

Study on the Radula of Korean Marine Gastropods*

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韓國產 海產 卷貝類 齒舌의 形態에 關한 研究*

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권패류 치설의 형태는 권패류 분류에 있어서 중요한 분류 형질의 하나이다.

본 연구는 수집된 9과에 속하는 31종의 해산 권패류들의 치설 형태를 조사하여 종간(種間), 과간(科間)의 형태적 차이를 비교 도시 하였다.

INTRODUCTION

The radula is one of the important characteristics for the classification of gastropods (Habe 1943, Arakawa 1957).

Many studies on the radula of gastropods have been carried out, and needless to say, have contributed to correct many follercies of the past classifications based chiefly on the shell characteristics. The studies have also given much more detailed descriptions and have helped to determine the systematic position of the gastropod species.

The purpose of this study is to describe and illustrate the radula of 31 species of Korean marine gastropods belonging to 6 Families together with some differences among these families.

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Co., for supplying the necessary specimens. The author especially wishes to give my gratitude to Dr. Tadashige Habe, National Science Museum, Tokyo, Japan, for his valuable advice.

MATERIALS AND METHODS

Preparations were made according to the method of Arakawa(1957).

In the staining process of the radula a modified method was employed. That is saturated solution of crystal violet in absolute alcohol for 5 to 20 minutes was used instead of dahlia violet.

The shells were referred to Habe(1961, 1965), Kira (1964) and Kuroda (1954).

The Scientific and Korean common names of species were based on the Thiel (1931~35) and Lee (1956).

DESCRIPTIONS OF THE RADULAE

Buccinum striatissimum Sowerby, 물래고둥,
(Pl. I, Figs. 1, 2, 3)

Specimens examined; 19 individuals

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The rachidian tooth could be divided into two groups, 4-cusped and 5-cusped. All cusps are strong and sharply pointed with a broad base, of which the anterior margin is curved smoothly. In the case of the 4 cusped rachidian, the 2 central cusps are shorter than the marginal one, and in 5 cusped, the central cusp is the smallest and becomes larger and stronger towards the marginal cusp.

The lateral tooth has 3 cusps bearing a resemblance to other buccinid species. Slightly modified cusps are present in the rachidian and the marginal tooth(Fig. 3).

Remarks; Dr. Habe advised in a personal letter, that some variation can be seen in the features of the radula, especially in the number of cusps in certain species. Therefore the best method in categorizing is to observe as many specimens as possible.

Neptunea intersculpta(SOWERBY), 조각매물고둥, (Pl. I, Figs. 4,5,6)

Specimens examined; 16 individuals

The rachidian tooth are divided into 3 and 4 cusped types. The former type possesses cusps of almost the same size, small but strong with a broad base; and the latter possesses 4 marked cusps arranged on the base evenly spaced, or in some cases the central 2 cusps are somewhat smaller being closely located than the marginal one. A peculiar shape of radulae appears in one example (Fig. 6)

Neptunea arthritica (BERNARDI), 판절매물고둥, (Pl. I, Figs. 7,8,9,10,11)

Specimens examined; 23 individuals

This species has many variations in the features of radula, as well as in shapes of shells. The rachidian tooth possesses strong cusps, from 3 to 7. They are normally 3, 4 and 5 cusps, and 6 and 7 cusped rachidian teeth are seen only in one individual each. The lateral tooth is the same with other buccinid species, but there are variations in the shapes of the side of the lateral tooth (Fig. 7, Fig. 8).

Remarks; Habe and Sato(1972) described that the radula of this species has 4 cusped rachidian,

but he gave a suggestion to the author that there can be seen variations in the numbers of cusps with a variety of shell features.

Neptunea arthritica cumingi CROSSE, 흑매물고둥, (Pl. II, Figs. 1,2,3,4)

The appearance of the shell is similar to that of the *N. arthritica* except for that this species has scales along its spire. The two species appear to have the same radula characteristics, except that the base of the rachidian tooth is more elongated laterally in this species. The rachidian tooth has 4 to 7 cusps. The lateral tooth on each side is not the same in some case, the left one possessing 3 cusps and the right 4 cusps (Fig. 4).

Kelletia lischikei KURODA, 매물고둥, (Pl. II, Fig. 5)

Specimens examined; 5 individuals

The rachidian tooth of this species has 3 prominent cusps on the broad base, The central cusp is a little longer than the lateral one.

Remarks: Habe(1943) gave an illustration for the radula of this species, which well agrees with specimens from Korean waters.

Babylonia japonica(REEVE), 수랑, (Pl. II, Fig. 7)

Specimens examined; 3 individuals

The radula of this species displays a peculiar characteristics. The rachidian tooth possesses 5 cusps, of which petal-like 1 central cusp and 2 lateral cusps are large, broadened at the middle and pointed at the tip. The central cusp is shorter than the lateral one. The marginal cusps are sharply pointed and broadened at the base. The lateral tooth possesses 1 inner and 1 outer cusps.

Remarks: A detailed illustration for the radula of this species based on the specimens from Japan was given by Habe(1943), which is identical to the specimens at the present study.

Searlesia hirasei KURODA et HABE, (Pl. II, Fig. 9)

The radula of this species is very small in size and very thin. The rachidian tooth has 3 cusps triangular in shape. The central cusp is slightly longer than the lateral one.

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? , (Pl. IV, Fig. 1)

The rachidian tooth has 3 feeble cusps with a irregular rectangular base, the front margin of which is cut roundly

? , (Pl. III, Fig. 2)

The rachidian tooth has 3 cusps which are very small, almost inconspicuous and blunt. The base is massive and rectangular.

Colus(Helicofusus)eschycus DALL, (Pl. III, Fig. 3)

Specimens examined; 4 individuals

The rachidian tooth possesses 3 strong cusps which are located on a broad base. The central cusp is a bit narrower than the lateral one. There is an example with 4 cusped lateral tooth.

Pisania (Jap euthria) ferra (REEVE), 타래고둥, (Pl. III, Fig. 4)

Specimens examined; 5 individuals

The species shows a remarkable avariation in the feature of radula among individuals or within the individual. The rachidian tooth has 5 to 6 cusps of almost all the same size. The anterior basal margin has a shallow round depression. The lateral tooth has 3 to 4 cusps.

Cantharus cecillai (PHILIPPI), 칸타루스 새시래, (Pl. III, Fig. 5)

Specimens examined: 2 individuals

The rachidian tooth possesses 5 or 7 cusps sharpened at the tip. The central cusp is the largest of them, the outer being the smallest in size. The base is rectangular in shape and bent anteriorly. The lateral tooth bears a resemblance in shape to that of other buccinid species except that 3 thorns are projected on the outer margin of the inner cusp.

Volutopsius hirasci (PILSBRY), (Pl. III, Fig. 14)

Specimens examined; 5 individuals

The rachidian tooth of this species has 3 long acute cusps which are situated on the broad base, of which the anterior margin is dug deeply. The lateral tooth lacks a central cusp.

Remarks: Habe and Sato(1972) illustrated the radula of this species from the North Pacific and proposed to establish a new genus, *Fusivolutopsius* for this species, because which differs from the *V. middendorffi* (DALL) in having the ce-

ntral tooth, longer and broad, deep depression at the front margin, and armed with 3 large sharply pointed cusps on the posterior margin.

Hemifusus ternatanus (GMELIN), 털탑고둥, (Pl. II, Fig. 6)

Specimens examined; 2 individuals

The rachidian has 3 well developed cusps which are broadened at the base and cover most of the posterior basal margin. The central cusp is strong, sharp at the point, and is shorter than the lateral cusps. The lateral cusps are sharply-pointed and bent exteriorly.

The lateral tooth possesses 2 strong thick cusps. The inner cusp is shorter, about two thirds the length of the outer one.

Fulgoraria Kaneko HIRASE, (Pl. II, Fig. 8)

Specimens examined ; 2 individuals

Only the rachidian tooth exists. The rachidian tooth has 3 cusps. The central cusp is longer but narrower than the lateral one. All the cusps are sharp at the tip. The anterior basal margin is arched deeply.

Mitrella bicincta (GOULD), (Pl. II, Fig. 10)

Specimens examined; 2 individuals

The rachidian tooth has no cusp and forms a narrow rectangular shape. The lateral tooth possesses 2 fork-like cusps.

Fusinus sp. (Pl. II, Fig. 11)

Specimens examined; 3 individuals

The bell-like 3 cusped rachidian tooth is very small. The lateral tooth is composed of 8 cusps and is rather small in size compared to that of other species which belong to this genus. The cusps are extended downwardly, forming a sharp point at the tip and becoming longer towards the 6th cusp. The other two located on the lateral margin of the base decrease in length. The outermost posterior basal margin has a projection that can not be called a cusp.

Fusinus forceps (PERRY), (Pl. II, Fig. 12)

Specimens examined; 4 individuals

The rachidian is composed of 3 marked cusps. The lateral tooth has 10 to 14 acute cusps, this being exceptionally large number compared to the shell size.

Fusinus akitai KURODA et HABE, (Pl. II, Fig. 13)

Specimen examined; 1 individual

The rachidian tooth is identical to that of *F. forceps*. The number of the lateral tooth is not the same on each side, 9 cusps on the left side and 8 on the right.

Rapana thomasiana CROSSE, 피빨고둥, (Pl. III, Fig. 6)

Specimens examined; 9 individuals

The rachidian tooth has 3 cusps. All of them are well defined, broadened at the base and sharpened at the tip. The central cusp is the largest, and thickens at the center forming a groove between the central cusp and the lateral cusp.

The lateral cusps are strong but shorter by about two thirds than the central one. Both margins of the lateral cusps are carved with a number of acute minute denticles, sometimes these are merely wrinkles. The base is abrupt rectangular and broadened at the posterior base.

The lateral tooth is falcate in shape.

Remarks: Tanaka (1958) described the rachidian tooth of this species serrated with about ten small well marked toothlets.

Arakawa (1964) also gave an illustration of the radula of this species. The outside of each lateral cusp possesses a number of minute blunt toothlets. Arakawa mentioned that the differences appear in specimens from different locations in Japan and the number of these toothlets appears to vary over a wide range within species.

Thais bronni (DUNKER), (Pl. III, Fig. 7)

Specimens examined; 13 individuals

The rachidian tooth is 3 cusped. All cusps are prominent, strong and thickened at the center. Out of them, the central cusp is certainly the largest, being nearly two times as long as the lateral one. The lateral cusps possess a small but definite inner denticle attached to the inner margin. The outer margin is toothed by a number of sharp denticles, which is linked to the marginal cusp.

The marginal cusp forms a small blunt trian-

gular hump.

The base is rectangular with a concavity at the anterior surface. The lateral tooth is similar to that of the other species belonging to this family.

Remarks; The radula feature of this species illustrated by Arakawa (1962) nearly corresponds to the present specimens.

Thais clavigera (KUSTER), (Pl. III, Fig. 11)

Specimens examined; 5 individuals

The rachidian tooth has 3 cusps. The central cusp is pointed at the tip and very long, more than two times in length than that of the lateral one. The inner margin of the lateral cusp has a thin broad denticle worn at the tip. On the outer margin, a number of small but conspicuous denticles are present.

Ceratostoma burnett (ADAMS et REEVE), 빨고둥, (Pl. III, Fig. 8)

Specimen examined; 1 individual

The rachidian tooth has 3 well marked cusps. The central cusp is two times as long as the lateral one. The lateral cusp is thickened along the center and quite a bit wider than the central one. Inner denticle attached to the base of the lateral cusp is small but apparent. Four denticles occupy the margin between the lateral and the marginal cusp. The base is wide and rectangular with a concavity on the posterior surface.

Ceratostoma rorifluum (ADAMS et REEVE), 뽕사리, (Pl. III, Fig. 9)

Specimens examined; 7 individuals

The rachidian tooth has 3 cusps with a massive base. Out of them the central cusp is the largest and rather narrower than the lateral one. The lateral cusp has a small acute inner denticle. Four to 5 small outer denticles are located along the outer margin of the lateral cusp.

Ocenebra japonica (DUNKER), 입빨고둥, (Pl. III, Fig. 10)

Specimen examined; 1 individual

The rachidian tooth resembles to the *C. rorifluum* in shape and size.

Tonna luteostoma (KUSTER), 대고둥, (Pl. III, Fig. 13)

Specimens examined; 2 individuals

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The large strong rachidian tooth is composed of a acute central cusp and 2 short triangular lateral cusps having blunt tip. The posterior base has shallow groove. The arched lateral tooth is massive, and has a groove inside. Two marginal teeth are sharply pointed at the tip and curved downwards.

Charonia saulia macilenta KURODA et HABE, (Pl. III, Fig. 12)

Specimens examined; 2 individuals

The rachidian tooth has a big strong central cusp, both margins of which possess 5 to 8 small denticles which are diminished in size towards the margin. The base has a concavity on the middle of the anterior margin and a groove inside the posterior base.

The lateral tooth is beak-like in shape and grooved inside. The marginal teeth are bent roundly and sharply pointed at the tip.

Fusitriton oregonensis (REDFIELD), 후시트리톤, (Pl. III, Fig. 14)

Specimen examined; 1 individual

The rachidian tooth with a massive base has a slender but acute central cusp and 5 to 7 well cut minute denticles along its margin. The base becomes broader towards the posterior. The lateral tooth is massive of which the basal margin extends downwards and makes a groove inside, and carved by bluntly cut several denticles on the outer margin. The ribbon-like 2 marginal cusps are strong, hard and curved.

Monoplex echo KURODA et HABE, (Pl. III, Fig. 16)

Specimens examined; 2 individuals

The rachidian tooth with a broadened base is characterized by the blunt but sharp central cusp and 5 to 7 very small outer denticles which make unclear wrinkles on the base.

The lateral tooth bent inwardly is simple. The sickle-like inner marginal tooth is slender and long.

The outer marginal tooth curved gently is thin and shorter than the inner one.

Lunatia fortunei (REEVE), (Pl. III, Fig. 15)

Specimens examined; 3 individuals

The rachidian tooth has 3 prominent cusps which located inside of the anterior base and projected posteriorly.

The bottom of the base is broadened. The lateral tooth possesses 2 defined cusps one of which located on the anterior base is massive, triangular in shape and has one small denticle on the outer margin and the inner margin on 2 minute denticles. The other one situated at the bottom of the base is considerably smaller than that of the upper one, but is as strong. The marginal teeth are same with the other species described in this paper except for that the inner marginal tooth possesses a small denticle on the inner margin.

Neverita (Glossaulax) didyma (RODING), 큰구슬고둥, (Pl. III, Fig. 17)

Specimens examined; 3 individuals

The rachidian tooth possesses 3 strong cusps with a massive base, of which the posterior is broader than the anterior, forming 4 small legs at the corner.

Remarks; The radula of this species slightly differs from Azuma's report(1961). According to that report both outer margins of the lateral cusps are occupied by a series of wavy ornaments, and the lateral tooth which has a massive cusp with several number of minute projections along the both margins of the cusps is curved.

SUMMARY

The purpose of the present study on the radula of Korean marine gastropods is to determine the systematic position of the species by the radula features.

The radula features of 9 Families based on the observation of specimens consisting of 31 species are described briefly as follows.

1. Naticidae; Radula formula 2-1-C-1-2. Rachidian is 3-cusped. All cusps are strong and pointed. The lateral tooth is massive and strong with a huge triangular cusp. Two marginal teeth are slender, long and strong.

2. Cymatidae; Radula formula 2-1-c-1-2. Rachidian, 1-cusped. Cusp is strong and acute. The basal margin is toothed with a number of small denticles. The lateral tooth is beak-like and strong with groove inside. The marginal teeth are slender and pointed.

3. Tonnidae; Radula formula 2-1-C-1-2. Rachidian, 3 cusped. Central cusp is huge, strong and abruptly pointed. Lateral cusp is blunt and relatively small. The lateral tooth and marginal teeth are identical to that of the preceding one.

4. Muricidae; Radula formula 1-C-1. Rachidian has 3 to 5 cusps. Central cusp, long, thick, strong and pointed. Lateral cusps are rather shorter than central, thick, strong and well cut with several minute denticles along outer margin. The lateral tooth is falciform.

5. Pyrenidae; Radula formula 1-c-1. Rachidian lacks of cusp. The base is thin, narrow, small and rectangular. Lateral tooth has 2 cusps with a crescent shaped base.

6. Buccinidae; Radula formula 1-C-1. Rachidian has 3 to 7 cusps. The base is massive and broadened laterally. The lateral tooth is large and has 2 to 4 cusps. The central cusp is the shortest, and become longer towards the each side.

7. Busyconidae; Radula formula 1-C-1. Rachidian, 3-cusped with a massive base. All cusps are pointed and strong. Central cusp is rather shorter than lateral one. Lateral tooth, 2-cusped. Inner cusp short about one half the length of outer one.

8. Fasciolaridae; Radula formula 1-C-1. Rachidian, 3 to 4-cusped. Very small in size. Lateral tooth broadened laterally with about 10 thin, long, sharp cusps.

9. Volutidae; Only the rachidian exists. Rachidian, 3-cusped. All cusps are strong and sharply pointed. Central cusp is narrower than lateral ones. Anterior basal margin is concave.

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EXPLANATION OF PLATES

Plate I.

- Figs. 1-3. Half transverse row of *Buccinum striatissimum* SOWERBY
Figs. 4-6. Half transverse row of *Neptunea intersculpta* (SOWERBY)
Figs. 7-11. Half transverse row of *Neptunea arthritica* (BERNARDI)

Plate II.

- Figs. 1-4. Half transverse row of *Neptunea arthritica cumingi* CROSSE
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Plate III.

- Fig. 1. Half transverse row of?
Fig. 2. Half transverse row of?
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Fig. 17. Half transverse row of *Neverita didyma* (RÖDING)

Plate I

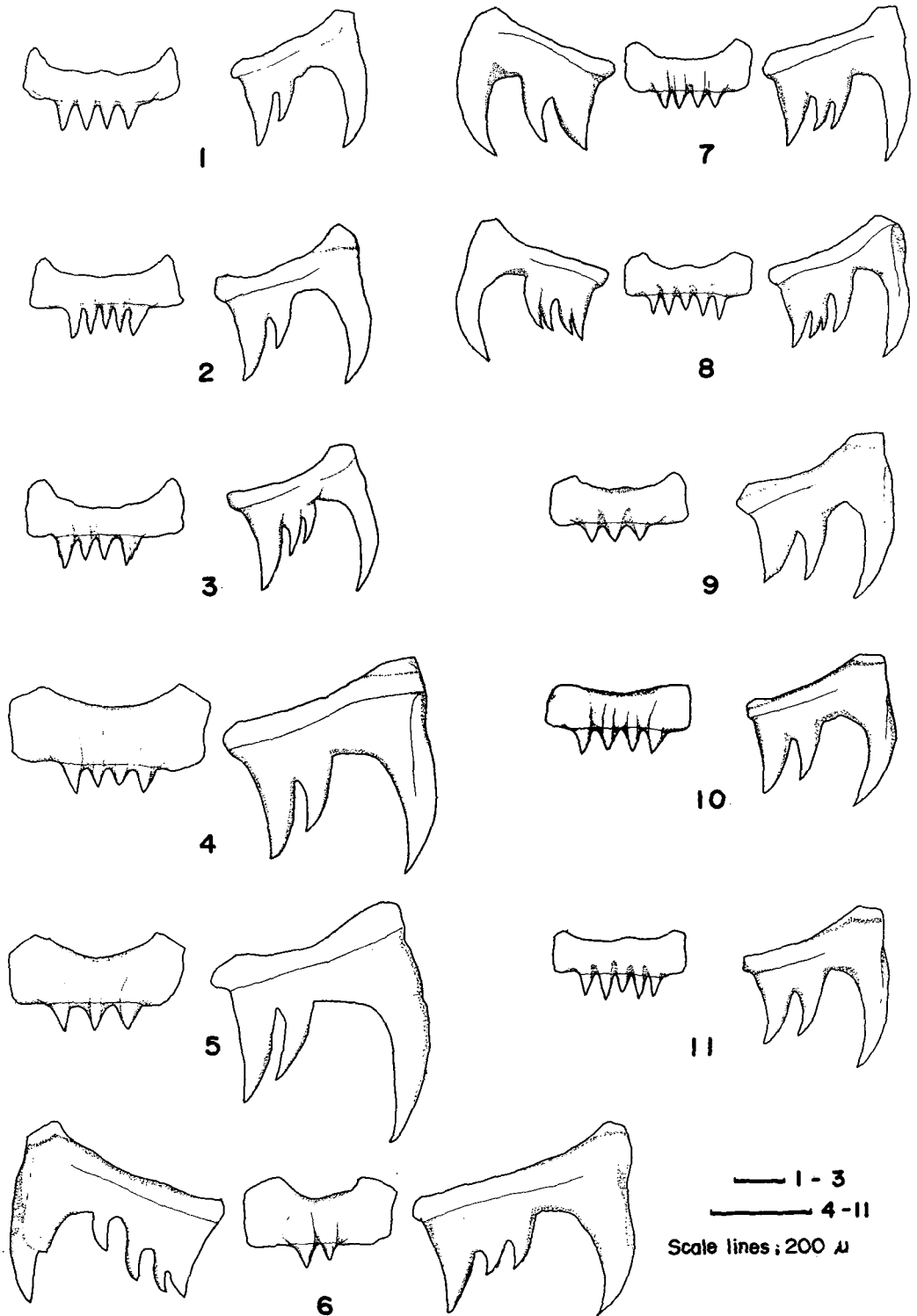


Plate II

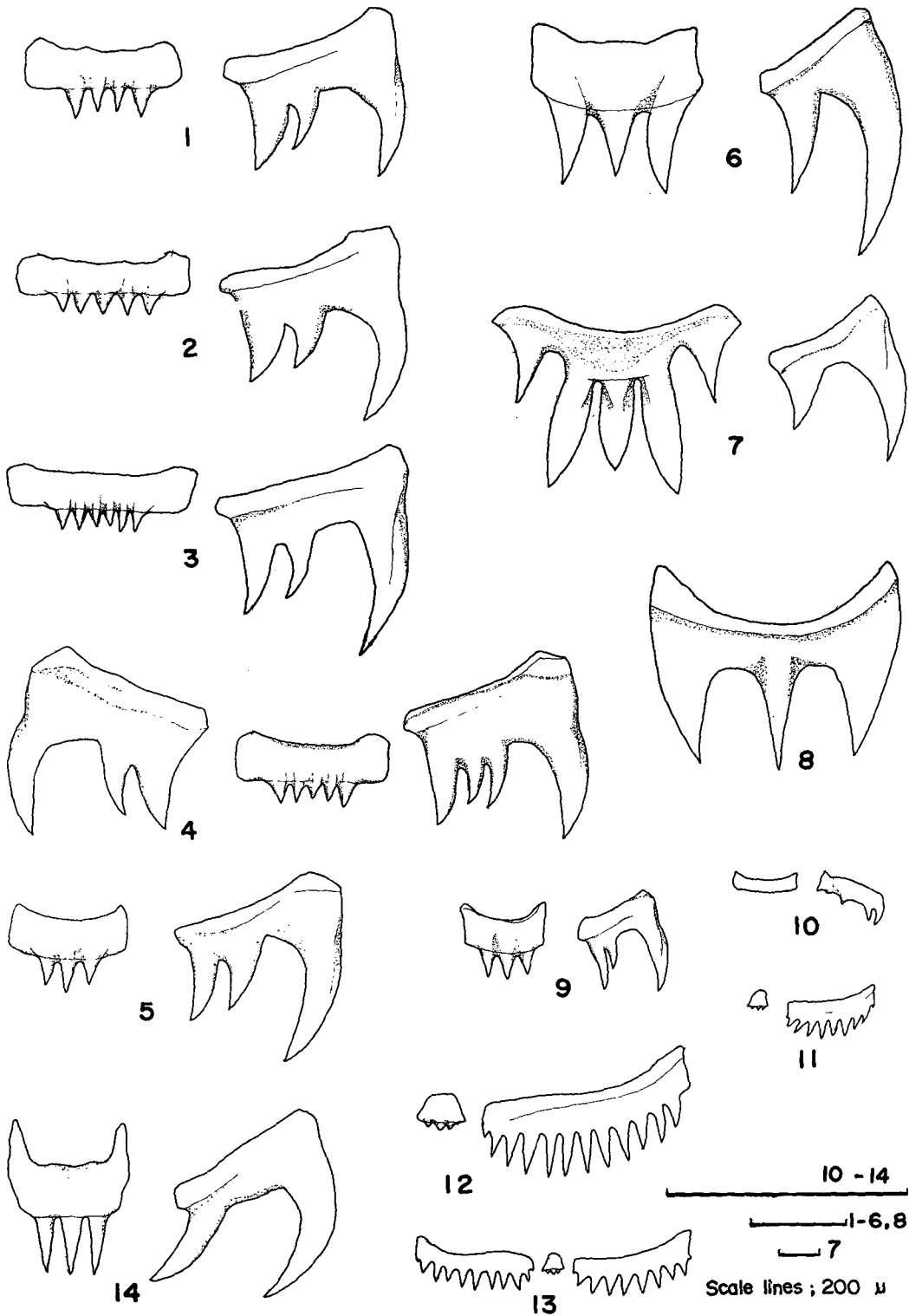


Plate III

