TOPIC 3. SYSTEMS CHARACTERISTICS

Systems of the body have specific biological functions, and their physical characteristics are of particular interest when evaluating these functions in the ecological context.

Anatomical measurements become very useful for interpreting functional capabilities of an animal. These interpretations are essential for an understanding of the animal-environment relationships that exist in natural habitats.

Volumes of the different parts of systems are important considerations in the overall ecology of animals because volumetric constraints may limit the availability of some resources. Ingested forage is processed in the gastrointestinal tract where nutrients are released for transport by the cardiovascular system and synthesis into new body tissue. The volume of the stomach limits the amount of food that can be ingested during a feeding period, which limits the amount of nutrients available for processing before the next feeding period. The volume of the heart, considered in relation to the frequency of the heartbeat, limits the amount of nutrient-carrying blood that can be pumped. There is a limit to the amount of blood present in the vascular system of an animal also. Since blood carries both nutrients and oxygen to different tissues for metabolism, characteristics of both gastrointestinal and cardiovascular systems are of interest when calculating metabolic characeristics in different environmental conditions.

There are many general relationships between the sizes and weights of animals and the sizes, weights, and volumes of different organs in the different systems. These relationships change through time as growth occurs and may limit the amounts or rates of biological activities of importance to animals at different times in their life cycles. The relative sizes of the four compartments of the stomach, for example, change as the nursing animal ingests greater amounts of forage. The rumen and reticulum are undeveloped at birth, but end up to be about 85% of the total volume of the stomach as a fully functional ruminant. The capacity of the rumen and reticulum represents an upper limit to the amount of forage that can be ingested, an important consideration when low-quality forage is being ingested that may not contain enough nutrients to supply a growing animal's needs.

Similar evaluations of biological limits can be made for the organs of the cardiovascular system. The capacity of the heart to pump blood and of the lungs to exchange oxygen and carbon dioxide provide upper limits to the intensity and duration of physical activity. Knowledge of the rates of movement of blood through the cardiovascular system and ingesta through the digestive system, as well as transfer rates through absorption membranes, helps one understand the metabolic limits of animals.

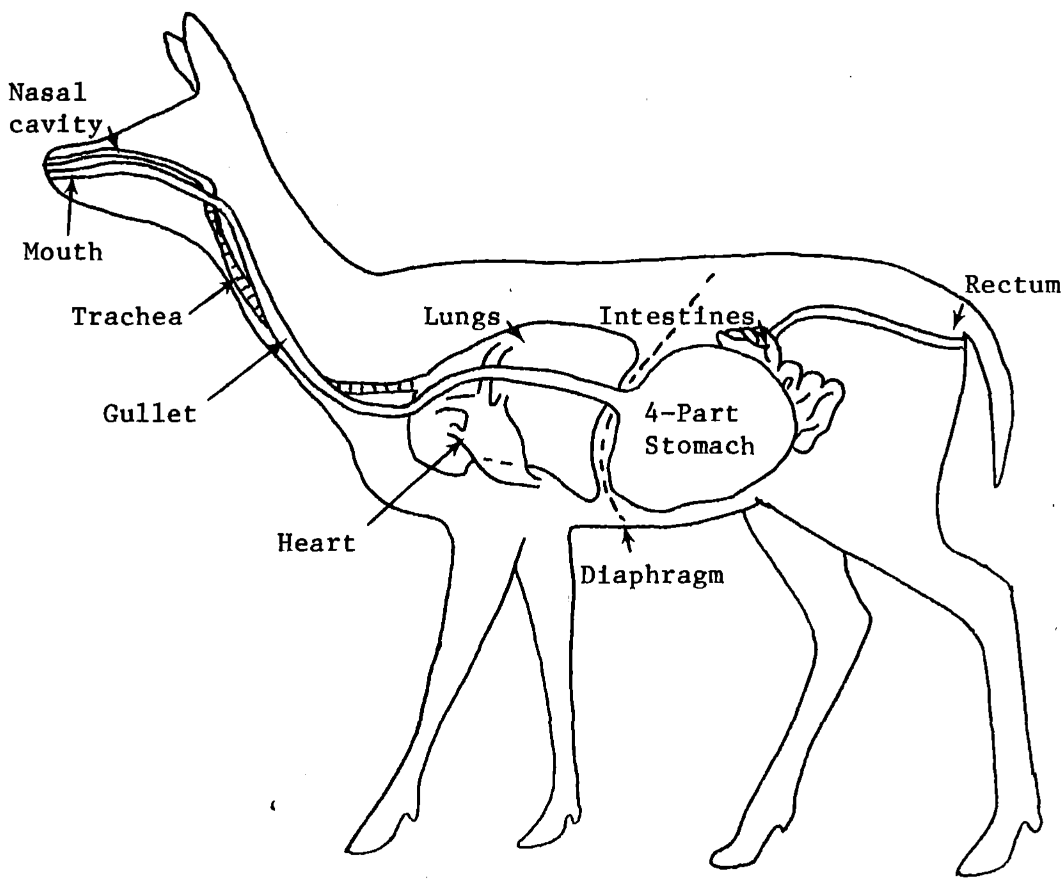
The systems characteristics of wild ruminants are of considerable interest because these animals live under very different conditions, ranging from the arid areas of the southwest part of the United States to the cold interior of Alaska and Canada. Some of them--deer for example--are quite similar in weight to humans. Some--bison--are similar in weight to domestic cattle. Are these wild ruminants more hardy than other mammals of similar weights? Do they have cardiovascular adaptations that make them uniquely capable of thriving under varied conditions of climate and altitude? White-tailed deer have a well-developed carciovscular system, with a heart that is generally larger per unit body weight than that of humans which fall in the same weight range. How ecologically significant is this?

Skeletal characteristics are used by mammalogists for comparative purposes in taxonomic studies, and by ecologists and wildlife managers for sex and age determinations in population studies.

Physical characteristics of the systems discussed above plus discussion of the respiratory, endocrine, reproductive, excretory, muscular, and nervous systems follow in the next eight UNITS. Data describing systems characteristics are generally scattered between species and geographical areas. The relationships evaluated in the WORKSHEETS may be used in later analyses when ecological or management-related questions are being considered.

UNIT 3.1: GASTROINTESTINAL SYSTEM CHARACTERISTICS

The alimentary canal of herbivorous animals has a relatively larger capacity than that of carnivorous animals. This increased capacity permits the extensive fermentation necessary for the break-down by microorganisms of bulky, fibrous plant materials ingested by the host. Carnivores, on the other hand, have shorter digestive tracts in which to digest their food. The differences in the sizes of the alimentary canals of herbivores and carnivores are possible because the former ingest mainly plant food with its thick and certainly complex (from a molecular point of view) cell walls. Carnivore diets, on the other hand, include mainly animal tissue with thin cell membranes, resulting in a fairly rapid breakdown of, for example, protein into amino acids.



The main organs of the gastrointestinal tract of wild ruminants (based on Cheatum, undated Information Leaflet, N.Y. State Conservation Department) are the four-part stomach, small intestine, large intestine (colon), and rectum. These are part of the alimentary canal, which also includes the mouth and esophagus. The four-part stomach is unique to ruminants, and includes, in order of food passage, the rumen, reticulum, omasum, and abomasum. The first three develop as diverticula from the embryonic abomasum, or true stomach.

The relative sizes and positions of these compartments are not constant throughout the life of a ruminant animal (Short 1964; 454). In the newborn, the abomasum or true stomach is larger than the other three parts, and it is not until the age of 1 to 2 months that the volume relationships between the omasum plus abomasum and the rumen-reticulum is reversed. After that time, the rumen increases in size and eventually comprises over 80% of the total stomach capacity (Moen 1973).

When the newborn ruminant is drinking, the milk or water does not go into the rumen, but is diverted directly to the orifice between the reticulum and the omasum through the esophageal groove (Swenson 1970:430). Thus the milk goes directly into the omasum and then to the abomasum where it is digested and absorbed. This diversion results from a reflex action in the young ruminant that gradually disappears as the animal matures.

Rumen development coincides with the increased ingestion of plant materials. Plant materials, which the newborn ruminant begins to eat a few days after birth, go to the rumen where populations of micro-organisms build up as the rumen develops.

The physical development of the alimentary canal of wild ruminants is important because it represents finite limits to the amount of food that the animal can ingest, and this limit extends to the actual amount of potential or gross energy available for metabolic purposes. Variations in the potential or gross energy of foods will be discussed later. There is also variation in the time it takes for breakdown of the food materials, or i.e., turnover times. Thus the physical characteristics of the ruminant alimentary canal are the structural components of a dynamic system of energy intake and output, accomplished in the ruminant with the assistance of microorganisms who form a metabolic system of their own.

Volume and weight characteristics of the organs of the gastrointestinal tract are considered in this UNIT. Volumes are used to evaluate the amounts of forage that can be needed for digestion each day. Weights are used to evaluate live weight: dressed weight relationships, along with weights of other organs.

Stomach volume:body weight relationships of wild ruminants are important when evaluating energy relationships for growth, maintenance, and survival during winter stress, reproductive capabilities, and other productive functions. Animals with greater rumen capacities may be more likely to survive periods of stress than animals with less capacity. Greater capacity provides a larger reserve of food material in the rumen at the onset of a stress period, such as deep snow in the winter, and animals with larger capacities may be able to regain lost energy more quickly.

Differences in the stomach capacity of age classes within a species are of ecological significance, too. Short (1964) points out that the relatively small stomach capacity of deer fawns may be an important factor in winter mortality. The browse diet characteristic of deer in the winter in forested areas may not be digested rapidly enough to satisfy the metabolic rate necessary to maintain body temperature during periods of cold weather. This relationship and other characteristics of the social and thermal energy relationships of fawns with their environment are discussed in detail in later chapters; there are many factors operating against the smaller deer during times of stress.

The accuracy of predictions of forage intake may be checked by comparing intake with the capacities of parts of the gastrointestial tracts. If it takes two days for ingesta to be processed and pass through the rumen, for example, the capacity of the rumen must be at least two times the volume of daily forage intake. This relationships is so important, especially for animals on poor range, that serious efforts should be made to get good estimates of forage intake, live weight: rumen-reticulum volume relationships, and rates of passage of ingesta through the stomach compartments for all species of wild ruminants.

Rumen and reticulum volumes. Relationships between the live weight of an animal and the volume of its rumen and reticulum is especially important since this volume is the space available for ingesta. Finer particles, masticated and partially digested, are continually moving out of this space to be replaced by more recently-ingested forage. Particularly fibrous ingesta, mechanically resistant to breakdown into smaller particles, accumulates in the rumen, and may depressing appetite and inhibiting further ingestion. Such low quality material may take up more space than it is worth nutritionally, and this definitely affects the well-being of an animal. Such conditions develop most often in late winter when only poorly digested forage is available.

Omasum and abomasum volumes. The bulk of the ingesta has been much reduced by the time it gets to the omasum and abomasum as a result of the physical and chemical action in the rumen and reticulum. Water absorption in the omasum reduces the mass of ingested material to a rather solid mixture of fine particles. Thus, the volumes of these last two compartments may be less than the volumes of the first two. It is not known whether omasum and abomasum volumes limit intake by a "damming up" effect, but that likely does not occur.

Relative volumes of the four compartments of the ruminant stomach change with age as milk makes up a decreasing part and forage makes up an increasing part of the diet. The changing proportions can be expressed with equations and volumes calculated for any AGDA during the suckling period. The best data are available for white-tailed deer; equations may be derived for other species that are based on the assumption that development from birth to weaning is parallel in other speceis over the entire length of the suckling period.

The WORKSHEETS that follow the list of REFERENCES provide opportunities for expressing these important physical relationships numerically, and the equations will be used later when evaluating live weight: field-dressed weight relationships, predictions of forage consumed based on animal requirements, and other relationships of importance ecologically.

LITERATURE CITED

Moen, A. N. 1973. Wildlife Ecology. W. H. Freeman Co., San Francisco, pp. 160-161.

Short, H. L. 1964. Postnatal stomach development of white-tailed deer. J. Wildl. Manage. 28(3): 445-458.

Swenson, M. J., Ed. 1970. Duke's Physilogy of domestic animals. Cornell University Press, Ithaca, N.Y. 1463 pp.

REFERENCES, UNIT 3.1

GASTROINTESTINAL TRACT CHARACTERISTICS

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
MAMLA	38--2	295	314	arti	stomach evol, artiodactyla	langer,p	1974

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
CPSCA	7---4	217	218	odvi*	organ:body weight relation	robinson,pf	1966
JANSA	38--4	871	876	odvi*	body composition of white-	robbins,ct; moen/	1974
JOMAA	31--1	5	17	odvi*	weight relations, georg re	hamerstrom,fm,jr/	1950
JWMAA	28--3	445	458	odvi*	postnatal stomach developm	short,hl	1964

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	36--3	474	476	odhe	alimentary canal ph values	browman,lg sears,	1955
JOMAA	46--2	196	199	odhe*	ruminoreticular characteri	short,hl; medin,/	1965
JOMAA	52--3	628	630	odhe*	tiss, organs, tot body mas	hakonson,te; whic	1971
WAEBA	589--	1	6	odhe	the mule deer carcass	field,ra; smith,/	1973

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	15---	253	268	ceel	relatio, age, size, poland	dzieciolowski,r	1970
JOMAA	27--4	308	323	ceel	mammals of northern idaho	rust,hg	1946
JWMAA	35--4	673	680	ceel	rumen characteristi, red d	prins,ra; geelen,	1971
JWMAA	39--3	621	624	ceel	compar digestiv organ size	nagy,jg; regelin,	1975
WAEBA	594--	1	8	ceel	the elk carcass	field,ra; smith,/	1973
ZEJAA	4---4	169	171	ceel	[capaci, parts of dig tra]	gill,j; jaczewski	1958
ZSAEA	41--3	167	193	ceel/	[caca forestom mucos anat]	hofmann,rr; geig/	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				alal			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975
NJZOA	24--4	407	417	rata*	morph,fat stor,org wei,win	krog,j; wika,m; /	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
WAEBA	575--	1	6	anam	the pronghorn carcass	field,ra; smith,/	1972

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				bibi			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovca			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				obmo			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				oram			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	13---	499	509	bibo	capac, weigh, walls, diges	gill,j	1968
ATRLA	14---	349	402	bibo	morphology digestive tract	pytel,sm	1969

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JWMAA	34--4	887	903		repro, grow, resid, dieldr	murphy,da; korsch	1970

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JWMAA	35--4	673	680	caca	rumen characteristi, red d	prins,ra; geelen,	1971
JWMAA	39--3	621	624	caca	compar digestiv organ size	nagy,jg; regelin,	1975

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JWMAA	35--4	673	680	dada	rumen characteristi, red d	prins,ra; geelen,	1971
JWMAA	39--3	621	624	dada	compar digestiv organ size	nagy,jg; regelin,	1975

CHAPTER 1, WORKSHEET 3.1a

Rumen and reticulum volumes of white-tailed deer (odvi)

Rumen and reticulum volumes in cubic centimeters (RRVC) and omasum and abomasum volumes in cubic centimeters (OAVC) are expressed as linear regression equations in Moen (1973; 142) based on data in Short (1964). The equations are:

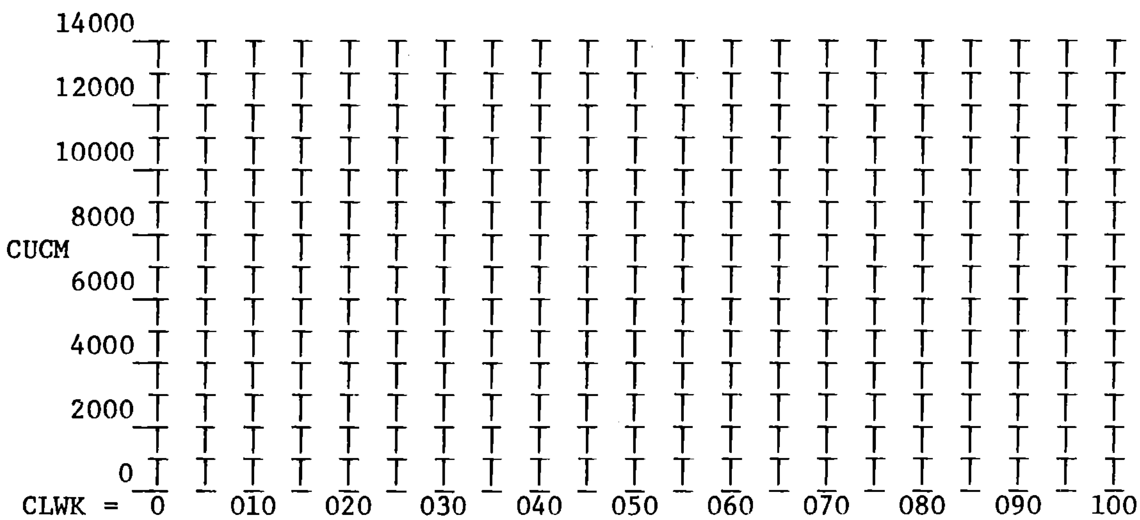
RRVC = 103.35 CLWK + 304.64

OAVC = 11.75 CLWK + 514.64

The total volume of all four stomach compartments in cubic centimeters (TVSC) is the sum of these two equations:

TVSC = 115.10 CLWK + 819.28

Calculate these relationships and plot the three lines. Volumes are expressed in cubic centimeters (CUCM).



LITERATURE CITED

Moen, A. N. 1973. Wildlife Ecology. W. H. Freeman Co., San Francisco. 458 pp.

Short, H. L. 1964. Postnatal stomach development of white-tailed deer. J. Wildl. Manage. 28(3):445-458.

CHAPTER 1, WORKSHEET 3.1b

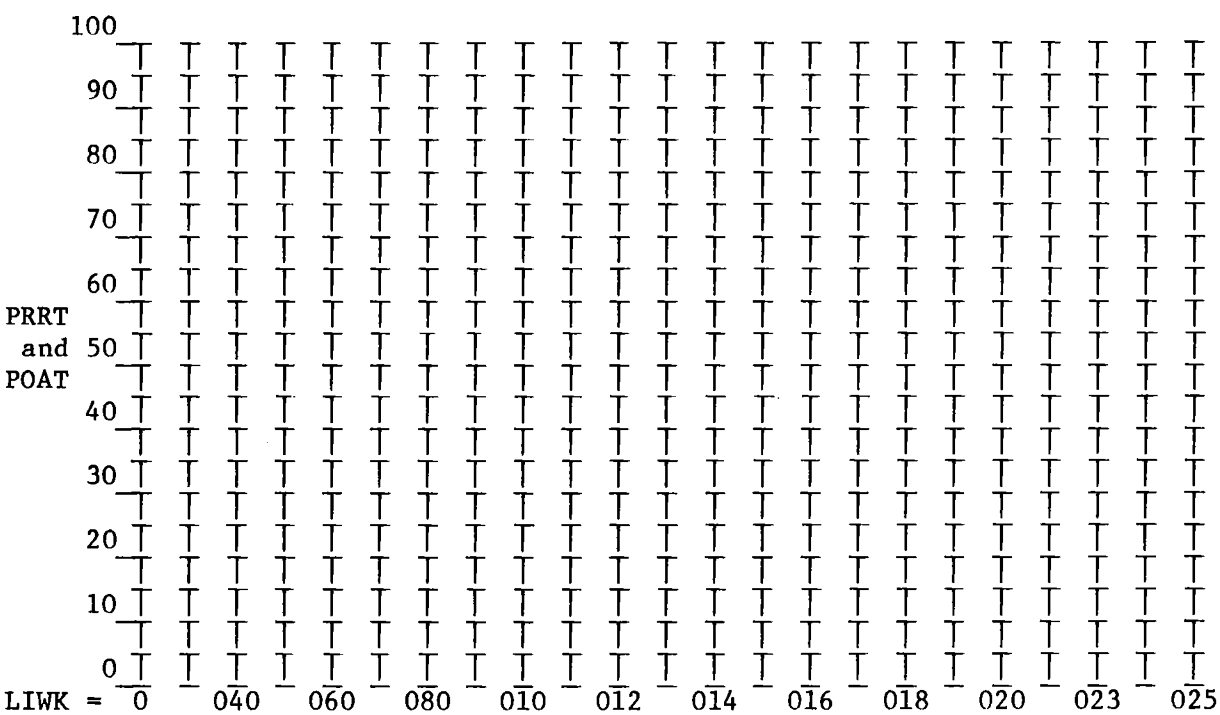
Relative proportions of the stomach compartments of white-tailed deer (odvi) during the suckling periods

Absolute volumes of the different stomach compartments are unique to each species. If development of the different compartments is proportional for different species, then an equation expressing relative proportions in relation to body weight for one species may be transferred for use with other species. The equation in Moen (1973:143) expressing the percent of the total stomach volume attributed to the rumen and reticulum (PRRT) for white-tailed deer is:

$$PRRT = 37.635 \ln LIWK - 35.666$$

The percent of the total volume attributed to the omasum and abomasum (POAT) = 100 - PRRT.

The percent reaches its biological limit for white-tailed deer when CLWK = 25 kg, which is about weaning weight. Plot these relative relationships below.



LITERATURE CITED

Moen, A. N. 1973. Wildlife Ecology. W. H. Freeman Co., San Francisco. 458 pp.

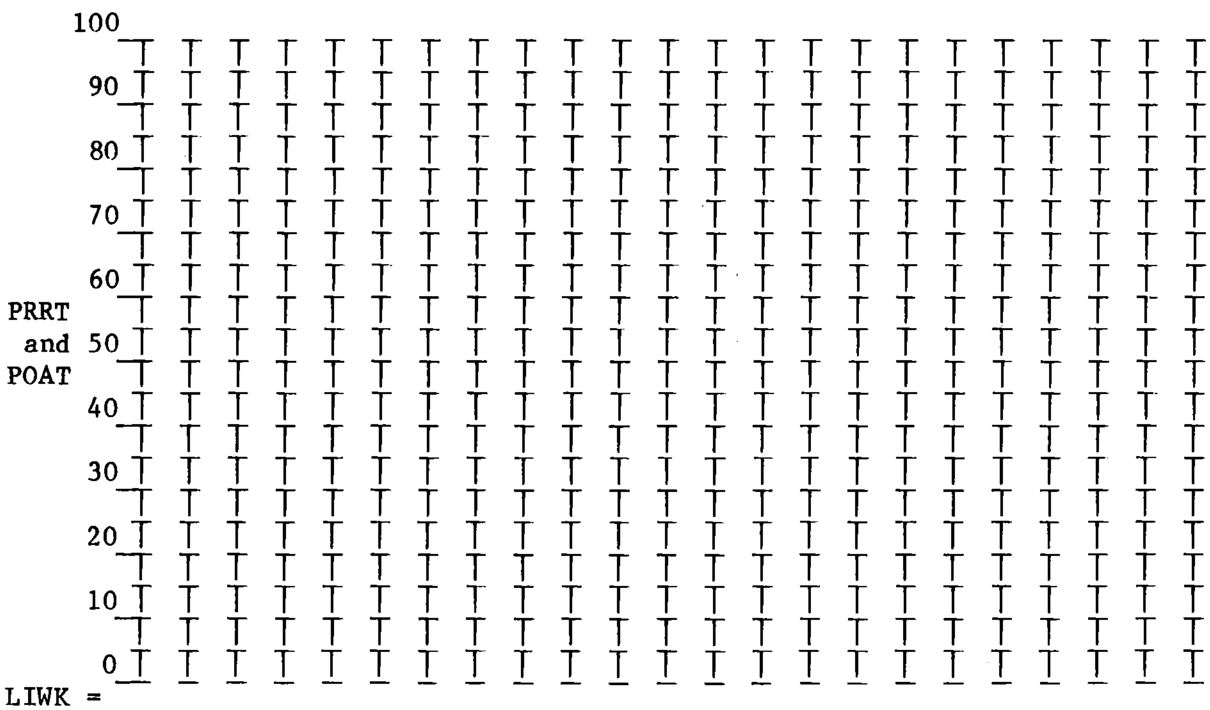
CHAPTER 1, WORKSHEET 3.1c

Relative proportions of the stomach compartments of wild ruminants during the suckling period

If stomach development of other species of wild ruminants is proportional to that of white-tailed deer from birth to weaning, the equation in WS3.1b can be modified for use with any species if weaning weight in kg (WEWK) and the live weight of the nursing young (LIWK) are known. The equation is:

$$PRRT = 37.635 \ln [(25/WEWK)] LIWK - 35.666$$

Label the x-axis for LIWK in the graph below to include the range of weights from birth to weaning of the species selected and plot the approximations of PRRT for these species.



UNIT 3.2: CARDIOVASCULAR SYSTEM CHARACTERISTICS

The cardiovascular system includes the heart, blood vessels, blood, and spleen. The heart pumps the blood through the blood vessels, the blood carries oxygen and nutrients to body cells and waste metabolites away from the cells, and the spleen is a storage organ for red blood cells.

The physical characteristics of the cardiovascular system are of interest because they limit the amounts of the nutrients and respiratory gas involved in metabolism. Cardiac volumes limit the amount of oxygen- and nutrient-carrying blood that can be pumped to the sites of metabolism. Further, the pumping capacity of the heart has a direct bearing on an animal's ability to escape predators and to withstand stressful thermal conditions. These functions may be rate-limited due to limitations to heart and blood volume which, in turn, place limits on nutrient and oxygen transport. Little is known about cardiovascular anatomy and physiology of wild ruminants, however; such research is technically difficult and very expensive.

Heart volume is an important parameter when evaluating heart rates, because it is the stroke volume, a function of the physical size of the heart, and the beat frequency that determines the circulating blood volume.

Blood volumes are an important consideration when evaluating the capabilities of an animal for reacting to stressful situations. Packed cell volumes are sometimes measured in addition to total blood volumes; red cells have important roles in oxygen transport.

It is useful to express heart weights in relation to live weights, ingesta-free weights, and metabolic weights when evaluating cardiac characteristics of a range of weights in a population. In general, larger animals have larger hearts and slower heart rates, which indicates that stroke volumes must also be greater. There are few data on the cardiovascular characteristics of different species, so first approximations have to be made from general relationships between weight and organ characteristics when evaluating the cardiovascular system of the different species of wild ruminants. For some species, the only data available are for groups of organs removed in field-dressing, such as the heart, lungs, and liver. Weights of individual organs may have to be determined by subtracting single organ weights from combined weights. This can be done using data on individual organs from different species, expressing weights of individual organs in relation to body weights and applying the results to other species on the basis of similar proportions between different species.

The format for tabulating heart weights in gms (HEWG) in relation to live (LIWK), ingesta-free (IFWK), and metabolic weights in kg (MEWK = $IFWK^{0.75}$ is shown below. Curve-fitting of linear, exponential, logarithmic, and power curves results in identification of the best fit for numerical representation of this relationship. Similar tabulations may be made for blood weights in gms (BLWG).

	Independent variables			Dependent variables	
	LIWK	IFWK	MEWK	HEWG	BLWG
1.	____	____	____	____	____
2.	____	____	____	____	____
.					
.					
N.	____	____	____	____	____

Reasonable estimates of blood weights can be used to estimate blood volume by multiplying weight by the specific gravity of the blood. Blood volumes may be used to estimate blood weights too, of course.

Similarities and proportional results are certainly to be expected when body weights and heart and blood weights are determined. Brody (1964:596) noted that "athletic" land animals had relatively larger hearts than non-athletic and marine animals. Since wild ruminants have coexisted with swift carnivorous predators, they must be in the "athletic" group, and larger hearts, proportional to body weights might be expected.

LITERATURE CITED

Brody, S. 1974. Bioenergetics and growth. Hafner Publishing Company, N.Y. 1064 pp.

CARDIOVASCULAR SYSTEM CHARACTERISTICS

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ABBIA	127--	711	717	odvi	hemoglobin heterogeneity	huisman,thj; doz/	1968
ABBIA	151-2	540	548	odvi	struct, hemogl alph chains	harris,mj; wilso/	1972
ACBCA	33---	335	343	odvi	struct sickl deer type III	schmidt,wc,jr; g/	1977
AHEMA	3----	250	261	odvi	maj arteries, shoulder,arm	bisaillon,a	1974
AJPHA	199--	190	192	odvi	tactoid forma, hemoglobin	moon,jh	1960
AJVRA	30--1	143	148	odvi	serum prot, normal, arthri	sikes,d; hayes,f/	1969
AJVRA	33-12	2545	2549	odvi	blood seru, arthrit reumat	sikes,d; kistner/	1972
AKASA	30---	50	51	odvi	electroph pattern, 2 subsp	jackman,gs; garne	1976
ANYAA	241--	594	604	odvi	sickling phenomona of deer	taylor,wj; easley	1974
ANYAA	241--	614	622	odvi	compar sickle eryth, human	simpson,cf; taylo	1974
ANYAA	241--	653	671	odvi	dome,embryo, fetal hemoglo	kitchen,h; brett,	1974
BLOOA	29--6	867	877	odvi	hemoglobin polymorphism in	kitchen,h; putna/	1967
BLOOA	43--6	899	906	odvi	ultrastruc sickl erythrocy	simpson,cf; taylo	1974
BLOOA	43--6	907	914	odvi	ultrastr sickl erythr pt 2	taylor,wj; simpso	1974
BUCDA	29--2	105	105	odvi	geogr dist, hemoglo compon	harris,mjw	1971
CBCPA	19--2	471	473	odvi	red cell life span, w-t de	noyes,wd; kitchen	1966
CBPAB	30--4	695	713	odvi/hemat,	bloo chem prot poly	seal,us; erickson	1969
CBPAB	58a--	387	391	odvi	short-term chan, corti, in	bubenik,ga; bube/	1977
CJCMA	34--1	66	71	odvi	ser biochem, hemat par cap	tumbleson,me; cu/	1970
CJZOA	44--4	631	647	odvi	odhe var, blood ser, elect	van tets,p; cowan	1966
CJZOA	53--6	679	685	odvi/amb	temp eff, physio trait	holter,jb; urban/	1975
CPSCA	7---4	217	218	odvi*organ:body	weight relation	robinson,pf	1966
EXMPA	2---2	173	182	odvi	mechan, sickl erythrocytes	pritchard,wr; ma/	1963
JBCHA	247--	7320	7324	odvi	heterog, hemogl alpha chai	taylor,wj; easle/	1972

odvi continued on the next page

CODEN	vo-nu	bepa	enpa	anim kewo	auth	year
JOMAA	31--1	5	17	odvi*weight relations, georg re	hamerstrom,fm,jr/	1950
JOMAA	39--2	269	274	odvi blood composition of w-t d	teeri,ae; vircho/	1958
JOMAA	39--2	309	311	odvi aspects of blood chemistry	wilbur,cg; robin/	1958
JOMAA	49--4	749	754	odvi hematologica volumes, mich	johnson,he; youa/	1968
JOMAA	54--1	270	274	odvi geograph dist, hemoglo var	harris,mj; huism/	1973
JOPAA	59--6	1091	1098	odvi hematol chan, fawns, ticks	barker,rw; hoch,/	1973
JWIDA	9---4	342	348	odvi combin etorphine, xylazine	presidente,pja;/	1973
JWIDA	10---	18	24	odvi blood char, free-rang, tex	white,m; cook,rs	1974
JWMAA	29--1	79	84	odvi/comp blood, nurs doe, fawn	youatt,wg; verm/	1965
JWMAA	36--4	1034	1040	odvi eff immobil, blood analyse	seal,us; ozoga,/	1972
JWMAA	36--4	1041	1052	odvi nutri eff, thyroi act, blo	seal,us; ozoga,/	1972
JWMAA	38--4	845	847	odvi restrain appar, blood samp	mautz,ww; davis/	1974
JWMAA	39--2	342	345	odvi ser cholest lev chan, mich	coblentz,be	1975
JWMAA	39--2	346	354	odvi*chan blood prot, ges, suck	hartsook,ew; wh/	1975
JWMAA	39--4	692	698	odvi energ, prot, blood urea ni	kirkpatrick,rl;/	1975
JWMAA	40--3	442	446	odvi plas progest, pubert, fawn	abler,wa; buckl/	1976
MGQPA	32	113	138	odvi physiol baselines, hematol	karns,pd	1972
NAWTA	3----	890	892	odvi enlarg spleen, glac nat pa	aiton,jf	1938
PSEBA	117--	276	280	odvi sickling, heteroge, hemogl	weisbergen,as	1964
SCIEA	144--	1237	1239	odvi hemoglob polymor, sickling	kitchen,h; putn/	1964
TJSCA	27	155	161	odvi var,corr, os cordis, heart	long,ca; smart,d	1976
VJSCA	26--2	61	61	odvi immobi drug, pack cell vol	wesson,ja III; s	1975
WDABB	3---1	32	34	odvi serolog surv, 2 herds n y	friend,j; halter	1967

CODEN	vo-nu	bepa	enpa	anim kewo	auth	year
CJZOA	34--5	477	484	odhe age, nutrition, blood chem	kitts,wd; bandy/	1956
CJZOA	35--2	283	289	odhe age, nutrition, blood chem	bandy, pj; kitt/	1957
CJZOA	47--5	1021	1024	odhe observa haematology, races	cowan,imct; band	1969
JANSA	33--1	244	244	odhe/plasma mineral indexes,nev	rohwer,gl; lesp/	1971
JANSA	34--5	896	896	odhe/lipid, plas comp lev, neva	lesperance,al; /	1972
JANSA	38--6	1331	1332	odhe blood compon, seas, wt, fe	o'brien,jm; les/	1974
JOMAA	36--3	474	476	odhe erythrocyte val, mule deer	browman,lg; sear	1955
JOMAA	52--3	628	630	odhe*tiss, organs, tota body ma	hakonson,te; whi	1971
JOMAA	53--2	384	387	odhe*total serum protein in pop	anderson,ae; me/	1972
JWIDA	8---2	183	190	odhe/blood serum electrol, colo	anderson,ae; med	1972
JWMAA	34--2	389	406	odhe erythrocyte, leukocy, colo	anderson,ae; me/	1970

odhe continued on the next page

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
NAWTA	17---	482	496	odhe	rel hematol, condit, calif	rosen,mnj; bisch	1952
PCZOA	2--10	46	46	odhe	chang, plas lipid thr year	stewart,sf; nor/	1963
WLMOA	39---	1	122	odhe*	carcas, bone, organ, gland	anderson,ae; me/	1974

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	15---	253	268	ceel/	relat age and size, poland	dziecioloski,r	1970
CBPAB	43a-3	649	653	ceel	blood chemis roosevelt elk	weber,yb; bliss,	1972
JOMAA	27--4	308	323	ceel	mammals of northern idaho	rust,hg	1946
JOMAA	49--4	762	764	ceel	physiol stud, rocky mounta	herin,ra	1968
JOMAA	53--4	917	919	ceel	sickling phenom, erythrocy	weber,yb; giacom	1972
ZEJAA	4---4	171	177	ceel	[regulation of blood pres]	jaczewski,z; ja/	1958

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ANYAA	97--1	296	305	alal	studi, blood, serum groups	braend,m	1962
CJZOA	53--/	1424	1426	alal	serum cortic, handl stress	franzmann,aw; f/	1975
HEREA	85--2	157	162	alal	var, red cell enzy, scandi	ryman,n; beckma/	1977
JEBPA	12--4	347	349	alal/	rata, card comp emot stres	roshchevskii,mp/	1976
JOMAA	27--1	90	91	alal	weights of minnesota moose	brechinridge,wj	1946
JOMAA	50--4	826		alal	blood chemis, shiras moose	houston,db	1969
VEZOA	69--3	13	18	alal	[venous syst, pector limb]	komarov,av	1969
VEZOA	71--4	31	38	alal	[venous syst, thorac limb]	komarov,av	1971

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
APSSA	396--	96	96	rata	blood circulation, finnish	hirvonen,l; jar/	1973
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975
CJZOA	44--2	235	240	rata	electroly, red cells, plas	manery,jf; barl/	1966
CJZOA	46--5	1031	1036	rata	hematologi studies, bar-gr	mcewan,eh	1968
CJZOA	47--4	557	562	rata*	changes in blood with age	mcewan,eh; white	1969
CJZOA	50--1	107	116	rata*	seas changes, blood volume	cameron,rd; luic	1972
CNJMA	24--5	150	152	rata	haematol val, bar grou car	gibbs,hc	1960
NJZOA	24--4	407	417	rata/	morpho, fat stor, organ wt	krog,j; wika,m	1976
ZOLZA	57--6	944	948	rata	[dev phys char, 1st month]	segal,an	1978

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				anam			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
BIGEB	9---1	1	11	bibi	two hemoglobin phenotypes	harris,mj; wils/	1973
EVOLA	12--1	102	110	bibi	studies on blood groups	owen,rd; stormon	1958
GENTA	61	823	831	bibi	electroph forms, carb anhy	sartore,g; stor/	1969
JWIDA	11--1	97	100	bibi	hematol, blood chemi, kans	marler,rj	1975
JWIDA	12--1	7	13	bibi	hematolo val, 5 areas, u s	mehrer,cf	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
CBPAB	40b--	567	570	ovca	ovda,ovmu transfer, hemogl	nadler,cf; woolf	1971
JAVMA	157-5	647	650	ovca	physiol val, cap, handling	franzmann,aw; th	1970

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	39--4	554	559	obmo	serologica evid, relations	moody,pa	1958

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				oram			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
CBPAB	23--1	149	157	many	serum proteins, transferri	nadler,cf; hugh/	1967
JWMAA	40--3	517	522	many	iden hemoglob, law enforce	bunch,td; meado/	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	12---	463	465	bibo	electrocard, experim death	nagorski,f; grod	1967
ATRLA	12---	361	365	bibo	curr stat stud blood prope	gasparski,j	1967

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
CBPAB	40b--	521	530	ovli	transferr, hemoglobi, iran	lay,dm; nadler,c	1971

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JAVMA	157-5	604	606	many	hematol val, arctic mammal	dieterich,ra	1970

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JWMAA	37--4	584	585		serol tech, ident blo prot	tempelis,ch; rod	1973
NATUA	187--	333	334	elda	sickling phenomenon in dee	undritz,e; betk/	1960

Heart weight:live weight relationships of white-tailed deer (odvi)

Heart weights of 11 male and 8 female white-tailed deer and the a and b values for a linear regression equation for all 19 animals combined are given by Robinson (1966).

Linear, exponential, logarithmic, and power regression equations for each sex have been determined from the data of Robinson to see if a non-linear curve provides a better fit. The R^2 values are:

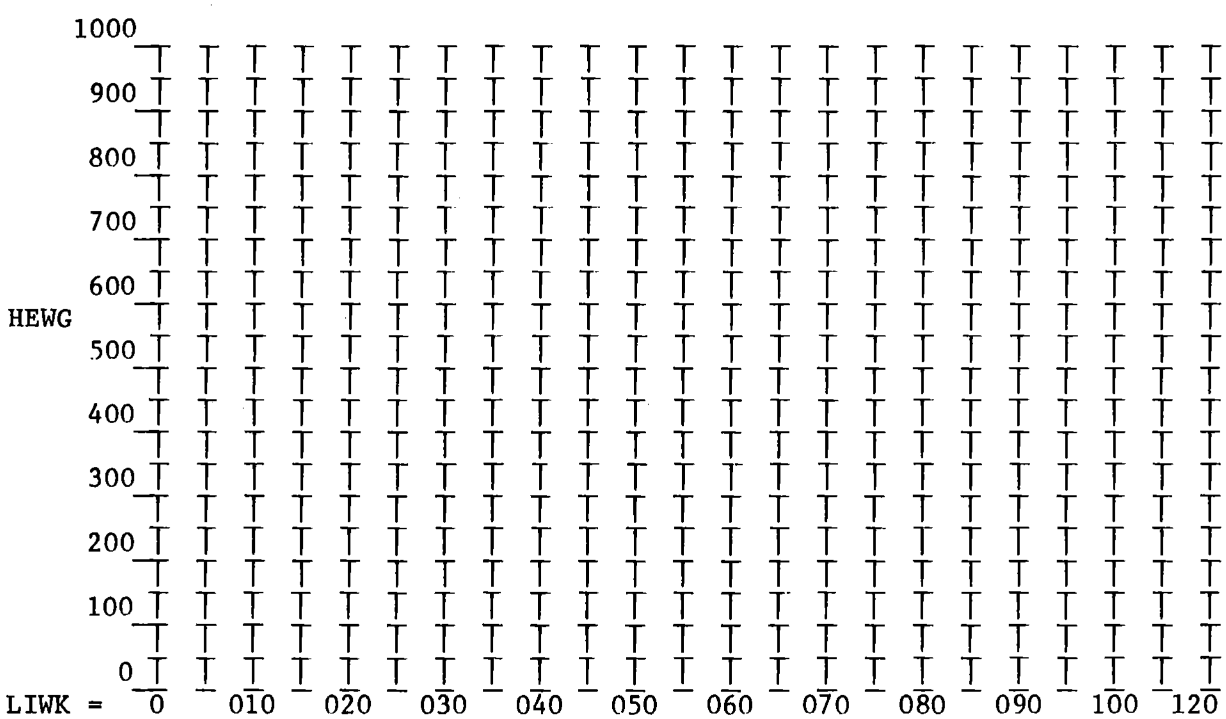
	Linear	Exponential	Logarithmic	Power
male	0.95	0.96	0.88	0.92
female	0.96	0.92	0.96	0.94

The linear fit is best when both sexes are considered. The equations for males and females are:

male: HEWG = 8.71(LIWK) - 105.58
female: HEWG = 9.48(LIWK) - 100.70

A t-test shows that the slopes are not different (P = 0.99) for males and females. Thus, a single equation represents the heart weight:live weight relationships for both sexes. The equation is:

HEWG = 8.54 LIWK - 81.27



LITERATURE CITED

Robinson, P. F. 1966. Organ:body weight relationships in the white-tailed deer, Odocoileus virginianus. Cheasapeake Science 7(4):217-218.

CHAPTER 1, WORKSHEET 3.2b

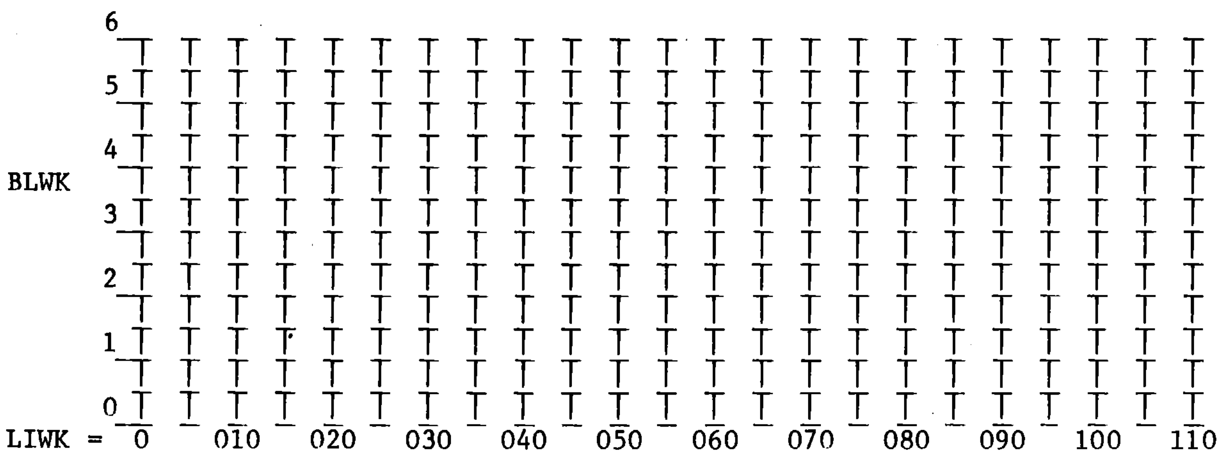
Blood weight:live weight relationship of white-tailed deer (odvi)

The weight of the blood of white-tailed deer, presumably determined by direct collection and measurement of 13 sacrificed male deer was given in relation to live weight by Cowan et al. (1968).

Direct collection of the blood results in an underestimation of the total blood present because some of the residual blood in the capillaries. The equation, based on the data given, is:

$$BLWK = 0.498 + 0.045\ (LIWK)$$

Plot the blood weights in relation to live weight in kg (LIWK) below.



LITERATURE CITED

Cowan, R. L, E. W. Hartsook, J. B. Whelan, J. L. Watkins, J. S. Lindzey, R. W. Wetzel, and S. A. Liscinsky. 1968. Weigh your deer with a string. Penn. Game News 39(11):17-18.

CHAPTER 1, WORKSHEET 3.2c

Heart weight:live weight relationship for mature mammals

Brody (1964:596) presents a figure with plotted points and a regression line for the heart weight (kg): body weight (kg) relationship for mature mammals. The equation is:

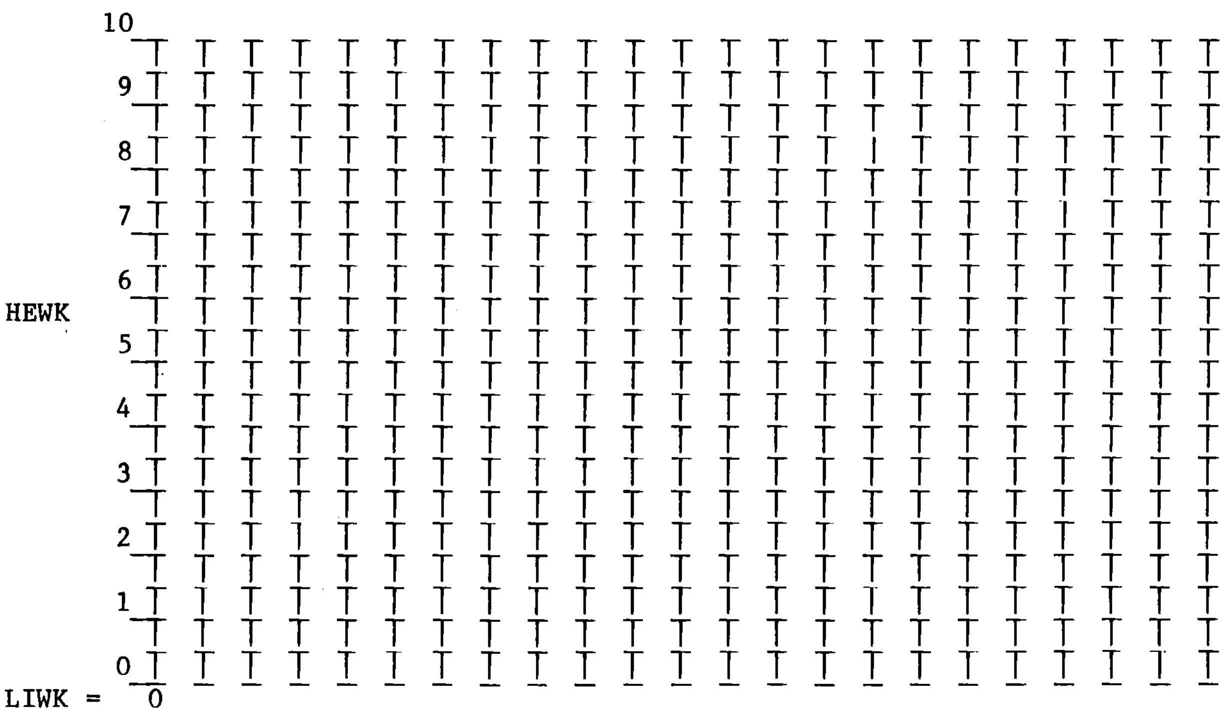
$$HEWG = 0.00588\ LIWK^{0.984}$$

Compare heart weights with this calculation and from WORKSHEET 3.2a for deer weighing 100 kg. Note that the deer equation results in a larger HEWG than the general equation. Complete the table below for species and weights of your choice. Remember that this general equation may result in an underestimation for wild ruminants in general.

Brody (1964:643) gives the a and b values for another equation for dairy cattle. That equation is:

$$HEWK = 0.064\ LIWK^{0.56}$$

Compare the results from this equation to the one for deer.



LITERATURE CITED

Brody, S. 1964. Bioenergetics and growth. Hafner Publishing Company, Inc., New York. 1023 pp.

UNIT 3.3: RESPIRATORY SYSTEM CHARACTERISTICS

The major organs of the respiratory system are the lungs and the air passages leading to them. The lungs, surrounded by pleural sacs, are located in the thorax. The air passages are the mouth cavity, pharynx, larynx, trachea, and bronchi. The diaphragm is the major muscle involved in breathing, assisted by muscles of the thorax. The movement of air through the air passages to ventilate the lungs is called external respiration. The exchange of oxygen and carbon dioxide in the process of metabolism is called internal respiration, and is discussed in Part III.

Lung Surface Area. The lungs of mammals are finely divided into tiny sacs or diverticuli which increase the internal surface areas of each lung tremendously compared to their outer surface areas. This structural characteristic provides large amounts of surface areas for ventilation, resulting in efficient O_2 and CO_2 exchange necessary for continuing internal respiration.

Lung Volumes. Lung volumes of a wide range of weights of mammals (including no wild ruminants, however) were very constant (Gordon 1962;162).

$$LUVO = 0.0567\ IFWK^{1.02}$$

The increase was not quite directly proportional as the equation expressing this relationship includes weight to the power 1.02. This means that lung volumes of larger animals are relatively larger than those of smaller animals, although the increase is slight. The effects of an exponent of 1.02 compared to a direct proportion to weight (1.00) are made in WORKSHEET 3.3a.

Air passages. The structure of the air passages is important for the exchange of heat energy between the animal and the atmosphere. Very cold inhaled air, for example, is warmed as it passes through the respiratory tract, removing heat energy from body tissue. If the air exhaled is warm air, the amount of heat lost could be substantial for a wild ruminant in cold, northern weather conditions.

The air passages of caribou have membranes that are folded over each other, functioning as heat exchanges to warm the inhaled air and cool the air to be exhaled. In this way, heat energy is exchanged within the air passages rather than between the air passages and the atmosphere, resulting in potentially important reductions in respiratory heat loss.

LITERATURE CITED

Gordon, M. S., G. A. Bartholomew, A. O. Grinnell, C. B. Jorgensen, and F. N. White. 1962. Animal Function: Principles and adaptations. The MacMillan Company, New York. 560 pp.

REFERENCES, UNIT 3.3

RESPIRATORY SYSTEM CHARACTERISTICS

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	31--1	5	17	odvi	*weight relations, georg re	hamerstrom,fm,jr/	1950

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	52--3	628	630	odhe	*tiss, organs, tota body ma	hakonson,te; whic	1971
WLMOA	39---	1	122	odhe	*carcas, bone, organ, gland	anderson,ae; med/	1974

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	27--4	308	323	ceel	mammals of northern idaho	rust,hg	1946
RSPYA	29--2	225	230	ceel	/select oxygen transp param	mckean,t; staube/	1977

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	27--1	90	91	alal	weights of minnesota moose	brechinridge,wj	1946

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975
NJZOA	24--4	407	417	rata	/morph, fat stor, organ wt	krog,j; wika,m; /	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				anam			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
RSPYA	30--3	305	310	bibi	blood respirato properties	haines,h; chiche/	1977

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovca			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				obmo			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				oram			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	12---	349	360	bibo	physiological properties	janusz,g	1967

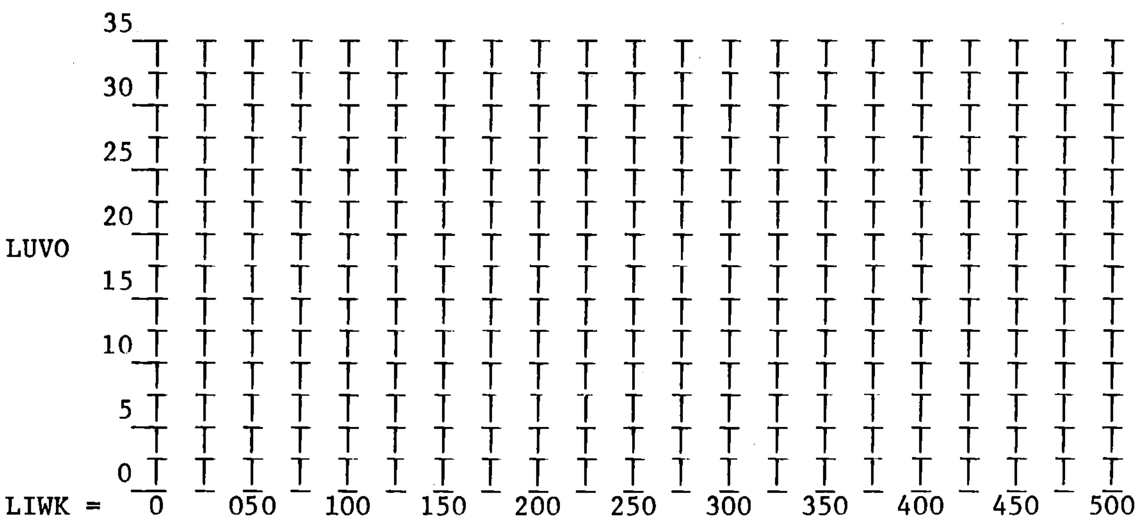
CHAPTER 1, WORKSHEET 3.3a

Lung volumes in relation to body weights

The lung volumes of a wide range of weights of animals may be expressed with the equation modified from Gordon (1962;162):

$$LUVO = 0.0567\ LIWK^{1.02}$$

No ruminants were included in the data used to derive the above equation. Since there are no other data available on lung volumes of wild ruminants, this equation will serve as a first approximation. Lung volumes get larger as animal weights increase since the exponent 1.02 is greater than 1.00. Evaluate lung volumes for animals weighing 50 kg (deer) to 500 kg (bison) using the equation above. Then, use a direct proportion (exponent = 1.00) and calculate LUVO. Plot the results below. What are the differences at different weights?



LITERATURE CITED

Gordon, M. S., G. A. Bartholomew, A. O. Grinnell, C. B. Jorgensen, and F. N. White. 1962. Animal Function: Principles and adaptation. The MacMillan Company, New York. 560 pp.

UNIT 3.4: REPRODUCTIVE SYSTEM CHARACTERISTICS

The reproductive system of wild ruminants includes the scrotum, testes, and penis of the males and the uterus, ovaries and vagina of the females. Characteristics of the male and female reproductive organs are used to evaluate breeding condition and potentials. Testes volumes increase as the rutting season approaches, with the hormone testosterone having a significant role in stimulating these physical changes. The ovaries of the female serve as indicators of the female's reproductive history. Teat lengths measured on hunter-killed animals are very good indicators of lactation the previous summer in yearling deer, helping to establish the frequency of suckling young born to yearlings, which is a good indicator of animal condition in relation to the range.

Several characteristics of the reproductive system are of distinct ecological importance. The age at reproductive maturity is an important characteristic affecting the ratio of breeding: non-breeding animals in a population. Animals that breed at an earlier age contribute new individuals to the population sooner than late-maturing animals do, resulting in potentially greater variations in number from one breeding season to the next.

Lengths of the gestation periods (LEGP) of the North American wild ruminants are:

		LEGP
white-tailed deer;	odvi	200
mule deer;	odhe	200
elk;	ceel	260
moose;	alal	245
caribou;	rata	220
pronghorn;	anam	240
bison;	bibi	290
big-horn sheep;	ovca	150
Dall sheep;	ovda	150
muskox;	obmo	270
mountain goat;	oram	180

Reproductive system characteristics are related to those of the endocrine system, of course. Functional relationships between these two systems are discussed in Part III.

LITERATURE CITED

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism, and forage intake of white-tailed deer. J. Wildl. Manage. 42(4): 715-738.

REFERENCES, UNIT 3.4

REPRODUCTIVE SYSTEM CHARACTERISTICS

BOOKS

type	publ	city	page	anim	kewo	auth/edit	year
aubo	coup	itny	670	mamm	patterns mammalian reprodu	asdell,sa	1964

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOANA	94--1	1	33	cerv	aspects of placentation	hamilton,wj; har/	1960

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AJANA	126-2	201	241	odvi	morphogen, fetal membranes	sinha,aa; seal,u/	1969
AJANA	127-4	369	395	odvi	ultrastr amnion, amni plaq	sinha,aa; seal,u/	1970
AJANA	132-2	189	205	odvi	ultrastr corpus lute, preg	sinha,aa; seal,u/	1971
AJVRA	39--6	1053	1056	odvi	antl, long bone mass, andr	brown,rd; cowan,/	1978
BIREB	16--3	340	343	odvi	repro ster, fema seas chan	plotka,ed; seal,/	1977
BIREB	17--1	78	83	odvi	repr, proges, estrog, preg	plotka,ed; seal,/	1977
CIRIB	6---2	1053	1056	odvi	collec semen, electro ejac	bierschwal,cj; m/	1968
CJZOA	44--1	59	62	odvi	breeding seasons, manitoba	ransom,ab	1966
CJZOA	56--1	121	127	odvi	seas var LH,FSH, tes, male	mirarchi,re; how/	1978
CNJNA	54--2	259	259	odvi	doca, cotyled attach, uter	scanlon,pf	1974
COVEA	39--3	282	291	odvi	corpora lutea, ovul incide	cheatum,el	1949
CPSCA	7---4	217	218	odvi*	organ:body weight relation	robinson,pf	1966
ENDOA	94--4	1034	1040	odvi	annual testos rhyth, adult	mcmillin,jm; sea/	1974
JANSA	31--1	225	225	odvi/	sperm reserves of w-t deer	lambiase,jt,jr; a	1970
JANSA	39--1	225	225	odvi	dosh, doca, placentomes in	scanlon,pf	1974
JANSA	40--1	185	186	odvi/	andr lev, antl cy, bree se	mirarchi,re; sca/	1975
JANSA	42--1	271	272	odvi/	seas var, gonad char, male	mirarchi,re; sca/	1976
JAVMA	157-5	627	632	odvi	char semen coll, elec ejac	bierschwal,cj; m/	1970

odvi continued on the next page

CODEN	vo-nu	bepa	enpa	anim kewo	auth	year
JOMAA	31--1	5	17	odvi*weight relations, georg re	hamerstrom,fm,jr/	1950
JOMAA	32--4	411	421	odvi analys reproduc pat, s tex	iilege,d	1951
JOMAA	40--1	108	113	odvi/breed record, capt, alabam	haugen,ao	1959
JOMAA	46--1	107	107	odvi placen ingest, partur mort	knowlton,ff; mich	1965
JOMAA	47--2	266	280	odvi*endocrine glands,seas chan	hoffman,ra; robin	1966
JOMAA	53--4	760	773	odvi/ovar comp, repr phys,venez	brokx,pa	1972
JRPFA	47--1	161	163	odvi chan estro, estradi, pregn	harder,jd; woolfl	1976
JWIDA	9---4	356	358	odvi multipl anomali, w-t fetus	wobeser,g; runge,	1973
JWIDA	11--4	497	501	odvi congen anom, neonat, alber	barrett,mw; chalm	1975
JWMAA	10--3	242	248	odvi regi diff, breed poten, ny	moroton,gh; cheat	1946
JWMAA	10--3	249	263	odvi breeding season, new york	cheatum,el; morto	1946
JWMAA	14--3	290	295	odvi/breed rec, upper pen, mich	haugen,ao; davenp	1950
JWMAA	27--1	142	143	odvi technique for preser uteri	haugen,ao	1963
JWMAA	28--1	171	173	odvi birth of white-tai d fawns	michael,ed	1964
JWMAA	29--1	53	59	odvi reproduc cycle, male texas	robinson,rm; tho/	1965
JWMAA	29--1	74	79	odvi/reproducti studies, penned	verme,lj	1965
JWMAA	29--3	487	492	odvi corpora lutea variation of	trauger,dl; hauge	1965
JWMAA	29--3	634	636	odvi fertility in w-t buck fawn	silver,h	1965
JWMAA	30--4	843	845	odvi regional diff, fawning tim	weber,aj	1966
JWMAA	31--1	114	123	odvi reprodtive biolo, manitoba	ransom,ab	1967
JWMAA	33--3	708	711	odvi fertility, male w-t fawns	follmann,eh; klim	1969
JWMAA	33--4	881	887	odvi/repro pattern, nutri plane	verme,lj	1969
JWMAA	35--2	369	374	odvi/accessory corp lute, ovari	mansell,wd	1971
JWMAA	36--3	868	875	odvi/reproductive physiol, male	lambiase,jt,jr; /	1972
JWMAA	37--3	423	424	odvi support dev, field laparot	scanlon,pf; lenke	1973
JWMAA	38--2	183	196	odvi eff diethylstilbes, reprod	harder,jd; peterl	1974
JWMAA	39--4	684	691	odvi/uterin comp, growth, pregn	robbins,ct; moen,	1975
JWMAA	40--2	373	374	odvi initia, preg, lactating de	scanlon,pf; murp/	1976
JWMAA	40--4	792	795	odvi noneff, mechan birth contr	matschke,gh	1976
JWMAA	41--1	87	91	odvi diethylstilbestr, contrace	matschke,gh	1977
JWMAA	41--1	92	99	odvi/ann chang, sperm prod, org	mirarchi,re; sca/	1977
JWMAA	41--2	178	183	odvi androg levels, antl develo	mirarchi,re; sca/	1977
JWMAA	41--2	194	196	odvi antifertil act, syn proges	matschke,gh	1977
JWMAA	41--4	715	719	odvi fact aff peak fawning, vir	mcginnes,bs; down	1977
JWMAA	41--4	731	735	odvi ferti control, steroi impl	matschke,gh	1977
NAWTA	29---	225	236	odvi hypogonadism in wtd, texas	thomas,jw; robin/	1964
NFGJA	16--2	261	261	odvi twin fawns born 2 days apa	hesselton,wt; van	1969
NFGJA	18--1	42,	51	odvi reprod anomali, female, ny	hesselton,wt; jac	1971
NFGJA	20--1	40	47	odvi/breedi, parturit dates, ny	jackson,lw; hesse	1973
OJSCA	78-AP	14	14	odvi possibl superfeta, spontan	lamvermeyer,bl; m	1978
PCGFA	9----	128	131	odvi birth dates of alabama dee	lueth,fx	1955
PCGFA	29---	646	651	odvi oral accep, eff, diethylst	matschke,gh	1975
PIAIA	71---	241	247	odvi/struc, cervic regi, uterus	morris,je	1964

odvi continued on the next page

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
POASA	56---	24	25	odvi	breeding season, e oklahom	dunbar,mr	1976
TJSCA	26	417	420	odvi	breeding season in s texas	harwell,wf; barro	1975
TNWSD	27---	19	38	odvi	photoperiodism, breeding	mcdowell,rd	1970
VJSCA	23--3	116	116	odvi	a laparotomy technique w-t	scanlon,pf; lenke	1972
VJSCA	23--3	116	116	odvi	aspects of early pregnancy	scanlon,pf; murp/	1972
VJSCA	24--3	112	112	odvi	ovula, pregnan, lactat dee	scanlon,pf; murp/	1973
VJSCA	24--3	112	112	odvi	spermatozoan reserves in d	lenker,dk; scanlo	1973
VJSCA	26--2	59	59	odvi	plas androg lev,repro char	mirarchi,re; sca/	1975
VJSCA	26--2	60	60	odvi	seas, age dif, male org wt	russell,md; wess/	1975
VJSCA	27--2	46	46	odvi	plas progest lev, estr cyc	kirkpatrick,rl; /	1976
WLSBA	3---4	152	156	odvi	hormon implan, contr repro	bell,rl; peterle,	1975

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ACATA	84--1	118	128	odhe	anam, morpho, cervix uteri	kanagawa,h; hafez	1973
AMNAA	83--1	303	304	odhe	accidents, parturient deer	miller,fl	1970
ANREA	122--	335	340	odhe	quadruplets in mule deer	sears,hs; browman	1955
APAVD	1976-	208	215	odhe	environ eff on reproductio	sadleir,rmfs	1976
CAFGA	43--1	91	96	odhe	breedin seas, herds, calif	bischcoff,ai	1957
CAFGA	44--3	253	259	odhe	productiv, herds californi	bischoff,ai	1958
CJZOA	48--1	123	132	odhe	odvi, develo, fetal period	ommundsen,p; cowa	1970
CJZOA	54-10	1617	1636	odhe	horm reg, repro, antl cycl	west,no; nordan,h	1976
CJZOA	54-10	1637	1656	odhe	eff methallibure,hormon tr	west,no; nordan,h	1976
JOMAA	38--1	116	120	odhe	gesta per, breed, fawn beh	golley,fb	1957
JOMAA	52--3	628	630	odhe*	tiss, organs, tota body ma	hakonson,te; whic	1971
JOMAA	53--2	403	404	odhe	biolog, an antlered female	mierau,gw	1972
JOMAA	54--1	302	303	odhe	reproductio, b-t deer fawn	thomas,dc; smith,	1973
JRPFA	44--2	261	272	odhe/	reprod pattern, female b-t	thomas,dc; cowan,	1975
JWIDA	7---1	67	69	odhe	bilateral testicular degen	murphy,bd; clugst	1971
JWIDA	11--1	101	106	odhe	testicular atrophy, calif	demartini,jc; con	1975
JWMAA	14--4	457	469	odhe	bree seas, prod, faw, utah	robinette,wl; gas	1950
JWMAA	17--2	225	225	odhe	proof fawns breeding, utah	crane,hs; jones,d	1953
JWMAA	21--1	62	65	odhe	ovarian anal, reprod perfo	golley,fb	1957
JWMAA	40--4	795	796	odhe	preg fawn, quintupl mule d	nellis,ch; prent/	1976

odhe continued on the next page

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
MRLTA	50--1	12	12	odhe	record, multiple ovulation	fowle,ke	1969
SWNAA	15--1	29	36	odhe	indices repro, surv, n mex	anderson,ae; sny/	1970
THGNB	3---3	101	106	odhe	early pubert, female b-t d	mueller,cc; sadle	1975
WLMOA	39---	1	122	odhe*	carcas, bone, organ, gland	anderson,ae; med/	1974

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
BEHAA	16	84	92	ceel	charact of estrus, captive	morrison,ja	1960
CIRIB	8---4	994	997	ceel	freezi red d semen, polan	jaczewski,z; mor/	1976
JOMAA	36--1	145	145	ceel	fetus in yearling cow elk	saunders,jk jr	1955
JOMAA	47--2	332	334	ceel	fetus resorption in elk	haugen,ao	1966
JOMAA	51--4	812	813	ceel	precoci antl dev, sex matu	moran,rj	1970
JRPFA	25--1	41	54	ceel/	puberty, seas breedin male	lincoln,ga	1971
JRPFA	27--3	427	438	ceel/	female reprodu cycl, scotl	guiness,f; linco/	1971
JWMAA	16--3	313	315	ceel	age at sex maturity, male	conoway,cf	1952
JWMAA	17--2	177	184	ceel	reproduction, yellowstone	kittans,wh	1953
JWMAA	17--2	223	223	ceel	pregnant yearling cow elk	coffin,al; reming	1953
JWMAA	23--1	27	34	ceel	breed seas, known-age embr	morrison,ja; tra/	1959
JWMAA	24--3	297	307	ceel	ovarian char, breed histor	morrison,ja	1960
JWMAA	31--1	145	149	ceel	determ preg, rectal palpat	greer,kr; hawkins	1967
JWMAA	32--2	368	376	ceel	exper studies, contr repro	greer,kr; hawkin/	1968
JZOOA	163-1	105	123	ceel/	seas reprodu changes, stag	lincoln,ga	1971
JZOOA	172-3	363	367	ceel	timing, reproduc, latitude	fletcher,tj	1974
JZOOA	185-1	105	114	ceel	calving times, red d, scot	guiness,fe; gibs/	1978
MAMLA	35--2	204	219	ceel	ruru, season, births, n z	caughley,g	1971
NAWTA	21---	545	554	ceel	postconcept ovulation, elk	halazon,gc; buech	1956
OIKSA	23--1	142	144	ceel	field measu, organ volumes	langvain,r	1972
ZEJAA	1---1	69	75	ceel	caca, dada [time of birth]	rieck,w	1955
ZEJAA	4---3	105	130	ceel	[reproductive phenomena]	valentincic,si	1958
ZEJAA	21--4	238	242	ceel	1 sided testicle shrinkage	wurster,k; hofma/	1975

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AVSPA	14--1	81	91	alal	morph, ultrastr, spermatoz	andersen,k	1973
JOMAA	27--1	90	91	alal	weights of minnesota moose	brechinridge,wj	1946
JOMAA	37--2	300	300	alal	late breeding, moose, alce	moisan,g	1956
JWMAA	26--4	360	365	alal	in gravelly, snowcrest mou	peek,jm	1962
JWMAA	39--2	450	451	alal	aerial sexing, wh vulv pat	roussel,ye	1975
VILTA	6---3	1	299	alal/	reproductio, moose, sweden	markgren,g	1969

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975
CAFNA	90--4	449	463	rata	annual antler cycle, newfo	bergerud,at	1976
CAFNA	90--4	498	499	rata	twin fetuses, woodland car	shoesmith,mw	1976
CJZOA	50--1	43	46	rata	reprodu, female reind, car	mcewan,eh; whiteh	1972
CJZOA	53--9	1213	1221	rata/	repro seas, carib, newfoun	bergerud,at	1975
CJZOA	56--8	1684	1696	rata/	morphol, b-g caribou ovary	dauphine,tc,jr	1978
JOMAA	49--4	778	778	rata	placental remnants, rumens	miller,fl; parker	1968
JOMAA	52--2	479	479	rata	twinning in caribou	mcewan,eh	1971
JOMAA	54--3	781	781	rata	twinning in reindeer, nwt	nowosad,rf	1973
JWMAA	25--2	205	205	rata	sex determi caribou calves	bergerud,at	1961
JWMAA	28--3	477	480	rata	field meth, parturiti rate	bergerud.at	1964
JWMAA	35--1	175	177	rata	antl shedd, parturi, reind	espmark,y	1971
JWMAA	38--1	54	66	rata/	synchronous mating, b gr c	dauphine,tc,jr; m	1974
JZOOA	164-4	419	424	rata	collec, exam, reinde semen	dott,hm; utsi,mnp	1971
JZOOA	170-4	505	508	rata	artific insemina, reindeer	dott,hm; utsi,mnp	1973
NCANA	97--1	61	66	rata	calving dates, carib, queb	desmeules,p; sim	1970
NJZOA	24--4	407	417	rata	morpho, fat stor, organ wt	krog,j; wika,m	1976
PASCC	22---	17	17	rata	repro patter, reind, carib	mcewan,eh; whiteh	1971
ZOLZA	46-12	1837	1841	rata	[reproduc, wild, taimyr p]	michurin,ln	1968

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
WMBAA	16---	17	23	bibi	biol, manage, national par	fuller,wa	1962

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
CJZOA	46--5	899	944	ovca	social, physical maturatio	geist,v	1968
JWMAA	9---2	155	156	ovca	non-breeding in bighorn sh	pulling,avs	1945
JWMAA	30--1	207	209	ovca	twinning in bighorn sheep	spalding,dj	1966
SWNAA	22---	153		ovca	minimum breeding age, utah	mccutchen,he	1977

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
FUNAA	24	96	100	obmo	early matur, fecund, norwa	alendal,e	1971
FUNAA	24	101	103	obmo	gestation period of muskox	alendal,e	1971
JWMAA	19--4	417	429	oram	two-year study, crazy moun	lentfer,jw	1955

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JRPFA	21--1	1	8	dada	reproductive cycle, male	chapman,di; chapm	1970

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	12---	333	334	bibo	breeding, zool garden, pol	landowski,j; woli	1967
ATRLA	12---	407	444	bibo	reprod biol, reserve, free	krasinski,z; racz	1967
CBCPA	43A--	673	679	mamm	gestation period, body wt	kihlstrom,je	1972
JZOOA	170-2	150	151	*mure	breed rec, muntjac d, capt	chaplin,re; dange	1973
ZSAEA	33--4	193	214	many/[developm antlers, reprod]		lau,d	1968

*mure = Muntiacus reevesi = muntjac deer

UNIT 3.5: EXCRETORY SYSTEM CHARACTERISTICS

The excretory system includes the kidney, bladder, tubular channels, and the rectum. The first three are connected anatomically, with the kidney being associated with the circulatory system where it acts as a physiological filter for the separation of wastes from the blood. The product of this filtration process, urine, is stored in the bladder between periodic urinations.

The rectum is associated with the digestive system. It is a storage area for undigested food materials, or feces, along with spent metabolic tissue. Feces are eliminated by defecation at periodic intervals.

The defecation rate per day is one of the practical characteristics of the excretory system. Number of defecations per day and the resistance of the feces to breakdown are importyant considerations when using pellet-group census methods. Feces, as undigested food materials, persist on the ground for varying lengths of time, depending on their characteristics and on weather conditions that affect both mechanical breakdown and decomposition by lower organisms.

Fecal materials change seasonally in number and resistance to breakdown, depending on the diet, range phenology, and physical condition of the animals. Diets with lower digestible forage result in fecal groups with higher resistance to breakdown, and these can persist for several years, especially in dry weather conditions. These several considerations of factors surrounding fecal characteristics indicate how interrelated ecological considerations can be when evaluating animal range relationships.

REFERENCES, UNIT 3.5

EXCRETORY SYSTEM CHARACTERISTICS

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JWMAA	26--1	50	55	od	rain, count of pellet grou	wallmo,oc; jacks/	1962
JWMAA	33--3	506	510	od	qual ident forage remnants	zyznar,e; urness,	1969

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
CPSCA	7---4	217	218	odvi*	organ:body weight relation	robinson,pf	1966
JOMAA	31--1	5	17	odvi*	weight relations, georg re	hamerstrom,fm,jr/	1950
JWMAA	20--1	70	74	odvi	eval pell gr count, census	eberhardt,l; van	1956
JWMAA	29--4	723	729	odvi	sourc of error, pell group	van etten,rc; ben	1965
NFGJA	7---1	80	82	odvi	persist, wint pelle gr, ny	patric,ef; bernha	1960

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	52--3	628	630	odhe*	tiss, organ, tota body mas	hakonson,te; whic	1971
JWMAA	28--3	435	444	odhe	defacation rates of mule d	smith,ad	1964
JWMAA	31--1	190	191	odhe	anam, id fecal gr, pH anal	howard,vw,jr	1967
JWMAA	34--1	29	36	odhe	ceel, freq dist, pellet gr	mcconell,br; smit	1970
JWMAA	36--2	579	594	odhe/	indices of carc fat, color	anderson,ae; med/	1972
NAWTA	8----	369	380	odhe	census math, management of	rasmussen,di; dom	1943
UASPA	32---	59	64	odhe	weathering, persist pel gr	ferguson,rb	1955
WLMOA	39---	1	122	odhe*	carcas, bone, organ, gland	anderson,ae; med/	1974

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	15---	253	268	ceel	relat age and size, poland	dzieliolowski,r	1970
JWMAA	24--4	429	429	ceel	dyes to mark ruminan feces	kindel,f	1960
JWMAA	29--2	406	407	ceel	determ defeca rate for elk	neff,dj; wallmo,/	1965
NZJSA	13--4	663	668	ceel	kidney wt, kidne fat index	batcheler,cl; cl/	1970

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	27--1	90	91	alal	weights of minnesota moose	brechinridge,wj	1946

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JWMAA	40--2	374	375	alal	daily wint pell gr,bed, al	franzmann,aw; ar/	1976
NCANA	95--5	1153	1157	alal	[numb pellet-gro each day]	desmeules,p	1968

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975
JWMAA	39--2	379	386	rata*kidney wt fluct, fat index		dauphine,tc,jr	1975
NJZOA	24--4	407	417	rata/morpho, fat stor, organ wt		krog,j; wika,m	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				anam			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				bibi			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ANREA	169-2	343	343	ovca	observ kidney, desert bigh	horst,r; langwort	1971

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				obmo			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				oram			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	27--4	308	323	many	mammals of northern idaho	rust,hg	1946

UNIT 3.6: SKELETAL SYSTEM CHARACTERISTICS

The vertebrate skeleton includes an axial portion and an appendicular portion. The axial portion includes the backbone which provides the main line of internal support for the rest of the body. Bones in the axial portion of the skeleton have restricted articulation, and some are fused together tightly. Bones in the appendicular portion articulate freely with other bones. The skeleton serves as a reserve of minerals, nutrients, and blood cells for use by other systems of the body.

Bone is very definitely living tissue, and skeletal growth is essentially positive from birth to death. At birth, the bones are far from mineralized, and as a result they are rather cartilaginous and flexible. They quickly gain more rigidity, and the rapidity of the growth in the dimensions of long bones (legs), flat bones (ribs), and the rest of the skeleton is truly remarkable in wild ruminants.

Maximum skeleton dimensions are generally reached after reproductive maturity. Reproducing females will continue to grow after bearing their first offspring, and males are capable of breeding before they are physically mature.

The skeleton is composed of minerals, primarily calcium and phosphorous, that accumulate during growth, and of water. Horns and antlers, characteristic of the males of all species and the females of some species of ruminants, are extensions of the skeletal system, and represent annual recurrent growth in some species. The minimum amounts of minerals required for horn and antler growth can be estimated by analyzing the quantities deposited. The demand for minerals exceeds the amounts ingested during rapid stages of antler growth, and minerals are mobilized from the long bones and ribs to meet this demand.

Ash contents of white-tailed deer in October were determined by Robbins et al. (1974). Further measurements of chemical composition of deer carcasses throughout the year are being completed at the Wildlife Ecology Laboratory, and the time-dependent equation for ash determined. Data on the ash and specific mineral contents of other species are very limited.

LITERATURE CITED

Robbins, C. T., A. N. Moen, and J. T. Reid. 1974. Body composition of white-tailed deer. J. Anim. Sci. 38(4):871-876.

REFERENCES, UNIT 3.6

SKELETAL SYSTEM CHARACTERISTICS

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
EVOLA	24--1	220	229	odvi	anal div skull morph, mich	rees,jw	1970
JOMAA	31--2	5	17	odvi*	weight relations, georg re	hamerstrom,fm,jr/	1950
JOMAA	50--2	302	310	odvi/	alal, stuctur adapta, snow	kelsall,jp	1969
JOMAA	52--1	223	226	odvi	mandible variati, sex, age	rees,jw	1971
JOMAA	52--4	724	731	odvi	odhe, anal diver mandi mor	rees,jw	1971
JOMOA	128--	95	112	odvi	morph var, cranium, mandib	rees,jw	1969
JOMOA	128--	113	130	odvi	morph var, mandibl, skelet	rees,jw	1969
JWMAA	29--2	397	398	odvi	kidney, marrow fat, condit	ransom,ab	1965
NYCOA	3---5	19	22	odvi	bone marrow, malnutr index	cheatum,el	1949

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
CJZOA	41--4	629	636	odhe	age determ, ossif, long bo	lewall,ef; cowan,	1963
CAFGA	41--4	327	346	odhe	dosh, dogo, skeletal diffe	hildebrand,m	1955
CAFGA	42--1	15	21	odhe/	odvi, pelv girdl, rel, sex	taber,rd	1956
JOMAA	45--2	226	235	odhe/	rang-rel gro dif, sk ratio	klein,dr	1964
JOMAA	52--3	628	630	odhe*	tiss, organ, tota body mas	hakonson,te; whic	1971
MVPRA	52--4	50	50	odhe	spont repair, comminu frac	dinesen,hl; cliff	1971
WLMOA	39---	1	122	odhe*	carcas, bone, organ, gland	anderson,ae; med/	1974

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATRLA	11--5	129	194	ceel	morph varib, skull, body w	mystkowska,ec	1966
CJESA	14---	963	986	ceel	postglac ungulates, albert	shackleton,dm; hi	1977
JOMAA	37--1	129	129	ceel	healing, fractured leg bon	gilbert, pf; hill	1956
JWMAA	30--1	135	140	ceel*	measurements, weight relat	blood,da; lovaas,	1966
JWMAA	30--2	369	374	ceel	bone char assoc with aging	knight,rr	1966

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
NZJSA	14--4	993	1008	ceel	hybrid red de, wapiti, n z	caughley,g	1971
PZESA	24---	57	75	ceel	cran stud, adap, hybr, nz	batcheler,cl; mcl	1977
PZSLA	166-3	303	311	ceel	var mandib length, body wt	lowe,vpw	1972
ZEJAA	23--2	92	94	ceel	[anomaly, nasal bones,]	meyer,p	1977

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	27--1	90	91	alal	weights of minnesota moose	brechinridge,wj	1946

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ATICA	19--2	111	113	rata	functn brow tine, caribou	pruitt,wo	1967
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975
JWMAA	28--1	54	56	rata*	relatio mandi length, sex	bergerud,at	1964
NJZOA	24--4	407	417	rata/	morpho, fat stor, organ wt	krog,j; wika,m	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				anam			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	45--4	630	632	bibi	new data, b. bison, athaba	bayrock,la; hill	1964
JOMAA	56--4	871	887	bibi	var cranial char, alberta	shackleton,dm; /	1975
PLNAA	18-60	132	139	bibi	agin, sexi post crani skel	duffield,lf	1973

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
FLDZA	61--1	1	88	ov	co-evo soc beh, cran morph	schaffer,wm; ree	1972

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovca			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				obmo			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	51--1	60	73	oram	variation in the mt goat	cowan,imct; mccro	1970

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AMNTA	113--	103	122	mamm	scal, skel mass, body mass	prange,hd; ander/	1979

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JOMAA	27--4	308	323	many	mammals of northern idaho	rust,hg	1946

CHAPTER 1, WORKSHEET 3.6a

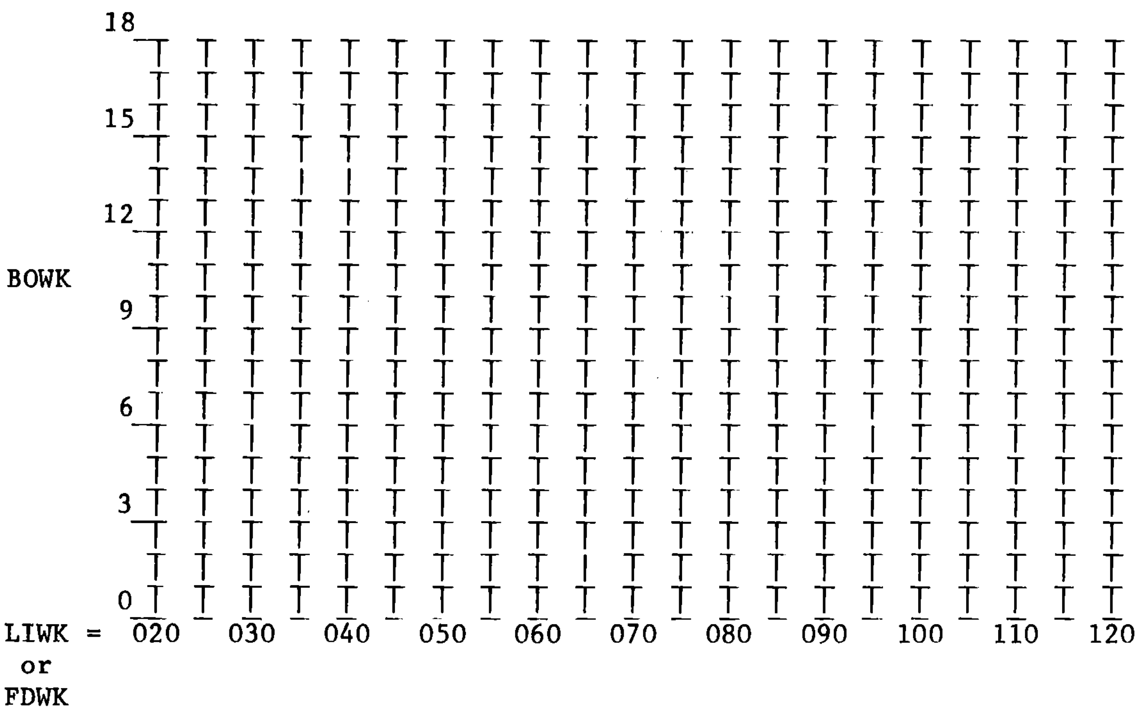
Bone weight:live weight relationships of white-tailed deer (odvi)

Bone weights in relation to live weights and field dressed weights are given by Cowan et al. (1968). The equations derived from these data are:

$$BOWK = 1.215 + 0.108\ LIWK$$

$$BOWK = 1.650 + 0.122\ FDWK$$

Plot the bone weight in relation to live weight and field dressed weights in kg below.



LITERATURE CITED

Cowan, R.L, E. W. Hartsook, J. B. Whelan, J. L. Watkins, J. S. Lindzey, R. W. Wetzel, and S. A. Liscinsky. 1968. Weigh your deer with a string. Penn. Game News 39(11): 17-18.

UNIT 3.7: MUSCULAR SYSTEM CHARACTERISTICS

The muscular system of wild ruminants includes both involuntarily-controlled muscles and voluntarily-controlled ones. Muscles involved in breathing heart muscles, and those of the gastrointestinal tract are the major involuntary muscles. Those involved in movement of the skeletal system are under voluntary control.

The voluntary muscles function primarily in the maintenance of body posture and in locomotion. Wild ruminants are generally more alert than domestic ones, and a larger proportion of maintenance energy may go for maintenance of posture in wild than in domestic ruminants. Wild ruminants also have more highly developed locomotor skills than domestic ones; they run to escape potential danger, and are capable of fast rates of speed.

Muscle characteristics that relate to these functions have not been studied in wild ruminants. Carcass characteristics, including the fraction of whole body weight that is muscle, have been measured, and meat characteristics used for identifying meats for law enforcement purposes have been described for some species.

Carcass characteristics are of interest when evaluating the amount of food provided by a wild ruminant when taken by predators. Muscle makes up a large part of the animal's body, and provides large amounts of nutrients because it is very digestible.

Changing proportions of muscle and other body components in relation to whole body weights are of interest in detailed energy flow studies. Data on muscle weights and chemical composition data, are useful for this purpose. In general, physically mature wild ruminants increase in body weight in the fall, but the function of the body weight that is in muscle remains quite constant. Increases in body weight reflect changing proportions of fat and water rather than muscle tissue. This is discussed further in CHAPTER 2.

REFERENCES, UNIT 3.7

MUSCULAR SYSTEM CHARACTERISTICS

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ANANA	137-4	381	394	odvi	musculature of hip, thigh	bisaillon,a	1974
JOMAA	31--1	5	17	odvi*	weight relations, georg re	hamerstrom,fm,jr/	1950

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
HILGA	19---	265	284	odhe	anam accep, food val, meat	cook,bb; witham/	1949
JOMAA	52--3	628	630	odhe*	tiss, organ, tota body mas	hakonson,te; whic	1971
WAEBA	589	1	6	odhe	the mule deer carcass	field,ra; smith,/	1973
WLMOA	39---	1	122	odhe*	carcas, bone, organ, gland	anderson,ae; med/	1974

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
WAEBA	594--	1	8	ceel	the elk carcass	field,ra; smith,/	1973

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JEBPA	13--2	133	136	alal	ceel, rata, compar myoglob	sukhomlinov,bf; /	1977
JOMAA	27--1	90	91	alal	weights of minnesota moose	brechinridge,wj	1946

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975

rata continued on the next page

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
HLTPA	18--2	127	134	rata	lead-210,polonium-210, ala	blanchard,rl; moo	1970
HLTPA	20--6	585	591	rata	cesium-137, seas pat, alas	hanson,wc	1971
MNLHA	48-21	1	26	rata	[varia carcass wt, norway]	movinkel,h; prest	1969
NJZOA	24--4	407	417	rata	morpho, fat stor, organ wt	krog,j· wika,m	1976
PASCC	14---	69	69	rata	influence rut, meat palati	winters,rl	1963

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JANSA	36--6	1195	1195	anam	collagen charact of muscle	kruggel,wg; field	1973
JFDSA	39--3	639	640	anam	collagen character, muscle	kruggel,wg; field	1974
WAEBA	575--	1	6	anam	the pronghorn carcass	field,ra; smith,/	1972

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				bibi			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovca			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				obmo			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				oram			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
JANSA	36--6	1195	1195	many	quality, quantity of meat	smith,fc· field,r	1973
JOMAA	27--4	308	323	many	mammals of northern idaho	rust,hg	1946
JWMAA	20--2	169	172	many	identif, game, precip reac	keiss,rw; morriso	1956
JWMAA	34--4	917	921	many	id game meat, electrophore	dilworth,tg; mcke	1970

CHAPTER 1, WORKSHEET 3.7a

Edible meat in relation to live weights and dressed weights of white-tailed deer (odvi)

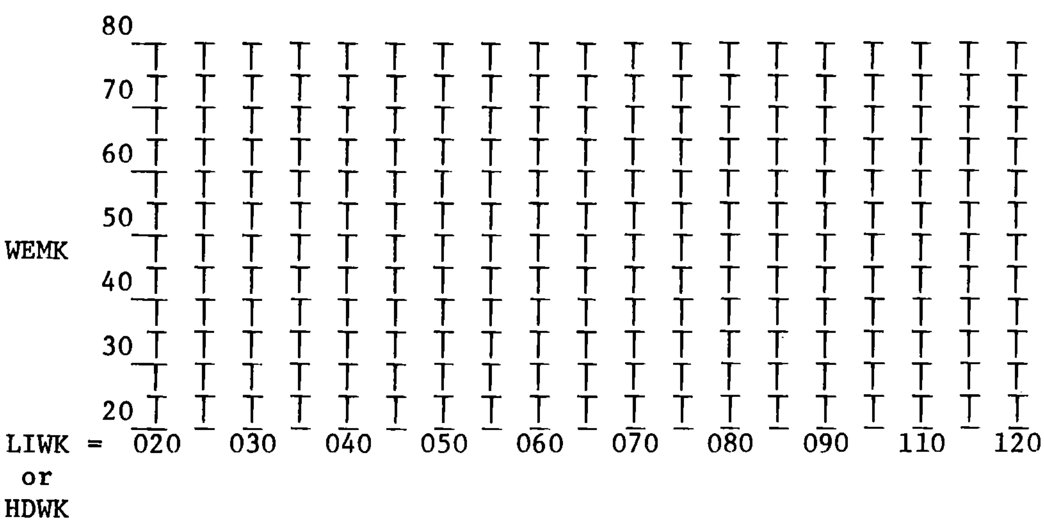
Ratios of calculated live weights and dressed weights to edible meat were published for nine deer by Hamilton (1947). Linear regression equations have been determined from the data in the abbreviated table below. Original data were given in pounds; values in kg are:

Calculated live weight (LIWK)	Hog dressed weight (HDWK)	Weight of edible meat (WEMK)
69.4	54.4	40.4
67.1	52.6	34.0
88.9	69.9	53.5
86.6	68.9	53.5
80.3	63.0	44.0
100.2	78.9	60.8
51.3	40.4	28.6
63.5	49.9	35.8
64.0	50.3	37.6

Using a linear regression curve-fitting program, the equations are:

$$WEMK = 0.68\ LIWK - 7.61;\ R^2 = 0.96$$
$$WEMK = 0.86\ HDWK - 7.33;\ R^2 = 0.97$$

Verify your linear regression curve-fitting program if you wish, and then plot the data using the equations derived.



LITERATURE CITED

Hamilton, W. J., Jr. 1947. Dressed weights of some game mammals. J. Wildl. Manage. 11(4):349-350.

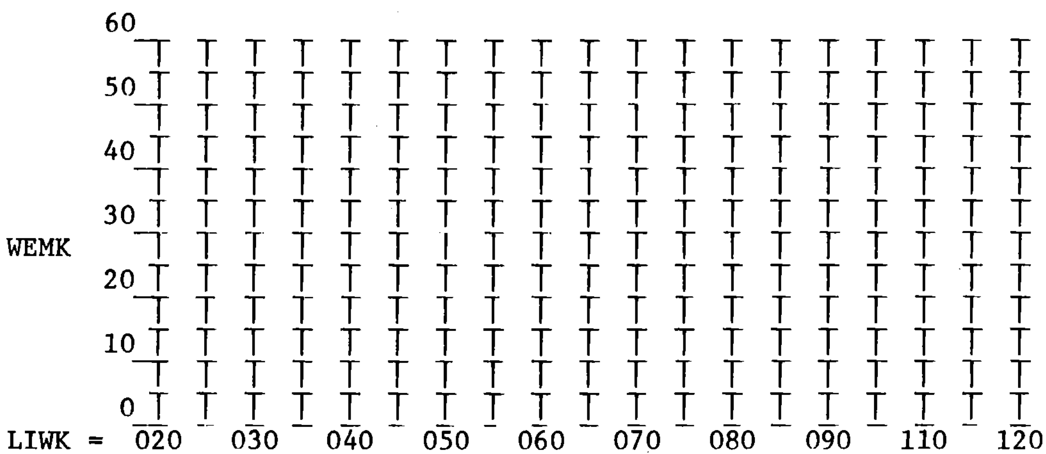
Live weight:edible lean meat relationships in white-tailed deer (odvi)

Live weight:edible lean meat data are given by Cowan et al. (1968). The linear regression equation derived from their table, is:

$$WEMK = 0.69 + 0.44\ LIWK$$

where WEMK = weight of edible meat in kg and LIWK = live weight in kg.

Plot the data below and compare the results with those on the previous WORKSHEET.



LITERATURE CITED

Hamilton, W. J., Jr. 1947. Dressed weights of some game mammals. J. Wildl. Manage. 11(4):349-350.

UNIT 3.8: NERVOUS SYSTEM CHARACTERISTICS

The nervous system of wild ruminants includes the brain, spinal cord, peripheral nerves, and receptors. These major anatomic divisions include billions of cells, all interacting in a coordinated control system that enables various body parts to function well together.

The brain is composed of a medulla oblongata, which connects to the spinal cord, cerebral hemispheres, and cerebellum. Each of these contain different centers for regulating visceral functions such as respiration, blood pressure, and heart rate, and sensory and motor functions. The brain itself contains many parts that perform different functions, though the parts themselves are not necessarily discernible as physical entities. Detailed drawings are available in such books as Swenson (1970) and Weichert (1970).

The spinal cord contains many nerve tracts which connect the brain with spinal nerves (Swenson 1970:866). Tracts for sensory and motor neurons are largely separated; there are tracts for both ascending and descending transmissions between the brain and the peripheral nerves.

Peripheral nerves contain many axons, or connecting fibers between the receptors and the central nervous system. There are also collections of neurons called ganglia outside of the central nervous system. These function as coordinating centers for viscera, glands and muscle tissues, without involving the central nervous system.

Receptors are cells that initiate an impulse to the rest of the nervous system in response to environmental stimuli. Several kinds of receptors are found in wild ruminants, including mechanoreceptors (touch or pressure), chemoreceptors (taste, smell, and blood composition), thermoreceptors (temperatuare changes), light receptors, sound receptors, and gravity and motion receptors. In addition, pain is elicited from different kinds of receptors, and from stimulation of nerve endings in tissues.

There is a dearth of published information on the nervous system characteristics of wild ruminants, so the distribution and capabilities of different receptors is not well known for the different species.

One of the most interesting and challenging characteristics of wild ruminants is their altertness and ability to escape danger, a direct function of the nervous system. We can only assume that the general anatomy is similar to other closely related vertebrates, and generalities are necessary if information is needed on the nervous system characteristics of wild ruminants.

LITERATURE CITED

Swenson, M. J., Ed. 1970. Dukes' physiology of domestic animals. Cornell University Press, Ithaca, N.Y. 1463 pp.

Weichert, C. K. 1970. Anatomy of the chordates. McGraw-Hill Book Company, New York. 814 pp.

REFERENCES, UNIT 3.8

NERVOUS SYSTEM CHARACTERISTICS

SERIALS

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AJVRA	39--4	699	702	odvi	cone, rod photo receptors	witzel,da; sprin/	1978

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				odhe			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
RVTSA	10---	448	452	ceel	distr nerves, skin, red	jenkinson,dm;malo	1969

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				alal			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
AVCSA	18---	152	158	rata	alal, caca cornea structur	rehbinder,c; winq	1977
AVSPA	57---	1	18	rata	topograph, internal organs	engebretsen,rh	1975

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				anam			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
ANREA	184-2	187	201	bibi	a macroscopic study, brain	harper,jw; maser,	1976

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovca			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				ovda			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				obmo			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
				oram			

CODEN	vo-nu	bepa	enpa	anim	kewo	auth	year
BIJOA	119--	47p	47p	many	fatty acids, evol nerv sys	crawford,ma	1970

CLOSING COMMENTS

Physical characteristics of wild ruminants have been introduced in CHAPTER 1. Weights and seasonal variations in weights, geometry, and system characteristics are used in analyses of behavior, metabolism, heat loss, and population structures in later PARTS and CHAPTERS.

The next chapter (CHAPTER 2) contains more detailed information on various body parts. Some of these details are important for understanding biological functions, and some are useful management indicators. These relationships will be evaluated in remaining CHAPTERS.

GLOSSARY OF SYMBOLS USED - CHAPTER ONE

AEAM = Area of the ear in meters
AFMM = Area of the face, muzzle in meters
AGDA = Age in days
AGMO = Age in months
AGYE = Age class in years
AHEM = Area of the head in meters
ALFM = Area of the lower front leg in meters
ALHM = Area of the lower hind leg in meters
ANEM = Area of the neck in meters
ANWG = Antler weight in gms
ANWK = Antler weight in kg
ATRM = Area of the trunk in meters
AUFM = Area upper front leg in meters
AUHM = Area upper hind leg in meters

BASM = Bed area in square meters
BEAR = Bed area
BHTC = Belly height in cm
BIWK = Birth weight in kg
BLWG = Blood weight in gms
BLWK = Blood weight in kg
BOWK = Bone weight in kg

CLWK = Calculated live weight in kg
CUCM = Cubic centimeters (volumes)

DIGE = Days into gestation

EFWK = Estimated field-dressed weight in kg
ELWK = Estimated live weight in kg

FATK = Fat in kg
FDWK = Field-dressed weight in kg
FEWK = Fetal weight in kg
FWAB = Fetal weight at birth

GIWK = Gastrointestinal weight in kg

HAWG = Hair weight in gms
HDWK = Hog dressed weight in kg
HEFR = Height of forage reached
HEGC = Heart girth in cms
HEWG = Heart weight in grams
HEWK = Heart weight in kg
HFRC = Height of forage reached in cm
HFRM = Height of forage reached in m
HLLK = Heart, lung, liver weights in kg

IFWK = Ingesta-free weight in kg

JDAY = Julian day

LEGP = Length of gestation period
LIWK = Live weight in kg
LORA = Longest radius
LUVO = Lung volume

MAWK = Maximum weight in kg
MEWK = Metabolic weight in kg
MIWK = Minimum weight in kg

OAVC = Omasum and abomasum volumes in cubic cms

POAT = Percent of omasum and abomasum of total volume
PRPC = Primary phase correction
PRRT = Percent of rumen and reticulum total volume

RRVC = Rumen and reticulum volumes in cubic cm

SEPC = Secondary phase correction
SHRA = Shortest radius
SQCM = Square cm

TSAM = Total surface are in meters
TVSC = Total volume of stomach in cubic cms

WEMK = Weight of edible meat in kg
WEWK = Weaning weight in kg

GLOSSARY OF CODE NAMES - CHAPTER ONE

CODEN	
ABBIA	Archives of Biochemistry and Biophysics
ACATA	Acta Anatomica
ACBCA	Acta Crystallographica Section B Structural Crystallography and Crystal Chemistry
AHEMA	Anatomia Histologia Embryologia
AJANA	American Journal of Anatomy
AJPHA	American Journal of Physiology
AJVRA	American Journal of Veterinary Research
AKASA	Arkansas Academy of Science Proceedings
AMNAA	American Midland Naturalist
AMNTA	American Naturalist
ANANA	Anatomischer Anzieger
ANREA	Anatomical Record
ANYAA	Annals of the New York Academy of Sciences
APAVD	American Association Zoo Veterinarian Annual Proceedings
APSSA	Acta Physiologica Scandinavica Supplementum
ATICA	Arctic
ATRLA	Acta Theriologica
AVCSA	Acta Veterinaria Scandinavica
AVSPA	Acta Veteinaria Scandinavica Supplementum
AZWBA	Arizona Game and Fish Department Wildlife Bulletin
BEHAA	Behaviour
BICOB	Biological Conservation
BIGEB	Biochemical Genetics
BIJOA	Biochemical Journal
BIREB	Biology of Reproduction
BJNUA	British Journal of Nutrition
BLOOA	Blood
BPURD	Biological Papers of the University of Alaska Special Reports
BUCDA	Bulletin of the Georgia Academy of Sciences
BUFOA	Beaufortia
BVJOA	British Veterinary Journal
CAFGA	California Fish and Game
CAFNA	Canadian Field Naturalist
CBCPA	Comparative Biochemistry and Physiology
CBPAB	Comparative Biochemistry and Physiology - A comparative physiology
CFGGA	California Department of Fish and Game, Game Bulletin
CGFPA	Colorado Division of Game, Fish, and Parks Special Report
CIRIB	Congres International de Reproduction Animale et Insemination Artificielle
CJCMA	Canadian Journal of Comparative Medicine
CJESA	Canadian Journal of Earth Science
CJZOA	Canadian Journal of Zoology
CNJMA	Canadian Journal of Comparative Medicine and Veterinary Science
CNJNA	Canadian Journal of Animal Science

COVEA	Cornell Veterinarian
CPSCA	Chesapeake Science
CWRSB	Canadian Wildlife Service Report Series
ENDOA	Endocrinology
EVOLA	Evolution
EXMPA	Experimental and Molecular Pathology
FLDZA	Fieldiana Zoology
FUNAA	Fauna
GENTA	Genetics
GROWA	Growth
HEREA	Hereditas
HILGA	Hilgardia
HLTPA	Health Physics
JANSA	Journal of Animal Science
JAVMA	Journal of the American Veterinary Medical Association
JBCHA	Journal of Biological Chemistry
JEBPA	Journal of Evolutionary Biochemistry and Physiology
JFDSA	Journal of Food Science
JOANA	Journal of Anatomy
JOMAA	Journal of Mammalogy
JOMOA	Journal of Morphology
JOPAA	Journal of Parasitology
JPHYA	Journal of Physiology
JRPFA	Journal of Reproduction and Fertility
JWIDA	Journal of Wildlife Diseases
JWMAA	Journal of Wildlife Management
JZAMD	Journal of Zoo Animal Medicine
JZOOA	Journal of Zoology
LBASA	Laboratory Animal Science
MAMLA	Mammalia
MDCBA	Minnesota Deptartment of Conservation Technical Bulletin
MDCRA	Michigan Department of Conservation Game Division Report
MGQPA	Minnesota Department of Natural Resources Game Research Project
MNLHA	Meldinger fra Norges Landbrukshogskole
MRLTA	Murrelet, The
MVPRA	Modern Veterinary Practice
NATUA	Nature
NAWTA	North American Wildlife and Natural Resources Conference, Transactions of the,
NCANA	Naturaliste Canadien, Le
NFGJA	New York Fish and Game Journal
NJZOA	Norwegian Journal of Zoology
NYCOA	New York State Conservationist
NZJSA	New Zealand Journal of Science

OIKSA	Oikos
OJSCA	Ohio Journal of Science
PAABA	Pennsylvania Agricultural Experiment Station Bulletin
PASCC	Proceedings of the Alaskan Scientific Conference
PCGFA	Proceedings of the Southeastern Association of Game and Fish Commissioners
PCZOA	Proceedings of the International Congress of Zoology
PIAIA	Proceedings of the Iowa Academy of Science
PLNAA	Plains Anthropologist
PMASA	Proceedings of the Montana Academy of Sciences
POASA	Proceedings of the Oklahoma Academy of Science
PSEBA	Proceedings of the Society for Experimental Biology and Medicine
PZESA	Proceedings of the New Zealand Ecological Society
PZSLA	Proceedings of the Zoological Society of London
RSPYA	Respiration Physiology
RVTSA	Research in Veterinary Science
SCIEA	Science
SWNAA	Southwestern Naturalist
SZSLA	Symposia of the Zoological Society of London
THGNB	Theriogenology
TJSCA	Texas Journal of Science
TNWSD	Transactions of the Northeast Section, The Wildlife Society
UAABB	University of Alberta Agriculture Bulletin
UABPA	Biological Papers of the University of Alaska
UASPA	Proceedings of the Utah Academy of Sciences, Arts and Letters
UCPZA	University of California Publications in Zoology
VEZOA	Vestnik Zoologii
VILTA	Viltrevy
VIWIA	Virginia Wildlife
VJSCA	Virginia Journal of Science
WAEBA	Wyoming Agricultural Experiment Station Bulletin
WCDBA	Wisconsin Department of Natural Resources Technical Bulletin
WDABB	Bulletin of the Wildlife Disease Association
WGFBA	Wyoming Game and Fish Commission Bulletin
WLMOA	Wildlife Monographs
WLSBA	Wildlife Society Bulletin
WMBAA	Wildlife Management Bulletin Series 1
WSCBA	Wisconsin Conservation Bulletin
XNFSA	U S National Park Service Fauna of the National Parks of the U.S., Fauna Series
ZEJAA	Zeitschrift fuer Jagdwissenschaft
ZOGAA	Zoologische Garten
ZOLZA	Zoologicheskii Zhurnal
ZSAEA	Zeitschrift fuer Saeugetierkunde

LIST OF PUBLISHERS - CHAPTER ONE

coup	Cornell University Press	Ithaca, NY	itny
whfr	W. H. Freeman Co.	San Francisco, CA	sfca

LIST OF WORKSHEETS IN CHAPTER ONE

LIST OF WORKSHEETS IN CHAPTER ONE (CONTINUED)