# THE LAMINATIN OF THE MASSETER OF THE HUMPBACK WHALE*

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## PREFACE

Basing upon the comparative anatomical study of the masseter of various mammals, which include the marsupial (kangaroo), the insectivore (mole), the chiroptera (macro- and microchiropteras), the primate (monkey, apes and man), the rodent (rat and marmot), the lagomorph (rabbit), the carnibore (dog, cat and bears), the artiodactyl (pig, camel, deer, goat, sheep and cattle), the perissodactyl (horse), Yoshikawa et al (1961, 1962) proposed that the masseter of mammal shows a laminar structure, which consists of the following six elements:

A. The proper masseter,
   1) M. masseter superficialis, lamina prima,
   2) M. masseter superficialis, lamina secunda,
   3) M. masseter intermedius,
   4) M. masseter profundus, pars anterior and pars posterior.

B. The improper masseter,
   5) M. maxillomandibularis,
   6) M. zygomaticomandibularis.

The above laminar pattern is the modification of that of Seiferle (1958) in the dog, in which Seiferle overlooked the second superficial masseter and the maxillomandibular muscle. Although these six elements receive, of course, the various modification as the animal varies, the fundamental principle seems to be applicable through the various animal. Then, how far the laminar pattern described above can be applied to the whale, one of the most specialised forms in the mammal?

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## MATERIAL AND METHOD

The male fetus of the humpback whale, *Megaptera nodosa* Bonn., is used, the body length of which measures 17 cm long (Fig. 1).

When the laminar structure is investigated, the tendon of the muscular layer should never be cut through. It is recommendable to cut the muscular substance of the layer along the terminal line. By cutting the indicated line, the blade can reach the tendon of the underlying layer. By scraping along the underlying tendon, the layer can be easily separated. There is the ' reversal relation of the tendon and the muscular substance ' between the succeeding layers.

* Dedicated to Professor T. Ogawa for his sixtieth birthday

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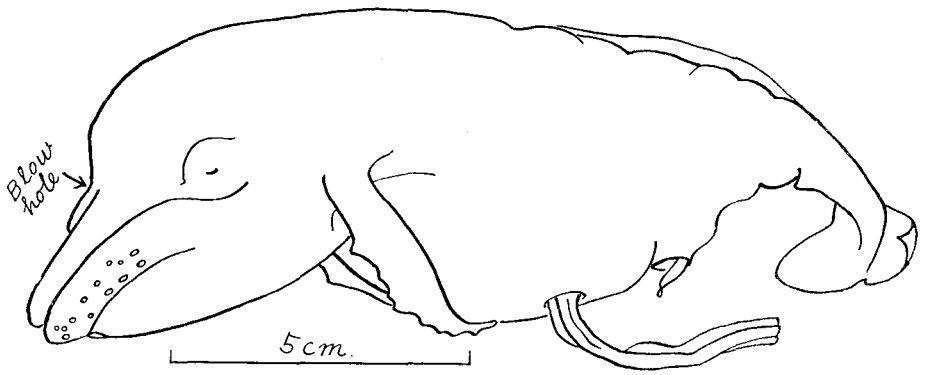


Fig. 1. The fetus of the humpback whale.

## DESCRIPTION

The mandible does not yet ossify completely. The posterior part of the zygomatic arch only develops, while the anterior half of the arch presents the tendinous structure, making the ventral border of the orbit.

The first superficial masseter arises from the ventral border of the orbit with the narrow tendon, running ventrocaudally. It terminates along the mandibular angle with the rich muscular substance, spreading in the semicircular form (Fig. 2, A and B). Crossing under this narrow tendon, the slender muscle which takes

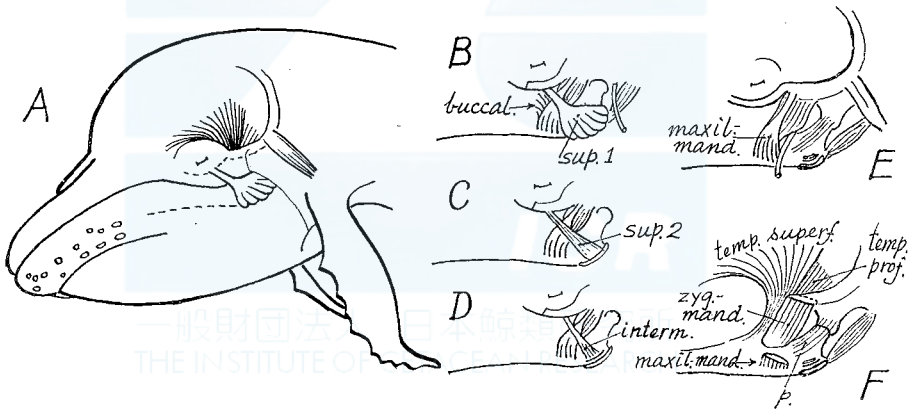


Fig. 2. The laminar structure of the masseter of the humpback whale.
buccal . . . M. buccalis, interm . . . M. masseter intermedius, maxil.-mand . . . M. maxillomandibularis, p . . . M. masseter profundus, sup. 1. . . . M. masseter superficialis, lamina prima, sup. 2. . . . M. masseter superficialis, lamina secunda, temp. superf . . . M. temporalis superficialis, temp. prof . . . M. temporalis profundus, zyg.-mand . . . M. zygomaticomandibularis.

its origin at the anterior extremity of the zygomatic process of the temporal bone runs anteroventrally. This is the maxillomandibular muscle (side infra). When the first superficial masseter is overturned by cutting its muscular substance along

the mandibular angle, the slender second superficial masseter is found, the direction of which coincides with the narrow tendon of the first superficial masseter (Fig. 2, C). Its tendon is found on the mandibular side and the muscular substance develops on the orbital side. When the muscular substance of the orbital side is cut cautiously, the tendon of the intermediate masseter makes its appearance, the muscular substance of which develops on the mandibular side (Fig. 2, D). Comparing with the first superficial masseter, the second superficial and intermediate masseters are very narrow, overlapping in the same form.

The deep masseter does not make a good development, spreading as a thin sheet between the root of the condyloid process and the glenoid fossa of the zygomatic arch (Fig. 2, E and F).

Making the X-form with the superficial masseter, the thick muscular column develops, connecting the anterior extremity of the zygomatic process of the temporal bone and the mandible. This column can be divided into the medial thick column and the lateral thin muscular plate. The latter is the maxillomandibular muscle, which arises as the thin plate at the anterior extremity of the zygomatic process of the temporal bone, spreading anteroposteriorly (Fig. 2, E). The former is the zygomaticomandibular muscle, which originates from the medial side of the anterior extremity of the zygomatic process and terminates near the root of the small coronoid process (Fig. 2, F).

The temporal muscle can be divided into the superficial and deep muscles (Fig. 2, A and F). The superficial temporal muscle arises from the dorsal side of the orbita and the anterior half of the temporal fossa and terminates on the vestigial coronoid process. The deep temporal muscle is recognised between the posterior margin of the superficial temporal muscle and the zygomatic arch.

## CONSIDERATION

In the specialised mammal such as the whale, whalebone or toothed, we expected the modification of the laminar pattern of the masseter. The result of investigation, however, proved that the laminar subdivision after Yoshikawa et al can be also applied to the whale. The proper masseter, however, shows the atrophy as the layer deepens ; while the improper masseter makes a good development, especially the zygomaticomandibular muscle.

Such a poor differentiation of the proper masseter coincides well with the loss or weak development of teeth, which does not require the quick and strong mastication. On the contrary, the enormously long mandible requires the strong closure. To this purpose, the development of the improper masseter plays a good role. The analogous model is furnished with the forceps, which is easily closed by pressing the sides with fingers, while it is not easily closed by manipulating the base of the forceps.

Toldt (1905) reported the masseter of the dolphin, *Delphinus delphis*, in which Toldt mentioned only two layers. The superficial layer is piriform and corresponds to the first superficial masseter after Yoshikawa et al. The deep

layer which is covered by the superficial layer corresponds to the intermediate masseter after Yoshikawa et al. The existence of zygomaticomandibular muscle is denied, owing to the incomplete zygomatic arch. If Toldt cuts the muscular substance of the superficial layer along the mandibular terminal line, he would easily succeed to discover the tendon of the second superficial masseter. Toldt mentioned the maxillomandibular muscle in the rodent only and included it in the zygomaticomandibular muscle in the other mammal.

In the dolphin, the zygomatico- and probably maxillomandibular muscles may be hidden behind the zygomatic process of the temporal bone. The complete absence of these muscles can not be imagined in the toothed whale from the result of investigation, not only in the whalebone whale, but also in the general mammal.

## SUMMARY

In the fetal humpback whale, one of the mistacoceti, the proper masseter presents the atrophy as the layer deepens, while the improper masseter makes a good development, especially the zygomaticomandibular muscle.

In the proper masseter, the first superficial masseter makes fairly a good development, while the second superficial and intermediate masseters remain narrow and thin muscles. The deep masseter remains rudimentary.

In the improper masseter, the maxillomandibular muscle is a broad but thin muscle. The zygomaticomandibular muscle is the thick muscular column, which plays the most important role to close the long mandible.

## LITERATURES

GREGORY, W. K. (1957). *Evolution emerging.* Vol. II, fig. 22. 12 a, b (p. 902–3). (Anatomy of foetal whalebone whale. After Schulte.) MacMillan, New York.

NICKEL, R., A. SCHUMMER & E. SEIFERLE (1958). *Lehrbuch der Anatomie des Haustiere.* Bd. 1, S. 266. Paul Parey. Berlin u. Hamburg.

SEIFERLE, E. (1958). See NICKEL, R., A. SCHUMMER & E. SEIFERLE (1958).

TOLDT, C. (1905). Der Winkelfortsatz des Unterkiefers beim Menschen und bei den Säugetieren und die Beziehungen der Kaumuskeln zu demselben. Teil 2. *Sitz.-berichte d. Mathem. Nat.-wissenschaftl. Klasse.* 113, (3) : 434–5.

YOSHIKAWA, T., T. SUZUKI, R. KIUCHI & H. MATSUURA (1961). The comparative anatomy of the M. masseter of the mammal. *Acta Anatomica Nipponica,* 36 (1) : 53–71.

YOSHIKAWA, T., T. SUZUKI, R. KIUCHI & H. MATSUURA (1962). The lamination of the M. masseter of the crab-eating monkey, orang-utan and gorilla. *Acta Anat. Nippon.,* 37 (3) : 206–217.

YOSHIKAWA, T. & T. SUZUKI (1962). The lamination of the human masseter—the new identification of M. temporalis superficialis, M. maxillomandibularis and M. zygomaticomandibularis in the human anatomy. *Acta Anat. Nippon.,* 37 (4) : 260–267.

YOSHIKAWA, T. & T. SUZUKI (1962). The lamination of the masseter of the bat. *Acta Anat. Nippon.,* 37 (5) : 352–358.

YOSHIKAWA, T. & T. SUZUKI, R. KIUCHI & H. MATSUURA (1962). The lamination of the masseter of the ruminantia. *Acta Anat. Nippon.,* 37 (6) : 430–442.