

MEDDELELSER OM GRØNLAND

UDGIVNE AF

KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND

Bd. 107 · Nr. 5

THE SUPERFICIAL
FACIALIS MUSCULATURE OF
THE GREENLAND MUSK-OX,
OVIBOS MOSCATUS

BY

THYDSEN MEINERTZ

WITH 24 FIGURES IN THE TEXT

KØBENHAVN

C. A. REITZELS FORLAG

BIANCO LUNOS BOGTRYKKERIS

1954

CONTENTS

	Page
Introduction	5
Technique and Material	6
The superficial facialis musculature of <i>Ovibos moschatus</i>	7
I. Sphincter colli superficialis	7
II. Platysma and its derivates	8
A. Platysma	8
B. The retro-auricular musculature	10
a. The cervico-auricular musculature	11
Layer 1: <i>M. cervico-auricularis</i>	12
<i>M. cervico-scutularis</i>	12
Layer 2: <i>M. cervico-auricularis medius</i>	13
<i>M. occipito-auricularis medius</i>	14
Layer 3: <i>M. cervico-auricularis posterior profundus</i>	14
<i>M. cervico-occipito-auricularis profundus</i>	16
β. <i>Mm. auriculares proprii</i>	16
<i>Cartilago auriculae</i>	16
<i>Mm. transversi et obliqui</i>	17
<i>M. antitragicus</i>	18
<i>M. helix</i>	18
III. Sphincter colli profundus and its derivates	18
1. Pars auris	20
2. Pars intermedia and its derivates	20
a. Pars intermedia ventralis	20
b. Pars intermedia dorsalis and its derivates	22
a. The pre-auricular musculature	22
The deep layer of muscles	22
The intermediate plate	22
<i>M. zygomatico-labialis</i>	23
<i>M. subscutulo-auricularis</i>	24
<i>M. subscutulo-auricularis frontalis</i>	24
<i>M. auriculo-scutularis anterior profundus</i>	24
<i>M. auriculo-scutularis posterior profundus</i>	26
<i>M. auriculo-scutularis inferior profundus</i>	28
The lateral <i>Mm. auriculares proprii</i>	28
<i>M. concho-helycinus</i>	28
The superficial layer of muscles	29
<i>M. auriculo-scutularis anterior superior</i>	29
<i>M. auricularis anterior inferior</i>	29
<i>M. fronto-scutularis</i>	30

	Page
β. The orbito-nasal musculature	30
M. frontalis (orbitalis)	31
M. retractor anguli oculi lateralis	32
M. orbicularis oculi.....	32
M. retractor anguli oculi med. profundus	32
M. naso-labialis superficialis	34
3. Pars palpebralis	35
4. Pars oris and its derivates	36
M. maxillo-labialis.....	36
M. naso-labialis profundus	37
M. bucinatorius	38
IV. Nervus facialis in <i>Ovibos moscatus</i>	41
A. The nerve supply of the dorsal, post-auricular musculature.....	42
Ramus auricularis posterior	42
B. The nerve supply of the remaining superficial musculature	46
Ramus auricularis anterior.....	46
Ramus temporalis + R. zygomatico-orbitalis	47
Ramus temporalis	48
Ramus zygomatico-orbitalis.....	52
Plexus buccalis	52
Ramus colli	53
Ramus platysmaticus superficialis	53
Summary	54

INTRODUCTION

In my previous works on the superficial facialis area of the rodentia I have given a detailed survey of the topography and innervation of the superficial facialis musculature, out from a phylogenetic point of view. In broad outline the results proved to coincide with corresponding examinations on the dog, by E. HUBER.

In the present work on the facialis area of the musk-ox, the topography of the muscles and the innervation will be dealt with from the same point of view.

Between the carnivora and rodentia on one side, and the musk-ox on the other, many points of distinction reveal themselves to the eye of the trained investigator, at the same time as, principally, there is surprisingly great accordance, especially when we take into consideration the general contrast between such primitive forms as the carnivora and rodentia and a form so specialized as the musk-ox.

The to some degree disputed question as to the position of the musk-ox in the system, makes it on the whole appropriate to go into a comparison with, partly the sheep-group, and partly the ox-group. Such comparison will appear in a following treatise on the facialis area of these two groups.

The present, likewise as my previous works in this field, was carried out in the Institute for Comparative Anatomy of the University of Copenhagen.

Translation by M. SKINNER.

TECHNIQUE AND MATERIAL

As to the technique employed I wish to refer to my remarks in "The Skin Musculature of the Greenland Lemming, *Dicrostonyx Groenlandicus* (Traill)", 1941. A thorough description is, moreover, to be found in my work "Die Hautmuskulatur der Säugetiere. I. *Cavia cobaya*." 1932. The nitric acid method, however, has not been used on the head of the adult musk-ox examined, likewise as the binocular preparation microscope could not be employed; the ear excepted though. In the case of the two, fairly large, embryos, the nitric acid method has been used for the investigation of the innervation conditions, and by the examination it was also possible to make use of magnification.

The material examined consisted of the head of an adult musk-ox from East Greenland. This head was not particularly suitable for an examination of the facialis area, but yielded, nevertheless, a number of good results, and had to be included in the investigation, also because of the dominant influence of the horns. Furthermore, 2 embryos were available for the examination. The lengths of these were about 0.5 m and 0.75 m, respectively. I am very thankful to mag. scient. PALLE JOHNSEN for procuring these embryos, as they lent themselves excellently to anatomical investigations. It must, however, be observed that it has not been possible to explain all innervation conditions on the said two embryos, partly because embryos are not often suitable for examinations on the peripheral nervous system, partly because a thoroughgoing and complete topographic survey on the peripheral nervous system generally demands a larger material.

THE SUPERFICIAL FACIALIS MUSCULATURE OF OVIBOS MOSCATUS

In broad outline we may point out that the facialis musculature in the musk-ox shows a comparatively large number of, rather independent, muscular individuals, and comparatively few, slightly differentiated, muscular sheets, in comparison with the carnivora and rodentia, a fact which must be interpreted as a specialization phenomenon. Principally the innervation conditions are the same as in the carnivora and rodentia, so that the classification of the musculature into two groups: The Platysma and its derivates, and the Sphincter colli profundus and its derivates, comes natural in the case of Ovibos, too. The derivates of the Platysma are retro-auricular muscles, whilst the derivates of the Sphincter colli profundus are pre-auricular muscles.

In the following the adult musk-ox will be marked A, the smaller embryo, B, and the larger, C. The general description applies to all three animals, except when specially pointed out otherwise.

I. Sphincter colli superficialis.

The fundamental material for the facial musculature of the mammals must have been a Sphincter colli primitivus. Such a Sphincter primitivus was pointed out in the cat by E. HUBER (1918). In some cases Huber has likewise been able to show that the Sphincter colli prim. was connected with the Sphincter colli superficialis and with the Platysma cervicale. In the rabbit we have, in a single case, been able to demonstrate a connection between the Sphincter colli primitivus and the Platysma cervicale (MEINERTZ, 1935).

In the musk-ox we find no indication whatever of a superficial Sphincter colli, neither in the adult animal, nor in the embryos. This is, for that matter, not surprising, as in numerous forms this muscular sheet has entirely disappeared, and if it does exist, it is as a rule relatively weak.

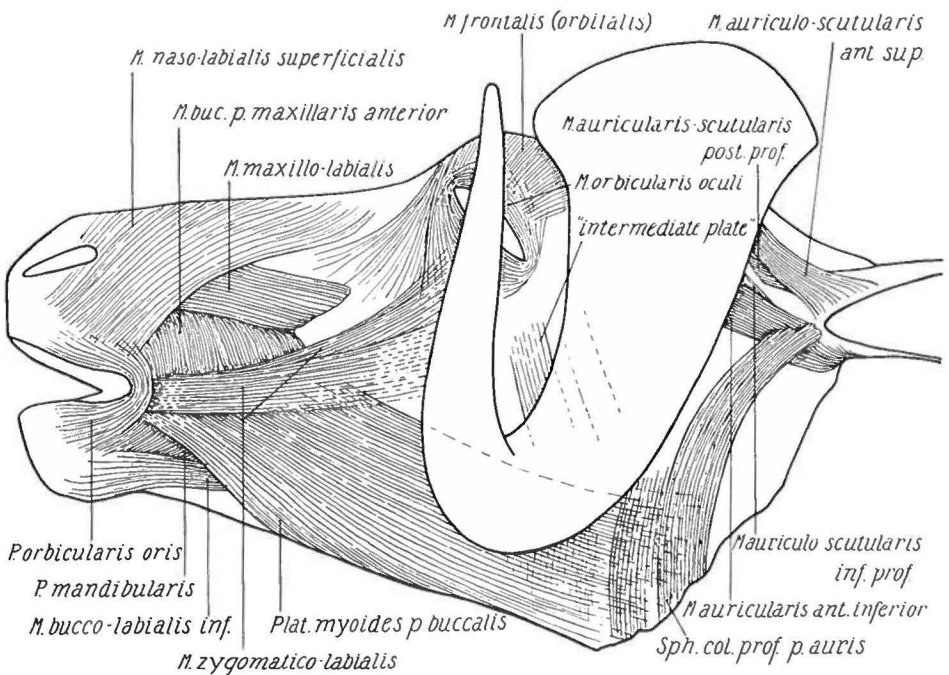


Fig. 1. *Ovibos* A, left side, showing the extent of the superficial facialis musculature. The horn partly covers the intermediate plate and the anterior end of the pre-auricular muscles. In front of *Sph. colli prof. p. auris*, *Pars intermedia ventralis* is seen showing through the here very thin *Platysma myoides*.

II. *Platysma* and its derivatives.

A. *Platysma*.

B. The retro-auricular musculature.

The cervico-auricular muscles.

Mm. auriculares proprii.

A. *Platysma*.

Figs. 1, 2.

In the musk-ox the *Platysma* consists of a single muscular sheet only, whilst in the rodentia it consists of 2 sheets, viz. the *Platysma cervicale*, situated in the region at the back of the head and neck, and usually forming a caudal continuation of the profound layer in the cervico-auricular musculature, and of the *Platysma myoides*, situated on the sides of head and neck.

In the musk-ox the *Platysma cervicale* is lacking, whilst the *Platysma myoides* is present. The *Platysma* is a comparatively thin muscular

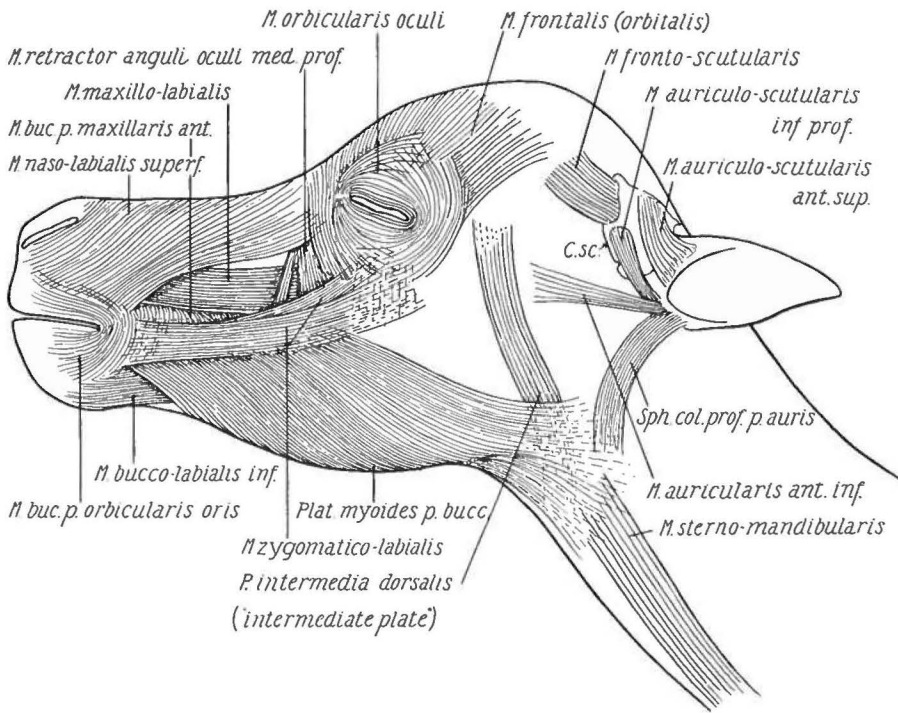


Fig. 2. *Ovibos B*, embryo, left side, showing the extent of the superficial facialis musculature. The broken lines in *Platysma myoides* indicate the thin, translucent, fascia-like plate, marking the field of origin of the muscle. The broken lines ventrally to *Orbita* indicate *Pars palpebralis*, situated under the field of origin of *M. zygomatico-labialis*. The ventral part of the intermediate plate may be dimly discerned under *Platysma*. *M. sterno-mandibularis* does not belong to the facialis area.

sheet, originating in the connective tissue under the skin on the side of the head, and ventrally on the neck. On the side of the head the origin lies ventrally to the ear, while on the under side of the neck it is a little further back, on a level with the larynx, and reaching almost the ventral median line.

In the field of origin the muscle fibres come from a thin, translucent tendinous sheet, of a substance like the connective tissue, and through which we may dimly discern the fibres in the somewhat reduced *Pars intermedia ventralis* in the adult animal (A), and the ventral end of the intermediate plate in musk-ox embryo B. From the origin the fibres pass, slightly converging, in the direction of the mouth. In front of the *Bucinatorius* complex the muscular sheet partly splits up posteriorly, into two layers by the ventral margin of the *M. zygomatico-labialis*. The outer thin layer contains a few fibres only, which proceed up on to the outside of the *M. zyg.-lab.*, while the inner powerful layer

extends up under this muscle. The fibres in the inner layer terminate here, partly in the connective tissue, partly between the fibres in the *M. zyg.-lab.* The fibres in the anterior part of the *Platysma* proceed up under the *M. zyg.-lab.* and enter the *M. bucinatorius* behind the corner of the mouth, partly together with the *M. zyg.-lab.*

In several rodentia the field of insertion covers a large area, which gives occasion for a dividing up of the *Platysma myoides* into a *Pars orbitalis*, a *Pars buccalis*, and a *Pars mentalis*. In the musk-ox there is no *Pars mentalis*. Here the *Platysma myoides* answers to the *Pars buccalis*. In the case of the hindmost field of fibres we might possibly speak of a *P. orbitalis*, answering to the more strongly developed corresponding portion in the Greenland lemming.

The innervation of the *Platysma* takes place through the *Ramus platysmaticus superficialis*.

An *M. mandibulo-labialis* does not exist in the musk-ox. The muscle portion which in the musk-ox passes out into the lower lip (the chin) is no doubt part of the *Bucinatorius* complex, and has direct muscular connection with the rest of the portions in the *M. bucinatorius*. In the case of the musk-ox this portion is designated *M. bucco-labialis inferior* (the *M. depressor labii inferioris* of the veterinary anatomy). It is highly probable that these topographic conditions in the musk-ox are showing us how an independent *M. mandibulo-labialis* may have come into existence, and, in such case, that it originates from the *Sphincter colli pars oris*.

B. The retro-auricular musculature.

The musk-ox has well developed and powerful ears. Tallying herewith the retro-auricular musculature is relatively well developed and fairly strongly differentiated into single muscular individuals. As in the case of the rodentia these muscles are divided into two groups, viz. the *cervico-auricular muscles*, which as indicated by the name pass from the neck to the cartilage of the ear, and the *Mm. auriculares proprii*. The former muscular group consists of three layers, and the latter of the *Mm. transversi et obliqui*, the *M. antitragicus*, and the *M. helcis*. An *M. mandibulo-auricularis* seems to be lacking.

In the musk-ox the retro-auricular musculature shows considerable agreement with the corresponding musculature of our domestic animals of the ungulate group. We must, however, point out that the differentiation into independent muscular individuals is not equally pronounced in the latter types of animals. By means of this examination we have shown that the cervico-auricular musculature and the *Mm. transversi et obliqui* are supplied by the *Ramus auricularis posterior*; on the other hand, we have not succeeded in tracing the nerve branches right into the *M. antitragicus* and the *M. helcis*.

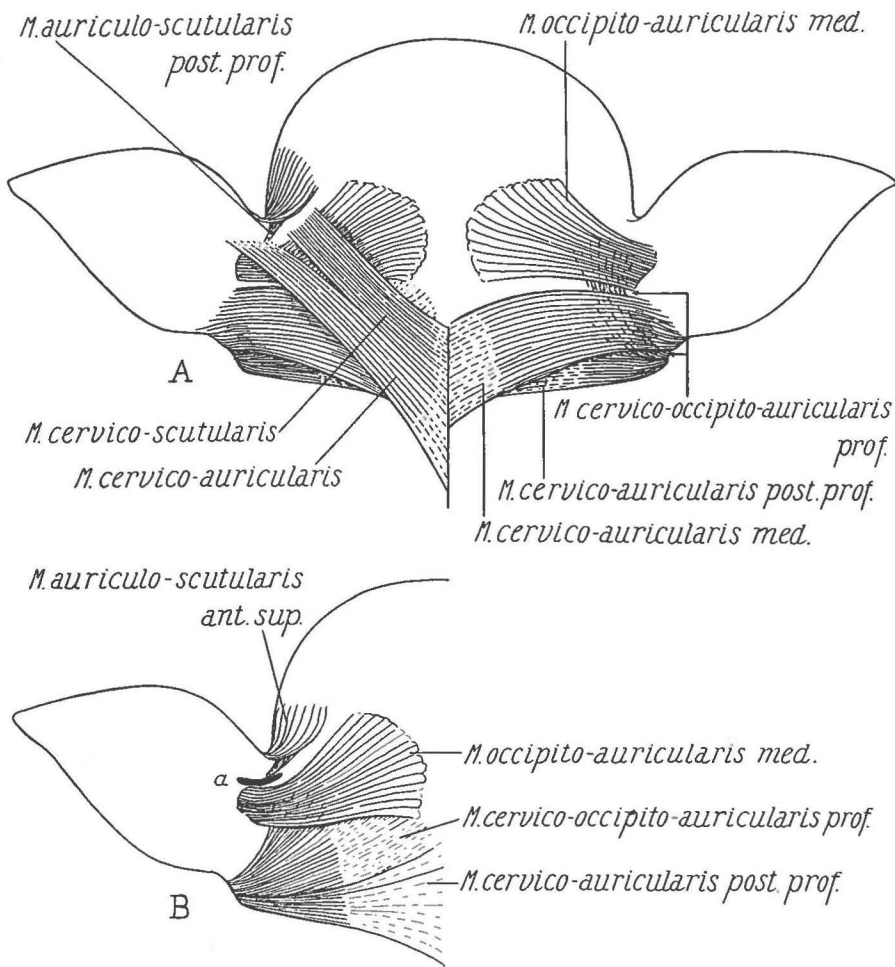


Fig. 3. *Ovibos B*. The cervico-auricular musculature. A, left side: all muscles are entered; A, right side: the muscles in layer 1 have been removed, so that the middle layer may be seen in full. B, left side: the muscles in layer 1 and *M. cervico-auricularis med.* have been removed to show the muscles in the profound layer. a = attachment of *M. cervico-auricularis*.

a. The cervico-auricular musculature.

Layer 1:

Figs. 3, 4, 5.

Layer 1 consists of 2 muscular individuals, the *M. cervico-auricularis* and the *M. cervico-scutularis*, situated on the same plane and separated in the distal two thirds only. The differentiation has advanced a little farther than in *Epimys norvegicus*, but not quite so distinctly as in *Dicrostonyx groenlandicus*. In the rodents previously examined by

me layer 1 moreover varies from consisting of one single, very simple sheet of muscle (*Marmota*), right up to comprising a number of strongly differentiated muscular individuals (*Lepus*). The medial part of the originating tendon is firmly cemented to the originating tendon of the underlying *M. cervico-auricularis medius*.

M. cervico-auricularis.

The *M. cervico-auricularis* originates from the Ligamentum nuchae together with the muscle mentioned below. The originating part consists of a thin sheet of tendon. In the embryo the muscle is a thin sheet, in the adult a powerful sheet. The fibres take a parallel course in a latero-cranial direction out on to the Cartilago auriculae, where with a short tendinous transition they are attached to the Eminentia fossae conchae (fig. 5). The field of insertion is narrow and situated in just about the longitudinal direction of the cartilage of the ear, in the adult as well as in the embryo.

M. cervico-scutularis.

The *M. cervico-scutularis* originates, together with the muscle mentioned above, from the Ligamentum nuchae as a short sheet of tendon. The muscle runs with parallel fibres in a latero-cranial direction, and is attached to the margin and the under side (fig. 5) of the caudal corner of the Cartilago scutularis. This muscle is a little thinner than the previous, and in the adult musk-ox must be described as a muscle of spread fibres. Tracing it down below the Cartilago scutularis we see that the caudal fibres to all appearance are directly continued in the *M. auriculo-scutularis anterior profundus*. This condition is the same in the embryo and in the adult.

The veterinary anatomy states that in the domestic ox layer 1 consists of one muscle only, the *M. cervico-scutularis*, and in my opinion this muscle probably answers to the *M. cervico-scutularis* in the musk-ox. A corresponding muscle is found in the hog. The group of muscles which in the horse is designated as *M. scutularis* should no doubt, in part or altogether, be classed with the pre-auricular musculature. Judging by the topographic conditions, the *M. cervico-scutularis* of this group might belong to the retro-auricular muscles, a matter, however, that may safely be established only through an examination of the innervation of the separate muscular individuals.

Layer 2:

Figs. 3, 4, 5, 11.

Layer 2 consists of two muscles, one situated caudally and one cranially, entirely separated from one another by a narrow interval.

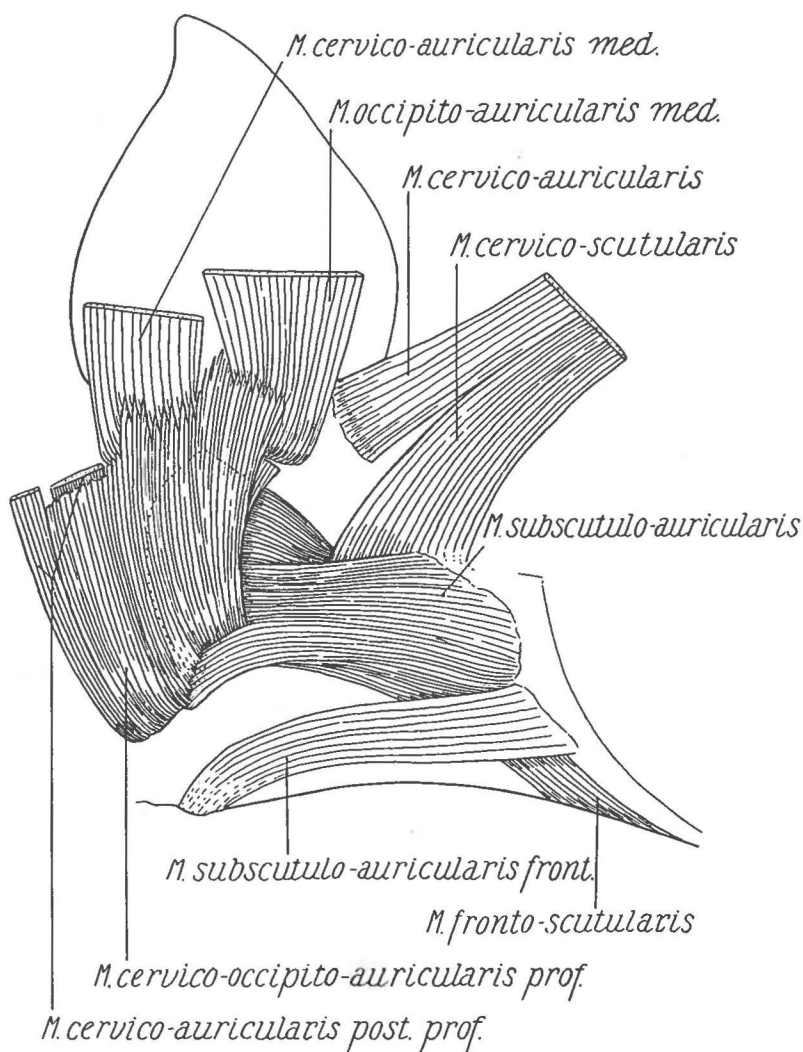


Fig. 4. *Ovibos B*, left side of the cervico-auricular and subcutular musculature, seen from the under side. A paramedian cut has been made dorsally on the back of head and on the neck, and the muscles and ear turned over. The dotted line indicates the hidden dimension of *M. subcutulo-auricularis*.

The two muscles are the *M. cervico-auricularis medius* and the *M. occipito-auricularis medius*. Two corresponding muscles are found in the domestic ox, in the hog, and in the horse.

M. cervico-auricularis medius.

The proximal end of this muscle is covered by the two muscles in layer 1. In the embryo it originates in the Lig. nuchae with a thin sheet

of tendon, the length of about a centimetre, and difficult to separate from the corresponding tendinous sheets in the muscles in layer 1. The field of origin itself reaches just as far ahead as the field of origin for layer 1, but not so far to the rear as the latter. It is a muscle of medium strength, running, with almost parallel fibres, in a lateral direction out towards the caudal bend of the ear cartilage; the distal end of the attachment is rather narrow and enters the *Mm. transversi et obliqui*; the proximal end is considerably broader and joins the area of attachment of the *Pars auris* (figs. 5, 11). During the course from origin to attachment the whole sheet of muscle twists about 90° . The torsion is most pronounced in the distal end.

M. occipito-auricularis medius.

In the adult musk-ox the *M. occipito-auricularis medius* is a fairly powerful sheet of muscle, originating partly from the occipital crest, partly in the front part of the *Lig. nuchae*. In the embryo it originates exclusively and directly from the cranium. The cause of this difference in the adult and the embryo may probably be looked for in the development of the huge horns with their unusually broad base. The fibres pass, evenly converging, in a near enough lateral direction, down under the distal part of the muscles in layer 1, and out on to the *Cartilago auriculæ*, where they are attached, directly or with short tendinous fibres, to the *Eminentia fossae conchæ*, somewhat caudally to the area of attachment of the *M. cervico-auricularis* (fig. 5). The area of attachment itself adjoins the distal margins of the *Mm. transversi et obliqui*.

Layer 3:

Figs. 3, 4.

Layer 3 consists of a caudally situated, relatively thin muscle, and a considerably more powerful muscle, situated more cranially. Both are attached on the ear cartilage, more basally than the rest of the cervico-auricular muscles, and both, reckoned from the attachment, swing in a curve, first in a dorsal, then in a medial direction, in across the neck and the cranium. A corresponding layer of muscles is found in the three domestic animals previously mentioned.

M. cervico-auricularis posterior profundus.

The *M. cervico-auricularis post. prof.* originates with a sheet of tendon from the *Lig. nuchae*. The origin is covered by the *M. cervico-auricularis medius*. The sheet of tendon forms about half of the length of the muscle. The fibres in the sheet of tendon as well as the muscle fibres converge very strongly during their course towards the attach-

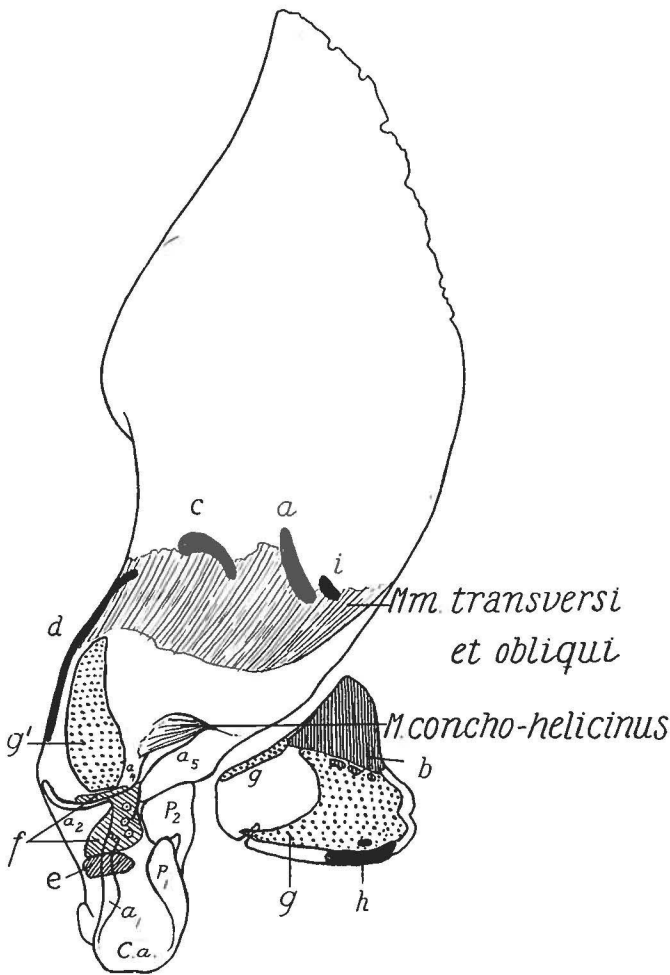


Fig. 5. *Ovibos* B, embryo, left Cartilago auriculae in natural position, seen from the medial surface. Cartilago scutularis is seen from the under side. *Mm. transversi et obliqui* and *M. concho-helacinus* are entered. The fields of insertion (origin) of the remaining auricular muscles are indicated: a = *M. cervico-auricularis*; b = *M. cervico-scutularis*; c = *M. occipito-auricularis medius*; d = *M. cervico-auricularis medius*; e = *M. cervico-auricularis post. prof.*; f = *M. cervico-occipito-aur. prof.* (the small round fields marking insertion of fibres from *M. subscutulo-auricularis*); g and g' = origin and attachment, respectively, of *M. subscutulo-auricularis*; h = attachment of *M. subscutulo-auricularis frontalis*; i = attachment of *M. auriculo-scutularis posterior profundus*.

ment, which lies across Anteron 2, Anteron 1, and on the connective tissue between Anteron 1 and Posteron 1. In the muscular part of the sheet there is an indication of there being 2 portions in the embryo examined. The posterior portion is narrow and rather thick, the anterior broader and somewhat thinner (figs. 4 and 5).

M. cervico-occipito-auricularis profundus.

This muscle is attached basally on the ear cartilage, exactly distally to the attachment of the *M. cervico-auricularis post. prof.* The field of insertion (fig. 5) comprises the margin of Anteron 4, Anteron 2, and the tip of Anteron 1, together with the connective tissue between the distal end of Anteron 2 and Posterion 2. Some of the fibres reach right across on to the tip of Anteron 5 and the margin of Posterion 2.—The caudal end of the muscle is covered by the muscle mentioned above (fig. 4). The fibres take their course, strongly diverging, from the attachment towards the origin, for which latter it is impossible to make a sharp demarcation, as the fibres enter the distal end of the muscles in the middle layer, and may be dimly discerned from the dorsal side (fig. 3).

These two muscles in layer 3 are difficult to separate from each other near their insertion on the ear cartilage, and this fact, together with the strange condition of origin, makes it difficult to recognize the presence of two muscular individuals.

The muscle has no doubt originally had its origin on the neck bone and the *Lig. nuchae*, as is the case in numerous rodents. The development of the powerful horns has no doubt been a contributory cause to its being forced away from its primary field of origin, and this may explain the difficult demarcation of the field of origin.

β. Mm. auriculares proprii.

Figs. 5, 9, 10, 11.

The retro-auricular *Mm. auriculares proprii* are, compared to the rest of the ear muscles, all rather small. They only consist of the *Mm. transversi et obliqui*, the *M. antitragicus*, and the *M. helcis*. An *M. mandibulo-auricularis* is lacking. They all have their origin as well as their attachment on the ear cartilage.

Cartilago auriculae.

Fig. 6.

Musk-ox Embryo B. The earlier nomenclature for the ear cartilage is here replaced by the nomenclature introduced by Boas ("Ohrknorpel und äusseres Ohr der Säugetiere", Kopenhagen 1912). Here is a short collocation of the designations (names) formerly in general use, and the nomenclature by Boas: the Tragus plate = Posterion 4 (p_4), the Antitragus = Posterion 5 (p_5), lacking in *Ovibos moschatus*, and the Spina helcis anterior = Anteron 5 (a_5). The *Cartilago scutularis* is present; it is a near enough triangular plate with rounded corners, situated in front of Anteron 5. The *Cartilago annularis* is a square plate with an incision in the distal margin.

With regard to the topography of the ear cartilage see the above mentioned work by Boas; we must, however, observe that the Anteron 3 found in a single case by Boas, was not present in the embryo examined, nor in the adult animal. For further reference see fig. 6 and my work on *Dicrostonyx groenlandicus* (1941).

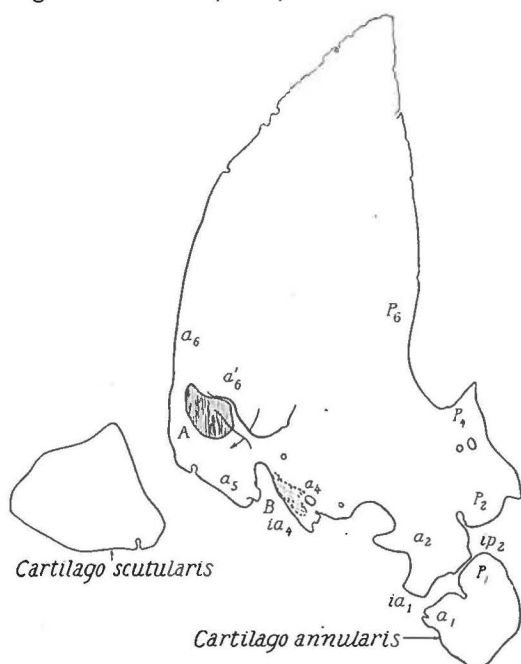


Fig. 6. *Ovibos B*, left *Cartilago auriculæ*, seen from the lateral side. p_1-p_6 = Posteron 1-6 (p_3 is lacking). a_1-a_6 = Anteron 1-6 (a_3 is lacking). ia_1 and ia_4 = Incia 1 and 4. ip_1 = Incip 1. The arrow indicates a tunnel under an arch of cartilage by $a'6$. A = field of origin of *M. concho-helicinus*; B = attachment on the medial side of the ear cartilage of same muscle.

Mm. transversi et obliqui.

Figs. 5, 10, 11.

In the musk-ox these muscular regions consist in a transverse muscular belt only, the fibres of which pass in the longitudinal direction of the ear cartilage. They take up the field between the insertions of the *M. cervico-auricularis* and the *M. occip.-aur. med.*, distally, and the area of attachment (origin) of the *M. subscutulo-auricularis* and the *Pars auris*, proximally. On the caudal bend of the ear cartilage, the attachment of the *M. cervico-auricularis med.* enters the muscular mass. The muscular regions do not extend so far as the cranio-lateral bend of the ear cartilage, but stop just a little in front of the attachment of the *M. cervico-auricularis*, whereas they extend right round on to the caudo-lateral bend, where they join the fibres from the *Pars auris*.

M. antitragicus.

Figs. 9, 11.

The *M. antitragicus* is a small, thin, conic muscle, showing on the lateral side of the ear. It originates on the ear cartilage with a small rounded field close up against the margin of Incisura posterior 4. From here the fibres pass, gently converging, towards the attachment on Posterion 6. They are attached to the ear cartilage by means of a short, powerful tendon. Like the origin the attachment too, lies close up against the free margin of the ear cartilage. In the domestic ox and in the horse the muscle has about the same placing (*M. caudo-antitragicus*); the same applies to the hog.

M. helcis.

Figs. 9, 10, 11.

The *M. helcis*, like the muscle above, is small and thin, relatively larger in the embryo than in the adult (cf. fig. 9 and fig. 10). It originates from a long, narrow field on and around the free margin of Anterior 6, and is attached in a more concentrated field on Posterion 4, near the free, distally facing margin of this latter. The insertion of the *M. helcis* varies somewhat in the different mammals. In the Greenland lemming and *Cavia* its insertion is likewise situated on Post. 4, whilst in many other rodents the muscle is inserted into Ant. 5 (rabbit, hare, *Alactagulus*, *Arvicula*, *Epimys*, *Marmota*, *Sciurus*, *Hydrochoerus*, *Myocastor*, and others). The fact that the *M. helcis* in the musk-ox is inserted into Post. 4, is maybe a consequence of this latter being situated close up against the inner side of Ant. 5.

III. Sphincter colli profundus and its derivatives.

Sphincter colli profundus.

In *Ovibos moschatus* there is very little left of the original Sphincter colli profundus. In this point it differs highly from the more primitive rodentia, nearly all of which have preserved a considerable part of a primitive Sphincter colli profundus. In a few cases only this sheet of muscle has undergone a noticeable reduction, and then as a rule because of the pressure exercised on it by a well developed *M. masseter*. In other mammal groups too, we may find preserved considerable parts of a primitive Sphincter colli profundus.

The present remains of the Sphincter colli prof. are presumably derived from the original Sphincter muscle in the neck region, the Sphincter colli primitivus, which during the phylogenetic evolution—presumably from reptiles to mammals—has wandered forward on to

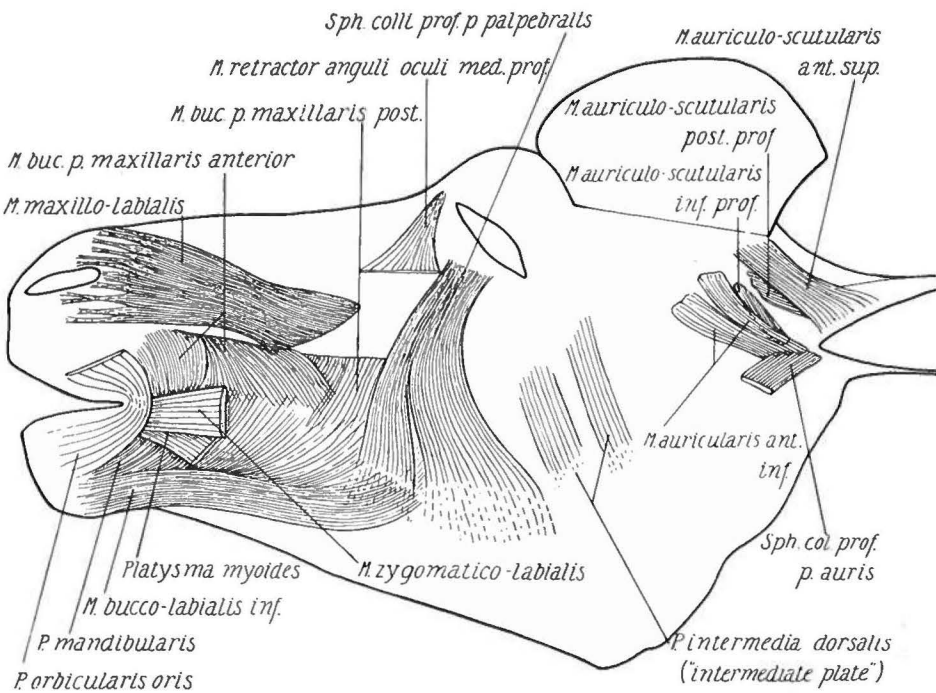


Fig. 7. *Ovibos A.*, left side. The greater part of the horn is imagined removed. *M. naso-labialis superf.*, *Platyisma*, *Pars auris*, and *M. orbicularis oculi* have been removed. The ventral part of *Pars palpebralis* passes into a thin, fascia-like sheet on the outside of the thickest part of *M. masseter*.

the head, and here sent off derivatives to the ear, the eye, and the nose. During this process of evolution the ventral part of the Sphincter muscle has, to a larger or smaller degree, been preserved as a simple muscular sheet, frequently divided up into cross-belts, situated ventrally to the ear, between the ear and the eye, ventrally to the eye, and ventrally to the nose. This leads naturally to a quite specific classification in the descriptive part of the mention of this musculature. In the musk-ox there is, however, no topographic basis for such classification; but it will, nevertheless, be used in this publication, for this reason that the special conditions in the musk-ox are owing to a reduction phenomenon only.

The division of the Sphincter colli profundus, taken postero-anteriorly, becomes as follows:—

1. *Pars auris*.
2. *Pars intermedia*.
3. *Pars palpebralis*.
4. *Pars oris*.

1. Pars auris.

Figs. 1, 2, 7, 8, 10, 11, 12, 23.

Ovibos A. In the adult musk-ox the Pars auris (figs. 1, 7) is a long, narrow muscular band, about 3 cm wide, which is attached on the caudo-lateral bend of the ear cartilage. The field of insertion is situated right in front of the basal part of the insertion of the M. cervico-auricularis med. Part of the fibres interlace with the fibres from the M. auricularis anterior inferior (fig. 10). The fibres are parallel, and the muscular band extends down on to the side of the neck, somewhat behind the angle of the jaw. The superficial fibres terminate in the sheet of connective tissue from the Platysma myoides. The deep fibres terminate in the connective tissue deep down, right inside the dorsal margin of the M. sterno-mandibularis. In the embryo, *Ovibos B*, we find corresponding topographical conditions on the left side (fig. 8). On the right side (fig. 12) the Pars auris is not separated from the Pars intermedia ventralis lying in front of it. Corresponding conditions are found in the other embryo (*Ovibos C*), where the Pars auris on both sides likewise has preserved the connection with the ventral remains of the Pars intermedia (fig. 23). The Pars auris has not given off any derivatives; it must be considered the hindmost remainder of an original Sphincter colli profundus.

The Pars auris and the said ventral remainder, where this latter appears, are innervated by the Ramus colli.

2. Pars intermedia and its derivatives.

The Pars intermedia is divided into the *Pars intermedia ventralis*, only slightly developed in the musk-ox, and the *Pars intermedia dorsalis*, which has differentiated into numerous muscular individuals. In this work these latter are collected into two groups: *The pre-auricular musculature*, and *the orbito-nasal musculature*.

Pars intermedia ventralis.

Figs. 1, 2, 7, 8, 12.

The Pars intermedia ventralis is much reduced in comparison with what we find in several other mammal groups. On the left side of the embryo (*Ovibos B*) there was no vestige that might be interpreted as being the remains of a ventral Pars intermedia (fig. 2). On the right side of the embryo (fig. 12) there was a distinct Pars intermedia ventralis of almost the same breadth as the Pars auris, but here its dorsal extension was considerably larger than in the adult musk-ox. In the dorsal part the fibres were somewhat diffused and slightly diverging. We must

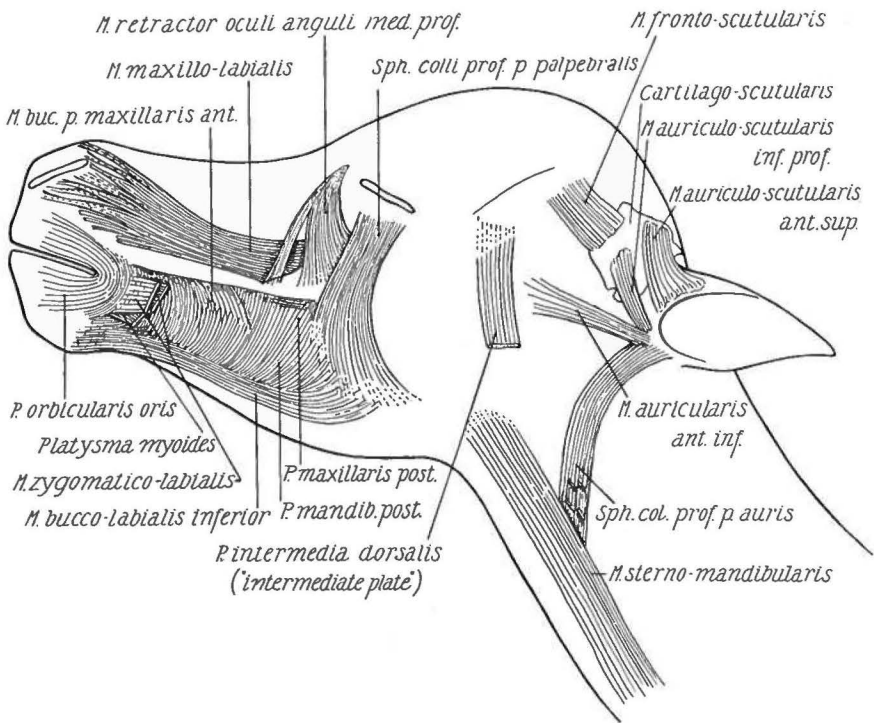


Fig. 8. Ovibos B, left side. *M. naso-labialis superficialis*, *Platysma*, *M. orbicularis oris*, and *M. frontalis (orbitalis)* have been removed. In *M. buccinatorius p. maxillaris post.* some dorsal, profound fibres are dimly to be discerned.

also point out that the *Pars auris* and the *Pars intermedia ventralis* were not differentiated into two independent muscular individuals, but formed a coherent sheet of muscle. In the other embryo (Ovibos C) there was, likewise as on the right side of Ovibos B, a ventral *Pars intermedia* in muscular connection with the *Pars auris* (fig. 23). In the two embryos the *Pars intermedia ventralis* is continued anteriorly by the ventral part of the intermediate plate, only separated by a very narrow fissure. Thus in a certain area the three muscle portions form a topographic entirety; this must no doubt be regarded as a primitive condition. On the left side of the adult musk-ox (fig. 1) there was in the connective tissue in front of the ventral part of the *Pars auris*, a couple of thin regions of muscular fibres. The hindmost of these muscular regions is of the same breadth, and the fibres have a similar course, as in the *Pars auris*; it is situated behind the angle of the jaw, and the muscular part is rather short and continues dorsally in a sheet of connective tissue. The anterior muscular region is considerably broader, but of a lesser dorso-ventral extension. The cranial part is partly covered by the *Platysma myoides* and the rather thin tendinous sheet of the

latter. None of these muscular regions were in muscular connection with their dorsal continuation, viz. the muscular regions that must be regarded as the reduced intermediate plate.

Pars intermedia dorsalis and its derivatives.

***a.* The pre-auricular musculature.**

In several mammals the pre-auricular musculature is divided into two layers. These layers are also traceable in the musk-ox, and in the following they are designated as *the deep layer of muscles* and *the superficial layer of muscles*.

The deep layer of muscles.

The deep layer of muscles consists, besides of a slightly differentiated remainder of the original Pars intermedia dorsalis, viz. the *intermediate plate*, of the following:—

- M. zygomatico-labialis.
- M. subscutulo-auricularis.
- M. subscutulo-auricularis frontalis.
- M. auriculo-scutularis anterior profundus.
- M. auriculo-scutularis posterior profundus.
- M. auriculo-scutularis inferior profundus.
- Mm. auriculares proprii.

The intermediate plate.

Figs. 1, 2, 12, 23.

The intermediate plate forms, together with the Pars intermedia ventralis, in many mammalia (*Dicrostonyx groenlandicus*, *Sciurus vulgaris*, Carnivora) a ring-shaped sheet of muscle, situated between the ear and the eye. In others this muscular ring is often broken on the side of the head, because of the pressure from the *M. masseter*. This for instance is the case in many hystricomorphous rodents. At the same time the intermediate plate is often reduced, and its adjacent split-off products strongly differentiated.

In the musk-ox, in the adult (*Ovibos A*) as well as in the embryo (*Ovibos B*), the intermediate plate is reduced to a small, relatively thin muscular band of about the same breadth as the *Pars auris*. It originates behind the *Orbita* outside the post-orbital arch with a thin, short sheet of connective tissue. The fibres are parallel, and the muscle passes in a ventral direction down under the tendinous sheet of the *Platysma myoides*, where they disappear in the connective tissue. On the right side in the embryo (*Ovibos B*) the intermediate plate does not reach so far down on the side of the head as on the left side (fig. 12).

Moreover it is broader and dorsally partly split up into sections. In the anterior section part of the fibres enter the *M. orbicularis oculi* at the lateral corner of the eye. The posterior part does not reach up so far, and the fibres disappear in the connective tissue, cranially to the *M. auricularis anterior inferior*.

On the left side of the adult musk-ox we found, in front of the intermediate plate here described, a similar, but somewhat shorter and broader muscular region with more spread fibres. Dorsally these entered between the fibres in the *M. orbicularis oculi*, ventrally to the lateral corner of the eye. This muscular portion shows great resemblance to a *Pars palpebralis*, but must in the musk-ox be regarded as a cranial, detached part of the intermediate plate. In the other embryo (*Ovibos C*) the muscle sheet on the right side is so broad dorsally that the foremost fibres reach right up under the lateral corner of the eye. On the left side the sheet consists of two sections, ventrally stuck together for a short distance. The anterior section reaches farther ahead below the eye than do the anterior fibres on the right side (fig. 23).

M. zygomatico-labialis.

Figs. 1, 2.

The *M. zygomatico-labialis* is a comparatively well developed muscle, stretching from the zygomatic arch to the corner of the mouth. In the musk-ox there is nothing in the muscular topography that indicates an earlier connection between this muscle and the intermediate plate; but the derivation of the *M. zyg.-lab.* from the intermediate plate is plainly demonstrated in other mammalia, by means of topographic examinations as well as through the innervation conditions. The innervation of the *M. zygomatico-labialis* and the intermediate plate through a common pre-auricular facialis branch, indicates that also in the musk-ox the *M. zygomatico-labialis* is a derivate of the intermediate plate.

The *M. zygomatico-labialis* consists of a dorsal, smaller portion, and a ventral, larger portion. The smaller portion originates in the connective tissue, between the fibres in the ventral part of the *M. orbicularis oculi*; in the adult musk-ox, however, the most ventral fibres come from a thin sheet of tendon. Orally the muscle fibres enter the *M. bucinatorius*, partly covered by the ventral, larger portion. This latter originates with a thin, but distinct tendinous sheet, ventrally to the Orbita on the cranio-lateral margin of the zygomatic arch (fig. 14). This portion is more than twice as powerful and broad as the portion first mentioned. The fibres are parallel, and the muscle takes its course in an oral direction, and enters the *M. bucinatorius* just behind the *Pars orbicularis oris*, in the adult with a distinctly tendinous part, in

the embryos (Ovibos B and C) with a section, partly tendinous and partly muscular. The greater part of the *Platysma myoides* passes in under the ventral margin of the *M. zyg.-lab.*; caudally only, a number of superficial fibres enter the *M. zyg.-lab.* Below the caudal, tendinous part of the origin we may dimly discern the *Pars palpebralis*. The *M. zygomatico-labialis* is presumably homologous with the *M. zygomaticus* of the veterinary anatomy, a muscle well demarcated in the horse as well as in the ox and the hog.

M. subscutulo-auricularis.

Figs. 4 and 5.

The *M. subscutulo-auricularis* is a powerful muscle, originating on the under side of the *Cartilago scutularis*. It is divided into two portions, not distinctly separated from each other. This incomplete differentiation seems to have been brought about by a torsion of the sheet of muscle. The larger portion is situated almost ventro-laterally in relation to the minor portion. It originates on the cranial and lateral part of the *Cartilago scutularis*, in a posteriorly open, horseshoe field. The minor portion originates from the medial margin of the cartilage and a small part of the adjoining under side. The major portion extends in a dorso-caudal (caudal) direction and is attached on the ear cartilage, partly together with the cranial part of the *M. cervico-occipito-auricularis prof.*, partly independently in a field distally to the latter. The smaller portion passes in a somewhat more dorsal (dorso-caudal) direction than the larger, and is attached on the ear cartilage in a distal continuation of the field of insertion of the larger portion. The free field of insertion itself stretches from about the margin of *Ant. 4* to the caudal part of the *M. transversus et obliqui*.

M. subscutulo-auricularis frontalis.

Figs. 4, 5, 20.

The *M. subscutulo-auricularis frontalis* is a thin muscle, originating with a tendon from the cranium, medially to the basis of the *Tubus*. It passes with almost parallel fibres in a dorso-cranial direction and is attached on the under side of the *Cartilago scutularis*, just inside the cranio-lateral margin of this latter. The field of insertion adjoins that of the origin of the larger portion in the *M. subscutulo-auricularis*. The *M. subscutulo-auricularis frontalis* and the above mentioned *M. subscutulo-auricularis* are being innervated from pre-auricular *facialis* branches (fig. 20).

M. auriculo-scutularis anterior profundus.

Figs. 10, 11.

In the embryo (Ovibos B) this muscle is entirely covered by the *M. auriculo-scutularis anterior superior*. In the adult musk-ox the basal,

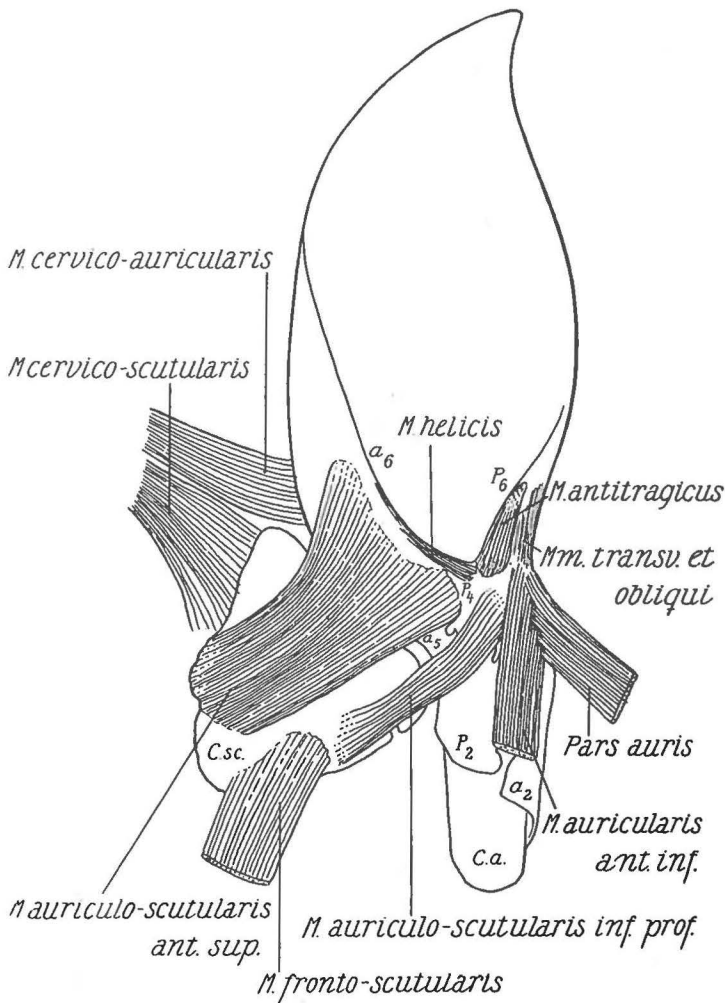


Fig. 9. Ovibos B, lateral side of left ear cartilage showing the pre-auricular ear muscles. p_2, p_4, p_6 = Posterons 2, 4, 6; a_2, a_5, a_6 = Anterons 2, 5, 6; C.a. = Cartilago annularis; C.sc. = Cartilago scutularis.

proximal corner is visible at the ventral margin of this muscle. It is a relatively powerful and short sheet of muscle, originating near the margin of Anteron 5. The muscle fibres pass, more or less converging, in a medio-caudal direction, and in the case of the greater part are attached posteriorly on the caudo-lateral margin of the Cartilago scutularis. Part of the muscle fibres seem to continue in the *M. cervico-scutularis*. This connection is probably of a secondary nature, arisen partly because the insertion fields of the two muscles on the Cartilago scutularis meet, partly because the fibres in the two muscles have the same direction.

The *M. auriculo-scutularis ant. prof.* answers in origin and attachment to the *M. scutulo-auricularis superf. med.* in the horse, the ox, and the hog.

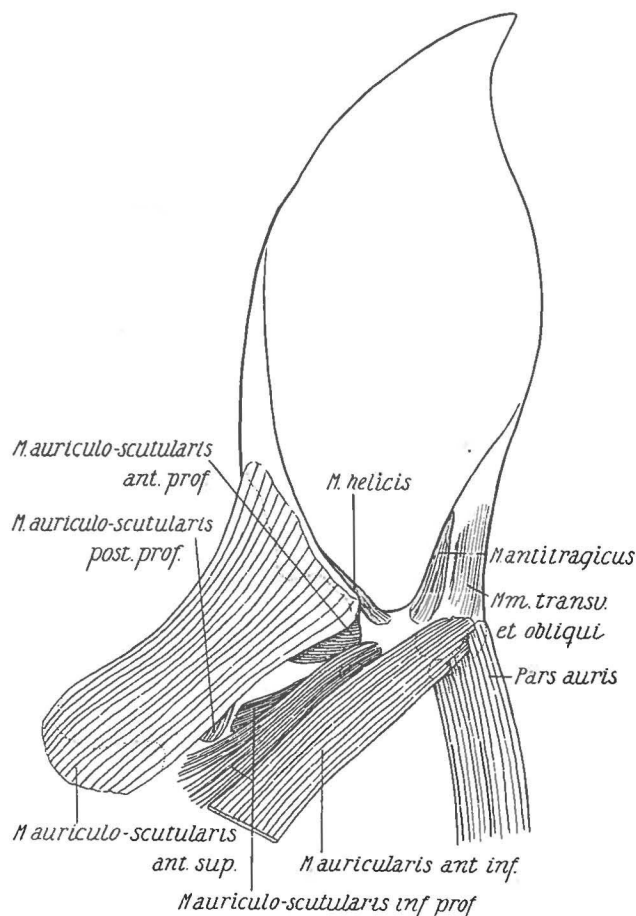


Fig. 10. *Ovibos A*, left ear seen from the lateral side, showing the pre-auricular ear muscles. The dotted lines indicate the field of insertion of the muscles belonging to them.

M. auriculo-scutularis posterior profundus.

Figs. 5, 10, 11.

This muscle is a small, independent muscle, the topographic conditions of which do not indicate anything as to whether it belongs to the retro-auricular musculature or to the pre-auricular muscles. It originates on the medial surface of the ear cartilage on the Eminentia fossae conchae. The field of origin is small, situated right in front of the field of attachment of the *M. cervico-auricularis*. It originates with

a thin tendon and passes with distinctly diverging fibres in a nasal direction, and continues in under the *M. auriculo-scutularis ant. superior*.

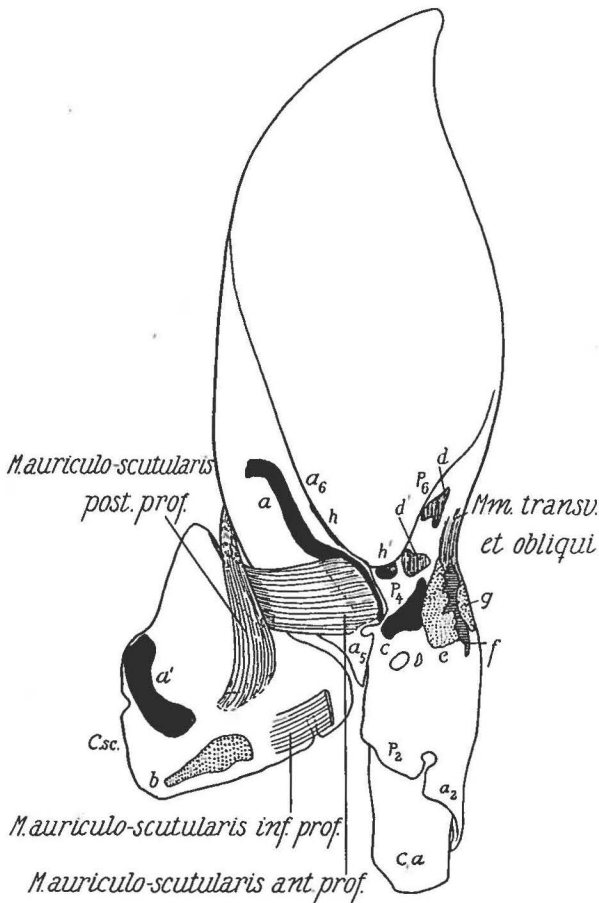


Fig. 11. *Ovibos B.* Left ear cartilage seen from the lateral side, showing partly pre-auricular ear muscles, partly fields of origin or insertion, of muscles removed. Compare with fig. 9. p_2, p_4, p_6 = Posteron 2, 4, 6; a_2, a_5, a_6 = Anteron 2, 5, 6. C.a. = Cartilago annularis. C.sc. = Cartilago scutularis. a and a' = attachment and origin, respectively, of *M. auriculo-scutularis ant. sup.*, d' and d of *M. antitragicus*, h' and h of *M. helcis*. c = attachment of *M. auriculo-scutularis inf. prof.*, e = attachment of *M. auricularis ant. inf.*, f = attachment of Pars auris, g = attachment of *M. cervico-auricularis medius*.

It has a muscular attachment on the dorsal side of the Cartilago scutularis. In the embryo the field of insertion is hidden by the *M. auriculo-scutularis ant. sup.*, but in the adult musk-ox visible at the latero-cranial margin of this latter muscle.

The *M. auriculo-scutularis post. prof.* presumably corresponds with the *M. scutulo-auricularis superf. accessorius* of the veterinary anatomy (the horse and the ox; this muscle is lacking in the hog).

M. auriculo-scutularis inferior profundus.

Figs. 9, 10, 11.

The topographic conditions in the embryo (*Ovibos B*) are such that it is difficult to determine whether it is a matter of a muscle from the deep or from the superficial layer. It is a thin, muscular band with parallel fibres, originating on the lateral bend of the *Tubus* on *Posteron 4*, and passing in a cranio-medial direction. It is attached on the dorsal side of the *Cartilago scutularis* near the latero-cranial margin of this latter. In the adult musk-ox (*Ovibos A*) this little muscle consists of two portions, situated on a level with the two above mentioned deep muscles, and with the lateral margin partly covered by the *M. auricularis anterior inferior*. The field of insertion is of a greater extent than in the embryo. The outer or lateral portion is the larger, and is split towards the field of attachment. The minor portion is attached exactly ventro-laterally to the attachment of the *M. auriculo-scutularis post. prof.* The origin and the proximal end are covered by the larger portion.

The lateral Mm. auriculares proprii.

In the examined specimens of the musk-ox we have found only a single muscle belonging to this group. The *M. trago-helycinus*, generally found in the rodentia, and usually stretching between *Post. 4* and *Ant. 5*, is thus lacking. It is true that the muscle, in the present designated the *M. auriculo-scutularis inferior profundus*, originates from *Post. 4*, but during its course it passes *Ant. 5* and continues to the *Cartilago scutularis*. The *M. concho-helycinus*, which is solely connected with the actual ear cartilage, may, on the other hand, be classed with the lateral *Mm. auriculares proprii*.

M. concho-helycinus.

Figs. 5 and 6.

The *M. concho-helycinus* is a small, very thin muscle. It originates on the concave (lateral) surface of the ear cartilage, more precisely on *Anteron 6* and the proximal, adjoining part of *Anteron 5*. The field of origin stretches in on to the cartilaginous bridge from *Anteron 6*. It is attached on the convex (medial) surface of *Anteron 4* and on the *Incia 4* facing margin of *Anteron 4*. The *M. concho-helycinus* may be observed from the lateral side of the ear cartilage when the front and back margins of the latter have been forced apart. It may likewise be observed on the medial surface of the ear cartilage, as it passes right across *Incia 4*.

The superficial layer of muscles.

The superficial layer of muscles in the musk-ox does not form any coherent or partly coherent sheet of muscle, as may be the case in many other mammalia. A contributory cause to this condition is beyond doubt the development of the over-dimensioned horns. It was therefore to be expected that in the embryo we should find more primary topographic conditions than in the adult. This indeed is the case, but not to the degree expected. The following muscles may be included in the superficial layer of muscles: *The M. auriculo-scutularis anterior superior*, the *M. auricularis anterior inferior*, and the *M. fronto-scutularis*.

M. auriculo-scutularis anterior superior.

Figs. 1, 2, 7, 9, 10, 11.

It is here a matter of a rather powerful, fairly broad sheet of muscle, originating on the cranio-lateral bend of the ear cartilage. The field of origin is relatively narrow, and is situated on Anteron 6 and the distal part of Anteron 5. The fibres extend, gently converging, partly forward and partly, and chiefly so, in a medial direction (fig. 2). The muscle is inserted dorsally on the Cartilago scutularis, near the medial margin of this latter, in the embryos entirely covering the *M. auriculo-scutularis post. prof. et ant. prof.*, but in *Ovibos A* not entirely so (fig. 10). In the adult musk-ox the basis of the horn has extended right up to the field of insertion of this muscle. The muscle is comparatively weaker in the adult musk-ox than in the embryo. The *M. auriculo-scutularis ant. sup.* is no doubt homologous with the *M. scutulo-auricularis superf. dors.* in the hog and the ox. In the horse this muscle is not separated from the *M. interscutularis* and the *M. cervico-scutularis*.

M. auricularis anterior inferior.

Figs. 1, 2, 7, 8, 9, 10, 11, 14, 23.

The *M. auricularis ant. inf.* is a sheet of muscle of about the same breadth and thickness as the *Pars auris*. In the embryo it arises caudally on the zygomatic arch and passes with gently converging fibres in a caudal direction towards the ear cartilage. Here it is inserted on the lateral bend of this cartilage on Posterion 4. The field of insertion is situated between, and adjoining, the fields of origin of the *Pars auris* and the *M. auriculo-scutularis inferior prof.* (fig. 11). In *Ovibos C*, left side, a dorsal, narrow muscular band has been split off (fig. 23). In the adult musk-ox the origin is bifurcated and hidden by the descending horn (fig. 7). In the field of insertion the muscle fibres interlace with the fibres in the *Pars auris*. The muscle might also be called the *M. zygomatico-auricularis* or the *M. depressor helicis* (Cavia); together with the

Pars auris it is pulling the ear forward and downward. It has no connection with the *M. zygomatico-labialis*. The corresponding muscle in the horse and the ox is called, in the veterinary anatomy, the *M. zygomatico-auricularis*. Neither is there in these two forms any connection with the *M. zygomaticus*. It is doubtful whether the muscle of the same name in the hog is homologous with that of the horse and the ox. Together with the *M. scutulo-aur. superf. ventr.* it more probably corresponds with the *M. scutulo-auricularis superf. ventralis* of the horse. In the musk-ox the *M. auricularis ant. inf.* is innervated by the *R. temporalis*.

M. fronto-scutularis.

Figs. 2, 9, 11, 23.

The *M. fronto-scutularis* is entirely lacking in the adult musk-ox; it has been altogether superseded by the horn. In the embryo (*Ovibos B*) it consists of a short sheet of muscle twice as broad as the *Pars auris*. It arises on the cranium in the field which in the adult is taken up by the horns, and the fibres pass in the direction towards the ear, and are inserted on the dorsal side of the *Cartilago scutularis*, near the cranio-lateral margin of this latter. Roughly, this muscle resembles a continuation of the *auriculo-scutulares* muscles, and it may then be regarded as an *M. interscutularis*, a muscle which, in its typical form, I have found only among the rodents in the *Lepus* genus.

It is also possible that it should be regarded as a remainder of an *M. frontalis (auricularis)*. It is then, as in several rodents, separated from its orbital portion, in this type evidently because of the development of the horn. In the elder embryo (*Ovibos C*, fig. 23) the *M. fronto-scutularis* has already been reduced into a thin muscular region on the left side, with the same placing otherwise. On the right side it is divided into two muscular regions, a dorsal narrow muscular region, and a broader ventral muscular region, which latter, with diverging fibres, reaches ahead to the caudal margin of the intermediate plate.

In the domestic animals previously mentioned, the *scutulares* group is well developed and differentiated into several, rather independent muscular individuals. It is possible that the *M. fronto-scutularis* is to be homologized with the *M. interscutularis* of the veterinary anatomy, or with part of this muscle; but judging from the topographic conditions in the ox, the horse, and the hog, I should take it that it ought sooner to be compared with the *M. fronto-scutularis pars frontalis* in the said three domestic animals.

β . The orbito-nasal musculature.

The orbito-nasal musculature groups itself mainly around the eye, and consists here of the following, more or less independent, muscles:

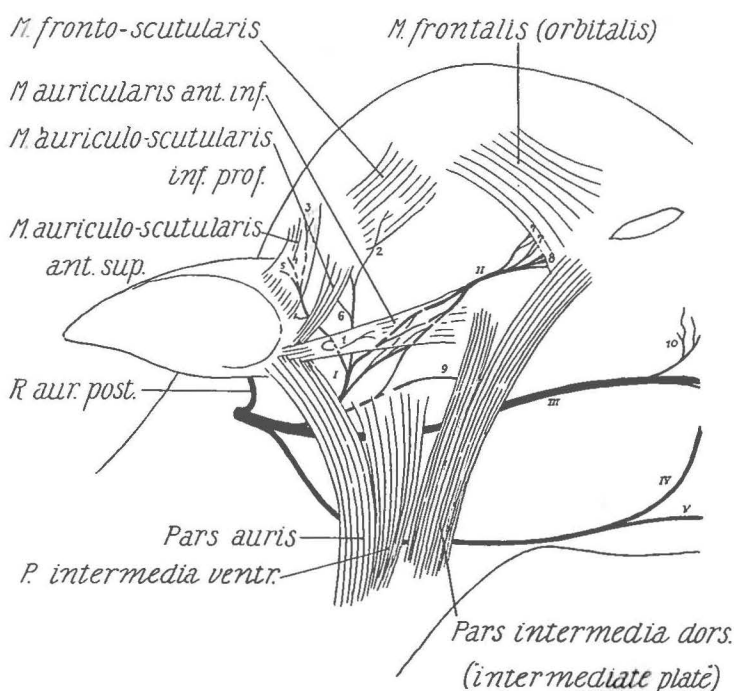


Fig. 12. *Ovibos B*, right side, showing the connection between Pars auris, Pars intermedia ventralis, and the ventral part of the intermediate plate. I, II, III, IV, and V = Ramus temporalis, R. zygomatico-orbitalis, R. bucco-labialis sup., R. bucco-labialis inf., and R. marginalis mandibulae.

Nerve branch to: 1) *M. auricularis ant. inf.*; 2) *M. fronto-scutularis*; 3) *M. auriculo-scutularis ant. sup.*; 4) *M. auriculo-scutularis post. prof.*; 5) *M. auriculo-scutularis ant. prof.*; 6) subscutular muscles; 7) *M. frontalis (orbitalis)*; 8) *M. orbicularis oculi*; 9) intermediate plate; 10) Pars palpebralis.

The *M. frontalis (orbitalis)*, the *M. retractor anguli oculi lateralis*, the *M. orbicularis oculi*, the *M. retractor anguli oculi medialis profundus*. The *M. naso-labialis superficialis* has, however, advanced out on to the nose.

M. frontalis (orbitalis).

Figs. 1, 2, 13.

The orbital *M. frontalis* is in the adult musk-ox a comparatively powerful sheet of muscle of a rather large extension. It originates from the Aponeurosis above the Os frontalis, medially and caudo-medially to the Orbita. In the adult musk-ox the caudal part of the muscle is partly supplanted by the broad basis of the horn. The muscle fibres pass, converging, in the direction of the Orbita, where part of them enter between the dorsal fibres in the *M. orbicularis oculi*. The nasal field of fibres joins with the free, anterior fibres in the *M. orb. oculi*

as they pass the medial corner of the eye. In this field, thus, there is no separation of these two muscles, and this applies to the adult animal as well as to the embryo. It is, however, plain to see that the *M. frontalis* (orbitalis) appears as a profound layer of muscle compared with the *M. orbicularis oculi*, and that anteriorly it lies on a level with the *M. naso-labialis superficialis*. These conditions support the reflections on the phylogenetic evolution I have advanced in my principal work on the superficial facialis area of the rodents.

M. retractor anguli oculi lateralis.

Fig. 23.

The *M. retractor anguli oculi lateralis*, frequently found in the rodents, is presumably not present in the musk-ox, normally. It was lacking in the adult musk-ox examined, and in one embryo (Ovibos B). It was, however, present in Ovibos C, where it consisted of a narrow bundle of fibres, originating from the lateral corner of the eye, between the fibres in the *M. orbicularis oculi*. The fibres passed in a caudal direction and were inserted in the skin between the eye and the ear.

M. orbicularis oculi.

Figs. 1, 2, 13.

The *M. orbicularis oculi* is a superficial muscle of medium strength and typical appearance. A great part of the fibres originate from the ligament at the medial corner of the eye, and take their course, in the case of the inmost fibres, parallel to the margins of the eyelids, and back to the point of origin. The peripheral fibres are broken off, dorsally as well as ventrally to the eye, the free ends crossing each other. The ventral part of the muscle is, in the adult animal, larger than the dorsal part, and on the right side a greater part of the fibres from the *M. zygomatico-labialis* enter between the fibres of the *M. orbicularis oculi* than is the case on the left side. In the embryos examined the anterior fibres in the intermediate plate enter the ventro-caudal part of the *M. orbicularis oculi*. This is seen most clearly on the left side in Ovibos C. Here the anterior bundle of the intermediate plate contacts the *M. zygomatico-labialis*, too (fig. 23).

M. retractor anguli oculi medialis profundus.

Figs. 1, 2, 7, 8.

The name above has come into being because the ventral part of the medial fibres in the *M. orbicularis oculi* no doubt are able to function as a superficial Retractor anguli. This profound Retractor oculi med. is, moreover, the same as the *M. malaris* of the veterinary anatomy. When

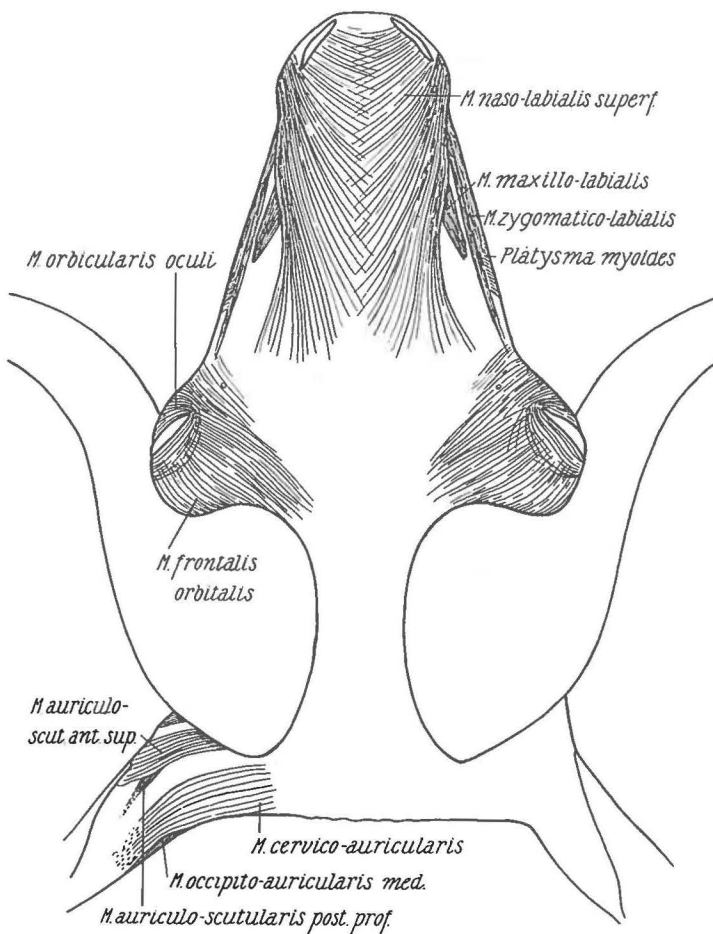


Fig. 13. *Ovibos A*, seen from dorsal side, showing especially the dorsal extension of *M. naso-labialis superf.*, and the relations between *M. frontalis (orbitalis)* and the medial part of *M. orbicularis oculi*.

in the embryo (*Ovibos B*) we remove the superficial medial fibres in the *M. orbicularis oculi* (the anterior fibres in the *M. frontalis orbitalis* included) and the latero-caudal end of the *M. naso-labialis*, the whole proximal end of the *M. retractor anguli oculi med. prof.* appears. It has a weak tendinous origin, and the field of origin is situated on the cranium, just inside the medial corner of the eye. The fibres pass, diverging, in a ventral direction down under the *M. zygomatico-labialis*, where they terminate in the connective tissue. The cranial fibres are the longest, and there is an anteriorly split-off bundle of fibres. The caudal fibres pass gently into the deep, ventro-medial fibres in the *M. orbicularis oculi*. In the adult musk-ox the fibres pass in a ventro-

oral direction; the anterior of these run for a distance along the lateral margin of the *M. naso-labialis*, suggesting a closer connection between these two muscles.

It is possible, and maybe most probable, that the *M. retractor anguli oculi med. prof.*, or the *M. malaris* of the veterinary anatomy, is to be regarded as an *M. naso-labialis*. The topographic picture in the musk-ox and the domestic ox to some degree renders this perception probable.

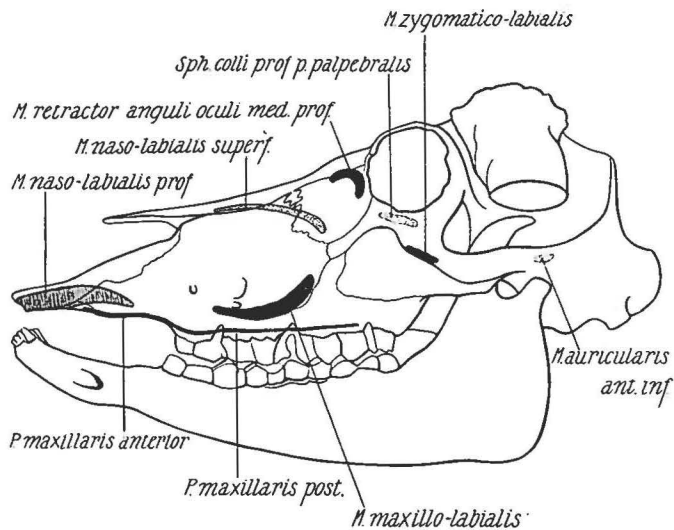


Fig. 14. Left side of cranium of an adult musk-ox. Origins of the facialis muscles from *Ovibos A* are entered.

In the horse the *M. malaris* and the *M. levator naso-labialis* form an undivided sheet of muscle, a fact that points in the same direction. In such case the nasal part of the original sheet of muscle, that is the part which enters the upper lip itself, has entirely disappeared in the musk-ox and the domestic ox.

M. naso-labialis superficialis.

Figs. 1, 2, 13, 14, 15.

The *M. naso-labialis superficialis*, which in the veterinary anatomy in the case of the domestic ox bears the name of *M. levator naso-labialis*, is a sheet of muscle of medium strength, the greater part of fibres of which originate from the connective tissue on the bridge of the nose. In the embryo (*Ovibos B*) a few of the lateral fibres reach in between the *M. retractor anguli oculi med. prof.* and the anterior margin of the *M. orbicularis oculi*. This is not the case in the adult, because the muscle does not extend so far, posteriorly. The fibres are strongly converging during their course towards the upper lip. In the nasal part of the muscle the fibres run almost across, in the latero-caudal part, on the

other hand, almost lengthwise in the longitudinal direction of the head. The sheet of muscle swings laterally round the nostril, whereupon the fibres enter partly between the fibres in the *M. orbicularis oris*, partly into the upper lip outside this muscle. On the anterior part of the bridge of the nose the fibres cross those in the corresponding muscle on the opposite side. Between the two nostrils we find, belonging to the *M. naso-*

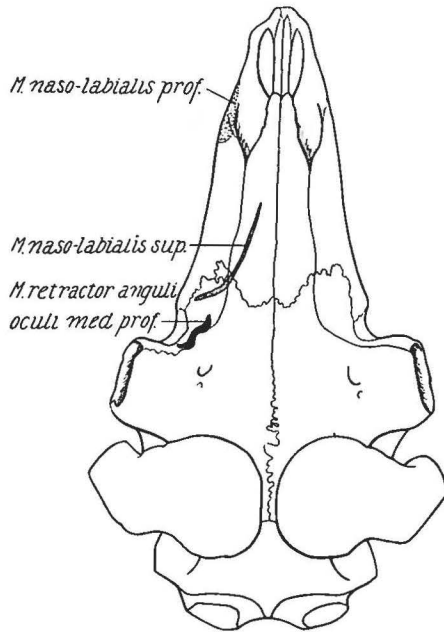


Fig. 15. Dorsal side of cranium of an adult musk-ox. Origins of the facialis muscles from *Ovibos A* are entered.

labialis superficialis, a number of more diffused muscle fibres, which terminate medially to the nostril. The topographic conditions of the muscle correspond entirely with those of the *M. naso-labialis superficialis* in the rodents, and it must no doubt be regarded as such. Indeed the innervation conditions are not explained in the case of the *M. naso-labialis superficialis* of the musk-ox, but if the *M. retractor anguli oculi med. prof.* is to be regarded as an *M. naso-labialis*, and, because of its innervation, as an *M. naso-labialis infraorbitalis*, then the *M. naso-labialis superficialis* should, in my view, be regarded as an *M. naso-labialis superficialis (infraorbitalis)* (see further under *N. facialis*).

3. Pars palpebralis.

Figs. 7, 8, 14.

The Pars palpebralis is situated inside the caudal part of the *M. zygomatico-labialis* and the dorsal midmost part of the *Platysma myoides*.

Thus it is not visible unless these superficial muscles have been removed. We may, however, dimly discern a little of the Pars palpebralis when the two covering muscles are thin. The Pars palpebralis has lost all muscular connection with the Pars intermedia as well as with the Pars oris. It is an isolated and independent muscle. A small part of the fibres originate between the ventral fibres in the *M. orbicularis oculi*, but most of them rise in the connective tissue on the bony, lower orbital margin. The fibres pass, gently diverging, in a ventral direction, and pass rather abruptly into a tendinous sheet of connective tissue, which disappears in the connective tissue on the caudal part of the *M. bucinatorius* and the anterior part of the *M. masseter*. In *Ovibos A* there is an indication of a division of the muscle. The anterior portion of the latter is inserted into the connective tissue on the *M. bucinatorius*, whilst the posterior portion passes into the tendinous sheet of connective tissue which is attached to the *M. masseter*. The fact that the muscle fibres disappear above the thick part of the *M. masseter* and are replaced by the thin tendinous sheet, has no doubt its cause in the pressure exercised on the outside lying tissue by the contraction of the *M. masseter*. In my previous publications I have pointed out this condition in the case of several rodents.

4. Paris oris and its derivatives.

Figs. 7, 8, 12, 14, 16, 17.

With the exception of the *M. naso-labialis superficialis* the whole of the musculature of the muzzle belongs to this group of muscles. There is no primitive Sphincter. Only the *M. bucinatorius p. orbicularis oris* may be considered as an only slightly transformed remnant of a primitive Sphincter. To this muscular region belong the *M. maxillo-labialis*, which is the most sharply differentiated muscle, the *M. naso-labialis profundus*, and the *M. bucinatorius*. There is no *M. dilator nasi* present in the musk-ox.

M. maxillo-labialis.

Figs. 7, 8, 1, 2, 14.

The *M. maxillo-labialis* is a very powerful muscle, about 4 cm broad and $\frac{1}{2}$ cm thick, which rises on the upper jaw in an oblong field of origin, somewhat dorsally to the midmost molars (fig. 14). The fibres are parallel and pass in the direction of the nostril. The muscle runs in under the *M. naso-labialis superf.*; here the muscle fibres are continued in several tendons, which enter between the fibres, partly in the *M. naso-labialis superf.*, but especially in those of the *M. naso-labialis prof.* The tendons are flattened distally and terminate on the

nasal cartilage or in the connective tissue round the nostril, laterally as well as medially to this latter. Part of the ventral muscle fibres in the embryo do not terminate in tendons, but enter, dorsally to the corner of the mouth, directly the *M. naso-labialis superf.*

The *M. maxillo-labialis* is also found in the domestic ox, in which it has a similar appearance and corresponding extension as in the musk-ox. We must, however, mention that the *M. maxillo-labialis* in the veterinary anatomy bears the name of *M. caninus*. In the domestic ox it has, without sufficient topographic basis, been divided into three muscles: The *M. levator labii superioris proprius*, the *M. caninus*, and

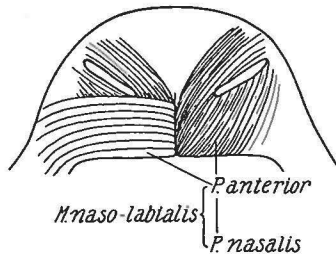


Fig. 16. *Ovibos B.* Muzzle, seen from in front, showing the here placed portions in *M. naso-labialis profundus*.

the *M. depressor superioris*. All these three muscles answer to the *M. maxillo-labialis* of the musk-ox.

In the horse the muscle corresponding to the *M. maxillo-labialis* in the musk-ox, bears the name of *M. caninus*. The *M. levator labii superioris proprius* of the horse and the hog is, however, no doubt the equivalent of the *M. dilatator nasi* found in several rodents. Regarding this point, see my previous work on "Das oberflächliche Facialgebiet der Nager", 1941, and several of my monographies on the same subject.

M. naso-labialis profundus.

Figs. 16, 14.

Ovibos A. The head of the adult musk-ox at my disposal was regarding this muscle in a none too good condition. Only two plainly separated portions could be demonstrated, viz. a ventral and a dorsal portion. The ventral portion corresponds to the *Pars media inferior et superior* and the *Pars anterior*, and the dorsal portion answers to the *Pars interna* in the rodents examined by me, for instance in the Greenland lemming.

The ventral portion consists of an unusually powerful muscular mass originating from the middle of the upper jaw (fig. 14). The field of origin covers the whole of the anterior part of the middle jaw, extending

over the adjacent part of the upper jaw, and reaching as far back as the middle of the origin of the *M. bucinatorius p. max. ant.*

The fibres from the anterior part of the origin take their course partly in a lateral, partly in a dorsal and dorso-lateral direction. The laterally passing fibres form a rather powerful portion of muscle, passing along the margin of the upper lip towards the corner of the mouth. The fibres enter between the fibres from the ascending part of the *M. bucinatorius p. orbicularis oris*. This portion in all probability answers to the *Pars anterior* in the rodents (f. inst. the *Mus decumanus*), or part of it. The fibres running dorsally or dorso-laterally (*Pars nasalis*) are attached partly to the cartilage of the lateral wall of the nostril, partly, and to a lesser degree, on the medial wall of the nostril; the fibres medially situated, continue past the nostril in across the origin of the *Pars interna*, which originates from a furrow in the nasal cartilage, dorso-caudally to the nostril. The two portions of muscle mentioned here, in all probability answer to the *M. dilatator nasis apicalis* (the veterinary anatomy) of the domestic ox, and the *P. interna* to the *M. dilatator nasis medialis*.

The fibres from the remaining part (caudal part) of the origin, pass, in the case of the greater part, in a caudal, caudo-dorsal, and a caudo-ventral direction, forming the major part of the musculature in the upper lip. The muscle fibres from this origin enter the *Pars orbicularis oris*, the *M. naso-labialis superf.*, and the ventral fibres in the *M. maxillo-labialis*.

The dorsal portion, the *Pars interna*, is a relatively thin sheet of muscle, the fibres of which arise from a deep furrow in the nasal cartilage, dorsally and caudally to the nostril. The fibres pass chiefly in a dorsal direction, and enter between the fibres in the *M. naso-labialis*, having first passed the intervals between the tendons in the *M. maxillo-labialis*. There is no *M. bucco-naso-labialis* in the musk-ox.

M. bucinatorius.

Figs. 7, 8, 14, 17.

This complex of muscle, which in many rodents is most extraordinarily differentiated into independent muscular individuals, reaching its highest development in the Greenland lemming, is of a rather simple build in the musk-ox, and with no far-going differentiation into independent portions.

As a main characteristic may be mentioned that the muscular fibres mostly pass in a dorso-ventral direction, forming a simple lateral wall of the oral cavity. The whole complex of muscle may be divided into the following portions:

superficial portions:

Pars orbicularis oris,
Pars maxillaris anterior,
Pars maxillaris posterior,
Pars mandibularis.

*deep muscular regions.**Pars orbicularis oris.*

Figs. 1, 2, 7, 8.

The P. orbicularis oris is the last non-differentiated remnant of the primitive Sphincter colli prof. p. oris. In the adult musk-ox it is a relatively powerful muscle, the fibres of which are strongly concentrated caudally to the corner of the mouth. In the dorsal direction the fibres pass slightly diverging along the margin of the upper lip, and enter between the fibres in the M. naso-labialis superf. and the M. naso-labialis prof., especially into the Pars anterior of the latter. Here the fibres penetrate between the fibres in the portions of the M. bucinatorius situated just behind. The P. orbicularis oris occurs as a, to all appearance, superficial portion. It passes gently into the part of the M. bucinatorius lying behind. The Pars orbicularis is homologous with the muscle of the same name in the domestic ox and in the horse. Together with the M. naso-lab. prof. p. anterior it forms an almost unbroken Sphincter oris, placed along the margins of the lips.

Pars maxillaris anterior.

Figs. 7, 8, 1, 2, 14

The Pars maxillaris anterior answers to the P. intermaxillaris in many rodents (f. inst. *Dicrostonyx groenlandicus*). In the adult musk-ox there is an indication of a division into two portions. The anterior portion rises ventro-medially on the Maxillare, and the fibres swing in a latero-caudal direction down towards the lateral line of insertion in the field where the *Platysma myoides* enters the M. bucinatorius. This portion is in muscular connection with the P. orbicularis oris. The posterior portion is a simple caudal continuation of the anterior, rising, however, more laterally on the Maxillare. The fibres likewise pass in a latero-caudal direction—the caudal ones more caudally than the rest—and enter the line of insertion, where they cross the fibres from the Pars mandibularis. The caudal part of this portion covers the anterior part of the subsequent dorsal muscular portion. This latter and the portions mentioned below are equivalent to the M. buccalis + the M. depressor labii inferioris of the veterinary anatomy.

Pars maxillaris posterior.

Figs. 7, 8.

This portion takes origin from the upper jaw right dorsally to the row of molars. It is a rather thin sheet of muscle, the fibres of which run in a latero-ventral direction. The anterior fibres enter under the caudal margin of the P. maxillaris anterior. The fibres in the anterior part of the sheet enter the lateral line of insertion, crossing indistinctly the fibres from the Pars mandibularis. The fibres in the posterior part of the sheet *seem to continue directly into the P. mandibularis*. A small part of the sheet of muscle is covered by the M. masseter.

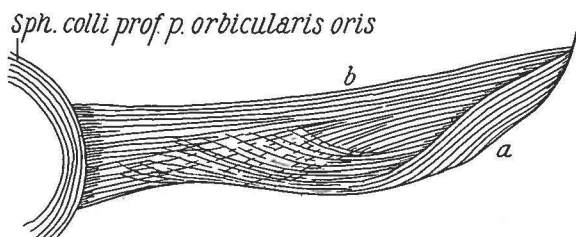


Fig. 17. Ovibos B, left side, showing the deep muscle portions (P. longitudinalis prof. ventralis) in ventral part of M. buccinatorius. b = longitudinally passing muscle fibres; a = caudal outer layer with turning fibres.

Pars mandibularis.

Figs. 7, 8, 1, 2.

The Pars mandibularis forms the whole of the ventral part of the wall of the oral cavity. In the anterior two thirds the muscle fibres rise from the lateral line of insertion, and they pass, in the adult musk-ox in a ventro-oral direction, in the embryo chiefly in a ventral direction. The anterior fibres run into the upper lip together with the fibres in the P. orbicularis oris and the buccinatorius portion mentioned below. The remaining fibres terminate in the connective tissue laterally on the lower jaw. This portion of muscle has only an indirect connection with the lower jaw.

M. bucco-labialis inferior.

Figs. 7, 8, 1, 2.

This portion of muscles shows, mostly anteriorly, great likeness to an M. mandibulo-labialis in certain rodents. It is highly probable that the conditions in the musk-ox are showing us how an independent M. mandibulo-labialis may have come into being. In such case it must have its origin in the Sphincter colli profundus pars oris. In the embryo as well as in the adult musk-ox the fibres rise from the connective tissue on the lateral line of insertion at the anterior margin of the M. masseter.

First they pass for a short distance in a ventral direction, then swing in an oral direction, and proceed as a narrow, long muscular band along the Ramus mandibularis. Anteriorly they enter the ventral part of the lower lip. During its course the muscular band, especially in the adult animal, receives a small contribution of fibres from the Pars mandibularis. In the ventral median line of the chin the fibres cross the fibres in the corresponding muscle on the opposite side. In the lower lip, moreover, the fibres cross those in the P. orbicularis oris and the anterior part of the P. mandibularis.

The M. bucco-labialis inferior is homologous with the M. depressor labii inferioris of the domestic ox and the horse.

Deep muscular sheets in M. bucinatorius.

Profound muscular regions in the M. bucinatorius appear to a modest extent only. Under the dorsal part of the Pars maxillaris posterior we thus find a thin muscular region with a longitudinal course, and which in the embryo (Ovibos B) may be dimly perceived through the Pars max. post. (fig. 8).

Inside the Pars mandibularis and the M. bucco-labialis inferior we also find a thin, but more extensive layer of muscles, rising from a narrow thin field along the molars in the lower jaw, and which might be named Pars longitudinalis prof. ventralis. Posteriorly there is a thin, superficial field of fibres with a ventro-oral course. This layer reaches barely half way to the corner of the mouth. The fibres in the inside layer pass chiefly longitudinally, and terminate round the corner of the mouth, between the fibres in the Pars orbicularis oris. In the mid-most field, part of the fibres swing in a nasal direction and interlace with the longitudinal fibres.

IV. Nervus facialis.

The present material was not particularly suitable for investigations of nerves, and without making use of the nitric acid method, the examination would have given poor and unsafe results. To this comes that in practice it is a very cumbersome, nay an almost unfeasible undertaking, to use on such big objects the large magnifications demanded for obtaining safety when establishing the course of the finer nerve branches in the muscular sheets. Regarding the technical conditions pertaining to the examination of the N. facialis, I refer to my previous examinations on the facialis area of the mammals (1932, 1935, 1941).

The Nervus facialis passes out of the cranium through the Foramen stylo-mastoideum. It immediately gives off a powerful branch: *Ramus auricularis posterior*, to the retro-auricular musculature. Then it passes

in an oral direction across the cheek as *Ramus auricularis anterior*, sending off several powerful branches.

One of the embryos has been used especially for the examination of nerves, so where nothing else is mentioned in the text, it is to this specimen we refer. Below is given a survey of the nerve trunks to the superficial facialis musculature:

- 1) To the dorsal, post-auricular musculature the following branches run:

Ramus auricularis posterior:

- Ramus auricularis posterior, R. I,
- Ramus auricularis posterior, R. II,
- Ramus auricularis posterior, R. III,
- Ramus auricularis posterior, R. IV.

- 2) To the remaining superficial musculature:

- I. Ramus temporalis,
- II. Ramus zygomatico-temporalis,
- III. Ramus bucco-labialis superior,
- IV. Ramus bucco-labialis inferior,
- V. Ramus marginalis mandibulae,
- VI. Ramus colli,
- VII. Ramus platysmaticus superficialis.

A. The nerve supply of the dorsal, post-auricular musculature.

Ramus auricularis posterior.

Figs. 18, 19, 20.

The Ramus auricularis posterior takes origin from the principal trunk just at its exit from the Foramen stylo-mastoideum. It runs in a dorsal direction and soon divides into two trunks, the anterior of which is the most powerful. In the following the posterior trunk is designated R. I. Level with the medial margin of the M. subscutulo-auricularis the anterior trunk divides into three trunks, designated R. II, R. III, and R. IV.

During the first part of its course R. I gives off an anastomosis to the anterior trunk. Shortly afterwards it divides into two branches, the caudal one of which branches actively on the under side of the M. cervico-auricularis post. prof., and enters this latter (1 in figs. 19 and 20). The anterior trunk ramifies into the M. cervico-occipito-aur. prof. (2 in figs. 19 and 20), a single side branch, however, passing into the M. cervico-aur. post. prof. We find anastomoses between the two branches.

The principal trunk (R. II, R. III, R. IV) passes on the under sides of the two muscles mentioned above. Near the cranial margin of the M. cervico-occipito-aur. prof., R. II penetrates this muscle and proceeds on the under side of the middle layer. R. III and R. IV continue on to the under sides of the middle and the superficial layer, respectively, and further along to the medial surface of the ear cartilage.

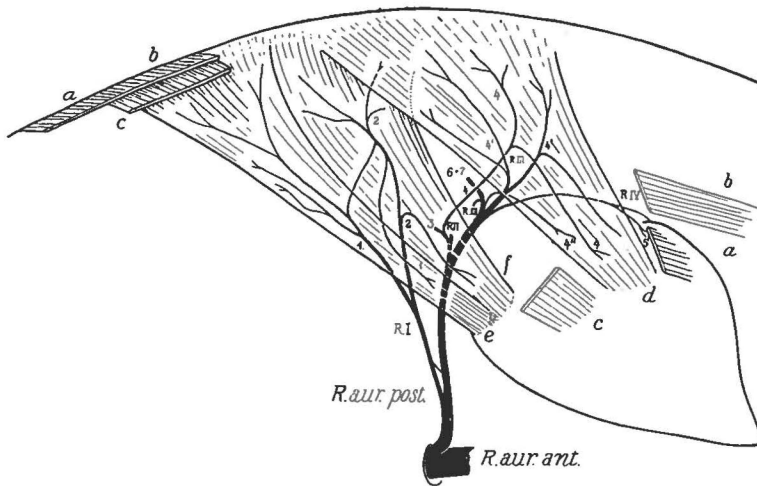


Fig. 18. Ovibos C, right side, schematic drawing of Ramus auricularis post. and the cervico-auricular musculature. A piece of the two profound muscles has been removed. R. I–R. IV = principal branches in R. aur. post. R. I is the posterior nerve trunk, R. II–R. IV form the anterior trunk.

Nerve branch to: 1) M. cervico-auricularis post. prof.; 2) M. cervico-occipito-auricularis prof.; 3 and 3') M. cervico-auricularis med.; 4, 4' and 4'') M. occipito-auricularis med.; 5 and 5') Mm. transv. et obliqui; 6) M. cervico-scutularis; 7) M. cervico-auricularis.

a = M. cervico-auricularis; b = M. cervico-scutularis; c = M. cervico-auricularis med.; d = M. occipito-auricularis med.; e = M. cervico-auricularis post. prof.; f = M. cervico-occipito-aur. prof.

R. II consists of two branches, the caudal one of which, branching vigorously (3 in figs. 18 and 20), supplies the M. cervico-auricularis med. At the cranial margin of the muscle, a side branch swings in on to the top side, and out on to the caudal bend of the ear cartilage. Here the nerve branch had broken and could not be traced any farther. Presumably it supplies the here lying parts of the Mm. transversi et obliqui and the M. antitragicus. The cranial branch enters partly the M. occipito-auricularis med. (4 in figs. 18 and 20), partly the M. cervico-auricularis medius. A smaller side branch (5 in figs. 18 and 20) passes out on to the ear cartilage and enters the Mm. transversi et obliqui.

R. III likewise consists of two branches. Ramifying actively, the cranial branch supplies the M. occipito-aur. med. (4' in figs. 18–20). The caudal branch also takes part in the supply of this muscle (4''), and, with numerous small branches, in that of the M. cervico-aur. med. (3'). The principal branch continues to the under side of the superficial muscular layer, and from here supplies the M. cervico-aucularis (7) and the M. cervico-scutularis (6).

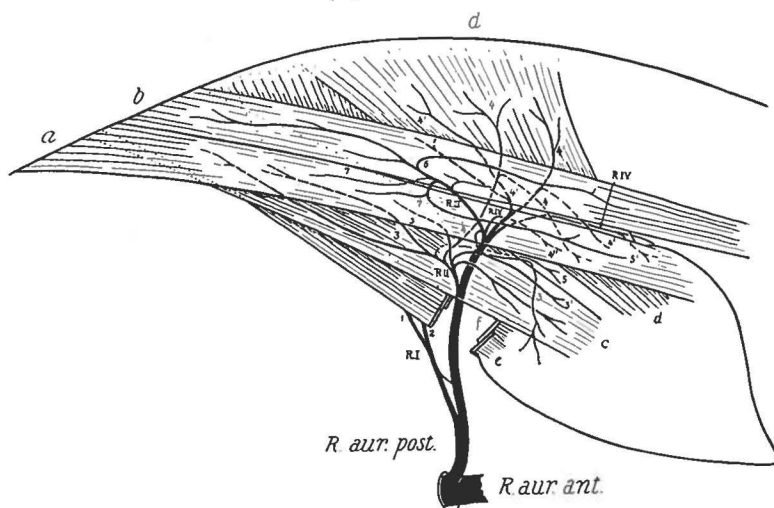


Fig. 19. *Ovibos C*, right side. Schematic drawing of Ramus auricularis post. and the cervico-auricular musculature. The muscles in layer 1 and M. cervico-auricularis med. are removed. R. I–R. IV = principal branches in R. auricularis post.

Nerve branch to: 1) M. cervico-auricularis post. prof.; 2) M. cervico-occipito-auricularis prof.; 3) M. cervico-auricularis med.; 4, 4' and 4'' M. occipito-auricularis med.; 5') Mm. transversi et obliqui; 6 + 7) common trunk for the muscles in layer 1. a and b = M. cervico-auricularis and M. cervico-scutularis, respectively; c and d = M. cervico-auricularis med. and M. occipito-aur. med., respectively; e = M. cervico auricularis post. prof.; f = M. cervico-occipito-auricularis prof.

R. IV passes out on to the cranial bend of the ear cartilage, where it sends off a branch into the Mm. transversi et obliqui (5'). The principal branch continues in under the M. auriculo-scutularis ant. superior. We did not succeed in tracing the principal branch further ahead, but in all probability it has continued—as is the case in all the species hitherto examined by me—to the M. helcis.

The topography of the muscles shows that the cervico-auricular musculature in the Greenland musk-ox consists of 3 layers. This answers to what we usually find in the carnivora and rodentia. In the Greenland lemming, however, we found layers 1 and 3 only (MEINERTZ 1941). The whole of the retro-auricular musculature must be regarded as derivatives

of the *Platysma cervicale*, as shown by E. HUBER, as well as by myself, in the case of several species of mammals. In the musk-ox the *Platysma cervicale* has, however, been lost, while its derivatives are preserved. The

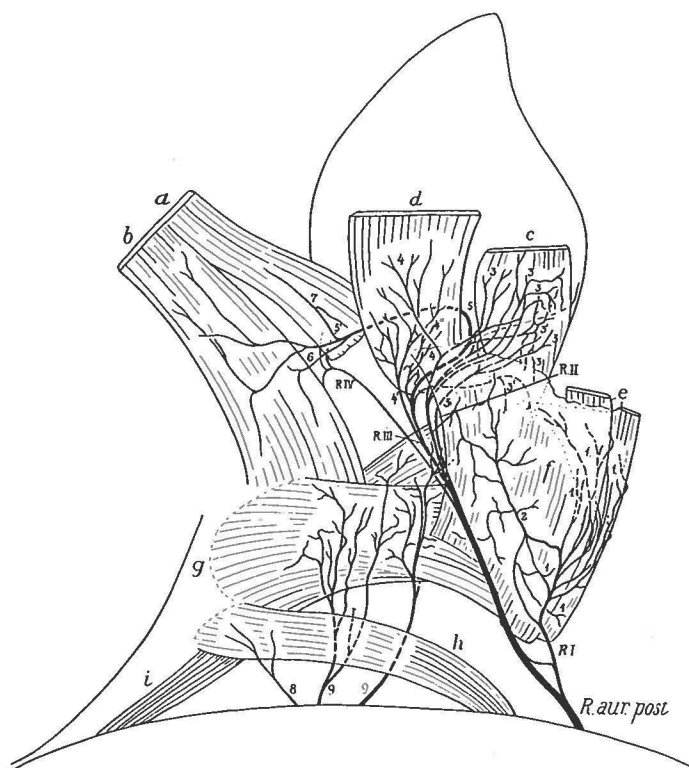


Fig. 20. *Ovibos C.*, right side of the cervico-auricular and subcutaneous musculature, seen from the under side. A cut has been made paramedian dorsally on the back of head and neck, and the muscles are turned, so that they are seen from the under side. The nerve branches slightly schematized. R.I–R.IV = the principal branches in *Ramus auricular posterior*.

Nerve branch to: 1) *M. cervico-auricularis post. prof.*; 2) *M. cervico-occipito-auricularis prof.*; 3 and 3') *M. cervico-auricularis med.*; 4, 4' and 4'') *M. occipito-auricularis med.*; 5 and 5') *Mm. transversi et obliqui*; 6) *M. cervico-scutularis*; 7) *M. cervico-auricularis*; 8 and 9) pre-auricular nerve branches to *M. subcutulo-auricularis frontalis* and *M. subcutulo-auricularis*, respectively.

a = *M. cervico-auricularis*; b = *M. cervico-scutularis*; c = *M. cervico-auricularis post. prof.*; f = *M. cervico-occipito-auricularis prof.*; g = *M. subcutulo-auricularis*; h = *M. subcutulo-auricularis frontalis*; i = *M. fronto-scutularis*.

profound layer of the cervico-auricular muscles seems to have obtained a certain independence compared to the two other layers, as they are innervated by an early split-off branch (R. I) from the *Ramus auricularis post.* As regards the *Mm. transversi et obliqui*, the nerve supply

only gives the information that they must be derived from the middle layer or from layer 1 of the cervico-auricular muscles. For it has been established that it is nerve branches from at anyrate R. II and R. IV that supply these muscular regions. Judging by the topographic conditions the most obvious conclusion is that they must be derived from the middle layer, the distal end of which covers the greater part of them.

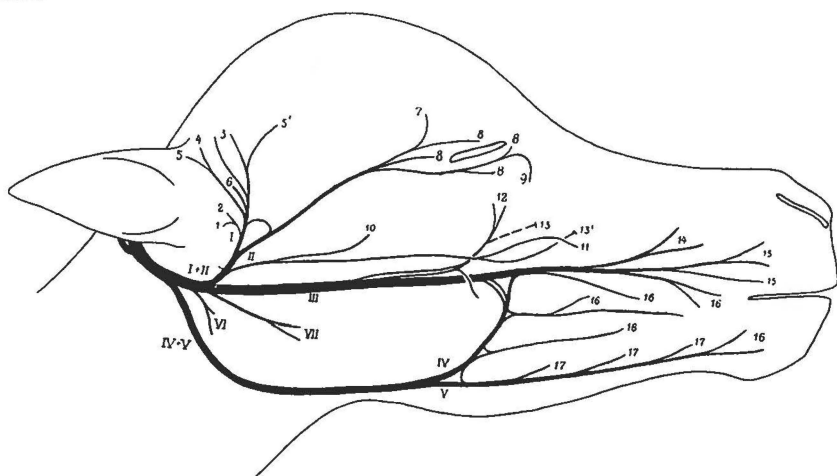


Fig. 21. Schematic drawing of Ramus auricularis anterior in the musk-ox. I: Ramus temporalis; II: Ramus zygomatico-orbitalis; III: Ramus bucco-labialis superior; IV: Ramus bucco-labialis inferior; V: Ramus marginalis mandibulae; VI: Ramus colli; VII: Ramus platysmaticus superficialis.

Nerve branch to: 1) M. auricularis ant. inf.; 2) M. auriculo-scutularis inf. prof.; 3) M. auriculo-scutularis ant. sup.; 4) M. auriculo-scutularis post. prof.; 5) M. auriculo-scutularis ant. prof.; 5') M. fronto-scutularis; 6) subcuticular muscles; 7) M. frontalis (orbitalis); 8) M. orbicularis oculi; 9) M. retractor anguli oculi med. prof.; 10) intermediate plate; 11) M. zygomatico-labialis; 12) Pars palpebralis; 13) broken nerve branch, found in *Ovibos C*, left side, possibly passing to M. naso-labialis superf.; 13') broken nerve branch, presumably to same muscle (found in *Ovibos C*, right side); 14) M. maxillo-labialis; 15) M. naso-labialis prof.; 16) M. buccinatorius complex; 17) M. bucco-labialis inf.

B. The nerve supply of the remaining superficial musculature.

Ramus auricularis anterior.

Fig. 21.

Having sent off the Ramus auricularis posterior, the N. facialis passes, under the name of Ramus auricularis anterior, ventrally to the bony auditory meatus in the direction towards the muzzle. During the first part of its course it is deep and pierces the Parotis. On this stretch the R. auricularis ant. sends off in a ventral direction the Ramus marginalis mandibulae, which is fused together with the R. bucco-labialis

inferior, and, in a dorsal direction, a powerful trunk, which answers to the R. temporalis and R. zygomatico-orbitalis in the rodents examined by me. On the same stretch are sent off the considerably more slender trunks, the R. colli and the R. platysmaticus-superficialis. At the anterior margin of the M. masseter, the R. bucco-labialis superior and the R. bucco-labialis inferior, which is now separated from the R. marginalis mandibulae, form a concentrated and simple plexus, from which best part of the musculature of the muzzle is supplied.

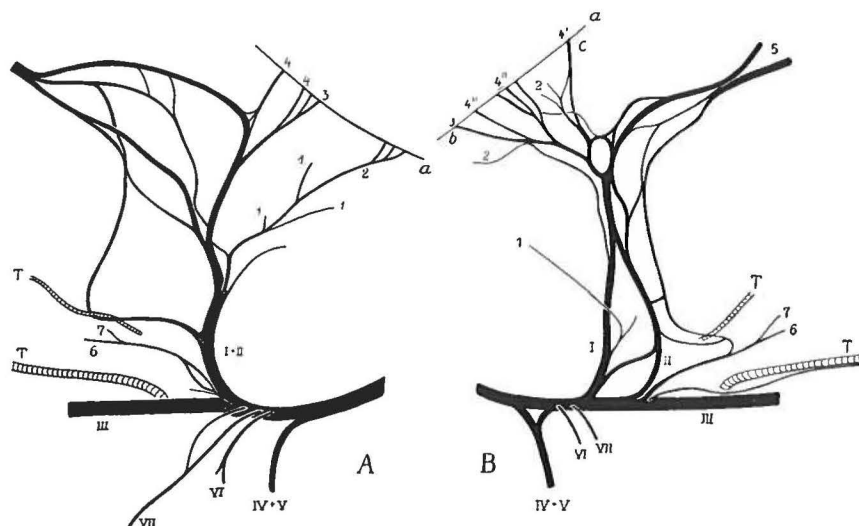


Fig. 22. *Ovibos* C. Plexus orbito-temporalis. A = Ramus temporalis (I) et zygomatico-orbitalis (II) of the left side; B = R. temporalis and R. zygomatico-orbitalis of the right side. T = branches from N. trigeminus. III = Ramus bucco-labialis superior; IV and V = Ramus bucco-labialis inferior et marginalis mandibulae; VI = Ramus colli; VII = Ramus platysmaticus superficialis. a: ventral margin of M. auriculo-scutularis inf. prof.

Nerve branch to: 1) M. auricularis ant. inf.; 2) M. auriculo-scutularis inf. prof.; 3) M. auriculo-scutularis ant. sup. and M. auriculo-scutularis post. prof.; 4) the muscles under Cartilago scutularis (4') M. subscutulo-auricularis frontalis; 4'') M. subscutulo-auricularis). b supplies, in *Ovibos* B, right side, also M. auriculo-scutularis ant. prof., and c is sending a branch to M. fronto-scutularis, too; 5) M. orbicularis oculi, M. frontalis (orbitalis), M. retractor anguli oculi med. prof.; 6) M. zygomatico-labialis; 7) the intermediate plate.

Ramus temporalis + Ramus zygomatico-orbitalis.

Fig. 22.

These two trunks may be fused together in their origin. Then they branch actively, forming the Plexus orbito-temporalis, situated between the ear and the eye. From this plexus nerve branches are sent out in

a dorso-caudal direction to the pre-auricular musculature of the ear. These nerve branches answer to the Ramus temporalis in for instance the Greenland lemming. From the orbital part of the plexus, in a cranial direction, some powerful branches are sent off, answering to the R. zygomatico-orbitalis. These branches supply the musculature round the Orbita.

The Plexus orbito-temporalis shows a very different topographic picture. Fig. 22 shows an example of the difference of this plexus in the right side and in the left side in *Ovibos C*. As appears it is different on the two sides; thus the two trunks on the left side are fused at their origin, whilst on the right side they are free. Roughly, however, we may find some agreement. In *Ovibos B* the Plexus orbito-temporalis is considerably more simple, especially on the right side (fig. 12), and the distribution of the nerve branches in the R. temporalis differs likewise from what was found in *Ovibos C*.

Ramus temporalis.

Figs. 22, 20.

The R. temporalis consists in both embryos of several branches, coming from the Plexus orbito-temporalis. It has not been possible to carry out the examination of the nerve branches from one single plexus; but the four plexus on *Ovibos C* and *B* have together given information regarding the nerve supply of the pre-auricular muscles, except in the case of a single one.

Ovibos C, left side. The ventro-caudal branch sends off a couple of side branches, distributing themselves in the M. auricularis anterior inferior (1 in fig. 22), then continues into the M. auriculo-scutularis inferior prof., where it disintegrates into numerous branches (2 in fig. 22A). The middle, caudal branch sends off a couple of branches, which like the dorsal branch pass in under the Cartilago scutularis to the muscles on the under side of this cartilage, then continue in under the M. aur.-scut. inf. prof., and proceed in between the M. auriculo-scutularis ant. superior and the M. auriculo-scutularis post. prof., supplying these two muscles.

Ovibos C, right side. The topographic picture of the R. temporalis diverges from that of the R. temporalis of the left side. The dorsal branch (4' in fig. 22) passes in under the Cartilago scutularis and supplies the M. subscutulo-auricularis frontalis (fig. 20). Two other branches also pass in under this cartilage, take their course laterally to the said muscle, branching actively in the powerful M. subscutulo-auricularis. The M. auricularis ant. inf. is supplied by an independent branch (1) from the basis of the plexus. The M. auriculo-scutularis inf. prof. is supplied through several small branches (2) from the plexus.

Ovibos B, right side (fig. 12). The ventral branch passes under the *M. auriculo-scutularis inf. prof.*, proceeds in between the *M. auriculo-scutularis ant. sup.* and the *M. aur.-scut. post. prof.*, and supplies these two muscles together with the *M. auriculo-scutularis ant. prof.* The dorsal branch sends off a side branch to the *M. fronto-scutularis*.

From the above it appears that the *R. temporalis* is supplying all the pre-auricular muscles. An exception, however, is the *M. concho-helicinus*, the innervation of which we have not succeeded in establishing with safety. There is hardly any doubt, though, that this muscle, likewise as in the rodentia and carnivora, is being innervated from the *R. temporalis*.

Ramus zygomatico-orbitalis.

Figs. 22, 24.

The nerve branches forming the *R. zygomatico-orbitalis* all originate cranially from the Plexus orbito-temporalis. Most often all nerve branches are united, in the dorso-cranial corner of the plexus, as a rather powerful trunk, which shortly afterwards begins to branch before entering the muscles they supply. This is how we find conditions in *Ovibos C* and on the right side in *Ovibos B* (fig. 12). On the left side in *Ovibos B* two powerful branches issue from the plexus.

Laterally to the lateral corner of the eye this nerve trunk is ramifying vigorously. The greater part of these branches supply the dorsal as well as the ventral part of the *M. orbicularis oculi*. A couple of the dorsal branches dissolve in the rather powerful *M. frontalis (orbitalis)*. All the other dorsal branches distribute themselves in the dorsal part of the *M. orbicularis oculi*, one of the branches reaching right ahead to the muscle fibres in front of the medial corner of the eye.

Despite a thorough search on both sides, in *Ovibos C* as well as *Ovibos B*, none of the nerve fibres could be traced to the *M. naso-labialis superficialis*. *So this muscle cannot*—unless future examinations are able to establish a supra-orbital nerve supply—*be of a supra-orbital origin.*

Most of the ventral branches distribute themselves in the ventral part of the *M. orbicularis oculi*, right ahead to the muscle fibres at the medial corner of the eye. A single, ventrally situated, branch dissolves in the *M. retractor anguli oculi med. prof.* (*Ovibos C*). None of these branches could be traced to the *M. naso-labialis superficialis*.

From the common ventral part of the *R. temporalis* and the *R. zygomatico-orbitalis*, in *Ovibos C* as well as *B*, a nerve branch originates which passes ahead between the eye and the *R. auricularis anterior*. This nerve branch passes in under the intermediate plate, sending off a side branch (7 in fig. 22), which dissolves in this muscle (*Ovibos C*, left side, fig. 24). Then it (6 in fig. 22) continues forwards and supplies the *M. zygomatico-labialis*.

On the right side of *Ovibos C* the topographical conditions of the nerve trunk to the *M. zygomatico-labialis*, are somewhat altered. After the issue of the side branch to the intermediate plate, it continues undivided to the caudal margin of the *Pars palpebralis*. Here it sends off a powerful side branch, broken by mishap, under such circumstances that there was cause to presume that it would have been supplying the *M. naso-labialis superf.* On the left side in *Ovibos C* (fig. 24) the three branches arise which supply the *Pars palpebralis* from the *R. bucco-labialis superior* on a distance caudally to the *Plexus buccalis*. The connection between these three branches and the *R. bucco-labialis sup.* is, otherwise, rather loose on a long distance to the rear. The anterior of the branches is exclusively supplying the *P. palpebralis*. The two other branches merge, the common branch partly supplying the anterior part of the *P. palpebralis*, and partly sending off a rather powerful branch, which passes in the direction towards the *M. naso-labialis superf.* and presumably supplies this muscle; this, however, could not be established with safety, as it was broken shortly before reaching the muscle.

Should it turn out to be the case that the here mentioned, broken, nerve branch actually does supply the *M. naso-labialis superf.*, then it must be an *M. naso-labialis superf. infraorbitalis*, corresponding with what we find in the hystricomorphous rodents. In these rodents both the *M. naso-labialis superf. (infraorbitalis)* and the *M. retractor anguli oculi med. prof.* are innervated by infraorbital branches. In the musk-ox the *M. retractor anguli oculi med. prof.* is innervated infraorbitally, and the *M. naso-labialis superf.*, according to the above, possibly too.

There is a distinct separation between the pre-auricular ear muscles, the intermediate plate, and the orbito-nasal muscles. When in some cases the intermediate plate (figs. 12 and 23) through interlacing gets into contact with the ventral part of the *M. orbicularis oculi*, it is no doubt a matter of a secondary condition. The innervation of these muscular groups is plainly separate (fig. 22). The nerve branches to the pre-auricular ear muscles rise from the caudal part of the *Plexus orbito-temporalis* and no doubt originate from the *R. temporalis*; the fronto-orbital musculature is innervated from the *R. zygomatico-orbitalis*, and the intermediate plate and the *M. zygomatico-labialis* from an independent branch from the basis of the plexus, or from the common trunk for the *R. temporalis* and the *R. zygomatico-orbitalis*.

In dealing with the musk-ox we cannot use the topography of the muscles—as done for instance with the rodentia and carnivora—to show that the orbito-nasal musculature and the pre-auricular ear muscles originate from the cranial and the caudal part of the intermediate plate, respectively. The nerve supply through the *R. temporalis et zygomatico-orbitalis*

shows, however, a phylogenetic community. The nerve supply of the intermediate plate and the *M. zygomatico-labialis* through a common branch, shows furthermore that the *M. zygomatico-labialis* is a derivate of the *Sphincter colli profundus p. intermedia*, and that it is not a derivate of the *Sphincter colli prof. p. oris*, which one might assume considering its topographical placing.

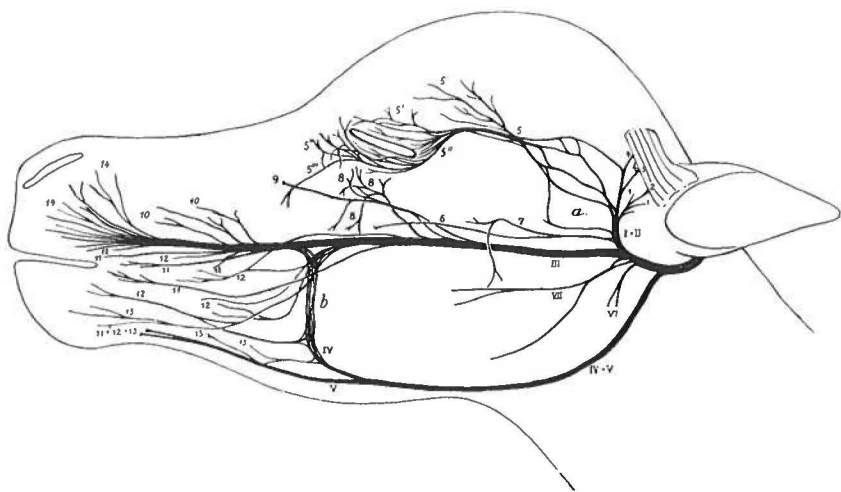


Fig. 23. *Ovibos C.*, left side, showing the innervation through Ramus colli (VI) and R. platysmaticus superficialis (VII), and the nerve supply of the intermediate plate (7) and *M. zygomatico-labialis* (6). I + II = Ramus temporalis et zygomatico-orbitalis; III = R. bucco-labialis superior.

The course of the Ramus auricularis anterior across the *M. masseter*.

Fig. 24.

After the giving off of the pre-auricular nerve trunks mentioned above, the R. auricularis ant. passes, as mentioned previously, across the *M. masseter*. In many rodents the R. auricularis ant. is, in this part of its course, divided into three trunks: *The Ramus bucco-labialis superior*, *the Ramus bucco-labialis inferior*, and *the Ramus marginalis mandibulae*. In the musk-ox the first mentioned of these three trunks is an independent trunk. The R. bucco-labialis inferior and the R. marginalis mandibulae form one common trunk, which passes along the caudal and ventral margin of the lower jaw. Not until the anterior margin of the *M. masseter* do the two trunks separate, the R. bucco-labialis inf. entering the Plexus buccalis, whilst the R. marginalis mand. continues to the ventral part of the Bucinatorius complex.

Plexus buccalis.

Fig. 24.

The Plexus buccalis is situated at the anterior margin of the M. masseter. It is formed of the fibres from the Ramus bucco-labialis sup., together with the fibres in the R. bucco-labialis inf., which near the plexus are split off from the R. marginalis mandibulae. The Plexus buccalis supplies the whole of the musculature of the muzzle, with the

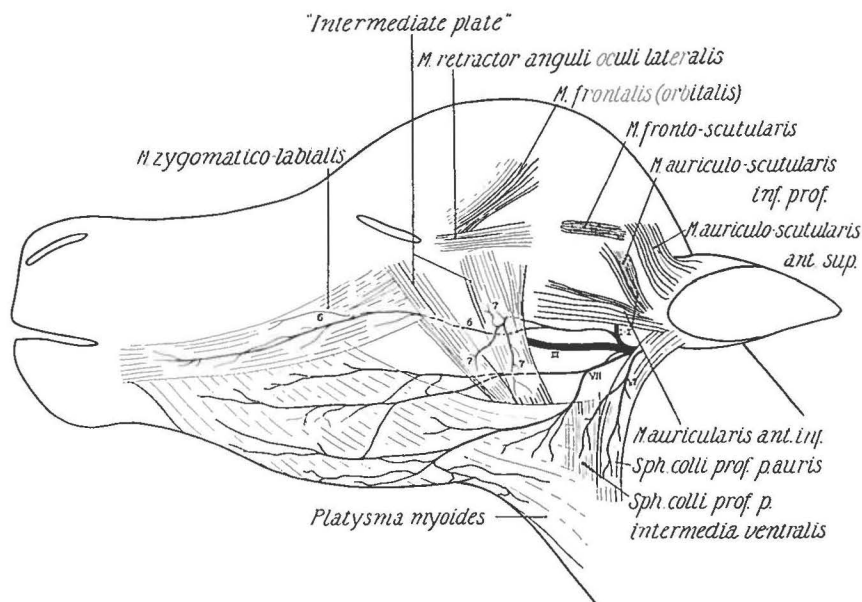


Fig. 24. *Ovibos C*, left side. Outline of R. auricularis anterior, slightly schematized. I + II = R. temporalis et zygomatico-orbitalis; III = R. bucco-labialis sup.; IV = R. bucco-labialis inf.; V = R. marginalis mandibulae; VI = Ramus colli; VII = R. platysmaticus superficialis. a = Plexus orbito-temporalis; b = Plexus buccalis. 1-5 as in fig. 22.

Nerve branch to: 5') M. frontalis (orbitalis); 5'') M. orbicularis oculi; 5''') M. retractor anguli oculi med. prof.; 6) M. zygomatico-labialis; 7) "intermediate plate"; 8) Sphincter colli prof. p. palpebralis; 9) nerve branch, presumably to M. nasolabialis superficialis; 10) M. maxillo-labialis; 11) P. orbicularis oris; 12) M. buccinatorius; 13) M. bucco-labialis inf.; 14) M. nasolabialis prof.

exception of the M. zygomatico-labialis (and the M. nasolabialis superficialis).

Ovibos C, left side. In the dorsal corner of the Plexus buccalis the fibres unite into a powerful trunk, which passes in under the M. zygomatico-labialis, appearing at the dorsal margin of the latter. From this trunk four branches are sent off, which enter the M. maxillo-labialis from the ventral margin of this muscle. The remaining part of the trunk

ramifies in the *M. naso-labialis* prof. From the ventral margin of the trunk several branches go out, which supply the intermediate and anterior dorsal part of the *M. bucinatorius*.

From the midmost part of the plexus a number of more slender fibres issue, passing partly to the anterior and midmost part of the *M. bucinatorius*, partly to the *Pars orbicularis oris*, and to the anterior part of the *M. bucinatorius*, ventrally to the attachment of the *Platysma*. A single branch supplies the *M. bucco-labialis* inf. (*Depressor labii inferioris*), which also receives fibres from the, towards the lower lip passing, *R. marginalis mandibulae*. The *R. marginalis mandibulae* sends its remaining fibres out into the ventral, anterior part of the *M. bucinatorius* and into the *Pars orbicularis oris*.

On the right side in *Ovibos C* and in *Ovibos B* we found principally the same conditions, even though there were of course several topographic variations.

Ramus colli.

Figs. 23, 24.

Ovibos C, left side. In this embryo the *Ramus colli* originates from the *R. auricularis ant.*, between the origin of the *R. marginalis mandibulae* and the *R. temporalis et zygomatico-orbitalis*. It passes on the inside of the *Sph. colli* prof. p. *auris*, ramifying in this muscle. The *R. colli* is rather slender, answering to the comparatively slender *Pars auris*. On the right side the *R. colli* originates with two branches, which we have not traced in details.

Ramus platysmaticus superficialis.

Fig. 23, 24.

The *Ramus platysmaticus superf.* has been traced in all details only on the left side in *Ovibos C*. It originates with two roots from the *Ramus auricularis ant.*, somewhat in front of the origin of the *Ramus colli*. On a short distance the two roots merge into a single trunk, after which they divide into a dorsal and a ventral branch. These pass for some distance on the inside of the *Platysma myoides*, before with numerous branches they dissolve in this muscle. The *R. platysmaticus superf.* is considerably more powerful than the *R. colli*. A corresponding topographic picture was found on the left side in the adult musk-ox.

Summary

of the superficial facialis musculature and its innervation in the Greenland musk-ox.

From the tabular survey below appears briefly which facialis muscles we have found in the Greenland musk-ox; these muscles are given in the first column. The nerve supply of these muscles is seen in the second column, and in the third column is stated from which muscular region the separate muscles originate. When in the case of some muscles there is no mention of the innervation, this is due to the fact that by the examination there has not been sufficient material available to safely establish the nerve supply of these muscles.

The result of the present work is briefly the following: We have given an account of the topography of the muscles of the superficial facialis area, and of the innervation of the muscles examined. In broad outline this examination confirms the fundamental results of HUBER's investigations on the facialis area in the carnivora, likewise as it also confirms the results of my own corresponding examinations of the rodentia.

The cervico-auricular musculature is divided into three layers, and, like the remaining retro-auricular musculature, it has its origin in the *Platysma cervicale*, which in the musk-ox has entirely disappeared. The presence of a well developed *Cartilago scutularis* is the cause of several muscular individuals being attached, besides to the ear cartilage, to the former cartilage, too. This is the case especially with the pre-auricular ear muscles. In the musk-ox the pre-auricular ear muscles, the intermediate plate, and the orbito-nasal muscles are without muscular connection with each other. The conditions of the topography of the muscles therefore do not show the closer phylogenetic connection; this connection is traced through the innervation conditions, as these groups of muscles are supplied from the *Rr. temporalis et zygomatico-orbitalis*, with the reserve, however, expressed in the table below.

Of special interest is the ventral extension of the intermediate plate. In several cases the ventral part of the latter forms a natural cranial continuation of the *Pars auris et intermedia ventralis*, and this must be taken as a primary condition, pointing to an original, undivided and widespread, ventral *Sphincter colli profundus*.

The *M. zygomatico-labialis* is entirely without muscular connection with the intermediate plate. As to the phylogenetic relationship with the original *Pars intermedia dorsalis* there can be no doubt, as it is innervated by the same nerve branch as the intermediate plate.

Ramus auricularis posterior supplies	nerve	derivate from
M. cervico-auricularis, layer 1	R. III	Platysma
M. cervico-scutularis, layer 1	R. III	"
M. cervico-auricularis med., layer 2	R. II	"
M. occipito-auricularis med., layer 2	R. II + R. III	"
M. cervico-aur. post. prof., layer 3	R. I	"
M. cervico-occipito-aur. prof., layer 3	R. I	"
Mm. transversi et obliqui	R. II + R. IV	"
M. antitragicus	(?)	"
M. helicis	(?)	"

Ramus auricularis anterior supplies	nerve	derivate from
Intermediate plate	II	Pars intermedia dorsalis (prim.)
M. zygomatico-labialis	II	"
M. subscutulo-auricularis	I	"
M. subscutulo-aur.-frontalis	I	"
M. auriculo-scutularis ant. prof.	I	"
M. auriculo-scutularis post. prof.	I	"
M. auriculo-scutularis inf. prof.	I	"
M. concho-helicinus	(?)	"
M. auriculo-scutularis ant. sup.	I	"
M. auricularis ant. inf.	I	" (prim.)
M. fronto-scutularis	I	"
M. frontalis (orbicularis)	II	"
M. retractor anguli oculi lateralis	II	"
M. orbicularis oculi	II	"
M. retractor anguli oculi med. prof.	II	"
M. naso-labialis superf.	(?)	"
M. maxillo-labialis	Plexus buccalis (III-IV)	Pars oris
M. naso-labialis prof.	"	" "
M. buccinatorius	"	" "
M. bucco-labialis inf.	Plexus buccalis (VI-V)	" "
Sph. colli profundus p. auris	VI	Sph. colli prof.
Sph. colli prof. p. intermedia ventralis	VI	" " "
Sph. colli prof. p. palpebralis	III	" " "
Platysma myoides	VII	Platysma

R. I-R. IV are post-auricular nerve trunks. I = R. temporalis. II = R. zygomatico orbitalis. III = R. bucco-labialis superior. IV = R. bucco-labialis inferior. VII = R. marginalis mandibulae.

The *M. bucinatorius* is, compared with the corresponding muscle in the rodents, of a simple build, and only divided into few portions. A ventral portion, the *M. bucco-labialis inferior*, is relatively independent, but is still in muscular connection with the *M. bucinatorius* itself. Its topography has so strong a resemblance to the *M. mandibulo-labialis*, not infrequently found in the rodents, that here we presumably are confronted with a stage of development which gives us the understanding of how the *M. mandibulo-labialis* may have come into being.

The insufficient examination of the nerve supply of the *M. naso-labialis superficialis* makes the placing of this muscle somewhat unsafe. The topography points to its being a superficial muscle. The supra-orbital facialis branch does not seem to continue to the *M. naso-labialis superf.*, whereas we found broken infra-orbital facialis branches which must be presumed to continue out into the muscle. Until new investigations are available, it will be most reasonable to take it that this muscle is an infra-orbital *M. naso-labialis superficialis*.

LIST OF LITERATURE

- ADAMS, WHEELER and EDGEWORTH. On the Innervation of the Platysma and the Mandibulo-auricularis, Journ. of Anatomy, Vol. LXIII, Part II, 1929.
- AKAJEWSKY, A. Zur Morphologie des M. levator nasolabialis und des M. malaris bei einigen Haustieren. Anat. Anz., Bd. LXXIII, 1931.
- ALEZAIS, HENRI. Étude anatomique sur le cobaye. Paris 1903.
- BAUM und KIRSTEN. Vergl.-anatomische Untersuchung über die Ohrmuskulatur verschiedener Säugetiere. Anat. Anz., Bd. XXIV, 1904.
- BOAS, J. E. V. Zur vergleichenden Anatomie des Ohrknorpels der Säugetiere. Anat. Anz., Bd. 30, 1907.
- BOAS, J. E. V. und PAULLI, S. Über den allgemeinen Plan der Gesichtsmuskulatur der Säugetiere. Anat. Anz. Bd. 33, 1908.
- BOAS, J. E. V. Ohrknorpel und äusseres Ohr der Säugetiere. Kopenhagen, 1912.
- BOAS, J. E. V. und PAULLI, SIMON. The Elephant's Head. Studies in the Comparative Anatomy of the Organs of the Head of the Indian Elephant and Other Mammals, 1. Part 1908, 2. Part 1925.
- BRODIE, ARNOLD F. and RALPH PRIDDY. Facial Musculature, Nerves and Blood Vessels of the Hamster in Relation to the Cheek Pouch. Journal of Morphology, Vol. 83, no. 2, 1948.
- BRONDSTED, H. V. Bygningen af snuden og ansigtsmuskulaturen hos nogle Pinnipedier med særligt hensyn til oppustningssekken hos Klapmysen. Kgl. Danske Videnskabernes Selsk. Skr. nat. math. Afd., 1931.
- CORDS, E. Der M. transversus mandibulae. Anat. Anz. Bd. 51, 1919.
- Der M. mandibulo-auricularis. Anat. Anz. Bd. 56, 1922.
- ELLENBERGER und BAUM. Systematische und topographische Anatomie des Hundes. Berlin 1891.
- Handbuch der vergl. Anatomie der Haustiere. Berlin 1932.
- FRICK, HANS. Über die oberflächliche Facialismuskulatur von Orycteropus aethiopicus. Morph. Jahrb., Band 92, Heft 2, 1952.
- FÜRBRINGER, M. Untersuchungen zur Morphologie und Systematik der Vögel. 2. Bd. Die Muskulatur und ihr Verband mit dem Nervensystem, 1888.
- FUTAMURA, R. Über die Entwicklung der Facialis-Muskulatur des Menschen, Anat. Hefte, Bd. XXX, 1906.
- Beiträge zur vergl. Entwicklungsgeschichte der Facialis-Muskulatur. Anat. Hefte, Bd. 32, 1907—.
- GREENE, E. C. Anatomy of the Rat. Transactions of the American Philosophical Society, Philadelphia, New Series, Vol. XXVII, 1935.
- HÄNEL, H. Über die Gesichtsmuskulatur der katarrhinen Affen. Morph. Jahrb., Bd. LXXII, 1932.
- HILL, JOHN ERIC. Morphology of the Pocket Gopher Mammalian Genus Thomomys. University of California Publications in Zoology, Vol. 42, 1937.

- HUBER, E. Über das Muskelgebiet des N. facialis bei Katze und Hund, nebst allgemeinen Bemerkungen über die Facialismuskulatur der Säuger. *Anat. Anz.* Bd. 51, 1918.
- Über die Morphologie des M. procerus nasi des Menschen, *Anat. Anz.* Bd. 51, 1918.
 - Überreste des Sphincter colli profundus beim Menschen, *Anat. Anz.*, Bd. 51, 1918.
 - Über das Muskelgebiet des Nervus facialis beim Hund, nebst allgemeinen Betrachtungen über die Facialismuskulatur. *Morph. Jahrb.*, Bd. 52, 1. Teil, 2. Teil, 1922/23.
 - Zur Morphologie des M. auriculo-mandibularis der Säugetiere. Das Experiment als Unterstützung der morphologischen Muskelforschung. *Anat. Anz.*, Bd. 58, 1924.
 - Über die Bedeutung der experimentellen Methode in der Facialisforschung, nebst Betrachtungen über die phylogenetische Entwicklung der Facialismuskulatur in der Vertebratenreihe, *Anat. Anz.* Bd. 58, 1924.
 - Der M. mandibulo-auricularis, nebst Bemerkungen über die Ohrmuschel und das Scutulum der Säugetiere. Zur Wertschätzung der Innervationsverhältnisse bei vergleichend-morphologischen Muskeluntersuchungen. *Anat. Anz.*, Bd. 59, 1924/25.
 - Der Mandibulo-auricularis der Säugetiere, nebst weiteren Beiträgen zur Erforschung der Phylogenese der Gesichtsmuskulatur. (Zur Wertschätzung der Innervationsverhältnisse bei vergleichend-morphologischen Muskeluntersuchungen). *Morph. Jahrb.* Bd. 55, 1925.
 - Ein M. mandibulo-auricularis bei Primaten, nebst Beiträgen zur Kenntnis der Phylogenese der menschlichen Ohrmuskulatur. *Anat. Anz.* Bd. 60, 1925–1926.
- HUBER, E. and HUGHSON, W. Experimental Studies on the Voluntary Motor Innervation of the Facial Musculature. *Journ. Comp. Neur.*, V. 42, 1926.
- HUBER, E. Zur Morphologie der Supraorbital- und Glabellarmuskulatur des Menschen. Experimentelle Bestimmung der Innervation des M. procerus nasi (M. depressor glabellae, Virchow). *Anat. Anz.* Bd. 62, 1926–1927.
- Comparative Anatomical Investigations on the Facial Musculature of the Whale. *Anat. Rec.*, 35¹, 1927.
 - Correlation in the Evolution of Facial Musculature and the Cutaneous Field of the Trigemini in Mammals, *Anat. Rec.*, 42¹, 1929³.
 - The Evolution of Mimetic Musculature and Facial Expression in the Primates. *Anat. Rec.*, 42¹, 1929³.
 - Evolution of Facial Musculature and Cutaneous of Trigemini. The Quarterly Review of Biology, Part I, Vol. V, 1930; Part II, Vol. V, 1930.
 - Studies on the Organization of the Monotremes, contrasted with the Marsupials and Placentals. *Morph. Jahrb.*, Bd. 66, 1931.
 - Evolution of Facial Musculature and Facial Expression. Baltimore and London, 1931.
- JAZUTA, KONSTANTIN. Zur vergleichenden Anatomie der Hautmuskulatur bei Säugetieren. 1. Mitteilung: Hautmuskulatur bei einigen Fleischfressern. *Anat. Anz.*, Bd. 79, 1934.
- Zur vergleichenden Anatomie der Hautmuskulatur bei Säugetieren. 2. Mitteilung: Halshautmuskulatur von einigen Nagetieren. *Anat. Anz.* Bd. 79, 1935.
 - Zur vergleichenden Anatomie der Hautmuskulatur bei Säugetieren. 3. Mitteilung: Halshautmuskulatur von einigen Huftieren. *Anat. Anz.* Bd. 80, 1935.

- LANGWORTHY, O. R. The Panniculus Carnosus in Cat, Dog and its Genetical Relationship to the Pectoral Musculature. Journ. Mammalogy, Vol. 5, 1924.
- A Morphological Study of the Panniculus Carnosus and its Genetical Relationship to the Pectoral Musculature in Rodents. Am. Journ. Anat., Vol. 35, Nr. 2, 1925.
- LIGHTOLLER, G. S. Facial Muscles. Journ. Anat., Vol. LX, 1925.
- The Facial Muscles of Three Orang Utans and Two Cercopithecidae. Journ. of Anatomy, Vol. LXIII, 1928. Cambridge University Press.
- The Facial Musculature of some Lesser Primates and a Tupaia. A Comparative Study. Proc. Zool. Soc. London, Part 2, 1934.
- The Comparative Morphology of the *M. caninus*. Journ. of Anatomy, Vol. LXXIV, Part 3, 1940.
- The Comparative Morphology of the Platysma. A Comparative Study of the Spinster profundus and the Trachelo-platysma. Journ. of Anatomy, Vol. LXXIV, Part III, 1940.
- Matrices of the Facialis Musculature: Homologization of the Musculature in Monotremes with that of Marsupials and Placentals. Journ. of Anatomy, LXXVI, Part III, 1942.
- MEINERTZ, THYDSEN. Die Hautmuskulatur der Säugetiere. Untersuchungen über die Hautmuskulatur der Säugetiere mit besonderer Rücksicht auf das oberflächliche Facialisgebiet. I. *Cavia cobaya*. Morph. Jahrb., Bd. 69, 1932.
- Die Hautmuskulatur der Säugetiere. Untersuchungen über die Hautmuskulatur der Säugetiere mit besonderer Rücksicht auf das superfizielle Facialisgebiet. II. Das Kaninchen. 1. *Cutaneus maximus*, *Sphincter colli superficialis*, samt *Platysma* und seine Derivate beim Kaninchen. Morph. Jahrb., Bd. 75, 1935.
- Ibidem. II. Das Kaninchen. 2. *Sphincter colli profundus* und seine Derivate beim Kaninchen. Morph. Jahrb. Bd. 76, 1935.
- Samme hovedtitel. II. Das Kaninchen. 3. *Nervus facialis*. Morph. Jahrb., Bd. 77, 1936.
- Ibidem. III. Der Hase mit dem Kaninchen verglichen. Morph. Jahrb., Bd. 77, 1936.
- Das oberflächliche Facialisgebiet der Nager. Zool. Jahrb., Bd. 67, 1941.
- Das superfizielle Facialisgebiet der Nager. IV. Die Muriden. 1. *Epimys norvegicus* (Erxleben) und *Cricetus cricetus* (L.). Morph. Jahrb., 1941.
- Samme Hovedtitel. VI. Die Sciuriden. 1. *Sciurus vulgaris* L. Zeitschrift für Anat. u. Entwicklungsgesch., 1. Abt., Bd. 112, 1943.
- Ibidem. IV. Die Muriden. 2. *Arvicola terrestris* und *Dicrostonyx groenlandicus*. Morph. Jahrb., Bd. 88, 1943.
- Ibidem. VI. Die Sciuriden. 2. *Marmota marmota* (L.). Zeitschrift für Anat. und Entwicklungsgesch. 1. Abt., Bd. 112, 1943.
- Ibidem. V. Die Dipodiden. *Alactagulus pumilio* Kerr. Morph. Jahrb., Bd. 89, 1944.
- Ibidem. VII. Die hystricomorphen Nager. Zeitschrift für Anat. und Entwicklungsgeschichte, 1. Abt., Bd. 113, 1944.
- Ibidem. VIII. *Bathyergini* Winge, sowie einige Bemerkungen über *Pedetes caffer* (Pall.). Morph. Jahrb. Bd. 90, 1951.
- MICHELSSON, G. Die Hautmuskulatur des Igels (*Erinaceus europaeus*). Morph. Jahrb., Bd. 51, 1921.
- MUCHAMEDGALIEV, FASUL. *Mm. levator nasolabialis* und *malaris* bei Kamel, Hornvieh und Pferd des südlichen Kasakstan. Anat. Anz. Bd. 74, 1932.
- REICHARD, J. & JENNINGS, H. S. Anatomy of the Cat. New York, 1923.

- RUGE, G. Über die Gesichtsmuskulatur der halbbaffen. *Morph. Jahrb.*, Bd. XI, 1885.
— Die Hautmuskulatur der Monotremen und ihre Beziehungen zu dem Marsupial und Mammarapparate. Aus Semon, *Zoolog. Forschungsreisen*, Bd. II, *Jenaische Denkschriften*, V, 1895.
- SCHREIBER, HANS. Die Gesichtsmuskulatur der Platyrrhinen. *Morph. Jahrb.*, Bd. 60, 1928.
— Untersuchungen über die Facialismuskulatur einiger Nager. *Morph. Jahrb.*, Bd. 62, 1929.
- VIRCHOW, H. Die Muskulatur des Kinnes. *Ergänzungsheft 5, Anat. Anz.*, Bd. LVII, 1923.
- VRAA-JENSEN, GUSTAV FR. Nucleus motorius nervi facialis. *Zeitschr. für Anat. und Entwicklungsgesch.*, 112, Band, 3. Heft, 1943.
-