

# Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes

Editor: M. STEHMANN

Part A: Selachii. No. 4:

Order: Orectolobiformes

Families: Brachaeluridae, Ginglymostomatidae, Hemiscylliidae, Orectolobidae, Parascylliidae, Rhiniodontidae, Stegostomatidae.

Order: Pristiophoriformes - Family: Pristiophoridae

Order: Squatiniformes - Family: Squatinidae

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## Abstract

With the exception of the unavailable genera *Heteroscyllium* and *Sutorectus*, this fascicle comprises the descriptions of microteeth of the genera of the orectolobiform families Brachaeluridae, Ginglymostomatidae, Hemiscylliidae, Orectolobidae, Parascylliidae, Rhiniodontidae, Stegostomatidae, of the pristiophoriform family Pristiophoridae and the squatiniform family Squatinidae. Detailed descriptions of the tooth morphology, and rostral spine morphology for Pristiophoriformes are given, as well as SEM-photographs. The tooth morphology of the genera concerned is compared in order to elucidate the interrelationships within these shark orders also from an odontological point of view. The dental histology for the orectolobiform genera is commented on, and their dental vascular types are re-examined in order to understand the various root forms. The results are summarized in a differential diagnosis for all orectolobiform genera and families. Dental morphology, histology and vascularization results allow to provide an odontological key to all supraspecific taxa of these orders and to suggest a number of systematical adjustments. The glossary for the series, as published so far, has been complemented and updated.

**Key-words:** Elasmobranchii - Selachii - Orectolobiformes - Pristiophoriformes - Squatiniformes - Odontology.

Morphologie, histologie et vascularisation dentaires permettent de proposer une clé odontologique pour tous les taxons supraspécifiques concernés, d'avancer quelques hypothèses d'ordre phylétique et de suggérer quelques réajustements systématiques.

**Mots-clés:** Elasmobranchii - Selachii - Orectolobiformes - Pristiophoriformes - Squatiniformes - Odontologie.

## Kurzfassung

Außer den nicht verfügbaren Genera *Heteroscyllium* und *Sutorectus* befaßt dieser Teil sich mit der Beschreibung der Mikro Zähne der Gattungen der orectolobiformen Familie, Brachaeluridae, Ginglymostomatidae, Hemiscylliidae, Orectolobidae, Parascylliidae, Rhiniodontidae, Stegostomatidae, der pristiophoriformen Familie Pristiophoridae und der squatiniformen Familie Squatinidae. Die Morphologie der Kieferzähne und, für die Pristiophoridae, der Rostralzähne wird für die jeweiligen Beispielarten beschrieben und mit REM-Photos illustriert. Die Zahnmorphologie der hier behandelten Gattungen wird verglichen, um die Verwandtschaftsbeziehungen innerhalb dieser Haiordnungen auch unter odontologischen Gesichtspunkten zu erhellen. Die Zahn-histologie der orectolobiformen Gattungen wird kommentiert, und die verschiedenen Formen des Zahngefäßsystemes sind erneut untersucht worden. Alle Ergebnisse sind in einer Differentialdiagnose für alle Gattungen und Familien der Orectolobiformes, Pristiophoriformes und Squatiniformes zusammengefaßt. Die vollständigen Ergebnisse zur Zahnmorphologie, -histologie und -fäßversorgung ermöglichten die Aufstellung eines zahnmorphologischen Bestimmungsschlüssels für alle supraspezifischen Taxa dieser Haiordnungen und Vorschläge für eine Reihe von möglichen Änderungen der Klassifikation. Das Glossar für bisher veröffentlichte Beiträge der Serie wurde vervollständigt und auf den aktuellen Stand gebracht.

**Schlüsselwörter:** Elasmobranchii - Selachii - Orectolobiformes - Pristiophoriformes - Squatiniformes - Odontologie.

## Résumé

Hormis celle des genres *Heteroscyllium* et *Sutorectus* non disponibles, la morphologie dentaire des genres que comprennent les diverses familles des Orectolobiformes (Brachaeluridae, Ginglymostomatidae, Hemiscylliidae, Orectolobidae, Parascylliidae, Rhiniodontidae, Stegostomatidae), des Pristiophoriformes (Pristiophoridae) et des Squatiniformes (Squatinidae) est décrite et figurée. La morphologie des dents rostrales des Pristiophoridae l'est également. L'histologie dentaire et les différents types de vascularisation de la racine dentaire des Orectolobiformes sont réexaminés.

## Introduction

This fascicle deals with the three shark orders: Orectolobiformes, Pristiophoriformes and Squatiniformes.

After the recentmost revision of COMPAGNO (1984), the Orectolobiformes comprise 7 families: Brachaeluridae, Ginglymostomatidae, Hemiscylliidae, Orectolobidae, Parascylliidae, Rhiniodontidae and Stegostomatidae.

The Pristiophoriformes are monotypic with the family Pristiophoridae only, as well as the Squatiniformes with the family Squatinidae.

Several previous publications have partly illustrated teeth of orectolobiform genera – Applegate (1972), Bass, d'Aubrey & Kistnasamy (1975) and Herman & Crochard (1977) –, of pristiophoriform genera, Bass, d'Aubrey & Kistnasamy (1975) and of the squatiniform genus, Bass, d'Aubrey & Kistnasamy (1975).

The illustrations, however, are poor and cannot serve for the more detailed odontological studies of this contribution.

The tooth morphology of all genera of the families mentioned above is described and illustrated, and their dental histology is commented on. The ichthyodorulites of Pristiophoriformes are also described and illustrated (rostral spines).

Species of the genera *Sutorectus* and *Heteroscyllium* were not available and are therefore not included in this study.

The systematic arrangement of the orders mentioned above is based on COMPAGNO (1984) and differs from the results of this study. However, the authors will here not draw any nomenclatorially valid conclusions from their odontological results. Being aware of dealing with one complex of characters only, they will present their odontological results and leave it to following revising authors to incorporate also odontological points of view in a full systematic review with possible taxonomic and nomenclatorial changes.

The original literature reference of each specific taxon will be given in the descriptive part, respectively, and not be repeated in the bibliography.

## Systematics and materials

### ORDER: ORECTOLOBIFORMES sensu COMPAGNO (1984)

Family: Brachaeluridae APPLGATE, 1974

Genus: *Brachaelurus* OGILBY, 1907

Type species: *Brachaelurus waddi*

Genus: *Heteroscyllium* REGAN, 1908

Type species: *Heteroscyllium colcloughi*

Family: Ginglymostomatidae GILL, 1862

Genus: *Ginglymostoma* MÜLLER & HENLE, 1837

Type species: *Ginglymostoma cirratum*

Genus: *Nebrius* RÜPPELL, 1837

Type species: *Nebrius ferrugineus*

Family: Hemiscylliidae GILL, 1862

Genus: *Chiloscyllium* MÜLLER & HENLE, 1837

Type species: *Chiloscyllium plagiosum*

Genus: *Hemiscyllium* MÜLLER & HENLE, 1837

Type species: *Hemiscyllium ocellatum*

Family: Orectolobidae GILL, 1896

Genus: *Eucrossorhinus* REGAN, 1908

Type species: *Eucrossorhinus dasypogon*

Genus: *Orectolobus* BONAPARTE, 1834

Type species: *Orectolobus maculatus*

Genus: *Sutorectus* WHITLEY, 1939

Type species: *Sutorectus tentaculatus*

Family: Parascylliidae GILL, 1862

Genus: *Cirrhoscyllium* SMITH & RADCLIFFE, 1913

Type species: *Cirrhoscyllium expoliturum*

Genus: *Parascyllium* GILL, 1862

Type species: *Parascyllium variolatum*

Family: Stegostomatidae GILL, 1862

Genus: *Stegostoma* MÜLLER & HENLE, 1837

Type species: *Stegostoma fasciatum*

Family: Rhiniodontidae MÜLLER & HENLE, 1839

Genus: *Rhiniodon* SMITH, 1828

Type species: *Rhiniodon typus*

### ORDER: PRISTIOPHORIFORMES sensu COMPAGNO (1984)

Family: Pristiophoridae BLEEKER, 1859

Genus: *Pliotrema* REGAN, 1906

Type species: *Pliotrema warreni*

Genus: *Pristiophorus* MÜLLER & HENLE, 1837

Type species: *Pristiophorus cirratus*

### ORDER: SQUATINIFORMES sensu COMPAGNO (1984)

Family: Squatinidae BONAPARTE, 1838

Genus: *Squatina* DUMERIL, 1806

Type species: *Squatina squatina*

The teeth of the following 56 specimens of 21 species were examined:

<i>Brachaelurus waddi</i>	1 ♂	1 ♀
<i>Chiloscyllium plagiosum</i>	2 ♂	1 ♀
<i>Chiloscyllium griseum</i>	1 ♂	
<i>Cirrhoscyllium expoliturum</i>		1 ♀
<i>Eucrossorhinus dasypogon</i>	3 ♂	2 ♀
<i>Ginglymostoma cirratum</i>	2 ♂	3 ♀

<i>Hemiscyllium freycineti</i>		1 ♀
<i>Hemiscyllium ocellatum</i>	1 ♂	
<i>Nebrius ferrugineus</i>	1 ♂	2 ♀
<i>Orectolobus maculatus</i>	1 ♂	2 ♀
<i>Orectolobus ornatus</i>		1 ♀
<i>Parascyllium collare</i>		1 ♀
<i>Parascyllium variolatum</i>		1 ♀
<i>Pliotrema warreni</i>		1 ♀
<i>Pristiophorus cirratus</i>	1 ♂	
<i>Pristiophorus schroederi</i>		1 ♀
<i>Rhiniodon typus</i>	1 ♂	
<i>Squatina aculeata</i>	6 ♂	4 ♀
<i>Squatina oculata</i>		2 ♀
<i>Squatina squatina</i>	4 ♂	3 ♀
	1 of unknown sex	
<i>Stegostoma fasciatum</i>	3 ♂	1 ♂

vex. An uvula is present at the central crown base. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two root lobes. Foramina are absent.

The inner face of the root shows a strongly developed central protuberation, with one well developed foramen.

On the crown-root junction one or two foramina may be present at each side of the protuberation.

The basal part of the root displays a large triangularly shaped central depression at the outer part. A large foramen is always present below the protuberation at the innermost part of the depression, with sometimes one or two smaller foramina in addition. One or two expanded foramina may also be present at the end of the root lobes.

Family: *Ginglymostomatidae* GILL, 1862

### Descriptions of the odontological morphotypes

ORDER: ORECTOLOBIFORMES  
sensu COMPAGNO, 1984

Family: *Brachaeluridae* APPLEGATE, 1974

#### HETERODONTY

*Brachaeluridae* show gradient monognathic heterodonty. Neither sexual nor ontogenetic heterodonty has been observed. (*Heteroscyllium* has not been examined).

Genus: *Brachaelurus* OGILBY, 1907

This genus is monotypic with the type species *Brachaelurus waddi*.

*Brachaelurus waddi* (BLOCH & SCHNEIDER, 1801)  
(Plates 1 to 3)

*Squalus waddi* BLOCH & SCHNEIDER, 1801. *Systema ichthyologiae iconibus ex illustratum*: 130.

The teeth of this species have a broad based relatively short principal cusp, which is erect in anterior teeth, becoming more oblique and shorter toward the commissure in laterals. A blunt, short, well developed cusplet is present at each side in anterior teeth but less developed in lateral and absent in commissural teeth.

The root is hemiaulacorhizid and has two root lobes, which are relatively long, narrow and angled at root base.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. A strongly developed, broad apron at the crown base overhangs the crown-root junction. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly con-

#### HETERODONTY

The *Ginglymostomatidae* show gradient monognathic heterodonty. Sexual heterodonty has not been observed. Ontogenetic heterodonty is characterized by a reduced number of cusplets.

Genus: *Ginglymostoma* MÜLLER & HENLE, 1837

This genus comprises 2 species: *Ginglymostoma brevicaudatum* and the type species *Ginglymostoma cirratum*.

*Ginglymostoma cirratum* (BONNATERRE, 1788)  
(Textplate 1, Plates 4, 5)

*Squalus cirratus* BONNATERRE, 1788. *Ichthyologie, Tableau encyclopédique et méthodique des trois règnes de la nature*. Paris: 7.

The teeth of this species have a broad based relatively short principal cusp, which is erect in anterior teeth, becoming weakly oblique toward the commissure. Two well developed cusplets are present at each side and on the extreme end of both mesial and distal cutting edges. A less developed third cusplet may be present.

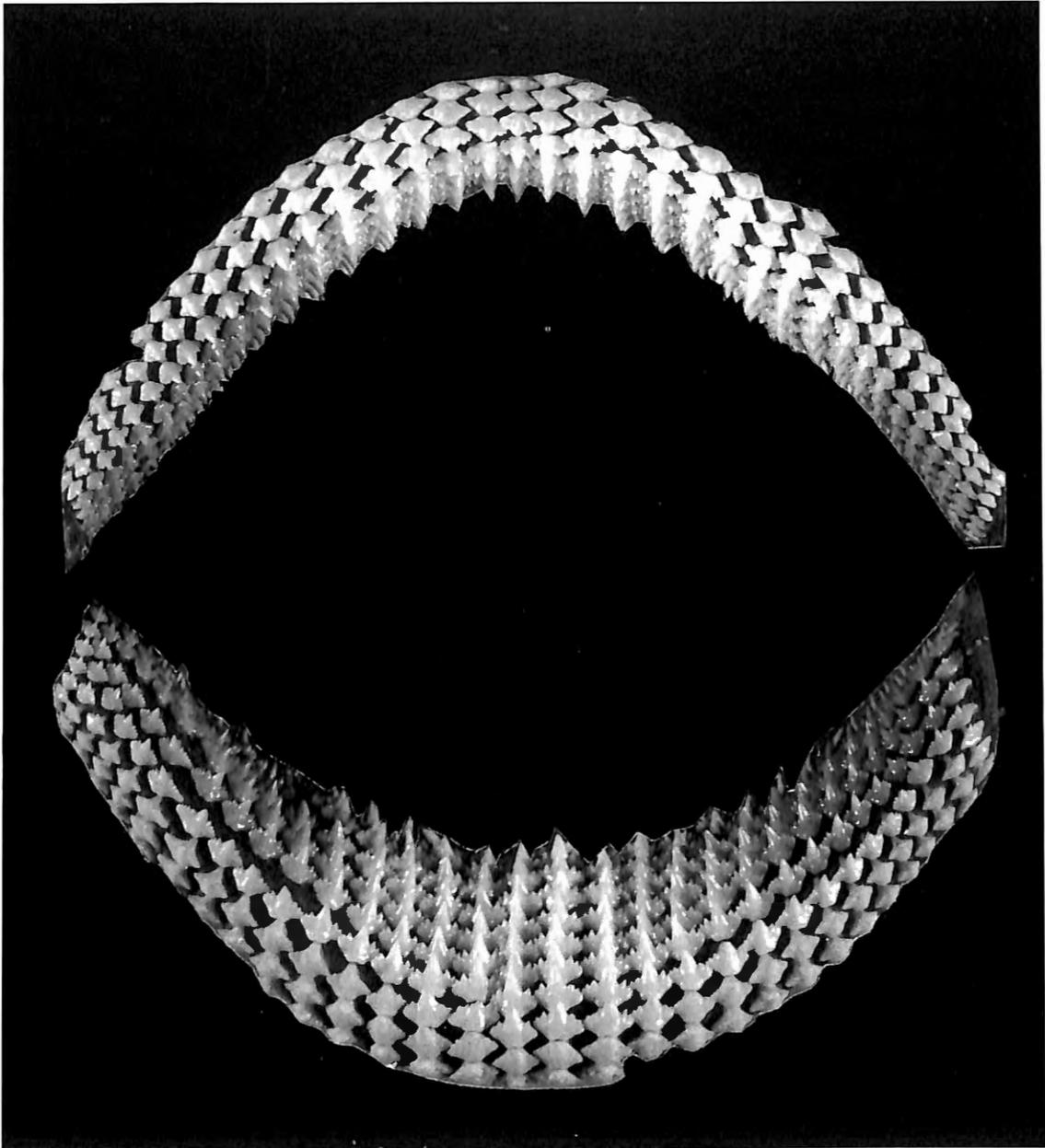
The root is hemiaulacorhizid and has two root lobes, which are relatively long, narrow and angled at root base.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. A broad apron at the crown base overhangs the crown-root junction. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly convex. An uvula is present at the central crown base. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two root lobes. Foramina are absent.



Textplate 1. – *Ginglymostoma cirratum* (BONNATERRE, 1788). Female 232 cm t.l., Senegal. Upper and lower jaws  $\times 0.75$ .

The inner face of the root shows a strongly developed central protuberation, with one well developed foramen. On the crown-root junction, up to three foramina may be present at each side of the protuberation.

The basal part of the root displays a large triangularly shaped central depression at the outer part. A large foramen is always present below the protuberation at the innermost part of the depression, which is expanded in outer-inner direction. The foramen is sometimes divided into two parts by bridging of the root lobe surfaces and the inner part can be merged with the inner central foramen. Numerous small foramina are scattered on both root lobes, of which most are more or less lined up along the inner part.

Genus: *Nebrius* RÜPPELL, 1837

This genus is monotypic with the type species *Nebrius ferrugineus*.

*Nebrius ferrugineus* (LESSON, 1830)  
(Plates 6 to 8)

*Scyllium ferrugineum* LESSON, 1830. Zoologie. In: Duperrey, L.I, Voyage autour du monde sur la corvette "La Coquille", pendant 1822-1825. Paris, 2 (1): 95.

The teeth of this species have a very short principal cusp, which is erect in anterior teeth and becoming

oblique toward the commissure. Up to six, small, well developed cusplets are present at each side, which are diminishing in size toward the end of both mesial and distal cutting edges.

The root is hemiaulacorhizid and has two root lobes, which are relatively short, broad and angled at root base.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. A large apron at the crown base overhangs the crown-root junction. Basal ornamentation, costules or striae are absent, but the apron surface shows some shallow depressions.

The inner face of the principal cusp is strongly convex. An uvula is present at the central crown base. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two root lobes. Some small scattered foramina are present.

The inner face of the root shows a strongly developed central protuberation, with one well developed foramen. On the crown-root junction, a foramen may be present at each side of the protuberation.

The basal part of the root displays a large triangularly shaped, central depression at the outer part. A very large foramen is always present below the protuberation at the innermost part of the depression, which is slightly expanded in outer-inner direction. The foramen merges sometimes with the inner central foramen. Numerous small foramina are scattered over the root lobes.

#### Family: Hemiscylliidae GILL, 1862

#### HETERODONTY

The Hemiscylliidae in general show gradient monognathic heterodonty. Neither sexual nor ontogenetic heterodonty has been observed.

#### Genus: *Chiloscyllium* MÜLLER & HENLE, 1837

This genus comprises 6 species: *Chiloscyllium arabicum*, *Chiloscyllium caerulopunctatum*, *Chiloscyllium griseum*, *Chiloscyllium indicum*, *Chiloscyllium plagiosum* and *Chiloscyllium punctatum*. The type species is *Chiloscyllium plagiosum*.

#### *Chiloscyllium plagiosum* (BENNETT, 1830) (Textplate 2, Plates 9 to 11)

*Scyllium plagiosum* BENNETT, 1830. Memoirs of the life and public services of Sir S. Raffles: 694.

The teeth of this species have a broad based relatively short principal cusp, which is erect in anterior and becoming more oblique toward the commissure in lateral teeth. A blunt, short cusplet is present at each side in anterior teeth but less developed in lateral and absent in

commissural teeth. Both mesial and distal cutting edge ends merge with the outer crown base.

The root is hemiaulacorhizid and has two root lobes, which are relatively long, narrow and angled at root base.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. A strongly developed, broad apron at the crown base overhangs the crown-root junction, which has a flat base in the centre. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly convex. An uvula is present at the central crown base. Basal ornamentation, costules or striae are absent on anterior or lateral teeth, but some coarse, little developed costules are present just below the cutting edges in posterior teeth.

The outer face of the root shows two root lobes. Foramina are absent.

The inner face of the root shows a strongly developed central protuberation with one well developed foramen. At the crown-root junction one or two foramina may be present at each side of the protuberation.

The basal part of the root displays a large, central depression at the outer part. A very large foramen is always present below the protuberation at the innermost part of the depression. Some small foramina are present on the root lobes, of which some are more or less expanded in outer-inner direction.

#### Genus: *Hemiscyllium* MÜLLER & HENLE, 1837

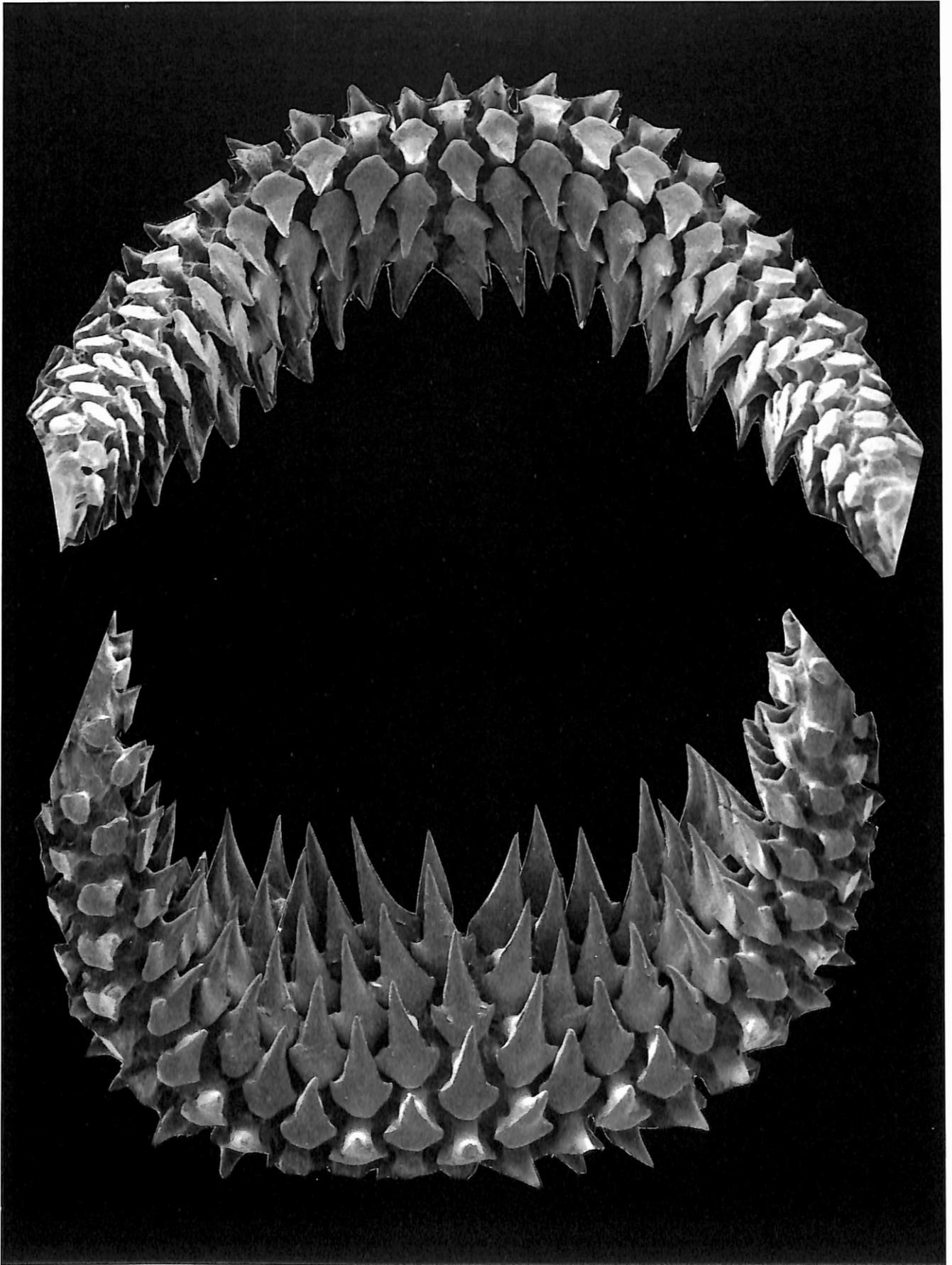
This genus comprises 5 species: *Hemiscyllium freycineti*, *Hemiscyllium hallstromi*, *Hemiscyllium ocellatum*, *Hemiscyllium strahani* and *Hemiscyllium trispiculare*. The type species is *Hemiscyllium ocellatum*.

#### *Hemiscyllium ocellatum* (BONNATERRE, 1788) (Plates 12 to 14)

*Squalus ocellatus* BONNATERRE, 1788. Ichthyologie, Tableau encyclopédique et méthodique des trois règnes de la nature. Paris: 8.

The teeth of this species have a broad based relatively short principal cusp, which is erect in anterior and becoming more oblique toward the commissure in lateral teeth. A poorly developed cusplet is present in upper anterior teeth at the most extreme part of the mesial and distal cutting edges. Instead of cusplets rounded mesial and distal cutting edges are present at each side of the principal cusp of all lower and upper lateral and posterior teeth. The ends of the cutting edges are merged with the outer crown base.

The root is hemiaulacorhizid and has two root lobes, which are relatively long, narrow and angled at root base.



Textplate 2. – *Chiloscyllium plagiosum* (BENNETT, 1830). Female 22 cm t.l., Philippines. Upper and lower jaws  $\times 30$ .

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. A strongly developed, broad apron at the crown base overhangs the crown-root junction, which has a flat base in the centre. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly convex. An uvula is present at the central crown base. Basal ornamentation, costules or striae are absent on anterior or lateral teeth.

The outer face of the root shows two root lobes. Foramina are absent.

The inner face of the root shows a strongly developed central protuberation with one well developed foramen. On the crown-root junction, a foramen may be present at each side of the protuberation.

The basal part of the root displays a large, shallow, central depression at the outer part. A very large foramen is always present below the protuberation at the innermost part of the depression. A few small foramina are present at the inner part of both root lobe ends, of which some are more or less expanded in outer-inner direction.

Family: *Orectolobidae* GILL, 1896

#### HETERODONTY

The *Orectolobidae* show strongly gradient monognathic heterodonty by having two or three anterior teeth with extremely elongated principal cusps and with a broad space between each row in both upper and lower jaw halves. These are followed by narrowly spaced lateral rows of teeth having much lower principal cusps diminishing in size toward the commissure. *Eucrossorhinus* has lower symphyseal teeth of the same size as the anteriors, and *Orectolobus* presents a very small-sized upper symphyseal row. Neither sexual nor ontogenetic heterodonty was observed. (*Sutorectus* was not examined).

Genus: *Eucrossorhinus* REGAN, 1908

This genus is monotypic with the type species *Eucrossorhinus dasypogon*.

*Eucrossorhinus dasypogon* (BLEEKER, 1867)  
(Plates 15 to 18)

*Crossorhinus dasypogon* BLEEKER, 1867, Archives néerlandaises des sciences exactes et naturelles. 2: 400.

The anterior teeth of this species have a broad based, extremely elongated, erect principal cusp, that has extended, almost horizontally running cutting edges curving toward the crown base. The lateral teeth have a lower, slightly oblique principal cusp, with more

extended cutting edges. The smooth cutting edges are as long as one third of the crown height in anterior, and as long as the crown height in lateral teeth. Cusplets are absent.

The root is hemiaulacorhizid and has two broad, flattened root lobes, which are angled at the root base.

The teeth are centimetrical in range.

The outer face of the principal cusp is rather convex. A narrow apron at the crown base overhangs the crown-root junction. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly convex. A narrow uvula is present at the central crown base, supported by a central root protuberation. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two lobes. Foramina are absent.

The inner face of the root shows a strongly developed central protuberation, with one well developed foramen. At the crown-root junction, up to three foramina in anterior and up to ten in lateral teeth may be present at each side of the protuberation.

The flat, triangularly shaped basal part of the root displays a large outer, central depression. Up to four large foramina may be present in the depression. Numerous small foramina are scattered all over the slightly curved root lobes.

Genus: *Orectolobus* BONAPARTE, 1834

This genus comprises 4 species: *Orectolobus japonicus*, *Orectolobus maculatus*, *Orectolobus ornatus* and *Orectolobus wardi*. The type species is *Orectolobus maculatus*.

*Orectolobus maculatus* (BONNATERRE, 1788)  
(Plates 19, 20)

*Squalus maculatus* BONNATERRE, 1788, Ichthyologie, Tableau encyclopédique et méthodique des Trois règnes de la nature, Paris: 8.

The upper symphyseal teeth are small, having an elongated, strongly developed principal cusp. Cusplets are absent.

The root is bulb shaped by merged root lobes. The inner part is strongly protuberated.

The anterior teeth have a broad based, extremely elongated, erect principal cusp, which has extended, almost horizontally running cutting edges, curving toward the crown base. The lateral teeth have a lower, slightly oblique principal cusp, with more extended cutting edges. Both cutting edges are as long as one third of the crown height in anterior, and as long as the crown height in lateral teeth. On both mesial and distal extended cutting edges of lateral teeth, one or sometimes two, poorly developed cusplets are present.

The root is hemiaulacorhizid and has two broad, flat-

tened lobes, which are angled at the root base.

The teeth are centimetrical in range.

The outer face of the principal cusp is rather convex. A narrow apron at the crown base overhangs the crown-root junction. Coarse but little developed basal costules are present on anterior teeth and better developed but finer on lateral teeth. Striae are absent.

The inner face of the principal cusp is strongly convex. A narrow uvula is present at the central crown base, supported by a central root protuberation. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two lobes. Foramina are absent.

The inner face of the root shows a strongly developed central protuberation, with one well developed foramen. On the crown-root junction up to three foramina on anterior and up to ten on lateral teeth may be present at each side of the protuberation near the crown-root junction.

The flat, triangularly shaped basal part of the root displays a large, outer, central depression. Up to four large foramina may be present in the depression. Numerous small foramina are scattered all over the slightly curved root lobes.

Family: Parascylliidae GILL, 1862

#### HETERODONTY

The Parascylliidae show gradient monognathic heterodonty. Neither sexual nor ontogenetic heterodonty has been observed.

Genus: *Parascyllium* GILL, 1862

This genus comprises 4 species: *Parascyllium collare*, *Parascyllium ferrugineum*, *Parascyllium multimaculatum* and the type species *Parascyllium variolatum*. Only a juvenile specimen of the type species was available for examination, of which some teeth will be illustrated as additional information\*. Therefore an adult specimen of *Parascyllium collare* was used for description and illustration instead.

\* See Plates 21 to 23.

*Parascyllium collare* RAMSAY & OGILBY, 1888  
(Plates 24, 25)

*Parascyllium collare* RAMSAY & OGILBY, 1888. Proceedings of the Linnaean Society New South Wales, series 2, 3: 1310.

The teeth of this species have an elongated, relatively long and erect principal cusp. A poorly developed, blade-like cusplet is present at each side.

The root is hemiaulacorhizid and has two lobes, which are relatively long but broad and sharply angled at root base.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex or almost flat. An apron is absent and the crown base does not overhang the crown-root junction. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly convex. An uvula is absent at the central crown base. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two lobes. Foramina are absent.

The inner face of the root shows a broad central protuberation, with a well developed foramen. Foramina are absent on the crown-root junction.

The basal part of the root displays a large, sharp, triangularly-shaped, central depression at the outer part. A very large foramen is always present below the protuberation, with sometimes one or two smaller ones at the inner most part of the depression, which is merged with the inner central foramen in adult specimens to form a pseudogroove. Foramina are absent on the root lobes.

Genus: *Cirrhoscyllium* SMITH & RADCLIFFE, 1913

This genus comprises 3 species: *Cirrhoscyllium expositum*, *Cirrhoscyllium formosanum* and *Cirrhoscyllium japonicum*. The type species is *Cirrhoscyllium expositum*.

*Cirrhoscyllium expositum*  
SMITH & RADCLIFFE, 1913  
(Plate 26)

*Cirrhoscyllium expositum* SMITH & RADCLIFFE, 1913. Proceedings of the United States National Museum, 45 (1997): 568.

The teeth of this species have an elongated relatively long principal cusp, which points obliquely toward the commissure. A poorly developed cusplet, blade-like, is present at each side. The mesial blade joins the mesial cutting edge of the principal cusp in a notch.

The root is hemiaulacorhizid and has two lobes, which are relatively long but broad and sharply angled at root base.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex or almost flat. An apron is absent and the crown base does not overhang the crown-root junction. Basal ornamentation or striae are absent, but a few fine basal costules may occur.

The inner face of the principal cusp is strongly convex. The uvula is absent at the central crown base. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two root lobes. Foramina are absent.

The inner face of the root shows a broad central protuberation, with a well developed foramen. Foramina are absent on the crown-root junction.

The basal part of the root displays a sharp triangularly shaped, central depression at the outer part. A very large foramen is always present below the protuberation. Foramina are absent on the root lobes.

Family: Rhinodontidae MÜLLER & HENLE, 1839

#### HETERODONTY

The Rhinodontidae show gradient monognathic heterodonty. Neither sexual nor ontogenetic heterodonty has been observed.

Genus: *Rhiniodon* SMITH, 1828

This genus is monotypic with the type species *Rhiniodon typus*.

*Rhiniodon typus* SMITH, 1828  
(Plate 27)

*Rhiniodon typus* SMITH, 1828. South African Commercial Advertiser, 3 (145): 2.

The teeth of this species have an elongated, narrow based and erect principal cusp, which is strongly curved to the inner face. Cusplets are absent. The root is hemiaulacorhizid, however the originally separated root lobes are merged. The teeth are plurimillimetrical in range. The outer face of the principal cusp is strongly convex. The crown base is shaped like an apron, overhanging the crown-root junction. Basal ornamentation, costules or striae are absent. The inner face of the principal cusp is extremely convex. The inner crown base is extended to the inner face (uvula-like). Basal ornamentation, costules or striae are absent. Both inner and outer faces of the crown are merged. Mesial and distal cutting edges are absent. The outer face of the root shows a poorly developed mesial and distal extension. Foramina are absent. The inner face of the root is strongly protuberated, having a well developed foramen at each side of the crown and another smaller one in the centre of the protuberation. The slightly concave basal face is bulb-shaped, and shows a large central foramen, which is oval in inner-outer direction.

Family: Stegostomatidae GILL, 1862

#### HETERODONTY

The Stegostomatidae show gradient monognathic heterodonty. Neither sexual nor ontogenetic heterodonty has been observed.

Genus: *Stegostoma* MÜLLER & HENLE, 1837

This genus is monotypic with the type species *Stegostoma fasciatum*.

*Stegostoma fasciatum* (HERMANN, 1783)  
(Textplate 3, Plates 28 to 31)

*Squalus fasciatus* HERMANN, 1783. Tabula affinitatum animalium, Argentorati: 302.

The teeth of this species have an elongated, relatively long and erect principal cusp. A likewise relatively long and elongated cusplet is present at each side, of which the cutting edges at the distal and mesial tooth parts are merged with the outer crown base.

The root is hemiaulacorhizid and has two root lobes, which are relatively long, narrow and sharply angled at root base.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. An extremely broad apron, comprising the total crown base, overhangs the crown-root junction. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly convex. An uvula is present at the central crown base. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two root lobes. Foramina are absent.

The inner face of the root shows a strongly developed central protuberation, with one well developed foramen. On the crown-root junction, up to three foramina may be present at each side of the protuberation.

The basal part of the root displays a large, sharply angled, triangularly shaped, central depression at the outer part. A very large foramen is always present below the protuberation at the innermost part of the depression, which is connected with the inner central foramen by a broad canal. Some smaller foramina are present at the ends of both root lobes and at the inner part, of which some are more or less expanded in outer-inner direction.

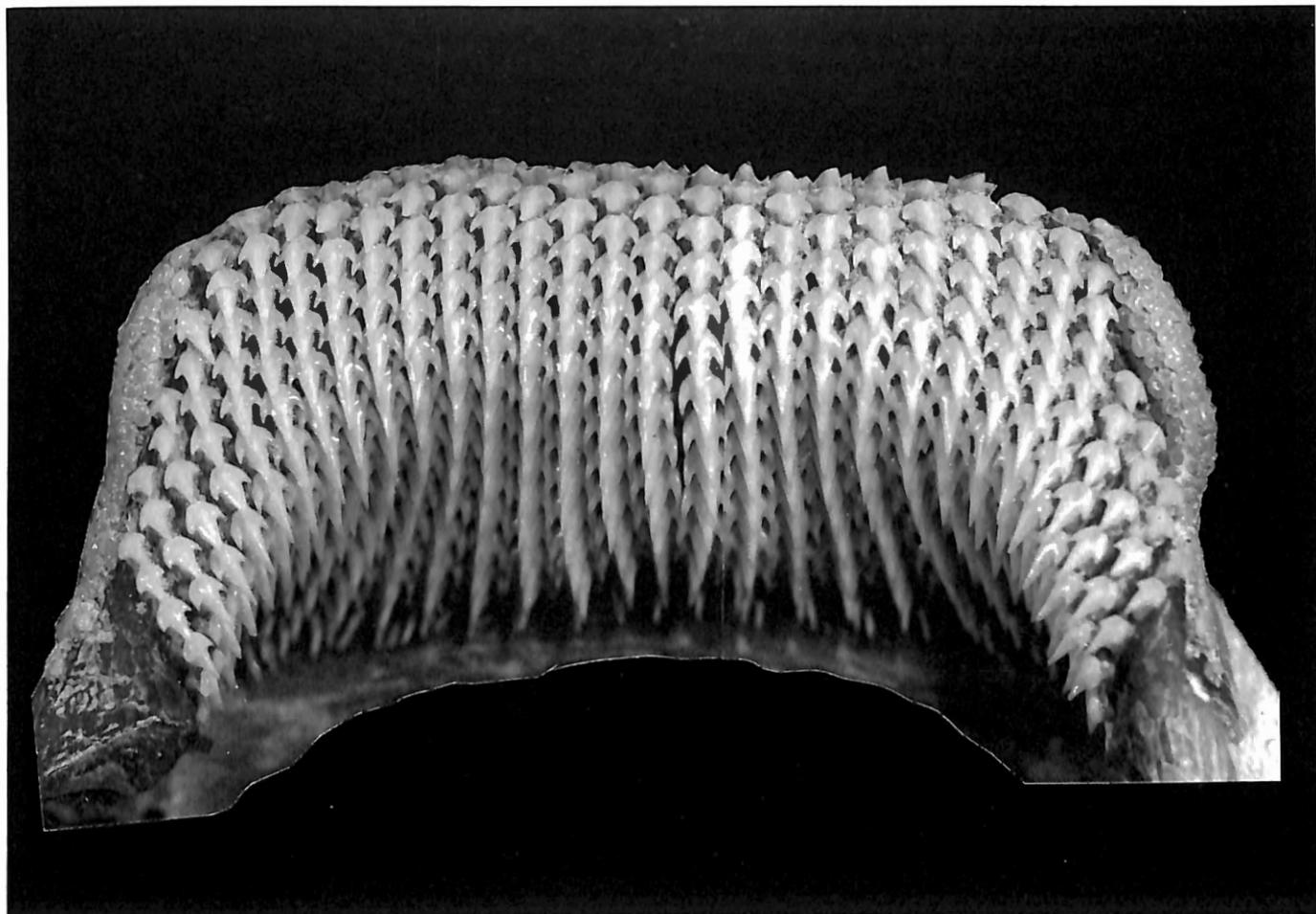
ORDER: PRISTIOPHORIFORMES  
sensu COMPAGNO, 1984

Family: Pristiophoridae BLEEKER, 1859

#### HETERODONTY

The Pristiophoridae show gradient monognathic heterodonty. Sexual heterodonty has not been observed. Ontogenetic heterodonty is present by a poorly developed apron in juveniles, which is well developed in mature specimens. An uvula is always present. The root is anaulacorhizid.

Ichthyodorulites are present as lateral rostral spines. These grow as normal dermal denticles do and, after full development, the root material dissolves, the spines are shed from the rostrum and replaced by new ones. (see BUDKER, 1938).



Textplate 3. – *Stegostoma fasciatum* (HERMANN, 1783). Female 125 cm t.l., Indonesia. Upper jaw  $\times 5$ .

Genus: *Pliotrema* REGAN, 1906

This genus is monotypic with the type species *Pliotrema warreni*.

*Pliotrema warreni* REGAN, 1906  
(Plates 32 to 36)

*Pliotrema warreni* REGAN, 1906. Annals of the Natal Museum. 1 (1): 1.

The teeth of this species have a broad based relatively short principal cusp, with both mesial and distal cutting edges weakly bent mesially and distally, respectively. Cusplets are absent.

The root is anaulacorhizid and slightly arched, but lobation is absent.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. The mesial and distal crown base parts slightly curve toward the apex of the crown. A strongly developed, irregularly shaped, broad apron overhangs the crown-root junction, forming a notch at the junction with both mesial and distal crown base parts. Basal ornamentation or striae are absent. However a few, poorly developed costules may be present.

The inner face of the principal cusp is strongly convex. A well developed uvula is present at the central crown base. Both mesial and distal crown base parts curve strongly toward the apex of the crown, forming a sharp notch with the uvula.

Basal ornamentation or striae are absent. However some fine, poorly developed costules may be present.

The outer face of the root shows up to five large basal foramina, which are mostly oval-shaped.

The inner face of the root shows up to six well developed foramina along the crown-root junction at each side of the uvula. A basal foramen is present at each side of the uvula.

The basal face of the root is flat, partly showing some outer foramina.

The rostral spines of this species have a crown, which is elongated and has an oval-shaped base. The crown is slightly bent to the rear and flattened toward the apex, forming cutting edges at front and rear. The rear cutting edge is serrated by barbed hooks.

Both lower and upper faces of the root are curved outward from crown-root junction toward the root base.

The basal face shows a deep v-shaped median groove,

which is front-rear directed. An oval-shaped foramen is present in the centre of the groove.

Genus: *Pristiophorus* MÜLLER & HENLE, 1837

This genus comprises 4 species: *Pristiophorus cirratus*, *Pristiophorus japonicus*, *Pristiophorus nudipinnis* and *Pristiophorus schroederi*. The type species is *Pristiophorus cirratus*.

*Pristiophorus cirratus* (LATHAM, 1794)  
Plates 37 to 41)

*Pristis cirratus* LATHAM, 1794. Transactions of the Linnaean Society London, 2 (25): 281.

The teeth of this species have a broad based relatively short principal cusp, with both mesial and distal cutting edges weakly bent mesially and distally, respectively. Cusplets are absent.

The root is anaulacorhizid and slightly arched, but lobation is absent.

The teeth are plurimillimetrical in range.

The outer face of the principal cusp is slightly convex. A broad, poorly developed apron is present, overhanging the crown-root junction. Both mesial and distal crown base parts are slightly curving toward the root.

Basal ornamentation or striae are absent. However a few costules may occur.

The inner face of the principal cusp is strongly convex. A well developed uvula is present at the central crown base. Both mesial and distal crown base parts slightly curve toward the apex of the crown, forming a blunt notch with the uvula.

Basal ornamentation or striae are absent. However some fine, well developed costules are present.

The outer face of the root shows three to six large basal foramina, which are mostly oval-shaped.

The inner face of the root shows up to six well developed foramina along the crown-root junction at each side of the uvula. A basal foramen is present at each side of the uvula.

The basal face of the root is flat, showing some partly opened outer foramina.

The rostral spines of this species have a crown, which is elongated and has an oval-shaped base. The crown is slightly bent to the rear and flattened toward the apex, forming cutting edges at front and rear. Both front and rear cutting edges are smooth.

Both lower and upper faces of the root are curved outward from crown-root junction toward the root base.

The basal face shows a deep v-shaped median groove, which is front-rear directed. An oval-shaped foramen is present in the centre of the groove.

ORDER: SQUATINIFORMES  
sensu COMPAGNO, 1984

Family: Squatinidae BONAPARTE, 1838

HETERODONTY

The Squatinidae are gradient monognathic heterodont: their two or three anterior teeth are small; lateral teeth, with the principal cusp slightly bent toward the commissure, gradually become larger; posterior teeth are reduced in size again and show an erect but low principal cusp. Symphysial teeth are absent.

Neither sexual nor ontogenetic heterodonty were observed.

Genus: *Squatina* DUMERIL, 1806

This genus comprises 12 species: *Squatina aculeata*, *Squatina africana*, *Squatina argentina*, *Squatina australis*, *Squatina californica*, *Squatina dumeril*, *Squatina japonica*, *Squatina nebulosa*, *Squatina oculata*, *Squatina squatina*, *Squatina tergozellata* and *Squatina tergozellatoides*.

The type species is *Squatina squatina*.

*Squatina squatina* (LINNAEUS, 1758)  
(Plates 42 to 45)

*Squalus squatina* LINNAEUS, 1758. Systema Naturae. ed. 10, 1: 233.

The anterior teeth are smaller in size than the lateral teeth and have a broad based, short, erect principal cusp, with extended, almost horizontally running cutting edges, which curve toward the crown base. The lateral teeth have a lower, slightly oblique principal cusp with longer cutting edges. The smooth cutting edges are half as long as the crown height in anterior, and as long as the crown height in lateral teeth. Cusplets are absent.

The root is hemiaulacorhizid and has two broad, flattened root lobes, that are obtusely angled at the root base.

The teeth are hemicentimetrical to centimetrical in range.

The outer face of the principal cusp is rather convex. A narrow apron at the crown base overhangs the crown-root junction. Basal ornamentation, costules or striae are absent.

The inner face of the principal cusp is strongly convex. A narrow uvula is present at the central crown base, supported by a strong central root protuberation. Basal ornamentation, costules or striae are absent.

The outer face of the root shows two root lobes. Two or three small foramina are present at the root lobe edges.

The inner face of the root shows a strongly developed central protuberation, with one well developed foramen.

Up to seven foramina are present on the crown-root junction at each side of the protuberation.

The flat, triangular-shaped, basal part of the root displays a large outer central depression. One or two large foramina are present in the depression. Numerous small foramina are scattered all over the slightly curved root lobes.

### Differential diagnosis

The teeth of Orectolobiformes and Squatiniformes in general share two main features:

— Their root type is hemiaulacorhizid.

— The inner part of each tooth is overgrown by the previous tooth in the row. An uvula, supported by a strong inner central protuberation, is situated in a central outer depression of the root base of the previous tooth, by which all teeth in a row are interlocked. The vascularization is affected by this feature, and therefore the pattern of the foramina is also affected. (With the exception of *Rhiniodon*, *Parascyllium* and *Cirrhoscyllium*) *Parascyllium* and *Cirrhoscyllium* are odontologically closely related and differ from all other Orectolobiformes by the lack of an apron and a true uvula, which suggests a relationship with scyliorhinids. However, a relic of an outer basal root depression is present, the root type is hemiaulacorhizid and a series of outer foramina below the crown-root junction is absent, which is characteristic for Scyliorhinidae.

*Rhiniodon* has adapted filter feeding by taking small schooling fish and plankton in the mouth and strain out the water through of a specialized branchial apparatus. The teeth are no longer used in feeding and thus in regression. The heterodonty becomes unstable and results in a more irregular morphology. The root is hemiaulacorhizid.

*Chiloscyllium*, *Hemisycyllium* and *Stegostoma* show striking similarities: a very broad apron, merging of the outer crown base and extreme edges of cusplets or blades.

*Brachaelurus*, *Ginglymostoma* and *Nebrius* have the same shape of root with broad, short lobes and a very large central foramen. Their crowns are also similar: a short and broad-based principal cusp, a broad apron, a well developed short uvula.

*Squatina*, *Orectolobus* and *Eucrossorhinus* share some important characteristic features: root base with large outer central depression and a large inner central protuberation; crown with low mesially and distally extended cutting edges. A small but well developed apron is present, as well as an enlarged but narrow uvula.

Although they can be separated by the shape of the junction of uvula and inner mesial and distal crown base parts and the development of their apron, *Pristiophorus* and *Pliotrema* have a very similar tooth morphology.

The rostral spines also differ between both genera, in that the rear cutting edge is serrated in *Pliotrema*, but smooth in *Pristiophorus*.

Remarks on orectolobid and squatinid dental histotypes (See textplate 4).

Examination of the dental histotypes of the orectolobid and squatinid genera allows their grouping by differences found.

*Squatina*, *Orectolobus* and *Eucrossorhinus* share a dental histotype (see textplate 4, fig.1). The hemiaulacorhizy of the root is more or less intact, however, the former orthodontine in the crown has been partly replaced by osteodentine.

*Brachaelurus* has an ancient dental histotype (see textplate 4, fig. 2a) The root is hemiaulacorhizid with a large pulp cavity and the crown is filled with orthodontine.

*Ginglymostoma* and *Nebrius* share their root morphology with *Brachaelurus*. *Ginglymostoma*, as well as *Nebrius* have a different dental histotype, both developed from *Brachaelurus*.

The root of *Ginglymostoma* is hemiaulacorhizid, but the orthodontine of the crown has been affected by osteodont material (see textplate 4, fig. 2b).

In *Nebrius*, the orthodontine of the crown has completely been replaced by osteodentine. However, a pulp cavity is still present, with an adapted shape (see textplate 4, fig. 2c).

Hemisycylliidae, Parascylliidae and Stegostomatidae have the same dental histotype (see textplate 4, fig. 3). The root is hemiaulacorhizid, and the crown is filled with orthodontine.

Their pulp cavity is shorter than in *Brachaelurus*, as a result of the different root shape.

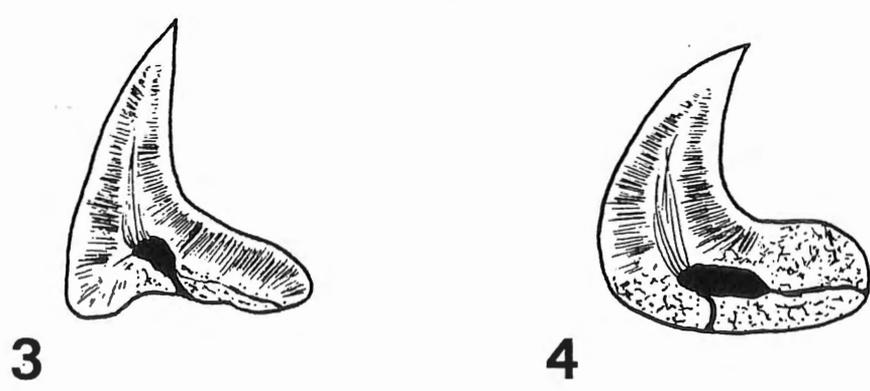
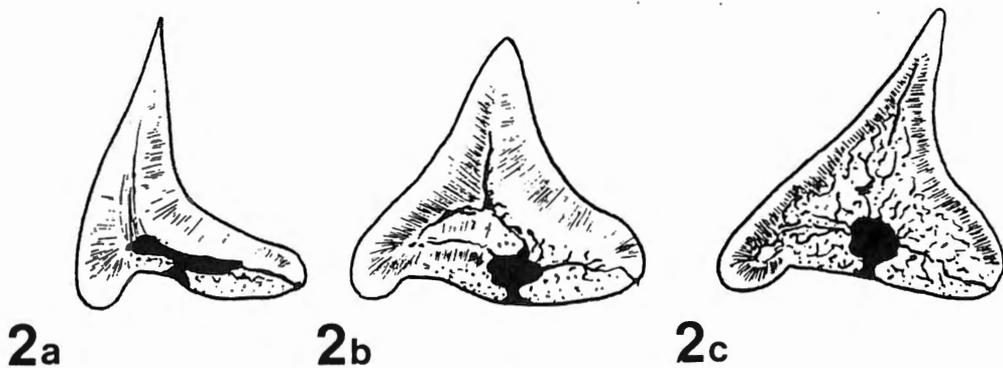
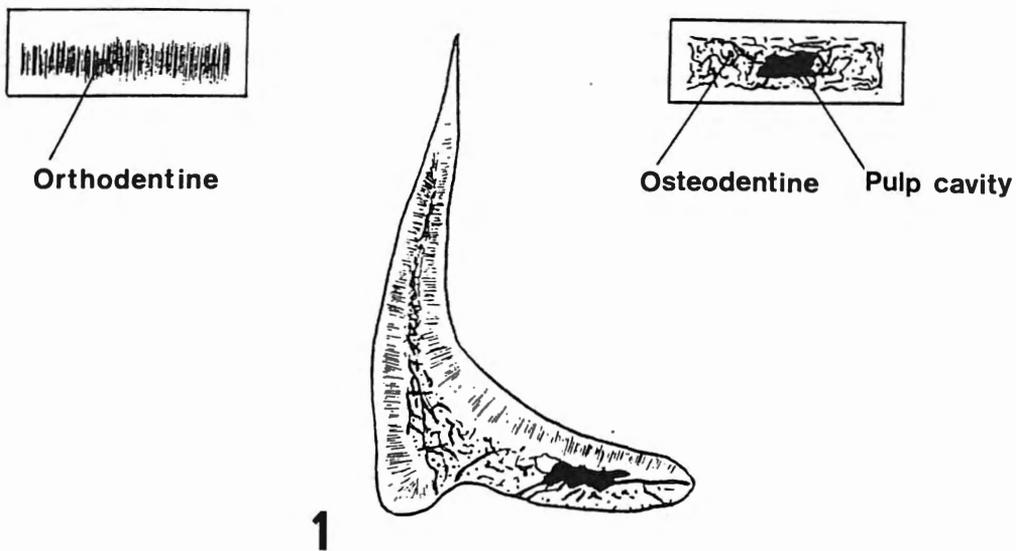
The dental histotype of *Rhiniodon* is orthodont (see textplate 4, fig. 4)

### Conclusions

The Parascylliidae, including the genera *Parascyllium* and *Cirrhoscyllium*, have a very specific tooth morphology, and document a separate development within the Orectolobiformes. Although their crown suggests a scyliorhinid relationship, the root has orectolobid affinities.

The Rhiniodontidae have a tooth morphology, that is in a regressive stage due to their adaptation to filter feeding. It results in becoming more primitive.

Hemisycylliidae and Stegostomatidae have a very similar tooth morphology. From the odontological point of



**Orectolobid & Squatinid  
Dental Histotypes**

view, separation of both families can hardly be maintained.

From the odontological point of view, Brachaeluridae (no information for *Heteroscyllium*) could well be lumped with Ginglymostomatidae. There is little odontological evidence to maintain two separate families.

The tooth morphology of Orectolobidae and Squatiniformes is very similar. They even share a specific extraordinary dental histology. Although the tooth arrangement in the jaws of Orectolobidae and Squatiniformes differs, there is no odontological evidence to maintain two separate orders. In fact, the Squatiniformes share all characteristic features of the Orectolobiformes.

Squatiniformes are an order with a consistent tooth morphology over a very long period. However, old ancient species of Orectolobidae have not been found (CAPPETTA, 1987), indicating, that they might be the result of a late evolutionary development within the Squatinidae.

Resuming, from the odontological point of view, the Squatinidae could well present an orectolobiform family, which includes also the species of the Orectolobidae.

Tooth morphology and dental histology confirm the paleoichthyological results, that the squatinid group is a separate evolutionary line within the Orectolobiformes.

Although they share many features, *Pliotrema* and *Pristiophorus* are odontologically separable. However, the differences are minimal, and their generic distinction is based on features other than tooth morphology.

#### Key to the orectolobid and squatinid genera based on odontological characters

- 1a Apron absent . . . . . 2
- 2a Mesial cutting edge of principal cusp sharply curving centrally, joining the mesial cusplet in a deep notch . . . *Cirrhoscyllium*
- 2b Cutting edges of principal cusp slightly sigmoidal. . . . . *Parascyllium*
- 1b Apron present . . . . . 3
- 3a Basal outer depression of the root absent . . . 4
- 4a Basal root part flat or slightly concave . . . . . *Orectolobus*  
(upper symphyseal tooth)
- 4b Basal root part strongly convex . . . *Rhiniodon*
- 3b Basal outer depression of the root well developed . . . . . 5
- 5a Cusplets absent. . . . . 6
- 6a Principal cusp elongated . . . . . 7
- 7a One or two large central foramina present on the basal root part . . . . . *Orectolobus*  
(anterior teeth)
- 7b More than two large central foramina present on the basal root part . . . *Eucrossorhinus*  
(anterior teeth)
- 6b Principal cusp short . . . . . 8
- 8a Outer basal costules present . . . *Orectolobus*  
(lateral and posterior teeth)
- 8b Outer basal costules absent . . . . . 9
- 9a Outer basal longitudinal ridge present on the crown . . . . . *Eucrossorhinus*  
(lateral and posterior teeth)
- 9b Outer basal longitudinal ridge absent on the crown . . . . . *Squatina*
- 5b Cusplets present . . . . . 10
- 10a Crown multicuspid. . . . . 11
- 11a Up to three mesial and distal cusplets present . . . . . *Ginglymostoma*
- 11b More than three mesial and distal cusplets present . . . . . *Nebrius*
- 10b One cusplet at each side of principal cusp. . . 12
- 12a Cusplets blade-like . . . . . 13
- 13a Principal cusp slightly oblique . . . . . *Hemisicyllium*
- 13b Principal cusp strongly oblique . . . . . *Brachaelurus*  
(posterior teeth)
- 12b Cusplets triangularly-shaped . . . . . 14
- 14a Cusplets poorly developed . . . *Chiloscyllium*
- 14b Cusplets well developed . . . . . 15

15a Principal cusp elongated . . . *Stegostoma*

15b Principal cusp short . . . . *Brachaelurus*  
(anterior and lateral teeth)

### Key to the pristiophorid genera based on odontological characters

1 Uvula forming a sharp notch with the inner mesial and distal crown base parts . . . . *Pliotrema*

2 Uvula forming a blunt notch with the inner mesial and distal crown base parts . . . . *Pristiophorus*

### Acknowledgements

We would like to thank Dr. L.J.V. COMPAGNO, formerly San Francisco State University, California, Dr. J.P. GOSSE, Institut Royal des Sciences naturelles de Belgique, Brussels, Mr. J.A. SEIGEL, Los Angeles County Museum of Natural History, Mr. B. SERET, Muséum National d'Histoire Naturelle, Paris, Dr. G.R. ALLEN and Mr. K. SMITH, Western Australian Museum, Perth, and Dr. M.J.P. VAN OIJEN, Rijksmuseum voor Natuurlijke Historie, Leiden, for permission to examine specimens at their disposal.

We would also like to thank Miss F. LADEUZE, F.N.R.S., Brussels, for technical assistance and critically reading the manuscript.

The SEM-photographs were taken by J. CILLIS, Institut Royal des Sciences naturelles de Belgique, Brussels, and the photographs printed by G. BROGNET, J. DEGREEF and M. VALLE, Brussels.

For the convenience of the interested users, the following issues of this series appeared so far:

HERMAN, J., HOVESTADT-EULER, M. and HOVESTADT, D.C., 1987. Order: Hexanchiformes, family: Hexanchidae. Commissural teeth. In: Contributions to the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes. Part A No. 1. Ed. STEHMANN, M. *Bulletin de l'Institut Royal des Sciences naturelles de Belgique, biologie*, 57: 43-56.

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other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes. Part A No. 2b. Ed. STEHMANN, M. *Bulletin de l'Institut Royal des Sciences naturelles de Belgique, biologie*, 60: 181-230.

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### Glossary

(also applying to previous issues of this series, and complementing the previous glossaries)

#### CONCERNING THE JAW

##### Anterior

Tooth position close to junction of left and right jaw parts.

- Commissural**  
Tooth position near the end of jaw.
- Dignathic**  
Heterodont by having different tooth morphology in upper and lower jaws.
- File**  
Tooth series from symphysis toward end of jaw.
- Heterodonty**  
Different tooth morphology within a tooth file. There are two types of heterodonty: dignathic and monognathic.
- Homodonty**  
Equal tooth morphology within a tooth file.
- Lateral**  
Tooth positions half way along the jaw.
- Longitudinal**  
Symphysial/commissural direction of a file.
- Monognathic**  
Heterodonty within one jaw only. This can appear as gradient or disjunct.
- Parasymphysial**  
First anterior tooth row, if a symphysial tooth row is absent.
- Posterior**  
Tooth positions toward the angle of jaw.
- Pseudosymphysial**  
One of the parasymphysial tooth rows placed in the position of the symphysial tooth row (symmetry).
- Row**  
Tooth series from inner face to outer face of jaw.
- Symphysial**  
Teeth at junction of both halves of a jaw.
- Transversal**  
Outer/inner direction of a row.
- CONCERNING THE TOOTH**
- An-, Hemi-, Hol- and Polyaulacorhizid**  
Concerning their vascularization, E. CASIER (1947) recognized and described 4 phylogenetically significant root types within the orthodont histotypes of elasmobranch teeth.
- Anaulacorhizid**  
Vascularization through scattered foramina of equal size on both outer and inner faces (e.g. Hexanchidae).
- Hemiaulacorhizid**  
Vascularization through a median groove and 1 or 2 lateral foramina on inner face (like in Squatinidae and Orectolobidae).
- Holaulacorhizid**  
Vascularization through many small foramina concentrated in a median groove running from outer to inner face (e.g. Rajidae).
- Polyaulacorhizid**  
Vascularization through many small foramina concentrated in several grooves running parallel from outer to inner face (e.g. Myliobatidae).
- Apron**  
Expansion of the central part of the outer crown base.
- Basal**  
Bottom face concerned.
- Costules**  
Short, vertical ridges sometimes present on inner and/or outer crown base.
- Crown**  
Enamelated tooth part.
- Distal**  
Tooth edge or part toward angle of jaws.
- Histotype**  
Type of internal tooth vascularization.
- Inner face**  
Viewed from inside the mouth.
- Longitudinally**  
Apico-basally directed structuring on a tooth.
- Median groove**  
Groove running from the inner root base to the inner crown-root junction, dividing a holaulacorhizid type of root into two root lobes. It includes the main foramina of the vascularization system.
- Median keel**  
Transverse ridge dividing the crown into inner and outer face.
- Mesial**  
Tooth edge or part toward junction (symphysis) of left and right jaw halves.
- Neo-holaulacorhizid**  
Modification of the holaulacorhizid type of root, combining a shallow median groove and an extremely expanded pulp cavity.
- Orthodont**  
Histotype of vascularization, by which a tooth is supplied primarily by an internal pulp cavity radiating into numerous tiny canals penetrating the orthodontine layer.
- Osteodont**  
Histotype of vascularization, by which a tooth is supplied without any pulp cavity by scattered tiny cavities and canals penetrating the osteodontine layer of the root and the internal crown material.
- Outer face**  
Viewed from outside the mouth.
- Pseudo-apron**  
Apron-like vertical ridges that appear sometimes on lateral and posterior teeth.
- Pseudo-osteodont**  
The former pulp cavity of an originally orthodont histotype of tooth being filled secondarily with osteodontine.
- Pulp cavity**  
Cavity inside the tooth from which the vascularization is spread via canaculi.
- Root**  
Non-enamelated tooth part, that forms the junction

with the jaw and provides vascularization of the tooth.

#### Striae

Vertical ridges running from crown base toward apex.

#### Secondarily anaulacorhizid

Median groove of a holaulacorhizid type of root totally overgrown to form a closed tube internally connected or merged with the pulp cavity.

#### Secondarily hemiaulacorhizid

Median groove of holaulacorhizid type of root overgrown to various extent, but terminally groove or pores still open.

#### Sulcus

Groove developed by the primary vascularization canals leading from root base to the main foramina in anaulacorhizid root type. It differs from the median groove, in which several foramina are concentrated, of the holaulacorhizid root type and the parallel grooves of the polyaulacorhizid root type, respectively, in that a sulcus lacks foramina.

#### Transversal

Mesio-distally directed.

#### Uvula

Lobate extension of the inner crown base.

the dermis and anchored therein with an extremely flattened, more or less radiating root (also called basal plate).

#### Rostrum

Usually cartilaginous skeletal support of the chondrichthyan snout in front of the neurocranium. Extremely developed in many rajoid skates, long-nosed chimaeras, rhinobatoid guitarfishes and pristiophorid, as well as pristid sawfishes. Only in the latter two families, the rostrum is an extremely elongated, hardened and inflexible, flattened sawblade-like structure.

#### Rostral spine

Partly very large lateral spine, being extremely modified dermal denticles, of nearly equal size, or various alternating sizes along rostral edges in Pristiidae and Pristiophoridae.

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#### CONCERNING OTHER ICHTHYODORULITES

#### Dermal denticle

The regular placoid scale, and its various morphological modifications in certain areas, of chondrichthyans. Basically a minute tooth-like structure, consisting of denture with a cap of enameloid, formed in

#### Composition of the plates

As far as possible, at least one plate with SEM-photographs of isolated teeth is presented for each genus. The plates have a consistent composition: upper teeth are presented with their cusps downward and lower teeth with their cusps upward.

The choice of left or right jaw halves illustrated depends on the preservation quality of the specimen's tooth files only.

The upper scale bar refers to the upper teeth, the lower scale bar to the lower teeth. Photographs of posterior and commissural teeth are mostly further enlarged and have their own scale bar.

#### Legend

s = symphysial position

lp = latero-posterior position

a = anterior position

p = posterior position

al = antero-lateral position

c = commissural position

l = lateral position

#### Provenance of the figured specimens.

Plate(s)	Specimen(s)	Provenance
1 - 3	Brachaelurus waddi	IRSNB Pal.dpt.
4, 5	Ginglymostoma cirratum	IRSNB Pal.dpt.
6 - 8	Nebrius ferrugineus	IRSNB Pal.dpt.
9 - 11	Chiloscyllium plagiosum	IRSNB Pal.dpt.
12 - 14	Hemisicyllium ocellatum	IRSNB Pal.dpt.
15 - 18	Eucrossorhinus dasypogon	
	♂ 23 cm	RMNH 5118
	♂ 90 cm	WAM P 7121 - 001
19, 20	Orectolobus maculatus	RMNH 4373
21 - 23	Parasicyllium variolatum	IRSNB Pal.dpt.
24, 25	Parasicyllium collare	IRSNB Pal.dpt.
26	Cirrhoscyllium expolatum	USNM - 74603
27	Rhiniodon typus ? 800 cm	BMNH
	♂ 520 cm	LTVC
28 - 31	Stegostoma fasciatum	IRSNB Pal.dpt.
32 - 36	Pliotrema warreni	IRSNB Pal.dpt.
37 - 41	Pristiophorus cirratus	IRSNB Pal.dpt.
42 - 45	Squatina squatina	IRSNB Pal.dpt.

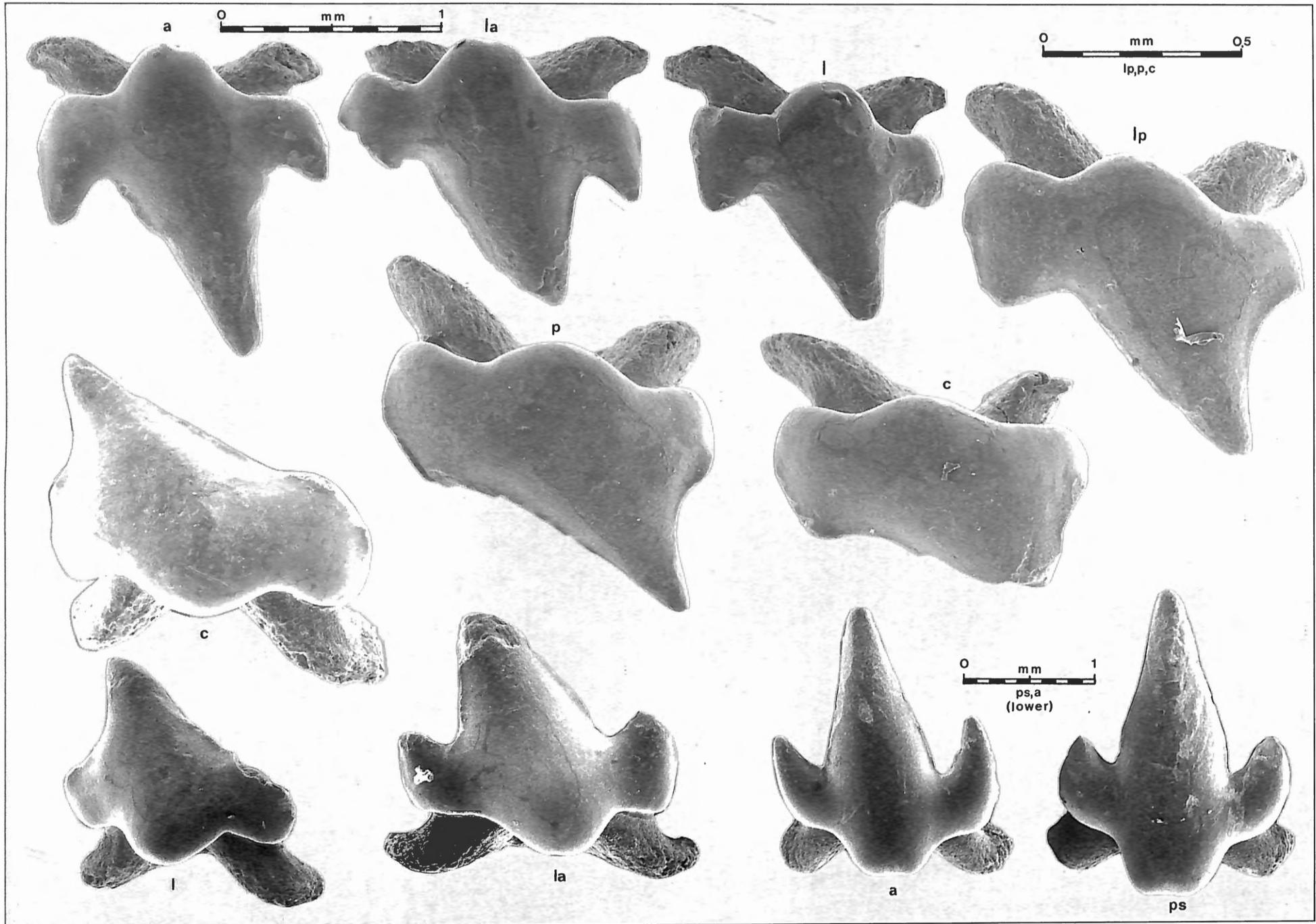


Plate 1. — *Brachaelurus waddi* (BLOCH & SCHNEIDER, 1801). Female 66 cm t.l., Sydney Australia. Outer views of upper and lower teeth

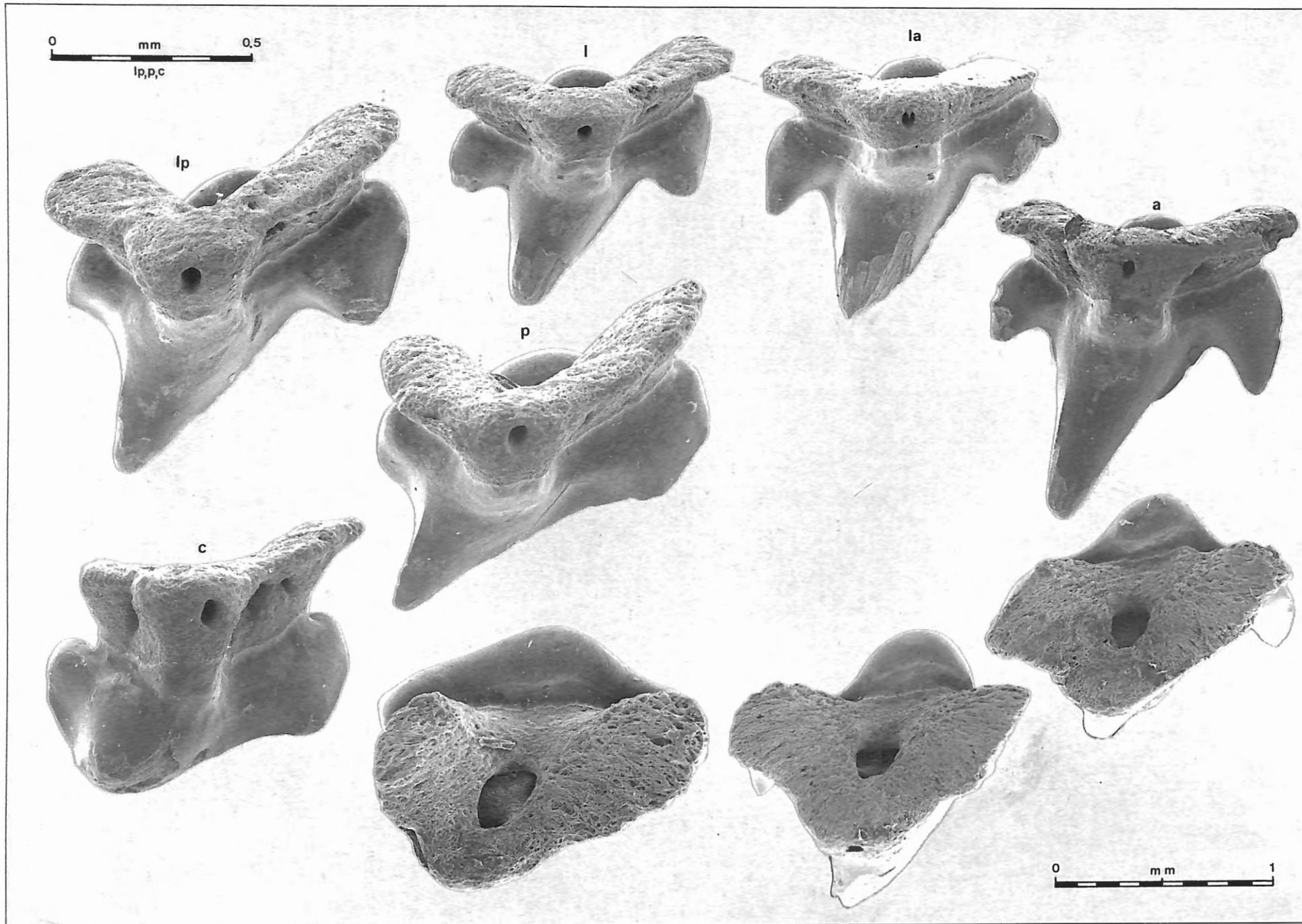


Plate 2. — *Brachaelurus waddi* (BLOCH & SCHNEIDER, 1801). Female 66 cm t.l., Sydney, Australia. Inner and basal views of upper teeth.

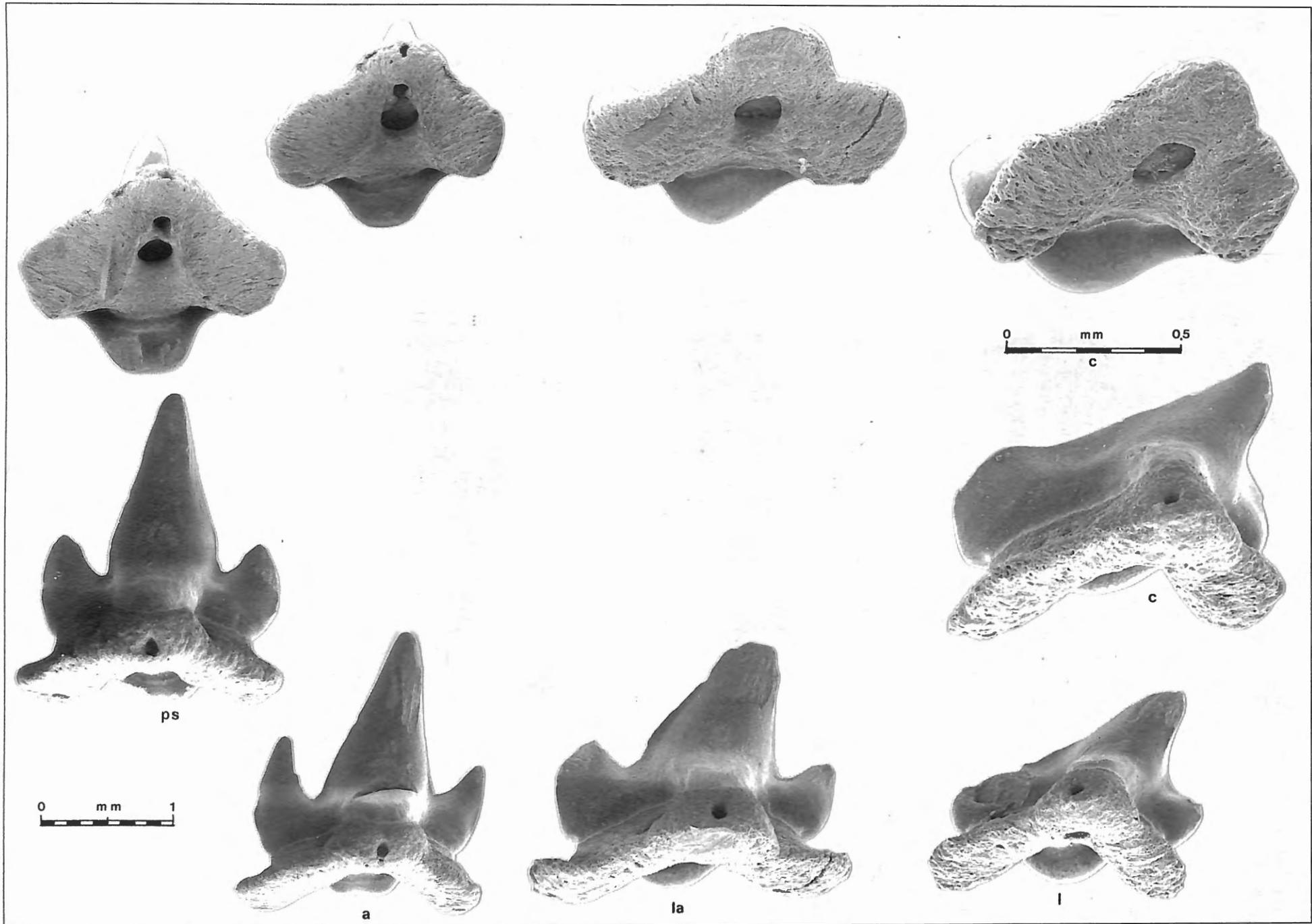


Plate 3. — *Brachaelurus waddi* (BLOCH & SCHNEIDER, 1801). Female 66 cm t.l., Sydney, Australia. Basal and inner views of lower teeth

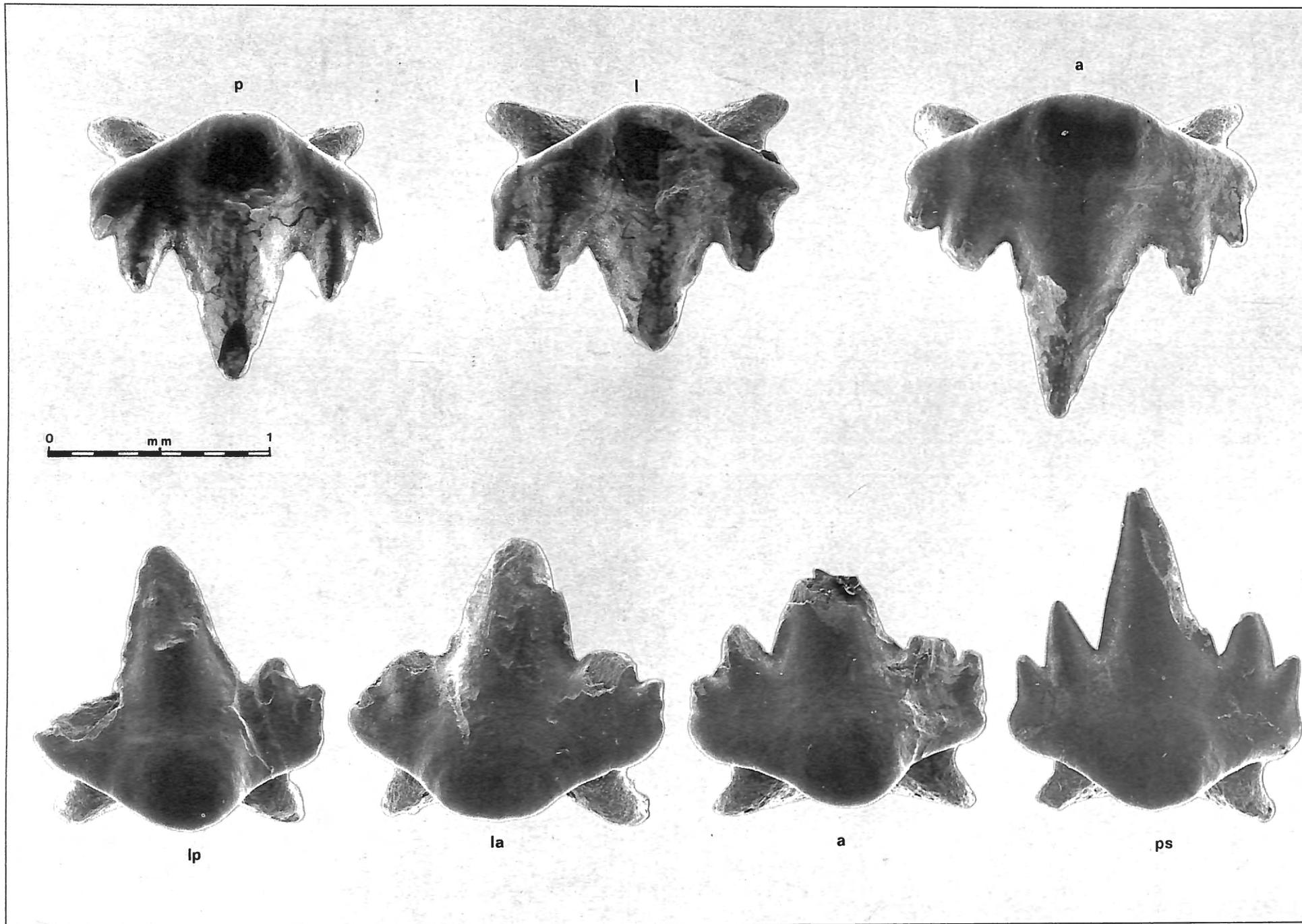


Plate 4. - *Ginglymostoma cirratum* (BONNATERRE, 1788). Male 38 cm t.l., California. Outer views of upper and lower teeth.

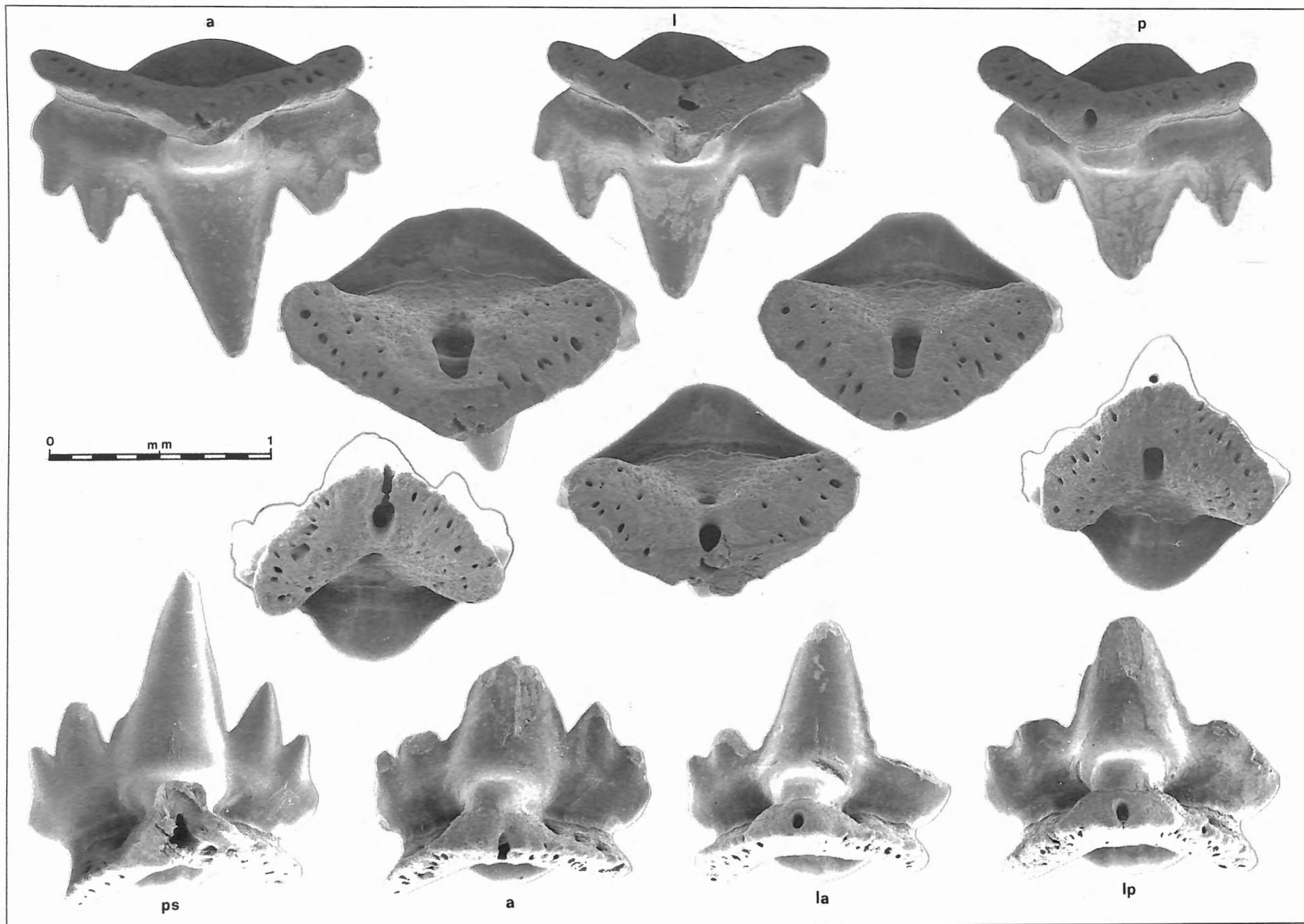


Plate 5. — *Ginglymostoma cirratum* (BONNATERRE, 1788). Male 38 cm t.l., California. Inner and basal views of upper and lower teeth.

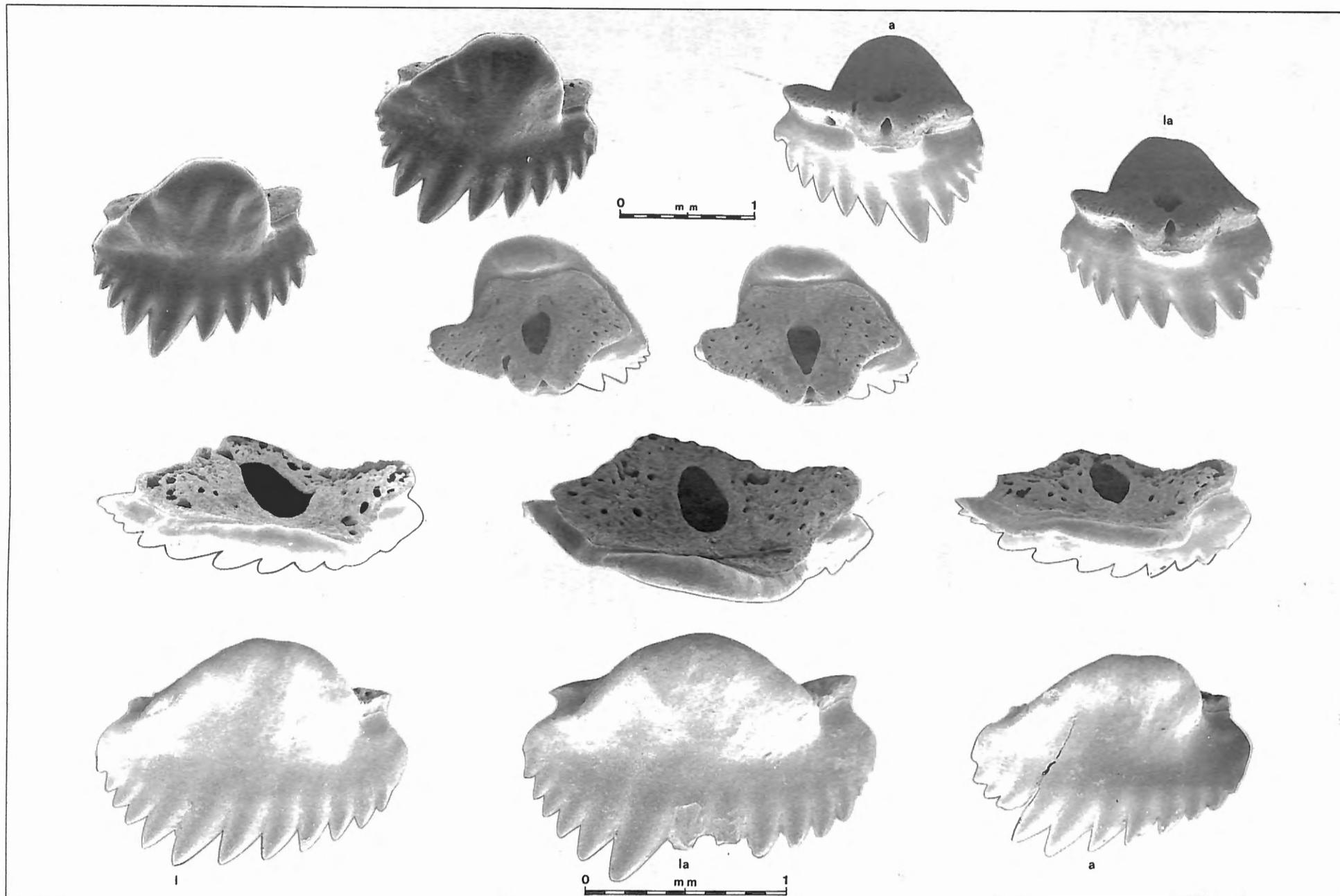


Plate 6. — *Nebrius ferrugineus* (LESSON, 1830). Outer, inner and basal views of two upper teeth of a female 105 cm t.l., Sumatra. Basal and outer views of three upper teeth of a male 64 cm t.l., Java.

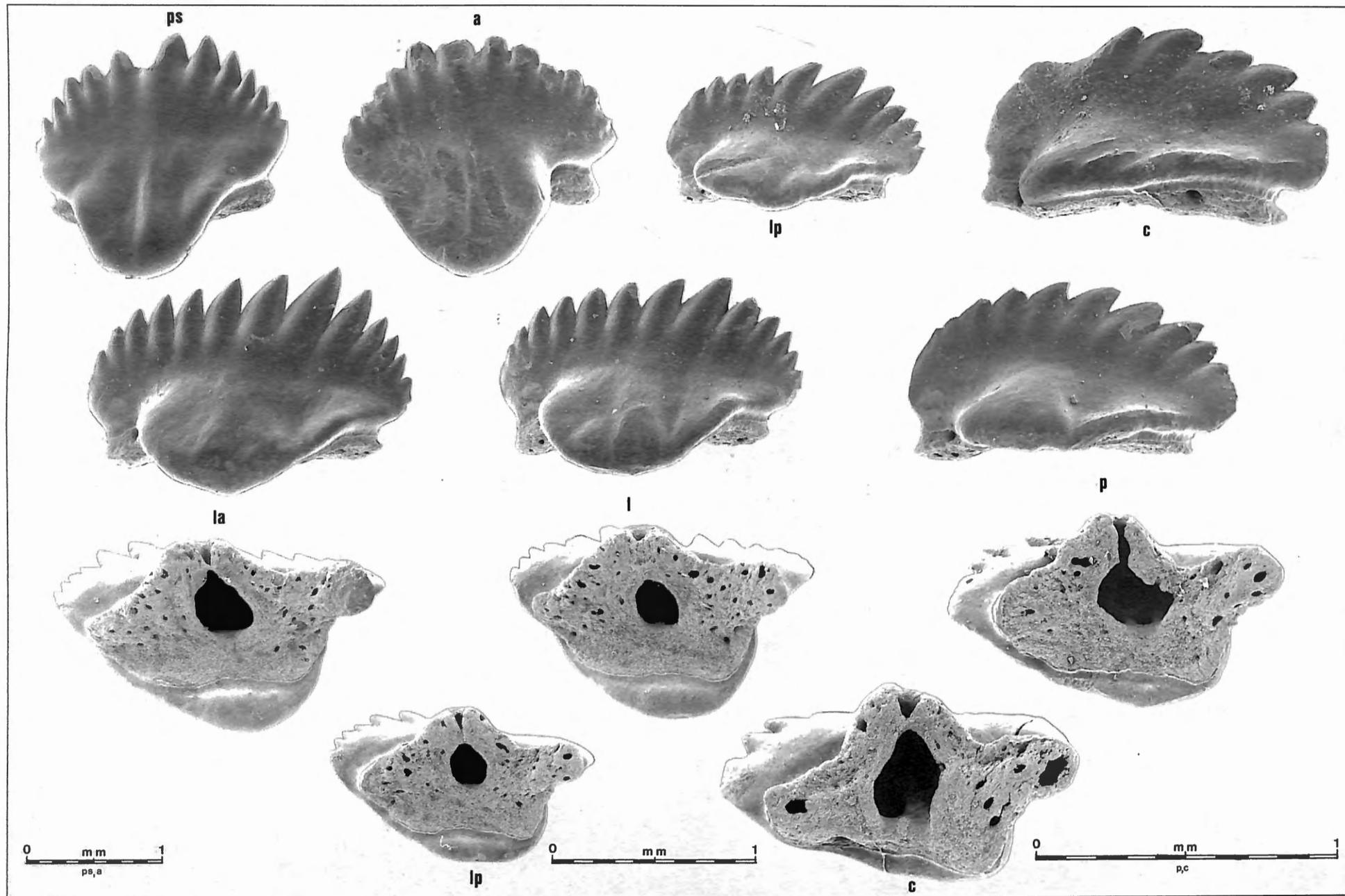


Plate 7. – *Nebrius ferrugineus* (LESSON, 1830). Outer views of two lower teeth of a female 105 cm t.l., Sumatra. Outer and basal views of five lower teeth of a male 64 cm t.l., Java.

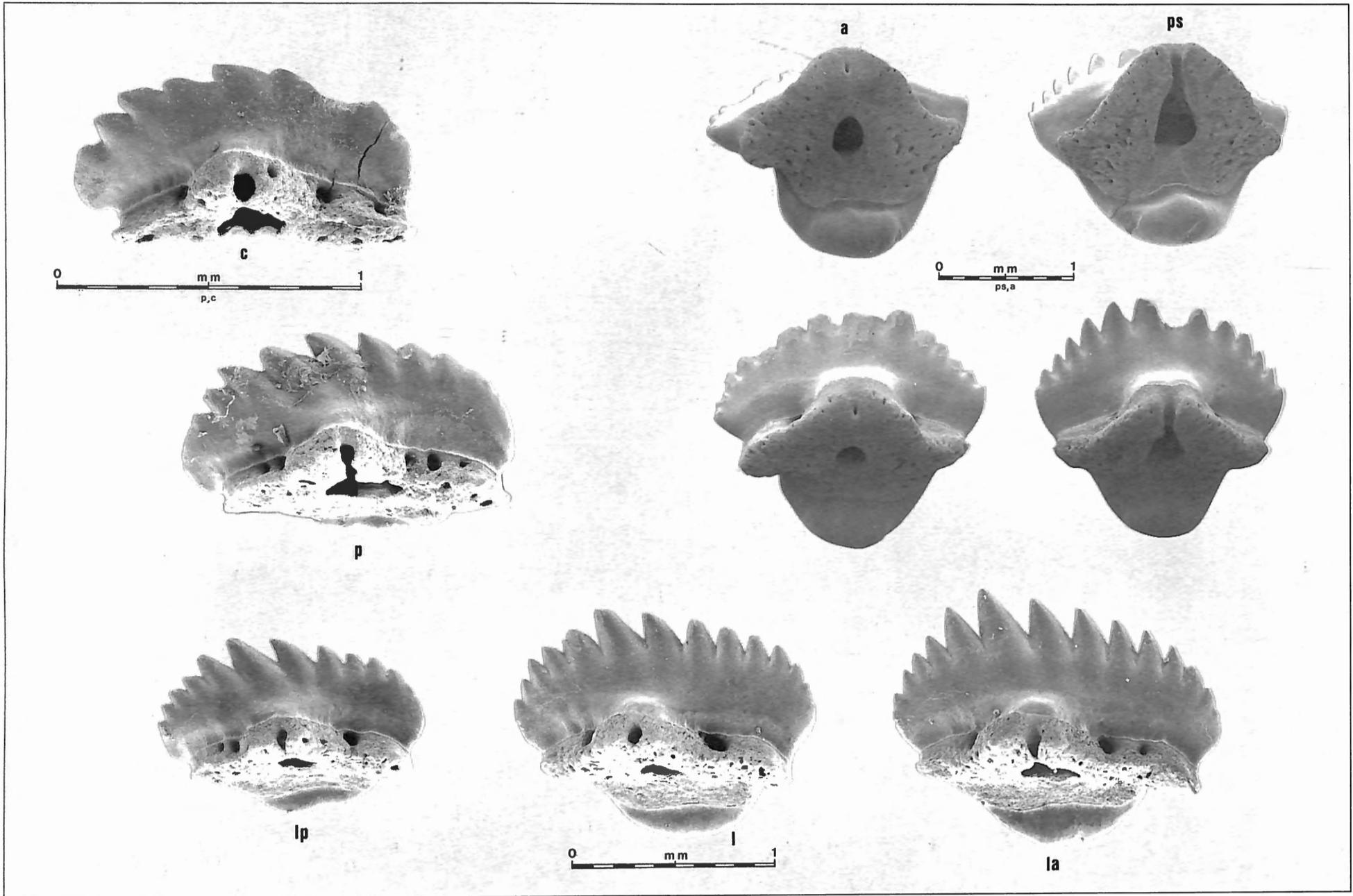


Plate 8. — *Nebrius ferrugineus* (LESSON, 1830). Inner views of five lower teeth of a female 105 cm t.l., Sumatra. Basal and inner views of two lower teeth of a male 64 cm t.l., Java.

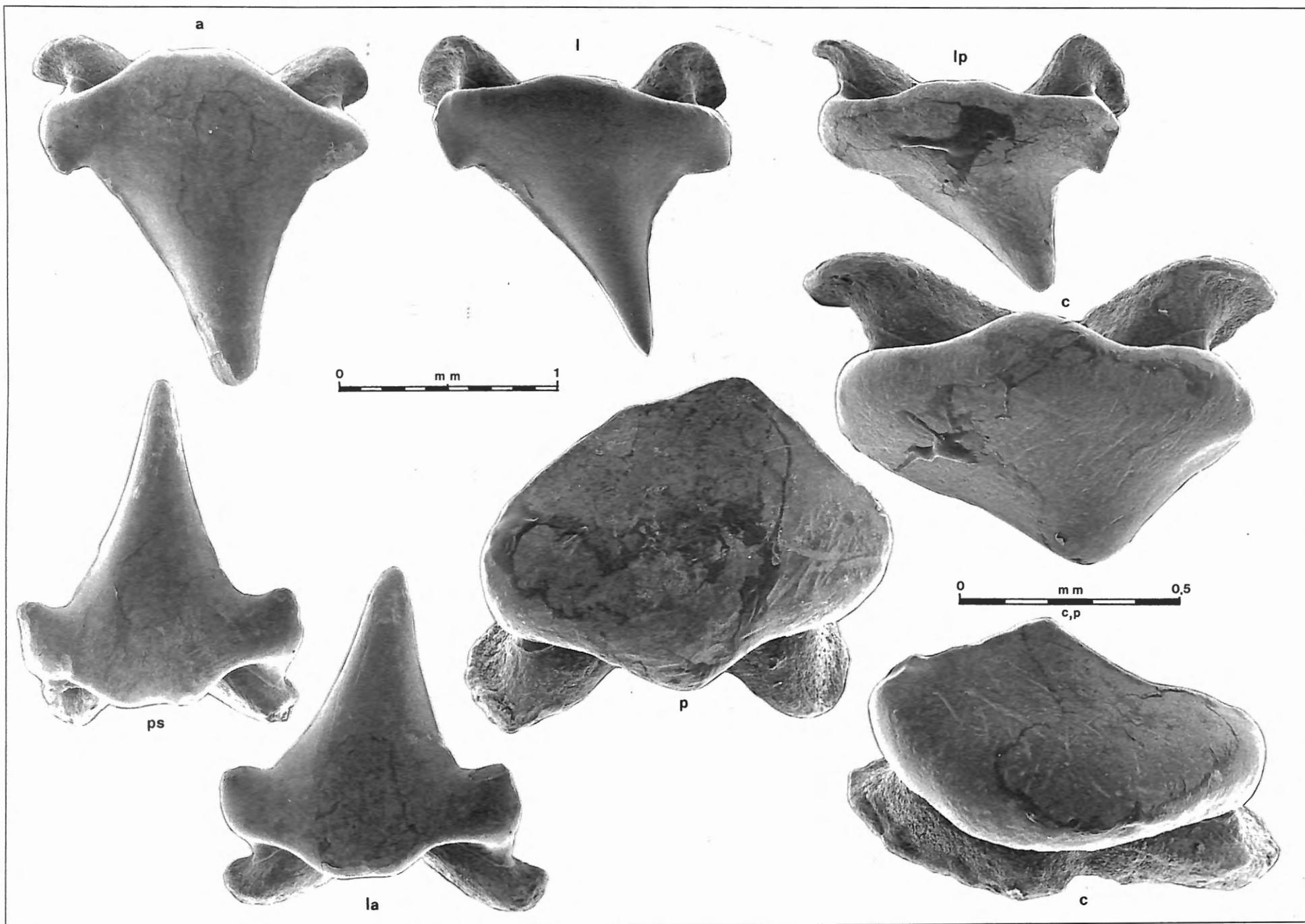


Plate 9. – *Chiloscylidium plagiosum* (BENNETT, 1830). Male 75 cm t.l., Taiwan. Outer views of upper and lower teeth.

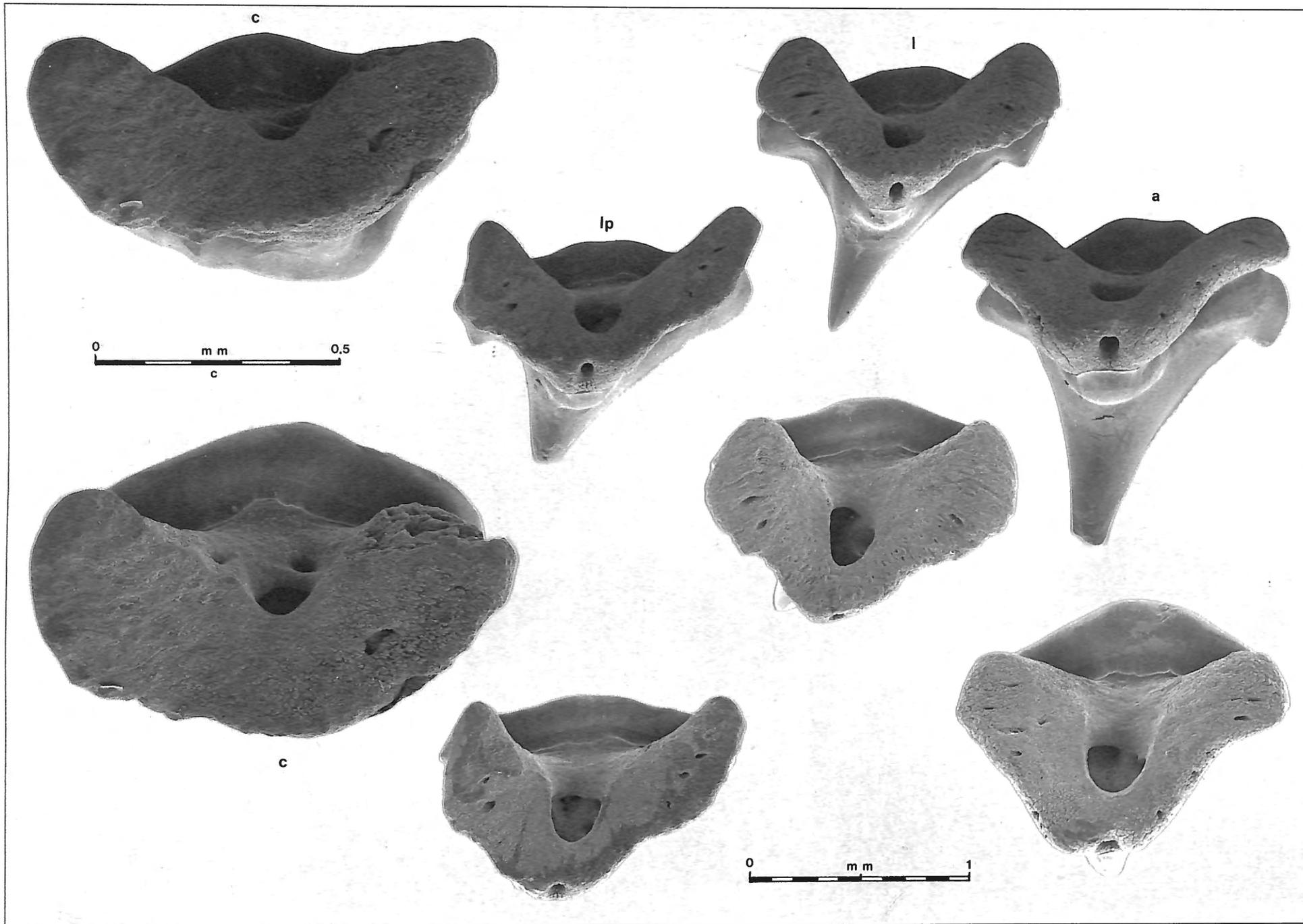


Plate 10. – *Chiloscylidium plagiosum* (BENNETT, 1830). Male 75 cm t.l., Taiwan. Inner and basal views of upper teeth.

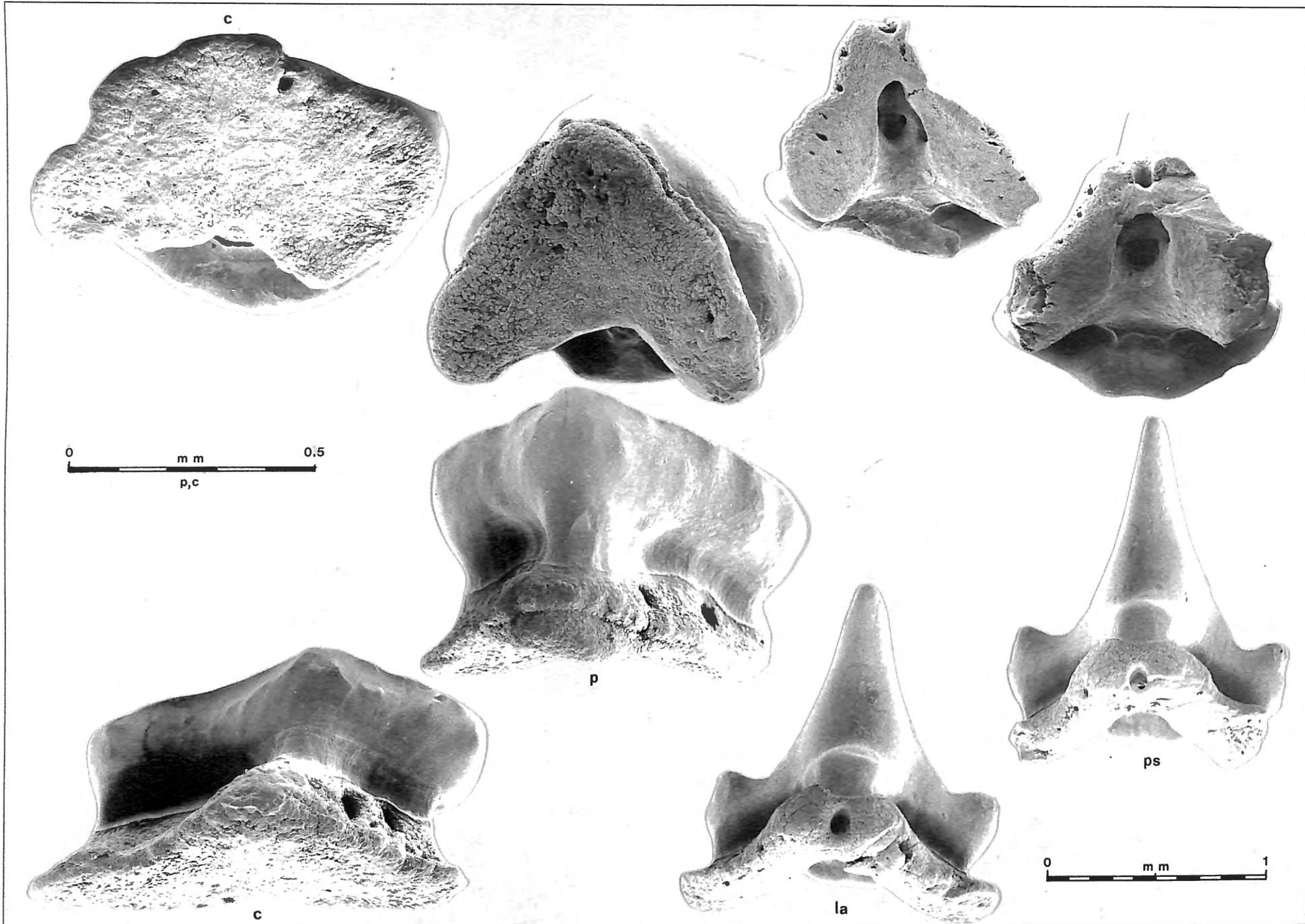


Plate 11. – *Chiloscyllium plagiosum* (BENNETT, 1830). Male 75 cm t.l., Taiwan. Basal and inner views of lower teeth.

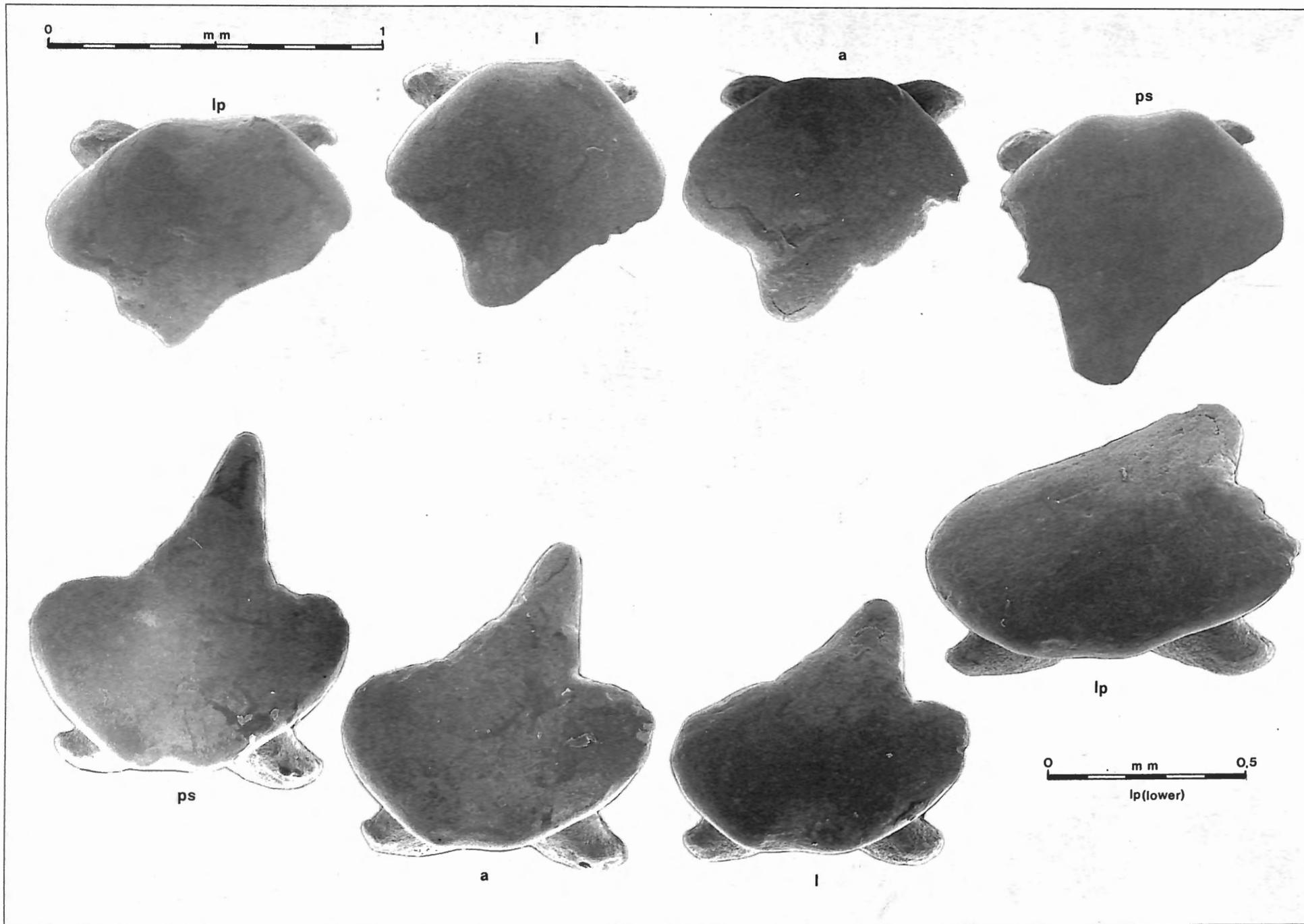


Plate 12. – *Hemiscyllium ocellatum* (BONNATERRE, 1788). Male 60 cm t.l., Southern Papua, New Guinea. Outer views of upper and lower teeth.

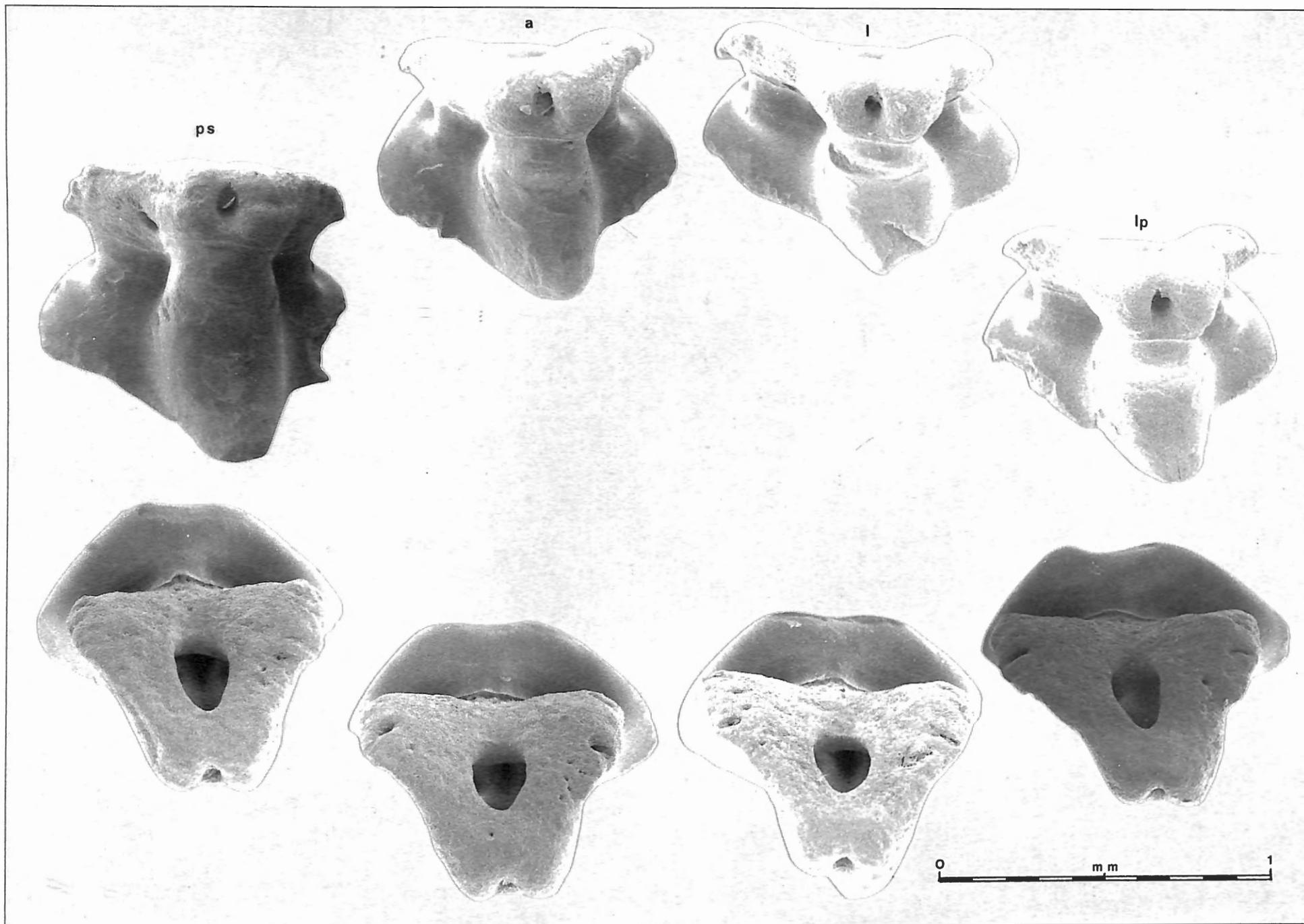


Plate 13. – *Hemiscyllium ocellatum* (BONNATERRE, 1788). Male 60 cm t.l., Southern Papua, New Guinea. Basal and inner views of upper teeth.

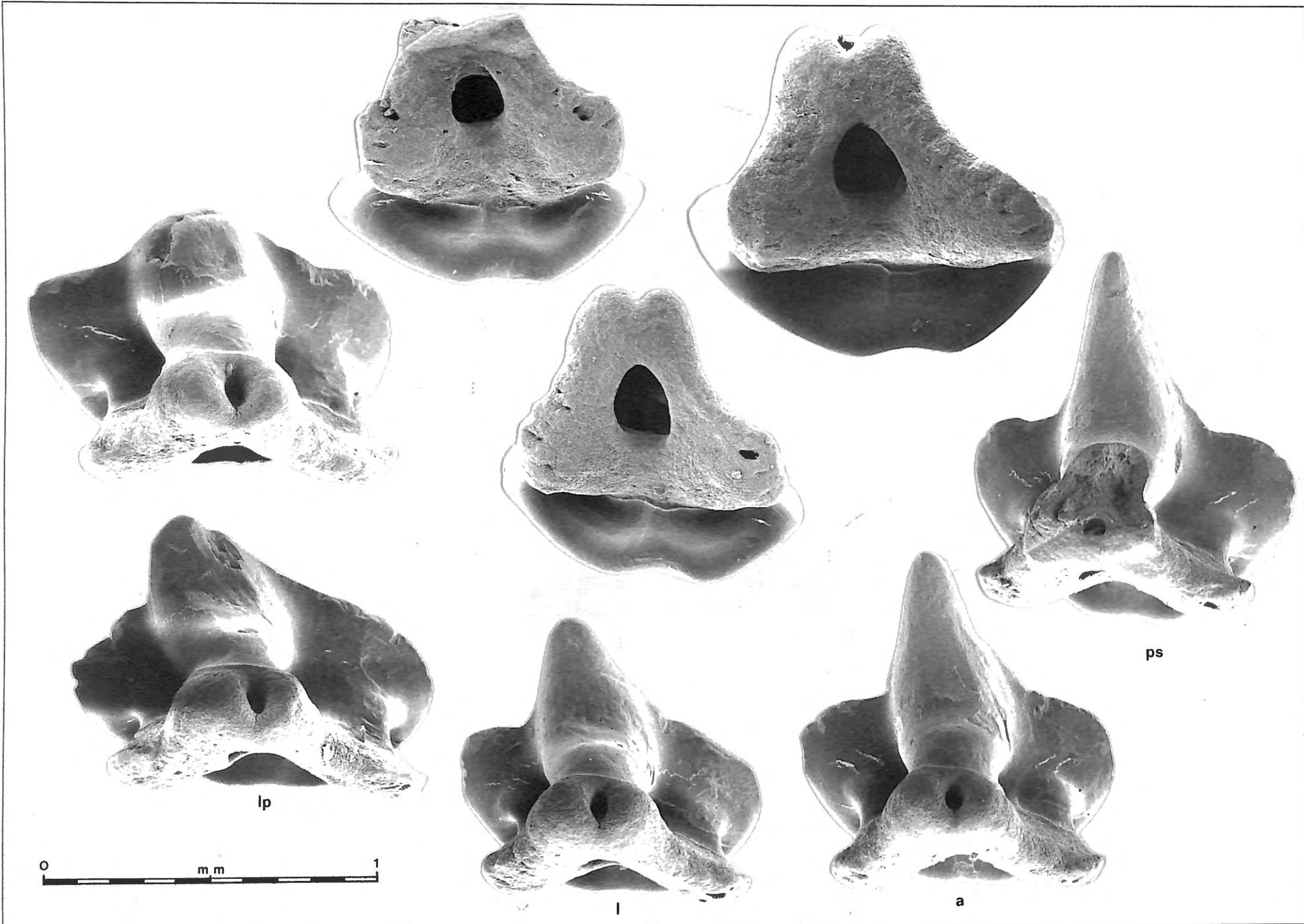


Plate 14. – *Hemiscyllium ocellatum* (BONNATERRE, 1788). Male 60 cm t.l., Southern Papua, New Guinea. Inner and basal views of lower teeth.

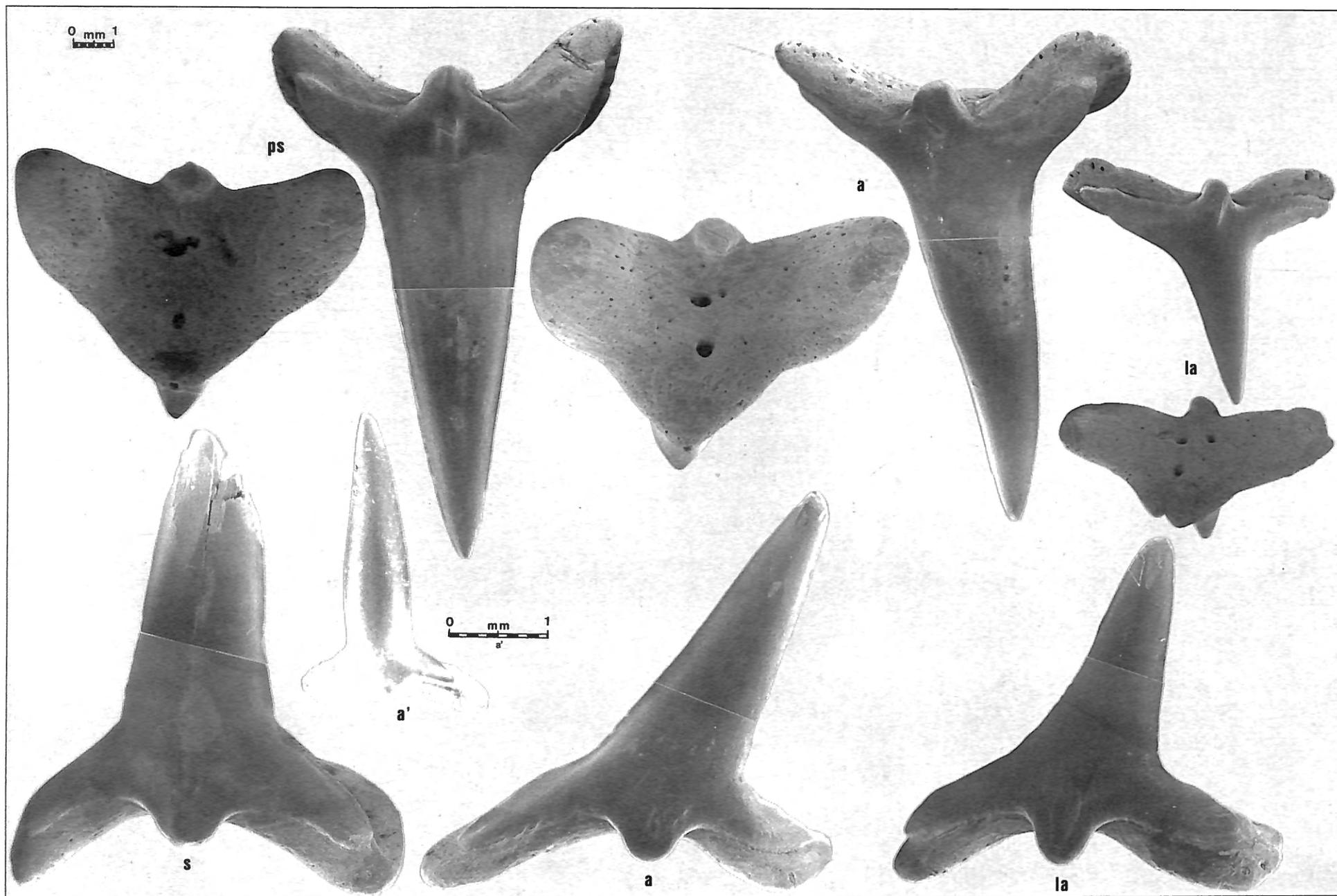


Plate 15. – *Eucrossorhinus dasypogon* (BLEEKER, 1867). Outer view of one lower tooth of a male 21 cm t.l., Indonesia. Outer and basal views of three upper teeth and outer views of three lower teeth of a specimen circa 90 cm t.l., Western Australia.

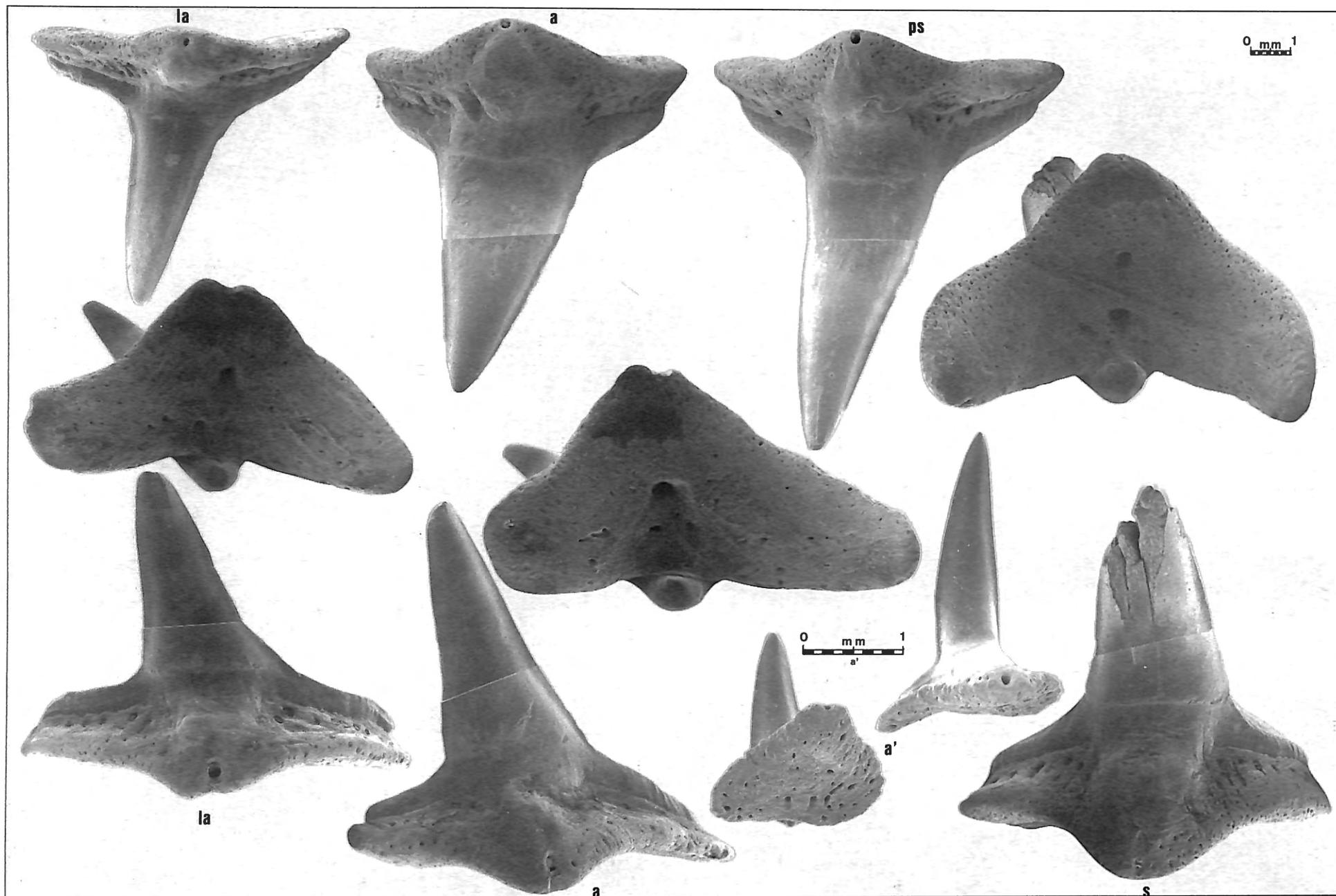


Plate 16. — *Eucrossorhinus dasypogon* (BLEEKER, 1867). Inner and basal views of one lower tooth of a male 23 cm t.l., Indonesia. Inner views of three upper teeth and basal and inner views of three lower teeth of a specimen circa 90 cm t.l., Western Australia.

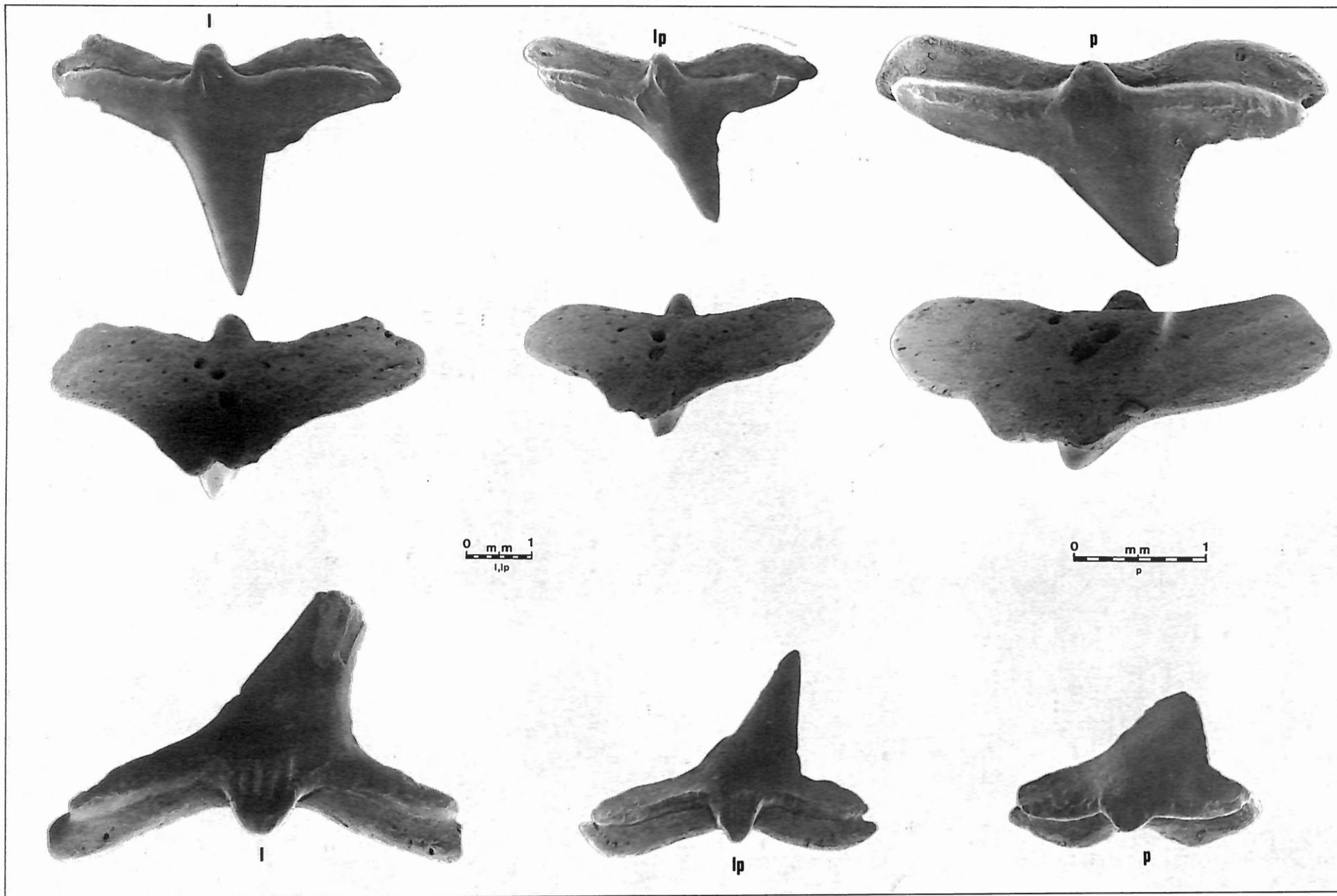


Plate 17. — *Eucrossorhinus dasypogon* (BLEEKER, 1867). Outer and basal views of upper lateral teeth and outer views of lower lateral teeth of a specimen circa 90 cm t.l., Western Australia.

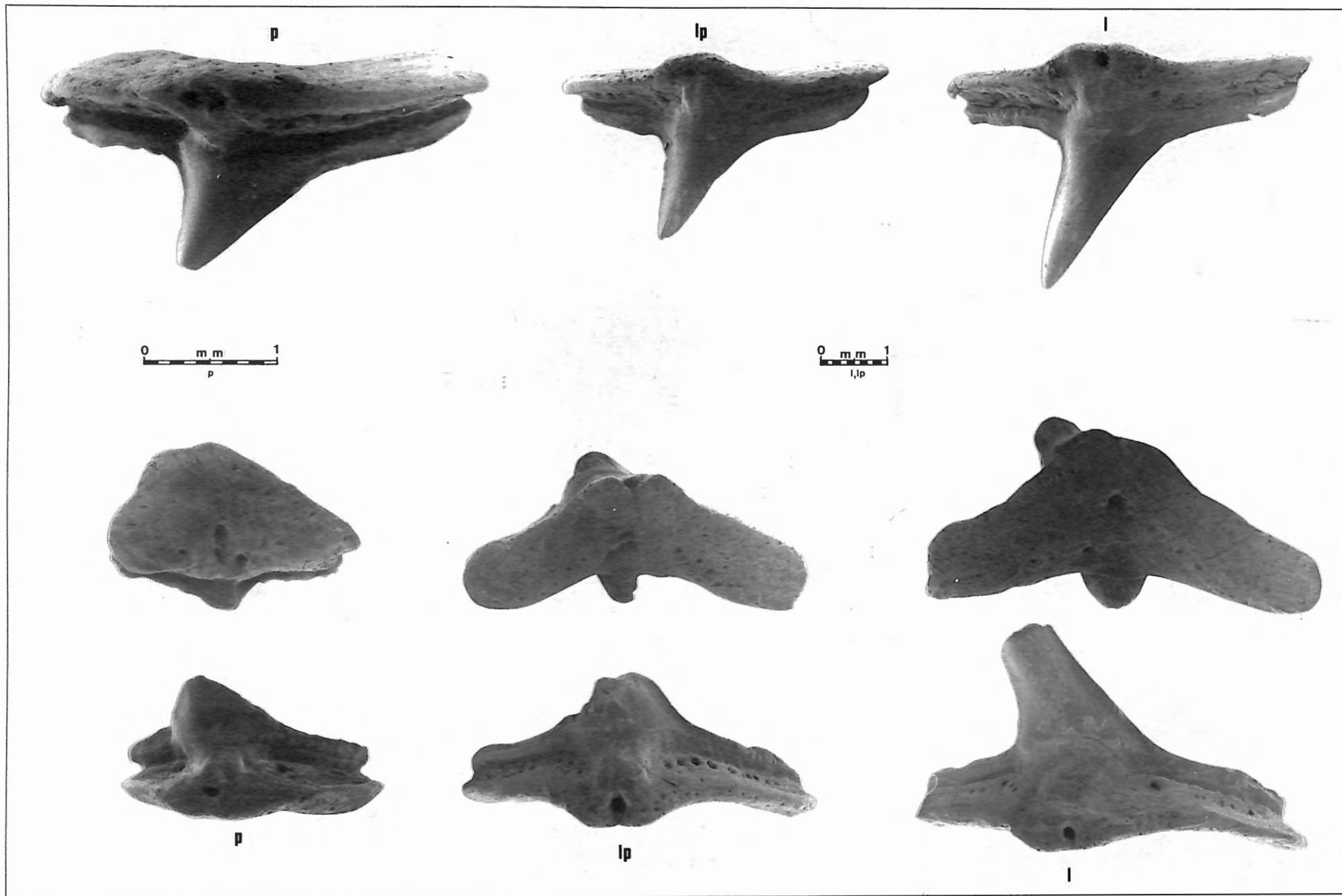


Plate 18. — *Eucrossorhinus dasypogon* (BLEEKER, 1867). Inner views of upper lateral teeth, basal and inner views of lower lateral teeth of a specimen circa 90 cm t.l., Western Australia.

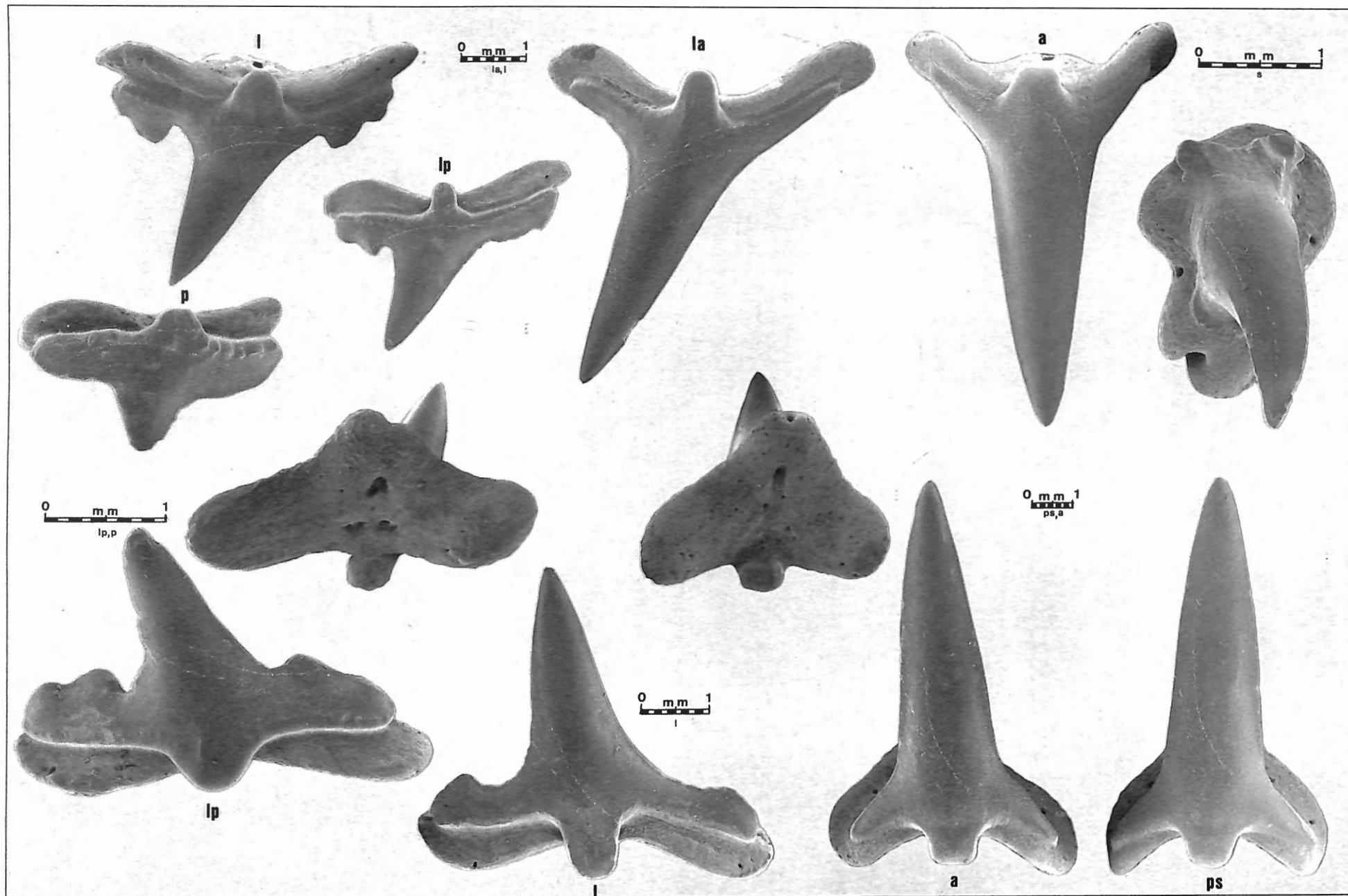


Plate 19. — *Orectolobus maculatus* (BONNATERRE, 1788). Female 84 cm t.l., New South Wales. Outer views of upper teeth, basal and outer views of lower teeth.

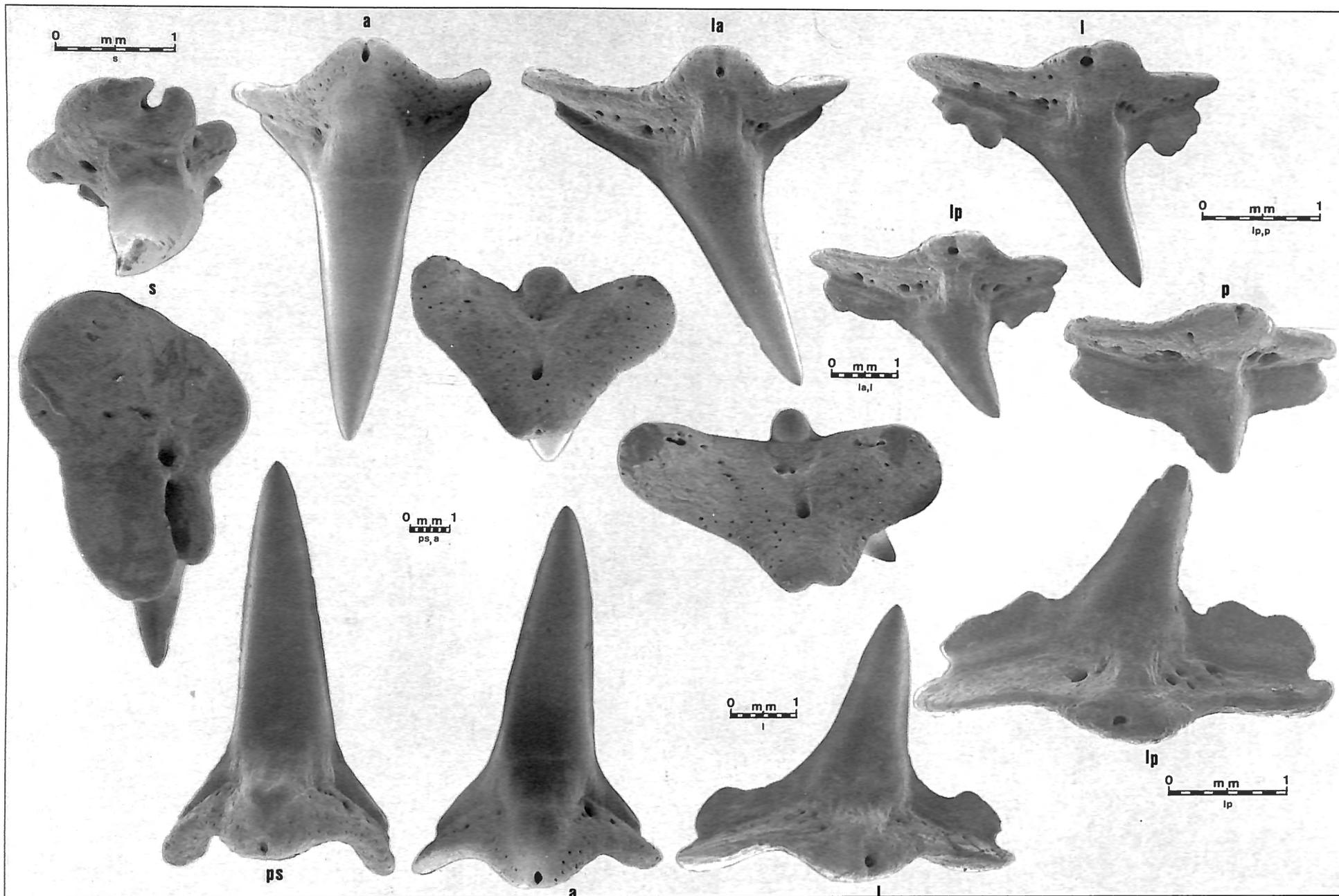


Plate 20. — *Orectolobus maculatus* (BONNATERRE, 1788). Female 84 cm t.l., New South Wales. Inner and basal views of upper teeth, inner views of lower teeth.

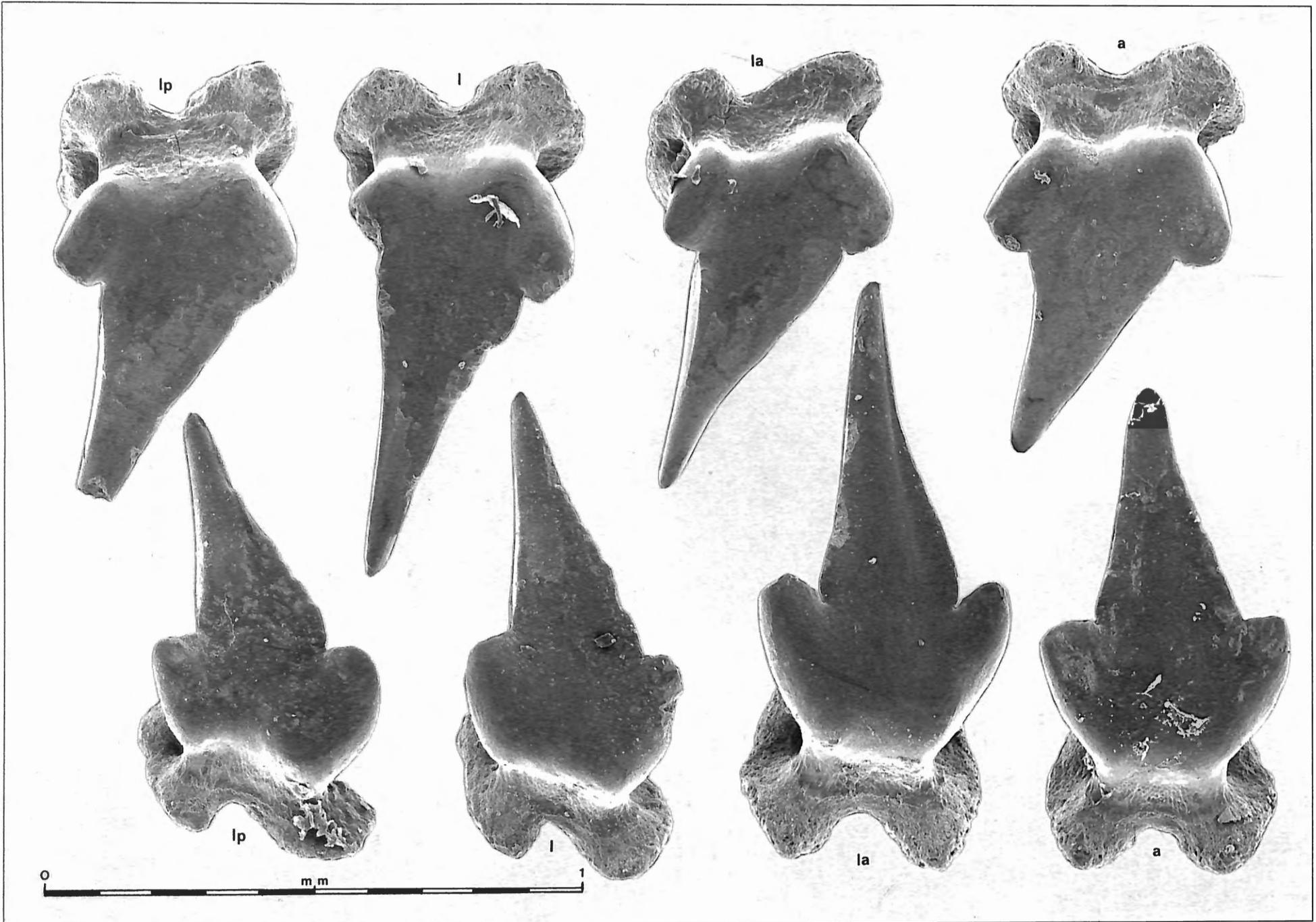


Plate 21. – *Parascyllium variolatum* (DUMERIL, 1853). Female 38 cm t.l., Tasmania. Outer views of upper and lower teeth.

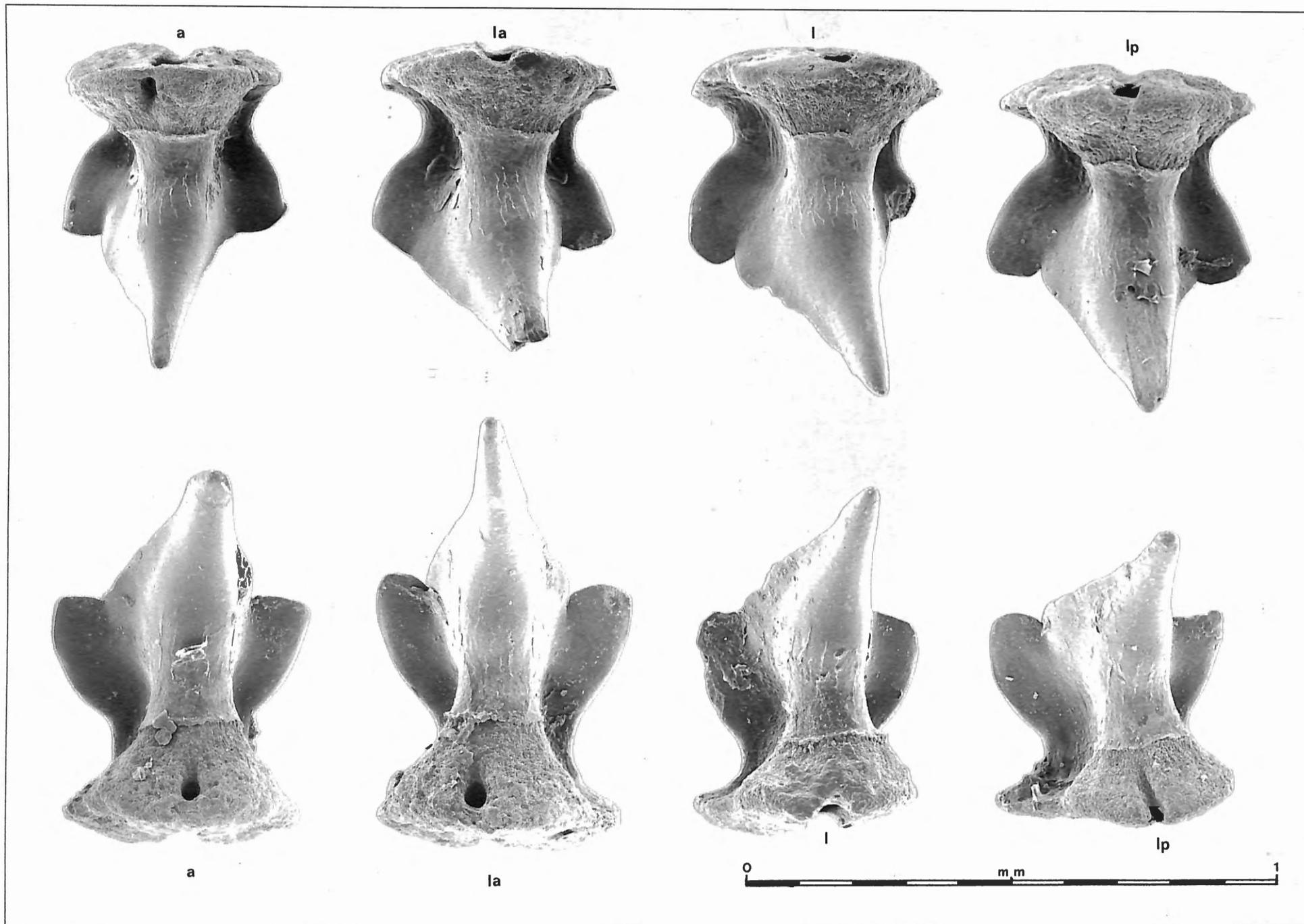


Plate 22. – *Parascyllium variolatum* (DUMERIL, 1853). Female 38 cm t.l., Tasmania. Inner views of upper and lower teeth.

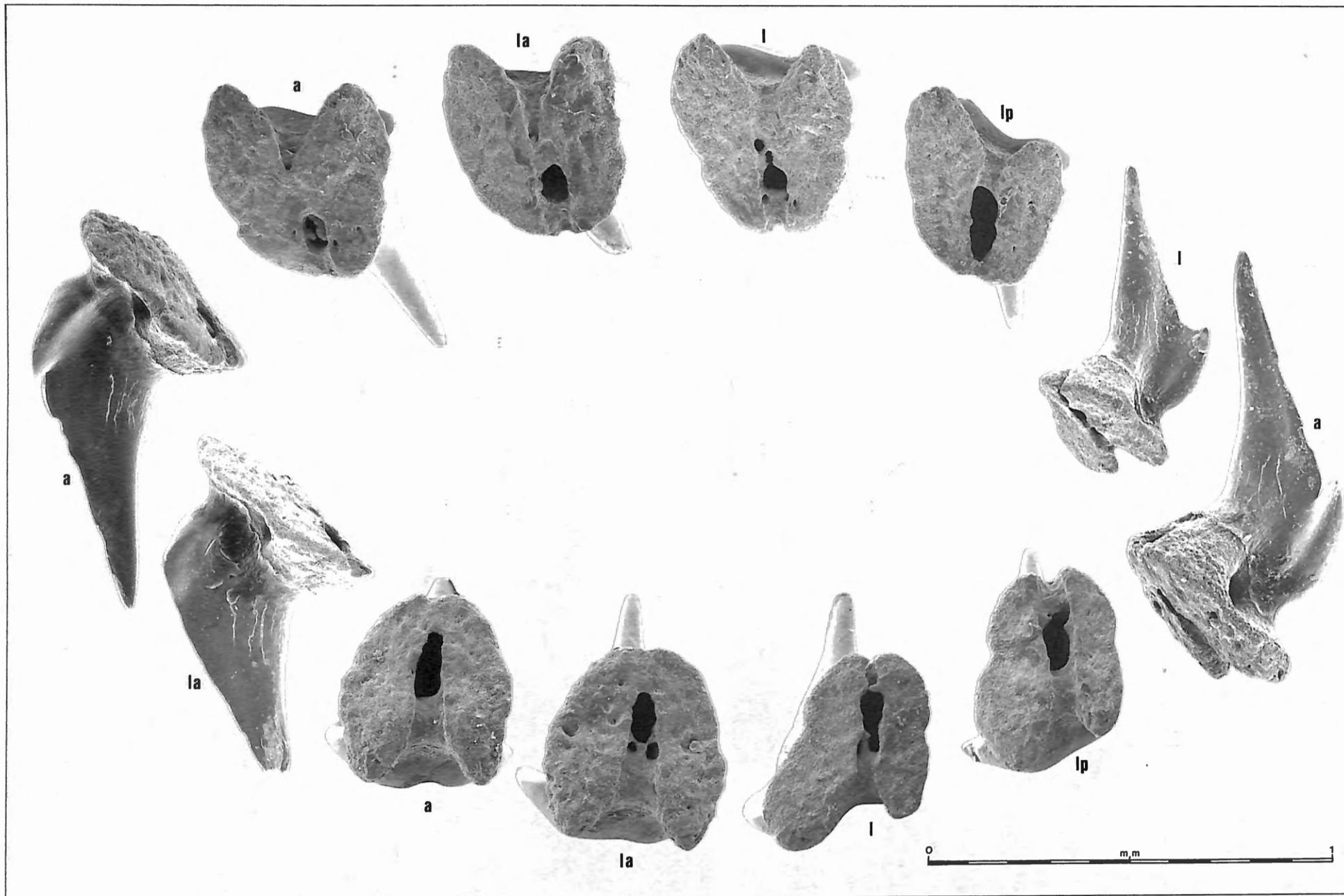


Plate 23. — *Parascyllium variolatum* (DUMERIL, 1853). Female 38 cm t.l., Tasmania. Lateral and basal views of upper and lower teeth.

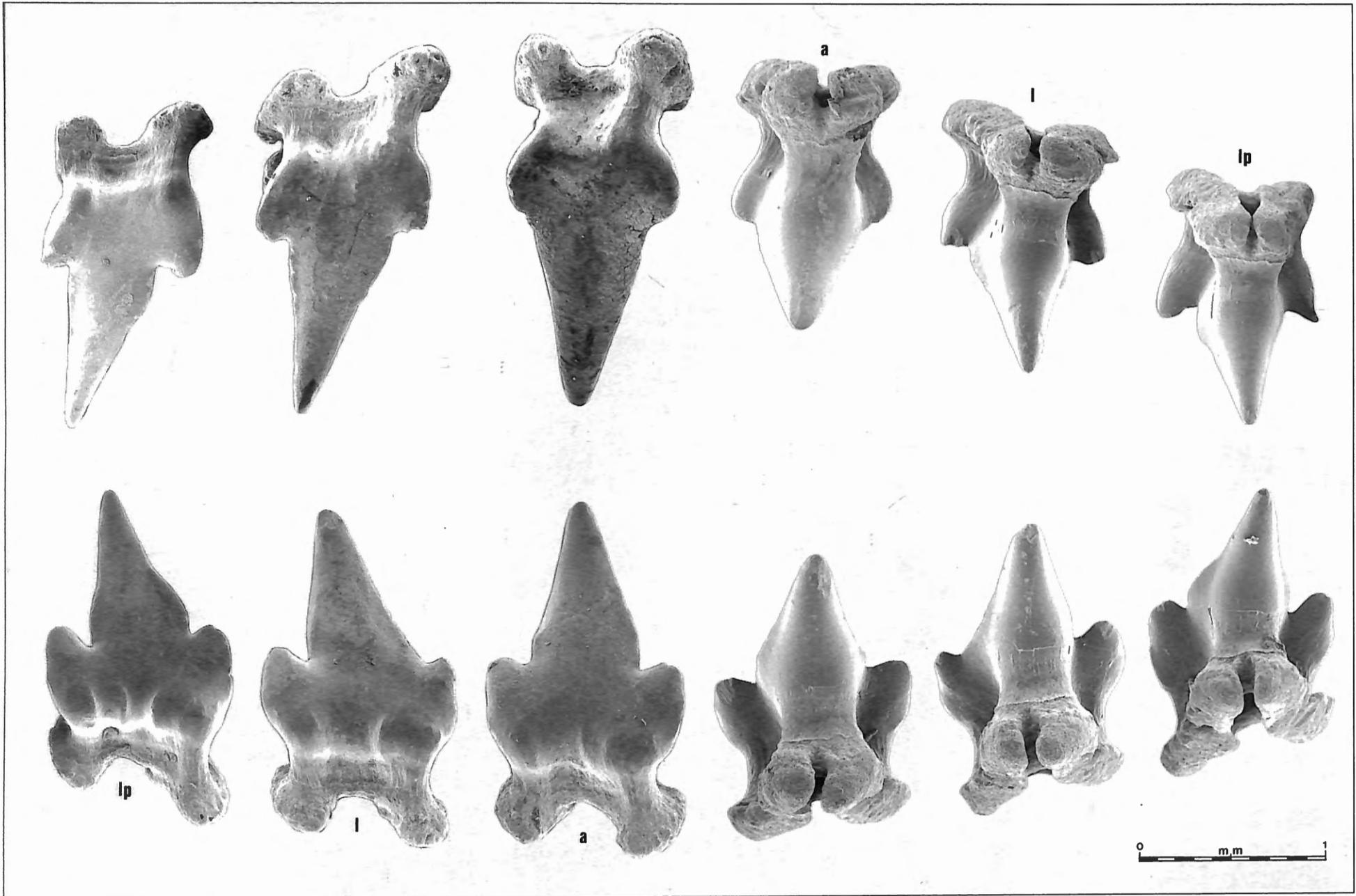


Plate 24. — *Parascyllium collare* (RAMSAY & OGILBY, 1888). Female 90 cm t.l. Tasmania. Outer and inner views of upper and lower teeth.



Plate 25. — *Parascyllium collare* (RAMSAY & OGILBY, 1888). Female 90 cm t.l., Tasmania. Lateral and basal views of upper and lower teeth.



Plate 26. — *Cirrhoscyllium expositum* SMITH & RADCLIFF, 1913. Female 34 cm t.l., holotype, China sea. Outer and inner views of lower teeth.



Plate 27. — *Rhiniodon typus* SMITH, 1828. Occlusal, basal and outer view of one lower tooth of a specimen circa 800 cm t.l., sex unknown, Seychelles. Outer, lateral and basal views of upper and lower tooth of a male 520 cm t.l., Indian

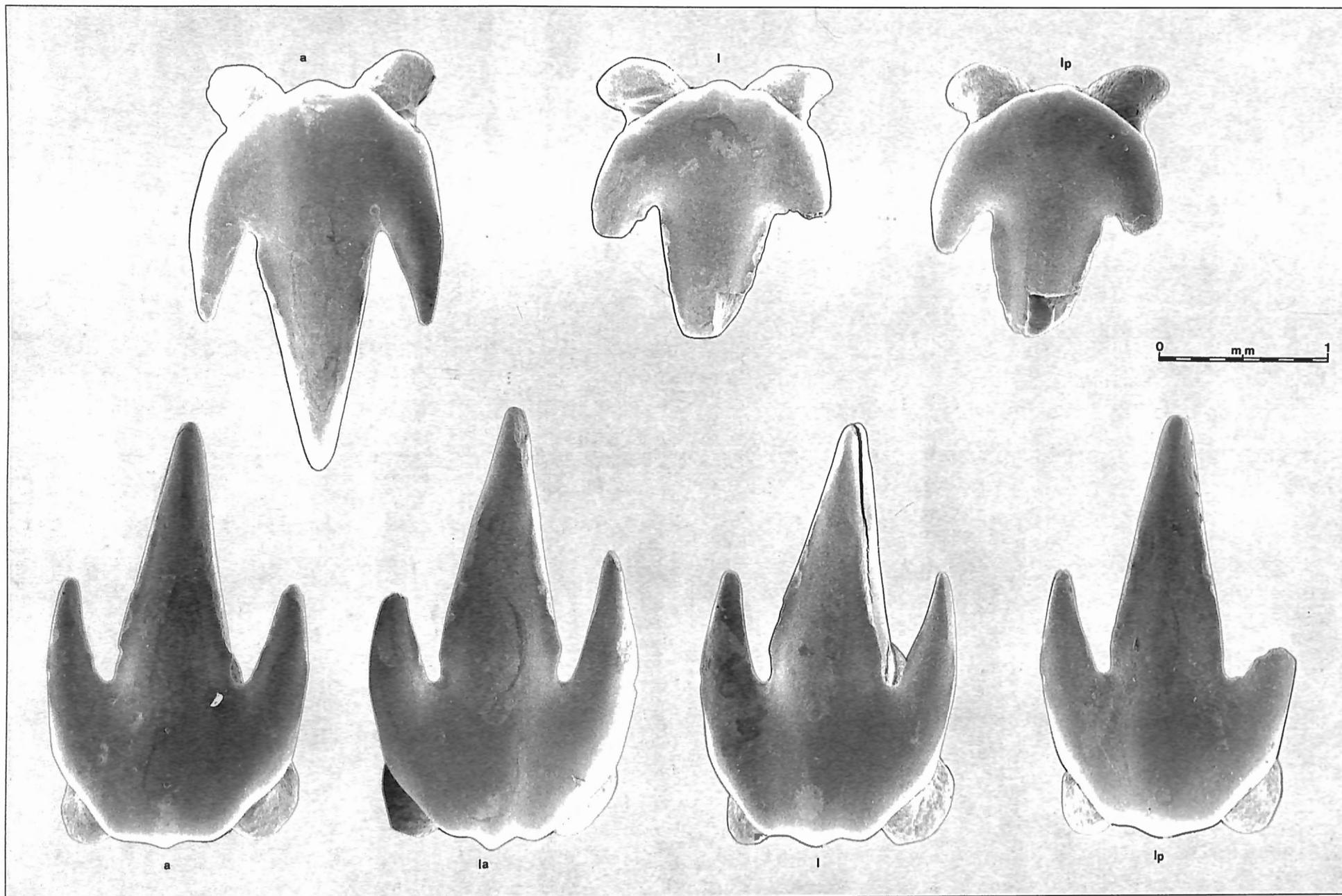


Plate 28. — *Stegostoma fasciatum* (HERMANN, 1783). Female 105 cm t.l., New Caledonia. Outer views of upper and lower teeth.



Plate 29. — *Stegostoma fasciatum* (HERMANN, 1783). Female 105 cm t.l., New Caledonia. Inner views of upper and lower teeth.

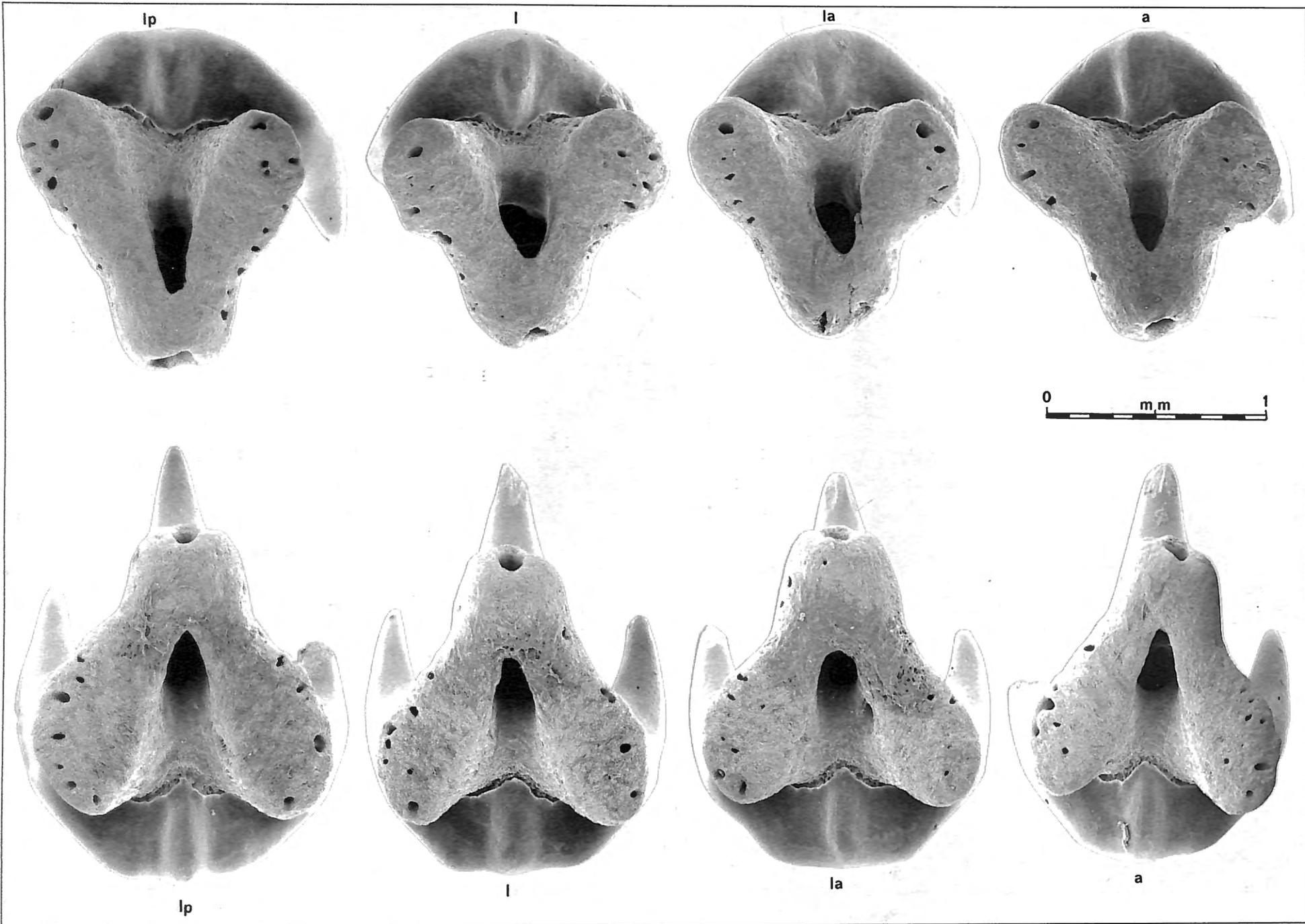


Plate 30. – *Stegostoma fasciatum* (HERMANN, 1783). Female 105 cm t.l., New Caledonia. Basal views of upper and lower teeth.

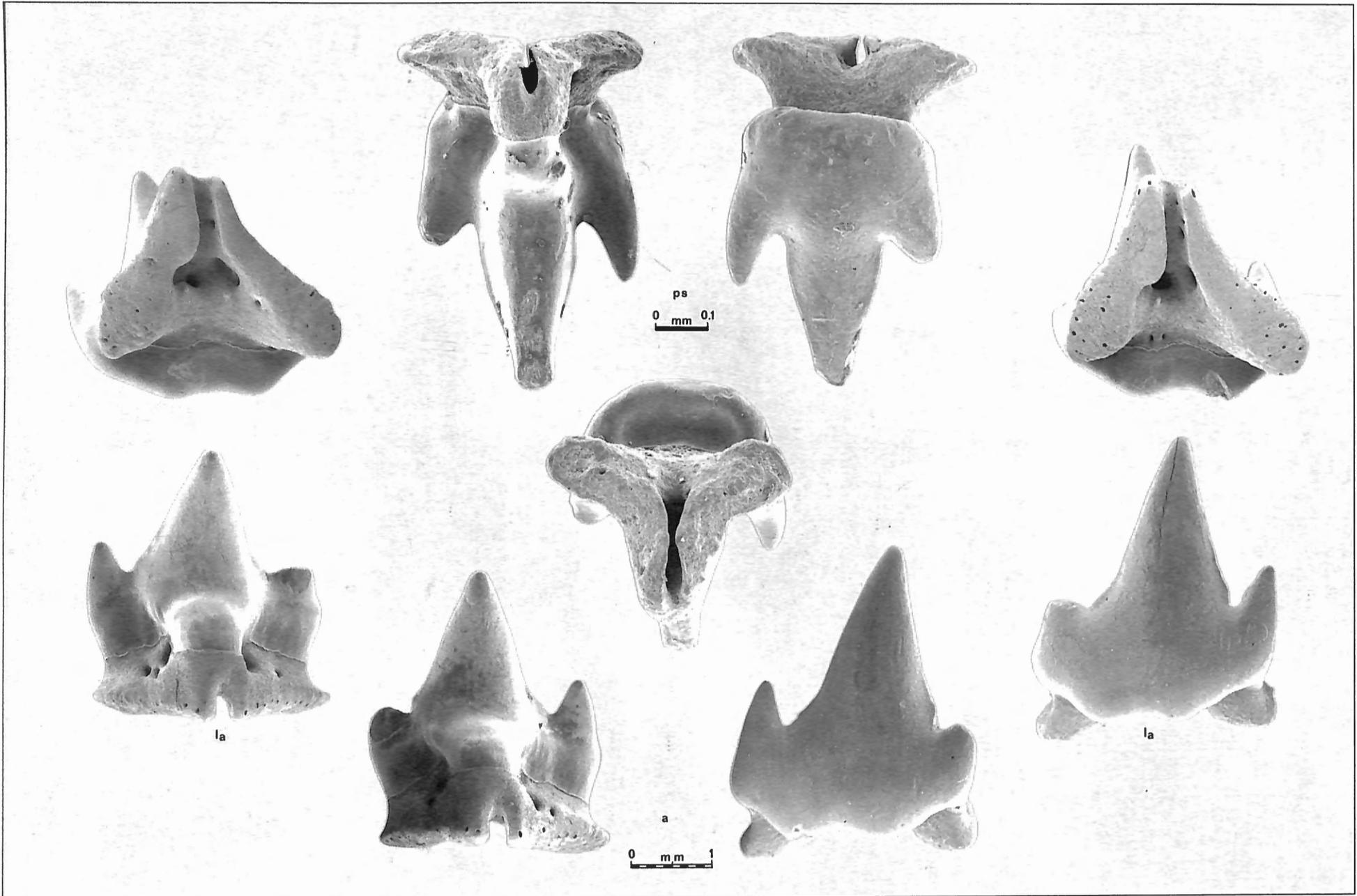


Plate 31. — *Stegostoma fasciatum* (HERMANN, 1783). Inner, outer and basal views of one upper tooth of a newborn male 28 cm t.l., Indian Ocean. Basal, inner and outer views of two lower teeth of a male 210 cm t.l. Red Sea.

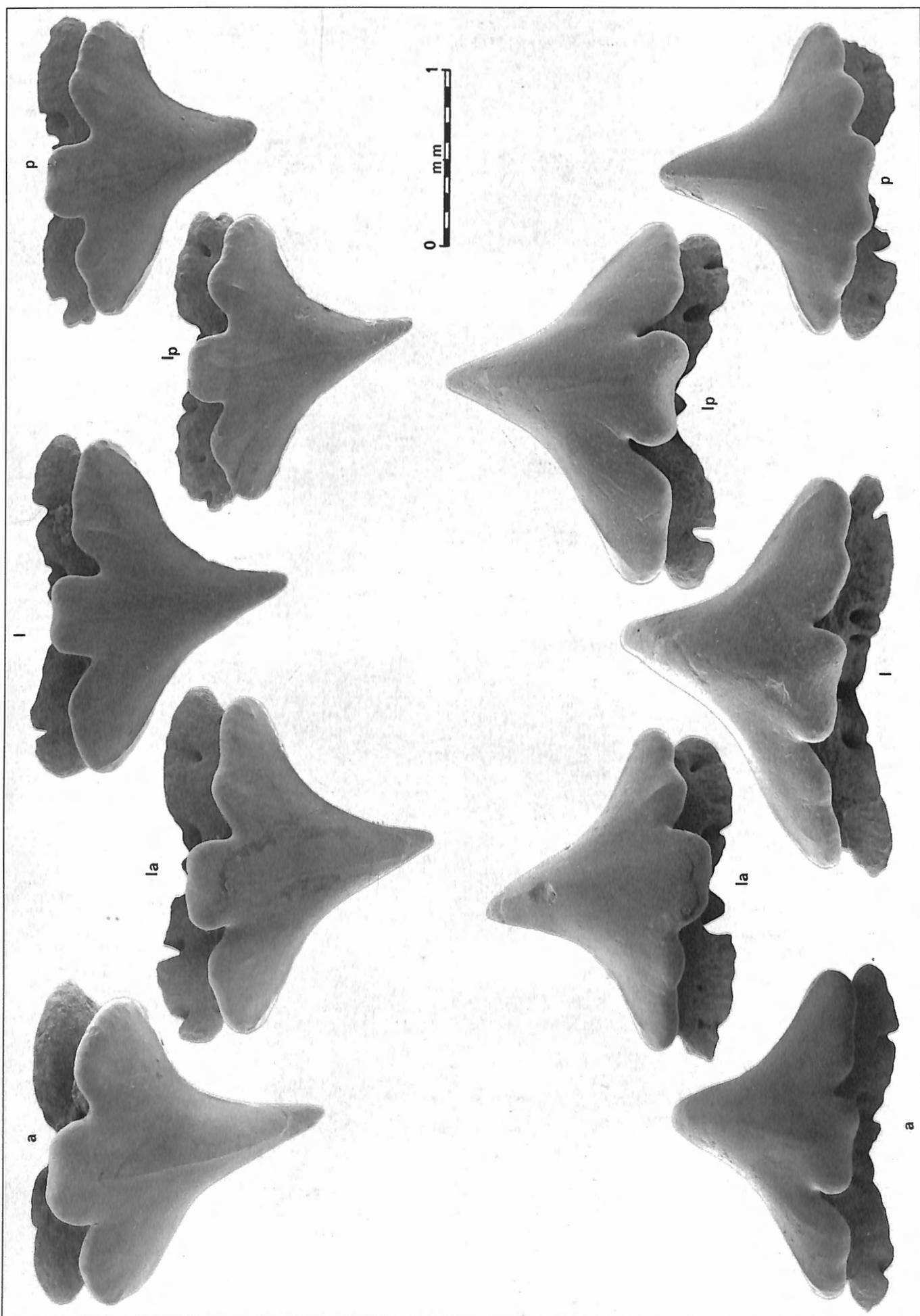


Plate 32. - *Pliotrema warreni* REGAN, 1906. Female 130 cm t.l., Zululand. Outer views of upper and lower teeth.

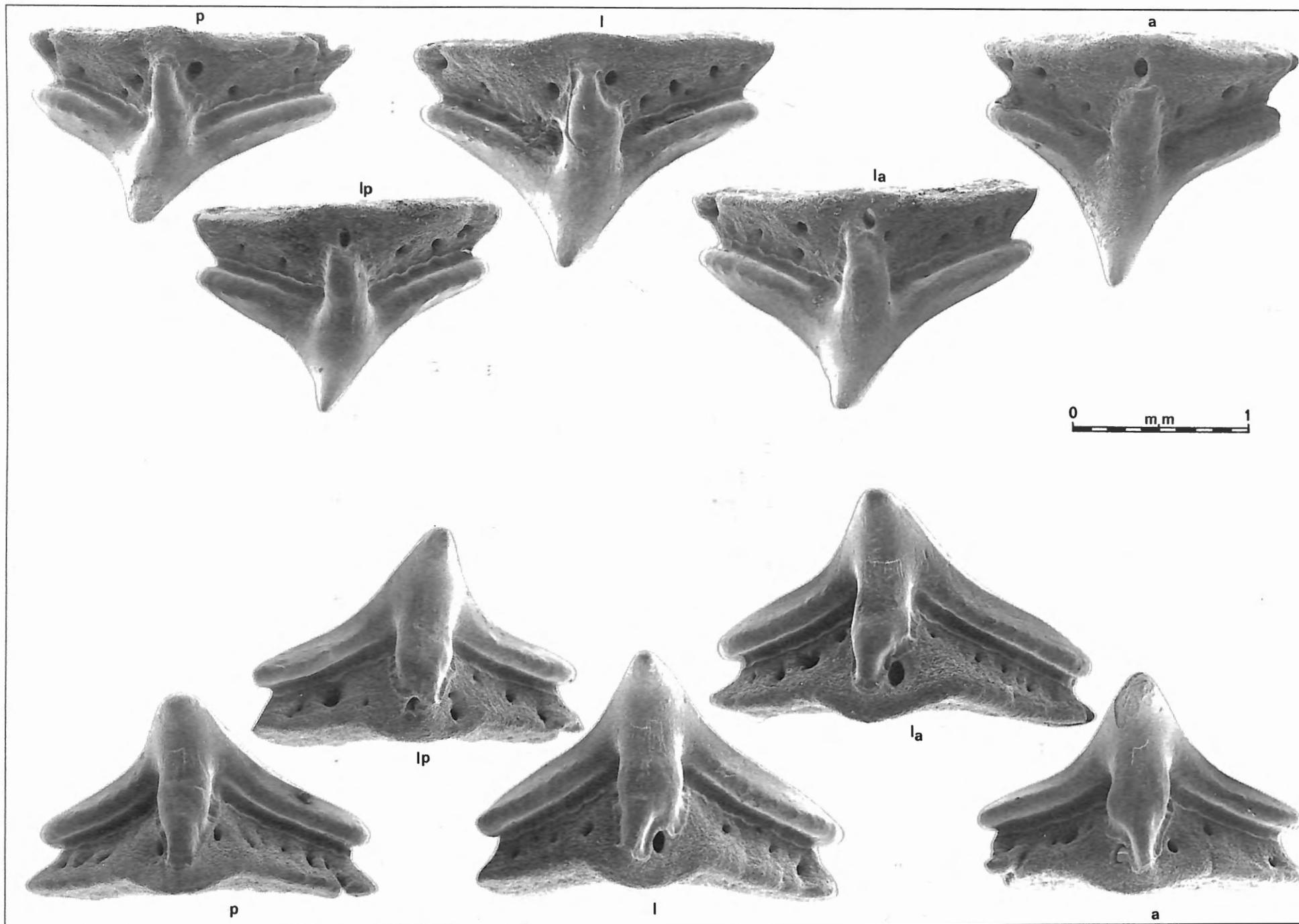


Plate 33. — *Pliotrema warreni* REGAN, 1906. Female 130 cm t.l., Zululand. Inner views of upper and lower teeth.

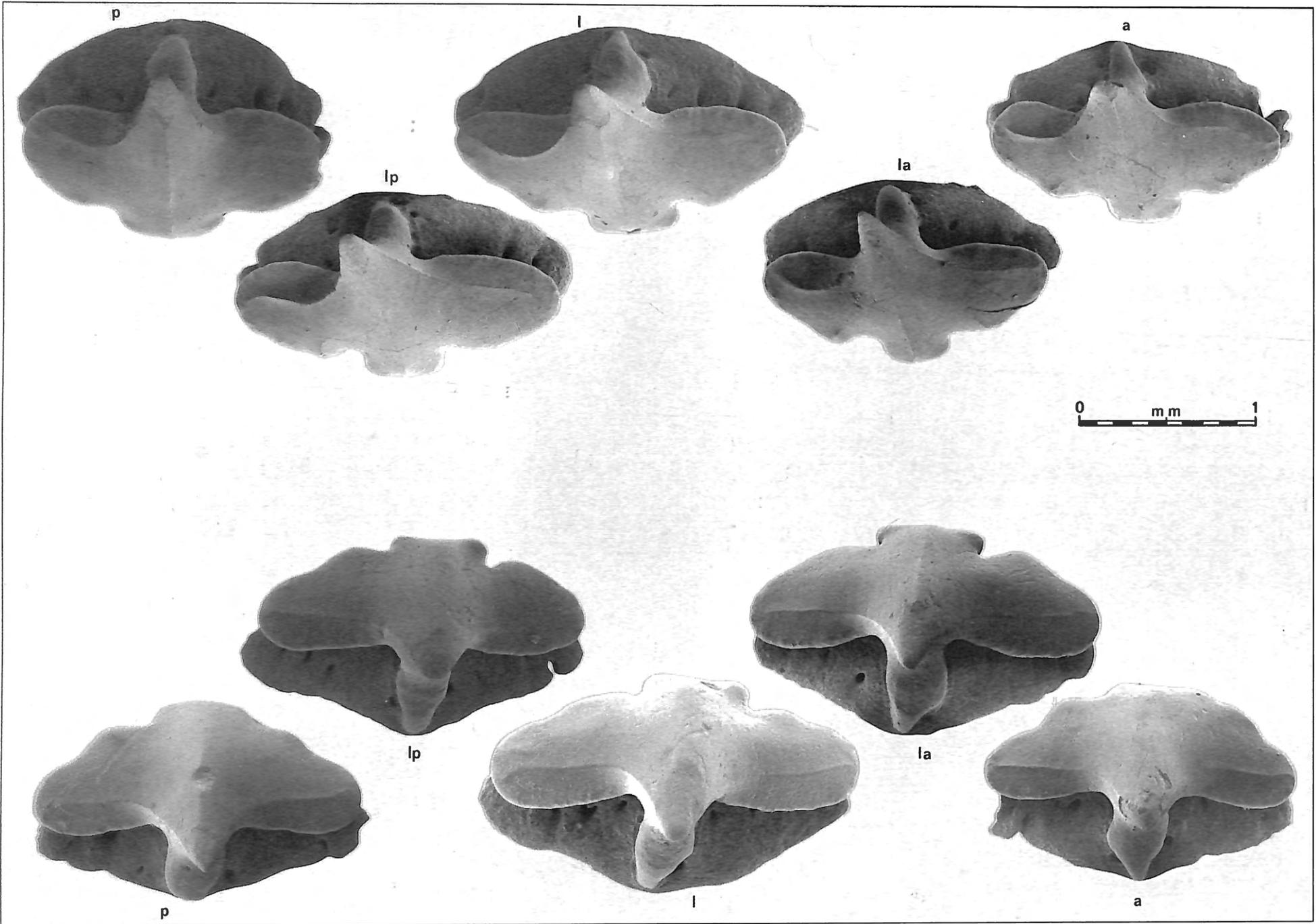


Plate 34. — *Pliotrema warreni* REGAN, 1906. Female 130 cm t.l., Zululand. Occlusal views of upper and lower teeth.

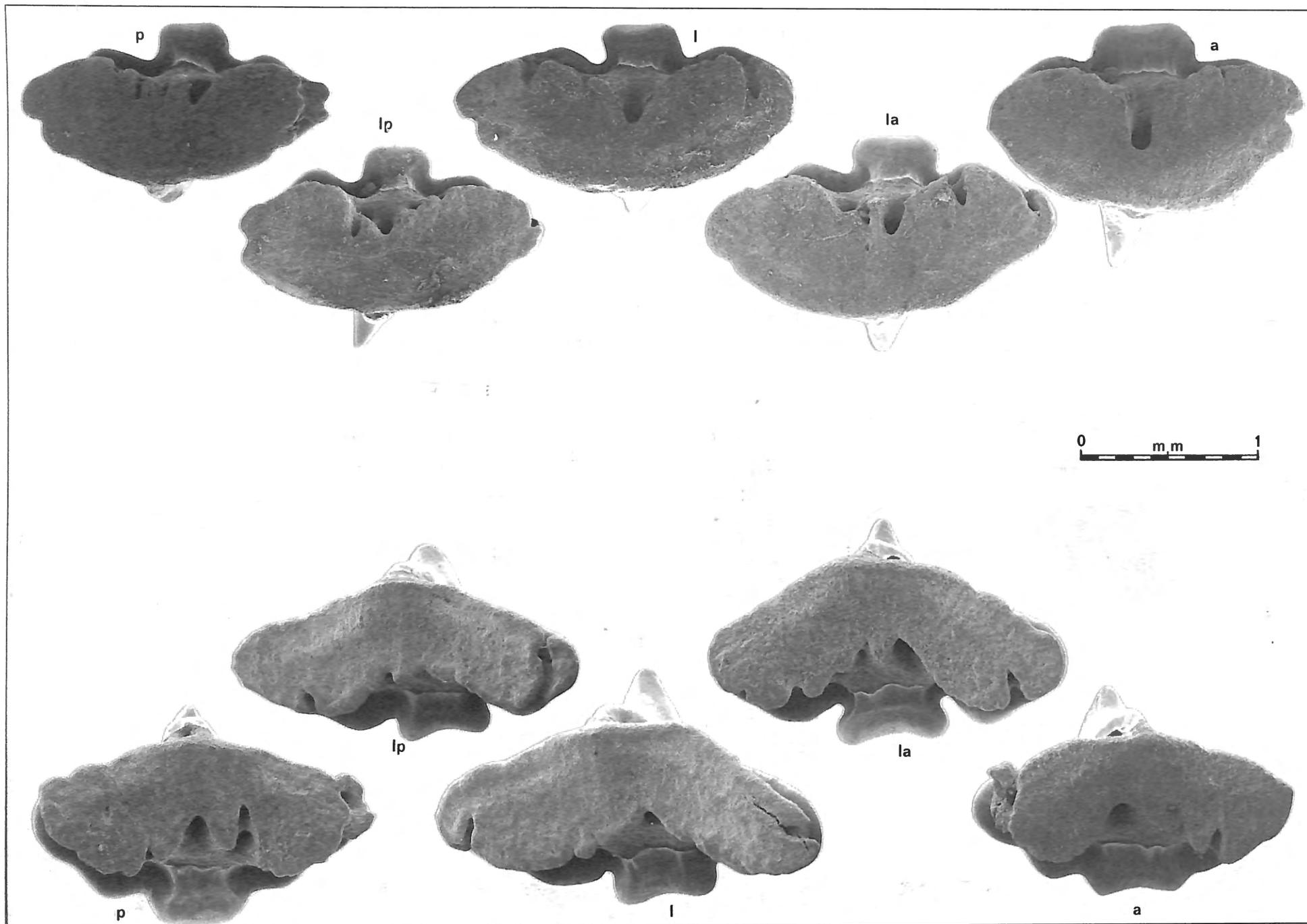


Plate 35. — *Pliotrema warreni* REGAN, 1906. Female 130 cm t.l., Zululand. Basal views of upper and lower teeth.

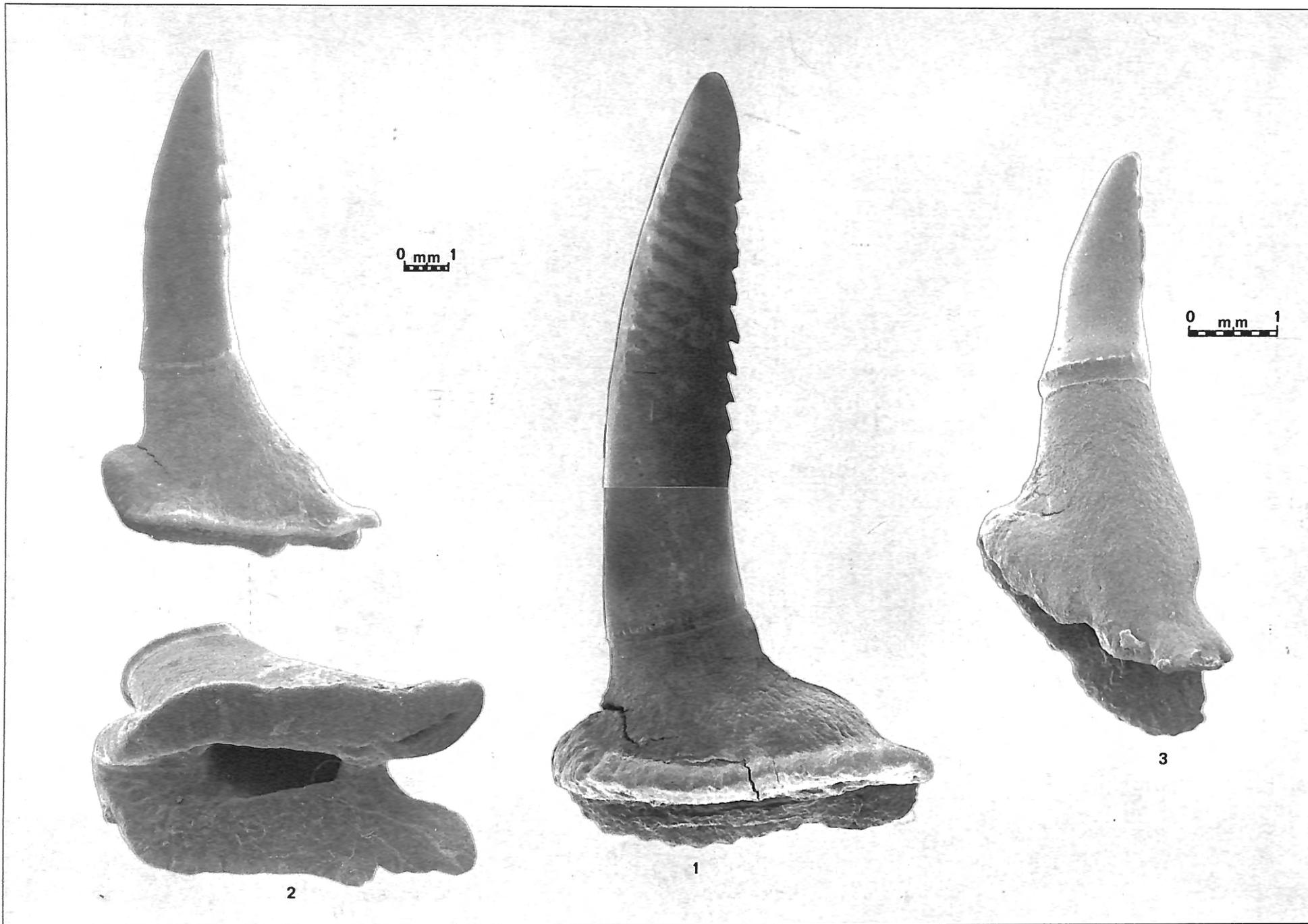


Plate 36. — *Pliotrema warreni* REGAN, 1906. Female 130 cm t.l. Zululand. Rostral spines (also called "rostral teeth"). 1. Mature. 2. Growing. 3. Newborn.

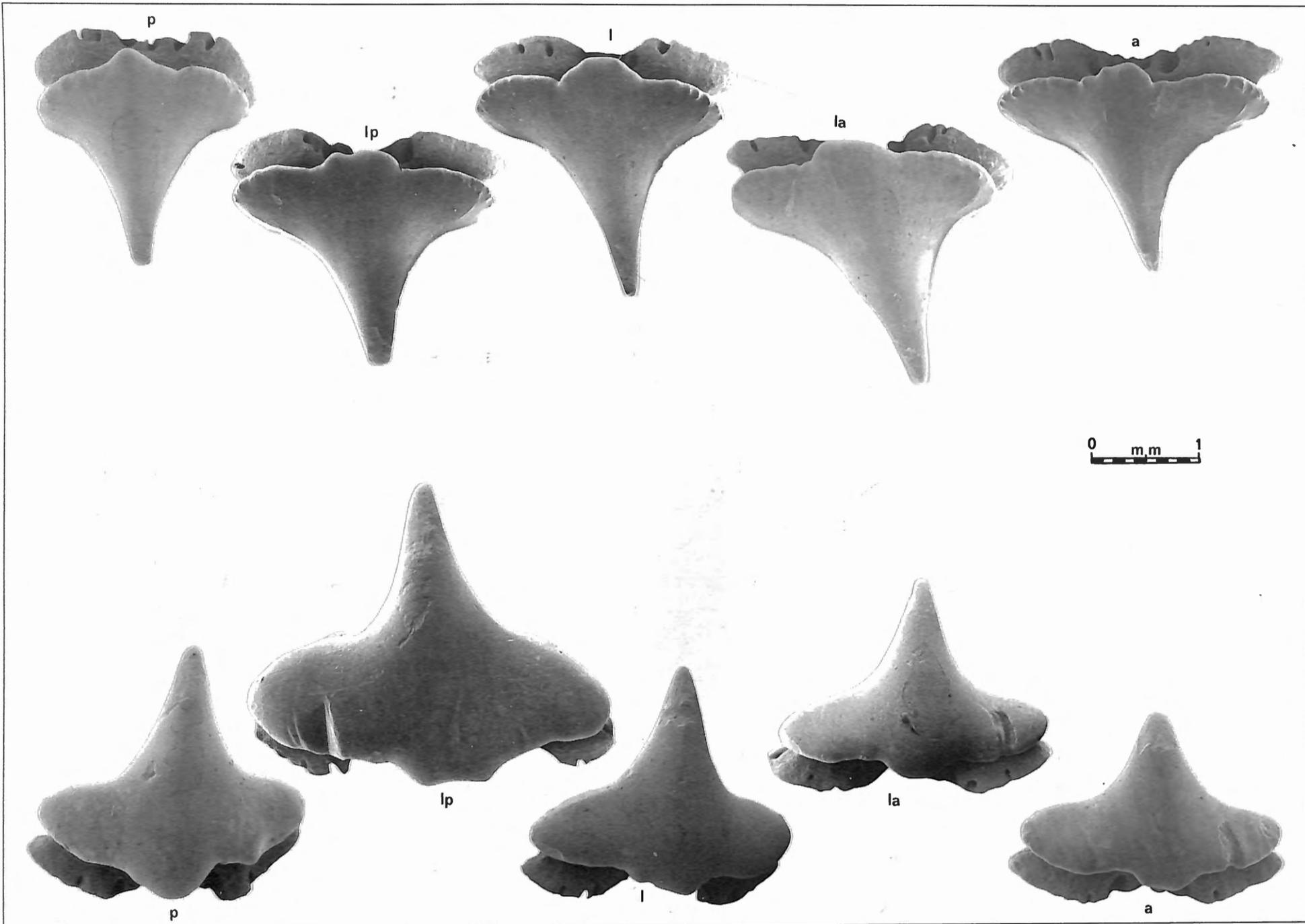


Plate 37. — *Pristiophorus cirratus* (LATHAM, 1794). Male 95 cm t.l., Victoria, Australia. Outer views of upper and lower teeth.

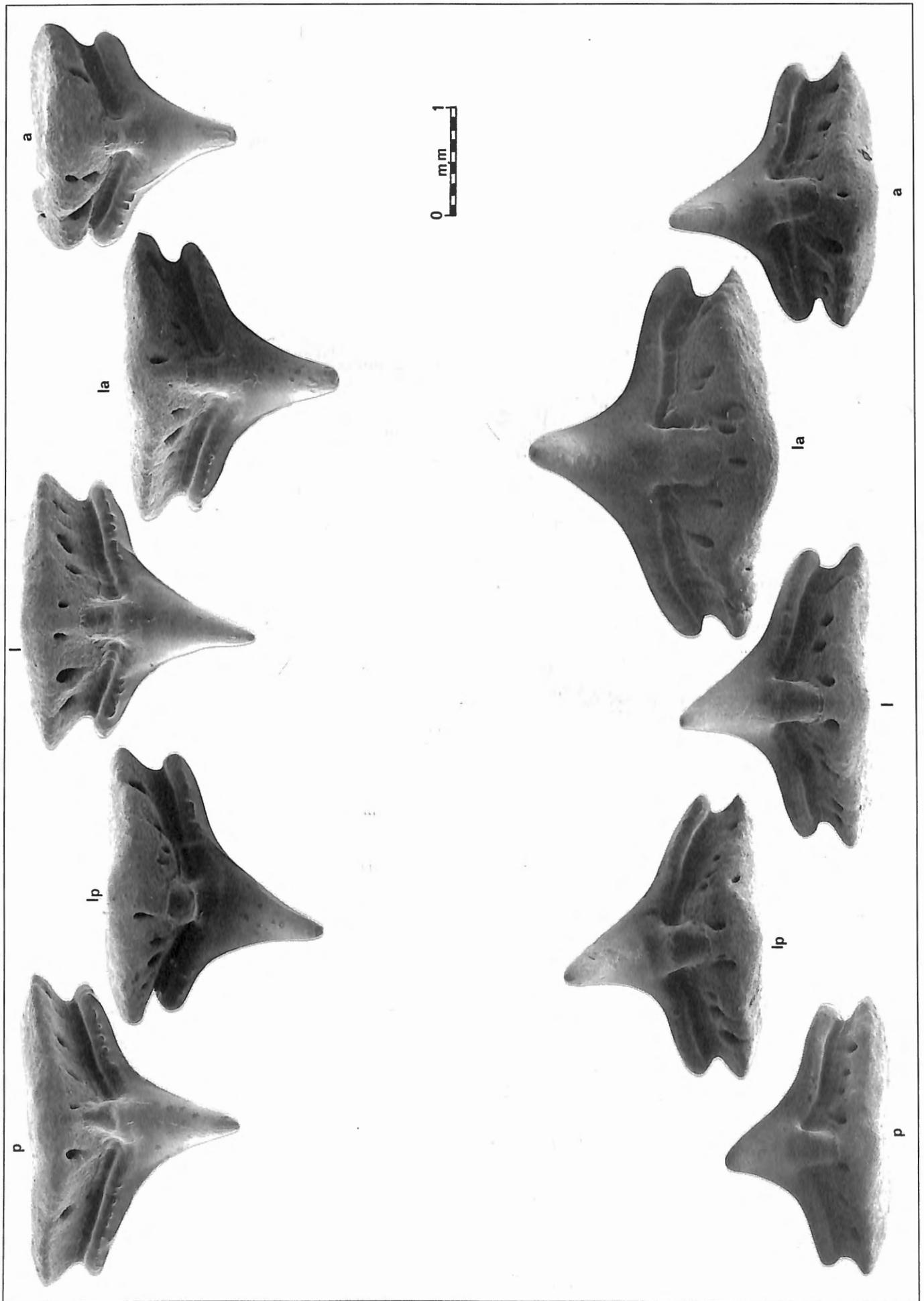


Plate 38. - *Pristiophorus cirratus* (LATHAM, 1794). Male 95 cm t.l., Victoria, Australia. Inner views of upper and lower teeth.

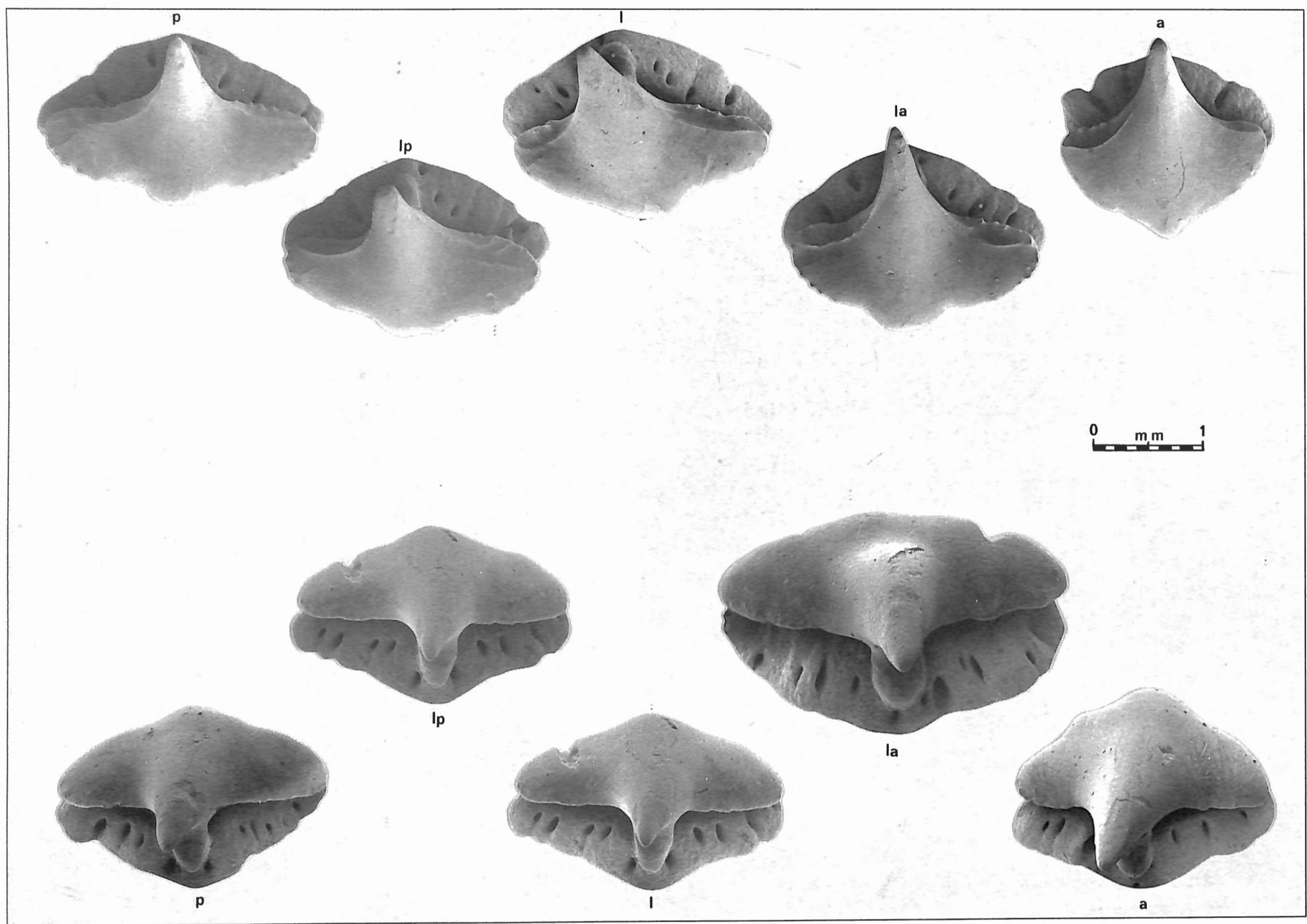


Plate 39. — *Pristiophorus cirratus* (LATHAM, 1794). Male 95 cm t.l., Victoria, Australia. Occlusal views of upper and lower teeth.

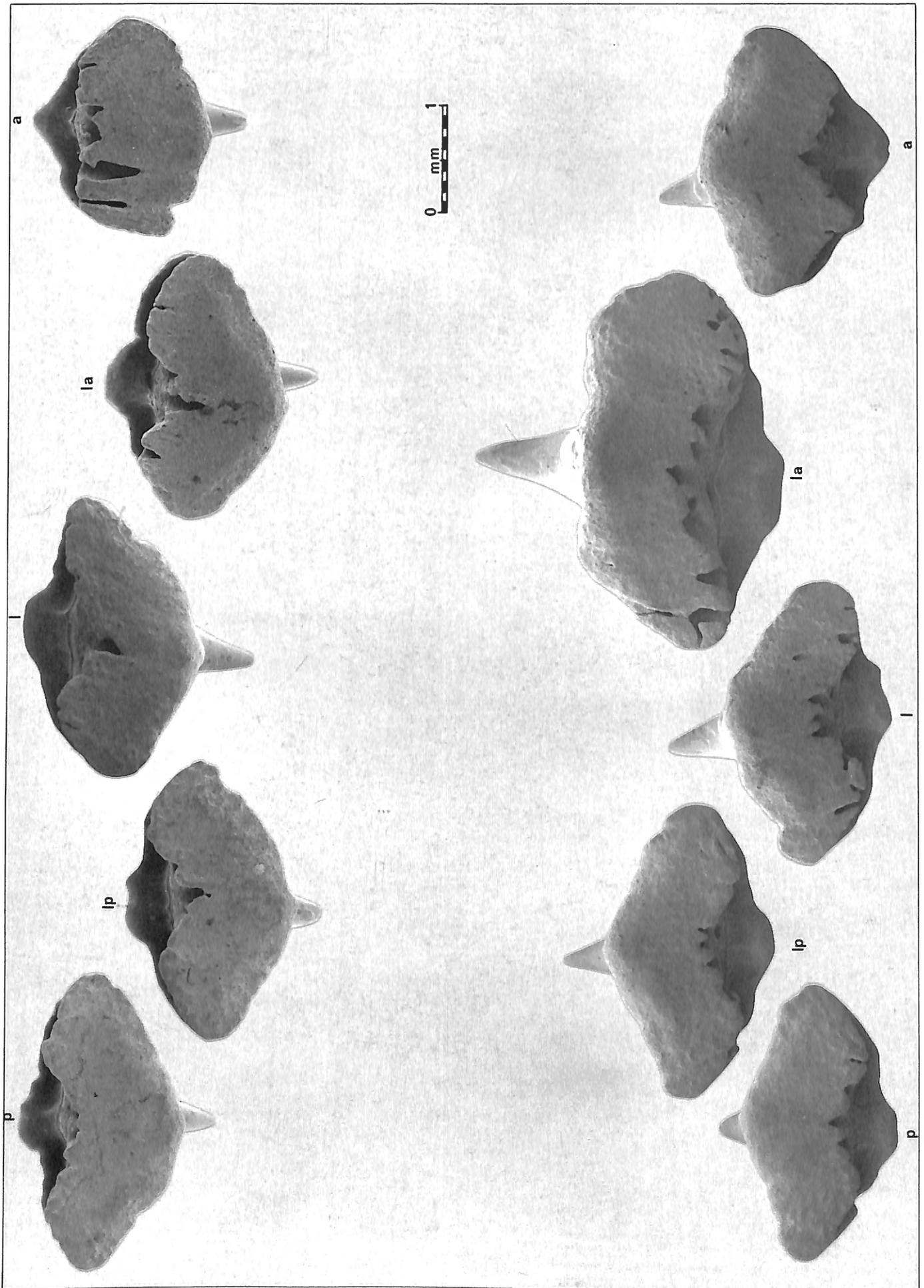


Plate 40. - *Pristiophorus cirratus* (LATHAM, 1794). Male 95 cm t.l., Victoria, Australia. Basal views of upper and lower teeth.

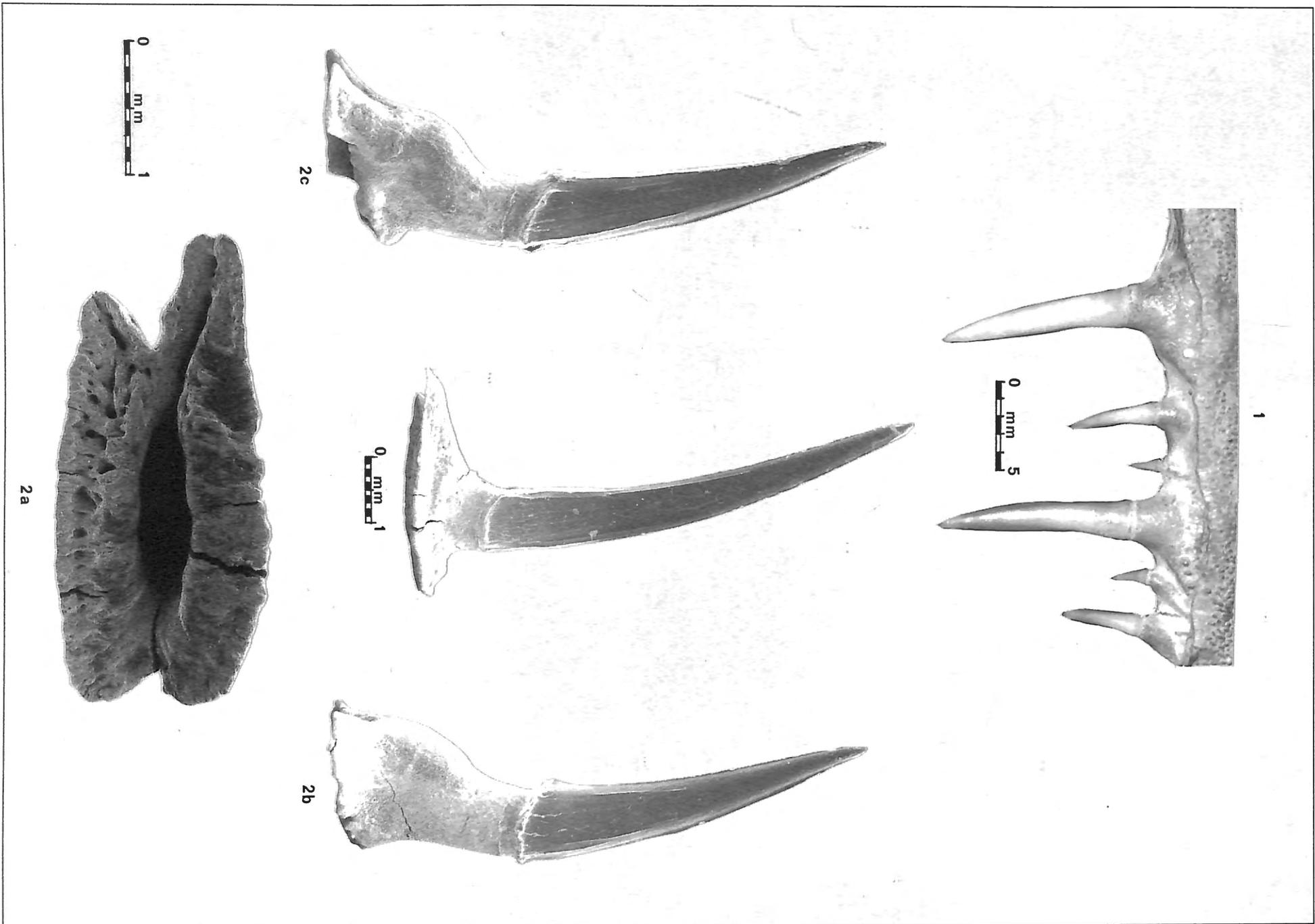


Plate 41. - *Pristiophorus cirratus* (LATHAM, 1794). Male 95 cm t.l., Victoria, Australia. Portion of the rostrum showing different generations of rostral spines (1). *Pristiophorus schroederi* SPRINGER & BULLIS, 1960. Female 50 cm t.l., Fish Creek, Pristiglav, Alaska (called "rostral tooth"): mature (2c), growing (2b), newborn (2a).

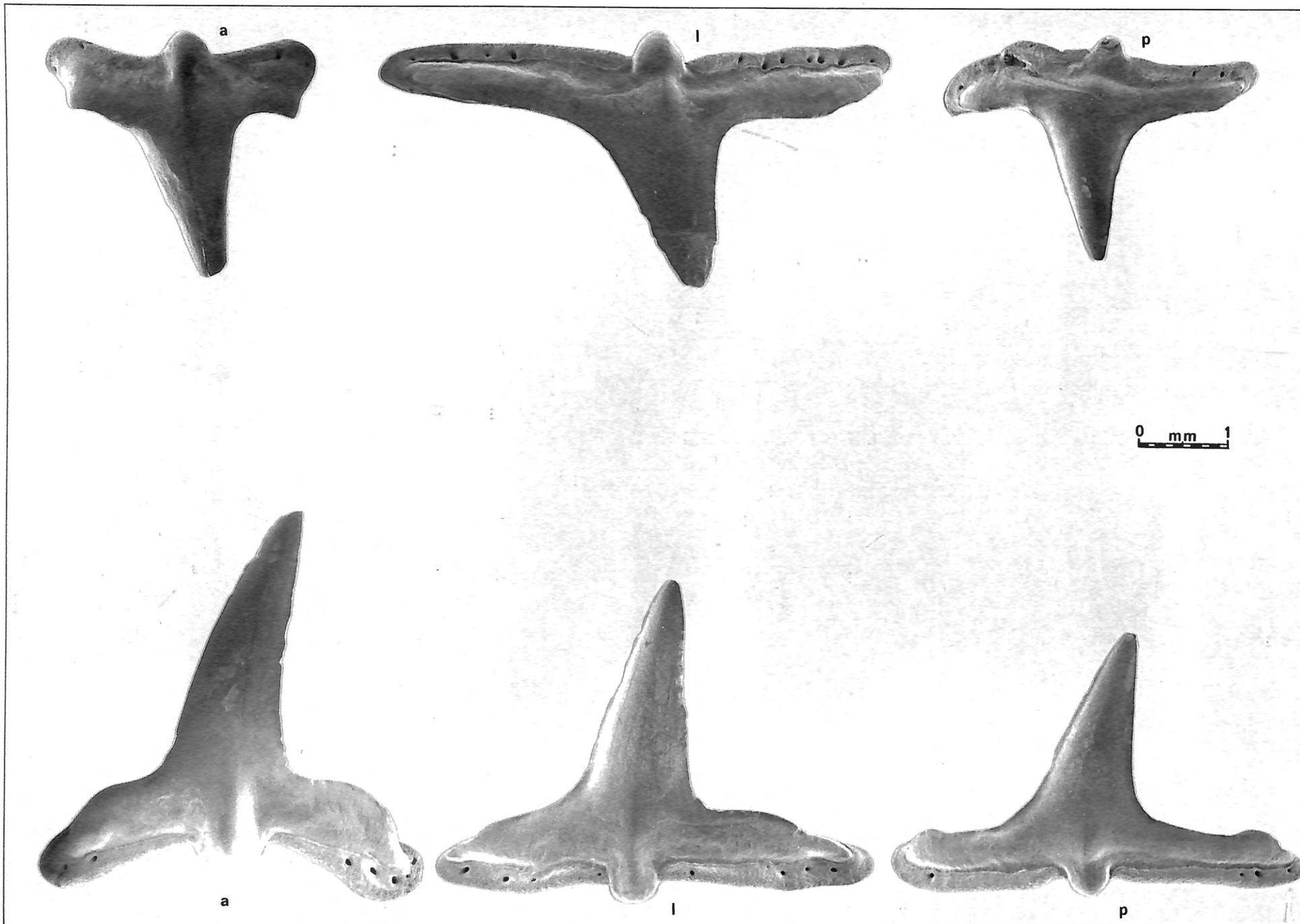


Plate 42. — *Squatina squatina* (LINNAEUS, 1758). Male 85 cm t.l., North Sea. Outer views of upper and lower teeth.

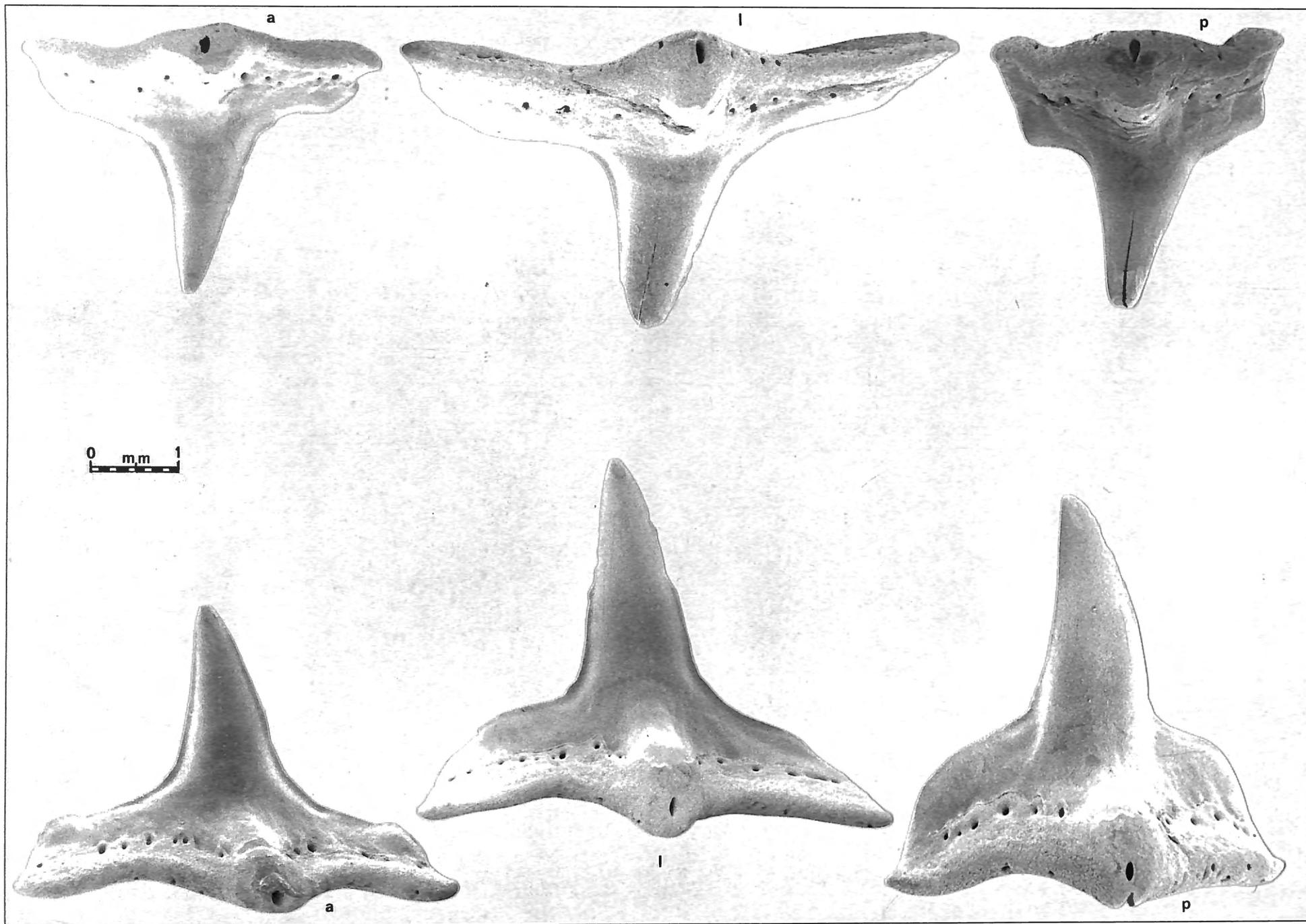


Plate 43. — *Squatina squatina* (LINNAEUS, 1758). Male 85 cm t.l., North Sea. Inner views of upper and lower teeth.

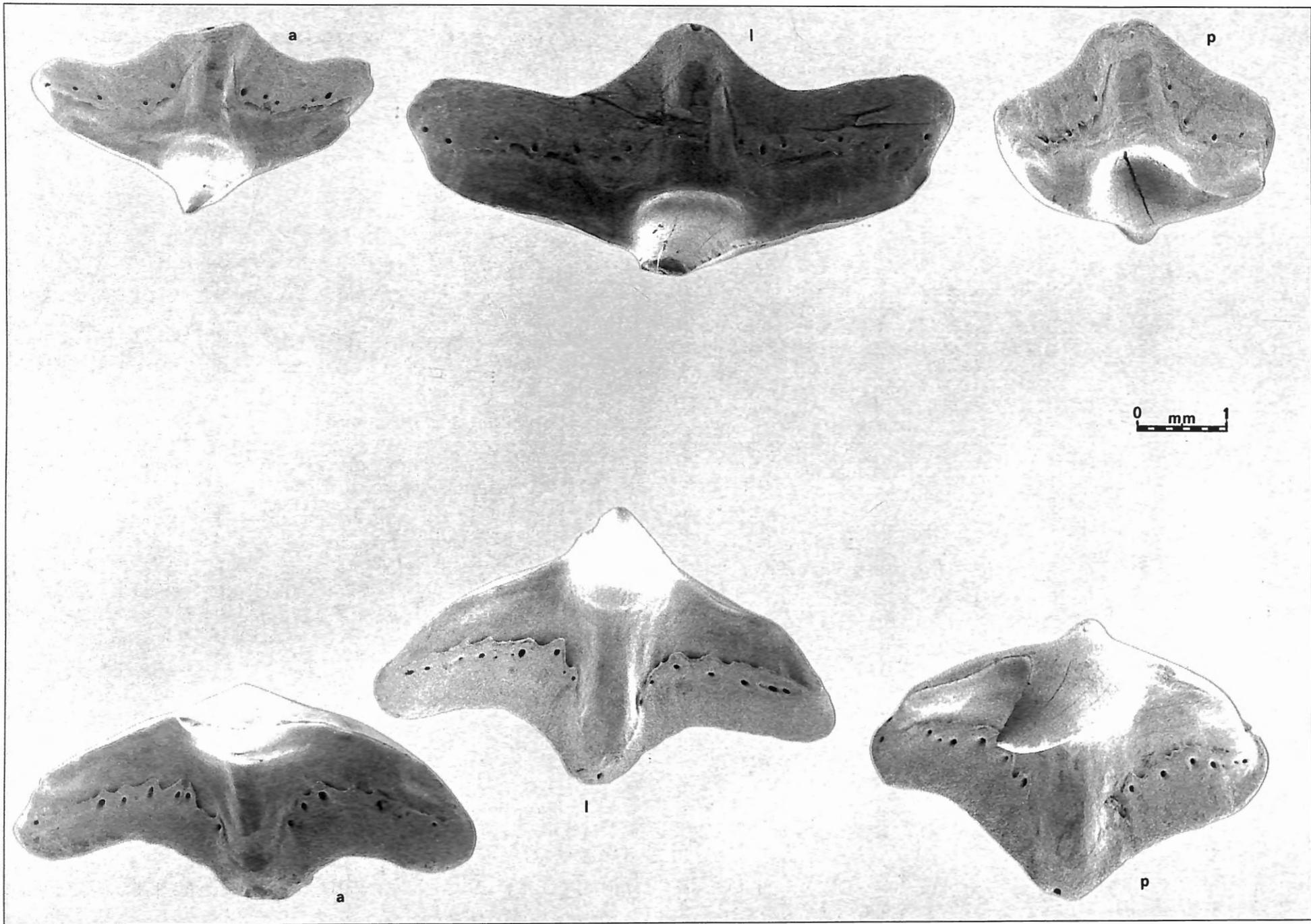


Plate 44. – *Squatina squatina* (LINNAEUS, 1758). Male 85 cm t.l., North Sea. Occlusal views of upper and lower teeth.

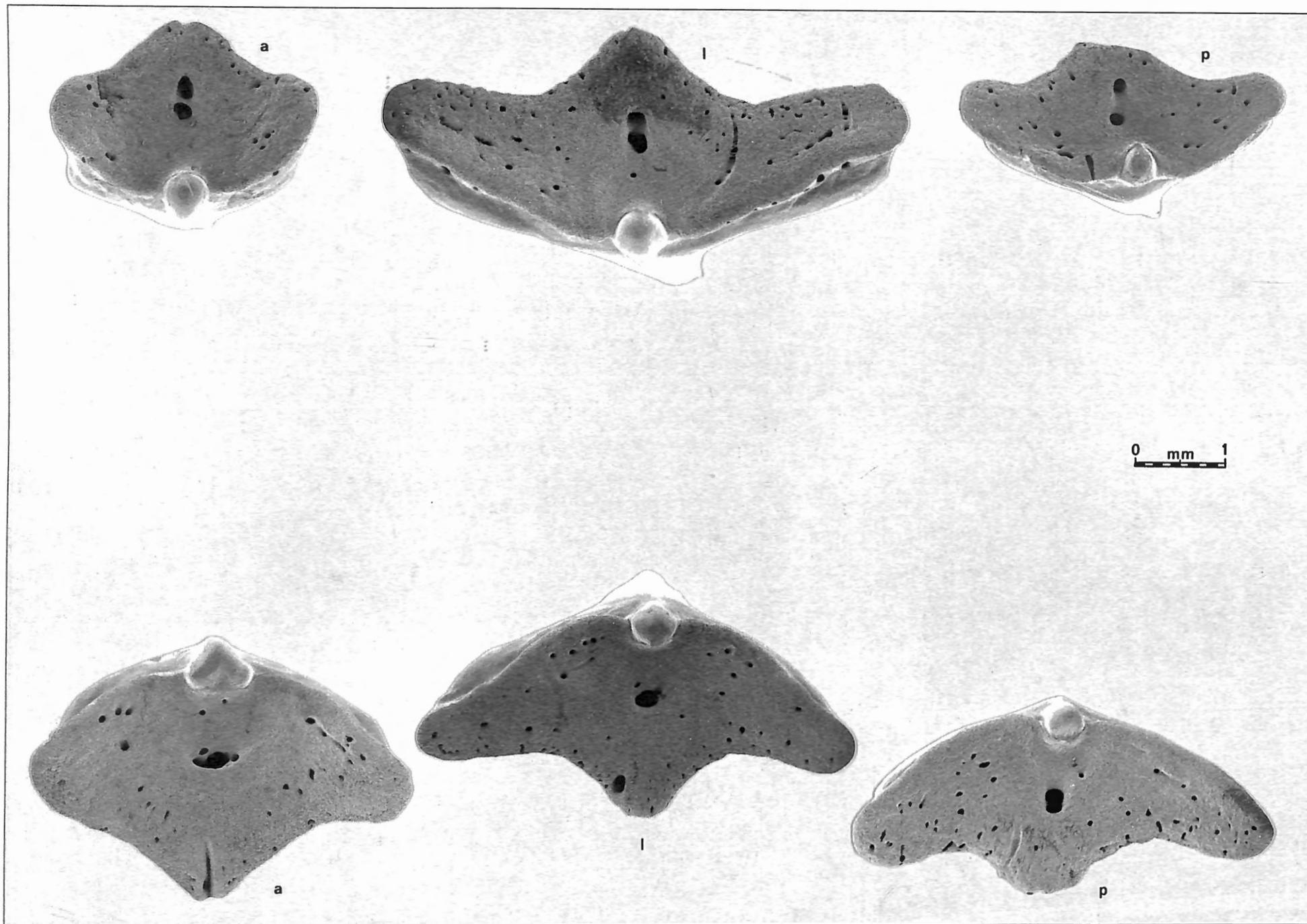


Plate 45. — *Squatina squatina* (LINNAEUS, 1758. Male 85 cm t.l., North Sea. Basal views of upper and lower teeth.