

Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supra-specific taxa of Chondrichthyan fishes

Editor: M. STEHMANN

Part B: Batomorphii 4a: Order Rajiformes - Suborder Myliobatoidei - Superfamily Dasyatoidea - Family Dasyatidae - Subfamily Dasyatinae - Genera: *Amphotistius*, *Dasyatis*, *Himantura*, *Pastinachus*, *Pteroplatytrygon*, *Taeniura*, *Urogymnus* and *Urolophoides* (incl. supraspecific taxa of uncertain status and validity), Superfamily Myliobatoidea - Family Gymnuridae - Genera: *Aetoplatea* and *Gymnura*, Superfamily Plesiobatoidea - Family Hexatrygonidae - Genus: *Hexatrygon*.

by J. HERMAN, M. HOVESTADT-EULER, D.C. HOVESTADT and M. STEHMANN

Abstract

Part B of this series, comprising the Batomorphii is continued with taxa of the Myliobatoidei. The tooth morphology of representatives of eight genera (incl. supraspecific taxa of uncertain status and validity) of the family Dasyatidae, two of Gymnuridae and one of Hexatrygonidae is described and illustrated by SEM-photographs. A differential diagnosis for a final conclusions on myliobatoid odontology will be given in a forthcoming issue dealing with the last myliobatoid taxa.

Key-words: Elasmobranchii - Batomorphii - Myliobatoidei - Odontology - Rajiformes.

Résumé

La deuxième partie (B) de cette série concerne les Batomorphii. Cette étude se poursuit par l'examen d'une partie des Myliobatoidei. La morphologie dentaire de huit genres de la famille des Dasyatidae, des deux genres des Gymnuridae et de l'unique genre des Hexatrygonidae est décrite et illustrée (clichés MEB). Diagnose différentielle et conclusions systématiques seront présentées dans le fascicule qui cloturera l'étude des Myliobatoidei.

Mots-clés: Elasmobranchii - Batomorphii - Myliobatoidei - Odontologie - Rajiformes.

Kurzfassung

Teil B dieser Serie wird fortgesetzt mit der Beschreibung und Illustrierung durch REM-Photos der Zahnmorphologie einer Gruppe von Taxa der Unterordnung Myliobatoidei.

Die Zahnmorphologie von acht Gattungen der Familie Dasyatidae, zwei der Gymnuridae und der einzigen der Hexatrygonidae wird beschrieben und illustriert. Eine zusammenfassende Differentialdiagnose und Bewertung zur Odontologie der Myliobatoidei werden zum Abschluß der Unterordnung in einem späteren Beitrag folgen.

Schlüsselwörter: Elasmobranchii - Batomorphii - Myliobatoidei - Odontologie- Rajiformes.

Part B: Batomorphii - Order: Rajiformes - Suborder: Myliobatoidei

General introduction

With the present issue part B of this series (HERMAN, HOVESTADT-EULER, HOVESTADT & STEHMANN, 1994, 1995, 1996 and 1997) is continued with the first contribution on tooth morphology of some supraspecific taxa of myliobatoid rays. The large number of supraspecific taxa within the suborder, families and subfamilies of myliobatoids has to be published, due to technical limitations, in at least two issues of this series. The sequence of publication will not reflect any certain classification or taxonomic ordering but merely depend on availability of study material and progress made in its investigation. The last contribution will provide for each higher taxonomic category, respectively, the summarizing discussion, final conclusion, and differential diagnosis.

The supraspecific systematics and classification of myliobatoid chondrichthyan fishes underwent a major revision by NISHIDA (1990). NELSON (1994) modified these systematics, which will be adopted in this issue.

The suborder Myliobatoidei is divided by NELSON (1994) into three superfamilies, namely the Dasyatoidea with the family Dasytidae, comprising the two subfamilies Dasyatinae and Potamotrygoninae, the Myliobatoidea with the families Gymnuridae and Myliobatidae, the latter comprising the subfamilies Mobulinae, Myliobatinae and Rhinopterinae and the Plesiobatoidea with the families Hexatrygonidae and Plesiobatidae.

This issue includes eight dasyatinid genera *Amphotistius*, *Dasyatis*, *Himantura*, *Pastinachus*, *Pteroplatytrygon*, *Taeniura*, *Urogymnus* and *Urolophoides* (status and validity of which are partly uncertain), the genus *Hexatrygon* of the monotypic family Hexatrygonidae and both genera *Aetoplatea* and *Gymnura* of the family Gymnuridae. Both genera *Amphotistius* GARMAN, 1911 (type species *D. kuhlii*) and *Pteroplatytrygon* FOWLER, 1910 (type species *P. violacea*) were not mentioned as valid genera of the Dasyatinae but listed under *Dasyatis* by NISHIDA (1990) and NELSON (1994) without giving any evidence or explanation. Their tooth morphology nonetheless is presented here to provide additional arguments for their final classification.

Due to the lack of recent revisions dealing with the validity of nominal species and genera of the myliobatoids (except for NISHIDA, 1990), unlike previous issues of this series, listings of the nominal species cannot always be given. An estimated number will be presented instead for the genera concerned.

The authors will not draw any nomenclatorially valid conclusions. 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 full bibliographical reference for each genus, subgenus and species described will be given in the descriptive section, respectively, and not be repeated under literature references. Along with every description of the tooth morphology, the vascularization of the teeth will be described and illustrated.

Superfamily: Dasyatoidea - Family: Dasytidae - Subfamily: Dasyatinae

Introduction

The subfamily Dasyatinae includes after Nelson (1994) 6 genera, namely *Dasyatis*, *Himantura*, *Hypolophus*, *Taeniura*, *Urogymnus* and *Urolophoides*. Additionally the tooth morphology of *Amphotistius kuhlii* and *Pteroplatytrygon violacea* will be described and illustrated here to provide additional arguments to clarify whether these genera are valid or not. *Hypolophus* MÜLLER & HENLE 1837 is considered here as a seniorsynonym of *Pastinachus*, RÜPPELL 1828.

Material

The following 97 specimen of 14 species were examined for this issue:

<i>Amphotistius kuhlii</i>		
ISH 81-1961	♂	506 mm TL
ISH 81-1961	♀	495 mm TL
ISH 64-1982 [juv.]	♀	150 mm TL
<i>Dasyatis americana</i>		
Coll.Herman	♀	450 mm TL
<i>Dasyatis centroura</i>		
Coll.Herman	♂	450 mm DW
Coll.Herman	♀	1007 mm DW
<i>Dasyatis hastata</i>		
Coll.Herman	♀	1500+mm TL
<i>Dasyatis margarita</i>		
Coll.Hovestadt	♀	170 mm DW
Coll.Hovestadt	♂	175 mm DW
Coll.Herman	♂	210 mm DW
Coll.Herman	♂	165 mm DW
Coll.Herman	♂	170 mm DW
Coll.Herman	♂	205 mm DW
Coll.Herman	♀	155 mm DW
Coll.Herman	♀	195 mm DW
Coll.Herman	♀	170 mm DW
Coll.Herman	♀	170 mm DW
Coll.Herman	♀	170 mm DW
Coll.Herman	♀	180 mm DW
Coll.Herman	♀	180 mm DW
Coll.Herman	♀	180 mm DW
Coll.Herman	♀	165 mm DW
Coll.Herman	♀	185 mm DW
Coll.Herman	♀	195 mm DW
Coll.Herman	♀	200 mm DW
Coll.Herman	♀	295 mm DW
Coll.Herman	♀	155 mm DW
<i>Dasyatis margaritella</i>		
ISH 164-1965	♂	1301 mm TL
ISH 164-1965	♀	460 mm TL
<i>Dasyatis marmorata</i>		
Coll.Hovestadt	♂	305 mm DW
Coll.Herman	♂	335 mm DW
Coll.Herman	♂	155 mm DW
Coll.Herman	♂	304 mm DW
Coll.Herman	♀	235 mm DW
Coll.Herman	♀	220 mm DW
Coll.Herman	♀	180 mm DW
<i>Dasyatis pastinaca</i>		
Coll.Herman	♂	430 mm DW
Coll.Herman	♀	560 mm DW
Coll.Herman	♀	650 mm DW

Coll.Hovestadt	♂	380 mm DW	<i>Taeniura grabata</i>	
Coll.Hovestadt	♂	440 mm DW	Coll.Herman	♀ 1580 mm TL
Coll.Hovestadt	♂	390 mm DW	Coll.Herman	♂ 1100 mm TL
Coll.Hovestadt	♂	440 mm DW	Coll.Hovestadt	♂ 780 mm DW
Coll.Hovestadt	♂	520 mm DW	ISH 360-1964	♂ 567 mm TL
Coll.Hovestadt	♂	440 mm DW		
Coll.Hovestadt	♂	460 mm DW	<i>Urogymnus asperrimus</i>	
Coll.Hovestadt	♂	440 mm DW	Coll.Herman	? ? mm TL
Coll.Hovestadt	♂	370 mm DW	MUTF26698	♀ 919 mm DW
Coll.Hovestadt	♂	440 mm DW	MUTF26699	♀ 222 mm DW
Coll.Hovestadt	♂	540 mm DW		
Coll.Hovestadt	♂	420 mm DW	<i>Urolophoides matsubarai</i>	
Coll.Hovestadt	♂	370 mm DW	HUMZ106269	♀ 396 mm DW
Coll.Hovestadt	♂	600 mm DW		
Coll.Hovestadt	♂	350 mm DW		
Coll.Hovestadt	♂	600 mm DW		
Coll.Hovestadt	♂	500 mm DW		
Coll.Hovestadt	♂	410 mm DW		
Coll.Hovestadt	♂	380 mm DW		
Coll.Hovestadt	♀	1200 mm DW		
Coll.Hovestadt	♀	660 mm DW		
Coll.Hovestadt	♀	720 mm DW		
Coll.Hovestadt	♀	550 mm DW		
Coll.Hovestadt	♀	350 mm DW		
Coll.Hovestadt	♀	550 mm DW		
Coll.Hovestadt	♀	300 mm DW		
Coll.Hovestadt	♀	520 mm DW		
Coll.Hovestadt	♀	340 mm DW		
Coll.Hovestadt	♀	310 mm DW		
Coll.Hovestadt	♀	370 mm DW		
Coll.Hovestadt	♀	1000 mm DW		
Coll.Hovestadt	♀	900 mm DW		
Coll.Hovestadt	♀	800 mm DW		
Coll.Hovestadt	♀	700 mm DW		
Coll.Hovestadt	♀	500 mm DW		
Coll.Hovestadt	♀	640 mm DW		
Coll.Hovestadt	♀	210 mm DW		
Coll.Hovestadt	♀	770 mm DW		
Coll.Hovestadt	♀	660 mm DW		
Coll.Hovestadt	♀	380 mm DW		
ISH 360-1964	♀	790+mm TL		
<i>Himantura uarnak</i>				
ISH 80-1961	♀	1130 mm TL		
Coll.Herman	♀	540 mm DW		
<i>Pastinachus sephen</i>				
MNH Data unknown	♂	380 mm DW		
BMNH 1988-18 11	♀	1015 mm TL		
" <i>Pastinachus sephen</i> "				
BMNH 1984-411.1	♂	620 mm TL		
(Doubtful determination)				
<i>Pteroplatytrygon violacea</i>				
Coll.Hovestadt	♀	610 mm TL		
Coll.Herman	♂	445 mm TL		
Coll.Herman	♂	? mm TL		
Coll.Herman	♀	425 mm TL		

Description of the odontological characters

Genus: *Amphotistius* GARMAN, 1913

If valid, this genus is monotypic with *A. kuhlii*.

Amphotistius kuhlii (MÜLLER & HENLE, 1841)
(Plates: 1 to 3)

Trygon kuhlii MÜLLER & HENLE, 1841 Systematische Beschreibung der Plagiostomen. p.185.

HETERODONTY

The dentition is gradient monognathic heterodont in that lateral teeth slightly are broader becoming narrower toward the commissure.

Sexual heterodonty is presented by a slightly lower crown in females. Ontogenetic heterodonty is absent.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broad pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent.

(See textfigure 1)



Textfigure 1.
Amphotistius kuhlii tooth histological cross-section.

MALES

In occlusal view the crown has an inward bent high crown with cutting edges at both sides, which divide the crown into an inner and outer part. The crown is as high as broad and slightly bending distally on lateral and posterior teeth. The outer margin of the crown is arched and the inner one more or less roundish to trapezoid shaped, and both margins join in mesial and distal marginal angles. The inner central ridge at the smooth inner face is poorly developed. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly concave outer part is smooth as well. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The holaulacorhizid root is more or less oval-shaped in cross-section, is oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina with sometimes one or two smaller ones at its outer part. Inner and outer foramina are absent, as well as root coating.

FEMALES

In occlusal view the crown has an inward bent high crown with cutting edges at both sides, which divide the crown into an inner and outer part. The crown is two third as high as broad, slightly bending distally on lateral and posterior teeth. The outer margin of the crown is arched and the inner one more or less roundish to trapezoid shaped, and both margins join in mesial and distal marginal angles. The inner central ridge at the smooth inner face is poorly developed or mostly even hardly perceptible. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly concave outer part is smooth as well at the lower region, but may present some poorly developed, irregular costules in the midsection. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The holaulacorhizid root is more or less oval-shaped in cross-section, is oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina with sometimes one or two smaller ones at its outer part. Inner and outer foramina are absent, as well as root coating.

Genus: *Dasyatis* RAFINESQUE, 1810

The genus comprises about 15 species. The type species is *D. pastinaca*.

Dasyatis pastinaca (LINNAEUS, 1758)
(Plates: 4 to 7; Textplates: 1 and 2)

Trygon pastinaca LINNAEUS, 1758. Systema Naturae, ed. X: p.396.

HETERODONTY

The dentition is gradient monognathic heterodont with lateral and posterior teeth becoming lower and bent toward the commissure.

Sexual heterodonty is presented by a high crown on anterior and antero-lateral teeth in males, versus a transverse keel across the crown in females. Ontogenetic heterodonty is present in male juveniles by having adult female tooth morphology.

VASCULARIZATION

Although the external morphology the teeth shows a holaulacorhizid root type, the pulp cavity is absent in the root area, but there is osteodentine instead. The vascular tubes of the orthodentine in the crown region radiate from the osteons into crown and root. Inner lateral foramina are absent.

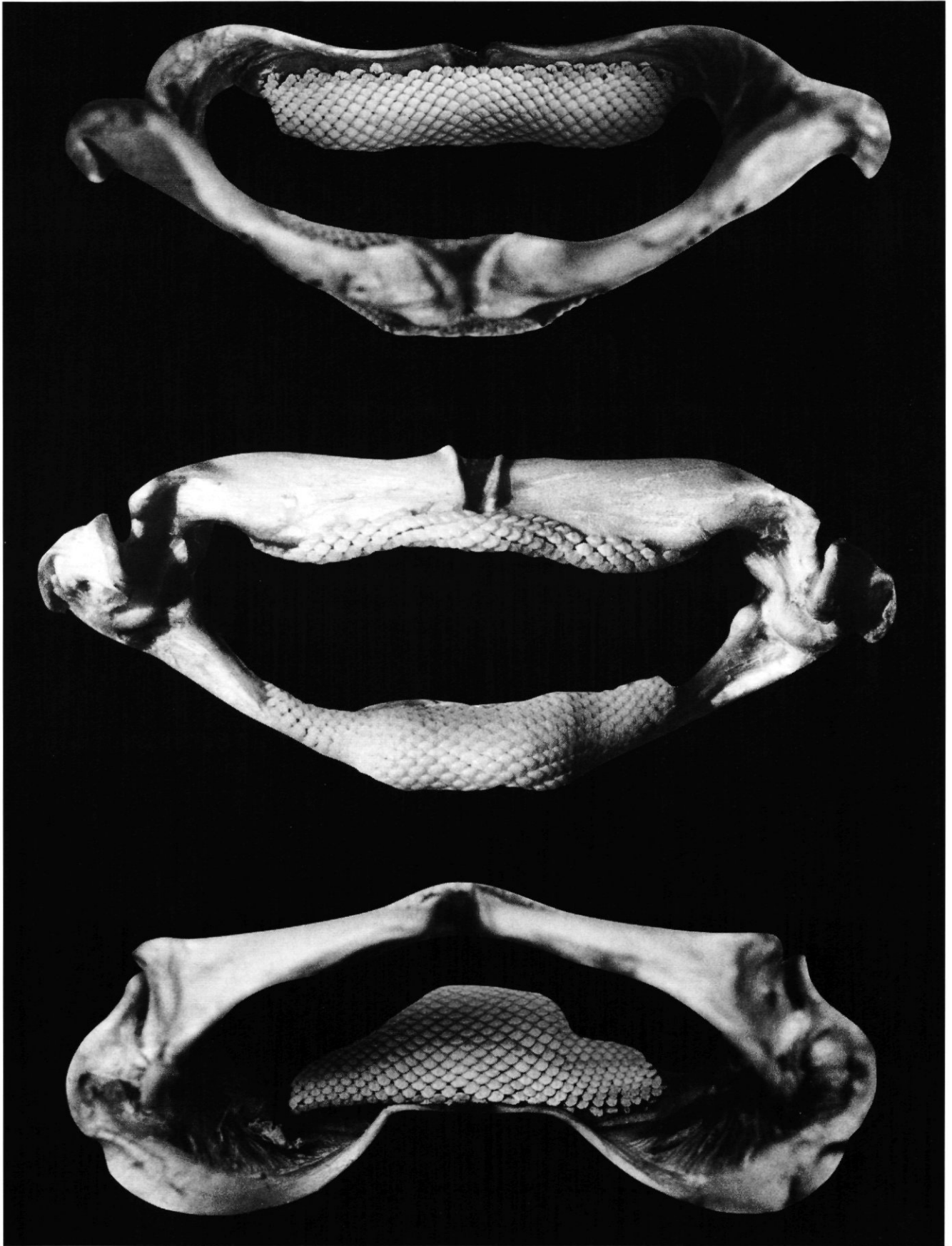
(See textfigure 2).

MALES

In occlusal view, the crown has an inward bent high crown with cutting edges at both sides, which divide the crown into an inner and outer part. The crown is higher than broad in anterior and lateral teeth, slightly bending distally and diminishing in height on lateral and transformed into a transverse keel in posterior teeth. The outer and inner margins of the crown are arched, and both margins join in blunt mesial and distal marginal angles. The inner central ridge at the smooth inner face is well developed. The lower mid-section and mesial and distal regions are slightly concave and slope toward the rounded



Textfigure 2.
Dasyatis pastinaca tooth histological cross-section.



Textplate 1. – *Dasyatis pastinaca* (LINNAEUS, 1758). Female 65 cm d.w., Eastern Scheldt, The Netherlands. Inner view of the upper dentition, outer view of the jaws and inner view of the lower dentition.



Textplate 2. – *Dasyatis pastinaca* (LINNAEUS, 1758). Male 46 cm d.w., La Rochelle, France. Occlusal view of the upper dentition, outer view of the jaws, occlusal view of the lower dentition and enlargement of the last one.

inner crown rim. The slightly concave outer part presents a well developed reticulated ornamentation, formed by small, deep depressions above the smooth rim, which become wider and shallower toward the smooth apex. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The holaulacorhizid narrow, moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina. Inner foramina are absent but an outer one may be present above the median groove. Root coating is absent

FEMALES

In occlusal view the crown shows a broadly, rounded transverse keel, that is slightly bent inward, dividing the crown into an inner and outer part. The outer margin of the crown is bluntly angled, the inner one is trapezoid shaped, and both margins join in sharp mesial and distal marginal angles. The inner central ridge at the smooth inner face is narrow. The lower mid-section and the mesial and distal regions are slightly concave and slope toward the rounded inner crown rim. The slightly convex outer part presents a well developed reticulated ornamentation, formed by small, deep depressions above the smooth rim, which become slightly wider and shallower close to the transverse keel. The basal view of the crown shows a rather, broad, relatively flat crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The holaulacorhizid, narrow and moderately high root is more or less oval to circular in cross-section, is oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina. Inner foramina are absent but an outer one may be present above the median groove. Root coating is absent.

Genus: *Himantura* MÜLLER & HENLE, 1837

This genus comprises at least 8 species. The type species is *H. uarnak*

Himantura uarnak (FORSKÅL, 1775)
(Plates: 8 and 9; Textplate: 4)

Raia uarnak FORSKÅL, 1775 *Descriptiones animalium, avium, amphibiorum, piscium, insectorum, vermium; quae in itinere orientali observavit. Molleri, Hauniaae*: p.18.

HETERODONTY

The dentition is gradient monognathic heterodont through low crowned teeth, that diminish in size toward the commissure. Although no males were available for examination, a weak sexual heterodonty may be assumed because of a smooth transverse keel in females, which is slightly pointed at the mid-section in males according to the illustration of a group of male teeth by BIGELOW & SCHROEDER (1948). Ontogenetic heterodonty may be given, in that juvenile males possess teeth with the usual tooth morphology remaining in large females.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broadly, elongated pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent.

(See textfigure 3)

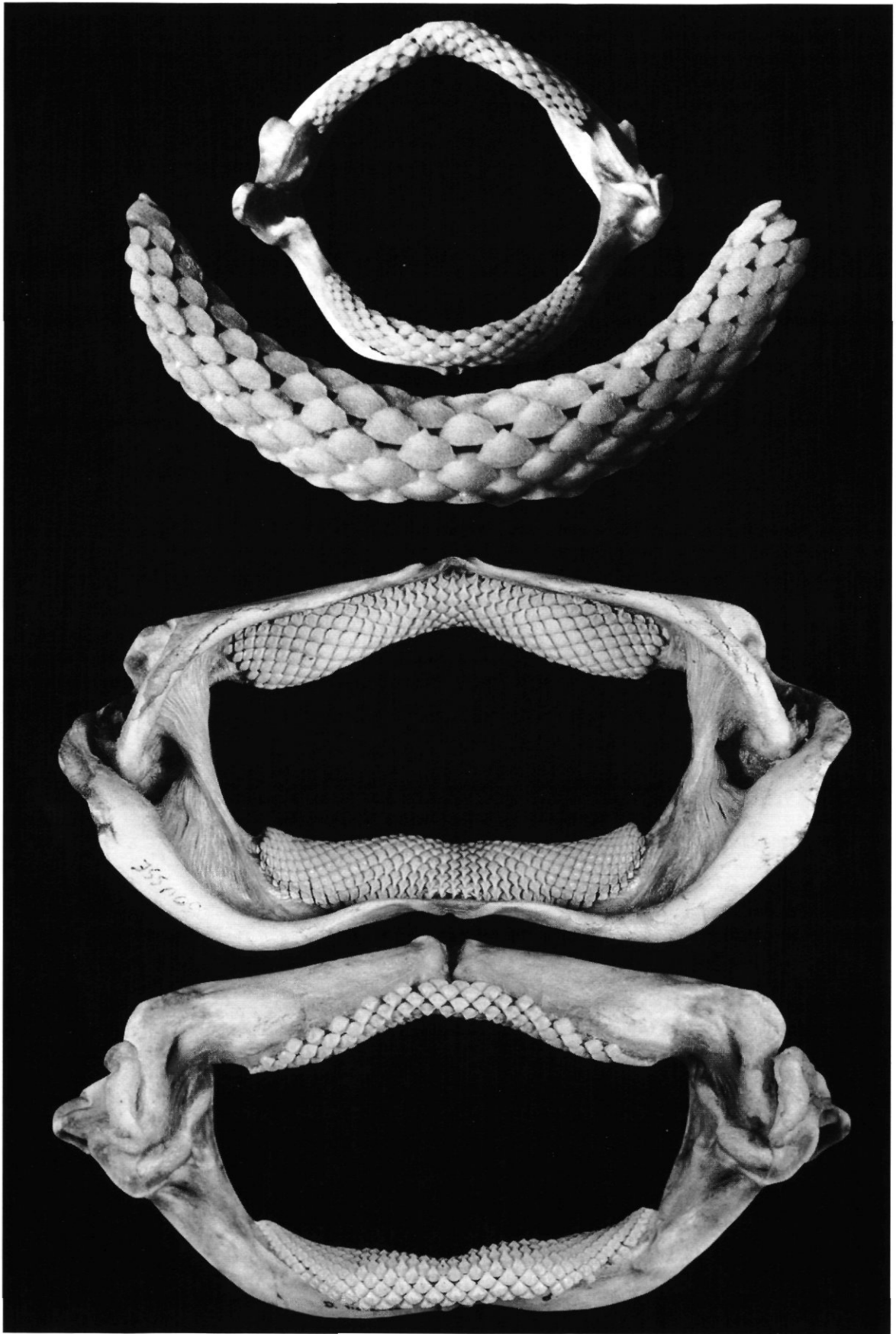
FEMALES

In occlusal view the crown has an inward bent low transverse keel, which is often flattened by abrasion. It divides the semi-oval shaped crown into an inner and outer part. The smooth inner face is concave, lacking an inner central ridge and slopes toward the rounded inner crown rim. The outer face is divided into an upper and lower depression, separated by a transverse ridge, running more or less parallel to the transverse keel. Inner and outer ornamentation is absent. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown. The mainly holaulacorhizid root is more or less oval in cross-section, slightly oblique toward the rear of the tooth, and slightly diverges at the root base (secondary hemiaulacorhizid and secondary anaulacorhizid is sometimes shown in lateral and posterior teeth). The root base presents a well developed, deep median groove, that encloses one large central foramina in holaulacorhizid teeth, which have no inner and outer foramina. Secondary hemiaulacorhizid and anaulacorhizid teeth present one or two outer foramina. Inner foramina as well as root coating are absent.

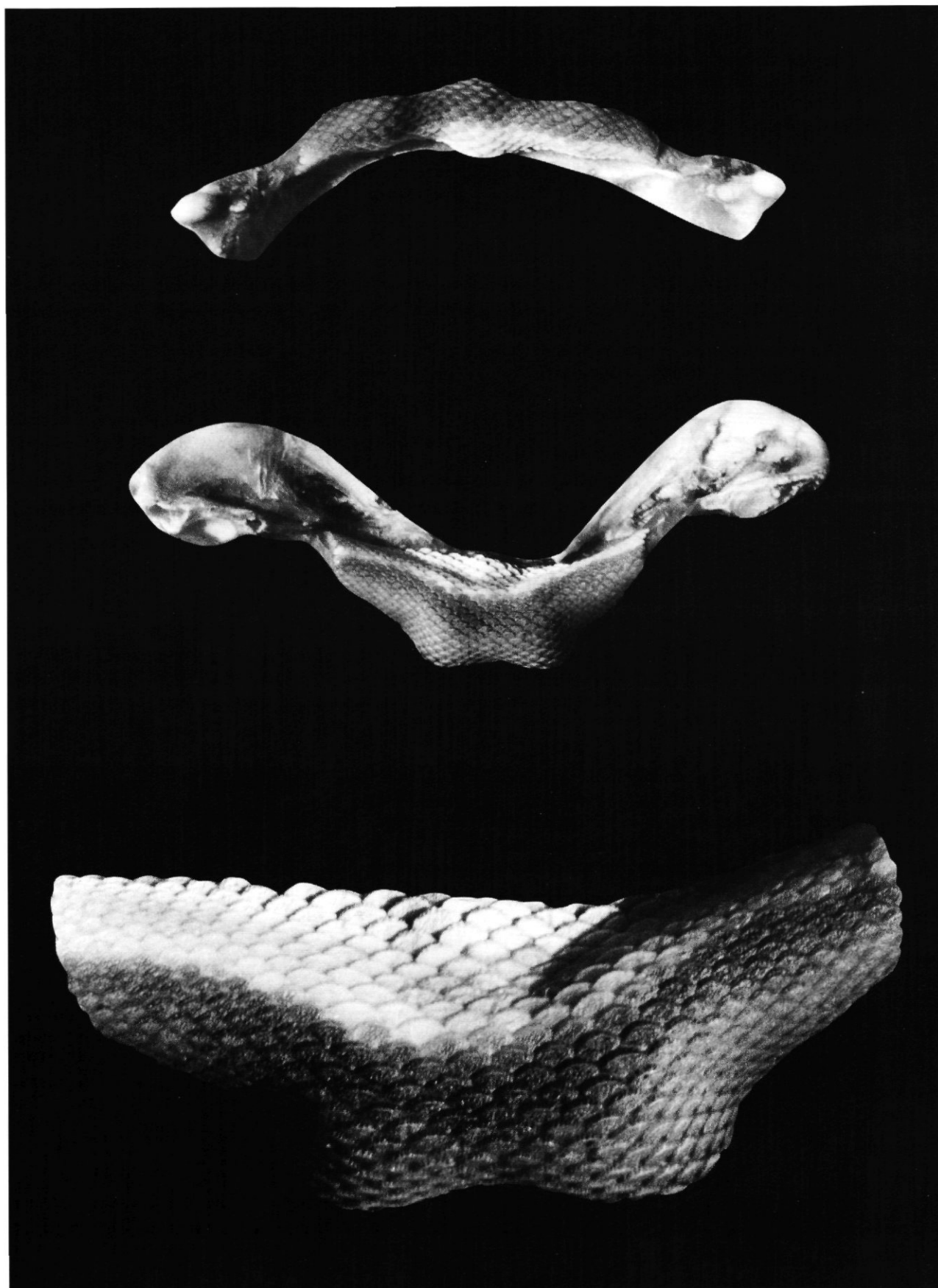


Textfigure 3.

Himantura uarnak tooth histological cross-section.



Textplate 3. – *Pteroplatytrygon violacea* (BONAPARTE, 1832). Female 106 cm t.l., Channel of Sicilia, Italia. Outer view of the jaws and occlusal view of the lower dentition. Male circa 75 cm d.w., Sousse fishmarket, Tunisia. Inner and outer views of the jaws.



Textplate 4. – *Himantura uarnak* (FORSKAL, 1775). Female 54 cm d.w., Djibouti. Occlusal views of the upper and the lower dentitions, enlargement of the last one.

Genus: *Pastinachus* RÜPPELL, 1828

As said in the introduction *Hypolophus* MÜLLER & HENLE, 1843 is considered as senior synonym of *Pastinachus*. The genus seems to be monotypic with *P. sephen*. The tooth morphology as well as the vascularization of the specimen (BMNH 1984 4.11:1) illustrated on Plate 13 do not correspond with those of *Pastinachus*. This plate has been added for its possible paleontological implications.

Pastinachus sephen (FORSKÅL, 1775)
(Plates: 10 to 12)

Raia sephen FORSKÅL, 1775 Descriptiones animalium, avium, amphibiorum, piscium, insectorum, vermium; quae in itinere orientali observavit. Molleri, Hauniae: p.17

HETERODONTY

The dentition is disjunct monognathic heterodont with low crowned mesial-distally narrow anterior teeth, becoming broad and larger sized in laterals, and diminish in size toward the commissure. In occlusal view the shape of the crown changes rather suddenly from rhomboid in anteriors to hexagonal in laterals and posteriors. Sexual heterodonty is absent. Ontogenetic heterodonty is presented by a relatively higher crown in adults.

VASCULARIZATION

Although, the external morphology of the teeth show a holaulacorhizid root type, the pulp cavity in the root area, as well as a large part of the orthodentine are absent, but there is osteodentine instead. Most of the osteons are vertically directed with some interconnections. The orthodentine dentine is only present along the enamel of the crown. Inner lateral foramina are absent.
(See textfigure 4)

MALES AND FEMALES

In occlusal view, the crown has an inwardly bent, low transverse keel, which is often flattened by abrasion. It divides the crown into an inner and outer part. The lateral and posterior teeth possess trapezoid shaped inner



Textfigure 4.
Pastinachus sephen tooth histological cross-section.

and outer margins, which gives the crown a hexagonal shape. Both margins are triangularly shaped in anterior teeth, giving the crown an rhomboid appearance. The smooth inner face is concave, lacking an inner central ridge and slopes toward the rounded inner crown rim. The outer face is divided into an upper and lower depression, separated by a relatively high transverse ridge running more or less parallel to the transverse keel. Inner ornamentation is absent, but the upper, outer depression presents a coarse, shallow, reticulated ornamentation. The lower, outer depression presents subvertical costules, that are well developed near the transverse ridge and weaken toward the crown rim. The basal view of the crown shows a rather, broad, slightly concave crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The high holaulacorhizid root is more or less oval in cross-section, lightly oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove. Inner and outer foramina as well as root coating are absent.

Genus: *Pteroplatytrygon* FOWLER, 1910

If valid this genus is monotypic with *P. violacea*.

Pteroplatytrygon violacea (BONAPARTE, 1832)
(Plates: 14 to 17; Textplate: 3)

Trygon violacea BONAPARTE, 1832 Icononografia della fauna itallica per le quattro classi degli animali vertebrati. Tomo III, Pesci: p.71.

HETERODONTY

The dentition is gradient monognathic heterodont through lowering and diminishing in size of the lateral and posterior teeth.

Sexual heterodonty is presented by a high crown on anterior and antero-lateral teeth in males, versus a transverse keel in females. Ontogenetic heterodonty is present by juvenile tooth morphology as in large females.

VASCULARIZATION

Although, the external tooth morphology shows a holaulacorhizid root type lacking a pulp cavity. Instead, there is osteodentine in the root area, which has taken over a large part of the orthodentine in the crown area as well. The orthodentine is only present along the enamel of the crown. Inner lateral foramina are absent.
(See textfigure 5)



Textfigure 5.
Pteroplatytrygon violacea tooth histological cross-section.

MALES

In occlusal view, the crown has an inwardly bent high crown with cutting edges at both sides, which divide the crown into an inner and outer part. The crown is about twice as high as broad in anterior and lateral teeth, slightly bending distally and rapidly diminishing in height to become a transverse keel on slightly broader lateral and diminishing in size toward the commissure. The outer margin of the crown is arched, the inner one is trapezoid, and both margins join in mesial and distal marginal angles. The inner central ridge is absent. The inner face is slightly concave and slopes toward the rounded inner crown rim. The slightly concave outer part presents a well developed reticulated ornamentation, formed by deep depressions above the smooth rim which become wider and shallower toward the smooth apex or transverse keel. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The holaulacorhizid narrow, moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep and broad median groove, that encloses one large aperture. Inner and outer foramina as well as root coating are absent.

FEMALES

In occlusal view the crown has an inwardly bent transverse keel, which divides the crown into an inner and outer part. The transverse keel of anterior teeth is pointed in the midsection, the lateral teeth become broader and diminish in size toward the commissure. The outer margin of the crown is arched, the inner one is trapezoid, and both margins join in mesial and distal marginal angles. The inner central ridge is absent. The inner face is slightly concave and slopes toward the rounded inner crown rim. The slightly concave outer part presents a well developed reticulated ornamentation, which is formed by deep depressions above the smooth rim, which become slightly shallower toward the transverse keel. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its

width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The holaulacorhizid narrow, moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep and broad median groove, that encloses one large aperture. Inner and outer foramina as well as root coating are absent.

Genus: *Taeniura* MÜLLER & HENLE, 1837

This genus comprises about 4 species. The type species is *Trygon ornatum* GRAY, 1832 synonym of *Raia lymma* FORSKAL, 1775. Because the teeth of *T. lymma* available for this study were so damaged by formol, teeth of *T. grabata* were used instead for descriptions and illustrations.

Taeniura grabata (E.GEOFFROY SAINT-HILAIRE, 1817) (Plates: 18 and 19; Textplate: 5)

Trygon grabatus E.GEOFFROY SAINT-HILAIRE, 1817. Histoire naturelle des poissons de la mer Rouge et de la Méditerranée. Commission d'Égypte. Atlas vol.1, pl. 25 fig.1,2.

HETERODONTY

The dentition is gradient monognathic heterodont through low crowned teeth, that diminish in size toward the commissure. Sexual heterodonty is absent. Ontogenetic heterodonty may be presented by a lesser developed outer ornamentation at the crown.

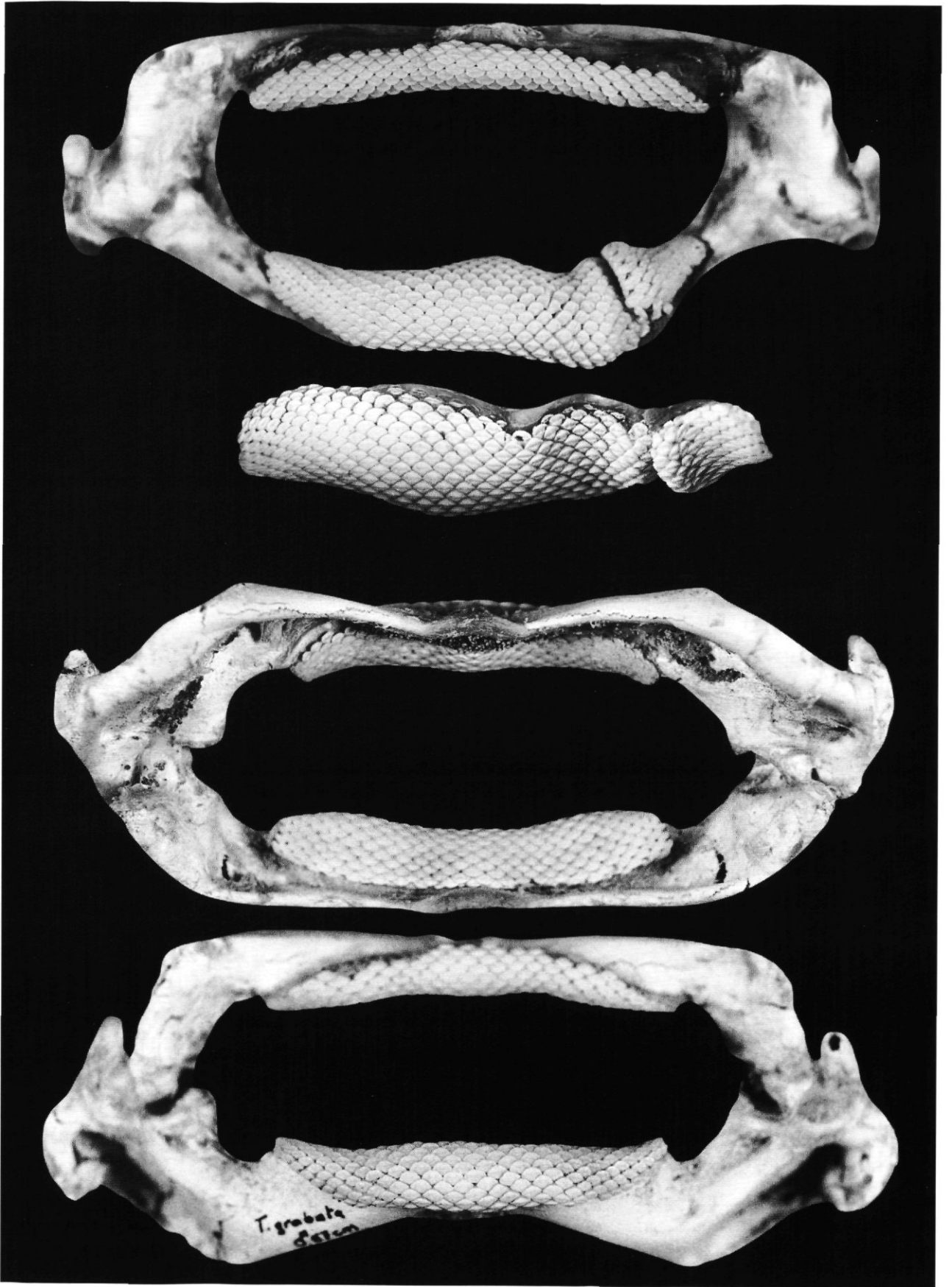
VASCULARIZATION

Although, the outer morphology the teeth show a holaulacorhizid root type, the pulp cavity is absent. Instead, there is osteodentine in the root area, which has taken over a large part of the orthodentine as well. The orthodentine is only present along the enamel of the crown. Inner lateral foramina are absent.

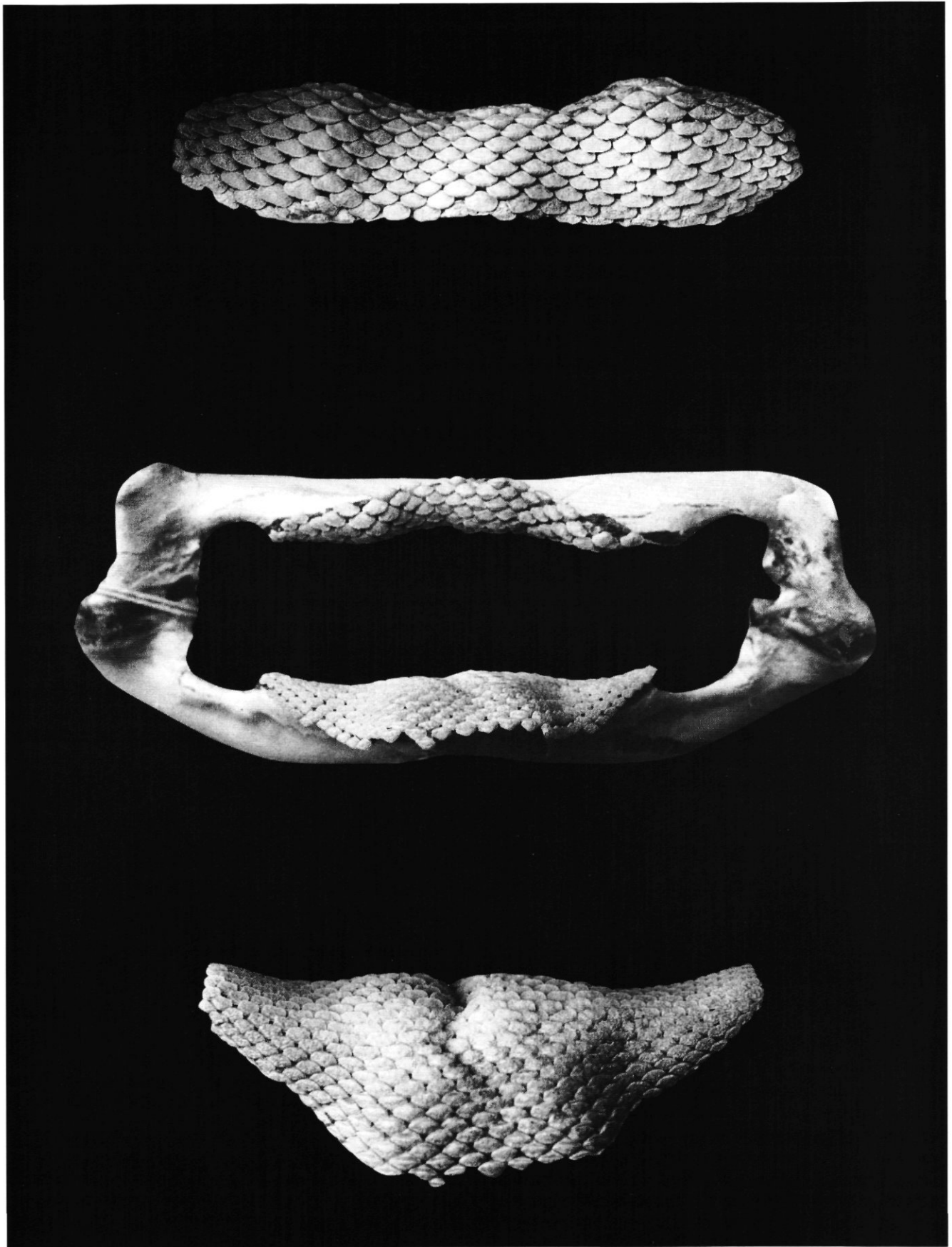
(See textfigure 6)



Textfigure 6.
Taeniura grabata tooth histological cross-section.



Textplate 5. – *Taeniura grabata* (GEOFFROY SAINT-HILAIRE, 1809). Female 158 cm t.l., Gorea Island, Senegal. Outer view of the jaws and occlusal view of the traumatic lower dentition.
Male 57 cm d.w., off Dakkar, Senegal. Inner and outer views of the jaws.



Textplate 6. — *Urogymnus asperrimus* (BLOCH & SCHNEIDER, 1801). Female 92 cm d.w., Panian Islands, Ponape. Occlusal view of the upper dentition, outer view of the jaws, inner and occlusal views of the lower dentition.

MALES AND FEMALES

In occlusal view, the crown has a broad, almost straight, rounded transverse keel, dividing the crown into an inner and outer part. The outer margin of the crown is less arched than the inner one, and both margins join in sharp mesial and distal marginal angles. The inner central ridge is absent and the slightly convex inner surface exhibits an ornamentation along the transverse keel, which consists of coarse irregular costules. The outer surface possesses a deep depression along the transverse keel with some poorly developed costules near the transverse keel and in the depression and with a well developed reticulated ornamentation at the outer margin. The basal view of the crown shows a rather, broad, relatively flat crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a rather deep depression in the center of the basal surface of the crown.

The holaulacorhizid narrow, moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses two or three central foramina. Inner and outer foramina, as well as root coating are absent.

Genus: *Urogymnus* MÜLLER & HENLE, 1837
(Plates: 20 to 23; Textplate: 6)

The genus is monotypic with *U. asperrimus*.

Urogymnus asperrimus (BLOCH & SCHNEIDER, 1801)

Raia asperrima BLOCH & SCHNEIDER, 1801 M.E. Blochii Systema ichthyologiae iconibus ex illustratum. Post orbitum auctoris opus inchnatum absolvit, correxit, interpolavit: p.367

HETERODONTY

The jaws of this species underwent extraordinary development, in that they became mildly undulated. This has resulted in a large upper symphyisial protrusion and a less developed lateral one of each upper jaw half. The lower jaw halves have therefore, an indentation at the corresponding positions allowing exact interlocking of both jaws. Heterodonty is distinctive, in that upper jaw teeth are broader on top of the symphyisial and lateral protrusions but narrower down their sides and in the intermediate depressions, as well as toward the commissure. The opposite phenomenon is presented in the lower jaw, which shows narrower teeth at the symphyisial and both lateral depressions but wider teeth in the intermediate protrusions and toward the commissure. Although only jaws of females were available for examination sexual heterodonty seems not to be present. Ontogenetic heterodonty is presented by the lack of or less developed ornamentation in juveniles.



Textfigure 7.

Urogymnus asperrimus tooth histological cross-section.

VASCULARIZATION

Although, the outer morphology of the teeth shows a holaulacorhizid root type a pulp cavity is absent. Solid osteodentine is present in both the root and crown areas. Small patches of orthodentine are only present along the enamel of the crown. Inner lateral foramina are absent. (See textfigure 7)

MALES AND FEMALES

In occlusal view the crown has a broad, almost straight, rounded transverse keel, dividing the crown into an inner and outer part. The outer margin of the crown is less arched than the inner one, and both margins join in sharp mesial and distal marginal angles. The inner central ridge is absent and the slightly convex inner surface exhibits an ornamentation along the transverse keel, which consists of coarse irregular costules. The outer surface possesses a deep depression along the transverse keel with some poorly developed costules near the transverse keel and in the depression with a well developed reticulated ornamentation at the outer margins. The basal view of the crown shows a rather, broad, relatively flat crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a rather deep depression in the center of the basal surface of the crown. The holaulacorhizid narrow, moderately high root is more or less oval to circular in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses numerous foramina, that are scattered on the outer part of the root depression as well. Inner and outer foramina, as well as root coating are absent.

Genus: *Urolophoides* SOLDATOV & LINDBERG, 1930

The genus probably comprises at least three species. Tooth materials of the type species *U. giganteus* were not available for examination. *U. matsubarai* was used instead for description and illustration.

Urolophoides matsubarai (MIYOSI, 1939)
(Plates: 24 and 25)

Dasyatis matsubarai Miyosi, 1939. Description of three new species of elasmobranchiate fishes collected at Hyuga Nada, Japan. Bulletin of the Biogeographic Society of Japan 9(5): 91-97



Textfigure 8.
Urolophoides matsubarai tooth histological cross-section.

HETERODONTY

The dentition is gradient monognathic heterodont, with lateral and posterior teeth lowering toward the commissure.

Lacking reference material of juveniles and full grown males, ontogenetic nor sexual heterodonty could be determined.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broad pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent.

(See textfigure 8)

MALES AND FEMALES

In occlusal view, the crown is mesio-distally broad and exhibits an inwardly bent, relatively high transverse keel, which is often flattened by abrasion. It divides the crown into an inner and outer part. The outer and inner margins of the crown are more or less equally arched, and both margins join in sharp mesial and distal marginal angles. The smooth inner face is concave with a weak undulation, lacks an inner central ridge and slopes toward the rounded inner crown rim. The outer face is divided into an upper and lower depression, separated by an outwardly bent, low transverse ridge. Inner ornamentation is absent, but both depressions of the outer face present a coarse, relatively deep, reticulated ornamentation, with a fine second knob-like ornamentation in between. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The high holaulacorhizid root is more or less oval in cross-section, slightly oblique toward the rear of the tooth, and diverges at the root base. The root base presents a well developed, deep median groove. Inner and outer foramina as well as root coating are absent.

Superfamily: Pleisiobatoidea - Family: Hexatrygonidae

Introduction

The Superfamily Pleisiobatoidea comprises after NELSON (1994) the families Plesiobatidae and Hexatrygonidae. This issue deals with the monotypic family Hexatrygonidae (type species: *H. bickelii*).

Material

The following 6 specimen of 4 species were examined for this issue:

Hexatrygon brevirostris
NTUM 6597 ♀ 621 mm TL

Hexatrygon longirostris
MTUF 23715 ♂ 907 mm TL
MTUF 26699 ♂ 655 mm TL.
MTUF 26700 ♀ 712 mm TL.

Hexatrygon taiwanensis
NTUM 6505 ♀ 582 mm TL

Hexatrygon yangi
NTUM 6100 ♂ 1040 mm TL

Description of the odontological characters

Genus: *Hexatrygon* HEEMSTRA & SMITH, 1980

The genus *Hexatrygon* comprises (according to NELSON, 1994) the type species *H. bickelii* and four additional nominal species, of which the validity of which is still uncertain. These species are *H. brevirostris*, *H. longirostris*, *H. taiwanensis* and *H. yangi*. Tooth samples of the type species were not available for examination, and therefore, samples of *H. longirostris* were used instead.

Hexatrygon longirostris (CHU & MENG, 1981)
(Plates: 31 to 33)

Hexatremobatis longirostrum CHU & MENG, 1981.
Oceanologia Limnol. Sinica 12(2):p.111

HETERODONTY

The dentition is gradient monognathic heterodont with slightly broader lateral teeth and narrowing toward the commissure.

Sexual and ontogenetic heterodonty is absent.



Textfigure 9.
Hexatrygon longirostris tooth histological cross-section.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broad pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent.

(See textfigure 9)

MALES AND FEMALES

In occlusal view the crown has an inward bent low transverse keel, which is often flattened by abrasion. It divides the crown into an inner and outer part. The outer margin of the crown is arched and the inner one more or less trapezoid shaped, and both margins join in mesial and distal marginal angles. The smooth inner face presents a low inner central ridge. The lower mid-section and the mesial and distal regions are concave and slope toward the rounded inner crown rim. The slightly concave outer part is smooth as well, but presents some coarse basal depressions. The basal view of the crown shows a rather, broad, slightly convex crown rim at the outer part, gradually narrowing to half its width at the inner part. The crown-root junction lies in a shallow depression in the center of the basal surface of the crown.

The holaulacorhizid root is more or less oval in cross-section, oblique toward the rear of the tooth, and slightly diverges at the root base. The root base presents a well developed, deep median groove, that encloses one or two central foramina with sometimes one or two smaller ones at its outer part. Inner and outer foramina are absent, as well as root coating.

Superfamily: Myliobatoidea - Family: Gymnuridae

Introduction

This family comprises the two genera, *Aetoplatea* and *Gymnura*.

Material

The following 5 specimen of 2 species were examined for this issue:

Aetoplatea tentaculata
ISH 14-1961

♀ 212 mm TL

Gymnura altavela

ISH 163-1965

ISH 162-1965

ISH 1618-1966

Coll.Herman

♂ 261 mm TL

♀ 277 mm TL

♀ 1470 mm TL

♀ 1600 mm TL

Description of the odontological characters

Genus: *Aetoplatea* VALENCIENNES in MÜLLER & HENLE, 1839

This genus comprises after NELSON (1994) two species. The type species is *A. tentaculata*.

Aetoplatea tentaculata VALENCIENNES, 1839
(Plates: 26 and 27)

Aetoplatea tentaculata VALENCIENNES, 1839 In: Systematische Beschreibung der Plagiostomen MÜLLER & HENLE: p.175.

HETERODONTY

The dentition is gradient monognathic heterodont through slightly narrowing teeth toward the commissure. Lacking male reference material, sexual heterodonty could not be determined but is almost certainly absent. Lacking reference material of full grown specimens, ontogenetic heterodonty could not be determined but is almost certainly absent as well.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broad, elongated pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was not observed, and inner lateral foramina are absent. (See textfigure 10)

FEMALES AND MALES

The crown base has a concavely arched outer margin and a convexly arched inner margin in occlusal view. Inner and outer faces are divided by mesial and distal cutting



Textfigure 10.
Aetoplatea tentaculata tooth histological cross-section.

edges, which are bending from their origin to run almost horizontal over half their length and suddenly rise upward to terminate at the apex. The crown is as broad as high. Apron and ornamentation on the crown, as well as inner and outer ornamentation are absent. The inner surface is convex at the mid-section and concave at mesial and distal regions. The outer surface is strongly concave. The outer part of the crown overhangs the root and exhibits lappet-shaped mesial and distal extensions at the base, that are strongly bent outward. The outer crown base is slightly arched.

The holaulacorhizid root is short and broad, with a likewise broad, moderately deep median groove at the basal face, that encloses a central aperture. Inner foramina are absent, but one or two outer foramina may be present below the crown-root junction, at both sides or above the median groove. Root coating is present in the upper region near the crown-root junction on inner and outer faces.

Genus: *Gymnura* VAN HASSELT, 1823

The genus comprises about 6 species. The type species is *G. altavela*.

Gymnura altavela (LINNAEUS, 1758)
(Plates: 28 to 30)

Raia altavela LINNAEUS, 1758 Systema Naturae, ed. X: p.232.

HETERODONTY

The dentition is gradient monognathic heterodont through slightly broader lateral teeth, as compared with the narrow anterior ones, narrowing and becoming oblique toward the commissure. Sexual heterodonty and ontogenetic heterodonty are absent.

VASCULARIZATION

The teeth show an adapted, holaulacorhizid root type with a broadly, elongated pulp cavity in the root area, from which the vascular tubes of the circumpulpar dentine radiate into crown and root. Osteodentine was



Textfigure 11.
Gymnura altavela tooth histological cross-section.

not observed, and inner lateral foramina are absent. (See textfigure 11)

FEMALES AND MALES

The crown base shows a concavely arched outer margin and a convexly arched inner margin in occlusal view. Inner and outer faces are divided by mesial and distal cutting edges, which from their origin converge upward to terminate at the apex in an almost straight line. The crown is more or less triangular, being slightly higher than wide. Apron and ornamentation, as well as inner and outer ornamentation are absent. The inner surface is convex at the mid-section and concave at mesial and distal regions, the outer surface is strongly concave. The outer part of the crown overhangs the root and exhibit lappet-shaped mesial and distal extensions at the base, that are strongly bent outward. The outer crown base is strongly arched.

The root is relatively high with a moderately deep median groove at the basal face, that encloses a central aperture. Sometimes, the holaulacorhizid root type is modified to become secondary anaulacorhizid in posterior teeth. Inner foramina are absent, but one or two outer foramina may be present below the crown-root junction at both sides or above the median groove. Root coating is present in the upper region near the crown-root junction on inner and outer faces.

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General glossary

(applying to all previous issues of this series).

CONCERNING THE JAW

Anterior

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

Commissural

Tooth position near the end of jaw.

Dignathic

Heterodont by having different tooth morphology in upper and lower jaws.

File

Tooth row from symphysis toward end of jaw.

Heterodonty

Different tooth morphology within a tooth file. There are two types of heterodonty: dignathic and monognathic.

Homodonty

Uniform tooth morphology within a tooth file

Lateral

Tooth positions half way along the jaw.

Longitudinal

Symphysial/commissural direction of a tooth 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 jaws.

Pseudosymphysial

One of the parasymphysial tooth rows placed in the position of the symphysial tooth row (symmetry).

- Row**
Tooth row from inner face to outer face of jaw.
- Symphysial**
Teeth at junction of both halves of a jaw.
- Transverse**
Outer/inner direction of a row.
- CONCERNING THE TOOTH**
- An-,Hemi-,Hol- and Polyaulacorhizid**
Concerning their vascularization, E.Casier(1947) recognized and described four 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.
- Inner central ridge**
Convex protrusion at the upper midsection of the inner crown face.
- 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.
- 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 canaliculi.
- Root**
Non-enamelated tooth part, that forms the junction with the jaw gum and provides vascularization of the tooth.
- Root coating**
Coating on the upper part of the root (probably enameliod)
- Root stem**
Root part between the crown base and root lobe section.
- Secondary 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, converting the median groove to an internal tube, which is merged with the pulp cavity.

Striae

Vertical ridges running from crown base toward apex.

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.

Transverse

Mesio-distally directed.

Transverse keel

Transverse ridge dividing the crown into inner and outer face.

Uvula

Lobate extension of the inner crown base.

Composition of the plates

As far as possible plates of isolated teeth of one juvenile (male or female) and of both male and female adults are presented for each supraspecific taxon.

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.

Legend:

- a** = anterior position
- la** = latero-anterior
- l** = lateral position
- lp** = Latero-posterior
- p** = posterior position
- c** = commissural position

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Plate 1. — *Amphotistius kuhlii* (MULLER & HENLE, 1841). Female 28.5 cm t.l., off South West Bali. Upper and lower teeth.

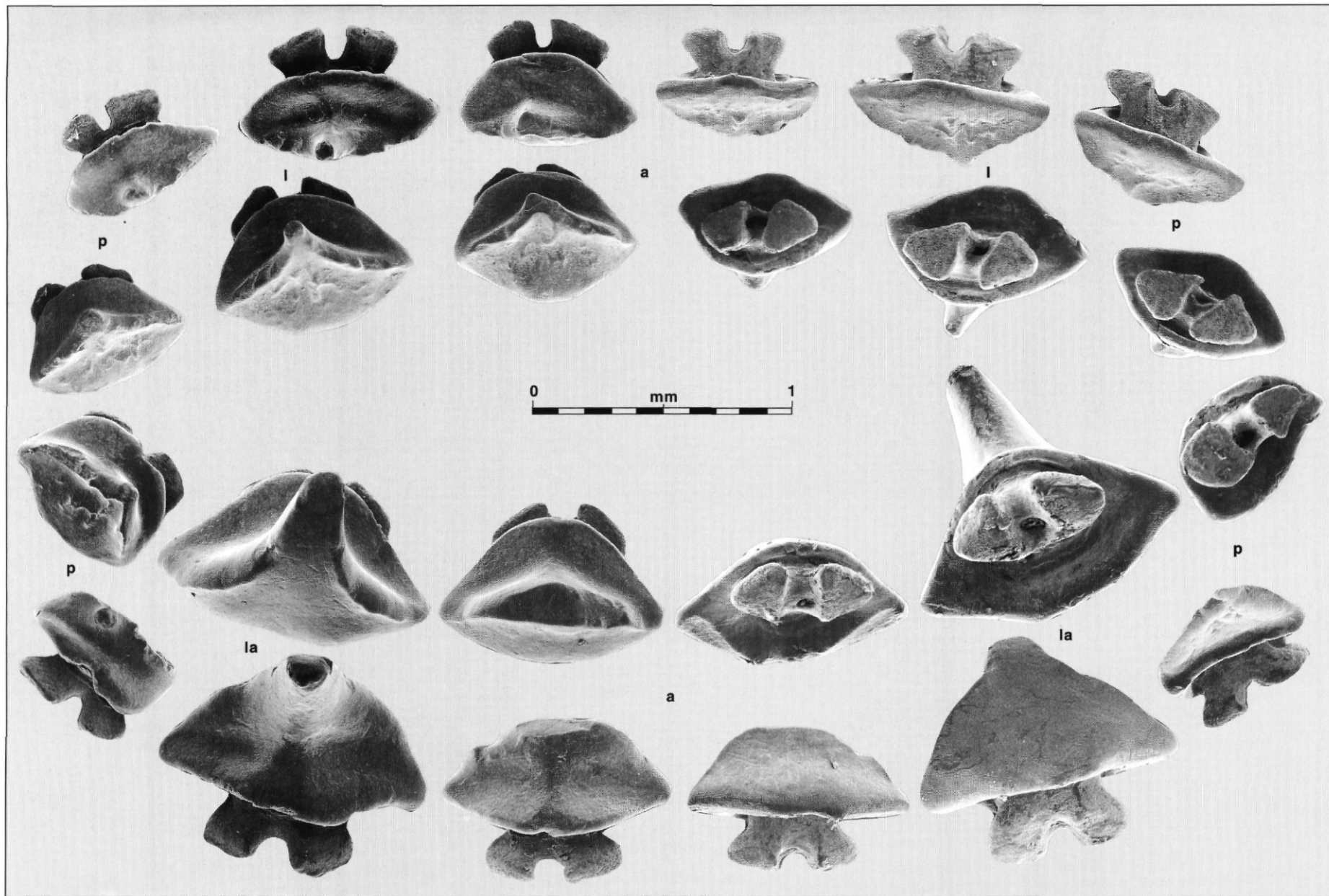


Plate 2. — *Amphotistius kuhlii* (MULLER & HENLE, 1841). Female 49.5 cm t.l., Gulf of Thailand. Upper and lower teeth.

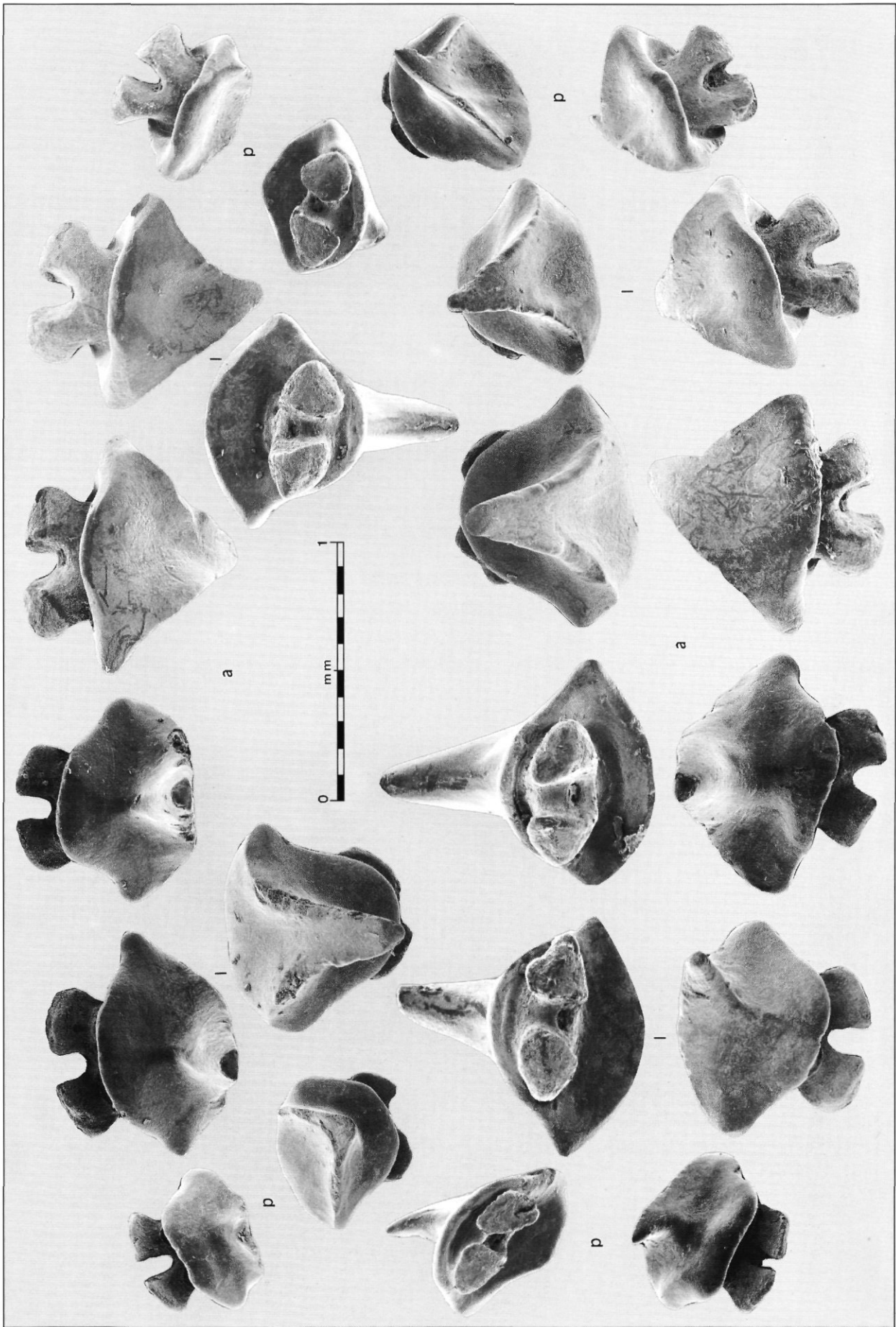


Plate 3. - *Amphiphotistius kuhlji* (MULLER & HENLE, 1841). Male 50.5 cm t.l., Gulf of Thailand. Upper and lower teeth.



Plate 4. – *Dasyatis pastinaca* (LINNAEUS, 1758). Female 80 cm d.w., Eastern Scheldt, southern North Sea. Upper teeth.

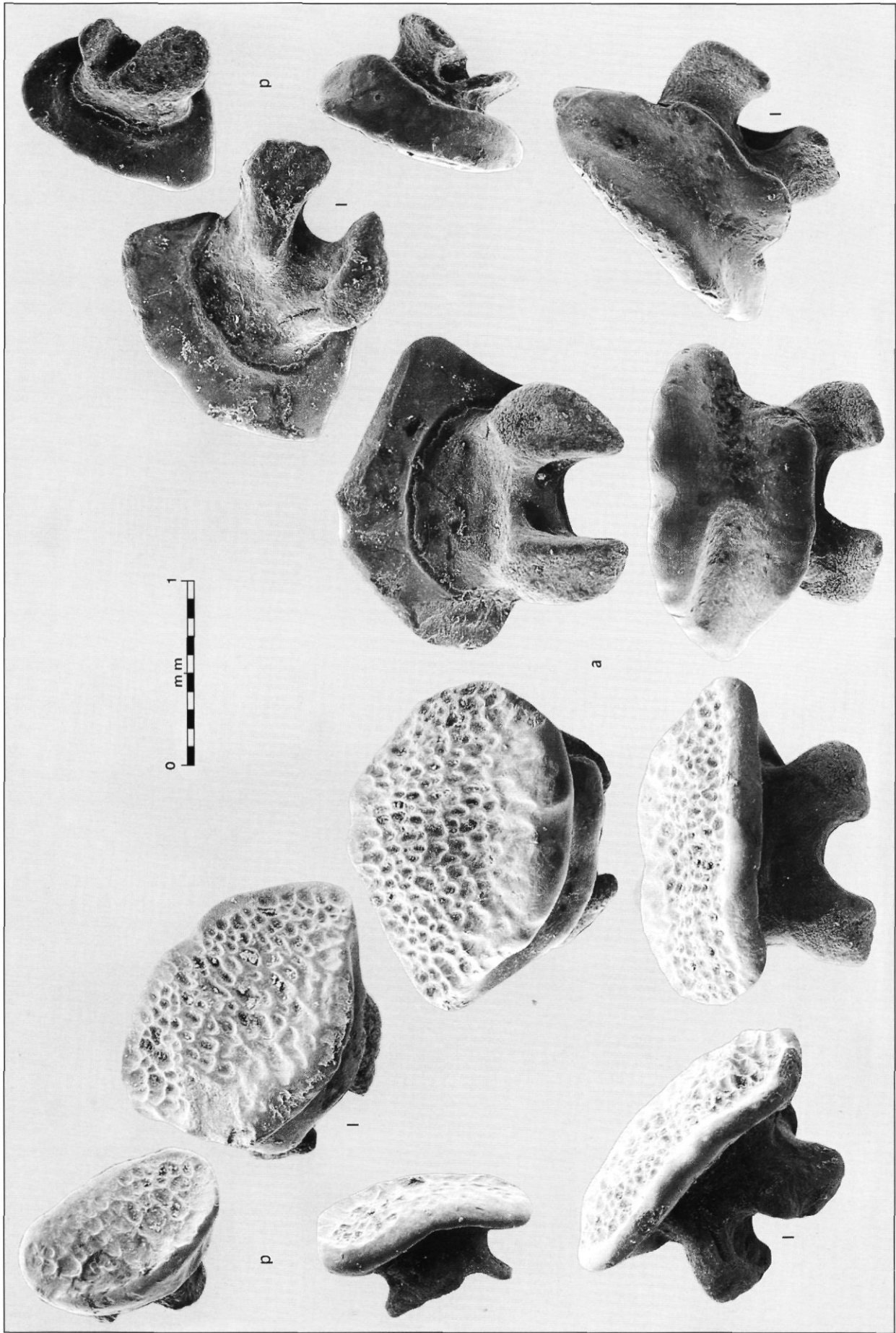


Plate 5. — *Dasyatis pastinaca* (LINNAEUS, 1758). Female 80 cm d.w., Eastern Scheldt, southern North Sea. Lower teeth.

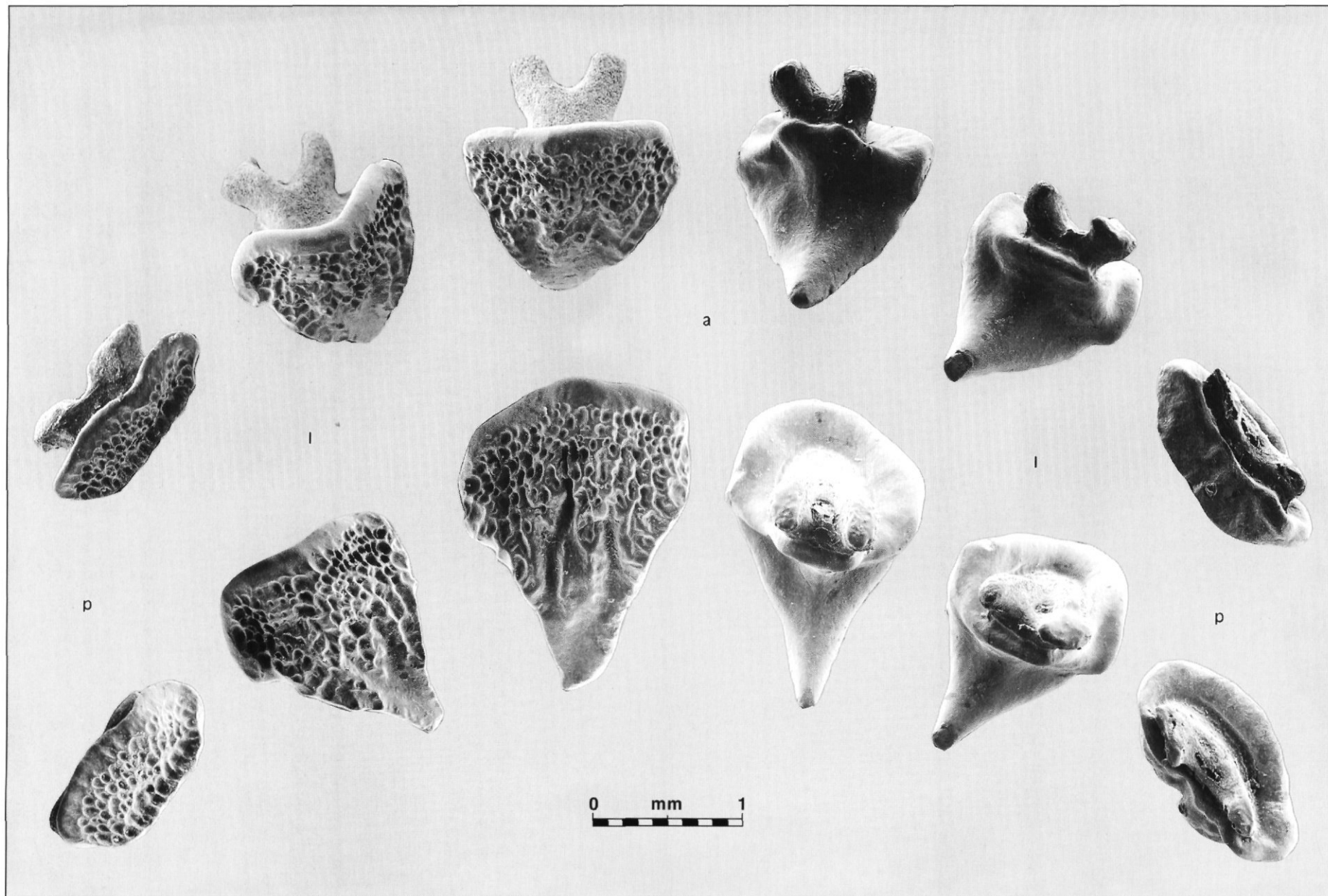


Plate 6. – *Dasyatis pastinaca* (LINNAEUS, 1758). Male 54 cm d.w., Eastern Scheldt, southern North Sea. Upper teeth.

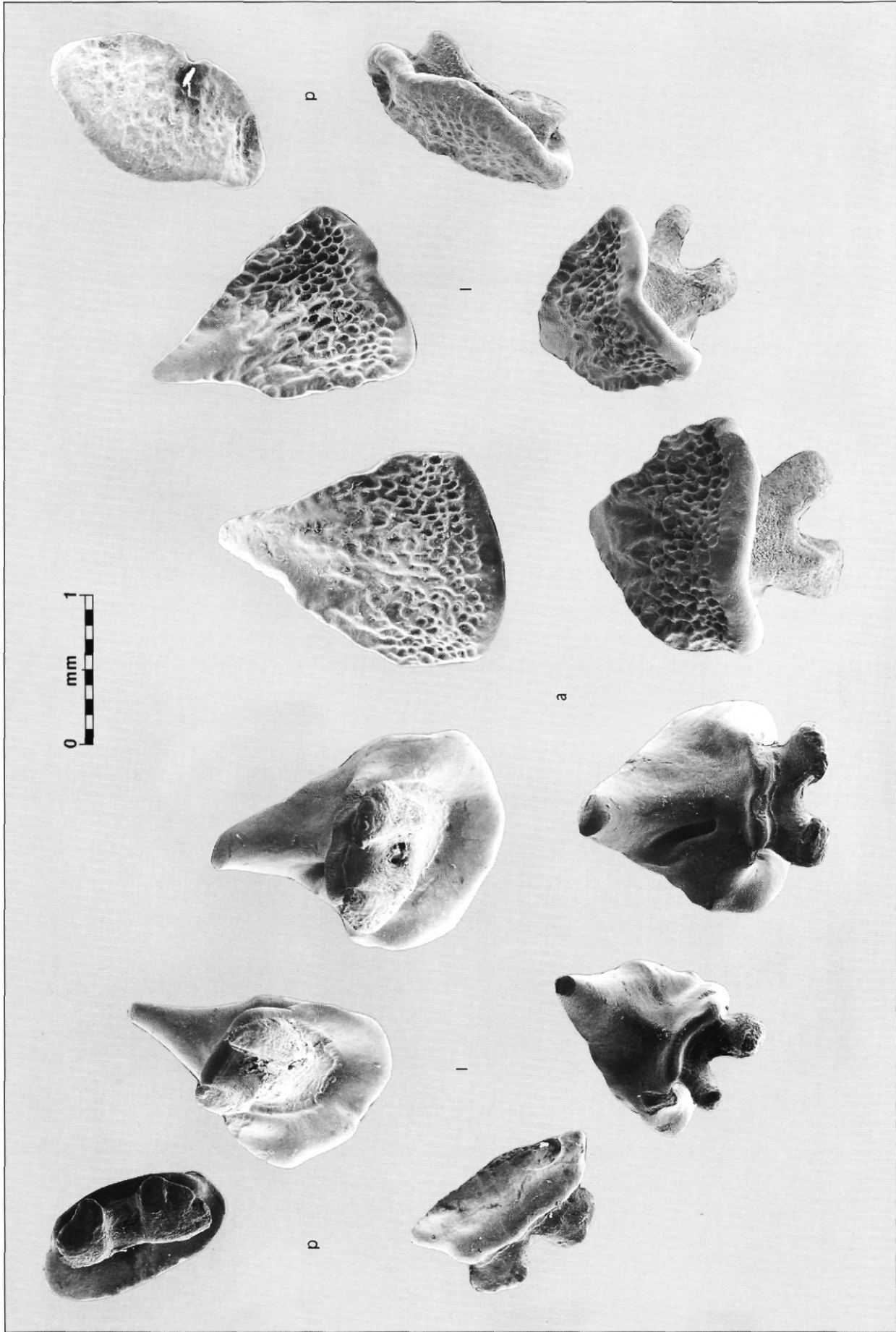


Plate 7. — *Dasyatis pastinaca* (LINNAEUS, 1758). Male 54 cm d.w., Eastern Scheldt, southern North Sea. Lower teeth.



Plate 8. – *Himantura uarnak* (FORSKAL, 1775). Female 113 cm t.l., Gulf of Thailand. Upper teeth.



Plate 9. - *Himantura uarnak* (FORSKAL, 1775). Female 113 cm t.l., Gulf of Thailand. Lower teeth.

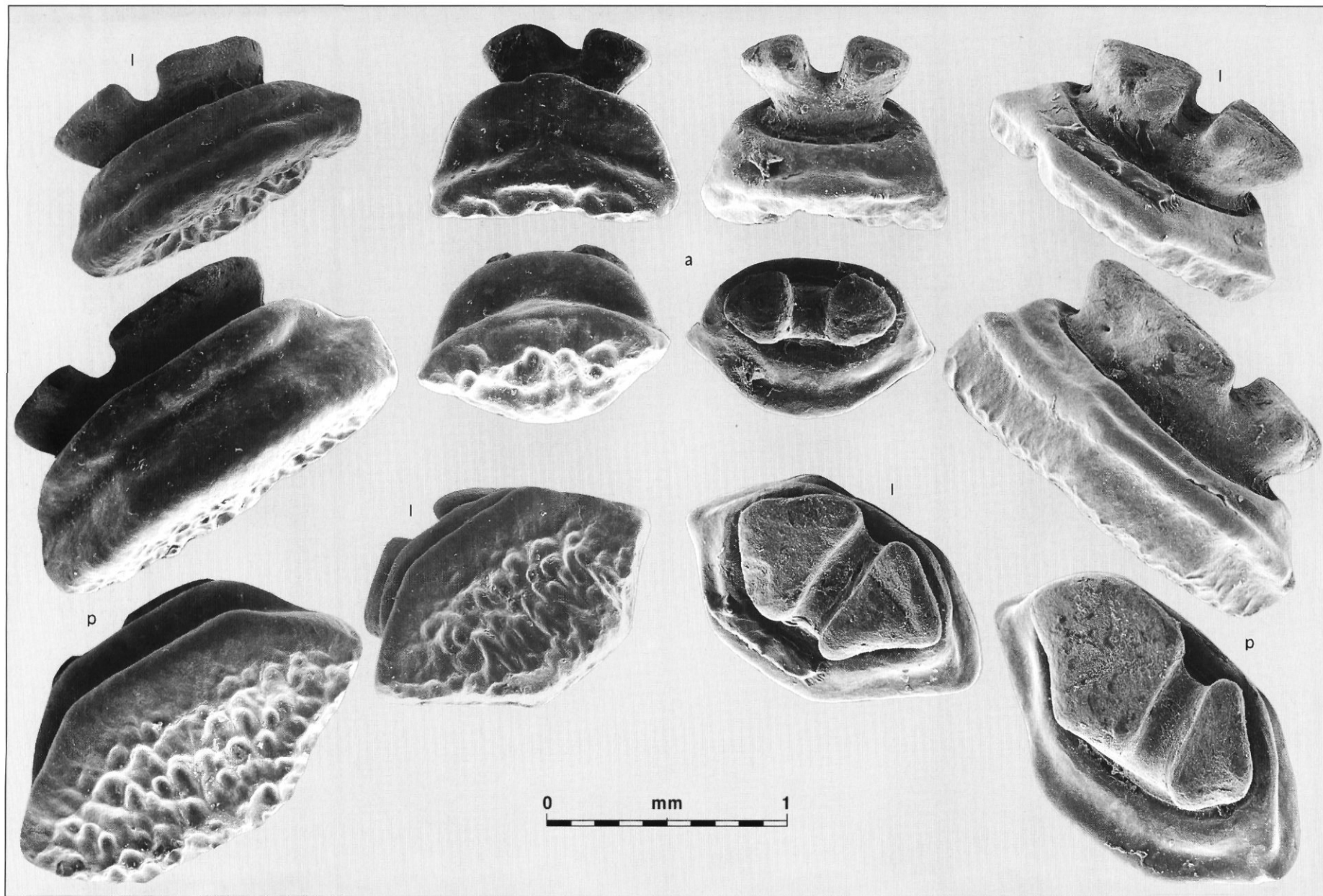


Plate 10. — *Pastinachus sephen* (FORSKAL, 1775). Male 38 cm t.l., Indian Ocean. Upper teeth.

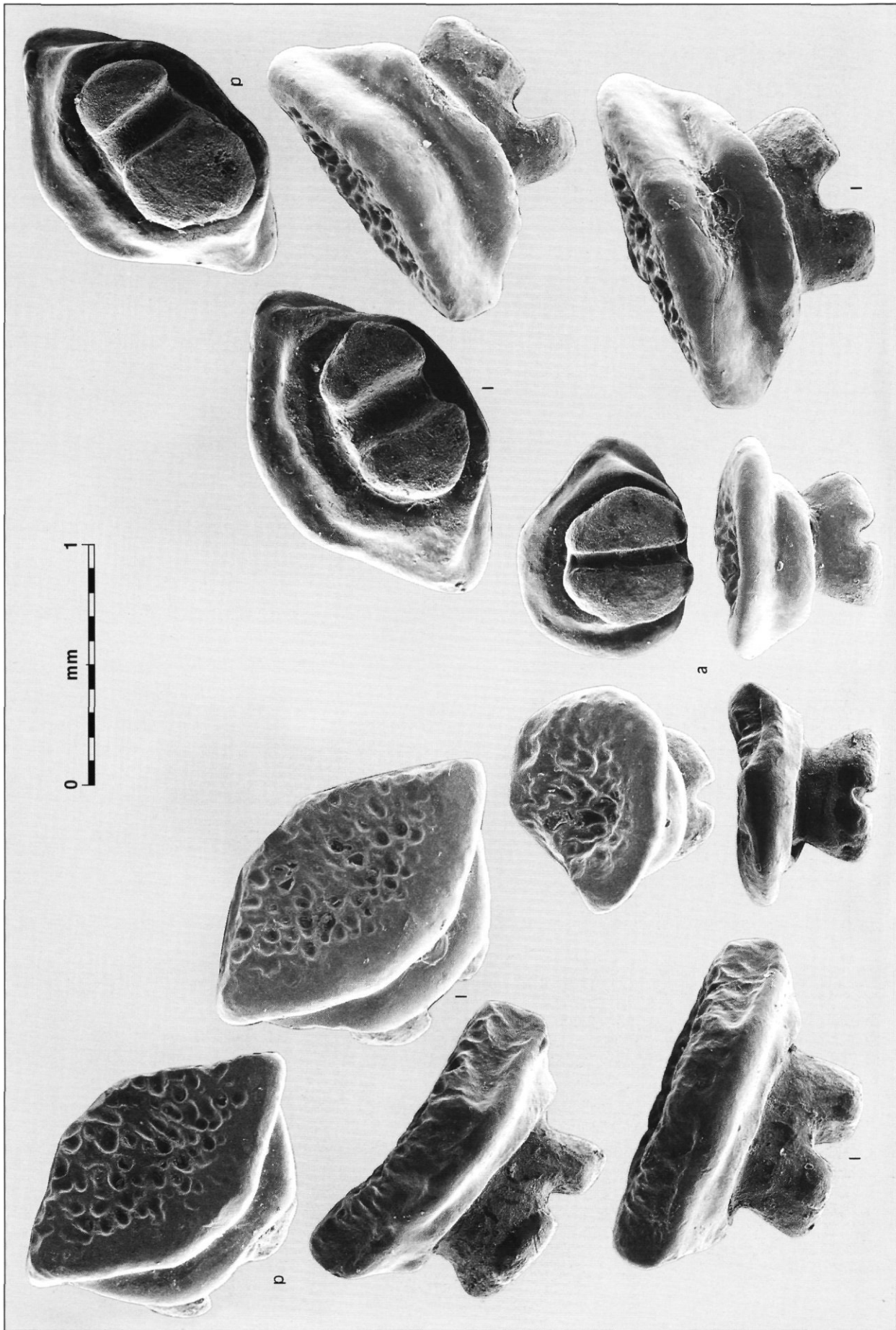


Plate 11. - *Pastinachus sephen* (FORSKAL, 1775). Male 38 cm t.l., Indian Ocean. Lower teeth.

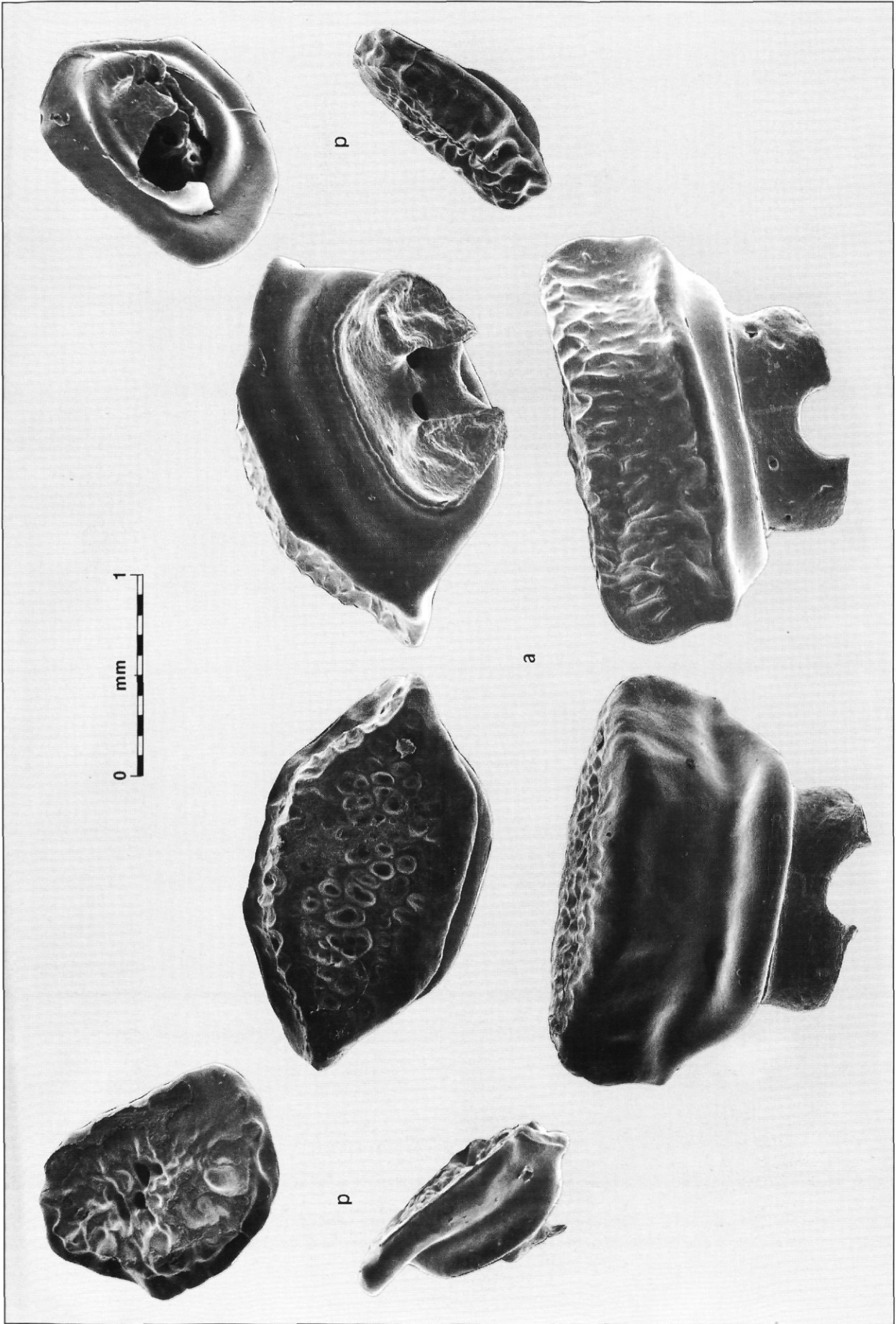


Plate 12. - *Pastinachus sephen* (FORSKAL, 1775). Female 101.5 cm t.l., Indian Ocean. Lower teeth.

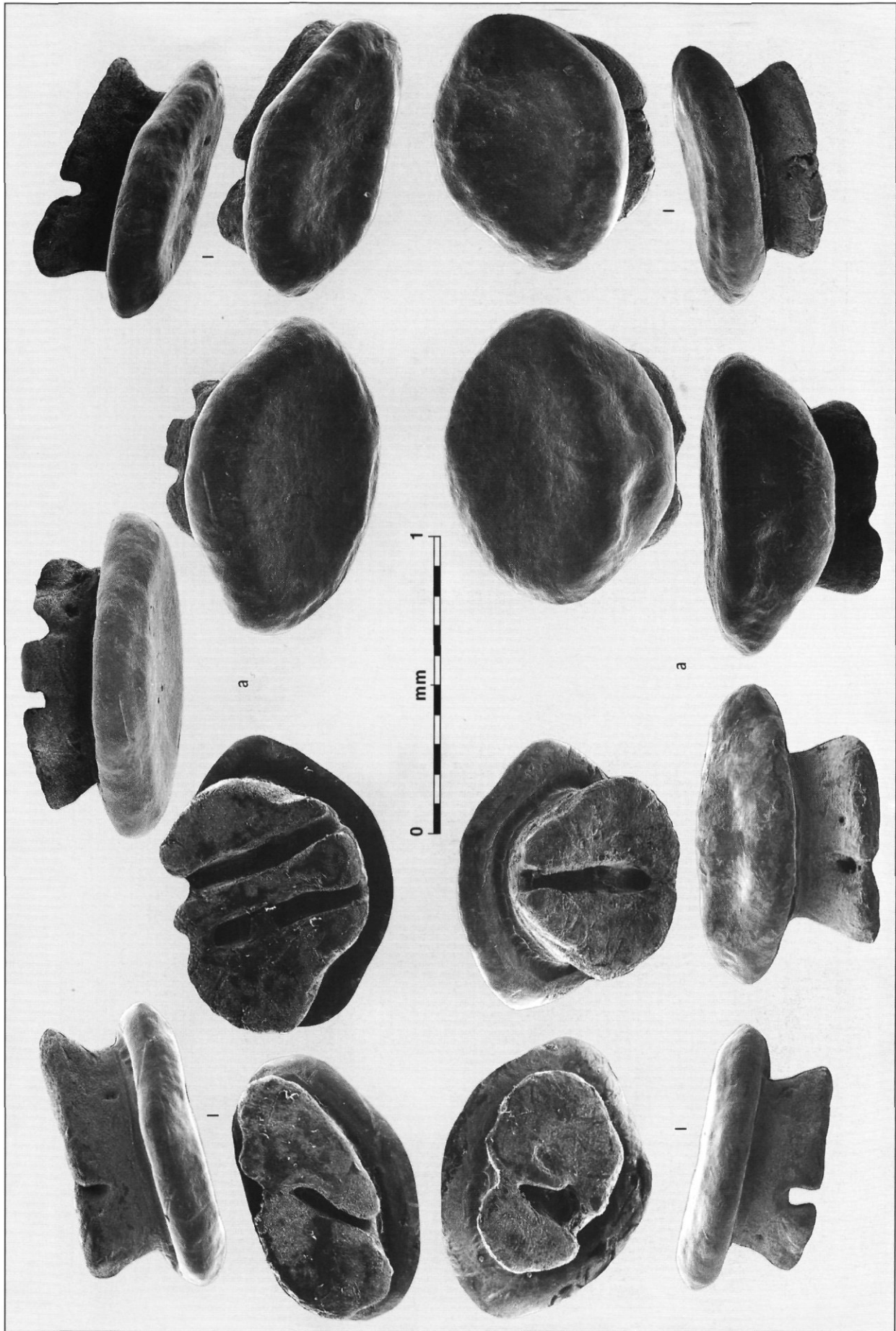


Plate 13. — "*Pastinachus sephen* (FORSKAL, 1775)". Male 62 cm t.l., off Sarawak. Upper and lower teeth.

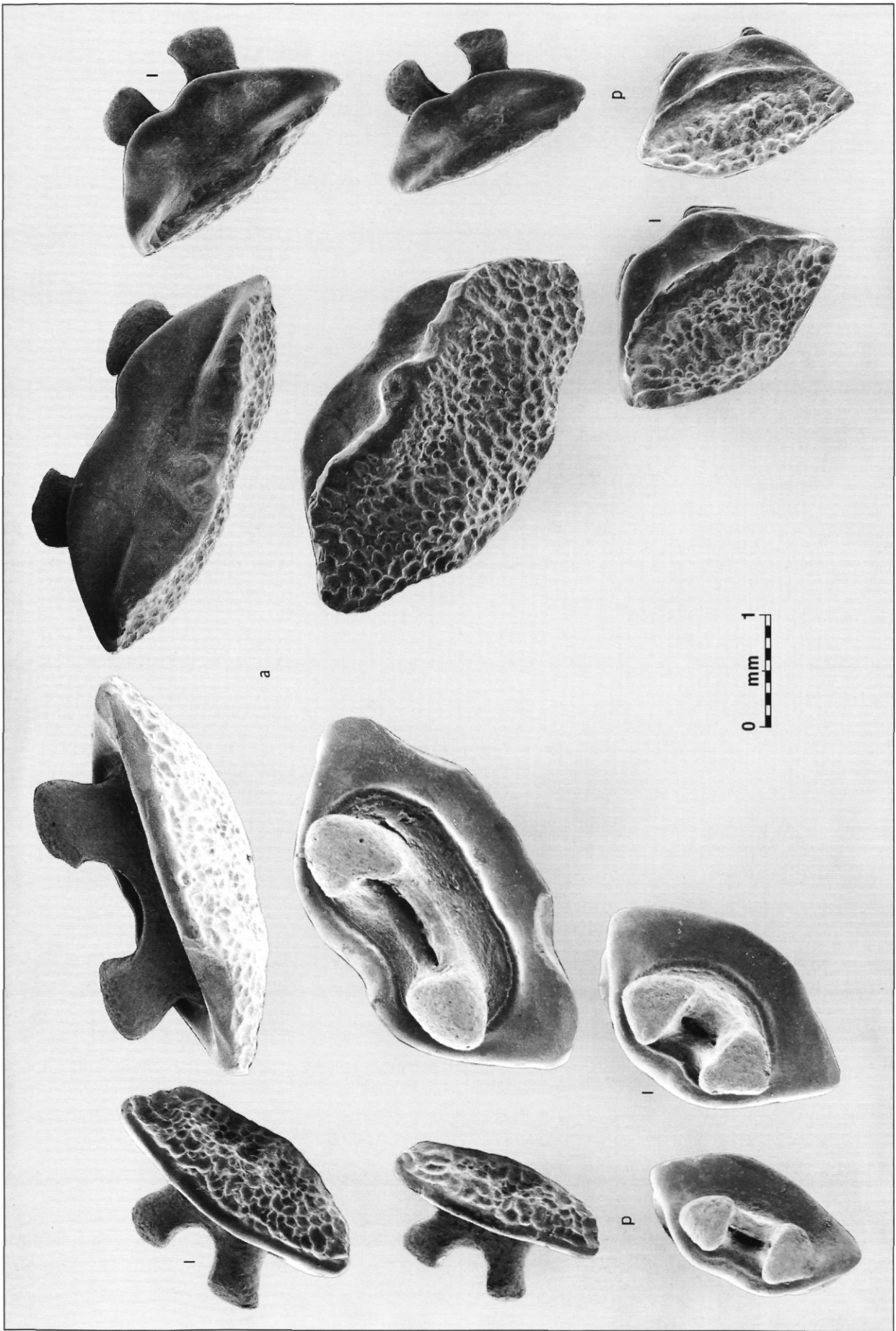


Plate 14. - *Pteroplanytrygon violacea* (BONAPARTE, 1832). Female 61 cm d.w., Algesiras fishmarket, Spain. Upper teeth.

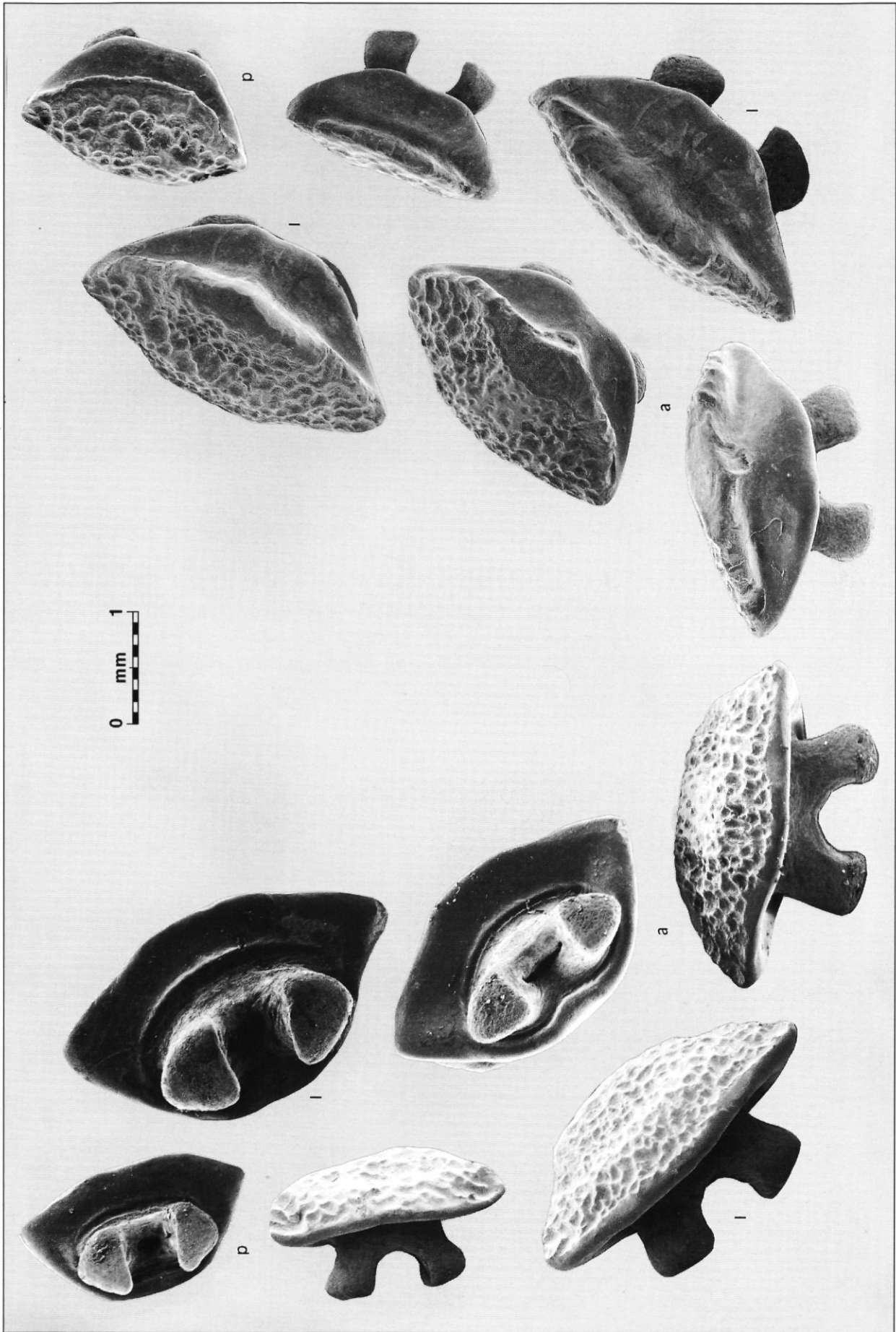


Plate 15. - *Pteroplatyrygon violacea* (BONAPARTE, 1832). Female 61 cm d.w., Algeiras fishmarket, Spain. Lower teeth.

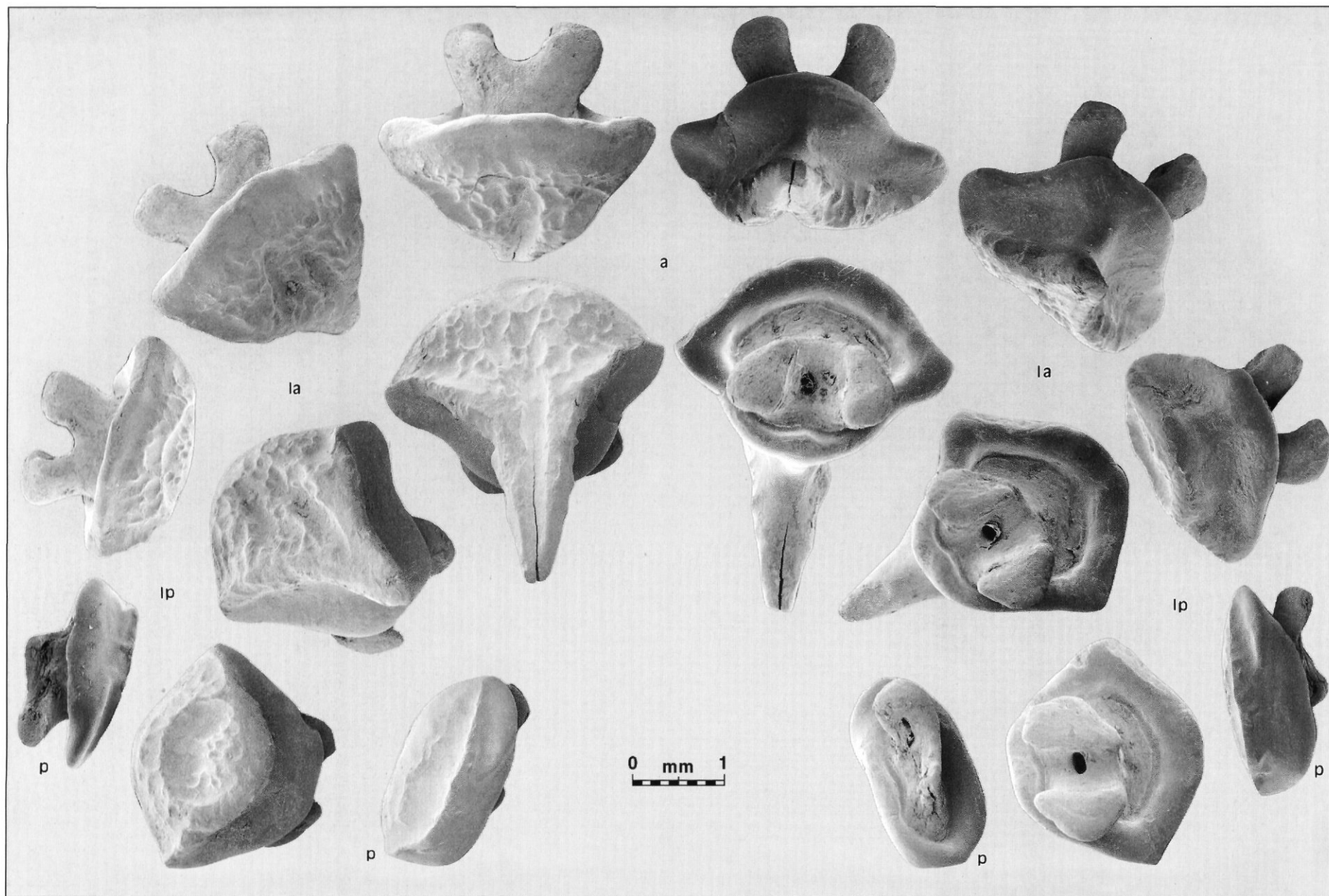


Plate 16. — *Pteroplatytrygon violacea* (BONAPARTE, 1832). Male circa 75 cm d.w., Sousse fishmarket, Tunisia. Upper teeth. Gift Eric Vanderhoeft (Brussels).

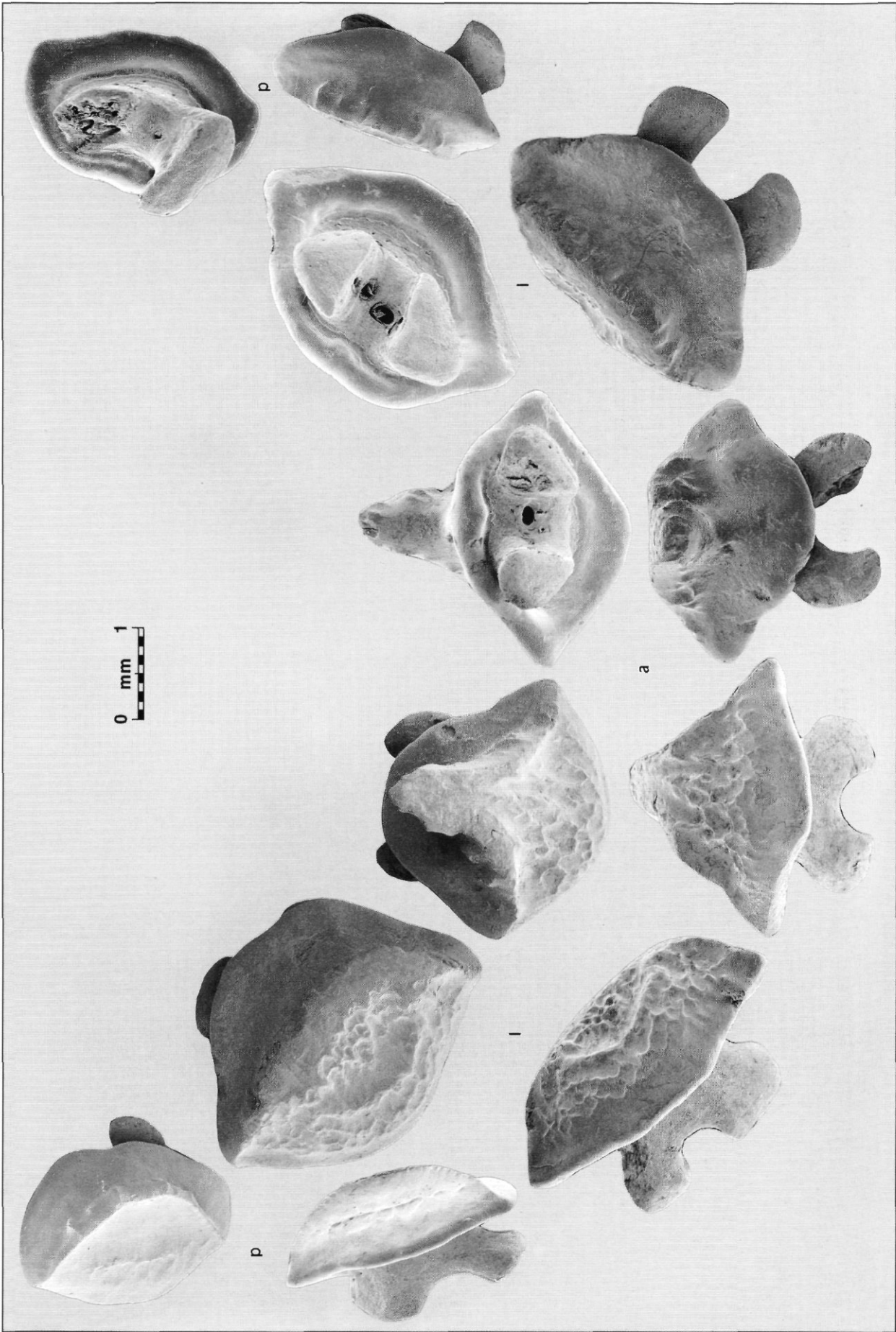


Plate 17. — *Pteroplatyrygon violacea* (BONAPARTE, 1832). Male circa 75 cm d.w., Sousse fishmarket, Tunisia. Lower teeth. Gift Eric Vanderhoeft (Brussels).

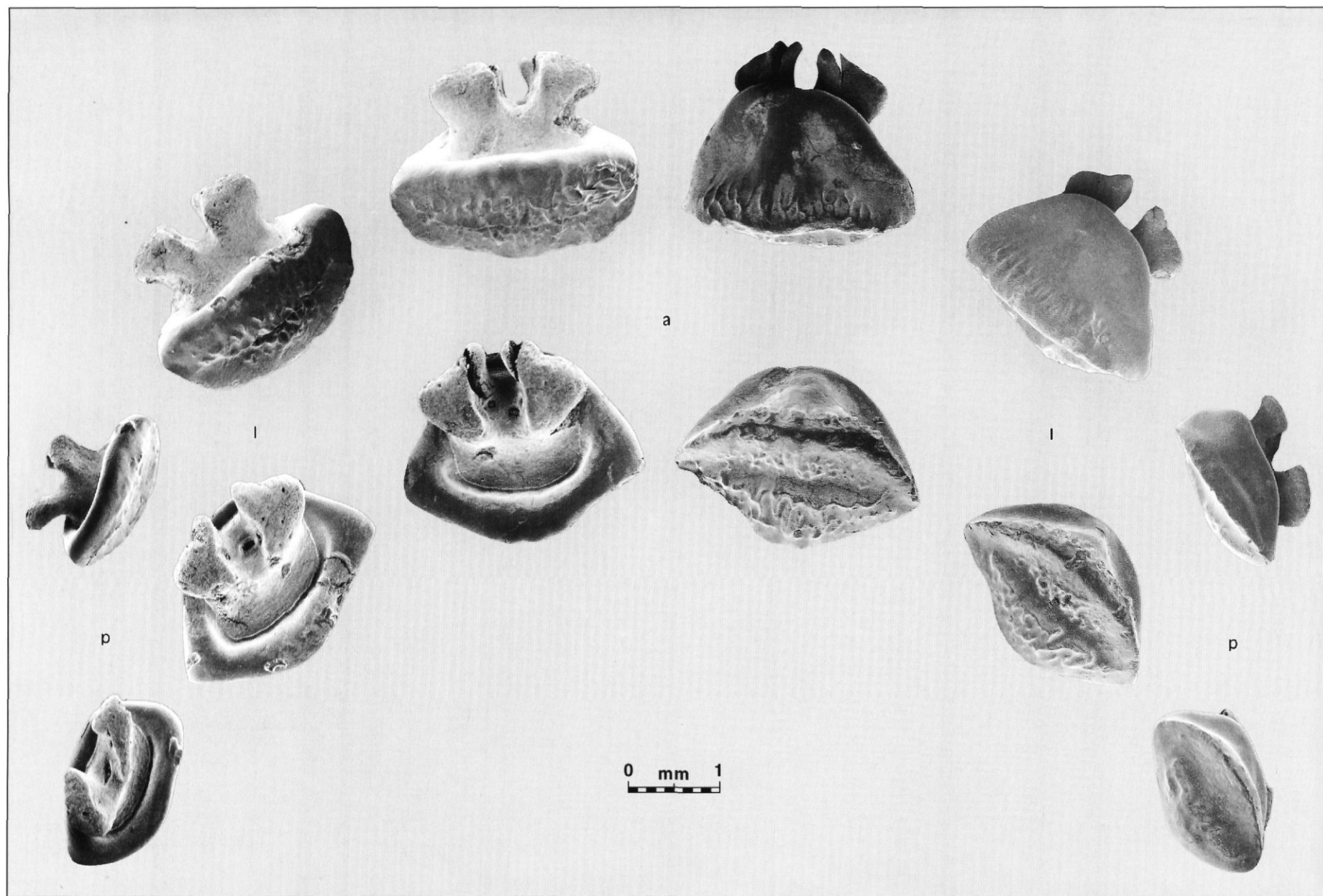


Plate 18. – *Taeniura grabata* (GEOFFROY SAINT-HILAIRE, 1809). Female 158 cm t.l., off Dakkar, Senegal. Upper teeth.

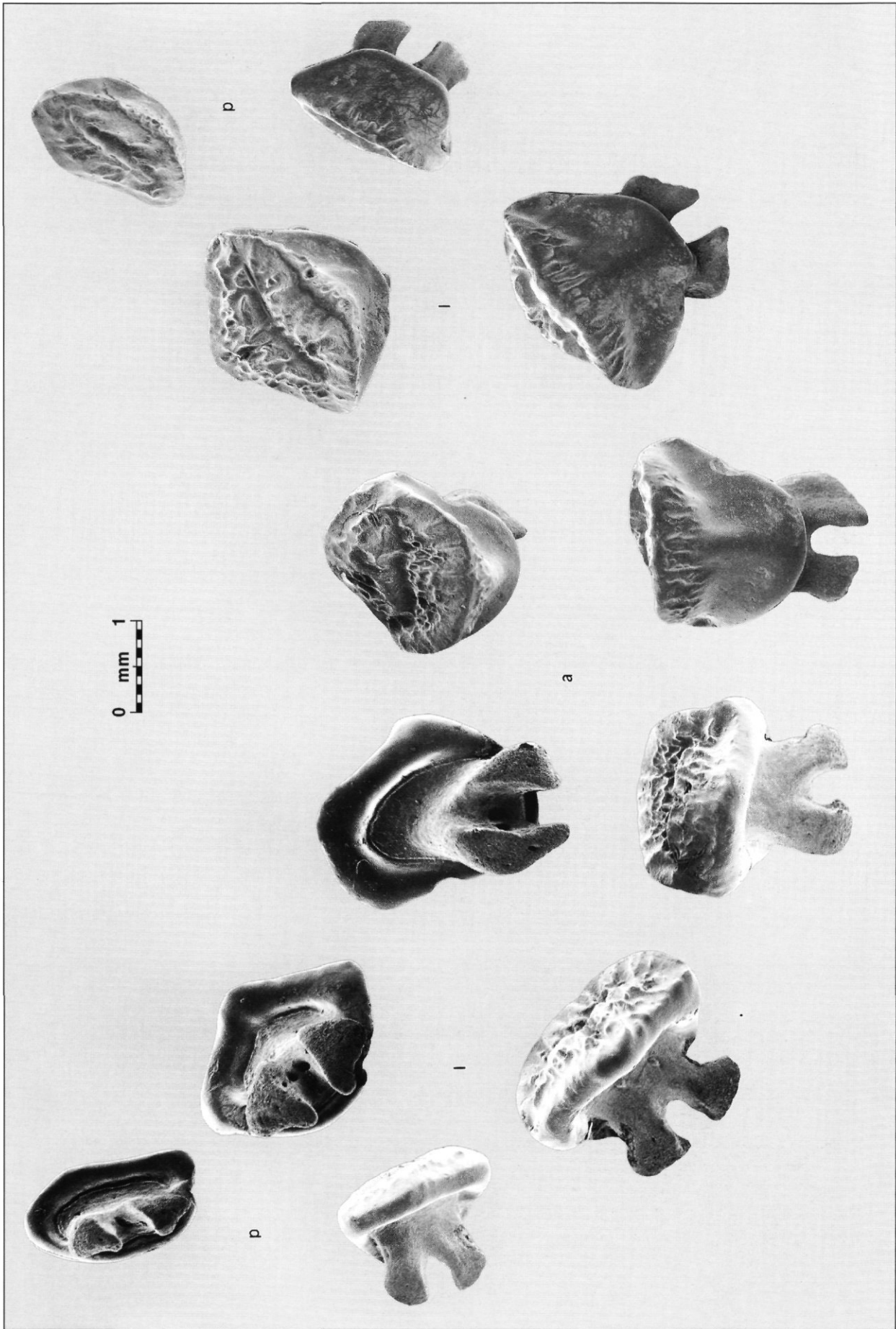


Plate 19. - *Taeniura grabata* (GEOFFROY SAINT-HILAIRE, 1809). Female 158 cm t.l., off Dakar, Senegal. Lower teeth.

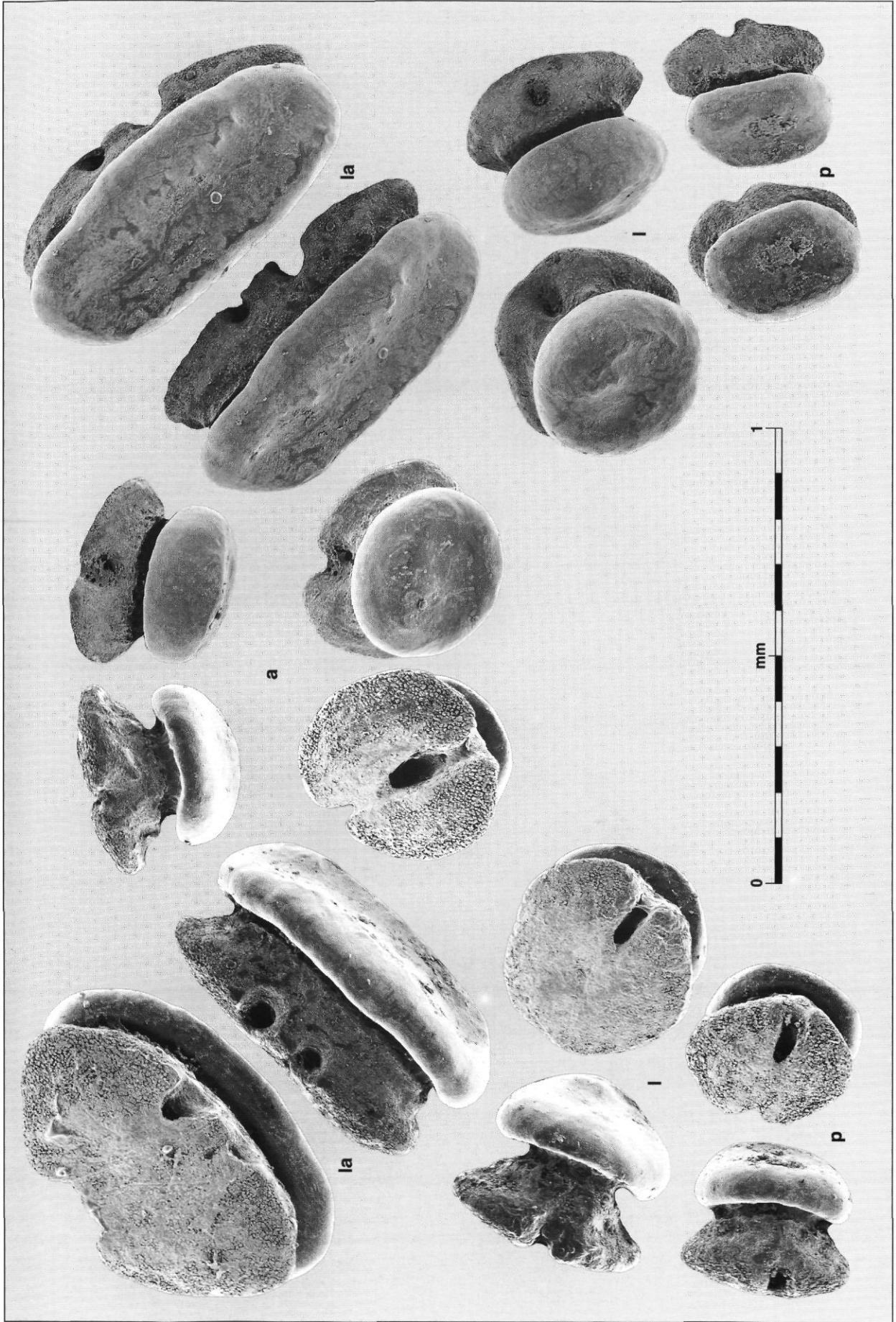


Plate 20. - *Urogymnus asperrimus* (BLOCH & SCHNEIDER, 1801). Female 22 cm d.w., Panian Island, Ponape. Upper teeth.

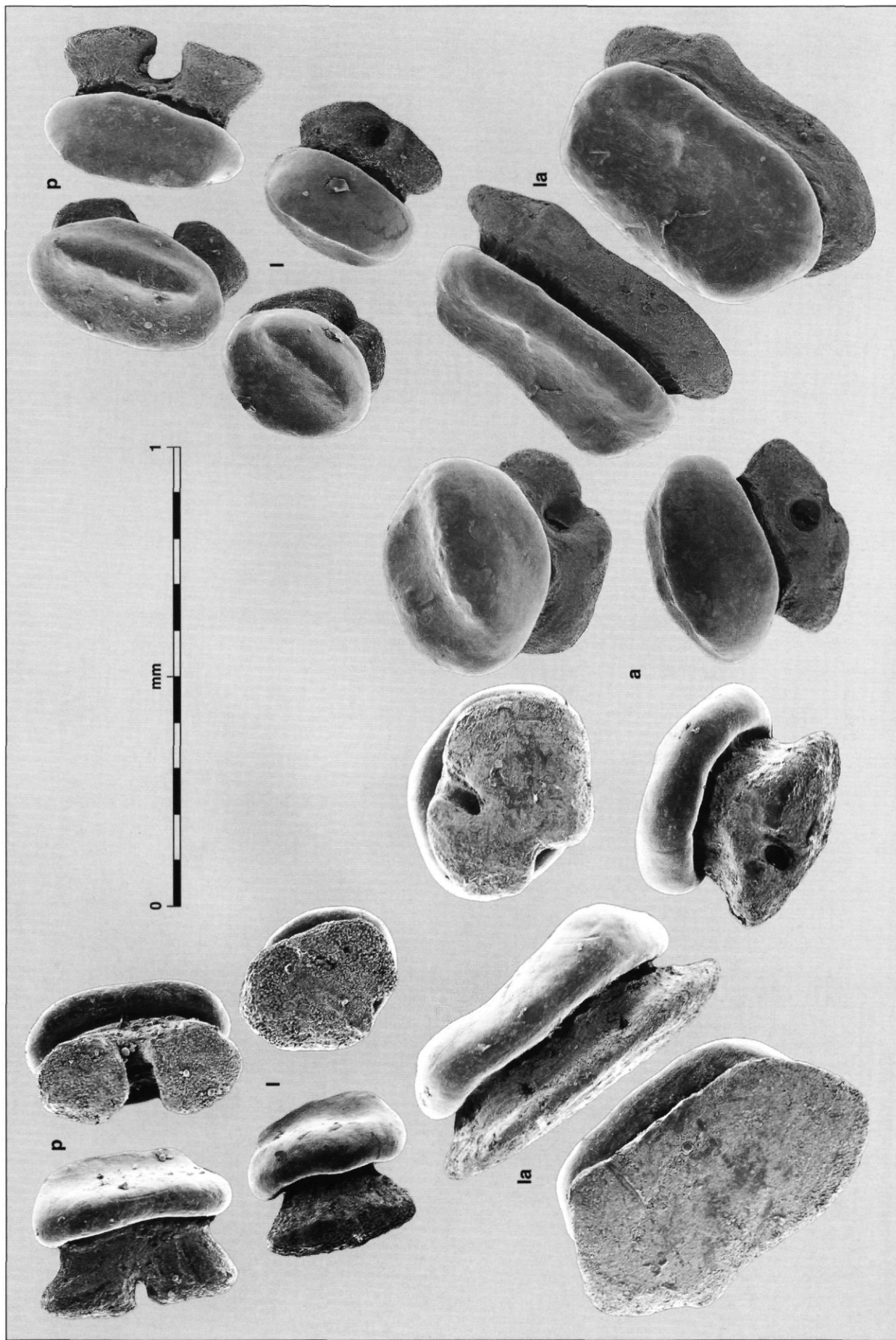


Plate 21. - *Urogymnus asperrimus* (BLOCH & SCHNEIDER, 1801). Female 22 cm d.w., Panian Island, Ponape. Lower teeth.

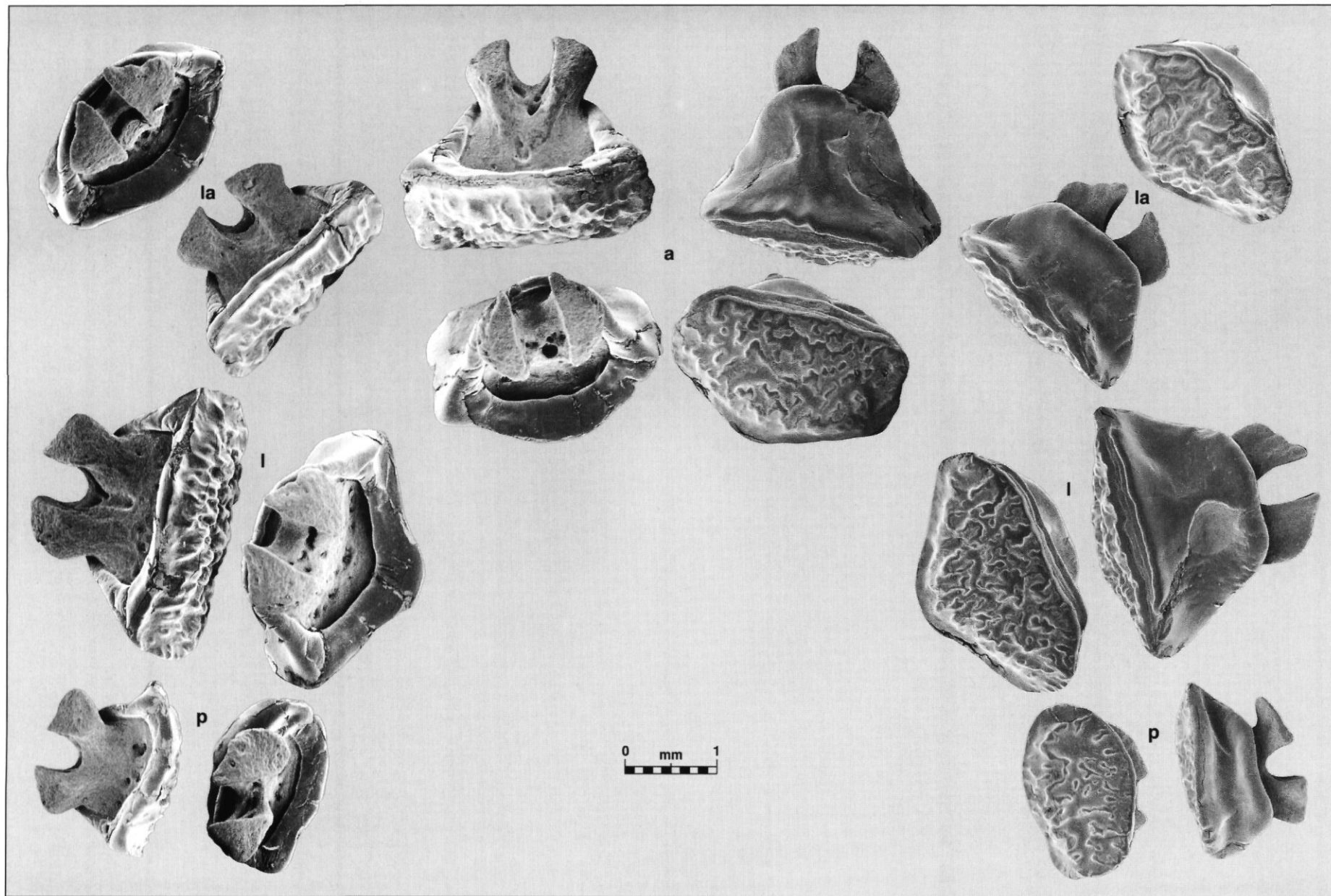


Plate 22. — *Urogymnus asperrimus* (BLOCH & SCHNEIDER, 1801). Female 92 cm d.w., Panian Island, Ponape. Upper teeth.

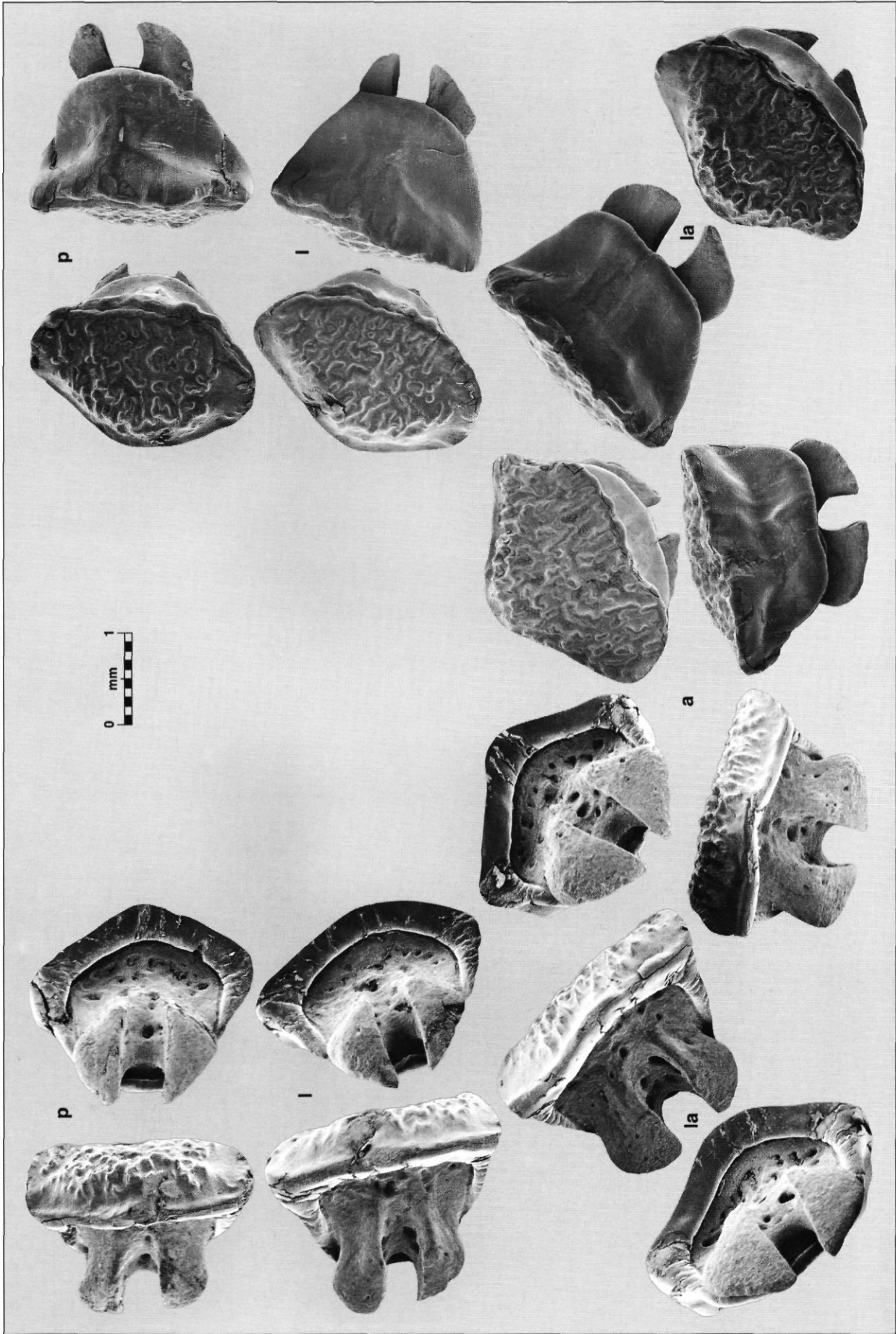


Plate 23. - *Urogymnus asperrimus* (BLOCH & SCHNEIDER, 1801). Female 92 cm d.w., Panian Island, Ponape. Lower teeth.

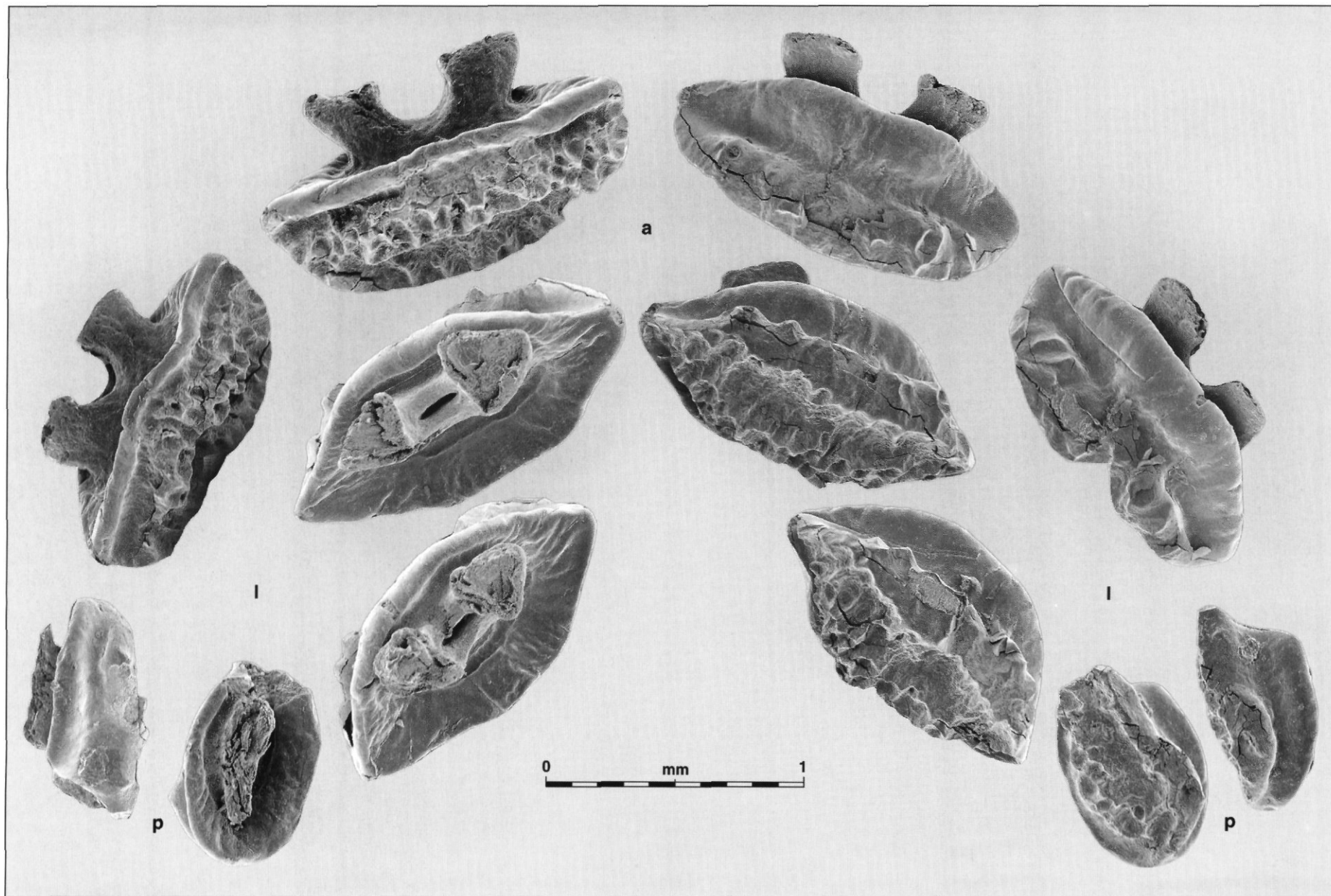


Plate 24. — *Urolophoides matsubarai* (MIYOSI, 1939). Female 39.5 cm d.w., Uchiura Bay, Hokkaido, Japan. Upper teeth.

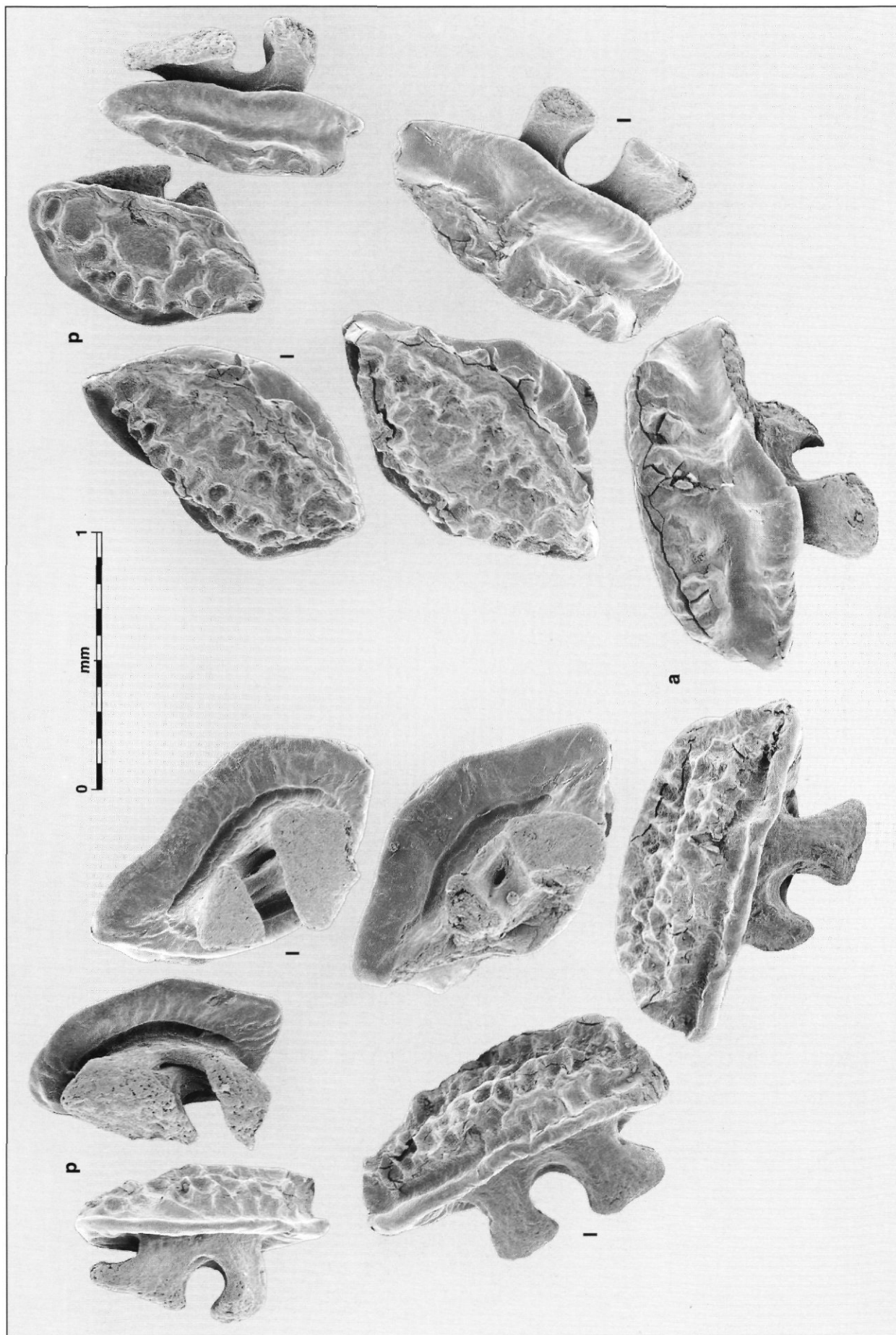


Plate 25. — *Urolophoides matsubarai* (MIYOSI, 1939). Female 39.5 cm d.w., Uchiura Bay, Hokkaido, Japan. Lower teeth.



Plate 26. — *Aetoplatea tentaculata* VALENCIENNES, 1839. Female 21 cm t.l., Arabian Sea. Upper teeth.



Plate 27. - *Actoplatea tentaculata* VALENCIENNES, 1839. Female 21 cm t.l., Arabian Sea. Lower teeth.

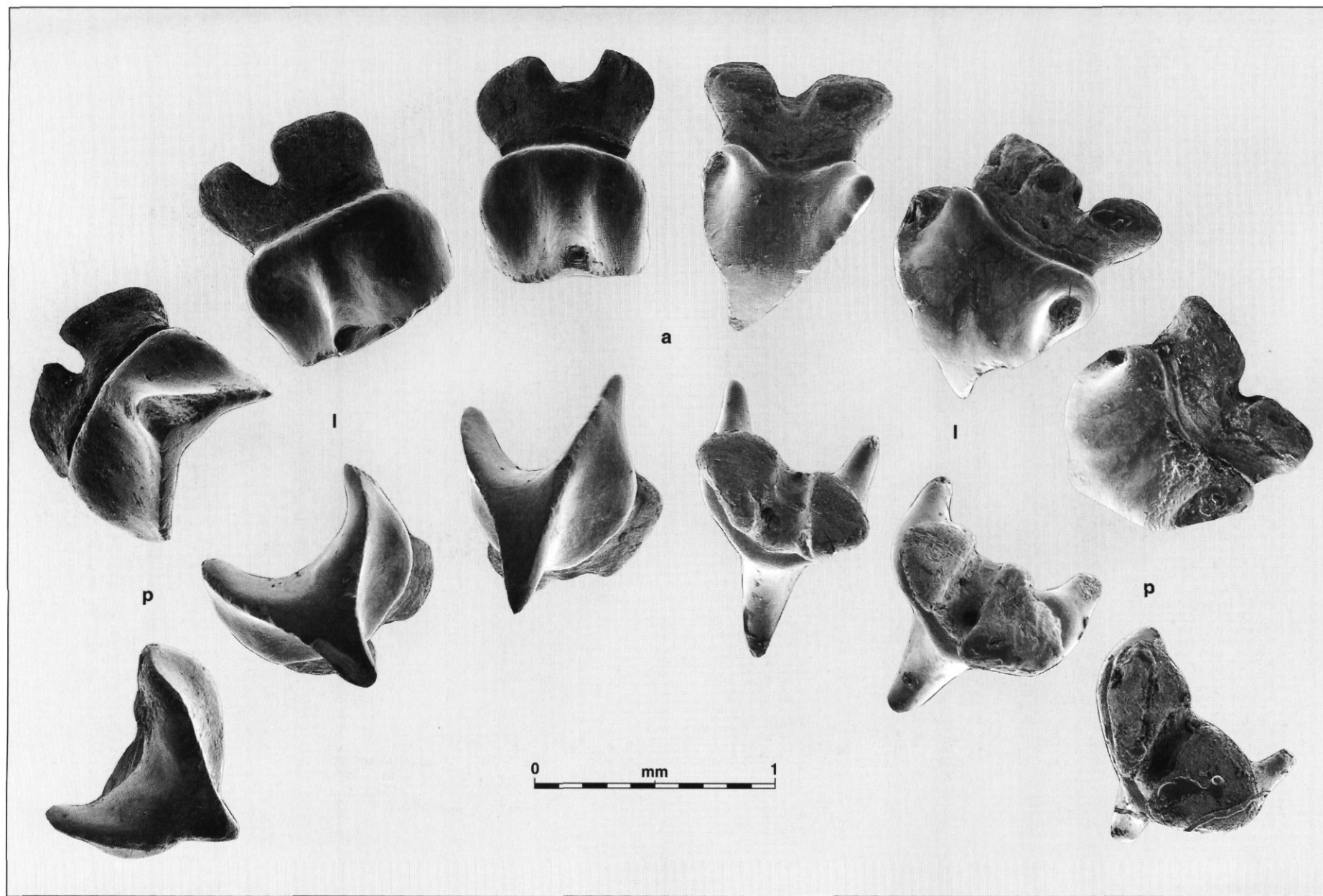


Plate 28. — *Gymnura altavela* (LINNAEUS, 1758). Female 147 cm t.l., off North Argentina. Upper teeth.



Plate 29. - *Gymnura altavela* (LINNAEUS, 1758). Female 147 cm t.l., off North Argentina. Lower teeth.

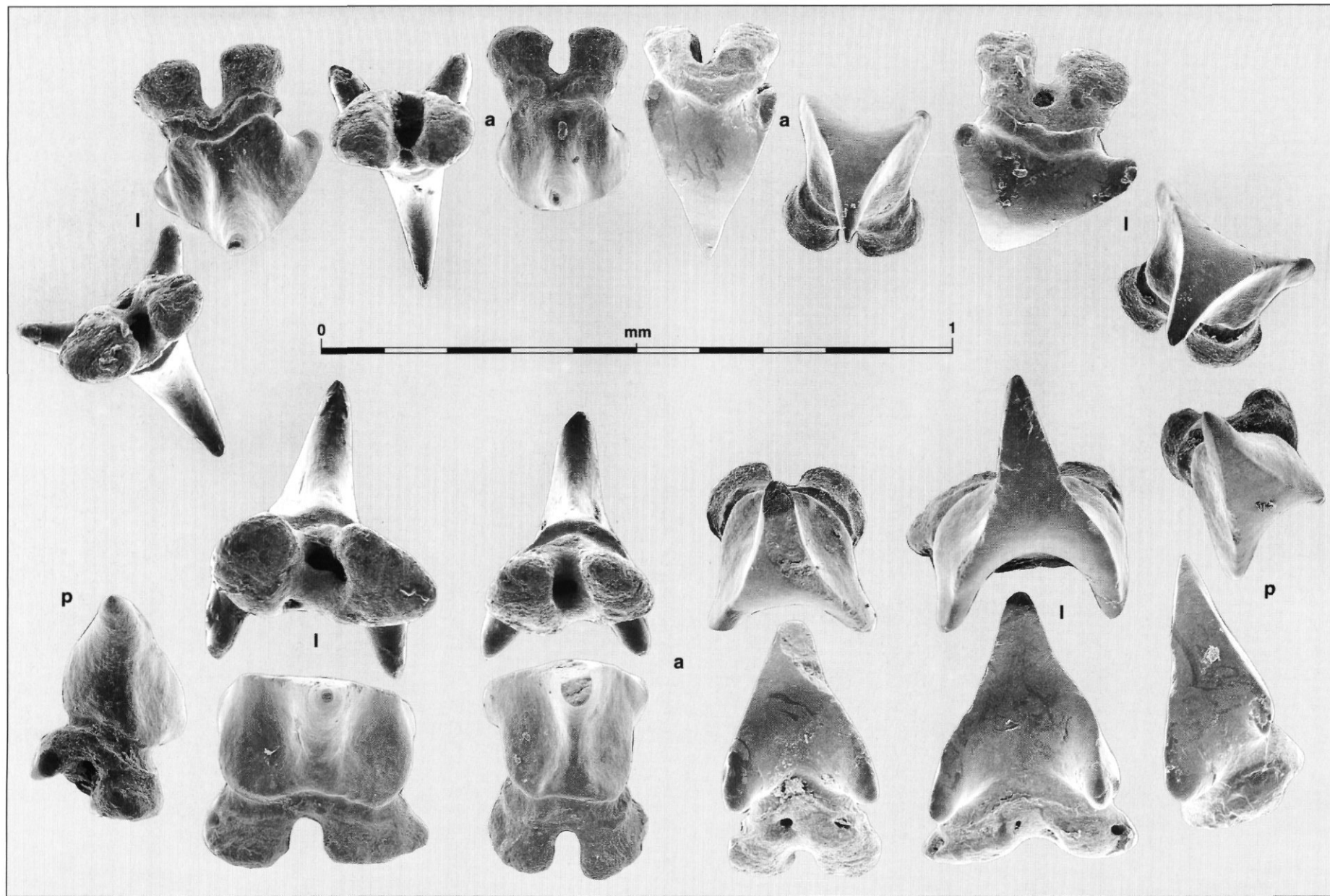


Plate 30. — *Gymnura altavela* (LINNAEUS, 1758). Male 34.5 cm t.l., central part Indian Ocean. Upper and lower teeth.

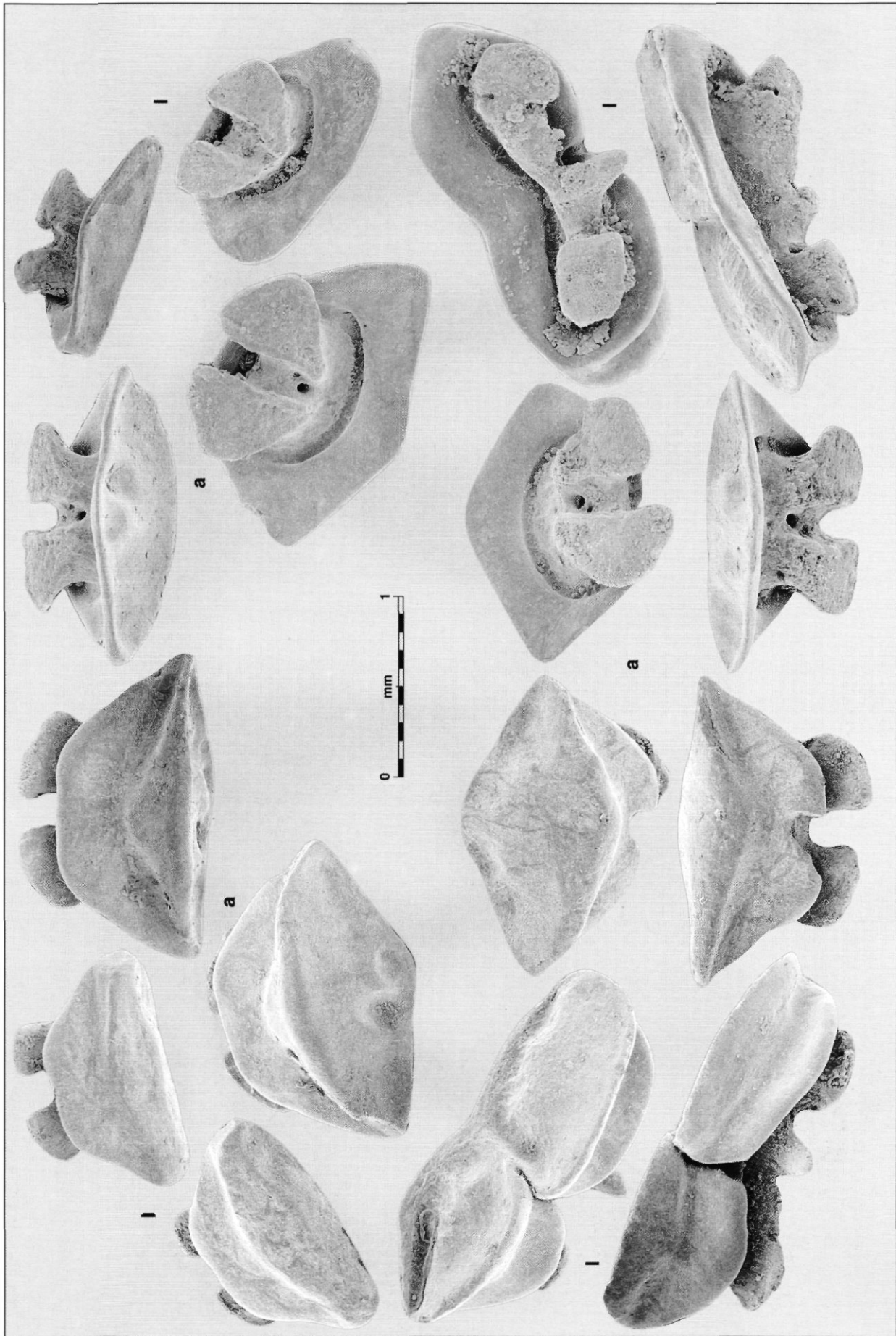


Plate 31. - *Hexatrygon longirostris* CHU & MENG, 1981. Female 71 cm t.l., off Japan. Upper and lower teeth.

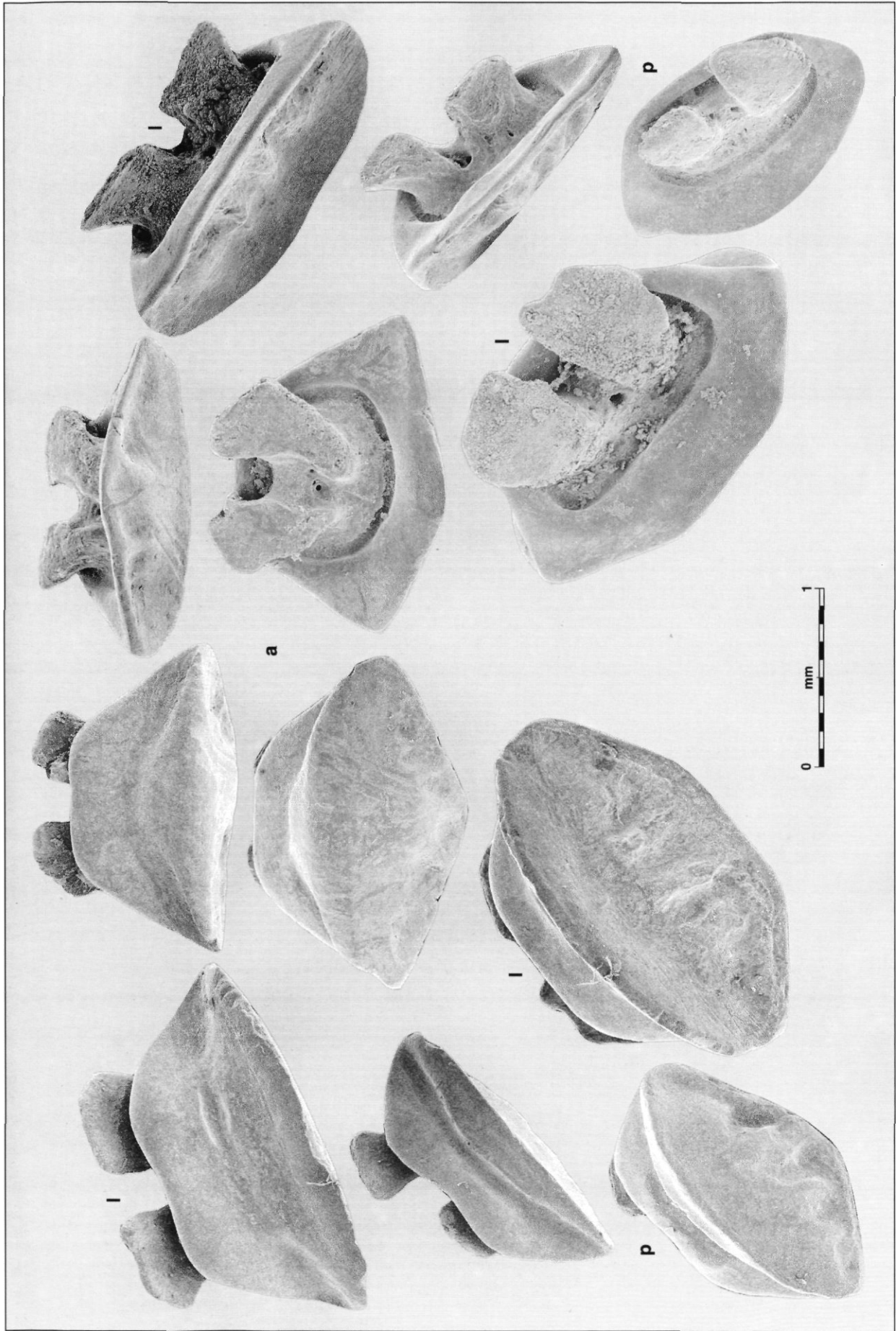


Plate 32. - *Hexatrygon longirostris* CHU & MENG, 1981. Male 65.5 cm t.l., off Japan. Upper teeth.

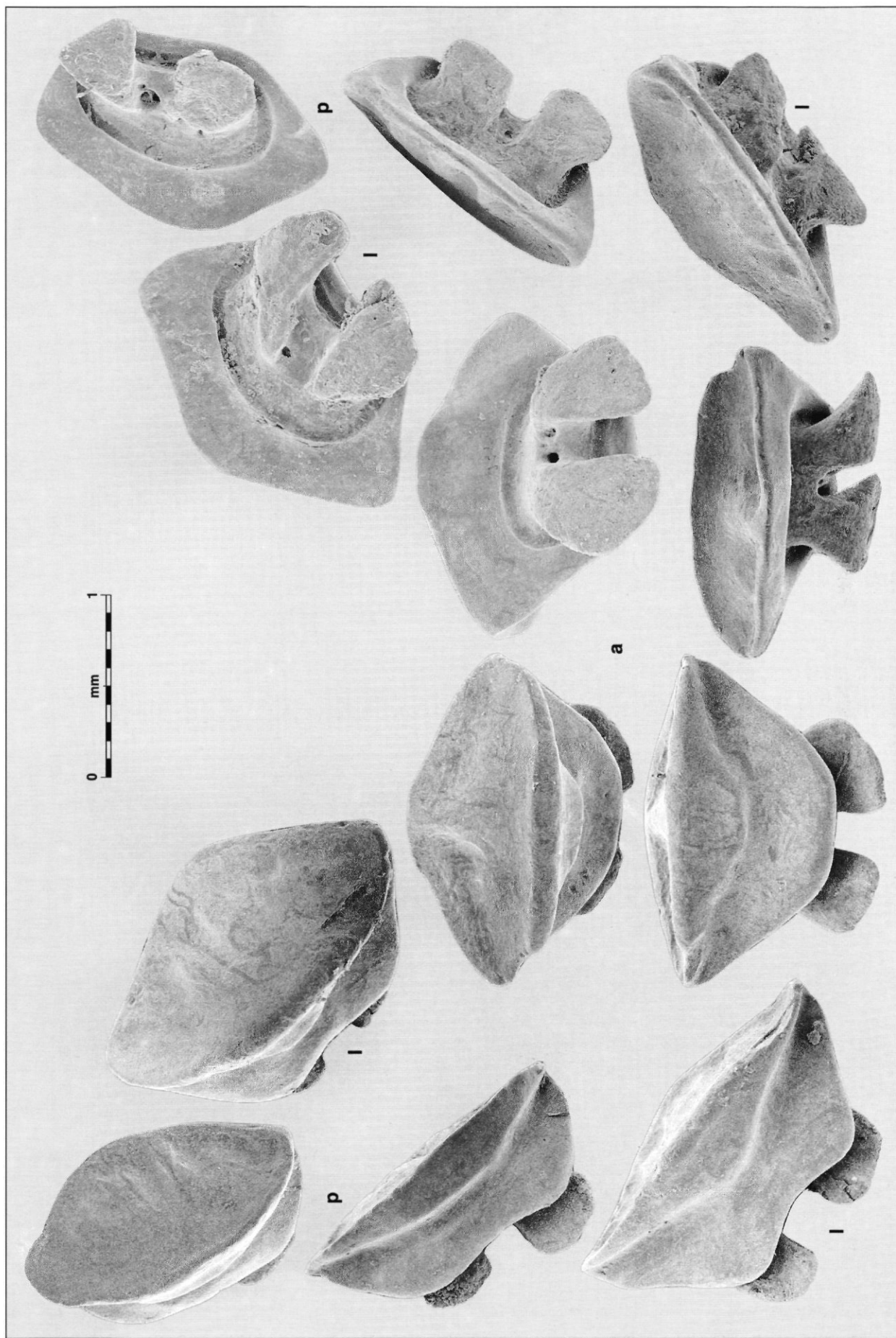


Plate 33. - *Hexatrygon longirostris* CHU & MENG, 1981. Male 65.5 cm t.l., off Japan. Lower teeth.

