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Research Note

Dental abnormalities of the southern thorny skate *Amblyraja doellojuradoi* (Chondrichthyes, Rajidae)

Anomalías dentarias de la raya erizo *Amblyraja doellojuradoi* (Chondrichthyes, Rajidae)

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Abstract.- Teeth morphology has been widely used in taxonomic, biological and fossil teeth studies of Chondrichthyes. Herein, dental abnormalities in *Amblyraja doellojuradoi* are described. Almost 10% of 182 specimens sampled presented any of these types of dental anomalies: (1) an additional incomplete tooth row between two complete rows, (2) an increasing tooth base size and division of its cusps until the complete splitting of teeth in the same row, and (3) an irregular tooth arrangement on the right side of the lower jaw. Possible causes producing these malformations such as mutation, damage by feeding or reproductive behavior are discussed.

Key words: Teeth, malformation, Southern Atlantic

Introduction

The genus *Amblyraja* Malm, 1877 consists of 10 species characterized by having a very rough dorsal disc with scattered coarse spinules and strong thornlets. *Amblyraja doellojuradoi* (Pozzi, 1935), inhabits the Southwest Atlantic (SWA) (Menni & Stehmann 2000) and the Southeastern Pacific Ocean (Lamilla & Bustamante 2005). In the Argentinean continental shelf, it is distributed from 35º to 56ºS, between 51-642 m of depth and 2-7ºC. Information on the southern thorny skate is scarce and it refers almost exclusively to its taxonomy and distribution (Menni & Stehmann 2000, Cousseau *et al*. 2007). A brief description of *A. doellojuradoi* diet was provided by Sanchez and Mabragaña (2002).

Teeth morphology is an important tool widely used in taxonomic, biological and fossil teeth studies of cartilaginous fishes (Herman *et al*. 1994, 1995, 1996, Kemp 1999, Adnet & Cappetta 2001, Sáez & Lamilla 2003). According to the consumed prey, chondrichthyan's teeth may take different forms which are attributed to different functions (Motta 2004). On the other hand, variations in tooth morphology may indicate any kind of malformation. Abnormal teeth were recognized and distinguished from normal teeth in terms of morphological attributes that lied outside the range of normal tooth variation (Becker *et al*. 2000). These phenomena have been reported in sharks but rarely in skates (Gudger 1933, Sáez & Lamilla 2003). In fact, in the most exhaustive reports of skate tooth morphology made by Herman *et al.* (1994, 1995, 1996), who described and illustrated dentition of representatives of 26 different genus worldwide, but nothing about teeth malformation was reported.

Given the paucity of information on teeth malformation in skates, the purpose of this study was to provide a qualitative description of the dentition and a detail depiction of three types of malformations found in *Amblyraja doellojuradoi* dentition.

Materials and methods

A total of 182 specimens were collected from research cruises carried out by the National Institute of Fisheries Research and Development in the Argentinean continental shelf from 36º to 47ºS from 2005 to 2010. Total length (TL) and disc width (DW) of each skate were measured to the nearest millimeter (mm), and weight to the nearest gram (g). Sex of each animal was recorded. The maturity status of each individual was registered following Stehmann (2002).

Skates were identified as *A. doellojuradoi* through Cousseau *et al*. (2007), not presenting any visible abnormality. Jaws were extracted, cleaned and prepared with two different treatments. Thirty five of them were dried and whitened with 30% diluted hydrogen peroxide, while the tooth plates of the rest were excised and pasted onto a vegetal paper. The number of teeth rows in the upper and lower jaws of each specimen was counted from the symphysial (1) to the commissural tooth (n) of each half jaw.

Results and Discussion

A dentition with gradient monognathic heterodonty was observed in *A. doellojuradoi*, which means that teeth from the same row are morphologically different. Also presents ontogenetic heterodonty, having the juveniles little developed cusps, and adults well developed and sharp-pointed cusps. This difference was manifest in males and females, although it was more evident in the former. Finally, in this species sexual heterodonty was observed; males presented more developed, erect and pointed crowns than females. Crown bases were semioval in females and rather circular in males. Further, tooth rows were sharper, and more separated one from another in males than in females (Fig. 1). The number of rows in the upper jaw was 27 to 36 (mean= 31.29) and in the lower was 26 to 34 (mean= 30.36). Contrasting the general characteristics of the teeth of the southern thorny skate, some anomalous teeth were found.

Three types of anomalies were observed in 18 specimens of *A. doellojuradoi*, representing 9.9% of all analyzed specimens (n= 182) (Table 1): (1) an additional incomplete tooth row between two complete rows, (2) an increasing tooth base size and division of its cusps until the complete splitting of teeth in the same row, and (3) an irregular tooth disposition.

Table 1. Details of specimens bearing dental anomalies. Anomalies types were: (1) an additional incomplete tooth row between two complete rows, (2) an increasing tooth base size and division of its cusps until the complete splitting of teeth in the same row, and (3) an irregular tooth disposition. *: indicates the rows where the incomplete row is located. X: Indicate in which jaw (upper or lower) is the irregular disposition / Datos de los especímenes que tienen anomalías dentales. Los tipos de malformación fueron: (1) una hilera incompleta adicional entre dos hileras completas, (2) el aumento del tamaño de la base de los dientes y división de sus cúspides, hasta que este se divide por completo formando dos hileras y (3) una disposición irregular de los dientes. *: Indica entre que hileras se encuentra la hilera incompleta. X: Indica en que mandíbula (superior o inferior) los dientes se encuentran dispuestos irregularmente

Dental Anomaly	Specimen number	Total length (mm)	Sex	Maturity stage	Number of rows Upper jaw	Number of rows Lower jaw	Row of the anomaly Upper jaw	Row of the anomaly Lower jaw
Anomaly type 1								
	1	491	Male	Mature	34	31	1-2 left*	
	2	538	Male	Mature	34	-		1-2 left*
	3 – 3’	473	Female	Mature	31	29	1-2 left*	4-5 left*
	4 – 4’	460	Female	Mature	38	-	6-7 right* and 2-3 left*	
	5	505	Female	Mature	31	31	11-12left*	
	6	498	Female	Mature	34	34	1-2 left*	
Anomaly type 2								
	7	475	Male	Mature	32	31	4 left	
	8	462	Male	Mature	33	32	8 left	
	9	509	Male	Mature	31	29	5 left	
	10	496	Male	Mature	35	32	1 right	
	11	521	Male	Mature	35	32	11 left	
	12	437	Male	Mature	30	30	5 right	
	13 – 13’	400	Female	Immature	34	32	1	1
	14	452	Female	Mature	32	28		1
	15	458	Female	Mature	32	29		11 right
	16	470	Female	Mature	33	31		15 left
Anomaly type 3								
	17	514	Female	Mature	30	-		X
	18	476	Male	Mature	30	27		X

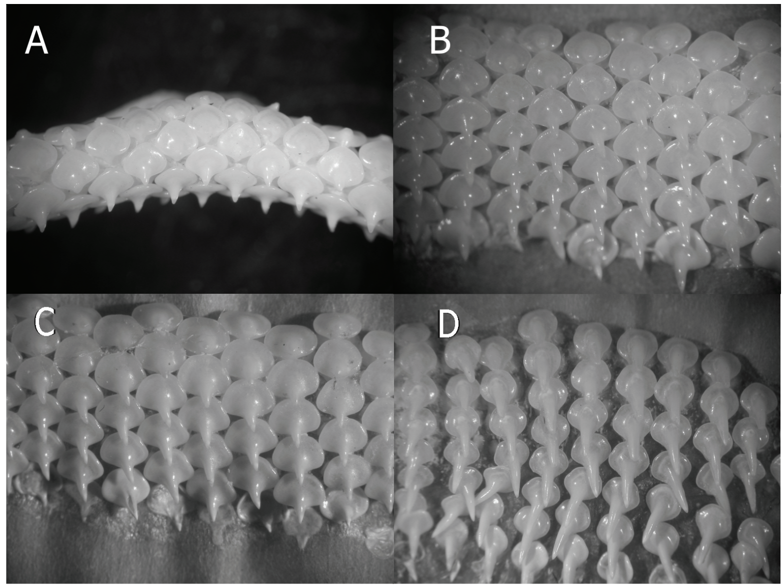

Figure 1. Jaws of the specimens without dental anomalies. A) Immature female (390 mm TL), B) Mature female (515 mm TL), C) Immature male (396 mm TL) and D) Mature male (516 mm TL). Bar scale= 15 mm / Mandíbulas de los especímenes sin anomalías dentales. A) Hembra inmadura (390 mm LT), B) Hembra madura (515 mm LT), C) Macho inmaduro (396 mm LT) y D) Macho maduro (516 mm LT). Barra de escala= 15 mm

The specimens that belonged to the first group of jaw anomaly were two males and four females (Table 1). In these jaws, a file having teeth mostly smaller than normal, emerging from the inner to the outer face of the jaw, between two normal files was observed (Fig. 2A). The specimens that belonged to the second group of type anomaly were 6 males and 4 females. All males were sexually mature, while females were both immature and mature (Table 1). Bicuspid teeth were located as the first or last tooth of the row and from them two rows were arisen or continued with a single one (Fig. 2B). The anomaly was found mainly in upper jaw (Table 1). The third type of anomaly was observed in two specimens, a male and a female, in which a malformation in the lower jaw was presented. Basically, the teeth had underdeveloped cusps and deformed bases. This anomaly was observed on the left side of the inferior jaw (specimen # 17), and on the labial face of the jaw (specimen # 18) (Fig. 2C). In the later specimen, also an abnormal row arrangement was observed.

The most common tooth anomaly recorded for chondrichthyans was the division of teeth and rows (Gudger 1937). This kind of anomaly was found in some sharks, like *Heterodontus* sp., the blacktip reef shark, *Carcharhinus melanopterus* (Quoy and Gaimard, 1824) and the dusky shark, *Carcharhinus obscurus* (Lesueur, 1818) (Gudger 1937), but was never reported in skates, except in the present report for *A. doellojuradoi*. However, Reif (1980) stated that splitting could be the standard process for adding new tooth families and not a malformation. The scarce dental anomalies recorded for skates were size reduction and variation in tooth shape in the thornback ray, *Raja clavata* (Linnaeus, 1758) and in the barndoor skate, *Dipturus laevis* (Mitchill, 1818) (Gudger 1933), as well as teeth size reduction in a female of the graytail skate, *Bathyraja griseocauda* (Norman, 1937) (Sáez & Lamilla 2003).

According to Becker *et al*. (2000), two classes of teeth malformation can be observed: those involving the entire row and those that were limited to only one tooth. In the first case a long-term agent that inhibits normal production of the tooth (mutation) could be acting. The second case implied a short-term cause which was later corrected by some process of healing (Becker *et al*. 2000). The aforementioned author proposed some possible explanation for tooth anomalies in chondrichthyans, involving vital effects like injury, disease and mutation that act during the life of an animal. Damage suffered by chondrichthyans during feeding could produce a variety of dental deformities (Becker *et al*. 2000). Gudger (1937), Hubbell (1996) and Becker *et al*. (2000) clearly showed how the spines from the ray's tails and bony fishes, when were consumed by sharks, could damage their tissue producing teeth malformations. However, the damage

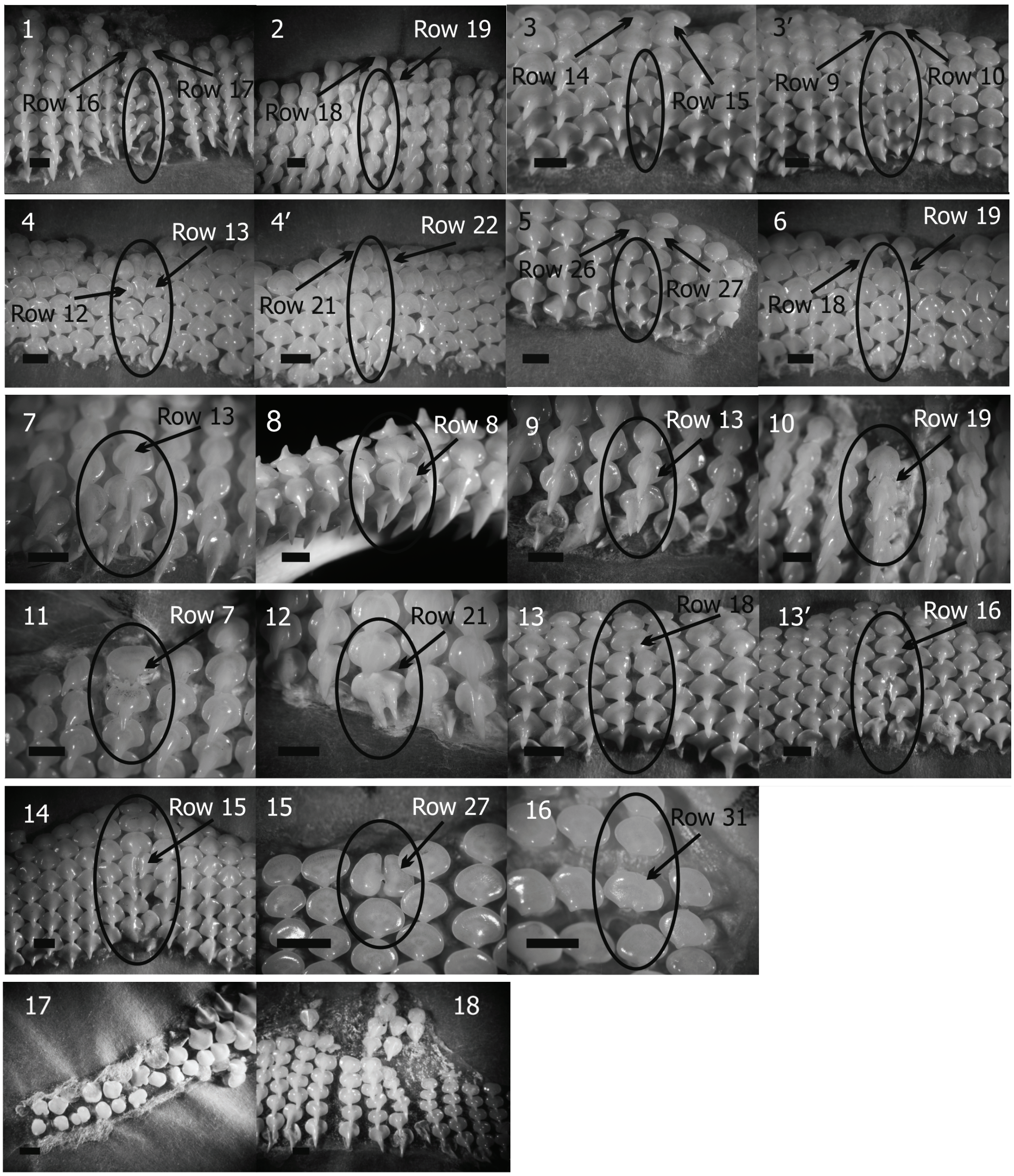

Figure 2. Jaw anomalies: A) Specimens 1 to 6, with the first type of jaw anomaly; B) Specimens, 7 to 16, with the second type of jaw anomaly; C) Specimens, 17 and 18, with the third type of jaw anomaly. Numbers of the specimens according to Table 1. Bar scale= 15 mm / Anomalías mandibulares: A) Especímenes 1-6 que poseen el primer tipo de anomalía; B) Especímenes 7-16 que poseen el segundo tipo de anomalía; C) Especímenes 17 y 18 que poseen el tercer tipo de anomalía. Los números de especímenes corresponden a los indicados en la Tabla 1. Barra de escala= 15 mm

occurred during feeding did not rule out the possibility of some genetic mutation, producing some anomalies. On the other hand, it is known that during copulation skates bite to grip (Luer & Gilbert 1985); therefore, in species with robust spines on the dorsal face, bitting could provoke damage in their jaws.

The causes of the anomalies described for *Amblyraja doellojuradoi* are unknown. Based on what was previously discussed, the malformations could be attributed to mutations, damage by feeding or copulation or a standard process for adding new tooth families. In specimens of *A. doellojuradoi* with the first type of anomaly, the malformation involved the entire file. Therefore, the cause could be a mutation or simply splitting. In those with the second type of malformation, besides the previous causes, jaw injury in some life time should not be avoided. In specimens with the third type of anomaly, malformation clearly seemed to be the result of jaw tissue damage. *A. doellojuradoi* fed mainly on crabs and their hard exoskeleton could generate some tissue injury. On the other hand, since this species distinctively posses robust spines on the dorsal face this could provoke jaw injuries during copulation. However, there is no strong evidence that these causes are dominant in producing the anomalies described for *A. doellojuradoi*.

Further analysis regarding behavior during feeding and copulation, as well as histological studies on damaged tissues are needed to understand some of the anomalies described here. In addition, it would be of major importance to analyze if splitting is the consequence of mutation or a natural process of adding teeth rows, taking into account that this process has never been reported in skates so far and may play an important role in skate tooth development.

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