THE BIOLOGY AND MANAGEMENT OF WILD RUMINANTS

CHAPTER NINE

MINERAL, WATER, AND VITAMIN METABOLISM OF WILD RUMINANTS

bу

Aaron N. Moen

Professor of Wildlife Ecology

Department of Natural Resources

College of Agriculture and Life Sciences

Cornell University

Ithaca, N.Y. 14853

and

Certified Wildlife Biologist
(The Wildlife Society)

Published by

CornerBrook Press Box 106 Lansing, N.Y. 14882

Copyright © 1981 by Aaron N. Moen

No part of this book may be reproduced by any mechanical, photographic or electronic process, or in the form of a phonograph recording, nor may it be stored in a retrieval system, transmitted, or otherwise copied for public or private use without written permission of Aaron N. Moen

Library of Congress Catalog Card Number 80-70984

CONTENTS OF CHAPTER NINE

MINERAL, WATER, AND VITAMIN METABOLISM OF WILD RUMINANTS

1. I	MINER A	AL MI	ETA]	BOL	ISM	1		• .	•		•		•	•	•	•				•	•		•	•	•	•	•		:
UNIT	1.1:	MI	NER.	AL I	RE([ענ	ERI	EMI	EN 3	rs																•			-
UNIT	1.2:																												
																						•							
01111	1.3.	1/171		1110	<u></u>	•	•	•	•	٠	•	•		٠	•	•	•	•	•	•	•	•	•	•	•	•	•	•	12
2. T	ያልጥፑው	МЕТ	N R A I	TC	wr .																								1 9
JN I.I.	2.2:	KEI	EKI	≤NC)	ES	•	•	•	•	•	•	٠	•	•	•	•	٠	•	•	•	•	•	•	•	•	•	•	•	15
_						_						٠													•				
3. T	/ITAMI	N ME	CTAI	3OL	ISM	I	•	•	٠	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	٠	•	•	23
G COM	MENTS	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	٠	•	•	•	•	27
RY OF	F SYME	OLS	USI	ΞD	•	•	٠	•	•		•		•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	28
RY OF	CODE	INS			•			•			•		•					•					•						29
PUE	BLISHE	RS																											31
WOF	RKSHEE	ETS																											32
DAY	CALEN	IDAR																											33
	JNIT JNIT JNIT JNIT JNIT JNIT JNIT JNIT	JNIT 1.1: JNIT 1.1: JNIT 1.2: JNIT 1.2: JNIT 1.3: JNIT 1.3: JNIT 1.3: JNIT 1.3: JNIT 2.1: JNIT 2.1: JNIT 2.2: JNIT 2	JNIT 1.1: MINIT 1.1: REJUNIT 1.1: REJUNIT 1.2: CANDIT 1.2: REJUNIT 1.3: MINIT 1.3: MINIT 1.3: REJUNIT 2.1: WATTER JUNIT 2.1: REJUNIT 2.2: WATTER JUNIT 2.2: WATTER JUNIT 2.2: REJUNIT 2.2:	JNIT 1.1: MINER JNIT 1.1: REFERI JNIT 1.2: CALCU JNIT 1.2: REFERI JNIT 1.3: MINER JNIT 1.3: MINER JNIT 1.3: REFERI JNIT 2.1: WATER JNIT 2.1: WATER JNIT 2.1: REFERI JNIT 2.2: WATER JNIT 2.2: WATER JNIT 2.2: REFERI JNIT 2.2: REFERI JNIT 2.2: REFERI JNIT 2.3: REFERI JNIT 2.4: WATER JNIT 2.5: WATER JNIT 2.5: WATER JNIT 2.6: WATER JNIT 2.7: WATER JNIT 2.8: WATER JNIT 2.9: WATER JNIT 2.9: WATER JNIT 2.1: REFERI JNIT 2.1: WATER JNIT	JNIT 1.1: MINERAL JNIT 1.1: REFERENC JNIT 1.2: CALCULAT JNIT 1.2: REFERENC JNIT 1.3: MINERAL JNIT 1.3: MINERAL JNIT 1.3: REFERENC JNIT 2.1: WATER CO JNIT 2.1: WATER CO JNIT 2.1: REFERENC JNIT 2.2: WATER RE JNIT 2.2: REFERENC JNIT 2.2: REFERENC JNIT 2.2: REFERENC JNIT 2.3: REFERENC JNIT 2.4: WATER CO JNIT 2.5: WATER RE JNIT 2.5: WATER RE JNIT 2.6: WATER RE JNIT 2.6: WATER RE JNIT 2.7: WATER RE JNIT 2.8: WATER RE JNIT 2.9: WATER RE JNIT 2.9: WATER RE JNIT 2.1: WATER CO JNIT 2.1: WATER	UNIT 1.1: MINERAL RECOUNT 1.1: REFERENCES UNIT 1.2: CALCULATION UNIT 1.2: REFERENCES UNIT 1.3: MINERAL LIC UNIT 1.3: MINERAL LIC UNIT 1.3: REFERENCES UNIT 2.1: WATER COMPAUNIT 2.1: REFERENCES UNIT 2.2: WATER REQUI UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.1: REFERENCES UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.3: REFERENCES UNITAMIN METABOLISM UNIT 2.4: REFERENCES UNITAMIN METABOLISM UNIT 2.5: REFERENCES UNITAMIN METABOLISM UNIT 2.6: REFERENCES UNITAMIN METABOLISM UNIT 2.7: REFERENCES UNIT 2.8: REFERENCES UNIT 2.9: REFERENCES UNIT 2.1: REFERENCES UNIT 2.1: WATER COMPAUNIT 2.1: REFERENCES UNIT 2.1: REFERENCES UNIT 2.1: WATER COMPAUNIT 2.1: REFERENCES UNIT 2.1: REFERENCES UNIT 2.1: WATER COMPAUNIT 2.1: REFERENCES UNIT 2.2: REFERENCES UNIT 2.3: RE	JNIT 1.1: MINERAL REQUIDINT 1.1: REFERENCES . JNIT 1.2: CALCULATIONS JNIT 1.2: REFERENCES . JNIT 1.3: MINERAL LICKS JNIT 1.3: MINERAL LICKS JNIT 1.3: REFERENCES . 2. WATER METABOLISM . JUNIT 2.1: WATER COMPART JUNIT 2.1: REFERENCES . JUNIT 2.2: WATER REQUIRE JUNIT 2.2: REFERENCES . 3. VITAMIN METABOLISM . 4. COMMENTS	UNIT 1.1: MINERAL REQUIRED INIT 1.1: REFERENCES	UNIT 1.1: MINERAL REQUIREMENT 1.1: REFERENCES	UNIT 1.1: MINERAL REQUIREMENT UNIT 1.1: REFERENCES	UNIT 1.1: MINERAL REQUIREMENTS UNIT 1.1: REFERENCES UNIT 1.2: CALCULATIONS AND PREI UNIT 1.2: REFERENCES UNIT 1.3: MINERAL LICKS UNIT 1.3: REFERENCES UNIT 2.1: WATER COMPARTMENTS . UNIT 2.1: REFERENCES UNIT 2.1: REFERENCES UNIT 2.2: WATER REQUIREMENTS AN UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.3: REFERENCES UNIT 2.4: REFERENCES UNIT 2.5: REFERENCES UNIT 2.6: VITAMIN METABOLISM UNIT 2.7: REFERENCES UNITAMIN METABOLISM UNITAMIN METABOLISM	UNIT 1.1: MINERAL REQUIREMENTS . UNIT 1.1: REFERENCES UNIT 1.2: CALCULATIONS AND PREDICULATIONS AND PREDICULATION	UNIT 1.1: MINERAL REQUIREMENTS UNIT 1.1: REFERENCES UNIT 1.2: CALCULATIONS AND PREDICTIONS OF MUNIT 1.2: REFERENCES UNIT 1.3: MINERAL LICKS UNIT 1.3: REFERENCES UNIT 2.1: WATER COMPARTMENTS UNIT 2.1: REFERENCES UNIT 2.2: WATER REQUIREMENTS AND TURNOVER BUNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.3: REFERENCES UNIT 2.4: REFERENCES UNIT 2.5: REFERENCES UNIT 2.6: REFERENCES UNIT 2.7: REFERENCES UNITAMIN METABOLISM UNITAMIN METABOLIS	UNIT 1.1: MINERAL REQUIREMENTS UNIT 1.1: REFERENCES UNIT 1.2: CALCULATIONS AND PREDICTIONS OF MINERAL REQUIREMENT UNIT 1.2: REFERENCES UNIT 1.3: MINERAL LICKS UNIT 1.3: REFERENCES UNIT 1.3: REFERENCES UNIT 2.1: WATER COMPARTMENTS UNIT 2.1: REFERENCES UNIT 2.2: WATER REQUIREMENTS AND TURNOVER RATES UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNITAMIN METABOLISM COMMENTS YOF SYMBOLS USED YOF CODENS PUBLISHERS WORKSHEETS	UNIT 1.1: MINERAL REQUIREMENTS UNIT 1.1: REFERENCES UNIT 1.2: CALCULATIONS AND PREDICTIONS OF MINERAL REQUIREMENTS UNIT 1.2: REFERENCES UNIT 1.3: MINERAL LICKS UNIT 1.3: REFERENCES UNIT 2.1: WATER METABOLISM UNIT 2.1: WATER COMPARTMENTS UNIT 2.1: REFERENCES UNIT 2.2: WATER REQUIREMENTS AND TURNOVER RATES UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.2: REFERENCES UNIT 2.3: REFERENCES UNIT 2.4: REFERENCES UNIT 2.5: REFERENCES UNIT 2.5: REFERENCES UNIT 2.6: VITAMIN METABOLISM UNIT 2.7: REFERENCES UNIT 2.8: VITAMIN METABOLISM UNIT 2.9: REFERENCES UNITAMIN METABOLISM UNITAMIN META	UNIT 1.1: MINERAL REQUIREMENTS UNIT 1.1: REFERENCES UNIT 1.2: CALCULATIONS AND PREDICTIONS OF MINERAL REQUIREMENTS UNIT 1.2: REFERENCES UNIT 1.3: MINERAL LICKS UNIT 1.3: REFERENCES 2. WATER METABOLISM UNIT 2.1: WATER COMPARTMENTS UNIT 2.1: REFERENCES UNIT 2.2: WATER REQUIREMENTS AND TURNOVER RATES UNIT 2.2: REFERENCES 3. VITAMIN METABOLISM 4. COMMENTS 4. COMMENTS 4. COMMENTS 5. COMMENTS 5. COMMENTS 6. COMMENTS 6. WORKSHEETS	UNIT 1.2: CALCULATIONS AND PREDICTIONS OF MINERAL REQUIREMENTS UNIT 1.2: REFERENCES												

CHAPTER 9. MINERAL WATER, AND VITAMIN METABOLISM

Minerals, water, and vitamins are essential components of life processes. The role of minerals in the growth and annual cycle of wild ruminants is obvious. Skeletal growth is extremely rapid, and antler growth in those species which grow a new set of antlers each year is truly remarkable. Water is the major component in body tissue. Vitamins have little identifiable mass in the body, but they have major roles in physiological processes.

The importance of mineral, water and vitamin balances is not reflected by the amount of literature available on these subjects. An understanding of basic life processes is such an important foundation for management, yet the literature on these subjects is very sparse. The explanation for this may likely include the tendency for management to be approached from the management end, and the difficulty in studying the interrelated roles of minerals and vitamins in free-ranging animals. Neat experiments are not easily done with minerals and vitamins. Much of the research in such areas is done with small laboratory animals, for several good reasons.

This chapter includes a few basic ideas on the three TOPICS--mineral, water, and vitamin metabolism--and lists of published literature. The requirements for each of these three categories of nutrients could be used to calculate carrying capacity in the same way as energy and protein were used, except that neither the requirements nor the chemical components of forage have been determined precisely enough to make such calculations possible. Think of the nutrient requirement: nutrient supply concept underlying the calculation of carrying capacity, even if precise calculations cannot be made.