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Contributions to the odontological study of living Chondrichthyes. 1. The genus *Alopias* RAFINESQUE, 1810.

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Abstract

The tooth morphology of the three species of the genus *Alopias* is described and illustrated by SEM photographs. An interspecific diagnosis reveals the tooth morphological differences between the species *A. pelagicus*, *A. superciliosus* and *A. vulpinus*, that represent three morphotypes. The existence of a fourth undescribed species was mentioned by COMPAGNO (2001). The dentition of a set of jaws considered to belong to this species is described, illustrated and discussed.

Key words: Odontology – Chondrichthyes – Alopiidae - *Alopias* - Tooth morphology – Tooth vascularization.

Résumé

La morphologie dentaire des trois espèces du genre *Alopias* est décrite et figurée (clichés MEB). Une diagnose interspécifique précise les différences morphologiques dentaires observées entre *A. pelagicus*, *A. superciliosus* et *A. vulpinus*, qui représentent trois morphotypes. L'existence d'une quatrième espèce a été évoquée par COMPAGNO (2001). La dentition d'une mâchoire attribuable à cette espèce hypothétique est décrite, illustrée et commentée.

Mots-clés: Odontologie – Chondrichthyes – Alopiidae - *Alopias* – Morphologie dentaire –Vascularisation dentaire.

Kurzfassung

Die Zahnmorphologie der Arten der Gattung *Alopias* wurden beschrieben und illustriert mit REM Photos. Eine interspezifische Diagnose zeigt die zahnmorphologische Unterschiede zwischen den drei Arten *A. pelagicus*, *A. superciliosus* und *A. vulpinus*, die drei Morphotypen representieren. Eine unbeschriebene Art ist von COMPAGNO (2001) erwähnt und ein Kiefer der angenommen wird zu dieser Art zu gehören wird beschrieben, illustriert und diskutiert.

Schlüsselwörter: Odontologie – Chondrichthyes – Alopiidae - *Alopias* – Zahnmorphologie – Zahnvaskularisation.

General

This issue is the first of a series dealing with the results of studies on tooth morphological characteristics and their interspecific differences within the species of a genus.
The aim of these studies is to understand these differences better to provide necessary data for comparative purposes in ichthyological, as well as in paleoichthyological studies.
Each issue of this series must normally be followed by another one concerning the Belgian or other north-western European fossil taxa attributed or more or less related to the genus inferred. They will be published in the *Bulletin de l'Institut royal des Sciences naturelles de Belgique. Sciences de la Terre* or as *Professional Paper of the Geological Survey of Belgium.*
The tooth morphology of many living species of monotypic genera is described and illustrated in the series *"Contributions to the study of the comparative morphology of teeth and other relevant ichthyodorulites in living supraspecific taxa of Chondrichthyan fishes"* (Ed. STEHMANN, M.), and will not be repeated in this series. However, if multispecific genera are involved, the tooth morphology of species described in the series mentioned above will be incorporated here for comparative purposes. Although the series mentioned above was rather restricted to chondrichthyan taxa with micro-teeth only, species with macro-teeth will be incorporated here, as well.

Introduction

The tooth morphology of the three species of the genus *Alopias* was never properly described. Generally, chondrichthyan teeth are figured by line drawings (e.g. BIGELOW & SCHROEDER, 1948 or COMPAGNO, 1984 and 2001), however, the dentition of *A. pelagicus*, *A. superciliosus* and *A. vulpinus* were illustrated by photographs by BASS, D'AUBREY and KISTNASAMY (1975), with the aim to illustrate their general dentition. These photo-

graphs are used here as additional information for tooth counts. The dentition in general is illustrated by photographs and the specific morphological characteristics of relevant different teeth are described and illustrated by SEM photographs. Further, the tooth vascularization is examined, described and illustrated by photographs of tooth thin sections, made translucent after being soaked in anise-oil.

Material

For this study the following material was available:

Alopias pelagicus
Coll. Hovestadt ?± 2500 mm TL
Coll. Hovestadt ♂ 2790 mm TL

Alopias sp.
Coll. Harris ♂ 2950 mm TL

Alopias superciliosus
Coll. Mollen ♀ 2520 mm TL
Coll. Luypaerts ♀ 2690 mm TL
Coll. Hovestadt ♀ 2950 mm TL
Coll. Hovestadt ♂ 2640 mm TL
Coll. Hovestadt ♂ 3000 mm TL
Coll. Luypaerts ♂ 3010 mm TL
Coll. Luypaerts ♂ 3250 mm TL
Coll. Mollen ♀ 4150 mm TL

Alopias vulpinus
Coll. Hovestadt ♀ 4810 mm TL
Coll. Hovestadt ♀ 4500 mm TL
Coll. Mollen ♀ 4470 mm TL
Coll. Mollen ♀ 4460 mm TL
Coll. Wille ♀ 4050 mm TL
Coll. Mollen ♀ 2910 mm TL
Coll. Hovestadt ♀ 2000 mm TL
Coll. Hovestadt ♀ 1650 mm TL
Coll. Luypaerts ♀ 1400 mm TL
Coll. Hovestadt ♀ 1300 mm TL
Coll. Hovestadt ♀ 1100 mm TL
Coll. Mollen ♂ 4140 mm TL
Coll. Mollen ♂ 4050 mm TL
Coll. Mollen ♂ 4040 mm TL
Coll. Mollen ♂ 4020 mm TL
Coll. Mollen ♂ 3890 mm TL
Coll. Mollen ♂ 3870 mm TL
Coll. Mollen ♂ 3840 mm TL
Coll. Mollen ♂ 3790 mm TL
Coll. Mollen ♂ 3700 mm TL
Coll. Mollen ♂ 3630 mm TL
Coll. Luypaerts ♂ 1940 mm without caudal fin TL
Coll. Luypaerts ♂ 1520 mm without caudal fin TL

Description of the odontological morphotypes

Genus: *Alopias* RAFINESQUE, 1810

Carratteri Generi Nuovi Siciliae, 1810 : 12; type species, *A. macrourus* Rafinesque, 1810, Sicily,
synonym of *Squalus vulpinus* Bonnaterre 1788.

According to Compagno (2001) the genus *Alopias* comprises the three living species *A. pelagicus*, *A. superciliosus* and the type species *A. vulpinus*. A fourth undescribed species was mentioned, as well. A jaw specimen that is considered to belong to a specimen of this undescribed species was examined. However, avoiding damage to this jaw, no teeth were extracted. This restricted the examination of the teeth and disabled SEM photography, as well as preparation of a tooth thin section for examination of the tooth vascularization system. This specimen is referred to here as *Alopias* sp.
Tooth measurement : Depending on the position in the jaw of the tooth rows, the difference between height and width varies significantly. Generally, teeth in anterior rows are higher than broad, whilst those at the lateral positions are broader than high. A table is added to each species description that gives the difference of height and width of each tooth at its jaws position. If a tooth is higher than broad the outcome gives a negative percentage and if a tooth is broader than high the outcome gives a positive percentage. For example : if the outcome is –30%, the tooth is 30% higher than broad and if the outcome is 30%, the tooth is 30% broader than high. If the outcome is 0%, the tooth height and width are equal.

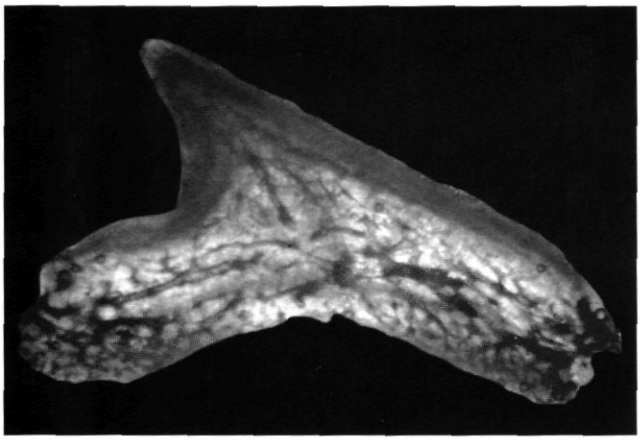
Alopias pelagicus NAKAMURA, 1935

Memoir of the Faculty of Sciences and Agronomy. Taihoku Imperial University. 14 (1) : 2.
Textfigures 1 and 2, Plates 1 to 4

Heterodonty: Tooth count in the upper and lower jaw of 3 specimens varies between 21 and 23 and 22 and 23 tooth rows, respectively. Although, generally, the dentition is gradient monognathic heterodont, the teeth of the upper jaw are slightly larger than those in the lower jaw, that varies per tooth position in the jaws. Generally, the size differences vary from 0 to 30%, increasing from lateral positions toward the commissure, respectively.
The dentition of the upper jaw is subdivided into 2 anterior tooth rows, 2 intermediary ones (eyeteeth) and 7 lateral, gradually changing into about 5 latero-posterior and about 6 posterior tooth rows. The transition between the lateral and latero-posterior teeth is marked by about 5 tooth rows with morphologically unstable teeth.
The dentition of the lower jaw is subdivided into 1 parasymphyseal tooth row, about 8 lateral and 12 posterior tooth rows. The transition between the lateral and posterior teeth is marked by 2 to 4 latero-posterior tooth rows with morphologically unstable teeth.
Comparison of the size differences of upper and lower jaw teeth is only relevant to lateral, latero-posterior and posterior teeth and resulting in 0 to 30%, generally increasing from the lateral jaw positions toward the posterior ones, respectively.
The ratio between width and height per tooth varies as well in

both upper and lower jaws. In contrast to all other teeth, the anterior and intermediary teeth are higher than broad. The biometric results of one specimen are given in table 1 below. Sexual heterodonty as well as ontogenetic heterodonty is absent.

Vascularization: In general, the vascularization is osteodont, presenting relatively coarse reticulated canals. Larger horizontal osteons are present in the root, running from mesial to distal direction (see **textfigure 1**).



Textfigure 1. : *Alopias pelagicus* Tooth vascularization.

Upper jaw: The teeth of the first anterior tooth row have a more or less triangularly shaped principal cusp, which is more or less upright in the first and slightly oblique in the second row. The teeth of both intermediary rows are generally smaller than those of the anterior and first lateral tooth rows and possess a strongly distally oblique principal cusp, as well as a distal blade.

The smooth mesial cutting edge is straight from the apex down and slightly curved at the mesial margin. The teeth of the lateral tooth rows are similar to the intermediary ones, but those of the first lateral is much larger, gradually diminishing in size in those of the successive rows, respectively. The mesial cutting edge is bent upward in the posterior tooth rows. Those in the latero-posterior rows present the transition from a straight to a bent mesial cutting edge. Generally, the distal blade might form a blunt cusplet-like shape, which varies intraspecifically (see **textfigure 2**).

The labial face of the crown is smooth and slightly convex. The labial crown base presents a transverse ridge of shallow, relatively coarse costules and more or less overhangs the root.

The lingual face is also smooth and strongly convex.

The bilobated root is wide, low and the lower part is arched. The root of teeth in the anterior rows is less wide than those in the intermediary, lateral and posterior ones.

The labial face of the root is slightly concave presenting numerous scattered foramina. The lingual face of the root presents a well-developed, relatively shallow median groove that separates the relatively flat surfaces of both root lobes. One or two central apertures are present in the median groove. Other foramina or apertures are absent.

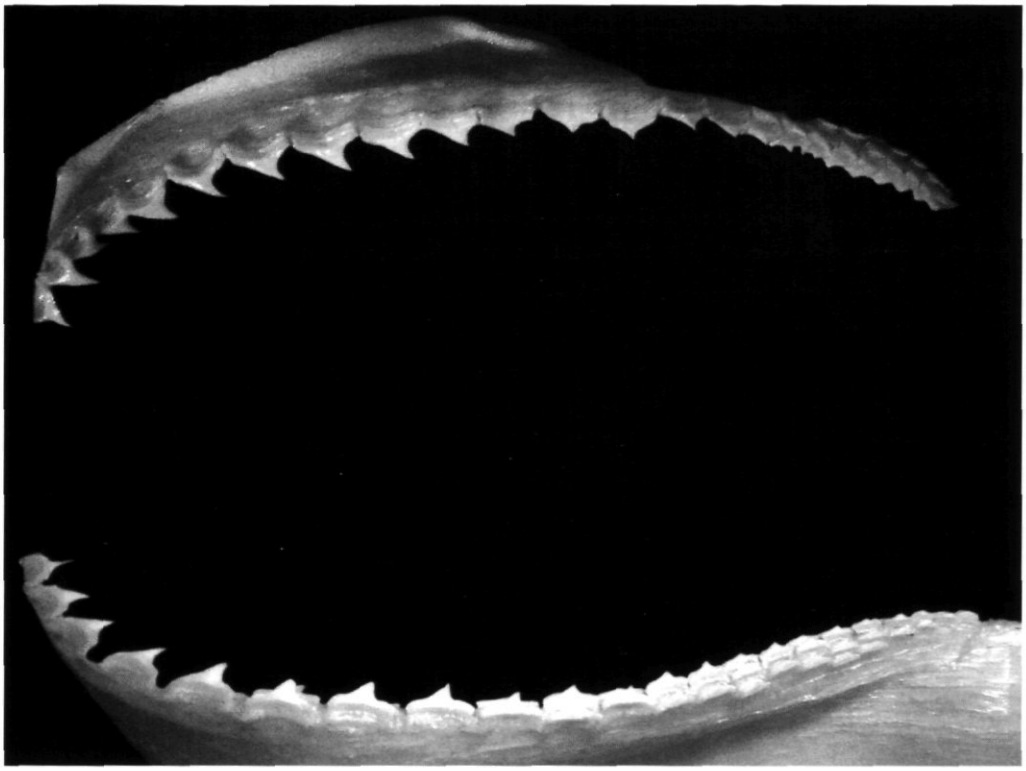
Lower jaw: The tooth of the parasymphyseal row is very small with a strongly oblique principal cusp. Its morphology is rather unstable and varies intraspecifically. The teeth of the lateral positions possess a principal cusp that is strongly oblique distally with a straight mesial cutting edge from the

	Paras.	1st Ant.	2st Ant.	1st.Interm.	2nd.Interm.	1st lat.	2nd lat.	3rd lat.	4th lat.	5th lat.	6th lat.	7th lat.
% differences between width and height in upper jaw teeth		-23%	-17%	38%	30%	20%	23%	27%	28%	25%	25%	28%
% differences between width and height in lower jaw teeth	40%					0%	0.6%	0%	20%	25%	31%	42%

	8th lat.	1st lat/post	2nd lat/post.	3rd lat/post.	4th lat/post.	5th lat/post.	1tst post.	2sd post.	3rd post.	4th post.	5th post.	6th post.
% difference between width and height in upper jaw teeth		28%	31%	37%	42%	46%	48%	50%	64%	66%	75%	75%
% difference between width and height in lower jaw teeth	42%						42%	35%	50%	46%	54%	50%

	7th post	8th post	9th post	10th post	11th post	12th post						.
% difference between width and height in upper jaw teeth												
% difference between width and height in lower jaw teeth	55%	55%	55%	55%	55%	40%						

Table 1 : *Alopias pelagicus* - Biometric data



Textfigure 2. :
Alopias pelagicus Jawset.

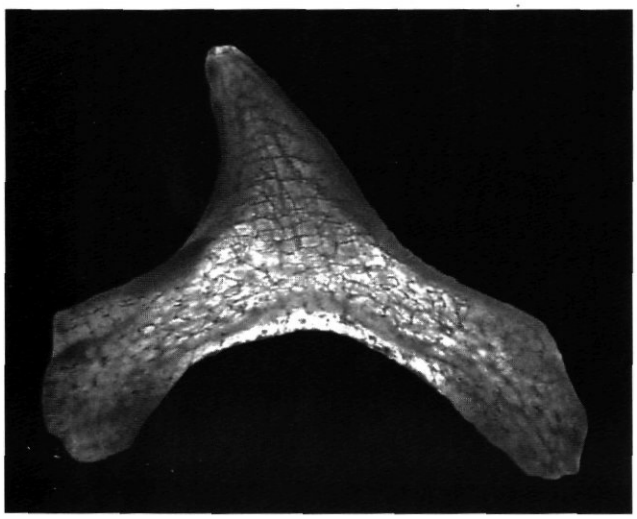
apex down, slightly curved at the mesial edge and presenting a distal blade. The teeth in the first lateral tooth row are large, gradually diminishing in size in teeth in the successive rows, respectively. The mesial cutting edge is bent upward in teeth in the posterior rows. Those in the latero-posterior rows present the transition from a straight to a bent mesial cutting edge. Generally, the distal blade can form a blunt cusplet-like shape, which varies intraspecifically.
The labial face of the crown is smooth and slightly convex. The labial crown base presents a transverse ridge of shallow, relatively coarse costules and more or less overhangs the root.
The lingual face is also smooth and strongly convex.
The bilobated root is low and the lower part is arched. The root of teeth in the anterior rows is less wide than those in the intermediary, lateral and posterior rows.
The labial face of the root is slightly concave presenting numerous scattered foramina. The lingual face of the root presents a well developed, relatively shallow median groove, that separate the relatively flat surfaces of both root lobes. One or two central apertures are present in the median groove. Other foramina or apertures are absent.

Alopias superciliosus (LOWE, 1840)
Alopecias superciliosus LOWE, 1840 Proceeding Zoological Society. London. 1840 (8) : 39.
Textfigures 3 and 4, Plates 5 to 9

Heterodonty: Tooth count in the upper and lower jaw of 5 specimens is constant with 12 and 11 tooth rows, respectively. Although, generally, the dentition is gradient monognathic heterodont, the teeth of the upper jaw are slightly larger than those in the lower jaw, varying per tooth row position. Generally, the size differences are 10 to 30%, increasing from lateral positions toward the commissure positions, respectively. The ratio between width and height per tooth varies as well in both upper and lower jaws. In contrast to all other teeth, those in the anterior tooth row is higher than broad.
The biometric results are given in table 2 below.
The teeth in the parasymphyseal and intermediary positions are absent. Sexual heterodonty as well as ontogenetic heterodonty is absent.
Vascularization: In general, the vascularization is osteodont, presenting very fine reticulated canals. Larger osteons are absent (see **textfigure 3**).

	Ant.	1^{e} lat.	2^{e} lat.	3th lat.	4th lat.	5th lat.	6th lat.	7th lat.	8th lat.	9th lat.	Lat/post	post.
% difference between width and height in upper jaw teeth	-22%	0%	10%	10%	20%	25%	27%	42%	33%	39%	45%	45%
% difference between width and height in lower jaw teeth	14%	23%	23%	23%	27%	33%	33%	37%	23%	45%	33%	

Table 2 : *Alopias superciliosus* - Biometric data



Textfigure 3. : *Alopias superciliosus* Tooth vascularization.

Upper jaw : The upper jaw teeth all possess principal cusp that is constricted directly over
the crown base, forming a mesial and distal, blade-like, lobate extension. The tooth in the anterior row has a more or less triangularly shaped upper part of the principal cusp, which is slightly distally oblique. In teeth in lateral rows the upper part of the principal cusp is strongly bent distally, that is stronger in teeth closer toward the commissural positions, their sizes gradually diminish and the distal lobate extension develops a blade.
The teeth in the latero-posterior and posterior rows possess a small blunt lateral cusplet that arise from the distal extension (see **textfigure 4**).
The labial face of the crown is smooth and slightly convex. The labial crown base is smooth, with a slight central depression just over the crown base and more or less overhangs the root .
The lingual face is also smooth and strongly convex.
The bilobated root is low and the lower part arched. The root of the teeth in the anterior position is less wide than those of the lateral ones.
The labial face of the root is slightly concave presenting some scattered foramina. The lingual face of the root presents a well-developed relatively shallow median groove that separates the relatively flat surfaces of both root lobes. One or two central apertures are present in the median groove. Other foramina or apertures are absent.
Lower jaw: The lower jaw dentition is a series of eleven rows of teeth, which possess a principal cusp that is constricted directly over the crown base, forming a mesial and distal, blade-like, lobate extension. The teeth in the anterior row possess a principal cusp with a more or less triangularly shaped upper part that is slightly distally oblique. The upper part of the principal cusp is strongly bent distally in the teeth of the successive rows, that is stronger in teeth closer toward the commissural positions, their sizes gradually diminish and the distal lobate extension develops a blade.
The labial face of the crown is smooth and slightly convex. The labial crown base is smooth, with a slight central depression just over the crown base and more or less overhangs the root.
The lingual face is also smooth and strongly convex.
The bilobated root is low and the lower part is arched. The

Textfigure 4. :
Alopias superciliosus Jawset.

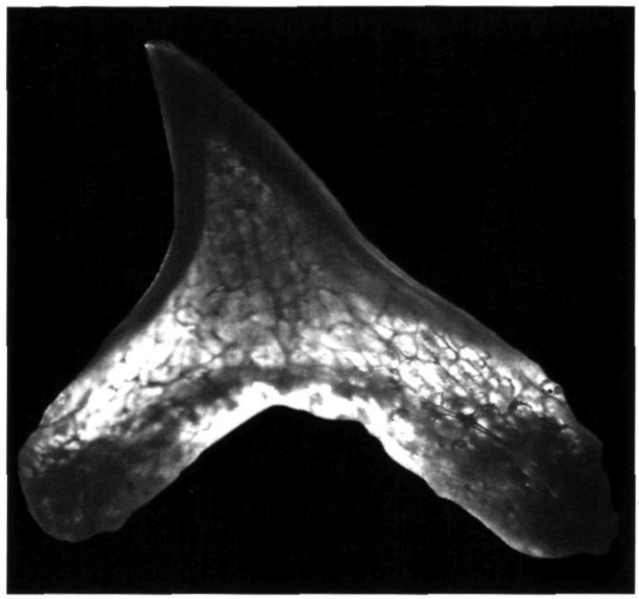
root of the teeth in the anterior row is less wide than those in the lateral ones.
The labial face of the root is slightly concave presenting some scattered foramina. The lingual face of the root presents a well developed, relatively shallow median groove, that separates the relatively flat surfaces of both root lobes. One or two central apertures are present in the median groove. Other foramina or apertures are absent.

Alopias vulpinus (BONNATERRE, 1788)

Squalus vulpinus BONNATERRE, 1788 . Tableau encyclopédique et méthodique des trois règnes naturels , Ichthyologie. Paris. p.9.

Textfigures 5, 6and 7, Plates 10 to 17

Heterodonty: Tooth count in the upper and lower jaw of 3 specimens varies between 19 and 22 and 20 and 24 tooth rows, respectively. Although, in general, the dentition is gradient monognathic heterodont, varying per tooth position in the jaws, the teeth of the upper jaw are slightly larger then those in the lower jaw. Generally, the size differences are 10 to 30%, increasing from lateral positions toward the commissure, respectively.
The dentition of the upper jaw is subdivided into 2 anterior, 1 intermediary (eyetooth), 13 lateral, and 4 posterior tooth rows. The dentition of the lower jaw is subdivided into one parasymphyseal tooth row, 3 anterior, about 14 lateral and 6 posterior ones. Morphologically unstable posterior teeth mark the transition from lateral to posterior positions (see table 3).
Comparison of the size differences of upper and lower jaw teeth is only relevant to teeth in lateral, latero-posterior and posterior rows and resulting in 0 to 30%, generally increasing from the lateral jaw positions toward the posterior ones, respectively. The ratio between width and height per tooth varies as well in both upper and lower jaws. The biometric results of one specimen are given in table 3 below.
Sexual heterodonty as well as ontogenetic heterodonty are absent.
Vascularization: In general, the vascularization is osteodont,



Textfigure 5. : *Alopias vulpinus* Tooth vascularization.

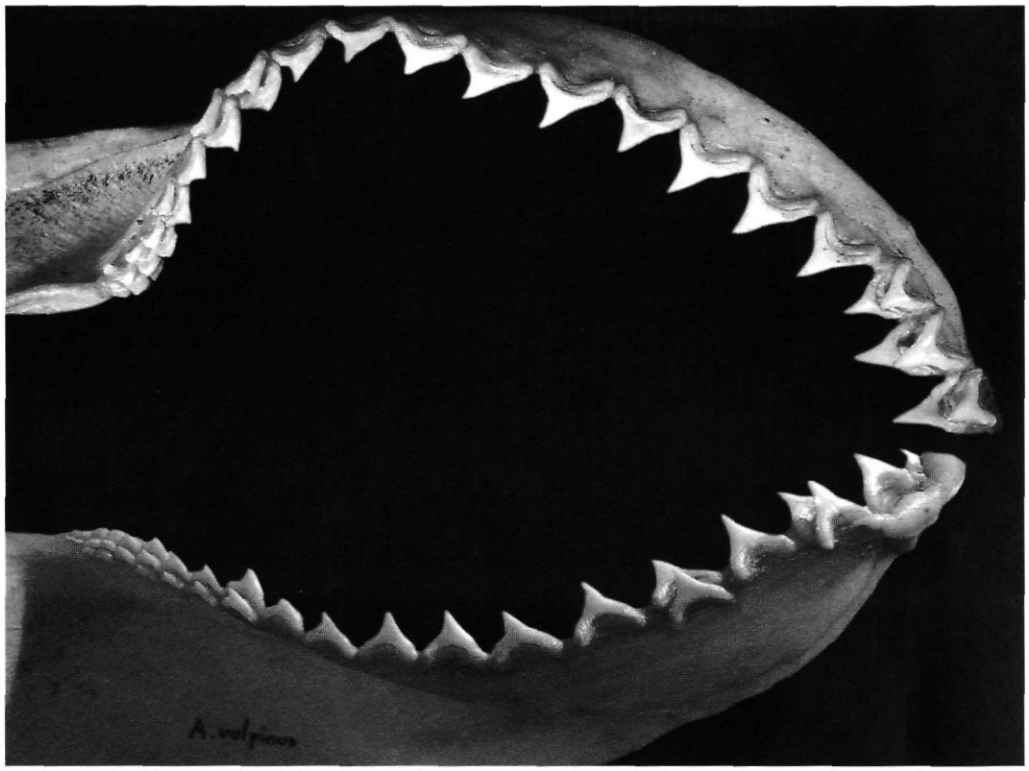
presenting relatively coarse reticulated canals. Larger horizontal osteons are absent in the root (see **textfigure 5**).
Upper jaw: The teeth in the first anterior tooth row have a more or less triangularly shaped, upright principal cusp, which is slightly oblique in those of the second one. Sometimes, both mesial and distal cutting edges present a small cusplet-like irregular formation near the crown base. The teeth in the intermediary position are generally smaller than those in the anterior and first lateral positions.
The teeth in the first and second anterior row possess a principal cusp that is more or less triangularly shaped and slightly bending distally. The teeth in the lateral positions are similar to those in the second intermediary position, but the teeth in the first lateral row is much larger, gradually diminishing in size in the teeth in the successive rows, respectively. The principal cusp is strongly bent distally, leaving only a small, poorly developed apex in posterior teeth. A distal blade is absent (see **textfigure 6**).

	Paras.	1st Ant.	2st Ant.	3st Ant	1st.Interm.	1st lat.	2nd lat.	3rd lat.	4th lat.	5th lat.	6th lat.	7th lat.	8th lat.
% differences between width and height in upper jaw teeth		-30%	-20%		-14%	-17%	-12%	0%	-5%	0%	0%	5%	6%
% differences between width and height in lower jaw teeth	-25%	-20%	-18%	-6%			0%	10%	-7%	-7%	0%	0%	20%

	9th lat.	10th lat.	11th lat.	12th lat.	13th lat.	14th lat.	1rd post.	2th post.	3th post.	4th post.	5th post	6th post.	7th post
% difference between width and height in upper jaw teeth	0%	0%	20%	17%	17%	33%	25%	30%	0%	5%			
% difference between width and height in lower jaw teeth	9%	29%	10%	25%	-30%	-30%	-40%	0%	0%	0%	0%	0%	0%

Table 3 : *Alopias vulpinus* - Biometric data

Textfigure 6. :
Alopias vulpinus Jawset.



The labial face of the crown is smooth and slightly convex. The labial crown base presents shallow, relatively coarse costules and more or less overhangs the root.
The lingual face is also smooth and strongly convex.
The bilobated root is low and arched shaped. The root of the teeth in the anterior row is less wide than those in the intermediary, lateral and posterior ones.
The labial face of the root is slightly concave presenting numerous scattered foramina. The lingual face of the root presents a well-developed, relatively shallow median groove that separates the relatively flat surfaces of both root lobes. One or two central apertures are present in the median groove. Other foramina or apertures are absent.
Lower jaw: The teeth of the parasymphyseal position are very small with a strongly oblique principal cusp and a thick root. Those in the 3 lateral positions possess a principal cusp, with cutting edges slightly curving upward. The teeth in lateral tooth rows have a principal cusp bending slightly

Textfigure 7. :
Alopias vulpinus Detail of the upper dentition..

distally, gradually diminishing in size and bending stronger distally in teeth in the following rows, respectively. The principal cusp is strongly bent distally, leaving only a small, poorly developed apex the teeth in posterior rows. A distal blade is absent (see **textfigure 6**).
The labial face of the crown is smooth and slightly convex. The labial crown base presents shallow, relatively coarse costules and more or less overhangs the root.
The lingual face is also smooth and strongly convex.
The bilobated root is low and the lower part is arched. The root of teeth in the anterior positions is less wide than those in intermediary, lateral and posterior positions.
The labial face of the root is slightly concave presenting numerous scattered foramina. The lingual face of the root presents a well developed, relatively shallow median groove, that separates the relatively flat surfaces of both root lobes. One or two central apertures are present in the median groove. Other foramina or apertures are absent.
Examining the dentition of juvenile specimens of *A. vulpinus* revealed that the tooth size of succeeding teeth in a row doubles in specimens of approximately 1100 to 1400mm TL. The tooth growth normalizes in specimens of approximately 1600mm TL and only is hardly perceptible in specimens of 2000mm TL or larger (see **textfigure 7**).

Alopias sp.
Textfigure 8, Plate 18

Heterodonty: Tooth count in the upper and lower jaw of is 19 and 20 tooth rows, respectively. Although, the species is in general gradient monognathic heterodont, varying per tooth position in the jaws, the teeth of the upper jaw are slightly larger then those in the lower jaw. Generally, the size differences are 10 to 30%, increasing from lateral positions toward the commissure, respectively.
The dentition of the upper jaw is subdivided into 2 anterior tooth rows, 1 intermediary (eyetooth), 11 lateral, and 5 posterior tooth rows. The dentition of the lower jaw is subdivided into one parasymphyseal tooth row, 3 anterior, 11 lateral and 5 posterior ones. The posterior teeth are marked by a less regular shape. (see table 4).
Comparison of the size differences of upper and lower jaw teeth is only relevant to teeth in lateral, latero-posterior and posterior rows and resulting in 0 to 20%, generally increasing from the lateral jaw positions toward the posterior ones, respectively. The ratio between width and height per tooth varies as well in both upper and lower jaws. In teeth of the anterior rows are higher than broad. The biometric results of one specimen are given in table 4 below.
Having one set of jaws available only for examination, sexual heterodonty as well as ontogenetic heterodonty could not been determined.
Upper jaw: The teeth in the first anterior tooth row have a more or less triangularly shaped, upright principal cusp, which is slightly oblique in the second row teeth.
The teeth in the intermediary position are generally smaller than those in the anterior and first lateral positions. The teeth in the first and second anterior positions possess a more or less triangularly shaped principal cusp that is slightly bending distally. The teeth in the lateral positions are similar to the one in the intermediary position, but are much larger, gradually diminishing in size in the teeth in the successive rows, respectively. The principal cusp is strongly bent distally, leaving only a small, poorly developed apex in posterior teeth. A distal blade is absent.
The labial face of the crown is smooth and slightly convex. The labial crown base sometimes presents shallow, relatively coarse, but poorly developed costules and more or less overhangs the root.
The lingual face is also smooth and strongly convex.
The bilobated root is low and the lower part is arched. Both labial and lingual faces of the root could not be examined, as no teeth were isolated for examination.
Lower jaw: The teeth of the parasymphyseal position are very small and poorly developed. The teeth in lateral rows have a principal cusp bending slightly distally, gradually diminishing in size and bending stronger distally in teeth in the successive rows, respectively. The principal cusp is strongly bent distally, leaving only a small, poorly developed apex the

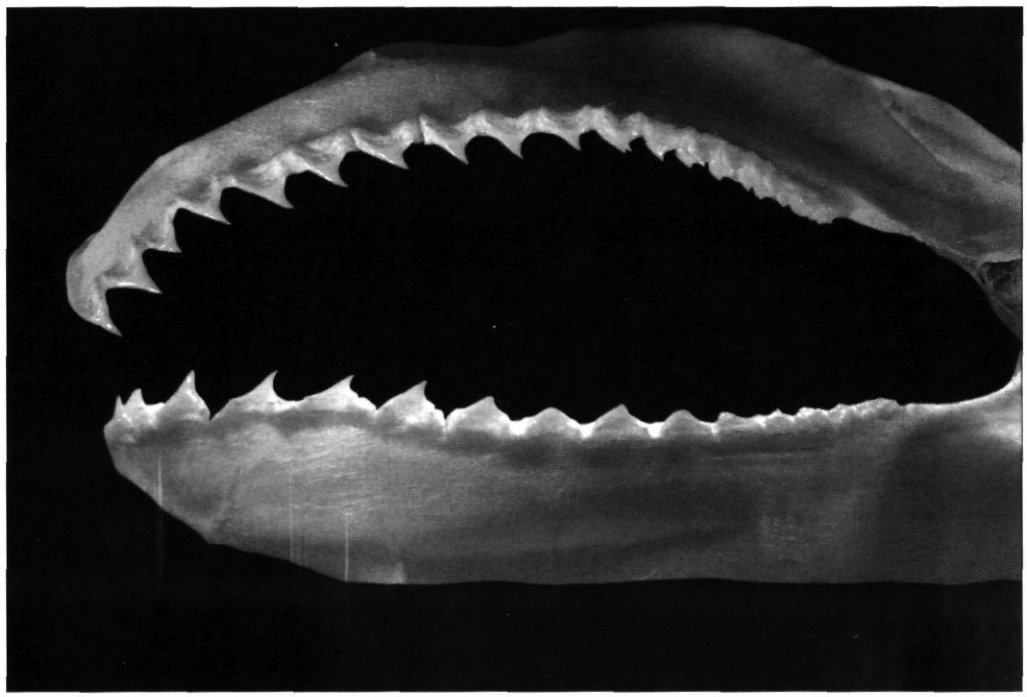
	Paras.	1st Ant.	2st Ant.	3st Ant	1st.Interm.	1st lat.	2nd lat.	3rd lat.	4th lat.	5th lat.	6th lat.	7th lat.	8th lat.
% differences between width and height in upper jaw teeth		-25%	-2%		10%	13%	27%	23%	20%	23%	21%	7%	12%
% differences between width and height in lower jaw teeth	*	4.8%	-23%	-9%		8%	14%	29%	29%	40%	43%	54%	50%

	9th lat.	10th lat.	11th lat.	1rd post.	2th post.	3th post.	4th post.	5th post					
% difference between width and height in upper jaw teeth	-4%	12%	21%	17%	54%	43%	48%	50%					
% difference between width and height in lower jaw teeth	40%	59%	57%	35%	52%	55%	55%	33%					

* not measurable

Table 4 : *Alopias sp.* - Biometric data

Textfigure 8. :
Alopias sp. Jawset.



teeth in posterior rows. A distal blade is absent (see **textfigure 8**).
The labial face of the crown is smooth and slightly convex. The labial crown base sometimes presents shallow, relatively coarse, but poorly developed costules and more or less overhangs the root
The lingual face is also smooth and strongly convex.
The bilobated root is low and the lower part is arched. Both labial and lingual faces of the root could not be examined, as no teeth were isolated for examination.

Interspecific diagnosis

The dentition of the upper jaw in *Alopias pelagicus* comprises about 22 tooth rows with 2 anterior, 2 intermediary, 7 lateral, about 5 latero-posterior and about 6 posterior ones. The dentition of the lower jaw possesses about 21 tooth rows with 1 parasymphyseal, about 8 lateral and about 12 posterior ones.
Generally, the teeth of upper and lower jaws possess a crown with a distally oblique principal crown that has a more or less straight to concavely shaped mesial cutting edge and a mesial blade-like or sometimes cusplet-like extension. The labial crown base presents a transverse ridge of shallow, relatively coarse costules and more or less overhangs the root.
The labial crown base presents a transverse ridge of shallow, relatively coarse costules.
The bilobated root is wide, low and arched shaped with shallow median groove.
The osteodont vascularization presents relatively coarse reticulated canals.
The dentition of the upper jaw in *Alopias superciliosus* comprises about 12 tooth rows with 1 anterior, 9 lateral, about 2 posterior ones. The dentition of the lower jaw possesses about 11 tooth rows with 1 anterior, about 8 lateral and about 1 posterior row.
Generally, the teeth of upper and lower jaws possess a crown with a distally bent principal crown that has a more or less sigmoidal shaped mesial and distal cutting edges and resulting from a constriction at the base. The labial crown base is smooth, with a slight central depression just over the crown base and more or less overhangs the root.
The bilobated root is wide, low and arched shaped with a shallow median groove.
Osteodont vascularization has very fine reticulated canals.
The dentition of the upper jaw in *Alopias vulpinus* comprises about 22 tooth with 2 anterior tooth rows, 1 intermediary, 14 lateral and about 4 posterior ones. The dentition of the lower jaw possesses about 24 tooth rows with 1 parasymphyseal, about 3 anterior, 14 lateral and about 6 posterior ones.
Generally, the teeth of upper and lower jaws possess a crown with a distally bent principal cusp that has a slightly sigmoidal shaped mesial and distal cutting edge, resulting from a slight constriction at the base. The labial crown base presents a transverse ridge of shallow, relatively coarse costules and more or less overhangs the root.
The labial crown base presents shallow, relatively coarse costules.
The bilobated root is wide, low and arched shaped with a shallow median groove.
Osteodont vascularization has coarse reticulated canals.
With 2 anterior tooth rows, 1 intermediary, 11 lateral and 5 posterior rows in the upper jaw and 1 parasymphyseal, 11 lateral and 5 posterior rows in the lower jaw the heterodonty of *Alopias* sp. is very similar to *Alopias vulpinus*. However, the successive lateral rows in upper and lower jaws gradually diminish in size, they maintain the same morphology until the last few commissural ones in *A.* sp. that is less stable in *A.vulpinus*. The ratio between width and height of the teeth

of *A. vulpinus* and *A.* sp. shows, that particularly the teeth in the lateral and posterior rows of *A.* sp. are significantly wider than high than in those of *A. vulpinus*.

Conclusions

Although the outer morphology of the three species of *Alopias* is rather similar with a fusiform body shape and a caudal fin as large as, or larger than the body length, their tooth morphology is strongly different. Generally, *A. superciliosus* possesses only half the amount of tooth rows of *A. pelagicus* and *A. vulpinus*. However, tooth morphologically *A. superciliosus* and *A. vulpinus* share more similarities with a principal cusp generally constricted at the base and bent distally than *A. pelagicus* ,which possesses an oblique principal cusp with a slightly sigmoidal to more or less straight mesial cutting edge.
The three species share a similar shaped root that is generally wide, low and arched at the lower part and overhung by the labial root base.
The tooth morphological features within the three species of *Alopias* strongly differ and allow to consider that each represents a separate phylogenetic development, clearly distinguishable by their own morphotype.
The dentition of *Alopias* sp. is very similar to *A. vulpinus* and from the odontological point of view there is not enough evidence to support a new species.

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We like to thank Dr. G. Lenglet, Institut royal des Sciences Naturelles de Belgique for giving access to species at his disposal. We particularly wish to thank Mr. J.P. Luypaerts, Waterloo (Belgium), Mr. F. Mollen, Lier (Belgium), Mr. E. Wille , Wuustwezel (Belgium), and Mr. M. Harris, Florida (USA) for lending specimens from their collections for examination. The SEM photographs were taken by J. Cillis (Institut royal des Sciences Naturelles de Belgique).

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Presentation and composition of the plates

The only constant rule is that upper teeth or upper jaws are presented with their cusps downward and lower teeth or lower jaws with their cusps upward.
As far as possible the succession of the plates respects the following scheme for each species : presentation of one or more complete set of jaws , details of particular parts of the jaws (anterior, symphyseal, lateral or commissural) and at last SEM photographs of isolated teeth.

SEM Plates : abbreviations

a = anterior
c = commissural
i = intermediar (eye tooth)
la = latero-anterior
l = lateral
lp = latero-posterior
p = posterior
pr = parasymphyseal
ps = pseudosymphyseal
s = symphyseal

Plate 1 : ***Alopias pelagicus* NAKAMURA, 1935.** Male 2790 mm t.l., caught in 1999, Kudat Market, Sarawak, Malaysia. Outer view of the dried jaw set (18 cm width , 15.5 cm height) with details of upper and lower symphyseal and anterior parts of the dentition, as well as upper and lower posterior to commissural parts of the dentition.

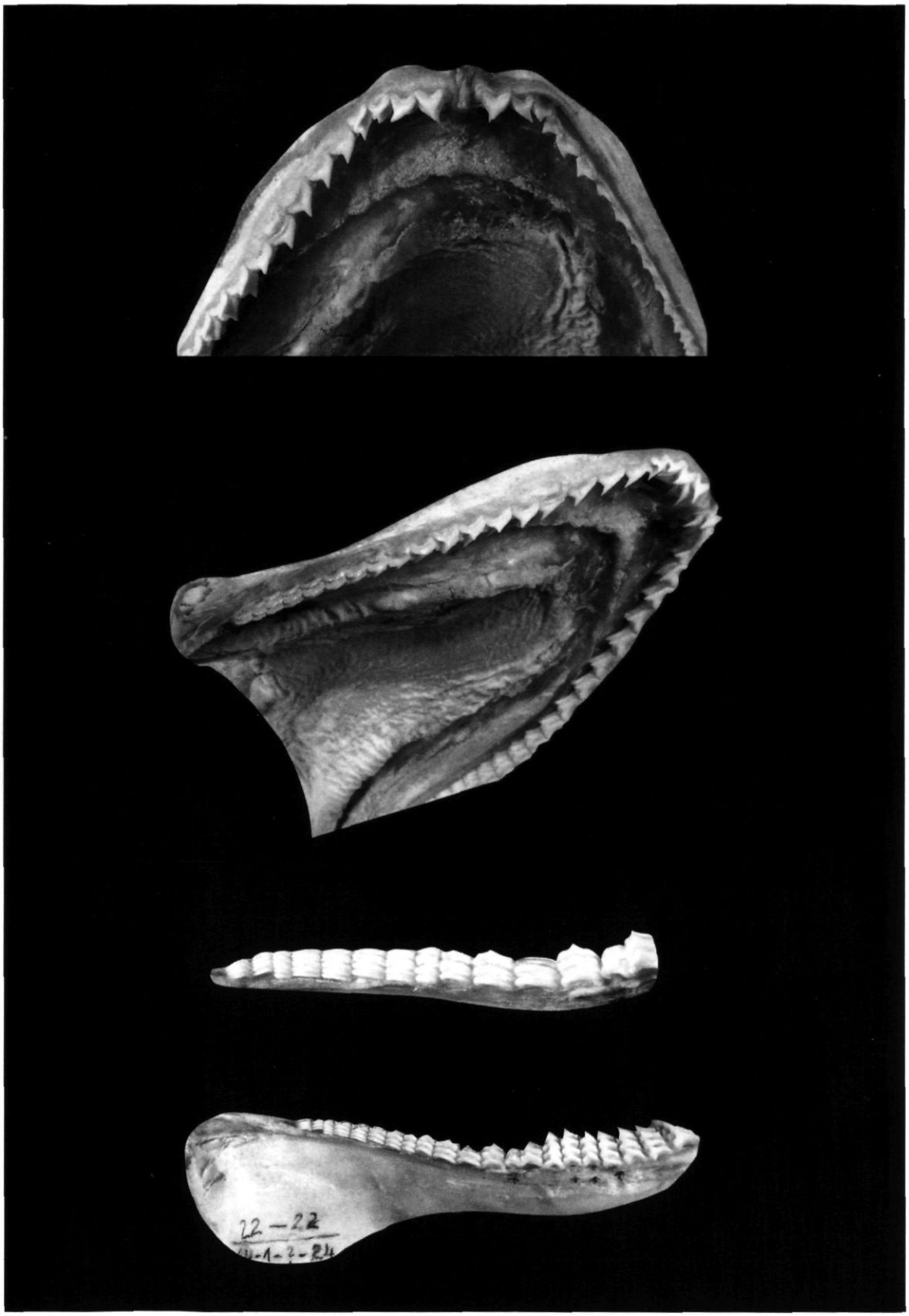

Plate 2 : ***Alopias pelagicus*** **NAKAMURA, 1935.** No data, caught in 1999, 50 miles off Pulo Candor, Vietnam. Dried skull. View oft he upper anterior part of the jaw set (width 8 cm), oblique view of the upper jaw, outer view of the lower dentition set (length 7.5 cm) and detail of the lateral to commissural files.

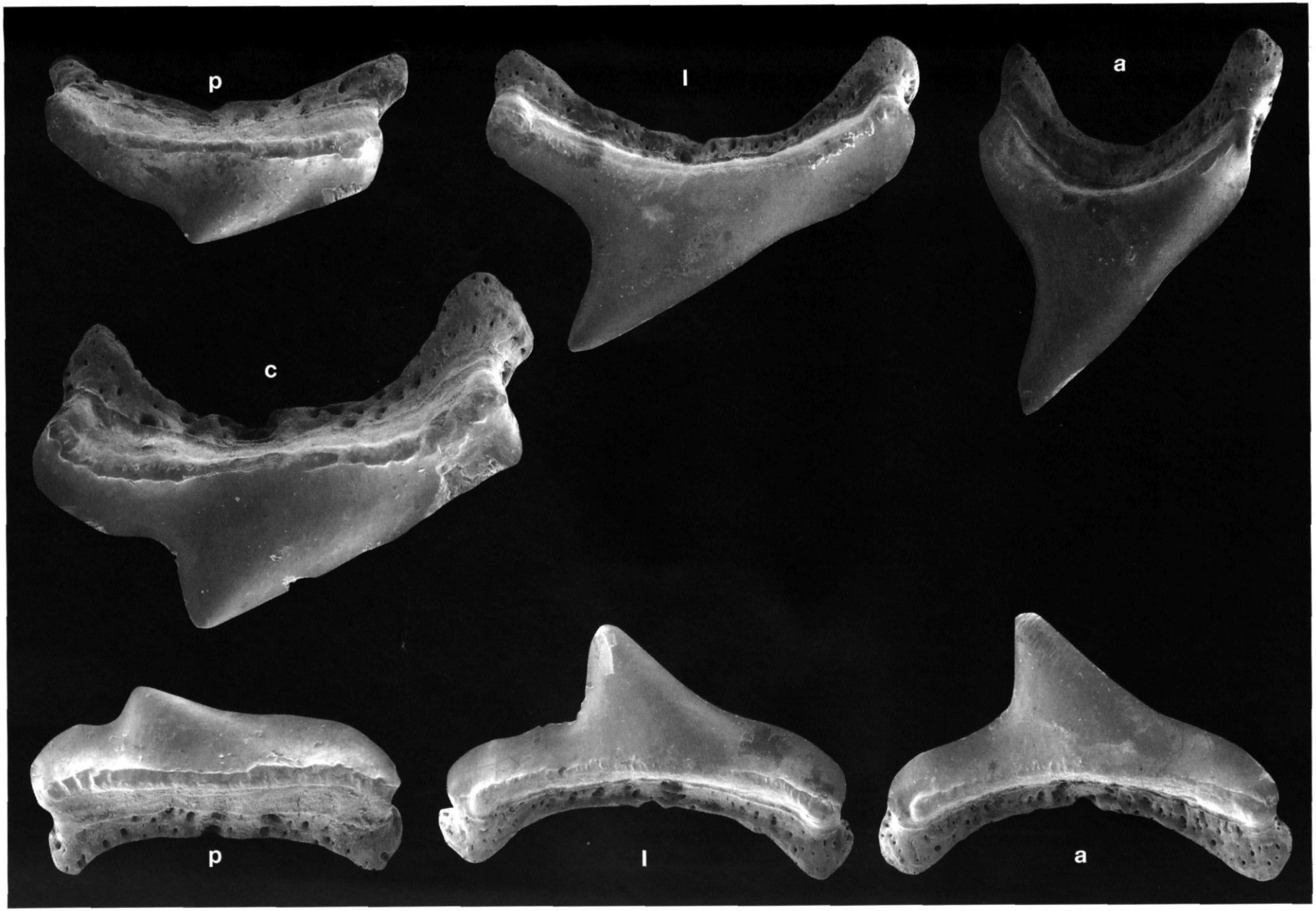

Plate 3 : ***Alopias pelagicus*** **NAKAMURA, 1935.** Male 2790 mm t.l., caught in 1999, Kudat Market, Sarawak, Malaysia. Outer view of upper and lower teeth : **a** and **l** x12, **p** x24 and **c** x40.

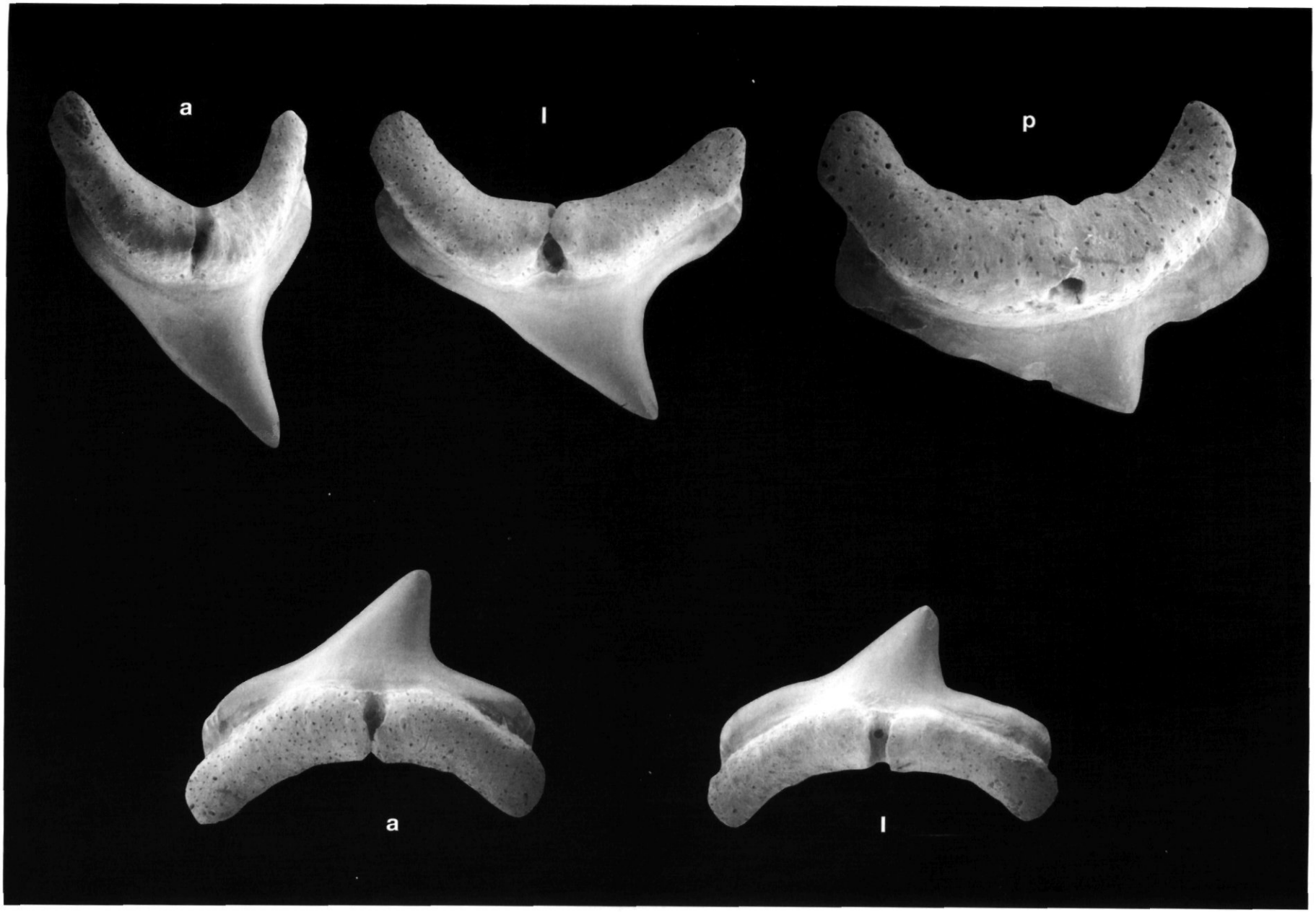

Plate 4 : ***Alopias pelagicus*** **NAKAMURA, 1935.** Male 2790 mm t.l., caught in 1999, Kudat Market, Sarawak, Malaysia. Inner view of upper and lower teeth: **a** and **l** x12, **p** x24.

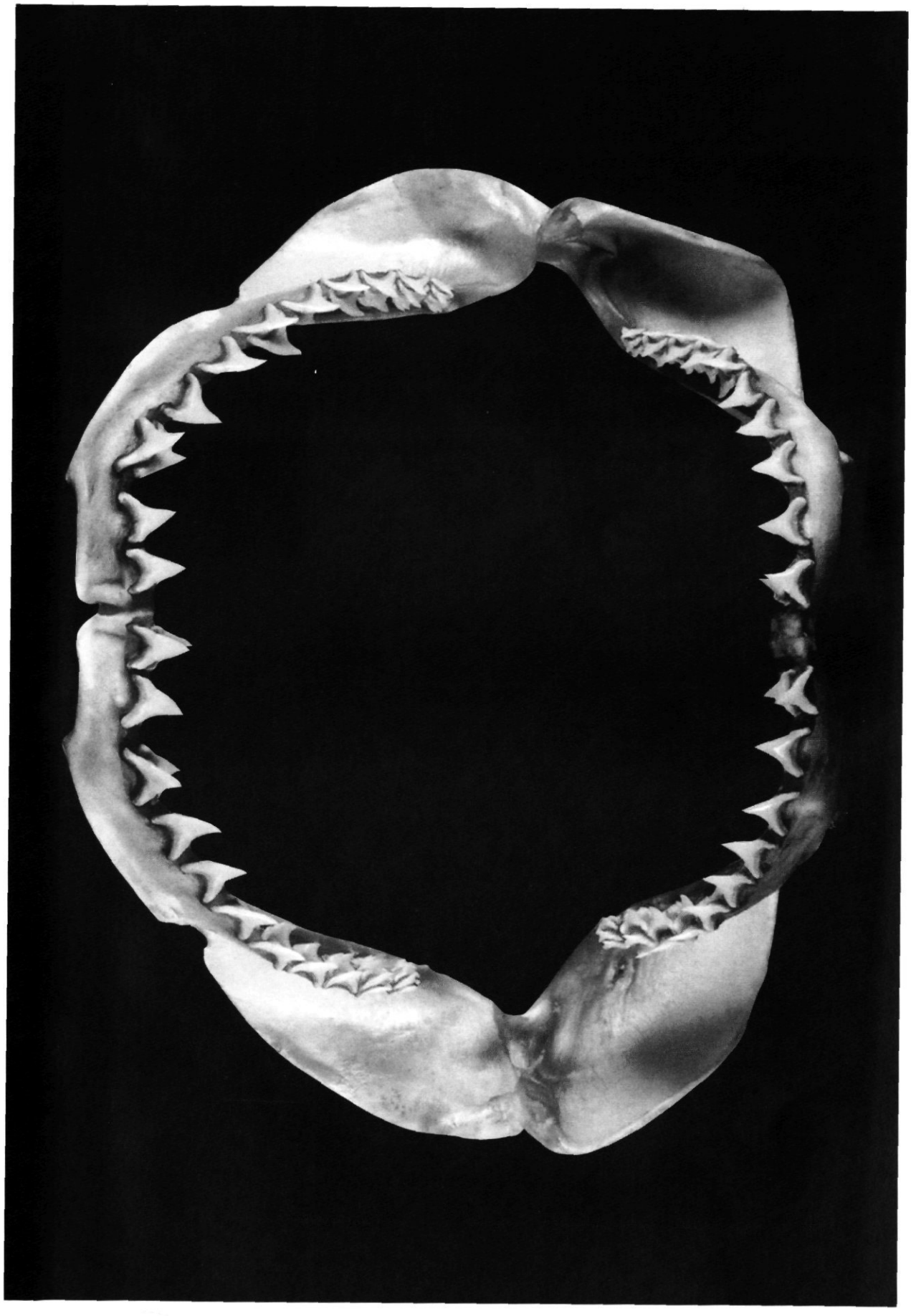

Plate 5 : ***Alopias superciliosus*** **(LOWE, 1840).** Female 4150 mm t.l., off Durban, Republic of South Africa, august 2003. Outer view of the dried jaw set (26 cm width, 18.5 cm height).

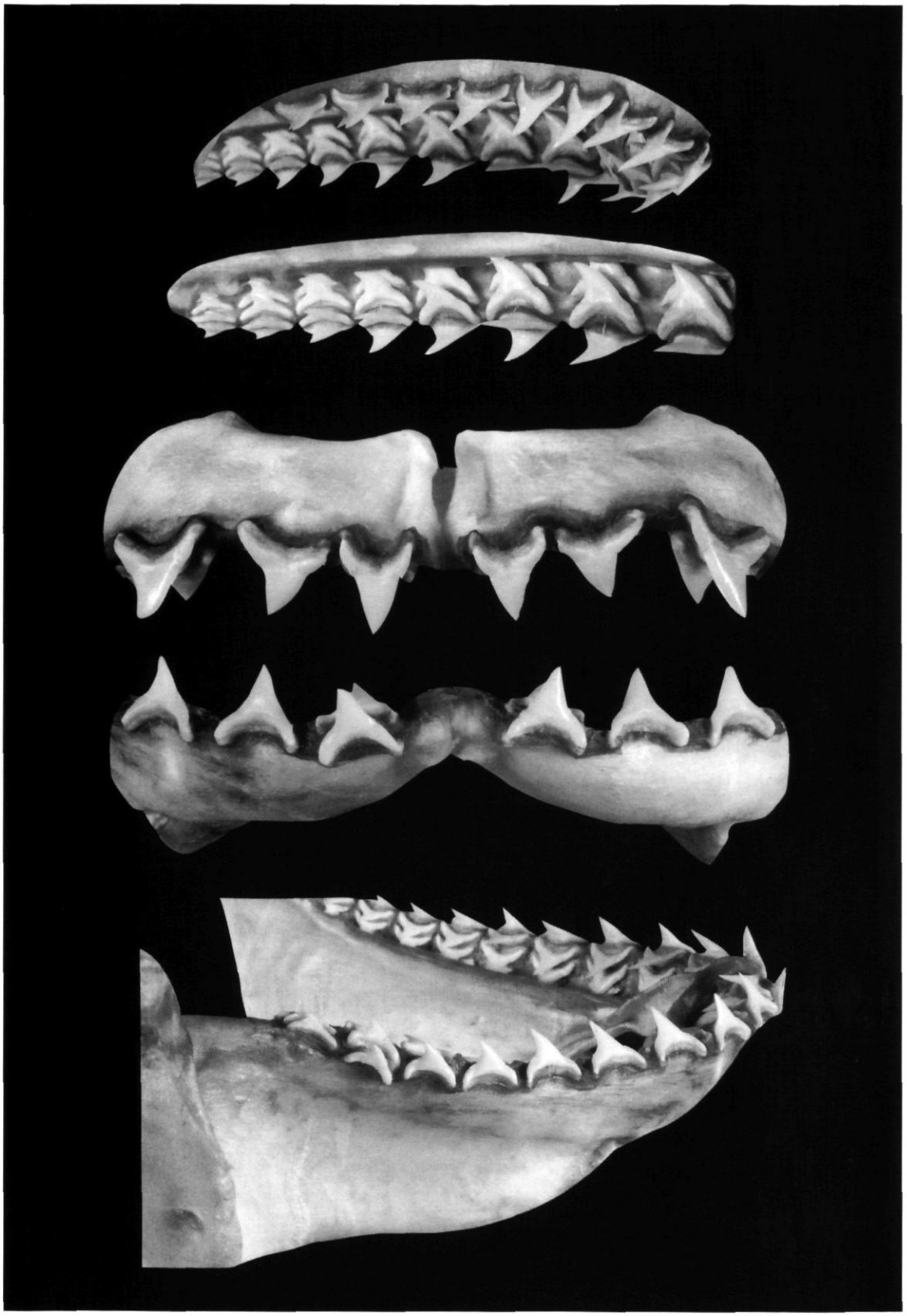

Plate 6 : ***Alopias superciliosus*** **(LOWE, 1840).** Female 4150 mm t.l., off Durban , Republic of South Africa , august 2003. Oblique view of the lower jaw (bottom), outer views of lower and upper anterior part of the jaws, inner view of lateral to posterior upper teeth files and oblique view of the upper jaw (top).

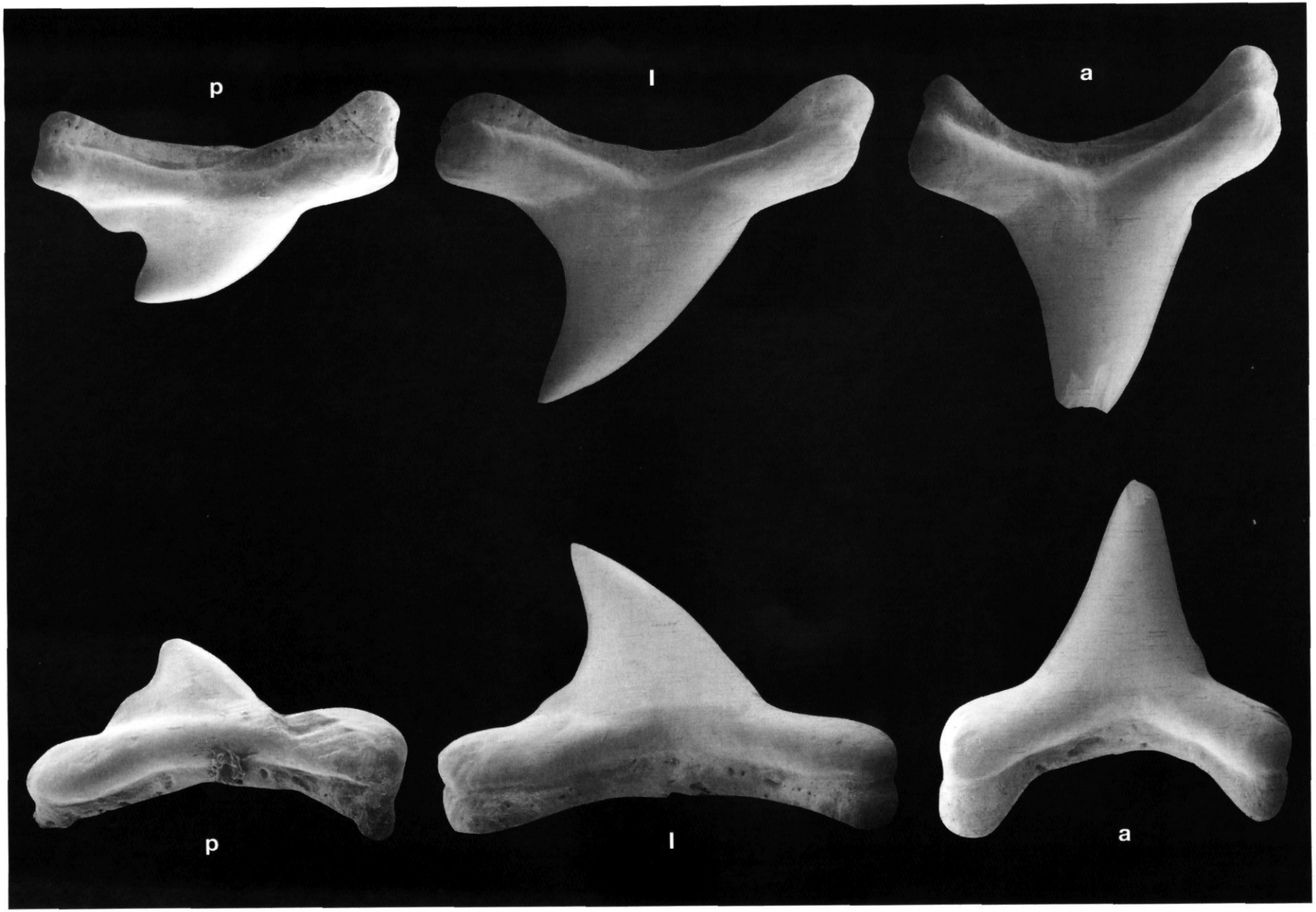

Plate 7 : ***Alopias superciliosus*** **(LOWE, 1840).** Male 3010 mm t.l. , Algesiras Market , Spain , 1983. Outer view of upper and lower teeth : **a** and **l** x8 , **p** x16.

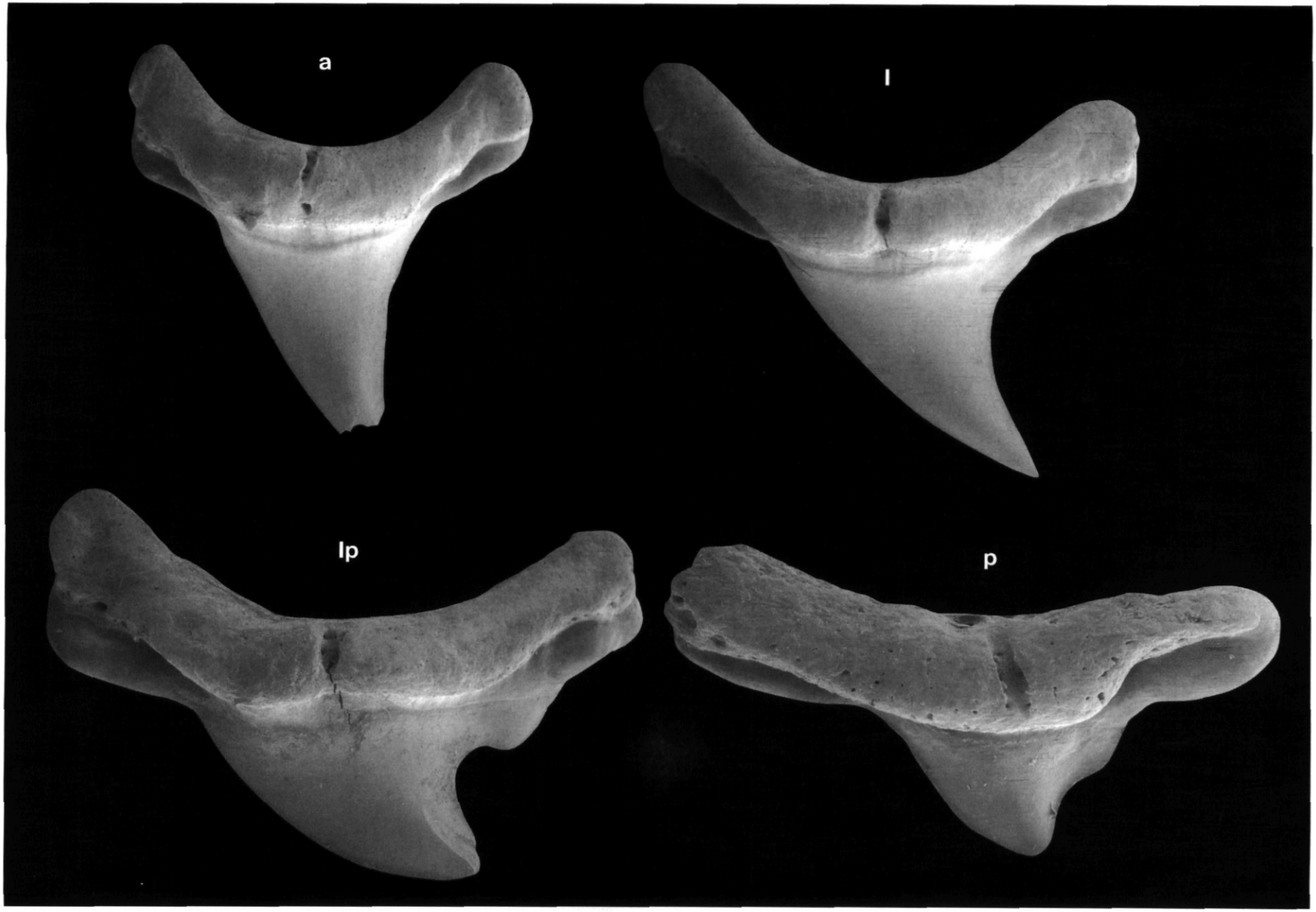

Plate 8 : ***Alopias superciliosus*** **(LOWE, 1840).** Male 3010 mm t.l. , Algesiras market , Spain , 1983. Inner view of upper teeth : **a** and **l** x10 , **lp** x24 and **p** x48.

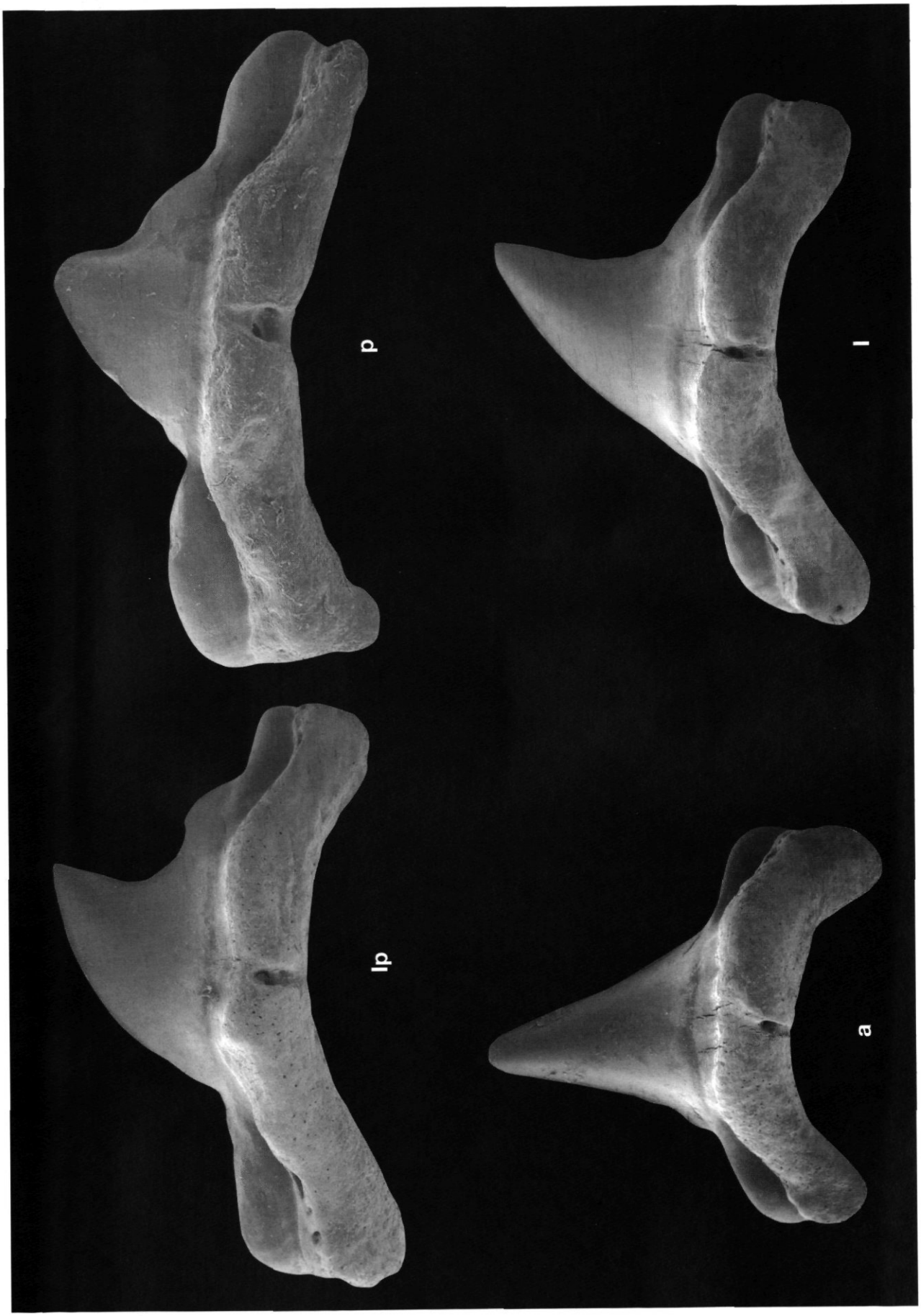

Plate 9 : ***Alopias superciliosus*** **(LOWE, 1840).** Male 3010 mm t.l. , Algesiras Market , Spain , 1983. Inner view of lower teeth : **a** and **l** x10 , **lp** x24 and **p** x48.

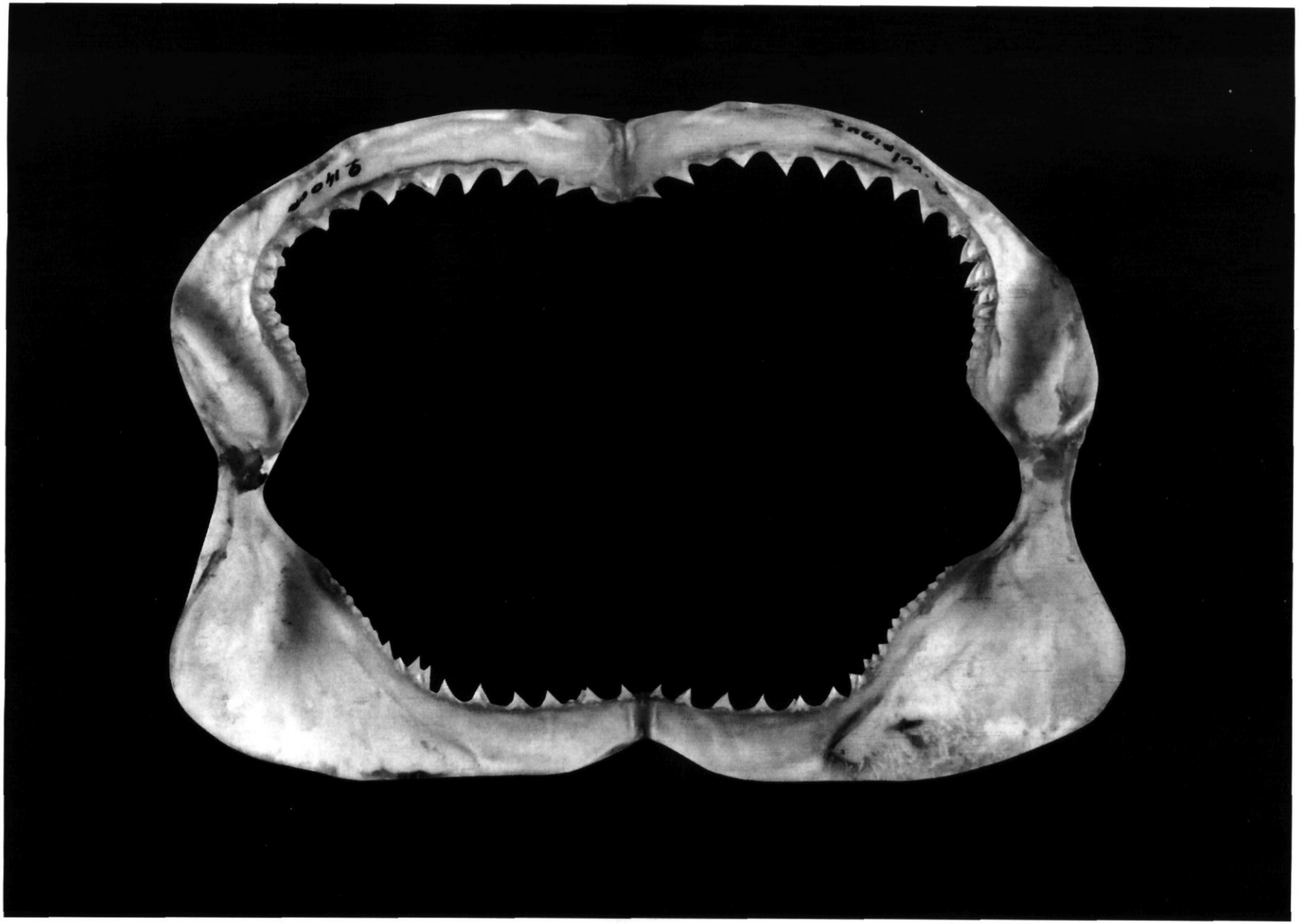

Plate 10 : ***Alopias vulpinus*** **(BONNATERRE, 1788).** New born female 1400 mm t.l., Port de Concarneau , France, 1970. Outer view of the dried jaw set (width : 8 cm, height : 6 cm) .

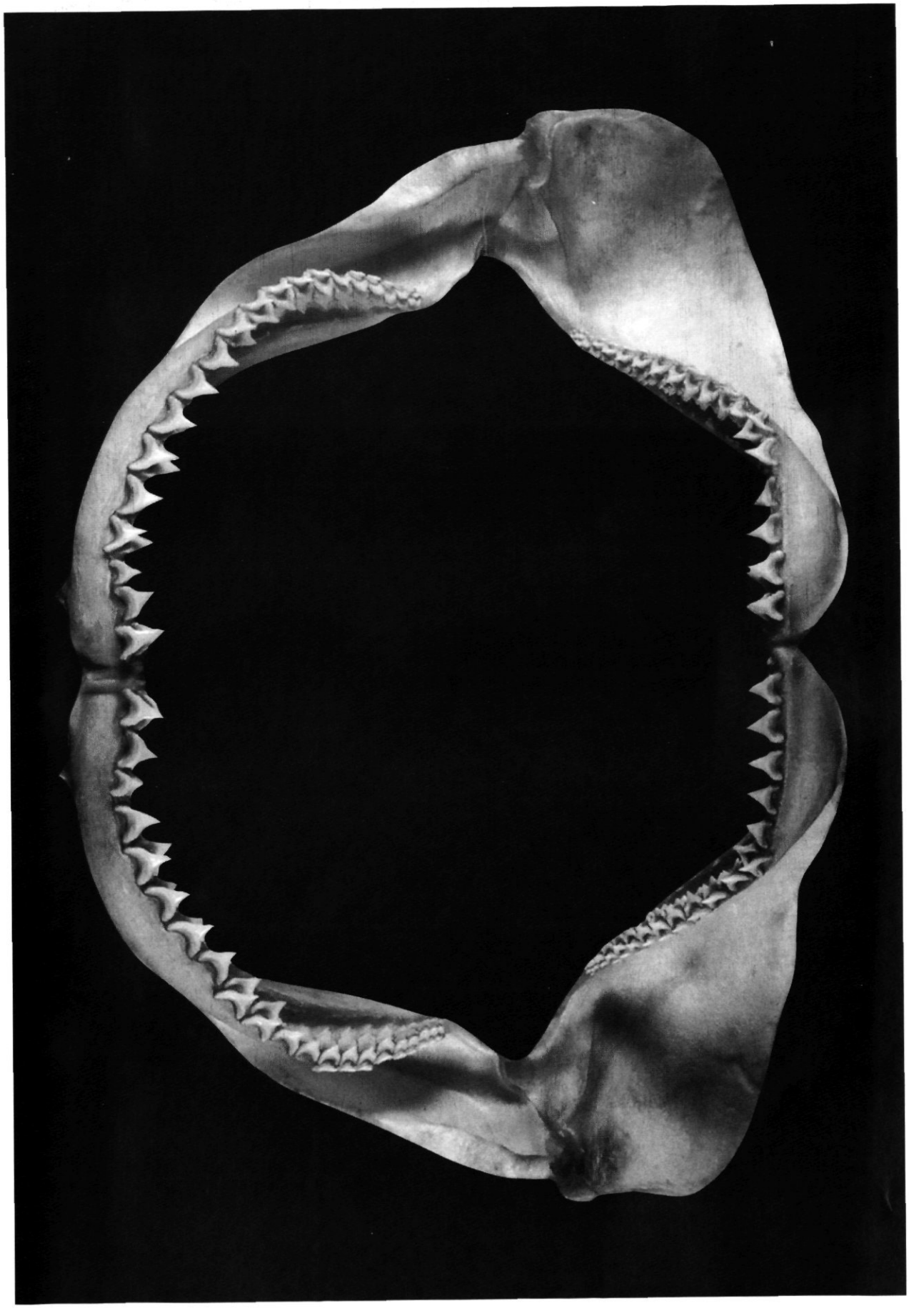

Plate 11 : ***Alopias vulpinus*** **(BONNATERRE, 1788).** Female 4140 mm t.l. , Port de La Rochelle , France , 1988. Outer view of the dried jaw set (width : 24 cm, height : 17 cm) .

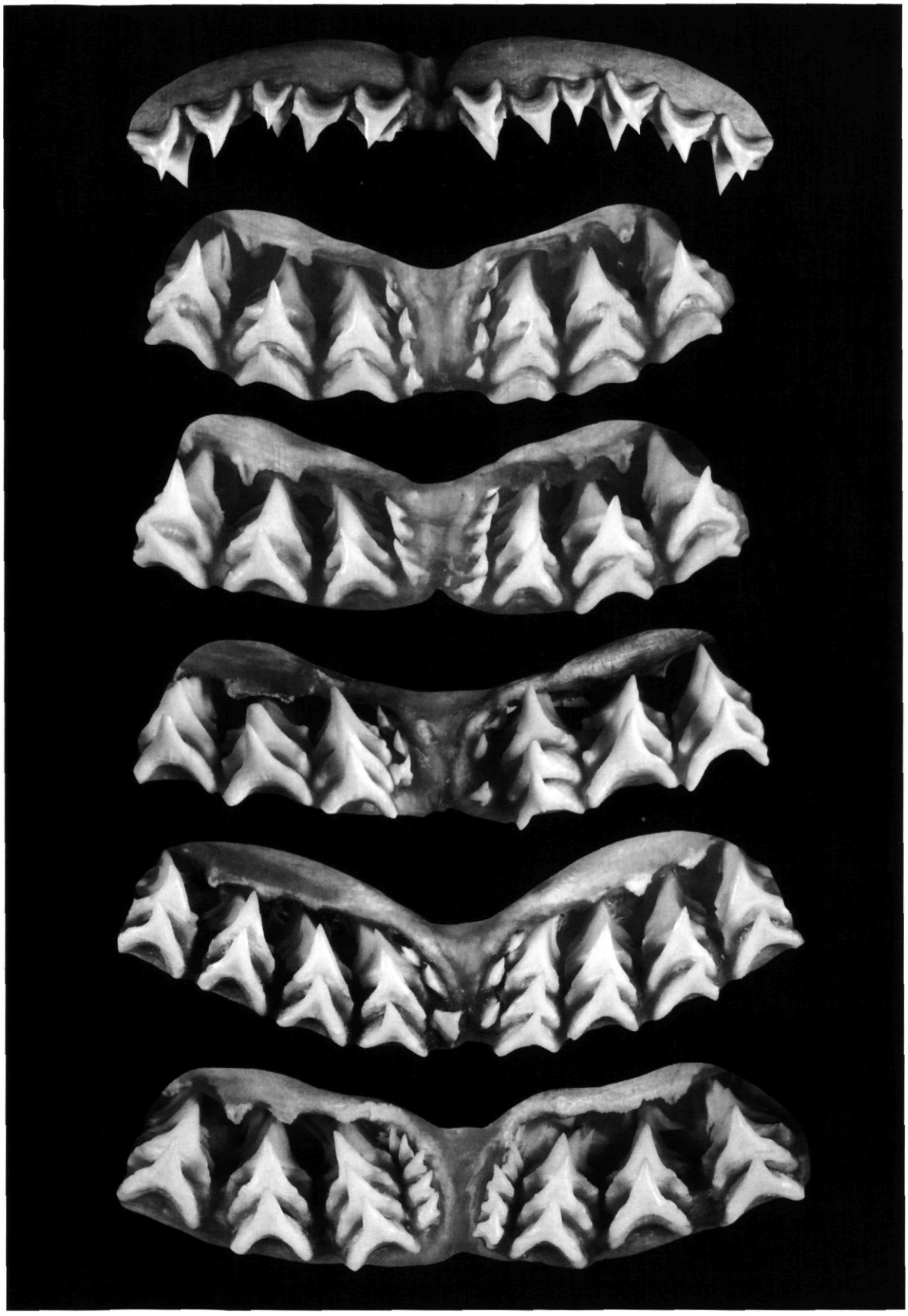

Plate 12 : *Alopias vulpinus* **(BONNATERRE, 1788).** Outer views. Detail (top) of the two upper anterior, the intermediar (eye tooth) and the two first lateral files of a female of 4140 mm t.l., and detail of the lower two parasymphyseal and the lower three anterior files of five specimens : males of 3700, 3840, 4020, 4040 and 4050 mm t.l. respectively, Port de La Rochelle , France.

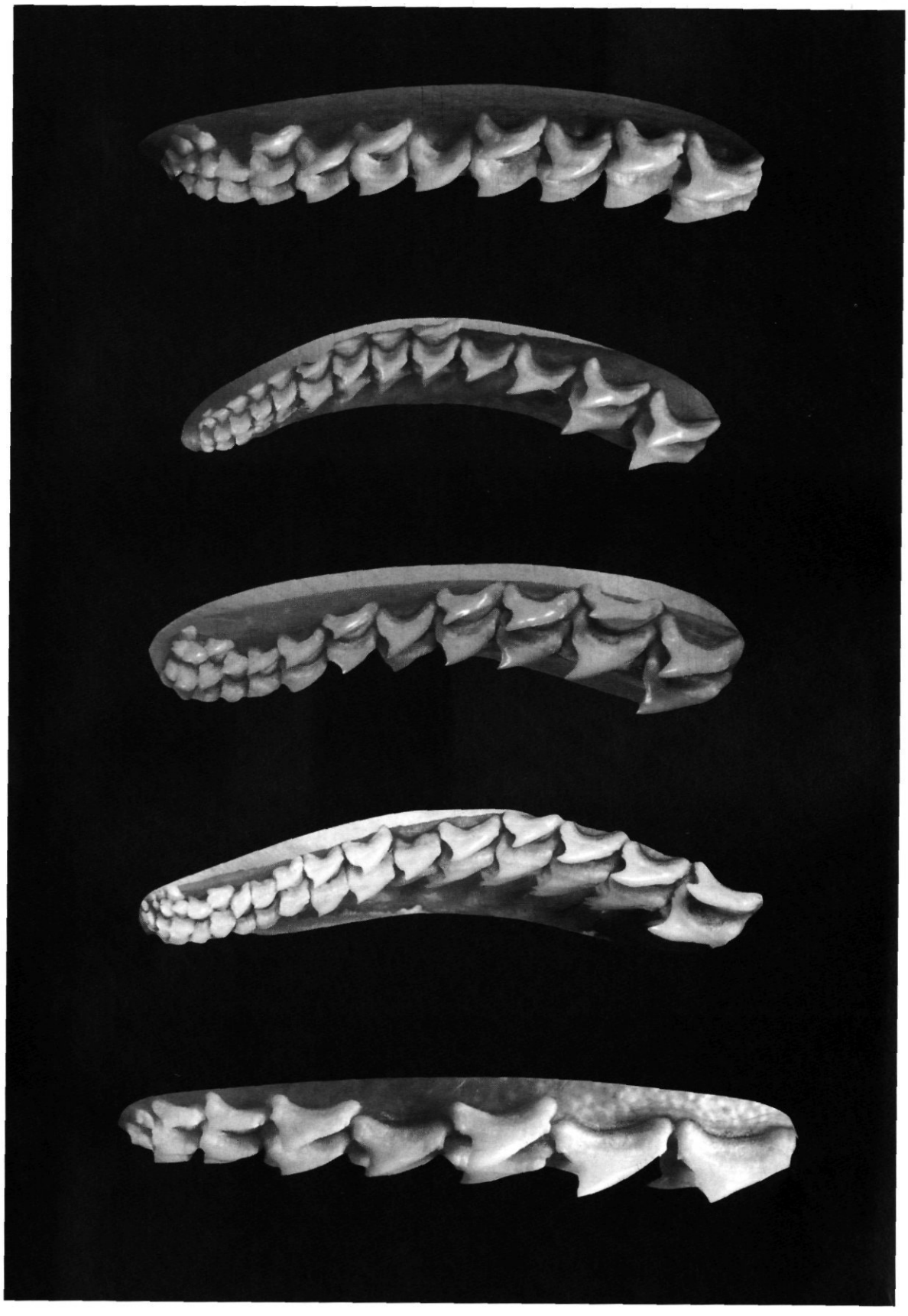

Plate 13 : ***Alopias vulpinus*** **(BONNATERRE, 1788).** Outer views. Detail of upper posterior to commissural files of (top) a female of 4810 mm t.l., and (below) four males of 3840, 4020, 4040 and 4150 mm t.l. respectively, Port de La Rochelle , France.

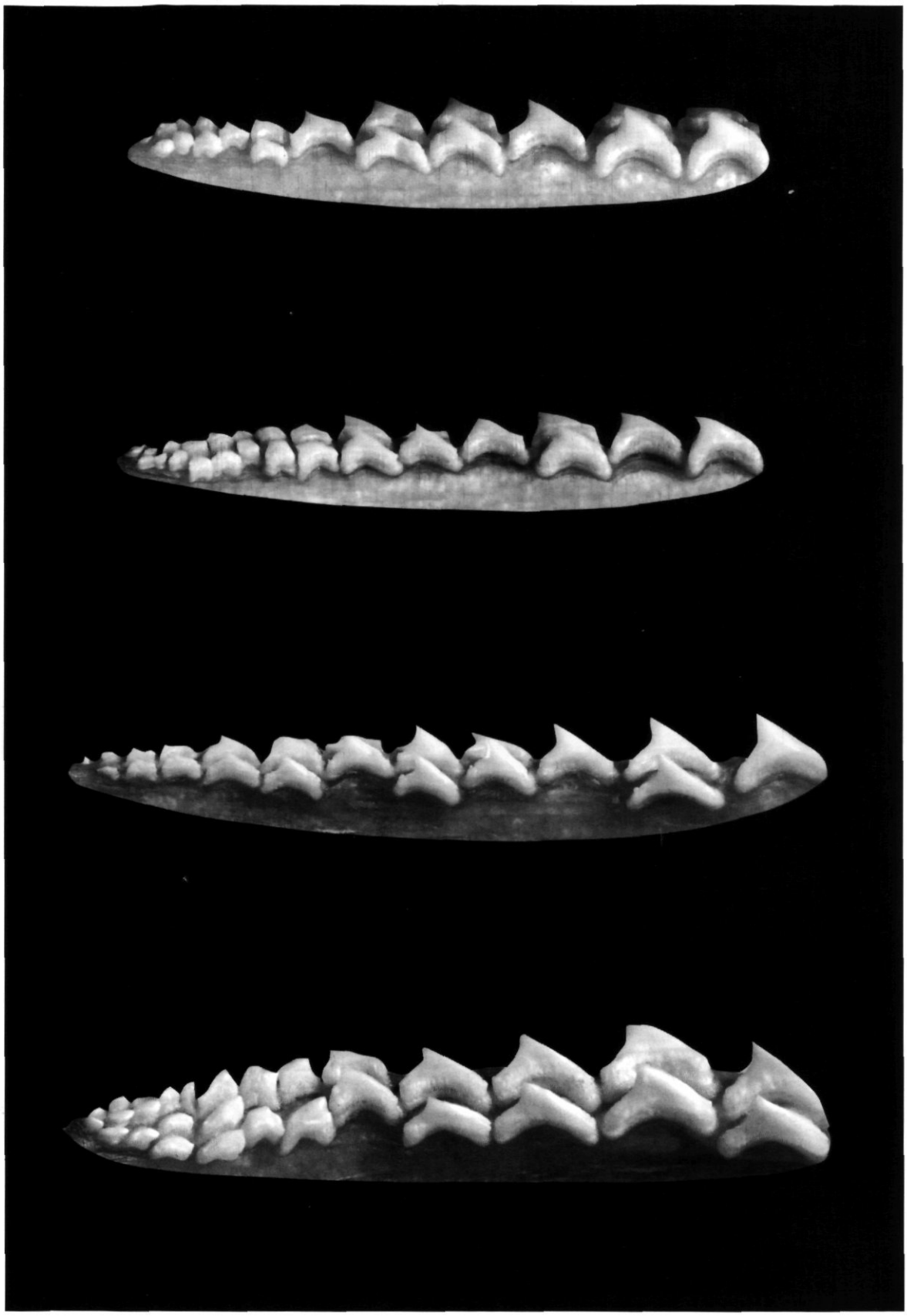

Plate 14 : *Alopias vulpinus* **(BONNATERRE, 1788).** Outer views. Detail of lower posterior to commissural files of (below) a female of 4810 mm t.l., and (top) three males of 4040, 4020, and 3840 mm t.l. respectively, Port de La Rochelle , France.

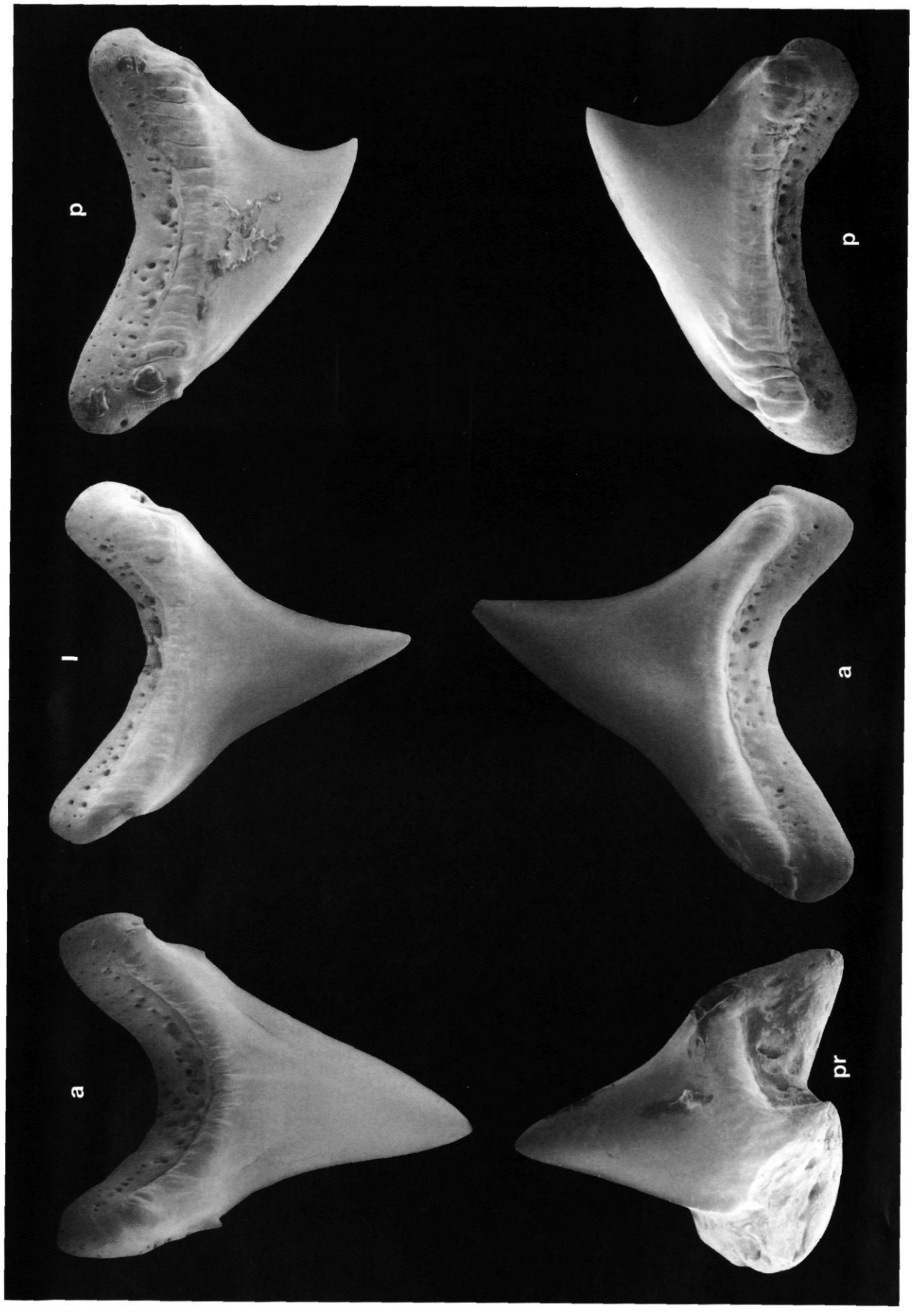

Plate 15 : ***Alopias vulpinus*** **(BONNATERRE, 1788).** Male 1940 mm t.l. (without caudal fin). Outer views of upper and lower teeth : **a** and **l** x8 , **p** x12 , **pr** x16 .

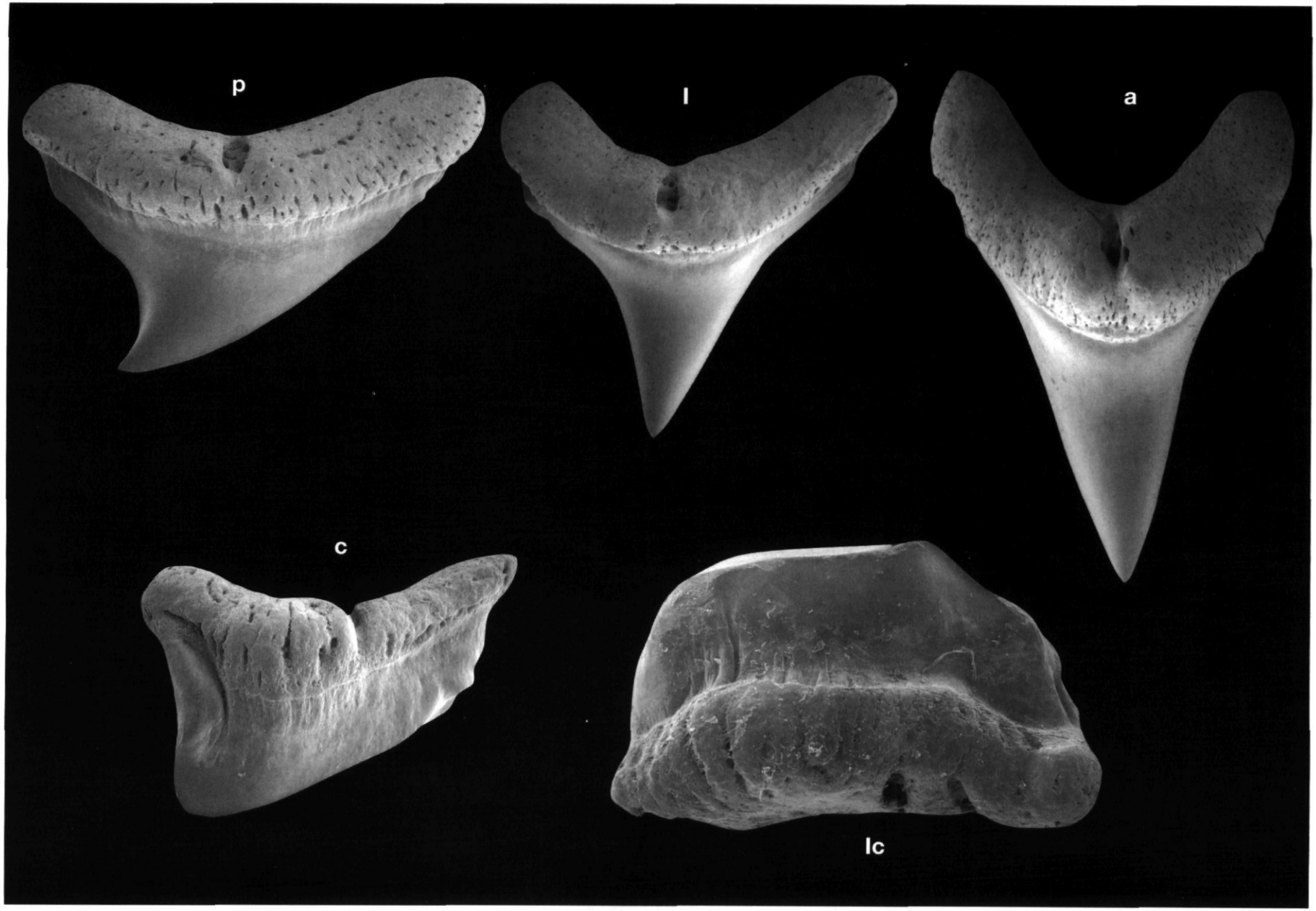

Plate 16 : ***Alopias vulpinus*** **(BONNATERRE, 1788).** Male 1940 mm t.l. (without caudal fin). Inner views of four upper teeth (**a**nterior x16, **l**ateral x16, **p**osterior x24 and **c**ommissural x50) and one lower commissural (**lc** x 60) tooth.

Plate 17 : ***Alopias vulpinus*** **(BONNATERRE, 1788).** Male 1940 mm t.l. (without caudal fin). Inner views of lower teeth **pr** x32 , **a** x16, **p** x32.

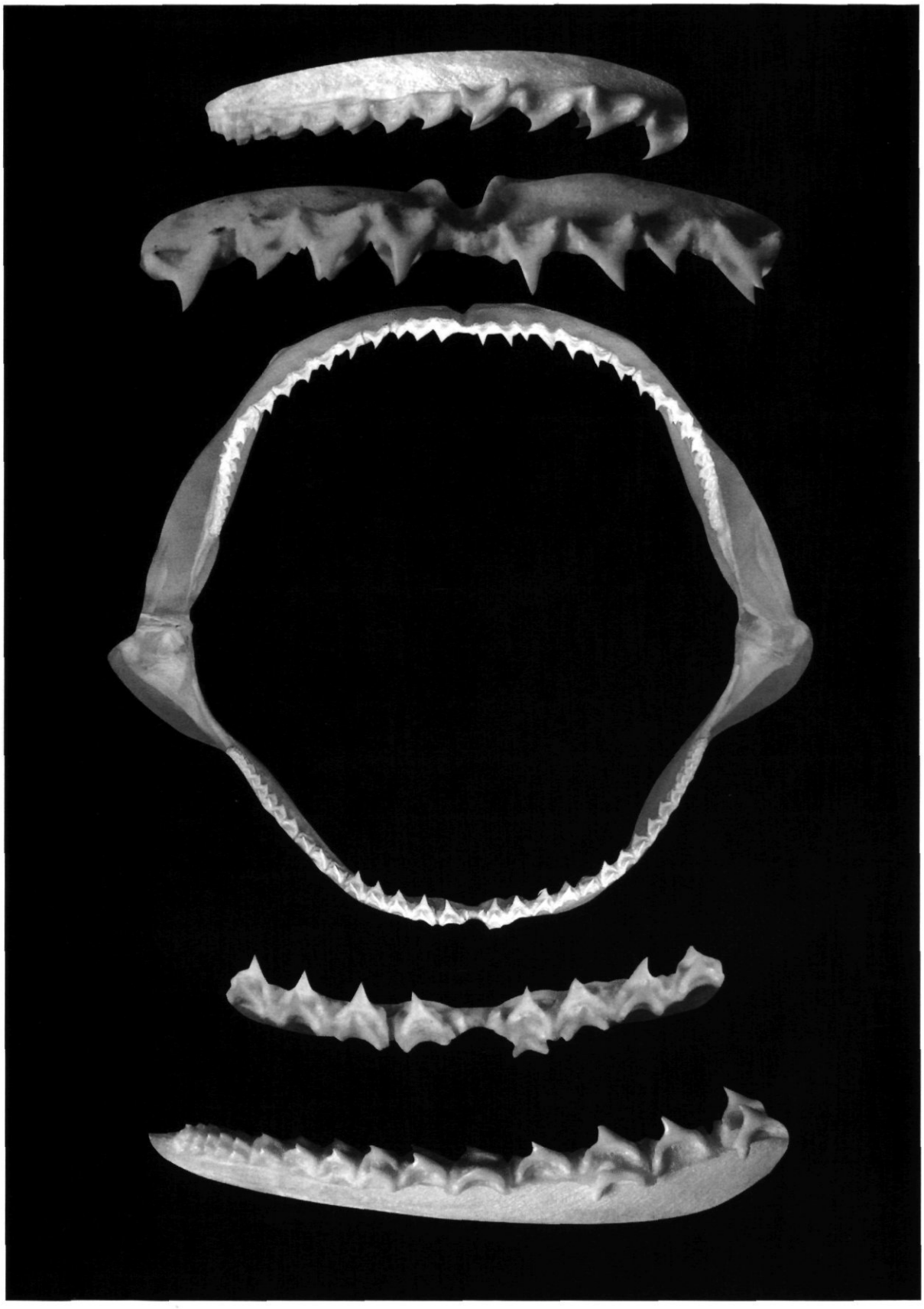

Plate 18 : ***Alopias* sp.** Male 2440 mm t.l., off Ventura, California, U.S.A. Outer view of the dried jaw set (17 cm width, 14 cm height) with details of upper and lower symphyseal and anterior parts of the dentition, as well as upper and lower lateral to commissural parts of the dentition.