

nature and, exactly because of that to try to forestall the ultimate consequence of it. Getting mutual information, learning medical and ecological backgrounds, discussing guidelines and feeling our way to future cooperation. All this and among other things methods to reach this goal. We were able to pass unanimously a resolution on the protection of marine mammals and to take the first step to the formation of the European Association of Aquatic Mammals. Thanking the speakers for their contributions, and everybody who took part in the discussions and last but not least the Dolfinarium Harderwijk for its organisation, I will close this symposium hoping and expecting that there will be many meetings of this kind in the years to come in order that mankind will say: 'Fish I love you and respect you very much. I will protect you and save you until the end of our days.'

THE ANATOMY OF DELPHINIDS

Summary of an introductory lecture given during the symposium at Harderwijk by P.E. Purves, Ph. D., Head Department Cetacea, Pinnipedia, Sirenia, of the British Museum of Natural History, Cromwell Road, S. Kensington, London SW7, England.

Perhaps because of the beauty of external form, the great swimming performance, acute sense of hearing, superior intelligence and playfulness of the dolphins, it has often been imagined that the anatomy of cetaceans is some how quite novel and different from that of other mammals, including Man.

In fact, nothing that has hitherto been discovered in the anatomy of the cetacea is without its counterpart in terrestrial mammals and it more often happens that structures have been lost rather than gained.

The most obvious features are the total absence of hind limbs, external ears and genitalia.

The body is perfectly smooth and devoid of hair and the skin at the end of the tail is expanded into a pair of horizontal flukes which constitute the chief locomotor organs. The front limbs are greatly shortened and there are no separate digits in the hands which have been modified to form the flippers.

The nostrils are placed on the top of the head so that the melon can be regarded as an extreme modification of the upper lip whilst the blubber is simply a thickening of the panniculus adiposus which is found under the skin of Man and some other terrestrial mammals.

The brain is exceptionally large and convoluted and more similar to that of Man than those of most other mammals.

As a general rule, it may be stated that the modification to the sense organs, the skull, skeleton and muscles are in response to purely mechanical stresses, whilst those of the respiratory, vascular, alimentary and urinogenital systems are adopted to both physiological and mechanical stresses in the aquatic environment.

However, the epidermis is a layer of keratinized epithelium like that on the surface of the skin of Man, but since there are neither hair follicles nor sweat pores it has a very much smoother texture and does not rub off in small scales. The epidermis is keyed on to the dermis in a series of parallel ridges like those visible on the hands and feet of men and monkeys but they are not visible on the surface and extend over the whole surface of the body. As they lie in the direction of the flow of water over the body, they are thought to counteract the effect of shearing stresses during rapid acceleration.

Underlying the dermis is a thick layer of heatinsulating blubber which is a great elaboration of the adipose layer that is normally found under the skin of Man, more especially in women. When it is necessary to lose heat rather than conserve it the flow of blood through the blubber to the surface of the skin can be greatly increased.

Muscles

When the blubber has been removed, a thin sheet of muscle, the panniculus carnosus, which in land mammals produces mobility of the pelt, can be seen covering over the external contours of the underlying muscles and exchanging the streamlined shape. After removal of the panniculus, the muscles normally found in land mammals can be seen quite clearly on the ventral surface of the body, but these are not so clear on the dorsal aspect of the adult dolphin. The reason for this is that all the individual muscles that are responsible for the complex movements of the spine in land mammals have become fused with those of the tail to form a single propulsive unit operating the flukes.

The great mass of muscle associated with the blowhole of cetaceans is the equivalent of the small slips associated with the nose in Man and the 'Melon' is the greatly modified upper lip.

The Skeleton

The proportions of the skeleton have been altered so that the neck vertebrae are flattened and are generally fused into a solid mass. The lumbar vertebrae have been increased in number, being augmented by units of the sacrum and the pelvis exists only as a pair of small bones representing the ischium.

The tail vertebrae are very well developed and have enlarged mobile chevron bones for the attachment of tail tendons.

All the vertebrae are extremely simplified and have high neural spines for the attachment of the large, locomotor muscles. Many of the posterior ribs have lost their double articulation with the spine and in dolphins the anterior ribs are connected to the sternum by fully ossified 'sternal ribs'.

It is often stated that the separate bones of the skull have been telescoped into one another but this applies only to the upper surface of the cranium where the bones overlap. On the under surface the reverse is true, the units having been extended forward in conformity with the elongated bones of the snout. The upper nasal region of the skull presents an asymmetrical appearance associated with the differential development of the nostrils.

The teeth, except in very primitive species are simple, conical structures and are frequently very numerous.

The Senses

There is no sense of smell in the toothed cetacean so there are no olfactory organs and therefore no necessity for paired nostrils, the blowhole being equipped for more efficient ventilation. The sense of taste is, however, well developed, as evinced by the presence of numerous taste buds on the tongue.

The eye is characterized by its very thick, pressure resisting sclerotic, non adjustable, spherical lens and the lenticular shape of the optic chamber.

The ear is reduced to a narrow, cartilaginous tube which ends at the tympanic ligament - or modified eardrum - and the three small, sound conducting ossicles normally found in terrestrial mammals. The sound analysing organ, the cochlea is essentially similar to that of land mammals except that it is adapted to receive ultrasonic sounds.

The pressure in the middle ear is adjusted by a system of collapsible air reservoirs which also serve acoustically to isolate the cochlea from vibrations transmitted through the skull and thus give directionality to the sense of hearing.

Respiration

There are no muscles for closing the blowhole so the water is kept out by a system of pressure air-locks which are also used during phonation. The glottis takes the form of an elongated spout which protrudes into the nasopharynx and is surrounded by a powerful nasopharyngeal sphincter muscle which prevents air escaping through the mouth during phonation and diving. The epiglottic spout is an integral part of the larynx, which is the main sound producing organ in cetaceans as it is in terrestrial mammals. The cavity of the larynx is continuous with the trachea, bronchi and bronchioles which in cetaceans are surrounded by incomplete cartilaginous rings and lined by a vascular mucous membrane which allows considerable contraction of the lumen.

The pulmonary air chambers, or alveolae of the lungs are guarded by small sphincter muscles and are confined to the outer layers of the lung, the main body being elastic tissue. This arrangement allows for complete exchange of the pulmonary air during respiration.

Digestive System

Owing to the intranarial position of the epiglottic spout the pharynx is divided at this point into a double passage so that food has to pass along either side of the glottis.

From here the short oesophagus leads into a muscular, nonglandular forestomach where the food is retained and pulverized.

The finely ground mass then passes through a narrow aperture into the main digestive stomach which is thick walled and highly glandular.

The main stomach leads into a pyloric stomach which may be divided into as many as five compartments.

The following, somewhat dilated duodenum receives the pancreatic duct and hepatic duct from the liver the two being frequently joined together. There is no gall bladder. The rest of the intestine is remarkably uniform in diameter, there being no caecum nor appendix but the intestine is very long and thick walled suggesting strong peristaltic action.

The Urinogenital System

The kidneys of cetaceans are not single organs but are composed of a great number of small renules, each with its own artery, vein and branch of the ureters. They are very large and lie above the peritoneum on each side of the lumbar vertebrae.

The ureters lead into a comparatively small muscular bladder between the pelvic bones. The testes are always internal and are suspended below and posterior to the kidneys. The retractor penis muscle causes the penis to be pulled into a complete loop within the perineum. The uterus is the bicornuate type found in many other mammals, the two horns ending in the fallopian tubes which terminate in large fallopian funnels which completely cover the ovaries.

The Vascular System

The vascular system of cetaceans is remarkable for elaborate net works of blood vessels which are mainly space-filling systems but may have other important functions. Beginning at the head-end there is an extensive pterygoid venous plexus associated with the collapsible air reservoirs of the middle ear which is supplied by the external carotid artery and communicates a large intercranial sinus and the spinal veins.

The internal carotid artery is reduced in function and the main blood supply to the brain is carried by a pair of large spinal meningeal arteries within the spinal canal.

These large arteries are supplied by branches from a mass of small vessels which follow a serpentine course between the heads of the ribs and the thoracic vertebrae. The main source of supply for these small vessels is the posterior thoracic artery. In the abdominal cavity above the peritoneum there is a continuous plexus of large veins into which the veins of the abdominal walls and locomotor muscles drain before entering the inferior vena cava.

The Nervous System

The delphinids have a very large, convoluted brain and are comparable with Man in the degree of cephalization. In conformity with the telescoping and rotation of the bones of the skull, the cerebral hemispheres completely overlie the cerebellum.

There is no olfactory bulb or nerve, but both the trigeminal and acoustic nerves are very large being consistent with the enbranched auditory and tactile senses. The roots and cortical centres of these nerves are also unusually large.

The brachial plexus is well developed but the iliac plexus is rudimentary and consistent with the absence of hind limbs.

The spinal nerves are interconnected in the post-thoracic region for the coordination of the locomotor muscles.

OBSERVATION ON THE BASIC NUTRITION, VITAMINS AND FOOD PREPARATION IN DOLPHINS

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The diet of dolphins in natural circumstances is living fish. We try to imitate their habitat by providing them with clean artificial seawater, but feeding dolphins live healthy fish is at this moment too expensive. If at some future time, fish hatcheries should develop at the same rate as chicken hatcheries did in the past it could become feasible to treat dolphins in captivity to living fish. Today dead raw fish is their exclusive diet.