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Determining thermal stress during the transport of mammals

Wimberger, Kirsten

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APPENDIX 1

Ethical clearances and permissions of authorisations to conduct my experiments.

Species	Ethics clearance	Authorisation
Impala (*Aepyceros melampus*)	2002/24/5	Zoological Research Committee, National Zoological Gardens, Pretoria, South Africa
Blesbok (*Damaliscus dorcus phillipsi*)	2002/24/5	Johannesburg Zoological Gardens, Johannesburg, South Africa
Tsessebe (*Damaliscus lunatus*)	2003/61/5	AfriVet, Karina, South Africa
Angora goats (*Capra aegagrus*)	2000/27/4.	Hopedale farm, Steytlerville, South Africa
Mixed breed goats (*Capra hircus*)	2003/51/3	N/A
White rhinoceros, blesbok, elephant, black buck	2002/41/4	Various capture teams (see Table 2.1)

General capture and transport procedures used in my study

All capture and transport of wild animals were carried out by professional capture teams. The capture process varied from chemical capture (darting) to mass capture using nets or bomas. During chemical capture, animals were immobilized using a dart gun. Once immobilized, they were carried or walked to the transport vehicle and placed inside one of the compartments. The animals then were injected with a narcotic drug antagonist, so that they were not sedated during transport, but were still tranquilized. Mass capture involved chasing the animals with a helicopter into a net or boma in the field. Animals trapped in a net were handled individually, injected with a tranquillizer, and lead into the transport vehicle. Those that were caught in a boma were not handled, but chased into the vehicle, where they were then tranquilized. Horned animals, namely the impala males, tsessebe and blesbok, had their horns covered with plastic piping to prevent them from harming themselves and the game capture operators. In addition to measuring air temperature during capture, I also measured globe temperature, using a globe thermometer attached to the exterior top of a ventilated metal box. The globe thermometer consisted of a globe painted matt black, where air and globe temperatures were measured using a data logger (see sections 1.3 and 4.1.3). The globe thermometer was placed on the ground, in an area with the least amount of cover, so that the globe was facing upwards and away from the shade.

Transport containers

The transport containers used in my study were all designed specifically to transport animals, and included an open pick-up truck, a trailer attached to a towing vehicle and an enclosed container or wooden crate on the back of a truck (Appendices 3.a and 3.c). The open pick-up truck had guardrails on its sides and straw on the floor. The trailer and the container on the truck had two compartments, so that the animals could be divided into two smaller groups. The trailer compartments each had dimensions of 1.8 x 1.6 x 1.6 m. The trailer and container both had ventilation holes and man-holes on the roof, while the floor and walls were covered with rubber matting. The wooden crate (2.5 x 0.6 x 1.4 m) was suited only for the transport of an individual animal. It had ventilation holes, and straw, instead of matting, on the floor. During transport, the globe thermometer was placed inside the transport vehicle, out of the reach of the animals. Most animals were transported on single lane roads at speeds of about 80 km/h, though on occasion some were transported on dual carriageway highways at speeds of about 120 km/h. There were occasional stops on route, lasting no more than ten minutes each.

APPENDIX 3.A

Different types of containers on vehicles used to transport animals in my study. The top picture shows a container used for rhino transport, while the bottom picture shows a container used for elephant transport.





APPENDIX 3.B

Two different ways of loading animals, used in my study. The top picture shows a blesbok being loaded into a trailer, while the bottom picture shows an elephant being loaded into an enclosed container on the back of a truck.





APPENDIX 3.C

Examples of a trailer and a crate used to transport animals in my study. The top picture shows a trailer that was attached to a towing vehicle to transport impala, blesbok and tsessebe. The bottom picture shows a crate used to transport individual animals, such as an adult impala ram and a black buck.





APPENDIX 4

Generic name, brand name and supplier of the drugs used in my study

Type of drug	Generic name (concentration)	Brand name	Supplier
Anaesthetics	halothane (2-8%)	Fluothane	Zeneca, Johannesburg, South Africa
	ketamine hydrochloride (200mg/ml)	Ketamine	Kyron Laboratories, Johannesburg, South Africa
	lignocaine hydrochloride (4-8mg/kg)	Lignocaine	Centaur Labs, Johannesburg, South Africa
Tranquillizers	azaperone (40mg/ml)	Stresnil	Janssen-Cilag (Pty.) Ltd., Johannesburg, South Africa
	haloperidol (20mg/ml)	Haloperidol	Kyron Laboratories, Johannesburg, South Africa
	perphenazine enanthane (100mg/ml)	Trilafon	Schering-Plough (Pty.) Ltd., Johannesburg, South Africa

	zuclopenthixol acetate (50mg/ml)	Clopixol Acuphase	H.Lundbeck (Pty.) Ltd., Johannesburg, South Africa
Alpha-2-adrenoceptor-agonists	medetomidine (1mg/ml)	Domitor	Novartis, Johannesburg, South Africa
Alpha-2-adrenoceptor-antagonists	atipamezole hydrochloride (5mg/ml)	Antisedan	Novartis, Johannesburg, South Africa
Opioid agonists	etorphine hydrochloride (9.8mg/ml)	M99	Logos Agvet, Johannesburg, South Africa
	fentanyl citrate (30mg/ml)	Fentanyl	Kyron Laboratories, Johannesburg, South Africa
	thiafentanyl oxalate (10mg/ml)	A3080	AfriVet, Karina, South Africa
Opioid antagonists	diprenorphine hydrochloride (12mg/ml)	M50/50	Logos Agvet, Johannesburg, South Africa

	nalorphine hydrobromide (20mg/ml)	Nalorphine	Kyron Laboratories, Johannesburg, South Africa
	naltrexone hydrochloride (20 part of naltrexone to 1 part etorphine)	Naltrexone	Kyron Laboratories, Johannesburg, South Africa
Anticholinergics	biperiden lactate (5mg/ml)	Akineton	Knoll Pharmaceuticals South Africa (Pty.) Ltd., Midrand, South Africa
Antiparasitics	doramectin 1% (1ml/50kg)	Dectomax	Pfizer Laboratories SA (Pty.) Ltd., Johannesburg, South Africa
	Invermectin (1ml/50kg)	Ivomec	Merck (Pty.) Ltd., Midrand, South Africa
Anti-inflammatories	ramiphenazone, sodium phenylbutazone, dexamethasome, cinchocain HCL, benzalkonium chloride	Dexa-Tomanol	Centaur Labs, Johannesburg, South Africa

Antibiotics	procainbenzylpenicillin, benzathine benzylpenicillin, methylparaben, propylparaben (0.5-1ml/10kg)	Peni la Phenix	Phenix SA (Pty) Ltd., Midrand, South Africa
Vitamins and minerals	vitamin B_{12}, Na-selenite, K-aspartate, Mg-aspartate, ATP (2-5ml)	Biosolamine	Rhône-Poulenc, Johannesburg, South Africa
Ancilliary drugs	adrenaline (1mg/ml)	Adrenaline	Kyron Laboratories, Johannesburg, South Africa
	hyaluronidase (150iu/ml)	Hyalase	Fisons Pharmaceuticals, Chloorkop, South Africa

REFERENCES

Allen, W.M., Hebert, C.N. and Smith, L.P. (1974) Deaths during and after transportation of pigs in Great Britain, *The Veterinary Record*, vol. 94, pp. 212-214.

Altman, P.L. and Dittmer, D.S. eds. (1974) Blood volumes: vertebrates, In: *Biology Data Book*, 2nd ed. U.S.A: Federation of American societies for experimental biology, vol. III, p. 1847.

Anderson, D.E., Grubb, T. and Silveira, F. (1999) The effect of short duration transportation on serum cortisol response in Alpacas (*Llama pacos*), *The Veterinary Journal*, vol. 157, pp. 189-191.

Barnes, A., Beatty, D., Taylor, E., Pethick, D., Costa, N., Maloney, S., Stockman, C., Toovey, A., McCarthy, M., White, C. and Masters, D. (2003) Physiology of heat stress in cattle, *Technical Report LIVE209*, Meat and Livestock Australia.

Bland, J.M. and Altman, D.G. (1986) Statistical methods for assessing agreement between two methods of clinical measurement, *The Lancet*, pp. 307-310.

Bligh, J. and Harthoorn, A.M. (1965) Continuous radiotelemetric records of the deep body temperature of some unrestrained African mammals under near-natural conditions, *Journal of Physiology*, vol. 176, pp. 145-162.

Brengelmann, G.L. (1987) Dilemma of body temperature measurement, In: Shiraki, K. and Yousef, M.K .eds. *Man in Stressful Environments-Thermal and Work Physiology*, Springfield: Thomas, pp. 5-22

Burroughs, R.E.J. and McKenzie, A.A. (1993) Handling, care, and loading of immobilised herbivores, In: McKenzie, A.A. ed. *The Capture and Care Manual*, Pretoria: Wildlife Decisions Support Services and South African Veterinary Foundation.

Cheney, C.S. (1987) *Stress related to the chemical immobilization of impala-Aepyceros melampus (Lichtenstein)- and its effect on blood composition*. MSc Thesis, Johannesburg: University of Witwatersrand.

Crabtree, M. ed. (2001) Temperature, In: *Mick Crabtree's Handbook*, 2nd ed. Johannesburg: Crown Publications.

Dehnhard, M., Clauss, M., Lechner-Doll, M., Meyer, H.H.D. and Palme, R. (2001) Noninvasive monitoring of adrenocortical activity in roe deer (*Capreolus capreolus*) by measurement of fecal cortisol metabolites, *General and Comparative Endocrinology*, vol. 123, pp. 111-120.

Dimsdale, J.E. and Moss, J. (1980) Short-term catecholamine response to psychological stress, *Psychosomatic Medicine*, vol. 42, pp. 493-497.

Drew, M.L. (1996) The use of a tympanic membrane thermometer for assessing hyperthermia in bighorn sheep, *Journal of Wildlife Diseases*, vol. 32, pp. 512-516.

Drew, M.L. (1998) Comparison of tympanic membrane and rectal temperatures of anesthetized fallow deer (*Dama dama*), *Journal of Zoo and Wildlife Medicine*, vol. 29, pp 338-340.

Dukes, H.H. ed. (1955) Temperature regulation, In: *The Physiology of Domestic Animals*, 7th ed. Comstock: Ithaca, pp 636-653.

Ebedes, H. (1993) The use of long-acting tranquillizers in captive wild animals, In: McKenzie, A.A. ed. *The Capture and Care Manual*, Pretoria: Wildlife Decisions Support Services and South African Veterinary Foundation.

Ebedes, H., du Toit, J.G. and van Rooyen, J. (1996) Game capture. In: Bothma, J. du P. ed. *Game Ranch Management*, Pretoria: J.L.van Schaik Publishers.

Ewing, S.A. (1999) Stress: a challenge to well-being, In: Ewing, S.A, Lay, D.C. and von Borell, E. eds. F*arm Animal Well-being: Stress Physiology, Animal Behavior, and Environmental Design*. Upper Saddle River: Prentice-Hall, chapters 2 and 3.

Fowler, M.E. ed. (1978) *Restraint and handling of wild and domestic animals*, Ames: Iowa State University Press.

Friend, T.H., Martin, M.T., Householder, D.D. and Bushong, D.M. (1998) Stress response of horses during a long period of transport in a commercial truck, *Journal of American Veterinary Medical Association*, vol. 212, pp. 838-844.

Fuller, A., Moss, D.G., Skinner, J.D., Jessen, P.T., Mitchell, G. and Mitchell, D. (1999) Brain, abdominal and arterial blood temperatures of free-ranging eland in their natural habitat, *Pflügers Archives-European Journal of Physiology*, vol. 438, pp. 671-680.

Ganhao, M.F., Hattingh, J., Hurwitz, M.L. and Pitts, N.I. (1991) Evaluation of a simple plasma catecholamine extraction procedure prior to high-performance liquid chromatography and electrochemical detection, *Journal of Chromatography*, vol. 564, pp. 55-66.

Ganhao, M.F., Hattingh, J., Pitts, N.I. and Hurwitz, M.L. (1992) High pressure liquid chromatography (HPLC) with electrochemical detection (ECD) for the determination of plasma catecholamines, *Medical Technology SA 6* (1 and 2), pp. 36-39.

Gardiner, M.R. and Craig, J. (1970) Factors affecting survival in the transportation of sheep by sea in the tropic and subtropics, *Australian Veterinary Journal*, vol. 46, pp. 65-69.

Geers, R., Puers, R. and Goedseels, V. (1997) Electronic identification and monitoring of pigs during housing and transport, *Computers and Electronics in Agriculture*, vol. 17, pp. 205-215.

Gericke, M.D., Hofmeyr, J.M. and Louw, G.N. (1978) The effect of capture stress and haloperidol therapy on the physiology and blood chemistry of springbok, *Antidorcus marsupialis*, *Madoqua*, vol. 11, pp. 5-18.

Goodwin, S.D. (1998) Comparison of body temperature of goats, horses, and sheep measured with a tympanic infrared thermometer, an implantable microchip transponder, and a rectal thermometer, *Contemporary Topics* by the American Association for Laboratory Animal Science, vol. 37, pp. 51-55.

Goss, W.B. and Siegel, P.B. (1993) General principles of stress and welfare, In: Grandin, T. ed. *Livestock Handling and Transport*, 2nd ed., CAB International, United Kingdom, pp. 21-34.

Grandin, T. (1997) Assessment of stress during handling and transport, *Journal of Animal Science*, vol. 75, pp. 249-257.

Guyton, A.C. ed. (1986) The nervous system, In: *The Textbook of Medical Physiology*, 7th ed. U.S.A: W.B. Saunders Company.

Hahn, G.L., Eigenberg, R.A., Nienaber, J.A. and Littledike, E.T. (1990) Measuring physiological responses of animals to environmental stressors using a microcomputer-based portable data logger, *Journal of Animal Science*, vol. 68, pp. 2658-2665.

Harper, J.M. and Austad, S.N. (2000) Fecal glucocorticoids: a non-invasive method of measuring adrenal activity in wild and captive rodents, *Physiological and Biochemical Zoology*, vol. 73, pp. 12-22.

Harris, P.J., Schaare, P.N., Cook, C.J. and Henderson, J.D. (2001) An ambulatory physiological monitor for animal welfare studies, *Computers and Electronics in Agriculture*, vol. 32, pp. 181-194.

Hattingh, J. (1988) Comparative quantitation of the physiological response to acute stress in impala and roan antelope, *Comparative Biochemistry and Physiology A*, vol. 89, pp. 547-551.

Hattingh, J., Pitts, N.I. and Ganhao, M.F. (1988) Immediate response to repeated capture and handling of wild impala, *The Journal of Experimental Zoology*, vol. 248, pp. 109-112.

Hetzel, D.J.S., Bennett, I.L., Holmes, C.R., Encarnacao, R.O. and Mackinnon, M.J. (1988) Description and evaluation of a telemetry system for measuring body temperature in cattle, *Journal of Agricultural Science Cambridge,* vol. 110, pp. 233-238.

Hicks, L.C., Hicks, W.S., Bucklin, R.A., Schearer, J.K., Bray, D.R., Soto, P. and Carvalho, V. (2001) Comparison of methods of measuring deep body temperature of dairy cows, In: Stowell, R, Bucklier, R and Botcher, R.W. eds. *Livestock Environment VI,* Proceedings of the sixth international symposium, May 21-23 2001, Louisville, Kentucky.

Hofmeyr, J.M. and de Bruine, J.R. (1975) The problems associated with the capture, translocation and keeping of wild ungulates in South West Africa, *The Lammergeyer,* vol. 18, pp. 21-29.

Hofmeyr, J.M., Louw, G.N. and du Preez, J.S. (1973) Incipient capture myopathy as revealed by blood chemistry of chased zebras, *Madoqua*, vol. 7, pp. 45-50.

Ingram, J.R., Cook, C.J. and Harris, P.J. (2002) The effect of transport on core and peripheral body temperatures and heart rate of sheep, *Animal Welfare*, vol. 11, pp. 103-112.

Jacobson, L.H. and Cook, C.J. (1998) Partitioning psychological and physical sources of transport-related stress in young cattle, *The Veterinary Journal*, vol. 155, pp. 205-208.

Kamerman, P.R., Di Zio, L.C. and Fuller, A. (2001a) Miniature data loggers for remote measurement of body temperature in medium-sized rodents, *Journal of Thermal Biology*, vol. 26, pp. 159-163.

Kamerman, P.R., Fuller, A., Faurie, A.S., Mitchell, G. and Mitchell, D. (2001b) Body temperature patterns during natural fevers in a herd of free-ranging impala (*Aepyceros melampus*), *The Veterinary Record*, vol. 149, pp. 26-27.

Knottenbelt, M.K. (1990) Causes of mortality in impala (*Aepyceros melampus*) on 20 game farms in Zimbabwe, *The Veterinary Record*, vol. 127, pp. 282-285.

Knowles, T.G. and Warriss, P.D. (2000) Stress physiology of animals during transport, In: Grandin, T.ed. *Livestock Handling and Transport*, 2nd ed. CAB international, pp. 385-406.

Knowles, T.G., Warriss, P.D., Brown, S.N. and Kestin, S.C. (1994) Long distance transport of export lambs, *The Veterinary Record*, vol. 134, pp. 107-110.

Knowles, T.G., Warriss, P.D., Brown, S.N. and Edwards, J.E. (1998) Effects of stocking density on lambs being transported by road, *The Veterinary Record*, vol. 142, pp. 503-509.

Knox, C.M. (1992) *Boma-stress in the impala Aepyceros melampus melampus (Lichtenstein, 1812)*, PhD thesis, Johannesburg: University of Witwatersrand.

Kock, M.D., Clark, R.K., Franti, C.E., Jessup, D.A. and Wehausen, J.D. (1987) Effects of capture on biological parameters in free-ranging bighorn sheep (*Ovis canadensis*): evaluation of normal, stressed and mortality outcomes and documentation of postcapture survival, *Journal of Wildlife Diseases*, vol. 23, pp. 652-662.

Kock, M.D., du Toit, R., Kock, N., Mortan, D., Foggin, C. and Paul, B. (1990a) Effects of capture and translocation on biological parameters in free-ranging black rhinoceroses (*Diceros bicornis*) in Zimbabwe, *Journal of Zoo and Wildlife Medicine*, vol. 21, pp. 414-424.

Kock, M.D., du Toit, R., Mortan, D., Kock, N. and Paul, B. (1990b) Baseline biological data collected from chemically immobilised free-ranging black rhinoceroses (*Diceros bicornis*) in Zimbabwe, *Journal of Zoo and Wildlife Medicine*, vol. 21, pp. 283-291.

Kolka, M.A., Quigley, M.D., Blanchard, L.A., Toyota, D.A. and Stephenson, L.A. (1993) Validation of a temperature telemetry system during moderate and strenuous exercise, *Journal of Thermal Biology*, vol. 18, pp. 203-210.

Lefcourt, A.M. and Adams, W.R. (1996) Radiotelemetry measurement of body temperatures of feedlot steers during summer, *Journal of Animal Science*, vol. 74, pp. 2633-2640.

Livingstone, S.D., Grayson, J., Frim, J., Allen, C.L. and Limmer, R.E. (1983) Effect of cold exposure on various sites of core temperature measurements, *Journal of Applied Physiology*, vol. 54, pp. 1025-1031.

Mackay, R.S. (1965). Telemetering from within the body of animals and man: endoradiosondes, In: Caceres, C.A. ed. *Biomedical Telemetry*, New York: Academic Press.

Maloney, S.K., Fuller, A., Mitchell, G. and Mitchell, D. (2001) Rectal temperature measurement results in artifactual evidence of selective brain cooling, *American Journal of Physiology* (*Regulatory Integrative Comparative Physiology*), vol. 281, pp. R108-R114.

Maloney, S.K., Fuller, A., Mitchell, G. and Mitchell, D. (2002) Brain and arterial blood temperature of free-ranging oryx (*Oryx gazella*), *Pflügers Archives-European Journal of Physiology*, vol. 443, pp.437-445.

Martucci, R.W., Jessup, D.A., Gronert, G.A., Reitan, J.A. and Clark, W.E. (1992) Blood gas and catecholamine levels in capture stressed desert bighorn sheep, *Journal of Wildlife Diseases*, vol. 28, pp. 250-254.

McKenzie, J.E. and Osgood, D.W. (2004) Validation of a new telemetric core temperature monitor, *Journal of Thermal Biology*, vol. 29, pp. 605-611.

Meyer, L., Matthee, A., Fick, L., Kamerman, P.R., Mitchell, D. and Fuller, A. (2004) Capture-induced hyperthermia: a fright not flight response. <http://www.ltxgamebreedingcentre.co.za/capture%20%20induced%20hyperthermia.htm> [accessed 10 Jan 2005].

Michler, I. (2002) Rotten meat… or just unfair game? *Africa Geographic*, June, pp. 33-38.

Mitchell, D. and Laburn, H.P. (1985) Pathophysiology of temperature regulation, *The Physiologist*, vol. 28, pp. 507-517.

Mitchell, D., Maloney, S.K., Laburn, H.P., Knight, M.H., Kuhnen, G. and Jessen, C. (1997) Activity, blood temperature and brain temperature of free-ranging springbok, *Journal of Comparative Physiology* B, vol. 167, pp. 335-343.

Mitchell, D., Maloney, S.K., Jessen, C., Laburn, H.P., Kamerman, P.R., Mitchell, G. and Fuller, A. (2002) Adaptive heterothermy and selective brain cooling in arid-zone mammals, *Comparative Biochemistry and Physiology* B, vol. 131, pp. 571-585.

Moberg, G.P. (1985) Biological response to stress: Key to assessment of animal well-being? In: Moberg, G.P. ed. *Animal Stress*, U.S.A: American Physiological Society, pp 27-49.

Montané, J., Marco, I., López-Olvera, J., Manteca, X. and Lavȝn, S. (2002) Transport stress in roe deer (*Capreolus capreolus*): effect of a short-acting antipsychotic, *Animal Welfare*, vol. 11, pp. 405-417.

Moran, D.S., Pandolf, K.B., Shapiro, Y., Laor, A., Heled, Y. and Gonzalez, R.R. (2003) Evaluation of the environmental stress index for physiological variables, *Journal of Thermal Biology*, vol. 28, pp. 43-49.

Morton, D.J., Anderson, E., Foggin, C.M., Kock, M.D. and Tiran, E.P. (1995) Plasma cortisol as an indicator of stress due to capture and translocation in wildlife species, *The Veterinary Record*, vol. 136, pp. 60-63.

Möstl, E. and Palme, R. (2002) Hormones as indicators of stress, *Domestic Animal Endocrinology*, vol. 23, pp. 67-74.

Möstl, E., Maggs, J.L., Schrötter, G., Besenfelder, U. and Palme, R. (2002) Measurement of cortisol metabolites in faeces of ruminants, *Veterinary Research Communications*, vol. 26, pp. 127-139.

Murray, M.G., Lewis, A.R. and Coetzee, A.M. (1981) An evaluation of capture techniques for research on impala populations, *South African Journal of Wildlife Research*, vol. 11, pp. 105-109.

Mustafa, A. (2005) From feed to milk: understanding rumen function. http://animsci.agrenv.mgill.ca/courses/450/extra/feed_to_milk/rumen [accessed 20 March 2005]

Nevill, C.H. and Friend, T.H. (2003) The behavior of circus tigers during transport, *Applied Animal Behaviour Science*, vol. 82, pp. 329-337.

Nwe, T.M., Hori, E., Manda, M. and Watanabe, S. (1996) Significance of catecholamines and cortisol levels in blood during transportation stress in goats, *Small Ruminant Research*, vol. 20, pp. 129-135.

O'Brien, C., Hoyt, R.W., Buller, M.J., Castellani, J.W. and Young, A.J. (1998) Telemetry pill measurements of core temperature in humans during active heating and cooling, *Medicine and Science in Sports and Exercise*, vol. 30, pp. 468-472.

Openshaw, P. (1993) Transportation of wild herbivores, In: McKenzie, A.A. ed. *The Capture and Care Manual*, Pretoria: Wildlife Decisions Support Services and South African Veterinary Foundation.

Palme, R. and Möstl, E. (1996) Measurement of cortisol metabolites in faeces of sheep as a parameter of cortisol concentration in blood, *Proceedings of the 1st International Symposium on Physiologie and Ethology of Wild and Zoo Animals*, Berlin, Germany. Sept. 18-21, Supl. II, pp. 192-197.

Parrott, R.F., Bradshaw, R.H., Lloyd, D.M. and Goode, J.A. (1998) Effects of transport and indomethacin on telemetered body temperature and release of cortisol and prolactin in pre-pubertal pigs, *Research in Veterinary Science*, vol. 64, pp.51-55.

Parrott, R.F., Lloyd, D.M. and Brown, D. (1999) Transport stress and exercise hyperthermia recorded in sheep by radiotelemetry, *Animal Welfare*, vol. 8, pp. 27-34.

Perry, T. (1996) Rhino deaths sour US-China relations. 18 December, *Cape Argus.*

Prendiville, D.J., Lowe, J., Earley, B., Spahr, C. and Kettlewell, P. (2002) Radiotelemetry systems for measuring body temperature, *Beef Production Series* no.57, Grange Research Centre.

Raath, J.P. (1993) Chemical capture of the African elephant *Loxodonta africana*, In: McKenzie, A.A. ed. *The Capture and Care Manual*, Pretoria: Wildlife Decisions Support Services and South African Veterinary Foundation.

Schmidt-Nielson, K. (1990) Temperature regulation, In: *Animal Physiology*, 4th ed. Cambridge: Cambridge University Press.

Schönbaum, E. and Lomax, P. eds. (1991) Temperature regulation and drugs: an introduction, In: *Thermoregulation: Pathology, Pharmacology and Therapy*, New York: Pergamon Press, Inc., pp. 1-17.

Seely, M.K., Mitchell, D., Goelst, K. (1990) Boundary layer microclimate and *Angolosaurus skoogi* (*Sauria: Cordylidae*) activity on a northern Namib dune, In: Seely, M.K. ed., Namib ecology: 25 years of Namib research, *Transvaal Museum Monograph* No.7, Pretoria: Transvaal Museum, pp. 155-162.

Selye, H. (1973) The evolution of the stress concept, *American Scientist*, vol. 61, pp. 692-699.

Smith, B.L., Jones, J.H, Carlson GP and Pascoe JR. (1994) Effect of body direction on heart rate in trailered horses, *American Journal of Veterinary Research*, vol. 55, pp. 1007-1011.

South African Bureau of Standards (2001) *Translocation of Certain Species of Wild Herbivore*, 1st ed. South African Code of Practice (SABS 0331).

Spraker, T.R. (1993) Stress and capture myopathy in artiodactylids, In: Fowler, M.E. ed. *Zoo and Wild Animal Medicine: Current Therapy 3*, U.S.A.: WB Saunders Company.

Swan, G.E. (1993) Drugs used for the immobilization, capture, and translocation of wild animals, In: McKenzie, A.A. ed., *The Capture and Care Manual*, Pretoria: Wildlife Decisions Support Services and South African Veterinary Foundation.

Trendler, K. *pers.comm*. In: Rogers, P.S. (1993) Hand-raising of orphaned rhinoceros calves, In: McKenzie, A.A. ed., *The Capture and Care Manual*, Pretoria: Wildlife Decisions Support Services and South African Veterinary Foundation.

Van Logtestijn, J.G., Romme, A.M.T.C. and Eikelenboom, G. (1982) Losses caused by transport of slaughter pigs in the Netherlands, In: Moss, R. ed. *Transport of Animals Intended for Breeding, Production and Slaughter*, the Hague: Martinus Nijhoff Publishers, pp.105-113.

Von Borell, E.H. (2001) The biology of stress and its application to livestock housing and transportation assessment, *Journal of Animal Science*, vol. 79, pp. E260-E267.

Von Mickwitz, G. (1982) Various transport conditions and their influence on physiological reactions, In: Moss, R. ed. *Transport of Animals Intended for Breeding, Production and Slaughter*, the Hague: Martinus Nijhoff Publishers, pp.45-55.

Waas, J.R., Ingram, J.R. and Matthews, L.R. (1997) Physiological responses of red deer (*Cervus elaphus*) to conditions experienced during road transport, *Physiology and Behaviour*, vol. 61, pp. 931-938.

Wasser, S.K., Hunt, K.E., Brown, J.L., Cooper, K., Crochett, C.M., Bechert, U., Millspaugh, J.J., Larson, S. and Manfort, S.L. (2000) A generalised fecal glucorticoid assay for use in a diverse array of nondomestic mammalian and avian species, *General and Comparative Endocrinology*, vol. 120, pp. 260-275.

Wenzel, H.G. (1983) Contribution of air humidity and heat radiation to heat stress due to elevated air temperature, In: Khogali, M. and. Hales, J.R.S. eds. *Heat Stroke and Temperature Regulation*, Sydney: Academy Press.

Wiggett, D. (2002) Buck truck death horror. 21 May, *The Citizen*, p. 1.

Yaglou, C.P. (1968) Thermometry, In: Newburgh, L.H. ed. *Physiology of Heat Regulation*, New York: Hafner Publishing Co.