

**AMERICAN ZOO AND AQUARIUM ASSOCIATION
ANTELOPE TAXON ADVISORY GROUP**

ANTELOPE HUSBANDRY MANUAL

CEPHALOPHINAE



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**ZOOLOGICAL SOCIETY OF SAN DIEGO
at the
SAN DIEGO WILD ANIMAL PARK**

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**(previous page)
Zebra-banded Duiker
*Cephalophus zebra***

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CEPHALOPHINAE

GENERAL CHARACTERISTICS

Bay Duiker *Cephalophus dorsalis* (Gray, 1846)

wt. 15-24 kg. Ht. 40-56 cm
Bright chestnut color with a black dorsal band and a blackish band edging the belly.

Jentink's Duiker *Cephalophus jentinki* H. Smith, 1827

wt. 55-80 kg ht. 75-100 cm
It is uniquely colored with a blackish head and neck, and a light grey to white collar, and a uniformly grey body.

Yellow-backed Duiker *Cephalophus sylvicultor* (Afzelius, 1815)

wt. 45-80 kg ht. at shoulders 65-87 cm
Dark brown body with a triangular yellow spot on the rear of its back. Both sexes have short spike-like horns.

Maxwell Duiker *Cephalophus maxwelli* Blyth, 1840

wt. 6-10 kg ht. 35-42 cm
Similar to the blue duiker only smaller, differing mainly in its uniform mouse-grey color.

Blue Duiker *Cephalophus monticola* Gray, 1846

wt. 3.5-9 kg ht. 32-41 cm
Smallest of the duikers, horns relatively long and absent in the female of the East African race. Its color is a bluish-grey in the east of its range, changing to dark brown in the west.

Red Forest Duiker *Cephalophus natalensis* Gray, 1842

wt. 12-14 kg ht. 40-43 cm
Its color is a bright chestnut. Eight races have been described, the most distinctive of which is the East African Harvey's duiker. Harvey's has a more vivid color and a blackish face.

Black Duiker *Cephalophus niger* (Gray, 1846)

wt. 16-24 kg ht. 45-55 cm

A medium sized species with a rather thick coat of a uniformly dark color ranging from brown to black.

Red-flanked Duiker *Cephalophus rufilatus* (Gray, 1846)

wt. 6-14 kg ht. 30-38 cm

Its general color is a bright reddish chestnut with a dorsal grey-black line and lower legs.

Zebra-banded Duiker *Cephalophus zebra* K. Meyer, 1907

wt. 15-20 kg ht. 40-50 cm

It is marked with about 12 broad, transverse brownish black bands on a pale background.

Common, bush, gray or Grimm's Duiker *Sylvicapra grimmia* Ansell, 1977

wt. & 12-25.5 kg ht. 45-70 cm

% 11-21.5 kg

Very different in color to the Cephalophus group, it is a grizzled grey. Horns are upright instead of backwardly directed and present normally only in the male, but sometimes occur in the female.¹

ISIS LISTING

(from ISIS Mammalian Taxonomy 1991)

| MAMMALIA | | MAMMALS | |
|---------------------|---|--------------------------------------|------------------------|
| ARTIODACTYLA | | EVEN-TOED UNGULATES | |
| BOVIDAE | | COWS, ANTELOPES, SHEEP, GOATS | |
| 1419 | CEPHALOPHUS | DUIKER | |
| 1419009 | | | |
| 1419009009 | | | |
| 1419009009001001 | <i>Cephalophus adersi</i> | Zanzibar Duiker | Zanzibar |
| 1419009009002001 | <i>Cephalophus callipygus</i> | Peters Duiker | Congo, Gabon, Cameroon |
| 1419009009003001 | <i>Cephalophus dorsalis (no subsp)</i> | Bay Duiker | Congo |
| 1419009009003002 | <i>Cephalophus dorsalis dorsalis</i> | Bay Duiker | W. Africa |
| 1419009009003003 | <i>Cephalophus dorsalis arrhenii</i> | Bay Duiker | Congo |
| 1419009009003004 | <i>Cephalophus dorsalis castaneus</i> | Bay Duiker | Eastern Nigeria-congo |
| 1419009009003005 | <i>Cephalophus dorsalis leucochilus</i> | Bay Duiker | Congo |
| 1419009009004001 | <i>Cephalophus jentinki</i> | Jentink's Duiker | Liberia |
| 1419009009005001 | <i>Cephalophus leucogaster</i> | Gaboon Duiker | Central Africa |
| 1419009009006001 | <i>Cephalophus maxwelli (no subsp)</i> | Maxwell's Duiker | Sierra Leone |
| 1419009009006002 | <i>Cephalophus maxwelli maxwelli</i> | Maxwell's Duiker | West Africa |
| 1419009009006003 | <i>Cephalophus maxwelli liberiensis</i> | Maxwell's Duiker | Liberia |
| 1419009009006004 | <i>Cephalophus maxwelli lowei</i> | Maxwell's Duiker | Sierra Leone |
| 1419009009007001 | <i>Cephalophus monticola (no subsp)</i> | Blue Duiker | Zanzibar |

¹ Kingdon, J., 1997

| | | | |
|------------------|--|----------------------|---------------------------|
| 1419009009007002 | <i>Cephalophus monticola monticola</i> | Blue Duiker | East Africa |
| 1419009009007003 | <i>Cephalophus monticola aequatorialis</i> | Blue Duiker | Uganda, Tanzania |
| 1419009009007004 | <i>Cephalophus monticola anchietae</i> | Blue Duiker | West Africa |
| 1419009009007005 | <i>Cephalophus monticola bicolor</i> | Blue Duiker | Natal |
| 1419009009007006 | <i>Cephalophus monticola congicus</i> | Blue Duiker | Congo |
| 1419009009007007 | <i>Cephalophus monticola defriesi</i> | Blue Duiker | Zambia, Angola |
| 1419009009007008 | <i>Cephalophus monticola fusicolor</i> | Blue Duiker | Eastern Zimbabwe |
| 1419009009007009 | <i>Cephalophus monticola hecki</i> | Blue Duiker | Mozambique Coast |
| 1419009009007010 | <i>Cephalophus monticola lugens</i> | Blue Duiker | Southwestern Tanzania |
| 1419009009007011 | <i>Cephalophus monticola melanorheus</i> | Blue Duiker | Fernando Po |
| 1419009009007012 | <i>Cephalophus monticola musculoides</i> | Blue Duiker | Kenya |
| 1419009009007013 | <i>Cephalophus monticola pembae</i> | Blue Duiker | Pemba Island |
| 1419009009007014 | <i>Cephalophus monticola schultzei</i> | Blue Duiker | South, southwest Cameroon |
| 1419009009007015 | <i>Cephalophus monticola schusteri</i> | Blue Duiker | Northeastern Tanzania |
| 1419009009007016 | <i>Cephalophus monticola simpsoni</i> | Blue Duiker | Central Congo |
| 1419009009007017 | <i>Cephalophus monticola sundevalli</i> | Blue Duiker | Zanzibar |
| 1419009009008001 | <i>Cephalophus natalensis</i> | Red Duiker | Africa |
| 1419009009008002 | <i>Cephalophus natalensis natalensis</i> | Red Forest Duiker | Southern Natal |
| 1419009009008003 | <i>Cephalophus natalensis amdenus</i> | Red Forest Duiker | Southeastern Transvaal |
| 1419009009008004 | <i>Cephalophus natalensis barbetoni</i> | Red Forest Duiker | Kenya |
| 1419009009008005 | <i>Cephalophus natalensis bottegoi</i> | Red Forest Duiker | Somalia, Kenya |
| 1419009009008006 | <i>Cephalophus natalensis harveyi</i> | Red Forest Duiker | Northern Malawi |
| 1419009009008007 | <i>Cephalophus natalensis ignifer</i> | Red Forest Duiker | Kenya |
| 1419009009008008 | <i>Cephalophus natalensis lembombo</i> | Red Forest Duiker | Northeastern Natal |
| 1419009009008009 | <i>Cephalophus natalensis robertsi</i> | Red Forest Duiker | Mozambique, Tanzania |
| 1419009009008010 | <i>Cephalophus natalensis rutshuricus</i> | Red Forest Duiker | Eastern Congo |
| 1419009009008011 | <i>Cephalophus natalensis walkeri</i> | Red Forest Duiker | Southern Malawi |
| 1419009009008012 | <i>Cephalophus natalensis weynsi</i> | Red Forest Duiker | Congo, Uganda |
| 1419009009009001 | <i>Cephalophus niger</i> | Black Duiker | Sierra Leone, Nigeria |
| 1419009009010000 | <i>Cephalophus nigrifrons</i> | Black-fronted Duiker | Ruwenzori |
| 1419009009010001 | <i>Cephalophus nigrifrons</i> | Black-fronted Duiker | Central Africa |
| 1419009009010002 | <i>Cephalophus nigrifrons nigrifrons</i> | Black-fronted Duiker | Central Africa |
| 1419009009010003 | <i>Cephalophus nigrifrons fosteri</i> | Black-fronted Duiker | Mt. Elgon |
| 1419009009010004 | <i>Cephalophus nigrifrons hooki</i> | Black-fronted Duiker | Mt. Kenya |
| 1419009009010005 | <i>Cephalophus nigrifrons kivuensis</i> | Black-fronted Duiker | Southern Uganda |
| 1419009009010006 | <i>Cephalophus nigrifrons rubidus</i> | Black-fronted Duiker | Ruwenzori |
| 1419009009011001 | <i>Cephalophus ogilbyi</i> | Ogilbys Duiker | West Africa |
| 1419009009011002 | <i>Cephalophus ogilbyi ogilbyi</i> | Ogilbys Duiker | Fernando Po, Cameroon |
| 1419009009011003 | <i>Cephalophus ogilbyi brookei</i> | Ogilbys Duiker | Togo West |
| 1419009009012001 | <i>Cephalophus rufilatus</i> | Red-flanked Duiker | Cameroons East |
| 1419009009012002 | <i>Cephalophus rufilatus rufilatus</i> | Red-flanked Duiker | West Africa |
| 1419009009012003 | <i>Cephalophus rufilatus rubidior</i> | Red-flanked Duiker | Cameroons East |
| 1419009009013001 | <i>Cephalophus spadix</i> | Abbotts Duiker | Tanzania |
| 1419009009014001 | <i>Cephalophus sylvicultor (no subsp)</i> | Yellow-backed Duiker | Angola, Zambia |
| 1419009009014002 | <i>Cephalophus sylvicultor sylvicultor</i> | Yellow-backed Duiker | East + Central Africa |
| 1419009009014003 | <i>Cephalophus sylvicultor ituriensis</i> | Yellow-backed Duiker | East Africa |
| 1419009009014004 | <i>Cephalophus sylvicultor ruficrista</i> | Yellow-backed Duiker | Angola, Zambia |
| 1419009009015001 | <i>Cephalophus zebra</i> | Zebra-banded Duiker | Sierra Leone, Ivory Coast |

| 1419009010 | SYLVICAPRA | DUIKER, GREY | |
|-------------------|--|---------------------|----------------------------|
| 1419009010001001 | <i>Sylvicapra grimmia (no subsp)</i> | Grey Duiker | Rwanda, Burundi |
| 1419009010001002 | <i>Sylvicapra grimmia grimmia</i> | Common Duiker | South, West Cape Province |
| 1419009010001003 | <i>Sylvicapra grimmia abyssinicus</i> | Common Duiker | Ethiopia |
| 1419009010001004 | <i>Sylvicapra grimmia altivallis</i> | Common Duiker | Kenya |
| 1419009010001005 | <i>Sylvicapra grimmia burchelli</i> | Common Duiker | Eastern Cape Province |
| 1419009010001006 | <i>Sylvicapra grimmia caffra</i> | Common Duiker | Natal, Transvaal, Zimbabwe |
| 1419009010001007 | <i>Sylvicapra grimmia campbelliae</i> | Common Duiker | Nigeria |
| 1419009010001008 | <i>Sylvicapra grimmia coronata</i> | Common Duiker | Senegal, Gambia, east |
| 1419009010001009 | <i>Sylvicapra grimmia deserti</i> | Common Duiker | Kenya, Somalia |
| 1419009010001010 | <i>Sylvicapra grimmia lobeliarum</i> | Common Duiker | Mt. Elgon |
| 1419009010001011 | <i>Sylvicapra grimmia lutea</i> | Common Duiker | Uganda |
| 1419009010001012 | <i>Sylvicapra grimmia nyansae</i> | Common Duiker | Northeastern Tanzania |
| 1419009010001013 | <i>Sylvicapra grimmia orbicularis</i> | Common Duiker | Central Mozambique |
| 1419009010001014 | <i>Sylvicapra grimmia pallidior</i> | Common Duiker | E. Nigeria, Cen. Afr. Rep. |
| 1419009010009015 | <i>Sylvicapra grimmia roosevelti</i> | Common Duiker | Nw Uganda, Ne Congo |
| 1419009010009016 | <i>Sylvicapra grimmia shirensis</i> | Common Duiker | Northern Malani Area |
| 1419009010009016 | <i>Sylvicapra grimmia splendidula</i> | Common Duiker | Angola, So. Congo |
| 1419009010009017 | <i>Sylvicapra grimmia steinharadti</i> | Common Duiker | Southwest Africa, Botswana |
| 1419009010009018 | <i>Sylvicapra grimmia transvaalensis</i> | Common Duiker | Transvaal, Botswana, rhod. |
| 1419009010009018 | <i>Sylvicapra grimmia uvirensis</i> | Common Duiker | Rwanda, Burundi |

VETERINARY CARE²

Restraint (Manual)

Manual restraint: Physical restraint of small to medium duikers can be used for rapid, minor procedures or to facilitate administration of chemical restraint. Following restraint the animal should be released into another small, darkened, heavily bedded stall. They will generally settle down if keepers leave quickly and there is no other auditory or visual stimulation. (Frahm)

Chemical immobilization, recommended drugs:

Chemical restraint:

Small to medium duikers are usually manually restrained then immobilized with isoflurane gas. Giant duikers need to be chemically restrained with injectables, with results ranging from excellent to anesthetic death. Regurgitation is the leading complication, so intubation should be done as quickly as possible. Withholding food and water seems to have little effect. (Frahm)

Tranquilization:

²Frahm DVM, Michelle Willette, Medical Management of Duikers (reprinted by permission of W.B. Saunders Co. for ZOO AND WILD ANIMAL MEDICINE: CURRENT THERAPY 4, 1999)

For tranquilization, Haloperidol is the tranquilizer of choice for duikers at doses ranging from 0.25 to 0.75 mg/kg administered intravenously. Effects should be seen within five minutes. Transitory side effects may include licking, chewing, and pica. Tranquilization may last –12 hours, although auditory and visual stimulus and prior chemical immobilizing agents may affect neuroleptic effects. (Frahm)

Bailey reports good anesthesia of blue duikers using a combination of ketamine and medetomidine, with atipamezole as the reversal drug. Mean dosages: ketamine, 2.2 mg/kg; medetomidine, 190 µg/kg; atipamezole, 0.95 mg/kg given as a split dose IV and IM.³ This combination has also been used with blue duikers at the Burgers Zoo, Arnhem, the Netherlands. For anesthesia in grey duikers at the Burgers Zoo, a combination of ketamine and xylazine were used, with reversal by atipamezole.

Neonatal examinations:

A neonatal examination should be done 12 to 24 hours after birth and include a check of the heart and lungs, feet and legs (for deformities), and palate (for cleft palate deformities). The umbilicus should be soaked with 3% iodine and checked for herniation. A gluteraldehyde or Bova-S test can determine the immunoglobulin status. Glucose, temperature, weight, and state of hydration should all be checked. A neonatal exam is typically when animals are given their permanent identifications (earnotch, tag, microchip). Examination should be conducted quickly to avoid extended separation from the dam. Two zoos have reported maternal aggression after a calf was returned following a neonatal examination.

Parasites:

Parasites usually present few problems for captive duikers, although serious illness has been attributed to both *coccidiosis* and intestinal nematodes; positive animals should be treated with routine antiparasitics. (Frahm)

Commonly observed parasites and recommended treatment:

Coccidia.....Albon

| | |
|-----------------|---|
| Nematodirus... | These parasites may be treated with Ivermectin when you have "hands on" the animal. Otherwise, worming medication, Fenbendazole, may be milled into the alfalfa pellet. |
| Strongyles..... | |
| Trichuris..... | |

Fecal examination and treatment should be made at least biannually. They should be done more frequently in heavily contaminated exhibits or as needed in individuals

³Bailey, Thomas A., 1995

displaying symptoms characteristic of parasitic infestation (i.e. loose stools, facial swelling, stools containing visible tapeworm segments, weight loss, bloating, lethargy.)

Infectious Diseases:

Wild duiker species were found to have positive antibody titers for leptospirosis, blue tongue virus, infectious bovine rhinotracheitis, epizootic hemorrhagic disease, brucellosis, and anaplasmosis. A red-flanked duiker in captivity died of malignant catarrhal fever. The symptoms included diarrhea, ataxia, and recumbency. Giant duikers with viral encephalomyelitis showed clinical signs of depressed WBC, anorexia, rough hair coat, mild diarrhea and progressively severe ataxia, becoming comatose before dying. Some lab results have implicated Venezuelan equine encephalitis. (Frahm)

Subcutaneous abscesses occur in duikers, most often in the soft facial tissues and mandibles. Nondestructive mandibular proliferation may occur with the infection and appears to be permanent. Considered endogenous in origin, carrier animals have been implicated in introducing pathogenic bacteria to previously naive animals. *Actinomyces pyogenes*, *Fusobacterium necrophorum*, and *Bacteroides* spp have been isolated from the abscesses. Treatment included antibiotic therapy, local debridement, flushing with antibacterial solutions, and drain placement. Antibiotics should be used long-term, but benefits must be weighed against the stress and hazards of administration. Anecdotally, oral trimethoprim-sulfamethoxazole dosed on an equine schedule has been effective on sensitive organisms. Tilmicosin has also been effective at the bovine schedule and has the added advantage of a 72 hour dosing schedule. (Frahm)

Two zebra duikers the Los Angeles Zoo with jaw abscesses were treated by lancing, draining, and frequent flushing. A third was treated with Bactrovet instead of lancing. After five days the abscesses had regressed.⁴

Mandibular osteomyelitis (lumpy jaw) is a common problem in duikers. Salmonellosis was the cause of death of a bay duiker in captivity, and pneumonia is a common cause of death. (Frahm)

Intestinal upsets noted included periodic outbreaks of coccidiosis which required prompt and vigorous treatment, and enterotoxemia.⁵

Other diseases included septicemia, hepatitis, congestive heart failure, central nervous system problems of unknown etiology, and osteomyelitis following a compound pelvic fracture. (Farst)

⁴Udell, Carole C., 1981

⁵Farst, Donald et al, 1980

Neonatal medical problems include septicemia leading to septic arthritis, hematogenous eye infections resulting in blindness, pneumonia, and peritonitis.

Non-infectious diseases:

At Gladys Porter Zoo, healthy female duikers in late stage pregnancies, or shortly after parturition appeared to be overwhelmed by secondary shock, metritis, or pneumonia. Diets supplemented with high levels of minerals and high calorie food did not alleviate problems. (Farst) Cage mates with identical nutrition and housing situations were not affected.

Acral lick dermatitis is common as duikers will “worry” a wound, aggravating it and preventing healing. Chronic renal disease is a common necropsy finding, especially in aged animals. (Frahm)

In several cases, bay duikers showed evidence of possible adrenal exhaustion. Clinical signs included acute, generalized paresis or recumbency, hypoglycemia, and abnormal Na:K ratios. Fluid therapy with 0.9% NaCl with 5% dextrose produced improvement within a few days. (Frahm)

Physiological norms:

Little is published on normal resting heart and respiratory rates of duikers, but estimates based on allometric scaling equation can be useful.

$$\begin{aligned} \text{HR} &= 241 \times (\text{BW})^{\text{kg}-0.25} \\ \text{RR} &= 53.5 \times (\text{BW})^{\text{kg}-0.26} \end{aligned}$$

Values obtained from blue duikers under Ketamine/medetomidine anesthesia were temperature of 39.4EC, heart rate of 83.3 beats/minute. (Frahm)

More information on heart and respiratory rates and blood chemistries has been published by ISIS and the Zoological Society of London ⁶.

Common injuries and treatments:

Fractures, contusions, and lacerations are the most common injuries seen in duikers. They usually sustain these injuries when they crash into the pen walls or fences as an explosive reaction to a change in their normal routine or some other disturbance.

⁶ISIS Physiological Data Reference, Aug. 1996.

Exaggerated flight responses can result in self-trauma and particularly fractured jaws. Cage mate trauma, male-female or parent-offspring, can cause injuries and even death.

Other Medical Problems:

Several veterinarians recount case histories of a "duiker wasting syndrome". Clinical signs range in severity between institutions and between individuals: poor hair coats and variable fecal consistency, fluid-filled, distended rumens, or cachexia and emaciation. While these problems are especially prevalent in the smaller species of duiker, they have occurred in both Jentink's and Yellow-backed duikers. In some instances these conditions have been responsive to changing the base concentrate to a browser diet (Mazuri® Bovine Browser Breeder Diet #5653, PMI Feeds Incorporated, St. Louis, MO, 63144, USA) (Frahm) Overgrown hooves can be troublesome, with some institutions recommending hooftrims every 1 to 3 months depending on wear. (Penn State)

Copper deficiency, primarily in the smaller duikers, result in weight loss (with good appetite), wide pendulous abdomen, soft dog-like stools, a rough, dull, or sparse hair coat, and general debilitation. Copper supplementation can be accomplished either intravenously or through oral bolusing. Oral bolusing administered manually at the rate of one bolus (12.5g) per duiker (wt. range 11.34 to 16.78 kg) with an oral copper oxide product (Copasure 12.5, Schering-Plough Animal Health, Kenilworth, NJ 07033) produced good results. Lower doses in a zebra duiker failed to produce a clinical response. Animals positive for trichurids had significantly lower copper values. (Frahm)

At least one institution has had recurrent problems with urolithiasis in bay duikers. This problem has been substantially diminished by feeding a base concentrate containing ammonium chloride (Shepherd's Choice 15, Countrymark Cooperative, Incorporated, Indianapolis, IN, 46204, USA) along with salted, grated carrots.(Frahm)

Other recommended routine medical procedures:

Preshipment/Quarantine: Specific tests may vary depending on the destination of the animal but generally will include: CBC, CHEM, R/C, TB, *Brucellosis*, *Mycobacterium paratuberculosis* (Johnes), and fecal screening for a parasite check. Also this is typically when animals are given their permanent identifications (earnotch, tag, microchip, etc.)

No vaccinations are recommended for all regions although some particular regions may dictate that animals be immunized against rabies, clostridial diseases © and D tetanus), bovine viral diarrhea, and equine encephalides.⁷

⁷Kranz, Karl and LaRue, 1998

Life span (in captivity): ⁸

| | |
|--------------------------------------|------------|
| <i>Cephalophus monticola</i> | 10-15 yrs. |
| <i>Cephalophus maxwelli</i> | 10 yrs. |
| <i>Cephalophus rufilatus</i> | 8-10 yrs. |
| <i>Cephalophus jentinki</i> | 17 yrs. |
| <i>Cephalophus sylvicultor</i> | 10-12 yrs. |
| <i>Cephalophus zebra</i> | 12 yrs. |
| <i>Cephalophus niger</i> | 10 yrs. |
| <i>Cephalophus natalensis</i> | 15 yrs. |
| <i>Cephalophus dorsalis</i> | 12 yrs. |
| <i>Sylvicapra grimmia</i> | 12 yrs. |

Post-mortem protocol:

⁸ Spinage, C. A., 1986 and Marvin Jones 1993

A thorough post mortem examination (necropsy) of each animal that dies in the facility, by a veterinarian, preferably a veterinary pathologist, provides valuable information not only on the cause of death for that animal, but also on other concurrent medical problems. Often these problems, such as parasites, nutritional deficiencies, or dental disease, may be present in the animal collection without causing any obvious symptoms. Their detection at postmortem examination indicate that diagnostic tests or treatment should be performed on the remaining animals before clinical symptoms or disease transmission occur.⁹

NUTRITION

Much interest has been generated in this area of late as it is one of the most unique and least understood aspects of captive management. Simultaneously browsers and frugivores and occasionally carnivorous, duikers are considered concentrate selectors. Duikers are described as primitive ruminants with significant cecal fiber fermentation. Numerous ruminal and cecal adaptations facilitate a quick turnover of food and a high fermentation rate; a mean transit time of 42.2 ∓ 6.4 hr has been recorded for a Maxwell's duiker. Nutrient requirements have not been determined but Roeder, et. al., (1991) suggest that a Ca:P ratio of 0.5%:0.4% appears to be the best suited for the blue duiker. Diets should contain vitamin E at a level of 200 IU/kg DM..

There have been numerous anecdotal reports of "nutritional" problems in duikers including calcium/phosphorus imbalances, copper deficiencies, urolithiasis, and "wasting syndromes". However, there have been no systematic investigations of these presumed dietary induced maladies. Copper deficiency has been diagnosed several times, primarily in the smaller species including the bay, the black (*Cephalophus niger*), and the zebra duikers. Clinical signs include weight loss despite an excellent appetite, a rough, dull, or sparse hair coat, a wide, pendulous abdomen, soft, dog-like stools, and general debilitation. (Frahm)

Captive Diets:

In captivity duikers are easily maintained on good quality hay, mixed grains, fruits, vegetables and trace mineral blocks. Duikers seem to require a high caloric intake and carbohydrates appear to be better than protein or fat.¹⁰ There are many reports that duikers tend to have an affinity for eating animal protein. The one Jentink's duiker maintained in France routinely caught and ate young chickens, while the young male maintained in the Ivory Coast ate rabbits on a regular basis. This carnivorous tendency has been seen infrequently with the animals at the Gladys Porter Zoo, usually on an

⁹ Hinshaw, Amand, Tinkleman, 1996

¹⁰Farst, D. D., et al 1988

opportunistic basis when a feral animal entered their enclosure. Almost all the duikers at the Gladys Porter Zoo refuse raw ground meat when it is offered to them, but will readily eat pelleted dog food with animal protein¹¹.

Mineral salt blocks should be available *ad lib*.

Sample diets:

Present diets used at the Gladys Porter Zoo, Brownsville, Texas

| Item | Amount fed per animal per day | |
|--------------------------|--|---|
| | Zebra duiker <i>Cephalophus zebra</i> | Jentink's duiker <i>Cephalophus jentinki</i> |
| Acco 16% dairy chow | 0.4 kg | 0.68 kg |
| Purina dairy conditioner | 0.4 kg | 0.68 kg |
| Acco dry dog food | 0.1 kg | 0.23 kg |
| Acco pig starter | - | 0.23 kg |
| Apple | ½ | 1 |
| Banana | 2 | 2 |

¹¹Schweers, S., 1981

| | | |
|--|------------------------------------|--|
| Carrot | 3 | 4 |
| Tomato | 1 | 1 |
| Alfalfa hay and trace mineral salt block | <i>ad libitum</i> multivitamins | <i>ad libitum</i> one slice bread with multivitamins |

Present diet used at the Los Angeles Zoo for duikers

Diet for one adult animal: This same diet is offered to both **Black Duikers** *Cephalophus niger* and **Red-flanked Duikers** *Cephalophus rufilatus*. The only difference is that the larger Black Duikers consume a significantly larger amount of the free choice alfalfa hay and pellets (ADF-16 and Bovine Browser)

Free choice alfalfa hay
 1 chopped carrot
 ½ chopped apple
 1 stalk broccoli
 ½ bunch spinach
 1 tsp. Vitamin E powder sprinkled over produce
 Free choice Mazuri® Bovine Browser pellet¹²
 Free choice Herbivore pellet ADF-16 ½"¹³

¹²Mazuri® Bovine Browser: Crude protein not less than.....12%
 Crude fat not less than.....2%
 Crude fiber not more than.....28%
 Ash not more than.....8.0%
 Added minerals not more than....3%

¹³ADF-16 Herbivore Pellet ½": Crude protein, not less than.....17.0%
 Crude fat, not less than.....3.0%
 Crude fiber, not more than.....13.0%
 Ash, not more than.....8.5%

free choice browse varieties:

most often offered: Acacia *Acacia saligna*
 Fern leaf Acacia

occasionally offered: Mulberry *Morus*
 Plumbago *Plumbago auriculata*
 Natal Plum *Carissa macrocarpa*
 Ficus *Ficus benjamina*
 Poplar *Populus fremontii*
 Jacaranda *Jacaranda mimosifolia*
 Cape Honeysuckle *Tecomaria capensis*
 Passion Vine *Passiflora*
 Chinese Elm *Ulmus parvifolia*

Diets offered at the San Diego Wild Animal Park

Maintenance diet for one adult:

| Diet items ∴ | Yellow-backed duiker <i>Cephalophus sylvicultor</i> | Kaffir-crowned duiker <i>Sylvicapra grimmia</i> | Maxwell's duiker <i>Cephalophus maxwelli</i> |
|---------------------------------------|---|---|--|
| Lo fiber herbivore pellet ADF-16 | SMTWThFSa 4 qts (2400g) | SMTWThFSa 3 cups (430g) | SMTWThFSa 9ozs (255g) |
| Leafeater, Dry/Lemur (Marion Zool) | M Th Sa 1 cup (72g) | M Th Sa ½ cup (36g) | M Th Sa ½cup (34g) |
| carrot, raw, chopped | S T Th 1 whole (105g) | | M Th 1 oz. (28.3g) |

Added minerals, not more than...2.0%

| | | | |
|----------------------------------|-------------------------------|-----------------------------|----------------------------------|
| yam, raw, chopped | M W F ½ whole 83g | | T F 1 oz. (28.3g) |
| variable root vegetable, chopped | Sa ½ whole 100g | | S W 1 oz. (turnip) (28.3g) |
| alfalfa hay | SMTWThFSa ½ flake 1330g | SMTWThFSa cflake 333g | SMTWThFSa ¼ flake 665g |

*Browse feeding should not exceed one 3' section per individual daily.

Diet offered at the Burger's Zoo, Arnhem, Netherlands

(Amounts for 4 **Blue Duikers** *Cephalopus monticola*/day)

15 handfuls of oats (crushed)
8 handfuls of carob
4 hard boiled eggs
1/4 loaf bread
8 carrots
10 apples
1 cucumber
2 bananas
½ bundle of endive
4 potatoes
“some additional vegetables as available” all cut into fairly large chunks
Vitamin E powder
“every now and then a 1-day old chick is given”

Other items offered:

In addition to items listed in diets from other zoos; San Antonio Zoo has also offered their Blue Duikers blueberries, corn, and peas, and for browse: mulberry, ash, and huckleberry.

Supplements:

Mineral salt blocks
Clovite - multiple vitamin powder (Gladys Porter Zoo)
Copper dietary supplement for zebra duiker *Cephalopus zebra*, (Gladys Porter Zoo)

An increased requirement for copper was suggested. Some animals developed problems, such as weight loss, rough coats and general debilitation; but no abnormalities were found other than low serum copper. Normal serum copper levels are about 250mg% but the affected animals had levels of 30mg%. They responded well to injections of copper and their serum copper increased greatly. (Farst, et al)

Diets which have caused problems:

Some institutions have reported that too much animal protein has caused loose stools.

Other items which caused diarrhea in certain individual animals were kale and apple. Once these items were eliminated from the diet the problems were resolved.

Coarse stemmy hay should be avoided as oral abscesses can develop.

Behavior related to feeding:

In some groups the male will dominate browse and produce when fed. Due to this, items are fed in two areas. They will run from one station to another several times during a feeding.¹⁴

CAPTIVE MANAGEMENT

Duikers have an explosive flight reaction that must be considered at all times, but especially prior to any handling procedure or change in their routine. (Farst, 1988) Care should be taken by the keeper to avoid startling the animal when approaching the enclosure. Rattling keys or making some other low level sound to announce the keepers presence should be used when entering the duikers exhibit. A radio playing in the barn provides some background noise to help keep the animals desensitized to unusual sounds and unannounced human contact (Kranz, et al. 1998).

Individual identification methods:

Several methods of individual identification have been used successfully with duikers including ear n

Recommended crating and transport procedures:

Transport may be safely accomplished by trailer or crate. In both situations it is important to construct a crate or partition the trailer to give the animal only enough space

¹⁴ Robin Parker, LA Zoo, pers. comm.

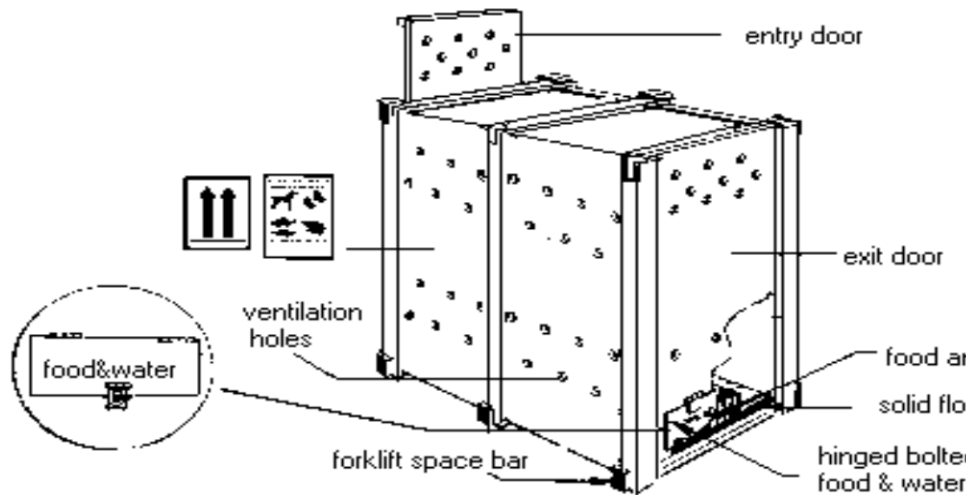
to stand or lie down. Too much room allows the animal to turn around or jump up, potentially injuring itself. Animals will generally be less agitated if their mode of transport is dark, so holes for ventilation should be just large and numerous enough to allow adequate air flow, while limiting light. The ventilation holes should be about 1" in diameter and be placed in a band around the top and bottom of the crate. As duikers are easily frightened it is advisable to cover the holes with burlap or a similar material to reduce light, and help keep the animal calm during transport. Make sure that material used to reduce light does not interfere with ventilation. The crate or trailer may be bedded with Bermuda grass hay, and a tub for water should be fastened into place near the head end of the crate prior to loading the animal. A fill hole should be located to allow convenient watering of the animal during transport. Air transportation is preferred with a non-stop flight if possible.

To keep the animals acclimated to wooden shipment crates, it is important that they always have access to a kennel or wooden crate either indoors or in their exhibit at all times. Occasionally place "treats" (produce) into the crate in order to keep them crate trained. Several days prior to crating, produce should be fed in the crate until the duiker is comfortable going all the way into the crate. On the day of crating nothing is changed in the routine except that the crate door is closed.

For animals which are not crate trained, you may need to "herd" them into the crate. Ideally, exhibit design should incorporate an adjoining smaller "catch pen" into which an animal can be trapped for the purpose of crating. There should be a doorway in the corner of the catch pen leading to an alleyway. The animal is then moved down the alleyway and into a crate. It may be necessary to follow the animal down the alley with a push board to persuade it into the crate or trailer. A hand held push board may be safely used with the smaller species of duikers. A built in push board mounted or suspended on runners is very useful and safer for all involved, when moving large duikers.

Container Requirement 73

Reproduced with permission of IATA, Mr. Daniel Lebrun, Assistant Director, Marketing & Sales. (The following general IATA information has been slightly modified to reflect the special needs of shipping duikers.)



Container construction

Materials: wood, burlap for light reduction, if required.

Dimension: The height and width of the container must allow the animal to stand erect with its head extended, even if horned. The size of the container must sufficiently restrict movement so that the animal cannot turn around and in so doing trap or injure itself, nor have space to kick and damage the container. The dimensions will vary according to the species being shipped.

Frame: Must be made of 2.5 cm (1 in) solid wood or metal parts, bolted or screwed together. When the weight of the container plus animal exceeds 60 kg (132 lbs.), additional metal bracing must be present around the whole container.

Sides: Suitable plywood or similar material must closely line the frame to a level slightly above the animal's head.

Floor: The base must be solid and leak-proof and bedded with hay to prevent the animal from slipping.

Doors: Hinged or sliding entry and exit doors must be provided. They must be fastened in such a way that they cannot be accidentally opened. They must have similar ventilation openings as on the sides.

Ventilation: Two rows of ventilation holes, with a minimum diameter of (1 inch) 2.5 cm must be present, above eye level, on all four sides.

Spacer Bars/Handles: Must be made to a depth of 2.5 cm (1 inch) and formed from the framework of the container.

Feed and Water Containers: Food and water containers must be provided with outside access from a hinged bolted flap that must be large enough for the entry of a water dish and/or quantities of appropriate food.

Feeding and Watering Guide: Animals do not normally require additional feeding or watering during 24 hours following the time of dispatch. Shipper's watering instruction must be followed. If feeding is required due to an unforeseen delay, fodder must be provided but care must be taken not to overfeed.

General Care and Loading: It is recommended that polyethylene sheeting and absorbent material, such as wood shavings, be placed underneath the container and stapled to the sides of the container (without blocking ventilation holes) to prevent spillage of excreta.

Some animals may require tranquilizing for transportation with a long acting sedative. The name of the medication and the time of administration must be provided by the shipper and affixed to the container and that information must also accompany the Shipper's Certification.

For requirements and regulations regarding transport crate size and design, please refer to IATA, USDA, and APHIS.¹⁵

Pest control:

Bait stations and snap traps may be placed around the barns where the duikers have no access. Snap traps have been placed in the exhibits only when all animals have been removed from the exhibit for the evening. All snap traps must be removed from the exhibit prior to returning the animals to the exhibit.

HOUSING AND ENCLOSURE REQUIREMENTS

¹⁵International Air Transport Association, United States Dairy Association, Animal & Plant Health Inspection Service

Containment barriers:

Off exhibit containment may be achieved with chain link, with reed fencing or a similar material attached as a sight barrier. On exhibit, a glass-fronted exhibit with gunnite (shot-crete) walls will cut down on patron noise and allow patron viewing from only one area. Enclosure walls should be solid at the bottom and free of protrusions; if chain link, they should have plywood, plastic, masonite, or some other solid material extending up the sides at least 3' (1 m).¹⁶ Duikers can be very nervous and flighty and should never be surrounded by viewing patrons. Pools or other water features make good exhibit additions but may not be effective as the primary barrier as duikers are good swimmers.

Shelter requirements:

Both indoor and outdoor facilities should provide “hiding places” which may be anything from a lean-to shelter, kennel, crate, or some kind of alcove to provide a sense of security.

Substrate/topography:

A relatively flat natural substrate of dirt and grass is preferred. Tall grass, bushes, trees, or small logs may serve as hiding places.

Water source:

Fresh clean drinking water should be available at all times. Plastic, rubber, or stainless steel containers are suitable as well as automatic float drinkers.

Special furnishings:

The potentially fractious, explosive disposition of some duikers must be taken into consideration when furnishing their exhibits. Some objects such as rocks, logs, trees, bushes, etc. are advisable to provide them with hiding places but too many large items may impede the animals view of their enclosure and interfere with their ability to move quickly through it.

Environmental enrichment:

¹⁶Kranz, Karl and LaRue, Fred, 1998

It is best to establish any environmental enrichment items (such as those listed under special furnishings) prior to introduction of animals to exhibit. Changing the exhibit or introducing novel items into the pen may panic the animals.

Temperature/humidity requirements:

Duikers should be kept at 50-90E F (10-32E C) avoiding extremes of cold and heat. They can be given access at cooler temperatures (30-40EF or 0-5EC depending on wind chill), but should have continual access to warmer quarters away from drafts, etc.

Minimal acceptable and optimal size of enclosures:

The most successful housing for duikers are relatively small, dimly lit quarters measuring 5'x5'x8' for the small to medium sized animals. Larger species do well in enclosures measuring 10'x10'x8'. The floor of the enclosure, if concrete, should have a rough finish to prevent slipping or have rubber mats provided. Bedding should be used at all times. Bedding that can be used includes shavings, hay or sawdust.

Outdoor enclosures should be large enough for the animal to keep its distance from the keeper during servicing. Cover in the form of planting, brush piles or other structures should be provided to give the animal a place of security. The terrain of the exhibit should be as flat as possible with minimal obstructions so as not to restrict the duikers view of the enclosure or impede the animals movements within the enclosure. For the most part, duikers should be allowed access to indoor enclosures when outside so that they can retire from human contact if they wish (Kranz, et al., 1998) Burlap or other "solid" barriers should be put up around the enclosure, prior to introducing the animal into a new exhibit, to provide a sense of security and to allow the duiker to get used to it's new surroundings. Failure to do this could result in the animal running into enclosure barriers, resulting in injury or death.

Capture, handling, restraint facilities:

Duikers can be manually or chemically restrained, taking care to watch out for the stabbing of the short horns which can cause puncture wounds, during manual restraint, to the animal handler involved. Manual restraint can be used for short duration treatments or health checks. Manual restraint should take place in a small enclosed space and caution should be exercised to effect the restraint quickly to prevent the animal from injuring itself. Duikers will resist capture by head tossing, kicking, and even biting.

Nets can be used to capture duikers but this increases the risk of broken horns and entanglement in the net possibly resulting in injury to the animal.

For animals that are crate-trained, crate the animal before any capture. If the animal requires immobilization this allows the vet easier access to the animal.

When using restraint, extreme caution must be exercised to keep the restraint time as brief as possible as post-capture shock can result in the death of the animal. The best advice on restraining duikers is “don’t, unless absolutely necessary”. If it must be done, complete the procedure as rapidly as possible and then leave the animal alone in a quiet place to recover from the shock (Farst, et al., 1980).

Utilities:

Natural lighting is sufficient in outdoor enclosures; dim light is best for indoor situations.

Sanitation:

As duikers are focal defecators, it is relatively simple to remove fecal material daily. Enclosures should have all feed piles and soiled bedding removed daily, and should be thoroughly stripped, cleaned and disinfected every 2-3 weeks. The hard surface of indoor areas should be cleaned and disinfected weekly. Walls should be washed every 2-3 months. (Kranz and LaRue)

Isolation from similar or the same species:

The following hybridizations have occurred in zoological collections worldwide:

Cephalophus caerulus aequatorialis Matschie (Equatorial Blue Duiker)
x *Cephalophus simpsoni* Thomas (Simpson’s Duiker)

Cephalophus caerulus schultzei Schwartz (Cameroon's Blue Duiker)
x *Cephalophus maxwelli* H. Smith (Maxwell's Duiker)

Cephalophus dorsalis Gray (Bay Duiker)
x *Cephalophus rufilatus* Gray (Red-flanked Duiker, Coquetoan
Little Red Antelope)
x *Cephalophus zebra* Gray (Zebra Antelope, Banded Duiker, Zebra

Antelope,

Cephalophus maxwelli H. Smith (Maxwell's Duiker)
x *Cephalophus caerulus schultzei* Schwartz (Cameroon's Blue Duiker)
x *Cephalophus (?) monticola* Thunberg (Pygmy Duiker)

Cephalophus monticola Thunberg (Pygmy Duiker)
x *Cephalophus maxwelli* H. Smith (Maxwell's Duiker)

Cephalophus natalensis A. Smith (Red Duiker, Natal Duiker)
x *Sylvicapra grimmia grimmia* Linnaeus (Grey Duiker, Duikerbok)

Cephalophus niger (Gray, 1846) Black duiker
x *Sylvicapra grimmia* Ansell 1977 Eastern Common Duiker

Cephalophus rufilatus Gray (Red-flanked Duiker, Coqueton Antelope, Little
x *Cephalophus dorsalis* Gray (Bay Duiker)

Cephalophus simpsoni Thomas (Simpson's Duiker)
x *Cephalophus caerulus aequatorialis* Matschie (Equatorial Blue Duiker)

Cephalophus zebra Gray (Zebra Antelope, Banded Duiker, Zebra Duiker)
x *Cephalophus dorsalis* Gray (Bay Duiker)¹⁷

BEHAVIOR AND SOCIAL ORGANIZATION

Duikers generally live in pairs or are solitary. Most species spend their lives concealed in dense forests or woodland thickets. Only one species prefers to reside in bush or grasslands. Pair territory is marked by both sexes using preorbital glands. Pairs and females with young rub faces and horns together. In thick cover, duikers travel through tunnel-like runs. Defecation and resting places are in thick bush or grassy thickets. In Maxwell's Duiker *Cephalophus maxwelli maxwelli*, pairing for life is known. Grey Duikers *Sylvicapra grimmia* the grassland species, are primarily solitary and form pairs only at mating time. They are mainly active in the morning and evening. They can go for long periods without drinking.¹⁸

Males are territorial and combative with each other, they can be contentious with females in estrus, and are frequently hostile with calves. Short lengths of hose can be placed over the horns of particularly aggressive individuals. (Frahm)

Introduction of new animals

When introducing duikers to a new exhibit allow continuous access to an off exhibit area if public viewing is close, or viewing is from more than one side of the exhibit. Also keep males separated from females in small inside pens. (Farst, 1988)

Maxwell's Duiker *Cephalophus maxwelli* -

¹⁷ Gray, Annie P., 1972

¹⁸ Haltenorth, Theodor, 1984

Individuals are especially intolerant of conspecifics of the same sex. As with other duikers, this species is not gregarious and is usually seen singly or in pairs.¹⁹

Introduction of more than one individual at a time is not recommended.

Age of dispersal/removal of young

With sexual maturity being attained at around 8-12 months for both sexes, most young duikers should be removed from adult pairs before they reach one year old. This may vary somewhat by species and size of exhibit.

Young blue duikers leave their parents during the second year of life to establish territories.²⁰

Introductions and removals (effect on group and group reaction)

Duikers are normally displayed as a pair or pair plus one offspring. The introduction of a new female or male should only be done when the addition will create a pair situation after introduction. The removal of offspring usually has little impact except it will probably reduce the amount of aggression between it and a member of the same sex. The breakup of a long term pair may leave the remaining individual in a stressful situation. The lack of a partner is not a prolonged problem but may cause short term nervousness in the lone individual.²¹

Seasonal changes in social behavior

Generally there is no seasonal change in social behavior.

Grey Duiker *Sylvicapra grimmia* are primarily solitary, forming pairs only at mating time. In Central Africa young are born at all times of the year, showing no seasonality. In South Africa births are concentrated in the summer. Therefore in South Africa pair formation may indeed be seasonal. (Haltenorth, 1984) Birth trends, according to the studbook, show that duikers are not seasonal in captivity (Chris Pfefferkorn, pers. comm.)

¹⁹ Ralls, Katherine, 1973

²⁰ Dubost, G., 1980

²¹ Seen in Maxwell's Duiker *Cephalophus maxwelli* at the San Diego Wild Animal Park

Mixed species exhibit capability and recommendations:

The initial phases of setting up a mixed-species exhibit are crucial. Many species will live together compatibly once they become accustomed to each other's presence.²² One zoo had good results developing a mixed-species exhibit by using a surrogate species (in place of the duikers) to see how certain primates would react to a ground-dwelling species. The surrogate, a domestic rabbit, was placed into the exhibit first with a group of Colobus monkeys *C. guereza*. After several attempts the introduction was discontinued due to aggression by the monkeys toward the rabbit. A subsequent introduction of the rabbit to a group of African Green Monkeys *Cercopithecus aethiops* proved to be much more successful as well as the monkeys introduction to a group of 1.2 Blue Duikers. Only a few instances of grabbing have been reported, along with reports that the monkeys were observed grooming duikers in the afternoon.²³

Blue Duikers *Cephalophus monticola*

Blue duikers were successfully exhibited with African Green Monkeys *Cercopithecus aethiops* (more commonly known as grass monkeys, vervets or grivets). Burnet Park Zoo, Syracuse, NY.

Blue duikers have been successfully exhibited with Spekes Sitatunga *Tragelaphus spekei* and Western Crowned Cranes *Balearica pavonina pavonina* at the Virginia Zoo.

Bay Duiker *Cephalophus dorsalis*:

Bay duikers were successfully housed at the San Diego Wild Animal Park with:

- a herd of Bongo *Tragelaphus eurycerus*
- a herd of Lesser Kudu *Tragelaphus imberbis*
- a herd of Lowland Nyala *Tragelaphus angasi* and a pair of Klipspringer *O. Oreotragus*

However, the introduction of Bay Duikers into an exhibit housing an established herd of Greater Kudu *Tragelaphus strepsiceros* was not successful. Several adult female kudu attacked the duikers. San Diego Wild Animal Park

- Kirk's dik-dik *Madoqua kirki* and Crowned Crane *Balearica regulorum*, Ellen Trout Zoo

²²Thomas, Warren and Edward Marushka, 1996

²³Moore, Don and Adrienne Whiteley Moore, 1988

Yellow-backed Duiker *Cephalophus sylvicultor*:

This species has been successfully exhibited with okapi *Okapia johnstoni* and North Indian Muntjac *Muntiacus muntjak*. San Diego Wild Animal Park

Also “reasonably successful” when displayed with Bongos *Boocerus eurycerus* and bat-eared foxes *Otocyon megalotis*. Los Angeles Zoo

Maxwell's Duiker *Cephalophus maxwelli*:

This species was exhibited with Nyala *Tragelaphus angasi*. Some of the duikers chased and then panicked the nyala herd. Bronx Zoo

At the San Diego Wild Animal Park Maxwell's duikers have been successfully exhibited with:

- Okapi *Okapia johnstoni*
- Mhorr gazelle *Gazella dama mhorr*

Zebra Duiker *Cephalophus zebra*:

A group of Talapoin guenons *Miopithecus talapoin* was housed with this species. For three months the two species were living peacefully together. Then the monkeys became aggressive with the male duiker and had to be removed.

A pair of Ruffed Lemurs *Lemur variegatus* were housed with zebra duikers. This mix of species was successful for several months before the lemurs were removed due to a breeding loan commitment. The lemurs were hand-reared and friendly.

Other successful combinations were zebra duikers with the Crowned lemurs *Eulemur coronatus* and zebra duikers with Greater galagos *Nicticebus coucang*. Los Angeles Zoo

Black Duikers *Cephalophus niger*

Black duikers are currently displayed with harnessed bushbuck *Tragelaphus scriptus scriptus*, where the two species are confined to separate night quarters. Los Angeles Zoo

Black duikers are successfully exhibited with White Stork at the Miami Metro Zoo.

Southeastern Crowned Duiker *Sylvicapra caffra grimmia*

Crowned duikers are currently successfully exhibited with Giant Eland *Taurotragus derbianus gigas*, Red fronted Gaxelle *Gazella rufifrons laevipes*, and West African

Crowned Cranes *Balearica pavonina pavonina*. They are also exhibited in another area with Lowland Nyala *Tragelaphus angasi*. San Diego Wild Animal Park

Behavioral indicators of social stress, harassment, or impending social changes such as dispersal:

Maxwell's Duiker *Cephalophus maxwelli*:

The frequent up and down tail movements are not stress related. The function of this tail wagging is unknown. When these duikers are nervous they will "freeze", often with one leg off the ground. Even the tail wagging ceases. (Ralls)

Yellow-backed Duiker *Cephalophus sylvicultor*:

Stressful events elicit immediate erection of the hairs of the yellow rump patch. Piloerection may signal alarm or threat to conspecifics.²⁴

Increased aggression between same sex individuals is an indicator of social stress. Head-butting and chasing being the most commonly seen aggressive behaviors. Removal of one of the combatants will restore social order.

Olfactory behavior, scent marking, flehmen:

Blue Duiker *Cephalophus monticola*:

Territories of bonded pairs are saturated with scent clues emanating from a continuous flow from pedal glands and frequent rubbings from face (maxillary) glands, from feces, urine, and horn gratings.

Maxwell's Duiker *Cephalophus maxwelli*:

The female squats to urinate, when she urinates a male will often smell and lick the stream of urine, after which he will perform flehmen. Females also sample the urine of males. Scent marking with the maxillary gland is frequent. Both sexes participate in scent marking. (Ralls)

Yellow-backed Duiker *Cephalophus sylvicultor*:

Both sexes frequently mark objects with secretions from their maxillary glands. They usually rub their noses over the marked area as if to spread the secretion. Males display

²⁴ Lumpkin, Susan; Krantz, Karl, 1984

flehmen after sampling a females urine. (Lumpkin)

Auditory behavior:

Forest Duikers *Cephalophus*:

Excitement or anxiety calls consist of short snorts. Terror is indicated by scream.

Maxwell's Duiker *Cephalophus maxwelli*:

Two vocalizations are known, an alarm whistle and a loud bleat. The latter is given when picked up by a human or cornered by another duiker. (Ralls)

Common or Grey Duikers *Sylvicapra*:

Distress is conveyed by a hare-like scream in adults and a loud bleating in young. (Haltenorth)

Yellow-backed Duiker *Cephalophus sylvicultor*:

These duikers are known to vocalize using a "squealing bark" or bleat, and soft pig-like grunts. (Lumpkin)

Courtship behavior:

Maxwell's Duiker *Cephalophus maxwelli*:

The male "drives the female and bites at the root of her tail with such force that her hind feet are often lifted off the ground. The tail of a female in estrus is usually wet and frayed from the males chewing and biting. Driving gradually subsides into nose to tail circling. The male performs laufs Schlag before mounting. (Ralls)

Yellow-backed Duiker *Cephalophus sylvicultor*:

The male constantly investigates his mate to detect estrus. An estrus female will allow the male to sniff and lick her vulva, as he follows her around. When the female stops, the male may perform laufs Schlag before mounting her. Copulation is brief, consisting of one pelvic thrust before dismounting. (Lumpkin)

Bay Duiker *Cephalophus dorsalis*:

The male pursues the female relentlessly and tests her urine periodically while making a humming sound. The Bay duiker is the only duiker not observed to exhibit laufs Schlag as

a pre-mating behavior, but rather the male will rest his chin on the rump of the female prior to mounting. Copulation is very brief, lasting 1-3 seconds. (C. Pfefferkorn, pers. comm.)

Zebra duiker *Cephalophus zebra*:

Pre-copulatory behavior includes the male testing the female's urine, marking the female with his facial glands on her body and frequent mounting and head butting by the male (Udell).

Parental Care:

Parental care in duikers is minimal and seems to be uniform in the duiker species.

It is recommended to remove the male prior to the calf's birth as infant mortality has occurred in the Bay duiker from male aggression. The male may be re-introduced when the calf is about 12 weeks of age and able to navigate the exhibit. (C. Pfefferkorn, pers. comm.)

Maxwell's Duiker *Cephalophus maxwelli*:

Duiker calves receive a minimum of maternal care. The sire does not participate in infant care. Duiker calves are "hidiers" and spend most of their time lying alone in a protected spot. It appears that the calf selects the hiding spot and then seeks out the dam when it wants to nurse. The calf nurses from the side with its tail towards the dam's head. The dam licks the anus to stimulate defecation and eats the feces. The female grooms the calf frequently by licking its fur. (Ralls)

Yellow-backed Duiker *Cephalophus sylvicultor*:

Observations of captive calves show that there is minimal maternal care. The calves hide most of the time during their first weeks of life. Nursing is infrequent but bouts may last up to 7-15 minutes. Mothers have been observed to also lick and groom their calves. In captivity, males are usually indifferent towards calves. However sometimes males must be removed because they become aggressive with newborns. (Lumpkin)

Infant development and growth characteristics:

Healthy duiker calves should double their birth weight by one month of age and be at least \geq 18% of the adult weight. In larger duikers, calves may only be at 15%.

Common duikers *Sylvicapra grimmia*:

They may mature and reproduce much earlier than forest duikers. Six month old common duikers are nearly adult size, and some females may calve at one year.²⁵

Zebra-banded duiker *Cephalophus zebra*:

By one month the horns were about 4.5 cm. (Udell)

Yellow-backed duiker *Cephalophus sylvicultor*:

Calves begin to nibble vegetation almost immediately. Nursing bouts are infrequent (about three times a day) but lengthy (7-15 minutes.) Calves grow very rapidly and are weaned by six weeks. By nine months, they have reached adult proportions and coloration, and are sexually mature at one year. Horn buds begin to show after about one month, and light hair starts growing on the black back. (Kingdon) By four weeks of age, the calf may achieve 18% of adult body mass. At birth, neonates are uniformly blackish brown. At 30 days a thin strip of hair along the spine begins to lighten and by 5 months the triangular yellow rump patch is fully developed. (Lumpkin)

Maxwell's duiker *Cephalophus maxwelli*:

²⁵Estes, Richard D., 1991

Although tending to be slightly smaller at birth, females have been observed browsing earlier than males, and eventually overtake them in development.²⁶

Bay Duiker *Cephalophus dorsalis*:

Offspring begin eating solid food at 4-6 weeks of age. These calves develop rapidly. The duration of “laying out” or “tucking” varies from one to several weeks, and the calves are retrieved and suckled about three times during a 24 hour day.

Zebra-banded duiker *Cephalophus zebra*:

Zebra duikers are born weighing about 1.6 kg or 10% of the maternal body weight. They begin to nibble on solid foods within a week and feces become partially formed.

Maxwell’s Duiker *Cephalophus maxwelli*:

Newborns weigh from 710-954 gms. Or roughly 1/10th the weight of an adult female. Growth of the calf is rapid. They gain weight at the rate of 0.2kg per week. The calf first begins to nibble leaves at about 14 days of age. At the same time, the female shows the first signs of weaning behavior and occasionally interferes with attempts to nurse, often with success, for some weeks. The calf is completely weaned by two months of age. At birth, the single calf is the same color as its parents. (Ralls)

Yellow-backed Duiker *Cephalophus sylvicultor*:

One male calf weighed 6 kg at 4 days of age. He nearly doubled his body size between weeks 1 and 4 of life. This species appears to achieve about 18% of its adult mass by 4 weeks of age. One female weighed 36 kg at 130 days of age. Horns start to appear at about 30 days of age. Neonates are uniformly brownish-black in color. The yellow stripe is obvious by 118 to 140 days of age. (Lumpkin)

Jentink’s Duiker *Cephalophus jentinki*:

Bottle-raised calves become very gentle and can be handled quite easily. These calves will even tolerate injections or physical exams with minimal restraint. However, even the bottle-raised individuals retain the explosive flight reaction which can be initiated at any time.²⁷

Red-flanked duiker *Cephalophus rufilatus*:

²⁶Whittle, Cynthia and Patrick, 1977

²⁷ Farst, D.D., et al, 1988

The neonatal mass has been recorded as being 0.7 kg for males and 1.14 kg for females (Hayssen, et al., 1993) or roughly 10-11 percent of maternal body weight (Dittrich, 1969).

Environmental enrichment:

A variety of “hides” should be provided. Low branches, rocks, or other low scent-marking “targets” should be provided. A section or two of grass in the exhibit will provide grazing opportunities. Dispersal of chopped fruit or vegetable items throughout the exhibit will increase foraging.

Reproduction and Ontogeny

Characteristics of cyclicality²⁸

As many of the recorded interbirth intervals substantially exceed the presumed gestation periods, females may go through a post- partum anestrus or several periods of non-fertile estrous before becoming pregnant.

Bay Duiker *Cephalophus dorsalis*:

Estrous cycle lasts n/a
Females estrus lasts12-24 hours
Gestation 7.5-8 mos.
Interbirth interval 11-12 mos.
FecundityFemales - @ 14 mos. Males - n/a
Age at first reproduction24 mos.
Weight of offspring710-954 gm or 10% of dams body weight
Longevity10-16 yrs.

Yellow-backed Duiker *Cephalophus sylvicultor*:

Estrous cycle lasts 30 days
Females estrus lasts 1 day
Gestation 151 days

²⁸Estes, Richard, Farst, Don, Frahm, Michelle, Jones, Marvin, Kingdon, Jonathan,

Lunpkin, Susan, Mentis, Michael, Rall, Katherine, Udell, Carole

Interbirth interval 399 days
FecundityFemales - 9-12 mos. Males - 12-18 mos.
Age at first reproduction 1 yr.
Weight of offspring3.65 kg or 10% of dams body weight
Longevity 10-17 yrs.

Jentink's Duiker *Cephalophus sylvicultor*:

Estrous cycle lasts n/a
Females estrus lasts n/a
Gestation n/a
Interbirth interval 321 days
FecundityFemales - n/a Males - n/a
Age at first reproduction n/a
Weight of offspring n/a
Longevity 17 yrs.

Maxwell's Duiker *Cephalophus maxwelli*:

Estrous cycle lasts n/a
Females estrus lasts n/a
Gestation 4 mos.
Interbirth interval n/a
FecundityFemales - n/a Males - n/a
Age at first reproduction n/a
Weight of offspring n/a
Longevity 10 yrs.

Blue Duiker *Cephalophus monticola*:

Estrous cycle lasts n/a
Females estrus lasts1 day
Gestation 207 days, (low 167, high-205)
Interbirth interval 264 days, (low-208, high-446) n=39
FecundityFemales -1yr.-18 mos. Males - n/a
Age at first reproduction2 yrs.
Weight of offspring710-954 g
Longevity 10-15 yrs.

Common, bush, gray, or Grimm's Duiker *Sylvicapra grimmia*:

Estrous cycle lasts n/a
Females estrus lasts1 day
Gestation191 days

Interbirth interval232-298 days (Smithers)
FecundityFemales - 8-9 mos. Males - n/a
Age at first reproductionas early as 1 year
Weight of offspring160-190gm
Longevity 14 yrs.

Red-flanked duiker *Cephalophus rufilatus*:

Estrous cycle lasts n/a
Females estrus lasts ½-1 day
Gestation 223-245 days
Interbirth interval 235 days
FecundityFemales - 9 mos. Males - n/a
Age at first reproduction 2 yrs.
Weight of offspring 710 gm-1.14 kg
Longevity 8-10 yrs.

Zebra-banded duiker *Cephalophus zebra*:

Estrous cycle lasts1 mo.
Females estrus lasts ½-1 day
Gestation 190-245 days
Interbirth interval n/a
FecundityFemales -n/a Males - n/a
Age at first reproduction n/a
Weight of offspring 1.6 kg or 10% of adult
Longevity 12 yrs.

Black duiker *Cephalophus niger*:

Estrous cycle lasts n/a
Females estrus lasts n/a
Gestation 126 days
Interbirth interval n/a
FecundityFemales -n/a Males - n/a
Age at first reproduction n/a
Weight of offspring 1.75 kg or 10% of adult
Longevity 12 yrs.

Behavioral signs of estrus:

Although the signs of estrus may vary slightly from one species to another all duikers may exhibit a combination of the following behaviors: Male duikers sexual behaviors include persistent following or “driving” of the female, butting, licking her vulva, biting

at her tail base, urine-testing (flehmen), low stretch, foreleg lifting (laufs Schlag), prancing, social grooming, gland pressing with preorbital gland, and uttering “pig-like” grunts/snorts. Copulation is brief. The male keeps his head up, and jumps off the ground during ejaculation. After dismounting, he will lick his penis and begin another pursuit.²⁹

Behavioral signs of impending parturition:

Impending parturition is indicated by a distension of the female’s udder (2 inguinal mammae), a swollen vulva sometimes accompanied by the female carrying her tail away from her body, restlessness, pacing, and stretching. Post-partum the female will eat the placenta and thoroughly lick her newborn calf. (Lumpkin)

Management of pregnant animals:

In captivity males are generally indifferent to the calf, but occasionally become intolerant of the young and may need to be removed. (Lumpkin)

Assisted Reproduction Techniques

An assisted reproduction pregnancy in a yellow-backed duiker which resulted in the birth of twins had a gestation length of 206 days. Although the female calves were substantially smaller than normal (1.85 kg; average 4.8 kg) and failed to survive, they appeared to be well developed indicating they were close to term (unpubl. data). (Frahm)

embryo transfer- n/a

electroejaculation and other semen collection methods-

Semen evaluations have been conducted. Initial attempts at semen collection under manual restraint yielded poor results, probably due to the overall stress on the animal. Good erections were not achieved although small samples could be collected. Electroejaculation under gas anesthesia also produced poor results. Although a good erection and extension of the penis was achieved, the sample was frequently contaminated with urine. Chemical immobilization with carfentanil and ketamine yielded the best semen results. Sample volumes ranged from 0.2-1.2 ml and contained 10-20 x10⁶ sperm/ml (B. Foxworth, unpubl. data). (Frahm)

Semen has been successfully procured via electroejaculation and post-mortem collection. (pers. comm. B. Durrant, C.R.E.S.)

cryopreservation of semen-

²⁹Estes, Richard D., 1991

**Zoological Society of San Diego,
Center for Reproduction of Endangered Species**

| “Frozen Zoo” Species | Collection method | |
|---|--------------------------|----|
| Bay Duiker <i>Cephalophus dorsalis</i> | PM | |
| Kaffir-crowned Duiker <i>Sylvicapra grimmia capra</i> | PM | |
| Maxwell’s Duiker <i>Cephalophus maxwelli</i> | PM | EE |
| Yellow-backed Duiker <i>Cephalophus sylvicultor</i> | PM | EE |

PM=post-mortem

EE= electroejaculation

estrous cycle manipulation- n/a

Contraception

methods-

MGA implants:

Maxwell’s duiker *Cephalophus maxwelli*- There was one reported use (St. Louis) Pre-implant this female had 2 offspring via C-section. She was implanted 5/92 and died 7/92. She was not pregnant at necropsy.

Blue Duiker *Cephalophus monticola*- There was one reported use (Jacksonville Zoo). This implant was removed because it was falling out. There was no notation of infection at implant site. She was re-implanted and transferred to San Antonio on 4/95. She did not have any problems which could be attributed to the implant but had to be euthanized seven months later due to severe bilateral joint disease.

failure rate- n/a

problems- n/a

For more detailed information please refer to:

-AZA Contraception Advisory Group Contraception Report, II Ungulates.

-CAG Forum located at www.worldzoo.org/CAG

-Karen Dematteo, CAG database manager/CAG Forum manager at kdematteo@aol.com or phone 314-781-0900

Hand rearing

Zoological Society of San Diego Hand Rearing Standard Protocols

Formula Information:

Bovine colostrum, procured from certified *Mycobacterium paratuberculosis* (Johnes) - free commercial dairies, is the best choice; but when that is unavailable other colostrum substitutes have been used with good results.

San Diego Wild Animal Park (Infant Isolation Unit and Animal Care Center)

| | |
|---------------|---|
| 1st 24 hours: | 100% Bovine Colostrum (Igg's>90 mg/ml) |
| 2nd 24 hours: | 50% Bovine Colostrum (Igg's>90 mg/ml) 50% Formula |
| To 1 month: | 10% Bovine Colostrum (Igg's>60-85 mg/ml) 90% Formula |
| To weaning: | 100% Formula |

Supplements:

All facilities: Visorbin - SID through weaning (0.15 cc/lb.)

SDWAP: Bo-se - single dose upon arrival (0.05 cc/lb.)

Microbial powder (Probios TM³⁰) - every bottle for first 7 days, then SID through weaning.

SDZ: Plexol - SID through weaning

Solid food introduction:

SDWAP: Within first week:

- alfalfa hay
- acacia browse

³⁰Probios microbial powder contains a source of live (viable) naturally occurring microorganisms including: *Enterococcus faecium*, *Lactobacillus acidophilus*, *Lactobacillus casei*, *Lactobacillus plantarum*, not less than 10 million CFU (colony forming units)/g.

- 1/4" low fiber alfalfa pellet
- manna milk pellet
- omalene (horse ration)
- rolled corn and barley mix
- access to mineral/salt block

Gradually: Increase proportion of low fiber alfalfa pellet and decrease amount of other pellets.

Add adult food items at 2 weeks of age (i.e. fruit, vegetables, meat/protein)

SDZ: From 14 days:

- alfalfa hay
- acacia browse
- 1/4" low fiber alfalfa pellet
- omalene horse ration
- diced carrots and yams

Hand rearing protocol for Maxwell's Duiker *Cephalophus maxwelli*

| | | | | |
|--------------|--------|------------|-----|------------------------|
| | female | 945 gm avg | n=2 | range 880 gm - 1010 gm |
| Birth weight | male | 748 gm avg | n=2 | range 667 gm - 830 gm |

Normal body temperature in the first two weeks range from 100.5 - 103.5EF.

Current Formula:

- 1) 8 parts Evap. Goats milk
- 3 parts water
- 1 part Zoologic 33:40 powder (pre-diluted to 1 part powder to 5.25 parts water)

Alternate formula:

- 1) Whole fresh cows milk (L.A. Zoo)

Feeding Apparatus:

Human "preemie" nipple, "joey" or custom latex water deer nipple.

Feeding Regimen

| Age | Minimum Number of Feedings | Suggested Feeding Times |
|-----------------|-----------------------------------|-------------------------------------|
| 1 - 11 days | 6 | 6:30 am, 9, 12, 3:30, 6:30, 9:30 pm |
| 11 days - 3 wks | 5 | 6:30 am, 9, 12, 3:30, 6:30 pm |
| 3 - 6 wks | 4 | 6:30 am, 9:30, 12:30, 4:30 pm |
| 6 - 8.5 wks | 3 | 7:30 am, 12:30, 4:30 pm |
| 8.5 10 wks | 3 decreasing volume mid | 7:30 am, 12:30, 4:30 pm |
| 10 - 13 wks | 2 decreasing volume both | 7:30 am, 4:30 pm |
| 13 wks | weaned | |

Growth

| Age wks | % change from birth weight | body wt. - birth wt. Birth wt. X 100 | % body weight intake of formula |
|----------------|-----------------------------------|---|--|
| 1 wk | 11% n=4 | range: 6% - 15% | 18% n=4 |
| 2 wks | 36% n=4 | 28% - 42% | 17% n=4 |
| 3 wks | 71% n=3 | 63% - 84% | 17% n=3 |
| 4 wks | 99% n=3 | 93% - 110% | 16% n=3 |
| 6 wks | 150% n=3 | 111% - 195% | 15% n=3 |
| 8 wks | 215% n=3 | 182% - 267% | 12% n=3 |
| 10 wks | 276% n=3 | 228% - 334% | 9% n=3 |
| 12 wks | 341% n=3 | 299% - 400% | 5% n=3 |

Hand rearing protocol for Yellow-backed Duiker *Cephalophus sylvicultor*

Birth Weight:

Male - 5.0 Kg.

Birth Temperature (F):

Initial 103.9E
1st night 102.7E
next a.m. 103.2E

Current Formulas:

1) Evap. Cows / SPF-lac 1:1 *Spf-lac discontinued by manufacturer

Alternate formulas:

1)Evap. Cows 2
 Whole Cows 1
 Zoologic 33:40 1
 (Zoologic 33:40 powder pre-diluted with 5.25 parts water to 1 part powder)

Feeding Apparatus:

Soft latex lambs nipple

Feeding Regimen

| Age | Minimum number of feedings | Suggested feeding times |
|------------|-----------------------------------|--------------------------------|
| 1-4 | 3 | 6am, 12, 6pm |
| 4-12 wks | 2 | 6 am, 5 pm |
| 12-16 wks | 2 decreasing volume both | 6am, 4 pm |
| 16 wks | weaned | |

Note: Early morning or twilight nursers may need large volume bottles early and late with small mid-day bottle volumes.

Growth

| Age (wks) | % change from birth wt. | = | $\frac{\text{Body wt.} - \text{Birth wt.}}{\text{Birth wt.}} \times 100$ | % Body weight Intake of formula |
|--------------|-------------------------------|---|--|------------------------------------|
| 1 | | | 26% | 10% |
| 2 | | | 50% | 8% |
| 3 | | | 70% | 8% |
| 4 | | | 100% | 8% |
| 6 | | | 154% | 7.8% |
| 8 | | | 226% | 7.4% |
| 10 | | | 306% | 5.7 % |
| 12 | | | 400% | 4.8% |

Usually noted eating solids/ruminating at 2 weeks.
Add adult food items at 2 weeks of age (i.e. vegetables, meat/protein)

Los Angeles Zoo hand rearing protocol for duikers

Birth weights:

Black duiker (*Cephalophus niger*)1.75 kg
Red flanked duiker (*Cephalophus rufilatus*)1.00 kg
Zebra duiker (*Cephalophus zebra*)1.44 kg
Yellow backed duiker (*Cephalophus sylvicultor*) ...3.65 kg

Formula:

- First 72 hours: Cow's colostrum
- Second 72 hours: Cow's colostrum 1:1 whole fresh cow's milk
- Until 21 days: Cow's colostrum 1:9 whole fresh cow's milk
- 21 days through weaning: Whole fresh cows milk

Feeding schedule:

9am, noon, 3pm, 6pm, 9pm, midnight

Supplements:

Offered on day 7: 1/4 tsp vitamin E acetate (500 iu/gm) once daily, and a “pinch” of Probios granules in each bottle. Probois is discontinued at weaning, vitamin E is continued through adulthood.

Solids:

Alfalfa and acacia are offered from birth. ADF-16 Herbivore pellets and Mazuri Browser Maintenance pellets are offered at one month. Also at one month, produce items are offered, including diced apple, carrot, raw yam. Broccoli and spinach are offered on alternate days.

Weaning:

Begins on day 60 by eliminating one bottle feeding weekly until weaned at approximately 90+ days. Generally night feedings are dropped first.

Equipment:

- For smaller duiker species: Evenflow bottles and human preemie nipples
- For Yellow backed duiker: a ribbed nipple to start, then graduated to a lamb’s nipple
- For fussier calves: “joey” nipples

General information:

Bed newborns on alfalfa with towels. Shavings stick to wet noses and shavings impaction can be a problem. Stalls are kept at room temperature and spot heat is provided (250 watt lamp). Weigh infants daily on the same scale and at the same time for as long as they will tolerate it.

Cross fostering: n/a

Reintroduction of hand-reared animals: n/a

Methods to reduce chances of imprinting on humans:

Avoid prolonged separation of newborn from dam. Neonatal examination should be performed as quickly as possible.

Reproductive success of hand-reared animals:

Hand reared Black, Zebra and Red-flanked duikers have successfully reproduced and

raised offspring in captivity. The studbook indicated that this is not true for the Bay duiker.

Role of Keeper in Animal Management

Level and type of contact:

A daily husbandry routine is acceptable. Keep in mind that the level of contact should be kept to a minimum, as the presence of a keeper can cause elevated stress levels in most duikers. (C. Pfefferkorn, pers. comm.)

Role in management decisions:

Keepers are responsible for making accurate daily observations and evaluations of animals in their area, reporting any suspected health problems or abnormalities, and behavioral or social problems which may be occurring within the exhibit.

Animal training for husbandry and veterinary routines:

Duikers have been successfully crate trained. This training facilitates getting weights and reducing stress associated with transport.

In Situ Programs:

WWF-Tanzania has provided funding for a proposed project to translocate Ader's duiker *Cephalophus adersi* from Zanzibar to Chumbe Island. Conservation efforts are being coordinated by Antelope Specialist Group member Frank Reitkirk.

Also see African Antelope Database 1998, (Rod East) IUCN/SSC Antelope, Specialist Group Report, December 1998.

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