

A REGIONAL ANATOMY OF THE HEAD,
NECK, THORAX, AND ABDOMEN OF THE
CHINCHILLA, CHINCHILLA LANIGERA
LANIGERA BENNET, WITH SPECIAL
REFERENCE TO THE DIGESTIVE TRACT

Thesis for the Degree of Ph. D.
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Robert Kenneth Wolfer
1955

This is to certify that the

thesis entitled

A regional anatomy of the head, neck, thorax,
and abdomen of the Chinchilla, Chinchilla
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presented by

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OF THE CHINCHILLA, CHINCHILLA LANIGERA LANIGERA BENNET,
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By

Robert Kenneth Wolfer

A THESIS

Submitted to the School of Graduate Studies of Michigan
State University of Agriculture and Applied Science
in partial fulfillment of the requirements
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DOCTOR OF PHILOSOPHY

Department of Zoology

1955

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Frontispiece

An adult male chinchilla, Chinchilla lanigera
lanigera Bennet

Crown-rump length, 340 millimeters;
and over-all length, 405 millimeters.



Frontispiece

An adult male chinchilla, Chinchilla lanigera

lanigera Bennett

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and over-all length, 405 millimeters.



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To Doctor R. A. Fennell, major professor and chairman of the guidance committee, in appreciation for his continued encouragement, patience, supervision, and inspiration throughout this study, are dedicated the findings herein.

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The Kellog Sales Company of Battle Creek, Michigan, suggested the problem, furnished necessary financial support, and arranged for many of the specimens examined. Growers who have delivered specimens through the Kellog Sales Company, are as follows:

Mr. Dominic Circosta
Michigan Branch of the National Chinchilla Breeders Association
Southern Michigan Chinchilla Ranch
The Chapman Chinchilla Ranch, Inglewood, California

Mr. Henry O. Trinklein, owner of the Trinklein Chinchilla Ranch, Saginaw, Michigan provided several valuable animals, and proffered

his astute observations of the habits of living chinchillas. His outstanding assistance cannot be overestimated.

Mr. Edwin W. Ciolek, grower, of Lansing, Michigan also donated a specimen, as well as did others. The Michigan State University Department of Physiology supplied two specimens.

Mr. Harry Zerbo, Livonia, Michigan, member of the National Chinchilla Breeders of America, Inc., supplied three males and three females for study, at the request of the national office.

Mr. E. Jones Salbach, Santa Rosa, California supplied six animals, and Mr. E. L. Larsen, Ovid, Michigan supplied two pairs and one male upon request of the Chinchilla Association of America.

The Chinchilla Association of America, whose headquarters is located at Santa Rosa, California, has been very helpful in many ways, and especially by contributing a subscription to the national journal, The Chinchilla News, and by arranging for specimens.

At various meetings of certain branches of both national chinchilla organizations, the author was invited to report on the development of his research, and at such gatherings learned some of the problems of applied chinchilla morphology.

The assistance of the National Chinchilla Breeders of America, whose headquarters is in Salt Lake City, Utah, has also been incalculable. The association arranged for many specimens through various branch members, granted the author free access to research files of the national office, and provided various research bulletins.

The association also supplied some Kodachrome slides for use in a report on the present research given before the 1955 session of the Michigan Academy of Science, and granted financial help for the preparation of specimens by the General Biological Supply House, of Chicago, Illinois.

The tedious task of inking the drawings for duplication was performed by the author's wife.

Of vital importance, the author's wife, Shirley, her mother, and his parents and children were responsible directly and indirectly for essential comforts, health, and fortitude during the entire period of this undertaking.

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CURRICULUM VITAE

Robert Kenneth Wolfer, the 9th of 15 children, was born in Pekin, Illinois, in 1920. His early education was obtained in that city, where he was graduated from Pekin Community High School, in 1938.

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The author is a member of the society of Sigma Xi, of the American Association for the Advancement of Science, of the Michigan Audubon Society, and of the Associated Nature Clubs of America.

On May 16, 1943, he married Miss Emogene Shirley Strickland, registered nurse, and is the father of two daughters, ages three and two, respectively.

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AN ABSTRACT

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Year 1955

Approved

R. A. Jennell

ABSTRACT

Although the locomotor apparatus of rodents has been the subject of numerous investigations the gross anatomy of the digestive tract has been neglected. The present study represents an initial contribution to the detailed knowledge of the digestive system of the chinchilla, Chinchilla lanigera lanigera Bennet, a hystricomorph rodent.

Twenty-five adult animals were dissected and sixty-four drawings made of various dissections. For topographical reasons, the major axially-placed organs of the other body systems have been illustrated and briefly described.

The oral cavity presents a trichous post-incisal subdivision. The teeth are twenty in number, are monophyodont, and all erupt continuously. The tongue presents a wide variety of papillae. The pharynx is chiefly nasopharynx and a laryngeal pharynx is absent. The esophagus is not noticeably modified.

The stomach is relatively unsacculated. It is not possible to distinguish any definite subregions of the relatively long small intestine. Numerous macroscopic lymphatic nodules are present in the wall.

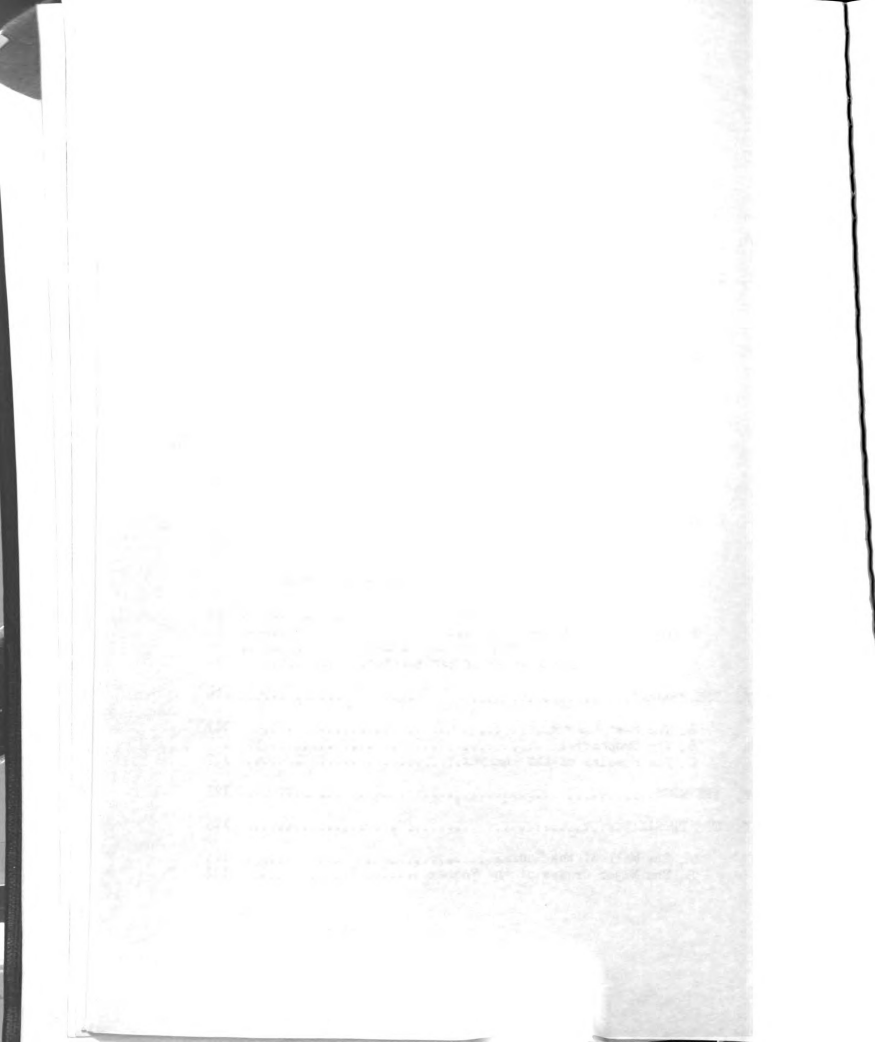
The large intestine has an expanded spiralled and sacculated cecum, a long large colon and a long and highly coiled small colon. Whereas the greater portion of the small intestine lies sinistrally, much of the small colon is located to the right of the mid-line. The rectum is only a relatively straight and uncoiled terminal segment of the small colon.

The large intestine is noticeably longer by about two-thirds than the small intestine.

Various myological observations stand at variance with the findings of Wood and White (1950) concerning certain muscles of the present species.

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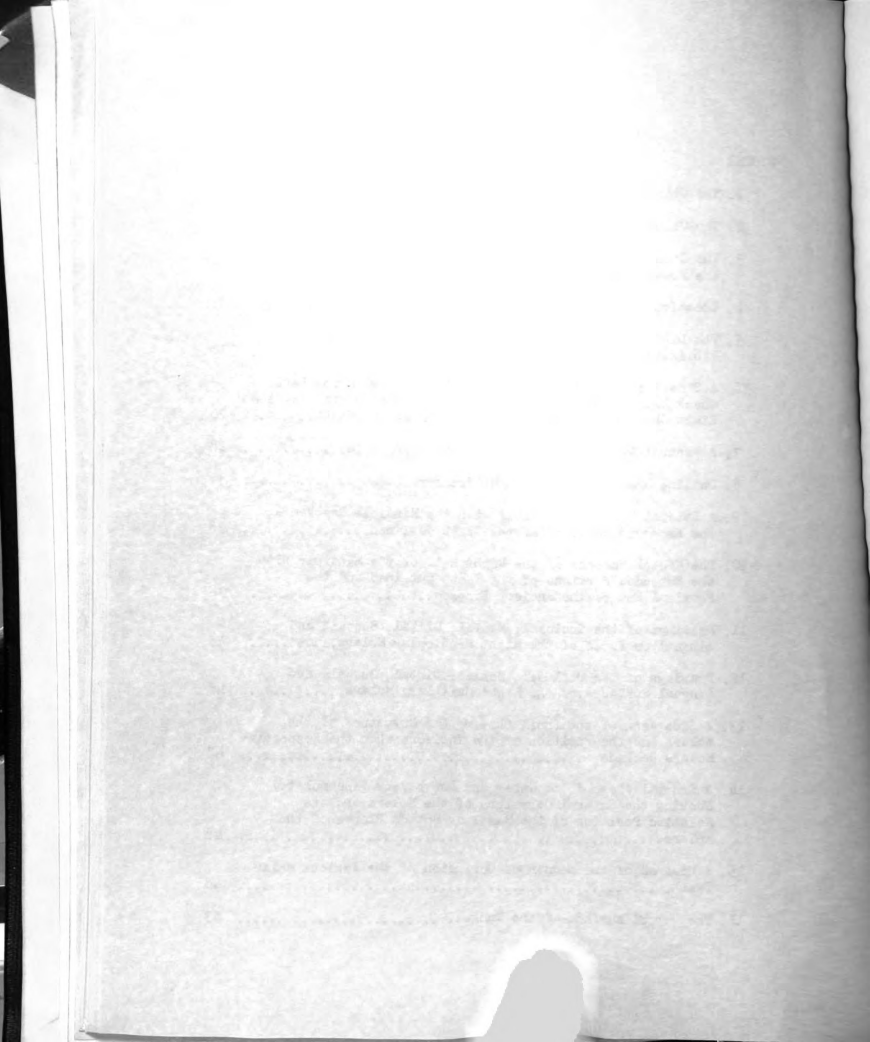
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I. INTRODUCTION

Kellog (1953) maintained that the chinchilla is endemic to South America. This species was introduced into the United States in 1923 by Mathias F. Chapman who obtained eleven animals from Chile for establishment of the first foundation stock on the North American continent for chinchilla ranching (National Chinchilla Breeders, 1953).

Since the species was first introduced breeding has become an extensive and prosperous industry. Brenon (1952) estimated the value of animals and equipment, in less than twenty per cent of the industry in the United States and Canada, to be about five million dollars.

It was to be expected that with heavy investments in both animals and equipment, there would be an increased interest in all aspects of both pure, and applied science dealing with chinchilla farming.

During the course of this study the author reviewed approximately two thousand references to the chinchilla in the files of the National Chinchilla Breeders of America, at Salt Lake City, Utah. The major portion of the articles were concerned with the various problems associated with chinchilla culture. A smaller number were concerned with incidental anatomical items.

The paucity of scientific publications on chinchilla morphology is but a reflection of the attitude of breeders. Cassini (1954) inspected various breeding establishments in all regions of this country and concluded that ranchers were fully aware of the need for additional

formation on chinchilla morphology. Publication of such observations is an important factor in the decision of the Kellogg Sales Company of Little Creek, Michigan to support this investigation.

Breeder interest was only one factor in motivation of this study. Hensman (1942) maintained that a vast field of unsolved problems remained to be worked out by embryological and anatomical procedures rather than by experimental investigations. Several of the problems related to the chinchilla remain to be worked out, i.e., the relationship of chinchilla to other species in the genus, the *Histricomorpha* in general, and the distribution of the suborder in South America, Africa, Europe and North America.

Only a limited number of investigations have been concerned with morphological features of the chinchilla. Yarrel (1828) described some of the features of this species. Bennet (1829) described this species in great detail and a portion of the material which he published was based on observations of living specimens. Yarrel (1831) made an additional anatomical contribution to chinchilla morphology. Bennet (1833) characterized the family Chinchillidae. Two years later, Bennet (1835) made additional comments on the family chinchillidae.

Owen's (1839) report was concerned with the anatomy of various organ systems. Flower and Leydekker (1891) and Autrons (1906) made additional comments on the anatomy of the chinchilla. Bickel (1931) also considered the chinchilla in his report.

More recently reports dealing primarily with the anatomy of the species have appeared in the literature. Detwiler (1949) described

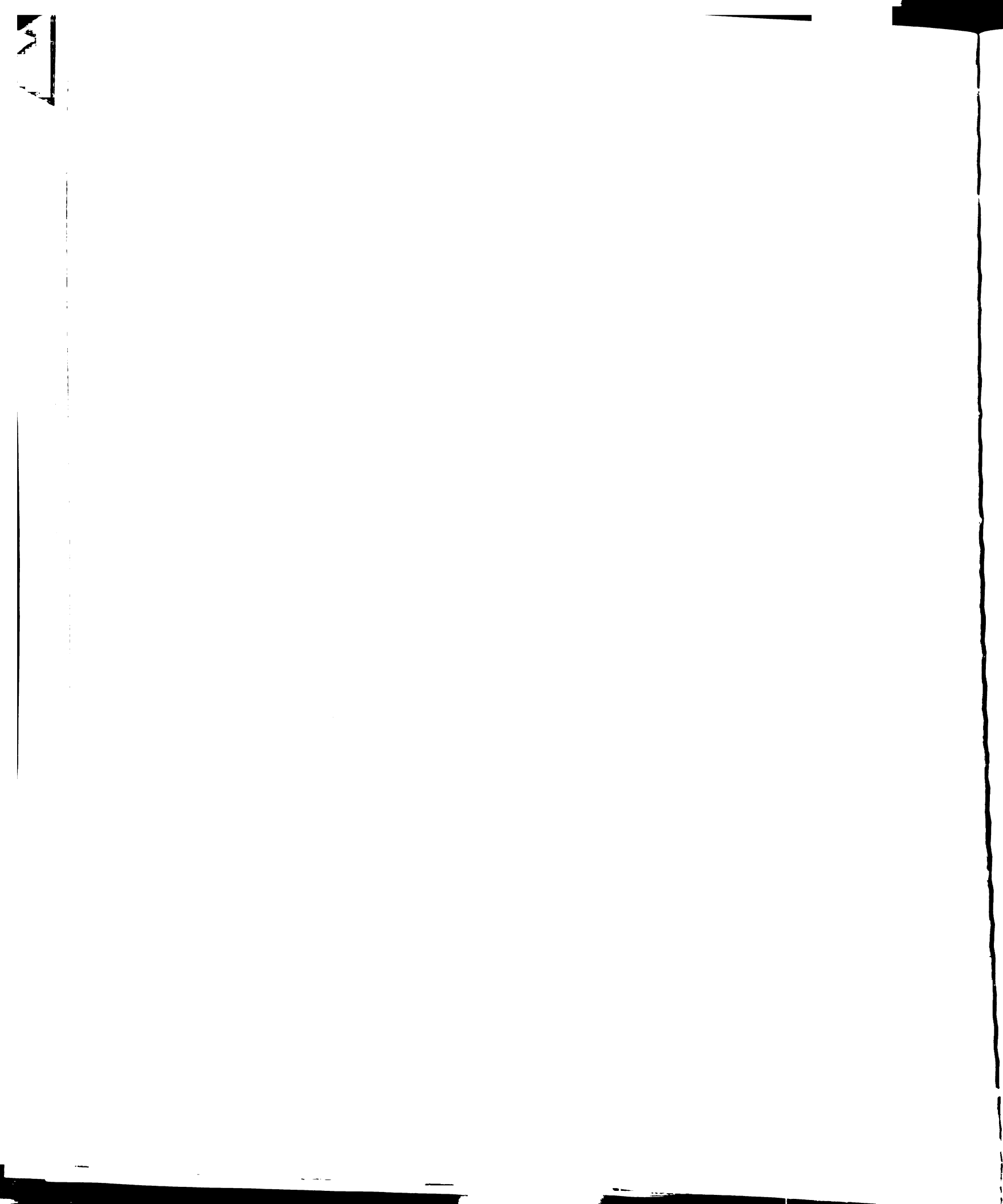
the eye of the chinchilla. Wood and White (1950) confined their report to the muscular system. Newberne (1951) considered various gross, microscopic, and physiological features in this species. Journey (1947) prepared an introductory atlas concerning the reproductive system. Wilcox (1950) described the skin and hair, and Brenon (1952) briefly surveyed the various body organs. Bullard and Parkinson (1953) described the male reproductive tract. Hausman (1954) studied the nature of hair coloration. The United States Testing Company (1954) investigated certain physical strengths of the hair. Shackelford and Roos (1954) described the gross anatomy of the genital system, two endocrine glands, and also listed body weights of chinchillas.

Wood (1951) indicated that there was a scarcity of information on muscles, bones, teeth, and other internal structures in most members of the suborder Hystricomorpha.

Allen (1942) referred to the chinchilla as Chinchilla lanigera lanigera Bennet. As this mammologist has set a precedent, the author has employed the same scientific name.

Shackelford and Roos (1954) used Chinchilla lanigera Bennet, with no subspecific designation. They also named the next most common chinchilla found in this country, the brevicaudata, as Chinchilla brevicaudata Waterhouse. Others referring to the form studied in this work as Chinchilla lanigera were Osgood (1941), Detwiler (1949), Brenon (1952) and Kellog (1953).

Papers by Prell (1934) and Osgood (1941) rather completely discussed the scientific name of the chinchilla, beginning with Molina's



paper of 1782 (cited by Osgood, 1941). Osgood was of the opinion that the naming of the chinchilla is a very delicate one, with much room for difference of opinion. The satisfactory naming of this animal is thus another of the problems which demands in part, anatomical resolution.

In behalf of general zoological information, careful studies should be made on this form. Albert (1901) recognized that the chinchilla was rapidly nearing extinction in South America and noted that on the twenty-fifth of October (1900) the Resident Agent of Antofagasta, Mr. C. M. Sayago, directed a letter to the Ministry of Industry asking for the complete prohibition of hunting and trapping of the animal for a period of five years to avoid its extinction. Von Blon (1928) discussed the same problem. Allen (1942) included the chinchilla among the extinct and vanishing mammals of the western hemisphere. The development of a sound pelting program would doubtless prolong the survival of this species, but in event such does not materialize, it is possible that the chinchilla will become an animal of the past. The present work constitutes a partial anatomical record of the chinchilla.

Finally, numerous diseases affect the chinchilla, some apparently common and pathogenic to man (Kennedy, 1952, and Sutter, et al., 1953). Anatomical studies would be useful as a standard of comparison for the study of the various morphological changes due to disease.

It is the purpose of this study to present a description of the regional anatomy of the digestive tract of the chinchilla, designated for the present as Chinchilla lanigera lanigera Bennet, and known in general by the industry as Chinchilla lanigera, or chinchilla.

2

This work is not a comparative study but some reference is made to the anatomical arrangement of common mammals as an aid in interpretation of the findings. Selected articles having a bearing on this work are included in the list of references.

II. MATERIALS AND METHODS

Eighteen chinchillas (Chinchilla lanigera lanigera); nine males and nine females, were embalmed and the blood vessels injected with colored latex at the General Biological Supply House, Chicago, Illinois. The above concern also prepared ligamentous skeletons of a male and a female chinchilla.

Nine males and three females were sacrificed and preserved in an embalming fluid bath until dissected.

One specimen was fresh-frozen and then cross-sectioned serially at approximately one-fourth inch intervals, for studies on topographical relationships.

Freshly killed specimens were used for comparison with various dissections of embalmed animals.

Additional specimens, few in number, and ranging from two hours post partum to several weeks in age, were preserved in embalming fluid and later dissected to determine the general arrangement of the digestive tract in immature chinchillas.

Six chinchillas, four males, and two females were sacrificed and the digestive organs immediately placed in formalin-acetic acid-alcohol fixing solution for histological studies. A survey of each part of the digestive tube, and of each digestive gland was made in order to verify certain gross interpretations, but no detailed histological study was made.

Six live animals were observed at frequent intervals throughout approximately one year, as a means of observing the various habits of captive chinchillas, as well as for studying dietary responses.

Sixty-four figures of dissections and four tables fortify the various descriptions. The figures are copies of india ink tracings of original drawings made at the time of dissection. No attempt was made to conform to exact enlargements, but the various organs of any figure are drawn proportionately. The greatest enlargements do not exceed about four times the actual material illustrated but most drawings are of a lesser magnification. Some actual measurements, in millimeters, of all digestive organs and major related organs are included as a guide to comparative sizes.

The various structures illustrated in the figures are labelled with letters or numerals placed on transparent overlays, and a key accompanies. In the text, the number of the figure or figures which includes the structure being discussed is included with the description.

A dissecting microscope was employed as a means of checking dissected structures, especially the various ducts of glands, and finer vessels and nerves. The microscope was equipped with 10X ocular lenses, and both 1X and 3X objective lenses.

The entire contents, including illustrations, were duplicated by the diazo dye wet process of direct-positive contact photoprinting.

[REDACTED]

III. THE ORAL CAVITY

The oral cavity constitutes the cephalic portion of the digestive system. The digestive tract of the chinchilla extends from the labial introitus to the anus, and is modified grossly into the oral cavity, pharynx, esophagus, stomach, intestines, and anus. Major glands associated with the tract include the liver, pancreas, and salivary glands.

The various non-digestive structures presented in this account are included for topographical reasons.

A. The Lips and Cheeks

1. The Lips

The labia oris of the chinchilla are complexly folded and capable of completely (fig. 1) or variously (figs. 1, 2 and 3) covering the incisors and the cephalic end of the oral cavity. When the lips are retracted, their angles (commissurae labia oris) can be seen to extend caudal to the incisors, and are located in the region of a broad diastema between the incisors and molars.

The lips assist in forming a post-incisal subdivision of the oral cavity which presumably acts as a recess for particles freed during the act of gnawing.

The pelage is modified near the labial margins by a reduction in size, number, and coloration of the hairs. The hairs nearest the

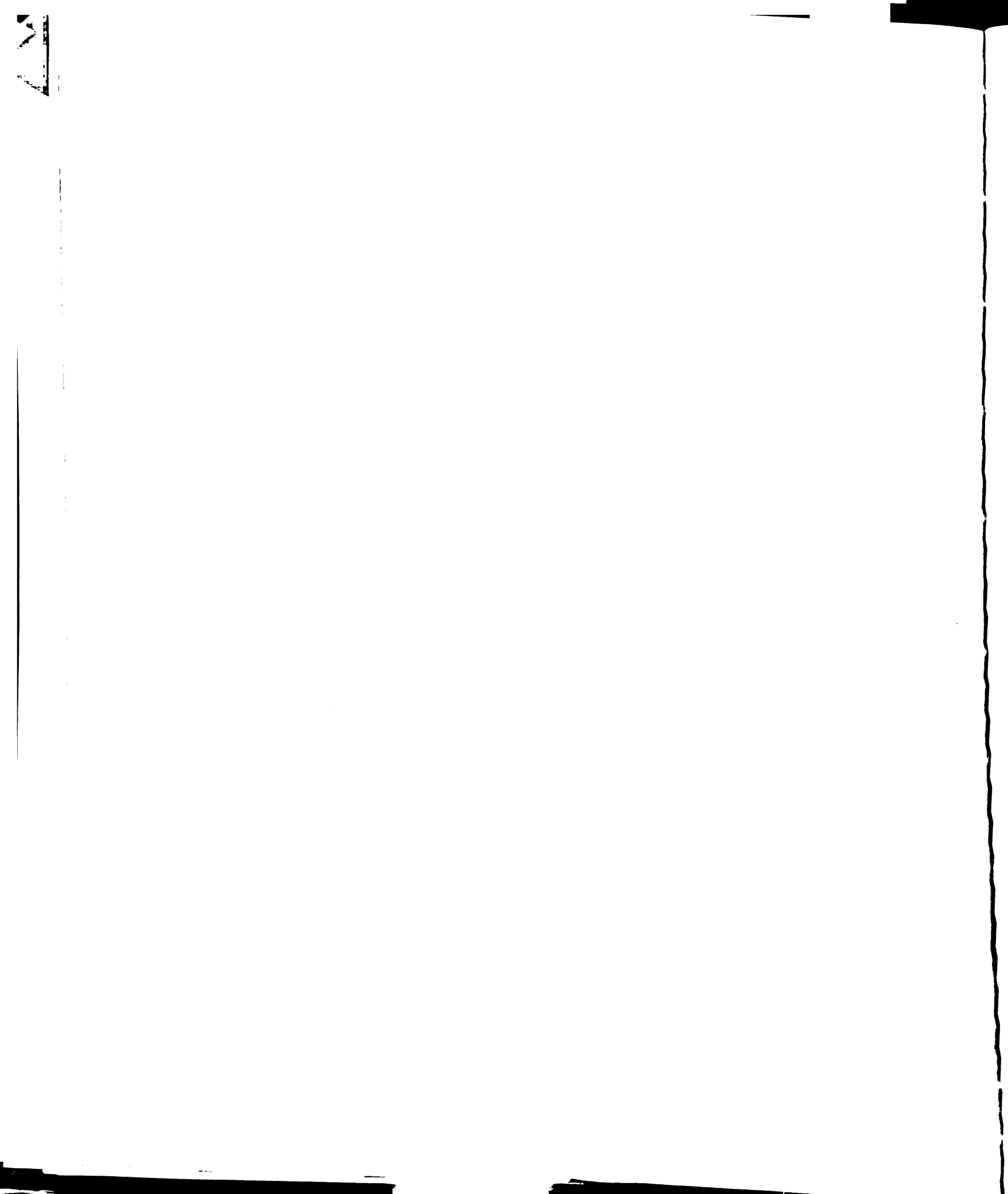


FIGURE 1. THE CHINCHILLA MUZZLE WITH THE LABIA CLOSED

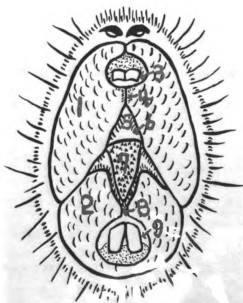
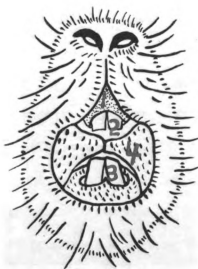
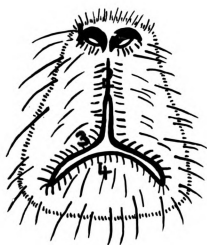
1. Anterior nares
2. Median raphe
3. Superior labium
4. Inferior labium

FIGURE 2. THE CHINCHILLA MUZZLE WITH THE LABIA PARTIALLY RETRACTED

1. Gingiva
2. Superior incisors
3. Inferior incisors
4. Post-incisal recess

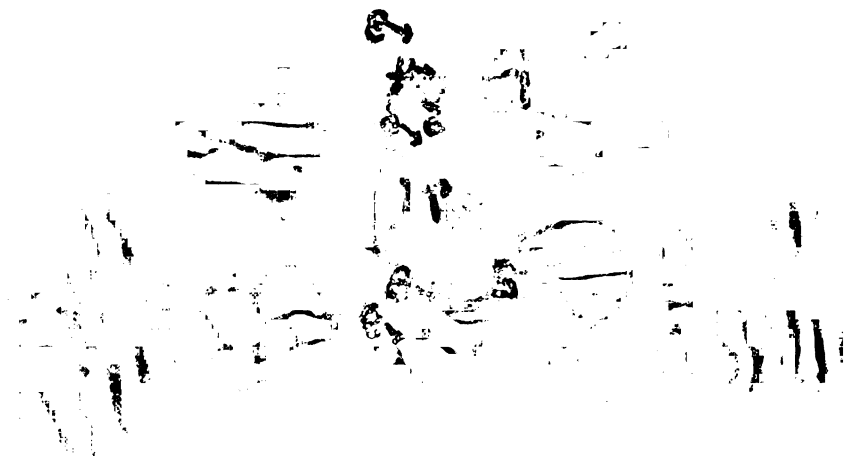
FIGURE 3. THE CHINCHILLA MUZZLE WITH THE LABIA FULLY RETRACTED AND THE MOUTH OPENED WIDELY

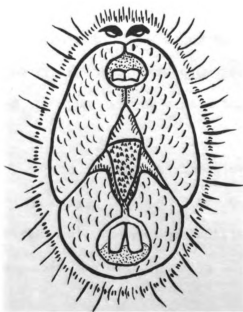
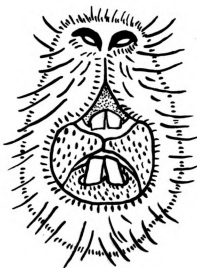
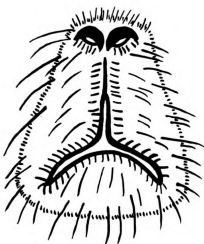
1. Inflexum pellitum superior
2. Inflexum pellitum inferior
3. Superior circumincisal vestibule
4. Inflexum pallitum superior raphe
5. Aperture of oral cavity proper
6. Bristles of buccal bristle pad
7. Dorsum of tongue
8. Inflexum pellitum inferior cleft
9. Inferior circumincisal vestibule



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rima oris are mostly white and lack color bands. This sparse distribution of short, fine hairs prevailed about the inner margins of the lip, and at the buccal bristle pad (fig. 3) the hairs participated in the tuft.

The superior labium is partially cleft at the midline (fig. 1), the dorsal uncleft portion being defined into right and left portions by an indistinct median raphe. The cleft portions meet in front at an acute angle directed toward the nasal septum, the upper incisors being exposed in the intervening interval.

The borders of the upper lip are folded inwardly to entirely surround the gingivae of the respective incisors (figs. 2 and 3). The edges of the infolded portion or inflexum pellitum (Weber, 1927) of opposite sides partially fuse at a short median raphe immediately caudal to the incisors. The circumincisal border attaches at the line of reflection of the gingivae and surrounding mucous membrane thus defining a shallow isolated vallate depression herein referred to as the superior circumincisal vestibule (figs. 2 and 3).

The inferior labium is uncleft, there being however an indication of a median raphe. The margin presents inward projecting circumincisal lobes similar to those of the upper labium except that they do not fuse caudal to the incisors.

The margins of the lobes do not fuse to the gingivae of the lower incisors, and hence there is only a functional and not a fixed isolated inferior circumincisal vestibule. The pelage modification resembled that described for the superior labium. The apex of the tongue appeared

to rest in a fossa defined by the infolded lobes of the lower lip. The lower lip is bound to the gingivae by two frenalae, one on each side of the median line.

The post-incisal lobes of the labia, the apex of the tongue, and a fleshy tubercle on the mid-dorsal diastemal portion of the hard palate, appeared to rest in contact, thus effectively separating the oral opening and the incisors from the oral cavity proper. The apparent functional significance of this arrangement is to permit extended action of the incisors for gnawing without constantly exposing the general oral cavity to the freed particles. This interpretation is supported by an opinion of the function of this arrangement in rodents in general as stated by Beddard (1909).

In life, there is considerable mastication accentuated by mandibular excursions, accompanied by rapid vibration of the mystacial vibrissae.

2. The Cheeks

The cheeks or buccae are defined as the fleshy portions of the sides of the face by Dorland (1947).

The definition referred to is more inclusive than that given for the cheek by various other authors. Major anatomical works are somewhat vague as to the limitations of the cheek (Gray, 1942, Buchanan, 1953, and Cunningham, 1951, for the human; Miller, 1952, for the dog). Reighard and Jennings (1935) described the cheeks of the cat as extending from the lips to the rami of the mandibles. Sisson and Grossman (1953) stated that the cheeks of the domestic animals formed the sides

of the mouth, were continuous with the lips cranial, and were attached to the borders of the bones of the jaws.

Webster's New International Dictionary (1946) indicated that the cheeks of man and other mammals are the fleshy wall or side of the mouth, the side of the face below the eye, and above and to the side of the mouth.

In the present study the cheeks are considered to include all structures from the integument to the mucous membrane of that portion of the face which bounded the mouth laterally from the lips to the fauces and to the pharyngeal entrance.

The external surface of the cheek is covered with fur similar to that of the general body surface. In addition, prominent mystacial vibrissae are present at the labial end of the cheeks (figs. 4 and 5).

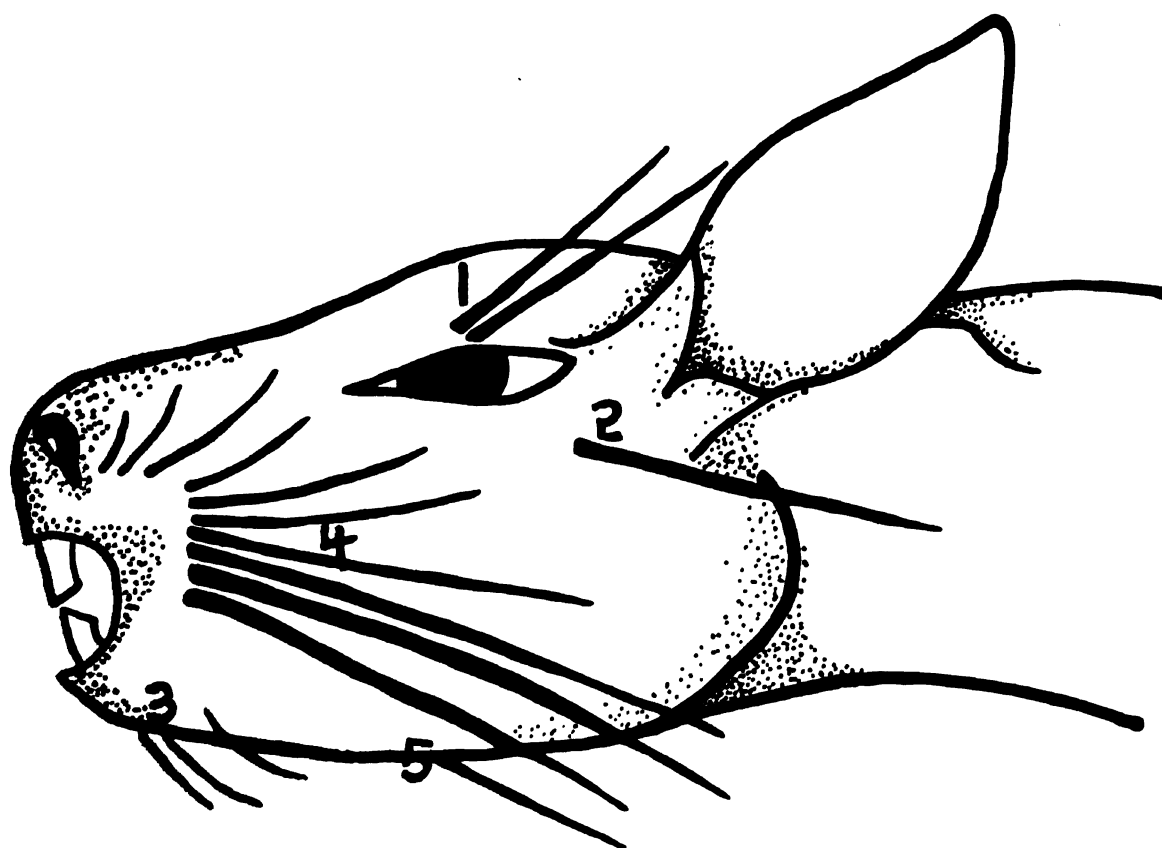
The vibrissae are prominent features of the chinchilla muzzle. Wilcox (1950) did not describe the vibrissae in detail and did not mention the vibrissal groups in his description of the chinchilla. Wilcox, *ibid.*, found that the vibrissae were long heavy sensory hairs completely separated from one another. In the present specimens this was true only for some mystacial vibrissae, whereas many were paired in the follicles, and in none of the specimens examined was there a complete lack of paired vibrissae.

Certain generalizations can be made concerning the specimens studied. There is no apparent significant sex related specialization of the vibrissae. They are not of equal length and the largest and the thickest are located at the caudal portion of the group.

FIGURE 4. LOCATION OF THE FACIAL VIBRISSAE*

1. Superciliary
2. Genal
3. Submental
4. Mystacial
5. Interramal

* Pocock (1914)



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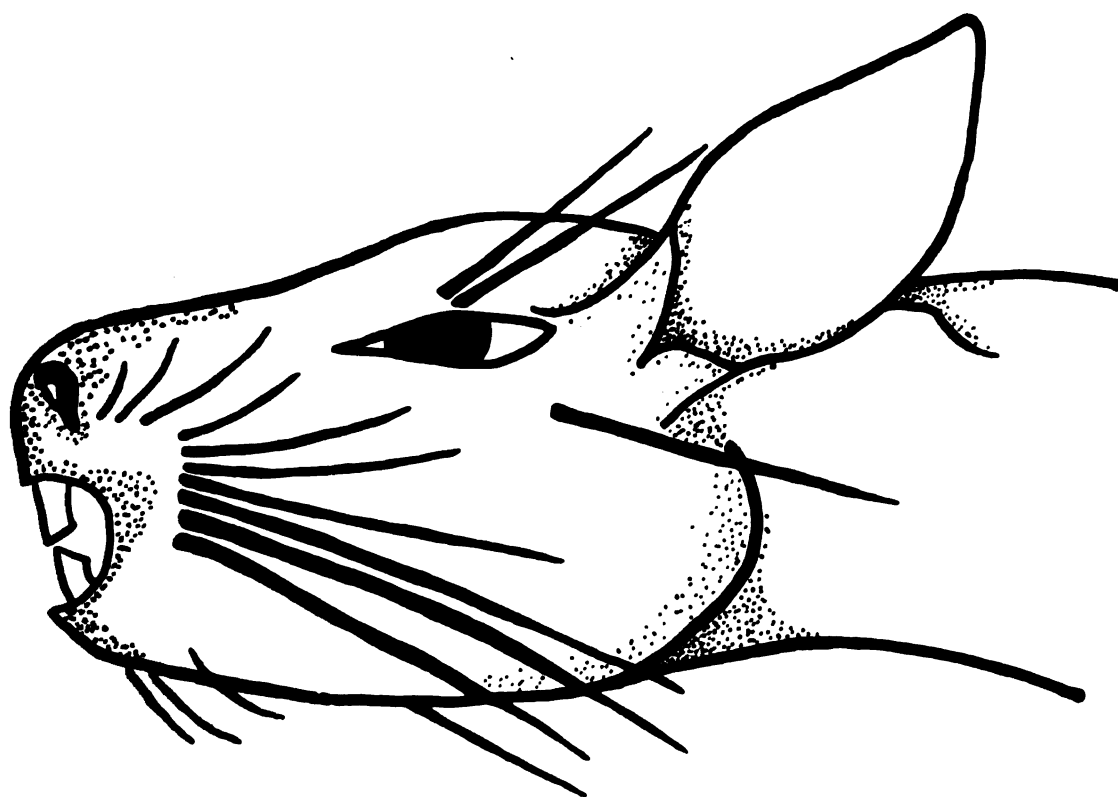


FIGURE 5. THE DISTRIBUTION OF THE TWENTY-FIVE LONGEST MYSTACIAL VIBRISSAE

1. Largest; and 25, shortest

1r. Male 1, right side

1l. Male 1, left side

2r. Male 2, right side

2l. Male 2, left side

3r. Female 1, right side

3l. Female 1, left side

4r. Female 2, right side

4l. Female 2, left side

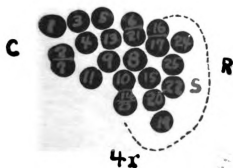
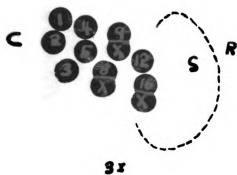
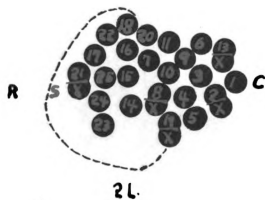
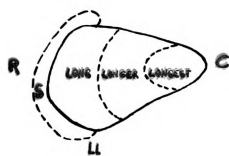
R. Rostral end of group

C. Caudal end of group

S. Outline of area containing the majority of vibrissae shorter than the twenty-five longest vibrissae (usually about double the number of longer vibrissae)

●. Two per follicle; x-shorter than first 25

Note: The numbers of the longest vibrissae indicated in this figure, correspond to those in Table I. Table I gives the length for each vibrissa to the nearest half millimeter.



THE FIRST PARTS

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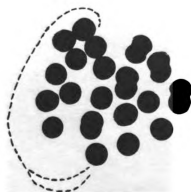
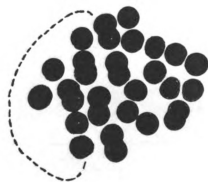
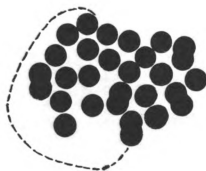
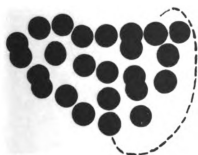
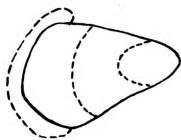
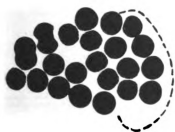


TABLE I
THE LENGTHS OF THE TWENTY-FIVE LONGEST MYSTACIAL VIBRISSAE
(± 0.5 mm)

Number	Male 1		Male 2		Female 1		Female 2	
	R	L	R	L	R	L	R	L
1	122.5	127.0	144.0	144.0	128.0	135.0	126.0	128.0
2	122.0	118.0	132.0	132.0	124.0	134.0	121.0	118.0
3	117.0	102.0	132.0	128.0	123.0	127.0	119.0	113.0
4	116.0	102.0	126.0	128.0	122.0	125.0	115.0	108.5
5	109.5	98.0	123.0	127.0	114.0	122.0	104.0	108.0
6	103.0	92.0	109.0	113.0	112.5	118.0	101.0	101.0
7	100.0	85.0	106.0	106.0	111.0	106.0	95.0	91.5
8	93.0	81.0	102.0	105.0	110.0	106.0	93.0	90.5
9	90.0	81.0	99.0	97.0	103.0	93.0	92.5	88.0
10	84.0	80.0	92.0	92.0	103.0	90.0	92.0	85.0
11	82.0	68.0	91.0	89.0	92.0	89.5	85.0	84.0
12	79.0	?	89.5	89.0	88.0	89.0	79.0	78.0
13	78.0	?	87.0	86.0	86.0	89.0	76.5	78.0
14	77.0	?	86.5	86.0	85.5	88.5	71.0	77.5
15	71.5	?	83.5	85.5	79.0	79.0	71.0	74.0
16	68.0	?	78.0	85.0	78.0	79.0	70.5	69.0
17	66.0	?	76.0	73.0	76.0	73.0	65.5	66.0
18	65.0	?	75.0	72.0	72.0	70.0	62.0	64.0
19	64.0	?	74.0	66.5	70.0	70.0	60.5	62.0
20	63.0	?	73.0	66.0	67.5	69.0	58.0	61.5
21	61.0	?	69.0	64.0	67.5	66.0	58.0	61.5
22	58.0	?	66.0	64.0	62.0	63.0	57.0	55.0
23	57.0	?	63.0	60.0	62.0	62.0	55.5	54.0
24	55.0	?	63.0	59.0	60.0	60.0	55.0	54.0
25	42.0	?	64.0	58.0	56.0	60.0	45.0	53.0

TABLE II
LENGTHS OF THE NON-MYSTACIAL VIBRISSAE
(± 0.5 mm)

Vibrissae	Male 1		Male 2		Female 1		Female 2	
	Length in Millimeters							
	R	L	R	L	R	L	R	L
Superciliary								
1	40.0	?	45.0	46.5	46.0	?	30.5	?
2	37.0	37.0	?	31.0	46.0	?	?	?
3	26.0	26.0	28.0	27.0	45.0	?	?	?
4	nf	nf	?	16.0	nf	nf	nf	nf
Genal	38.0	40.0	42.0	45.5	35.0	35.0	nf	nf
Submental								
1	?	?	23.0	16.0	?	?	18.0	18.0
2	16.0	16.0	26.0	25.0	31.0	?	18.0	?
3	nf	nf	23.0	25.0	nf	nf	18.0	18.0
Interramal	nf		nf		nf		nf	

R = right

L = left

nf = not found (not necessarily missing)

? = present but damaged by removal

TABLE III

THE COLOR OF THE TWENTY-FIVE LONGEST MYSTACIAL VIBRISSAE

Number	Male 1		Male 2		Female 1		Female 2	
	R		R	L	R	L	R	L
1	BBGW		WGW	BBBW	BBBB	BBGW	BBBB	BBWW
2	BGW		BBBB	BBWW	BBBW	BBBB	BBWW	BBBB
3	BBBG		BBWW	BBWW	BBBW	BBBB	BBBW	BWWW
4	BWWW		GGGG	BBBG	BBBB	BBBB	BWWW	BBBB
5	BBBB		WWW	WWW	BBBB	BBWW	BBBB	BBWW
6	BBWW		BBBB	BBBB	BBBB	BBBG	BBBB	BBBB
7	BGBB		BGW	BBWW	BBBW	BBBW	BBWW	BBWW
8	BBBW		GW	BBWW	BBBG	BBBW	BBBB	WWW
9	BBBW		BBBB	BBBB	BBBB	GW	BBWW	BBBB
10	GW		WWW	BBBB	BBWW	BBBB	BBBW	BBWW
11	BWWW		WWW	BBBB	BBBB	BBWW	GW	BBBW
12	BBBB		GGG	WWW	BWWW	BBWW	BBBB	BBBB
13	BBWW		BBBB	BBBB	BBBG	BBBB	BBBB	BBBB
14	BBBB		GW	BBBB	BBBW	BBBW	BBWW	BBBB
15	GW		WWW	WWW	BBBB	BBBB	BBWW	GW
16	GW		BWW	BBBB	BBBB	BBBB	BBBB	GGW
17	BBWW		WWW	BBWW	WWW	GW	BBBB	?
18	WWW		BBBB	BBBB	BBBG	GW	BBBB	BBBB
19	BBWW		WWW	WWW	BBBB	BBBB	BBWW	BBBB
20	BBBB		BBBB	WGW	BBWW	BBBB	GW	GGW
21	BWWW		BBWW	BBBB	GW	BBBG	?	GGW
22	BBBB		GBB	BBWW	WWG	BBBG	GW	GW
23	BWW		BWW	WWW	BBBB	BBBW	?	WWW
24	BBBW		BWW	WWW	BBBG	BBWW	BBBB	BBBB
25	BBWW		BBBW	WGG	WWW	WWW	BBBW	WWW

The letters represent the color to the nearest fourth of the vibrissal length. The first of each four letters represents the basal fourth, the last the apical fourth. The longest vibrissa is listed first, the others in decreasing order of length, the twenty-fifth being the shortest. Some fourths are banded rather than a solid color.

B = black

W = white

G = gray

? = color unrecorded

Labiad they are reduced in length and are bordered by shorter finer white hairs. The lengths are nearly the same on the right and left sides of the same animal. Some vibrissae are paired in the follicle, but a single hair per follicle prevails. No follicles studied contained more than two vibrissae.

There is considerable variation in length and thickness of individual vibrissae when two vibrissae are found in the same follicle. In some follicles the two members of the pair are similar in these dimensions. In other follicles the dimensions range from approximately the same to extreme difference in length and thickness.

The colors of paired vibrissae are similar in some follicles, while in other follicles the color varies, i.e., one vibrissa is uniformly colored while the other varies in color.

The colors are shades of black or cream (called white). Table III shows that there is no apparent relationship between sex and vibrissal features. For further details concerning morphological features of hair structure in the chinchilla consult Hausman (1954).

The integument is loosely attached to the underlying muscle which contributes to the wall of the cheek.

The lining of the cheek is, for the most part, a mucous membrane, which appears pale red in the fresh condition. At the rostral end there are bristle-covered pads of infolded integument along the inner margins of the commissurae labia oris. These modified trichous areas are delimited from the general buccal mucosa by shallow dorsoventral-linear depressions.

The hairs of the cheek pad project caudad. In the case of several subgenera of woodrats studied by Howell (1926) cheek pad hairs projected in essentially the same direction. He interpreted this arrangement as one in which ingress of food was impeded to the slightest possible degree.

The lining of the cheek is pierced by the ostium of the parotid salivary gland duct, at a point opposite the anterior superior molar, and near the anterior border and occlusal level of the molar.

B. The Vestibule

This restricted portion of the oral cavity is bounded by the teeth and gums internally, and by the cheeks or labia externally. There is an incisal and a molar portion.

1. The Incisal Vestibule

The incisal portion of the vestibule is located between the incisor teeth, the gingivae, and the lips. This portion is very shallow and is found around the gingivae of the incisors. It is completely isolated from the molar vestibule due to the fact that the upper lip forms an unbroken ring around the incisors. The shape of the lower vestibule is variable since it is dependent on both the movements and position of the labium. As the lower lip does not fuse caudal to the incisors, the circumscribed vestibule becomes continuous with the oral cavity post-incisal recess and oral cavity proper when the lobes of the inflexum pellitum separate to admit the lingual apex.

2. The Molar Vestibule

The molar vestibule is a very narrow space located between the cheek and the molars and respective gingivae. It is circumscribed by the reflection of the buccal mucosa from the gingivae. It is continuous with the oral cavity proper rostral and caudal to the cheek teeth row. There is no inter-molar communication with the oral cavity proper, as these teeth have no interspace.

The discontinuity of the various vestibules results from the presence of a long diastema between the incisors and the molars, and also to the complex labial inflexing.

C. The Postincisal Recess

The postincisal recess is the space immediately caudal to the incisors. It occupies the diastemal region of the mouth. Due to the labial infolding and to the buccal bristle pad caudal to the commissurae labia oris, it is lined with modified integument, rather than mucosa.

The recess is bounded by the labia and incisors rostrally, the inflexes dorsally as well as by the incisive papilla and hard palate. Ventrally the recess is lined with the inflexes and lingual apex, and laterally by the buccal bristle pad. When non-distended the recess is a very minor space when compared with the oral cavity proper. It opens into the oral cavity proper at the level of the first molar teeth.

Beddard (1909) found that the oral cavity of rodents was divided into two chambers by a hairy ingrowth behind the incisors. The present author refers to the first chamber as the postincisal recess, and the second, and much larger chamber as the oral cavity proper.

D. The Oral Cavity Proper

The *cavum oris proprius* (fig. 6) is directly continuous with the postincisal recess. It expands into an irregularly ovoid chamber containing the molar teeth and the tongue. Caudad the cavity is somewhat reduced; this region is the *isthmus faucium* which becomes continuous with the pharynx.

The shape of the cavity is not uniform. The molar teeth rows diverge caudally, and thus the cavity is restricted at the rostral end by the first molars, while it is much wider at the level of the last molars.

The lingual fossa is somewhat irregular. The roof is more regular and vaulted. The *isthmus faucium* is roughly elliptical in cross section.

The chief structures of the oral cavity proper consist of the palate, the floor, and sides, and in addition the molar teeth and tongue.

1. The Palate (figs. 6 and 7)

The palate of the chinchilla has three well defined regions.

a. The rostral region.

The rostral region continues into the postincisal recess, is an arched smooth area anterior to the first upper molars. It occupies the area of the superior diastema. Except for the superior inflexum pellitum of either side, the lining consists of a smooth moist mucous membrane. The principal structure of this portion of the palate is a fleshy pad or incisive papilla; the papilla serves as a landmark between the postincisal recess and the oral cavity proper.

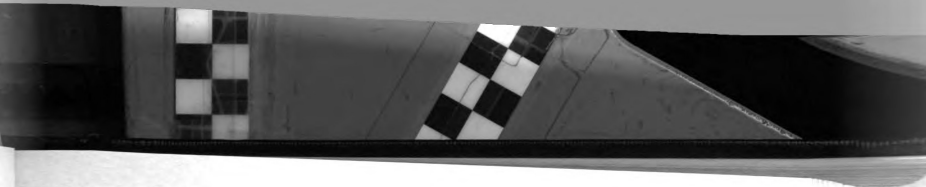
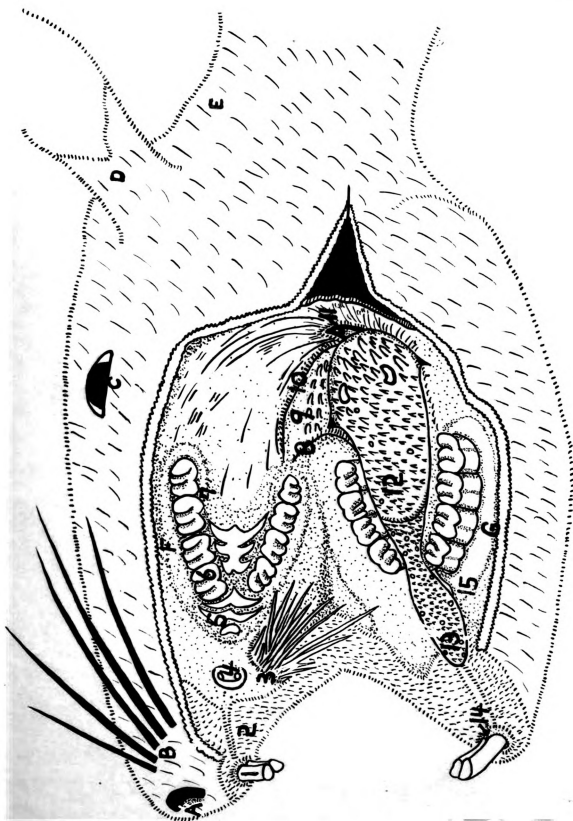
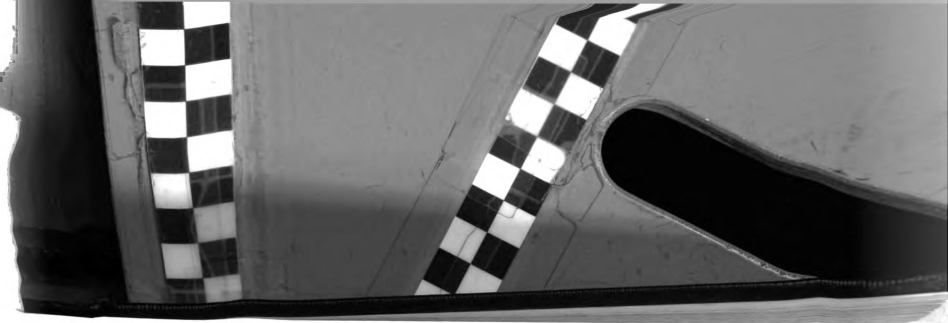


FIGURE 6. A SIDE VIEW OF THE HEAD OF THE CHINCHILLA WITH THE LEFT CHEEK REMOVED AND THE JAWS TILTED TO SHOW THE PALATE, THE INNER SURFACE OF THE RIGHT CHEEK AND FAUCES, AND THE FLOOR OF THE MOUTH

- | | |
|-------------------------------|-----------------------------------|
| A. Left naris | 9. Fauces |
| B. Mystacial vibrissae | 10. Pharyngopalatine arch |
| C. Eye | 11. Introitus pharyngus |
| D. Ear | 12. Intermolar eminence of tongue |
| E. Neck | 13. Apex of tongue |
| F. Upper jaw | 14. Inferior incisal vestibule |
| G. Lower jaw | 15. Inferior molar vestibule |
| 1. Incisors | |
| 2. Inflexum pellitum superior | |
| 3. Buccal bristle pad | |
| 4. Incisive papilla | |
| 5. Rugae of palate | |
| 6. Molar | |
| 7. Gingivae | |
| 8. Glossopalatine arch | |







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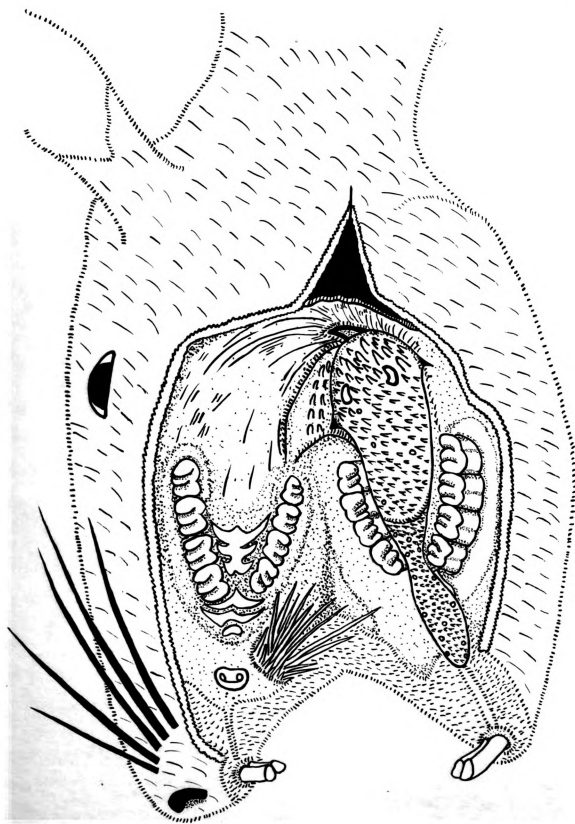
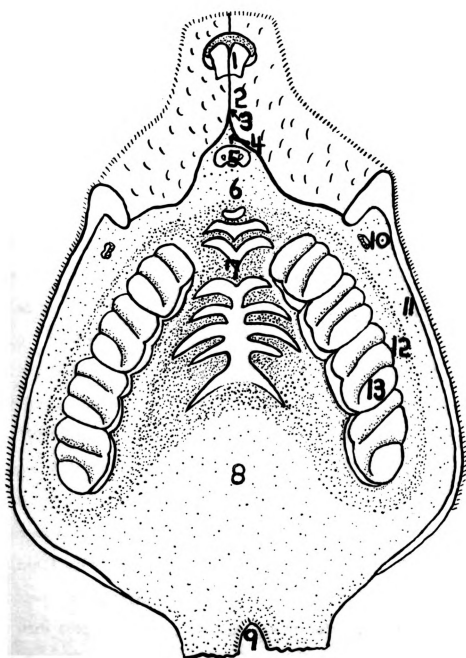




FIGURE 7. A VENTRAL VIEW OF THE PALATE OF THE CHINCHILLA

1. Superior incisors
2. Inflexum pellitum superior
3. Median raphe of lips
4. Postincisal recess
5. Incisive papilla
6. Smooth hard palate (rostral region of palate)
7. Hard palate with rugae (middle region of palate)
8. Soft palate (caudal region of palate)
9. Introitus pharyngeus
10. Ostium of parotid duct
11. Cheek
12. Gingiva
13. Molar tooth



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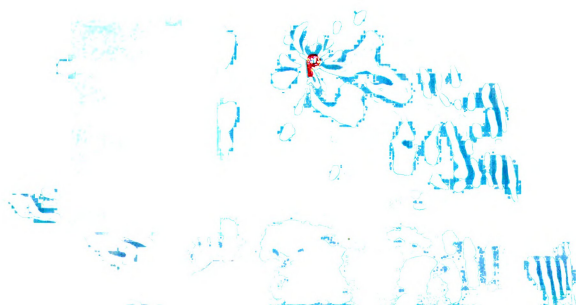
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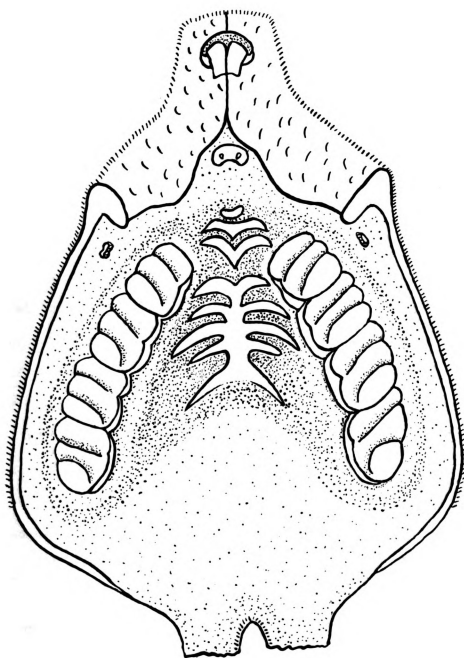
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The incisive papilla (figs. 6 and 7) is well developed in the chinchilla. When viewed with a dissecting lens, the papilla appears as a semicylindrical mass of tissue located in the midline just rostral to the level of the first upper molars. It is covered by the oral mucosa, and presents two ostia, one on each side of the apex of the papilla. The ostia are faintly visible to the unaided eye.

The ostia lead by means of expanding channels which arch dorsad and anterad to the floor of the nasal passage. The framework of the papilla consists of cartilaginous plates at the sides of the passages. The passage seems to be lined with oral mucosa at the oral and the nasal mucosa at the dorsal end.

The function of the incisive canals seems obscure in the case of the chinchilla. In various other mammals (Arey, 1946, Schour, 1953, for the human, Sisson and Grossman, 1953, for domestic animals, and Howell, 1926, for woodrats) the papilla and canals were associated with the organ of Jacobson or vomeronasal organ. Hill (1935) observed that the incisive foramina of rodents were elongated. Howell (1926) felt that the elongation of the incisal foramina could not be due to the rather small vomeronasal nerves, but rather that the larger organ of Jacobson was located within both of the apertures. The incisive canals were found to occupy the incisal foramina in the chinchilla.

b. The middle region.

The second or middle region of the palate is very firmly attached to the palatine processes of the overlying maxillary bones. This region occupies the area between the first and second molars.

The middle region is characterized by having transverse chevron-like palatal ridges or rugae (figs. 6 and 7). A minor variation was seen in the pattern of distribution of the rugae; usually four or five or more could be distinguished, the first being located slightly rostral to the first molars.

The rostral and middle regions of the palate can be classified as hard palate as the bones of the skull lie in contact with them dorsad.

c. The caudal region or soft palate (figs. 6 and 7).

The caudal or posterior portion of the palate is the soft palate. This portion is lined with oral mucosa, and is very flexible and largely muscular. The back portion of the caudal division of the palate vaults the roof of the isthmus faucium and also forms the caudal portion of the ventral wall of the nasopharynx. The front portion of the caudal division is located between the back two upper molar teeth of right and left sides.

2. The Floor (fig. 6)

The floor of the mouth consists of three general divisions. The postincisal area is lined by oral mucosa and inflexes of the lips. It presents a more or less v-shaped depression for the lingual apex. The middle of the oral floor is that area between the lower molars. The oral mucosa lining this area reflects from the molar gingivae and from the ventral or under surface of the body of the tongue.

A third or caudal portion of the floor of the mouth differs from the middle portion in that the body of the tongue gradually recedes

beneath the oral mucosa, thus the actual floor becomes the dorsum of the tongue and the surrounding mucosa. This third portion exhibits numerous lingual papillae.

The floor of the mouth is subtended by the mylohyoid, the geniohyoid, and digastric muscles, by various blood vessels, by certain cranial-nerve fibers, and by the various salivary glands other than the parotid, and finally by the integument on the bottom surface of the muzzle and neck.

3. The Wall of the Oral Cavity (fig. 6)

The wall of the oral cavity consists of the cheeks. The lining of the latter is modified in the faucial region by the presence of rows of conical faucial papillae similar to the papillae of the caudal region of the dorsum of the tongue. In addition to the papillae, the fauces are also lined by two nearly vertical arching folds of the mucosa called the glossopalatine and the pharyngopalatine arches or pillars. Dorsally the arches are reduced in size and lose their identity in the mucosa of the soft palate. They tend to converge dorsad but never quite meet.

The area between the pillars is somewhat triangular in outline with the broader base directed ventrally. The region bulges outward slightly, and with the unaided eye palatine tonsils were not discernable.

4. The Teeth

The dentition of the chinchilla is a matter of much concern to the industry, and numerous articles have been published which contain some

information pertaining to malocclusion and other irregular features of the teeth. Among these accounts are those of Buck (1954), Kennedy (1952), Lindsay (1955), Peterson (1952), and Raskin (1955). No detailed description of the teeth was found.

The teeth of the chinchilla are twenty in number, i.e., four incisors and sixteen molars. The dental formula (Diamond method, 1952) from the time of eruption of the complete complement of teeth was found to be $2(I \frac{1}{1} C \frac{0}{0} P \frac{0}{0} M \frac{4}{4}) 20$. As the dental formula indicates, there are two upper and two lower incisors; they are placed in the simplicidentata manner.

The incisors are of the gliriform, gnawing, or rodent type, i.e., they did not exhibit true roots. The molars are also capable of continuous eruption, as their pulp chambers likewise remain open after maturity. Their crowns are lophodont in form. According to Burt (1946) this type of crown is common to herbivorous rodents.

Beddard (1909) maintained that the teeth are monophyodont and that this condition is commonly found in rodents.

The incisors are usually present at time of birth, but for the few neonatal specimens examined some of the molars had not yet penetrated the gingivae, although the gingivae possessed elevated areas corresponding to underlying molars.

a. The incisors (figs. 8, 9, 10 and 13).

As indicated previously, the incisors are four in number and are arranged in a simplicidentate fashion. They are long, strong, curved teeth, with sharp chisel-like edges. They are supported by elongated

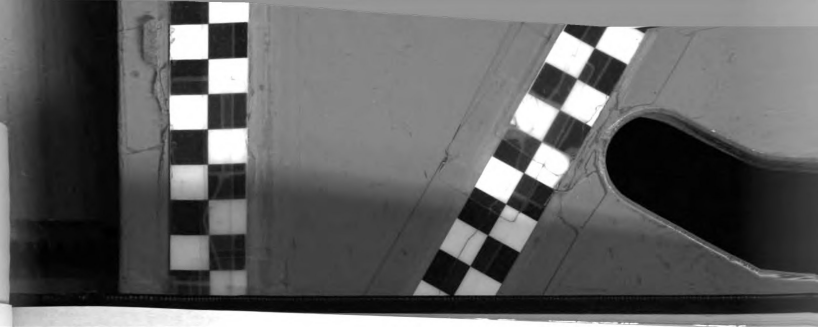


FIGURE 8. OUTLINE DRAWINGS OF THE RIGHT INCISORS

- A. Superior incisor; mesial, distal, and cross-section views, from left to right
- B. Inferior incisor; mesial, distal, and cross-section views, from left to right
- C. Position of superior and inferior incisors, from the mesial aspect

LA. Labial surface

LI. Lingual side

R. Root end

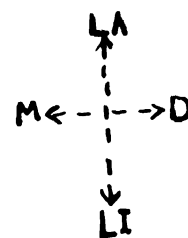
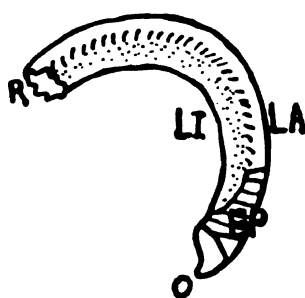
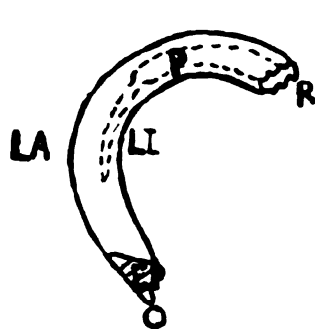
O. Occlusal end (apex)

M. Mesial surface

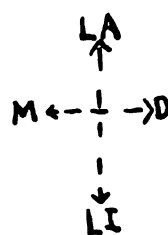
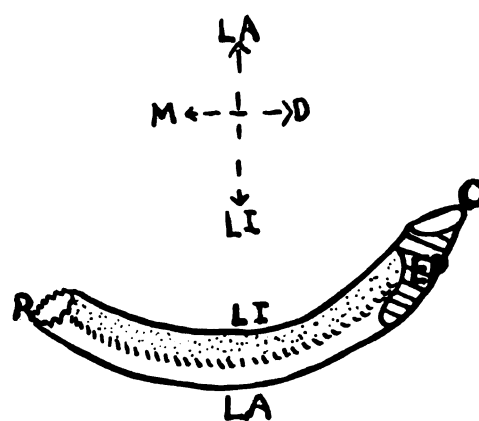
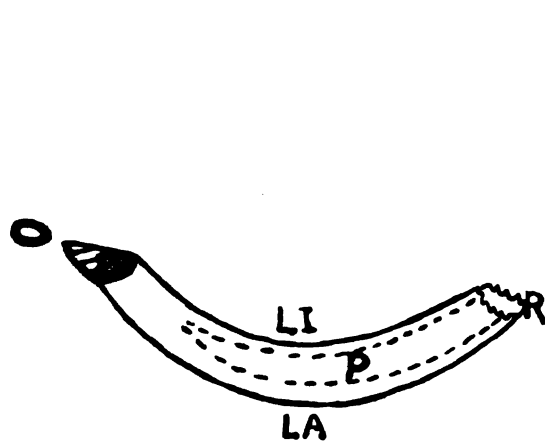
D. Distal surface

P. Pulp space

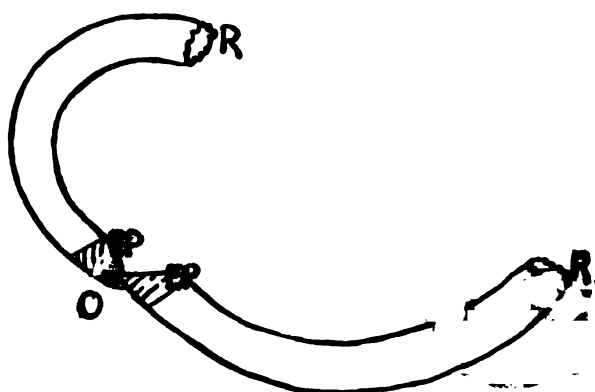
EP. Exposed portion (lined diagonally)



A



B



C

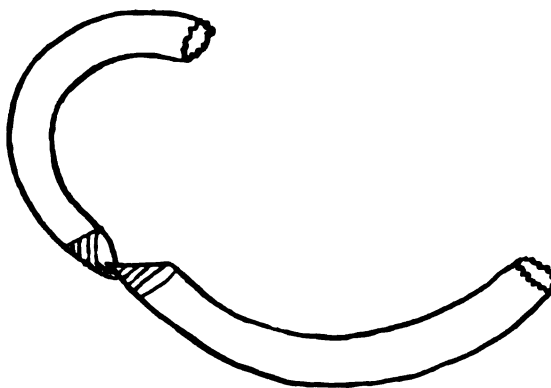
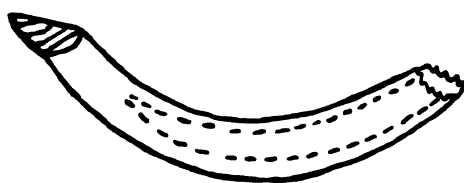
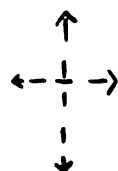
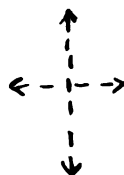
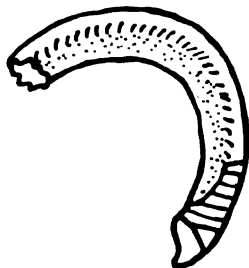
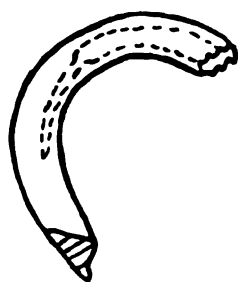
A
M
O
R
B

B

L
L
P
A

R
R

O
B



tubular alveolar processes of the premaxillae, and the mandibles. The major portions of the teeth are embedded or attached by a gomphosis in deep alveoli with approximately two millimeters of lingual, and eight to ten millimeters of labial exposure.

The labial surfaces are pigmented. The color ranges from a pale yellow in some very young animals, to a bright yellow-orange in some adult animals. The pigmentation did not extend below the alveolar ridges more than a millimeter in the specimens examined. Schour (1953) indicated that this pigment was contained in the outer portion of the dentine in the rat incisors. The dentine of rodent incisors generally contains two layers, the outer constituting about one-fifth the thickness of the dentine (Watson and Avery, 1954). No comment was made concerning the nature of the pigment. Attempts to remove the pigment from the chinchilla incisors indicated that the pigment was not merely a surface film.

The rate of growth of chinchilla incisors was studied by others. Kennedy (1952) observed that the average annual rate of growth was 2.34 inches for the uppers, and 3.16 inches for the lower incisors. Thus the rate of wear about equals the rate of growth. According to these figures and also on the basis of observations made in this study, the substance of the incisors will be replaced at least three times a year. Compared to the data by Schour (1953) for the rat, which indicated that the tooth substance is replaced every forty to fifty days, the rate of incisor growth in the chinchilla is relatively slower.

The upper or premaxillary incisors (figs. 3, 6, 8 and 9) are sharply curved, and almost form a complete semicircle. The length of the greater curvature (labial surface) is approximately 20 mm., while the length of the lesser curvature is approximately 13 mm. The diameters of the teeth are nearly the same, although somewhat greater in a labial-lingual direction (2 mm) than in a mesio-distal direction (1.9 mm).

The occlusal plane slopes at an acute angle to the cutting edge. On this surface a distinct transverse ledge was usually present, and apparently represented the point of greatest wear by occlusion with the incisal edge of the lower incisors.

The proximal or embedded end of the upper incisor remains widely open, the wall being a thin shell.

The rim of the shell on extracted teeth of skeletal preparations appears serrated or irregular and tissue-paper thin. The pulp chamber of the root is nearly as wide as the diameter of the tooth, and gradually becomes narrower and nearly displaced with tooth substance at about two-thirds the distance toward the occlusal or distal end (fig. 8). From this level occlusal a capillary-like canal proceeds; its caliber becomes too small to trace grossly at a point somewhat below the occlusal surface.

The proximal end rests in a rounded eminence at the junction of the premaxillary and maxillary bones, and is thus partially contained by both bones. The suture indicated lies about five millimeters rostral of the anterior root of the zygoma. The eminence over the apex forms the rostral and inferior margin of an extensive preorbital fossa on the lateral surface of bones of the face.

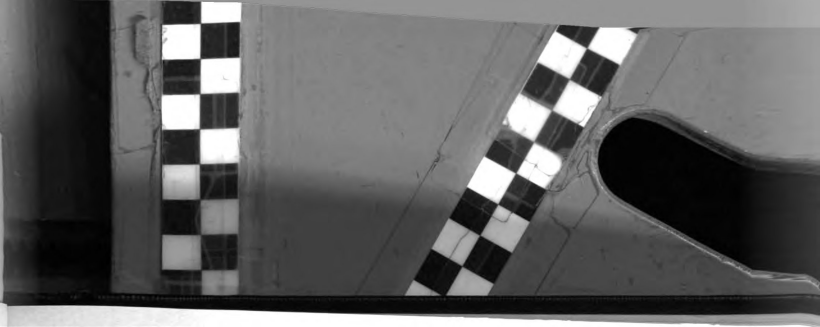
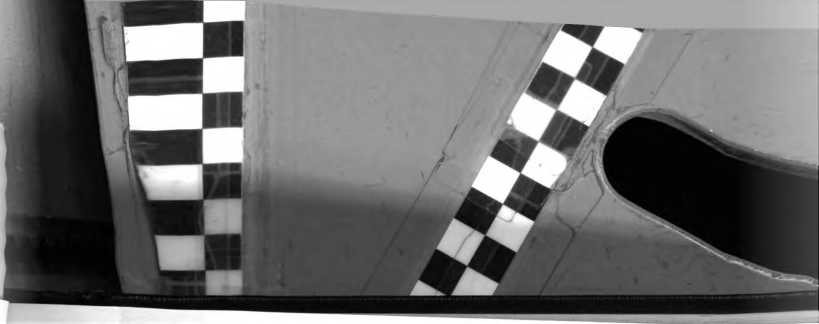


FIGURE 9. A LATERAL VIEW OF THE SKULL WITH THE MANDIBLE REMOVED AND THE EMBEDDED PORTIONS OF THE TEETH OUTLINED

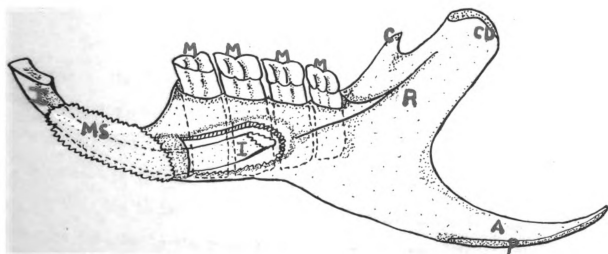
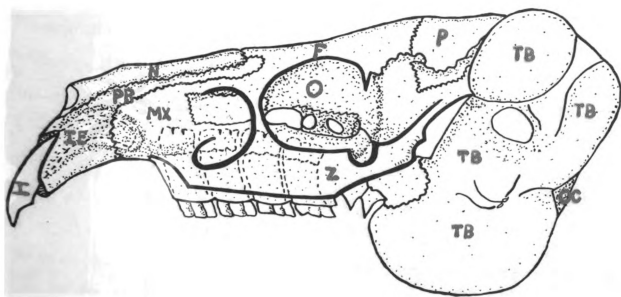
- I. Incisor
- IE. Incisal eminence of premaxillary bone
- PR. Premaxillary bone
- N. Nasal bone
- MX. Maxillary bone
- O. Orbit
- F. Frontal bone
- Z. Zygomatic arch
- P. Parietal bone
- TB. Tympanic bulla
- OC. Occipital bone

FIGURE 10. THE MEDIAL SURFACE OF RIGHT HALF OF THE MANDIBLE WITH THE EMBEDDED PORTIONS OF TEETH OUTLINED AND THE PROXIMAL END OF THE INCISOR EXPOSED

- I. Incisor
- MS. Mandibular process
- M. Molars
- R. Ramus
- C. Coronoid
- CD. Condyle
- A. Angular
- P. Pterygoid spine



38



ST 9
ST 7
ST 0
ST 4
ST 8
ST 5
ST 3
ST 2
ST 1
ST 0
ST 9
ST 8
ST 7
ST 6
ST 5
ST 4
ST 3
ST 2
ST 1
ST 0

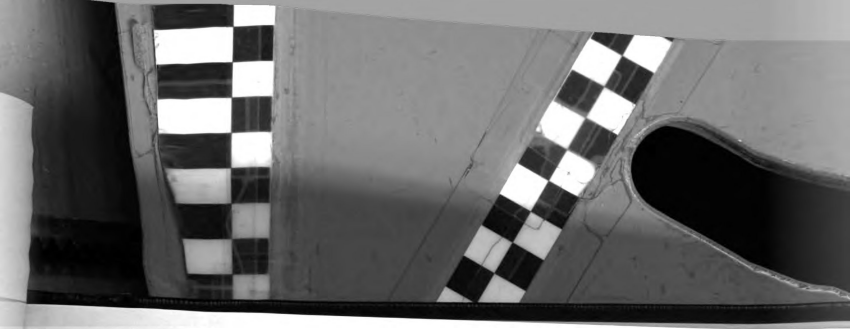
ST 9
ST 8
ST 7
ST 6
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ST 4
ST 3
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ST 9
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ST 3
ST 2
ST 1
ST 0

ST 9

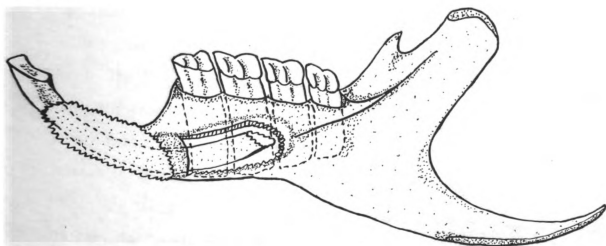
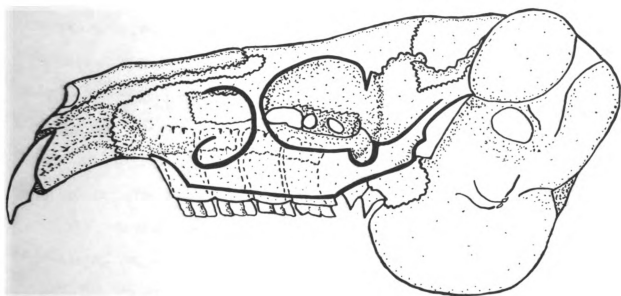
ST 1

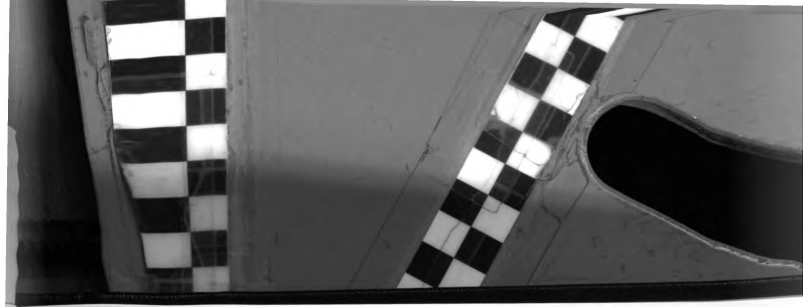
ST 2

ST 1



38





The lower incisors (figs. 3, 6, 8 and 10) resemble the upper incisors in form and structure. They appear much longer than the upper teeth because of a much lesser degree of curvature. By measurement they are only a few millimeters shorter, end to end. The pulp chamber remains widely open for a relatively greater length of the tooth (fig. 8). The diameters of the lower incisors are nearly the same as the diameters of the uppers. The teeth are somewhat thicker than wide.

The occlusal surfaces of the lower incisors slope away from the labial-occlusal angles as in the upper teeth, but bear no distinct ledges.

The temporomandibular articulation is such that it permits a forward-backward movement of the mandible. The lower incisor can thus strike the occlusal surface of the upper, or its occlusal surface can strike the incisal edge of the upper incisor. The upper and lower incisors are thus both kept sharpened in a chisel shape by the action of the opposing teeth.

The proximal portion of the mandibular incisors rest internal or medial to the cheek teeth or molar roots. The edge or base margin lies opposite the second and third intermolar space (fig. 9). Both the upper and lower incisors are deeply and firmly embedded, making them difficult to extract in fresh specimens without damaging other tissues.

When the incisors occlude the opposing molars are held apart by a narrow gap, due to the great length of the incisors. In addition the lower molars now shift forward in respect to the opposing upper molars, so that the last two molars lie inferior to the first two upper molars. The incisors and molars can thus not be in occlusion simultaneously.

b. The molars or cheek teeth (figs. 6, 9, 10, 11 and 12) .

The molars or cheek teeth total sixteen in number, i.e., four molars in each quadrant of the jaws. The molars are separated from the incisors by a long edentulous diastema, which is nearly as long as the cheek teeth rows immediately caudad.

The molars are monophyodont and possess lophodont crowns. Since the proximal ends remain open these teeth are classified as a continuous growth and eruption type. Reports on the rate of eruption and attrition of chinchilla molars were not found in the literature.

The morphological features of all the chinchilla molars are essentially alike. In outline they appear as square columns with rounded angles, and are roughly three times as high as wide. Each molar possesses a mesiodistal and a buccolingual curvature. The occlusal surfaces of the lower molars are somewhat more angular in outline than the corresponding surfaces of the upper molars. Though each molar appeared to be a solid block, close inspection revealed that each is composed of three somewhat unequal fused sub-units, although fusion of the units was not completed proximally. Due to the nature of the different shapes of the sub-units, and to the way in which fusion of units occurred, three portions were visible on the lingual surface of the mandibular molars, and on the buccal surface of the maxillary molars. Only two of the three portions were apparent on the opposite surfaces of these teeth (figs. 11 and 12).

As all of the molars are of the continuously erupting type, they do not have roots in the usual sense of the word (Sisson and Grossman 1953).

That portion which corresponds to the root in other teeth is referred to as the basal portion or proximal end by Schour (1953). Other than for the extreme proximal tip the teeth are quite similar in structure and in outline for their entire lengths. Thus, crown, neck, cingulum, and root do not exist as entities in chinchilla molars. The molar consists of an outer covering of cementum, a thin enamel layer, and an inner dentine adjacent to the pulp chamber. The latter is obliterated by dentine near the occlusal extremity.

The first lower molar is more triangular in outline than the other lower molars; the last or fourth upper molar is somewhat ovoid in outline as compared with the preceding three molars.

Two curvatures along the long axis of the molars are striking features of these teeth, but they do not become obvious until the teeth are removed from or are exposed in their alveoli.

Viewed laterally (fig. 13) when opposed, the upper and lower cheek teeth contribute equally to a sigmoid curve. The convexities of the upper molars are mesiad, and in the lower molars distad.

Viewed frontally (figs. 14 and 18) the opposing upper and lower molars are arranged in a continuous arc, with the convexity directed toward the lingual surface. Because of the lingual-buccal curvature, the bottoms of the teeth do not lie at right angles to the long axis nor in a horizontal plane when the head is level, and hence are not directed downward or upward in the respective jaws.

The basal surfaces of the maxillary molars are directed sidewise at about forty-five degrees to the horizontal. Thus they face the orbit.

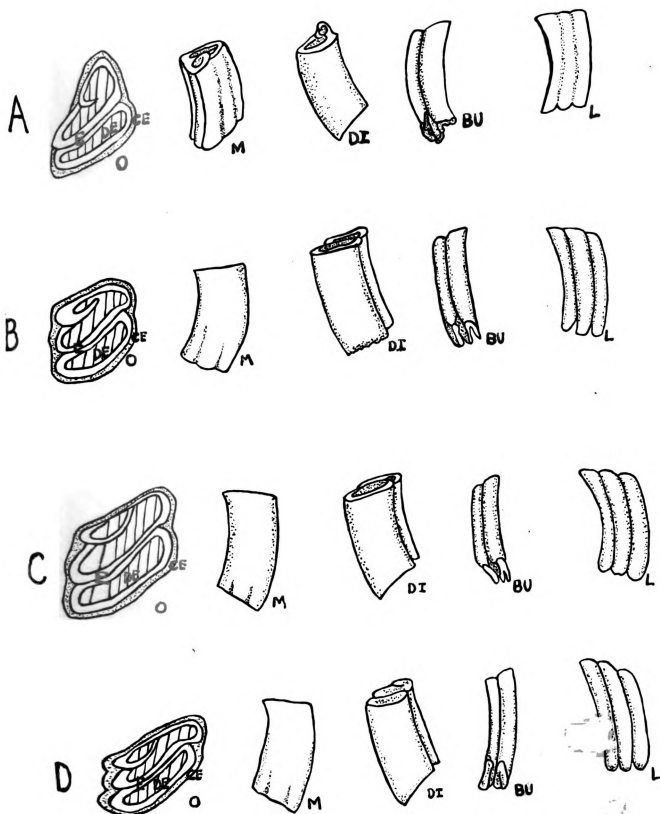
FIGURE 11. DRAWINGS OF THE OCCLUSAL, MESIAL, DISTAL, BUCCAL, AND LINGUAL SURFACES OF THE RIGHT MANDIBULAR MOLARS

- A. First molar
- B. Second molar
- C. Third molar
- D. Fourth molar

- O. Occlusal surface (8X)
- M. Mesial surface (3X)
- DI. Distal surface (3X)
- BU. Buccal surface (3X)
- L. Lingual surface (3X)

- E. Enamel ridge
- DE. Dentine
- CE. Cementum

Note: Measurements for the mandibular right molars illustrated in this plate are listed in Table IV.



A

E DE CE
O

M

DI

BN

T

B

E DE CE
O

M

DI

BN

T

C

E DE CE
O

M

DI

BN

T

D

E DE CE
O

M

DI

BN

T



43

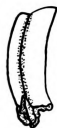


TABLE IV
MEASUREMENTS IN MILLIMETERS OF MOLARS ILLUSTRATED IN
FIGURES 11 AND 12

Mandibular Right Molar	Mesiodistal	Buccolingual	Length
1	3.0	3.0	9.8
2	3.0	3.1	9.5
3	2.5	3.0	10.0
4	2.0	3.0	8.5
Maxillary Right Molar			
1	3.0	3.5	9.9
2	3.0	3.5	9.8
3	3.0	3.5	8.9
4	3.5	3.0	7.9

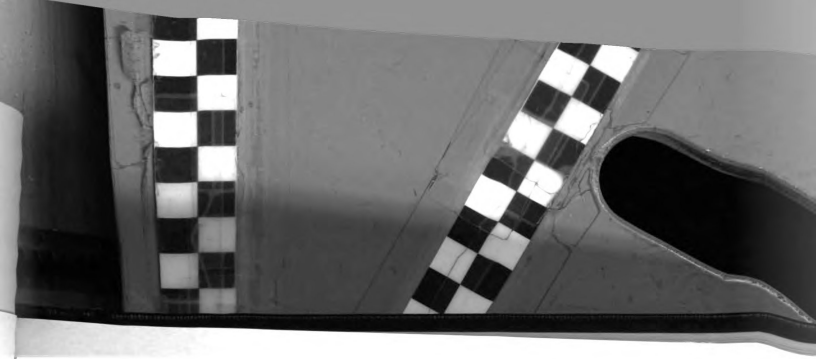


FIGURE 12. DRAWINGS OF THE OCCLUSAL, MESIAL, DISTAL, BUCCAL, AND LINGUAL SURFACES OF THE RIGHT MAXILLARY MOLARS

A. First molar

B. Second molar

C. Third molar

D. Fourth molar

O. Occlusal surface (8X)

M. Mesial surface (3X)

DI. Distal surface (3X)

BU. Buccal surface (3X)

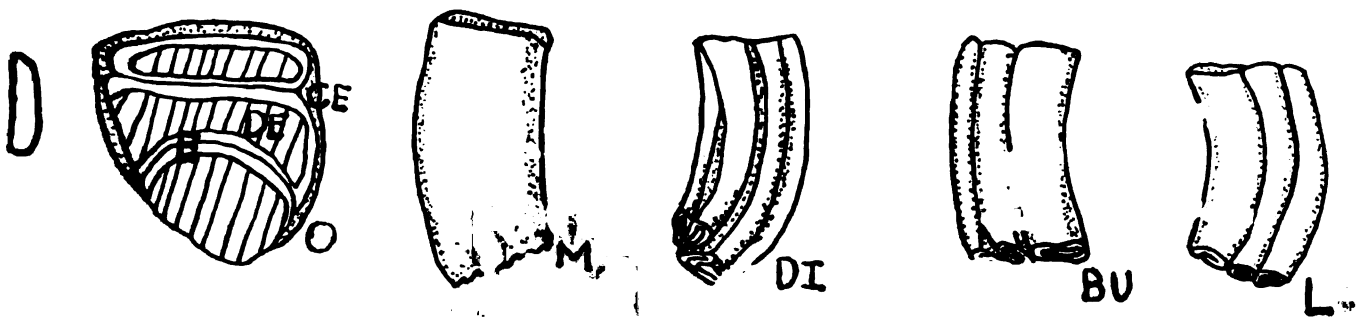
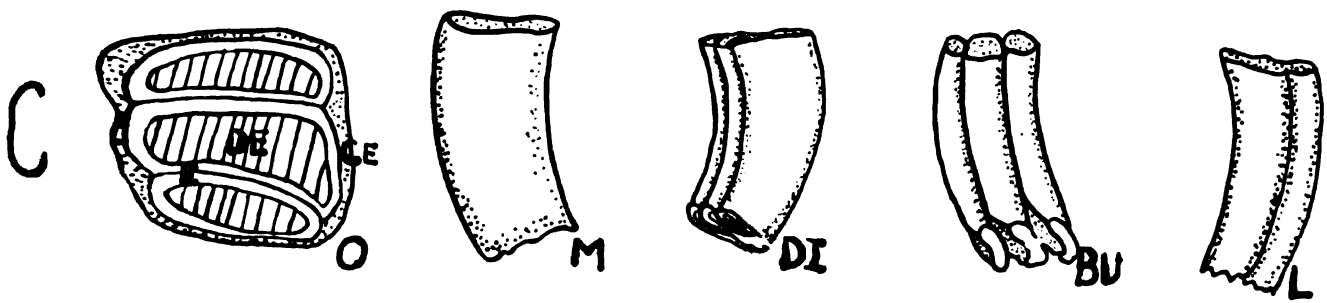
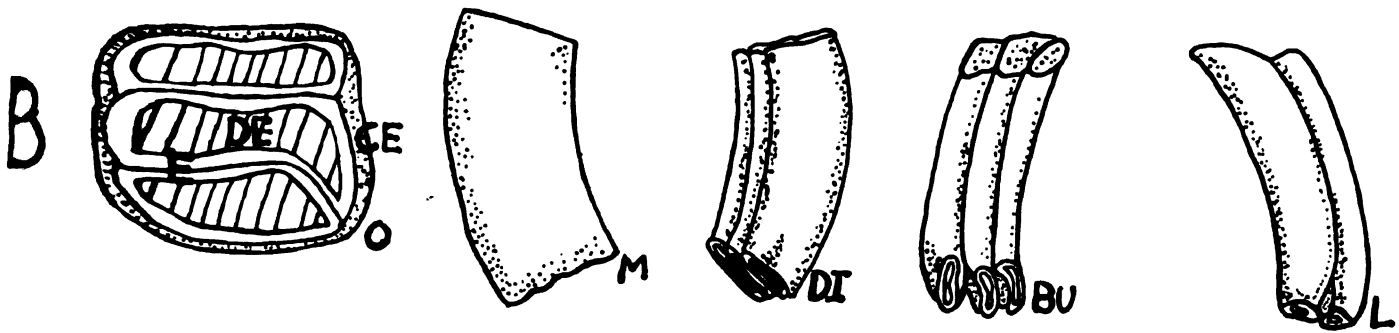
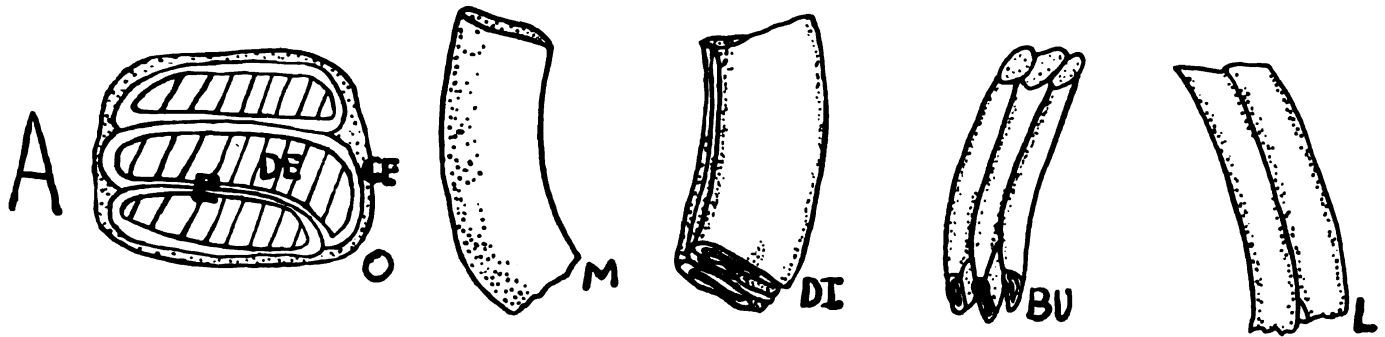
L. Lingual surface (3X)

E. Enamel ridge

DE. Dentine

CE. Cementum

Note: Measurements for the maxillary right molars illustrated in this plate are listed in Table IV.



A

O
E DE CE
M
DI
BT
T

B

O
E DE CE
T

C

O
E DE CE
M
DI
BT
T

D

O
E DE CE
M
DI
BT
T

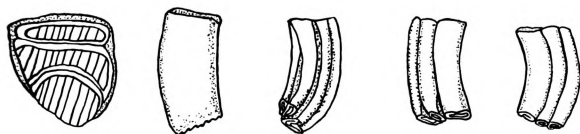
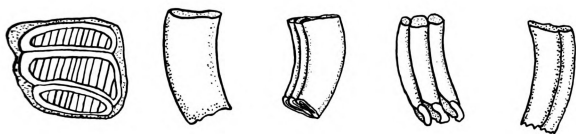
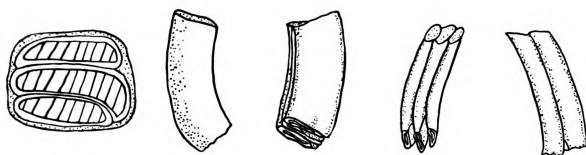


FIGURE 13. A SIDE VIEW OF THE SKULL SHOWING THE CURVATURE OF THE MOLARS AND THE POSITION OF THE INCISORS WHEN THE RESPECTIVE MOLARS OCCLUDE

- A. Incisor
- B. Molars
- C. Mandible
- D. Maxilla
- E. Premaxilla

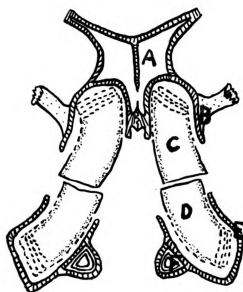
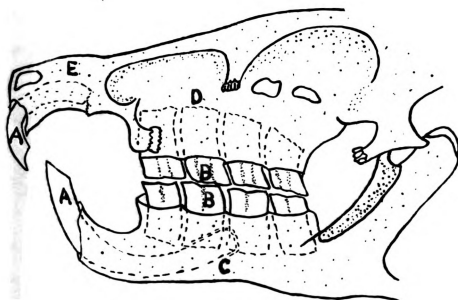
Note: The zygomatic arch has been removed, and the caudal portion of the skull is not shown.

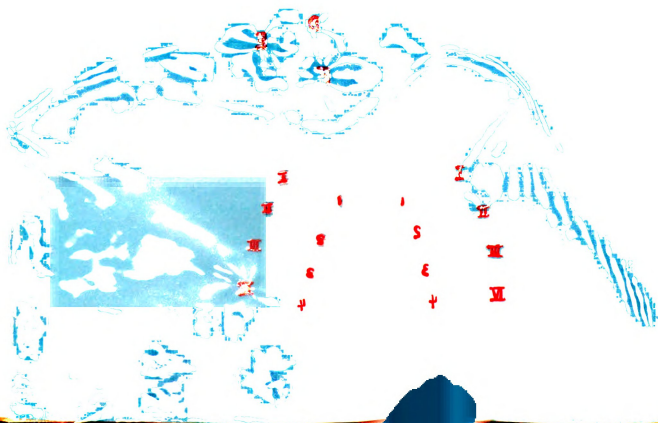
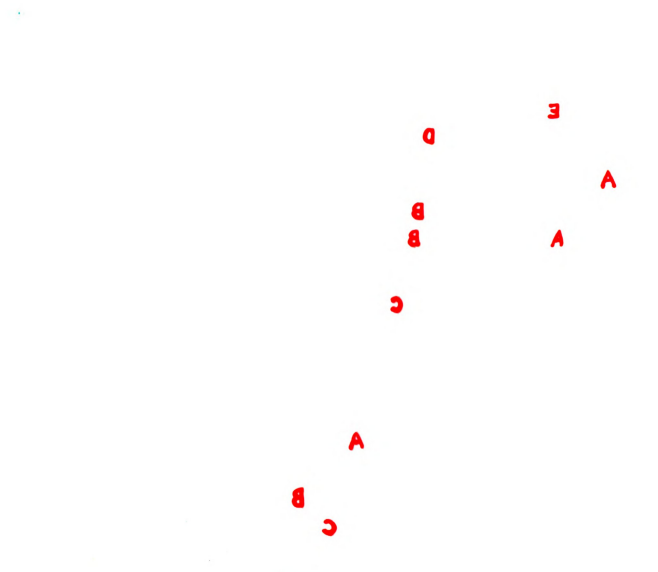
FIGURE 14. A FRONTAL VIEW OF THE UPPER AND LOWER JAWS (INCOMPLETE) SHOWING THE LATERAL CURVATURE OF THE MOLARS AND THE RELATIVE POSITION OF THE BASAL OR BOTTOM PLANES OF THE MOLARS

- A. Nasal Passage
- B. Maxilla
- C. Upper Molar
- D. Lower Molar
- E. Mandible
- F. Position of root of mandibular incisor

FIGURE 15. A DIAGRAM OF THE MANNER OF OCCLUSION OF THE VARIOUS MOLAR TEETH

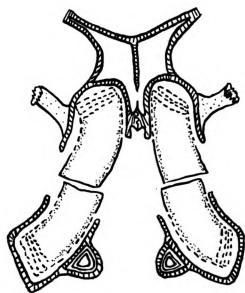
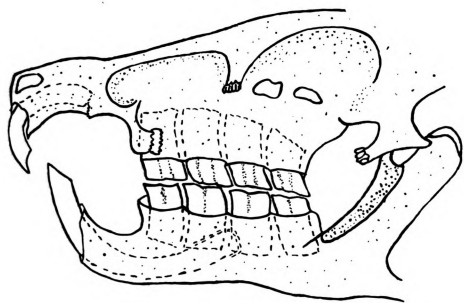
- I, II, III and IV -- Upper Molars
- 1, 2, 3 and 4 -- Lower Molars







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There is no expanded maxillary antrum above the teeth, and the medial wall of the orbit is partly formed by the lateral plate of the alveolar process of the maxilla, against the inner side of which rests the basal planes or bottom of the upper molars. The bottom surfaces or basal planes of the lower molars face almost directly laterad against the lateral wall of the body of the mandible, and hence lie at nearly a right angle to the long axis of the teeth. The basal planes are also thus nearly vertical in the level head.

The alveoli of the various cheek teeth are incomplete in that there is no bony partition between the occlusal two thirds or more of adjacent molars. There is a vertical inner-molar ridge along the walls of the alveoli opposite the line of contact of each two molars. Even though the molars are quite similar in shape and dimensions, the bony ridges prevent the interchange of teeth from socket to socket. As the inter-molar septum is incomplete, there is no interspace between the molars for most of their length.

When the mandible is fully retracted the upper molars occlude with their respective lower molars. Subsequent to maximum retraction of the mandible, occlusion is not perfect, since the upper molars are more widely separated than the lower molars (figs. 14 and 15). Further, as the width of the upper and lower molars is approximately the same, the lateral edges of the occlusal surfaces of the upper molars project beyond the lateral surfaces of the lower molars. If the lateral and medial surfaces of the upper and lower molars of one side are aligned,

the upper molars of the opposite side overhang the lower teeth by almost one half their width.

When the lower incisors strike the occlusal slope of the upper molars, the mandible is shifted anterad to the extent that the first lower cheek teeth lie rostrad to the first upper molars. When the lower incisors are shifted still more anterad so that the incisal edges of the upper incisors strike the occlusal surfaces of the lower incisors, both the first and second lower molars are rostrad to the first two upper molars. When the incisors occlude in either relationship, the opposing upper and lower molars of either side are separated by a gap of a millimeter or more, and hence do not occlude.

The occlusal surfaces of the molars are rough planes. When occlusion is achieved the opposing planes meet in a slanted rather than a horizontal plane, i.e., they slant downward from buccal to lingual.

Prominent ridges of enamel on the occlusal surface outline the subdivisions of each tooth. External to the enamel is a narrow covering of cementum, and internal to the enamel are central areas of dentine. The latter two substances are irregularly worn, so that between the enamel ridges depressions are formed in which the enamel ridges of the opposing teeth rest. For any one upper molar the rostral enamel ridge of the three subdivisions is less worn than the caudal ridge; for the lower molar the caudal enamel ridges of the subdivisions are less worn than are the rostral.

The central dentine areas exhibit depressions. When these regions are observed by means of a dissecting microscope (magnification 3X) the

depressions are found to be rough transverse grooves.

Examination of the drawings of the occlusal surfaces of the molars reveals (figs. 11 and 12) that the transverse ridges of the opposing upper and lower molars are variable, i.e., the ridges in the former are directed transversely and in the latter obliquely. For further details concerning dimensions of upper and lower molars see Table IV.

The teeth appear to be well adapted to a herbivorous diet.

For a short time after birth, each molar consists of three adherent portions and enamel ridges are not observed. By maturity the individual units are fused and the apices are worn away. The enamel becomes so reduced that only the outer portion around the cones remains as ridges, and the dentine is exposed centrally.

5. The Tongue (figs. 6, 16, 17, 18 and 19)

Literature dealing with the chinchilla tongue is fragmentary. Kennedy (1952) indicated that the actions of the tongue are sometimes hindered by malocclusion of the molars.

The tongue is a long slender highly muscular organ. Its length in embalmed specimens is found to range from thirty to thirty-five millimeters. The width varies considerably from the rostral tip to the caudal end, but the overall width increases from the apex to the root, giving the tongue a general wedge-like appearance. The narrowest portion is about three millimeters, and the widest about twelve millimeters.

The dorsal aspect presents several distinctive regions, namely; the apex, the intermolar constriction, the intermolar eminence, and the radix or root (fig. 16).

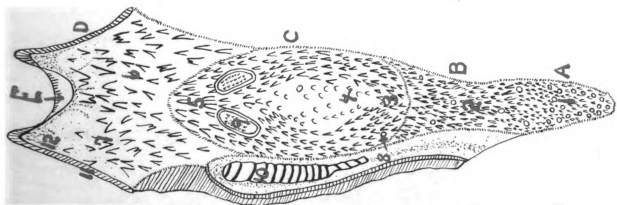
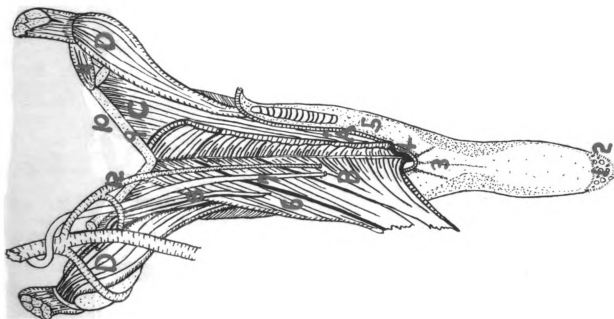


FIGURE 16. THE DORSAL SURFACE OF TONGUE

- A. Apex
 - B. Molar constriction
 - C. Intermolar eminence
 - D. Radix or root of tongue
 - E. Epiglottis
1. Short fine apical filiform papillae
 2. Long fine filiform papillae
 3. Medium-sized filiform papillae
 4. Reduced medium-sized filiform papillae
 5. Large filiform papillae
 6. Conical filiform papillae of radix
 7. Branched conical filiform papillae
 8. Fungiform papillae
 9. Vallate papilla
 10. Foliate papilla
 11. Conical filiform papillae of fauces wall
 12. Simplex papillae of fauces

FIGURE 17. A VENTRAL DISSECTION OF THE TONGUE

- A. M. lingualis, pars longitudinalis inferior
 - B. M. genioglossus
 - C. M. hyoglossus
 - D. M. styloglossus
1. Subapical papillae of tip of tongue
 2. Apex or free portion of tongue
 3. Frenulum
 4. Reflection of mucous membrane of oral floor
 5. Body of tongue
 6. M. geniohyoideus
 7. Lingual nerve
 8. Glossopharyngeal nerve
 9. Basihyoid bone
 10. Radix or root of tongue
 11. M. stylohyoideus
 12. Lingual artery





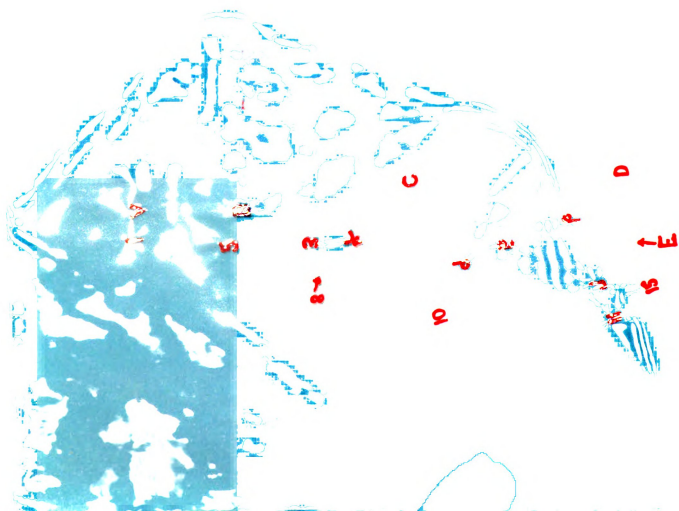
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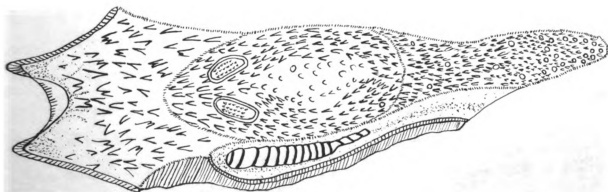
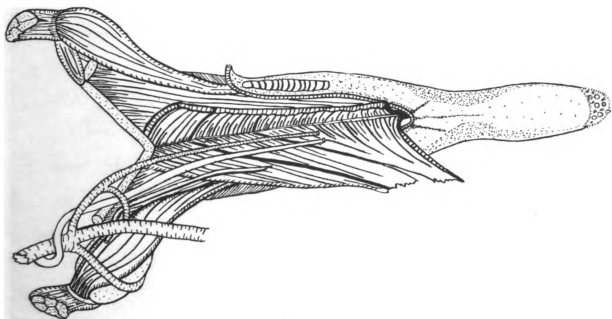
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The apex is rounded rather than pointed, and widens caudad, to about five millimeters. It rests in the diastemal region of the floor of the mouth, in a rounded fossa formed by the dorsum of the incisal alveoli of the mandible.

A second portion, designated as the intermolar constriction, is located between the first lower molars. Due to the closeness of the right and left molars, this portion of the tongue is bilaterally compressed to about three millimeters in width on the dorsal surface. The constriction imparts an hourglass appearance to the front half of the tongue.

The succeeding and more caudal portion of the tongue begins at the level of the second lower molars and widens caudad to occupy all of the remaining intermolar space. Due to a noticeable elevation of the dorsal surface, this region is designated as the intermolar eminence. The entire area is somewhat egg-shaped in outline, with the broadest end rostrad. This is distinctly the thickest region of the tongue; it is approximately ten millimeters in thickness in embalmed specimens.

The caudal end of the dorsum of the tongue widens and is confluent with the floor of the fauces. This region is depressed below the level of the preceding so that the back of the tongue presents a rounded declining slope. This is the region designated as the radix or root of the tongue. The bulk of the lingual components of this area is below the general level of the mucosa of the faucial floor.

Each of the regions indicated is distinctive for the type of papillae present. The author found ten distinguishable papilla modifications.

The numerous papillae of the tongue, the large conical papillae of the faucial walls, the inconspicuous simplex papillae of the soft palate, the hairs of the buccal bristle pad, and the hairs of the infolded lips, together with the rugae of the hard palate and the fleshy incisive papilla impart a very rough and irregular lining to the oral cavity.

a. The lingual papillae (figs. 16 and 9).

Each of the ten types of papillae exists in a relatively unmixed group.

1'. Short fine apical filiform papillae. The apex is covered dorsally with very short fine papillae most of which curve caudally. The surface has a roughened appearance but the actual individual papillae are distinguishable only by magnification of about ten times or more. Scattered among this type and among the various following ones, are circular fungiform papillae.

2'. Long fine filiform papillae. Numerous tall fine papillae are present from the caudal portion of the apex to the rostral margin of the intermolar eminence. They are taller than the preceding papillae but assume the same general proportions, and are also curved caudally. The caliber and height of these papillae are such that the papillae form a coarse mat on the constricted portion of the tongue. Under magnification, these papillae are considerably taller than thick, and appear as sharp bristles.

3'. Medium-sized filiform papillae. The periphery of the dorsum of the intermolar eminence possesses curving rows of taller and thicker

papillae. They are of a slightly greater caliber than the preceding type of papilla but are similarly curved.

4'. Reduced medium-sized filiform papillae. The papillae of the central area of the dorsal eminence appear to have been modified from the preceding type by attrition. Magnification reveals a central group of papillae whose diameter is about the same as that of the medium-sized papillae, but they do not possess tapered apices. The papillae seem to have been worn down considerably. Those nearest the outer portion of this area appear to be less reduced than the more central ones. It thus appears that the central region of the eminence is subject to more abrasion than is the periphery.

5'. Large filiform papillae. The caudal edge of the intermolar eminence possesses papillae which are thicker, larger, and less pointed than the medium-sized filiform papillae.

The apices of these papillae are directed caudad and mediad. No magnification is needed to observe the morphology of this restricted group of papillae. They are flattened and wider transversely.

6'. Conical filiform papillae. The papillae caudal to the eminence are of at least three types. Some scattered ones appear to be large filiform papillae. More numerous however are the very tall fleshy papillae; they are large enough so that their definite cone-like shape can be seen without magnification. They are not flattened as are the previous papillae. The apex is rounded.

7'. Branched conical filiform papillae. The third and largest papillae of the dorsum radix closely resemble the preceding but are

larger, and have two or more apical subdivisions or branches. In a few cases the branches appear to be inverted into the bases of the papillae. Some of the bases are partially flattened into rectangular columns.

The papillae near the epiglottis are smaller. The recess of the fauces which surrounds the introitus pharyngeus is lined with smooth non-papillated mucous membrane.

The tongue also possesses three types of non-filiform papillae.

8'. The fungiform papillae. Low flattened cylindrical papillae are found scattered between the various filiform papillae. On the lingual apex they project slightly above the numerous fine surrounding papillae. They are most numerous on the apex, even extending to the lower surface of the tip.

The fungiform papillae near the dorsal margin are grouped in curving rows, but on the remainder of the apex, on the constricted area, and on the intermolar eminence, they are scattered more or less randomly and sparsely. In all but the apical region surrounding taller filiform papillae partially conceal the fungiform papillae.

There is a marked uniformity in outline, diameter, and height of the fungiform papillae.

9'. The Vallate papillae. Two elongated and flattened reniform papillae are present on the posterior third of the intermolar eminence. These papillae are surrounded by a deep crevice which separates them from the surrounding wall of mucous membrane. On the dorsal surface of the vallate papillae are three longitudinal rows of very short stubby sub-papillae, barely visible to the unaided eye.

The vallate papillae are conspicuous by their reniform outline and by their somewhat elevated and smoother surface. The lateral side is curved convexly, and the medial side concavely. The medial curvature is the lesser curvature. The rostral and caudal ends are rounded.

The long axis of each vallate papilla is directed caudad and mediad. The papillae are approximately twice as long as they are wide.

10'. The foliate papillae. The lateral and under surfaces of the tongue are non-papillated except at the side of the middle third or more of the intermolar eminence. The foliate papillae are somewhat hidden from the dorsal aspect by the lateral margin of the tongue.

The foliate papillae consist of about twelve vertical and curved crevices of about equal length. Between the depressions are more or less rectangular elevations of the mucous membrane, each elevation having a shallow linear central fossa. Three or more reduced foliates are located at the rostral end of the general group.

In addition to the ten types of papillae of the tongue, the lateral wall of the fauces possesses two or more longitudinal rows of distinct caudally curving conical papillae morphologically similar to the conical papillae of the tongue.

The roof of the fauces or soft palate is smooth, except for scattered short inconspicuous simplex papillae which are barely visible grossly.

b. The relationships of the tongue (figs. 18, 19 and 24).

The tongue is bounded above by the palate; laterally by the cheeks, the molars, and the wall of the fauces. The floor of the mouth lies

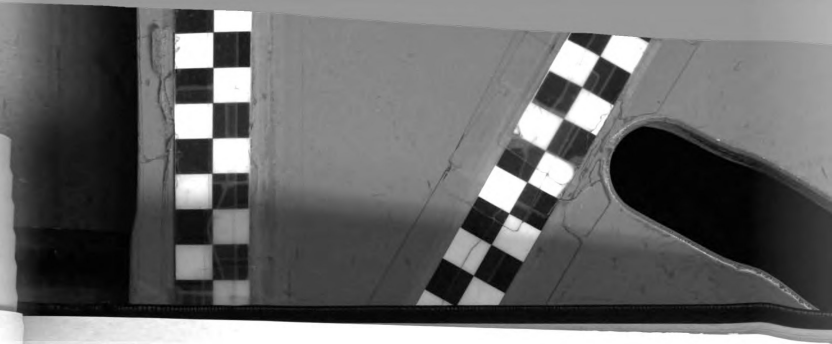
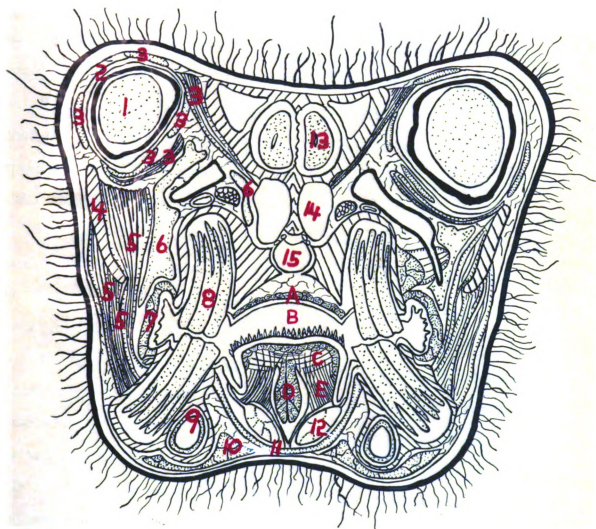


FIGURE 18. A CROSS SECTION OF THE HEAD TO SHOW THE TONGUE AND ORAL CAVITY RELATIONSHIPS

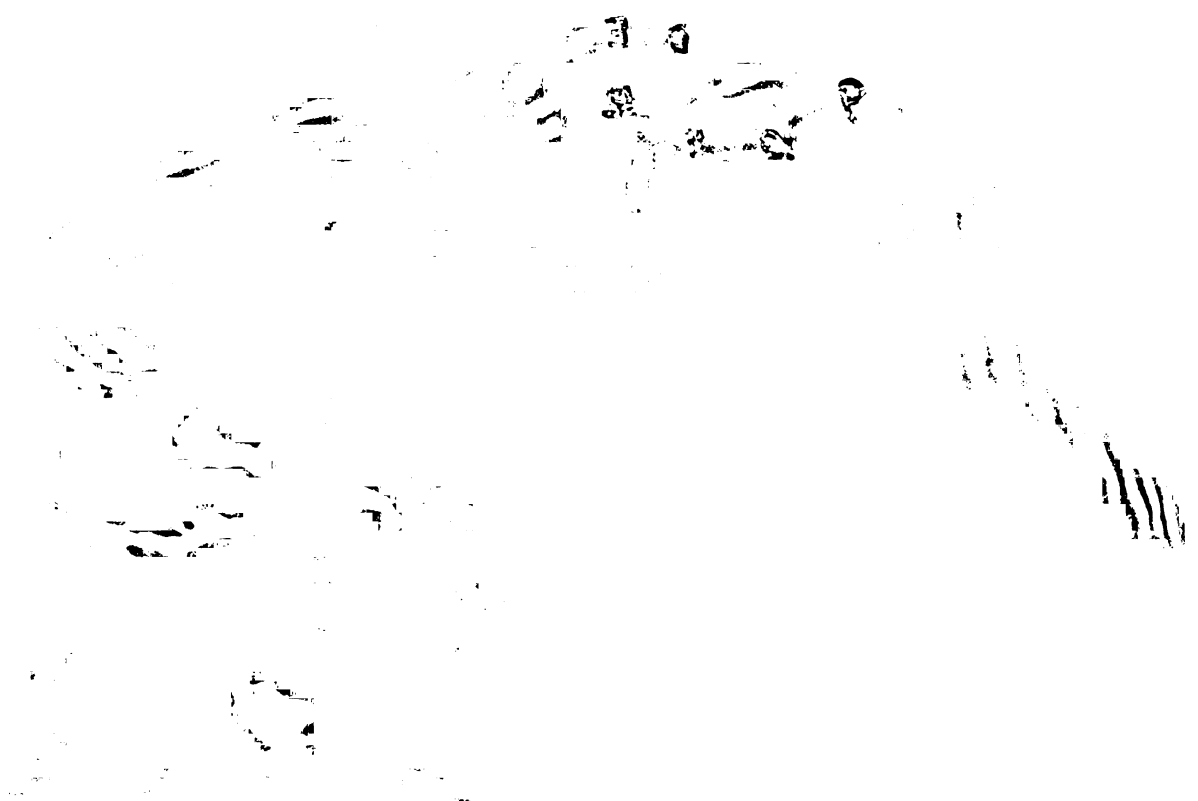
- A. Hard palate
 - B. Oral cavity
 - C. Tongue; direction of m. lingualis fibers
 - D. M. genioglossus
 - E. M. hyoglossus
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- 1. Lens of eye
 - 2. Sclera of eye
 - 3. Eye muscles
 - 4. Zygomatic arch
 - 5. M. masseter; three divisions
 - 6. Adipose tissue
 - 7. M. buccinator
 - 8. Upper molar
 - 9. Lower incisor, proximal end
 - 10. M. digastricus, pars anterior
 - 11. M. mylohyoideus
 - 12. Rostral sublingual gland
 - 13. Olfactory bulb
 - 14. Ethmoid sinus
 - 15. Nasal passage

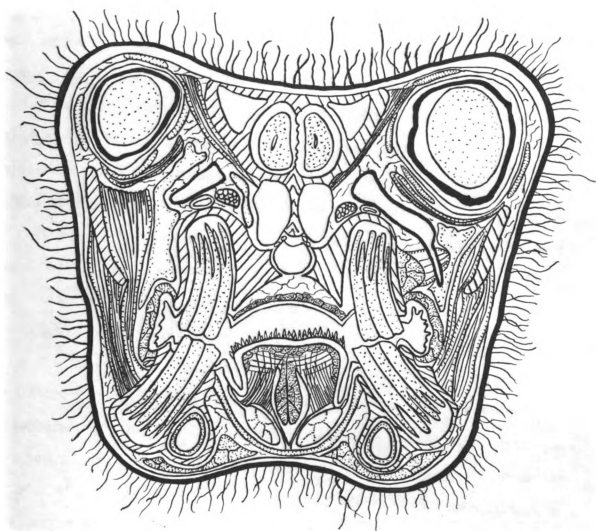
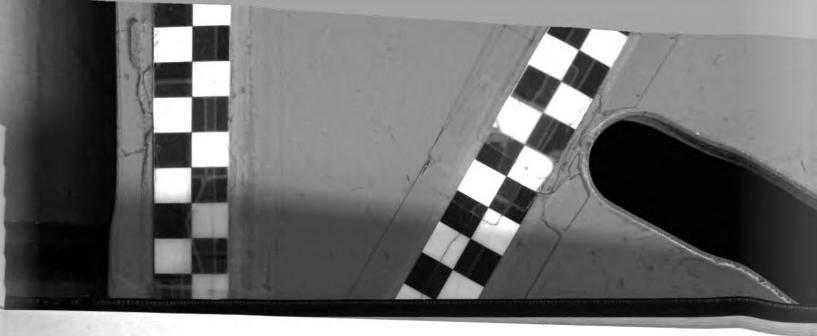


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below most of the tongue, except at the radix or root.

The floor of the mouth is lined by a smooth mucous membrane. Beneath the mucosa are (figs. 21, 22, 23 and 24) the suprahyoid muscles, the submaxillary and sublingual glands, the bodies of the mandible, and various nerves and vessels. A thin muscle, the M. transversus mandibulae crosses ventral to the apex of the tongue (fig. 24). Wood and White (1950) maintained this muscle degenerated in aged animals and that the mandibular symphysis fused solidly. It was present in all specimens which were dissected ventrally, regardless of age, and hence their opinion has not been verified by the present study.

The radix or root of the tongue is primarily attached to the hyoid bone, chiefly by muscles. It is attached to the mylohyoid fascia by vertical fibrous slips that pass lateral to the genioglossal and geniohyoid muscles (fig. 19).

The apex of the tongue is entirely free from attachments except for indistinct and very loose frenulae. Caudal to the apex the tongue is attached from below, but the bulk lies above the floor of the oral space; the tongue thus presents a lateral surface. Caudal to the eminence the body of the tongue recedes below the level of the oral floor lining, and the dorsum thus becomes the floor of the isthmus faucium.

c. The frenulae.

The under surface of the apex receives a very thin and variable fold of mucosa from the region of each lower first molar, and from the lower interincisal eminence.

d. The lingual glands.

Histological examination of mammalian tongues usually reveals salivary gland masses throughout the tongue. The author could not detect lingual glands grossly, or by means of a magnification of thirty times.

e. The muscles of the tongue.

The bulk of the tongue consists of muscle tissue. The lingual muscles are in two groups, the intrinsic and extrinsic groups.

1'. M. lingualis (figs. 18 and 19). The dorsal half of the tongue contains interlacing fibers which course in several directions. Fibers of any one general direction are given a collective name according to the direction; the entire mass is referred to as the M. lingualis, or intrinsic muscle of the tongue.

a'. M. lingualis, pars verticalis. A group of vertical fibers can be seen lateral to the midline, and for about one-half the height of the tongue. They are difficult to distinguish from extrinsic fibers of the genioglossal muscle, except near the apex.

b'. M. lingualis, pars transversus. Fibers which are also near the rostral end of the tongue pass across the tongue. Medially, the fibers of opposite sides interdigitate; they curve dorsally and laterally from the midline, at right angles to the vertical fibers.

c'. M. lingualis, pars longitudinalis superior. A thin layer of scattered longitudinal fibers exist just internal to the dorsal muscosa of the tongue.



d'. M. lingualis, pars longitudinalis inferior. At the lateral margin, the fibers which course longitudinally and which become ventral marginal fibers when the tongue is curved, are called by the above name. They are not discontinuous from the superior longitudinal fibers.

All parts of the lingualis muscle intersperse in such a manner that the tongue appears striated in a cross or a vertical section.

The remaining three muscles constitute the extrinsics.

2'. M. genioglossus (figs. 17, 19 and 24).

The genioglossal muscle is well developed in the chinchilla. It is only imperfectly separable from the more caudal m. geniohyoideus. Both muscles arise by a common flat fan-shaped tendon from a depression of the diastemal region of the mandibular body. The genioglossal muscle fibers arise along the dorsal margin of the tendon and pass verticalad, and mediad, to intermingle with and perhaps to contribute to the verticalis of the lingualis. The fibers of the genioglossus of opposite sides are in contact; the tendons diverge ventrad and anterad, and thus subdivide the under surface of the tongue.

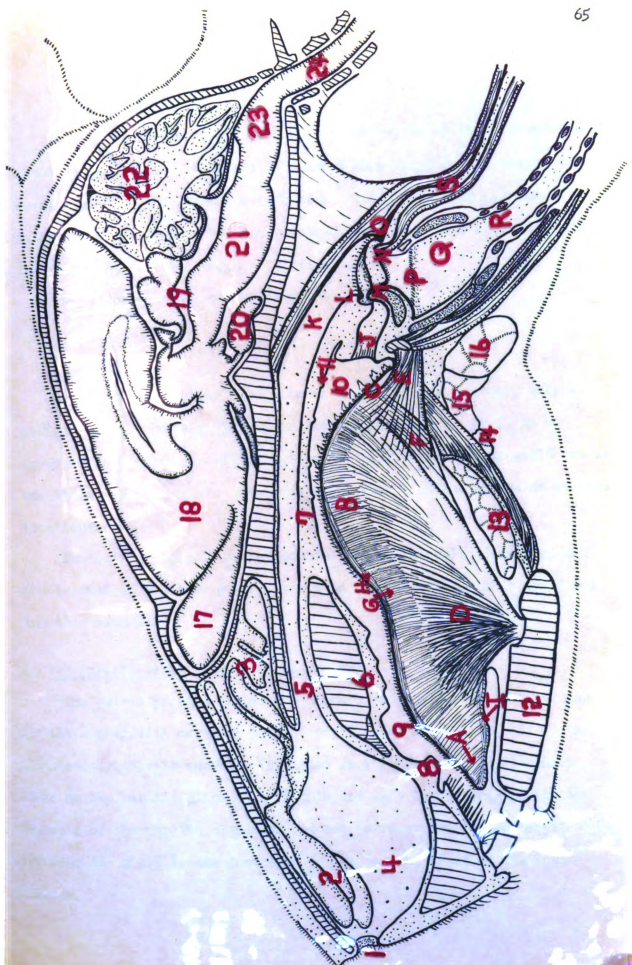
3'. M. hyoglossus (figs. 17 and 19).

The hyoglossus arises from the basihyoid and ventral end of the keratohyoid to course anterad, mediad, and dorsad to enter the body of the tongue where it intermingles with the more caudal fibers of the genioglossus. The radix of the tongue is thus firmly attached to the hyoid structures and to the mandible. The fibers of opposite sides are separated by tendinous septa located on each side of the genioglossal and geniohyoideus muscles (fig. 17).

FIGURE 19. A PARASAGGITAL SECTION OF THE HEAD TO SHOW THE TONGUE AND THE PHARYNX

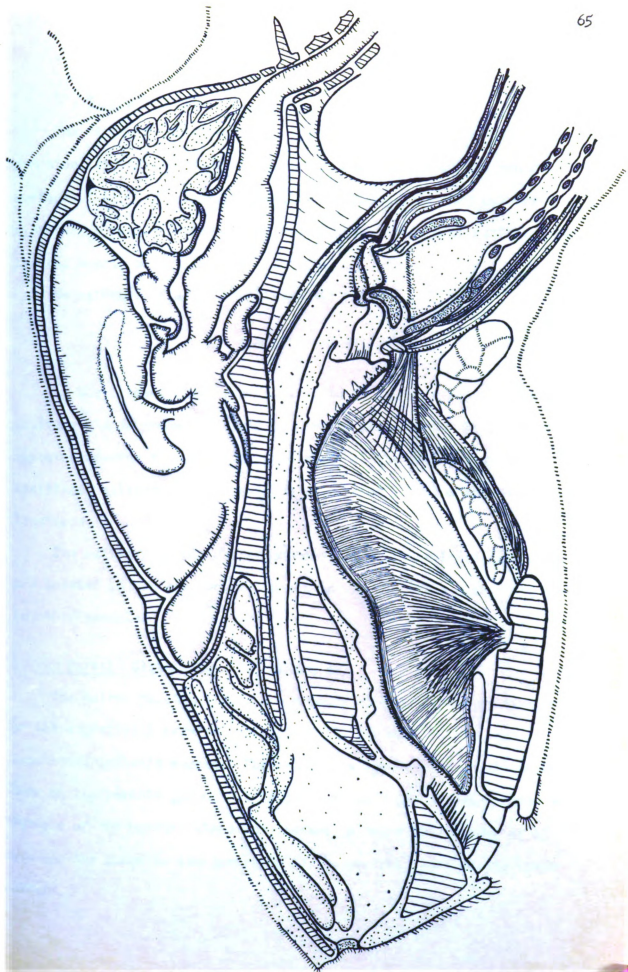
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| A. Apex of tongue | K. Nasal pharynx |
| B. Intermolar eminence of tongue | L. Folds of soft palate |
| C. Radix of tongue | M. Epiglottis |
| D. M. genioglossus | N. Arytenoid fold |
| E. M. hyoglossus | O. Esophageal fold or sphincter |
| F. M. geniohyoideus | P. Vocal cord or fold |
| G. M. lingualis, pars verticalis | Q. Larynx |
| H. M. lingualis, pars longitudinalis superior | R. Trachea |
| I. M. lingualis, pars longitudinalis inferior | S. Esophagus |
| J. Intreitus pharyngeus | |
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| 1. Naris | 9. Oral cavity | 17. Olfactory bulb of brain |
| 2. Turbinate | 10. Isthmus facium | 18. Cerebrum |
| 3. Ethmoid labyrinth and recess | 11. Simplex papilla of palate | 19. Midbrain |
| 4. Nasal vestibule | 12. Mandible | 20. Pituitary gland |
| 5. Nasal passage | 13. Rostral sublingual gland | 21. Pons |
| 6. Hard palate | 14. Middle sublingual gland | 22. Cerebellum |
| 7. Soft palate | 15. Caudal sublingual gland | 23. Medulla oblongata |
| 8. Incisal papilla | 16. Submaxillary gland | 24. Spinal cord |





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4'. M. styloglossus (fig. 17).

The styloglossus arises from the caudal region of the petrotympanic junction, and then spreads out as a broad thin sheet on the ventral surface of the lower tympanic inflation. The muscle then narrows to a ribbon-like portion which passes rostrad along the under surface of the lateral margin of the tongue.

No evidence of a chondroglossus was observed.

E. The Salivary Glands

As the present study was confined to macroscopic anatomy, only the salivary glands grossly visible are herein considered. It is to be expected however that a microscopic study of the oral cavity would reveal additional salivary gland substance associated with the mucosa at various locations.

The salivary glands described here are well developed glands, and are located in the same general areas in which similar glands are found in other mammals.

1. The Parotid Gland (figs. 20, 21 and 22)

The paired parotid glands are bounded externally by the integument, by the superficial cervical portion of the platysma muscle, and by the parotidoauricularis muscle. The later is a ribbon-like muscle which lies on the parotid gland. It is thin and wide at its origin from the capsule of the parotid gland and becomes narrower and thicker as it crosses the gland to its insertion on the conchal crest at its lower border.

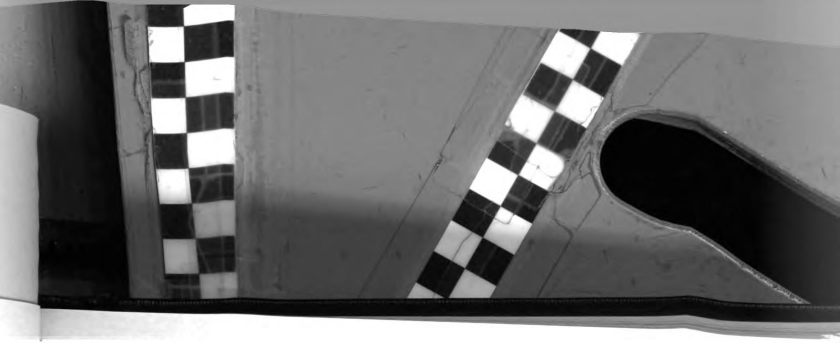


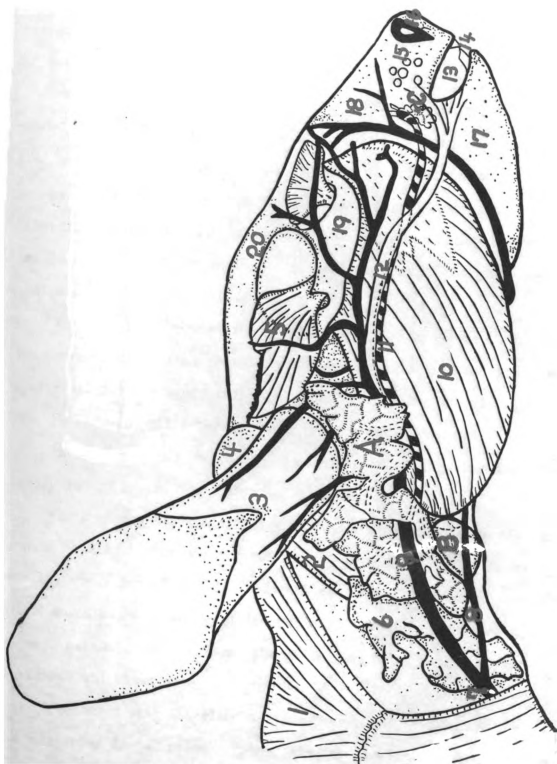
FIGURE 20. THE RIGHT PAROTID, SUBMAXILLARY, AND BUCCAL SALIVARY GLANDS

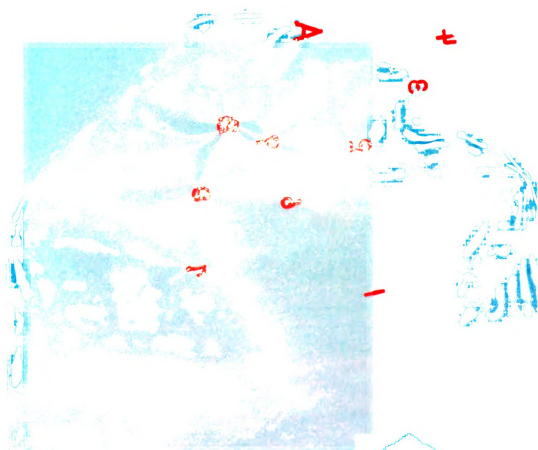
A. Parotid gland

B. Submaxillary gland

C. Buccal gland

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| 1. M. trapezius | 11. Parotid gland duct |
| 2. M. cleidomastoideus | 12. Dorsal buccal nerve |
| 3. Auricle of ear | 13. Postincisal recess |
| 4. Tympanic expansion | 14. Incisor teeth |
| 5. M. temporalis | 15. Mystacial vibrissae |
| 6. Fat body | 16. Naris |
| 7. External jugular vein | 17. Mandible |
| 8. Anterior facial vein | 18. Premaxillary bone |
| 9. Posterior facial vein | 19. Zygomatic arch |
| 10. M. masseter | 20. Frontal bone |





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The gland is enclosed in an extensive capsule or extension of the deep cervical fascia. Also surrounding the gland is a variable amount of adipose tissue, especially at the caudal third or more.

Removal of the above structures from the area ventral to the auricle and from around the angle of the mandible, exposes the central area of the gland. From this central area the gland spreads ventrad and mediad to the lateral border of the infrahyoid musculature. It likewise extends dorsad, its upper border sometimes being notched by the rounded base of the auricle. A small portion of the gland may extend a short distance rostrad from the ear.

The gland is somewhat rectangular, with the long axis being in an craniocaudal direction. Measurements show the gland to be approximately thirty millimeters long, and at various places along the gland from five to fifteen millimeters or more from dorsal to ventral.

In cross section the parotid is irregularly triangular and extends deeply inward toward the pharyngeal surface.

The profound surface of the gland rests in contact with the carotid sheath bearing the common carotid artery, the internal jugular vein, and the vagus nerve. It also contacts the lateral border of the infrahyoid musculature, the digastric muscle at the angle of the mandible, as well as the central area of the underlying belly of the sternocleidomastoideus muscle.

Associated with the gland are numerous blood vessels and nerves. The posterior facial branch of the external jugular vein courses upon the lateral surface, and at some places becomes superficially embedded

in the glandular substance. These veins and their branches appear to be the venous supply of the gland.

Arteries supplying the gland can be traced from the external maxillary branch of the external carotid artery. Numerous fine branches of the facial nerve and other nerves penetrate the gland. Functional nerve connections were not determined.

The parotid gland is less compact than the following salivary glands, and consists of numerous grossly visible lobules. Eighty-nine lobules were counted in one gland. The lobulations make it easy to distinguish this slightly pinkish gland from surrounding adipose tissue.

The terminal excretory duct of the parotid gland follows a course very similar to that indicated for the mink (Mustella vison) by Kainer (1954a), and also for the fox squirrel (Sciurus niger) by Jenkins (1954). The duct arises along the ventral border of the gland, and receives various sub-branches as it curves upward and rostrad beyond the cranial border of the gland. It soon contacts the dorsal buccal branch of the facial nerve (fig. 25) along the ventral border of the latter and is partially covered by the nerve. Both structures course rostrad toward the angle of the mouth, and upon approaching the cranial third of the masseter muscle upon which the structures lie, the parotid duct crosses internal to the dorsal buccal nerve, and then it extends rostrad along the superior border of the latter.

As the duct reaches the cranial border of the masseter muscle, it bends sharply inward around the border to traverse a short distance in the tissues of the cheek lining. The duct then penetrates the buccal

mucosa at a point opposite the anterior wall of the maxillary first molar at the level of the occlusal surface.

Immediately before penetrating the buccal mucosa a tiny lobulated gland (molar gland) of about five millimeters in diameter is attached to the duct.

It is difficult to determine the exact number of subdivisions which converge to form the principle duct. At least three rather large divisions are seen in each case, as well as a small number of smaller branches whose lesser subdivisions are invisible grossly.

2. The Molar Gland (fig. 20)

These tiny paired glands of the Chinchilla cheek send ducts into the distal end of the parotid duct, whereas similar glands in the cat are said to empty by several short ducts directly into the mouth (Reighard and Jennings, 1935). The glands are located rostral to the cranial border of the masseter muscle, at about the level of the oral fissure.

The glands are flat, of two or more lobules, and are about five millimeters in diameter. The lobules resemble those of the parotid gland. Molar glands were present in each of the (six) specimens in which they were sought.

3. The Submaxillary Glands (figs. 21, 22, 23 and 24)

The paired submaxillary glands (submandibular, of Buchanan, 1953) are lenticuloid to avoid organs located below the floor of the mouth, and lateral to the rostral end of the larynx. They rest in a pyramidal depression formed by the posterior portion of the masseter muscle, and

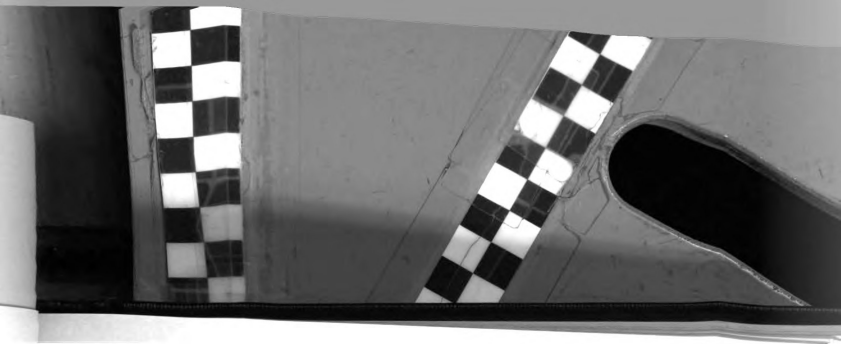
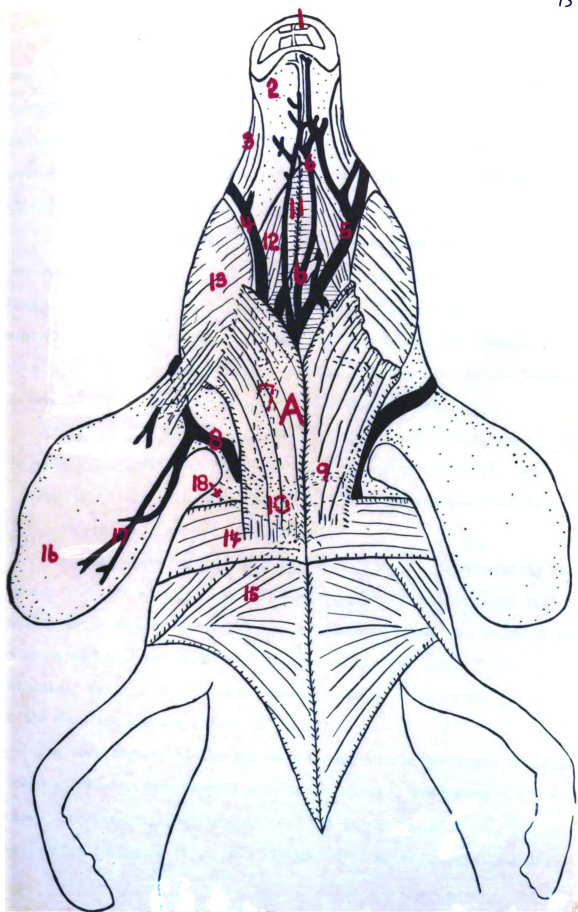


FIGURE 21. A VENTRAL VIEW OF THE HEAD TO SHOW THE PLATYSMA MUSCLE AND OTHER STRUCTURES RELATED TO THE UNDERLYING SUBMAXILLARY GLANDS

- A. M. platysma
- 1. Incisors
- 2. Mandible
- 3. M. platysma, rostral slip
- 4. Right anterior facial vein
- 5. Left anterior facial vein
- 6. Submental vein
- 7. Common anterior facial vein
- 8. Right posterior facial vein
- 9. Left posterior facial communicating vein
- 10. Right external jugular vein
- 11. M. mylohyoideus
- 12. M. digastricus, pars anterior
- 13. M. masseter
- 14. M. pectoralis major
- 15. M. pectoralis minor
- 16. Auricle of ear
- 17. Posterior auricular vein
- 18. Outline of clavicle



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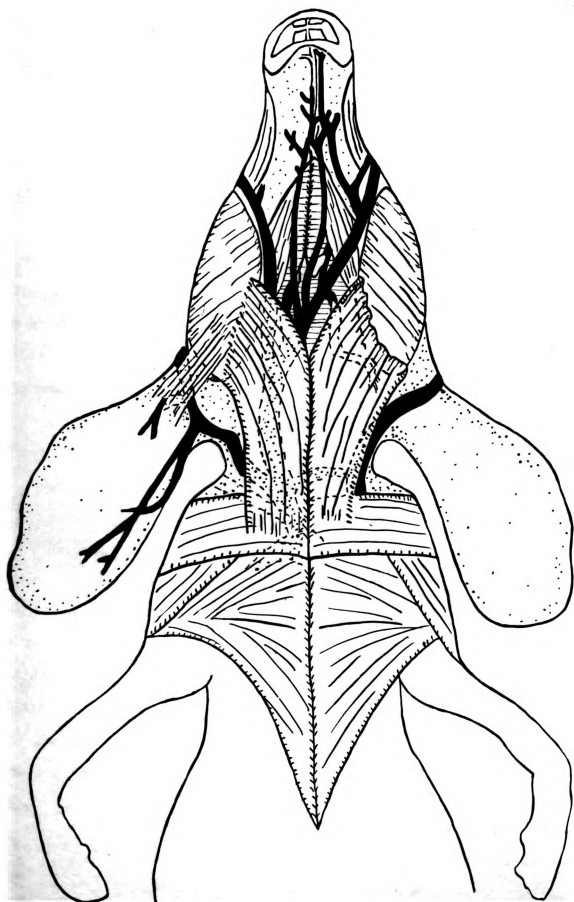
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the posterior belly of the digastric muscle laterad, by the infrahyoid musculature mediad, and by the cranial border of the sternocleidomastoideus muscle as it obliquely crosses the ventral surface of the neck from the sternum to the base of the auricle. The medial borders of the right and left glands are nearly in juxtaposition.

The compact submaxillary glands are the most conspicuous organs ventral to the pharynx. They are about thirteen millimeters long, the long axis being in a craniocaudal direction. The superficial or ventral surface of the gland is smooth and convex and the lobules of the gland are much more closely bound together than are the parotid lobules. In cross-section, the glands appear somewhat pyramidal.

The glands are covered superficially by the integument, and by the superficial cervical portion of the platysma muscle (fig. 21). The platysma muscle is well developed at this location and tends to obscure the underlying pale submaxillary glands.

The right common facial vein on the right, and a communicating vein between the left anterior and left posterior facial veins on the left are usually found superficially. In one specimen examined, the veins alluded to traversed the deep surface of the submaxillary glands. These veins ultimately empty into the large external jugular veins at the junction of the neck and sternum (figs. 21 and 22).

The deep surface of the glands rests upon an accumulation of adipose tissue which surrounds several structures, namely, the common carotid artery, the internal jugular vein, and the larger branches of cranial nerves nine to twelve (fig. 24). As indicated above, several muscles



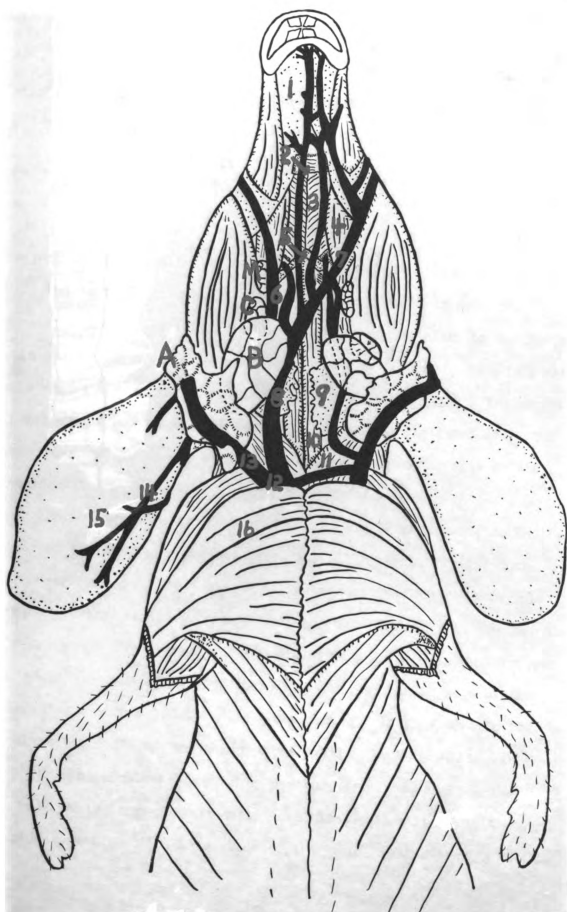
FIGURE 22. A VENTRAL VIEW OF THE HEAD AND NECK TO SHOW THE PAROTID, THE SUBMAXILLARY, AND THE CAUDAL AND MIDDLE SUBLINGUAL GLANDS, AFTER REMOVAL OF THE PLATYSMA MUSCLE

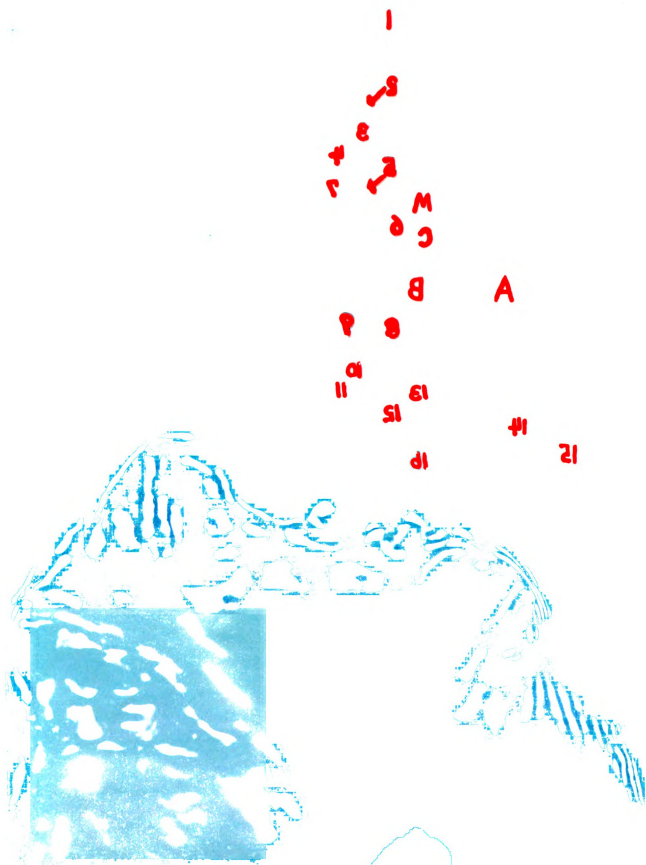
- A. Parotid gland
- B. Submaxillary gland
- C. Caudal sublingual gland
- M. Middle sublingual gland

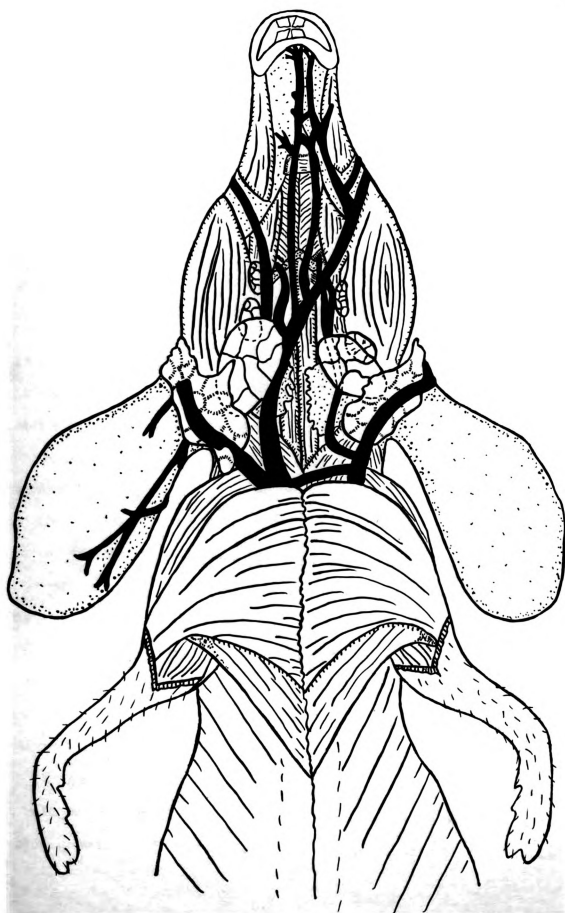
- 1. Ventral surface of mandible
- 2. M. transversus mandibulae
- 3. M. Mylohyoideus
- 4. M. digastricus, pars anterior
- 5. Hyoid
- 6. Right anterior facial vein
- 7. Left anterior facial vein
- 8. Common anterior facial vein
- 9. Fat body
- 10. M. sternohyoideus
- 11. M. sternomastoideus
- 12. Right external jugular vein
- 13. Right posterior facial vein
- 14. Posterior auricular vein
- 15. Auricle of ear
- 16. M. pectoralis major



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form the bed for this gland, but the posterior belly of the digastric muscle underlies the majority of the surface of the gland.

Lymph nodes are not conspicuous structures in the ventral cervical region of the chinchilla but a few small nodes are present.

The cranial margin of the submaxillary gland contacts a diminutive 'major' sublingual gland, which in turn is near a second diminutive 'major' sublingual gland that lies a few millimeters rostrad.

The duct of the submaxillary gland though small in caliber, is grossly visible. It arises in the substance of the gland by an irregular main canal with a variable number of tiny side branches. The duct gains exit near the anterior or rostral end of the deep surface. The superficial origin can be readily located by inverting the gland (fig. 23), thus exposing the dorsal or deep surface in an inferior view of the intermandibular area.

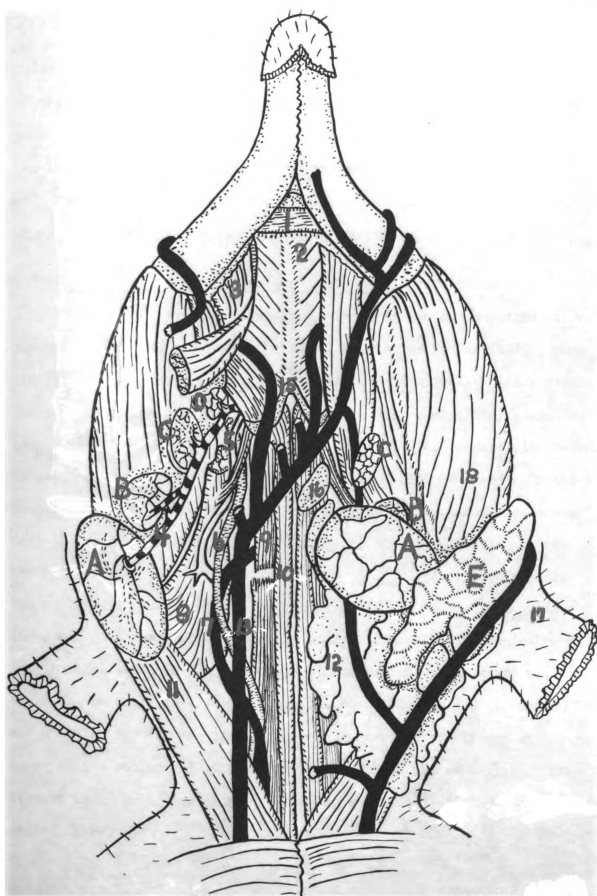
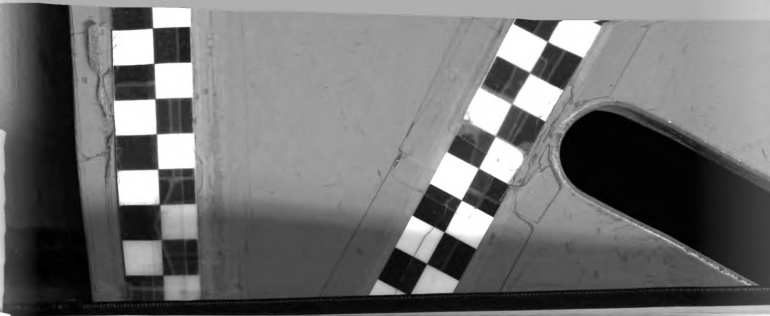
The total length of the duct from the gland to its orifice in the floor of the mouth, is about thirty-five millimeters. As the duct progresses rostrad, about seven millimeters of its length is visible before it turns upward or deeply between the medial edge of the masseter muscle and anterior portion of the digastric muscle. The duct courses for about an equal distance to pass between the cranial edge of the mylohyoideus muscle and the hyoglossus muscle. In this portion it receives the ducts of the two or three smaller 'major' sublingual glands.

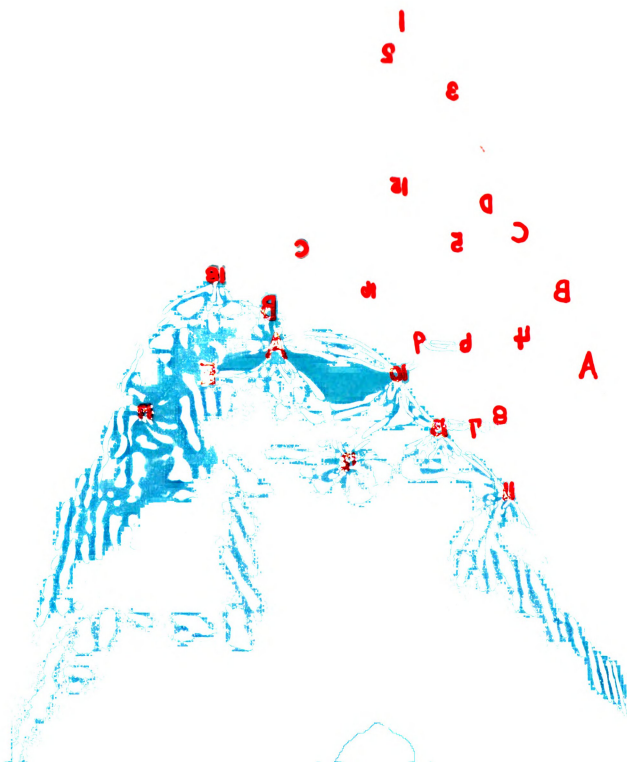
The duct continues rostrad by passing medial to, and lengthwise of the relatively large rostral sublingual gland. At this point the duct is closely attached to the surface of the gland, rather than to the medially

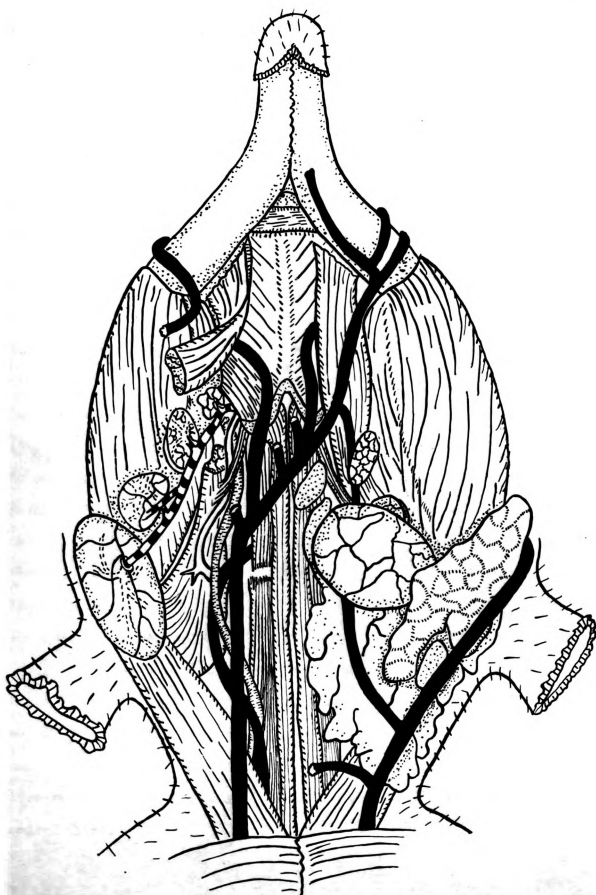


FIGURE 23. THE VENTRAL SURFACE OF THE HEAD SHOWING THE SUBMAXILLARY AND SUBLINGUAL GLANDS DISPLACED Laterally, AND THE ORIGIN AND COURSE OF THE SUBMAXILLARY DUCT TO THE LEVEL OF THE MYLOHYOID MUSCLE

- A. Submaxillary glands
- B. Caudal sublingual glands
- C. Middle sublingual glands
- D. Right accessory sublingual gland
- E. Left parotid gland
- 1. M. transversus mandibularis
- 2. M. mylohyoideus
- 3. M. digastricus, pars anterior (sectioned)
- 4. Submaxillary duct
- 5. Lingual nerve
- 6. Common carotid artery
- 7. Internal jugular vein
- 8. M. digastricus, pars posterior
- 9. M. thyrohyoideus
- 10. M. sternohyoideus
- 11. M. sternocleidomastoideus
- 12. Fat body
- 13. External jugular vein
- 15. Hyoid bone
- 16. Lymph node
- 17. Auricle of ear
- 18. M. masseter







lying hyoglossus muscle. Immediately before reaching the caudal border of the gland, the submaxillary duct is crossed ventrally by the lingual nerve. As the duct passes rostrad to the rostral sublingual gland it receives one or more fine ducts from the latter gland in some cases.

The terminal portion of the submaxillary duct then turns dorsad, to open upon the floor of the mouth, in the region of the diastema.

4. The Caudal, Middle, and Accessory Sublingual Glands

The submaxillary duct receives the ducts of two and sometimes three diminutive lobulated salivary glands. According to Greene (1935), such glands have been designated in the rat as major sublingual glands even though they are more closely associated with the submaxillary gland and its duct. In the rat the most rostral salivary gland beneath the tongue is designated by Greene (*ibid.*) as the minor sublingual gland. In the case of the human there is only one sublingual gland, and it is located near the mandibular symphysis in essentially the same location as the minor sublingual gland of the rat (Greene, *ibid.*). In the chinchilla the sublingual gland near the mandibular symphysis is much larger than the sublingual near the submaxillary gland. To add to the confusion of terminology, there is a trend at present to designate the gland now known as the submaxillary gland as the submandibular gland (Buchanan, 1953), although the former name is still generally used. Thus if one wishes to refer to the sublingual glands in relationship to the submaxillary gland it must be known if one means also the submandibular gland of more modern usage.

The present author arbitrarily employs the longer established name for the modern term submandibular gland; namely, the submaxillary gland. The sublingual gland closest to the submaxillary gland of the chinchilla is called the caudal sublingual, the next sublingual gland rostrad, the middle sublingual, and the most rostrad gland located at the mandibular symphysis, the rostral sublingual.

Such usage is not according to the conventional designation used in the case of rodents, as employed by Greene (1935). Inasmuch as the gland which would have to be called the major sublingual gland by such usage is much smaller than the so-called minor sublingual in the case of the chinchilla, the conventional usage has been abandoned in favor of a less ambiguous topographical usage. This still presents the difficulty of clearly designating still smaller occasional collections of lobules not associated with any of the caudal, middle, or rostral sublinguals, but which nevertheless appear to discharge into the duct of the submaxillary gland as do the sublinguals.

a. The Caudal Sublingual Gland (figs. 22 and 23).

The most caudal sublingual gland is in direct contact with the rostral surface of the submaxillary gland, and in some cases is concealed by the submaxillary in ventral view. The general size is about five millimeters by two and one-half millimeters, and in outline it is more or less reniform. In those cases in which the gland resembles surrounding lymph nodes, it is distinguishable due to the usual salivary gland type of lobulation. The lobules are not tightly bound, and hence are easily dissectable.

b. The Middle Sublingual Gland (figs. 22 and 23).

A few millimeters rostrad another similar appearing, but somewhat reduced, middle sublingual is present. It, as does also the previous sublingual, resembles the submaxillary in substance but not in volume.

c. The Accessory Sublingual Gland (fig. 23).

In one specimen studied a third gland very similar in appearance to the first two sublingual glands was found. It was much smaller than the former two and hence is referred to as an accessory sublingual purely for sake of reference. It had a very short duct (a millimeter or less in length) which connected with the submaxillary duct immediately before the latter duct passed rostrad between the mylohyoideus and the hyoglossus muscles. Though only less than half as large as the caudal and middle sublingual glands this gland was easily distinguishable from small lymph nodes of the same region.

5. The Rostral Sublingual Gland (fig. 24).

The rostral sublingual gland is much larger and much more characteristic in form than the caudal and middle sublingual glands. It has diameters of about seven by thirteen millimeters, and though these approximate the dimensions of the submaxillary gland, the rostral sublingual is distinctly laterally compressed, and is thus less voluminous. The gland closely resembles an almond in form, and stands edgewise below the floor of the mouth. The dorsal edge contacts the mucous membrane of the oral floor, the ventral edge and lateral surface contact the hyoglossus muscle. The ventral edges of the two closely placed rostral



FIGURE 24. A VENTRAL VIEW OF THE HEAD, THE SUBLINGUAL GLANDS, AND THE TERMINATION OF THE SUBMAXILLARY DUCT

- A. Rostral sublingual gland
- B. Submaxillary duct (terminal portion)
- C. Rostral sublingual gland ducts
- 1. Ventral surface of lingual apex
- 2. Mucous membrane of oral floor
- 3. Right half of mandible reflected laterally
- 4. M. genioglossus
- 5. M. geniohyoideus
- 6. M. mylohyoideus reflected laterally
- 7. M. masseter
- 8. M. digastricus, pars posterior and hyoid slip
- 9. Hyoid bone
- 10. M. sternohyoideus
- 11. Trachea
- 12. Lingual branch of trigeminal nerve (N V)
- 13. Glossopharyngeal nerve (N IX)
- 14. Vagus nerve (N X)
- 15. Spinal accessory nerve (N XI)
- 16. Ascending and descending hypoglossal (N XII)
- 17. Common carotid artery
- 18. Internal carotid artery
- 19. External carotid artery
- 20. External maxillary artery
- 21. Lingual artery



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8. M. digastricus, pars posterior and hyoid slip
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17. Common carotid artery
18. Internal carotid artery
19. External carotid artery
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21. Lingual artery

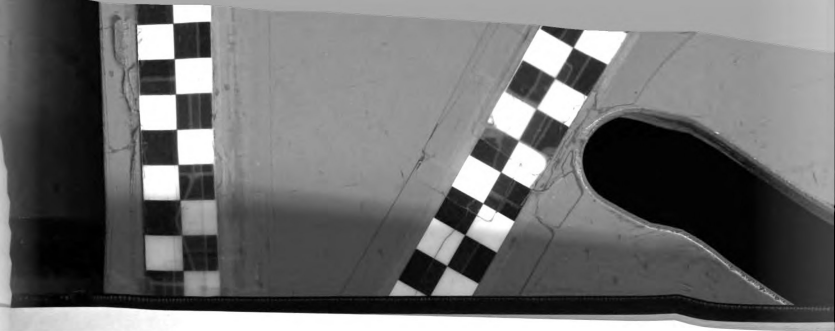


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sublingual glands of opposite sides produce a sublingual prominence of the mylohyoideus muscle, causing the muscle to protrude between the anterior portions of the right and left digastric muscles, as was indicated by Wood and White (1950).

The rostral sublingual gland corresponds very closely in form and in location to the sublingual gland in man. It can best be seen from below by cutting the mandibular symphysis and then separating the halves of the mandible. Medially the gland contacts the genioglossus muscle, the hyoglossus muscle, the submaxillary duct, the lingual nerve, and terminal branches of the hypoglossal nerve.

The gland possesses from eight to ten or more grossly visible ducts which emerge vertically from the dorsal or lesser curvature of the gland to open into the floor of the mouth medial to the ridge formed by the incisal alveolus of the mandible in the region of the diastema. The ducts course nearly parallel to each other and are somewhat equidistant; they lie in a straight row from rostral to caudal.

In two cases connections from the anterior apex of the gland seemed to join the submaxillary duct near the terminus (fig. 24).

The lobulations of the lateral surface are closely bound, the gland thus appearing very smooth and glistening. On the medial side the lobulations are less tightly bound.

The gland appears to be nearly white in contrast to the muscles of embalmed specimens.

The rostral sublingual (minor sublingual of Greene, 1935) was in all cases the most characteristic and constant in form of all the salivary

glands, and the third largest. The largest salivary gland was the parotid, the next largest the submaxillary.

F. The Muscles of Mastication

The chewing muscles and other muscles closely associated with them occur in three general groups. The major and prime movers of the mandible consist of the masseters, temporals, and pterygoids. The hyoid musculature, illustrated in various figures (19, 22, 23 and 24), acts as synergists. Related either functionally or topographically (or both), to the above groups, are the muscles of facial expression. This latter group is considered in some detail to verify previous accounts of them in the literature, as well as to add to the completeness of the description of the structure of the oral cavity.

1. The Muscles of Facial Expression

The expression musculature is concentrated in the buccal and auricular regions. All expression muscles are comparatively flat thin sheets, and according to Huber (1931), they are not bound by a coherent superficial fascia; the latter fact enables them to move individually as well as in groups.

a. The buccal group.

1'. M. levator labii superioris (fig. 25).

This thin muscle arises at the infraorbital foramen at the ventral border of the latter. Its fibers are directed rostrad and ventrad to insert into the superior labium. The muscle is pierced by numerous mystacial vibrissae.

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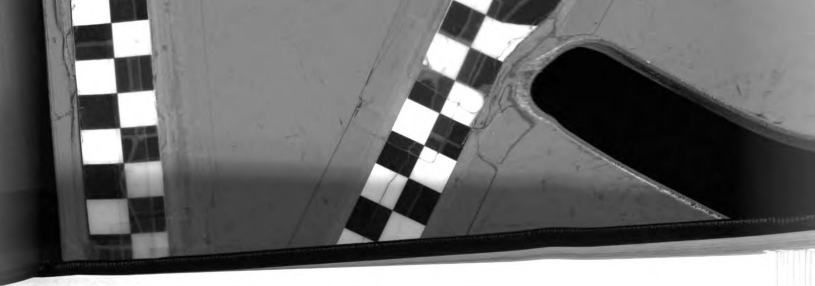


FIGURE 25. A LATERAL VIEW OF THE HEAD AND NECK TO SHOW THE VARIOUS MUSCLES OF FACIAL EXPRESSION AND VARIOUS UNDERLYING STRUCTURES

- | | |
|------------------------------------|-------------------------------|
| A. M. levator labii superioris | 8. Fat body |
| B. M. platysma | 9. Submaxillary gland |
| C. M. zygomaticus | 10. Posterior facial vein |
| D. M. buccinator | 11. Anterior facial vein |
| E. M. orbicularis oris | 12. M. sternocleidomastoideus |
| F. M. orbicularis oculi | 13. M. trapezius |
| G. M. frontalis | 14. Auricle of ear |
| H. M. parotideoauricularis | |
| I. M. auricularis anterior | |
| 1. Dorsal buccal nerve | |
| 2. Parotid duct | |
| 3. Orbit | |
| 4. Parotidomasseteric fascia | |
| 5. Anterior facial vein and artery | |
| 6. Superficial temporal vein | |
| 7. Parotid gland | |

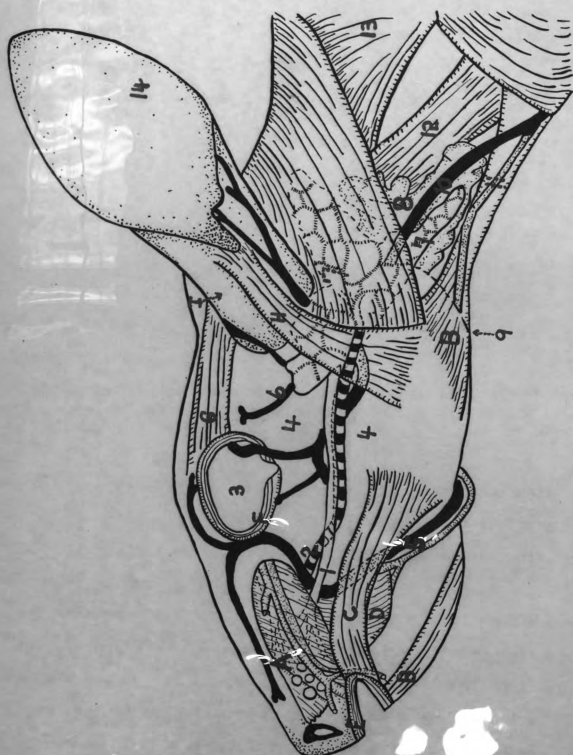
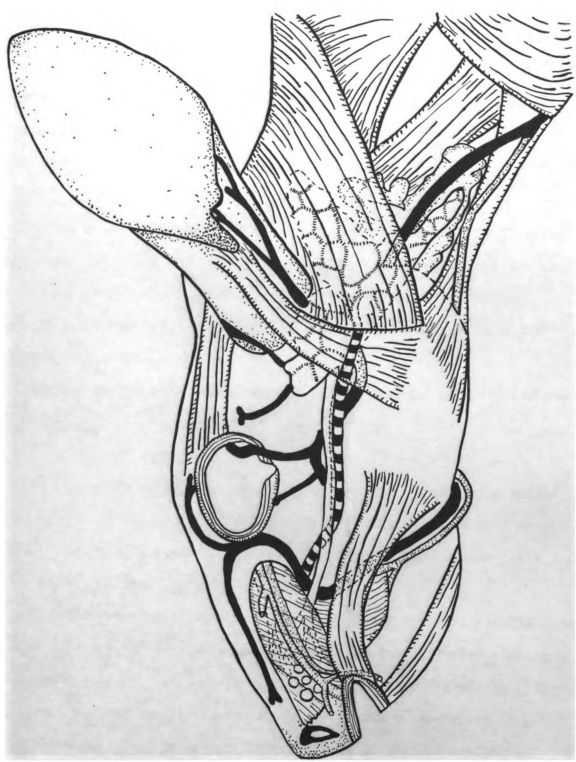


FIGURE 1. A LATERAL VIEW OF THE HEAD AND NECK TO SHOW THE VARIOUS MUSCLES OF FACIAL EXPANSION AND VARIOUS UNDERLYING STRUCTURES

- A. M. levator labii superioris
- B. M. platysma
- C. M. zygomaticus
- D. M. buccinator
- E. M. orbicularis oris
- F. M. orbicularis oculi
- G. M. frontalis
- H. M. parotidomandibularis
- I. M. auricularis anterior
6. Fat body
9. Submandibillary gland
10. Posterior facial vein
11. Anterior facial vein
12. M. sternocleidomastoideus
13. M. trapezius
14. Auricle of ear
4. Dorsal brachial nerve
2. Sublingual duct
3. Sublingual gland
4. Parotidomandibular fascia
5. Anterior facial vein and artery
6. Superficial temporal vein
7. Parotid gland



2'. M. zygomaticus (fig. 25).

The zygomaticus is a thin muscle of about one to two or somewhat more millimeters in width. The origin is from the zygomatic arch at the region ventral to the orbit. The fibers course directly anterad to the commissurae labium oris. The muscle is median in position to the zygomaticus and the anterior fibers of the platysma.

3'. M. platysma (figs. 21 and 25).

The platysma is the broadest muscle of facial expression. It arises from the dorsum of the neck, and from the fascia of the pectoral musculature. Some fibers pass anterad across the face to insert along the margin of the lower lip. Additional fibers will be discussed with the muscles of the auricular group.

Internal to the above three muscles are two smaller muscles, and the M. buccinator.

4'. M. dilator naris (fig. 26).

The dilator naris is very thin and narrow (approximately two millimeters wide). It arises from the internal surface and the lateral margin of the infraorbital foramen. The fibers are directed toward the naris.

5'. M. maxillonasolabialis (fig. 26).

The maxillonasolabialis is a thin serrated muscle with a parallelogram outline. The origin is by several slips over the intraalveolar portion of the upper incisor. In one specimen a slip was separated widely from the main mass. The muscle inserts along the margin of the upper lip, from about midway, to the angle. The muscle is primarily vertical in position.



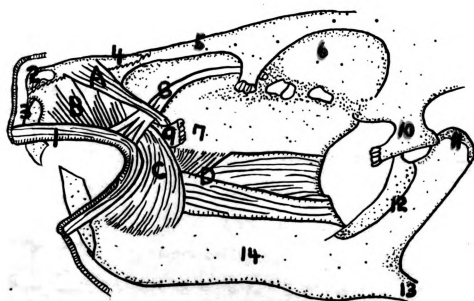
FIGURE 26. THE RIGHT SIDE OF THE FRONT HALF OF THE SKULL TO SHOW THE DEEP MUSCLES OF FACIAL EXPRESSION

- A. M. dilator naris
- B. M. maxillonasolobialis
- C. M. buccinator, pars buccalis
- D. M. buccinator, pars molaris

- 1. M. orbicularis
- 2. Naris
- 3. Incisor
- 4. Nasal bone
- 5. Frontal bone
- 6. Orbit
- 7. Maxillary bone
- 8. Infraorbital nerve
- 9. Anterior root of zygomatic arch
- 10. Posterior root of zygomatic arch
- 11. Condyle of mandible
- 12. Ramus of mandible
- 13. Angular process
- 14. Body of mandible



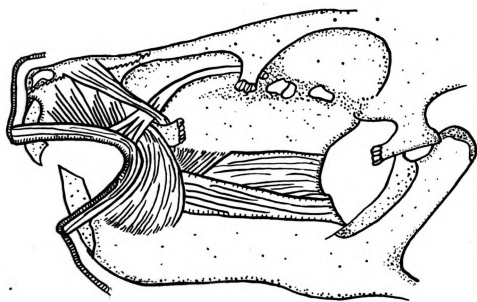
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The muscle underlies the infraorbital nerves which supply the mystacial vibrissae, whereas the M. levator labii superioris covers the external surface of the nerves. The muscle also covers the external surface of a portion of the deep masseter muscle rostral to the infra-orbital foramen.

The name selected for this muscle is based on the attachments. The same name is employed by Miller (1952), and by Huber (1931) for a muscle with the same general location in the dog and other species.

More particularly, this is doubtless the same muscle of the chinchilla designated as the buccinator by Wood and White (1950).

Due to a sparcity of materials available to them, it is likely that Wood and White did not discover the true buccinator muscle; a much more extensive but deeper muscle, which as in other forms, occupies the major portion of the wall of the buccal cavity.

6'. M. buccinator (figs. 25 and 26).

This muscle is distinctly not that designated as the buccinator by Wood and White (1950), and was not described in their paper on the myology of the chinchilla.

The M. buccinator is by far the most extensive facial muscle. It occupies the area of the cheek from the orbicularis oris caudally to the pharynx. The caudal two-thirds lies deep to the masseter muscle. The inner surface of the muscle contacts the mucous membrane lining the cheek.

The buccinator is attached to the orbicularis oris rostrad, and along the outer surfaces of the alveolar processes of both the upper and

lower teeth. The caudal border is attached to an indistinct fibrous pterygomandibular raphe, along which raphe the rostral margin of the nasal pharyngeal constrictor occurs.

The fibers of the muscle course in various directions. In the diastemal region the fibers pass vertically between the alveolar processes of the upper and lower incisors. Caudal to this region the fibers tend to subdivide into two groups. The upper fibers pass obliquely forward and ventrad, although there is some deviation by various individual fibers. The inferior fibers pass obliquely rostrad and dorsad.

There are two distinct portions to the muscle, they are here referred to as the pars buccalis and the pars molaris after Sisson and Grossman (1953). The pars buccalis is somewhat thicker, the belly tending to bulge outward over the internal bristle pad of the cheek. The pars molaris begins at the rostral margin of the overlying superficial portion of the masseter muscle.

7'. M. orbicularis oris (figs. 25 and 26).

The circumoral muscle is a very narrow band (little more than a millimeter in width) which receives fibers from the buccinator, zygomaticus, and the labii muscles. It is not uniformly orbicular, as the upper lip is cleft.

b. The auricular group.

The auricular group is primarily of topographical interest, due to its relationship to the underlying temporal and masseter muscles, and to the underlying salivary glands.

1'. M. platysma (figs. 21 and 25).

A distinct rostral derivative of the auricular portion of the platysma forms the buccal portion of the platysma.

The platysma muscle has a distinct ventrocervical portion (fig. 21). The dorsocervical portion arises from the fascia over the cervical spines. The rostral border of this portion lies deep to the levator auris longus muscle. The fibers of the dorsocervical portion pass obliquely ventrad and rostrad to pass across the lateral surface of the cheek, ventral to the auricle. As such, it rests over most of the parotid salivary gland (fig. 25) and the caudal portion of the masseter muscle. Its aponeurotic tendon fuses rostrally with the fascia of the superficial muscles of the muzzle.

The ventral cervical portion (fig. 21) arises from the fascia over the pectoral muscle and from the manubrium of the sternum, to cover the ventral aspect of the neck and the intermandibular area. The muscle fibers appear to end rostrad at about the level of the hyoid bone. The aponeurosis of the muscle continues to the fascia of the superficial muscle of the ventral aspect of the genum.

This portion of the platysma covers the superficial surface of the infrahyoid musculature, and of the submaxillary and caudal and middle sublingual glands (fig. 21).

2'. M. parotideauricularis (fig. 25).

This muscle is located on the surface of the parotid gland. The muscle has a trianguloid origin from the parotideomasseteric fascia and narrows to form a longitudinal band of muscle fibers which pass dorsad

to the conchal crest of the auricle. The fibers of the muscles are sparse and the outlines of underlying structures are visible through the muscle.

3'. M. orbicularis oculi (figs. 25 and 26).

The circumorbital cutaneous muscle consists of a very thin strand of muscle of only a few fibers. Some fibers extend to the eyelids. The caudal portion overlies the orbital edge of the temporalis muscle.

4'. M. auricularis anterior (fig. 25).

This muscle arises as a well developed muscle over the caudal rim of the orbit and orbicularis oculi muscle. It passes caudad to insert on the medial side of the base of the auricle. Greene (1935) did not identify this muscle in the rat. Wood and White (1950) mentioned the frontalis, but not the auricularis anterior.

5'. M. frontalis (fig. 25).

As described by Wood and White (1950) the frontalis is very small in the chinchilla.

The frontalis is located on the dorsal aspect of the skull between the orbits, and passes caudad to end in the tendinous epicranial aponeurosis in common with the frontalis of the opposite side, and the occipitalis muscle.

6'. M. interscutularis.

Two interscutular muscles elevate the ears and in so doing possibly tense the parotideomasseteric fascia which covers the temporalis, the masseter, and the parotid gland. They are not illustrated in the text.

The interscutularis is a thin band of muscle which crosses the parietal region of the skull to the bases of the auricles. It was not identified in one specimen.

7'. M. levator auris longus.

The levator auris longus is a well developed interscutular muscle with a cranial and a caudal portion; the latter overlaps the cranial fibers of the cranial portion of the platysma muscle. The levator arises from the region of the first few cervical spines and inserts on the caudal aspect of the auricular bases.

8'. M. occipitalis.

A few median fibers appear to rise from the occipital region and pass rostrad between the inflated bullae on the dorsal surface of the skull. They end in the tendinous epicranial aponeurosis, in the area between the orbits and the auricles. This muscle was not described by Wood and White (1950).

2. The Prime Muscles of Mastication

The principal muscles of mastication are located internal to various of the muscles of facial expression. All are thick, well developed muscles in harmony with the powerful bite of the chinchilla. The author observed that the chinchilla is able to gnaw white pine lumber, and thin gauge galvanized sheet metal when the opportunity and inclination exist.

Two of the principal muscles of mastication are located on the lateral aspect of the skull, and two on the medial aspect of the ramus of the mandible.

a. The lateral group.

1'. M. masseter (figs. 20, 21, 23, 24, 26, 27, 28, 29 and 30).

The masseter muscle of the chinchilla consists of four portions. It is by far the most massive muscle of the head.

The naming of the subdivisions of the masseter presents some difficulty. It is not subdivided in the same way in all species, and in addition, the terminology employed when divisible into four portions is not uniform.

Gray (1942) describes the human masseter as having a superficial and a deep division, the former being much larger. The deep portions are most massive in the case of the chinchilla.

Greene (1935) named the four masseter units of the rat, the anterior and posterior superficial and deep masseters. Hill (1937) stated that masseter of the pocket gopher (genus Thomomys) has three main divisions: the superior, lateral, and deep. The lateral and deep divisions are said to be divisible into anterior and posterior parts. This indicates a five-parted masseter.

Young (1937) found only two subdivisions in the beaver (Castor canadensis); the superficial and the deep, but does not describe the relative sizes of the divisions. In his description, mention was made of a rounded tendon attached to a mandibular tubercle; this agrees with such a tendon seen for the anterior deep masseter of the chinchilla. Orwall (1940), who studied the osteology and myology of the fox squirrel (Sciurus niger), gray squirrel (Sciurus carolinensis), and red squirrel (Tamiasciurus hudsonicus), found these forms to possess three masseter divisions; the pars superficialis, pars major, and pars profundus.

Wood and White (1950) found four divisions of the masseter in the chinchilla. Observations made in this study support this view. The divisions were designated as the superficial portion; the lateral portion; the anterior; and the posterior deep portions. The author prefers to designate the part called the lateral portion by Wood and White, the *intermedius*--a more meaningful term since it is located between the superficial part, and the posterior deep part, rather than laterally.

a'. The *pars superficialis* (fig. 27) is a somewhat rectangular massive appearing portion, located in the region ventrad to the zygomatic arch. The ventral-caudal corner presents an apex which overlies the tip of the long angular process of the mandible. The rostral portion of the muscle is in the form of a diverging glistening tendon which spreads out on the rest of the muscle in a serrated fashion. The tendon presents a firm point of attachment to the rostral root of the zygoma.

Arising from the zygoma, the fibers of this portion pass obliquely toward the angle of the mandible. The muscle mass wraps inwardly around the inferior margin of the angle and its process, to insert in two ways. The caudal three fourths is loosely attached to a longitudinal spine of insertion ventrad to the deeper internal pterygoid muscle. The rostral fourth of the infolded ventral margin of the muscle remains tendinous at its border, which contacts the medial surface of the body of the mandible. The mandible presents a rounded fossa opposite this portion. The tendinous fibers pass obliquely dorsad and caudad on the medial ramal surface to insert along a central oblique and linear masseteric spinous process of the ramus.

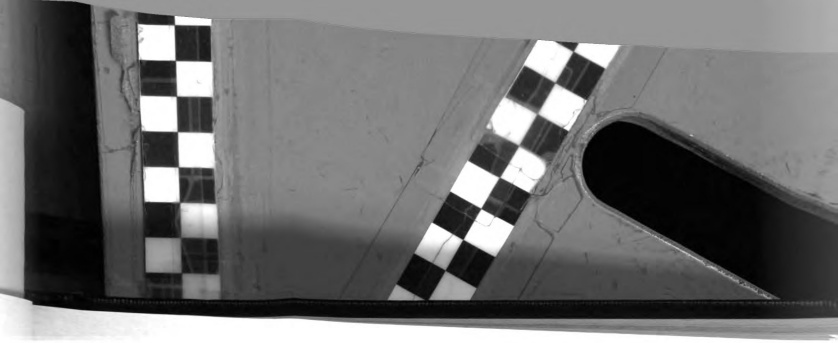
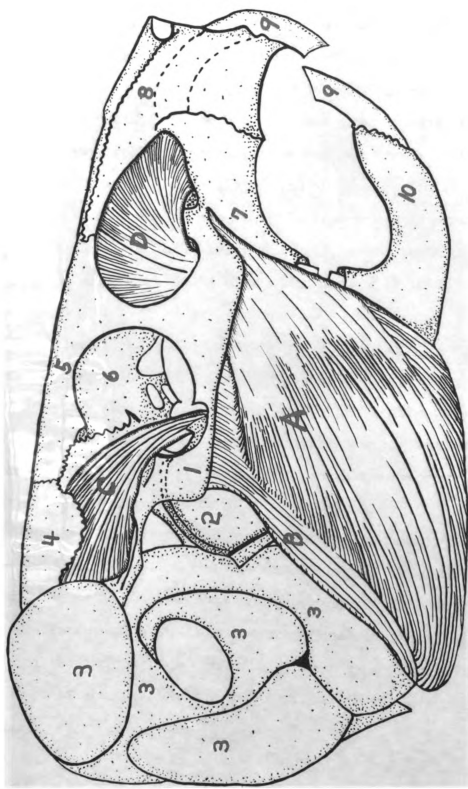
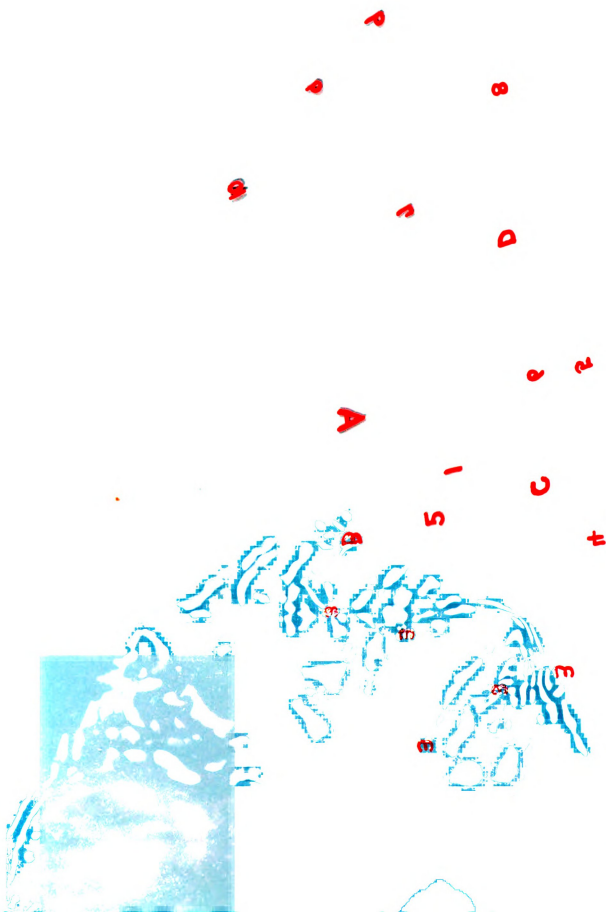


FIGURE 27. A LATERAL VIEW OF THE SKULL TO SHOW THE SUPERFICIAL
PORTION OF THE MASSETER MUSCLE

- A. M. masseter, pars superficialis
 - B. M. masseter, pars intermedius
 - C. M. temporalis
 - D. M. masseter, pars profundus anterior
-
- 1. Zygomatic arch
 - 2. Condyle of mandible
 - 3. Tympanic bulla
 - 4. Parietal bone
 - 5. Frontal bone
 - 6. Orbit
 - 7. Maxillary bone
 - 8. Premaxillary bone
 - 9. Incisor
 - 10. Incisal process of body of mandible

10. Incisal process of body of mandible

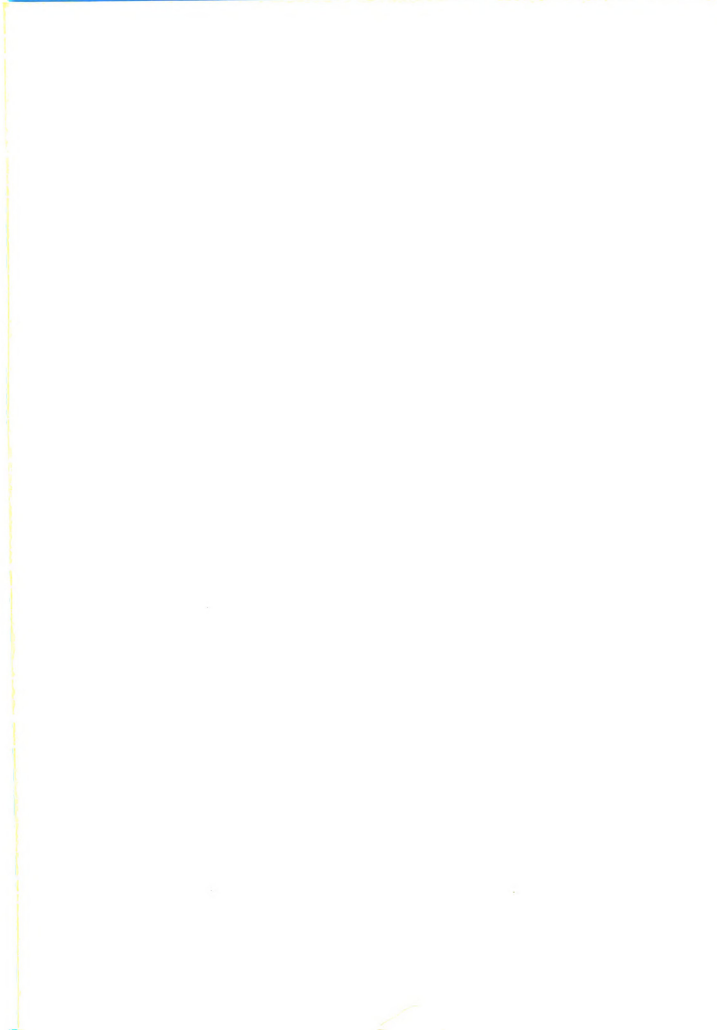






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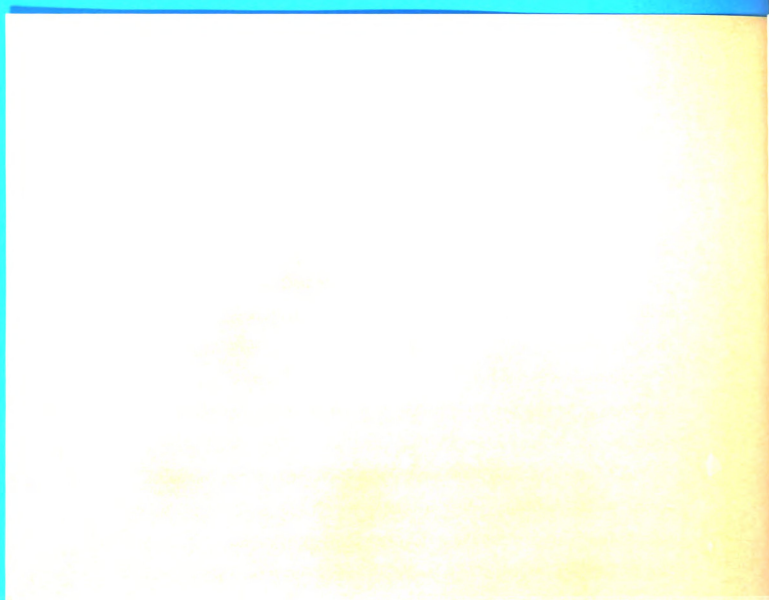
The pars superficialis appears to be much thicker than it is, being bulged outwardly by the underlying portions of the muscle.

b'. The pars intermedius (fig. 26) is a flat parralleloid muscular sheet, located internal to the pars superficialis, and superficial to the pars profundus posterior, as indicated above. The intermediate portion is not completely covered by the superficial portion. The dorsal-caudal corner of the former is exposed. This portion contacts the lateral surface of a portion of the body, and of the angle and angular process, as well as of the lower third or more of the mandibular ramus.

The origin is along the inner surface of the ventral border of the zygoma, as far caudad as the posterior rim of the orbit. Its insertion does not wrap around the inferior margin of the mandible, but is rather along a lateral longitudinal masseteric spine near the ventral border of the angle and its process. The mandible presents a masseteric fossa internal to the insertional third of this portion.

The fibers are directed obliquely ventrad and caudad, but are not quite parallel to the fibers of the superficialis. The caudal portion is almost twice as thick as the rostral portion of this subdivision.

Some intermingling of fibers occurs between the superficial and the intermediate portions, thus preventing a clean separation of the two units. This is particularly true along the caudal margin of the superficial portion.



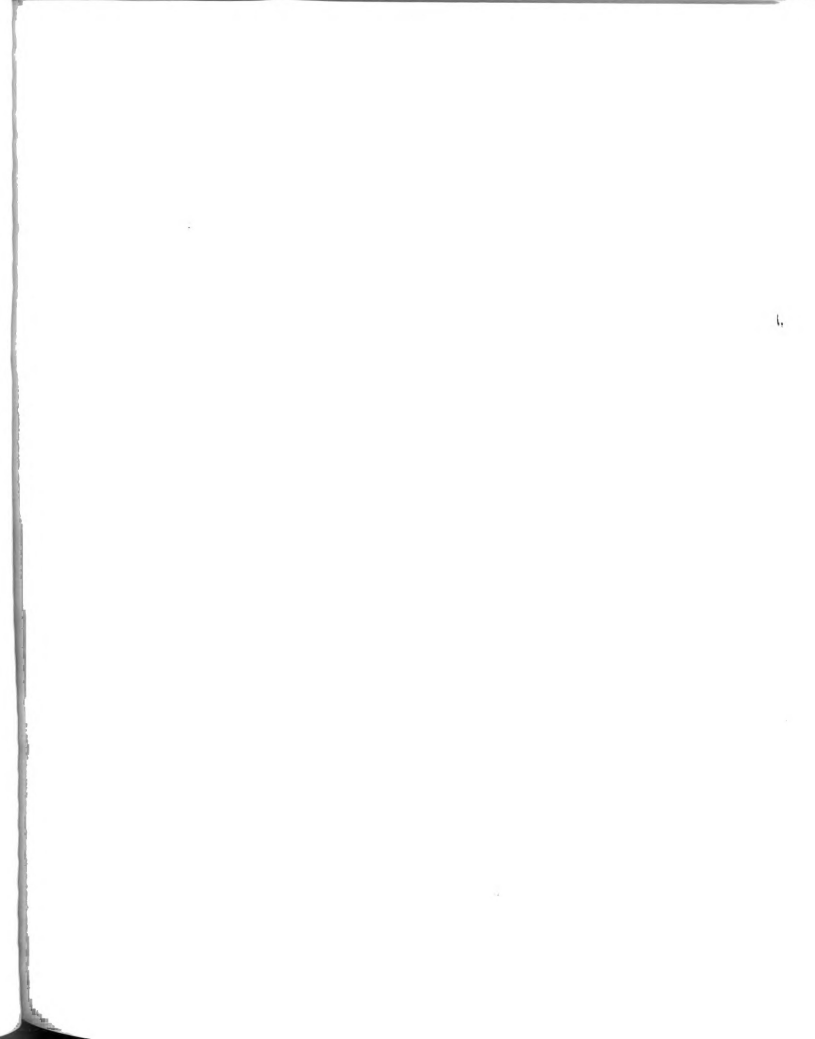


FIGURE 28. A LATERAL VIEW OF THE ZYGOMATIC ARCH AND THE INTERMEDIATE PORTION OF THE MASSETER MUSCLE

- | | |
|---|------------------------------------|
| A. M. masseter, pars intermedius | |
| B. M. temporalis | |
| C. M. masseter, pars profundus anterior | |
| 1. External auditory foramen | 6. Orbit |
| 2. Tympanic expansion | 7. Angular process of mandible |
| 3. Condyle of mandible | 8. Body of mandible |
| 4. Zygomatic arch | 9. Masseteric tubercle of mandible |
| 5. Coronoid process of mandible | 10. Molar teeth |





8

A

3 + 2

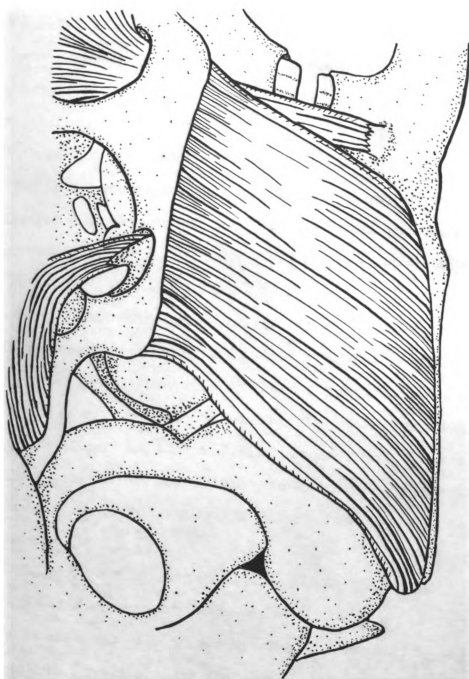
B

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9



c'. The pars profundus posterior (fig. 29), due to its greater thickness, and to its extensive origin along the entire zygoma and ventral rim of the orbit is doubtless the most massive portion of the masseter muscle. This fact is not obvious upon initial observation, because much of the muscle lies internal to the zygoma and orbital rim.

The origin of the posterior deep portion is inseparable rostrally from the fibers of origin of the pars profundus anterior. The latter division forms a strong tendon for most of its length, and the posterior unit is easily separable from this. Caudad, the origin extends into the mandibular fossa of the temporal bone. As the origin occurs along the medial surface rather than the ventral rim, it can best be observed by removal of the ventral half of the entire zygoma.

The pars profundus posterior inserts from the caudal edge of the mandibular masseteric tubercle, along the lateral surface of the alveolar process of the lower molars, and on a distinct rounded and deep masseteric fossa which courses the length of the mandibular ramus.

The coarse fibers are almost vertical in direction. Between the caudal fibers pass various vessels and nerves, imparting a somewhat serrated appearance in this region. The fibers remain outside the fibrous orbital capsule.

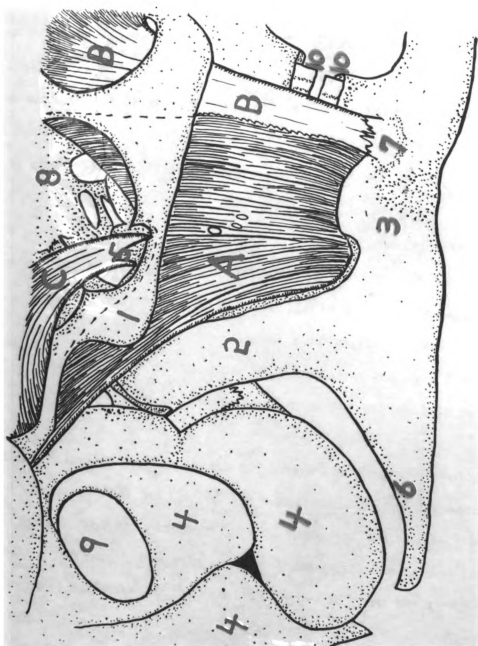
d'. The pars profundus anterior (figs. 27, 28, 29, 30 and 31) occupies a broad shallow ovoid fossa rostral of the orbit. The muscle originates on the edges of fossa and extends into the orbit by way of a broad infraorbital foramen, where the muscle becomes continuous with the posterior deep portion of the masseter.



FIGURE 29. A LATERAL VIEW OF ZYGOMATIC ARCH AND THE POSTERIOR DEEP
PORTION OF THE MASSETER MUSCLE

- A. M. masseter, pars profundus posterior
- B. M. masseter, pars profundus anterior
- C. M. temporalis

- | | |
|---------------------------------|------------------------------------|
| 1. Zygomatic arch | 6. Angular process of mandible |
| 2. Ramus of mandible | 7. Masseteric tubercle of mandible |
| 3. Body of mandible | 8. Orbit |
| 4. Tympanic expansion | 9. External auditory foramen |
| 5. Coronoid process of mandible | 10. Molar teeth |



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A B B
5 1 2 C 8

9

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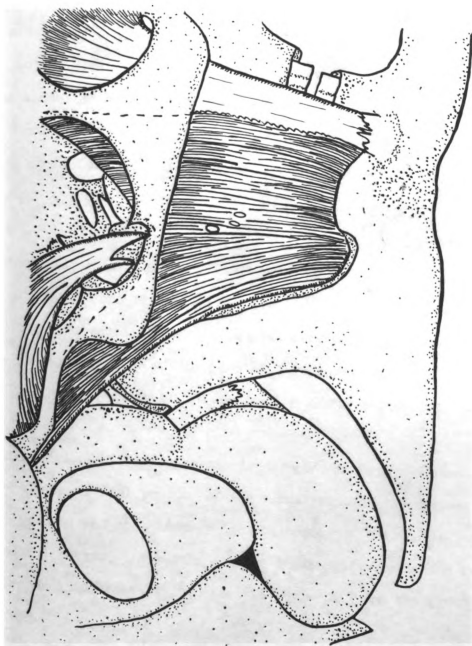
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The fibers of this somewhat pyriform muscle converge internal to the ventral root of the zygoma and then are replaced by a vertical rounded tendon which passes ventrad to insert on a distinct rough masseteric tubercle located on the lateral aspect of the mandible, ventral to the first and second molar junction.

The caudal edge of this tendon receives some fibers from the rostral border of the posterior deep portion, the two deep portions thus not being completely subdivided.

2'. M. temporalis (figs. 27, 28, 29, 30 and 31).

The temporalis muscle is less extensive and less massive than the masseter muscle, or any of the divisions of the latter. It is only faintly separable into two parts. The muscle is somewhat triangular in outline, the base arising from the lateral surface of the parietal bone, from the caudal extension of the base of the zygoma, and by a few fibers from the squamosal portion of the temporal near the parietal-temporal suture.

The insertion of the temporalis is directed rostrad and ventrad to pass over the horizontal portion of the caudal root of the zygomatic arch; the root serves as a raceway for the tendon of the muscle. Near the zygomatic process, the muscle becomes tendinous. The tendon inserts upon the coronoid process of the mandible, especially on the inner surface.

Wood and White (1950) maintained that the temporalis was inserted on the side of the body as well as on the ramus of the mandible. Observations made in this study did not reveal such an extensive insertion.

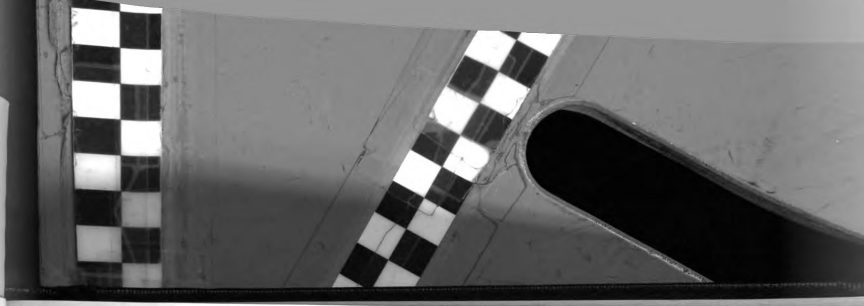


FIGURE 30. A LATERAL VIEW OF THE SKULL TO SHOW THE ANTERIOR DEEP PORTION OF THE MASSETER MUSCLE AND THE TEMPORALIS MUSCLE

A. M. masseter, pars profundus anterior

B. M. temporalis

1. External auditory foramen

2. Tympanic bulla

3. Parietal bone

4. Frontal bone

5. Premaxillary bone

6. Nasal bone

7. Naris

8. Incisor

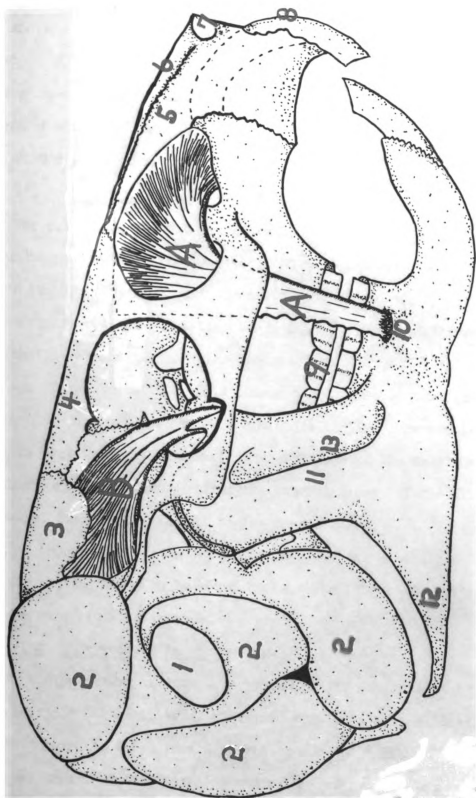
9. Molar

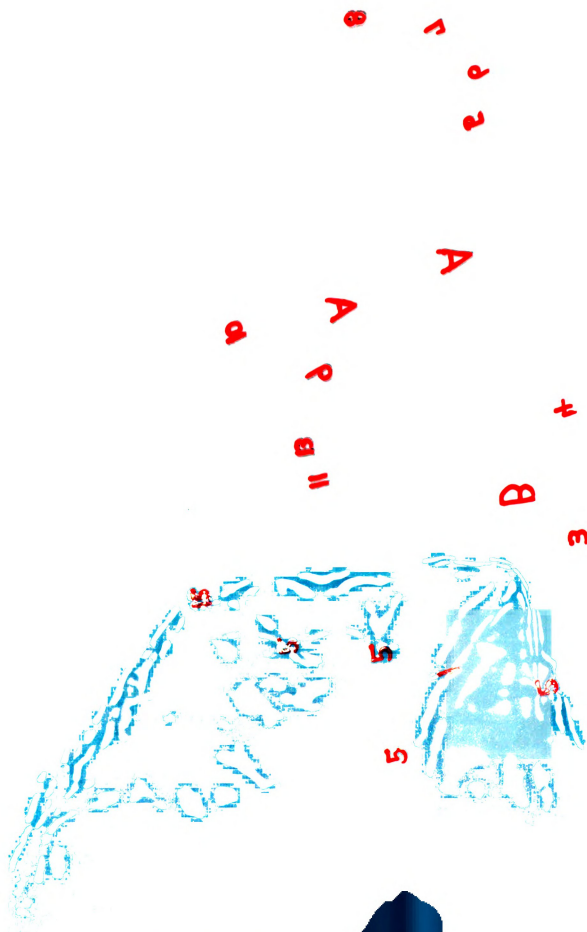
10. Tubercle of mandible for the tendon of the anterior deep portion of the masseter muscle

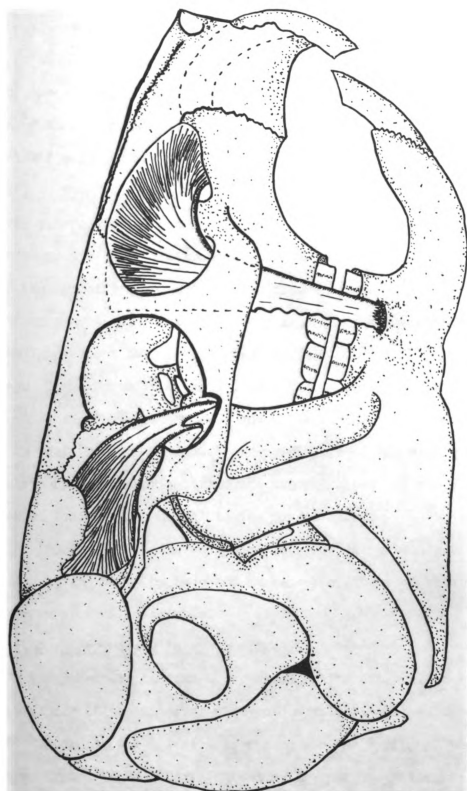
11. Ramus of mandible

12. Angular process of mandible

13. Masseteric fossa of mandible







The above workers indicated that the temporalis arose immediately in front of the lambdoidal crest. The present author found a large inflated area of the tympanic bulla located between the lambdoidal crest and the origin of the temporalis (fig. 30).

b. The prime muscles medial to the mandibular ramus.

1'. M. pterygoideus externus (fig. 31).

The external pterygoid muscle is located internal to the pars profundus posterior of the masseter, and also internal to the temporalis, but on the opposite side of the ramus of the mandible.

After removal of the latter two muscles, and all of the ramus of the mandible except the condylar process, the pterygoid muscles were exposed. The external pterygoid muscle has a somewhat more extensive origin than was indicated by Wood and White (1950). The muscle fibers arise in part from the external pterygoid ridge of the skull, and a sizeable portion also arises from the lateral aspect of the alveolar process of the maxilla, dorsal to the fourth molar.

The insertion is along the medial surface of the condyle of the mandible, as indicated by Wood and White. The fibers of this muscle converge in a caudal direction.

2'. M. pterygoideus internus (fig. 31).

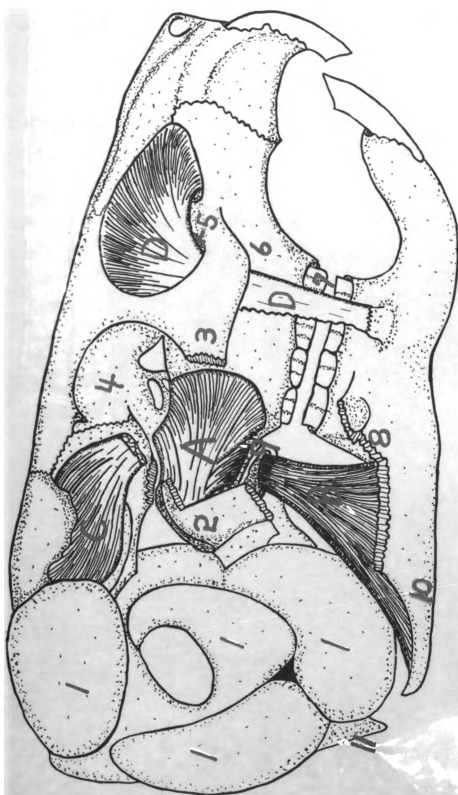
By the procedure indicated for exposing the external pterygoid, the lateral aspect of the internal pterygoid muscle is also exposed.

The internal pterygoid arises ventral to the origin of the external. It arises from a rounded fossa formed by the pterygoid laminae of the sphenoid. The fibers arise chiefly from the external aspect of the internal lamina.



FIGURE 31. A LATERAL VIEW OF THE SKULL WITH THE CAUDAL END OF THE ZYGOMATIC ARCH AND THE VENTRAL HALF OF THE RAMUS OF THE MANDIBLE REMOVED TO EXPOSE THE EXTERNAL AND INTERNAL PTERYGOID MUSCLES

- A. M. pterygoideus externus
 - B. M. pterygoideus internus
 - C. M. temporalis (dorsal end)
 - D. M. masseter, pars profundus anterior
-
- 1. Tympanic bulla
 - 2. Condyle of mandible
 - 3. Zygomatic arch (rostral portion)
 - 4. Orbit
 - 5. Infraorbital foramen and anterior part of deep masseter
 - 6. Maxillary bone
 - 7. Molars
 - 8. Origin of ramus of mandible
 - 9. Lateral pterygoid lamina
 - 10. Angular process of mandible
 - 11. Exoccipital process of occipital bone

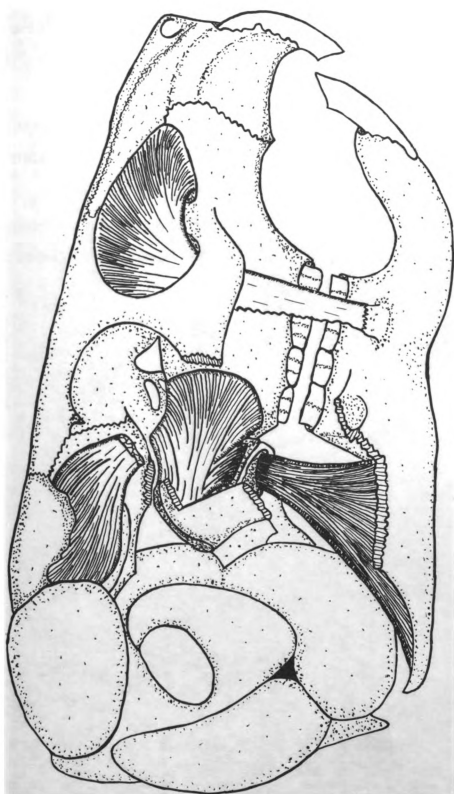




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D
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C



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The muscle passes ventrad and laterad at about a forty-five degree angle to the inner surface of the ramus.

The insertion of the internal pterygoid muscle is along the inner surface of the ventral margin of the angle and of the angular process of the mandible. The muscle is somewhat cylindrical near its origin, and then broadens and flattens near the insertion.

The insertion passes dorsal to the caudal end of the indistinctly subdivided digastricus muscle (fig. 24).

1. _____



IV. THE PHARYNX

The pharynx or throat of the chinchilla (figs. 19, 32 and 33) is a relatively long and arching musculo-membranous tube which connects the nasal cavity and the larynx.

According to the condition found in fresh and embalmed carcasses, the pharynx is at most times uninterrupted by the digestive tract. The laryngeal end of the pharynx serves as a cross-channel between the oral cavity and the esophagus during the act of deglutition.

Complex folds which bound the oral-pharyngeal aperture overlap the crest of the epiglottis and thus effectively close the passageway between the fauces and the pharynx. A similar arrangement of the folds which bound the pharyngeal-esophageal aperture overlaps the arytenoid crest of the larynx and closes the introitus esophageus.

The rostral two-thirds of the dorsal wall of the pharynx is membranous and the caudal third is muscular. The membranous portion adheres closely to the mid-ventral surface of the basisphenoid and the basioccipital bones.

At a point immediately ventral to the hypophysis (fig. 19) the dorsal wall curves ventrocaudad from the base of the cranium. The remaining third of the pharynx resembles the human pharynx, and is herein designated the pharynx proper. The dorsal wall of this portion consists of three constrictor muscles, a fibrosa, and a mucosa.

The pharynx proper is suspended from the basisphenoid and the basioccipital bones as well as from the atlas, and from the fascia of

the cranial end of the cervical portion of the M. longus colli by means of a pair of sheet-like vertical and longitudinal suspensory ligaments. The ligaments continue a few millimeters beyond pharynx along the dorsal lateral surfaces of the proximal end of the esophagus.

The ventral wall of the pharynx is less membranous and presents various openings. The openings include the unpaired posterior naris, the caudal oral aperture, the aperture of the larynx, and of the esophagus.

The attachments of the ventral wall are complex. The rostral end rests on the hard and soft palates. The next portion is attached to the rim of the posterior naris and to the caudal end of some fibers of the M. buccinator along the pterygomandibular raphe'. It also contacts the ventro-lateral surfaces of the hyoglossal muscles, the hyoid bone, the thyrohyoid ligament, the thyroid cartilage, the cricothyroid ligament, the cricoid cartilage, and the proximal end of the trachea and the esophagus.

The openings of the pharynx include the four indicated above and the paired ostia of the eustachian tube or salpinx. The usual number of openings in mammals with paired choanae is seven.

The cavity of the pharynx is approximately thirty-five millimeters in length, the rostral twenty millimeters being that portion above the palate. The transverse diameter is about five millimeters, and exceeds the dorsoventral diameter by a millimeter or more.

The outline of the pharyngeal cavity is variable. Except for a mid-dorsal longitudinal and outwardly directed crease, the suprapalatal

or rostral portion of the pharyngeal chamber is nearly cylindrical in outline.

The cavity is expanded into a slight pharyngeal recess in the region of the commencement of the ventrocaudal curvature of the pharynx. This corresponds to the nasopharynx region of man. It receives the laterally placed slit-like ostia of the salpinx.

The pharynx assumes a gradual caudoventral curvature from the nasal cavity to the larynx; the caudal or laryngeal region is curved somewhat more sharply than is the remainder of the organ.

The pharynx is related topographically to numerous structures (fig. 19). The rostral two-thirds is located dorsal to the oral cavity and to the hard and soft palates. Dorsal to the rostral portion are located the midventral region of the cranium and the cerebrum.

The pharynx proper is bounded above by the basisphenoid bone, the basioccipital bone, and by the vertebral column. Between the upper cervical vertebrae and the pharynx proper are located the cervical extremities of the Mm. colli muscles, and various vessels and nerves which course along the suspensory ligaments.

The lateral wall is confined by the ventral tympanic expansions, by the posterior portion of the digastric muscles, and by the common carotid and external and internal carotid arteries, by the internal jugular veins, and by the vagosympathetic trunks.

There are only two defineable regions of the chinchilla pharynx.

A. The Nasopharynx (fig. 19)

Practically the entire pharynx is nasopharynx. It extends from the nasal cavity along the hard palate and the entire length of the soft palate to the faucial aperture of the ventral wall of the pharynx. It receives the posterior naris and the ostia of the eustachian tube. The caudal third of the nasopharynx forms the major portion of the pharynx proper or that portion which is deflected ventrocaudad from the base of the skull.

B. The Oropharynx (fig. 19)

The very limited laryngeal end of the pharynx is designated as the oropharynx. It receives the openings from the mouth, the larynx, and from the esophagus; it is delimited from the long nasopharynx by the faucial-pharyngeal folds, and by the esophageal-pharyngeal folds.

As the esophageal orifice occurs at the level of the crest of the arytenoid cartilages of the larynx there is no laryngeal recess of the pharynx, and hence no laryngopharynx. The esophagus begins abruptly from the caudal side of the oral pharynx. The opening is generally closed by means of pharyngeal folds.

C. The Muscles of the Pharynx (figs. 32 and 33)

Three constrictor muscles form the bulk of the dorsal wall of the pharynx proper. In addition two distinct pairs of extrinsic muscles pass from the base of the skull to the dorsal wall of the pharynx.



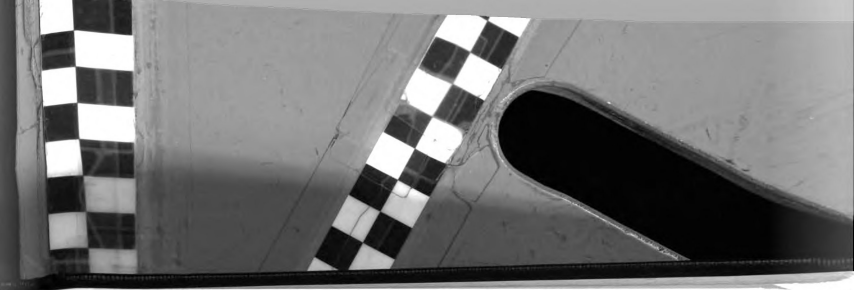


FIGURE 32. THE DORSAL SURFACE OF THE PHARYNX SHOWING THE INTRINSIC AND EXTRINSIC MUSCLES AND ALSO THE PROXIMAL END OF THE ESOPHAGUS AND TRACHEA

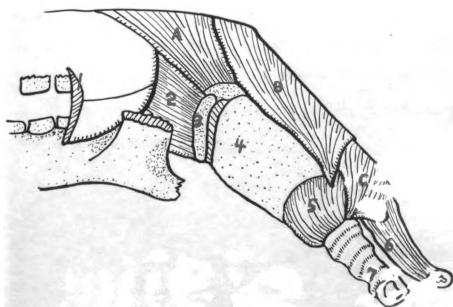
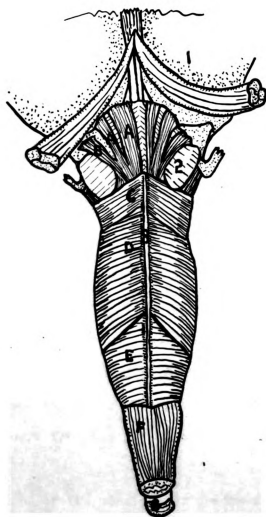
- A. M. salpingopharyngeus
 - B. M. pterygopharyngeus
 - C. M. constrictor pharyngeus cranialis
 - D. M. constrictor pharyngeus medius
 - E. M. constrictor pharyngeus caudalis
 - F. Esophagus
 - G. Trachea
-
- 1. Ventral tympanic expansion
 - 2. Membranous portion of pharynx proper
 - 3. Dorsal median raphe' of the pharynx

FIGURE 33. THE LATERAL SURFACE OF THE PHARYNX TO SHOW THE ATTACHMENTS OF THE PHARYNX

- A. M. constrictor pharyngeus cranialis
 - B. M. constrictor pharyngeus medius
 - C. M. constrictor pharyngeus caudalis
-
- 1. M. buccinator
 - 2. M. hyoglossus
 - 3. Hyoid bone
 - 4. Thyroid cartilage
 - 5. M. cricothyroideus
 - 6. Esophagus
 - 7. Trachea



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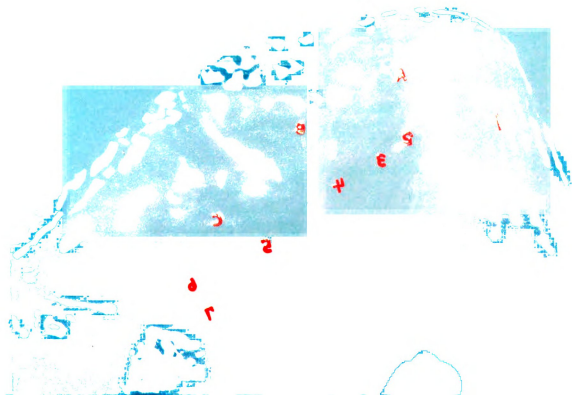
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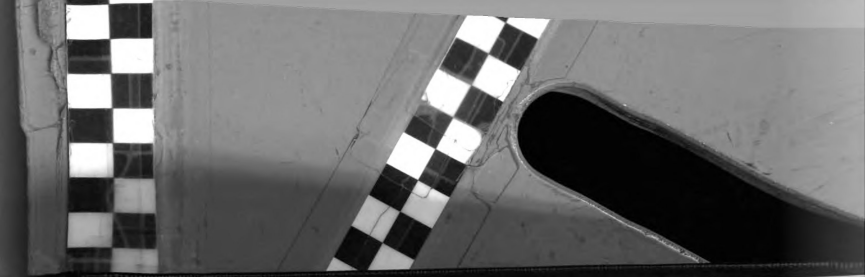
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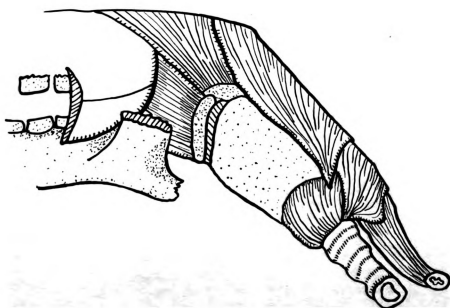
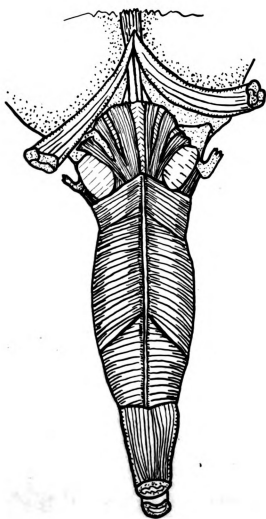
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A few fine fibers are also seen to pass from other muscles into the pharynx, but do not appear to constitute distinct muscles.

1. The M. constrictor pharyngeus cranialis (hypopharyngeus, superior constrictor, keratopharyngeus et chondropharyngeus figs. 32 and 33)

The cranial constrictor forms a flat sheet of muscle of about four millimeters in width. Its fibers more or less surround the pharynx from ventral to dorsal to insert with the fibers of the opposite side along the cranial third of the dorsal median raphe' of the pharynx.

A narrow connective tissue membrane intervenes between the base of the skull and the cranial constrictor.

Paired lateral bands of the cranial constrictor pass between the cranial border and the keratohyoid-epihyoid junction. This band appears to receive a few fibers from the medial border of the M. styloglossus (fig. 24).

The major portion of the constrictor arises from the thyroid cartilage.

2. The M. constrictor pharyngeus medius (thyreopharyngeus, middle constrictor, figs. 32 and 33)

The middle constrictor is the most extensive muscle of the pharynx. The fibers arise along the sides of the larynx and pass more or less directly around the pharynx and insert along the median raphe' opposite the fibers of the opposite side.

3. The M. constrictor pharyngeus caudalis (cricopharyngeus, inferior constrictor, figs. 32 and 33)

The caudal constrictor forms the bulk of the dorsal wall of the oropharynx. It arises from the sides of the cricoid cartilage and caudal end of the thyroid cartilage opposite the curving line of insertion of the cricothyroideus muscle. The muscle passes dorsoad and slightly cranial to insert along the caudal end to the median raphe'. It is directly continuous cranial with the middle constrictor and overlaps the proximal end of the esophagus caudad.

4. The M. salpingopharyngeus (fig. 32)

This is a thin narrow muscle which passes from the region of the auditory salpinx caudad along the median raphe' to insert internal to the cranial border of the cranial constrictor. It is readily separable into two more or less equal portions.

5. The M. pterygopharyngeus (fig. 32)

This strap-like muscle lies lateral to the salpingopharyngeus muscle on the dorsal surface of the membrane which extends between the base of the skull and the cranial constrictor. It arises from the medial pterygoid lamina and curves mediad and caudad to insert internal to the cranial border of the cranial constrictor muscle.

The muscles of the pharynx, of which the last two are extrinsics, and the former three intrinsics, are best seen upon removal of the cervical vertebrae and all other structures dorsal to the pharynx proper. The dorsal surface of the pharynx can then be viewed in its entirety.

Although a few scattered fibers of the hyoglossus, the buccinator, the palatinus, and the styloglossus appear to pass into the cranial constrictor, their presence was difficult to establish and at best they hardly constitute distinct muscles in the present form.

V. THE NECK

The neck is of particular interest in the present study in that it contains the caudal portion of the pharynx, the cranial third of the esophagus, and related structures.

The neck of the chinchilla is short (about 50 millimeters in length) compared to the other regions under consideration. The neck or cervical region extends between the first or upper rib and the sternum and clavicle cranial to the angle of the mandible.

From ventral to dorsal the neck contains the integument, the cervical portion of the platysma muscle, and the underlying sternocleidomastoides muscles (figs. 21, 22, 23 and 24). Associated with these ventrally placed muscles, are various branches of the external jugular veins.

Deeper, the infrahyoid musculature (figs. 22, 23 and 24), namely: the sternothyroideus, sternothyroideus, the thyrohyoideus and the cricothyroideus muscles, are found.

Dorsal to the infrahyoid muscles are located the larynx and the trachea. Lateral to the trachea are found the carotid arteries, the internal jugular veins, the vagosympathetic nerve trunk, the phrenic nerves, and the recurrent laryngeal nerves.

The cervical portion of the trachea is nearly thirty millimeters in length and within it are some twenty-five supporting cartilages of the tracheal wall.



The cervical portion of the esophagus lies dorsal to the trachea, and is crossed dorsad by the aorta. The deep central structures of the neck contact the longus colli muscles and the vertebral centra.

There are seven cervical vertebrae in the chinchilla, as in the majority of mammalian species. The axis or second cervical vertebra bears a long stout spinous process while the remaining cervical spines are greatly reduced.

The cervical fasciae are arranged in a manner quite like that in the human. They include the usual investing, prevertebral, middle cervical, pretracheal, buccopharyngeal, and carotid sheath fascias.

VI. THE THORAX

The distal two-thirds or approximately fifty millimeters of the esophagus courses through the thoracic cavity. The cavity also contains important non-digestive structures, namely, the heart, lungs, aorta, pre- and post cavas, nerves, and the thymus gland.

A. The Wall of the Thorax

The skeleton of the chest includes the thirteen or fourteen ribs and the related thoracic vertebrae. Newberne (1951) also found a variable number of thoracic vertebrae. Greens (1953) found that vertebral variation was an index of subspecies in the case of mice, and followed genetical ratios; insufficient material was available to warrant such conclusions in the case of the chinchilla variations.

The thorax is covered by a dense pelage consisting of clusters or tufts of fine hairs. The integument of the ventral thorax is modified by the presence of the areola and nipple of the thoracic mammary gland which is located lateral to the level of the ensiform process of the sternum and over the eleventh or twelfth rib and interspace.

The thoracic spine possesses a noticeable dorsal bow as is true for mammals in general (Slijper, 1946).

The musculature of the chest wall (figs. 34 and 35) includes the intercostal muscles, the pectoral and serratus muscles, and the thoracic portions of the sacrospinalis muscles and the intertransversarii (Wood and White, 1950, pp. 559-560).

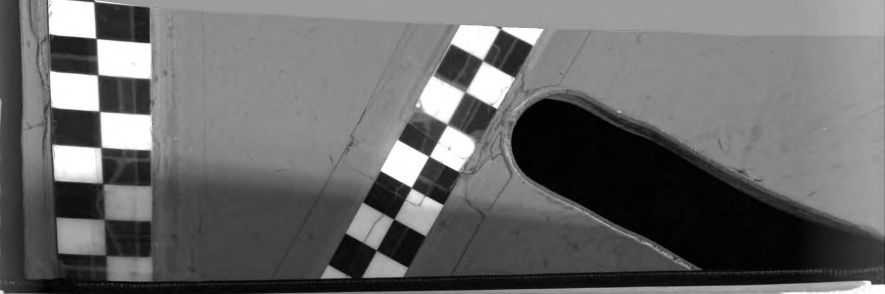
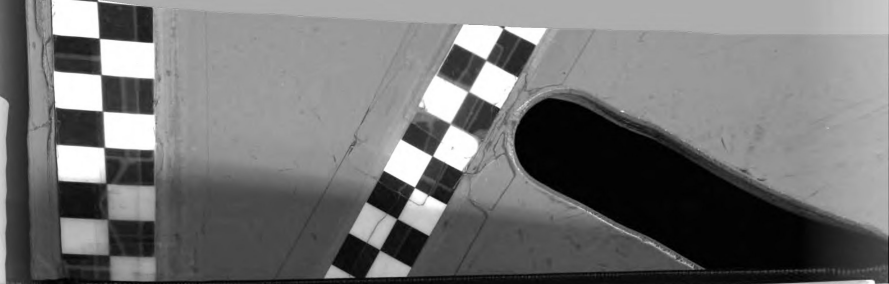
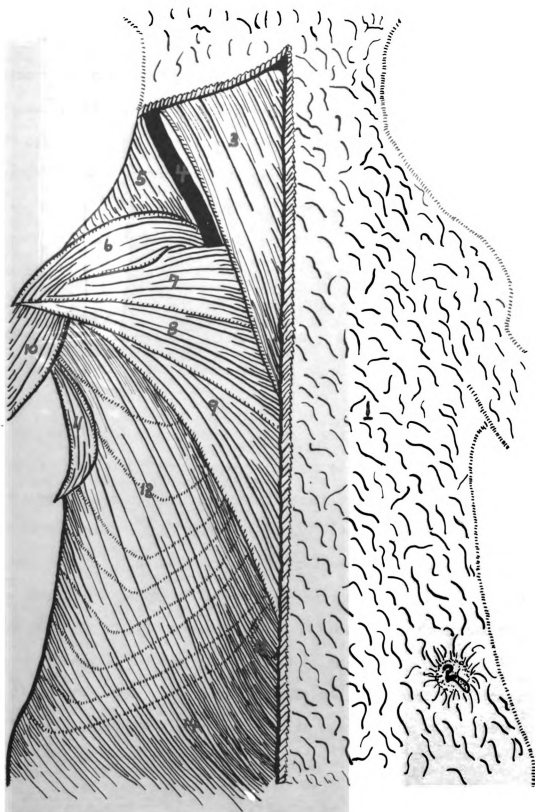


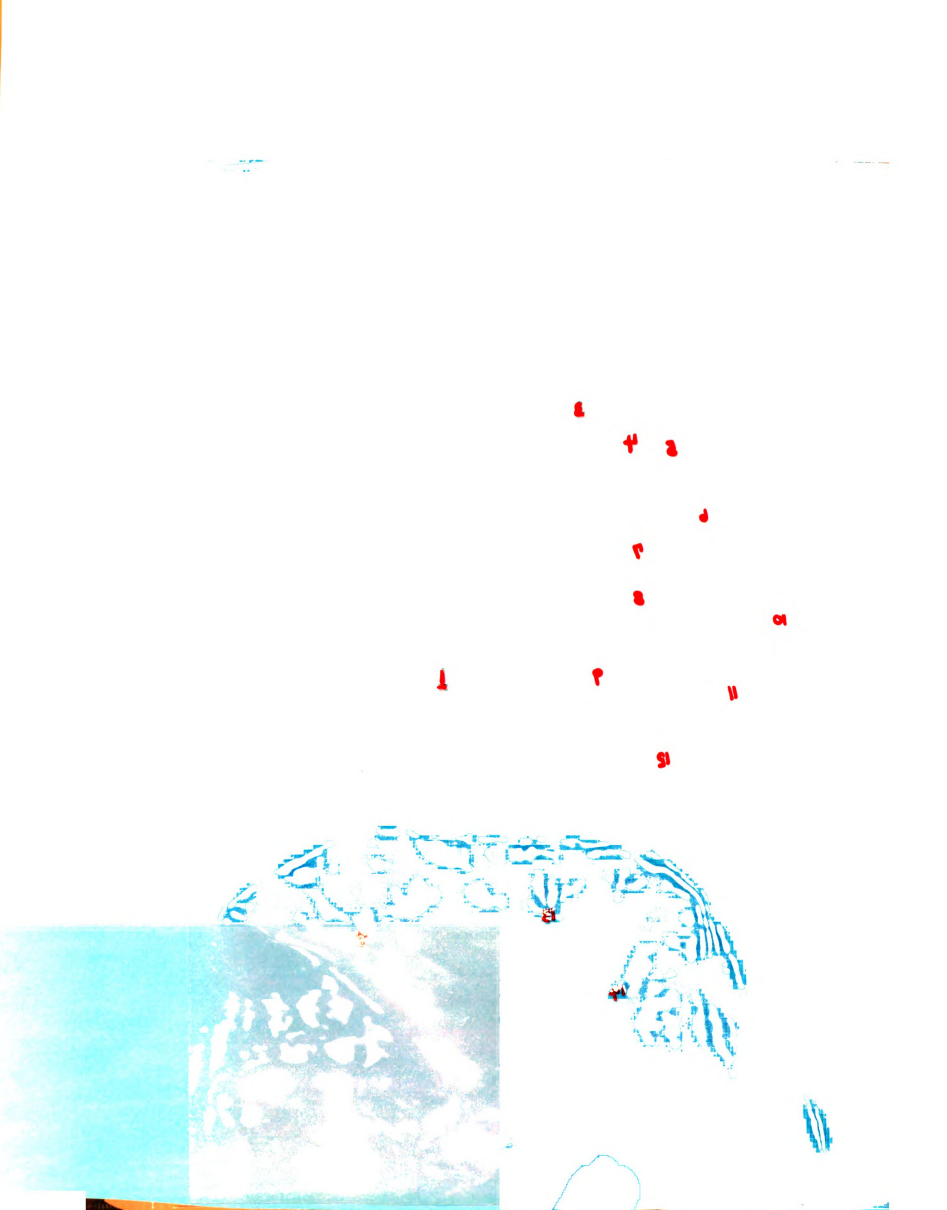
FIGURE 34. THE SUPERFICIAL STRUCTURES OF THE VENTRAL SURFACE OF THE NECK AND CHEST

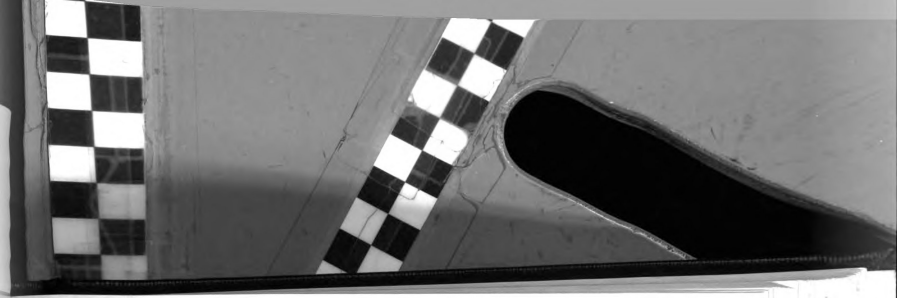
1. Integument
2. Cranial mammary gland teat
3. M. platysma
4. External jugular vein
5. M. trapezius
6. M. acromiodeltoideus
7. M. pectoralis, pars anterior superficialis
8. M. pectoralis, pars posterior superficialis
9. M. pectoralis, pars abdominis
10. M. biceps brachii
11. M. cutaneous trunci
12. Outline of rib
13. Outline of ensiform cartilage
14. M. obliquus externus abdominis



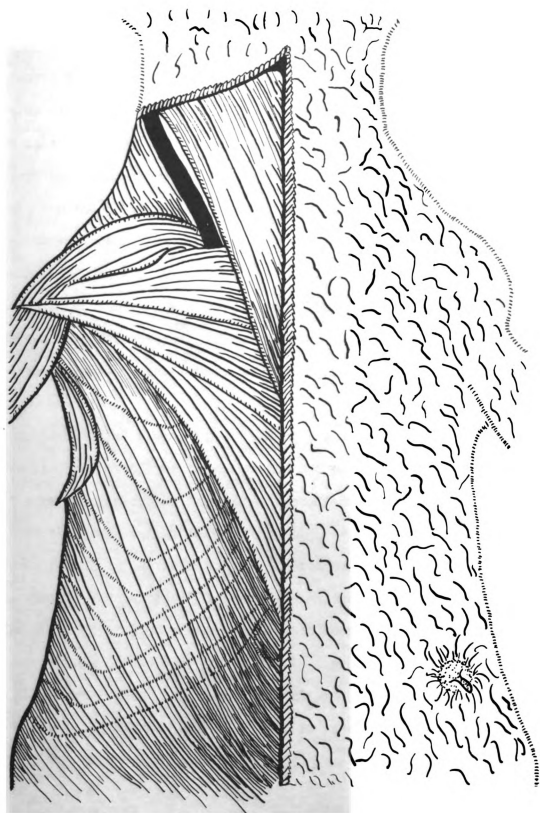
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B. The Major Organs of the Thorax

Removal of the ventral wall of the thorax and of the superficial structures of the neck (fig. 35) reveals the thymus glands, which are pink in color and consist of small firm rounded lobules. Cranial to the thymus can be seen the trachea, apical lymph nodes, the carotid arteries, and the precaval and jugular venous stems.

The thymus glands are partially embedded and partially separated from each other and from the auricles and base of the heart by a large collection of mediastinal adipose tissue. The apex of the heart can be seen through the fat-covered pericardial sac. Caudal to the heart is located the diaphragm, and lateral to the heart, the various lobes of the lungs.

A deeper ventral dissection of the neck and thorax (fig. 35) which involves the removal of the thymus glands and of the pericardium, as well as a reflection of the infrahyoid musculature, reveals the major portion of the trachea, the left side of the cervical portion of the esophagus dorsal to the left side of the trachea, the larynx, and the various vessels and nerves of the neck listed previously.

The thoracic portion of the trachea and esophagus pass dorsal to the great vessels of the base of the heart (figs. 36, 37, 38 and 39) and to the heart itself. The heart presents the usual four chambers. The aorta presents a brachiocephalic root in place of the right innominate artery and the left common carotid artery.

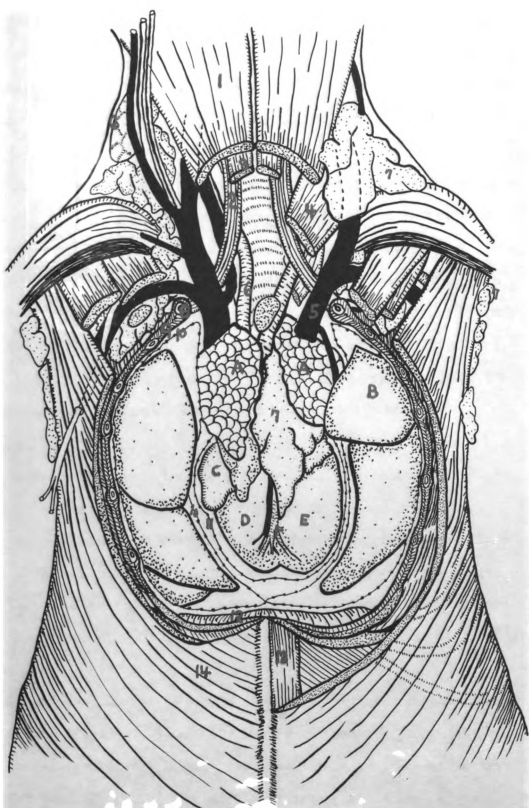




FIGURE 35. A VENTRAL VIEW OF THE THYMUS GLANDS, THE LUNGS, AND THE HEART

- A. Thymus gland
- B. Left superior lobe of lung
- C. Right auricle
- D. Right ventricle
- E. Left ventricle
- F. Coronary vessels
- G. Parotid gland

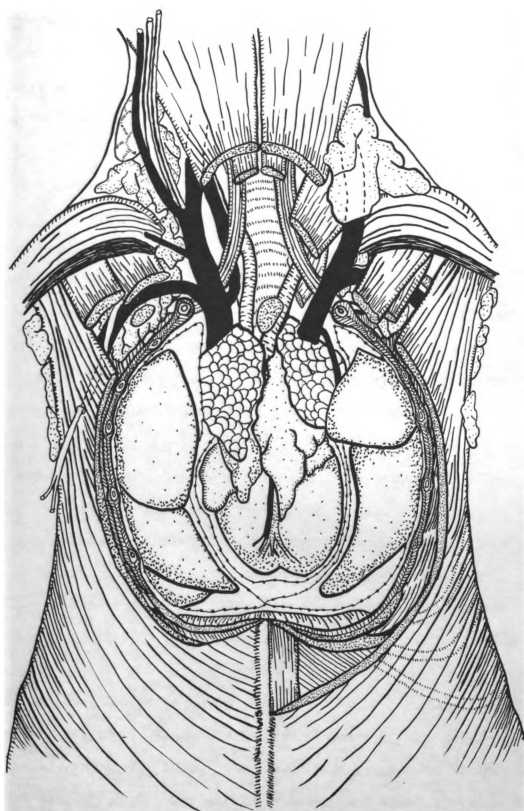
- 1. M. platysma
- 2. M. sternothyroideus
- 3. M. sternohyoideus
- 4. M. sternomastoideus
- 5. Left precava
- 6. Right common carotid artery
- 7. Adipose tissue
- 8. Rib one
- 9. M. intercosti externis et internis
- 10. Parietal pleura
- 11. Pericardium
- 12. Diaphragm
- 13. M. rectus abdominis
- 14. M. obliquus externus abdominis







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A conspicuous feature of the chinchilla is the presence of two precaval veins. The left precava (fig. 36) passes caudad to the level of the heart and then dorsad into the auricular-ventricular or coronary sulcus of the heart to join the left inferior corner of the right atrium (fig. 36).

Jenkins (1950) found two *venae cavae superiores* in the fox squirrel (*Sciurus niger*). There are also two precavas in the rat (Hunt, 1924).

The chinchilla has a right azygos vein and a left accessory hemiazygos. Hunt (1924), and Greene (1935), located an azygos vein in the rat on the left side of the vertebral column. Jenkins (1950) and Mizeres (1950) found the azygos on the right side in the fox squirrel.

The present author suspects that the so-called azygos vein of the rat represents the accessory hemiazygos vein of the human and of the chinchilla.

The azygos vein joins the right precava and the hemiazygos joins the left precava rather than the azygos vein as in man.

The arrangement and location of the inferior cervical or stellate sympathetic ganglion, of the nervous ansa subclavius, and of the recurrent laryngeal branches of the vagus nerves was essentially the same as found by Mizeres (1950) and by Jenkins (1954) in the case of the fox squirrel.

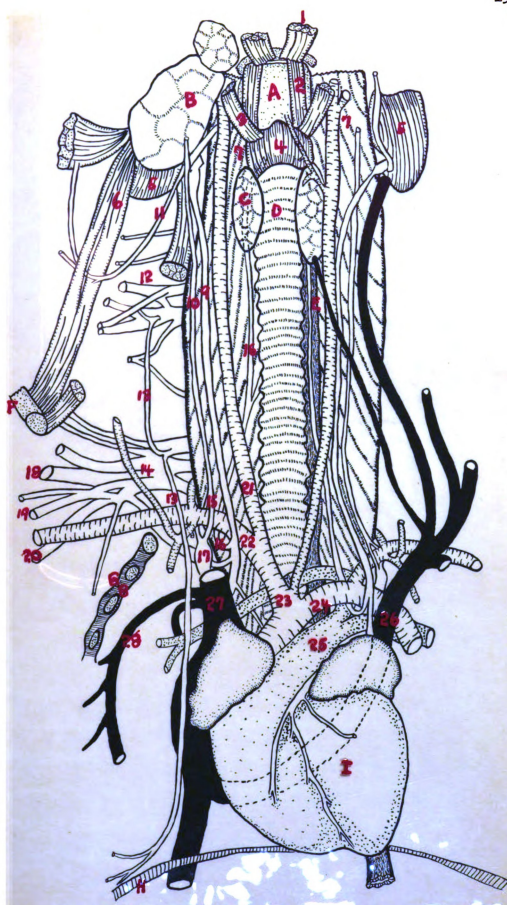
The heart was removed to expose the lungs and the branches (fig. 37). The right lung (figs. 35, 37 and 39) has four lobes i.e., cranial, middle, caudal, and azygos lobes. The azygos lobe is adjacent to the pericardial sac. Caudally, the apical and caudal lobes are related to the cranial surface of the diaphragm.

1. The first part of the document is a list of names and addresses of the members of the committee.

FIGURE 36. A VENTRAL VIEW OF THE DEEPER STRUCTURES OF THE NECK AND CHEST

- A. Larynx
- B. Submaxillary gland
- C. Thyroid gland
- D. Trachea
- E. Esophagus
- F. Clavicle
- G. Chest wall
- H. Diaphragm
- I. Heart-left ventricle

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| 1. M. sternohyoideus | 15. Ansa subclavius |
| 2. M. thyrohyoideus | 16. Recurrent laryngeal nerve |
| 3. M. sternothyroideus | 17. Inferior cervical ganglion |
| 4. M. cricothyroideus | 18. Radial nerve |
| 5. M. digastricus | 19. Median nerve |
| 6. M. sternocleidomastoideus | 20. Ulnar nerve |
| 7. M. longus coli | 21. Right common carotid |
| 8. M. intercostalis | 22. Subclavian artery |
| 9. Vagus nerve | 23. Brachiocephalic artery |
| 10. Cervical sympathetic trunk | 24. Aortic arch |
| 11. Spinal accessory nerve | 25. Pulmonary artery |
| 12. Cervical nerve plexus | 26. Left precava |
| 13. Phrenic nerve | 27. Right precava |
| 14. Brachial nerve plexus | 28. Azygos vein |



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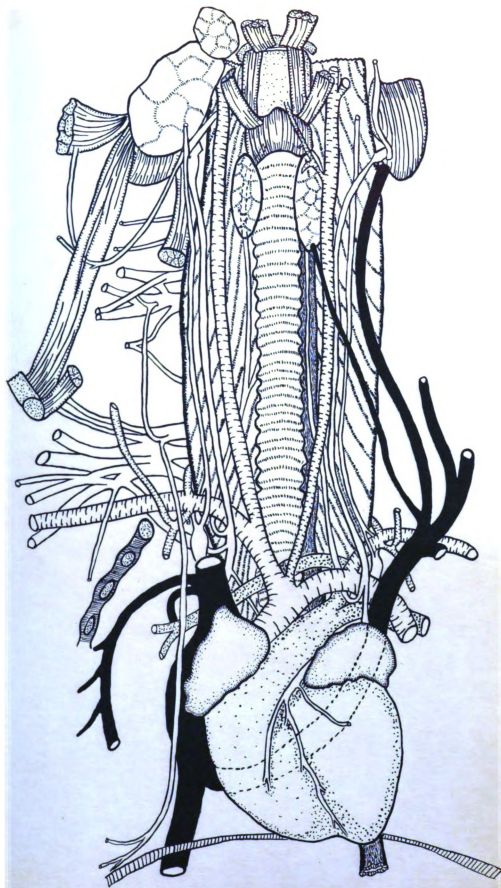
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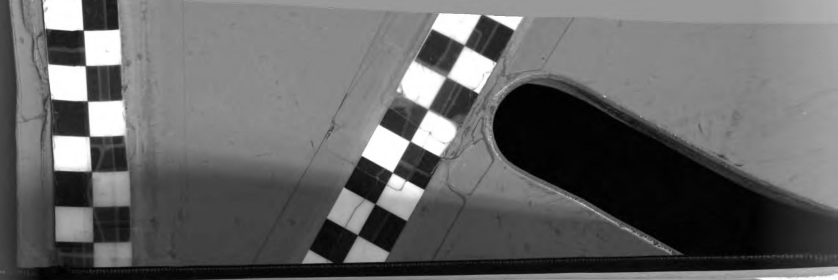
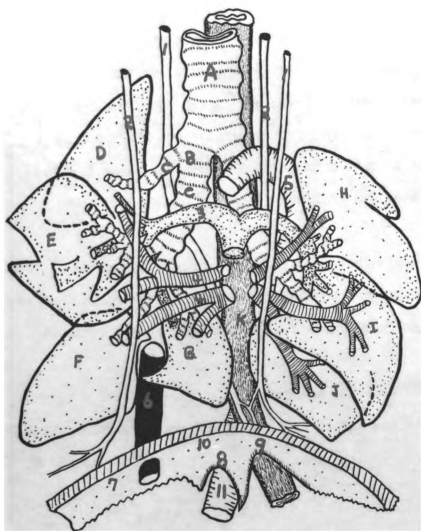


FIGURE 37. THE RELATION OF THE TRACHEA AND LUNGS TO THE ESOPHAGUS

- A. Trachea
- B. Right primary bronchus
- C. Right secondary bronchus
- D. Right lung; cranial lobe
- E. Right lung; middle
- F. Right lung; caudal lobe
- G. Right lung; azygos lobe
- H. Left lung; cranial lobe
- I. Left lung; middle lobe
- J. Left lung; caudal lobe
- K. Esophagus

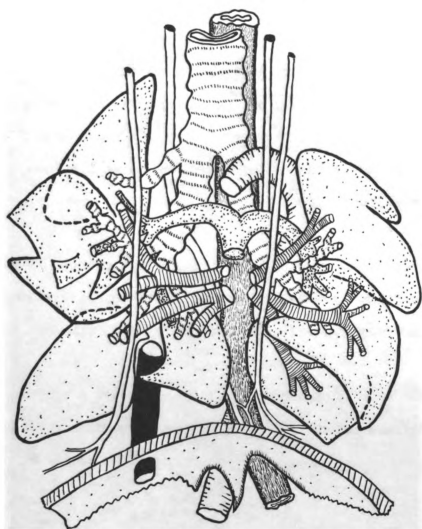
- 1. Vagus nerve
- 2. Phrenic nerve
- 3. Pulmonary artery
- 4. Pulmonary veins
- 5. Aortic arch
- 6. Postcava
- 7. Diaphragm
- 8. Aortic hiatus of diaphragm
- 9. Esophageal hiatus of diaphragm
- 10. Central tendon of diaphragm
- 11. Abdominal aorta







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The left lung has three lobes of about equal size. The lobes are designated as cranial or apical, middle, and caudal lobes.

The pulmonary artery divides dorsal to the root of the brachiocephalic artery and gives rise to a right and left pulmonary artery. There are four main pulmonary veins, two from each lung.

The pleural reflections are illustrated in figures 35 and 39.

The trachea bifurcates (fig. 39) at the level of the dorsal to the aortic arch. There is a right and a left primary bronchus; the former immediately gives off a secondary branch to the right cranial lobe. From this point distad the left and right bifurcations are essentially similar.

The thoracic portion of the phrenic nerves pass ventral to the pulmonary roots and the corresponding portions of the vagus nerves pass dorsal to the root (fig. 37) as is the case in the cat, man, and the fox squirrel (Mizeres, 1950).

Figure 38 shows a ventral view of the esophagus after a removal of the lungs and the respiratory tree. Figure 39 shows the position of the esophagus in the cervical region.



VII. THE ESOPHAGUS

The esophagus of the chinchilla resembles that of the dog, cat, and rat, both in general structure and in its relationships to other organs. It is a muscular tube about seventy-five millimeters in length.

A. The Cervical Portion of the Esophagus

The cervical portion (figs. 19 and 36) of the esophagus is approximately twenty-five millimeters in length. It extends from the caudal end of the pharynx to the level of the first rib. The thoracic portion (figs. 36, 37, 38 and 39) extends from the first rib to the esophageal hiatus of the dorsal border of the diaphragm. The third or abdominal portion is very short (approximately 2 mm in length). It is surrounded by a portion of the left lobe of the liver. It ends rather indistinctly at the cardiac portion of the stomach by a distal expansion.

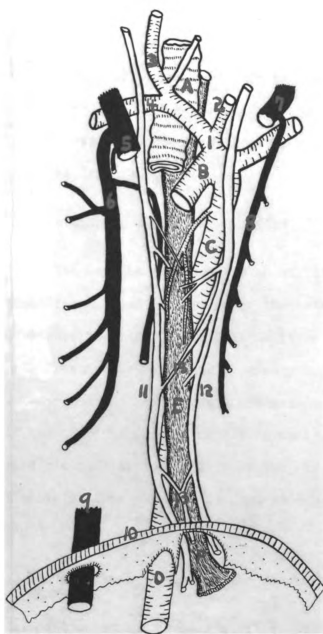
The cervical portion of the esophagus is located dorsal to the trachea, and shifted slightly to the left in respect to the latter, except at the extreme proximal end where it is entirely dorsal to the proximal end of the trachea. The esophagus extends caudad along the ventral surface of the left M. longus colli, pars cervicalis or obliquus superior.

It is accompanied by the vagus nerves and by the aorta for most of its length. The thoracic duct (fig. 39) crosses from the right to



FIGURE 38. A VENTRAL VIEW OF THE AORTA AND ESOPHAGUS

- A. Trachea
 - B. Aortic arch
 - C. Thoracic aorta
 - D. Abdominal aorta
 - E. Esophagus; thoracic portion
 - F. Esophagus; abdominal portion
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- 1. Brachiocephalic artery
 - 2. Left common carotid artery
 - 3. Right common carotid artery
 - 4. Right subclavian artery
 - 5. Right precava
 - 6. Azygos vein
 - 7. Left precava
 - 8. Hemiazygos vein
 - 9. Postcava
 - 10. Diaphragm
 - 11. Right vagus nerve
 - 12. Left vagus nerve
 - 13. Esophageal plexus of vagus nerve



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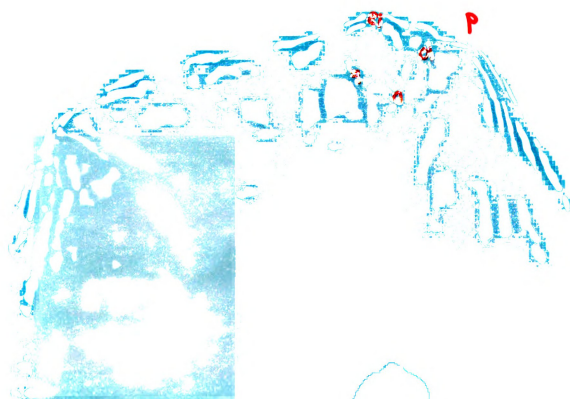
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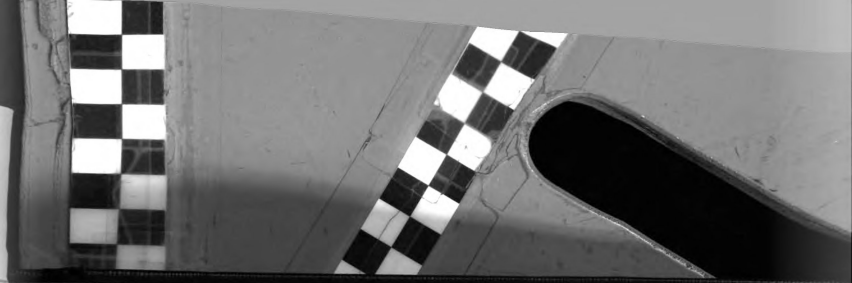
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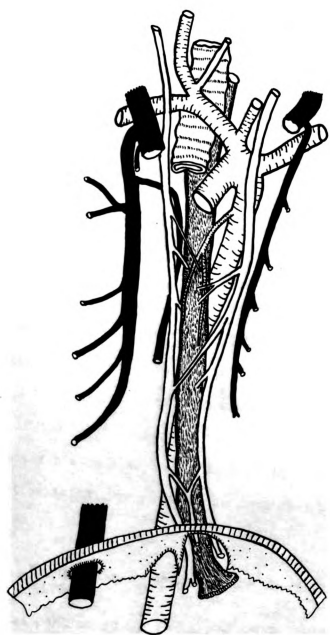
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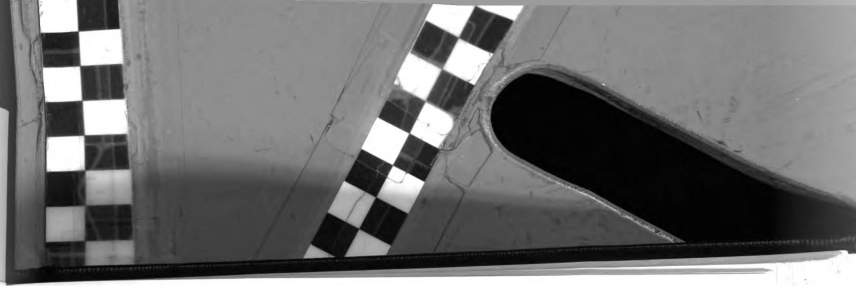
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left of the esophagus in the cervical regions, and in general passes from caudad to cervicad between the aorta and the esophagus.

The dorsal wall of the trachea is membranous and flexible and invaginates along the point of contact with the esophagus.

The recurrent laryngeal branch of the left vagus nerve courses cranial along the left ventral surface of the esophagus, immediately to the left of the trachea (fig. 36).

B. The Thoracic Portion of the Esophagus (figs. 36, 37, 38 and 39)

The thoracic portion of the esophagus is about fifty millimeters in length, and hence forms about two-thirds of the total length of the esophagus. It continues to shift to the left as it courses through the chest. It is crossed ventrally by the left primary bronchus.

Fibers from the right and left vagus anastomose to form plexuses on the surface of the thoracic portion of the esophagus.

The esophageal hiatus lies to the left of the mid-line and to the left of the aortic hiatus from which it is separated by a diaphragmatic crus or pillar.

C. The Abdominal Portion of the Esophagus

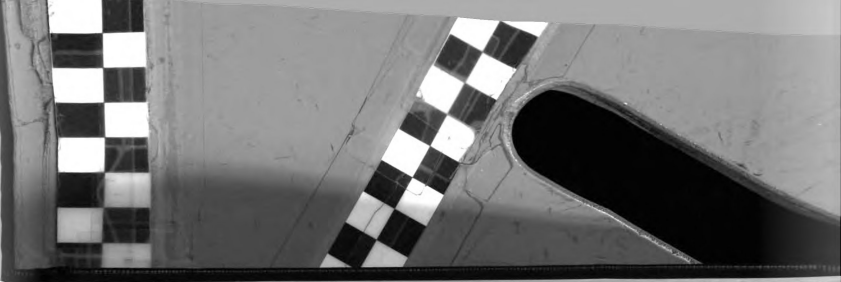
The abdominal portion of the esophagus (figs. 53, 54, and 64) is only about thirteen millimeters in length. The entire portion is surrounded ventrad, mediad, and laterad, by the left lobe of the liver.



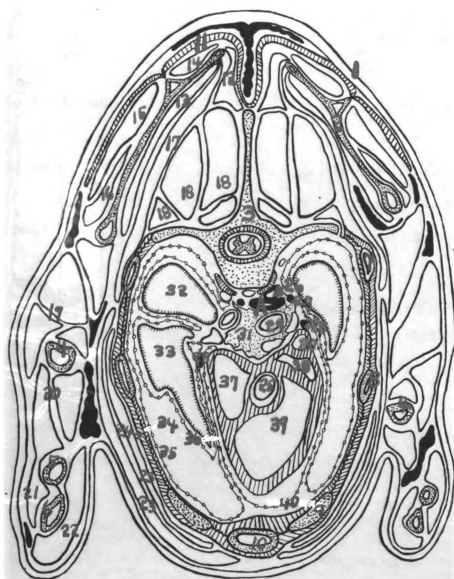
FIGURE 39. A CROSS SECTION OF THE THORAX AT THE LEVEL OF THE
RIGHT VENTRICLE

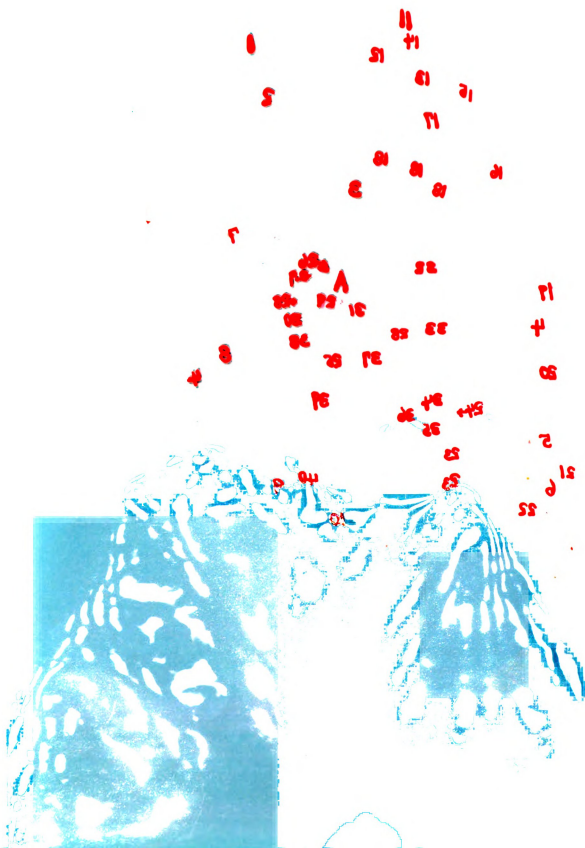
A. Esophagus

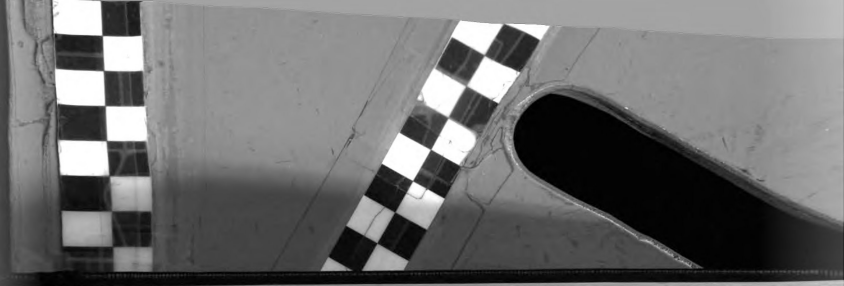
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|--------------------------|--------------------------------|
| 1. Integument | 21. Extensor muscles |
| 2. Scapula | 22. Flexor muscles |
| 3. Thoracic vertebra | 23. M. pectoralis |
| 4. Humerus | 24. M. intercostus externus |
| 5. Radius | 25. Aorta |
| 6. Ulna | 26. Thoracic duct |
| 7. Rib four | 27. Vagus nerve |
| 8. Rib five | 28. Phrenic nerve |
| 9. Rib six | 29. Aorta |
| 10. Sternum | 30. Pulmonary vein |
| 11. M. trapezius | 31. Mediastinal adipose tissue |
| 12. M. rhomboideus major | 32. Right lung; cranial lobe |
| 13. M. subscapularis | 33. Right lung; middle lobe |
| 14. M. supraspinatus | 34. Pleural cavity |
| 15. M. infraspinatus | 35. Parietal pleura |
| 16. M. teres major | 36. Visceral pleura |
| 17. M. serratus magnus | 37. Right atrium |
| 18. M. sacrospinalis | 38. Left atrium |
| 19. M. triceps brachii | 39. Right ventricle |
| 20. M. biceps brachii | 40. Pericardium |



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VIII. THE ABDOMINAL CAVITY

The abdominal cavity occupies the region of the trunk which is caudal to the diaphragm. In contrast to the thorax which is laterally compressed, the abdomen is rounded, flattened somewhat dorsoventrally, and has a greater volume.

The abdominal cavity is lined by a thin smooth parietal peritoneum and except for portions of the more caudal ribs, and for the lumbar and sacral vertebrae and the bones of the os coxae, the wall of the abdominal cavity is muscular.

The cavity has two general areas. The cranial and larger area extends from the caudal surface of the diaphragm to the cranial rim of the pelvis. The smaller area is in the pelvic region of the abdomen.

By far the most extensive portion of the digestive tract is within the abdominal cavity, namely: all structures from the abdominal portion of the esophagus to the anal canal, as well as the liver, gall bladder, and pancreas.

Furthermore, the cavity contains the spleen, male or female reproductive organs, urinary organs, all endocrine organs caudal to the diaphragm and various blood vessels and nerves.

A. The Walls of the Abdominal Cavity

The abdominal wall consists of ventrolateral, cranial, dorsal, and caudal or pelvic divisions.

1. The Ventrolateral Wall of the Abdominal Cavity (figs. 40 and 41)

The ventrolateral abdominal wall consists of the skin, fascia, and a laminated fibromuscular membrane except at the extreme cranial end. At the cranial end, ventral portions of the lower six ribs and intervening muscles extend beyond the diaphragm to help bound the abdominal region of the trunk.

The typically abdominal portion of the wall has a characteristic mammalian arrangement. The outer layer consists of skin (fig. 40). The second layer consists of the superficial abdominal fascia. It bears the superficial epigastric vessels and nerves, the cutaneous maximus division of the panniculus carnosus muscle, the cranial, middle, and caudal or inguinal mammary glands (fig. 40), as well as varying amounts of adipose tissue or the scanty panniculus adiposus of the chinchilla.

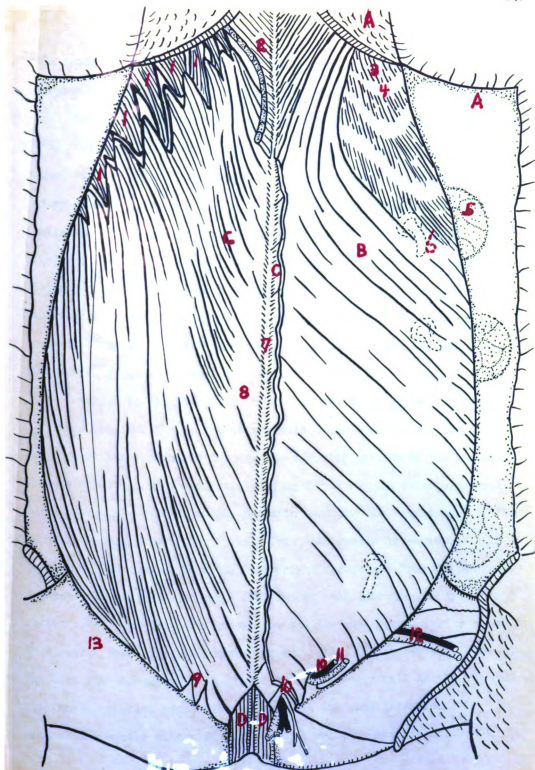
The M. cutaneous maximus is well developed as is the case for many rodents (Wood and White, 1950, and Howell (1926). The fibers of the muscle form a narrow band that courses ventroanteriorly lateral to the M. pectoralis major of the chest wall to insert along with the pectoralis on the proximal end of the humerus.

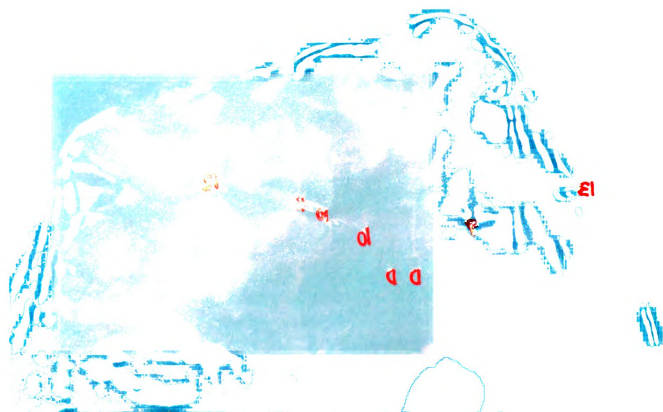
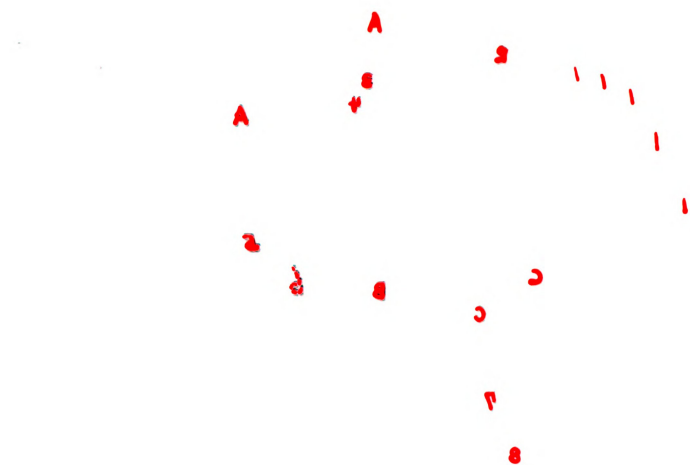
The third layer is the deep abdominal fascia which loosely binds the cutaneous maximus to the external oblique and to the rectus abdominis muscles and which also contributes to the sheath of the latter muscle. The dorsal border of the abdominal fascia with the lumbodorsal fascia, and ventrally it contributes to the strong aponeurosis of the ventral abdominal wall. At the ventral mid-line the deep abdominal fascia and



FIGURE 40. THE OUTER THREE LAYERS OF THE VENTRAL ABDOMINAL WALL OF AN ADULT FEMALE CHINCHILLA

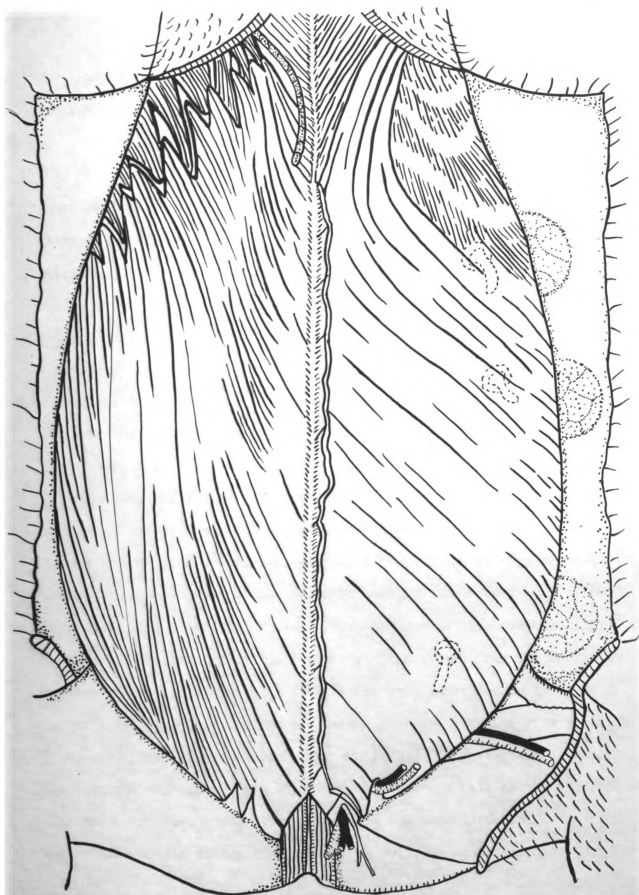
- A. Integument
 - B. M. cutaneous maximus
 - C. M. obliquus abdominis externus
 - D. M. rectus abdominis
-
- 1. M. serratus ventralis
 - 2. M. pectoralis major
 - 3. M. intercosti externus
 - 4. Outline of rib
 - 5. Cranial mammary gland substance
 - 6. Outline of cranial teat
 - 7. Linea alba
 - 8. Aponeurosis of M. obliquus abdominis
 - 9. Inguinal hiatus
 - 10. Inguinal vessels
 - 11. Inferior epigastric vessels
 - 12. Femoral vessels
 - 13. Muscles of thigh







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the aponeurosis of the abdominal muscles are fused into a narrow longitudinal linea alba of connective tissue.

The next deeper layer consists of the M. obliquus abdominis externus (fig. 40). It is a broad thin sheet of muscle which arises from the outer surface of the last ten or eleven ribs opposite interdigitating slips of the serratus ventralis muscle, in part from the fascia of the latissimus dorsi muscle, and the lumbodorsal fascia. The prominent fibers of the muscle which course ventrocaudad are discontinued at the lateral border of the rectus abdominis muscle. Connective tissue succeeds the muscle tissue by an aponeurosis and fuses with the sheath of the rectus abdominis and with the linea alba. The muscle also inserts on the crest of the ilium and the inguinal ligament.

Internal to the foregoing muscle, is the M. obliquus abdominis internus (fig. 41). It is a thin muscle whose muscular portion is relatively less extensive than is the muscular portion of the external oblique muscle. The aponeurotic portion forms a broad triangular area along the caudal border of the thoracic wall and the caudad half of the midventral line toward the pubis. Thus, the muscle is about one-half tendinous. It arises from the lumbodorsal fascia and from the inguinal ligament and pubic symphysis. Its aponeurotic insertion is into the rectus sheath and into the linea alba and the cartilages of ribs eight to eleven. Some cranial muscular fibers extend to the vertebral end of the last rib and appear to continue on the thoracic wall as the external intercostal muscles whose fibers course in the same direction. In general the muscle fibers of the internal oblique pass ventroanteriorad.

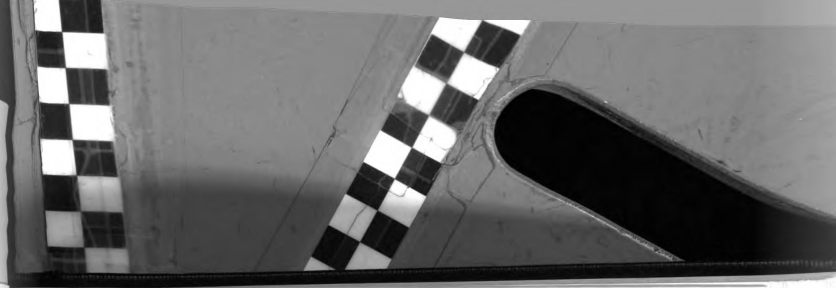
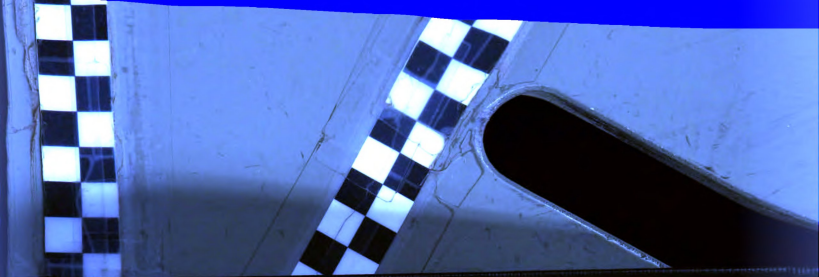
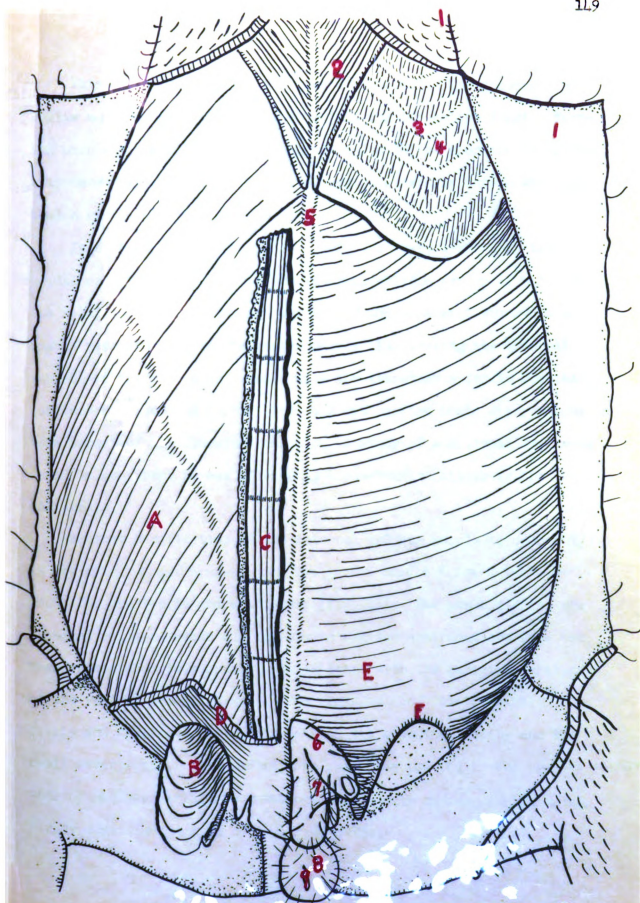


FIGURE 41. A DEEPER DISSECTION OF THE VENTRAL ABDOMINAL WALL TO SHOW THE INTERNAL OBLIQUE, THE TRANSVERSE, AND THE RECTUS ABDOMINIS MUSCLE, AND ALSO THE SCROTAL DIVERTICULUM

- A. M. obliquus abdominis internus
 - B. Cremasteric fibers of the internus abdominis in wall of scrotal sac
 - C. M. rectus abdominis (internal oblique sheath of rectus opened)
 - D. M. obliquus abdominis externus (cut)
 - E. M. transversus abdominis
 - F. Internal inguinal ring
-
- 1. Integument
 - 2. M. pectoralis major
 - 3. Outline of rib
 - 4. Intercostal muscles
 - 5. Linea alba
 - 6. Penis
 - 7. Frenulum of penis
 - 8. Anal prominence
 - 9. Anus



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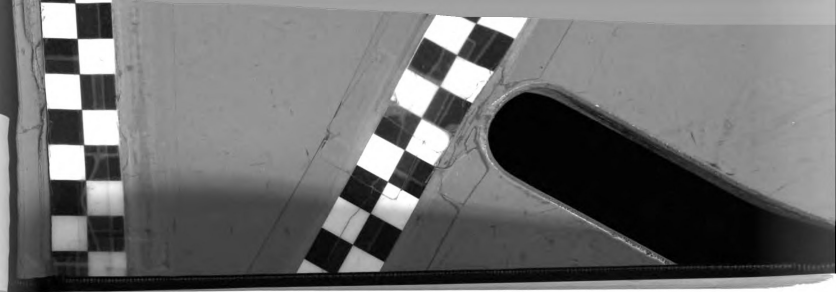
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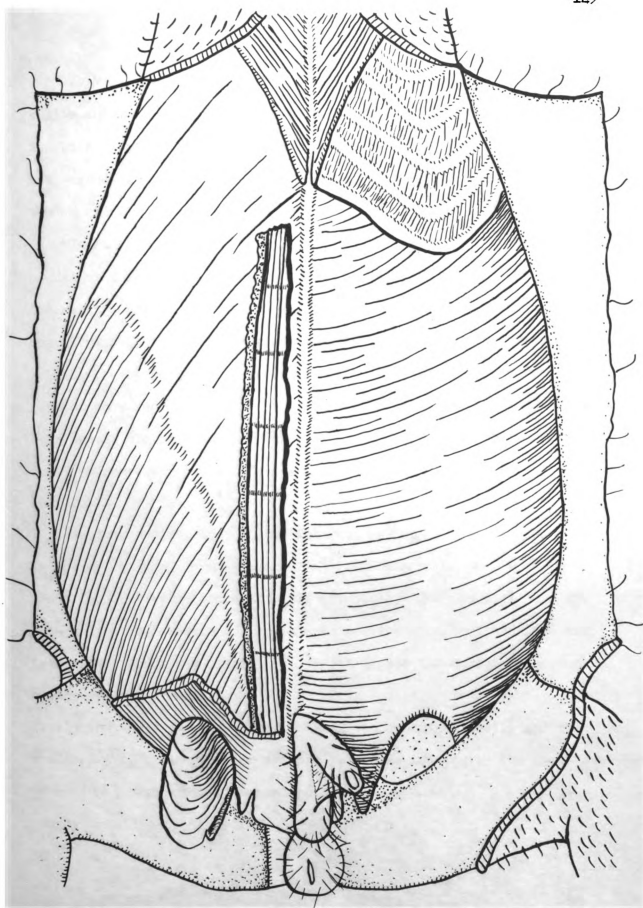
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This muscle has several features of interest. The aponeurosis splits and surrounds the rectus abdominis for its entire length, forming both an internal sheath in conjunction with the aponeurosis of the transversus abdominis, and the outer rectus sheath in common with the tendon of the external oblique.

In other species (dog, Miller 1952; man, Gray 1942) both the caudal or inferior portion of the internal oblique tendon as well as the related portion of the aponeurosis of the innermost transversus muscle pass external to the rectus muscle thus leaving the internal surface of the rectus in contact with the transversus fascia and the peritoneum. Wood and White (1950) did not publish their observations on this aspect of the abdominal muscles. A study of additional specimens would be necessary to see if this is a constant condition in the chinchilla.

Another modification of the internal oblique muscle is seen only in the male. A ventrocaudal portion of the muscle forms a cremasteric pouch for the testis and epididymis (fig. 41). The pouch pierces the external oblique muscle and appears to receive contributions from the transversus abdominis muscle. It is lined with the parietal peritoneum of the ventral abdominal wall. The right and left testes pass freely and apparently at random between the abdominal cavity and the small diverticula. The testes are sometimes located in the pouches at the time of mating; during other matings they remain within the abdominal cavity near the openings of the diverticula.

The wall of the scrotal sac is formed by fibers from the internal oblique muscle. A mesorchium is constant and extends into the wall of the diverticulum.

The skin over the scrotal diverticulum of the abdominal cavity does not form a corresponding bursa around the muscular sac; it does however distend somewhat when the testis is located within the bursa.

At the inguinal ligament immediately lateral to the rectus muscle, the transversus and the internal oblique form an internal inguinal canal, whereas the external oblique presents two triangular passages, the external inguinal canals which pass vessels and nerves to the pubic area.

The M. transversus abdominis (fig. 41) forms the innermost thin muscular sheet of the abdominal wall. It arises from the internal surface of the thoracic wall caudal to the attachments of the diaphragm with which it interdigitates, from the lumbodorsal fascia, and from the ilium and the inguinal ligament.

It inserts upon the linea alba. The fibers course almost directly dorsoventrad, deviating but slightly in a caudal direction; they end near the border of the rectus abdominis muscle, being replaced at this point by a band of aponeurosis.

The internal oblique muscle and the transversus muscles are quite firmly adherent, but are separable by careful dissection in the case of well preserved carcasses. The aponeurosis of the internal oblique seems more firmly attached to the underlying muscle fibers than is the muscular portion.

Enclosed within the divided layers of the internal oblique aponeurosis is the rectus abdominis muscle (figs. 40 and 41). It is attached caudally along the external surface of the pubic symphysis and adjacent rami, and cranially to the first to the fifth ribs. It is a narrow ribbon-like muscle, somewhat wider cranially. At intervals along its course, groups of muscle fibers are attached to the sheath which inserts it.

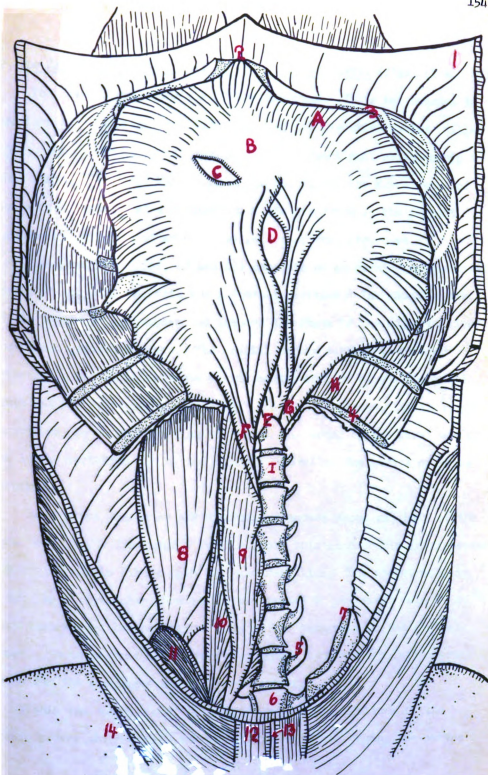
No pyramidalis muscle was found though Wood and White, ibid., described such a muscle for the chinchilla.

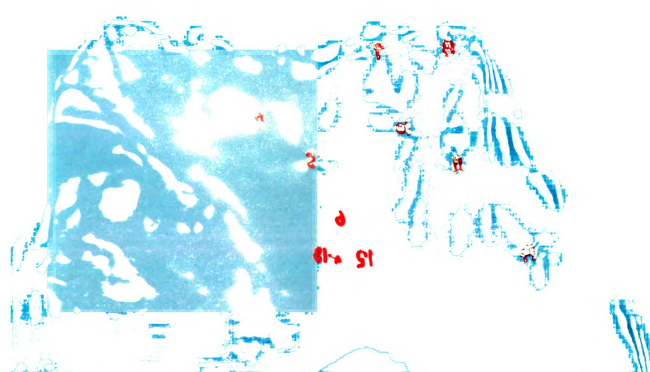
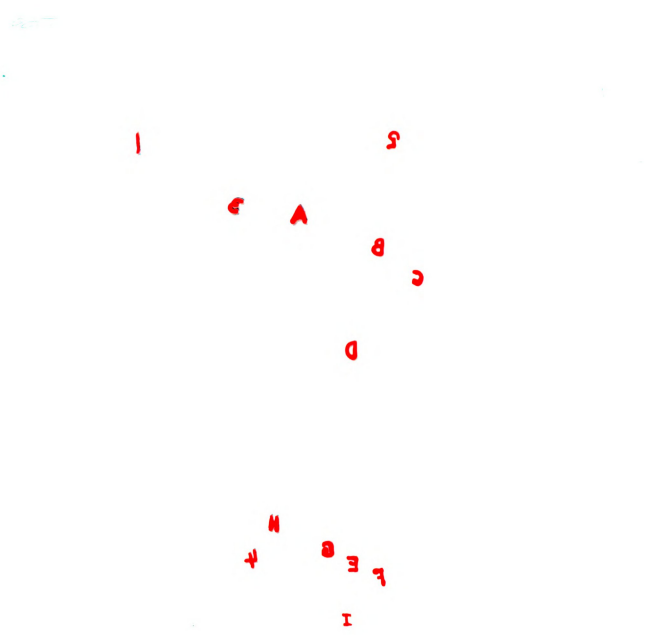
Associated with the abdominal wall are numerous important vessels and nerves. Within the sheath of the M. rectus abdominis are located the deep epigastric vessels, which course along the lateral border of the rectus. Branches of these vessels supply the rectus, and others extend laterally, parallel to the fibers of the external oblique to anastomose with the lower intercostal and the lumbar blood vessels, which have passed from the dorsal region to the abdominal wall. The last intercostal nerves and the first four lumbar nerves also run in a parallel manner in the direction of the fibers of the external oblique muscle. The lumbar nerves in order caudad are the iliohypogastric (fig. 43) which is preceded by a muscular branch in specimens having fourteen ribs, the ilioinguinal, and the fourth lumbar nerve (fig. 43), also referred to as a muscular nerve in the present work.

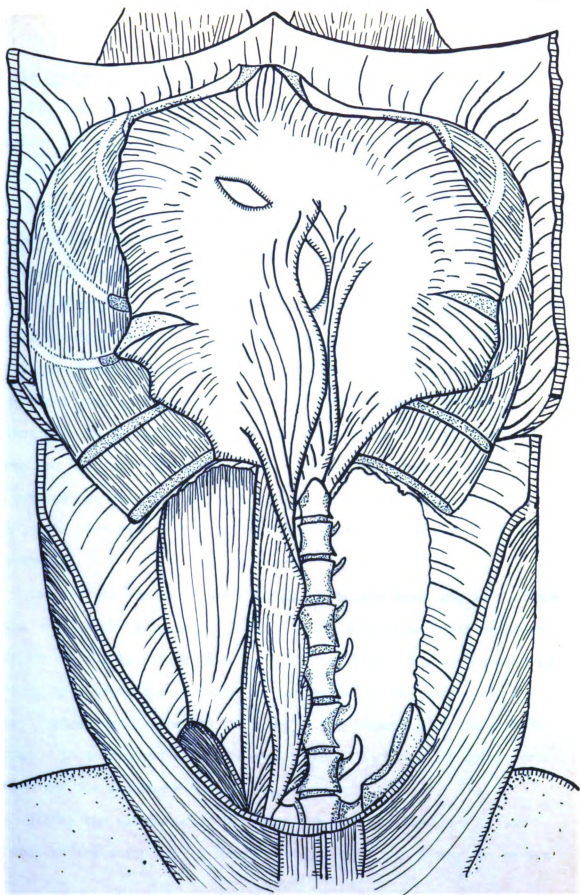


FIGURE 42. THE ABDOMINAL SURFACE OF THE DIAPHRAGM, THE SURROUNDING CHEST WALL, AND THE DORSAL BODY WALL AND LUMBAR SPINE

- A. Muscular border of diaphragm
 - B. Central tendon of diaphragm
 - C. Postcaval foramen
 - D. Esophageal hiatus
 - E. Aortic hiatus
 - F. Right crus or pillar of diaphragm
 - G. Left crus
 - H. Internal intercostal muscle
 - I. Lumbar vertebra number two
-
- 1. Ventral wall of abdomen (cut)
 - 2. Ensiform prominence of sternum
 - 3. Rib eight (chondral portion)
 - 4. Rib 13 (last rib of this specimen)
 - 5. Transverse process of seventh lumbar vertebra
 - 6. First sacral vertebra
 - 7. Iliac crest
 - 8. M. quadratus lumborum
 - 9. M. psoas minor
 - 10. M. psoas major
 - 11. M. iliacus
 - 12. M. rectus abdominis of ventral abdominal wall
 - 13. Linea alba
 - 14. Thigh







2 . The Cranial or Rostral Wall of the Abdominal Cavity (figs. 42 and 43)

The cranial wall consists of the diaphragm. It is not unusual to consider the diaphragm in a description of the digestive system (Miller, 1952) due to its internal position and its functional relationship to this system. Wood and White, 1950, in describing the musculature of the chinchilla, omitted a discussion of the diaphragm so the present information consists of an original report on this structure.

The diaphragm (figs. 42 and 43) consists of an arching dorsoventral septum between the thoracic and abdominal cavities. The caudal surface of the diaphragm is concave and assumes the shape of the adjacent liver and dorsal gastric surface. The cranial convex surface is related principally to the investments of the caudal surface of the heart and lungs and the surrounding mediastinal and pleural spaces. It is reniform in outline due to an incurving of the dorsal border by the first one or two lumbar vertebrae and by the muscles lateral to the centra of these structures.

The central tendon of the diaphragm composes about one half of the total area of the diaphragm. It is a broad thin aponeurosis interspersed with crural muscle fibers near the middorsal line. The aponeurosis is pierced by a lenticular foramen for the caudal or postcaval vein at a point ventral and lateral to the apex of the concavity of the central tendon. It is pierced along the centrodorsal border by an intercrural hiatus for the esophagus and the vagus nerves.

Within the substance of the diaphragm are ramifications of the phrenic nerves which supply the muscle fibers of the organ; the nerves

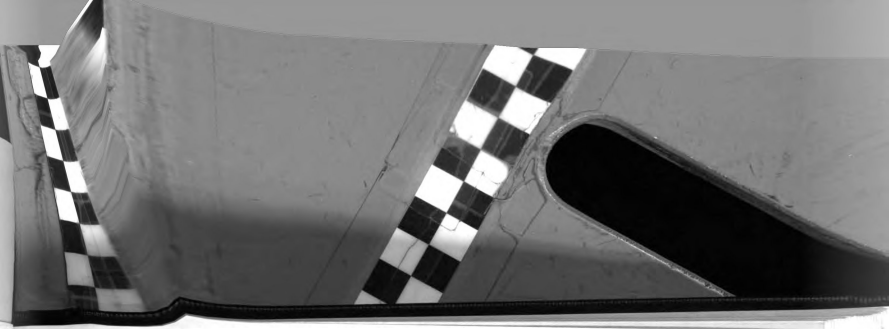
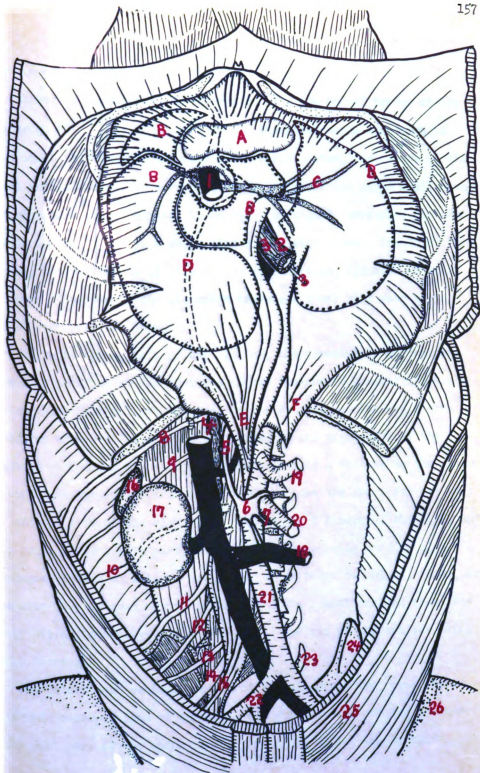
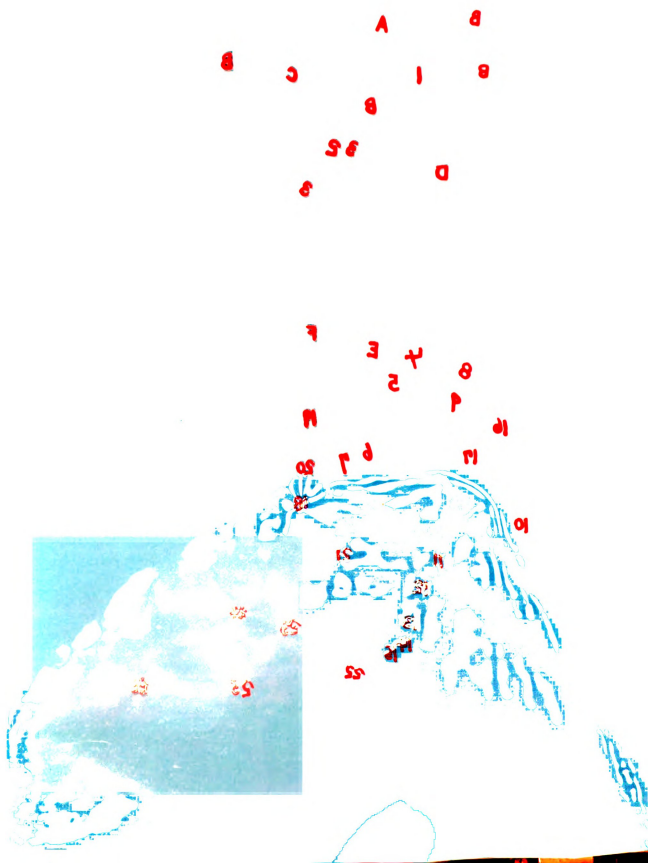


FIGURE 43. THE OUTLINE OF THE THORACIC STRUCTURES RELATED TO THE DIAPHRAGM AS SEEN FROM THE ABDOMINAL SURFACE OF THE DIAPHRAGM: AND THE MAJOR VESSELS AND NERVES RELATED TO THE DORSAL ABDOMINAL WALL

- A. Outline of heart
- B. Outline of lungs
- C. Outline of phrenic veins
- D. Outline of falciform ligament reflection from the abdominal surface of the diaphragm
- E. Right crus of diaphragm
- F. Left crus of diaphragm

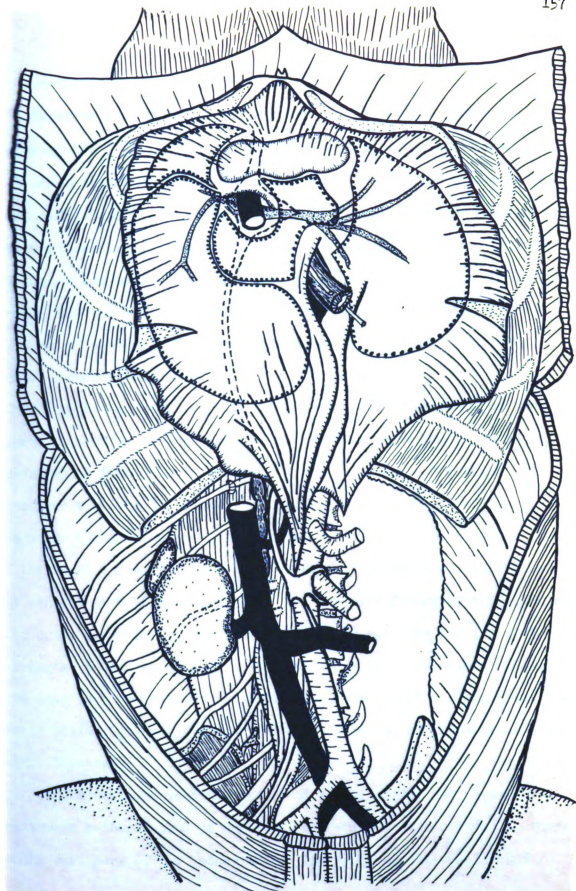
- | | |
|-------------------------------------|---|
| 1. Postcava | 14. Femoral nerve |
| 2. Esophagus | 15. Genitofemoral nerve |
| 3. Vagus nerves | 16. Adrenal gland |
| 4. Thoracic duct | 17. Right kidney |
| 5. Splanchnic nerve | 18. Left renal vein |
| 6. Mesenteric ganglion | 19. Celiac artery |
| 7. Mesenteric or solar plexus | 20. Superior mesenteric artery |
| 8. Subcostal nerve | 21. Abdominal aorta |
| 9. Muscular nerve | 22. Right common iliac vessels |
| 10. Iliohypogastric nerve | 23. Transverse process of seventh lumbar vertebra |
| 11. Ilioinguinal nerve | 24. Iliac crest |
| 12. Muscular nerve | 25. Ventral abdominal wall |
| 13. Lateral femoral cutaneous nerve | 26. Thigh |







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are accompanied by the corresponding blood vessels.

Numerous structures are associated with the dorsal border of the diaphragm (fig. 43). They include the abdominal aorta and thoracic duct which pass through a dorsal intercrural hiatus, the centra of the first and second lumbar vertebra, the psoas major and minor muscles and the right and left quadratus lumborii. Additional structures include the azygos and hemiazygos veins, the sympathetic trunks, the splanchnic nerves, and the bodies of ribs twelve and thirteen, and also of ribs fourteen if present. The diaphragm traverses these ribs near their costal-chondral junctions.

Slightly to the left of the midline, the dorsal half of the diaphragm is modified by the addition of two fan-shaped bundles of muscle fibers which form pillars or cruri of the diaphragm. The right crus is longer than the left, extending caudad to the right side of the second or third lumbar centrum, the left usually attaching to the centrum of the first vertebra. From their caudal apices the cruri fan out to the central area of the diaphragm. The adjacent fibers of the right and left cruri decussate in part, to surround the opposite borders of the esophageal hiatus as well as the border along their own hiatal edges, and then interlace ventrad beyond the hiatus. The crural muscles bound the aortic hiatus laterally, but do not cross, the rim of the orifice being mainly fibrous.

The lateral and ventral borders of the diaphragm are formed by a continuous c-shaped band of muscle fibers which course centrad to insert on the periphery of the aponeurosis. The width of the muscle band

averages approximately fifteen millimeters. There is a variability in the width of the muscle band at various areas, and in the proportions between muscle and aponeurosis (figs. 42 and 43). In the diaphragm illustrated, an amuscular trigone is shown on the left and right sides near the interspace of ribs ten and eleven, suggesting a division of the muscle into a ventral and a dorsal muscle of the diaphragm, as described for man (Cunningham, 1951). From lateral to ventral the periphery attaches to the bodies of ribs eleven, ten, and nine near their costal-chondral junctions, to the intervening structures, and to the xiphoid or ensiform cartilage of the sternum.

In anesthetized animals the diaphragm was seen to rhythmically compress the abdominal viscera by reducing its curvature; the ventrolateral wall of the cavity was expanded by the impinging viscera.

3. The Dorsal Abdominal Wall (figs. 41 and 42)

The dorsal wall of the abdomen is composed of integument, lumbo-dorsal fascia, sacrospinalis and intervertebral muscles, the seven lumbar vertebrae, and the three sacral vertebrae. The psoas major and minor muscles and the iliacus, as well as the ilium and ischium of the os coxae also bound the cavity dorsally.

The sympathetic nerve trunks, as well as the proximal ends of the lumbar and sacral nerves are closely associated with the dorsal wall.

The parietal peritoneum reflects for the most part along the dorsal body wall to serve as a mesenteric attachment for the viscera.

The abdominal aorta and the post cava, as well as the proximal ends of the first branches lie in contact with the dorsal wall.



4. The Caudal Abdominal Wall (figs. 47, 48 and 49)

The caudal wall is the least extensive of the boundaries of the abdominal cavity. It consists of the perineal diaphragm or musculo-fibrous transverse sheet which is attached to the caudal rim or outlet of the pelvis, and to the base of the first few coccygeal vertebrae dorsad. The caudal wall of floor of the cavity is significant in that it bears the anal aperture, the urethral canal, and in the case of the female, the vaginal outlet. The external surface bears an anal and genital prominence.

B. The Non-Digestive Organs of the Abdominal Cavity

The various abdominal organs related topographically to the digestive tract are of great economic and scientific interest to the chinchilla breeders.

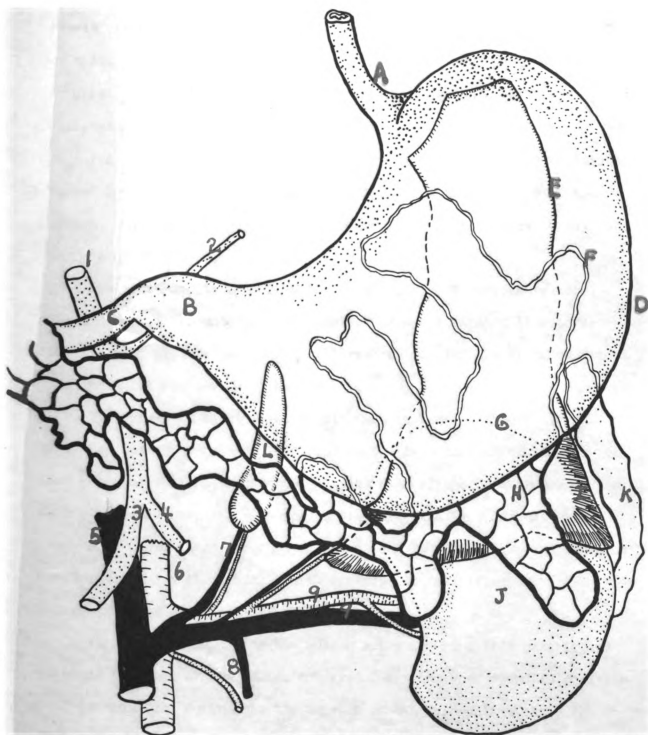
1. The Spleen (figs. 44, 45 and 59)

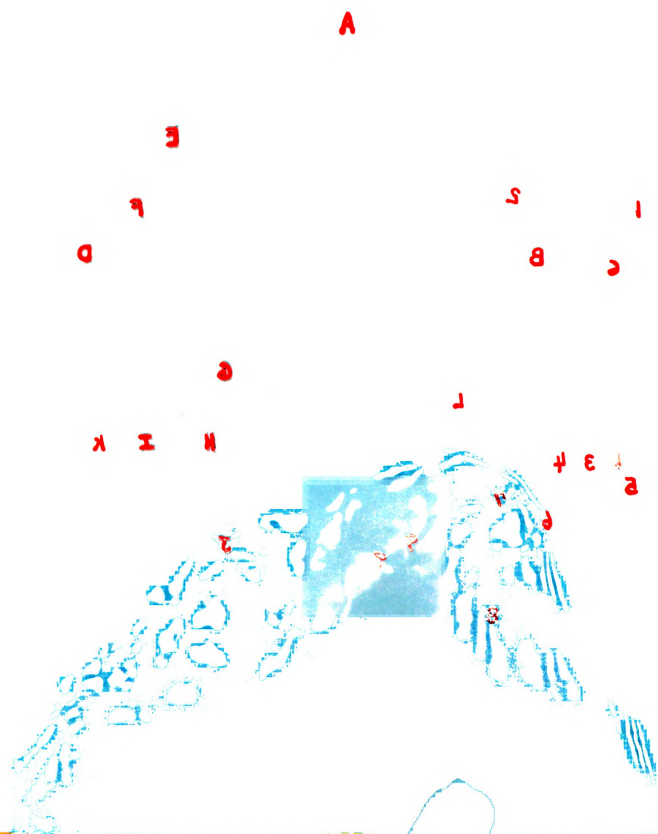
The spleen of the chinchilla is a dark red organ located at the left side of the abdominal cavity in close relation to the stomach and pancreas. Kennedy (1952) indicated that the spleen of the chinchilla is subject to infection by Listeria monocytogenes, a bacterium which has also been found in the guinea pig and rabbit (Maximow and Bloom, 1952), and in the chicken (Kennedy, 1952).

The dorsal surface of the spleen is smooth, and almost entirely surrounded by serosa. It has no attachments to the surrounding abdominal structures. It is nearly flat, having a gentle convexity in both a transverse and a longitudinal direction.

FIGURE 44. THE RELATIONSHIPS OF THE STOMACH, PANCREAS, SPLEEN, KIDNEY, AND LEFT ADRENAL GLAND. THE STOMACH IS MOST VENTRAL AND THE KIDNEY MOST DORSAL.

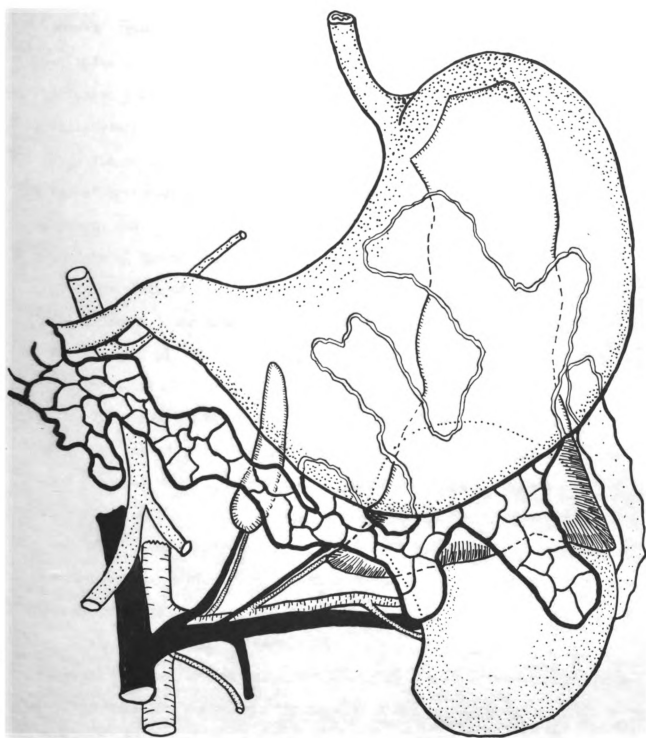
- A. Esophagus (abdominal portion)
 - B. Pyloric region of stomach
 - C. Duodenum
 - D. Greater curvature of the stomach
 - E. Outline of spleen
 - F. Outline of pancreas
 - G. Outline of kidney
 - H. Left mass of pancreas
 - I. Caudal portion of spleen
 - J. Left kidney
 - K. Fat body
 - L. Left adrenal gland
-
- 1. Hepatic portal vein
 - 2. Left gastric vein
 - 3. Superior mesenteric vein
 - 4. Inferior mesenteric vein
 - 5. Postcava
 - 6. Abdominal aorta
 - 7. Adrenal vessels
 - 8. Gonadal vessels
 - 9. Left renal artery and vein







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In cross-section, the spleen is seen to be a much flattened bi-convex organ, which tapers gradually to a very thin edge. The central or hilus area of the ventral surface is thickened somewhat. At the thickest point the spleen has a dorsal-ventral dimension of about two millimeters.

The ventral surface of the spleen presents a central and restricted "bare" or non-serosal area (fig. 45). This area is the hilus of the spleen, and it is the region at which the blood vessels pass through the surface of the organ.

The width of the spleen varies considerably at various regions. The width of the rounded cranial portion is about eight millimeters; for the central third about six millimeters, and for the expanded caudal portion about eighteen millimeters.

The spleen is about eighteen millimeters long.

The spleen is related (fig. 44) to the left portion of the stomach and pancreas ventrad, and to the cranial half of the left kidney dorsad. The right caudal apex of the spleen lies near the left adrenal gland.

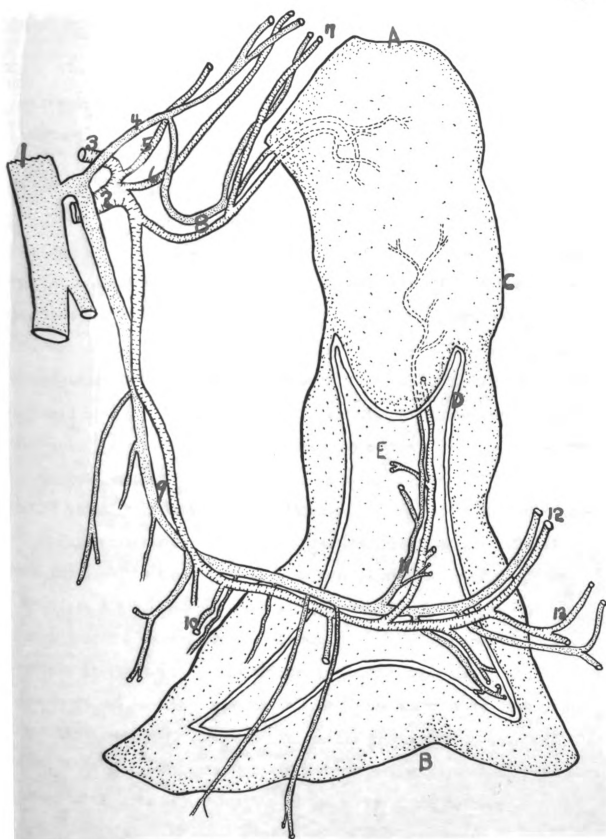
The cranial three-fourths of the spleen is strap-like, and somewhat rectangular, but the caudal fourth expands into a triangular portion which presents a pointed left and right apex.

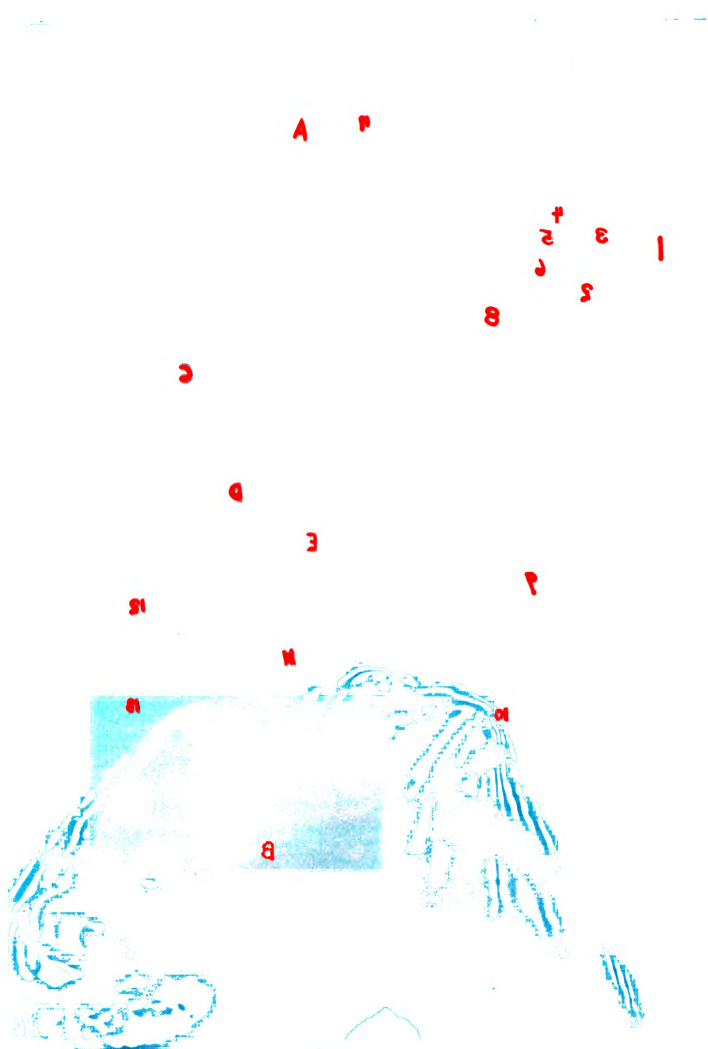
The arteries supplying the spleen arise from the left gastric and splenic branches of the celiac artery. The veins correspond in position and in name, and drain into the hepatic portal vein ultimately. The vessels of the spleen will be considered under the section on the vascular supply to the abdominal organs.



FIGURE 45. THE VENTRAL SURFACE OF THE SPLEEN, THE MESOSPLENIC ATTACHMENT OUTLINE, AND THE BLOOD VESSELS OF THE REGION

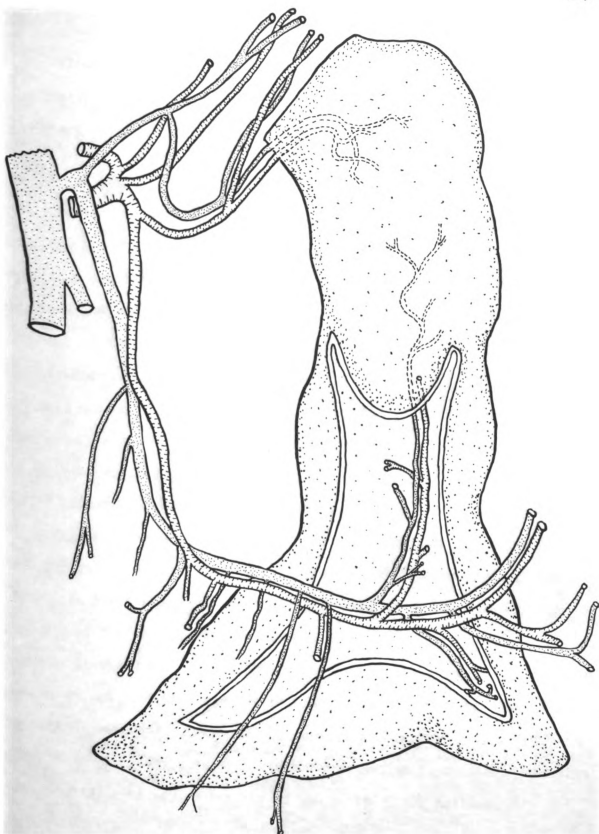
- A. Cranial border of the spleen
 - B. Caudal border of the spleen
 - C. Lateral border of the spleen
 - D. Line of attachment of mesentery of the spleen
 - E. Hilus or 'bare' area of the spleen
-
- 1. Hepatic portal vein
 - 2. Celiac artery
 - 3. Hepatic artery
 - 4. Left gastric vein
 - 5. Ventral left gastric artery
 - 6. Dorsal left gastric artery
 - 7. Fundic artery and vein
 - 8. Cranial splenic artery and vein
 - 9. Splenic artery and vein
 - 10. Pancreatic branches of splenic artery and vein
 - 11. Caudal splenic artery and vein
 - 12. Short gastric artery and vein
 - 13. Left gastro-epiploic artery and vein







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The spleen is supported by the splenic vessels, and by peritoneal reflections which form a medial and a lateral pancreaticosplenic ligament and which circumscribe a pancreaticosplenic fossa.

2. The Female Reproductive Organs (figs. 46, 47 and 48)

Besides having an interest in the general morphology of the reproductive system, various workers have considered other aspects of this system. Journey (1947) prepared an introductory atlas on the reproductive anatomy of the chinchilla. Newberne (1951) presented a brief account of the generative structures and illustrated them in figures twenty-four and twenty-five of his work. Makino (1953) reported that the haploid number of chromosomes was 32, and diploid sixty-four, and that the male bears the X-Y sex chromosome combination. He reported further on the chromosomes of the chinchilla in 1954. Castle (1953, abstract only) discussed mutation possibilities to be expected in the chinchilla.

Fish (1953) discussed the reproductive process of the chinchilla, and indicated that puberty occurs at four to six months of age, that gestation lasts 111 days, and parturition six hours. Pierce (1944a) considered the breeding habits of chinchillas, and indicated that the average litter was two, that the female would mate as early as four months of age, and that one female over twelve years of age bore young. Fish (1954) reported concerning chinchilla pregnancy. Pierce (1944b) noted that the young wean at sixty to seventy-five days of age, and that they sometimes cause irritations of the teats of the mothers.

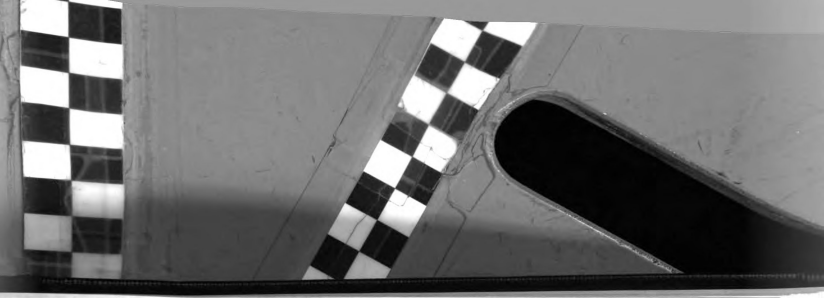
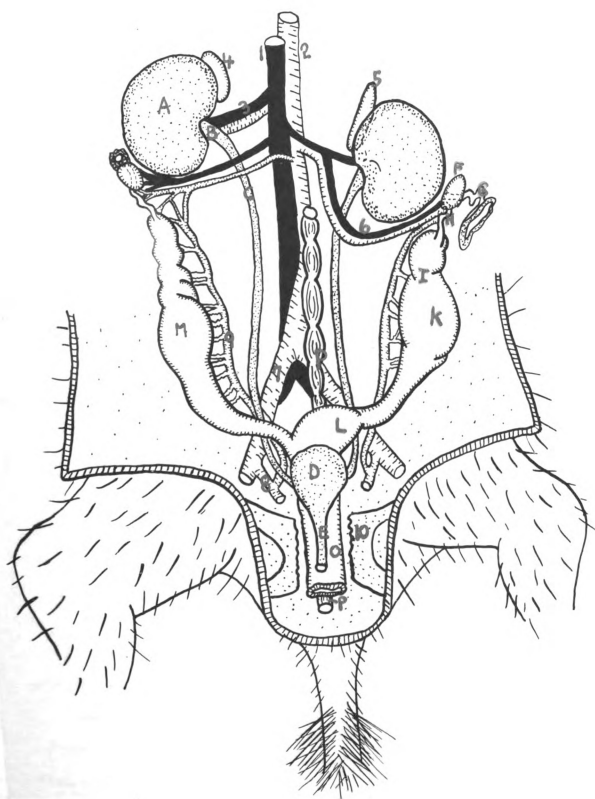
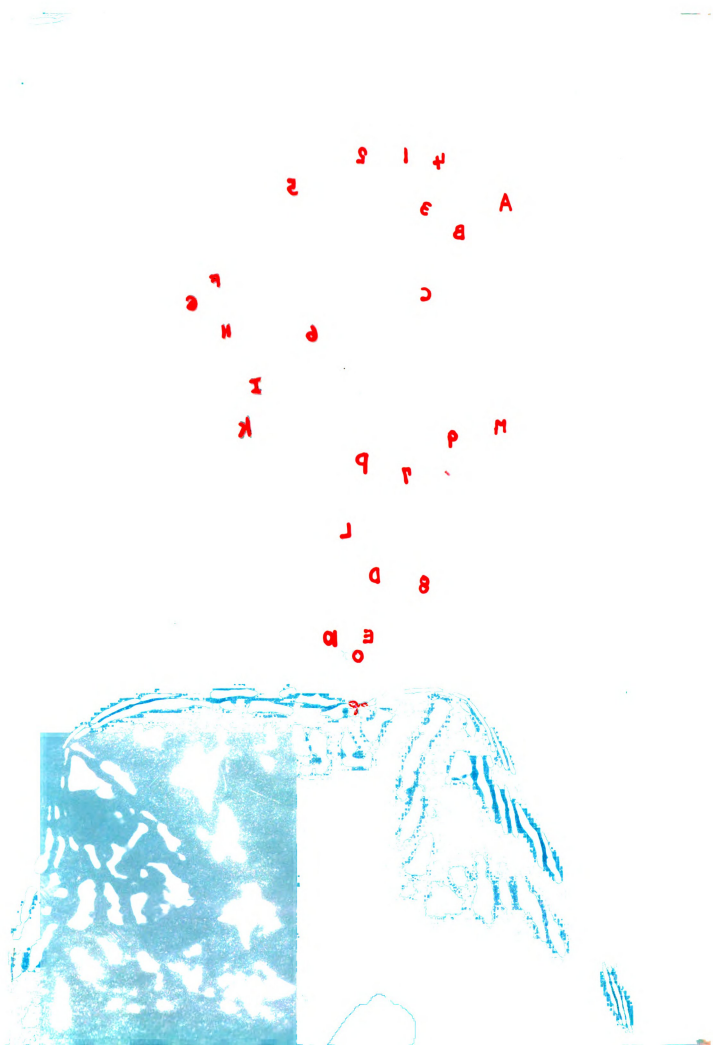


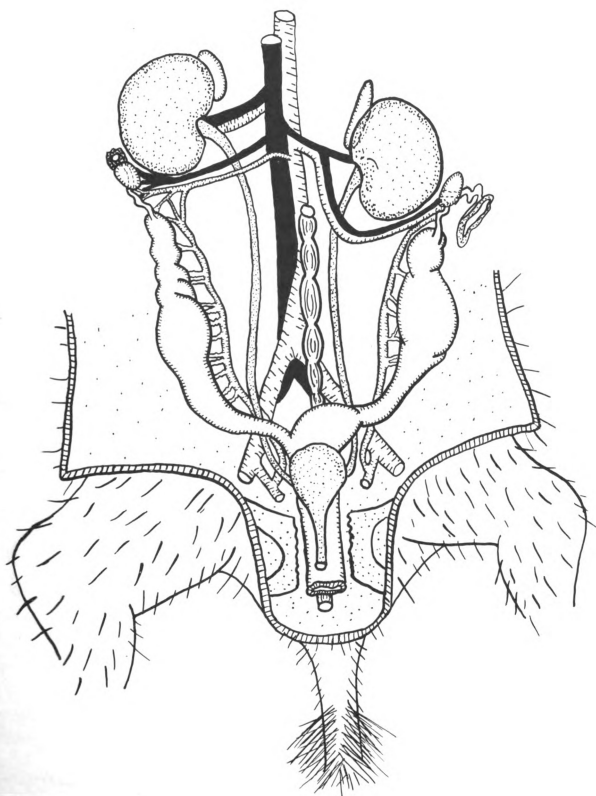
FIGURE 46. A VENTRAL VIEW OF THE REPRODUCTIVE AND EXCRETORY ORGANS OF A PREGNANT FEMALE

- A. Right kidney
- B. Pelvis of ureter
- C. Right ureter
- D. Urinary bladder
- E. Urethra
- F. Left ovary
- G. Left infundibulum (distended)
- H. Left oviduct
- I. Left uterine horn
- K. Fetal enlargement
- L. Fetal enlargement at junction of left horn and the body of the uterus
- M. Fetal enlargement in right uterine horn
- O. Vagina
- P. Rectum

- 1. Postcava
- 2. Abdominal aorta
- 3. Right renal artery and vein
- 4. Right adrenal gland
- 5. Left renal gland
- 6. Left ovarian artery and vein
- 7. Right common iliac artery
- 8. Right hypogastric artery
- 9. Right uterine artery
- 10. Pubic bone (cut)







The female reproductive organs (fig. 46) consist of right and left ovaries which are about five millimeters in length. The ovaries are vesiculated in adult females. The oviducts are serpentine and fine in caliber except for an expanded fimbriated ostium or infundibulum. The uterine horns are paired and in the non-pregnant female are ribbon-like; they are irregularly cylindrical in the gravid female. The horns extend from the caudal border of the kidney to a point directly dorsal to the apex of the urinary bladder where they fuse to form a brief internally-divided uterine body. The body presents a common os cervix which contains the two subopenings of the paired uterine horns immediately internal to the common os.

The cervix of the uterus protrudes into the transversely expanded proximal end or fornix area of the vagina. The cervix is directed dorsocaudad to contact the proximal end of the dorsal vaginal wall.

The vagina is located dorsal to the urethra and ventral to the rectum and anus. It passes caudad to a transverse slit-like ostium on the genital prominence. From the level of the cervix, the vagina, rectum, and urethra curve slightly dorsad, then gradually ventrad for the remainder of the terminal portions of these structures. The very terminal portions are curved somewhat more sharply.

The vaginal opening is closed off by a very thin membrane prior to estrus. At the time of mating the membrane perforates and the smooth lining of the vagina is seen to be moist and pink.

The vaginal lining presents numerous longitudinal rugae except in the cervical region where the rugae are predominantly transverse.

The proximal and distal ends of the vagina are expanded somewhat in a transverse direction.

The ovaries receive ovarian arteries either from the aorta or from the proximal end of the renal arteries. The ovarian veins take a similar course from the ovary to the precava.

The principal uterine artery arises from the hypogastric in the region of the pelvis and passes cranial in the mesometrium. In the pregnant female, numerous coiled arteries are visible between the uterine horn and the uterine artery.

The body of the uterus and of the vagina lie dorsad to the urinary bladder and to the female urethra. The rectum is located dorsad to the reproductive structures.

The female external genitalia (figs. 47 and 48) are located on the outer caudal surface of the abdominal cavity. There is a rounded prominence in the subcaudal area which contains a reduced number of hairs. The ventral half of the prominence is marked by an elevated urethral papilla which contains a pair of folds that surround the urethral opening. The folds can be easily retracted.

The central area of the prominence contains a transverse and slit-like vaginal stoma which is sealed by a thin membrane during non-estrus, and which is open during estrus. Though quite wide, the opening is not conspicuous unless the surrounding tissue is compressed.

Dorsal to the vaginal opening and between it and the base of the tail is an enlarged prominence which surrounds the anal orifice.

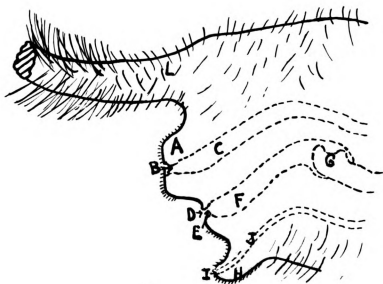
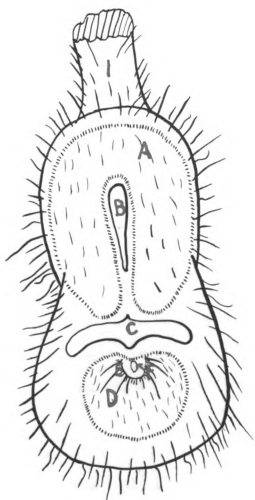


FIGURE 47. THE EXTERNAL GENITALIA OF THE FEMALE CHINCHILLA AS SEEN FROM BEHIND

- A. Anal prominence
- B. Anus
- C. Vaginal stoma
- D. Urethral papilla
- E. Lateral urethral fold
- F. Urethral opening
- 1. Ventral surface of proximal end of tail

FIGURE 48. A PROFILE VIEW OF THE FEMALE GENITALIA AND AN OUTLINE OF THE ASSOCIATED TUBES

- A. Anal prominence
- B. Anus
- C. Rectum
- D. Vaginal depression
- E. Vaginal stoma
- F. Vagina
- G. Cervix uteri
- H. Urethral papilla
- I. Urethral opening
- J. Urethra
- L. Proximal end of tail



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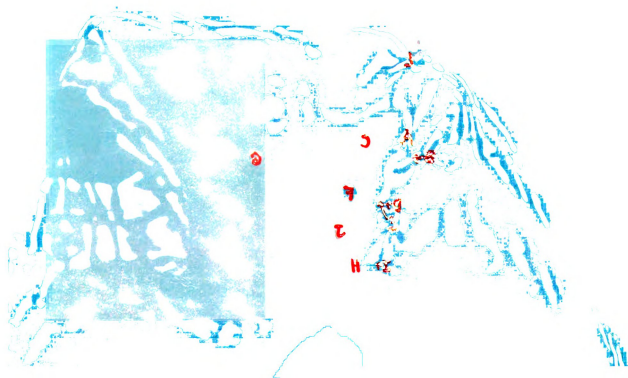
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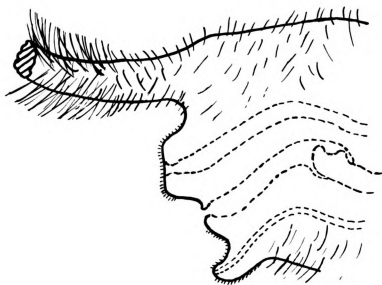
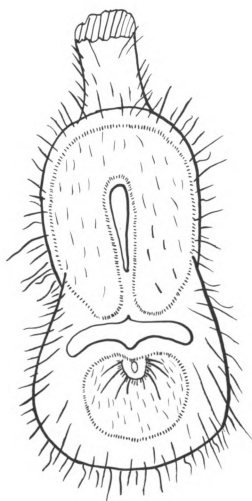
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The mammary glands of both sexes are in three pairs, the cranial, middle, and caudal or inguinal pairs. In the male and the non-pregnant female the gland substance is barely palpable through the cutis; during pregnancy, the female mammary gland enlarges and thickens and can be readily felt through the skin.

The teats are about the same length as are the hairs of the surrounding fur, and are easily located in both sexes.

3. The Male Reproductive Organs (figs. 49, 50, 51 and 52).

Less has been written concerning the male reproductive system of the chinchilla, than about the female system. The National Chinchilla Breeder (1952) states that both a fifty-day old and a fifty-one day old male successfully bred litter mates. Dalziel and Philips (1948) reported on the development of an artificial ejaculation technique which employed electric shock as the stimulus. The present author observed that ejaculation occurred in each animal which was sacrificed by electrocution. Newberne (1951) illustrated the male organs in figure twenty-four of his work. Kennedy (1952) among others, discussed polygamous mating and artificial insemination. He also discussed the adverse effect of the binding of the penis by hair after mating and indicated production of the copulation plug or "stopper" which is formed in the vagina from injected semen.

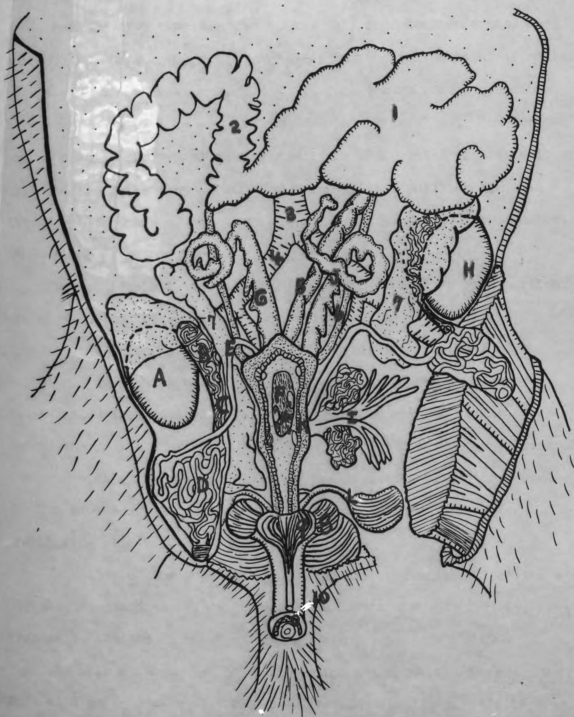
Bullard and Parkinson (1953), wrote about spermatogenesis in relation to reproduction, and Journey (1947) considered the reproductive organs of both sexes, with special reference to artificial insemination.



FIGURE 49. A VENTRAL VIEW OF THE MALE UROGENITAL ORGANS. (THE URINARY BLADDER HAS BEEN OPENED, THE PUBIC SYMPHYSIS REMOVED, AND THE LEFT THIGH AMPUTATED AND PULLED Laterally TO SHOW THE DEEPER GLANDS ON THE LEFT SIDE)

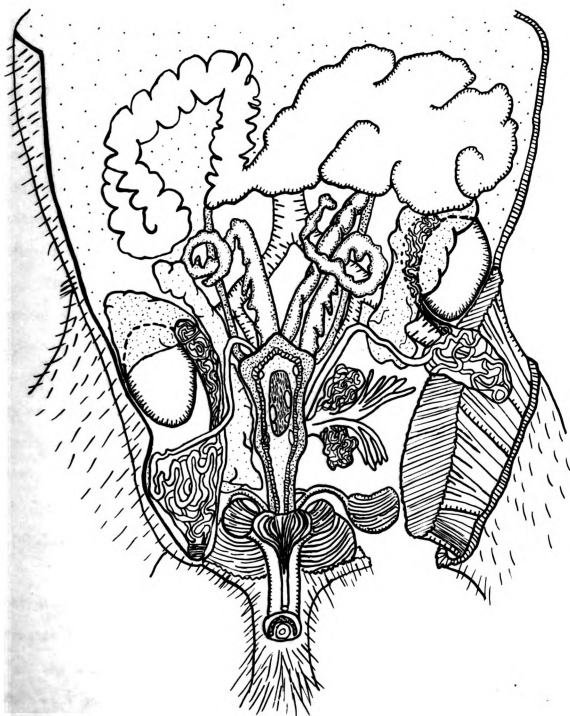
- A. The right testis
- B. The head of the right epididymis
- C. The central portion of the epididymis
- D. The tail of the right epididymis
- E. The right vas deferens
- F. Prostatic utricle
- G. The right seminal vesicle
- H. Left kidney pulled laterally
- I. The Left prostate gland
- J. Divisions of the left coagulating gland
- K. Prostatic thickening of the urethra
- L. Left bulbourethral gland and duct
- N. Openings on the utricle for the vas deferens and the accessory glands
- O. Corpus cavernosum penis
- 1. The cecum
- 2. Large colon
- 3. The terminal end of the abdominal aorta
- 4. Right common iliac artery
- 5. Rectum
- 6. Left ureter
- 7. Fat
- 8. Bulbocavernosus muscle
- 9. Erectile bulb of the penis
- 10. Base of tail

ANS. (THE
SURPRISIS
PULLED
LEFT SIDE)





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Shackelford and Roos (1954) discussed the overall aspect of the male genital tract.

From the testis to the urethra the male reproductive organs are paired. The testis (figs. 49 and 50) is located in the inguinal region of the prepubic ventral abdominal wall. The testes are attached to the dorsal body wall by a very loose and thin mesorchium. The testes can be readily compressed caudaventral into the scrotal or cremastic diverticula of the ventral wall, and when in this position they lie lateral to the base of the penis, forming lateral scrotal prominences. There is no pendulant scrotum.

The epididymis is in three portions; the cranial or head portion, the middle, and the caudal portion or tail of the epididymis.

The vas deferens (figs. 49 and 50) arises from the tail of the epididymis by a short tortuous section and then passes as a smooth thick-walled tube entered. It then curves from ventrad to dorsad around the medial surface of the cystic end of the respective ureter of the same side. The vas deferens then passes caudad along the dorsal surface of the urinary bladder laterad to the seminal vesicle or coagulating gland.

Each side of the prostatic enlargement of the urethra receives a coagulating gland, a vas deferens, and a prostate gland (fig. 49) from craniad to caudad.

The male urethra then courses through the penis to open near the apex at a pore located at the base of an apical penile papilla.



The penis of the chinchilla (figs. 41, 49, 50, 51 and 52) assumes a different form if erect or not erect. In the flaccid state the terminal half of the penis bends caudad and ventrad in respect to the proximal half of the penis, from which it is supported by a penile frenulum. The terminal portion is directed toward the tail or caudad in this state.

In the erect state, the distal half of the penis bends directly anterad, and the penis becomes a semi-rigid tubular organ which is much larger in length and in diameter than is the flaccid penis.

The erect penis usually exceeds fifty millimeters in length.

The penis possesses a loosely attached prepuce (figs. 50 and 51) and when the later is retracted the apical portion of the penis is seen to bear an urethral papilla and also a papilla over the sacculus glandis, a blind diverticulum in the terminal portion of the penis. The later structure could be mistaken for the urethral opening. Both the glans penis and the blind sac possess fine barbs; in the case of the glans surface the barbs are located in six or more rings of about forty to fifty barbs or spines.

The distal or apical fifteen or twenty millimeters of the penis contains a baculum or os penis.

The anal aperture of the male is located between the base of the penis and the proximal end of the tail.

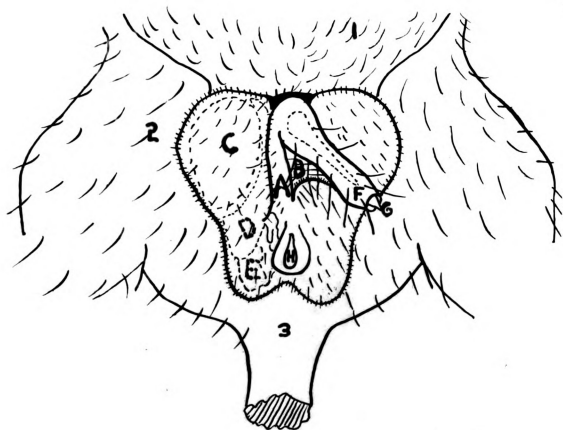
Glands of the male reproductive tract (fig. 49) include a long and much twisted seminal vesicle (paired) which is located dorsal to the urinary bladder. The vesicle is also referred to as the coagulating

FIGURE 50. A VENTRAL VIEW OF THE EXTERNAL GENITALIA OF THE MALE CHINCHILLA

- A. Penis
 - B. Frenulum of penis
 - C. Scrotal prominence distended by the testis
 - D. Epididymis outline
 - E. Epididymal fat
 - F. Prepuce of penis
 - G. Urethral papilla
 - H. Anus
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- 1. Ventral abdominal wall
 - 2. Right thigh
 - 3. Tail

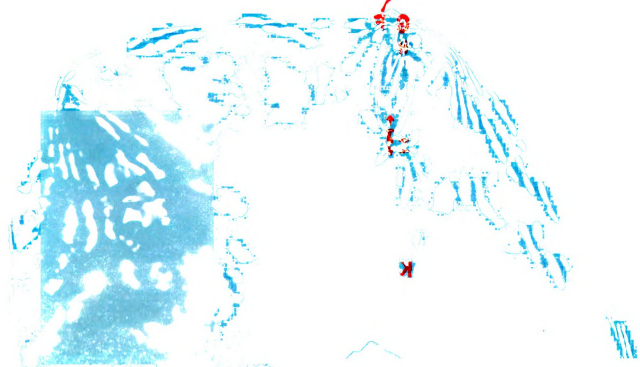
FIGURE 51. A VENTRAL VIEW OF THE ERECT PENIS WITH PREPUCE RETRACTED

- A. Urethral papilla
- B. Urethral opening
- C. Papilla of sacculus glandis
- D. Opening of sacculus glandis
- E. Glans (note tiny barbs which project proximad)
- F. Outline of os penis or baculum
- G. Penile barbs
- H. Smooth portion of penis
- I. Frenulum on ventral surface of prepuce
- J. Rounded papilla on prepuce
- K. Anus



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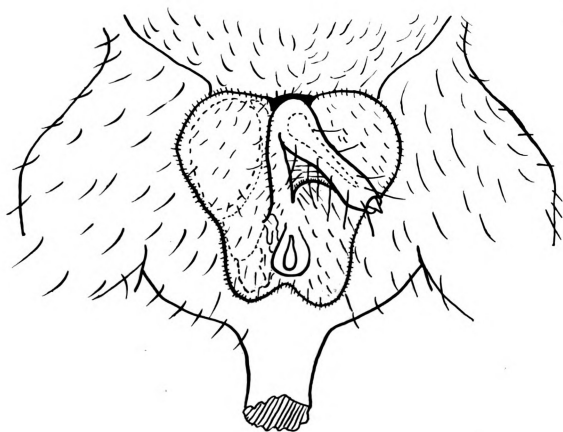
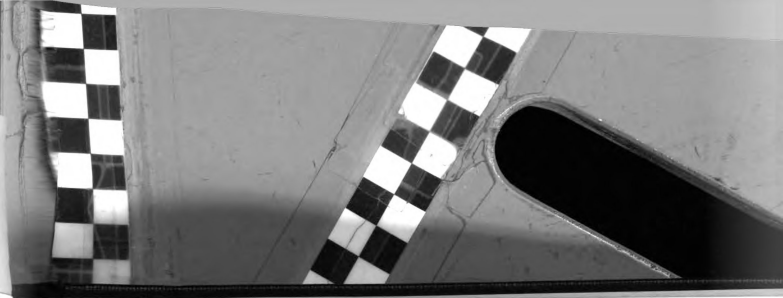


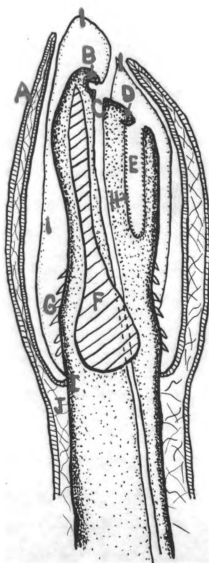


FIGURE 52. THE TERMINAL PORTION OR GLANS OF THE PENIS

- A. Prepuce
- B. Urethral papilla or process
- C. Orifice of the urethra
- D. Papilla of diverticulum or sacculus
- E. Sacculus glandis or diverticulum of glans
- F. Os penis
- G. Spines of glans
- H. Very short spines of sacculus glandis
- I. Line of preputial reflection
- J. Loose connective tissue
- 1. Coagulum (mistakeable for a papilla)



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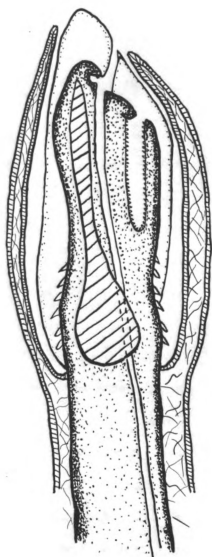
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gland (Newberne, 1951). The seminal vesicle possesses several short tubular diverticuli.

A somewhat divided and dorsoventrally compressed thin prostate gland is located on each side of the urethral enlargement of the prostatic region. Distal to the prostate gland, the urethra receives a pair of pisiform muscle-covered bulbourethral glands.

4. The Excretory Organs of the Chinchilla (figs. 43, 46, 47, 48, 49, 51 and 52)

The excretory organs of the chinchilla consist of paired kidneys and ureters, the single urinary bladder, and the male or female urethra.

The urinary system is subject to disorders. Newberne (1951) and Kennedy (1952) suspected a relationship between a certain morbid anatomy of the kidneys and the habit of fur chewing, one of the most prevalent and most dreaded sicknesses of the chinchilla.

The kidneys (figs. 43 and 46) are of the usual 'bean' shape and of the proportionate size to those of other mammals. The lateral border is convex, and the medial or hilus side, concave. The concavity contains the pelvis of the ureters and the vessels of the kidneys.

The kidneys are related to the dorsal abdominal wall and are attached to the ventral surface of the psoas muscles, and the quadratus lumborum muscle. They are retroperitoneal. The adrenal glands lie close to the craniomedial surface of the kidney, the left gland being somewhat farther away than the right.

The left kidney of the chinchilla is shifted a few millimeters caudad in respect to the right kidney, and is somewhat more distant from

the midline than is the right. The left renal vessels are thus longer than the right and arise from the aorta at a point slightly caudad to the origin of the right renal artery, and from the postcava in a similar relationship.

The right kidney is located from vertebral levels two to four, or five, and the left from vertebral levels three to five (fig. 42).

In the female, the ovaries lie close to the caudal border of the kidney, as do also the oviducts. In both sexes the pancreas crosses the ventral surfaces of the kidneys, and the spleen also lies ventral to the cranial portion of the left kidney.

The ureters (figs. 43, 46 and 49) pass dorsal to the crest of the urinary bladder and enter the dorsal surface of the bladder near the urethral opening.

The bladder (figs. 48 and 49) in both sexes is morphologically similar. It is located dorsal to the pubic symphysis and ventral to the respective pelvic regions of the individual sex organs, namely, the uterus and vagina in the female, and the seminal vesicles, vas deferens and prostate glands of the male. The terminal end of the rectum lies dorsal to the preceding structures. The bladder is somewhat pyriform in shape. The caudal portion gives rise to the urethra. The female urethra is simple and lies along the ventral surface of the vagina. It is tubular. It ends between the urethral folds of the urethral prominence.

The male urethra is modified by a small enlargement in the region of the prostate gland which receives the various male glands, and by

the entrance of the other male glands, the bulbourethral glands, at a point slightly distad to the prostatic portion of the urethra. The terminal portion of the male urethra passes through the penis and opens on the ventral surface of the penis at the base of the terminal papilla.

5. Other Non-digestive Abdominal Organs

The abdominal cavity also contains the various blood vessels which supply the organs. They are presented in a following section. Various reflections of the peritoneum form definite structures which will be considered in a subsequent section.

The abdominal cavity also contains the adrenal glands, the pancreas, the ovaries, and the testes. These structures are generally considered to contribute to the endocrine system of the body, and are illustrated both as to position, form, and vascular connections in the various drawings of the abdominal region.

The larger nervous structures of the abdominal cavity are also illustrated in various figures, but a discussion of their detailed anatomy is considered worthy of another study.

C. The Digestive Organs of the Abdominal Cavity

The abdominal digestive organs include the minor (abdominal) portion of the esophagus, the stomach, small intestine, cecum and other portions of the large intestine, the pancreas, and the liver and biliary structures.

Although the coiling of the intestines, their variation in length and position, and the proximity of non-digestive organs render a single

illustration of the complete abdominal digestive tract impossible, an introductory schematic drawing (figs. 53) illustrates the general arrangement of the stomach and intestines. Individual portions, along with their vascular relations will also be depicted in more detail.

The bulk of the small intestine and terminal portion of the large colon are located to the right of the mid-line caudal to the right lobes of the liver, and to the right portions of the pancreas.

Most of the small colon, easily identified by a regular and intermittent swelling of the wall due to a series of internal fecal pellets, is located sinistrally in respect to the midline, and immediately caudal to the stomach and left pancreatic lobules.

Both the small intestine, located as above, and the small colon form extensive coils and loopings which are not constant due to pendular, constrictive or segmentary, and mass peristaltic actions.

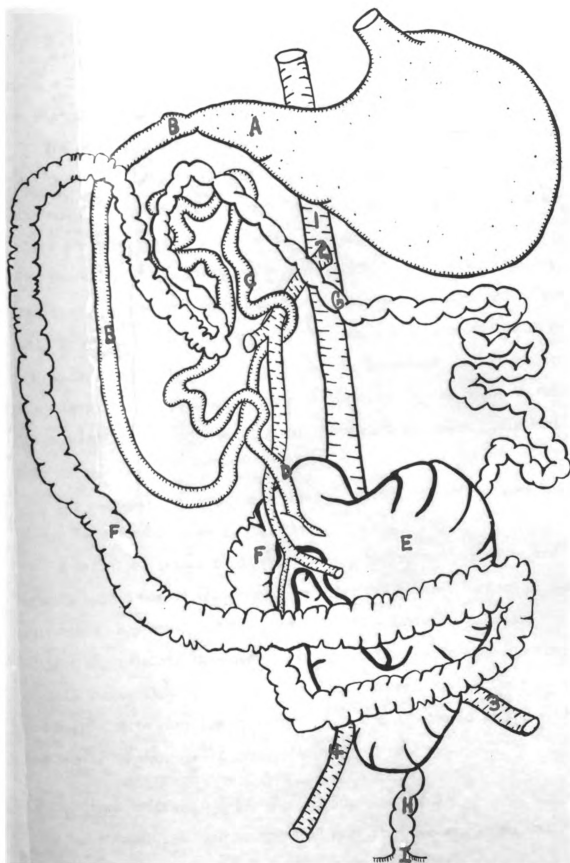
The cecum of the chinchilla is a prominent and large spirally sacculated organ which occupies about one-fourth of the abdominal cavity from the cranial rami and symphysis of the pubic bones, craniad.

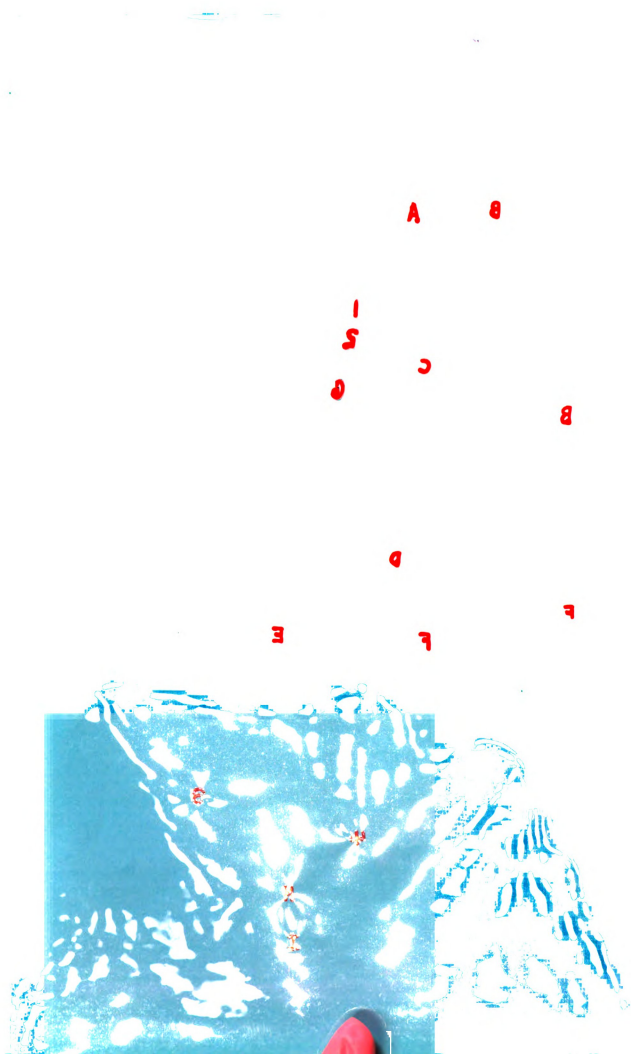
The large colon commences near the ileocecal junction, forms a u-shaped loop across the ventral surface of the cecum, passes craniad along the right side of the abdominal cavity to form subsequently the proximal half of a u-shaped transversely lying loop of the intestine; the terminal portion this u-shaped loop consists of the proximal end of the small colon.

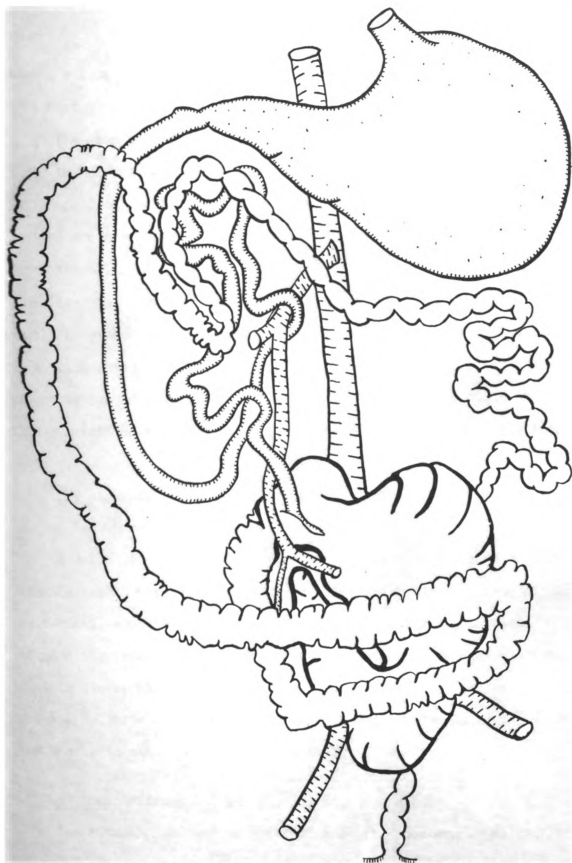
After contributing to the large colon-small colon loop, the small colon passes transversely to the left side of the abdominal cavity and

FIGURE 53. A DIAGRAMATIC VIEW OF THE VENTRAL SURFACE OF THE ABDOMINAL DIGESTIVE ORGANS

- A. Pyloric stomach
 - B. Duodenum
 - C. Jejunum
 - D. Ileum near cecal junction
 - E. Cecum
 - F. Large colon
 - G. Small colon
 - H. Rectum
 - I. Anus
-
- 1. Abdominal descending aorta
 - 2. Superior mesenteric artery
 - 3. Left common iliac artery
 - 4. Right common iliac artery







forms a long and frequently looped tube which topographically becomes the rectum, dorsal to the level of the anterior pubic rami.

The stomach and intestines are suspended by mesenteric reflections from the dorsal body wall. The liver is supported from the dorsal body wall and from the caudal surface of the diaphragm; the pancreas and spleen are supported by folds of the omentum.

The color of the digestive organs is uniformly characteristic. The liver is dark or bluish-red, the stomach and duodenal end of the small intestine pink to ashen gray. The cecum and large and small colons are dark green in color. The color of the intestine is not due to pigmentation of the wall but rather to the color of the contents which is transmitted through the thin and somewhat transparent intestinal layers.

The pancreas is yellowish-pink to tan; the spleen is somewhat darker red in color than is the liver.

A definite omental fold begins at the liver, and passes to and extends caudad beyond the stomach to cover the ventral surface of the intestines, especially on the right. Besides strips of lobulated adipose tissue along the omental vessels, rather large accumulations of this tissue also occur throughout the cavity. Particularly large and nearly white clusters of adipose tissue are adnexed to the epididymis and testis in the case of male chinchilla.

1. The Stomach (figs. 44, 53, 54, 55, 56, 60 and 64)

The stomach has been an organ of practical concern as is indicated in Newberne's studies on the anatomy of the chinchilla, 1951, and in

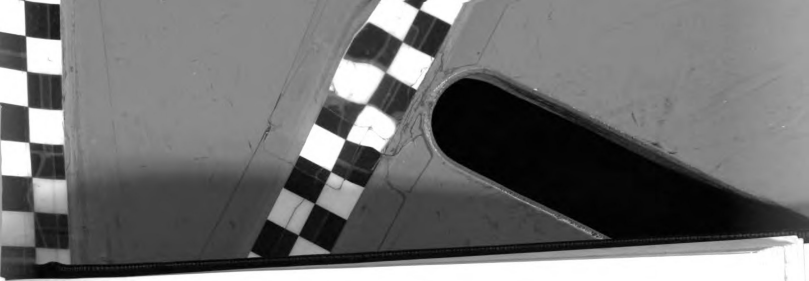
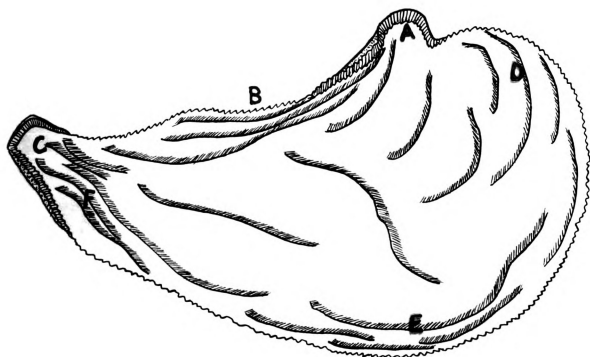
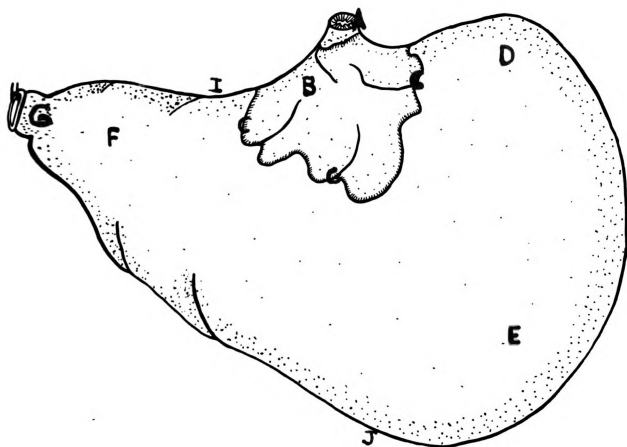


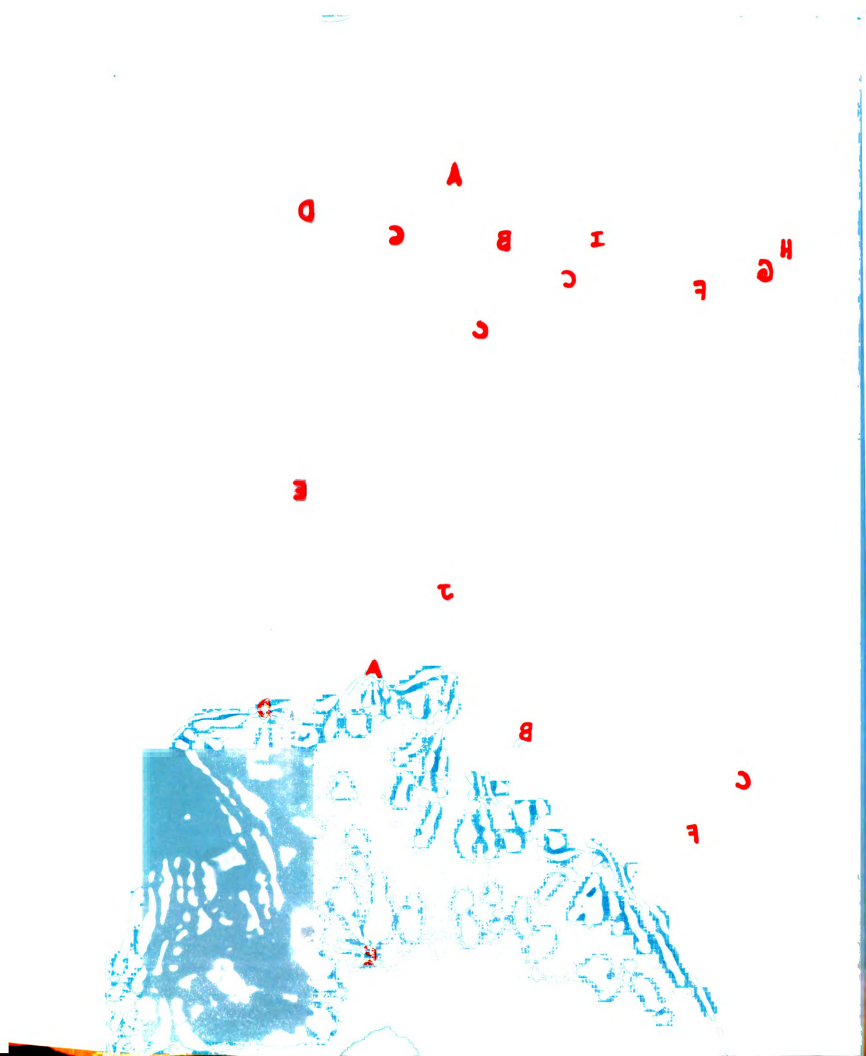
FIGURE 54. A VENTRAL VIEW OF THE REGIONS OF THE STOMACH

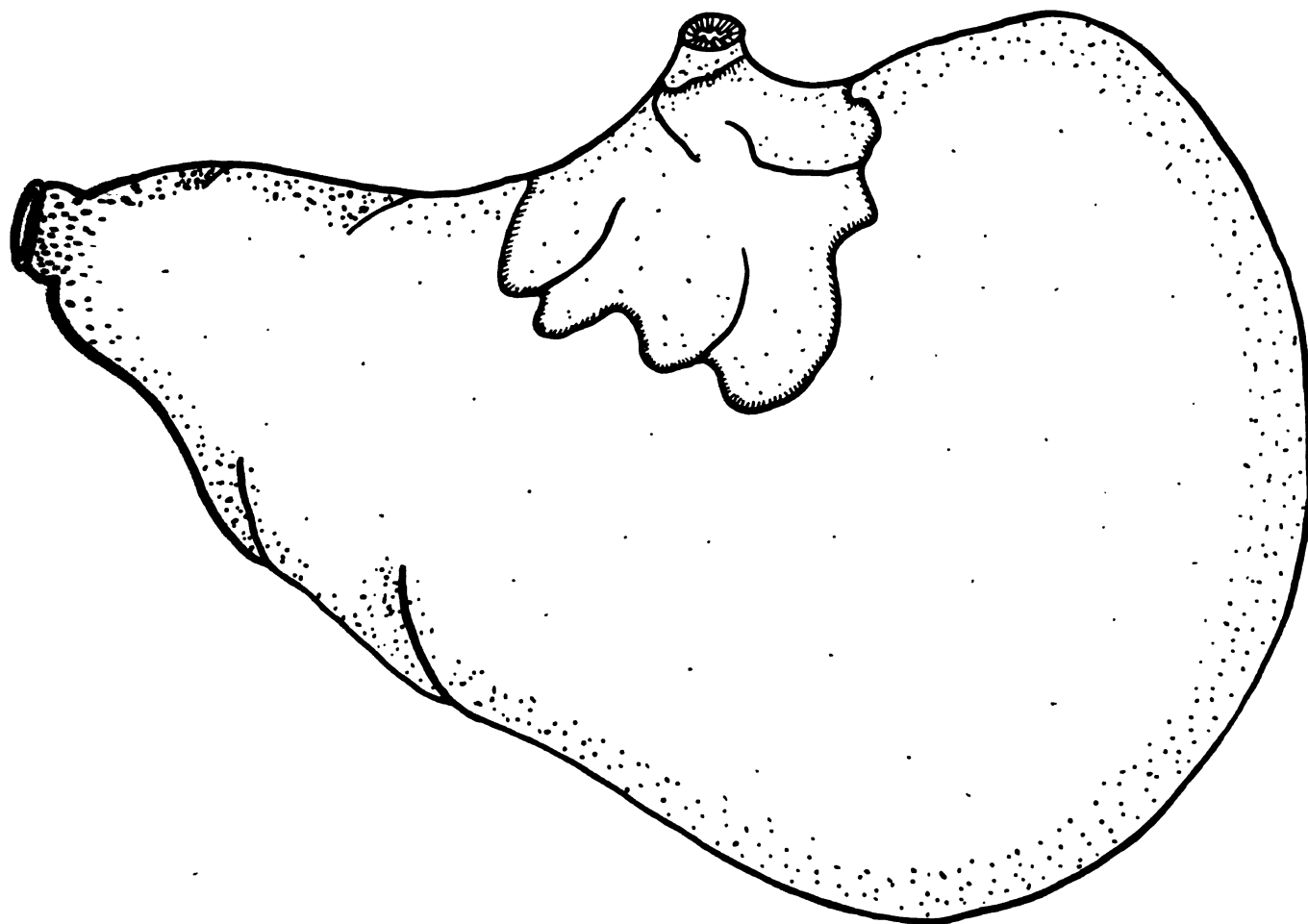
- A. The abdominal portion of the esophagus
- B. Cardiac region of the stomach
- C. Adipose tissue on the cardiac region
- D. Fundic region
- E. Body
- F. Pyloric region
- G. Gastrointestinal junction
- H. Duodenum
- I. Lesser curvature of the stomach
- J. Greater curvature of the stomach

FIGURE 55. THE GASTRIC FOLDS OR RUGAE

- A. Termination of the esophagus
- B. Lesser curvature
- C. Proximal end of the duodenum
- D. Fundic rugae
- E. Rugae of the body of the stomach
- F. Pyloric rugae







Kennedy's text, 1952, on the diseases of the chinchilla. The latter indicated that the chinchilla has been subject to bloat, gastroduodenal obstruction, and adhesion. Wells (1955) reported a case of extensive stomach ulceration. The present author observed a fungiform projection on the lining of the ventral surface of the stomach, near the middle region of the greater curvature.

The inner surface of the stomach is pale red or pink in fresh specimens. The lining is corrugated by a variable number of loose curved folds or rugae (fig. 55) which pass in the general direction of the esophagus to the pyloric junction.

The rugae are found to be higher and somewhat more numerous near the pyloric opening. They are not permanent folds and can be easily eliminated by mildly stretching the surrounding mucosa.

The stomach resembles a miniature human stomach. The contour is more or less regular and relatively unsacculated. The stomach presents a cranial lesser and concave curvature between the esophagus and duodenum; the caudal border forms a broad convex curvature which is somewhat altered by a slight general dilatation of the gastric fundus and body.

Grossly the stomach (figs. 54 and 55) has indistinct cardiac, fundic, body, and pyloric portions. The pyloric region is somewhat funnel-shaped and presents the apex at the intestinal junction.

The stomach is located ventrally to the kidney, spleen and pancreas (fig. 44), the pancreas being in direct contact with the dorsal surface of the body and fundus. The stomach also contacts the left adrenal gland in some specimens (fig. 44), and is entirely to the left of the

midline although the pyloric junction lies close to the latter.

The liver is related to the cranial surface, and the major portion of the small colon is located caudad.

Various amounts of fatty tissue contact the stomach, and a particularly conspicuous accumulation occurs over the cardium (fig. 54). The stomach is located between the layers of the mesogaster which form the visceral peritoneum of the stomach.

The volume of the stomach in fresh specimens is about fifty cubic centimeters. The stomach is about twenty millimeters craniocaudally, and thirty millimeters in a transverse diameter, measured across the widest points. The length of the lesser curvature is about thirteen millimeters, and of the greater, about one hundred.

2. The Intestines and Cecum

The intestines are typically differentiated into a small and a large intestine. The small intestine of the chinchilla is about one hundred centimeters in length. The large intestine is conspicuous in that it is much longer than the small; it is about one hundred and fifty centimeters long or roughly one and one-half times as long as the small intestine. Newberne (1951) reported a total length of one hundred and twenty-six inches for the intestine, and in the present study the range was from eighty to one hundred and fifteen inches.

The intestine is thus about ten times as long as the animal itself.

The small intestine contains numerous aggregated lymphatic nodules which are distributed from the pyloric junction to the cecal junction

and somewhat beyond. Titkemeyer and Calhoun (1955) found that the nodules could be easily counted from the exterior surface in the case of the dog; this was also true for the present species.

The cecum of the chinchilla is relatively long and of much greater caliber than is the rest of the intestine. Like the large colon, it is much sacculated. The large intestine has two clearly defined portions. The first and somewhat shorter portion or large colon, appears to be a continuation of the cecum and has a very similar appearance except that its diameter is less and it is not spiralled upon itself. The small colon is about of the same caliber as is the small intestine, but is distinguishable due to bead-like swellings of the wall as a result of its fecal contents.

a. The small intestine (figs. 53 and 56).

The entire length and blood supply of the small intestine is illustrated in figure 56. In this figure some loops of the small intestines have been spread somewhat and retracted to the left of the midline to expose the cecal termination. Most of the small intestine is located in several complex loops dorsal to the large intestine, and at the right of the midline.

Except for the first half-foot or more, the small intestine cannot be defined into regions except arbitrarily. The first or duodenal portion begins at the gastroduodenal junction and curves dextrad and caudad along the right abdominal wall, to the level of the cecum at which level it curves cranial to a point near its origin where it transforms into the second and longer portion of the small intestine. The duodenum is thus

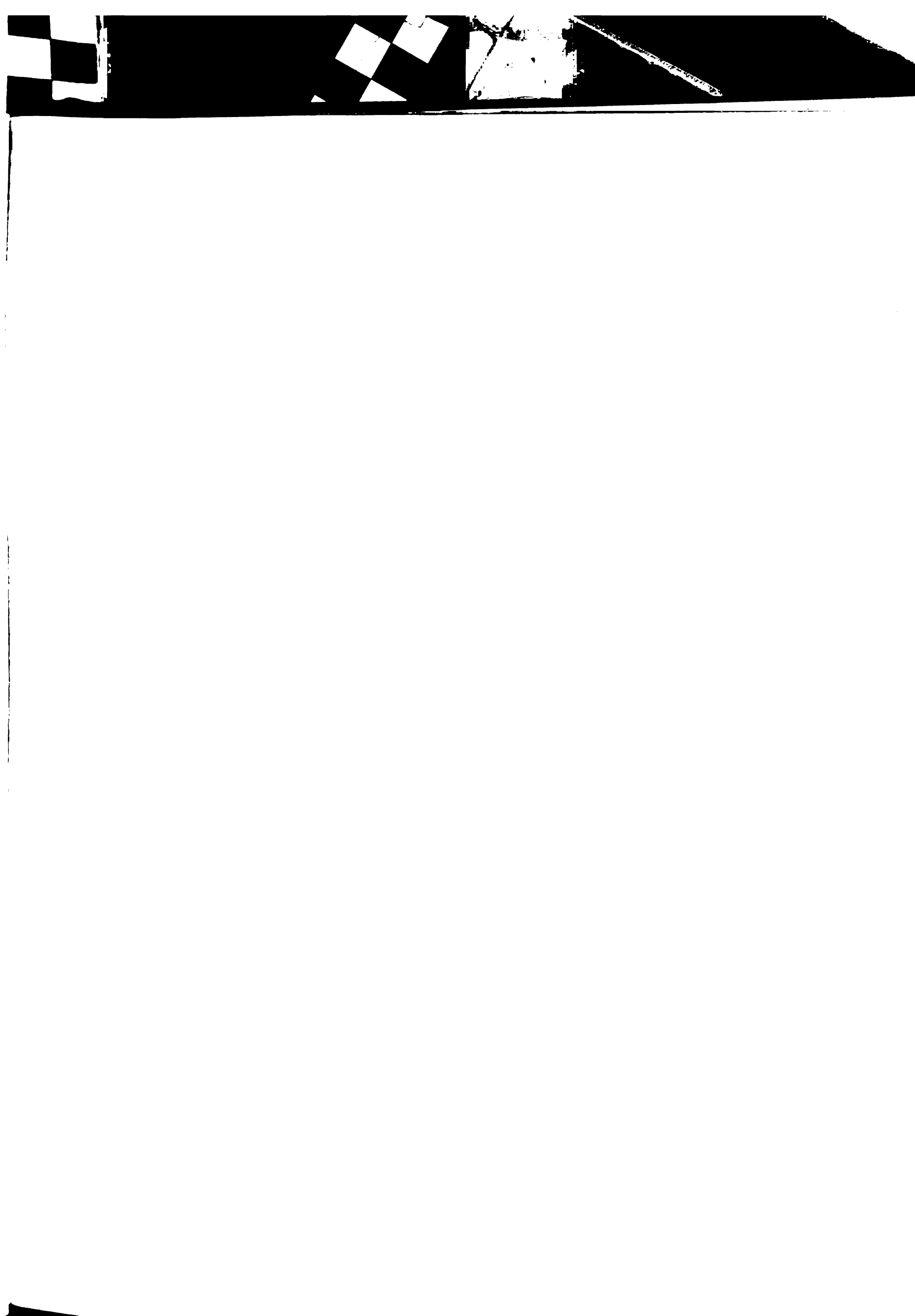
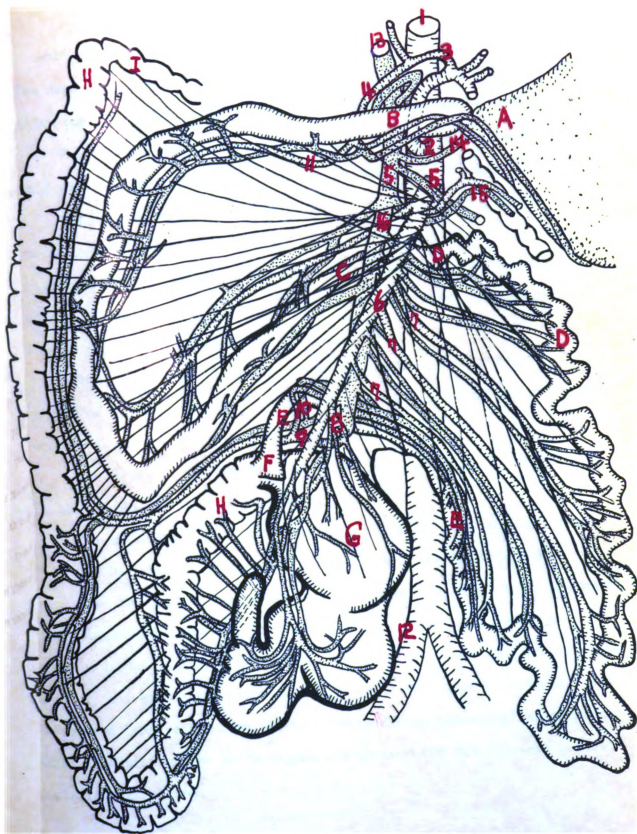
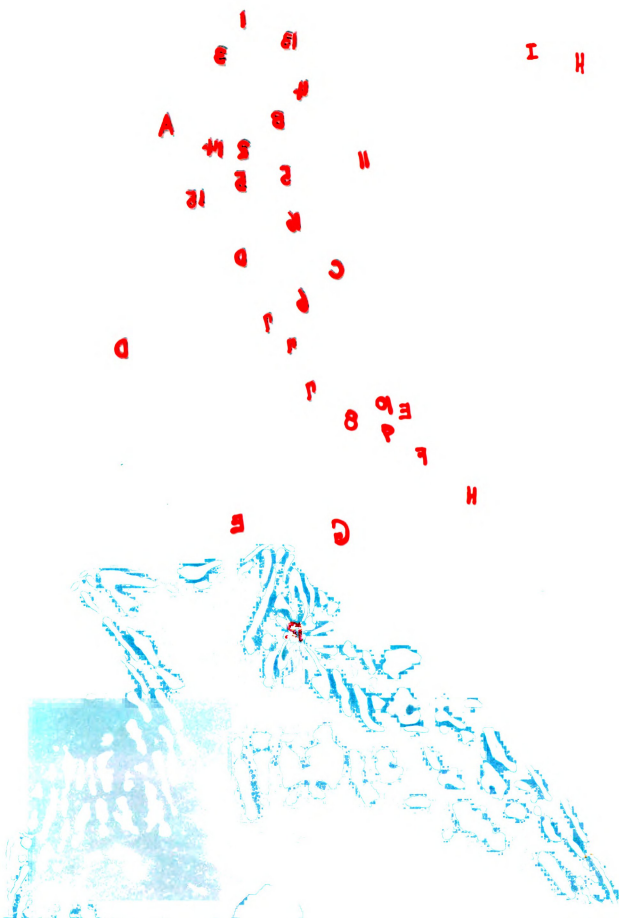


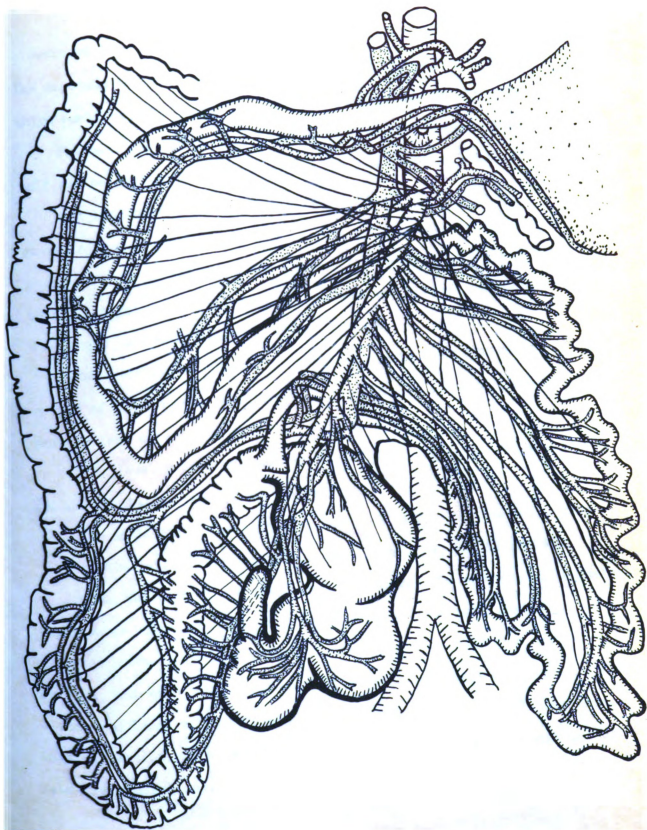
FIGURE 56. A SEMI-DIAGRAMATIC ILLUSTRATION OF THE SMALL INTESTINE AND ITS BLOOD SUPPLY

- A. Pyloric stomach
- B. Proximal end of the duodenum
- C. Distal end of the duodenum
- D. Jejunum (misplaced to the left of the midline)
- E. Ileum
- F. Terminal end of the ileum
- G. Cecum
- H. Large colon
- I. Small colon

- | | |
|--|-------------------------------|
| 1. Abdominal aorta | 9. Large colic artery |
| 2. Celiac artery | 10. Iliocolic artery |
| 3. Hepatic artery | 11. Duodenal artery |
| 4. Gastroduodenal artery | 12. Right common iliac artery |
| 5. Superior mesenteric artery and vein | 13. Hepatic portal vein |
| 6. Superior mesenteric artery | 14. Left gastric vein |
| 7. Mesenteric branches | 15. Inferior mesenteric vein |
| 8. Cecal arteries | 16. Superior mesenteric vein |







a c-shaped loop which corresponds roughly with the duodenum of man. The duodenum is of a slightly greater caliber than are the second and third portions. The color is yellowish-orange due to the contents.

The next portion is much longer and is highly coiled; about one-half can be designated as the jejunum and the terminal half, the ileum.

The length of the small intestine of the adult chinchilla is variable from specimen to specimen. The total length determined by placing a fine thread along the gut and then measuring the extended thread, ranged from seventy to one hundred and fifteen centimeters, and was longer in fresh than in embalmed animals.

The mesentery of the small intestine arises from the region of the origin of the superior mesenteric artery and the loops of the gut are more or less oriented around this structure.

The ileum or terminal portion of the small intestine ends abruptly on the cranial surface of the cecum.

The small intestine possesses internal villi, the large has none.

b. The large intestine (figs. 47, 48, 49, 53, 56, 57 and 58).

When the ventral abdominal wall is removed the superficial abdominal structures which come into view are the liver, stomach, testes or uterine horns in part, the apex of the urinary bladder when not concealed by fat, and very brief portions of the small and large intestines. The cecum and large colon form the major superficial intestinal structures. Only a portion of the above organs are exposed for fat clusters predominate in all regions.

The large intestine or colon consists of a definite large colon portion which is highly sacculated and a terminal and somewhat longer small colon which presents an appearance similar to that of a row of beads or sausages. The terminal portion of the small colon curves toward the midline to course with the urethra; it is arbitrarily called the rectum and the point of termination is the rectum.

1'. The cecum (figs. 53, 56 and 57).

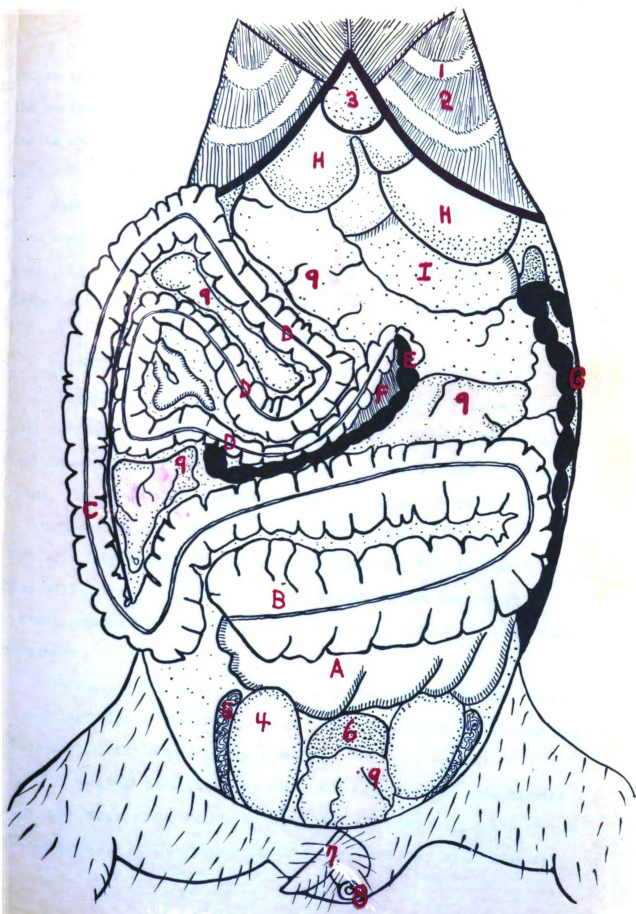
The cecum is located at the junction of the small and large intestines. It extends transversely across the abdominal cavity ventral to the distal portion of the abdominal aorta. The cecum is highly sacculated and thin-walled; it is usually dark green in color due to the color of the contents. Two or more longitudinal bands or taeniae restrict the amount of distension of embalmed cecums. The cecum is somewhat spiralled as in the guinea pig (Martin, 1923). The apex or blind end of the cecum is somewhat less restricted in size and conical in outline but does not form a discrete appendix. The orifice into the cecum is much restricted. This organ is about six and one-half centimeters in length.

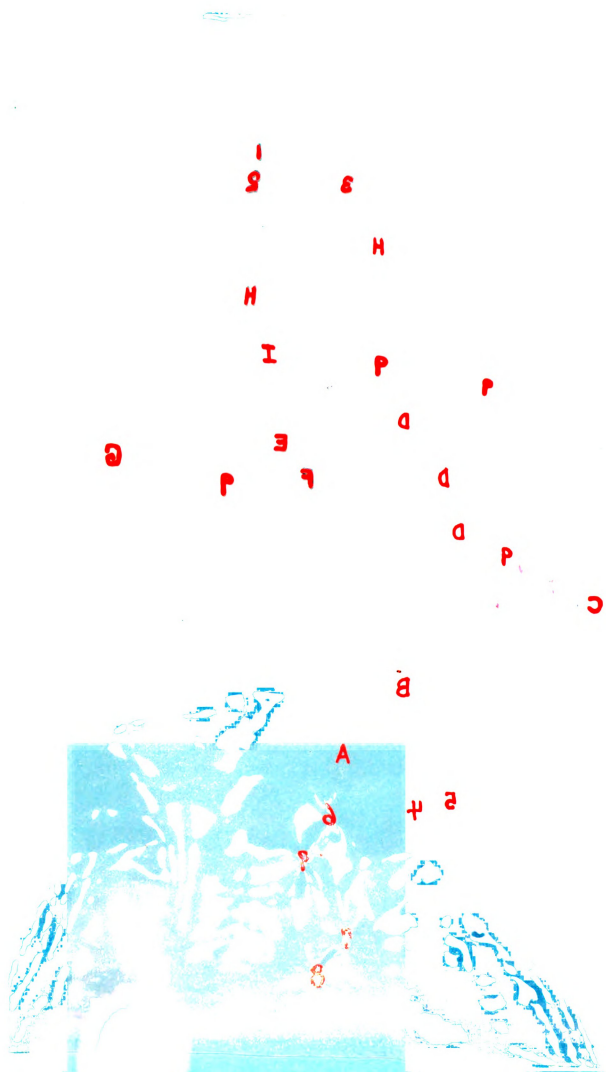
2'. The large colon (figs. 53, 56 and 57).

The large colon proper begins near the ileocecal junction and is largely confined to the right side of the abdominal cavity. It encircles the ventral surface of the cecum and then passes cranial to the region of the lower right ribs at which point it gives rise to two u-shaped loops; the distal arm of the second loop is formed by a closely applied proximal end of the small colon. The wall of the large colon has a

FIGURE 57. A VENTRAL VIEW OF THE LARGE COLON AND RELATED STRUCTURES

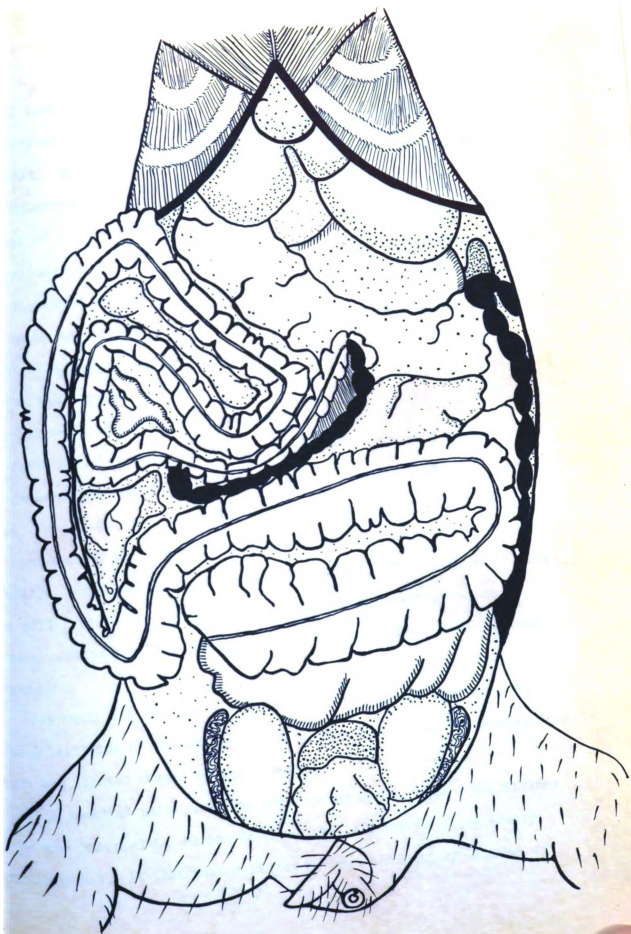
- A. Cecum
- B. Proximal end of the large colon
- C. 'Ascending' limb of the large colon
- D. Terminal loops of the large colon
- E. Proximal end of the small colon
- F. Small colon-large colon ligament
- G. Distal portion of the small colon
- H. Liver
- I. Stomach
- 1. Rib
- 2. Intercostal muscles
- 3. Ensiform process of sternum
- 4. Right testis
- 5. Head of the epididymis
- 6. Urinary bladder
- 7. Penis
- 8. Anus
- 9. Adipose tissue





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series of closely adherent haustra, and running longitudinally along the surface of the organ are two and sometimes three narrow bands or taenia coli. The diameter of the large colon is about one and one-half centimeters.

Most of the large colon is supported by a mesentery which arises from the outer curvature of the duodenum; this mesentery is much shorter than the general mesentery of the intestines and hence the duodenum and large colon are closely adjacent and in a more or less fixed relationship.

3'. The small colon (figs. 53 and 58).

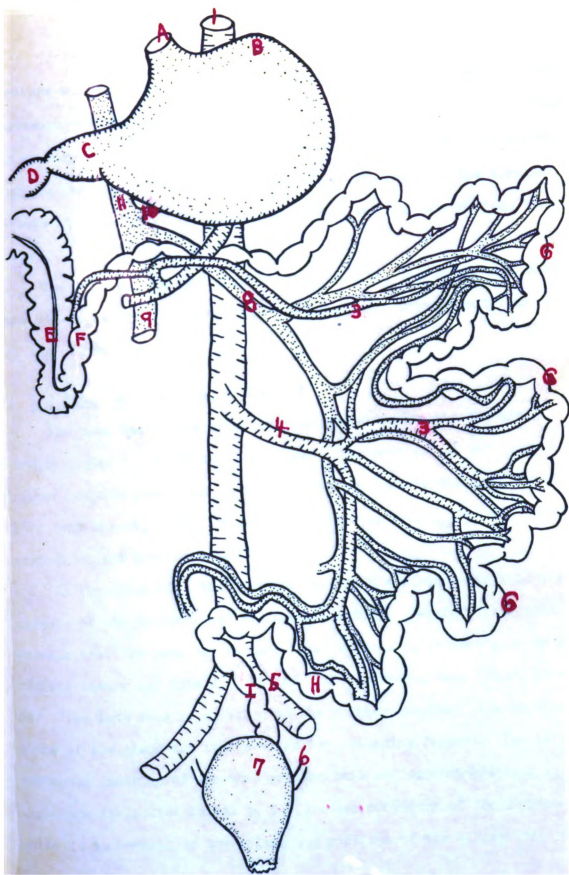
The small colon begins as the distal arm of a loop of the large colon and small colon as described above. It contains a large series of oval fecal pellets, about eighty in number, which impart a beaded outline to this otherwise smooth small tube. There are no haustra in the small colon. It is about the diameter of the small intestine but is easily distinguished by its irregular outline whereas the small intestine though similarly looped and coiled has a smooth contour. The diameter is about five millimeters. The length is about seventy to one hundred and fifteen centimeters long, being somewhat longer in fresh than in embalmed specimens.

The small colon arise to the right of the midline but soon crosses to the left side of the abdomen to give rise to a series of complex loops which are located caudad to the stomach.

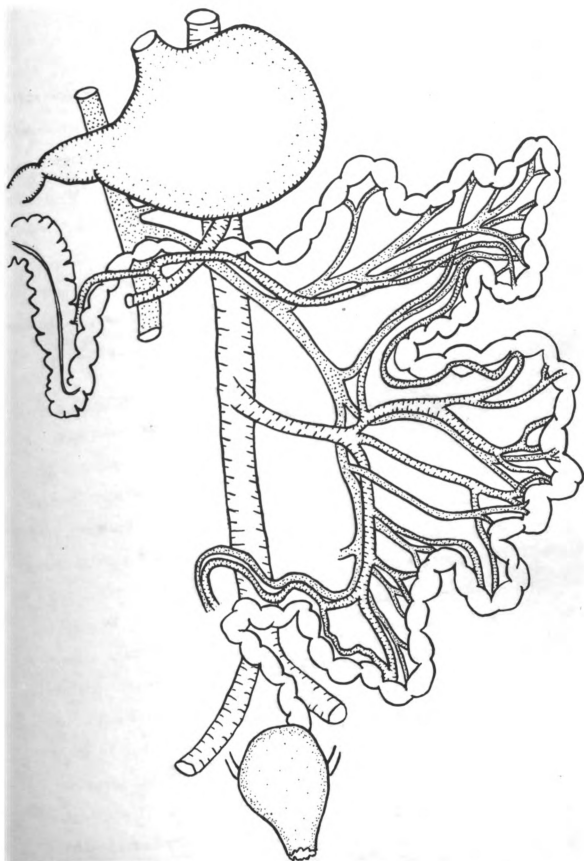
The terminal portion of the small colon curves toward the midline along the dorsopelvic region to cross the left common iliac artery ventrocaudad. It then passes caudad between the urinary bladder and

FIGURE 58. THE SMALL COLON AND SOME RELATED STRUCTURES

- A. Terminal portion of the esophagus
- B. Fundic stomach
- C. Pyloric stomach
- D. Duodenum
- E. Distal segment of large colon
- F. Proximal portion of small colon
- G. Loops of small colon
- H. Distal portion of small colon
- I. Rectum
- 1. Abdominal aorta
- 2. Celiac artery
- 3. Intestinal artery
- 4. Inferior mesenteric artery
- 5. Left common iliac artery
- 6. Ureter
- 7. Urinary bladder
- 8. Inferior mesenteric vein
- 9. Superior mesenteric vein
- 10. Splenic vein
- 11. Hepatic portal vein







urethra and the dorsal wall of the pelvis, the terminal portion curving somewhat ventrad to terminate on the anus (figs. 49, 53 and 58). There is no morphological difference between the rectal portion just described and the rest of the small colon, but due to its position the terminal nature it is arbitrarily called the rectum, and the termination, the anus.

The mesentery of the small colon is simple, and arises from along the mid-dorsal line from the superior mesenteric artery caudad to region of the pelvis.

3. The Pancreas (figs. 44, 59 and 60)

The pancreas of the chinchilla is spread across the abdominal cavity caudad to the stomach and liver. The pancreas of man forms a rather compact gland, but in the rat it is extremely diffuse (Morrel, 1872, and Greene, 1935). According to Morrel, 1872, the pancreas of various rodent species is diffuse.

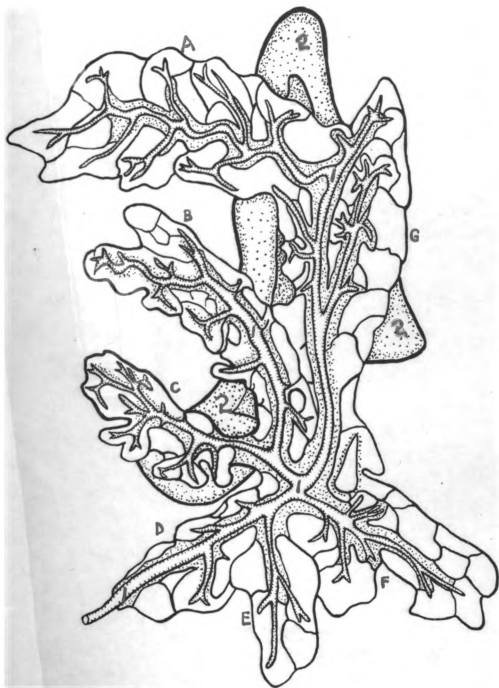
In the chinchilla the pancreas follows the finer mesenteric blood vessels of the duodenal and suprarenal regions. Careful dissection reveals that the pancreas is made up of several folia that more or less radiate toward and form a right and left pancreatic mass (figs. 59 and 60). The left mass is attached to the greater omentum. The ramifications of the gland are indicated in the preceding figures. The left pancreatic mass is of somewhat greater bulk and compactness than is the right and is located dorsal to the greater curvature of the stomach while it is ventral to the spleen and portions of the kidney (fig. 44).

FIGURE 59. THE LEFT AND PRINCIPAL PANCREATIC MASS, SHOWING FOLIATION

Number of surface lobules per folium:

- A. 124 lobules
- B. 116 lobules
- C. 42 lobules
- D. 67 lobules
- E. 46 lobules
- F. 74 lobules
- G. 121 lobules

- 1. Duct system
- 2. Spleen





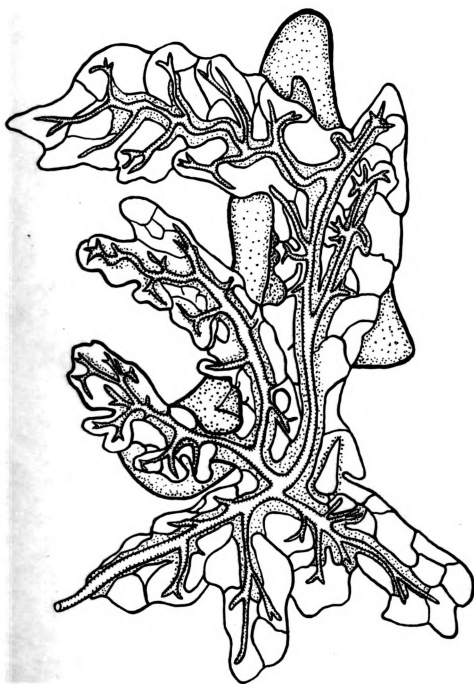
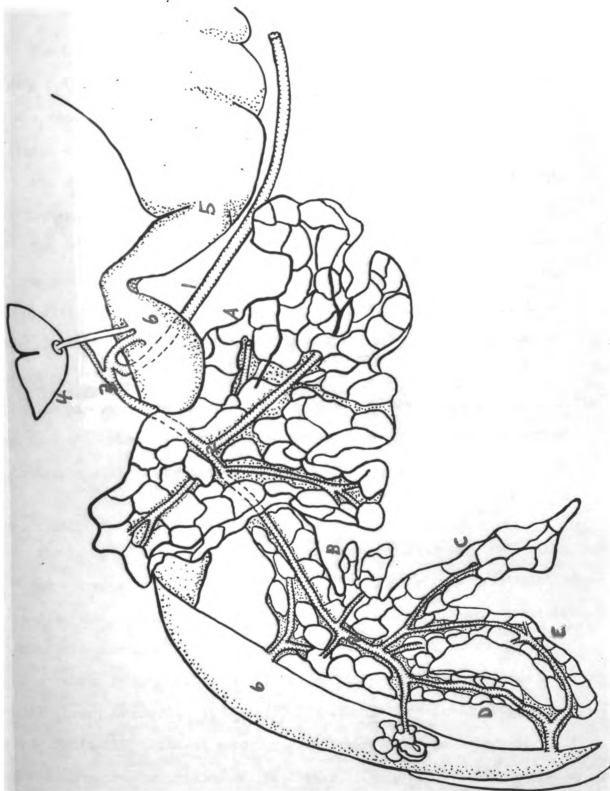


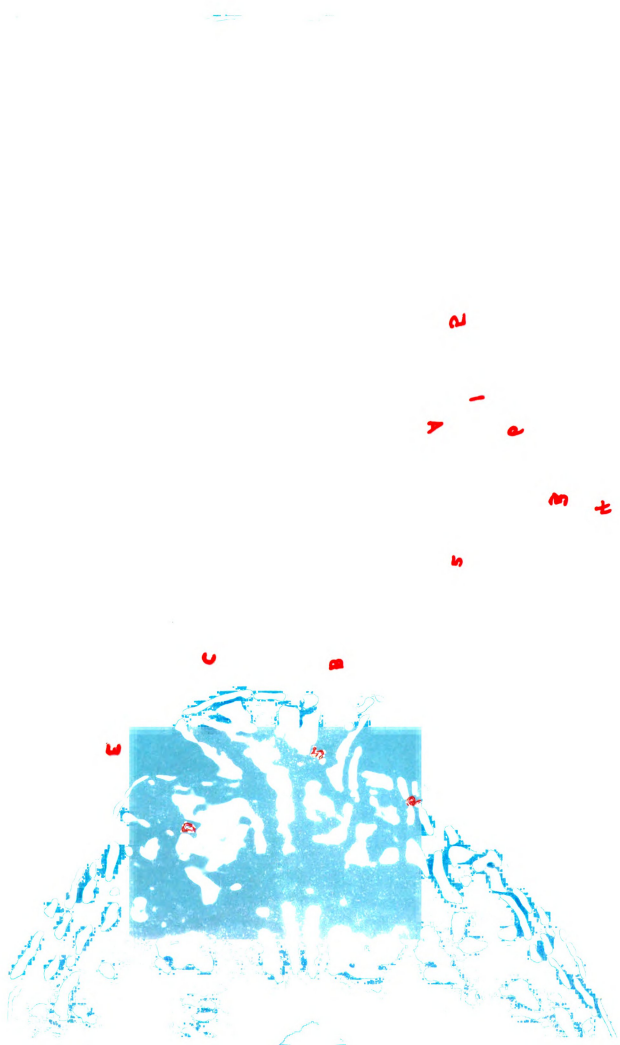
FIGURE 60. THE RIGHT PANCREATIC MASS, SHOWING FOLIATION

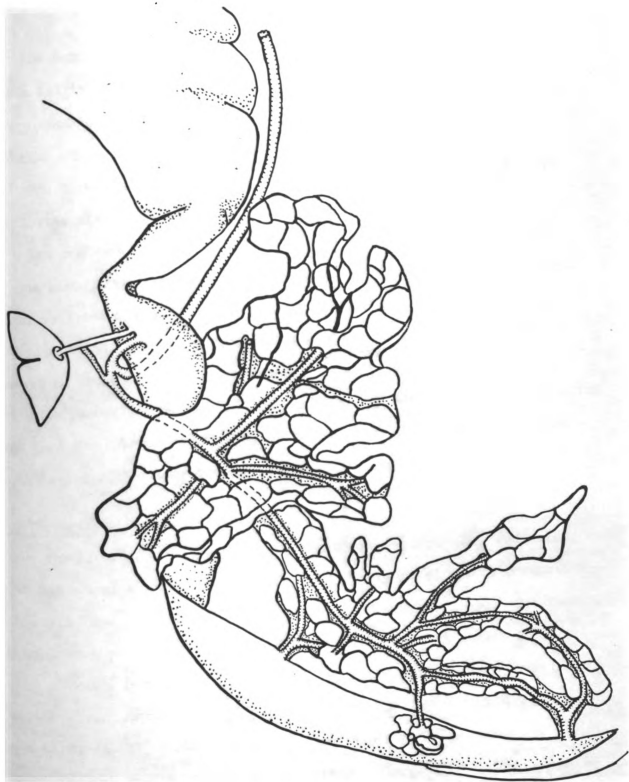
Number of surface lobules per folium:

- A. 312 lobules
- B. 103 lobules
- C. 38 lobules
- D. 18 lobules
- E. 20 lobules

- 1. Duct of left mass
- 2. Duct system of right mass
- 3. Openings of right ducts on the duodenum
- 4. Liver lobe (cut)
- 5. Pyloric region of stomach
- 6. Duodenum







The pancreatic ducts course along central vessels of the folia and form a fairly large left duct which communicates with the proximal end of the duodenum near the orifice of the common bile duct, though no definite ampulla arrangement was seen.

The duct communicates with those of the right pancreatic mass, but the latter also connects at two or more points on the duodenum.

The number of grossly visible lobules is very great. In the case of one gland, five hundred and ninety-one lobules on the surface of the right mass and 630 on the left or a total of 1221 lobules were visible (magnification, X10). The internal lobulation seemed similarly divided though no count of lobules was made.

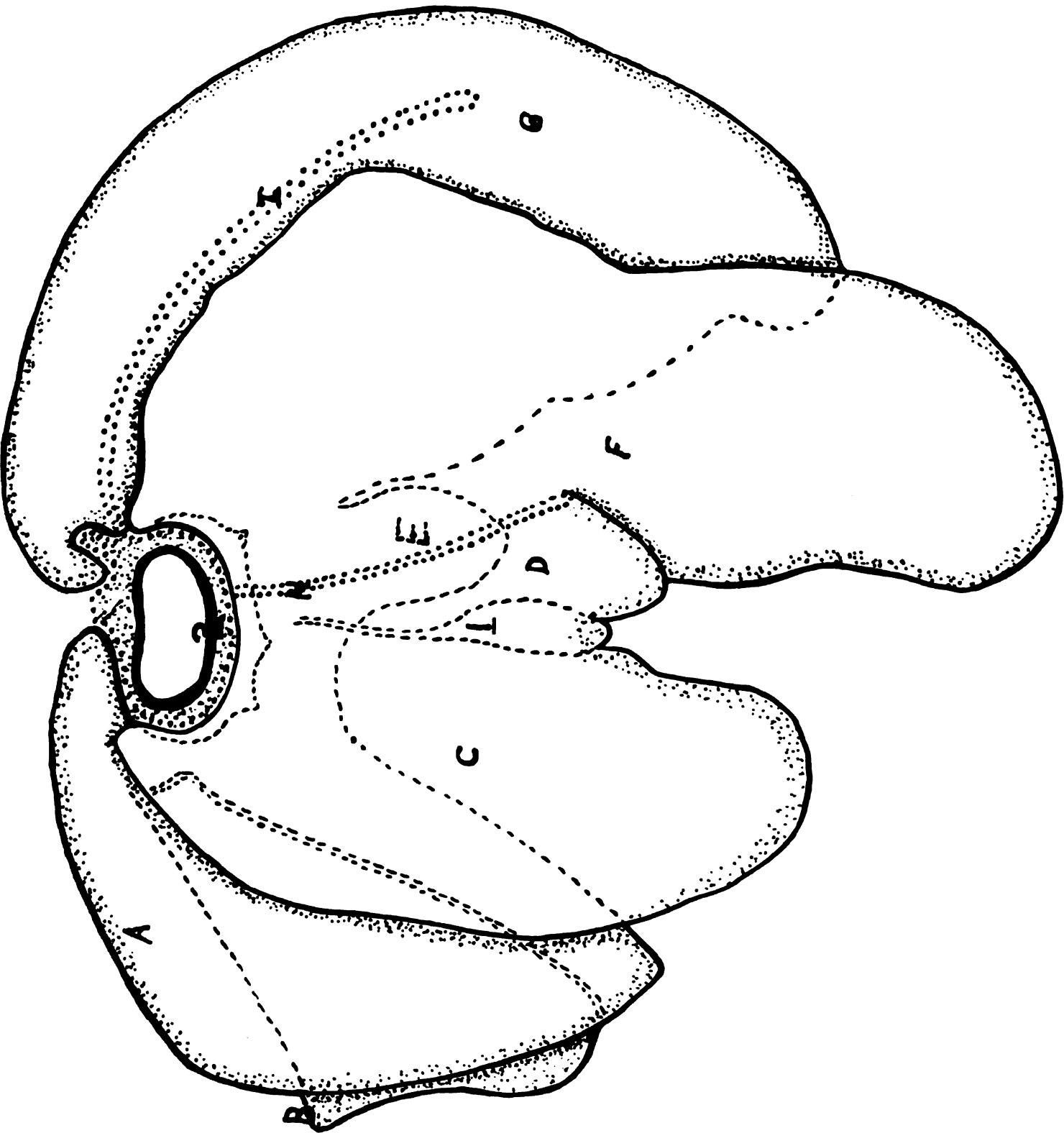
The pancreas receives its blood supply from the left gastric arteries and from the splenic artery; the venous drainage is into hepatic portal tributaries of the same name as the arteries (figs. 45 and 46).

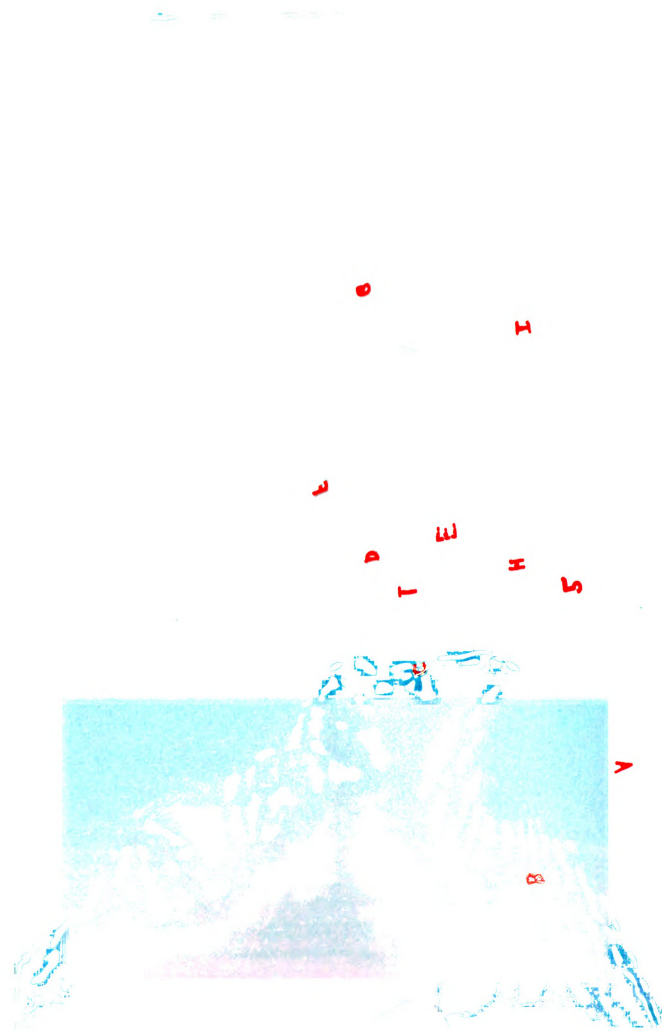
4. The Liver (figs. 61, 62, 63 and 65)

The liver of the chinchilla is of a characteristic dark red color, and has a typical pattern of lobulation. The finer structure consists of small lobules which are barely visible to the unaided eye. The functional arrangement of such lobules is still a manner of debate in the case of other forms. Elias (1953) has recently restudied the architecture of the liver, Rappaport, *et al.* (1954) challenged his interpretation, and Hartroft (1954) showed evidence from experimental pathology of the organ to support the opinion of the latter. The present author traced the distribution of the complex vascular supply to the limits of gross

FIGURE 61. A VENTRAL VIEW OF THE LIVER

- A. Right lobe (cranial portion)
 - B. Right lobe (caudal portion)
 - C. Middle lobe (right portion)
 - D. Middle lobe (triangular eminence)
 - E. Middle lobe (spigelian or caudate portion)
 - F. Middle lobe (left portion)
 - G. Left lobe of the liver.
 - H. Falciform ligament outline
 - I. Triangular ligament outline
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- 1. Outline of gall bladder
 - 2. Outline of post cava





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observation (figs. 62 and 63) in order to examine the structural arrangement in the present form.

The peripheral vessels were shown in connection with the intestines (figs. 45, 53, 56, 57, 58 and 64).

The liver is the largest digestive organ. It is located adjacent to the caudal surface of the diaphragm. It is supported from the diaphragm by a right falciform and a left triangular diaphragmatico-hepatic reflection of the peritoneum. The liver is almost entirely covered by serosa, the only bare areas being along the lines of the two layers of the peritoneal attachments (fig. 61).

The stomach and spleen are the major adnexia of the left side of the liver; the proximal end of the duodenum and small colon, portions of the jejunum and perhaps ileum, and the left pancreatic mass are related to the right portion of the liver. The cranial pole of the right kidney is in contact with the right dorsal margin of the liver. The abdominal segment of the esophagus is surrounded by the left lobe of the liver except on the dorsal surface of the tube.

The biliary system includes several fine ducts from the lobes of the liver; the ducts of each lobe combine to form one or more larger interlobular ducts. The interlobular ducts of the lobes converge to form the hepatic duct which gives rise to the cystic diverticulum or duct. The cystic duct and hepatic duct form a common bile duct which passes to the duodenum just distad to the pyloric junction.

There is a distinct gall bladder which is more or less suspended from the right lobe of the liver.

The liver presents a large left lobe, and a larger middle lobe which is somewhat divided underneath by a fossa in which the gall bladder rests. The ventral border of the middle lobe is indented by an incisure opposite the cystic apex, and a small secondary eminence appears to the immediate left of the deepest point of the cleft.

The right lobe is partially subdivided into a dorsal and a ventral pyramidal portion. A small triangular Spigelian or caudate lobule arises from the central region of the right lobe. This portion appears to pass into the lesser omental bursa near the epiploic foramen.

The bile duct and stem vessels of the liver pass caudad to the region of the pyloric sphincter. The structures are enclosed in a fold of the hepatogastric ligament of the mesogaster and as such pass ventral to and contribute to the border of the omental bursa.

The liver receives arterial supply from the hepatic artery, a branch of the coeliac axis artery. The origin and course of the latter is shown in figures 62, 63 and 64. The efferent vessels of the liver pass to the precava as it passes near the diaphragm.

The liver measures about five centimeters transversely, about seven dorsoventrally, and about three in thickness.

5. The Peritoneal Reflections to the Abdominal Digestive Organs (figs. 56, 57, 61 and 64)

The stomach, pancreas, and spleen are supported by the continuation of the falciform and triangular ligaments of the liver after investment of the liver surface. The support of the former organs is called the omentum (fig. 64). The omental layers surround the stomach and project

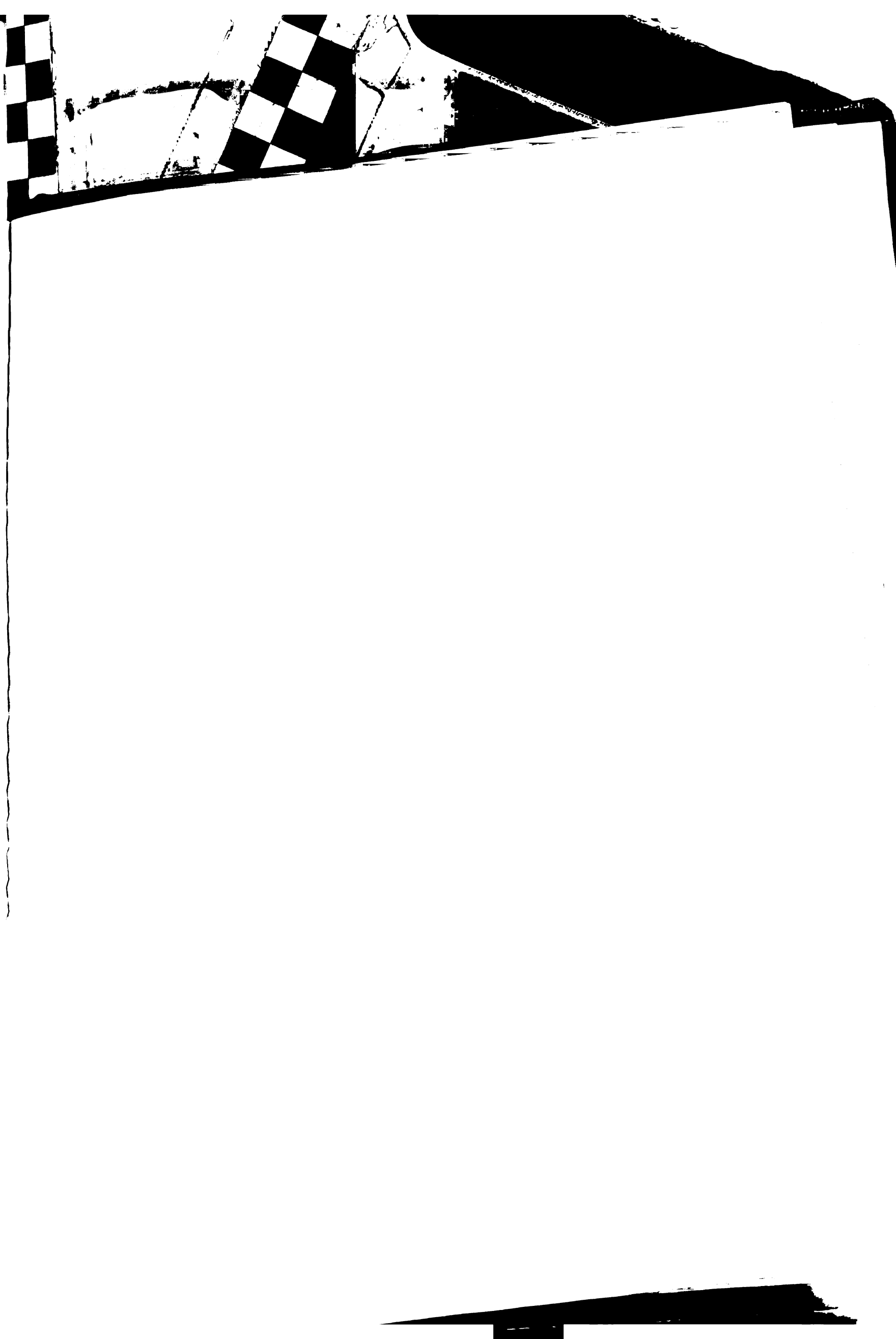
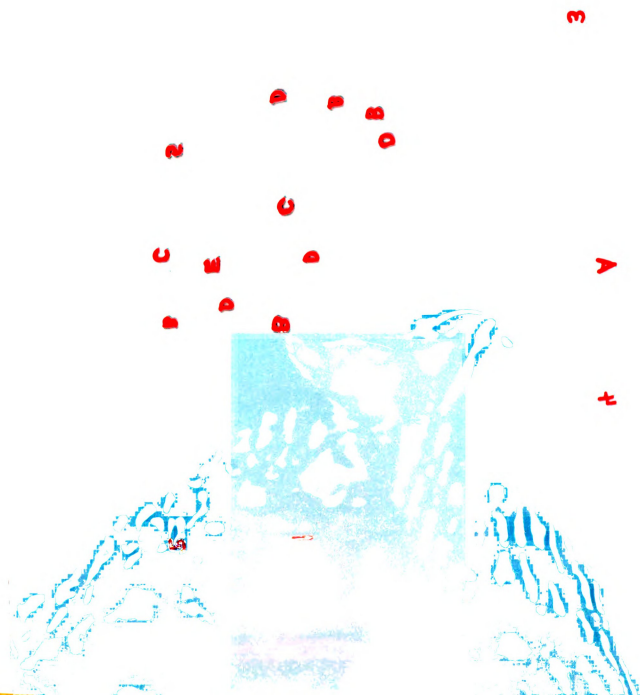
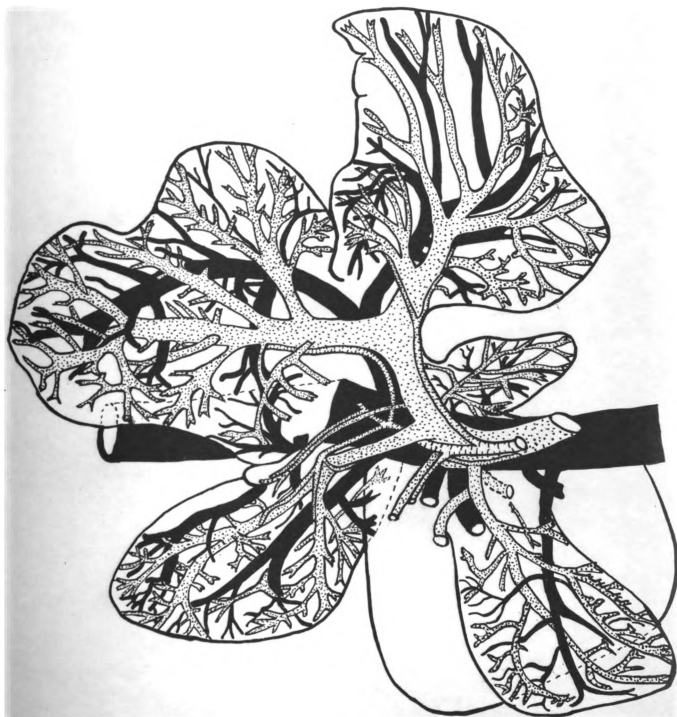


FIGURE 62. THE BLOOD VESSELS OF ALL EXCEPT THE CRANIAL SUBDIVISION OF THE RIGHT LOBE OF THE LIVER

- A. Porta
- B. Hepatic veins
- C. Hepatic portal vein
- D. Hepatic portal veins
- E. Hepatic artery
- 1. Right lobe (cranial portion)
- 2. Right lobe (caudal portion)
- 3. Middle lobe (left portion)
- 4. Middle lobe (right portion)
- 5. Caudal or Spigelian portion of middle lobe







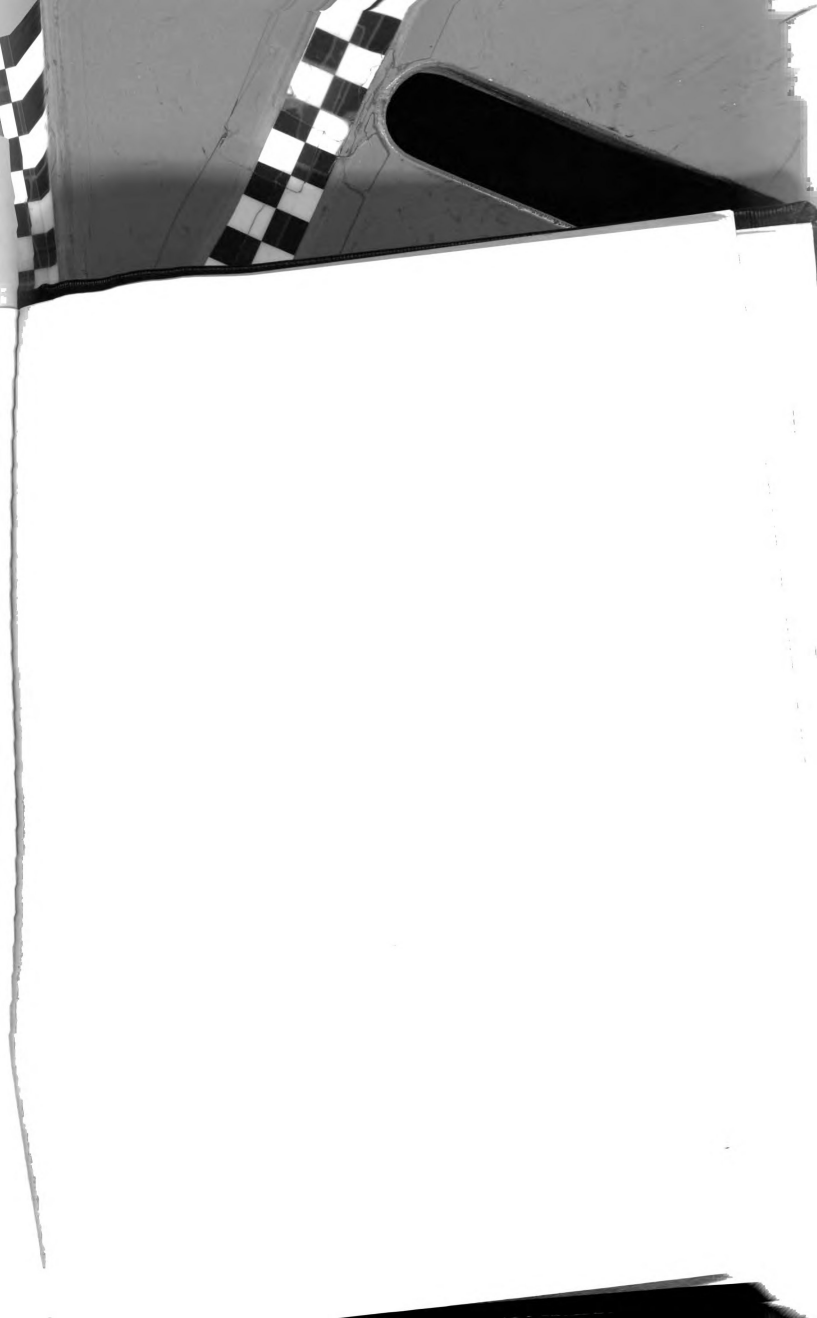


FIGURE 63. THE BLOOD VESSELS OF THE CRANIAL SUBDIVISION OF THE RIGHT LOBE
OF THE LIVER

A. Porta

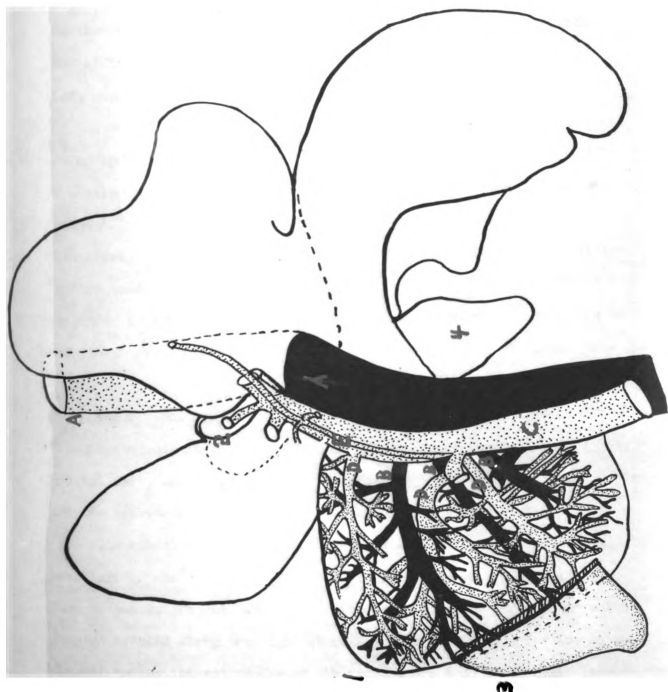
B. Hepatic veins

C. Hepatic portal vein

D. Hepatic portal veins

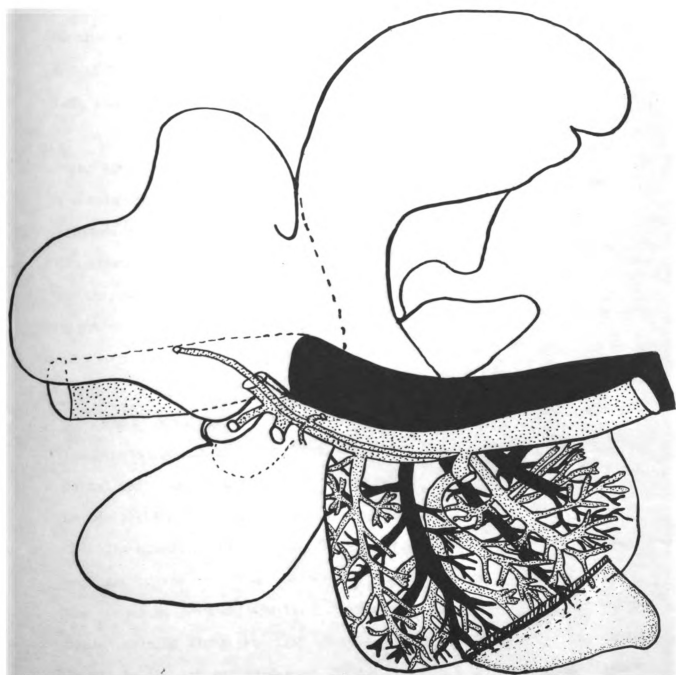
E. Hepatic artery

1. Cranial subdivision of the right lobe of the liver
2. Region of the gall bladder
3. Caudal subdivision of the right lobe of the liver
4. Caudate lobe



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beyond as a double layered membrane which folds dorsad and cranial to the midline between the liver and the duodenum. The portion of the omentum which passes from the stomach is called the greater omentum and it is this portion which invests the pancreas and spleen along the left edge of the fold.

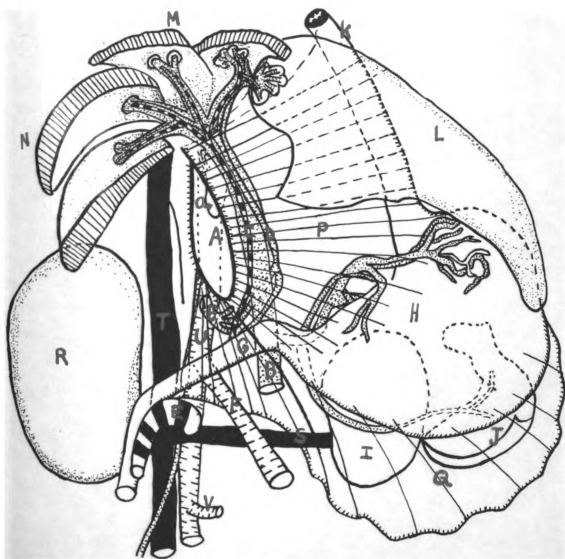
A sac is formed which communicates with the general serous cavity at an aperture called the epiploic foramen. The foramen is bounded by a continuous serous membrane and is elliptical in outline. It is important in that major vessels pass around the border of the opening. The craniocaudal diameter of the foramen is approximately six millimeters, and the dorsoventral about three. The foramen is located in the right or free border of the hepatoduodenal ligament, and occupies part of the interval between the hepatic hilum and the gastroduodenal junction.

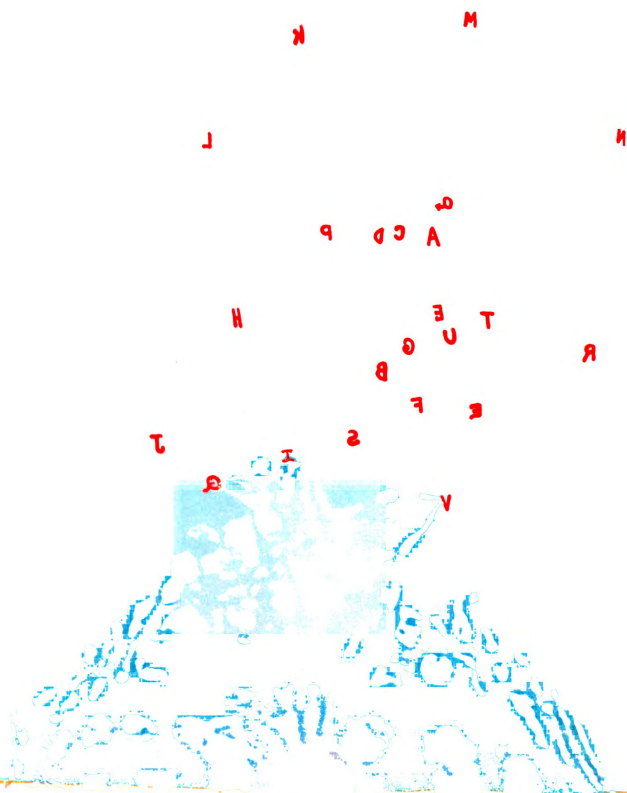
The ventral boundary of the foramen consists of the free border of the hepatoduodenal ligament. The rim of the foramen encloses the hepatic portal vein, and from the right to left along the ventral surface of the latter are the common bile duct and the hepatic artery proper.

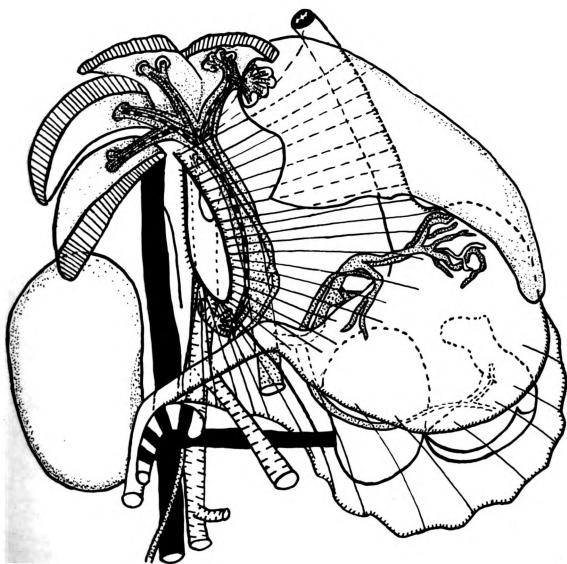
The mesentery of the small intestine arises from the mediandorsal body wall around the origin of the superior mesenteric artery and passes to the duodenum, jejunum, and ileum. The portion of the large colon which passes cranial along the right abdominal wall is attached for its entire length to the lateral border of the duodenum by a duodenal-colic ligament or mesentery (fig. 56), and a continuation of the same membrane supports the cecum. As the small colon crosses the midline from right

FIGURE 64. THE EPIPLOIC FORAMEN AND RELATED STRUCTURES

- A. The epiploic foramen
- B. Hepatic portal vein
- C. Common bile duct
- D. Hepatic portal artery
- E. Celiac artery
- F. Superior mesenteric artery
- G. Duodenum
- H. Stomach
- I. Left kidney
- J. Spleen
- K. Esophagus
- L. Left lobe of the liver
- M. Middle lobe of the liver
- N. Right lobe of the liver
- O. Caudate lobe of the liver
- P. Lesser omentum
- Q. Greater omentum
- R. Right kidney
- S. Left renal vein
- T. Posterior vena cava
- U. Abdominal aorta
- V. Inferior mesenteric artery







to left it receives a simple sheet of tissue which arise from the mid-dorsal line for the entire distance from the superior mesenteric artery to the pelvic limit of the rectum. This mesentery spreads out to accommodate the various loops of the small colon but at no place does it establish secondary attachments.

IX. SUMMARY

The morphology of the digestive organs and their relationships to surrounding structures was studied in detail.

Twenty-five adult chinchillas were dissected, and immature chinchillas of various ages were used in this study. Except for certain data concerning the teeth of the young, the descriptions pertain to mature forms.

Sixty-four drawings of dissections accompany the descriptions.

The labia of the chinchilla are complexly attached; the upper lip is cleft and the lower uncleft.

Four types of vibrissae are found on the lateral and ventral surfaces of the head. The mystacial vibrissae which are the largest and most numerous, are described in detail. The other types of vibrissae are smaller and less numerous.

The oral cavity consists of anterior and posterior divisions. The former is restricted to the diastemal area while the latter contains the molars and tongue.

Four incisors and sixteen molars are found in the chinchilla. All teeth are conspicuously curved and erupt continuously. The occlusal surfaces of the molars present distinct ridges and grooves.

The muscular tongue has three portions and a distinct intermolar eminence. Ten types of papillae are found on the surfaces of the tongue. Details concerning sizes, numbers, and distributions are included in the text.

The principal masticatory muscles are the masseter, temporalis, internal pterygoid, and external pterygoid. The masseter is large and subdivided. The temporalis is much reduced.

Parotid, submaxillary, sublingual, and buccal salivary glands are present. Four types of sublingual glands are considered in the text.

The pharynx has no distinct laryngeal portion: the nasopharynx is correspondingly more extensive.

The esophagus lies slightly left of the midline and presents no outstanding comparative features.

The stomach has no gross subdivisions and is relatively smooth in outline.

The small intestine is shorter than the large intestine. The former contains a large number of macroscopic lymphoid patches.

The large intestine consists of a large, spiralled, and sacculated cecum, a long sacculated large colon, and a long non-sacculated small colon. The terminal rectal part of the small colon is relatively straight and located near the median dorsal body wall. The large intestine is approximately one and two-thirds times as long as the small intestine.

The liver has right, middle, left, and caudate lobes. The pancreas is lobulated, diffuse and confined to the mesentery of the gut.

The intestinal blood supply is somewhat variable from specimen to specimen but is characteristically mammalian in arrangement.

The relationship of the intestines to other abdominal viscera is carefully depicted. In living animals the testes pass back and forth between the abdominal cavity and the respective cremasteric pouches.

The peritoneal reflections are simpler than is generally true in the case of human peritoneal reflections, except that a distinct and extensive omental bursa is formed.

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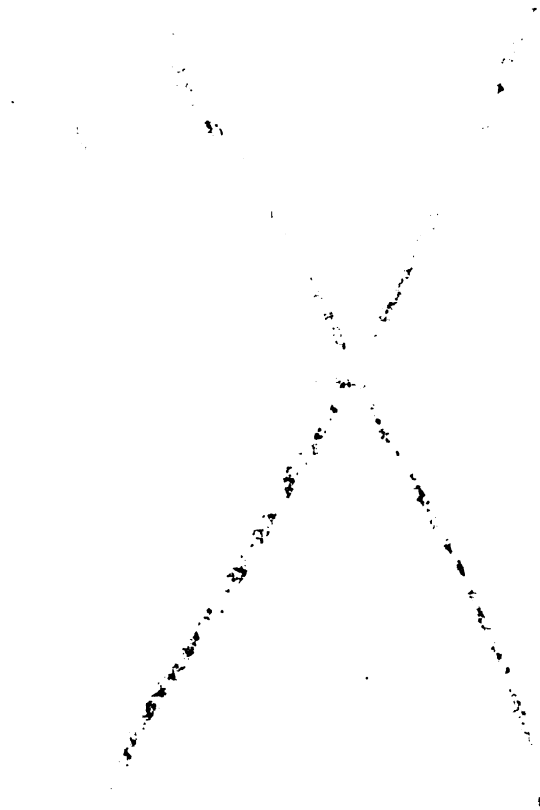
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