



Scientific note

Distribution of the lateral line canals in *Dasyatis matsubarai* (Elasmobranchii, Dasyatidae) from Japanese waters

AKEMI SHIBUYA¹ & SHO TANAKA²

¹Coordenação de Pesquisas em Biologia Aquática, Instituto Nacional de Pesquisas da Amazônia, INPA, Avenida André Araújo, 2936, Aleixo, 69083-000, Manaus, Amazonas, Brazil. E-mail: akemi_shibuya@yahoo.com.br

²Tokai University, School of Marine Science and Technology, 3-20-1 Orido, 424-8610, Shimizu, Shizuoka, Japan.

Abstract. The external morphology of lateral line canals was described for *Dasyatis matsubarai*. Despite the distribution of canals is similar to the most dasyatid species, the number of tubules and branches was different, especially to hyomandibular canal on the both dorsal and ventral surfaces.

Key words: mechanosensorial system, morphology, Myliobatiformes

Distribuição dos canais da linha lateral em *Dasyatis matsubarai* (Elasmobranchii, Dasyatidae) das águas japonesas. A morfologia externa dos canais da linha lateral foi descrita para *Dasyatis matsubarai*. Apesar dos canais terem a distribuição similar à maioria das espécies de dasyatídeos, o número de túbulos e ramificações mostrou-se diferente, principalmente para o canal hiomandibular das duas superfícies do corpo.

Palavras chave: sistema mecanossensorial, morfologia, Myliobatiformes

The lateral line canals (mechanosensory system) seem to be essential for batoid species (skates and rays) to prey localization and capture, especially due to visual limitations of the bottom during foraging behavior (Maruska 2001, Jordan *et al.* 2009). The positioning of mouth (ventral) and eyes (dorsal) on opposite sides of the body in batoids makes the mechanoreceptors of ventral lateral line canals important tactile organs for prey localization (Maruska & Tricas 2004). Despite of Chu & Wen (1979) have published a comprehensive work examining the lateral line canals of 73 shark, batoid and chimaera species, their uses were not mentioned. The biological, physiological and evolutionary aspects of the mechanoreception were described by Coombs *et al.* (1989) and the distribution and the role of lateral line canals, as well as the reception of water movements were later analyzed for some batoid species (Montgomery & Skipworth 1997, Maruska & Tricas 1998, Maruska 2001, Maruska & Tricas 2004). The pored canals on the dorsal surface

can identify water movements generated by predators (defense), prey (feeding) and conspecifics (schooling and mating, for example) and the non-pored canals has tactile function during the localization of buried prey (Maruska 2001, Coombs & Braun 2003, Maruska & Tricas 2004, Marzullo *et al.* 2011). The purpose of this investigation is to describe the morphology of the lateral line canals in *Dasyatis matsubarai* Miyosi, 1939. *Dasyatis matsubarai* is included in the red list of IUCN (International Union for Conservation of Nature and Natural Resources) as data deficient, evidencing the scarcity of any information about its biological and ecological aspects (Nishida & Nakaya 1990, Compagno *et al.* 2007).

Specimens of *D. matsubarai* (n=4; females adults) were obtained from the Suruga Bay, coast of Japan and were deposited at Department of Marine Biology, Tokai University (Japan). All specimens were fixed in 10% formalin solution and washed in flowing water for three days before being dissected;

the skin was removed from the dorsal and ventral body surfaces in order to examine the lateral line canals. The terminology follows Chu & Wen (1979) and Maruska (2001) for the lateral line canals: hyomandibular (HYO), infraorbital (IO), mandibular (MAN), nasal (NS), posterior lateral line (PLL), and supraorbital (SO) canals. Tubules, branched tubules, vesicles of Savi, and pores were counted on the left side of the body (assuming bilateral symmetry) for each canal, excluding the lateral line on the tail and the free neuromasts. The term “tubule” refers to extensions of the main canal with no neuromasts that terminate in pores; the term “pore” refers to the tubule opening on the skin surface that maintains the neuromast canal in contact with the external environment (following Maruska 2001, Jordan 2008). “Vesicles of Savi” are neuromasts enclosed in pouches on the ventral surface of Torpediniformes, some dasyatid species (Maruska 2001) and Potamotrygonid rays (Garman 1888, Shibuya *et al.* 2010).

Dorsal surface. All canals have tubules terminating in pores. The hyomandibular canal extends to near the margins of the pectoral fins and connect to the posterior lateral line canal near the scapular. The hyomandibular canal has long

marginally directed tubules that terminate in pores (four to six pores per tubule) (Fig. 1). In the rostrum section, the hyomandibular canal penetrates through the body joining to the hyomandibular canal on the ventral surface (Fig. 1, marked by squares). The infraorbital canal has short tubules and is located at the lateral margin of the eye and connects to the posterior supraorbital canal, between the eye and the spiracle. As in the hyomandibular canal, the infraorbital canal penetrates through the body on the midline of the rostrum and connects to the same canal of the ventral surface in all analyzed species (Fig. 1, marked by circles). The supraorbital canal has tubules that terminate in single pores and extends caudally from the rostrum and connects to the posterior lateral line canal. The posterior portion of the supraorbital canal is formed by a tree-like branching of short tubules that terminate in approximately 14 ± 2 single pores. The posterior lateral line canal is situated on the midline portion of the body. It begins on the posterior supraorbital canal and reaches the tip of the tail. Posteriorly to the supraorbital canal has a short connection between the canals of both left and right sides of the body.

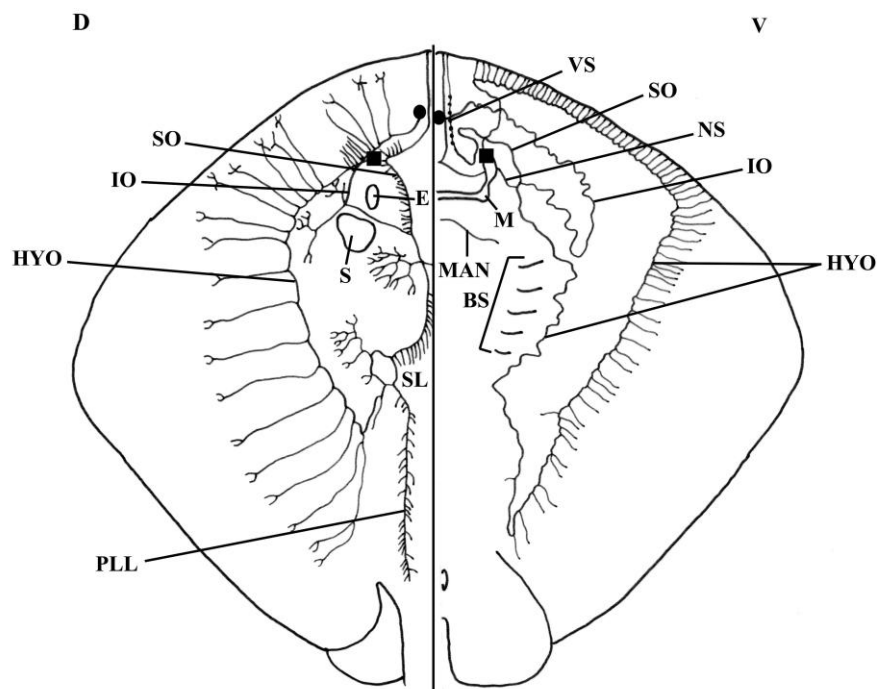


Figure 1. Distribution of the lateral line canals in *Dasyatis matsubarai* and their connections between the dorsal (D) and ventral (V) surfaces. BS = branchial slits; E = eye; HYO = hyomandibular canal; IO = infraorbital canal; M = mouth; MAN = mandibular canal; NS = nasal canal; PLL = posterior lateral line canal; S = spiracle; SL = scapular loop; SO = supraorbital canal; VS = vesicles of Savi. Squares = connection of the hyomandibular canal; Circles = connection of the infraorbital canal. DW (disc width) = 39.0 cm.

Ventral surface. The ventral surface has pored and non-pored canals and vesicles of Savi. Pored tubules were observed only in the hyomandibular canal. This canal extends near of the edge of the rostrum to the posterior portion of the body, margining laterally the branchial slits, and making a V-shaped loop (close to the pelvic fins). The hyomandibular canal on the ventral surface has a series of tubules that terminate in single pores, these being dense on the rostrum. The hyomandibular canal joins the infraorbital, supraorbital and nasal canals near the mouth. The infraorbital and supraorbital canals are concentrated around the mouth and nostrils. The infraorbital canal extends to the midline of the rostrum and penetrates through the body to connect to the same canal on the vesicles of Savi that are ordered longitudinally. The nasal canal extends from the rostrum to the lateral side of the nostril and connects to the junction of the hyomandibular, supraorbital, and infraorbital canals. The nasal canal has a slight connection between the left and right sides of the lateral line system on the ventral surface just anterior to the mouth. Pores are absent in the mandibular canal for all analyzed species and is located posteriorly to the mouth.

Dasyatis matsubarae was chosen as study species to be commonly captured by fishery gears and considered bycatch (Yokota *et al.* 2009). Also, it comprises one the most discarded species in Tateyama Bay, Japan (Akiyama 2007). It is known that *D. matsubarae* is abundantly captured by fishery, however there is no data about which type of prey this species consume. Yokota *et al.* (2009) observed the capture of specimens by longline and using fish (Mackerel) as bait. *Dasyatis matsubarae* may predate mackerels on the bottom, which need accuracy to search benthically (buried or not) associated prey. Jordan (2008) showed the dorsal canals present higher complexity of branching and number of pores than ventral canals. The same patterns were found for specimens of *D. matsubarae*. On the other hand, the life habit of each species may also be related to the pores distribution. *Dasyatis matsubarae* presents benthic habits, although this species also was found in surface of pelagic region (Camhi *et al.* 2009, Yokota *et al.* 2009). The high number of pores on the dorsal surface of *D. matsubarae* may detect water movements generated by predator. The density of canals near to the mouth and the pored hyomandibular canal on the ventral surface indicate the use of tactile mode to search and capture benthic prey, as observed by Maruka & Tricas (2004) for *D. sabina*. However, there is no information available concerning differences in the sensitivity and/or accuracy of these

mechanoreceptors that might be compensated for the quantity of pores in batoid species. Neurophysiological experiments will be necessary to test any hypotheses. The current analysis on the distribution of mechanosensory canals provided information on the prey-predator relationship for this batoid species, as well as it can be use as phylogenetic tool to Myliobatiform rays.

Acknowledgements

The authors would like to thank Jansen Zuanon (INPA) for his valuable comments on the manuscript. Hajime Ishihara (W&I Associates), for sending references about *Dasyatis*. The first author thanks the Japan International Cooperation Agency (JICA) for financial support and the technical trainee fellowship, as well as the Brazilian National Council for Scientific and Technological Development (CNPq) for the doctoral grant to the first author.

References

- Akiyama, S. 2007. Discards in large scale set net in Tateyama bay. **Nippon Suisan Gakkaishi**. In Japanese. 73(6): 1103-1108.
- Camhi, M. D., Valenti, S. V., Fordham, S. V., Fowler, S. L. & Gibson, C. 2009. **The conservation status of pelagic sharks and rays: Report of the IUCN Shark Specialist Group Pelagic Sharks Red List Workshop. IUCN Species Survival Commission Shark Specialist Group**. Newbury, UK. 78p.
- Chu, Y. T & Wen, M. C. 1979. **A study of the lateral-line canals system and that of Lorenzini ampullae and tubules of elasmobranchiate fishes of China**. Monograph of Fishes of China. Academic press, Shanghai. 132p.
- Compagno, L. J. V., Ishihara, H., Tanaka, S. & Orlov, A. 2007. *Dasyatis matsubarae*. In: **IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1**. Accessible at www.iucnredlist.org (accessed 29 August 2011).
- Coombs, S. & Braun, C. B. 2003. Information processing by the lateral line system. pp:122-138. In: Collin, S. P. & Marshall, N. J. (Eds.): **Sensory processing in aquatic environments**. Springer-Verlag, New York.
- Coombs, S., Gerner, P. & Münz, H. 1989. **The mechanosensory lateral line – Neurobiology and evolution**. Springer-Verlag, New York.
- Garman, S. 1888. On the lateral canal system of Selachia and Holocephala. **Bulletin of the Museum of Comparative Zoology**. 17:57-119.

- Jordan, L. K. 2008. Comparative morphology of stingray lateral line canal and electrosensory systems. **Journal of Morphology**. 269: 1325-1339.
- Jordan, L. K., Kajiura, S. M. & Gordon, M. S. 2009. Functional consequences of structural differences in stingray sensory systems. Part I: mechanosensory lateral line canals. **Journal of Experimental Biology**. 212: 3037-3043.
- Maruska, K. P. 2001. Morphology of the mechanosensory lateral line system in elasmobranch fishes: ecological and behavioral considerations. **Environmental Biology of Fishes**. 60:47-75.
- Maruska, K. P. & Tricas, T. C. 1998. Morphology of the mechanosensory lateral line system in the Atlantic stingray, *Dasyatis sabina*: the mechanotactile hypothesis. **Journal of Morphology**. 238: 1-22.
- Maruska, K. P. & Tricas, T. C. 2004. Test of mechanotactile hypothesis: neuromast morphology and response dynamics of mechanosensory lateral line primary afferents in the stingray. **Journal of Experimental Biology**. 207:3463-3476.
- Marzullo, T. A.; Wueringer, B. E.; Squire-Jr, L. & Collin, S. P. 2011. Description of the mechanoreceptive lateral line and electroreceptive ampullary systems in the freshwater whipray, *Himantura dalyensis*. **Marine and Freshwater Research**. 62:771-779.
- Montgomery, J. & Skipworth, E. 1997. Detection of weak water jets by the short-tailed stingrays *Dasyatis brevicaudata* (Pisces: Dasyatidae). **Copeia**. 4:881-883.
- Nishida, K. & Nakaya, K. 1990. Taxonomy of the genus *Dasyatis* (Elasmobranchii, Dasyatidae) from the North Pacific. Pp 327-346. *In*: Pratt, H. L., Gruber, S. H. & Taniuchi, T. (Eds.). **Elasmobranchs as Living Resources: Advances in the Biology, Ecology, Systematics, and Status of the Fisheries**. NOAA Technical Report NMFS 90. U.S. Department of Commerce.
- Shibuya, A., Zuanon, J., Araújo, M. L. G. & Tanaka, S. 2010. Morphology of lateral line canals in Neotropical freshwater stingrays (Elasmobranchii: Potamotrygonidae) from Negro River, Brazilian Amazon. **Neotropical Ichthyology**. 8(4):867-876.
- Yokota, K., Kiyota, M. & Okamura, H. 2009. Effect of bait species and color on sea turtle bycatch and fish catch in a pelagic longline fishery. **Fishery Research**. 97(1-2):53-58.

Received February 2012

Accepted July 2012

Published online November 2012