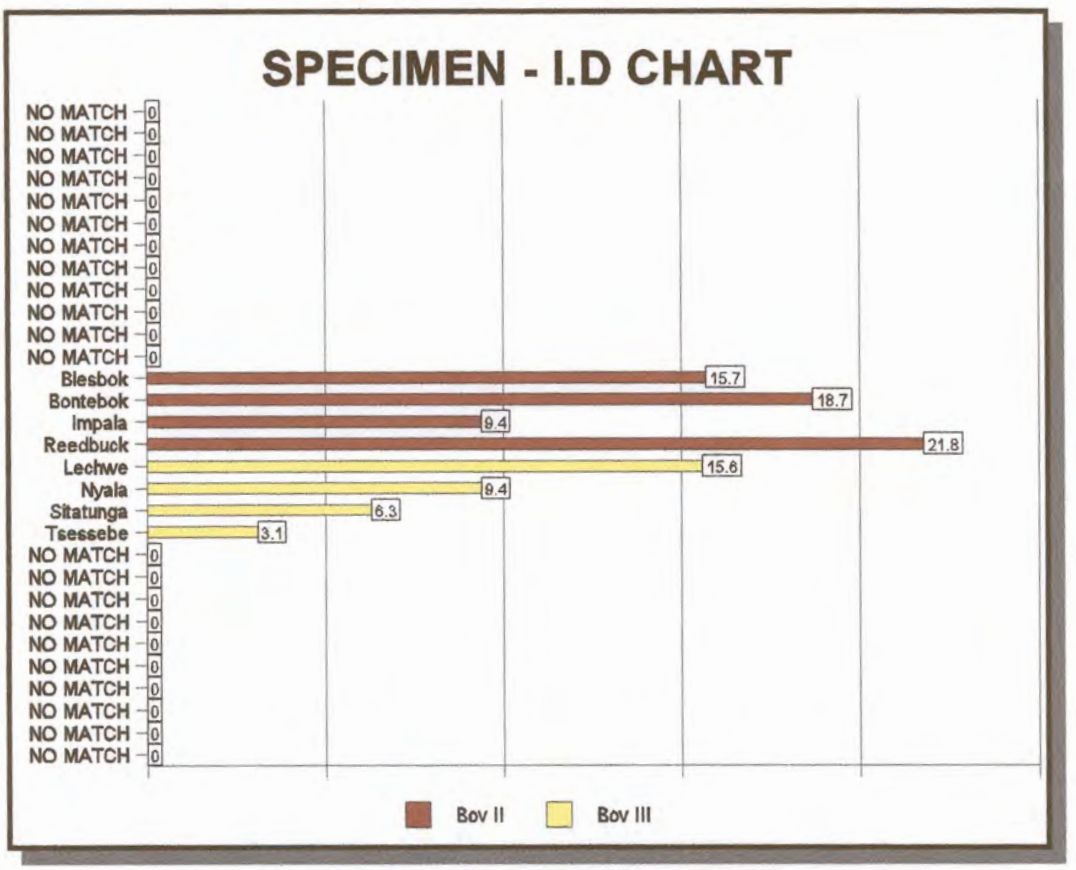

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Blesbok | 6% | Reedbuck | 6% |
| Bontebok | 6% | Nyala | 6% |
| Impala | 6% | | |

## KEMP'S CAVE SPECIMEN (LKC/93/35) Blesbok metatarsal

**TABLE 4.18:** Measurements of specimen LKC/93/35.

| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | 17.3 | - | 26.6 | 31.6 | 21.8 | 11.9 | 18.3 | 12.2 | - | - | - | - | - |

**FIGURE 4.25:** Identification chart of LKC/93/35 - FPP (%).



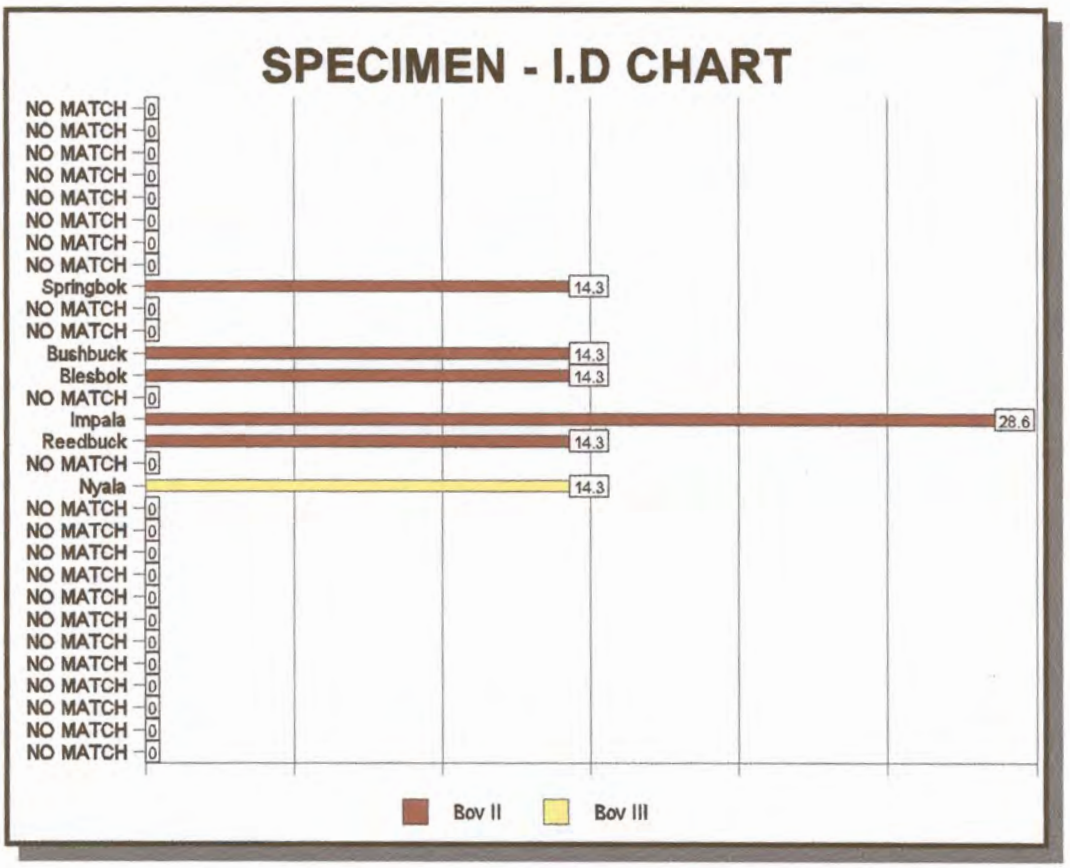

| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Blesbok | 31% | Lechwe | 30% |
| Bontebok | 38% | Nyala | 19% |
| Impala | 19% | Sitatunga | 12% |
| Reedbuck | 44% | Tsessebe | 6% |

## KEMP'S CAVE SPECIMEN (LKC/92/34) Blesbok metatarsal

**TABLE 4.19:** Measurements of specimen LKC/92/34.

| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | 16.7 | - | 25.6 | - | - | - | - | - | - | - | - | - | - |

**FIGURE 4.26:** Identification chart of LKC/92/34 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Springbok | 6% | Impala | 13% |
| Bushbuck | 6% | Reedbuck | 6% |
| Blesbok | 6% | Nyala | 6% |

## 3.2 Modern collection specimens

Figures 4.27a to 4.36a show the results of the modern specimens measured. The result of the test include the specimen number (AZ Museum number), the measurements taken (Tables 4.20 - 4.29) , the specimen - ID chart (with FPP values) as well as the IPP values for each of the species calculated by the developed programme.

These specimens are of known origin and include bones which were not utilized in the developed database. All specimens are part of the skeletal collection of the National Flagship Institution's archaeozoological department.

All the specimens were complete bones thus all measurements could be entered. This gives the Identification Percentage Probability (IPP) significant value, and will therefore be discussed at each test.

Figures 4.27b to 4.36b accompany each identification chart of the modern collection test specimens. As the programme might be used by archaeozoologists who mostly analyse fragmented specimens (mostly either, shaft, proximal or distal fragments of long bones), each test identification was repeated three times. Only shaft , proximal or distal measurements was entered respectively. Results of these tests can be seen in Figures 4.27b to 4.36b which compare the FPP values of the different species identified when only certain measurements were entered.

**AZ 1069 (Fig 4.27a and b) Klipspringer:**

Although Klipspringer had a relative high IPP value (54%), it was Cape Grysbok and Red Duiker which had the highest (25.6%) fractional probabilities. The FPP value of Klipspringer increased from 16.3% (all measurements entered) to 20% when only the shaft measurements were used for identification, but was never

identified as having the highest FPP value (see Figure 4.27b).

**AZ 526 (Fig 4.28a and b) Grey Rhebuck:**

Grey Rhebuck had the highest FPP (37.9%) and this value increased further to 80% when only the shaft measurements was utilised for identification. The five other species identified showed varied fractional probabilities from 3.4% to 24.1%. Common Duiker, Springbok, Oribi and Impala did not feature on the identification chart during the proximal extremity measurement identification (see Figure 4.28b).

**AZ 645 (Fig 4.29a and b) Red Hartebeest:**

A total of nine species were identified and was assigned a positive IPP value and showed varied percentages (2% to 22%) fractional probabilities. Although Tssesebe had the highest FPP value (22%), the Red Hartebeest had the second highest FPP value (20%) as well as a very high (77%) IPP value. It must be taken into account that there were only one Tsessebe specimen available for the database measurements. A larger sample size might have had different results, which may have identified Red Hartebeest as the most probable species. As can be seen in Figure 4.29b, Blesbok and Bontebok were only identified as being probable species with the distal extremity measurements. Tsessebe and Red Hartebeest showed equal (33.3%) FPP values in the proximal extremity input. The different measurement inputs did therefore not change the most probable species but did enhance the chances of it being correctly identified as Red Hartebeest.

**AZ 782 (Fig 4.30a and b) Steenbok:**

This result positively identified the specimen as Steenbok being the most probable species with a 29.8% fractional probability and a very high (93%) IPP value. Four other species showed positive IPP values with fractional probability values of

between 2.1% and 25.5%. The distal extremity measurement input showed that the FPP of Red Duiker increased substantially to a value equal to that of Steenbok (33.3%) with the same measurements entered (see Figure 4.30b).

**AZ 1032 (Fig 4.31a and b) Springbok:**

This specimen was identified as being either Mountain Reedbuck or Grey Rhebuck with equal FPP values (27.3%). Springbok had a FPP value of only 12.1%, but a 27% IPP value. Thus, although it was not identified as the most probable species, the measurements entered still corresponded with a 27% value with that of Springbuck. In Figure 4.31b it can clearly be seen that the reason why Reedbuck and Grey Rhebuck were identified as the most probable species, was because the shaft measurement entered matched almost perfectly with that of these two species.

**AZ 145 (Fig 4.32a and b) Black Wildebeest:**

This specimen was also positively identified as Black Wildebeest. Although the FPP vlaue was relatively low (21.1%), the IPP was 73%. The reason for the FPP value being low was that 12 other species also showed resemblance to some of the measurements. The FPP values ranged between 1.7% to 18.3%. If, however, only the distal extremity measurements would have been available, it would have identified Tsessebe and Red Hartebeest as being the most probable species (Figure 4.32b).

**AZ 1572 (Fig 4.33a and b) Cape Grysbok:**

Red Duiker was identified as being the most probable species with a very high FPP value (64.3%). Suni and Steenbok both had a FPP value of 7.1% and a IPP of 6%. Cape Grysbok was identified with a IPP of 19% and a fractional probability of 21.4%. If, however, only proximal measurements were entered into the system the

most probable species would have Cape Grysbok (40%) and the FPP value of Red Duiker would have decreased to 20% (Figure 4.33b). Both Suni and Steenbok only showed correlation with the shaft measurements entered.

**AZ 931 (Fig 4.34a and b) Bontebok:**

More than ten species were identified with fractional probabilities ranging form 1.6% to 15.9%. The large number of species identified as having corresponding measurements medians with that of the specimen entered, resulted in relatively low FPP values. Nyala and Blesbok had the highest (15.9%) FPP values. Although Bontebok had only a 12.7% chance of being the probable species, results showed that 50% of the measurements corresponded with the measurement entered. In Figure 4.34b it can be seen that Reedbuck would have been identified as the most probable species if only the distal extremity measurements would have been available. The proximal measurement values of Blesbok, as well as the distal measurements of Nyala showed to be the most significant measurements which identified them as the most probable species.

**AZ 127 (Fig 4.35a and b) Sable:**

Although Sable was identified as the second most probable species with a 11.8% FPP value, it was Black Wildebeest with a 14.1% FPP value that was identified as the most probable species. Nine of the 17 species identified showed correlation with only the shaft measurements with a FPP probability of 3.5%. Sable was, however, identified as being the most probable species when only the proximal measurements were entered. Red Hartebeest, however, would have been the most probabale species if the only measurements that were entered were that of the distal extremity (Figure 4.35b).

**AZ 1457 (Fig 3.36) Eland:**

Only three species were illustrated on the identification chart. These included Kudu and Eland with a 25% fractional probability and Buffalo with a 50% FPP value. In Figure 4.36b it can clearly be seen that the proximal and distal extremity measurements of the Buffalo showed a 100% correlation with that of the measurements entered. The shaft measurements, however, resembled that of the Eland and Kudu better (37.5%).

30% of the tests on the modern specimen collection showed the correct species as having the highest probability. There was, however, no identification chart that did not include the correct species and all showed these species as having the second or third highest FPP value.

By entering different sets of values which included elements of respectively the shaft, proximal extremity and distal extremity did in some cases change the results drastically in some cases and the correct species were identified as either sharing the highest FPP value or having the highest.

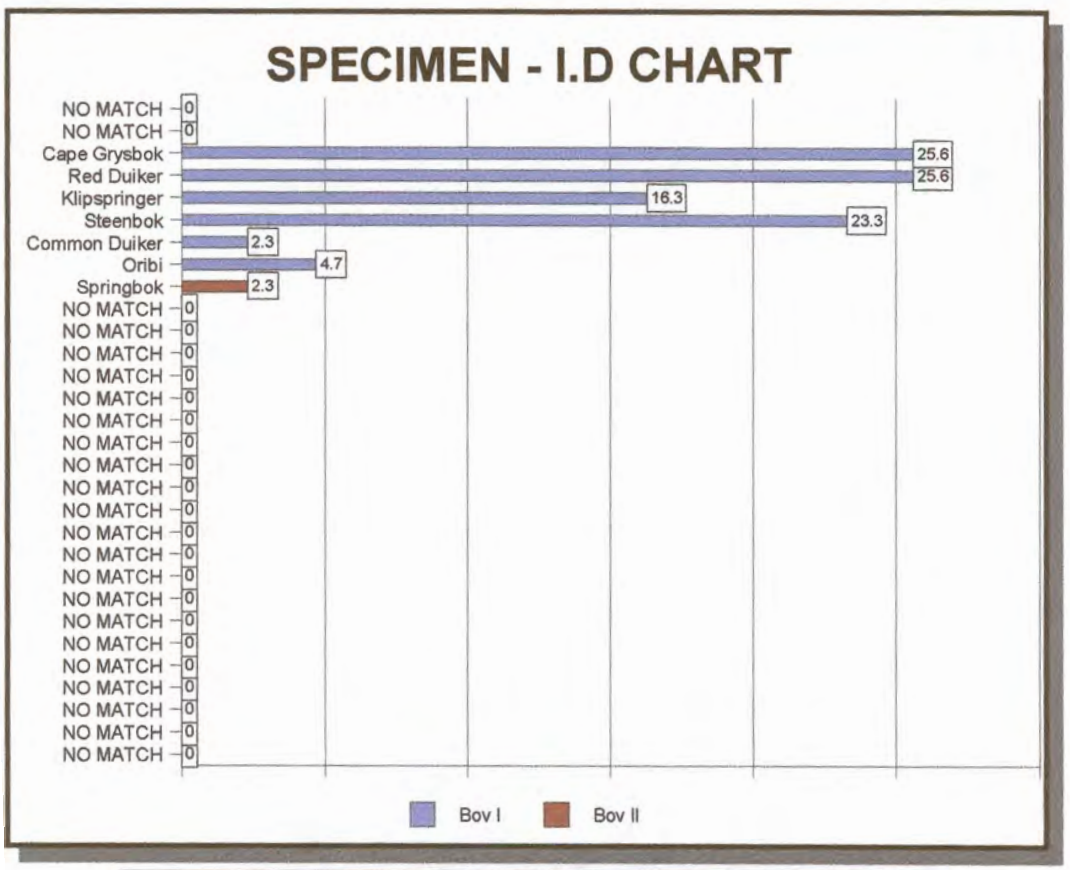
Table 4.30 gives a summary of the results when different measurements were entered into the computer programme with the modern collection test results. As can be seen, the proximal extremities of all three bones showed a higher (60%) identification accuracy. Six of the ten specimens that were not identified as the most probable species when all measurements were entered, were correctly identified when only measurements of certain portions of the bone were utilized. Only one specimen (AZ 526) was constantly identified as the most probable species, no matter which separate elements were entered.

## MODERN SPECIMEN (AZ 1069) Klipspringer femur

**TABLE 4.20:** Measurements of specimen AZ 1069.

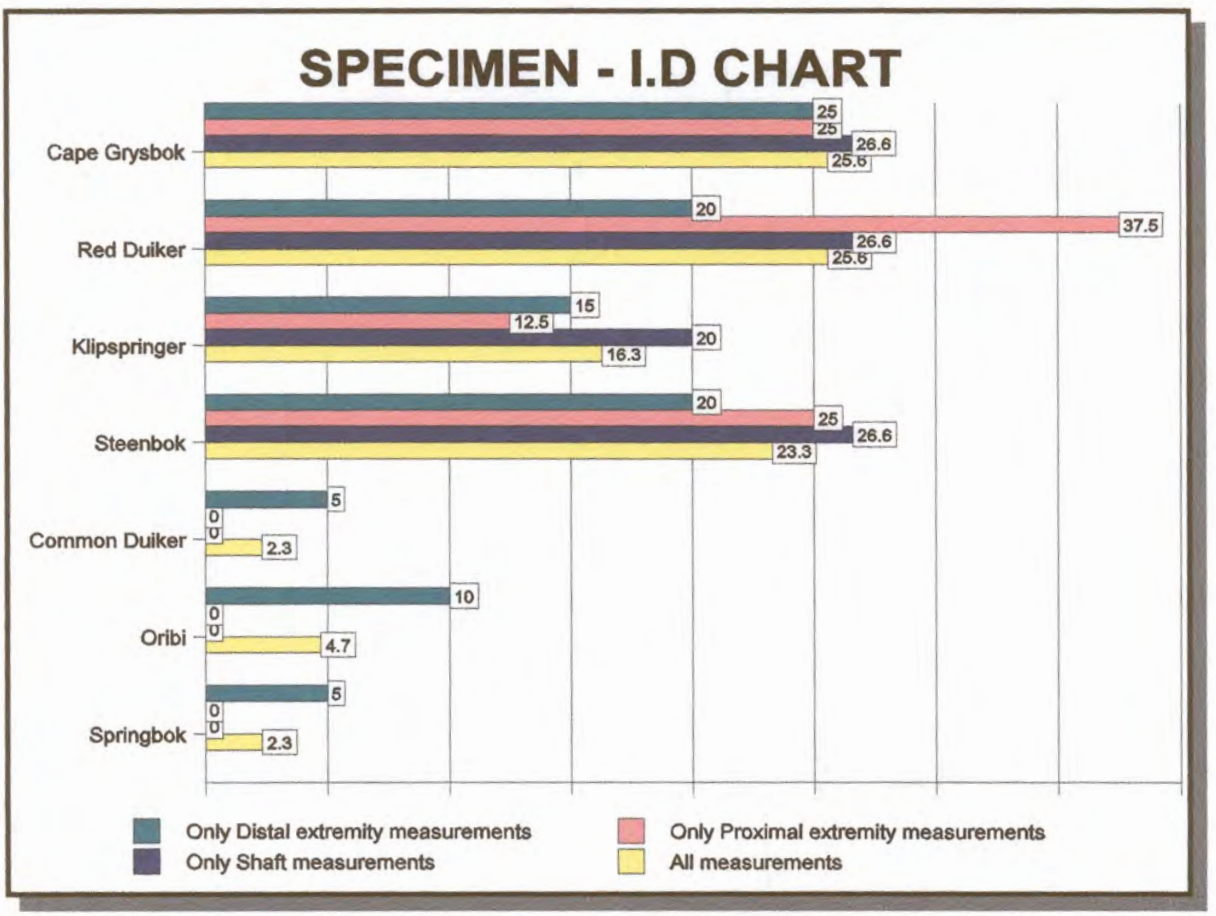
| F(GL) | F(GLH) | F(SBD) | F(SCD) | F(GBP) | F(GDH) | F(GBH) | F(GBD) | F(GLDD) | F(GMDD) | F(GBCF) | F(SBCF) | F(GBT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 151.5 | 149.0 | 12.1 | 40.0 | 33.0 | 16.1 | 18.5 | 30.0 | 33.0 | 35.5 | 9.3 | 8.3 | 14.2 |

**FIGURE 4.27a:** Identification chart of AZ 1069 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Cape Grysbok | 85% | Common Duiker | 8% |
| Red Duiker | 85% | Oribi | 15% |
| Klipspringer | 54% | Springbok | 8% |
| Steenbok | 77% | | |

**FIGURE 4.27b:** Differences in measurement input of AZ 1069 - FPP (%).

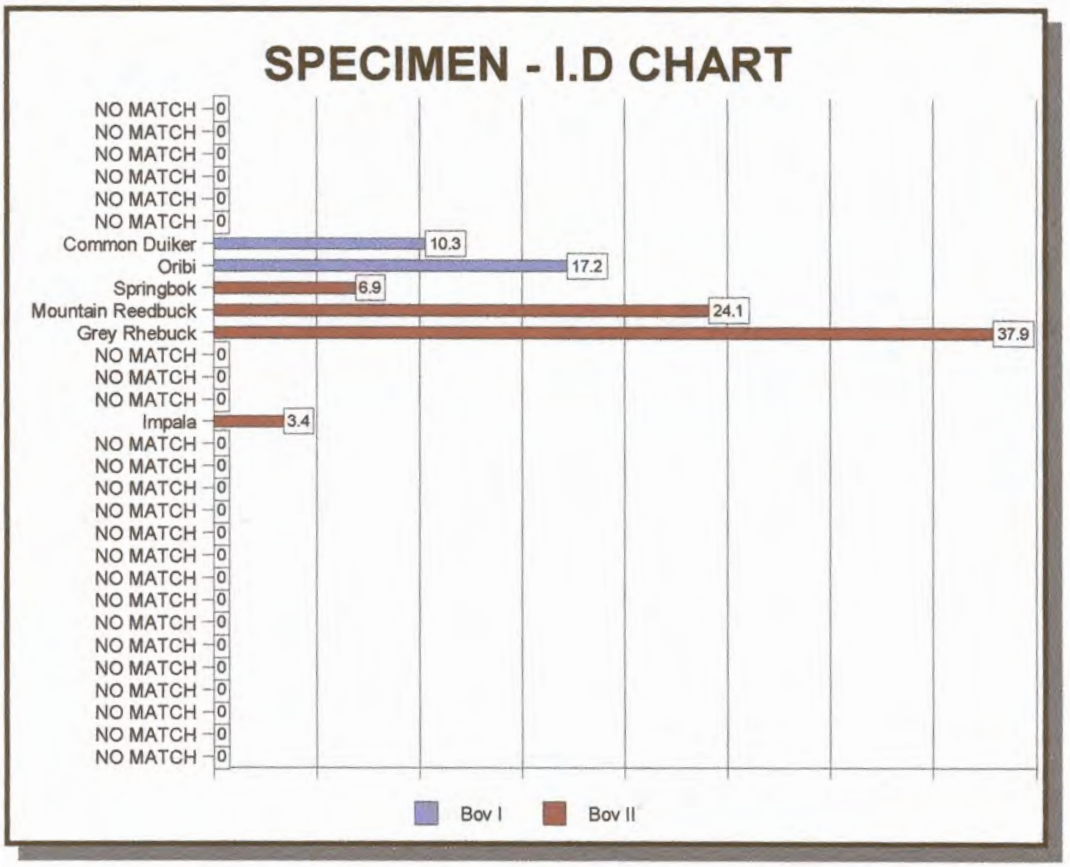


## MODERN SPECIMEN (AZ 526) Grey Rhebuck femur

**TABLE 4.21:** Measurements of specimen AZ 526.

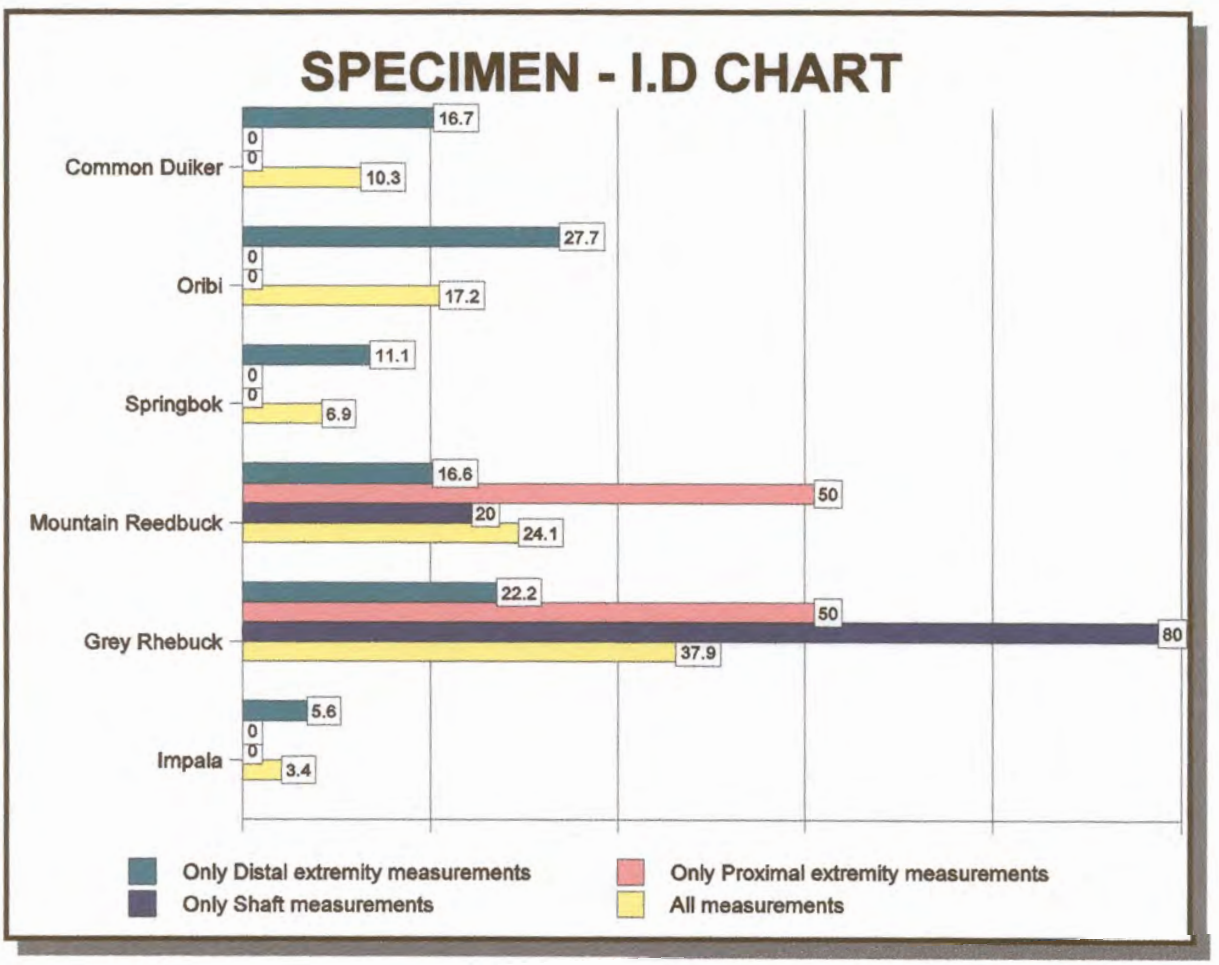
| F(GL) | F(GLH) | F(SBD) | F(SCD) | F(GBP) | F(GDH) | F(GBH) | F(GBD) | F(GLDD) | F(GMDD) | F(GBCF) | F(SBCF) | F(GBT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 190.0 | 185.0 | 16.3 | 52.0 | 46.3 | 20.2 | 27.0 | 37.6 | 42.8 | 47.4 | 11.0 | 8.2 | 20.5 |

**FIGURE 4.28a:** Identification chart of AZ 526 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Common Duiker | 23% | Mountain Reedbuck | 54% |
| Oribi | 38% | Grey Reedbuck | 85% |
| Springbok | 15% | Impala | 8% |

**FIGURE 4.28b:** Differences in measurement input of AZ 526 - FPP (%)

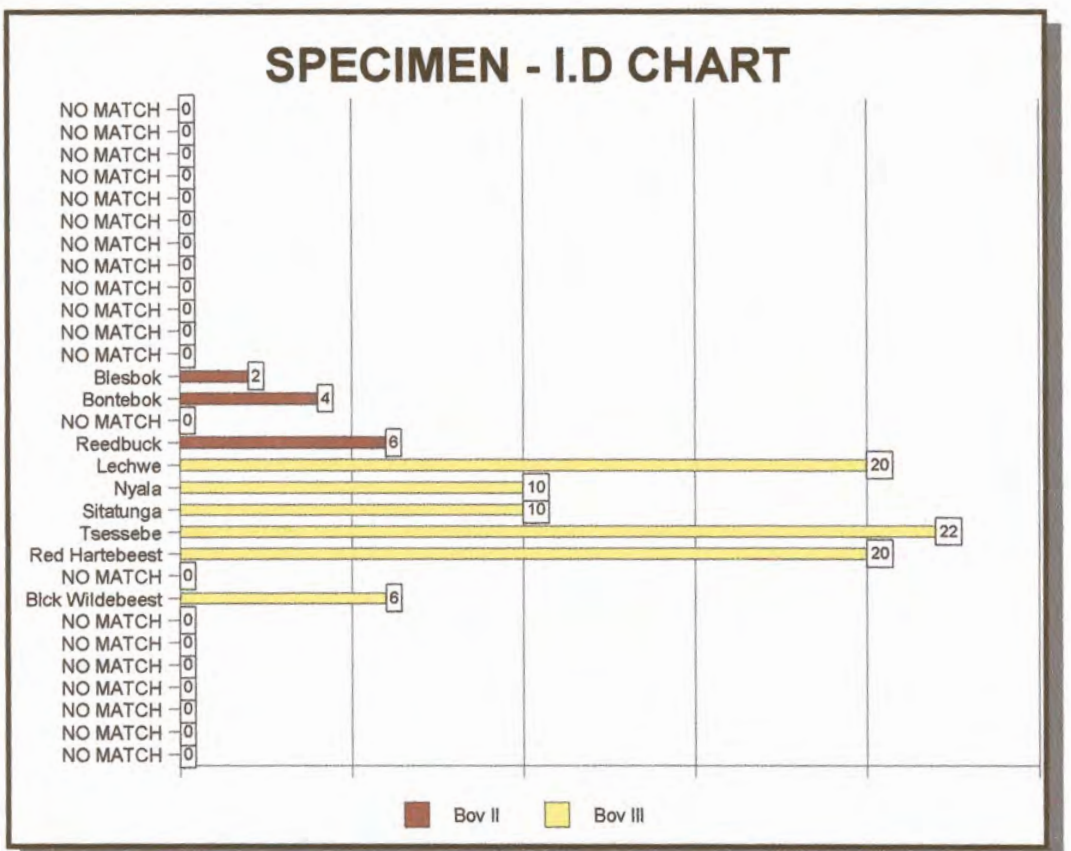


## MODERN SPECIMEN (AZ 645) Red Hartebeest femur

**TABLE 4.22:** Measurements of specimen AZ 645.

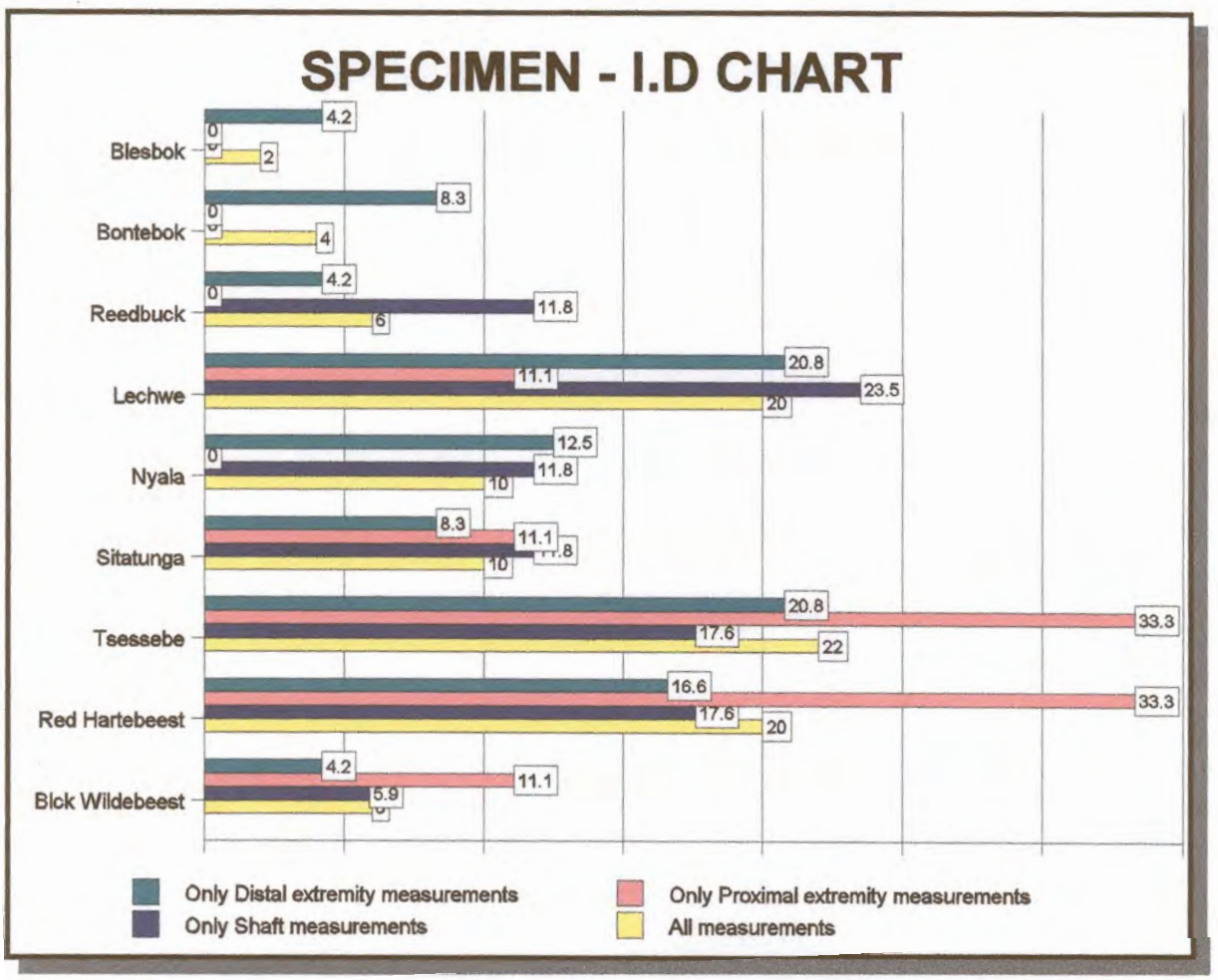
| F(GL) | F(GLH) | F(SBD) | F(SCD) | F(GBP) | F(GDH) | F(GBH) | F(GBD) | F(GLDD) | F(GMDD) | F(GBCF) | F(SBCF) | F(GBT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 281.5 | 268.0 | 23.5 | 80.0 | 77.6 | 33.5 | 42.9 | 62.6 | 71.2 | 83.8 | 13.8 | 11.8 | 32.2 |

**FIGURE 4.29a:** Identification chart of AZ 645 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Blesbok | 8% | Sitatunga | 38% |
| Bontebok | 15% | Tsessebe | 85% |
| Reedbuck | 23% | Red Hartebeest | 77% |
| Lechwe | 77% | Black Wildebeest | 23% |
| Nyala | 38% | | |

**FIGURE 4.29b:** Differences in measurement input of AZ 645 - FPP (%).

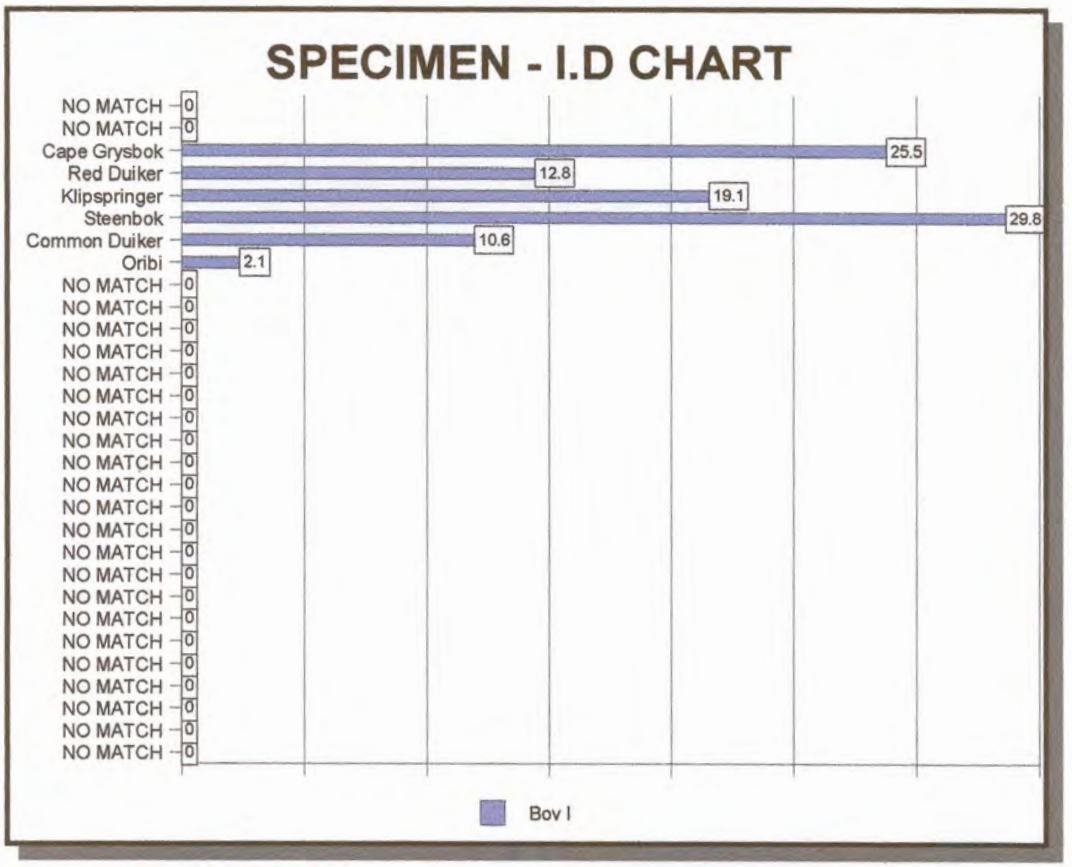


## MODERN SPECIMEN (AZ 782) Steenbok tibia

**TABLE 4.23:** Measurements of specimen AZ 782.

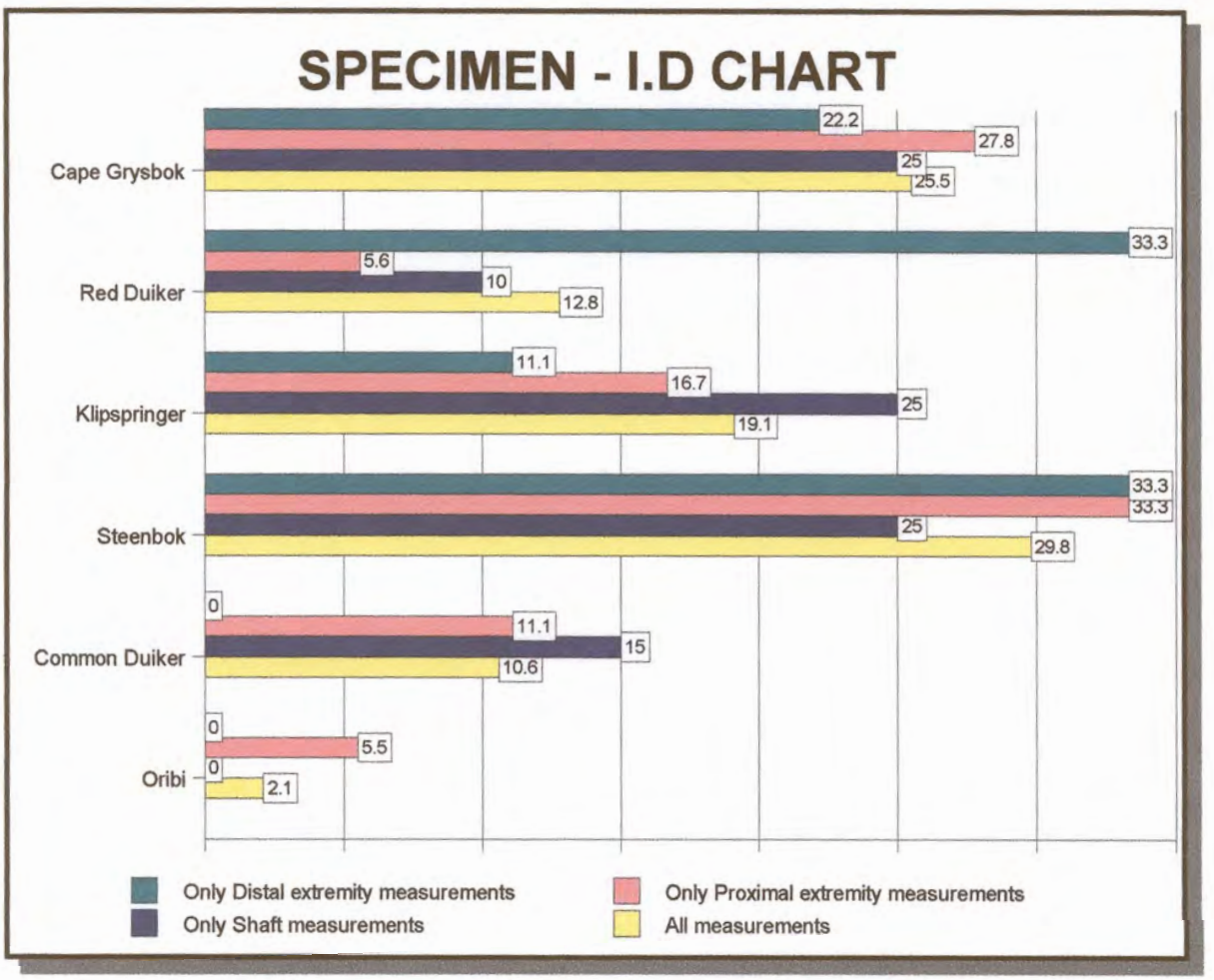
| T(GL) | T(GML) | T(GLL) | T(SBD) | T(SCD) | T(GBP) | T(GDP) | T(GDLC) | T(GDMC) | T(GDT) | T(GDTN) | T(SBIE) | T(GBD) | T(GDD) | T(SDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 183.0 | 180.5 | 180.0 | 12.2 | 37.0 | 30.8 | 35.0 | 22.7 | 19.2 | 34.5 | 10.5 | 6.6 | 19.1 | 14.9 | 10.4 |

**FIGURE 4.30a:** Identification chart of AZ 782 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Cape Grysbok | 80% | Steenbok | 93% |
| Red Duiker | 40% | Common Duiker | 33% |
| Klipspringer | 60% | Oribi | 7% |

**FIGURE 4.30b:** Differences in measurement input of AZ 782 - FPP (%).

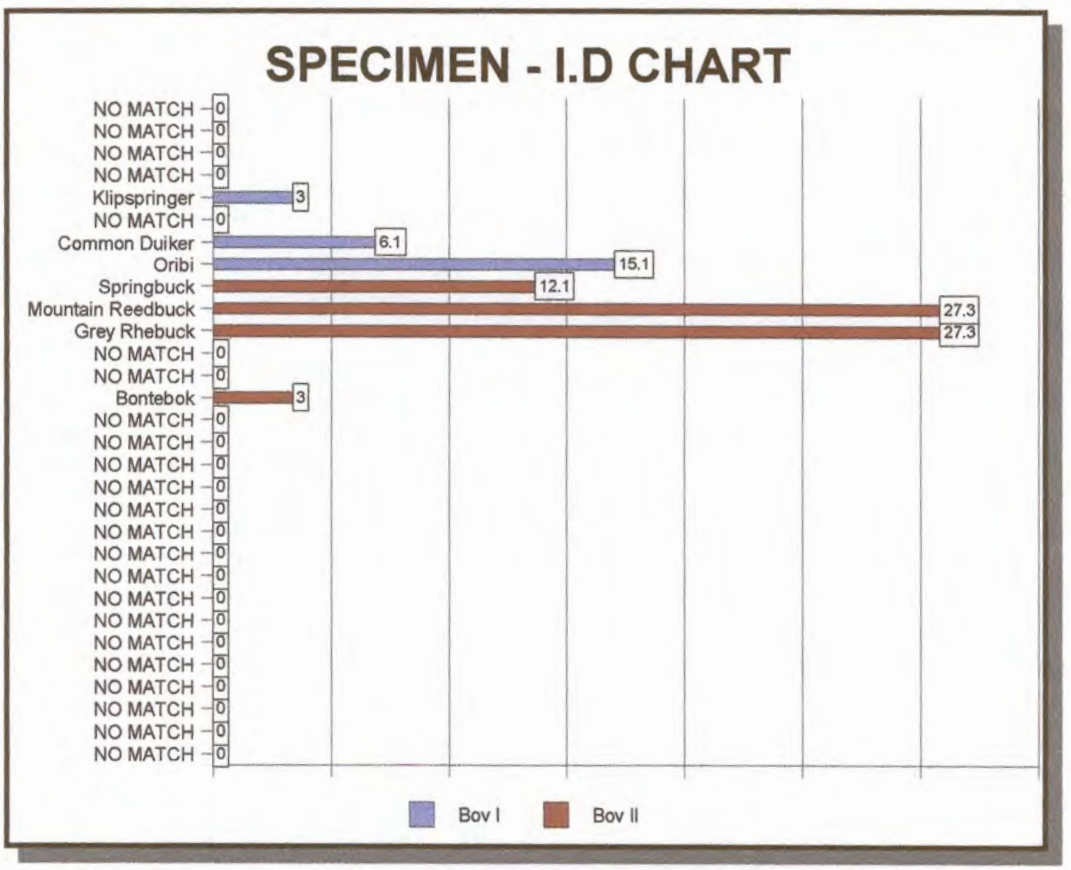


## MODERN SPECIMEN (AZ 1032) Springbuck tibia

**TABLE 4.24:** Measurements of specimen AZ 1032.

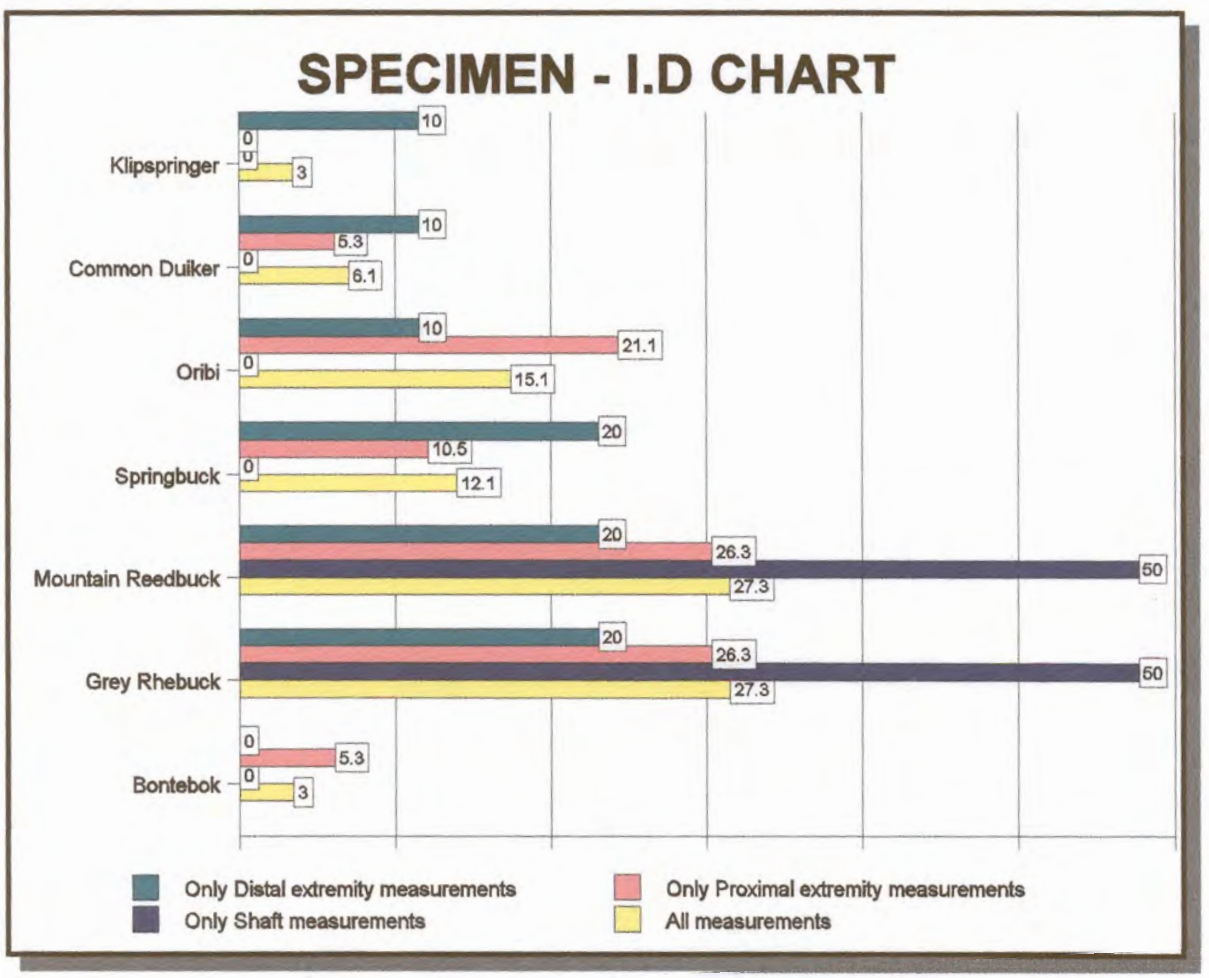
| T(GL) | T(GML) | T(GLL) | T(SBD) | T(SCD) | T(GBP) | T(GDP) | T(GDLC) | T(GDMC) | T(GDT) | T(GDTN) | T(SBIE) | T(GBD) | T(GDD) | T(SDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 232.0 | 227.0 | 224.5 | 16.9 | 51.0 | 42.8 | 43.5 | 29.3 | 22.4 | 40.5 | 11.7 | 8.9 | 28.1 | 21.6 | 13.0 |

**FIGURE 4.31a:** Identification chart of AZ 1032 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Klipsrpinger | 7% | Mountain Reedbuck | 60% |
| Common Duiker | 13% | Grey Rhebuck | 6% |
| Oribi | 33% | Bontebok | 7% |
| Springbok | 27% | | |

**FIGURE 4.31b:** Differences in measurement input of AZ 1032 - FPP (%).

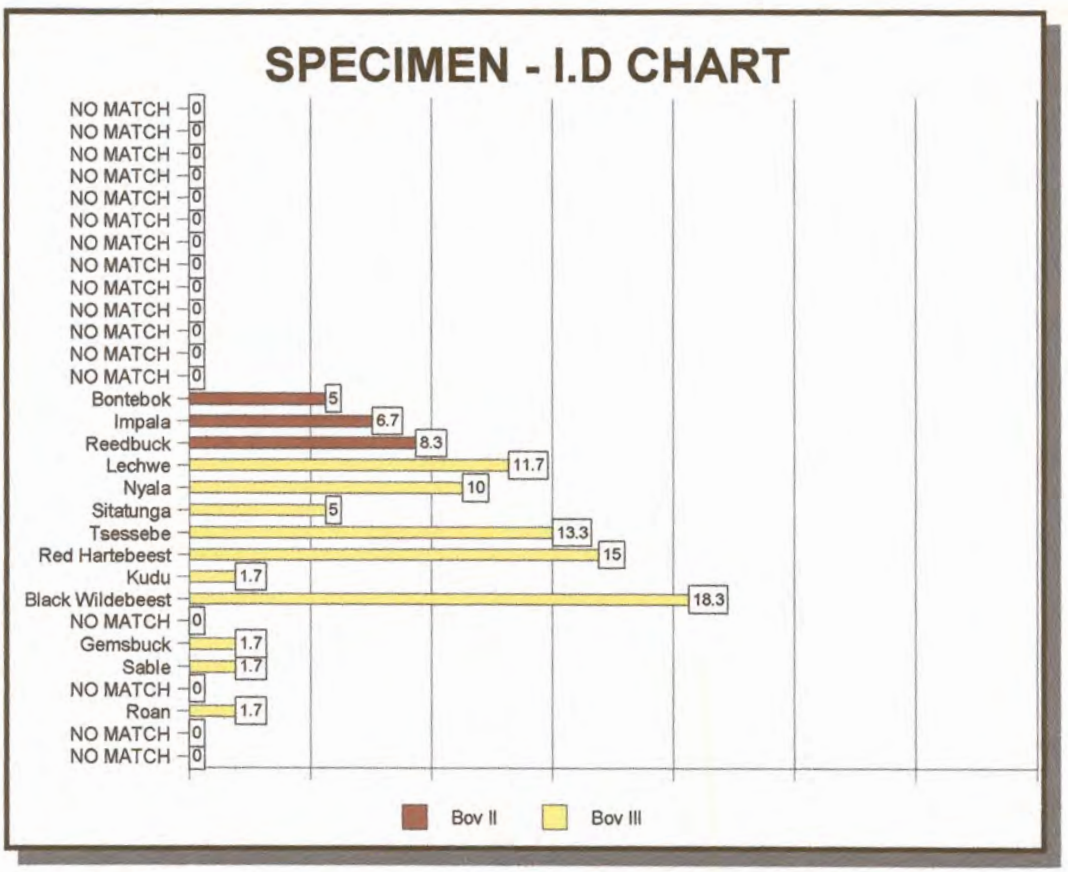


## MODERN SPECIMEN (AZ 145) Black Wildebeest tibia

**TABLE 4.25:** Measurements of specimen AZ 145.

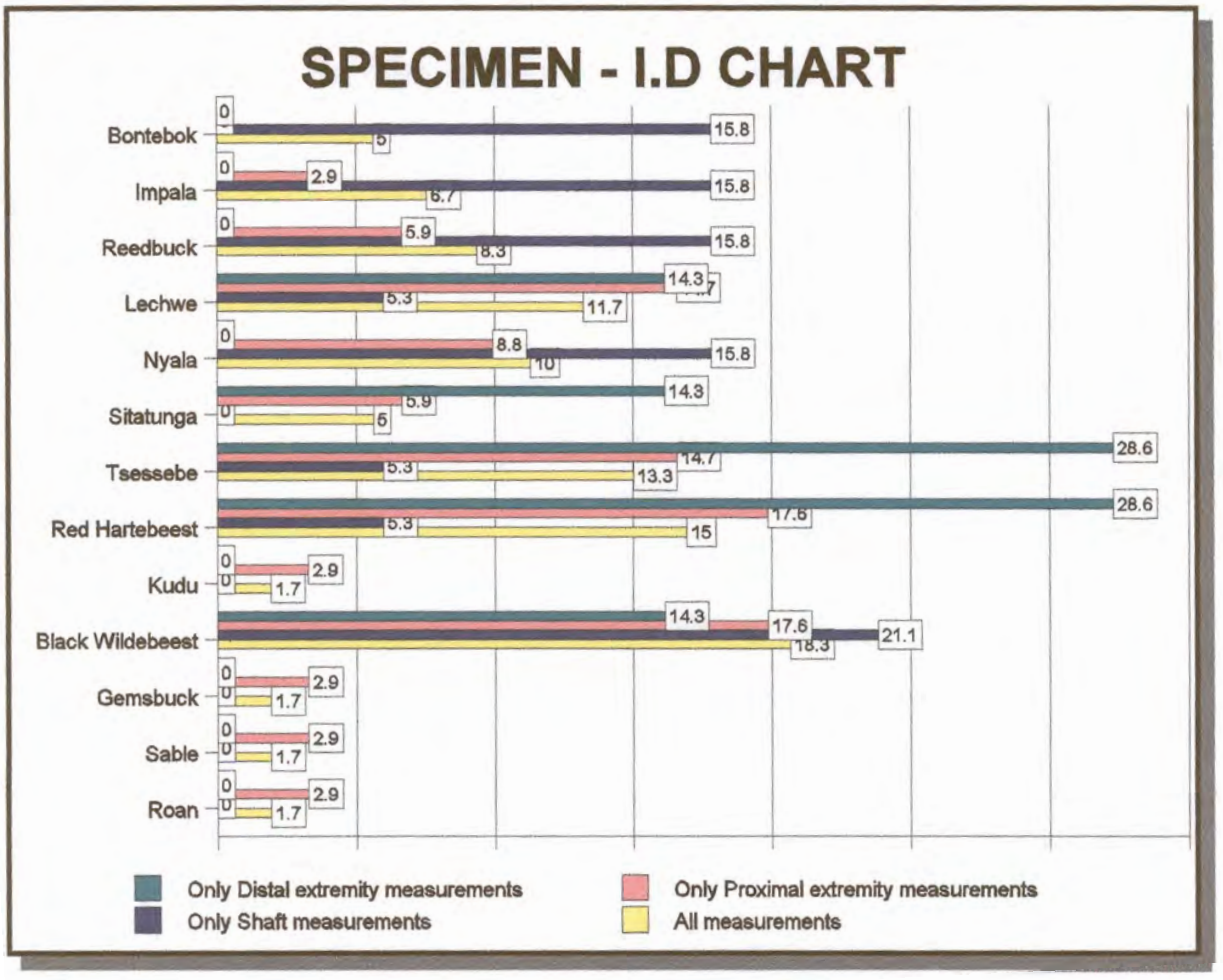
| T(GL) | T(GML) | T(GLL) | T(SBD) | T(SCD) | T(GBP) | T(GDP) | T(GDLC) | T(GDMC) | T(GDT) | T(GDTN) | T(SBIE) | T(GBD) | T(GDD) | T(SDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 312.0 | 302.5 | 298.5 | 26.9 | 76.0 | 72.3 | 67.5 | 39.9 | 42.6 | 57.5 | 18.0 | 12.4 | 42.4 | 32.3 | 22.7 |

**FIGURE 4.32a:** Identification chart of AZ 145 - FPP (%).




| SPECIES | IPP | SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|---|---|
| Bontebok | 20% | Sitatunga | 20% | Black Wildebeest | 73% |
| Impala | 27% | Tsessebe | 53% | Gemsbuck | 7% |
| Reedbuck | 33% | Red Hartebeest | 60% | Sable | 7% |
| Lechwe | 47% | Kudu | 7% | Roan | 7% |
| Nyala | 40% | | | | |

**FIGURE 4.32b:** Differences in measurement input of AZ 145 - FPP (%).

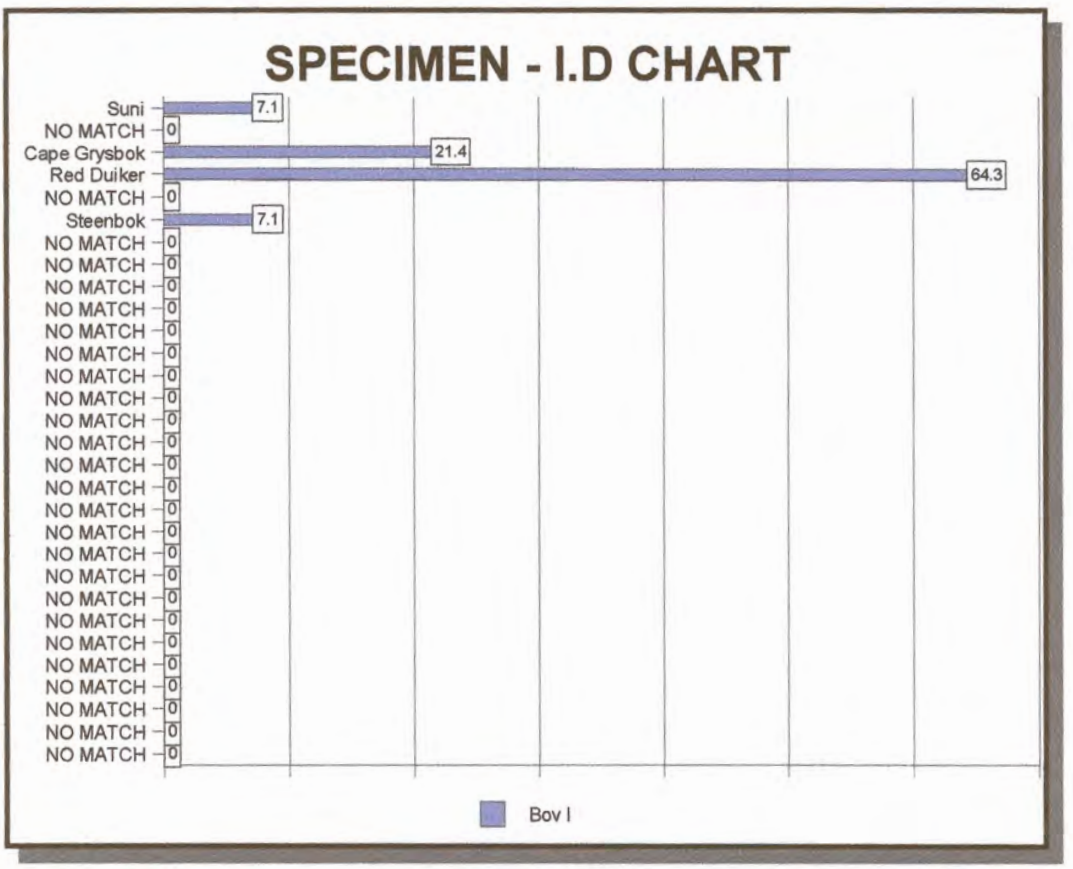


## MODERN SPECIMEN (AZ 1572) *Cape Grysbok metatarsal*

**TABLE 4.26:** Measurements of specimen AZ 1572.

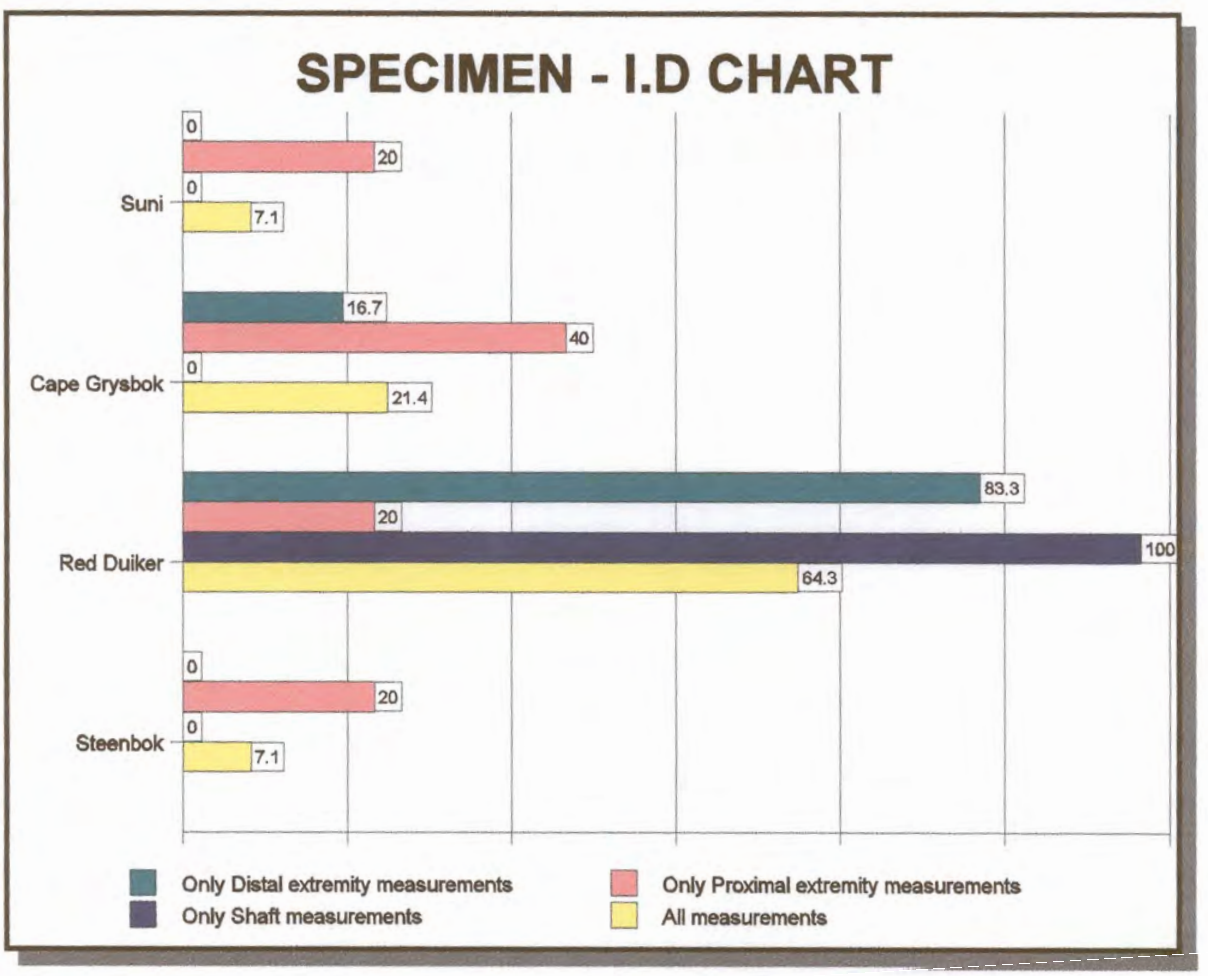
| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 121.0 | 118.5 | 119.9 | 8.2 | 28.0 | 14.6 | 14.5 | 10.9 | 4.6 | 7.5 | 6.2 | 15.7 | 11.4 | 7.4 | 6.9 | 7.5 |

**FIGURE 4.33a:** Identification chart of AZ 1572 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Suni | 6% | Red Duiker | 56% |
| *Cape Grysbok* | 19% | Steenbok | 6% |

**FIGURE 4.33b:** Differences in measurement input of AZ 1572 - FPP (%).

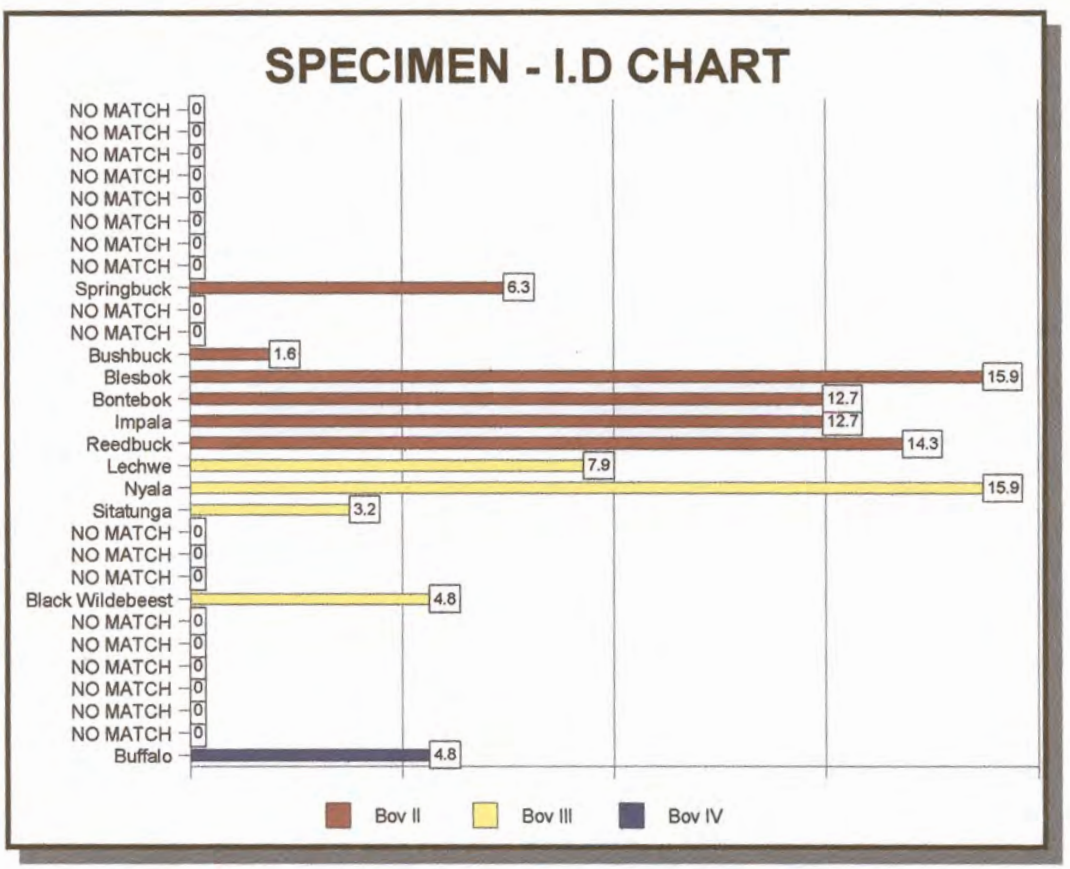


## MODERN SPECIMEN (AZ 931) Bontebok metatarsal

**TABLE 4.27:** Measurements of specimen AZ 931.

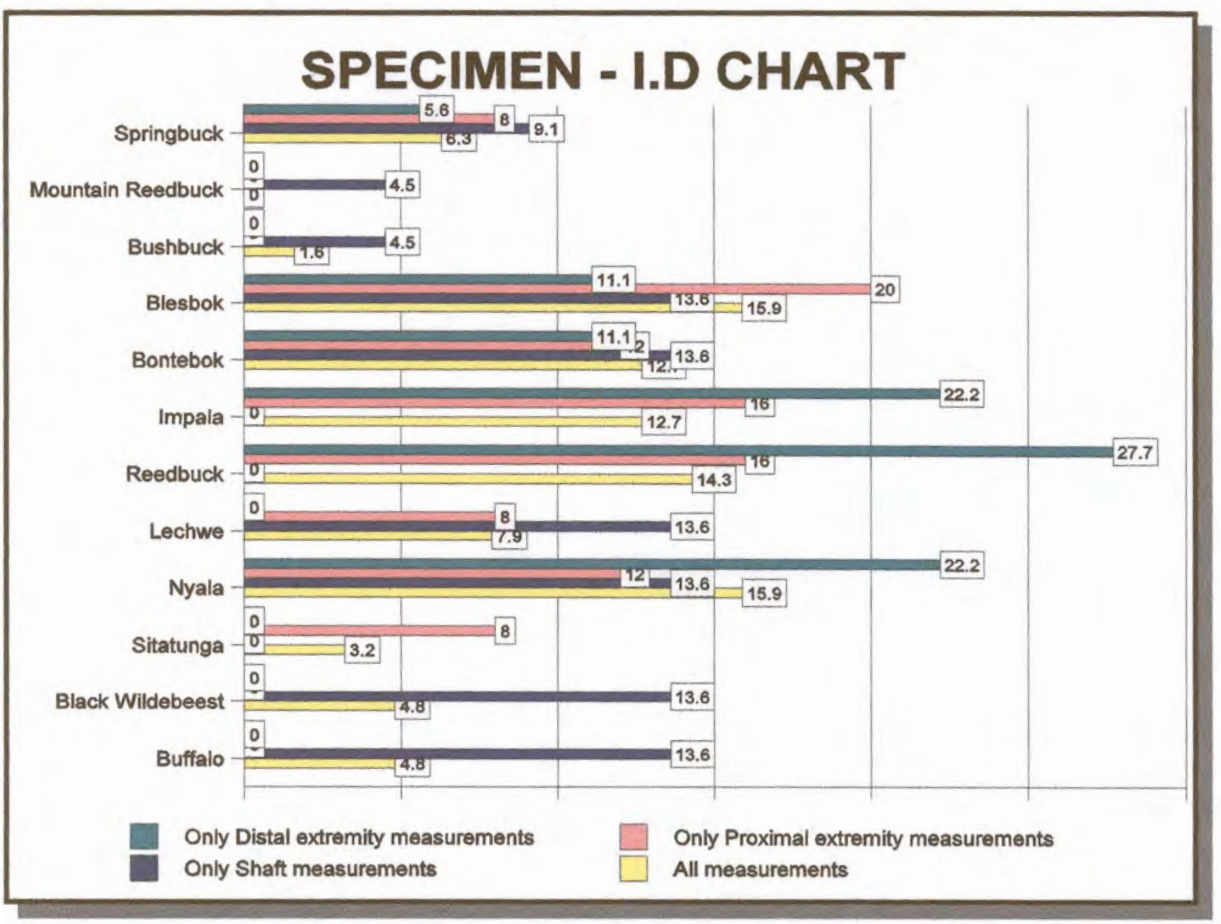
| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 217.0 | 213.0 | 214.0 | 14.3 | 48.0 | 27.2 | 28.9 | 19.7 | 12.0 | 18.0 | 10.6 | 28.4 | 20.7 | 12.7 | 12.7 | 14.3 |

**FIGURE 4.34a:** Identification chart of AZ 931 - FPP (%).




| SPECIES | IPP | SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|---|---|
| Springbok | 31% | Impala | 50% | Sitatunga | 13% |
| Bushbuck | 6% | Reedbuck | 56% | Black Wildebeest | 19% |
| Blesbok | 63% | Lechwe | 31% | Buffalo | 19% |
| Bontebok | 50% | Nyala | 63% | | |

**FIGURE 4.34b:** Differences in measurement input of AZ 931 - FPP (%).

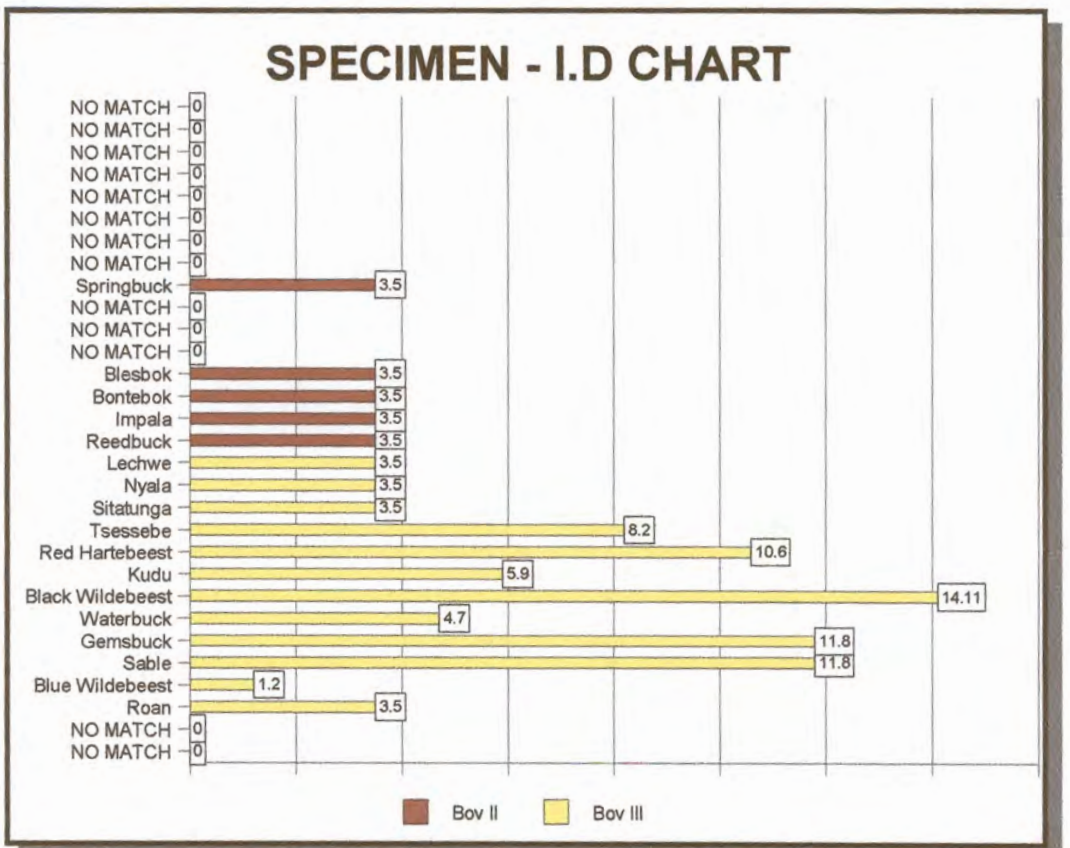


## MODERN SPECIMEN (AZ 127) Sable metatarsal

**TABLE 4.28:** Measurements of specimen AZ 127.

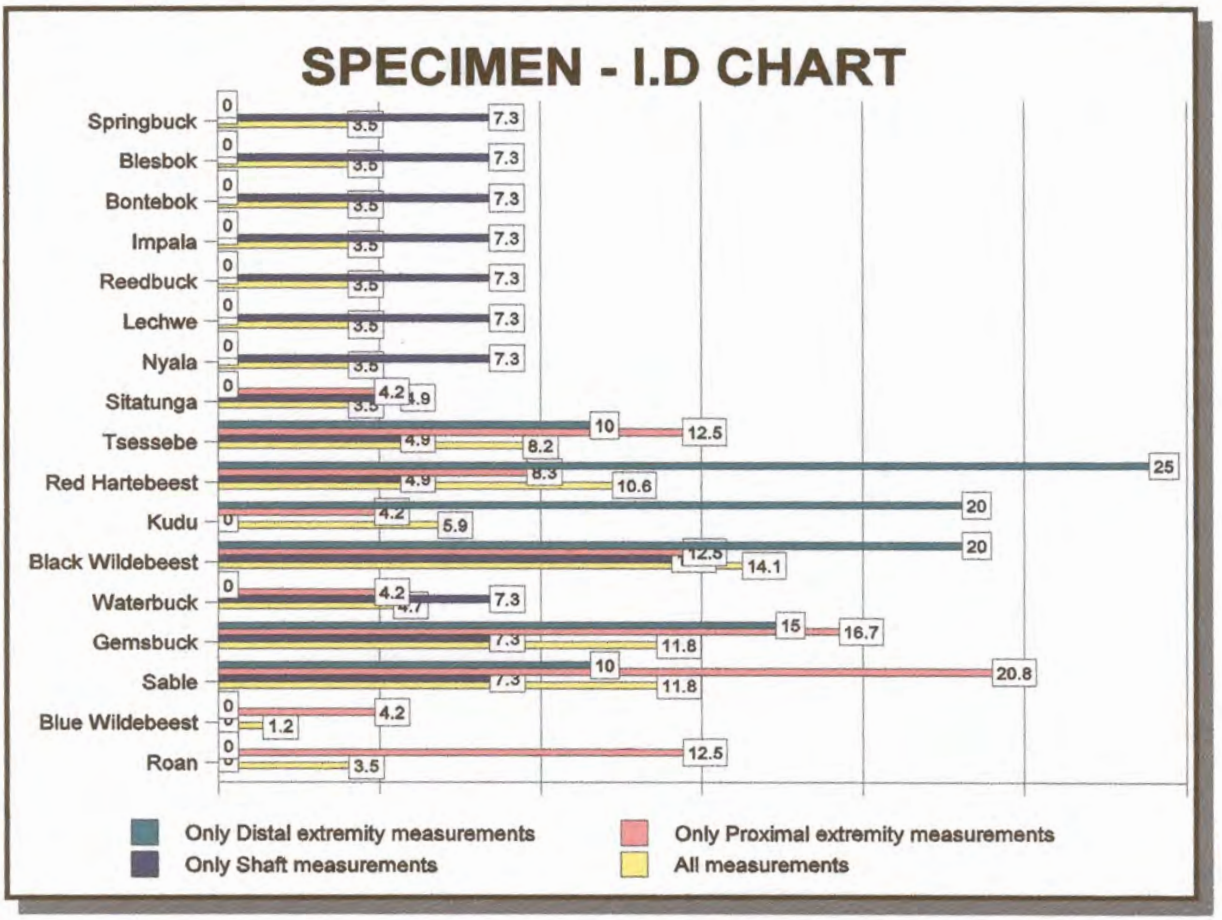
| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 234.0 | 228.0 | 230.0 | 21.1 | 73.0 | 37.8 | 38.2 | 26.7 | 15.9 | 21.7 | 15.2 | 42.2 | 27.5 | 19.9 | 19.0 | 19.0 |

**FIGURE 4.35a:** Identification chart of AZ 127 - FPP (%).




| SPECIES | IPP | SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|---|---|
| Springbok | 19% | Nyala | 19% | Waterbuck | 25% |
| Blesbok | 19% | Sitatunga | 19% | Gemsbuck | 63% |
| Bontebok | 19% | Tsessebe | 44% | Sable | 63% |
| Impala | 19% | Red Hartebeest | 56% | Blue Wildebeest | 6% |
| Reedbuck | 19% | Kudu | 31% | Roan | 19% |
| Lechwe | 19% | Black Wildebeest | 75% | | |

**FIGURE 4.35b:** Differences in measurement input of AZ 127 - FPP (%).

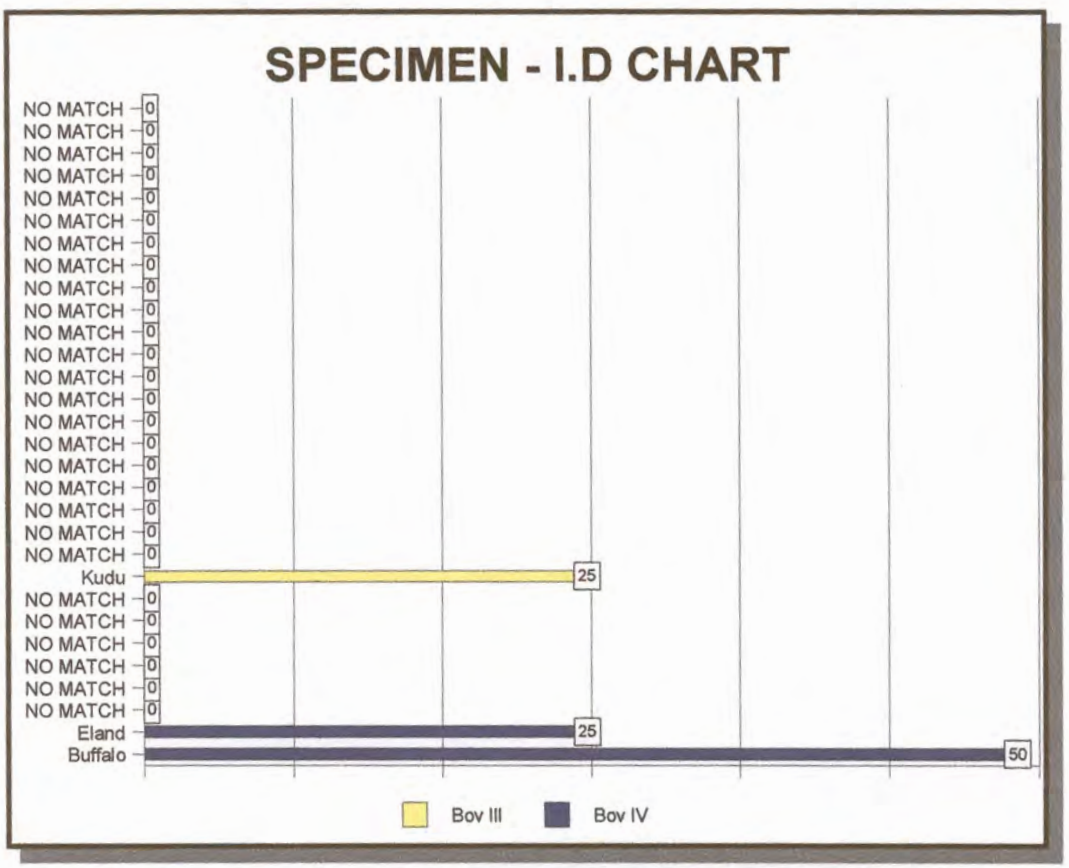


## MODERN SPECIMEN (AZ 1457) Eland metatarsal

**TABLE 4.29:** Measurements of specimen AZ 1457.

| M(GL) | M(GML) | M(GLL) | M(SBD) | M(SCD) | M(GBP) | M(GDP) | M(GLMA) | M(GBMA) | M(GLLA) | M(GBLA) | M(GBD) | M(GDD) | M(GMBC) | M(GBLC) | M(GBDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 316.0 | 310.0 | 312.0 | 37.0 | 123.0 | 57.5 | 58.5 | 40.9 | 24.0 | 40.0 | 24.0 | 60.4 | 40.4 | 28.6 | 27.8 | 28.6 |

**FIGURE 4.36a** Identification chart of AZ 1457 - FPP (%).




| SPECIES | IPP | SPECIES | IPP |
|---|---|---|---|
| Kudu | 19% | Buffalo | 38% |
| Eland | 19% | | |

**FIGURE 4.36b** Differences in measurement input of AZ 1457 - FPP (%).

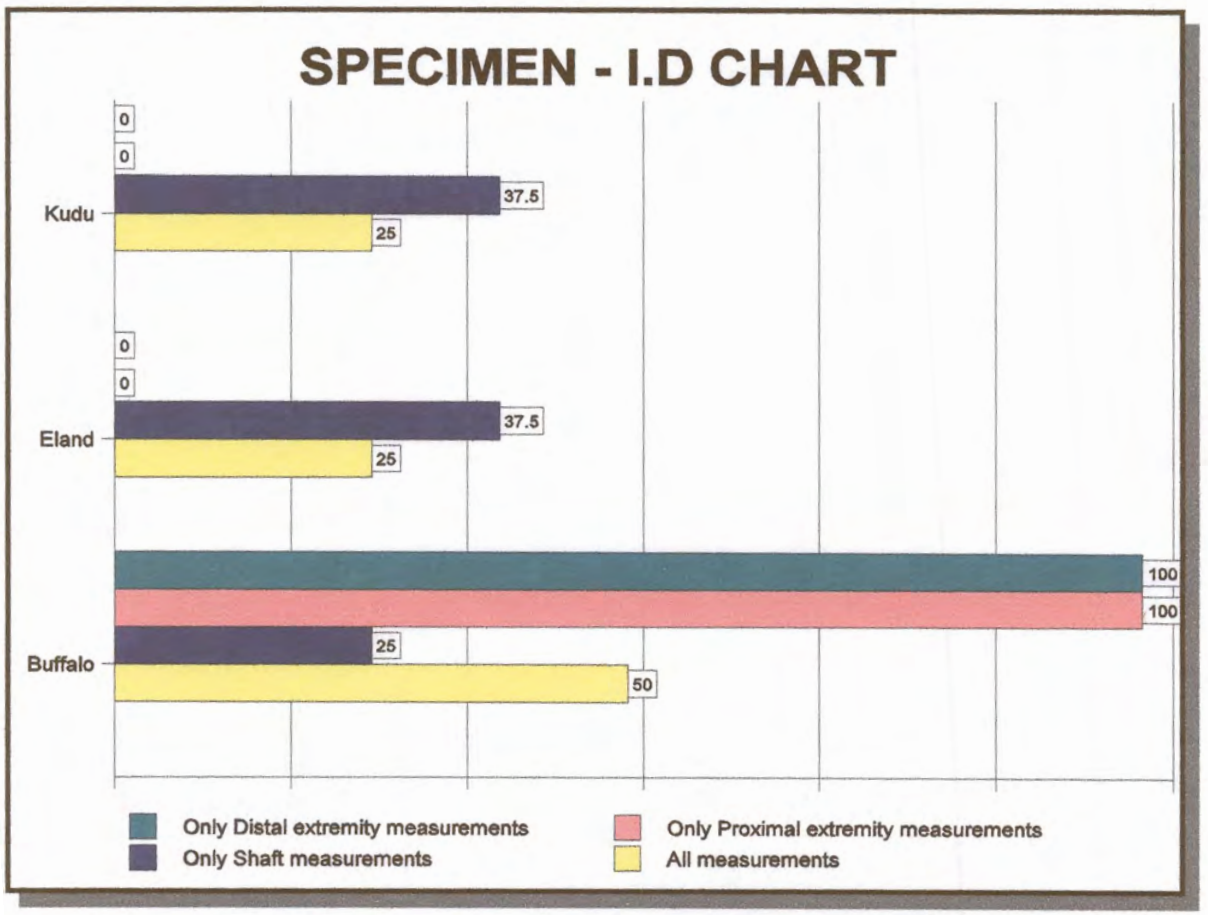


**TABLE 4.30:** Summary of the different measurement input results.

| Specimen | All | Shaft | Proximal | Distal |
|---|---|---|---|---|
| FEMUR | | | | |
| AZ 1069 (Klipspringer) | | | | |
| AZ 526 (Grey Rhebuck) | ● | ● | ● | ● |
| AZ 645 (Red Hartebeest) | | | ● | |
| Total for femur tests * | 33% | 33% | 66% | 33% |
| TIBIA | | | | |
| AZ 782 (Steenbok) | ● | | ● | ● |
| AZ 1032 (Springbuck) | | | | ● |
| AZ 145 (Black Wildebeest) | ● | ● | ● | |
| Total for tibia tests * | 66% | 33% | 66% | 66% |
| METATARSAL | | | | |
| AZ 1572 (Cape Grysbok) | | | ● | |
| AZ 931 (Bontebok) | | ● | | |
| AZ 127 (Sable) | | | ● | |
| AZ 1457 (Eland) | | ● | | |
| Total for metatarsal tests * | 0% | 50% | 50% | 0% |
| **GRAND TOTAL (%) **** | **30%** | **40%** | **60%** | **30%** |

● Identified as being the most probable species, thus having the highest FPP value
* The percentage of specimens of the femur, tibia or metatarsal specimens that was correctly identified as being the most probable species
** The total percentage of specimens that was correctly identified when respectively all, the shaft, the proximal extremity or the distal extremity measurements were entered into the computer programme