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"การตีพิมพ์และเผยแพร่งานวิจัยในการประชุมวิชาการ
ระดับชาติหรือนานาชาติหรือในวารสารวิชาการระดับชาติ
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National Posters (ระดับชาติ)

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SAGITTA MORPHOLOGY AND CRYSTALLINE STRUCTURE ON SULCUS ACUSTICUS IN *NEMIPTERUS* SPP. FROM COASTAL OF THAILAND

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ABSTRACT

The sagittal otoliths in three fish species of the genus Nemipterus *(*N hexodon, N. tambuloides and N. furcosus*) were collected from fishes along the coastal of Thailand. Morphology and crystalline structure on sulcus acusticus of these sagittae were studied by scanning electron microscope. Morphology of these sagittae was similar, however, distinctive morphology of each species was found, i.e. shape, margin sculpturing, ostium and cauda of sulcus acusticus. Crystals on sulcus acusticus of these sagittae showed different structure. Shape, size, crystalline surface and direction of crystalline arrangement in each species were unique. The differences in sagitta morphology alone could be used as a tool for identification of fish species. However, differences in crystalline structure on sulcus acusticus of sagittae of each species increase the information to confirm the identification of fish these species.*

Key words: *Sagittal otolith; Morphology;* Nemipterus*; Sulcus acusticus; Scanning electron microscope*

Introduction

The otoliths, or earstones, of fish are composed of the aragonite form of calcium carbonate. All teleost fishes (Osteichthyes) have three pairs of otoliths: sagittae, asteriscii and lapilli. The sagittae are the largest pair of otolith and vary tremendously in shape and size in different groups of fishes. Many different factors have been reported to influence sagitta morphology, one factor is the effects of differences in growth rate caused by environmental factors such as water temperature, depth, mineral and food availability.[1,2,11,13] These morphological variations of otolith have been used for the most widely studies of fish biology. Fisheries biologists have used the morphology of the sagittae for identification of fish species.[4,5,7,12,14,16,24,25] Palaeontologists have identified species of fishes from otoliths in sediments.[3] Biologists can use the otoliths recovered from stomach contents of squids [21]and marine birds[10] to determine the types of fishes which they have eaten. Otolith ultrastructures (crystal structures) have been also used for identification of fishes in the genus *Coelorinchus* [14].

Three fish species of the genus *Nemipterus* (*N. tambuloides, N. hexodon and N. furcosus*) are demersal, non-migration and distribute in Indo-west Pacific: Andaman Sea, Philippine, Gulf of Thailand, South China Sea and Indonesia. They inhabit sandy or muddy bottom in depths of 10 to 110 meters. The identification of these species is difficult because external

morphology e.g. dorsal spines, dorsal soft rays, anal spines and anal soft rays are equal in number. Moreover, the colour of these fishes is not usually considered as a character for identification. The purpose of this study is to investigate morphology of the sagittal otoliths in three fish species of *Nemipterus* and crystalline structure on sulcus acusticus of these sagittae in order to use them as a tool for identification of fish species.

Material and Methods

Sagittal otoliths of *N. hexodon, N tambuloides* and *N. furcosus* were collected from fishes along the coastal of Thailand during July 2002 to June 2003. At least ten fishes of each species were collected. The size of fish in adult stage was used as a standard size of each species. The standard length (SL) of each fish species was recorded. Fish were identified according to Bone et al.[6] and Nelson.[18] The sagittal otoliths were removed from head of fish by vertical method with forceps and washed to remove any residual tissue, gelatin membrane and blood. They were wiped with cloth or paper towel, or rinsed with freshwater, and allowed to dry. The sagittal otoliths were mounted on a brass stub 50 millimeters in diameter and 4 millimeters thick. Mounted otoliths were sputter-coated with a thin layer of gold using a standard coating time of two minutes. Photomicrographs of the whole sagittal otoliths and crystals in ostium of sulcus acusticus were taken with JEOL, JSM-6400 scanning electron microscope. Terminology of parts of sagitta were based on Smale et al.[23] (Fig. 1).

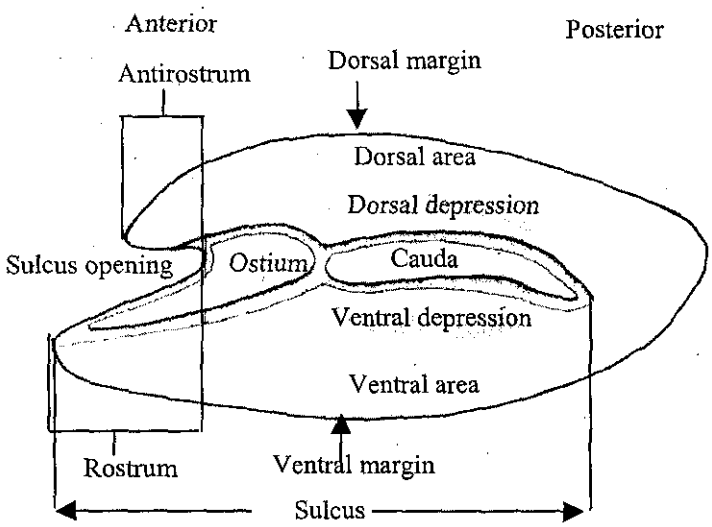

Fig. 1 Diagram of right otolith surface

Results

Otolith morphology

The sagittal otoliths in three species of the genus *Nemipterus* from coastal of Thailand show distinctive morphology that is species specific, i.e. shape, ostium and cauda of sulcus acusticus and margin sculpturing. The shapes of otoliths have 2 types: elliptic and ovate. The sulcus acusticus is heterosulcoid with ostial openning. The margins sculpturing have 3

characters: crenate, sinuate and lobe. Ostium is oval or narrow and elongate. Cauda is straight, flexed near tip ending closed to margin. Other morphology of the sagittal otoliths of *Nemipterus* e.g. rostrum, antirostrum, dorsal rim, ventral rim, dorsal area, ventral area, dorsal depressor, ventral depressor is also species specific. These anatomical characters are unique to each species.

The shape of sagittal otolith of *N. hexodon* is elliptic, while they are ovate in *N. tambuloides* and *N. furcosus* (Fig. 2). The posterior area is higher than the anterior area in all species. However, the posterior part of sagittal otolith in *N. furcosus* is smaller and narrower than in other two species. The anterior part of *N. hexodon* and *N. furcosus* is a well defined difference in the rostrum and antirostrum, while it is poorly defined in *N. tambuloides*. The sulcus acusticus of these three species is heterosulcoid but ostium and cauda are different. The ostium and rostrum is wide and oval in sagittal otolith of *N. tambuloides* but narrow and elongate in *N. hexodon* and *N. furcosus*. The cauda of sulcus acusticus of *N. hexodon* and *N. tambuloides* are similar, straight and gently flexed along its length, while in *N. furcosus* is strongly flexed tip and have ventral groove. The sculpturing on ventral margin of *N. hexodon* and *N. furcosus* are sinuate but of *N. tambuloides* is crenate. The sculpturing on dorsal margin of *N. hexodon* is sinuate whereas of *N. furcosus* and *N. tambuloides* are lobe (Fig. 2.)

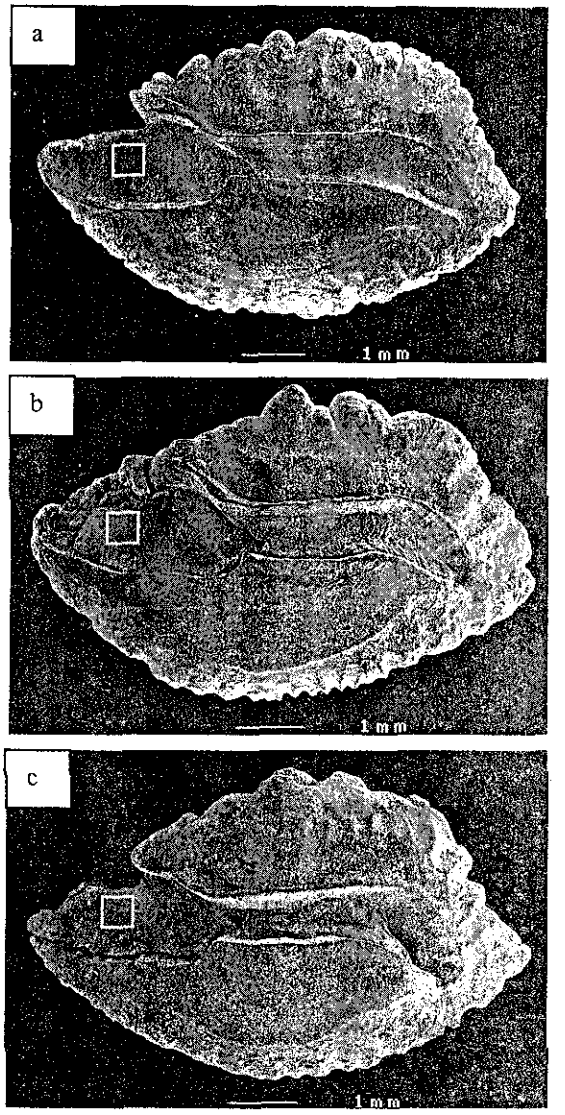

Fig. 2. The sagittal otoliths of (a) *Nemipterus hexoden*, (b) *N. tambuloides*, and (c) *N. furcosus*. Scale bar = 1 mm. The square (□) showing the area of ostium where crystals were enlarged and investigated.

Differences in other morphology of these sagittal otoliths are also found. The rostrum is wide and oval in *N. tambuloides* but narrow and elongate in *N. hexodon* and *N. furcosus*. The antirostrum of *N. tambuloides* is minute and round, while in other two species is large. The dorsal margin and dorsal area are more rough than ventral in all species. The dome-shaped on dorsal margin is found in sagittal otolith of *N. tambuloides*. The dorsal area of sagittal otolith in *N. tambuloides* is smoother than in *N. hexodon* and *N. furcosus*. In contrast, the ventral margin and ventral area of these sagittal otoliths are not different. The dorsal depression of the sagittal otolith in *N. hexodon* and *N. furcosus* are shallow, oval-shaped but it is extend to posterior cauda in *N. hexodon*, while it is deep and narrow over anterior cauda in *N. tambuloides*.

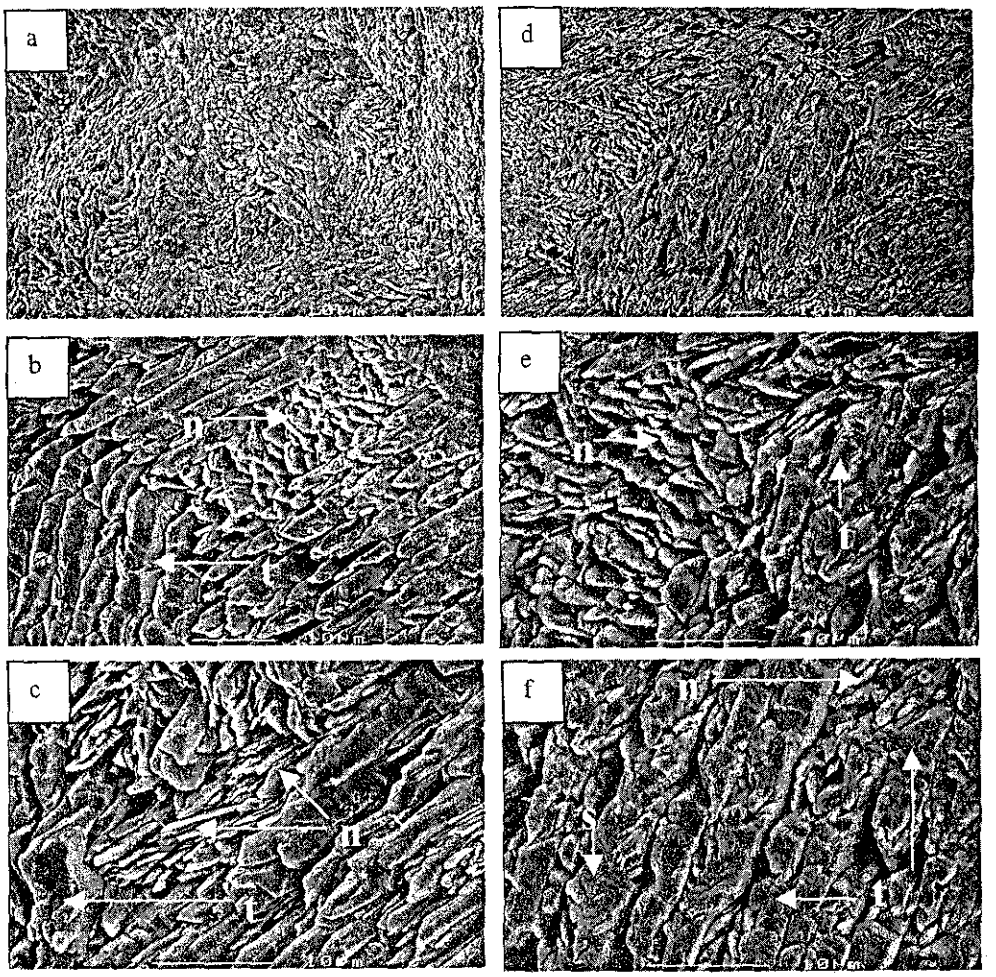

Fig. 3 Crystals on sulcus acusticus of (a-c) *N. hexodon* and (d-f) *N. tambuloides*, (a, d) crystalline arrangement, (b, c, e, f) enlarged crystals in (a) and (d) showing thick (t) and thin (n) crystals and fused thin crystals (s). Scale bar = 10um.

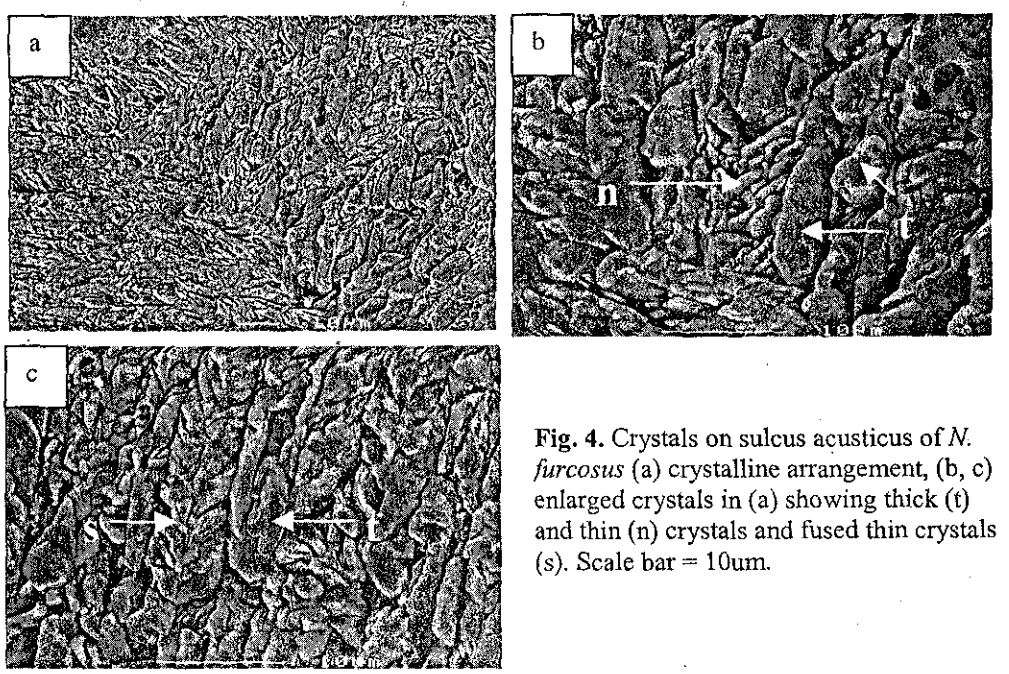

Fig. 4. Crystals on sulcus acusticus of *N. furcosus* (a) crystalline arrangement, (b, c) enlarged crystals in (a) showing thick (t) and thin (n) crystals and fused thin crystals (s). Scale bar = 10um.

Crystalline structure on sulcus acusticus

The crystals on sulcus acusticus of *Nemipterus* are separated into 2 types: thick and thin crystals. The thick crystals are long, rectangular-shaped and arranged in vertical plane, the thin crystals are flat, rectangular-shaped and stacked in horizontal plane (Fig.3 and 4). Differences of thick crystals among three species are found. The thick crystals of *N. hexodon* are longer and smoother than of *N. furcosus* and *N. tambuloides* and some of them are arranged in oblique direction. (Fig. 3a and 3b). The thick crystals of *N. furcosus* are shorter and thicker than of *N. tambuloides* (Fig. 3e and 4b-c). The thick crystals in some area of *N. tambuloides* and *N. furcosus* look like fusion of many thin crystals (Fig. 3e-f and 4b-c), especially in *N. furcosus* (Fig. 4c), which is not found in *N. hexodon*. Generally, the arrangement of thick and thin crystals on sulcus acusticus in *N. tambuloides* and *N. furcosus* are similar (Fig.3d and 4a), the differences are shown in *N. hexodon* (Fig.3a). The thin and thick crystals of *N. hexodon* are arranged 3 directions: vertical, oblique and horizontal planes (Fig. 3). In *N. tambuloides* and *N. furcosus* the thick crystals are grouped together in vertical plane and are surrounded by thin crystals which are stacked in horizontal plane as layers. The group of thick crystals can be clearly separated from the layers of thin crystals (Fig. 3d and 4a), this character is not found in *N. hexodon* (Fig. 3a). However, in some areas of these three species sagittae the thin crystals are grouped as a small clump and are surrounded by the thick crystals (Fig. 3b, 3e and 4a-b).

Discussion

The sagittal otoliths in three species of *Nemipterus* show different morphology, which is species specific. The morphology of *N. hexodon* sagittal otolith is clearly separated from *N. tambuloides* and *N. furcosus*. The shape of sagitta of *N. furcosus* shows the prominent posterior part which is smaller and narrower than of *N. tambuloides* and cauda of sulcus acusticus in *N. furcosus* is different from in *N. tambuloides*, it is strongly flexed tip and processes ventral groove (Fig. 2c).

The crystals on sulcus acusticus of sagittae in three species of *Nemipterus* are different in shape, size and arrangement. The crystalline structure in *N. hexodon* is clearly different from *N. tambuloides* and *N. furcosus*. The crystalline structure of *N. furcosus* can be distinguished from *N. tambuloides* in the area where thin crystals fuse or melt or pack together and become thick crystals as shown in Fig. 3f and 4c. This character can be seen clearly in *N. furcosus* in Fig. 4c.

The differences in sagitta morphology and crystalline structure on sulcus acusticus of *N. hexodon*, *N. tambuloides* and *N. furcosus* might relate to many different factors such as environmental factors,[1,2,11,13,24,26] biological factors,[9,17,19,25] etc. *N. hexodon* are found most abundant in depth range 20-50 meters, in tropical, 25° N- 26° S, Whereas *N. tambuloides* are found in depth range 50-70 meters, in tropical, 18° N- 8° S and *N. furcosus* are found in depth range 8-110 meters, in tropical, 34° N- 25° S.[8] The differences in environmental factors, i.e. latitude and depth range might cause these fishes to adapt to their environment which might effect the pattern of crystallization and shape of otoliths.[15, 20,22,26]

The findings of this study show that the sagittal otolith morphology alone can be used as a tool to identify *N. hexodon, N tambuloides* and *N. furcosus*. However, the information from

crystalline structure on sulcus acusticus will confirm the identification of these three fish species.

This paper presents the preliminary results of work documenting interspecific differences in sagitta morphology and crystalline structure on sulcus acusticus among three fish species of the genus *Nemipterus* from coastal of Thailand. Further study using many more fish species will be needed to compile the information of the sagittae of Thai marine fishes.

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