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PRELIMINARY SAGITTA OTOLITH SECTIONS OF SOME SMALL-SCALE FISHERY SPECIES IN THE COLOMBIAN PACIFIC OCEAN

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Abstract
Preliminary sagitta otolith transversal sections of six small-scale fishery species were performed (*Lutjanus guttatus, Lutjanus inermis, Haemulon flaviguttatum, Haemulon steindachneri, Rhencus panamensis, Diapterus brevirostris*). Sections showed clear growth rings in all species and the best section part to count them. Together with other few studies, these sections confirmed otoliths as a good tool to improve knowledge of fish life history aspects for fisheries management.

Keywords: otolith sections, *Lutjanus guttatus, Lutjanus inermis, Haemulon flaviguttatum, Haemulon steindachneri, Rhencus panamensis, Diapterus brevirostris*

Introduction
Otoliths are small inner ear bones made of calcium carbonate and other elements, related with mechanisms for equilibrium and hearing of fishes; three kinds of otoliths are found in bony fishes: sagitta, lapillus and asteriscus. The most used for different studies are the sagitta otoliths (e.g., Rossi-Wongtschowski et al., 2014; Callicó et al., 2017). Age determination and growth studies by means of otolith sections have been done in many fish species of the Eastern Tropical Pacific Ocean (ETPO) (Wiff et al., 2007; Solano-Fernandez et al., 2015; Cerna & Plaza, 2016; Pardo et al., 2017, among others).

There are four studies using otoliths in Colombia. Zapata and Herron (2002) used lapillus otoliths, Hermann et al. (2016) collected and studied some lapillae from *Brachyplatystoma rousseauxii* (n = 1) and *B. filamentosum* (n = 1) from the Caquetá River, near Araracuara in the Colombian amazon river basin. Puentes et al. (2019) described the morphology of whole sagitta otoliths and otolith sections of the yellowtail snapper *Lutjanus argentiventris* and the red grouper *Hyporthodus acanthistius* in the Colombian Pacific Ocean, and Puentes et al. (2022) reported on the morphometrics and morphology of the whole sagitta otoliths and otolith sections of the pacific bearded brotula *Brotula clarkae*. This work presents preliminary transversal sections of six small-scale fishery species in the Colombian Pacific Ocean (CPO), the spotted rose snapper *Lutjanus guttatus*, the golden snapper *Lutjanus inermis*, the Cortez grunt *Haemulon flaviguttatum*, the chere-chere grunt *Haemulon steindachneri*, the Panama grunt *Rhencus panamensis* and the Peruvian mojarra *Diapterus brevirostris*

Material and Method

Otoliths were extracted from fish collected in the project "Assessment and ecological fishery study to build a trophic model of marine resources of the Colombian Pacific Ocean" (INVEMAR, Buenaventura, 1997 – 2000) on board the research vessel ARC Malpelo, and at El Valle (Chocó, Colombia), with the collaboration of the fishermen cooperative "Los Piqueros". Otolith sections through the nucleus were performed for 14 sagitta otoliths of *Diapterus brevirostris*, 7 of *Lutjanus guttatus*, 5 of *Haemulon flaviguttatum*, 5 of *H. steindachneri,* 5 of *Rhencus panamensis* and 4 of *L. inermis.* Right otoliths of each specimen were embedded in epoxy resin for 48 hours to perform sections. Once properly compacted and labeled, transversal sections were made with a Microcutter type MC-201(Maruto Co. Ltd. Tokyo, Japan), and polished with a polisher type 9820 (Makita Co., Ltd, Tokyo, Japan), getting a 0.2 mm otolith section, which was mounted on a labeled slide. Each section was observed with a stereoscope LEICA MZ12.5 (Leica Microsystems, Heerburg, Switzerland). The best area to count and measure growth rings was determined in otolith sections based on Puentes et al. (2019).

Results and Discussion

These species are part of the small-scale fisheries with gillnet (locally called "trasmallo") and hook fishing gears and methods such as the artisanal longline (locally called "espinel"), or handline (locally called "linea de mano"), among others, described by Puentes et al. (2014) in the CPO; they are usually traded locally or for self-consumption (subsistence). Although *Haemulon maculicauda* is more common in the CPO, *H. steindachneri* is common in rocky reefs and sea mountains of the northern CPO (Chasqui et al., 2020) usually captured by hook fishing gears.

Transversal sections showed important characteristics and evidence of growth rings formation for these six species. In *L. guttatus* (**1A**) and *L. inermis* (**1B**), sections showed clear growth rings with better observed with reflected light. The best part to count and measure them seems to be on or slightly aside the dorsal tip of the sulcus acusticus. Sections of sagitta otoliths for *H. flaviguttatum* showed clear growth rings on both sides of sulcus acusticus, better with reflected light, that may be counted and measured next to the dorsal or ventral tip of sulcus acusticus. There is a defined nucleus towards the distal surface (**Figure 1C)**, and sulcus acusticus opens gradually in a "V" shape from the nucleus to the proximal surface. Growth rings are uniform, but the first two ones may be thicker than the rest. Sections of sagitta otoliths

for *H. steindachneri* allow to see and count growth rings better right next to the ventral tip of sulcus acusticus (**Figure 1D**); the nucleus is toward the distal surface, where sulcus acusticus starts opening towards the proximal surface. Sections of *R. panamensis* showed growth rings better with reflected light, but not so clear as in previous cases. Otoliths are thick from the distal-proximal perspective with a nucleus right in the middle, where sulcus acusticus starts in a "V" shape towards the proximal surface. The best place to count and measure growth rings is on or right next to the dorsal tip of sulcus acusticus (**1E**). Sections of sagitta otoliths of *D. brevirostris* showed better growth rings with reflected light, especially in the ventral area, where it seems to be better to count and measure them (**Figure 1F**). The nucleus is near the distal surface; the sulcus acusticus is opened towards the proximal surface with a "V" shape. Growth rings are uniform, but the first ones (near the nucleus) may be thicker than the others. Otoliths are thick and especially breakable, so that in the polishing process to get a 0.22 mm thick slide, it is possible to get easily broken.

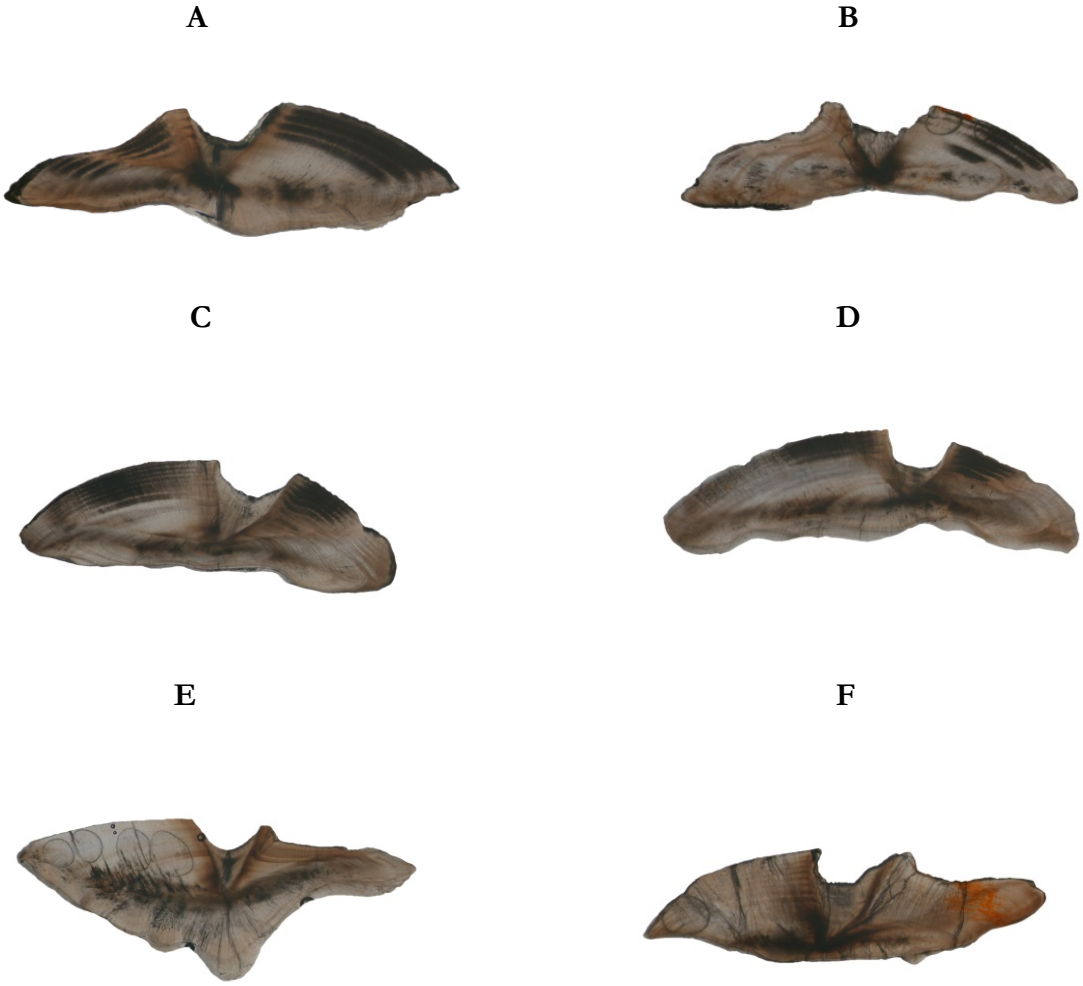

Figure 1. Transversal sections of sagittae otoliths for six marine fishery species in the Colombian Pacific Ocean. **A.** *Lutjanus guttatus*, **B.** *Lutjanus inermis*, **C.** *Haemulon flaviguttatum*, **D.** *Haemulon steindachneri* **E.** *Rhencus panamensis*, **F.** *Diapterus brevirostris*

No otolith analysis and/or transversal sections analysis of sagitta otoliths of these six marine fish species were found in Colombia. In Latin America or the ETPO, some studies were carried out with otoliths for *L. guttatus*. Maravilla (2001) used surface reading and daily growth increments in sagitta-sectioned otoliths in El Salvador. Amezcua et al. (2006) estimated age and growth from transversal otolith sections of specimens from the southeastern Gulf of California, which is a completely different environment from that found in the CPO. Soto-Rojas et al. (2009) used Sagitta otolith transversal sections to estimate age in the Nicoya Gulf (Costa Rica). *L. guttatus* and *L. inermis* sections were like those of *L. argentiventris* (Puentes et al., 2019) and even other lutjanid species (Newman et al., 2000; Newman, 2002; Fortaleza & Nañola 2017), where the most common characteristic is that they are distinctly concave by the distal surface. *L. inermis* may be captured by anglers in the northern CPO on rocky bottoms, as it was generally reported by Allen (1995); no otolith analysis for this species was found.

Gatica (2016) used the whole polished otoliths to determine age of *H. flaviguttatum* in Mexico. Erazo-Londoño (2018) reported the species in Gorgona Island (Southwestern Colombian Pacific). A growth study based on length frequency analysis was reported at Colima, Mexico (Cruz-Romero et al., 1993). Morales and Gonzalez (2010) used the whole otoliths to determine age embedded in glycerin for *H. steindachneri* in Venezuela. On the other hand, the chere-chere grunt *H. steindachneri* has records of length frequency growth studies in the Colombian Caribbean (Garcia & Duarte, 2006).

For *R. panamensis*, otolith sections showed clear growth rings, so similar studies may be performed, but growth rings reading must be done carefully. No reports of otolith studies were found for the species or other *Rhencus* species in the ETPO, but other *Rhencus* species showed good results in other parts of the world (e.g., Al-Husaini et al., 2002; Chater et al., 2015; Al-Nahdi et al., 2018). No otolith descriptive studies were found for *R. panamensis* in the region,

For *D. brevirostris*, Gallardo et al., (2014a, b) used whole otoliths to determine age and to describe sagitta otolith of the species. None of these studies described the transversal sectioned otoliths of the species, but growth was estimated by length frequency analysis in Costa Rica (Cabrera-Peña et al., 1996).

This preliminary analysis shows that sagitta otolith transversal sections in these species are useful to determine the age, growth, and conducting species´ stock assessment in the CPO. Few studies are so far carried out on otolith Colombian fish species, mostly descriptive, and a new field of study is opened to improve the knowledge of several aspects of fish life history and fishery management in the country.

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The authors declare that data are available from authors upon reasonable request.

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Contribution of authors
Vladimir Puentes: Conceptualization, Formal analysis, Validation, Writing original draft
Jorge A. Angulo: Sample acquisition, Investigation, review and adjustment of original draft.
Angel A. Villa: Sample acquisition, Investigation, review and adjustment of original draft.

References

Al-Husaini, M., Al-Baz, A., Al-Ayoub, S., Safar, S., Al-Wazan, Z., & Al-Jazzaf, S. (2002). Age, growth, mortality, and yield-per-recruit for nagroor, *Pomadasys kakaan*, in Kuwait's waters. *Fisheries Research*, *59*, 101-115. https://doi.org/10.1016/S0165-7836(01)00417-9

Al-Nahdi, A. H., Al-Siyabi, B., & McCarthy, I. D. (2018). Age and growth validation of the small spotted grunt *Pomadasys commersonnii* (Lacepède, 1801) from the northwestern coast of the Arabian Sea of Oman. *Journal of Applied Ichthiology, 34*(4), 834-841. https://doi.org/10.1111/jai.13687

Lutjanidae. Pargos. Guia FAO para Identificación de Especies para los Fines de la Pesca. Pacifico Centro-Oriental. In W. Fischer, F. Krupp, W. Schneider, C. Sommer, K. E. Carpenter and V. Niem (Eds.). FAO (Vol. 3, pp. 1231-1244). Rome.

Amezcua, F., Soto-Silva, C., & Green- Ruiz, Y. (2006). Age, growth, and mortality of the spotted rose snapper Lutjanus guttatus from the southeastern Gulf of California. *Fisheries Research, 77*(3), 293-300. https://doi.org/10.1016/j.fishres.2005.10.012

Cabrera-Peña, J., Solano-López, Y., & Mora-Hernández, M. (1996). Crecimiento de *Diapterus peruvianus* (Pisces: Gerridae) en los estuarios de los ríos Damas y Palo Seco, Costa Rica. *Revista de Biología Tropical, 44*(2), 935-937.

Callicó, R. G., Biolé, F., Llamazares, S., Fuchs, D. V., & Volpedo, A. V. (2017). Capítulo 1. Introducción al estudio de la morfología general de los otolitos. Atlas de otolitos de peces de Argentina. In A. V. Volpedo, G. A. Thompson, & E. Avigliano (Eds.). *Illustrations: Volpedo A.V. - Cap 1, 2, 3, 5, 6-; Fuchs, D. -cap 4-* (1st ed). Ciudad Autónoma de Buenos Aires.

Cerna, F., & Plaza, G. (2016). Daily growth patterns of juveniles and adults of the Peruvian anchovy (*Engraulis ringens*) in northern Chile. *Marine & Freshwater Research, 67*, 899–912. http://dx.doi.org/10.1071/MF15032

Chasqui, L., Rincón-Diaz, N., & Villa, A. A. (2020). Peces asociados a los arrecifes rocosos del pacifico norte chocoano. In L. Chasqui (Eds.). *Biodiversidad de los arrecifes rocosos (riscales y morros) del Pacifico Norte Chocoano* (pp. 284-318). Serie Publicaciones Generales No. 116 de INVEMAR. Santa Marta, Colombia. https://n2t.net/ark:/81239/m9x11f

Cruz-Romero, M., Espino-Barr, E., & García-Boa, A. (1993). Aspectos poblacionales de cinco especies de la familia Haemulidae (Pisces) en la costa de Colima, Mexico. Instituto Nacional de Pesca, Secretaria de Pesca. México. *Ciencia Pesquera, 9,* 43-54.

Chater, I., Romdhani, A., Dufour, J. L., Mahe, K., Francour, P., & Chakroun-Marzouk, N. (2015). Otolith Growth and Age Estimation of Bastard Grunt, *Pomadasys incisus* (Actinopterygii: Perciformes: Haemulidae), in the Gulf of Tunis (Central Mediterranean). *Acta Ichthyologica et Piscatoria, 45*(1), 57–64. https://doi.org/10.3750/AIP2015.45.1.06

Erazo-Londoño, J. P. (2018). *Peces Roncos. Haemulidae. Gorgona, Buenaventura*. v1.1. Ninguna organización. Dataset/Occurrence. https://ipt.biodiversidad.co/sibm/resource?r=muestreopecesrocoshaemulidaeislagorgonaybuenaventura&v=1.1

Fortaleza, M. A., & Nañola, Jr. C. L. (2017). Age Determination and Body Length Relationship of Two-Spot Red Snapper (*Lutjanus bohar*). *BANWA B,* 12res003

Gallardo-Cabello, M., Espino-Barr, E., Cabral-Solís, E. G., García-Boa, A., & Puente-Gómez, M. (2014a). Growth of the Shortnose Mojarra *Diapterus brevirostris* (Perciformes: Gerreidae) in Central Mexican Pacific. *Avances en Investigación Agropecuaria, 18*(2), 27-40.

Gallardo-Cabello, M., Espino-Barr, E., Cabral-Solís, E. G., Puente-Gómez, M., & Garcia-Boa, A. (2014b). Morphometric analysis on sagitta, asteriscus and lapillus of Shortnose Mojarra *Diapterus brevirostris* (Teleostei: Gerreidae) in Cuyutlan coastal Lagoon, Colima, Mexico. *Revista de Biología Marina y Oceanografía, 49*(2), 209-223. http://dx.doi.org/10.4067/S0718-19572014000200004

García, C. B, & Duarte, L. O. (2006). Length-based estimates of growth parameters and mortality rates of fish populations of the Caribbean Sea. *Journal of Applied Ichthyology. 22*, 193-200. https://doi.org/10.1111/j.1439-0426.2006.00720.x

Gatica, M. A. (2016). Edad y crecimiento por medio de lectura de otolitos en el ronco (*Haemulon flaviguttatum*) en Puerto Angel, Oaxaca. Tesis de Grado. Universidad Nacional Autónoma de Mexico. Facultad de Estudios Superiores. Zaragoza. 86p.

Hermann, T. W., Stewart, D. J., Limburg, K. E., & Castello, L. (2016). Unravelling the life history of Amazonian fishes through otolith microchemistry. *Royal Society Open Science*, *3*, 160206. http://dx.doi.org/10.1098/rsos.160206

Maravilla, E. A. (2001). Época reproductiva, hábitos alimentarios, edad y crecimiento del pargo mancha *Lutjanus guttatus* (Steindachner, 1869) (Pisces: Lutjanidae). Los Cobanos y Puerto de la Libertad. Tesis de Grado. Universidad de El Salvador. Facultad de Ciencias Naturales y Matemática. Escuela de Biología. 83p.

Morales, M., González, L. W. (2010). Edad y crecimiento del pez Haemulon steindachneri (Perciformes: Haemulidae) en el suroeste de la isla de Margarita, Venezuela. *Revista de Biología Tropical 58* (1), 299-310. http://dx.doi.org/10.15517/RBT.V58I1.5211

Newman, S. J., Cappo, M., & Williams, D. McB. (2000). Age, growth and mortality of the stripey, *Lutjanus carponotatus* (Richardson) and the brown-stripe snapper, *L. vitta* (Quoy and Gaimard) from the central Great Barrier Reef, Australia. *Fisheries Research, 48*(3), 263-275. https://doi.org/10.1016/S0165-7836(00)00184-3

Newman, S. J., Williams, D. McB, & Russ, G. R. (1996). Age validation, growth and mortality rates of the tropical snappers (Pisces: Lutjanidae) *Lutjanus adetii* (Castelnau, 1873) and *L. quinquelineatus* (Bloch, 1790) from the central Great Barrier Reef, Australia. *Marine and Freshwater Research 47*(4), 575-584. https://doi.org/10.1071/MF9960575

Pardo, A., Dos Santos, A., Laaz, E., Preciado, M., Ramos, W., Panchana R., Domínguez, L., & Jarrínace, J. M. (2017). Estudio para evaluar el uso de anillos anuales de otolitos para estimar la edad de Merluza (*Merluccius gayi*) capturadas en pesquerías Ecuatorianas. *Revista Tecnológica ESPOL – RTE, 30*(2), 140-151.

Puentes, V., Pavolini, G., Rojas, P., Gutierrez, C.F. & Villa, A.A. (2022). Morphometric relationships and basic morphology of sagitta otoliths of the Pacific Bearded Brotula

(*Brotula clarkae*) in the Colombian Pacific Ocean. Marine Reports, 1(1), 49-61. https://doi.org/10.5281/zenodo.6594226

Puentes, V., Polo, C.J., Roldán, A. M., & Zuluaga, P. A. (Eds.). (2014). *Artes y Métodos de Pesca en Colombia. Serie Recursos Pesqueros de Colombia – AUNAP 2014*. Capitulo IV. Artes y Métodos del Pesca del Océano Pacifico. Autoridad Nacional de Acuicultura y Pesca – AUNAP ©. Conservación Internacional Colombia ©. 92-125pp.

Puentes, V., Rojas, P., Pavolini, G., Gutierrez, C. F., & Villa, A. A. (2019). Morphology and morphometric relationships of sagitta otoliths for *Lutjanus argentiventris* (Pisces: Lutjanidae) and *Hyporthodus acanthistius* (Pisces: Serranidae) in the Colombian Pacific Ocean**.** *Universitas Scientiarum, 24*(2): 337-361. https://doi.org/10.11144/Javeriana.SC24-2.mamr

Rossi-Wongtschowski, C. L., Correia Siliprandi, C., Rito Brenha, M., De Almeida Gonsales, S., Santificetur, C., & Vaz-dos-Santos, A. M. (2014). Atlas of Marine Bony Fish Otoliths (Sagittae) of Southeastern- Southern Brazil Part I: Gadiformes (Macrouridae, Moridae, Bregmacerotidae, Phycidae and Merlucciidae); Part II: Perciformes (Carangidae, Sciaenidae, Scombridae and Serranidae). *Brazilian Journal of Oceanography, 62*(special issue), 1-103. http://dx.doi.org/10.1590/S1679-875920140637062sp1

Solano-Fernández, M., Montoya-Márquez, J. A., Gallardo-Cabello, M., & Espino-Barr, E. (2015). Age and growth of the Dolphinfish *Coryphaena hippurus* in the coast of Oaxaca and Chiapas, Mexico. *Revista de Biología Marina y Oceanografía, 50*(3), 491-505. https://doi.org/10.4067/S0718-19572015000400008

Soto-Rojas, R. L., Mejía-Arana, F., Palacios, J. A, & Hiramatsu, K. (2009). Reproducción y crecimiento del pargo mancha *Lutjanus guttatus* (Pisces: Lutjanidae) en el Golfo de Nicoya, Costa Rica. *Revista de Biología Tropical, 57*(1-2), 125-131. http://dx.doi.org/10.15517/rbt.v57i1-2.11303

Wiff, R., Ojeda, V., & Quiroz, J. C. (2007). Age and growth in pink cusk-eel (*Genypterus blacodes*) off the Chilean austral zone: evaluating differences between management fishing zones. *Journal of Applied Ichthyology, 23*, 270–272. https://doi.org/10.1111/j.1439-0426.2007.00854.x

Zapata, F. A., & Herron, P. A. (2002). Pelagic larval duration and geographic distribution of tropical eastern Pacific snappers (Pisces: Lutjanidae). *Marine Ecology Progress Series. 230,* 295-300. https://doi.org/10.3354/meps230295