MYOLOGY

It has been observed from the work of Watt & Williams (1951) and others that there is a correlation between the development of the masticatory muscles of mammals and the feeding behaviour of the particular species of mammal.

Since the mammals under investigation feed on a variety of food and the feeding habits are quite varied, it was anticipated that, as in case of osteology studied earlier, the possibility of existence of variations in myology also.

During the present studies the jaw and the tongue muscles have been studied in relation to their nature, the disposition, the origin, as well as insertion and function. A study of the innervation of these has also been made. As is well known, such a study leads to the understanding of the functional anatomy of the associated organs.

The following is a general pattern of the mammalian jaw and the tongue muscles.

Based on their functions, the muscles of the jaw apparatus may be divided as follows:
1. The muscles of mastication
   (i) M. Masseter
   (ii) M. Temporalis
   (iii) M. Pterygoideus
   (iv) M. Digastricus.

2. The muscles operating the floor of the buccal cavity
   (i) M. Transversus mandibularis and
   (ii) M. Mylo-hyoideus.

3. The muscles operating tongue
   (i) M. Genio-hyoideus
   (ii) M. Genio-glossus
   (iii) M. Hyo-glossus and
   (iv) M. Stylo-glossus.

4. The muscles responsible for the hyoid movements
   (i) M. Sterno-hyoideus
   (ii) M. Sterno-thyroides
   (iii) M. Omo-hyoideus
   (iv) M. Stylo-hyoideus
   (v) M. Crico-thyroides and
   (vi) M. Thyro-hyoideus.

The classification of the muscles made in above mentioned four categories is mainly based on the primary function of the muscle concerned. It may however be emphasized
here that a muscle quite often works in more than one way. Such actions if any have also been mentioned at appropriate places.

1. The muscles of mastication:

(i) M. Masseter: The muscle is divisible into a masseter pars superficialis and a masseter pars profundus. The latter part in some mammals is again divided into an anterioris and a posterioris parts. Besides these parts, in some mammals, one more part viz., a lateralis (also known as a medialis) part is also present. The masseter muscles by their contraction help mainly in pulling the mandible upward and forward.

(ii) M. Temporalis: This muscle is divided into three fasciculi viz., an anterior, a posterior and a zygomaticus. It is primarily responsible in bringing about the adduction of the lower jaw, by drawing the lower jaw in an upward direction.

(iii) M. Pterygoideus: The pterygoideus muscle is further split into an externus and an internus parts. The contraction of these parts primarily results in a sideward, forward or upward movement of the mandible.

(iv) M. Digastricus: This muscle comprises two bellies, namely an anterior and a posterior one. Both these bellies are either joined by a tendinous intersection or connected
by a long tendinous piece. When in the former condition the muscle is known as the digastricus intersectus and in the latter, the digastricus conjunctus. This muscle mainly functions as a depressor of mandible.

2. The muscles operating the floor of the buccal cavity:

The transversus mandibularis and mylo-hyoideus muscles are the main muscles, which bring about a movement of the floor of the buccal cavity. In some mammals however only mylo-hyoideus is represented. Both these muscles are generally disposed inbetween the two rami of the mandible. Their main function is a raising up of the buccal floor.

3. The muscles operating the tongue:

The M. genio-hyoideus and M. genio-glossus by their contraction throw the tongue out from the mouth. On the other hand the hyo-glossus and the stylo-glossus muscles, by their contraction help in the withdrawal of the tongue into the mouth.

4. The muscles responsible for the hyoid movements:

The muscles of the hyoid series are helpful in pulling the hyoid apparatus in a backward and/or downward direction. Further, they also generally help indirectly in a posteriorward and/or downward movement of the floor of the buccal cavity and the tongue. It may also be noted here that the omo-hyoideus muscle assists in a sideward movement of the hyoid apparatus.
INNERVATION (Plates X and XI)

The masticatory muscles are generally innervated by the secondary & tertiary branches of the Vth mandibular nerve. In addition, the digastricus muscle is also served by the VIIth facial nerve. The anterior belly of this muscle is innervated by a ramus from the Vth nerve, whereas the posterior belly is innervated by a branch from the VIIth facial nerve. Usually the hypoglossal nerve innervates the tongue muscles. The muscles those of the hyoid region are innervated by the 1st or 2nd cervical nerve and/or by the ansa-cervicalis.

The nomenclature followed here is that of Edgeworth (1935), Sprague (1944), Das (1955), Gray (1962), Sivaram and Sharma (1965) and Sharma and Sivaram (1967) with suitable modifications where necessary. To avoid any misconception, the nomenclature and the synonymy used by some authors in the past is given below.

NOMENCLATURE AND SYNONYMY

M. masseter pars superficialis:

M. masseter (part) anterior superficial —— Parsons (1894, 1896), Scott (1954)
M. masseter (layer) superficial —— Clark (1924), Raghavan (1964)
M. masseter (division) superficial masseter —— Wood and White (1950), Das (1955)
Plate X

The innervation of the jaw, the tongue and the hyoid muscles:

1. Hedgehog
2. Bat

Cl, C₂ and C₃ - First, second and third cervical nerve;
N.Crico-Thyr. - Nerve supply to crico-thyroideus.
Plate XI

The innervation of the jaw, the tongue and the hyoid muscles:

1. Guinea-pig
2. Mongoose

Legends as in Plate X.
M. masseter pars lateralis:

M. masseter (part) posterior superficial ---- Parsons (1894, 1896), Scott (1954)
M. masseter (layer) deep ---- Clark (1924), Raghavan (1964)
M. masseter (division) M. lateral masseter (part) anterior lateral and posterior lateral ---- Wood and White (1950), Das (1955)

M. masseter pars profundus anterioris:

M. masseter (part) anterior deep ---- Parsons (1894, 1896), Scott (1954)
M. masseter (division) M. deep masseter (part) ant. deep (maxillo-mandibularis) ---- Wood and White (1950), Das (1955)

M. masseter pars profundus posterioris:

M. masseter (part) posterior deep ---- Parsons (1894, 1896), Scott (1954)
M. masseter (division) M. deep masseter (part) posterior deep ---- Wood and White (1950), Das (1955)

M. temporalis anterior fasciculus:

M. temporal (part) superior ---- Parsons (1894, 1896)
M. temporalis (part) superficial head ---- Clark (1924)
M. temporalis (division) superior ---- Das (1955)
M. temporalis posterior fasciculus:

M. temporalis (part) middle ---- Parsons (1894, 1896)
M. temporalis (part) deep head ---- Clark (1924)
M. temporalis (division) middle ---- Das (1955)

M. temporalis zygomaticus fasciculus:

M. temporalis (part) inferior ---- Parsons (1894, 1896)
M. temporalis (division) inferior ---- Das (1955)
M. temporalis (part) M. temporalis pars supra zygomaticus ---- Nikolskaya (1965)

Following authors have not divided this muscle into different parts:

M. temporalis + M. pterygoideus internus ---- Meckel (1826), Raghavan (1964)
M. temporalis ---- Fewkes (1877), Westling (1884, 1889), Leche (1884, 1889), Toldt (1905), Gaughran (1954), Sisson (1962)
M. temporal ---- Macalister (1872), Washburn (1947), Scott (1954), Avis (1959)

M. pterygoideus externus:

M. external pterygoid ---- Parsons (1894, 1896)
M. pterygoideus externus ---- Meckel (1826), Fewkes (1877), Westling (1884, 1889), Toldt (1905), Clark (1924), Wood and White (1950), Gaughran (1954), Das (1955), Nikolskaya (1965)
M. pterygoideus medialis + pterygoideus lateralis ---- Sisson (1962)
M. pterygoideus lateralis ---- Raghavan (1964)

M. pterygoideus internus:

M. internal pterygoid ---- Parsons (1894, 1896)
M. pterygoideus internus ---- Clark (1924), Wood and White (1950), Gaughran (1954), Das (1955), Septimus (1962), Nikolskaya (1965)
M. pterygoideus medialis ---- Raghavan (1964)

M. digastricus:

M. biventer maxillae inferioris ---- Meckel (1826)
M. digastric ---- Macalister (1872), Dobson (1882), Parsons (1894, 1896), Howes (1896)
M. digastricus maxillae inferioris ---- Fewkes (1877), Westling (1884, 1889), Chaine (1900), Toldt (1905)
M. depressor maxillae inferioris ---- Leche (1888-1889)
M. detrahens mandibulae ---- Schulman (1906)
M. digastricus ---- Clark (1924), Edgeworth (1935), Sprague (1944), Wood and White (1950), Fiedler (1952), Gaughran (1954), Das (1955), Sisson (1962), Raghavan (1964), Nikolskaya (1965), Sivaram and Sharma (1965), Sharma and Sivaram (1967)

M. transversus mandibularis:

M. transverse mandibular ---- Parsons (1894, 1896)
M. intermandibularis anterior ---- Cords (1910, 1918, 1922)
M. mylohyoideus (part) superficial ---- Sprague (1944)
M. transversus mandibulae ---- Wood and White (1950), Das (1955)
M. mylohyoideus anterior ---- Fiedler (1952)
M. mylohyoideus (part) pars superficialis ---- Gaughran (1954)
M. transversus mandibularis ---- Sivaram and Sharma (1965), Sharma and Sivaram (1967)

M. mylo-hyoides:

M. mylohyoidien (la seconde portion) ---- Duvernoy (1850)
M. myloglossus (the deeper part and styloglossus) ---- Fewkes (1877)
M. myloglossus (die tiefe Schichte) ---- Westling (1884, 1889)
M. mylohyoideus (die tiefer Schichte) ---- Leche (1888, 1889)
M. transverse jugulaire (feuillet profond) ---- Chaine (1900)
M. mylohyoideus ---- Toldt (1905), Bijvoet (1908), Clark (1924), Wood and White (1950), Das (1955), Septimus (1962), Raghavan (1964), Sivaram and Sharma (1965), Sharma and Sivaram (1967)
M. mylohyoideus and tympanico-hyoideus ---- Schulman (1906)
M. intermandibularis ---- Cords (1910, 1918, 1922), Edgeworth (1935)
M. mylohyoideus (part) deep ---- Sprague (1944)
M. mylohyoideus posterior ---- Fiedler (1952)
M. mylohyoideus (part) pars profundus ---- Gaughran (1954)

M. genio-hyoideus:

M. geniohyoideus ---- Meckel (1826), Duvernoy (1850), Coues (1867, 1870), Fewkes (1877), Clark (1924), Edgeworth (1935), Sprague (1944), Wood and White (1950), Fiedler (1952), Gaughran (1954), Das (1955), Sisson (1962), Raghavan (1964), Sivaram and Sharma (1965), Sharma and Sivaram (1967)
M. geniohyoid ---- Parsons (1894, 1896)
M. glosso-vaginalis profundus, strata medium and externum ---- Ehlers (1894)

M. genio-glossus:

M. genioglossus ---- Meckel (1826), Duvernoy (1850), Edgeworth (1935), Sprague (1944), Gaughran (1954), Sivaram and Sharma (1965), Sharma and Sivaram (1967)
M. geniohyoglossus ---- Coues (1867, 1870) Parsons (1894, 1896), Clark (1924), Fiedler (1952)
M. genioglossus anticus and posticus —— Fewkes (1877)
M. glosso-vaginalis profundus, stratum internum ——
   Ehlers (1894)
M. genioglossus, medialer and lateraler —— Toldt
   (1905)

M. hyo-glossus:
M. thyro-hyo-glossus —— Meckel (1826)
M. hyoglossus —— Coues (1867, 1870), Clark (1924),
   Edgeworth (1935), Sprague (1944), Gaughran (1954),
   Sivaram and Sharma (1965), Sharma and Sivaram
   (1967)

M. stylo-hyoideus:
M. stylohyoid —— Parsons (1894, 1896)
M. stylohyoideus —— Clark (1924), Sprague (1944),
   Wood and White (1950), Fiedler (1952), Gaughran
   (1954), Das (1955), Sisson (1962), Raghavan
   (1964), Sivaram and Sharma (1965), Sharma and
   Sivaram (1967)

M. stylo-glossus:
M. styloglossus —— Parsons (1894, 1896), Howes
   (1896), Sprague (1944), Gaughran (1954), Sivaram
   and Sharma (1965), Sharma and Sivaram (1967)
M. sternohyoideus:

M. sternohyoid —— Macalister (1872), Parsons (1894, 1896)
M. sternohyoideus —— Clark (1924), Sprague (1944), Wood and White (1950), Gaughran (1954), Das (1955), Sivaram and Sharma (1965), Sharma and Sivaram (1967)
M. sterno-thyro-hyoideus? —— Sisson (1962), Raghavan (1964)

M. sternothyroideus:

M. sternothyroideus —— Mivart (1866), Fewkes (1877), Westling (1884, 1889), Clark (1924), Sprague (1944), Wood and White (1950), Gaughran (1954), Das (1955), Sivaram and Sharma (1965), Sharma and Sivaram (1967)
M. sterno-thyroid —— Parsons (1894, 1896)
M. sterno-hyoideus —— Schulman (1906)

M. thyro-hyoideus:

M. thyrohyoideus —— Clark (1924), Sprague (1944), Wood and White (1950), Gaughran (1954), Das (1955), Sivaram and Sharma (1965), Sharma and Sivaram (1967)

M. crico-thyroideus:

M. cricothyroid —— Walker (1889)
The description of various muscles associated with the feeding apparatus in the animals selected is as follows:

Hedgehog: (*Erinaceus collaris*)

The muscles of mastication:

**M. masseter** (Plates XII to XIV):

It is quadrilateral massive piece of muscle and is divided into two parts viz., pars superficialis and pars profundus. The main mass of the masseter covers a major portion of the vertical part of the dentary as well as its angular process.
Dorsal and lateral views of the jaw muscles of the hedgehog:

Post.Fasci. - Posterior fasciculus of Temporalis; Temp.
Zygo.Fasci. - Zygomaticus fasciculus of Temporalis;
Pars superficiales:

It is covered by a thick tendon except posteriorly and ventrally, where the fibres remained uncovered.

ORIGIN: It arises partly tendinously and partly fleshily from the outer and lower surface of the zygomatic arch. Most of its fibres arise from the lower surface of the tendon, but a few fibres also arise fleshily directly from the lower edge of the zygomatic arch. The arrangement of the muscle fibres shows a bi-pinnate structure.

INSERTION: The insertion is partly fleshy and partly tendinous. Some fibres insert directly on the ventral edge of the vertical part of the ramus of the dentary, while the rest of them are attached on to a triangular-shaped tendon, which inserts on the outer aspect of the anguloid process of the mandible.

Pars profundus (Plate XII, 1):

It lies ventral to the pars superficialis and is covered by a thick aponeurotic sheath. It fills the masseteric fossa of the mandible.

ORIGIN: It arises partly in a fleshy and partly in an aponeurotic origin from the inner lower surface of the zygomatic arch. Most of the muscle fibres are of uni-pinnate type, but some fibres which are situated inbetween the aponeurotic sheath and the triangular-shaped tendon show a bipinnate pattern.
Plate XIII

Lateral views of the jaw-muscles of the hedgehog:

1. Showing the M. mass. pars prof. (M. mass. pars sup. removed)

2. Showing the M. pterygoideus (ramus of the dentary cut)

Legends as in Plate XII.
INSERTION: Most of the fibres, which arise from the zygomatic arch insert fleshily on the masseteric fossa. But the fibres arising from the aponeurotic sheath are attached on the tendon, which inserts on the anguloid process just below the masseteric fossa.

ACTION: As the muscle contracts, the lower jaw is elevated in such a way that the masicatory surfaces of the lower teeth fit into the corresponding surfaces of the upper teeth. Further the incisors are also brought upwards so as to fit in between the gap formed anteriorly and laterally by the incisors. The contraction also helps in the close apposition of the articular condyles into the corresponding mandibular fossa formed by the squamous temporal bone. In short the muscle is adapted to act with a great force, in maintaining a tight grip over the prey and preventing its escape from the buccal cavity.

INNERVATION: It is innervated by a branch from the Vth mandibular nerve.

_M. temporalis_ (Plates XII and XIII):

It is a well developed muscle situated on the lateral side of the head and extending upwards as far as the parietal crest, where it almost meets the fellow of the opposite side. Posteriorly it extends as far as the lambdoidal crest. It consists of three fasciculi, viz., t.anterior, t.posterior and zygomaticus fasciculus, which
Plate XIV

Ventral view of the jaw, the buccal floor, the tongue and the hyoid muscles of the hedgehog:

1. Showing the superficial layer of muscles
2. Showing deeper layer of the tongue muscles
   (M. trans.mand., M. mylo-hy. and M. digast. removed)

OMO-HYO.
STERNO-HY.
MAND.
MYLO-HY.
DIGAST.ANT.Belly
TRANS. MAND.
DIGAST.POST.Belly
Mass. Pars Sup.
OMO-HYO.
STERNO-HY.
STERNO-THYR.

1

GENIO-HY.
GENIO-GLOSS.
STYLO-GLOSS.
HYO-GLOSS.
STERNO-HY.
OMO-HY.
STERNO-THYR.

2
arise variously from the dorsal and the lateral regions of the skull, but possesses a common insertion.

**Anterior fasciculus:**

This is the best developed of all the fasciculi. Dorsally it spreads as far as the parietal crest and becomes narrow as it runs more or less downwards and forwards. Dorsally the fasciculus is covered by a thin aponeurotic sheath. Towards the insertion the fibres are connected with a common tendon on which all the fasciculi of the temporalis gain attachment.

**ORIGIN:** It is partly fleshy and partly aponeurotic. The deep fibres arise fleshy from the anterior outer surface of the parietal. The superficial fibres, however, arise from the aponeurotic sheath, which is broad and thin and covers the upper surface. The arrangement of the fibres in general is of the uni-pinnate type. But the fibres arising from the aponeurotic sheath show a bi-pinnate arrangement, since they extend inbetween the aponeurotic sheath and the common tendon. Some of the lateral fibres also arise from the tendon of the posterior fasciculus.

**Posterior fasciculus:**

It is a quite massive and fan-shaped being broad towards the origin and becoming narrow as it runs forwards and downwards where the fibres join the common tendon.
mentioned earlier. The main mass is partly covered with a thin aponeurotic sheath which extends downwards and merges with the common tendon.

**ORIGIN :** The fibres of the fasciculus arise partly from the parietal, behind the origin of the anterior fasciculus, partly from the squamous temporal bone and the lower surface of the wall of the fossa.

**Zygomaticus fasciculus :**

It is in the form of a spindle-shaped structure, narrow at either ends and massive in the middle. It is situated along the anterior lower border of its posterior counterpart with which it is loosely attached.

**ORIGIN :** The muscle arises tendinously from the inner surface of the zygomatic arch and the adjoining part of the squamous temporal bone.

**INSERTION :** The deeper fibres of the posterior fasciculus insert directly along the anterior border of the coronoid process of the dentary, whereas the remaining superficial fibres as well as the entire anterior and the zygomaticus fasciculus insert by a common tendon on the coronoid process of the dentary, towards its junction with the horizontal part of the mandible. Some of the fibres of the posterior fasciculus however, insert fleshily on the inner surface of the vertical part of the coronoid process.
ACTION: By their contraction, all the fasciculi of the temporalis muscle together raise up the mandible, whereby the mouth gets closed. This movement is made possible by the upward pull of the anterior fasciculus, upward and backward pull of the posterior fasciculus and the backward pull of the zygomaticus fasciculus of the main mass. Once the mandible is protruded the zygomaticus fasciculus also helps in drawing the jaw slightly backwards.

INNERVATION: All the fasciculi of the temporalis muscle are innervated by the different branches from the Vth mandibular nerve.

*M. pterygoideus* (Plates XIII and XVI, 1):

The pterygoideus muscle consists of an externus and an internus parts. Ordinarily the muscle is covered by the distal portion of the mandible and only a portion of the internus is visible.

*M. pterygoideus externus*:

The muscle is divisible further into two fasciculi towards the origin. The upper of these, arises from the infra-temporal surface and from the ridge in the pterygo-palatine fossa. The muscle moves backwards and obliquely upwards. The lower fasciculus on the other hand arises from the latero-dorsal surface of the lateral part of the pterygoid where it is joined with its internus counterpart.
by a tendon. From here it moves upwards and backwards. The two fasciculi unite posteriorly to form a common insertion on a depression situated below the condyle of the mandible.

ORIGIN: The upper fasciculus is more or less fleshy in origin with a few tendinous fibres interspread superficially inbetween the muscle fibres. The lower head on the other hand is partly fleshy and partly tendinous. A tendinous sheath is observed towards the lower surface whereas medially there arises a tendinous sheet. Some muscle fibres also are observed to arise directly from the tendinous region and develop into a complicated pinnate pattern.

INSERTION: Towards the insertion, the tendon forms a capsule-shaped structure which fits on the condylar process of the mandible.

ACTION: It assists in the adduction of the dentary by pulling the head of the mandible in a backward direction. The contraction of the muscle helps the head of the mandible to glide over the articular disc, and brings the mandible forwards in a gliding movement. This results in a moderate closing of the mouth. The contraction of the muscle also helps in a slight sideward movement of the dentary.

INNERVATION: The muscle is innervated by a branch of the Vth mandibular nerve.
M. pterygoideus internus:

It is a well developed muscle with two tendons, a ventral and a median one. The ventral tendons forms a thick pad along the ventral surface of the muscle. This pad as well as some fibres arise directly from the pterygoid process of the palatine and latero-ventral surface of the pterygoid bone. The muscle fibres move forward and converge to attach on the median tendon. Some muscle fibres also arise from the ventral pad and as they move forwards, some of them gain attachment on the median tendon. The remaining muscle fibres arising from the median tendon, insert on the anguloid process of the mandible.

ACTION: This muscle helps in the adduction of the lower jaw. Further the contraction of this muscle also results in the mandible moving sidewards.

INNERVATION: It is innervated by a branch of the Vth mandibular nerve.

M. digastricus (Plates XII, XIII and XIV):

This muscle is generally known as digastricus intersectus, as it possesses two bellies, an anterior and a posterior, both of them joined by an intersection, which is a tendinous structure. After joining the two bellies, this tendinous structure extends forwards, downwards and inwards and meets the fellow of the opposite side at the
mid-region of the mylo-hyoideus muscle. This tendinous piece is more or less triangular in shape with the apex at the intersection of the digastricus. The anterior bellies of both the sides remain apart from each other, whereas in the carnivorous mongoose both the bellies remain adjacent to each other.

ORIGIN: The muscle arises in a narrow tendinous origin from the mastoid + paroccipital process and passes downwards and inwards.

INSERTION: The muscle inserts tendinously on the digastric fossa situated on the ventero-lateral surface of the dentary.

ACTION: The contraction of the muscle helps mainly in a downward pulling of the mandible, bringing about its depression. As the muscle is connected with the mylo-hyoideus muscle, its contraction also assists in the lowering down of the buccal floor.

INNervation: The anterior belly of the digastricus muscle is innervated by a branch of the Vth mandibular nerve and a posterior belly is innervated by a branch arising from the VIIth facial nerve.

The muscles operating the floor of the buccal cavity:

M. transversus mandibularis (Plate XIV):

This muscle extends as a thick sheet of muscle
fibres inbetween the two rami of the lower jaw a little behind the symphysis. Its fibres arise from a thin sheet of tendon, run directly inwards and merge medially so as to form a thin continuous sheet.

ACTION: The muscle helps in the raising up of the floor of the buccal cavity.

INNERVATION: The muscle is innervated by a branch of the mylo-hyoid nerve which arises from the Vth mandibular nerve.

**M. mylo-hyoides** (Plates XIII and XIV):

It is situated just behind M. transversus mandibularis and forms the main muscular mass of the floor of the buccal cavity. This is more massive, broad and well developed than M. transversus mandibularis. Medially it is covered by a tendon arising from the intersection of the digastricus muscle described earlier.

ORIGIN: The origin is partly tendinous and partly fleshy from the inner surface of the mandible from a depression of the mylohyoid line.

INSERTION: The fibres of both the sides converge medially so as to insert on a common tendon which runs along the median line of the floor of the buccal cavity. However, posterior fibres move first downwards and then inwards and backwards so as to insert on the postero-ventral surface of the basi-hyal of the hyoid apparatus.
ACTION: The contraction of the M. mylo-hyoideus assists in the raising of the buccal floor. This muscle also helps in moving the hyoid apparatus upwards and forwards.

INNERVATION: The muscle is innervated by a mylohyoid nerve arising from the Vth mandibular nerve.

The muscles operating the tongue:

M. genio-hyoideus (Plate XIV):

This is a thick ribbon-shaped muscle having a spear-shaped anterior end. It is situated just above the M. mylo-hyoideus and spreads inbetween the body of the dentary and the basi-hyal of the hyoid apparatus. The muscle meets its fellow of the opposite side along the median line and both the muscles together, present the appearance of a muscular pad.

ORIGIN: Towards the origin, the muscle is provided with a thin sheet of tendon. This tendon is attached with the lower surface of the body of the dentary towards the symphysis. The fibres run more or less directly backwards.

INSERTION: The insertion is broad and fleshy on the ventral surface of the basi-hyal.

ACTION: The contraction of the muscle brings about the forward as well as downward movement of the hyoid apparatus.
INNERVATION: It is innervated by a branch of the XIIth hypo-glossal nerve.

M. genio-glossus (Plates XIV and XV):

The muscle is thick and more or less fan-shaped and the fibres are arranged in such a way that the muscle meets its fellow along the median line.

ORIGIN: The origin is partly fleshy and partly tendinous from the inner lower as well as ventral surface of the ramus of the dentary. The origin is situated behind the origin of M. genio-hyoideus. The muscle becomes thick and narrow as it moves backwards and slightly upwards.

INSERTION: It inserts on the lower posterior surface of the thick pad-like portion of the tongue. However, a few fibres also reach up to the hyoid apparatus.

ACTION: The contraction of the muscle brings about the protraction of the tongue.

INNERVATION: It is innervated by a branch of the XIIth hypo-glossal nerve.

M. stylo-glossus (Plates XIV and XV):

This is a fleshy elongated more or less ribbon-shaped muscle, a major portion of which runs on the lateral surface of the pad of the tongue.
Plate XV

Ventral view of the tongue and the hyoid muscles of the hedgehog:

1. Showing the deeper layer of the tongue muscles (M. genio-hy. removed)

2. Showing the deeper layer of the tongue and the hyoid muscles (M. genio-gloss., M. sterno-hy. and M. omo-hy. removed)

Legends as in Plates XII and XIV.
ORIGIN: It arises in a fleshy origin from the outer surface of the tympanostyloid synchondrosis of the hyoid apparatus. It runs anteriorly towards the tongue, and inserts on its ventero-lateral surface.

ACTION: It is a retractor of the tongue. As the muscle contracts, the tongue is pulled inwards.

INNERVATION: It is innervated by the ramus of the XIIth nerve.

M. hyo-glossus (Plates XIV and XV):

This well developed muscle remains fleshy throughout. It runs anterforwards from the basi-hyal and thyro-hyal, contributing to the formation of the floor of the tongue. It remains inner to the M. stylo-glossus. Towards the origin the muscle is broad and flat. As it moves forwards, the muscle develops as a thin ribbon-shaped structure running laterally to the tongue. Anterior parts of both the counterparts converge towards the median line.

The muscle arises in a very broad and fleshy origin from the basi-hyal and the postero-lateral surface of the thyro-hyal of the hyoid apparatus. The insertion is on the inner surface of the lateral portion of the tongue-pad towards the median line.

ACTION: As the muscle contracts, the tongue is retracted into the buccal cavity. Thus this is also a retractor of
the tongue as like that of the M. stylo-glossus. The muscle also brings about the lateral and upward movements of the tongue.

INNERVATION: It is innervated by a branch of the XIIth nerve.

The muscles responsible for the hyoid movements:

M. stylo-hyoideus (Plate XV, 2):

It is a short, well developed and flat muscle situated inbetween the anterior and posterior cornua of the hyoid apparatus. It is fleshy in origin and arises from the inner surface of tympanostyloid synchondrosis and the stylo-hyal of the hyoid apparatus. The insertion is fleshy on the antero-lateral portion of the thyro-hyal. The insertion also extends slightly over the outer surface of the base of the hypo-hyal of the hyoid apparatus.

ACTION: When it contracts, the hyoid apparatus is elevated and is drawn backwards.

INNERVATION: It is innervated by a branch of the VIIth facial nerve.

M. sternohyoideus (Plates XIII to XV):

It is a long, well developed and strap shaped muscle, which is observed in the neck region running along the ventero-lateral side of the trachea. It runs
anteriorly almost in close association with its fellow, along the median line. Towards the insertion the two fellows slightly diverge from each other and move outwards. This muscle possesses a transverse intersection nearly at its mid-region.

It arises in a fleshy origin from the sternum along the dorsal surface of the anterior edge, where the first and the second ribs are attached. The insertion is on the postero-ventral surface of the basi-hyal as well as on the antero-lateral edge of the proximal end of the thyro-hyal.

ACTION: This muscle helps in depressing the hyoid apparatus during the swallowing process of the food.

INNERVATION: The muscle is innervated by the ansa cervicalis.

M. sterno-thyroideus (Plates XIII to XV):

Like the sterno-hyoideus muscle, this muscle also connects the sternum with the hyoid apparatus and runs dorsally along with the latter muscle. The muscle is long and thick. It is better developed than the sterno-hyoideus muscle. It also possesses an intersection like the sterno-hyoideus muscle.

ORIGIN: It arises fleshily from the sternum in a close association with the sterno-hyoideus muscle.
INSERTION: The insertion of this muscle is fleshy on the ventral margin of the thyroid cartilage.

ACTION: Due to the contraction of this muscle the larynx is drawn downwards.

INNERVATION: The muscle is innervated by a branch of the ansa ceratlicis.

*M. crico-tyroideus* (Plate XV, 2):

It is single short but broad, fleshy and fan-shaped muscle, situated over the cricoid cartilage and lies inbetween the cricoid and posterior edge of the thyroid cartilage. It is covered from above by the sterno-hyoides and the sterno-thyroides muscles. The muscle fibres are arranged parallel to one another.

ORIGIN: It arises fleshily and slightly in a narrow origin from the postero-ventral edge of the cricoid cartilage.

INSERTION: The insertion of the muscle on the posterior edge of the thyroid cartilage is broad and fleshy.

ACTION: It protracts the thyroid cartilage in a backwards and downwards direction, which ultimately helps in the engulfing of the food.

INNERVATION: The muscle is innervated by the first cervical nerve.
M. thyro-hyoideus (Plate XV, '2):

This is a small fleshy triangular-shaped muscle situated inbetween the thyroid cartilage and the basi-hyal, just above the sterno-thyroideus, the sterno-hyoideus muscles.

The origin of the muscle is fleshy from the posterior edge of the thyroid cartilage. It inserts fleshily on the thyro-hyal just dorsal to the insertion of the sterno-hyoideus muscle.

ACTION: As the muscle contracts, the posterior cornu is retracted slightly.

INNERVATION: It is innervated by the 1st cervical nerve.

M. omo-hyoideus (Plates XIII to XV):

It is a flat, ribbon-shaped and fleshy muscle, which runs obliquely inbetween the scapula and the thyro-hyal.

ORIGIN: It arises in a broad origin, partly tendinous and partly fleshy from the inner, anterior margin of the scapula. From the origin, it runs downwards and forwards in a obliquely manner.

INSERTION: It inserts fleshily on the proximal end of the thyro-hyal on its antero-lateral surface. The insertion is external and dorsal to the insertion of the sterno-hyoideus muscle, and behind the origin of the hyoglossus muscle.
ACTION: The omo-hyoideus muscle moves the hyoid apparatus sideward.

INNERVATION: The innervation of this muscle is by the ansa cervicalis nerve.

Bat (Cynopterus marginatus):

The muscles of mastication:

M. masseter (Plates XVII to XIX):

This is a moderately developed quadrilateral massive piece of muscle, which is spread on the lateral side of the skull. It is divisible into a pars superficialis and a pars profundus. The M. pars superficialis practically covers the deeper part from above. The muscle fibres show a complicated pinnate type of arrangement.

Pars superficialis:

This part is quite massive and is provided with a moderately developed aponeurotic sheath along the upper half of its dorsal surface. Within the belly, the muscle is provided with two internal tendons, one of which is attached with the zygomatic arch and the other with the anguloid process.

ORIGIN: The origin of the muscle is partly aponeurotic, partly fleshy and partly tendinous. Most of the muscle fibres arise from the lower surface of the aponeurotic
sheath. Some muscle fibres also arise fleshily from the ventral and inner surfaces of zygomatic arch. The remaining muscle fibres arise from both the surfaces of the median tendon. All the muscle fibres run downward and backward towards the anguloid process of the dentary.

**INSERTION**: The muscle inserts partly fleshily and partly tendinously on the outer as well as ventral surface of the anguloid process and also on the postero-outer surface of the ramus of the mandible, just below the masseteric fossa.

**Pars profundus (Plate XVII, 2)**:

This part is moderately developed. The muscle occupies the space within the masseteric fossa of the dentary.

**ORIGIN**: The origin is broad, weakly aponeurotic and mostly fleshly from the inner entire surface of the zygomatic arch from where the muscle runs downward and backward.

**INSERTION**: All the muscle fibres arising from the aponeurosis and the zygomatic arch gain attachment in a partly fleshly and partly tendinous manner on the masseteric fossa of the mandible.

**ACTION**: The two parts of the masseter together raise the lower jaw upward to grip the food. As the lower jaw is forced upward, the lower teeth fit into the corresponding
Plate XVI

1. Ventral view of the jaw muscles (tongue and the hyoid apparatus removed) of the Hedgehog

2. Dorsal view of the jaw muscles of the Bat

Legends as in Plates XII and XIV.
Plate XVII

Lateral views of the jaw muscles of the Bat:

1. Showing the superficial layer of muscles
2. Showing the M. mass. pars prof. (M. mass. pars sup. removed)

Legends as in Plates XII and XIV.
facets of the upper jaw. As a result, as the mouth is closed, a better grip is assured due to the pinnate nature of the muscle and thus it helps in crushing the food.

During the operation, the angular process moves obliquely upward and the nature of the joint is such that, only upward and downward movements are possible. As the masseter operates, due to the forward disposition of the lower jaw, the fruit is moderately squeezed by the incisors whereby the juice is released. Further, as the molars are brought closer, their masticatory surfaces crush the hard food materials such as seeds and hard fruits. Consequently, the food is transformed into the soft material which is gulped easily.

INNERVATION: Both the parts of the masseter muscle are innervated by a branch of the trigeminal nerve.

M. temporalis (Plates XVI to XVIII):

This is a massive, moderately developed muscle, situated on the dorsal and lateral sides of the skull. The muscle is provided superficially by a thick glistening aponeurotic sheath. This muscle is divisible into three different fasciculi viz., (1) t. anterior, (2) t. posterior and (3) t. zygomaticus fasciculus.

Anterior fasciculus:

This is a well developed more or less fan-shaped...
Plate XVIII

1. Lateral view of the jaw and the hyoid muscles of the Bat, showing the M. ptery. (the M. mass. removed and the ramus of the dentary cut)

2. Ventral view of the jaw, the buccal floor, the tongue and the hyoid muscles of the Bat, showing the superficial layer of muscles

Legends as in Plates XII and XIV.
fasciculus. It is attached on one side with the parietal and supraorbital process and on the other with the coronoid process of the dentary. This muscle shows a unipinnate type of fibre arrangement.

ORIGIN: The muscle arises partly aponeurotically and partly fleshily in a broad origin from nearly anterior half of the parietal ridge (which is situated slightly in a curved fashion on the lateral side of the parietal suture) and from the wall of the parietal bone. The muscle runs downward towards the coronoid process.

Posterior fasciculus:

This fasciculus is lodged posterior to its anterior counterpart and is better developed. The muscle fibres show unipinnate type of fibre arrangement.

ORIGIN: The origin of the muscle is slightly aponeurotic and mostly fleshy. A thick aponeurotic sheath is attached on the parietal ridge medially and posteriorly to the lambdoidal crest. The fleshy origin is from the parietal bone. The fasciculus runs forward and downward.

Zygomaticus fasciculus:

This is a feebly developed fleshy fasciculus and is situated in between the inner side of the zygomatic arch and the outer surface of the vertical part of the coronoid process. The arrangement of the muscle fibres is of a unipinnate type.
ORIGIN: It arises fleshily from the postero-inner surface of the zygomatic arch and the squamous temporal bone. The fasciculus runs from here in forward and downward directions.

INSERTION: All the fasciculy insert in a common tendinous insertion on the entire length of the coronoid process. Nonetheless, a few fibres of the posterior as well as zygomaticus fasciculus do insert in a fleshy manner on the inner and outer surfaces of the vertical, upwardly projected part of the coronoid process of the dentary.

ACTION: This muscle serves as a main adductor of the jaw. The anterior fasciculus pulls the jaw mainly in an upward direction and slightly in the backward direction. The contraction of the posterior fasciculus pulls the jaw in an upward and a backward directions. Further, the zygomaticus fasciculus draws the jaw mainly posteriorward and slightly upward.

All the fasciculi together bring about an upward pull of the lower jaw.

INNERVATION: All the fasciculi of M. temporalis are innervated by a branch of the 5th mandibular nerve.

M. pterygoideus (Plates XVII to XX):

M. pterygoideus is situated inbetween the lower part of the orbito-temporal fossa on one side and condylar and angular processes on the other. As usual, this muscle
consists of two parts, an externus and an internus. The internus part is better developed of the two.

M. pterygoideus externus:

This is a short and thick muscle situated obliquely inbetween the pterygoid and the condylar processes of the dentary. Distally, it possesses a capsular structure which is attached to the articular disc of the condyle of the mandible. The muscle fibres remain parallel type.

ORIGIN: The muscle arises partly fleshily and partly tendinously from the lower surface of the wall of the temporal fossa and the outer surface of the vertical part of the pterygoid. The lower muscle fibres arise in conjunction with the tendon of the pterygoideus internus.

INSERTION: The muscle inserts mostly tendinously and slightly fleshily on the condylar process. The tendinous insertion is in the form of a capsular structure which fits on the condyle of the mandible. The fleshy insertion on the other hand is on the neck of the mandible, just below the condyle.

M. pterygoideus internus:

This is an elongated massive muscle. It possesses a thick aponeurotic sheath towards the insertion. Two more tendons which arise from the pterygoid bone, are embeded
within the belly towards the origin. Most of the fibres arise from the either surface of the tendons. The muscle fibres show a bipinnate type of arrangement.

ORIGIN: The muscle arises by two heads in a broad and partly fleshy and partly tendinous origin from the lower surface of the wall of orbito-temporal fossa. The upper head arises fleshily from the lower surface of the wall of the orbito-temporal fossa, whereas the lower one arises tendinously from the ventral surface of the palatine and the vertical and lateral portions of the pterygoid bone. The fibres of the upper head run backward and slightly downward so as to attach on the aponeurotic sheath described earlier.

INSERTION: The insertion is partly fleshy and partly tendinous on the inner surface of the angular process of the mandible. The muscle runs from the origin slightly in a downward and backward direction.

ACTION: Both the parts together help in the adduction of the lower jaw. No lateral movement is possible and an upward movement occurs when the M. pterygoideus contracts.

The externus part is comparatively less developed, its contraction brings about the moderate upward movement of the dentary whereas the contraction of the internus part results in the powerful upward movement of the dentary.
INNERVATION: Both the muscles are innervated by a branch of the Vth mandibular nerve.

*M. digastricus* (Plates XVII and XVIII):

This is more or less a strap-shaped muscle, situated on the ventral side of the skull. The muscle extends inbetween the paroccipital process, the periotic region and the distal end of the ramus of the dentary.

The muscle is of an intersectus type, because it consists of two bellies, united by 'S'-shaped tendinous intersection. This tendinous intersection spreads anteriorly in the form of a fasciculus over the posterior region of the mylo-hyoides muscle. Both the fasciculi of the opposite counterparts join medially by an aponeurosis which forms the insertion of the mylo-hyoides muscle. Moreover, both the anterior bellies unite inbetween the two rami by an aponeurotic sheath, which is firmly attached with the mylo-hyoides muscle.

The anterior belly is broader and thicker than its posterior counterpart and runs on the inner-lateral side of the ramus of the dentary. The posterior belly on the other hand is slightly shorter and is situated inbetween the paroccipital process and intermediate tendinous intersection of these two bellies.

ORIGIN: It arises in a narrow, partly tendinous and partly fleshy origin from the paroccipital process of
the exoccipital and from a part of the periotic region of the skull.

**INSERTION**: The muscle inserts in a broad tendinous insertion on the inner ventero-lateral surface of the ramus of the dentary. The insertion occupies nearly a major portion of the ramus.

**ACTION**: The muscle acts in two ways. The main function of the muscle is the depression of the lower jaw, but when the mouth is kept closed, the contraction of the muscle pulls down the mylo-hyoideus muscle resulting in a downward movement of the floor of the buccal cavity. In this way, this muscle also helps in the deglutition of the food from the buccal cavity. Anterior bellies also help in pulling the buccal floor forward and downward.

**INNERVATION**: The anterior belly is innervated by a branch of the Vth mandibular nerve, whereas the posterior belly is innervated by a ramus of the VIIth facial nerve.

The muscles operating the floor of the buccal cavity:

**M. mylo-hyoideus** (Plate XVIII):

The M. transversus mandibularis observed in the Hedgehog is absent in this animal. The M. mylo-hyoideus is situated dorsal to the digastricus muscle in the form of a thin sheet of muscle fibres. It forms the major portion of the floor of the buccal cavity. Towards the
insertion this muscle is covered by the aponeurotic sheath of M. digastricus. The arrangement of the muscle fibres is of a parallel type.

ORIGIN: It arises partly aponeurotically and partly fleshily from the mylohyoid line which is situated on the inner-lateral surface of the ramus of the dentary.

INSERTION: The muscle runs first downward, then in a horizontal plane. The insertion is mostly on the aponeurotic sheath. A few fibres of this muscle also insert fleshily on the basihyal of the hyoid apparatus.

ACTION: As the muscle contracts the buccal floor is raised up. The contraction of this muscle also helps in a forward movement of the hyoid apparatus.

INNERVATION: The muscle is innervated by a branch of the 7th mandibular nerve.

The muscles operating the tongue:

M. genio-hyoideus (Plate XIX):

This is an elongated more or less spear-shaped muscle. It is situated inbetween the body of the dentary and basihyal of the hyoid apparatus. The muscle is situated inner to the M. mylo-hyoideus and remains covered by the aponeurotic sheath of the digastricus. Both the counterparts meet each other postero-medially. The
Plate XIX

Ventral view of the jaw, the tongue and the hyoid muscles of the Bat:

1. Showing the deeper layer of the tongue muscles (M. digast. and M. mylo-hy. removed)
2. Showing the M. genio-gloss. (M. genio-hy. removed)

Legends as in Plates XII and XIV.
arrangement of the muscle fibres remains mostly parallel, nonetheless, a few anterior fibres show a unipinnate type of arrangement.

ORIGIN : It arises in a narrow tendinous origin from the ventro-lateral part of the dentary from where the muscle runs backward towards the hyoid apparatus.

INSERTION : The muscle inserts in a broad and fleshy manner on the antero-ventral edge of the basihyal of the hyoid apparatus. However, a few fibres also extend over the anterior edge of the hypohyal of the hyoid apparatus.

ACTION : The contraction of this muscle brings about a forward projection of the hyoid apparatus. Further, as the mouth is opened, the contraction of the muscle also helps in protruding the tongue out from the buccal cavity.

INNERVATION : The muscle is innervated by a branch of the XIIth hypo-glossal nerve.

M. genio-glossus (Plate XIX) :

This is an elongated, well developed and fan-shaped muscle, situated just inner to the genio-hyoideus muscle. The muscle shows a unipinnate type of fibre arrangement.

ORIGIN : It takes its origin from the same tendon from which arises the M. genio-hyoideus. The origin is inner to the origin of the genio-hyoideus muscle. The muscle fibres arise from the dorsal and lateral surfaces of the
tendinous piece from where the fibres run in an upward and posteriorward directions.

INSERTION: The insertion is mostly on the tongue-pad. A few muscle fibres also insert on the antero-ventral edge of the basihyal.

ACTION: As the muscle contracts, the tongue is protruded out of the buccal cavity. Simultaneously, it also helps in a moderate anteriorward movement of the hyoid apparatus. It may be mentioned here that both the counterparts are situated inbetween the genio-hyoides muscles, and as such help in quick protruding action of the tongue.

INNERVATION: The muscle is innervated by a branch of the XIIth nerve.

*M. stylo-glossus* (Plate XIX, 1):

This is much elongated, ribbon-shaped well developed muscle, which runs anteriorward from the paroccipital process and periotic region of the skull from where it extends upto the tongue. The anterior portion of the muscle is situated just dorsal to the mylo-hyoides muscle, whereas the posterior portion is situated just dorsal to the posterior belly of the digastricus muscle which covers the former. The muscle fibres are arranged in a parallel fashion.

ORIGIN: The muscle arises partly fleshily and partly
by a thin tendon from the inner surface of the paroccipital process of the exoccipital and from the periotic region of the skull.

**INSERTION** : The insertion of the muscle is fleshy on the antero-ventral and lateral surfaces of the tongue. The insertion of this muscle is just lateral to the insertion of the genio-glossus muscle.

**ACTION** : The contraction of this muscle helps in the retraction of the tongue.

**INNERVATION** : The muscle is innervated by a branch of the XIIth nerve.

**M. hyo-glossus** (Plate XIX):

The muscle is well developed with broad posterior end. It is situated as usual inbetween the hyoid apparatus and tongue. The muscle is observed just inner to the well developed M. stylo-glossus.

**ORIGIN** : The muscle arises fleshily from the depression of the basihyal and the thyrohyal of the hyoid apparatus. The muscle fibres arise from the ventral surface of the basihyal and from the outer lateral surface of the thyrohyal. From the origin the muscle runs anteriorward towards the tongue.

**INSERTION** : The muscle inserts in a fleshy manner on the lateral surface of the tongue.
ACTION: The contraction of the muscle helps in the retraction of the tongue.

INNERVATION: The muscle is innervated by a branch of the XIIth nerve.

The muscles responsible for the hyoid movements:

**M. stylo-hyoideus (Plate XIX):**

This is a feebly developed, elongated, ribbon-shaped muscle, which runs forward and slightly inward from the paroccipital process.

ORIGIN: The muscle arises internal to the origin of the stylo-glossus muscle.

INSERTION: The insertion of the muscle is on the dorsal edge of the thyrohyal of the hyoid apparatus.

ACTION: The contraction of the muscle helps in a moderate posteriorward and upward movements of the thyrohyal, resulting in a posteriorward and upward pulling of the hyoid apparatus.

INNERVATION: The muscle is innervated by a small ramus of the VIIth facial nerve.

**M. sterno-hyoideus (Plates XVIII and XIX):**

This is an elongated, ribbon-shaped muscle, lodged inbetween the sternum and the hyoid apparatus. The
muscle runs along the ventero-lateral side of the trachea. The two counterparts remain slightly associated towards the insertion. The arrangement of the muscle fibres is of a parallel type.

ORIGIN: The origin of the muscle is partly fleshy and partly tendinous from the antero-dorsal surface of the sternum.

INSERTION: The muscle inserts partly fleshily and partly by a thin tendon on the postero-ventral edge of the basihyal.

ACTION: By its contraction the hyoid apparatus is pulled backward and downward. This movement helps in the swallowing process of the food.

INNERVATION: The innervation of this muscle is by a branch of the 2nd cervical nerve.

M. sterno-thyroideus (Plates XVIII and XIX):

It is also an elongated ribbon-shaped muscle like that of the sterno-hyoideus. It is situated just above the M. sterno-hyoideus. The muscle extends from the sternum to the thyroid cartilage. The arrangement of the muscle fibres remains of a parallel type.

ORIGIN: It forms a common origin with the sterno-hyoideus muscle from the sternum.
INSERTION: The muscle inserts partly fleshily and partly by a thin tendinous piece on the posterior edge of the thyroid cartilage.

ACTION: As the muscle contracts, the thyroid cartilage is pulled backward and downward resulting in further pulling of food from the mouth.

INNERVATION: The muscle is innervated by rami of 1st and 2nd cervical nerves.

M. crico-thyroideus (Plate XIX):

This is a short, more or less fan-shaped thin sheet of muscle which runs from the cricoid cartilage to the thyroid cartilage. The two counterparts are slightly separated anteriorly.

ORIGIN: It arises by a thin aponeurotic tendon from the postero-ventral surface of the cricoid cartilage from where the fibres run in a forward and outward direction.

INSERTION: The muscle inserts in a broad manner by a thin tendon on the posterior edge of the thyroid cartilage.

ACTION: By the contraction of this muscle, the thyroid cartilage is pulled backward and downward. Thus, this muscle helps in gulping of food.

INNERVATION: The muscle is innervated by a branch of the XIIth hypoglossal nerve.
Plate XX

1. Ventral view of the jaw muscles of the Bat (tongue and the hyoid apparatus removed)
2. Dorsal view of the jaw muscles of the Guinea-pig

Legends as in Plates XII and XIV.
M. thyro-hyoideus (Plate XIX):

This is a small more or less triangular-shaped muscle situated inbetween the thyroid cartilage and the basihyal of the hyoid apparatus. The muscle is observed just anterior to the M. crico-thyroideus and M. sterno-thyroideus. The arrangement of the muscle fibres remains parallel.

ORIGIN: The muscle arises fleshily from the postero-ventral edge of the thyroid cartilage and runs anteriorward so as to reach upto the thyrohyal.

INSERTION: The insertion of this muscle is fleshy and broad on the posterior margin of the thyrohyal just behind the insertion of the sterno-hyoideus muscle.

ACTION: The contraction of the muscle helps in a moderate backward movement of the hyoid apparatus.

INNERVATION: The innervation of this muscle is by a small twig of the XIIth nerve.

M. omo-hyoideus (Plates XVIII and XIX, t):

This is a ribbon-shaped muscle situated obliquely in the neck region inbetween the scapula and the hyoid apparatus. A tendinous intersection is present, nearly in the mid-region of the muscle. The muscle fibres are arranged in a parallel fashion.
ORIGIN: The muscle arises by a thin tendinous piece from the antero-ventral surface of the scapula from where it runs forward and inward towards the hyoid apparatus.

INSERTION: The insertion of the muscle is by a thin tendon on the posterior edge of the thyrohyal. The insertion is just anterior to that of the thyro-hyoideus muscle.

ACTION: The contraction of this muscle results in a sideward movement of the hyoid apparatus helpful in the engulfing process of the food.

INNERVATION: The muscle is innervated by a branch from the 1st cervical nerve.

Guinea-pig (Cavia porcellus):

Muscles of mastication:

M. masseter (Plates XXI to XXIV):

This is a massive and very well developed muscle which spreads on the lateral side of the skull. It extends from the infraorbital foramen and the zygomatic arch to the posterior region of ramus of the dentary. The muscle is divided into three main parts, viz., the pars superficialis, the pars lateralis and the pars profundus. The pars profundus is further divided into a pars anterioris and a pars posterioris.
Pars superficialis:

This is a well developed counterpart and covers most of the latero-outer portion of the ramus of the dentary. It occupies the space inbetween the ventral edge of the zygomatic arch and the anguloid process of the dentary. The muscle is provided with a stout tendinous cord towards its anterior end. A thick aponeurotic sheath arises from this tendon. The cord runs into the belly of the muscle and forms a calcified knob-like structure from where two tendinous strips arise. They run obliquely downward and inward. A thick membranous tendon is also observed towards the insertion. In view of the attachment of the muscle fibres with these tendinous structures, the entire muscle as a whole shows a complicated pinnate pattern of the fibre arrangement.

ORIGIN: The pars superficialis arises slightly in a cord-like tendon but mostly by a thick aponeurosis from the ventral edge and antero-ventral surface of the zygomatic arch. The tendinous origin is from a well developed depression of the zygomatic arch situated antero-ventrally. The aponeurosis on the other hand, arises from the ventral edge of the zygomatic arch behind the depression. Most of the muscle fibres arise from the ventral surface of this thick aponeurosis. All the muscle fibres, irrespective of their origin, run downward and backward. Some fibres also run in the inward direction.
Plate XXI

Lateral views of the jaw muscles of the Guinea-pig:

1. Showing the superficial layer of muscles
2. Showing the M. mass, pars lat. (M. mass, pars sup. removed)

Prof.Ant.- Masseter pars profundus anterioris; Mass.
Pars.Prof.Post.- Masseter pars profundus posterioris.

Other legends as in Plates XII and XIV.
INSERTION: Pars superficialis inserts partly fleshily and partly tendinously on the latero-ventral and the inner surfaces of the anguloid process of the dentary. The tendinous insertion is deeper and can be seen only after the removal of the superficially disposed fibres.

**Pars lateralis** (Plate XXI, 2):

It is a more or less quadrilateral piece of muscle, situated inbetween the zygomatic arch and the anguloid process. By comparison it is less developed than its superficial counterpart.

**ORIGIN:** The muscle arises mainly in a fleshy and slightly in a tendinous origin from the inner surface of the zygomatic arch and its fibres run downward and backward.

**INSERTION:** The insertion is mostly tendinous and slightly fleshy to certain extent on the outer-lower surface of the posterior part of the ramus of the dentary.

**Pars profundus** (Plates XXI to XXIV):

This is a well developed fan-shaped muscle which extends from the upper side of the skull with the wall of the infraorbital canal and zygomatic arch and the mid-region of the dentary. The muscle is divided into two parts, an anterior and a posterior both of which merge into a single muscle towards the insertion. The anterior part is provided internally with a cord-like tendinous structure which at its distal end, forms a strong bulbous calcified structure.
Plate XXII

1. Lateral view of the jaw muscles of the Guinea-pig showing the M. mass. pars prof. (M. mass. pars sup. and the M. mass. pars lat. removed and the zygomatic arch cut)

2. Ventral view of the jaw, the buccal floor, the tongue and the hyoid muscles of the Guinea-pig, showing the superficial layer of muscles

Legends as in Plates XII and XIV.
ORIGIN: The anterior part arises in a narrow partly tendinous and partly fleshy origin from a depression behind the premaxillo-maxillary suture. The muscle fibres run backward and downward.

The posterior part on the other hand arises in a broad more or less tendinous origin from the entire inner surface of the zygomatic arch. This part runs anteriorward and downward.

INSERTION: The insertion of the pars profundus is partly tendinous and partly fleshy on a well developed groove-like depression formed by the masseteric ridge which is situated in a curve-like fashion below the coronoid process. Most of the muscle fibres of the anterior part are attached on a cord which inserts in a pit developed towards the proximal end of the groove-like depression formed by the masseteric ridge.

ACTION: The contraction of the pars superficialis muscle helps in two ways. As this muscle contracts, the lower jaw is pulled upward and forward. As a result, the masticatory surfaces of the lower jaw teeth come in contact with the corresponding masticatory surfaces of the teeth of the upper jaw. Further, as the lower jaw moves forward, the incisors of both the jaws also come in contact with each other enabling chiselling action of the incisors. This helps in nipping the diet such as grass and other herbivorous products.
The contraction of the pars lateralis assists in upward pulling of the dentary.

The main muscle which brings about a forward movement of the lower jaw is pars profundus anterioris. Besides, the muscle also helps in the adduction of the dentary. The pars profundus posterioris muscle helps in a backward gliding of the lower jaw over the upper one.

Thus the combined action of the different counterparts results in the nipping, the cutting, the crushing and the chewing of the food.

INNERVATION: The different parts of the M. masseter are innervated by rami of the Vth mandibular nerve.

M. temporalis (Plates XX, 2; XXI and XXII, 1):

This is a feebly developed masticatory muscle situated on the postero-lateral wall of the cranium. The muscle extends from the mid-region of the parietal and squamous temporal bones to the small coronoid process of the dentary. The muscle runs anteriorward and downward within the moderately developed temporal fossa.

The muscle is divided into an anterior and a posterior parts. The zygomatic fasciculus and superficial aponeurotic sheath are absent which are present in the mongoose, the bat and the hedgehog.
Anterior fasciculus:

This is a feebly developed fasciculus occupying the anterior region of the temporal fossa. The muscle remains in close association with the supraorbital process, its posterior counterpart and its fibres are arranged in a unipinnate fashion.

ORIGIN: The muscle arises slightly aponeurotically and mostly fleshily. The aponeurotic origin is from the feebly developed supraorbital process, the anterior region of the parietal ridge and the squamous temporal bone, whereas, the fleshy origin is from the wall of the temporal fossa. The muscle runs forward and downward towards the coronoid process.

Posterior fasciculus:

This is a well developed fasciculus situated behind the anterior one and is attached on the upper side with the parietal, interparietal and the squamous temporal bones and on the lower side with the coronoid process of the dentary. Both the muscles of the opposite sides do not meet on the parietal suture as observed in the carnivorous mongoose where highly developed temporal muscles meet on the parietal crest.

ORIGIN: The origin of the muscle is broad, mostly fleshy and slightly aponeurotic. Most of the fibres arise fleshily from the wall of the parietal and squamous temporal bones.
INSERTION: Both the fasciculi of the temporalis muscle together insert on a common tendon which is long and attached with the small coronoid process of the dentary. A few fibres also insert fleshily on the inner surface of the coronoid process.

ACTION: The moderate development of the muscle results in not powerful adduction of the lower jaw. The muscle also helps in the backward movement of the dentary. This backward movement is particularly helpful in the chewing process.

INNERVATION: Both the fasciculi of the temporalis muscle are innervated by a branch of the Vth mandibular nerve.

M. pterygoideus (Plates XXII to XXV):

This is a very well developed and massive muscle. It is situated inbetween the anguloid and condyloid processes on one side and the pterygoid bone on the other. The muscle consists of an externus and an internus parts.

M. pterygoideus externus:

This part is less developed than its internus counterpart and is situated inbetween the pterygoid bone and the condylar process of the dentary. The muscle shows a unipinnate type of fibre arrangement.

ORIGIN: The origin of the muscle is narrow, partly
tendinous and partly fleshy from the pterygoid, squamous temporal and alisphenoid bones. The tendinous origin is from the anterior and the lateral edges of the more or less elliptical well developed mesopterygoid fossa which is formed by the pterygoid, alisphenoid and palatine bones. The fleshy origin is just postero-lateral to this fossa from the alisphenoid. The muscle fibres run backward, outward and slightly in an upward direction.

INSERTION: The muscle inserts partly by a tendinous capsule which fits on the condylar process of the mandible. The remaining fibres however, insert fleshily directly on the neck of the mandible below the condylar process.

**M. pterygoideus internus:**

This is a well developed muscle with a broad belly extending from the pterygoid bone to the anguloid process. It may be mentioned here that the pterygoid process of the palatine, pterygoid process of the alisphenoid and the pterygoid itself, together form a wide conical pterygoid fossa behind the molar teeth and the M. pterygoideus arises from this fossa.

The fibres of this muscle are supported by tendinous sheets two of which are situated towards the origin, whereas, the remaining three support the fibres towards the insertion. Because of these intervening tendons, the muscle presents a complicated pinnate structure.
ORIGIN: The muscle arises partly fleshily and partly in the form of the tendinous sheets mentioned earlier. The fleshy origin is from the deep surface of the pterygoid fossa. After arising from this fossa, some fibres attach distally along the inner surface of the outer tendinous sheath of the two. The other fibres arise from the inner sheath, run outward, backward and some of them attach on another tendinous sheath which covers the inner surface of the muscle towards the insertion. The remaining fibres insert on a median tendinous sheath. Fibres also arise from internal sheath along its external surface from where they run outward and attach on still another sheath situated externally towards the insertion.

INSERTION: The muscle fibres arising from the fleshy origin as well as from the three tendons insert broadly along the entire inner surface of the anguloid process of the dentary.

ACTION: Both the externus and the internus parts of the pterygoideus run obliquely outward and backward and as such are useful for upward and sideward movements of the lower jaw. The dentition also does not prevent a sideward movement as observed in mongoose and bat. So, based on their position, besides an upward movement, the muscle brings about an effective sideward movement in which an internus part plays a major part. During the simultaneous contractions of the temporalis, masseter, and pterygoideus, the latter also helps in gliding type of forward movement of the lower jaw.
The sideward movement of the muscle is particularly helpful in the chewing of the food.

INNERVATION: The externus as well as the internus part of the M. pterygoideus are innervated by a branch of the Vth mandibular nerve.

M. digastricus (Plates XXI and XXII):

This is a dumb-bell-shaped muscle, situated inbetween the dentary and the paroccipital process of the exoccipital. The muscle is well developed but a wide space exists inbetween the two counterparts. The muscle has two bellies separated by a long and thick tendon. It is thus a conjunctus type of muscle. The muscle fibres show a unipinnate type of arrangement.

The anterior belly is more massive and fan-shaped than its posterior counterpart and is situated behind the symphysis of the lower jaw.

ORIGIN: The origin of the muscle is narrow, partly tendinous and partly fleshy from the inner distal surface of the paroccipital process and the muscle runs anteriorward and inward.

INSERTION: The muscle inserts in a broad, partly tendinous and partly fleshy insertion on the ventral, inner and lateral surfaces of the dentary, behind the symphysis. It may be mentioned here that, the muscle is not connected with the M. mylo-hyoideus or the hyoid apparatus.
ACTION: The contraction of this muscle brings about the depression of the lower jaw.

INNERVATION: As usual, the anterior belly of the muscle is innervated by a ramus of the V\textsuperscript{th} mandibular nerve and the posterior belly is innervated by a branch of the VII\textsuperscript{th} facial nerve.

The muscles operating the floor of the buccal cavity:

\textit{M. transversus mandibulae} (Plates XXI and XXII):

This is a small, but thick and transverse sheet of muscle, interspread with the tendinous fibres. The muscle is situated just behind the symphysis inbetween the rami of the dentary, anterior to the insertion of the \textit{digastricus} muscle. Thus it forms a continuous sheet of muscle behind the symphysis.

ACTION: As this is movable symphysis mandibulae, the contraction of the muscle helps in the moderate anteriorwards and posteriorwards movements of both the rami of the lower jaw.

INNERVATION: The innervation of this muscle is by a small branch of the mylo-hyoideus nerve.

\textit{M. mylo-hyoideus} (Plates XXII and XXIII):

The muscle forms a major portion of the floor of the buccal cavity. It is mainly in the form of a muscular
sheet, situated above the digastricus muscle and occupies a major portion of the space in between the two rami of the dentary. Medially it is provided with a tendinous sheath.

ORIGIN: The origin of the muscle is fleshy from the obliquely situated mylohyoid line of the dentary, from where the muscle runs downward and slightly backward in a horizontal plane.

INSERTION: Most of the muscle fibres attach on the upper side of the median tendon. This tendon inserts on the lateral arms of the basihyal of the hyoid apparatus. A few fibres, however, insert fleshily directly on the lateral arms of the basihyal just below this tendon.

ACTION: As the muscle contracts the hyoid apparatus is pulled upward and slightly anteriorward resulting in the upward movement of the floor of the buccal cavity.

INNERVATION: The muscle is innervated by the mylo-hyoideus nerve.

The muscles operating the tongue:

_M. genio-hyoideus_ (Plates XXII and XXIII):

This is a more or less spindle-shaped massive muscle situated in between the dentary and the hyoid apparatus. The muscle shows a unipinnate type of fibre arrangement.
Plate XXIII

Ventral views of the jaw, the tongue and the hyoid muscles of the Guinea-pig:

1. Showing the deeper layer of muscles (M. digast. and the M. trans. mand. removed)
2. Showing the deeper layer of the tongue muscles (M. mylo-hy. removed)

Legends as in Plates XII and XIV.
ORIGIN: The muscle arises in a narrow, tendinous origin from a depression situated on the postero-lateral surface of the symphysis of the dentary. All the muscle fibres run slightly inward and then in a backward direction towards the hyoid apparatus.

INSERTION: Most of the muscle fibres insert on the tendon of the mylo-hyoideus muscle. The remaining fibres, however, insert directly on the basihyal.

ACTION: As the muscle contracts, the hyoid apparatus is pulled in an upward and a forward direction. As a result the food is forced towards the gullet and facilitate in gulping. Moreover, it also helps in the lowering down and simultaneously bring about a forward movement of the buccal floor.

INNERVATION: The muscle is innervated by a branch of the XIIth hypo-glossal nerve.

M. genio-glossus (Plates XXIII and XXIV):

This is a well developed more or less fan-shaped muscle and is connected with the tongue-pad as well as with the hyoid apparatus. The muscle lies inner to the genio-hyoideus muscle as observed in the bat. The fibres are arranged in a unipinnate fashion, but posteriorly mostly a bipinnate arrangement is formed as some fibres, after arising from the lower surface of the tendon, gain their attachment on the hyoid apparatus.
ORIGIN: The muscle arises mostly in a tendinous and slightly in a fleshy origin in such a way that the latter joins along the median line behind the symphysis. This tendon is thick and long. The tendon is attached with the dentary towards the symphysis just posterior and inner to the origin of the genio-hyoideus muscle and distally it provides attachment with the hyoid apparatus. The muscle fibres thus form a uni- and bi-pinnate types of arrangement.

INSERTION: The muscle inserts fleshily mostly on the ventral part of the pad of the tongue. A few fibres also insert on the anterior surface of the basihyal.

ACTION: The contraction of this muscle brings about the protruding out of the tongue as well as forward movement of the hyoid apparatus. Such an action helps in ingestion of the food into mouth as well as the gulping of the food from the mouth.

INNERVATION: The innervation of this muscle is by a ramus of the XII\textsuperscript{th} hypo-glossal nerve.

\textit{M. stylo-glossus} (Plates XXIII and XXIV):

This is more or less a fan-shaped muscle, situated in between tongue and anterior cornu of the hyoid apparatus. The muscle fibres are arranged in a parallel fashion.

ORIGIN: The muscle arises in a fleshy origin from the
Plate XXIV

Ventral views of the jaw, the tongue and the hyoid muscles of the Guinea-pig:

1. Showing the deeper layer of the tongue and the hyoid muscles (M. genio-hy. and the M. sterno-hy. removed)

2. Showing the M. hyo-glossus (M. stylo-gloss. and the M. genio-gloss. of one side removed)

Legends as in Plates XII and XIV.
ceratohyal of the hyoid apparatus, from where the muscle runs forward and slightly inward towards the tongue.

INSERTION: The insertion of this muscle is fleshy on the lateral surface of the tongue.

ACTION: The contraction of the muscle assists in the retraction of the tongue.

INNERVATION: A branch of the XIIth hypo-glossal nerve innervates this muscle.

M. hyo-glossus (Plate XXIV,2):

This is a very well developed muscle, extends from the hyoid apparatus and runs up to the tongue. The muscle is situated just inner to the stylo-glossus and outer to the genio-glossus muscles. The arrangement of the muscle fibres remains parallel type.

ORIGIN: The muscle arises in a broad and fleshy origin from the latero-outer surface of the basi- and hypo-hyals, from where the muscle runs anteriorwards. Most of the muscle fibres arise from the basihyal and lingual process of the hyoid apparatus.

INSERTION: The insertion of this muscle is narrow and fleshy on the lateral portion of the tongue.

ACTION: As the muscle contracts, the protruding tongue retracts back into the buccal cavity.
INNERVATION: The muscle is innervated by a branch of the XIIth hypoglossal nerve.

The muscles responsible for the hyoid movements:

M. stylo-hyoideus (Plates XXIII and XXIV):

This is a small, more or less spindle-shaped muscle. It extends inbetween the paroccipital process and stylohyal of the hyoid apparatus, above the posterior belly of the digastricus muscle. The muscle fibres are arranged in a unipinnate fashion.

ORIGIN: The muscle arises in a broad tendinous strip-like origin from the inner surface of the paroccipital process of the exoccipital bone.

INSERTION: The muscle runs obliquely forward and inserts fleshily on the inner surface of the stylohyal. The insertion also extends slightly over the ceratohyal.

ACTION: When the muscle contracts, the hyoid apparatus moves moderately in a downward direction, a process which helps in the engulfing process of food.

INNERVATION: The muscle is innervated by the VIIth facial nerve.

M. sterno-hyoideus (Plates XXI, XXII and XXIII):

This is a strip-shaped muscle running from the
Plate XXV

1. Ventral view of the jaw muscles of the Guinea-pig showing the M. pterygoideus
2. Dorsal view of the jaw muscles of the Mongoose

Legends as in Plates XII and XIV.
sternum anteriorward towards the hyoid apparatus, ventero-lateral to the trachea. The fibres show a parallel type of arrangement.

ORIGIN: The muscle arises in a fleshy origin from the antero-dorsal surface of the sternum and runs forward.

INSERTION: The insertion of the muscle is fleshy on the well developed depression formed by the basihyal of the hyoid apparatus.

ACTION: As the muscle contracts, the hyoid apparatus is pulled backward and downward. This facilitates the gulping of the food by pushing it towards the gullet.

INNERVATION: The muscle is innervated by a branch of the 2nd cervical nerve.

M. sterno-thyroideus (Plates XXI, 2; XXII, XXIII and XXIV):

This is a poorly developed, ribbon-shaped muscle, which runs dorsally to the sterno-hyoideus muscle. The muscle fibres are arranged in a parallel fashion.

ORIGIN: The origin of the muscle is from the dorsal aspect of the sternum and the sterno-hyoideus muscle. The muscle runs forward towards the thyroid cartilage.

INSERTION: The muscle inserts fleshily on the postero-outer edge of the thyroid cartilage.
ACTION: The contraction of this muscle results in a moderate backward and downward movement of the hyoid apparatus.

INNERVATION: A branch of the 2nd cervical nerve innervates this muscle.

**M. crico-thyroideus (Plate XXIV):**

This is a short and fan-shaped muscle, which covers most of the ventral part of the cricoid cartilage. The muscle fibres are arranged in a parallel fashion.

ORIGIN: The muscle arises mostly in a fleshy origin from the posterior edge of the cricoid cartilage. A few fibres however, also arise from a thin tendinous piece.

INSERTION: After running obliquely from the origin, the muscle inserts fleshily on the posterior edge of the thyroid cartilage, anterior to the insertion of the sterno-thyroideus muscle.

ACTION: As the muscle contracts, the thyroid cartilage moves in a backward and downward direction and thereby helps in the swallowing process of the food.

INNERVATION: This muscle is innervated by a small twig of the XIIth hypo-glossal nerve.

**M. thyro-hyoideus (Plate XXIV):**

This is a small triangular-shaped muscle situated
just above the sterno-hyoideus muscle. The arrangement of the muscle fibres is of parallel type.

ORIGIN: It arises in a narrow, fleshy origin from the posterior edge of the thyroid cartilage. The origin of the muscle is just anterior to the insertions of the crico-thyroideus and sterno-thyroideus muscles. The muscle runs anteriorward.

INSERTION: The insertion of the muscle is fleshy and broad on the posterior edge of the thyrohyal of the hyoid apparatus.

ACTION: By its action, the hyoid apparatus is pulled backward and helps in swallowing of the food.

INNERVATION: This muscle is innervated by a small branch of the XIIth hypo-glossal nerve.

M. omo-hyoideus:

This muscle observed in the Hedgehog and the Bat is absent in this mammal.

Mongoose (Herpestis gresius):

Muscles of mastication:

M. masseter (Plates XXVI to XXX):

This is a well developed, more or less quadrilateral compact piece of muscle, situated inbetween the zygomatic
arch and the posterior part of the ramus of the mandible. The muscle is divided into three parts, viz., 1. pars superficialis, 2. pars medialis and 3. pars profundus.

**Pars superficialis:**

This is the most massive of all the parts and is covered mostly by a thick and stout aponeurotic sheath except towards the insertion where it remains uncovered. The arrangement of the muscle fibres is of a unipinnate type. However, some fibres also show a parallel type of arrangement.

**ORIGIN:** It arises in a slightly fleshy and mostly in an aponeurotic origin. The aponeurotic sheath arises from the entire length of the outer surface of the zygomatic arch. Most of the muscle fibres arise from the inner surface of this sheath, but a few fibres also arise from the outer and ventral surfaces of the zygomatic arch.

**INSERTION:** The muscle inserts partly tendinously and partly fleshy on the anguloid process of the mandible, and the ventral edge of the dentary. Most of the muscle fibres which arise from the aponeurotic sheath first gain attachment on a fan-shaped tendon, which ultimately inserts on the anguloid process and the ventral edge of the ramus of the dentary. These muscle fibres exhibit a unipinnate pattern of arrangement. The remaining muscle fibres which arise from ventral and inner surfaces of the zygomatic
Plate XXVI

Lateral views of the jaw muscles of the Mongoose:

1. Showing the superficial layer of muscles
2. Showing the M. mass. pars med. and a part of the M. ptery. int. (M. mass. pars sup. removed)

Mass. Pars Med. - Masseter pars medialis

Other legends as in Plates XII and XIV.
arch, insert directly fleshily on the ventral edge of the dentary. These fibres show a parallel type of arrangement.

**Pars medialis (Plate XXVI, 2):**

By comparison this is a less developed part and is lodged just below the superficial counterpart, inbetween the zygomatic arch and the massetric fossa of the mandible. The muscle fibres are arranged in a unipinnate fashion.

**ORIGIN:** It arises slightly aponeurotically and mostly fleshily from the entire inner surface of the zygomatic arch and the muscle fibres run downward towards the lower edge of the masseteric fossa.

**INSERTION:** The insertion is tendinous along the entire lower ridge of the masseteric fossa.

**Pars profundus (Plate XXVII, 1):**

This part is more or less equally developed to that of the pars medialis and is situated inbetween the posterior part of the zygomatic arch, the condyle of the mandible and the masseteric fossa. Superficially, it is provided with a thick aponeurotic sheath which covers all the muscle fibres except a few towards the anterior region. The muscle fibres are arranged in a unipinnate fashion.

**ORIGIN:** It arises tendinously in a narrow origin from the outer surface of the condylar process of the mandible as well as from the outer postero-ventral part of the zygomatic arch.
Plate XXVII
Plate XXVII

Lateral views of the jaw muscles of the Mongoose:

1. Showing the M. mass. pars prof. (M. mass. pars med. removed)

2. Showing the deep layer of the jaw muscles (M. mass., the zygomatic arch and the ramus of the dentary cut)

Legends as in Plates XII and XIV.
INSERTION: The muscle runs obliquely anteriorward and downward towards the masseteric fossa and fills the entire deep depression of the latter. The insertion is fleshy, broad and compact.

ACTION: As the pars superficialis contracts, the dentary is pulled upward. This action helps in maintaining a tight grip over the prey and also in the tearing of the flesh and crushing hard bones.

The contraction of the pars medialis also brings about an upward movement of the mandible and thus accelerates the function of the pars superficialis.

The contraction of the pars profundus part helps in the postero-dorsal movement of the mandible.

Thus all these parts together help in the upward pull of the dentary.

INNERVATION: All these different parts of the M. masseter are innervated by a branch of the 5th mandibular nerve.

M. temporalis (Plates XXV, 2 to XXX):

It is a very well developed, massive and more or less fan-shaped muscle. The muscle is lodged inbetween the wall of the temporal fossa and the dentary. It consists of three fasciculi viz., an anterior, a posterior and a zygomaticus. All these fasciculi are covered by a common aponeurosis which is thick, stout and tendinous. This
The aponeurotic sheath is attached anteriorly with the supraorbital process, dorsally with the parietal crest and posteriorly with the lambdoidal crest and most of the part of the upper edge of the zygomatic arch. The muscle fibres of the anterior fasciculus arise from the inner surface of this sheath.

**Anterior fasciculus**:

This is a more or less fan-shaped fasciculus, situated on the anterior part of the temporal fossa.

**ORIGIN**: It arises mostly aponeurotically and partly fleshy. Most of the muscle fibres arise from the inner surface of the aponeurotic sheath whereas, a few fibres also arise directly from the wall of the temporal fossa. They exhibit parallel arrangement.

**Posterior fasciculus**:

It is a very well developed, massive fasciculus. Anteriorly and ventrally, it is covered by its counterparts whereas, posteriorly it occupies the space inbetween these fasciculi and the coronoid process.

**ORIGIN**: It arises in a broad, mostly fleshy and slightly aponeurotic origin from the major portion of the wall of the temporal fossa. The aponeurotic origin is from the parietal and lambdoidal crests. Most of the muscle fibres which arise from the wall of the temporal fossa run downward and forward towards the coronoid process.
Zygomaticus fasciculus:

This fasciculus is feebly developed and is situated along the inner side of the zygomatic arch. The fibres run anteriorward towards the coronoid process of the dentary.

ORIGIN: It arises partly tendinously and partly fleshily from the inner surface of the posterior end of the zygomatic arch as well as from the inner surface of the lambdoidal crest.

INSERTION: All the fasciculi run anteriorward towards the coronoid process of the dentary. Here most of the fibres gain attachment on a common broad tendinous piece which inserts along the edge of the coronoid process. A few fibres, however, insert fleshily on the coronoid process internal to the tendinous insertion.

ACTION: The contraction of the muscle helps in the tight holding up of the prey and prevents its escape. The muscle also helps in crushing the hard bones and tearing the large pieces of flesh into smaller bits. When the muscle contracts the teeth of the dentary fit into the gaps formed by the corresponding teeth of the upper jaw.

INNERVATION: The different fasciculi of the temporalis muscle are innervated by a branch of the Vth mandibular nerve.
M. pterygoideus (Plates XXVI, 2; XXVII, XXVIII, 2; XXIX and XXX):

The muscle is well developed, compact and is provided with highly tendinous materials. It extends inbetween the pterygoid complex on one side and the anguloid and the condylar processes on the other side. It is divided further into two parts viz., an externus and an internus.

M. pterygoideus externus (Plate XXVII, 2):

It is a small muscle and is situated obliquely inbetween the condylar process of the dentary and the pterygoid bone.

ORIGIN: The muscle arises partly tendinously and partly fleshily from the lower surface of the wall of the temporal fossa and the dorso-lateral surface of the pterygoid complex. The tendinous origin is from the pterygoid bone and the tendon is attached with the tendon of its internus counterpart whereas some fibres arise directly from the lower wall of the temporal fossa.

INSERTION: The insertion of the muscle is also partly tendinous and partly fleshy. The tendinous insertion is in the capsular structure which fits on the condyle of the mandible, whereas, the fleshy insertion is in the depression below the condyle of the mandible, i.e. in the neck of the mandible.
M. pterygoideus internus:

It is a well developed muscle, situated just below its externus counterpart. A thick aponeurotic sheath covers over half of its antero-dorsal surface. Two more tendinous membranes are embedded within the mass of the belly. Another membrane which is observed ventrally is also partly embedded within the muscle fibres.

The muscle shows a complicated bipinnate type of fibre arrangement. The muscle fibres arising directly from the lower wall of the orbit are attached on the lower surface of the aponeurotic sheath whereas, remaining fibres arise which from the inner surface of this aponeurotic sheath run obliquely posteriorward so as to attach on the tendon embedded within the muscle mass. Some of the muscle fibres remain attached inbetween these two tendons of the belly. The muscle fibres arising from the inner surface of the ventral tendon run posteriorward so as to attach on the another embedded tendon of the belly described earlier.

ORIGIN: The muscle arises in a broad, partly tendinous and partly fleshy origin from the shallow and elongated mesoptrygoid fossa, hamulus of pterygoid, lower wall of the orbit and the ventral part of the squamous bone. The tendinous origin of this muscle is from either surface of lateral part of the pterygoid bone whereas, remaining fibres arise fleshily from the lower wall of the orbit.
Thus, the origin of this muscle, as in the bat, is by two heads.

**INSERTION**: The muscle inserts mostly tendinously and slightly fleshily in the depression situated on the inner side of the anguloid process of the dentary. Most of the muscle fibres run obliquely backward and directly insert on the inner surface of the anguloid process, whereas the remaining fibres insert on the ventral as well as dorsal surfaces of the anguloid process.

**ACTION**: As the externus part contracts, it pulls the dentary upward. As a result, the condylar process rotates in the corresponding mandibular fossa of the squamous bone. Consequently, the teeth of the dentary fit into gaps of the upper dentition.

When the internus muscle contracts, the dentary is pulled upward very powerfully and brings about a closer contact inbetween the articular condyle and the mandibular fossa. Such an action of both the parts together helps in maintaining a tight grip over the prey.

**INNERVATION**: Both these parts of the pterygoideus muscle are innervated by a branch from the Vth mandibular nerve.

*M. digastricus* (Plates XXVI, XXVII,1 and XXVIII,1): This is a very well developed, compact and intersectus type of muscle, situated inbetween the ventral
surface of the dentary and the bulla-tympanica. It is composed of two bellies, an anterior and a posterior one. The two bellies are connected by an intermediate tendinous intersection which runs forward over the mylo-hyoideus muscle and on which it is firmly attached.

ORIGIN: The muscle arises by a tendinous strip from the postero-ventral surface of the bulla-tympanica. It moves downward, forward and slightly inward towards the body of the dentary.

INSERTION: The insertion of the muscle is by a thick and long tendinous piece on the ventero-lateral surface of the dentary behind the symphysis.

ACTION: The contraction of this muscle pulls the jaw backward and downward as a result of which the mouth opens wide. This muscle also helps in lowering down of the buccal floor as the intersecting tendon is connected with the M. mylo-hyoideus.

INNERVATION: The anterior belly of the muscle is innervated by a branch of Vth mandibular nerve whereas the posterior belly is innervated by a branch of the VIIth facial nerve.

The muscles operating the floor of the buccal cavity:

M. transversus mandibularis:

This muscle, like in the Bat, is also absent in this animal.
Plate XXVIII

Ventral views of the jaw, the buccal floor, the tongue and the hyoid muscles of the Mongoose:

1. Showing the superficial layer of the muscles
2. Showing the deeper layer of muscles (M. digast. removed)

Legends as in Plates XII and XIV.
M. mylo-hyoideus (Plates XXVI, 2; XXVII, 2 and XXVIII):

This is much elongated and triangular in shape. Anteriorly, it becomes narrow and reaches just behind the symphysis of the mandible. The muscle is situated inbetween the two rami of the dentary. The position of the muscle is most ventral on the floor of the buccal cavity in the form of a thin sheet of muscle fibres. Medially, it is covered by a thick triangular-shaped tendinous sheath of the digastricus muscle described earlier.

ORIGIN: It arises slightly tendinously and mostly fleshily from the mylo-hyoid line of the dentary. The muscle runs downward, inward and also anteriorward, so as to meet its fellow of the opposite side along the median line.

INSERTION: Both the counterparts meet along the median line and posteriorly they are attached with the basihyal of the hyoid apparatus.

ACTION: The contraction of the muscle brings about the raising up of the floor of the buccal cavity. It also assists in the lowering down of the buccal floor as it is connected with the digastricus muscle. Moreover, as this muscle is connected with the hyoid apparatus, the contraction of the muscle also helps in a forward pulling of the hyoid apparatus.

INNERVATION: The muscle is innervated by the mylo-hyoid nerve which arises from the 5th mandibular nerve.
Plate XXIX

Ventral views of the jaw, the tongue and the hyoid muscles of the Mongoose:

1. Showing the superficial layer of the tongue muscles (M. mylo-hy. removed)
2. Showing the M. genio-gloss. (M. genio-hy. removed)

Legends as in Plates XII and XIV.
The muscles operating the tongue:

**M. genio-hyoideus** (Plates XXVIII and XXIX,1):

It is a thick, elongated, well developed spindle-shaped muscle situated just above the mylo-hyoideus muscle. The muscle extends from the body of the dentary to the anterior part of the hyoid apparatus. The muscle fibres show a unipinnate pattern of arrangement.

**ORIGIN**: It arises as a thick, narrow, long and hollow tendinous cord-like strip from the dorsal surface of the body of the dentary lateral to the symphysis. Both the counterparts remain in close association and run parallel to each other. The muscle runs posteriorward towards the hyoid apparatus. Ventrally, towards the mid-line it is also associated closely with the mylo-hyoideus muscle.

**INSERTION**: The insertion which is mostly fleshy and slightly tendinous is on the anterior surface of the basihyal of the hyoid apparatus. The insertion also extends slightly over the hypohyal of the hyoid apparatus.

**ACTION**: The muscle assists in two ways. When the mouth is kept closed, its contraction helps in the forward pulling of the hyoid apparatus, resulting in a slight lowering down of the buccal floor. But as the mouth opens, the muscle helps in the protraction of the tongue. Moreover, as this muscle is attached with the M. mylo-hyoideus, its contraction brings about the raising up of the buccal floor.
Plate XXX

Ventral views of the jaw, the tongue and the hyoid muscles of the Mongoose:

1. Showing the deeper layer of the tongue and the hyoid muscles (M. genio-gloss. and the M. sterno-hy. removed)

2. Showing the M. pterygoideus internus (Tongue and the hyoid apparatus removed)

Legends as in Plates XII and XIV.
INNERVATION: The innervation of the muscle is by a ramus of the XIIth hypo-glossal nerve.

M. genio-glossus (Plates XXVIII and XXIX):

The muscle is soft, elongated and very well developed. It is more or less fan-shaped and situated dorsally and laterally to the M. genio-hyoideus.

ORIGIN: It arises in a broad tendinous origin from the dorsal surface of the body of the dentary, lateral to the symphysis. The origin also extends on the ventero-lateral surface of the dentary behind the symphysis. Moreover, it may be noted here that the origin is lateral to the origin of the M. genio-hyoideus, and is on the body as well as also on the ramus of the mandible. The arrangement of the muscle fibres is of a unipinnate type.

INSERTION: Both the counterparts run upward and backward to have a common broad and fleshy insertion along the median line of the floor of the tongue. However, a few fibres also insert on the antero-dorsal part of the hyoid apparatus.

ACTION: The contraction of the muscle brings about the protraction of the tongue. The muscle also assists slightly in the forward projection of the hyoid apparatus. The former action helps in the taking of pieces of flesh into the mouth whereas, latter action helps in the engulfing of flesh from the mouth.
INNERVATION: A branch of the XIIth hypo-glossal nerve innervates this muscle.

M. stylo-glossus:

It is an elongated well developed, ribbon-shaped muscle, situated in between the tympanostyloid synchondrosis, the stylohyal and the tongue. The muscle remains fleshy in nature.

ORIGIN: It arises fleshily in a broad origin from the tympanostyloid synchondrosis. The origin also extends slightly on the tympanic bulla.

INSERTION: The muscle runs anteriorward and inserts on the lateral surface of the pad of the tongue. The insertion of this muscle is in a fleshy manner.

ACTION: The muscle assists in the retraction of the tongue.

INNERVATION: The muscle is innervated by a small branch of the XIIth nerve.

M. hyo-glossus (Plates XXVIII, 2; XXIX and XXX, 1):

The muscle is situated in between the anterior part of the hyoid apparatus and the tongue. It is fleshy in nature. The arrangement of the muscle fibres remains parallel.

ORIGIN: It arises in a very broad and fleshy origin from the basihyal, the hypohyal and the ceratohyal of the hyoid apparatus. The origin also extends slightly on the thyrohyal of the hyoid apparatus.
ACTION: It assists in the retraction of the tongue. Besides, when the hyoid remains static, the contraction also helps in lateral movements of the tongue.

INNERVATION: This muscle is innervated by a branch of the XIIth hypo-glossal nerve.

The muscles responsible for the hyoid movements:

**M. stylo-hyoides** (Plates XXVII,2; XXVIII,2; XXIX and XXX,1):

This is a short, broad and fan-shaped muscle, situated inbetween the tympanic bulla and the hyoid apparatus. The muscle is fleshy in nature. The arrangement of the muscle fibres remains parallel.

ORIGIN: It arises fleshy in a slightly narrow origin from the mid-ventral surface of the bulla-tympanica, just inner to the origin of the stylo-glossus muscle. The muscle runs from the origin slightly in a downward direction, just inner to the cornu, so as to reach on thyrohyal of the hyoid apparatus.

INSERTION: The insertion of the muscle is broad and fleshy on the upper surface of the thyrohyal of the hyoid apparatus.

ACTION: The contraction of the muscle draws the hyoid apparatus in an upward direction.

INNERVATION: The innervation of this muscle is by a small twig from the VIIth facial nerve.
M. sternohyoideus (Plates XXVII to XXIX):

This is an elongated, strap-shaped, well developed and fleshy muscle. It is situated on the ventral side of the neck and trachea in between the sternum and the basihyal of the hyoid apparatus. Both the counterparts run in close association with each other and cover the trachea from below. The muscle is thick and broad posteriorly but it becomes gradually narrow anteriorly. It may be mentioned here that unlike in other mammals here the muscle possesses a transverse intersection behind its mid-region.

ORIGIN: It arises in a broad and fleshy origin from the antero-dorsal surface of the sternum. The origin also extends over the antero-dorsal surface of the proximal end of the first rib.

INSERTION: The insertion of the muscle is narrow and fleshy on the basihyal of the hyoid apparatus.

ACTION: It brings about a backward and downward movement of the hyoid apparatus and thus helps in the engulfing of the food.

INNERVATION: It is innervated by a branch from the 2nd cervical nerve.

M. sternothyroideus (Plates XXVII to XXX):

It is a less developed narrow muscle which runs
parallel and in close association with the sterno-hyoideus muscle. It is situated in between the sternum and the thyroid cartilage.

ORIGIN: It arises fleshily from the dorsal surface of the sternum in conjunction with the origin of the sterno-hyoideus muscle.

INSERTION: The insertion is slightly narrow on the lateral side of the thyroid cartilage.

ACTION: It helps in a backward pulling of the thyroid cartilage, and helps in the gulping of the food.

INNERVATION: The muscle is innervated by the 2\textsuperscript{nd} cervical nerve.

\textit{M. crico-thyroideus (Plate XXX,1)}:

The muscle is short and broad and arises behind the thyro-hyoideus muscle. Towards the origin, the muscle runs in close association with its counterpart, but towards the insertion, both the counterparts become narrow and diverge from each other. The arrangement of the muscle fibres is of a parallel type.

ORIGIN: It arises in a slightly narrow and fleshy origin from a triangular-shaped depression of the cricoid cartilage from where the muscle runs slightly obliquely anteriorward.
INSERTION: The insertion of the muscle is broad and fleshy on the surface of the posterior edge of the thyroid cartilage.

ACTION: As the muscle contracts, the thyroid cartilage is pulled backward and downward resulting in a further pushing of food from the mouth.

INNERRVATION: The innervation of this muscle is by a branch of the 1st cervical nerve.

M. thyro-hyoideus (Plates XXVII,2; XXIX and XXX,1):

This is a short but thick, well developed and fan-shaped muscle, situated inbetween the thyroid cartilage on one side and the thyrohyal and the basihyal of the hyoid apparatus on the other. The muscle is fleshy in nature and is situated anterior to the sterno-thyroideus muscle. The muscle is completely covered by the sterno-hyoideus muscle. The muscle fibres are arranged in a parallel fashion.

ORIGIN: The origin of the muscle is narrow and fleshy on the thyroid cartilage anterior to the insertion of the sterno-thyroideus muscle.

INSERTION: It inserts in a broad and fleshy manner on the anterior half of the outer surface of the thyrohyal. The insertion also extends slightly on the distal end of the basihyal.
ACTION: As the muscle contracts, the hyoid is drawn backward and slightly downward.

INNERVATION: The muscle is innervated by ramus of the 1st cervical nerve.

*M. omo-hyoideus*:

Like in the Guinea-pig, this muscle is not present here also.