

## Contributions to the odontological study of living Chondrichthyes.

### 3. The genus *Isistius* GILL, 1864

by J. HERMAN, M. HOVESTADT-EULER & D.C. HOVESTADT

**Abstract:** The tooth morphology of two of the three species of the genus *Isistius* is described and partly illustrated by SEM photographs. An interspecific diagnosis reveals significant tooth morphological differences, as well as a different vascularization pattern between the species *I. brasiliensis*, and *I. plutodus*, which allow dividing the species into two different morpho-types. The tooth morphology of *I. labialis* and *I. brasiliensis* appears to be quite similar.

**Key words:** Odontology – Chondrichthyes – Squaliformes – Dalatiidae – *Isistius* – Tooth morphology.

**Résumé:** La morphologie dentaire de deux des trois espèces du genre *Isistius* est décrite et figurée partiellement à l'aide de clichés MEB. Une diagnose interspécifique précise les différences de morphologie et de vascularisation dentaires observées entre *I. brasiliensis* et *I. plutodus*, permettant la définition de deux morphotypes différents. La morphologie dentaires de *I. labialis* semble s'apparenter à celle d' *I. brasiliensis*.

**Mots- clés:** Odontologie – Chondrichthyes – Squaliformes – Dalatiidae – *Isistius* – Morphologie dentaire .

**Kurzfassung:** Die Zahnmorphologie von zwei der drei Arten der Gattung *Isistius* werden beschrieben und teilweise illustriert mit REM Photos. Eine interspezifische Diagnose zeigt bedeutende zahnmorphologische Unterschiede, wie auch ein stark verschiedenes Vascularisationsmuster zwischen den Arten *I. brasiliensis* und *I. plutodus*, was erlaubt zwei Morphotypen zu unterscheiden. Die Zahnmorphologie von *I. labialis* scheint überein zu kommen mit *I. brasiliensis*.

**Schlüsselwörter:** Odontologie – Chondrichthyes – Squaliformes – Dalatiidae – *Isistius* – Zahnmorphologie.

#### Introduction

The tooth morphology of the taxa of the genus *Isistius* is, with the exception of *I. brasiliensis*, poorly known. For this study tooth material was available of *I. brasiliensis* and *I. plutodus*. The drawing of the teeth of the original description of *I. labialis* is used for comparison. The tooth morphology of *I. Brasiliensis*, which was described and illustrated by HERMAN, HOVESTADT-EULER & HOVESTADT (1989), will be used here and more information, as well as more illustrations are provided. For the terminology used here see HERMAN, HOVESTADT-EULER and HOVESTADT 1989.

#### Material

For this study was only available: *Isistius brasiliensis* : three females , *Isistius plutodus* : two females .

#### *Isistius* GILL, 1864

The genus is known by three species : the type species *I. brasiliensis*, *I. plutodus* and *I. labialis*.

#### *Isistius brasiliensis* QUOY & GAIMARD, 1824

QUOY J.R. & GAIMARD J.P., 1824 -1825: Description des Poissons. Chapitre IX.

For *I. brasiliensis* see p.198 (1824).

Textplates 1, 2 , Plates 1 to 4

#### HETERODONTY

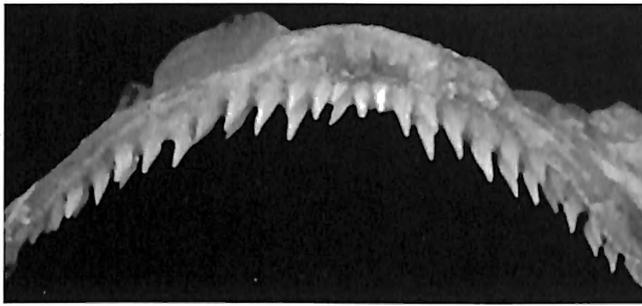
The species has a strong dignathic heterodonty and an anaulacorhizid root. The lower teeth are strongly interlocked. The upper teeth are plurimilimetrical and the lower teeth are subcentimetrical in range. The dental formula of *I. brasiliensis* is 34 upper rows and 12 to 15-1-12 to 15 lower rows.

#### VASCULARIZATION

The vascularization of the teeth is osteodont presented by coarse sub-horizontally arranged osteons, originating from the centre of the root, with finer reticulated osteons in the crown. At the lower part of the root the osteons are vertically arranged. Numerous fine parallel canaliculi radiate from the upper margins of the vascularization system into the cusp of the crown.

#### UPPER JAW

The teeth have an elongated principal cusp. Cusplets are absent. The smooth mesial and distal cutting edges are slightly curved. The crown is slightly distally inclined in lateral and posterior teeth and twice as high than its base width. The root is pseudobilobated by a deep sulcus, having quadrangular pseudo-lobes and is constricted just below the crown-root junction.



**Textplate 1 :** *Isistius brasiliensis* QUOY & GAIMARD, 1824.  
Female 410mm t.l. , caught off Dakar, Senegal.  
Outer view of the upper dentition x 3.

The inner face of the crown is slightly convex. Uvula is absent. A series of poorly developed vertically directed outer costules are present near the crown-root junction.

The outer face of the crown is flat to slightly convex with a basally rounded apron present.

The inner face of the root shows a longitudinal ridge near the crown-root junction, on which a large central aperture is present. The root is depressed downward below this ridge. A short, broad and deep basal sulcus is present.

The outer face of the root has three irregularly shaped small sized foramina below the apron. The central basal sulcus is also present on the outer face.

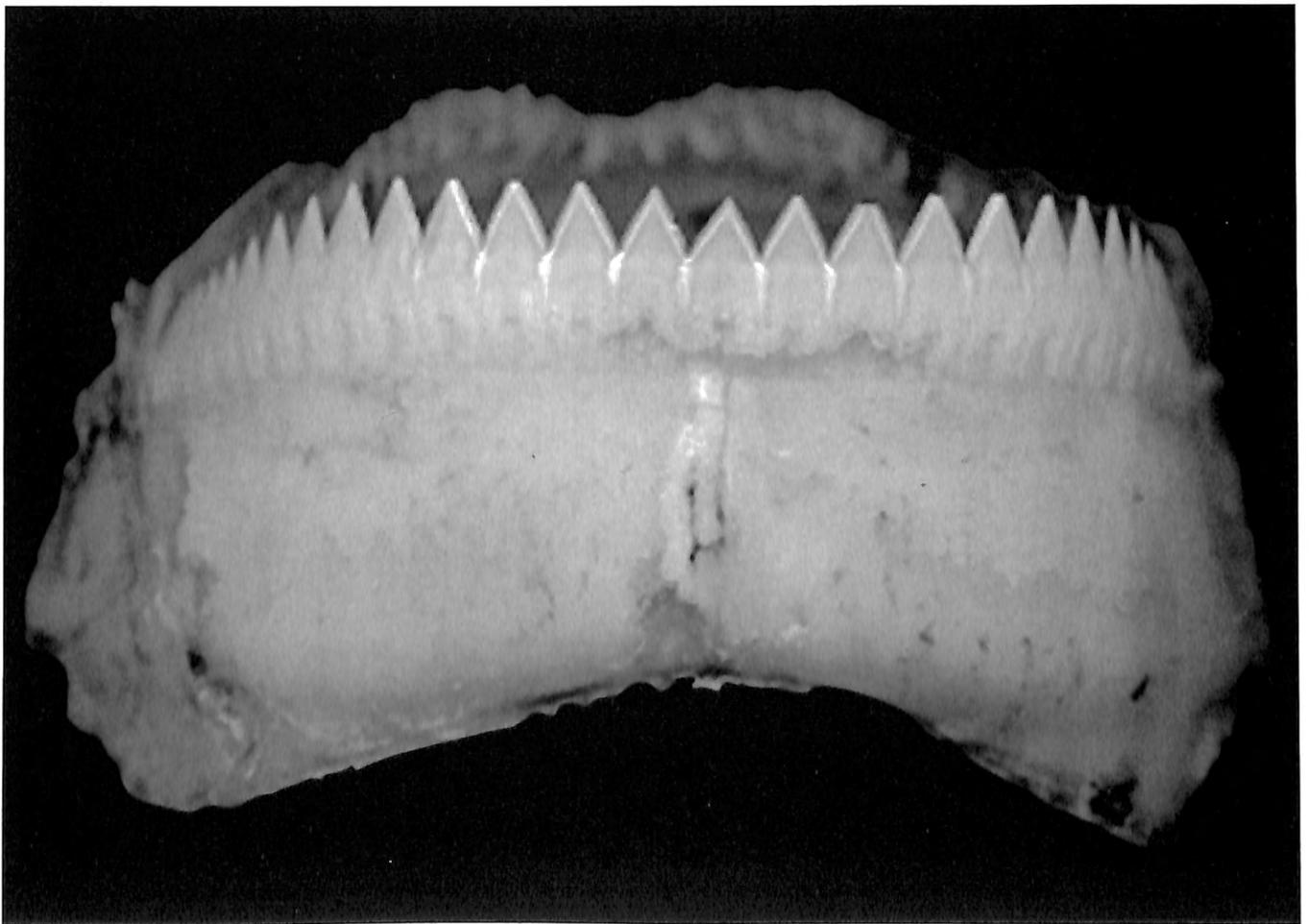
#### LOWER JAW

The strongly compressed teeth are always interlocked, presenting deep, vertically long, inner distal and outer mesial depressions. The smooth mesial and distal cutting edges are without blades. The crown inclines slightly toward the commissure in latero-posterior and posterior teeth. The crown is as high as the crown base width. The root is 10 to 80% higher than the crown.

The inner face of the crown is flat to very weakly convex. Uvula is absent.

The outer face of the crown is weakly convex. A vertically long quadrangular apron covers the central and distal part of the root. The apron is not overhanging the root but is smoothly joined with it at the base.

The inner face of the vertically long root is very flat, showing a longitudinal ridge near the crown-root junction with a central aperture and a small distal foramen with sometimes a small mesial foramen near the crown-root junction. A large elongated central aperture is present at the middle part of the



**Textplate 2 :** *Isistius brasiliensis* QUOY & GAIMARD, 1824. Female 410mm t.l. , caught off Dakar, Senegal. Outer view of the lower dentition x 2.5.

root. A distal depression, as result of interlocking, is well developed. The outer face of the root shows a central aperture near the crown-root junction, which is the origin of a vertical long central sulcus. There is also a smaller distal aperture present near the crown-root junction. A well developed mesial depression is present as a result of interlocking.

*Isistius plutodus* GARRICK & SPRINGER, 1964  
GARRICK J.A.F. & SPRINGER S., 1964. *Copeia*.  
Washington. 1964(4) : 678-682.  
Textplates 3, 4, Plates 5 to 8.

#### HETERODONTY

The species has a strong dignathic heterodonty and an anaulacorhizid root. The lower teeth are strongly interlocked. The upper teeth are plurimilimetric and the lower teeth are subcentimetric in range. The dental formula of *I. plutodus* (holotype) is 29 upper rows and 9-1-9 lower rows. The specimen described here also has 9-1-9 lower rows. The upper rows could not be counted due to an injury.

#### VASCULARIZATION

The vascularization of the teeth is osteodont presented by coarse osteons, radiating from the centre of the root, with finer reticulated osteons in the crown. At the lower part of the root the osteons are vertically arranged. Numerous fine parallel canaliculi radiate from the upper margins of the vascularization system into the cusp of the crown.

#### UPPER JAW

The teeth have an elongated principal cusp. Cusplets are absent. The mesial and distal cutting edges are slightly curved. The crown is slightly distally inclined in lateral and posterior teeth and approximately three times as high than its base width. The root is pseudobilobated by a deep sulcus, having quadrangular pseudo-lobes.

The inner face of the crown is convex. Uvula is absent. A series of poorly developed vertically directed costules reach from the crown base up to half way or more toward the apex of the crown.

The outer face of the crown is flat to slightly convex, with a basally rounded apron present.

The inner face of the root possesses a large central aperture near the protruded crown-root junction. A short, broad basal sulcus is present.

The outer face of the root has three or more irregularly shaped small sized foramina along the apron.

#### LOWER JAW

The strongly compressed teeth are always interlocked, presenting deep, vertically long, inner distal and outer mesial depressions. The mesial and distal cutting edges are without blades and possess a well developed fine micro-serration. The crown inclines slightly toward the commissure in latero-posterior and posterior teeth. The crown is approximately 12

to 13% higher than its base width. The root is 10 to 14% lower than the crown.

The inner face of the crown is flat to very weakly convex. The crown base possesses poorly developed rounded mesial and distal extensions both part of the interlocking of the teeth. In teeth toward the commissure the mesial one diminishes in size. Uvula is absent.

The outer face of the crown is weakly convex. A vertically long quadrangular apron covers the central and distal part of the root. The apron is not overhanging the root but is smoothly joined with it at the base.

The very flat inner face of the root is vertically long. A large central aperture is present at the crown root junction with sometime a small distal foramen. A distal depression, as result of interlocking, is well developed. The outer face of the root shows a central aperture near the crown-root junction, which is the origin of a vertical long central sulcus. There is also a smaller distal aperture present near the crown-root junction. A well developed mesial depression is present as a result of interlocking.

*Isistius labialis* MENG, ZHU & LI, 1985  
MENG Q.-W., ZHU Y.-D. & LI S., 1985. *Acta*  
*Zootaxonomica Sinica*. Beijing (Peking). 10(4) : 442-444.  
For the illustrations see p. 443.

#### HETERODONTY

The species has a strong dignathic heterodonty and an anaulacorhizid root. The upper teeth are plurimilimetric and the lower teeth are subcentimetric in range. The dental formula of *I. labialis* is 43 upper rows and 14-1-14 lower rows.

Tooth samples of *Isistius labialis* were not available for examination, and thus a detailed description of the tooth morphology was not possible. However, the illustrations of lower teeth, as published by MENG, ZHU & LI (1985) allow an estimate of the ratios between the tooth height and width, as well as the crown and root height.

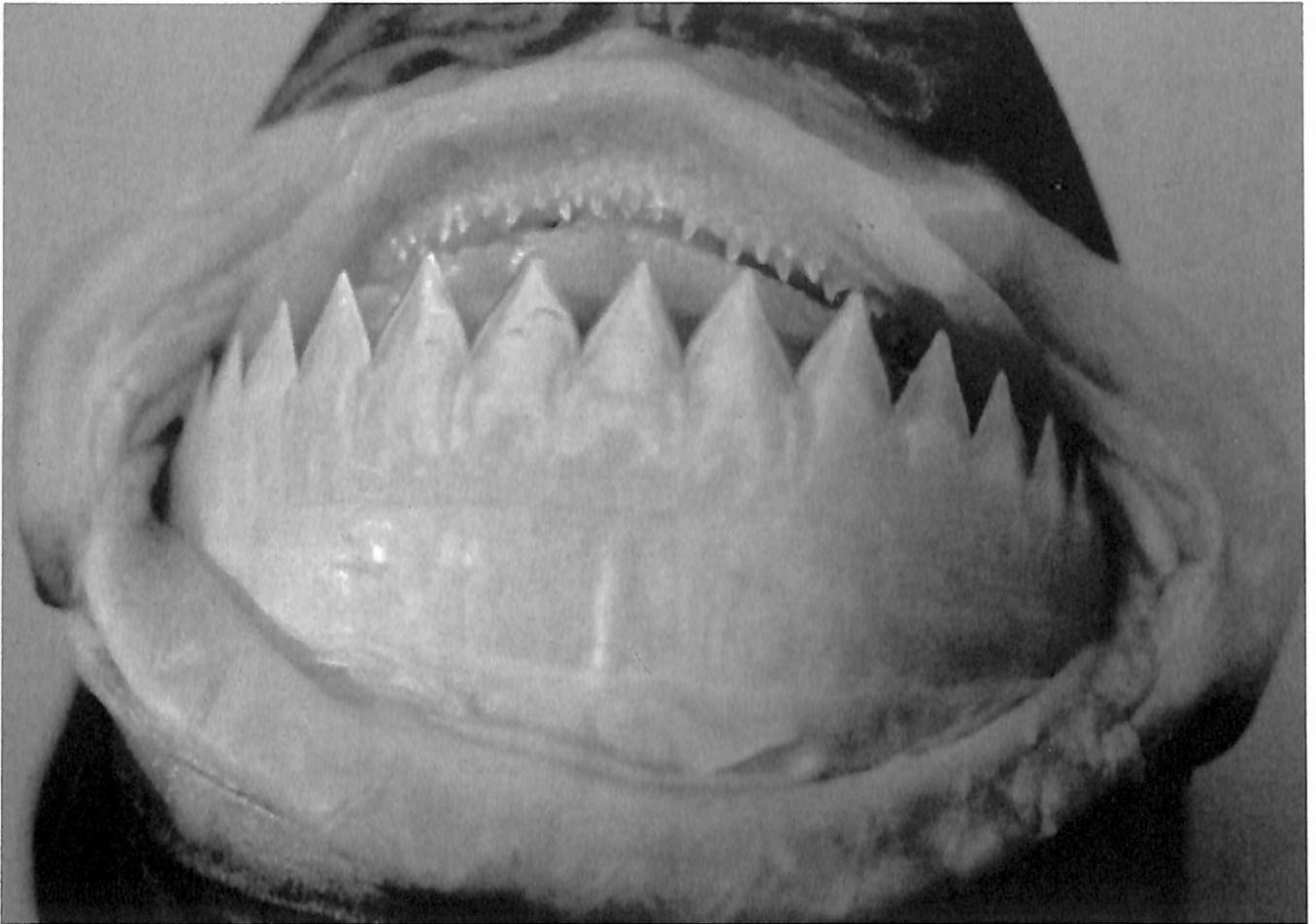
The crown base width of the antero-lateral teeth is more or less equal to the crown height. The root is approximately 7% lower than the crown.

#### Interspecific differential diagnosis

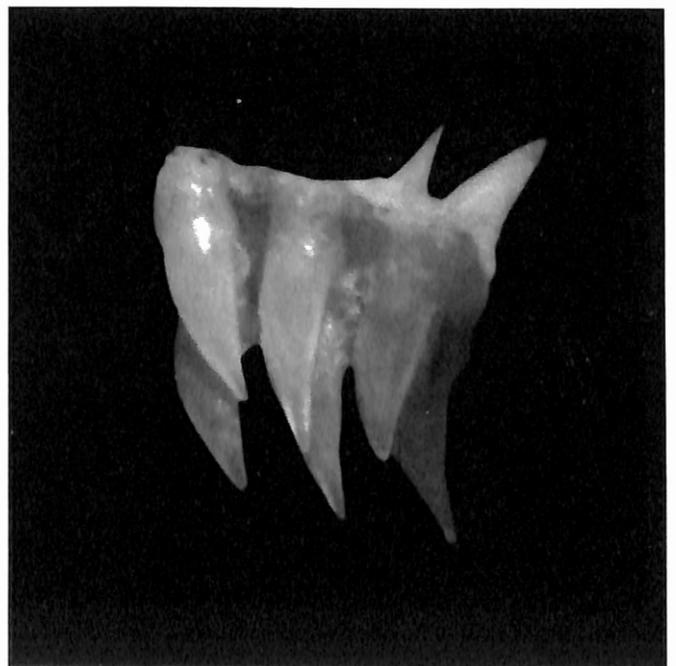
The tooth morphology of the three species of the genus *Isistius* is in general similar. Their differences are found in the biometrical results of the teeth, as well as some specific character features.

#### UPPER TEETH

The upper jaw teeth of *I. brasiliensis* and *I. plutodus* are rather similar. However, the constriction of the root in *I. brasiliensis* does not occur in *I. plutodus* and the crown is twice as high as its crown base in *I. brasiliensis* versus three times as high in *I. plutodus*. Further the inner costules are poorly developed and short, restricted to the crown base in *I.*



**Texplate 3 :** *Isistius plutodus* GARRICK & SPRINGER, 1964. Female 423mm t.l., Holotype, USNM 188386, caught off Alabama U.S.A. Close-up of the jaws x3. Photograph M. Crochard 1977.  
**Remark :** Because the photograph was taken without preliminary drying of the specimen, the very fine serrulation on the edges of the crown of the lower teeth is not visible.



**Texplate 4 :** *Isistius plutodus* GARRICK & SPRINGER, 1964. Female 363mm t.l., AMS 1.43044-002, caught off Newcastle, New South Wales, Australia. Small set of left teeth of the upper dentition x12.

Character feature	<i>I. brasiliensis</i>	<i>I. plutodus</i>	<i>I. labialis</i>
Upper teeth: Root constriction present	Yes	No	?
Upper teeth: Inner costules reaching half way the crown height or more	No	Yes	?
Upper teeth: crown three times as high as its crown base	No	Yes	No
Lower teeth: Crown higher than its base	No	Yes	No
Lower teeth: Cutting edges with a micro-serration	No	Yes	?
Lower teeth: Root lower than the crown	No	Yes	No
Lower teeth: Mesial and distal extensions of the crown base present	No	Yes	Yes ?
Dental formula: Upper teeth less than 30 rows; Lovers less than 20 rows	No	Yes	?
Vascularization pattern horizontally arranged	Yes	No	?

Table 1

*brasiliensis*, versus long and reaching up to half way the crown height or more in *I. plutodus*. The poor illustration of *I. labialis* does not allow comparison of these features.

#### LOWER TEETH

Biometrical results show a higher crown of the lower teeth in *I. plutodus* than in *I. brasiliensis* and *I. labialis*. In *I. brasiliensis* and *I. labialis* the crown seems to be of equal height. Although the cutting edges are smooth in *I. brasiliensis*, they possess a well developed micro-serration in *I. plutodus*. This could not be confirmed in *I. labialis*, due to the poor illustrations. The crown base is mesially and distally extended in *I. plutodus* which also seems to appear in *I. labialis*, according the illustrations. The root of *I. plutodus* is lower than in *I. brasiliensis* and *I. labialis*. The root height seems to be of equal height in *I. brasiliensis* and *I. labialis*. In *I. plutodus* this extension is absent.

The dental formula of *I. brasiliensis* and *I. labialis* is more or less similar, but with significantly fewer tooth rows in upper and lower jaw in *I. plutodus*.

The vascularization pattern of *I. plutodus* has the main osteons arranged radiating from the centre of the root, whilst those in *I. brasiliensis* are more or less horizontally arranged.

#### Conclusions

Significant tooth morphological differences exist between *I. plutodus* on the one hand and *I. brasiliensis* and *I. labialis* on the other hand. The tooth morphology of *I. brasiliensis* and *I. labialis* appears to be more or less similar. Based on these differences two different morpho-types can be distinguished that separates the species of the genus *Isistius* into an *Isistius plutodus* morpho-type and an *Isistius brasiliensis/labialis* morpho-type.

#### Acknowledgements

The authors like to thank Dr. M. McGrouther, Australian Museum, Sydney for giving access to species at their disposal. They also like to thank Dr. T. Trnski, Australian Museum, Sydney for taking tooth samples. The SEM photographs were taken by J. Cillis (Institut Royal des Sciences Naturelles de Belgique).

#### Bibliography

- BIGELOW H.B. & SCHROEDER W.C., 1948 : Fishes of the Western North Atlantic. Part.1. *Memoirs Search Foundation for Marine Research*. New Haven : 1-576.
- CADENAT J. & BLACHE J., 1981 : Requins de Méditerranée et d'Atlantique (plus particulièrement de la Côte Occidentale d'Afrique). *Editions de l'Office de la Recherche Scientifique et Technique Outre-Mer. Collection Faune Tropicale*. Paris. 22 : 141 - 149.
- CASIER E., 1961 : Transformation des systèmes de fixation et de vascularisation dentaires dans l'évolution des sélaciens du Sous-Ordre des Squaliformes. *Mémoires de l'Institut royal des Sciences naturelles de Belgique*. Bruxelles. 2<sup>ème</sup> Série. 65 : 1-61.
- COMPAGNO L.J.V., 1984 : FAO species catalogue. Vol.4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes. FAO Fisheries Synopsis. Roma. (125). Vol.4. Part 1 : 24-129.
- GARRICK J.A.F. & SPRINGER S., 1964 : *Isistius plutodus* a new Squaloid shark from the Gulf of Mexico. *Copeia*. Washington. 1964(4) : 678-682.
- HERMAN J., HOVESTADT-EULER M. & HOVESTADT D., 1989 : Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes. Part A : Selachii. N°3 : Order Squaliformes. Families Echinorhinidae, Oxynotidae and Squalidae. *Bulletin de l'Institut royal des Sciences naturelles de Belgique. Biologie*. Bruxelles. 59 : 101-157.

- HERMAN J., HOVESTADT-EULER M. & HOVESTADT D., 2003 : Contribution to the study of the comparative morphology of teeth and other relevant ichthyodolites in living supraspecific taxa of Chondrichthyan fishes. Part A : Selachii. Addendum to 1 : Order Hexanchiformes, 2 : Order Carcharhiniformes, 3 : Order Squaliformes. Tooth vascularization and phylogenetic interpretation. *Bulletin de l'Institut royal des Sciences naturelles de Belgique. Biologie*. Bruxelles. 73 : 5-26.
- LEDOUX J.-C., 1970 : Les dents des Squalidés de la Méditerranée occidentale et de l'Atlantique Nord-Ouest africain. *Vie et Milieu. Série A. Biologie marine*. Paris. 21(2a) : 309-362.
- MENG Q.-W., ZHU Y.-D. & LI S., 1985 : A new species of Dalatiidae (Squaliformes) of China. *Acta Zootaxonomica Sinica*. Beijing (Peking). 10(4) : 442-444.
- QUOY J.R. & GAIMARD J.P., 1824 -1825: Description des Poissons. Chapitre IX. in FREYCINET L. de, : Voyage autour du monde exécuté sur les corvettes de L.M. *L'Uranie* et *La Physicienne* en 1817, 1818, 1819 et 1820 : Voyage Uranie. Zoologie p.192-401 (1824 : 1-328, 1825 : 329-616) .
- STRASBOURG D.W., 1963 : The Diet and Dentition of *Isistius brasiliensis*, with Remarks on Tooth Replacement in other Sharks. *Copeia*. Washington. 1963(1) : 33-40.

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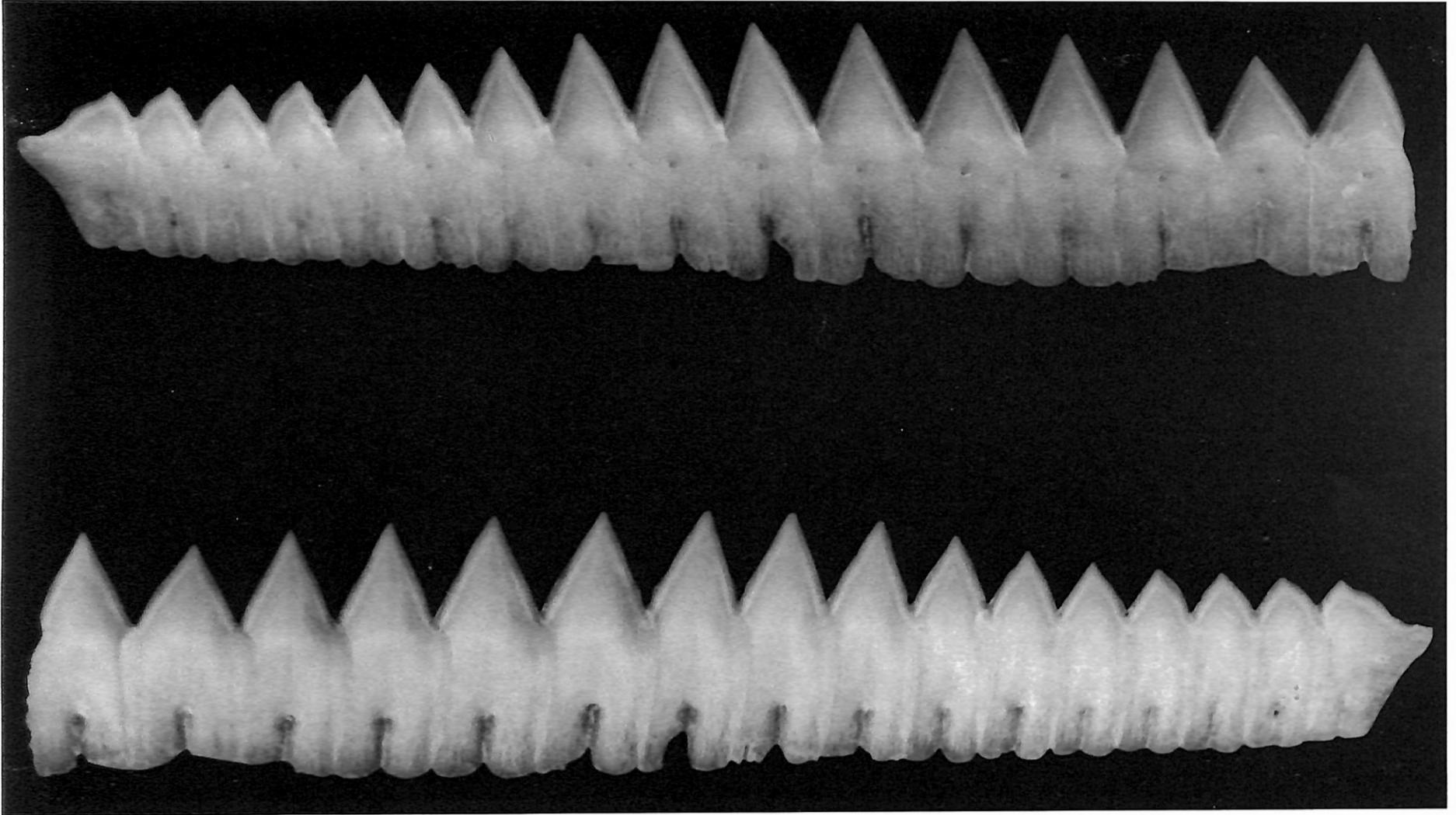


Plate 1 : *Isistius brasiliensis* QUOY & GAIMARD, 1824. Female 410mm t.l. , caught off Dakar, Senegal. Inner and outer views of the first non-functional teethset x4.



Plate 2 : *Isistius brasiliensis* QUOY & GAIMARD, 1824. Female 410mm t.l. , caught off Dakar, Senegal .SEM photographs : inner and outer views of parasymphyseal and fifth upper teeth x40, inner and outer views of symphyseal, seventh and commissural lower teeth x12.



Plate 3 : *Isistius brasiliensis* QUOY & GAIMARD, 1824. Female 240mm t.l. , caught off Philipinas. SEM photographs of outer and inner faces of the upper parasymphyseal and third upper teeth. x80.

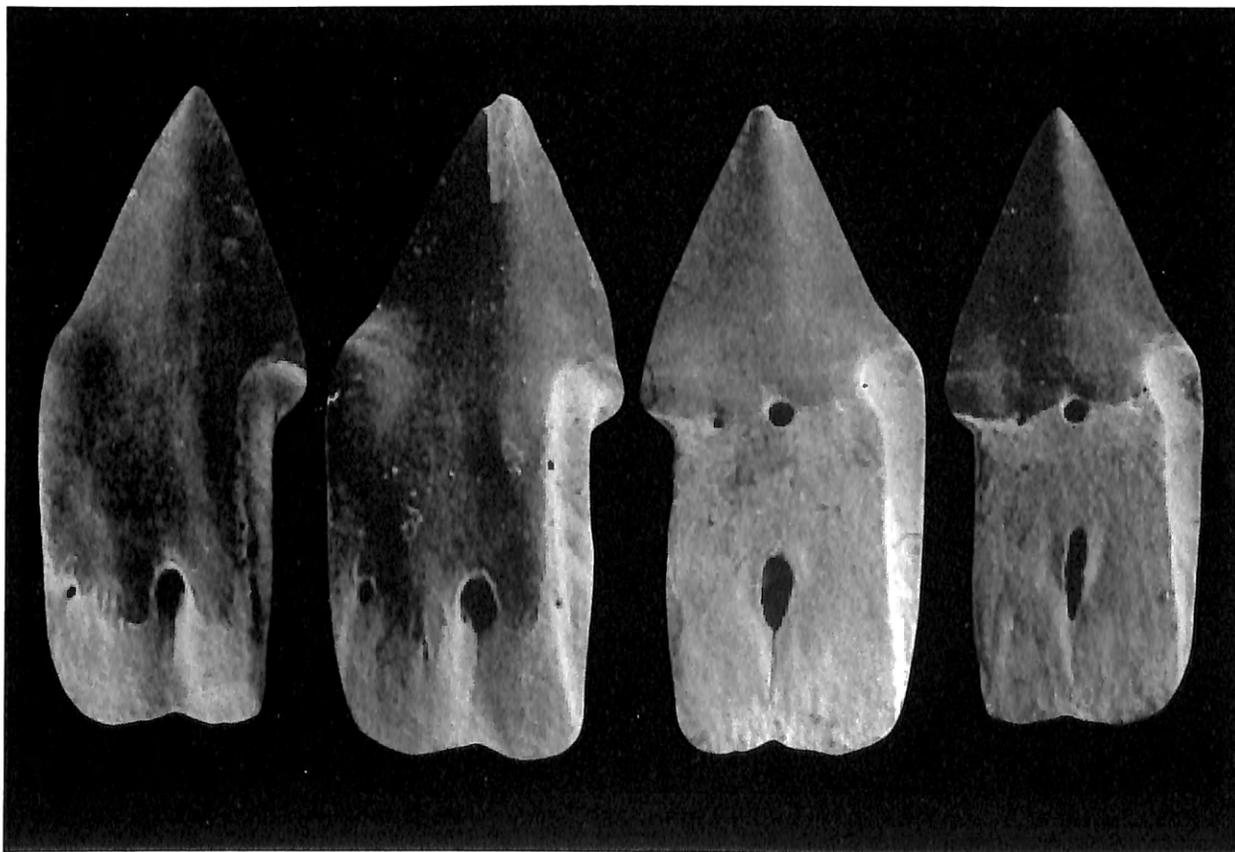
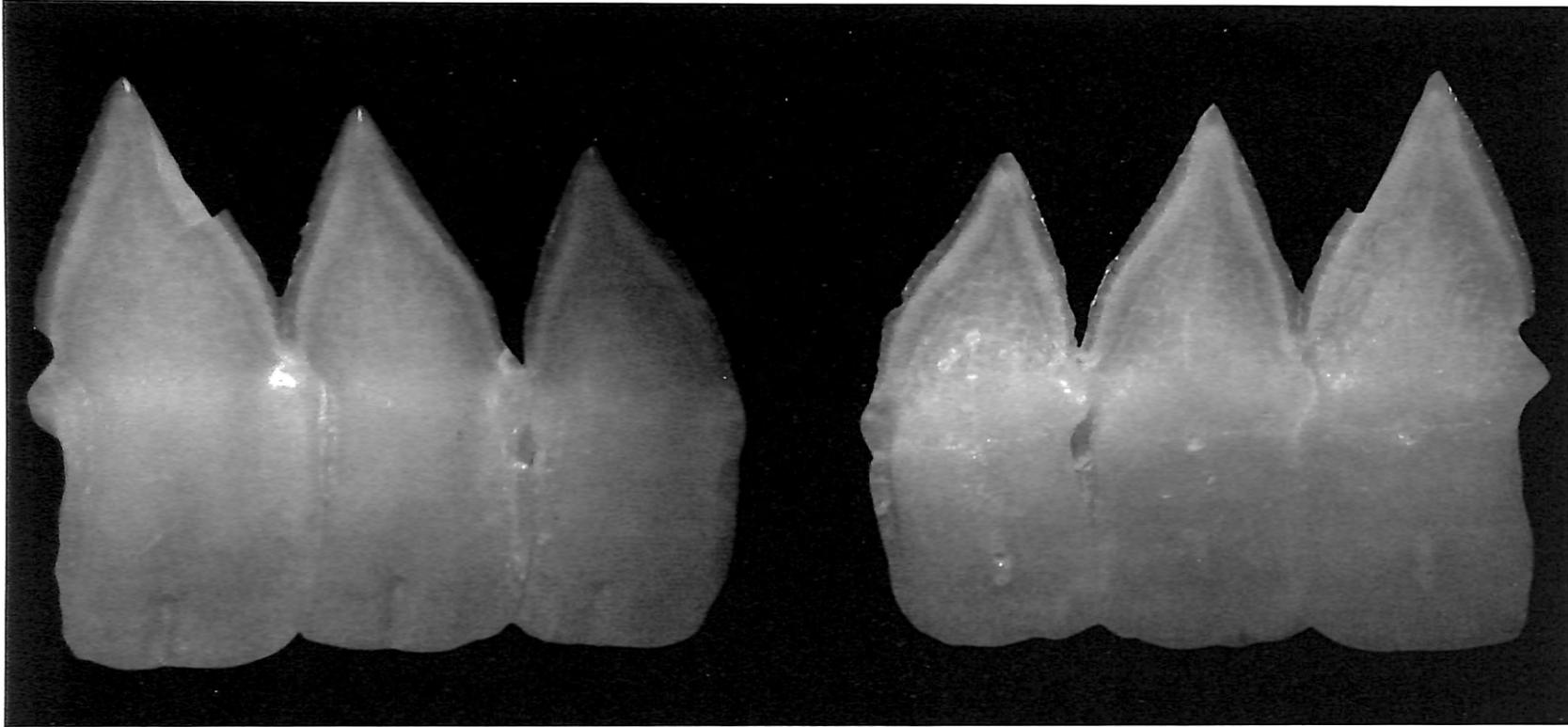


Plate 4 : *Isistius brasiliensis* QUOY & GAIMARD, 1824. Female 240mm t.l. , caught off Philipinas. SEM photographs of the outer and inner faces of the second and fourth lower teeth. x 20.



**Plate 5 :** *Isistius plutodus* GARRICK & SPRINGER, 1964. Female 363mm t.l. , AMS 1.43044-002, caught off Newcastle , New South Wales, Australia . Outer and inner views of the three first right lower anterior teeth in anatomical connection. x 12

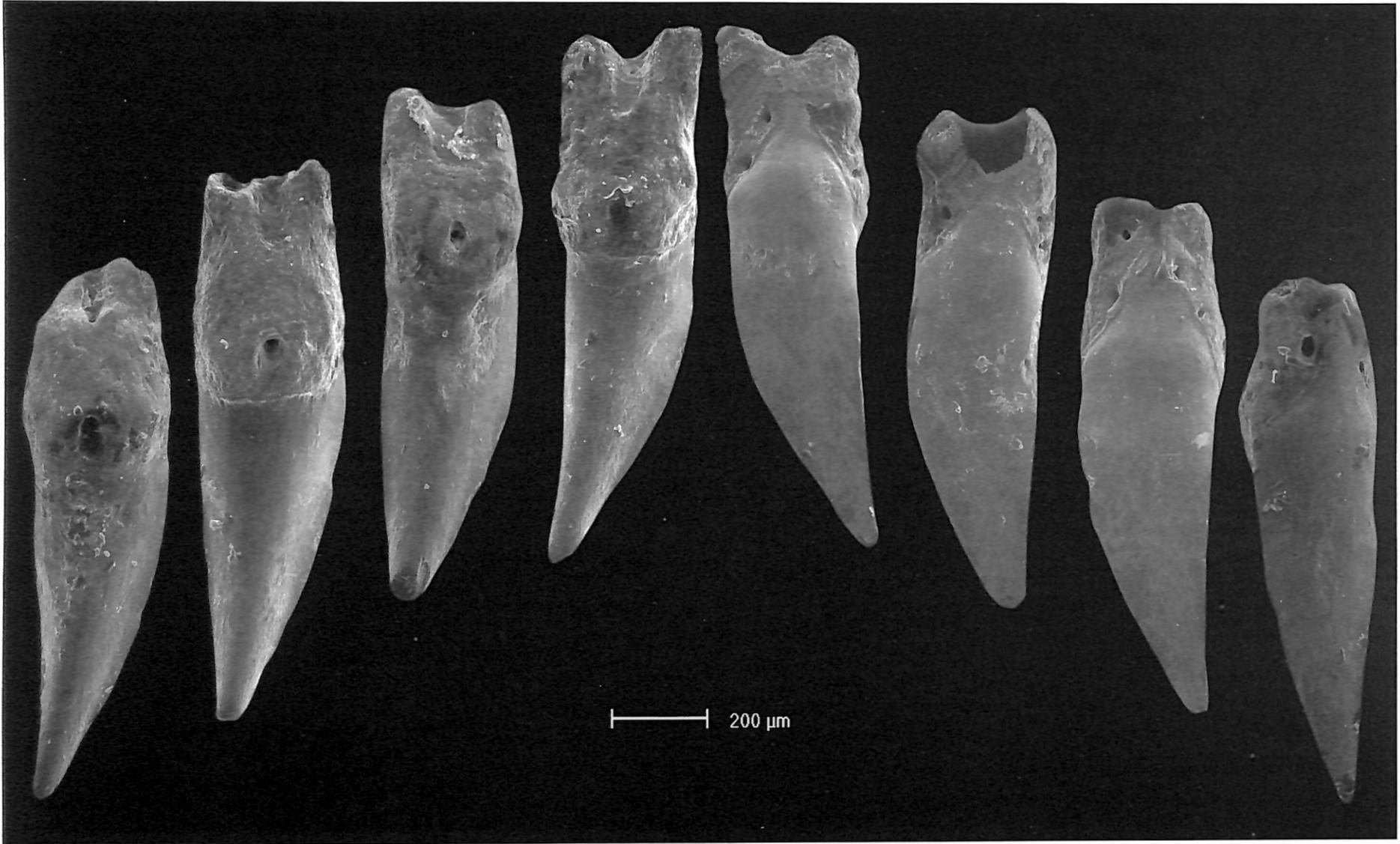


Plate 6 : *Isistius plutodus* GARRICK & SPRINGER, 1964. Female 363mm t.l. , AMS 1.43044-002, caught off Newcastle , New South Wales, Australia . SEM photographs. Outer and inner views of four of the first left upper anterior teeth.

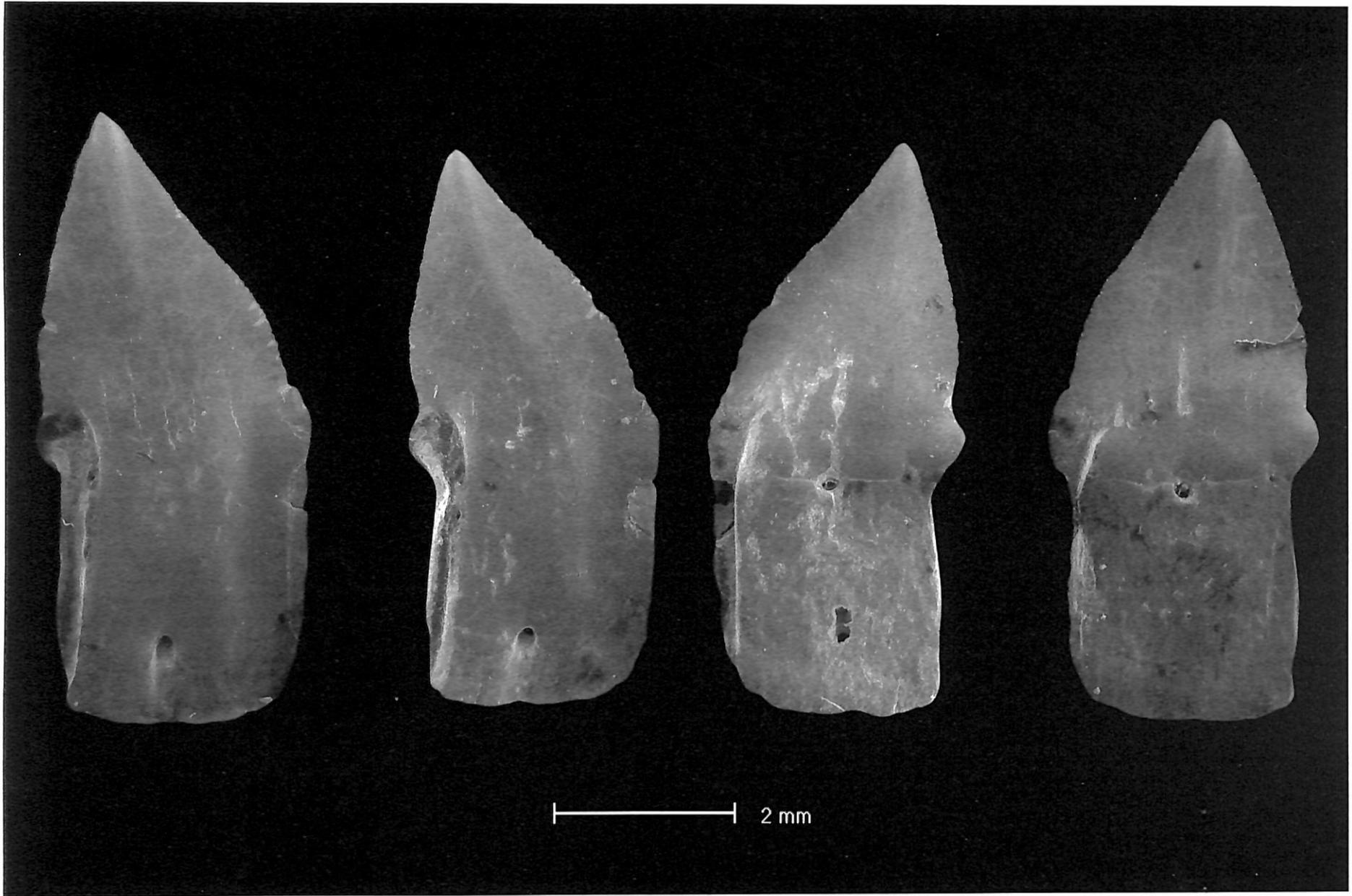
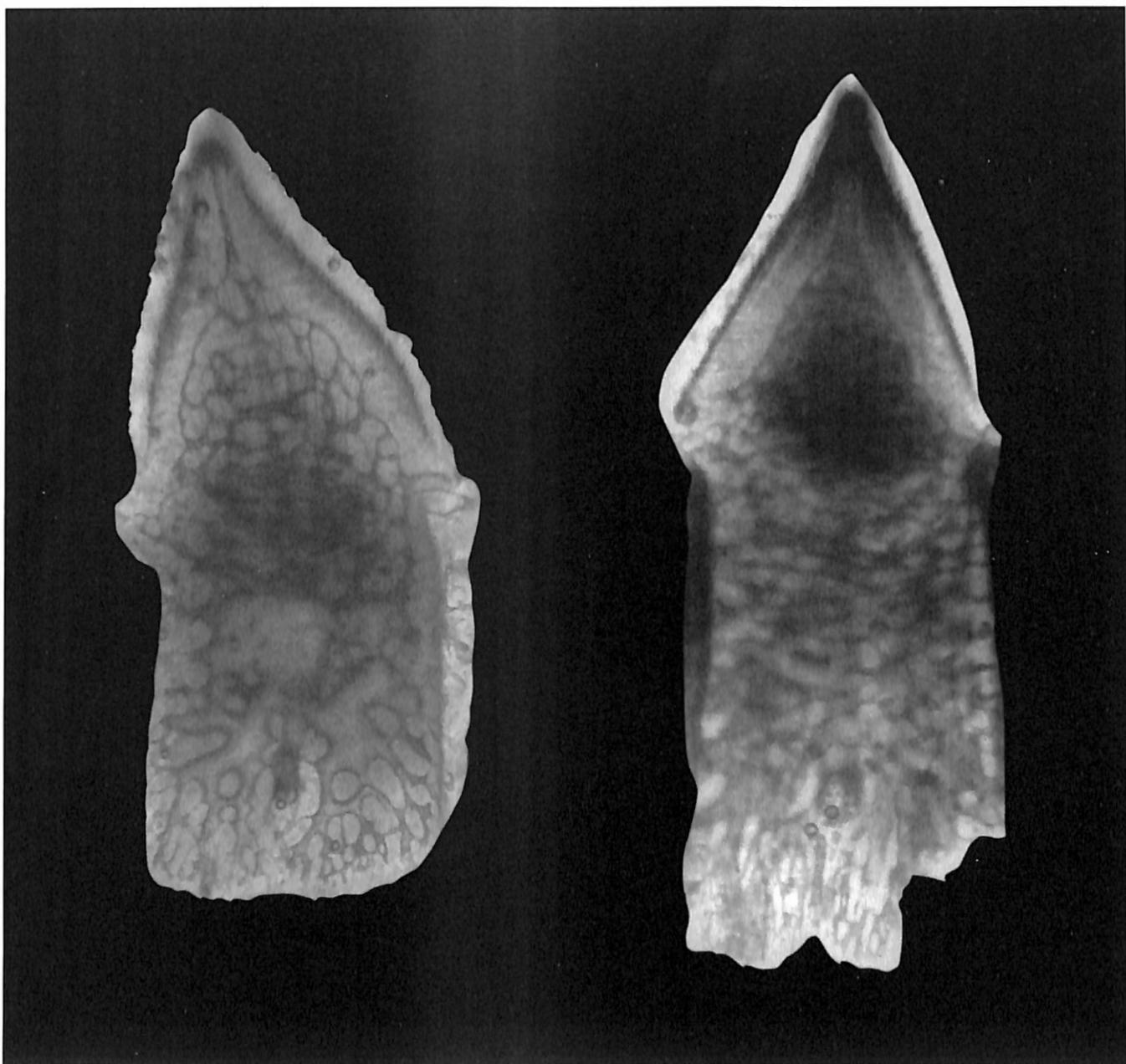


Plate 7 : *Isistius plutodus* GARRICK & SPRINGER, 1964. Female 363mm t.l. , AMS 1.43044-002,, caught off Newcastle , New South Wales, Australia . SEM photographs. Outer and inner views of the two first lower anterior teeth.



**Plate 8 :** Diagraphs of the first lower anterior tooth of *Isistius plutodus* GARRICK & SPRINGER, 1964, female 363mm t.l.(left) and of the first lower anterior tooth of *Isistius brasiliensis* QUOY & GAIMARD, 1824, female 410mm t.l.(right). Magnification x 25.