BULLETIN DE L'INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE, BIOLOGIE, 75: 5-20, 2005
BULLETIN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN, BIOLOGIE, 75: 5-20, 2005

Contributions to the odontological study of living Chondrichthyes. 2. The genus *Oxynotus* RAFINESQUE, 1810

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

Abstract: The tooth morphology of three of the four species of the genus *Oxynotus* is described and partly illustrated by SEM photographs. An interspecific diagnosis reveals the tooth morphological differences between the species *O. bruniensis, O. centrina* and *O. paradoxus.*

Key words: Odontology – Chondrichthyes – Squaliformes – Oxynotidae – *Oxynotus* – Tooth morphology.

Résumé: La morphologie dentaire de trois des quatre espèces du genre *Oxynotus* est décrite et figurée partiellement à l'aide de clichés MEB. Une diagnose interspécifique précise les différences morphologiques dentaires observées entre les espèces *O. bruniensis, O. centrina* et *O. paradoxus.*

Mots-clés: Odontologie – Chondrichthyes – Squaliformes – Oxynotidae – *Oxynotus* – Morphologie dentaire .

Kurzfassung: Die Zahnmorphologie von drei von der vier Arten der Gattung *Oxynotus* werden beschrieben und teilweise illustriert mit REM Photos. Eine interspezifische Diagnose zeigt die zahnmorphologische Unterschiede zwischen den Arten *O. bruniensis, O. centrina* und *O. paradoxus.*

Schlüsselwörter: Odontologie – Chondrichthyes – Squaliformes – Oxynotidae – *Oxynotus* – Zahnmorphologie.

Introduction

With the exception of *O. centrina,* the tooth morphology of the taxa of the genus *Oxynotus* is poorly known. For this study tooth material was available of *O. bruniensis, O. centrina* and *O. paradoxus.* Due to lacking tooth samples of *O. caribbaeus* this species could not be incorporated in this study. The tooth morphology of *O. bruniensis* and *O. paradoxus* will be described and illustrated. *O. centrina*, 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. An interspecific differential diagnosis reveals their tooth morphological differences. For the terminology used here, see HERMAN, HOVESTADT-EULER and HOVESTADT 1989.

Material

For this study , following material was available : *Oxynotus bruniensis* : two males, *Oxynotus centrina* : 13 males and 16 females, *Oxynotus paradoxus* : 5 males and 3 females.

Oxynotus RAFINESQUE, 1810

The genus *Oxynotus* comprises four species : *O .bruniensis* (OGILBY, 1893) , *O. caribbaeus*, CERVIGON, 1961, the type species *O. centrina* (LINNAEUS, 1758) and *O. paradoxus* FRADE, 1929.

Oxynotus bruniensis (OGILBY, 1893)

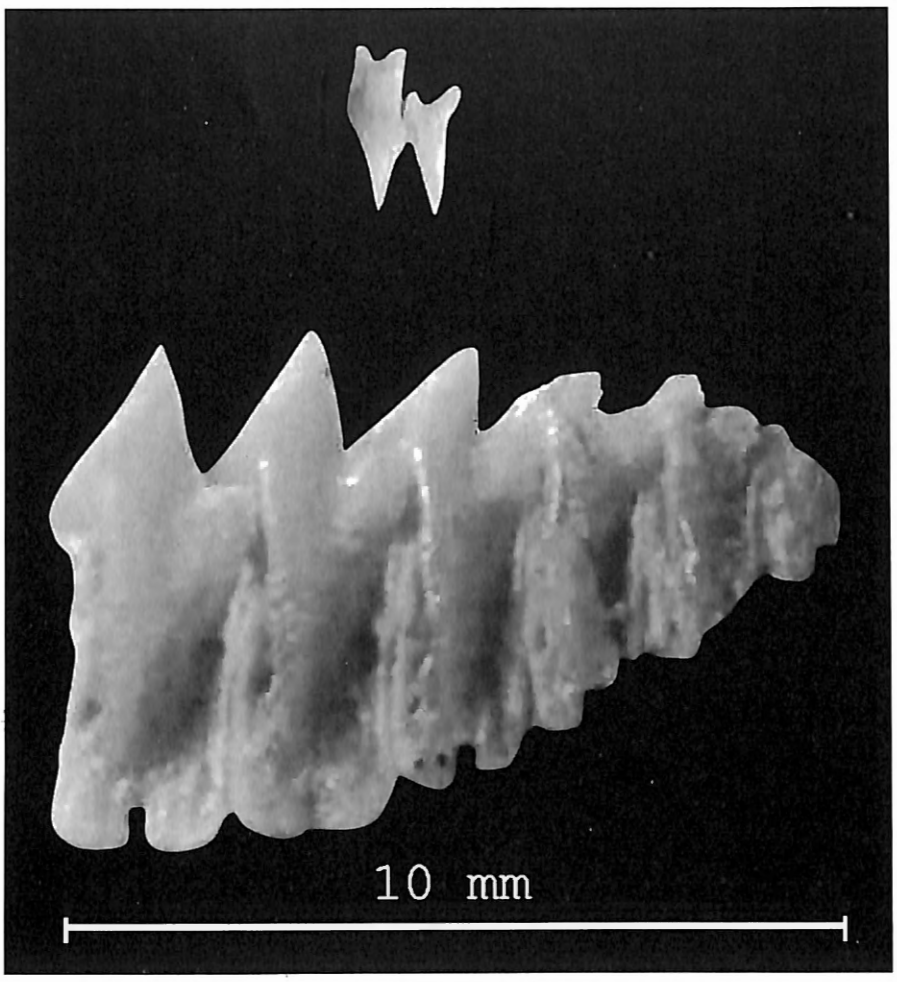
OGILBY J.D., 1893 : *Centrina bruniensis . Records of the Australian Museum.* Sidney. 2(5) :62-63.
Textplates 1,2, plates 1 to 3

For the first schematic illustration of upper and lower teeth *see* GARRICK J.A.F., 1960 : Studies on New Zealand Elasmobranchii. XI. Squaloids of the genera *Deania, Etmopterus, Oxynotus* and *Dalatias* in New Zealand waters. *Transaction of the royal Society of New Zealand.* Wellington. 88(3) : 519-557, 6 figs.
For a second one, with correct illustrations of outer faces of one upper tooth and one lower tooth *see* LAST P.R. & STEVENS J.D. , 1994 : *Sharks and Rays of Australia.* CSIRO division of Fisheries. Sidney. 513p., 84pl. (cf. p. 105).

This species shows a strong dignathic heterodonty and a weak monognathic heterodonty. The root is always anaulacorhizid.
The dimensions of the lower teeth are subcentrimetrical, those of the upper teeth plurimilimetrical in size.

UPPER JAW

The teeth are compressed, having a more or less vertically elongated crown and root.



Textplate 1 : ***Oxynotus bruniensis* (OGILBY, 1893).** Male 560mm t.l., caught off Wollongon, New-South-Wales, Australia. Outer view of two upper left anterior teeth and the whole lower left toothset

Textplate 2 : ***Oxynotus bruniensis* (OGILBY, 1893).** Male 560mm t.l., caught off Wollongon, New-South-Wales, Australia. Diagraph of the same lower left toothset.

The crown is twice as high as the crown base width and as high as the root. The symphyseal tooth has a symmetrical triangular crown. The lateral teeth maintain symmetrical, less high, and narrower toward the commissure. Both mesial and distal cutting edges are smooth.
The outer face is strongly convex and a broad apron extends nearly to the root base. The apron is arched at the base and slightly overhangs the root. A true outer or inner ornamentation is absent.
The root is elongated and has a more or less rectangular appearance. The basal edges of the root are slightly rounded. A foramen is present at each side of the apron. The inner face is flat, showing sometimes a median aperture near the crown-root junction. A shallow less developed medio-basal sulcus is present.

LOWER JAW

The teeth are strongly compressed and interlocked. The crown base width is approx. 30% less than its height, and also 30% the root height. The crown is high and symmetrically triangular in the symphyseal teeth but becomes increasingly asymmetrical and less high in lateral and commissural teeth. The crown possesses a relatively well developed rounded blade at each basal edge, continued upward as a poorly developed serration, which disappears totally toward the apex. The mesial blade is absent at lateral teeth and those toward the commissure. Both cutting edges are more or less straight.
The outer face of the crown is convex and a very broad apron extends nearly to the root base. The apron is not overhanging the root but forms one part with it. From the crown-root junction downward, the apron continues its width and more or less narrows to half its size near its lowest part. A shallow aperture is present at each side of the apron. The basal edges of the root are slightly rounded. A weak outer mesial depression is also due to interlocking.
On the inner face of the crown there is a well developed uvula without basal costules or depression. A large median aperture is present at each side of the uvula and one large, median aperture below the uvula. A short, broad, medio-basal sulcus is present. Two to four foramina surround the sulcus, and several scattered foramina are on the outer basal edge of the root. A weak inner distal depression is due to interlocking of the lower teeth.

Oxynotus centrina (LINNAEUS, 1758)

LINNAEUS, 1758 : *Squalus centrina*. Systema Naturae. Ed.10(1) :233.

Plates 4 to 6

This species shows a strong dignathic heterodonty and a weak monognathic heterodonty. The root is always anaulacorhizid.
The dimensions of the lower teeth are subcentrimetrical, those of the upper teeth plurimilimetrical in size.

UPPER JAW

The teeth are compressed, having a more or less vertically elongated crown and root.
The height of the crown is twice as high as the crown base width, but half the root height. The symphyseal tooth has a symmetrical triangular crown. The lateral teeth show a crown, becoming increasingly asymmetrical, less high, and broader based toward the commissure. Both mesial and distal cutting edges are smooth.
The outer face is strongly convex and a broad apron extends nearly to the root base. The apron is not overhanging the root but forms one part with it. A true outer or inner ornamentation is absent.
The root is elongated and has a more or less rectangular appearance. From the crown-root junction downward, the root is narrowing and the basal edges are slightly rounded. Two or three foramina are present at each side of the apron. The inner face is flat, showing a median aperture near the crown-root junction; sometimes a poorly developed median vertical groove is present, which is more distinct on the lateral and posterior teeth. A deep medio-basal sulcus is always present.

LOWER JAW

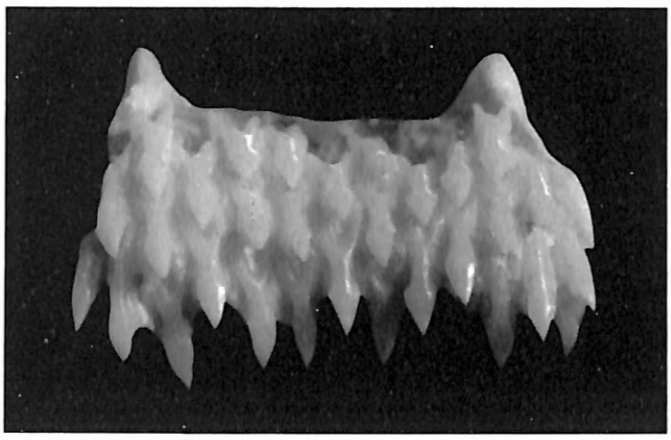
The teeth are strongly compressed and interlocked. The crown base width is equal to its height, but half the root height.
The crown is high and symmetrically triangular in the symphysial teeth but becomes increasingly asymmetrical and less high in lateral and commissural teeth. The crown possesses a relatively small, bluntly rounded blade at each basal edge, continued upward as strong serration, which becomes reduced in upper crown half and finally disappears totally toward the apex. The mesial blade diminishes in size on tooth positions toward the commissure. Both cutting edges are strongly sigmoid.
The outer face of the crown is convex and a broad apron extends nearly to the root base. The apron is not overhanging the root but forms one part with it. From the crown-root junction downward, the apron is narrowing to half its size. A large aperture is present at each side of the apron. Near the junction of the apron and root, some vertical protuberances are present. The basal edges of the root are slightly rounded. A weak outer mesial depression is also due to interlocking.
On the inner face of the crown there is a rectangular uvula at the symphyseal tooth that becomes more oblique and less developed in teeth toward the commissure. The uvula presents a basal depression. A large median aperture is present at each side of the uvula and one large, median aperture below the basal depression. A short, broad, medio-basal sulcus is present. Two to four foramina surround the sulcus, and several scattered foramina are on the outer basal edge of the root. A weak inner distal depression is due to interlocking of the lower teeth.

***Oxynotus paradoxus* FRADE, 1929**
Boletim de Sociedade Portuguesa de Ciencias naturais.
Lisboa. 10(22) : 263-267, fig.1.
Textplates 3, 4 , plates 7 to 10.

This species shows a strong dignathic heterodonty and a weak monognathic heterodonty. The root is always anaulacorhizid.
The dimensions of the lower teeth are subcentrimetrical, those of the upper teeth plurimilimetrical in size.

UPPER JAW

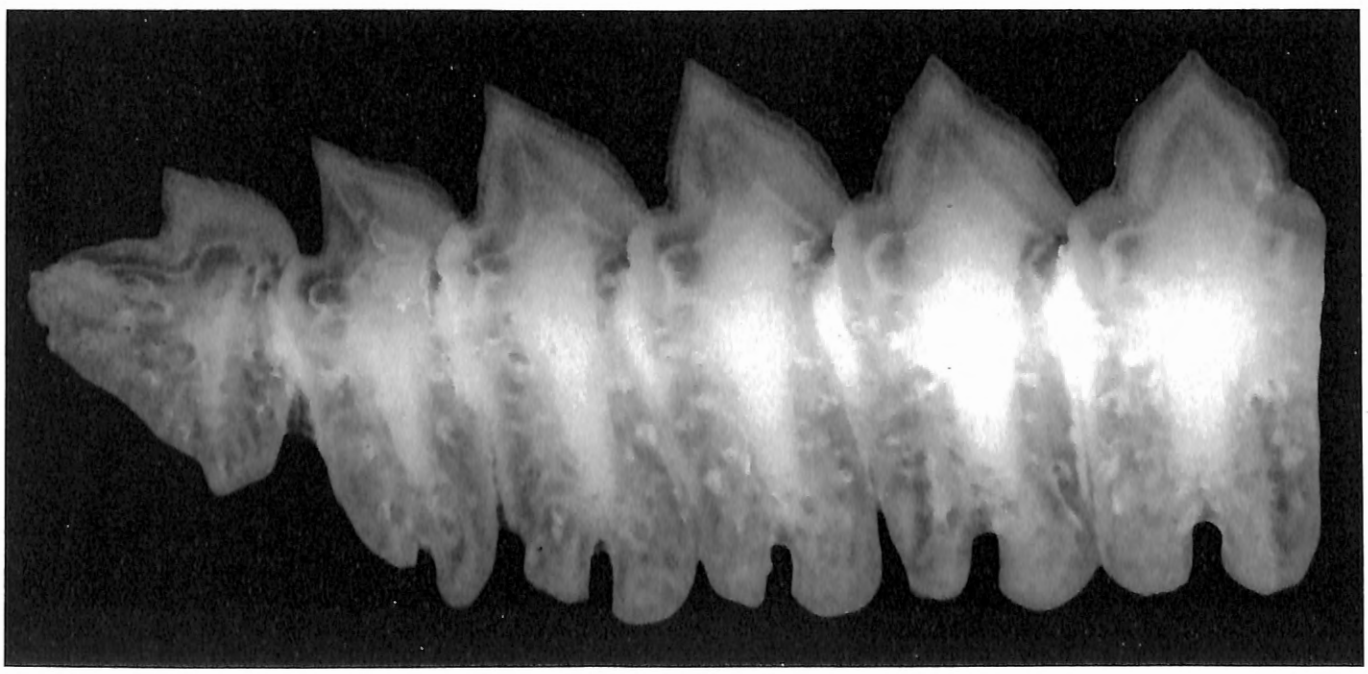
The teeth are compressed, having a more or less vertically elongated crown and root.
The height of the crown is twice as high as the crown base width, but half the root height. The symphyseal tooth has a symmetrical triangular crown with slightly arched cutting edges. The lateral teeth maintain symmetrical, less high, and narrower toward the commissure. Both mesial and distal cutting edges are smooth.
The outer face is strongly convex and a broad apron extends nearly to the root base. The apron is arched at the base and slightly overhangs the root. A true outer or inner ornamentation is absent.
The root is elongated and has a more or less rectangular appearance with a slight constriction half way its height. The root is slightly narrowing at he base and the basal edges are slightly rounded. Foramina are absent at each side of the apron. The inner face is flat showing a median aperture near the crown-root junction, becoming less developed in lateral teeth and disappears near the commissural positions. A deep medio-basal sulcus is always present.



Textplate 3 : ***Oxynotus paradoxus* FRADE, 1929.** Female 920mm t.l., caught off north-west Ireland, 540m depth, Ireland. Outer view of the upper dentition. Magnification x6.

LOWER JAW

The teeth are strongly compressed and interlocked. The crown base width is equal to its height, but half the root height. The crown is high and symmetrically triangular in the symphyseal teeth but becomes increasingly asymmetrical and less high in lateral and commissural teeth. The crown possesses a relatively well developed rounded blade at each basal edge, continued upward as a poorly developed serration, which disappears totally toward the apex. The mesial blade is absent at lateral teeth and those toward the commissure. Both cutting edges are slightly sigmoid.
The outer face of the crown is convex and a broad apron extends nearly to the root base. The apron is not overhanging the root but forms one part with it. From the crown-root junction downward, the apron continues its width and more or less narrows to half its size near its lowest part. A shallow



Textplate 4 : ***Oxynotus paradoxus* FRADE, 1929.** Female 920mm t.l., caught off north-west Ireland, 540m depth, Ireland. Diagraph of whole lower left toothset and of the symphyseal tooth (inner side) Magnification x14.

aperture is present at each side of the apron. The basal edges of the root are slightly rounded. A weak outer mesial depression is also due to interlocking.
On the inner face of the crown there is a uvula presenting coarse basal costules. A large median aperture is present at each side of the uvula and one large, median aperture below the uvula. A short, broad, medio-basal sulcus is present. Two to four foramina surround the sulcus, and several scattered foramina are on the outer basal edge of the root. A weak inner distal depression is due to interlocking of the lower teeth.

Interspecific differential diagnosis

UPPER JAW

The teeth of *O. centrina*'s upper jaw become oblique toward the commissure, with the outer apron not overhanging the root. Those of *O. paradoxus* and *O. bruniensis* maintain straight and the outer apron overhangs the root. The cutting edges of the crown of *O. paradoxus* are slightly arched, which are straight in *O. centrina* and *O. bruniensis*. The height of the crown is twice as high as the crown base width, but half the root height in *O. bruniensis, O. centrina* and *O. paradoxus*.

LOWER JAW

The teeth of *O .centrina*'s lower jaw possess strongly sigmoid cutting edges that are less sigmoid in *O. paradoxus* and more or less straight in *O. bruniensis*. The distal blade is small and poorly developed in *O. centrina*, but well developed in *O. bruniensis* and *O. paradoxus* in opposite to the mesial and distal serration that is poorly developed in *O. bruniensis* and *O. paradoxus* but well developed in *O. centrina*.
The crown base width is equal to its height, and half the root height in *O. centrina* and *O. paradoxus* but 30% less wide than the crown height and root height in *O. bruniensis*.
The apron is gradually narrowing downward to half its size in *O. centrina*, but continues its width downward in *O. bruniensis* and *O. paradoxus*. The uvula possesses a basal depression in *O. bruniensis*, coarse basal costules in *O. paradoxus*, and is smooth in *O. bruniensis*.

Character detail / Species	*Oxynotus bruniensis*	*Oxynotus centrina*	*Oxynotus paradoxus*
Upper jaw teeth toward commissure oblique	No	Yes	No
Upper jaw teeth apron overhangs the root	Yes	No	Yes
Upper jaw teeth cutting edges shape arched	No	No	Yes
Upper jaw teeth crown height twice the crown base width, but half the root height	Yes	Yes	Yes
Upper teeth apron gradually narrows downwards	No	Yes	No
Lower jaw teeth cutting edges shape sigmoid	No	Yes	Yes
Lower jaw teeth cutting edges shape straight	Yes	No	No
Lower jaw teeth distal blade well developed	Yes	No	Yes
Lower jaw teeth serration well developed	No	Yes	No
Lower jaw teeth crown base width equals height and half the root height	No	Yes	Yes
Lower jaw teeth crown base width 30% less than height and 30% of root height	Yes	No	No
Lower jaw teeth apron gradually narrows downwards	No	Yes	No
Lower jaw teeth uvula with basal depression	No	Yes	No
Lower jaw teeth uvula with coarse basal costules	No	No	Yes
Lower jaw teeth uvula smooth	Yes	No	No

Table 1

Conclusions

Although generally the three species share many tooth morphological characters, some significant differences appear in both upper and lower jaw (see table 1 above).

O. centrina shares upper and lower teeth dimensions and lower teeth sigmoid shape of the cutting edges with *O. paradoxus* but none of the characters with *O. bruniensis*.
O. paradoxus shares an overhanging apron of the upper teeth and a well developed distal blade with *O. bruniensis*.
O. bruniensis is unique by straight cutting edges and a crown base width 30% less than its height and 30% of root height in the lower teeth
O. centrina is unique by possessing lateral and commissural teeth becoming oblique with a gradually narrowing apron in the upper teeth and an apron gradually narrowing downwards, a uvula with a basal depression and a well developed serration on the cutting edges in the lower teeth.
O. paradoxus is unique by arch-shaped cutting edges in the upper jaw teeth and a uvula with coarse basal costules in the lower teeth.
The three species share the crown height that equals root but is half the root height in the upper teeth.

Acknowledements

Authors like to thank Dr. G. Lenglet, Institut royal des Sciences Naturelles de Belgique and Dr. M. McGrouther, Australian Museum, Ichthyology Section for giving access to specimens at their disposal. The SEM photographs were taken by J. Cillis (Institut royal des Sciences naturelles de Belgique).

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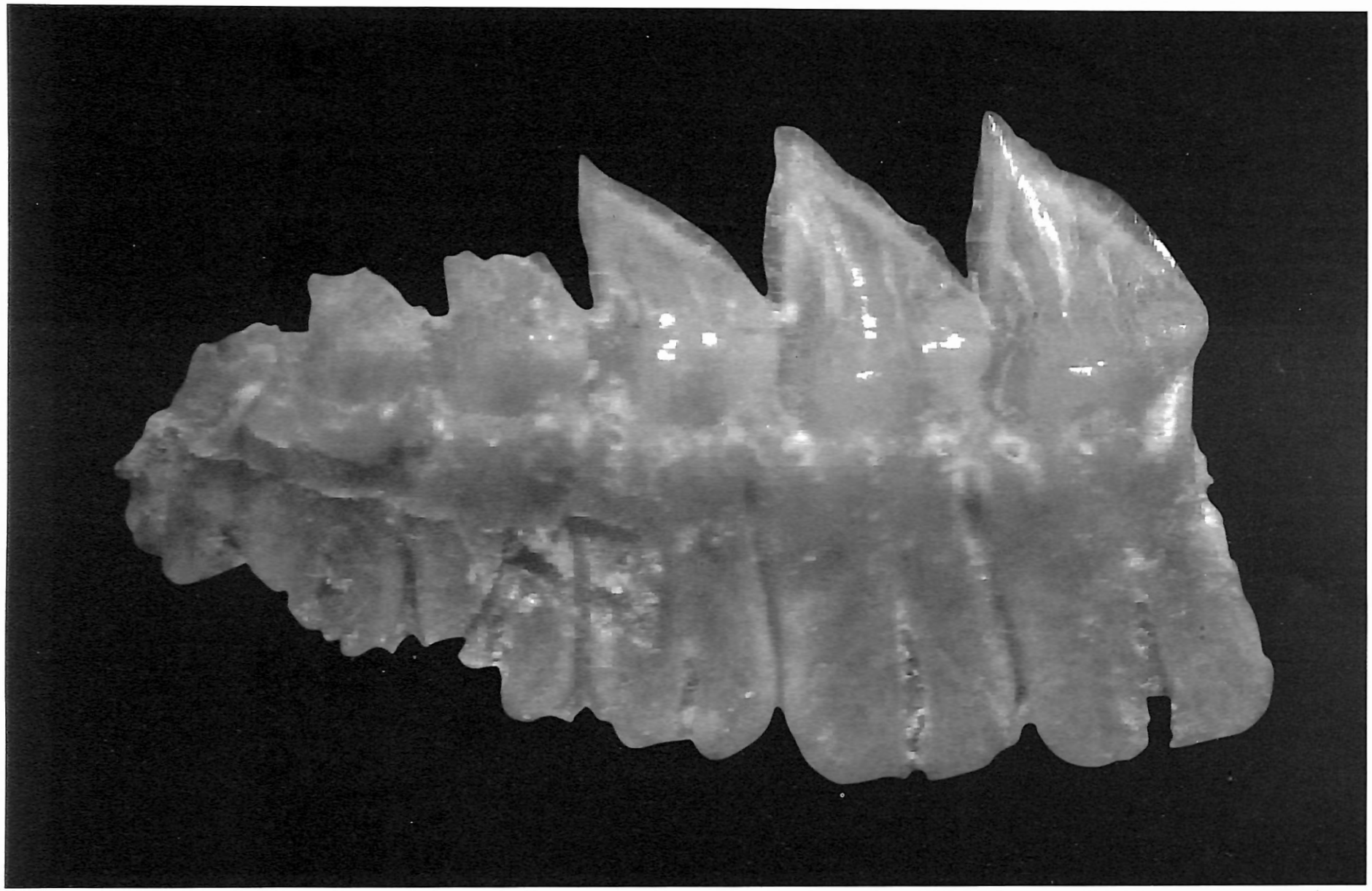

Plate 1 : ***Oxynotus bruniensis*** **(OGILBY, 1893).** Male 560mm t.l., caught off Wollongon, New-South-Wales, Australia. Inner view of the same lower left toothset.

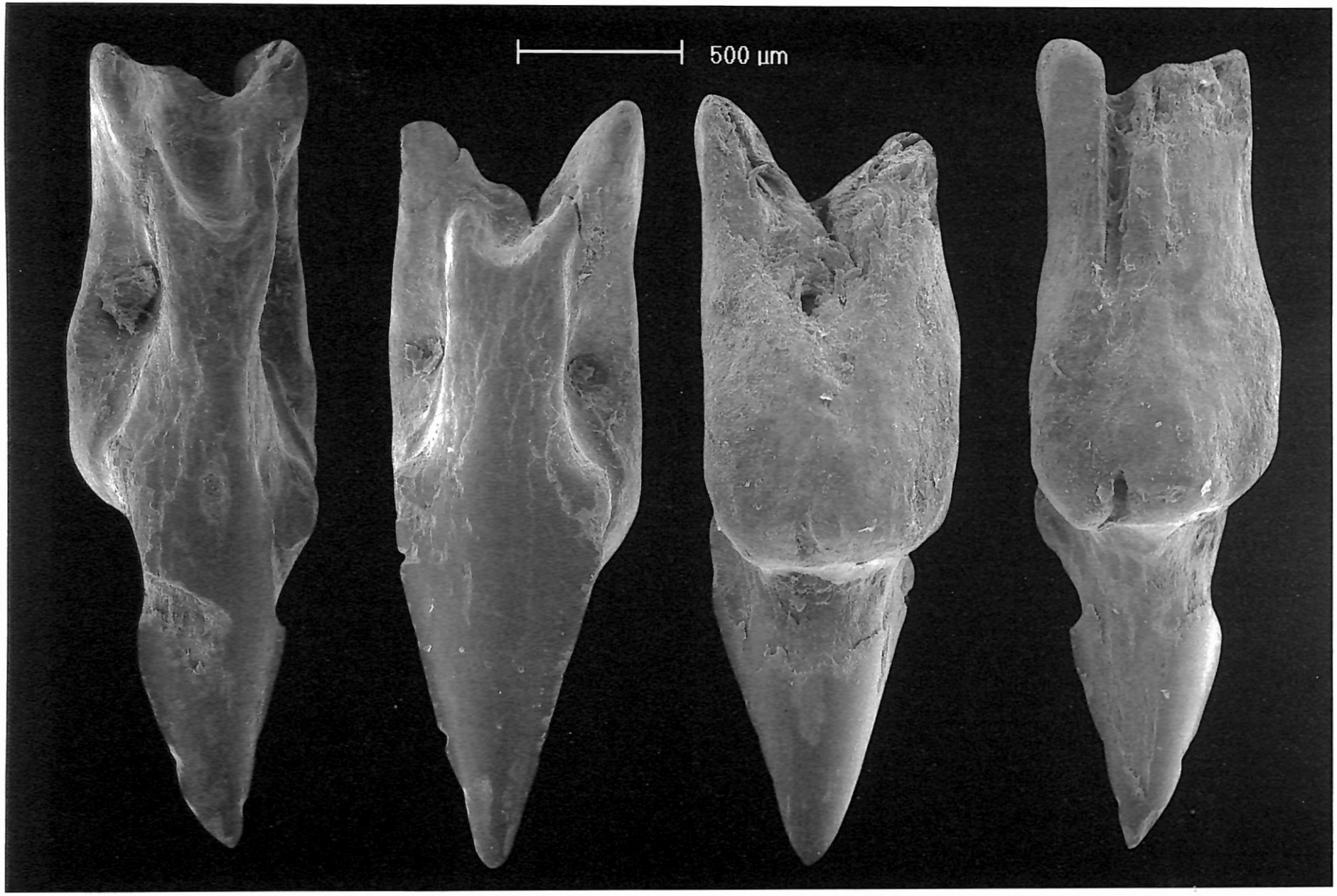

Plate 2 : ***Oxynotus bruniensis*** **(OGILBY, 1893).** Male 560mm t.l., caught off Wollongon, New-South-Wales, Australia. Outer and inner views of two upper anterior teeth.

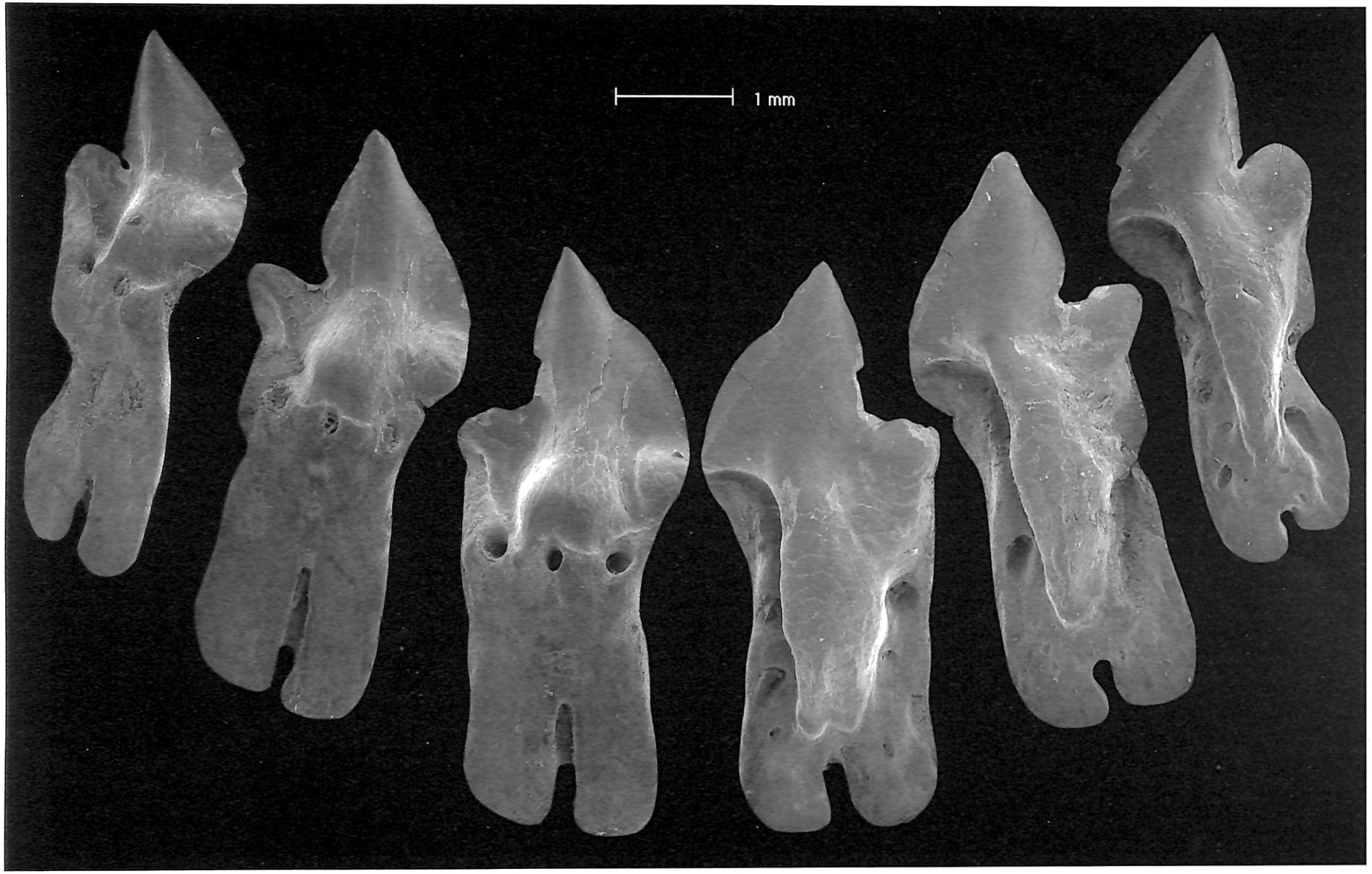

Plate 3 : ***Oxynotus bruniensis*** **(OGILBY, 1893).** Male 560mm t.l., caught off Wollongon, New-South-Wales, Australia. Inner and outer views of the three first lower teeth .

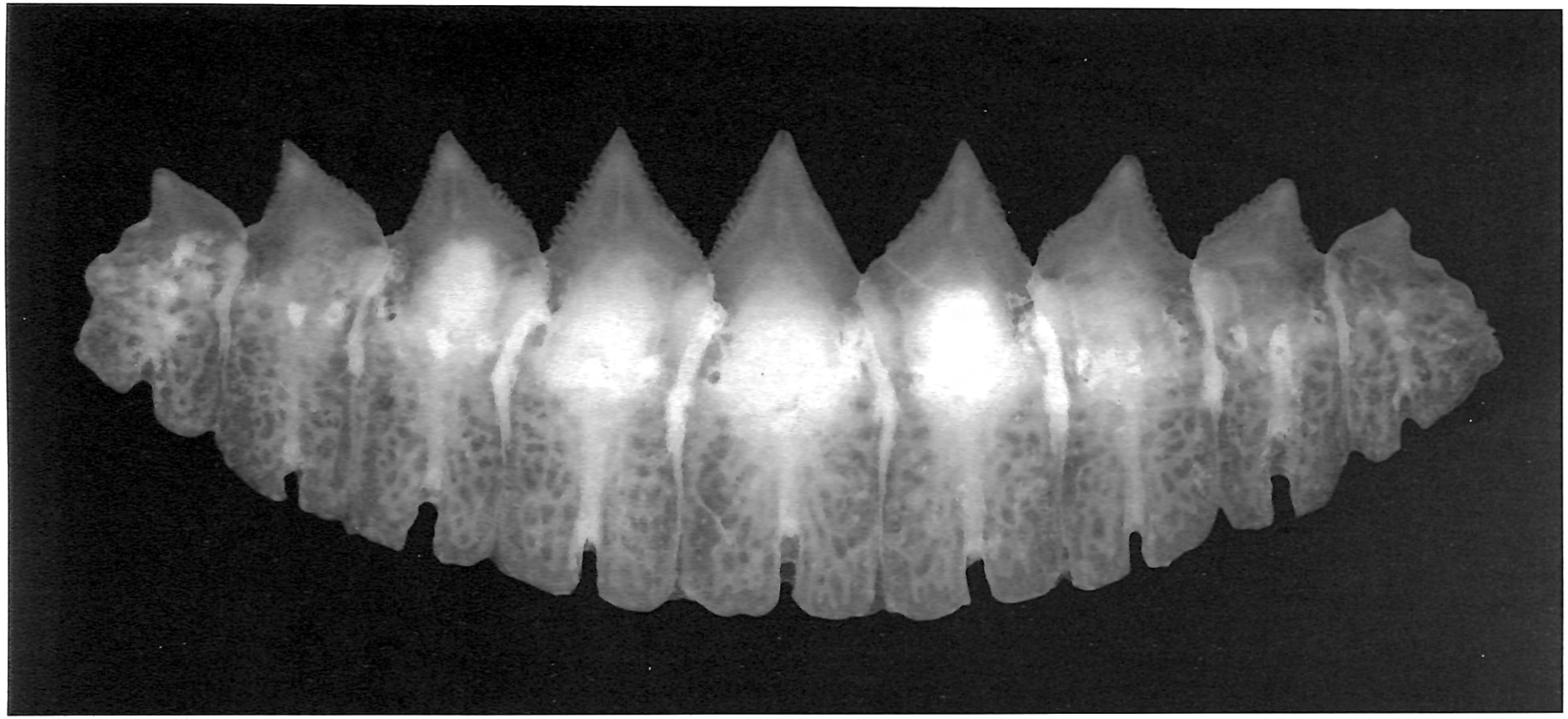

Plate 4 : ***Oxynotus centrina*** **(LINNAEUS, 1758).** Female 460mm t.l., caught Cap-des-Biches, 30m depth, Dakar, Senegal. Diagraph of the whole lower toothset (inner view). Magnification x 9.

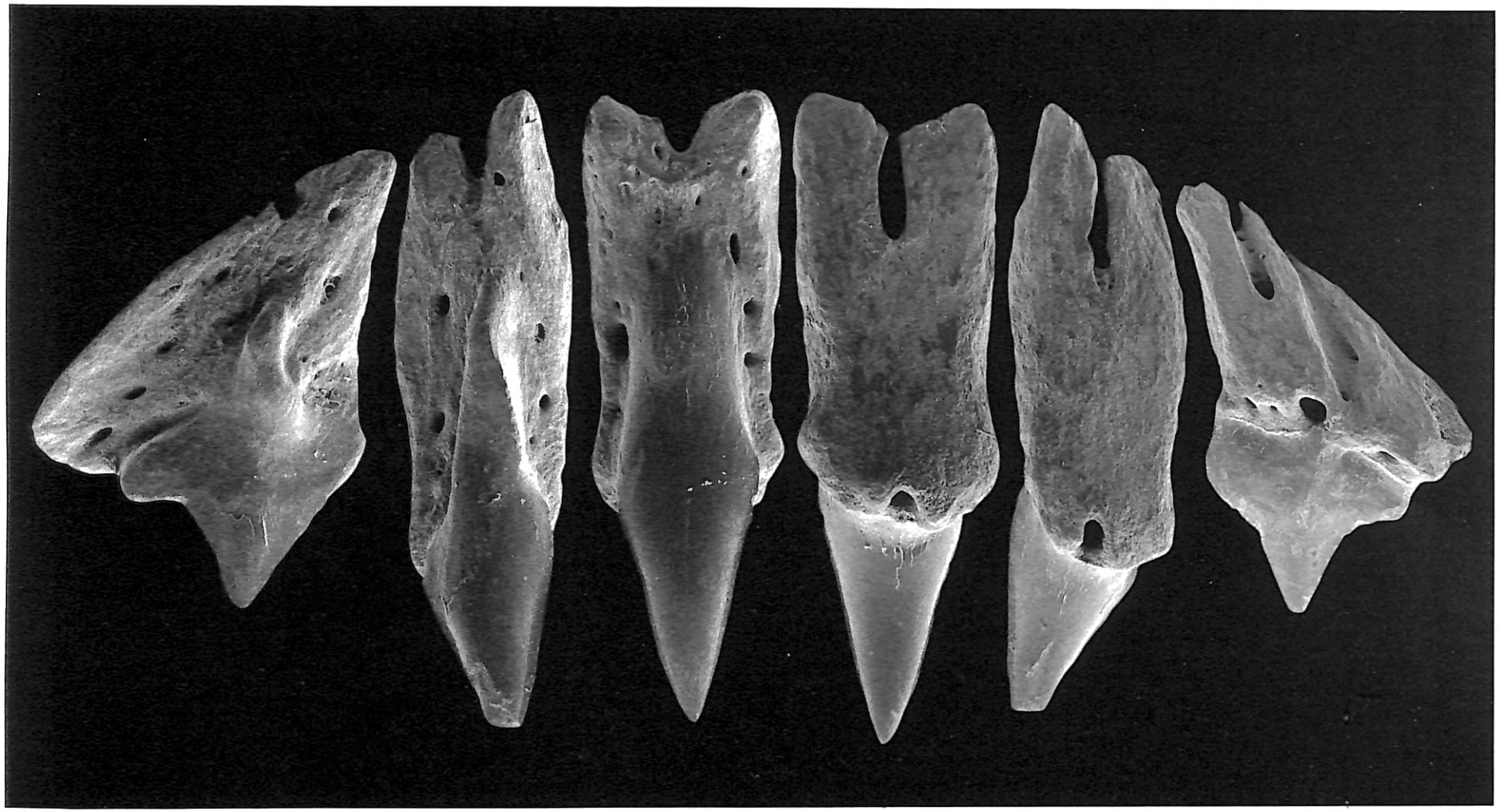

Plate 5 : ***Oxynotus centrina*** **(LINNAEUS, 1758).** Female 460mm t.l., caught Cap-des-Biches, 30m depth, Dakar, Senegal. Outer and inner views of upper parasymphyseal, lateral and commissural teeth. Magnification x 50.

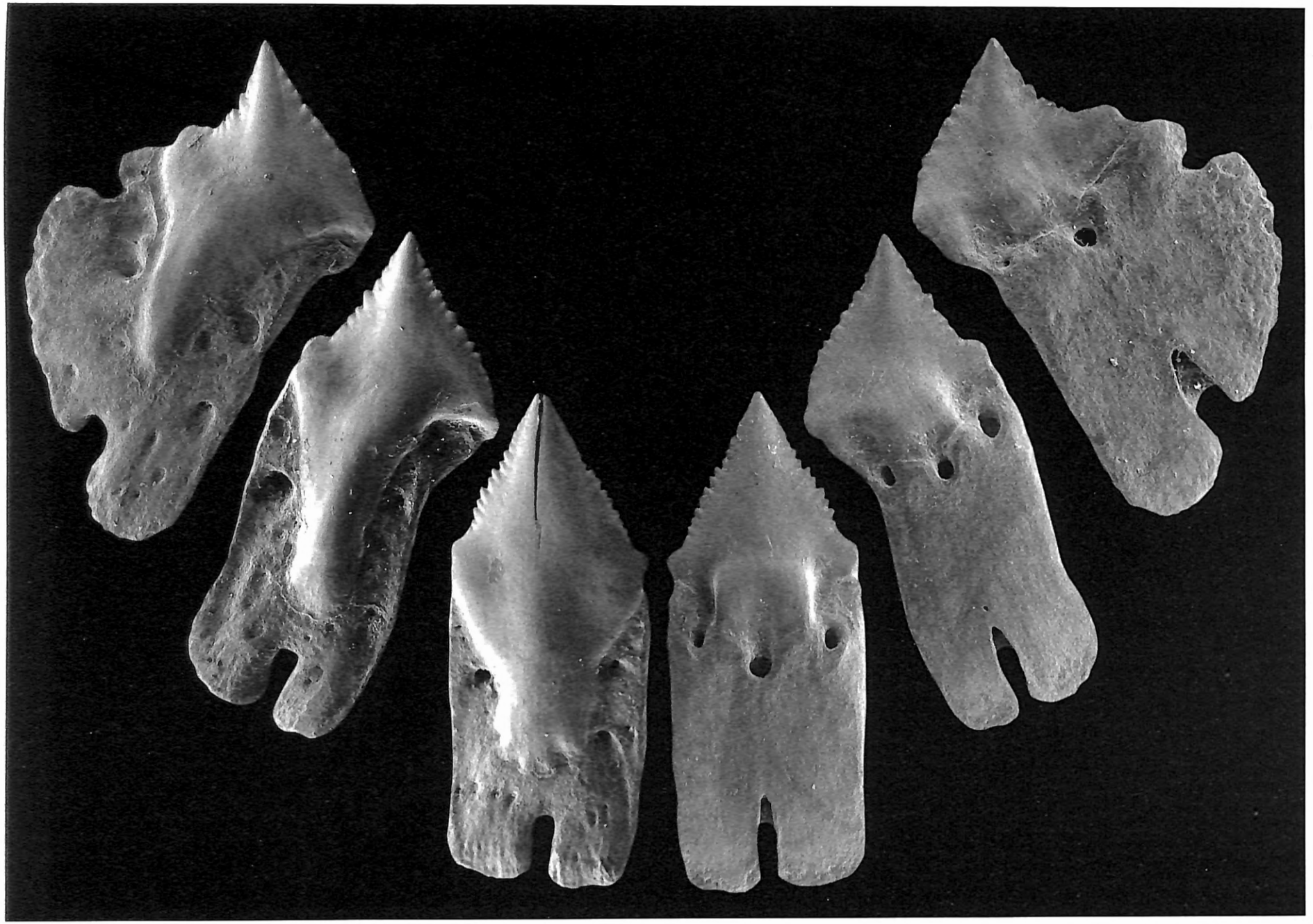

Plate 6 : ***Oxynotus centrina*** **(LINNAEUS, 1758).** Female 460mm t.l., caught Cap-des-Biches, 30m depth, Dakar, Senegal. Outer and iner views of symphyseal, third and commissural lower teeth. Magnification x20.

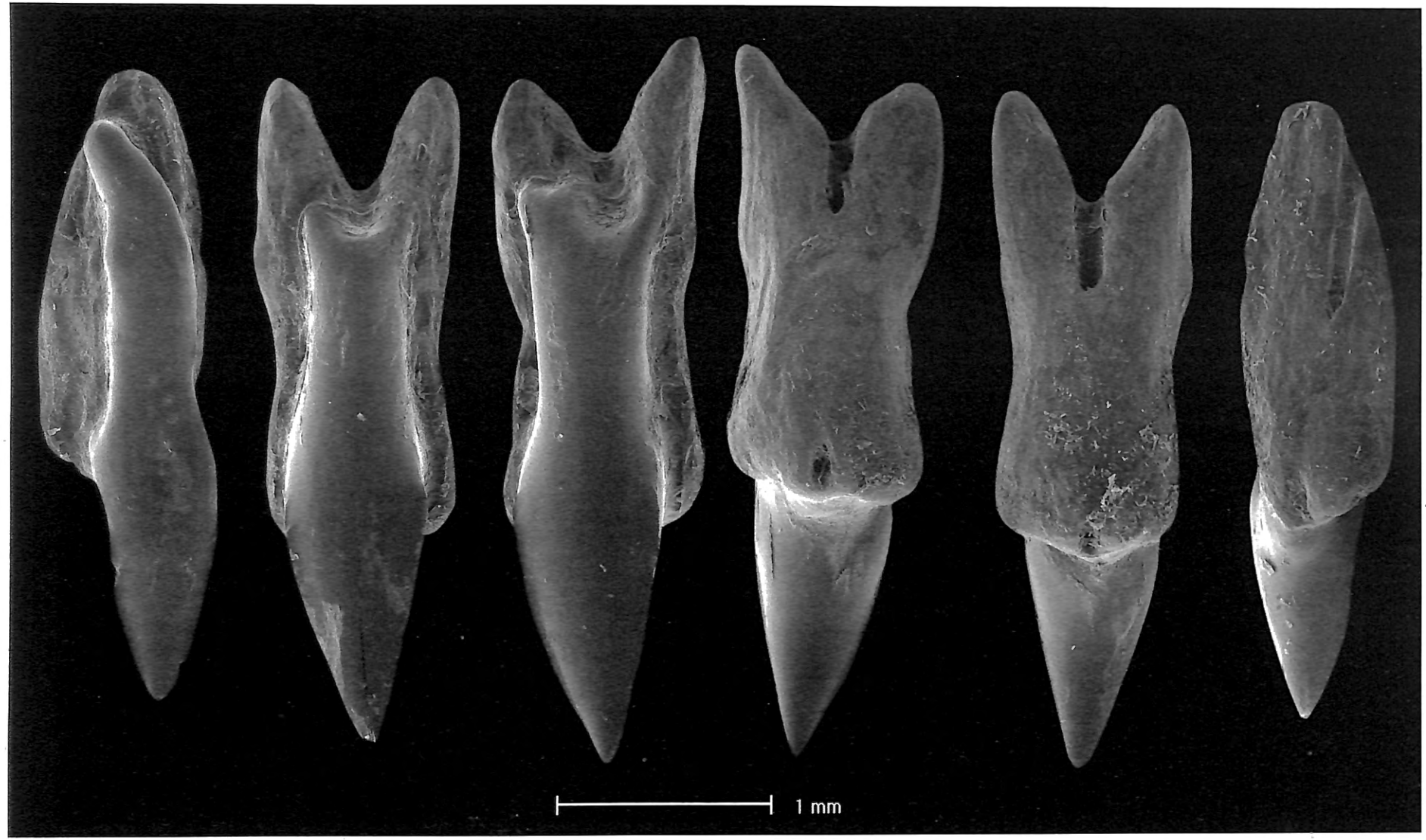

Plate 7 : ***Oxynotus paradoxus*** **FRADE, 1929.** Female 920mm t.l., caught off north-west Ireland, 540m depth, Ireland. Outer and inner views of parasymphyseal, third and fifth upper teeth.

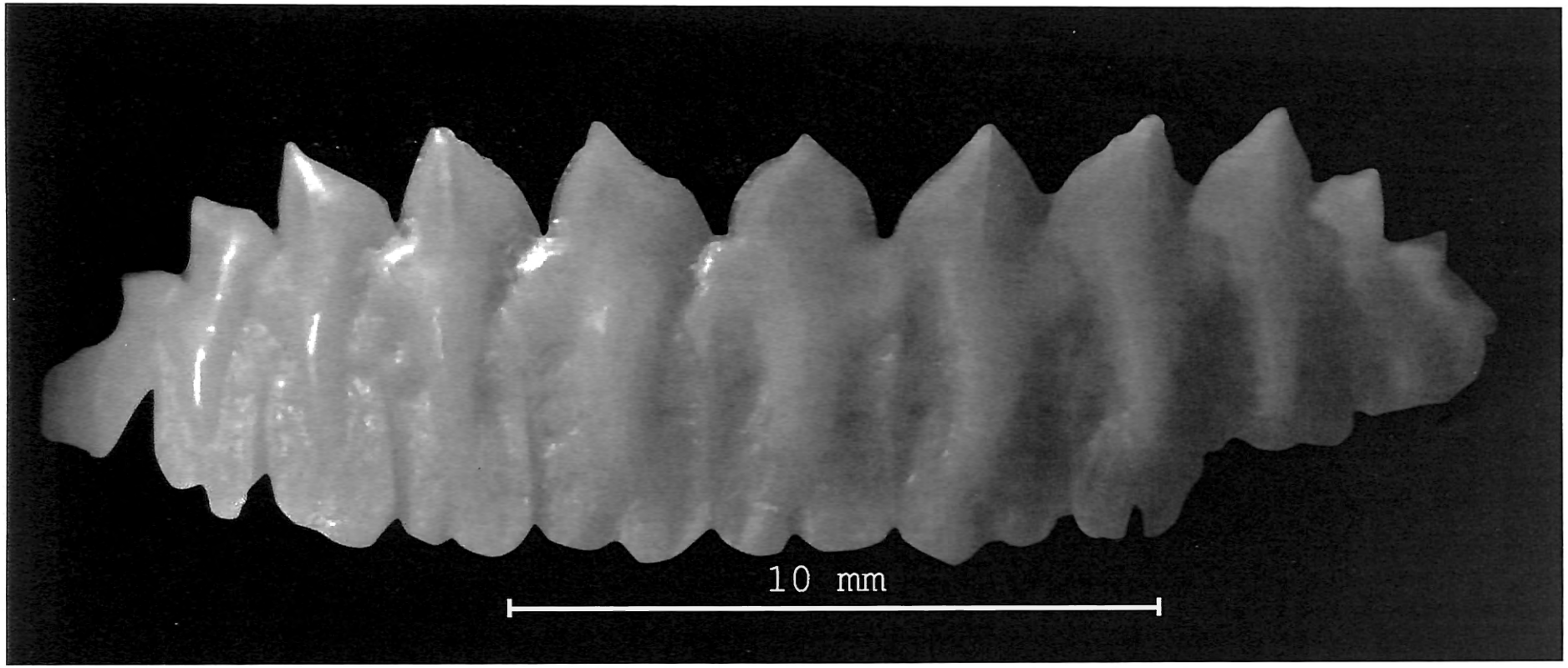

Plate 8 : ***Oxynotus paradoxus*** **FRADE, 1929.** Female 920mm t.l., caught off north-west Ireland, 540m depth, Ireland. Outer view of the whole lower toothset.

Plate 9 : ***Oxynotus paradoxus*** **FRADE, 1929.** Female 920mm t.l., caught off north-west Ireland, 540m depth, Ireland. Outer view of the lower right teeth (without the symphyseal).

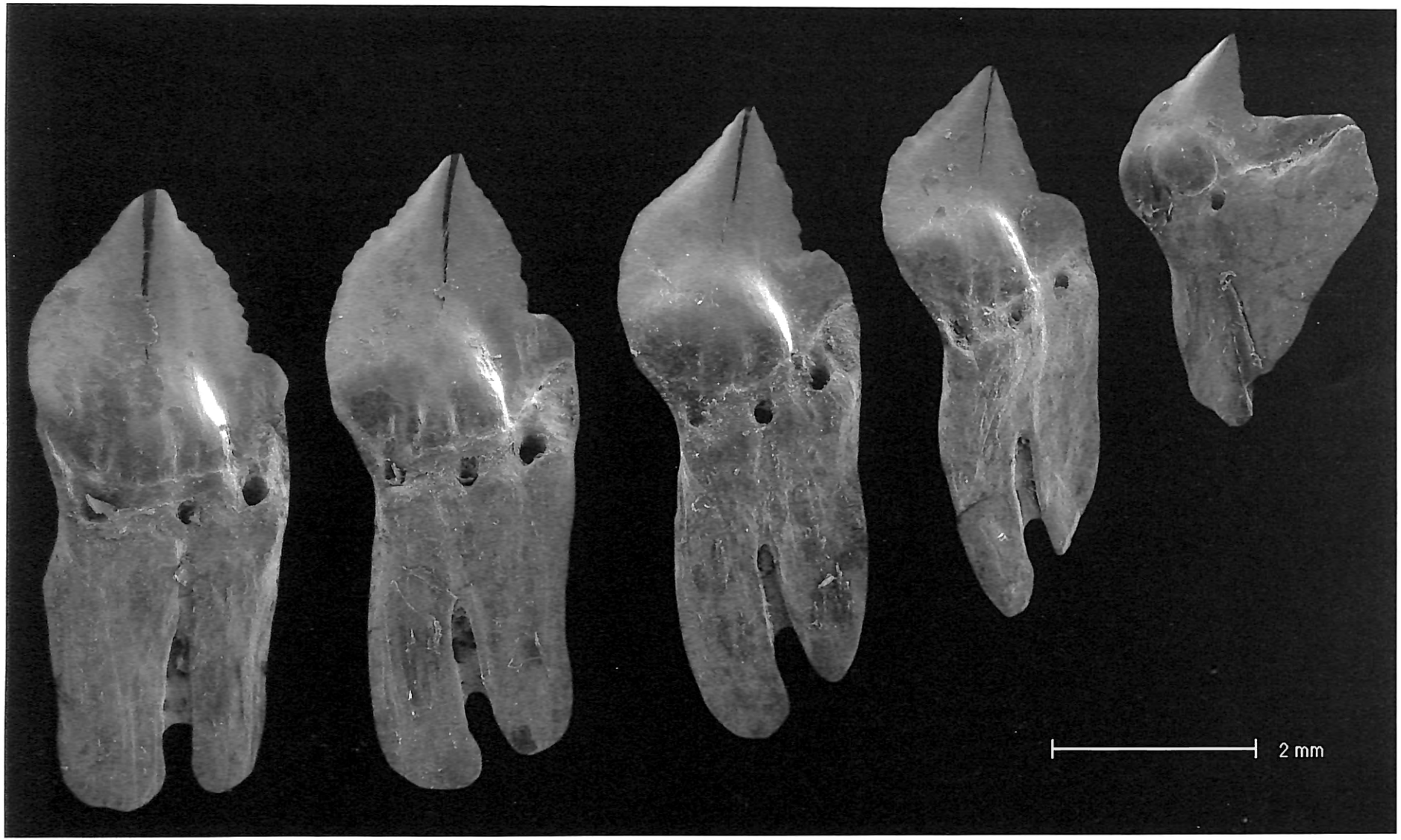

Plate 10 :*Oxynotus paradoxus* FRADE, 1929. Female 920mm t.l., caught off north-west Ireland, 540m depth, Ireland. Inner view of the lower right teeth (without the symphyseal).