STUDIES ON THE EVOLUTIONARY PROCESSES OF THE BONE AS NATURAL D.D.S. OF BIOLOGICAL CERAMICS

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ABSTRACT

The vertebrates is defined as a chordate having bony backbone i.e., vertebrae with different degree of ossification[1,2]. Therefore, skeletal substances of connective tissue composed with the collagen, the cartilage and the bone are definitive substances of the vertebrates. The bone is mineralized fibrous collagenous connective tissues. The bone can be seen as natural biological D.D.S. made of ceramics. Hydroxyapatite is mineral of the bone, of which phosphate offers pyrophosphate for energy metabolism as well as nucleic acid metabolism in genetic substances. The calcium ions of hydroxyapatite act as essential substance for the entire metabolism in organisms. The osseous tissues are remodelled by the action of the time, biomechanical stimuli and by nutritional condition of the organisms. Calcium ion, phosphate, collagen, and sulphate are delivered from the bone and cartilage during remodelling. The bone is definitive substance of the vertebrate and the tooth system as well as tooth morphology is the criteria of phylogenetic category in animals[1,2]. What is the origin of the tooth and the bone? "To known the essential function of the organ is to inquire that of origin in phylogenetics." This is the orthodox way to investigate the morphology established by the famous poet and scientist Goethe.

INTRODUCTIONS

Conventionally in evolutionary research origin of the vertebrates has not been substantially determine. To search for the origin of them what substance and where the part of organisms have we to pursue? From the definition origin of the vertebrates can be found to search for the cartilaginous exoskeletons as substance at the surface of the derma[3,4]. The bone derived from specialized tooth or the tooth can be seen as specialized bone. Because, at the initial stage of archetype vertebrate original skeletal substances were exoskeleton placoids which had been unified calcified organ of the bone and tooth in chondrichthyes[5]. Moreover, in stage of prochordata organisms have placoids on the surface of derma, which is detected cartilage with sulfer of chondroitin by microanalyser. Evolution of exoskeletons, endoskeletons, and splanchro skeletons in phylogenic stage are studied from the initial stage of prochordata up to the mammals. Through this research the origin of the vertebrates can be decided substantially.

EXPERIMENTS

Specimens for histology as well as microanalyser of skeletal substances of animals in all stages of phylogeny, i.e., prochordata, cyclostomata, chondrichthyes, amphibians, and reptiles are made and observed by microscope, SEM, and microanalyser.

MATERIALS AND METHODS

As prochordata ascidia, i.e., Halocynthia, as cyclostomata hagfish, as chondrichthyes Triakis and Heterodantus are prepared. As amphibian Mexican salamander (aholotol), as reptiles wall bizard are prepared. Specimens are observed with light-microscopy and SEM, as well as microanalyser Kevex 8000.

RESULTS

Placoids and teeth are the most important skeletal organs for research on vertebral evolution. At the surface of Halocynthia triconodont-type placoids are observed by light microscopy (Figure 1). By microanalyser Kevex 8000 placoids of Halocynthia are found made of cartilaginous tissue with sulfur (Figure 2-A, B). At the surface of hagfish derma no placoid is observed but thick mucous derma with sulfur is seen by microanalyser. In cranial region of hagfish great teeth composed with cartilage are observed by microanalyser, which resemble tooth germ of mammals (Figure 3). In next stage of phylogeny, in acantoidii cartilaginous teeth or placoids turned into calcified tissue, i.e., and hydroxyapatite. The ancestors of chondrichthyes are acantoidii and they have calcified teeth and placoids (Figure 4). Heterodantus have not only 3 kinds of tooth type, but also the masticatory system. The nose shape quite resembles that of mammalians.

The second important skeletons in evolution are these of the viscerocranium. Morphology of the nose and nostrils of Heterodantus quite resemble that of mammals of the embryo. The teeth are heterodontia having three kinds as the name indicate, therefore resemble these of the mammals. The caput of human embryo 32 days after fertilization is almost the same as that of an adult dog shark just like the recapitulation theory of Haeckel 5. On the other hand, the gill system of Triakis is quite similar to that of reptiles, which fuses to close fenestration of waterway of the branchial system to form the tongue in landing (Figure 5). These morphological changes which had occurred through billion years can be observed by neotenytype aholotols in 5 months, which are artificially landed by reducing water. Drastic changes of the gill system can be seen to form the tongue. The formation of the lungs from branchial glands is quite different between amphibians and mammals.

The third important skeletons for evolutionary research are the collarbones. The origin of the collarbone is found cartilaginous tissue around the heart of cyclostomata, which is covering pericardia sac (Figure 5, arrow). The cartilaginous skeletons join with fins. In chondrichthyes the collarbone join with chest fins constructing ventral wall of pericardia sac. In amphibian these cartilage construct 2 sliding armor-like collarbones in ventral side of the heart. In mammals the lung bud develops into the pericardia sac in ontogeny as well as in phylogeny. Therefore, the cartilage in chest of pericardiac cavity pushes upside toward cranial side distant from the heart. Different sites of collarbones between reptiles and mammals mean different developmental way of lungs between them.

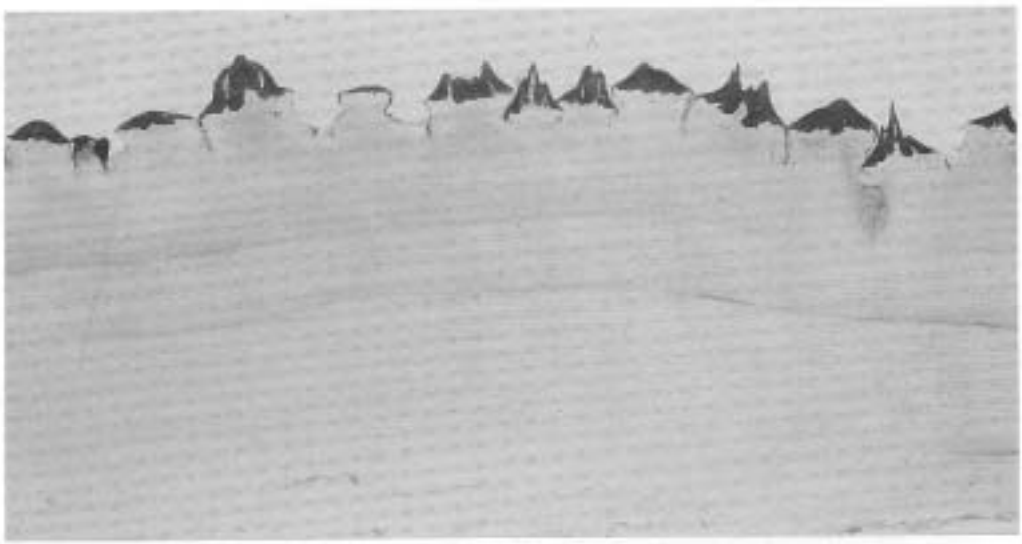
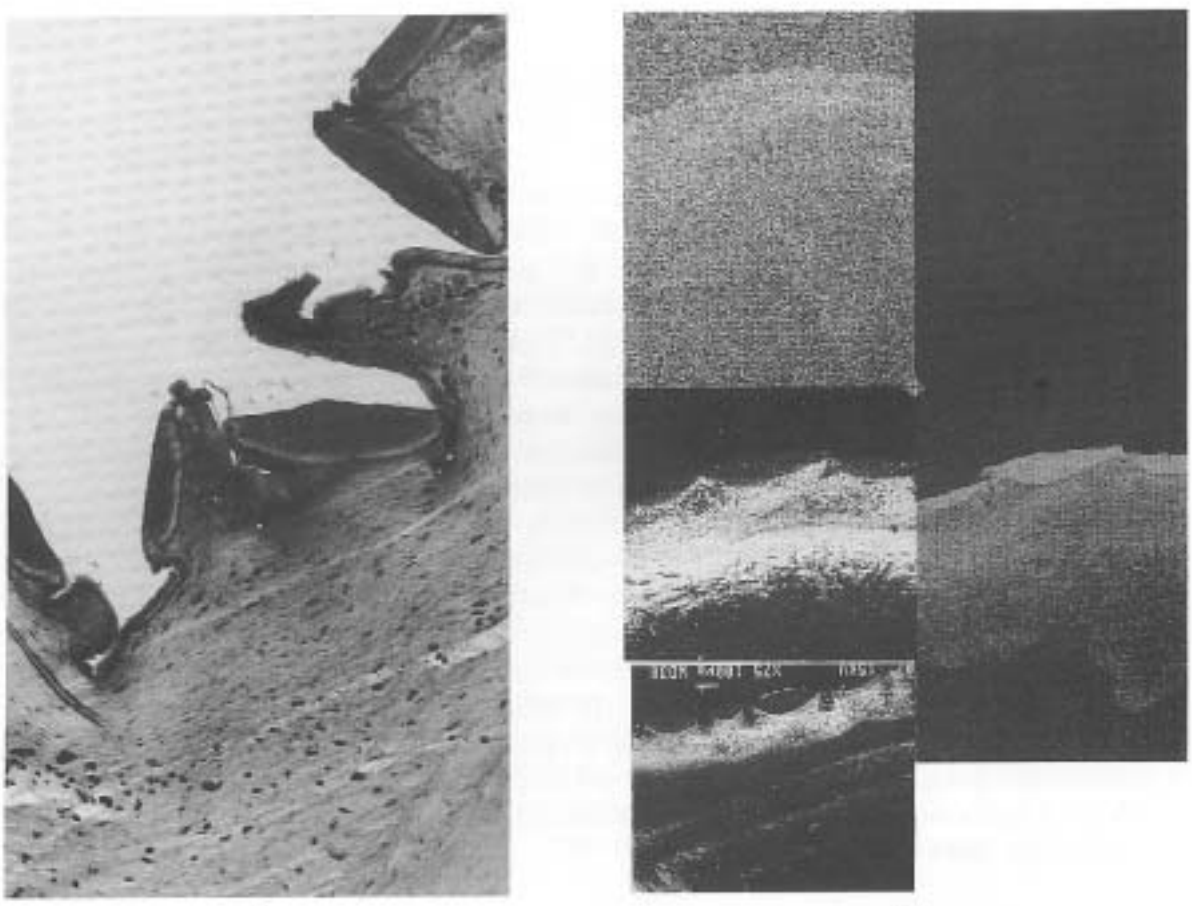


Figure 1

Placoids of ascidia Halocynthia



A **B**

Figure 2

A-Placoids of Halocynthia

B-Sulfur-containing cartilaginous placoids detected by microanalyzer

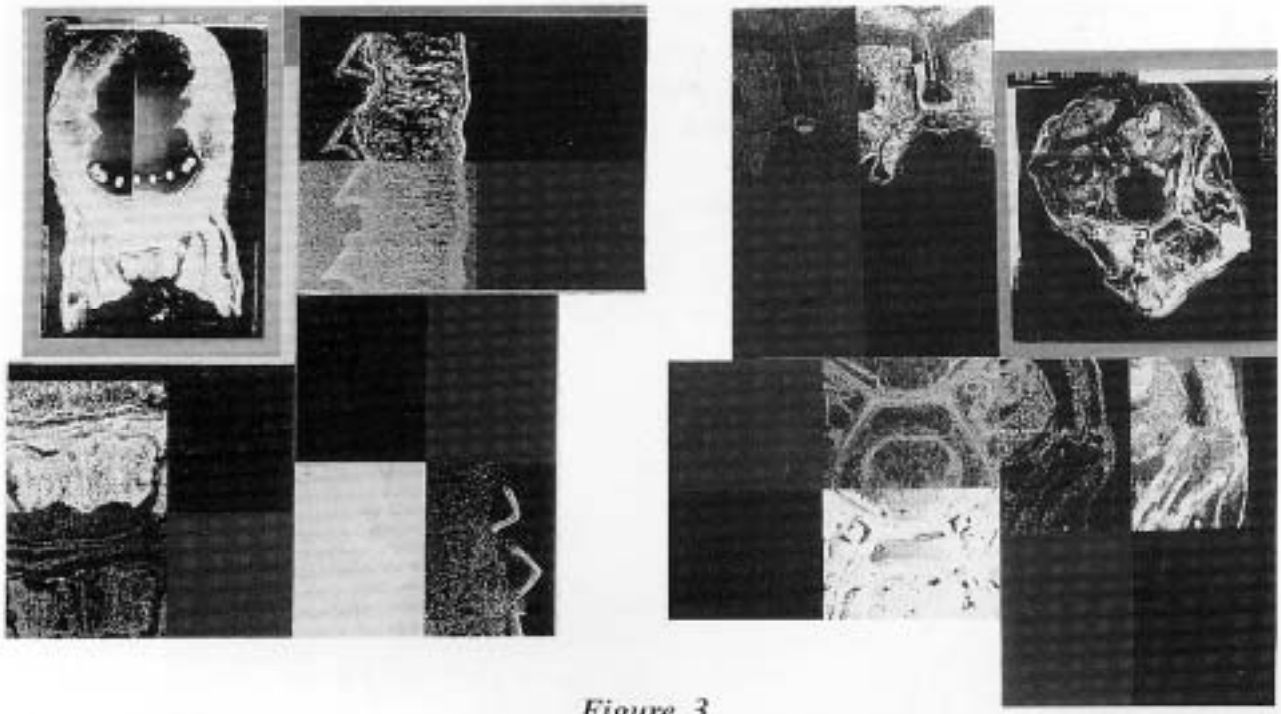


Figure 3

Cartilaginous teeth of hagfish detected by microanalyser

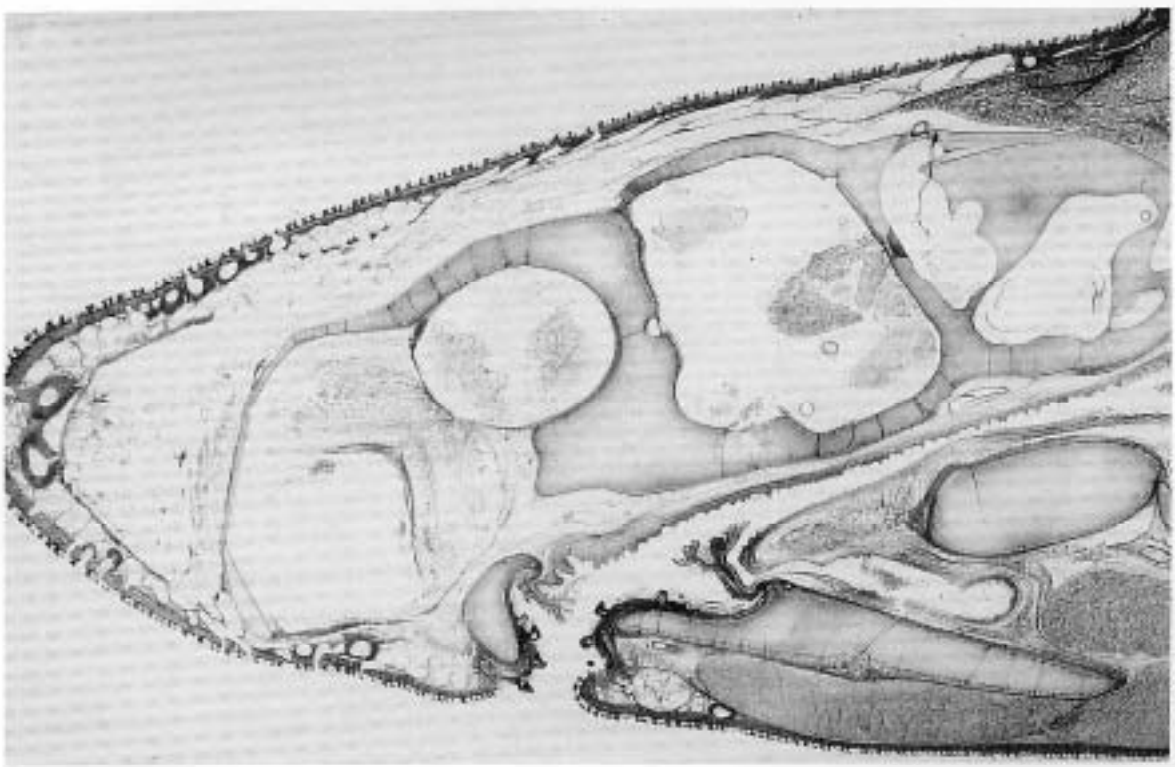
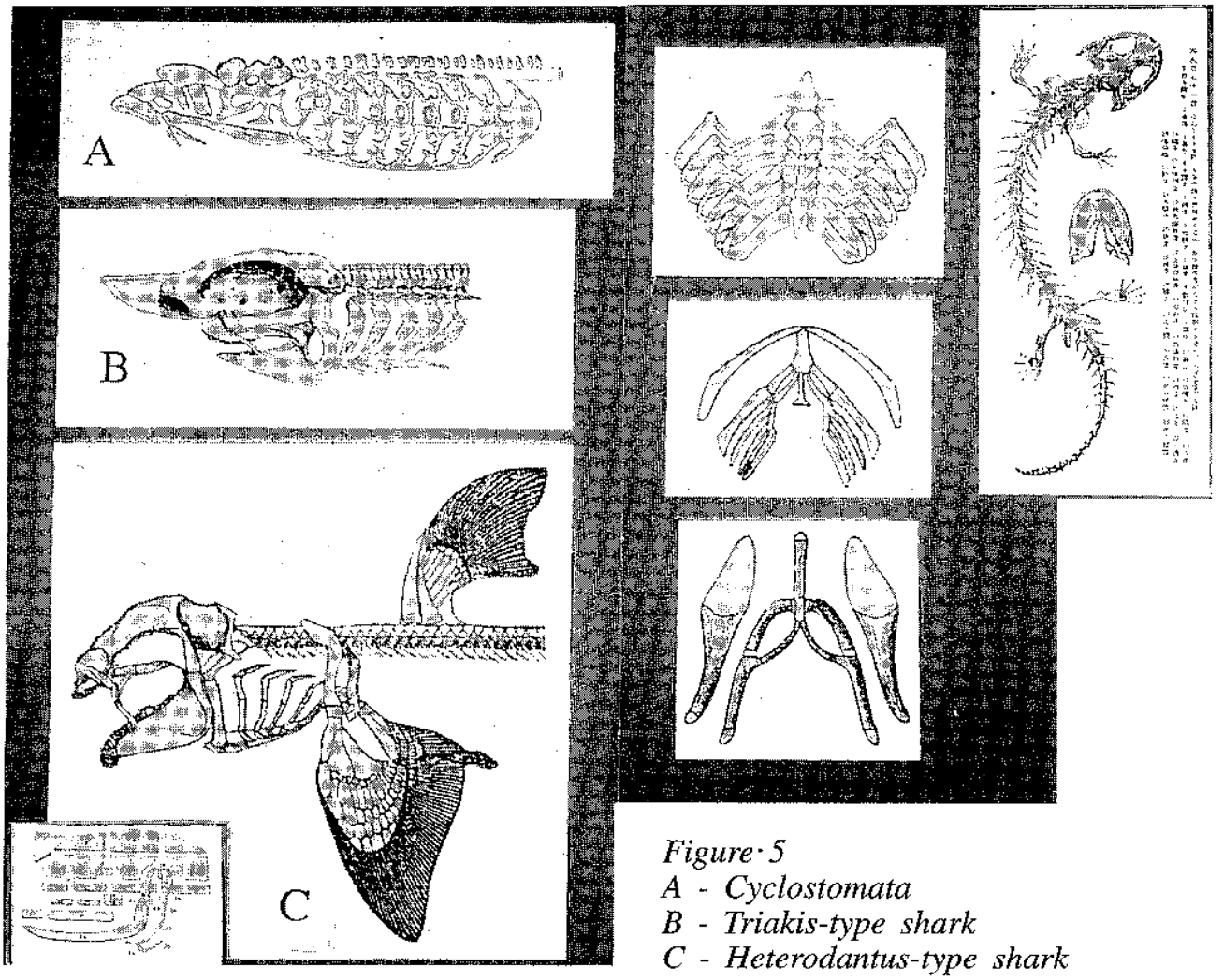


Figure 4

Placoids and teeth of Triakis, descendant of acantoidii
Teeth are specialized placoids.



Figure· 5
A - Cyclostomata
B - Triakis-type shark
C - Heterodantus-type shark

DISCUSSION

The vertebrates are defined as a chordate having bony backbone i.e., vertebrates with different degree of ossification, therefore, the origin of the vertebrates can be decided to search for cartilaginous exoskeleton placoids as well as cartilaginous teeth in primordial animals. Cartilage can be detected easily by microanalyser. From these series of researches archetype of shark teeth and placoids are found teeth of cyclostomata, and the origin of them can be decided as placoids of the ascidia. As ascidia are monosomite animal, it is considered that by gene-duplication of prochordata the polysomite animal, i.e., the vertebrates developed. Conventionally in phylogeny the origin of the vertebrates has been in missing rink without substantial evidence.

From the aspects of heterodontia, nostril shape, and collarbones as well as development of the lungs, Heterodantus can be found as original chondrichthyes of mammalian-type reptiles.

Conventional phylogenetics tells us that the reptiles evolved into the mammals. The vertebrates evolve by biomechanical stimuli, which influence the organisms throughoutphylogenic time span. Evolving modality by biomechanics is in accordance with the Wolff's Law. Therefore, reptile's lungs, which have no muscles around,

never induce diaphragm. In this research through comparative studies on ontogeny of mammals (rats) and amphibian (salamanders), the development of the lung system between them is observed completely different. From developmental studies on mammalian embryo, it is known that the lung buds had extended into central part of pericardial sac in the archetype chondrichthyes. On the otherhand, those of amphibians extend across the esophagus dorsally to the iliac bone in ontogeny. The difference of the lung development between amphibians and mammals are known by comparative anatomy of landed aholotols with developing embryo of rats. Through morphological observation on developing vertebrates as well as on comparative anatomy, Haeckel originated the ontogeny and phylogeny and established the empirical law of Recapitulation theory (Biogenetic Law), i.e., "Ontogeny recapitulates phylogeny". Recapitulate means morphological repetition of the Caput (viscerocranium). However, this law has been neglected until Perre Alberch noticed new concept of heterochrony, i.e. timedependent gene expressions by which ontogenetic metamorphoses can be explained. It has not been explained by the Law what is initial stage of primordial revolution of the vertebrates, during which archetype vertebrates with metmeric structure appeared from monomeric porchordata. Investigating metamorphosis in ontogeny with comparative anatomy between amphibian and mammals, the authors evidence in this paper that developments of viscerocranium and the gills, i. e., the jawbone and teeth, auditory ossicles, the lungs and diaphragum, the collarbones, and nostrils are quite different between them. Phylogenetical observations reveal that there are two kinds of present chondrichthyes and, one of them is Heterodantus which resembles the mammalian system in skeletal development of the viscerocranium, collarbone and in diaphragum development, and the other kind of chondrichthyes Triakis resembles amphibian-reptilian system of them. From these researches it is known that, divergence of reptiles and mammals had started in the stage of terrestrialization. By newly developed experimental research methods, the authors can evidence Heterodantus to be the archetype of the mammalian-type reptiles.

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