

RRH: SHORT COMMUNICATIONS

Capture and Immobilization of African Wolves (*Canis lupaster*) in the Ethiopian Highlands

Tariku Mekonnen Gutema,^{1,9} Anagaw Atickem,^{1,2} Alemayehu Lemma,³ Afework Bekele,⁴ Claudio Sillero-Zubiri,⁵ Dietmar Zinner,² Wenche Kristin Farstad,⁶ Jon M. Arnemo,^{7,8} and Nils C. Stenseth^{1,4}

¹ Centre for Ecological and Evolutionary Synthesis (CEES), Department of Biosciences, University of Oslo, PO Box 1066 Blindern, NO-0316 Oslo, Norway; ² Cognitive Ethology Laboratory, German Primate Center, Leibniz Institute for Primate Research Kellnerweg 4, 37077 Göttingen, Germany; ³ College of Veterinary Medicine and Agriculture, Addis Ababa University, DebreZeit, PO Box 34, Ethiopia; ⁴ Department of Zoological Sciences, Addis Ababa University, PO Box 1176, Addis Ababa, Ethiopia; ⁵ Wildlife Conservation Research Unit, Zoology Department, University of Oxford, Recanati-Kaplan Centre, Tubney House, Tubney OX13 5QL, UK.; ⁶ Department of Production Animal Clinical Sciences, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, PO Box 8146, NO-0033 Oslo, Norway; ⁷ Department of Forestry and Wildlife Management, Inland Norway University of Applied Sciences, Campus Evenstad, NO-2480 Koppang, Norway; ⁸ Department of Wildlife, Fish and Environmental Studies, Swedish University of Agricultural Sciences, SE-901 83, Umeå, Sweden;

⁹ Corresponding author (email: jtarikumg@gmail.com)

ABSTRACT: We captured 14 individual African wolves (*Canis lupaster*) a total of 16 times in the Ethiopian highlands in April 2015 and March 2016 using rubber-lined foot-hold traps and immobilized them with dexmedetomidine-ketamine. Traps were baited with sheep meat and surveyed every 2 h. Capture efficiency (number of captures/number of visits) was 0.94 and capture rate (number of captures/number of trap nights) was 0.24. Trapped wolves were immobilized with 0.025 mg/kg dexmedetomidine and 8-10 mg/kg ketamine based on respective estimated body mass. Mean (SD) induction times were 3.4 (0.5) min for subadults ($n=4$), 3.5 (0.3) min for adult males ($n=4$), and 4.7 (1.0) min for adult females ($n=6$). Inductions were calm, muscle relaxation was good, and all animals were completely immobilized. Apart from increased rectal temperatures, no major negative side effects were observed. Atipamezole at 10 mg intramuscularly per mg of dexmedetomidine administered was used for reversal at a mean of 43.5 (7.7) min after administration of dexmedetomidine-ketamine. Recoveries were relatively smooth and animals were on feet leaving the site within a mean of 13.6 (3.9) min, after atipamezole administration. Our results indicate that African wolves can be safely captured and immobilized using rubber-lined foot-hold traps, and dexmedetomidine and ketamine.

Key words: *Canis lupaster*, dexmedetomidine, immobilization, ketamine, Ethiopian wolf, foot-hold traps

Free-ranging canids are captured for research and management purposes. Typically, animals are trapped before administration of anesthetic drugs to enable safe handling (Larsen and Kreeger 2014). Physical restraint and induction of anesthesia are stressful procedures and require the use of optimal methods, equipment, and drugs (Caulkett and Arnemo 2015). A number of different physical capture techniques have been used in canids depending on the target species, habitat, and available resources and expertise. For instance, foot-hold traps proved to be effective in capturing side-striped jackals (*Lupulella adusta*), black-backed jackals (*Lupulella mesomelas*) and Ethiopian wolves (*Canis Simensis*; Sillero-Zubiri 1996).

A combination of medetomidine and ketamine has been widely used to immobilize free-ranging canids (Kreeger and Arnemo 2012). Medetomidine is a potent alpha-2 adrenoceptor agonist that produces sedation, analgesia, and muscle relaxation. Combined with a relatively low dose of ketamine, it induces anesthesia (Larsen and Kreeger 2014). Medetomidine is composed of equal parts of two optical enantiomers (dexmedetomidine and levomedetomidine), but its pharmacological effects are due almost exclusively to dexmedetomidine (Ansah et al. 1999). Although dexmedetomidine may have clinical benefits compared to medetomidine as a sedative in dogs (Kuusela et al. 2001), recent studies on dexmedetomidine and medetomidine as adjuncts to anesthesia in brown bears (*Ursus arctos*) are contradictory (Fandos Esteruelas et al. 2017). A new wolf species, the African wolf (*C. lupaster*), was discovered in the Ethiopian highlands in 2011 and confirmed as a distinctive species that diverged over a million years ago from its ancestral canids (Koepfli et al. 2015). Here we report the safe capture and immobilization of free-ranging African wolves using rubber-lined foot-hold traps and dexmedetomidine- ketamine.

We trapped African wolves in the Guassa Community Conservation Area (GCCA, (10°27'N; 39°45'–39°49'E) in April 2015 at three sites approximately 1.4 km from each other and in the Borena Saynt National Park (10°50'-10°53'N; 38°40'-38° 54'E; Fig 1) in March 2016 at three sites approximately 2.5 km from each other. GCCA has an area of 111 km² with an elevation of

3200-3700 m. The Borena Saynt National Park comprises 132 km² at an elevation of 1900-3700 m.

Both areas are habitats for the world's rarest canid, the Ethiopian wolf, which is endemic to the Ethiopian highlands.

We used rubber-lined Soft Catch foot-hold traps (Woodstream Corporation, Lititz, Pennsylvania, USA) size 1.5 and 3. The traps were set in the buffer zone of the respective protected areas. African wolves were frequently observed in these areas whereas Ethiopian wolves were rarely seen during our three months of assessment of the distribution of canids. Two foot-hold traps were buried on a 1 m² plot free from stones and other potentially harmful materials. Each trap was anchored with two metal sticks buried about 60 cm into the ground. The traps were set from 16:00 to 06:00 and checked every 2 hr to reduce risk of stress and injuries in trapped animals and to release non-target species, in particular the Ethiopian wolf. During each trapping session, four to eight trap stations were set up with sheep meat as bait (Rowe-Rowe and Green 1981, Kaunda 2001). Once trapped, the wolves were covered by a blanket and manually restrained for administration of 0.025 mg/kg of dexmedetomidine (Dexdomitor® 0.5 mg/mL, Orion Pharma Animal Health, Turku, Finland) followed by 8 (subadults) or 10 (adults) mg/kg of ketamine (Ketamine® 50 mg/mL, Rotexmedica, Trittau, Germany) based on estimated body weights. The drugs were injected into the semimembranosus muscle using a hand-held syringe. The induction time (time from administration of dexmedetomidine-ketamine to no response to handling) was recorded. To evaluate capture efficiency of the traps, the number of captured animals per visit was calculated (Kamler et al. 2008). In addition, we calculated capture rate as the number of captures divided by the number of trap nights (number of traps multiplied by number of nights; Rowe-Rowe and Green 1981, Kaunda 2001).

Immobilized wolves were wrapped in a blanket to maintain body heat as recommended by Sillero-Zubiri (1996). The ambient temperature during the capture ranged

from 1 to 8 C. Animals were weighed and their reproductive condition was assessed. Heart rates (using a stethoscope), respiratory rates (counting chest movements) and rectal temperatures (using a digital thermometer) were recorded once the animal became immobilized and failed to respond to stimuli. All animals were examined by an experienced veterinarian for possible trauma, especially to teeth and feet. Animals were classified as adults or subadults based on tooth wear (Landon et al. 1998). All wolves were fitted with a very high frequency radio collar (Telemetry Solutions, Concord, California, USA).

For reversal of immobilization, 10 mg of atipamezole (Antisedan® 5 mg/mL, Orion Pharma Animal Health) per mg of dexmedetomidine were administered intramuscularly in the thigh and the time to reversal (time from administration of dexmedetomidine-ketamine to injection of atipamezole) was recorded. Recoveries were observed and the times from administration of atipamezole to first signs of arousal (ear movements), and standing and starting to leave the site (on feet and leaving) were recorded.

Fourteen wolves were trapped, ten adults (three males, seven females) and four subadults (two males and two females). Two of the females were trapped twice. Also, two domestic dogs were captured. On average, six traps were set at each site for 11 d. During 66 trap nights, 16 wolves were captured. The capture efficiency was 94% and capture rate was 24%. Most of the wolves (94%) were captured between 1700 and 2300 hours, whereas 6 % were captured between 0400 and 0600 hours. Summary statistics for body mass, physiological variables, drug doses and effects, and recovery were collected (Table 1). Inductions were calm and muscle relaxation was good. Most immobilized animals had higher rectal temperatures than expected and some were considered hyperthermic (rectal temperature above 40 C). The blanket was therefore removed. No other obvious side effects were observed. None of the wolves needed additional drugs to maintain immobilization. No trauma

from the traps was observed. Recoveries were relatively smooth and all wolves left the capture site 10-22 min after atipamezole administration. All wolves survived for at least 1 yr. Hence, the rubber-lined Soft Catch foot-hold traps used in this study appeared to be an effective and safe method for the capture of African wolves. Our results supported the importance of this method, which has been used for a wide range of carnivore species, including Ethiopian wolves (Sillero-Zubiri 1996). We captured no Ethiopian wolves, regardless of their presence in close vicinity of the trapping site. In human dominated landscapes, carnivore activity is influenced by human activities, and certain period of the day might provide the highest capture rates (Virgos et al. 2016). In our study, the highest capture rate was recorded between 1700 to 2300 hours, which is a suitable period for trapping African wolves in the Ethiopian highlands.

A combination of dexmedetomidine and ketamine was effective for immobilization of African wolves. Inductions were fast, duration of immobilization was sufficiently long for all procedures to be completed, and recoveries were relatively quick and smooth after administration of atipamezole. The main side effect was hyperthermia. Rectal temperatures higher than 40 C are cause for concern and attempts should be made to cool the animal (Caulkett and Arnemo 2015). In future studies on African wolves, the rectal temperature should be measured in 5-10 min interval to detect thermoregulatory problems. Also, monitoring for respiratory depression (e.g., with pulse oximetry), is recommended. Supplemental oxygen should be available in case of hypoxemia. Admasu et al. (2004) used a relatively high dose of medetomidine (0.09 mg/kg, equivalent to 0.045 mg/kg of dexmedetomidine) and a low dose of ketamine (2.8 mg/kg) to anesthetize seven African wolves. Inductions (5.0 min) were longer than in our study. Recoveries, however, were quicker and the wolves moved away 6.3 min after reversal with atipamezole (0.45 mg/kg),

most likely due to the low dose of ketamine. Adamsu et al. (2004) found no obvious adverse effects of anesthesia but did not report data on physiological variables. Medetomidine (0.09 mg/kg) and ketamine (1.5 mg/kg) were also used to immobilize Ethiopian wolves for vaccination ($n=77$) and revaccination ($n=19$) against rabies (Knobel et al. 2008), but the authors gave no details on anesthetic effects or recoveries after reversal with atipamezole. Based on the 1-2 yrs follow-up (radio tracking, observations, and behavior) of our animals, there were no apparent long-term effects from the captures. In conclusion, we recommend rubber-lined Soft Catch foot-hold traps and dexmedetomidine-ketamine and atipamezole for capture and reversible immobilization of African wolves.

We acknowledge the Ethiopian Wildlife Conservation Authority for permission for this project. We thank the staff of the Menz-Guassa Community Conservation Area, and Borena Saynt National Park, for their assistance during the field work. We are grateful to the Ethiopian Wolf Conservation Programme for providing the capture equipment and to Alo Hussein, Burqa and Kassim for assistance setting up traps and handling the animals. We thank the Rufford Small Grants Foundation, the Mohamed bin Zayed Species Conservation Fund, the Centre for Ecological and Evolutionary Synthesis, and QUOTA SCHEME for financial support.

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Table 1. Summary statistics for African wolves (*Canis lupaster*) immobilized with dexmedetomidine-ketamine in the Ethiopian highlands in April 2015 and March 2016. Atipamezole at 10 mg per mg of dexmedetomidine was given for reversal. Values are presented as means (SD) and ranges.

Variable	Units	Adults			Subadults	
		Males (n=6)	Females (n=4)	Range	n=4	Range
Body mass	kg	9.0 (0.6)	8.1(0.7)	7-10	6.8 (0.54)	6-8
Dexmedetomidine	mg/kg	0.026	0.029	0.02-0.03	0.030	0.029-0.03
Ketamine	mg/kg	8.35 (0.47)	8.36 (0.53)	8-9	8.81(1.35)	8-10
Induction time	min	3.5 (0.3)	4.7 (1)	3-6	3.4 (0.5)	3-4
Respiratory rate	beats/min	17 (1)	18 (3)	14-20	16 (3)	12-18
Heart rate	beats/min	78 (9)	86 (7)	70-96	89 (25)	70-126
Body temperature	C	41.0 (1.3)	40.1(1.7)	37-41	39.1(0.8)	38-40
Time to reversal	min	51.0 (11.1)	53.5 (4.7)	43-67	46.0 (5.4)	40-53
Ear movements	min	6.0 (0.4)	6.7 (2.7)	5-11	6.0 (1.7)	4-9
On feet (start leaving)	min	15.5 (4.9)	14.2 (3.6)	10-22	10.7 (2.5)	8-13

Figure 1. Map showing the study areas where African wolves (*Canis lupaster*) were captured by soft leg-hold trapping and immobilized with dexmedetomidine and ketamine in the Ethiopian highlands in April 2015 and March 2016.

