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Epibionts on Lepidochelys Olivacea (Eschscholtz, 1829) Nesting in Two Municipalities on Colima's Coast, México

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Abstract: The *Lepidochelys olivacea* sea turtle is one of the world's seven species of sea turtles and can be found in Mexico. Sea turtles are pelagic species, which means they are also used as a surface area on which epibiont communities may develop. These organisms aren't dangerous for the turtle, except for *Ozobranchus branchiatus.* This research allowed us to identify species of epibionts and their incidence on turtle's body parts like ventral, dorsal and other six body regions of *L. olivacea.* Patrolling was made once a day during 15 days, getting epibionts from 46 nesting females of *L. olivacea*; the samples were preserved in 96% alcohol and the leeches on 70% formalin. Posteriorly, the samples were observed and identified in the Ecologic Center of Cuyutlán "El Tortugario". Six species of epibionts were identified. The species *Lepas hilli* ($P < 0.05$) showed the highest incidence, *O. branchiatus* ($P = 0.002$) and *Platylepas hexastylus* ($P = 0.002$) showed the smallest incidence. Turtles presented epibionts on different body regions, the ventral region ($P = 0.019$) showing the smallest incidence, like zone 2 ($P = 0.001$). The dorsal region and zone 1 showed the highest incidence. Finally, there's still a lot to discover about those interactions, as well as the damages the epibionts may cause on their hosts.

Key words: epibiosis, epibiont, basibiont, Lepidochelys olivacea, Cuyutlán, arribada

1. Introduction

The turtle *Lepidochelys olivacea* (Eschscholtz, 1829), usually called olive ridley or golfina (Spanish), is one of the world's seven species of sea turtles. Of these seven species, six of them come to Mexico [1].

Their nesting season is from June to May, with higher activity between August and October. One olive ridley turtle can lay up to 100 eggs per nest; those turtle eggs hatch after approximately 45 days. The hatchlings are dark gray or black, their size is 5 centimeters and they weigh 16 grams [2].

Nowadays, the olive ridley is the most common species in the world and its distribution is cosmopolitan. The turtles populations that get to Escobilla and Morro Ayuta beaches (Oaxaca, México) and Ostional beach (Nancite, Costa Rica) are the most important because of the highest number turtles and the presence of "arribada" [3].

The olive ridley turtle is one of the shortest sea turtles: it can reach 73 cm of length and weigh up to 50 kg. These turtles have rounded and flattened shells, with six or more olive green or dark gray's lateral scutes, while the plastron is yellow. Their head has a medium size, a triangular shape and they present a hooked, non-serrated beak [4].

As a result of the fisheries, modification of turtle's natural habitat, illegal harvesting of the eggs, ocean pollution and other factors, the olive ridley is now considered an endangered species according to the

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Mexican Official Norm NOM-059-SEMARNAT-2010; included in the Appendices I in The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the category "Vulnerable-VU" in International Union for Conservation of Nature and Natural Resources (IUCN).

As a pelagic organism, the sea turtle represents an ideal surface for the development of epibionts. Up to 200 species of them have been reported [5]. In fact, the marine epibiosis can be defined as a settlement of water organisms (epibiont) on other living organisms (basibiont) [6]; this concept is different from the parasitism, in which the organism is feeding from a living surface [7].

The sea turtles *Caretta caretta* (Linnaeus, 1758) and *Eretmochelys imbricata* (Linnaeus, 1766) present several epibionts; some corresponding to algae (*Padina* sp., *Ulva* sp. and *Polysiphonia* sp.), cirripeds (*Platylepas* sp., *Lepas* sp., *Conchoderma* sp., *Chelonibia sp.*), isopods (*Caprella* sp. and *Hyale* sp.), amphipods (*Elasmopus* sp. and *Jassa* sp.), copepods (*Balaenophillus* sp.), hydrozoans, crabs, briozoos and fishes like *Remora remora* (Linnaeus, 1758) [5].

Of the 26 species of epibionts registered on olive ridley, *Conchoderna virgatum* (Spengler, 1790), *Lepas hilli* (Leach, 1818), *Podocerus chelonophilus* (Chevreux and de Guerne, 1888) and *Ozobranchus branchiatus* (Menzies, 1791) are the most common [8-10].

The relation between sea turtles and epibionts aren't well defined yet; in extreme cases, the number and position of these on turtle's vitals parts can be the cause of severe injuries or a reduced mobility, which make the turtle more vulnerable to predators attacks. Also, a relation between the fibropapilomas and the presence of the leeches *Ozobranchus* sp. has been found [11]. Most researches study descriptive or migratory topics, forgetting about health topics. Due to less information about olive ridley's epibionts, the present research gives valuable information that can be added to other studied topics and contribute to sea turtle conservation.

2. Metodology

The studied area was 30 km long, of the 157 km registered for the Colima's coast [12], between 18°59'56" north latitude, 104°15'36" west latitude; this area includes the municipality of Manzanillo (Boca del mar, Tepalcates) and Armería (Pascuales River) (Fig. 1). The turtle's dorsal and ventral regions was divided in 6 areas to analyze the epibionts distribution (Figs. 2 and 3) [2]. Turtle patrols were made every day, during 15 days. First, we looked for olive ridley nesting females. Once we found them, we made a visual inspection, searching for epibionts on them. After that, we measured their longs shell (LCC) and wide shell (ACC). Finally, we took pictures with a digital camera (Sony DSC-W800) of turtle's body parts where the epibionts were located and then we collected those using pliers, scalpel and spatula. The samples were put on 96% alcohol and the leeches on 70% formalin, for their conservation, and identified with a piece of paper with the following information: date, number of turtle, body part and zone where the sample was found, number or individuals found and observations.

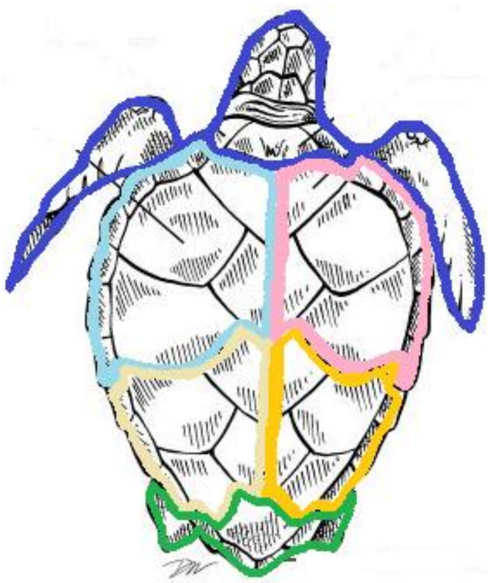
The samples were moved to Ecological Center of Cuyutlán "El Tortugario", located in Cuyutlán, municipality of Armería, state of Colima, México; that's where they were observed and studied using a stereoscopic microscope; pictures were took too, so we could identify the species. Matrices were made with the data and posteriorly were analyzed with a program "Paleontological Statistics" (PAST) [13] with the purpose of classifying individuals' presence by species, corporal zone and body region.

3. Results and Discussion

3.1 Species

We identified 6 epibionts species. Five of them are newly reported in compare with Gámez *et al.* (2009) [14] (who reported only *C. testudinaria* (Fig. 4)) for this study area: *Conchoderma virgatum* (Spengler, 1790) (Fig. 5), *L. hilli* (Fig. 6), *O. branchiatus* (Fig. 7), *Platylepas hexastylos* (Fabricius, 1798) (Fig. 8) and *Stomatolepas praegustator* (Pilsbry, 1916) (Fig. 9).

Fig. 1 Study area: Playa Cuyutlán, Armería, Colima, México.



1. Dark blue. - Head, neck, front flippers.

2. Light blue. - First costal, marginal and half of the first vertebral scutes (Left side).

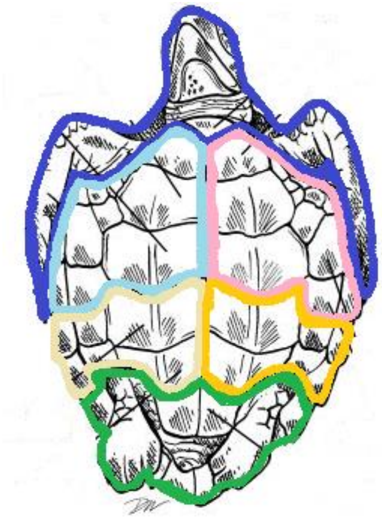
3. Pink. - First costal, marginal and half of the first vertebral scutes (Right side).

4. Light brown. – Next costal, marginal and half to next vertebral scutes (Left side)

5. Orange. – Next costal, marginal and half to next vertebral scutes (Right side).

6. Green. – Posterior carapace, tail and hind flippers.

Fig. 2 Six areas in the dorsal region.



1. Dark blue. - Head, neck, front flippers.

2. Light blue. – First humeral, pectoral and inframarginales scutes (Left side).

3. Pink. - First humeral, pectoral and inframarginales scutes (Right side).

4. Light brown. – Abdominal, femoral and inframarginales scutes. (Left side).

5. Orange. – Abdominal, femoral and inframarginales scutes. (Right side).

6. Green. – Anal scute, tail and hind flippers.

Fig. 3 Six areas in the ventral region.

Fig. 4 *Chelonibia testudinaria.*

Fig. 6 *Lepas hilli.*

Fig. 5 *Conchoderma virgatum*

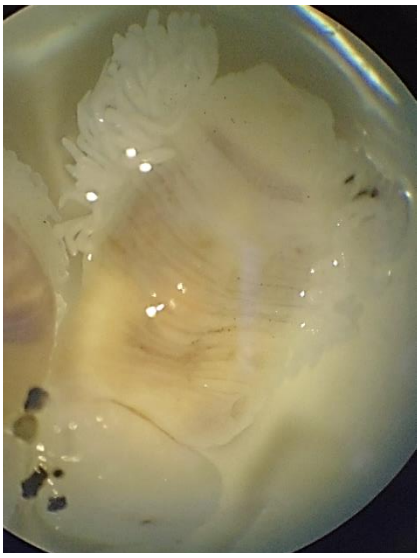


Fig. 7 *Ozobranchus branchiatus.*

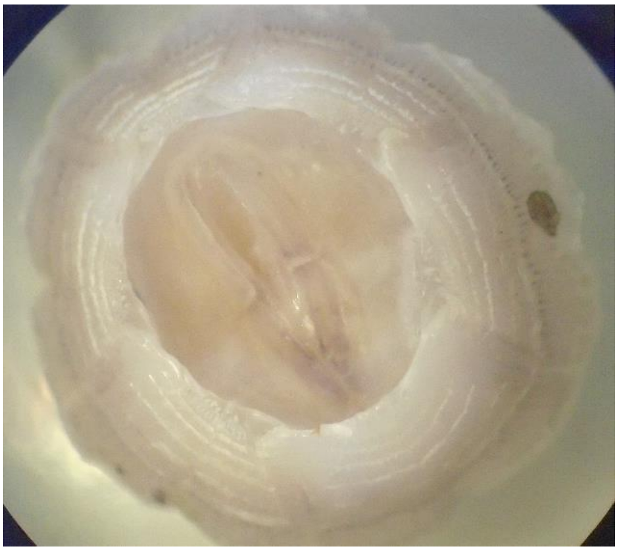


Fig. 8 ***Platylepas hexastylos.***

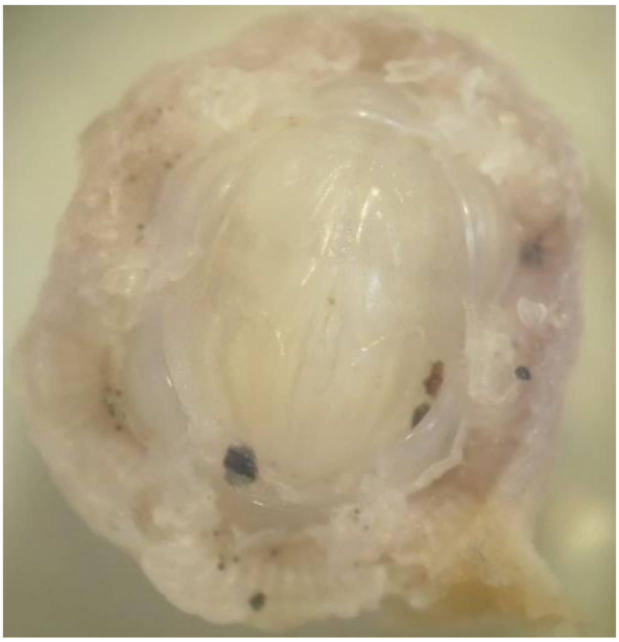


Fig. 9 ***Stomatolepas praegustator.***

Figs. 4-9 Identified species on olive ridley.

Figs. 5-9 New reports on olive ridley in Cuyutlán, Colima.

The new information allows us to better understand aboustomatt olive ridley's biology and behavior on the Colima coast; data as habitat preference, migratory routes before the nesting season could be deduced from the epibiotic load [15].

The small number of different species we found compared to other works could be caused by the effort, period, size and area of the sampling [16]. For example, Lazo (2011) [17] made three years' sampling and found 11 epibionts species to olive ridley; Sosa-Cornejo (2012) [16] made a sampling from May 2008 to December 2009, founding 11 species in olive ridley; Lara *et al*. (2019) [18] made the sampling in feeding and nesting zones and found 11 epibionts. However, for our study area, in agreement with Ecological Center of Cuyutlán records since 1992, the major number females olive ridley comes in September and October, some information tells us that the major presence of epibionts in females olive ridley is in October and as the season progresses increase the number the females with epibionts and the abundance of these [19, 20]; our sampling was made during 15 days in the month of August and had only 6 species and the absence the species common like *Caprella sp*., *Dulichia sp*. which are founding in algae's filaments [9, 20], also didn't find them in the present study. Algae commonly are in the carapace (lateral position) [17, 20, 21], this position is a disadvantage because they can break off during copulation [21] and this reason could be part of our results for the absence of this organism.

Although we don't find species like *R. remora* and *Planes major* (MacLeay, 1838) this have a low or null presence in olive ridley, the first commonly found alone in carapace and plastron, and the second always founding in the cloaca in couple [8, 10, 16-18, 20].

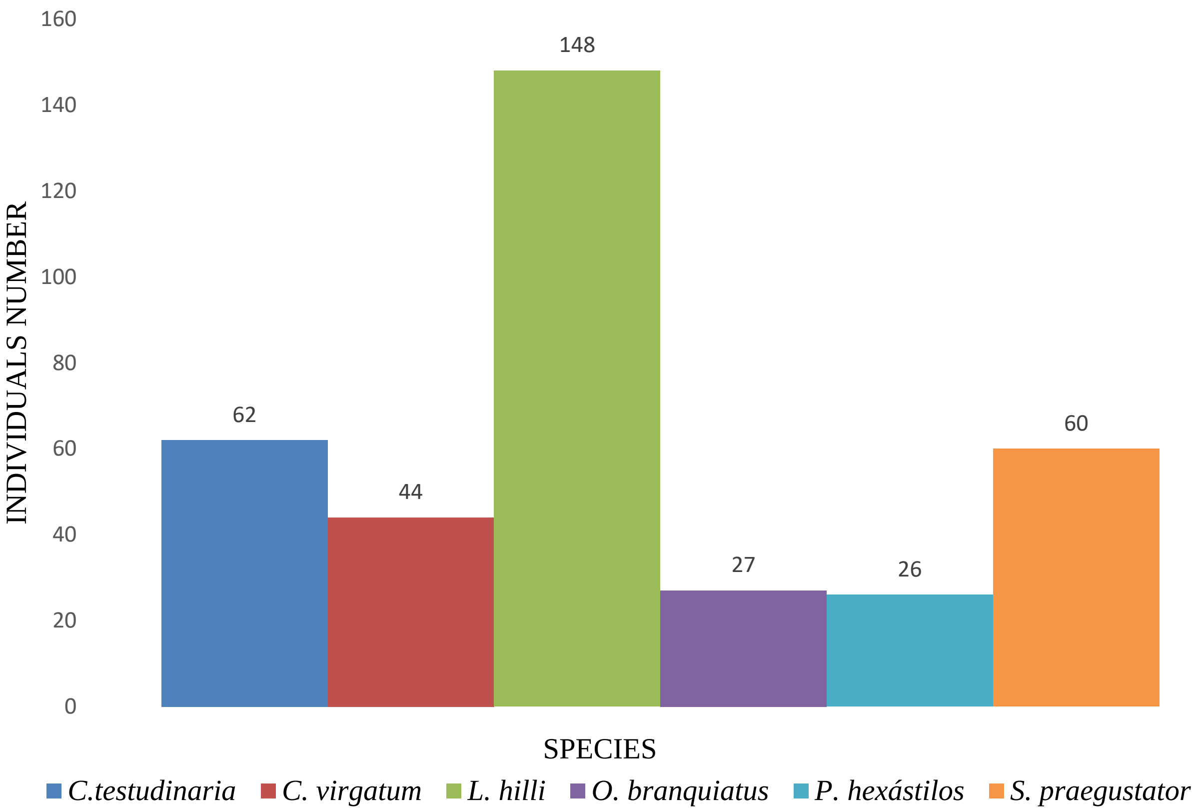
Finally, although the study made by Gámez (2006) [9] is part of the epibionts record and listed in the antecedents, its results are unreliable because the identification doesn't match the pictures: in the Fig. 1 corresponding to *L. hilli*, the caption indicates the specie *C. virgatum*; the Fig. 3 corresponding to *C. testudinaria*, *P. hexastylos* and *S. praegustator*, the caption indicates only the specie *C. testudinaria*.

3.2 Individuals by Species

The specie with greatest number of individual was *L. hilli* (148); the species with fewer number of individual were *O. branchiatus* (27) and *P. hexastylos* (26), (Graphic 1).

The significance was detected in these species: *L. hilli* (P = 0.016), *O. branchiatus* (P = 0.002), *P. hexastylos* (P = 0.002).

The presence of the *L. hilli* in mayor number in this study, suggest that the sea turtles sample has migrated of the aforementioned communities. The works that reported to *L. hilli* as an epibiont on olive ridley are Ildefonso *et al.* (2006), Lazo *et al.* (2011) [17] and Lara *et al.* (2019) [18], being Ildefonso *et al.* (2006) who mentions *L. hilli* as a species with greater presence in olive ridley. Juveniles and adults' olive ridley are founding on communities pelagic/oceanic, in these areas they converge with other species like epibionts, principally with genus *Lepas* and *Conchoderma* [15] also olive ridley spends periods internesting in oceanic habits [10].



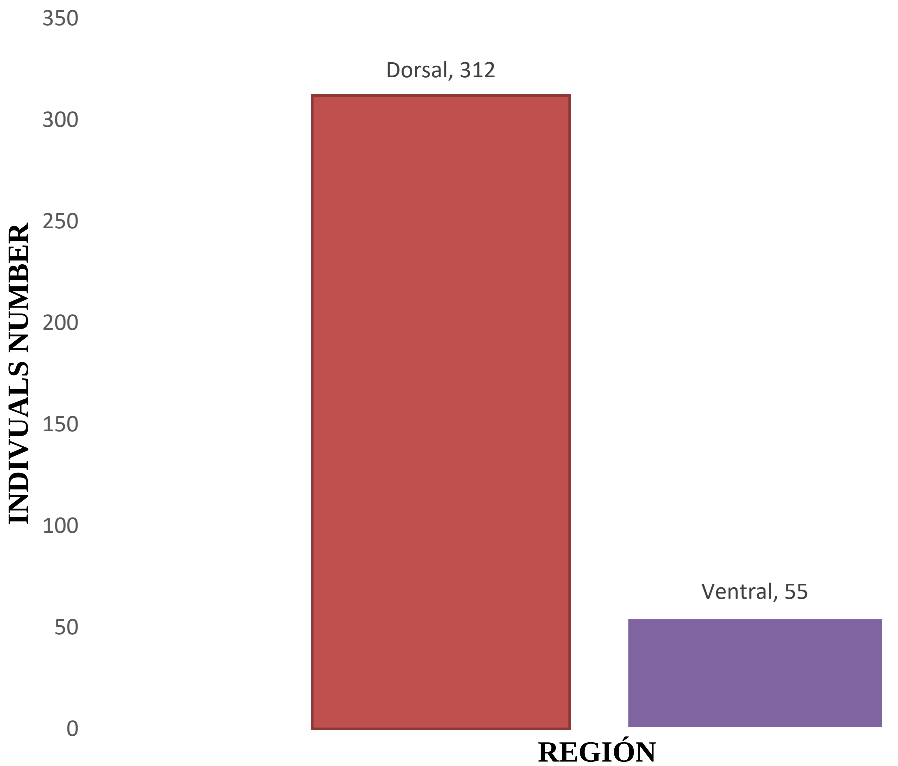
Graphic 1 Individuals by species found on olive ridley.

Most investigations, mentioned the presence of *P. hexastylos* and *O. branchiatus* in olive ridley [8-10, 16-21] moreover *O. branchiatus* is considered a parasite as a result of the association: *O. branchiatus* uses the olive ridley as transportation and it take blood as feeding [15]. The last studies with this leech, mentioned it as a vector in fibropapilloma [11]. The presence of this leech in low number could be associated to many reasons: when the turtle comes to nest area, the conditions change for the epibiont, in this case, *O. branchiatus* could shrivel up and fall [21]; the leech is hermaphrodite and all its life is in the same basibiont, thus there is a direct transfer among sea turtles in feeding and reproductive areas [20]; the last reason reaffirms that the olive ridley could have come of pelagic/oceanic areas.

3.3 Individuals by Region

The region with a lower number of the individual was the ventral region with a total of 55 (Graphic 2).

The significance was detected in the ventral region (P = 0.019). In comparison with the dorsal region, the ventral region is more in contact with other superficies (coral reefs, sea bottom, marine rocks, and other animals, including other body parts like flippers), all these factors could cause loss of epibionts. In our study, the possible cause for the low number was the sea turtles' moving from the beach to the nesting site, the direct contact of the ventral region with the sand could cause the detachment of the epibionts before the sampling. In the opposite case, we could say that the dorsal region has the best conditions for epibionts development; for example, the cirripeds need a firm and smooth surface [15] these characteristics found in the sea turtle's carapace more than in other parts, also the cirripeds search for established colonies [15, 19] so if the ventral region has a constant loss of epibionts, the colonies don't establish. Few investigations focus in epibionts in the ventral region, Frazier (1989) [21], Hernández and Valadez (1998) [8], Ayala and González (2006) [20] coincide with us in the low number; Hernández and Valadez (1998) [8] found only 11 individuals in the region ventral, Ayala and González (2006) [20] found only 1 epibiont, *R. remora*.



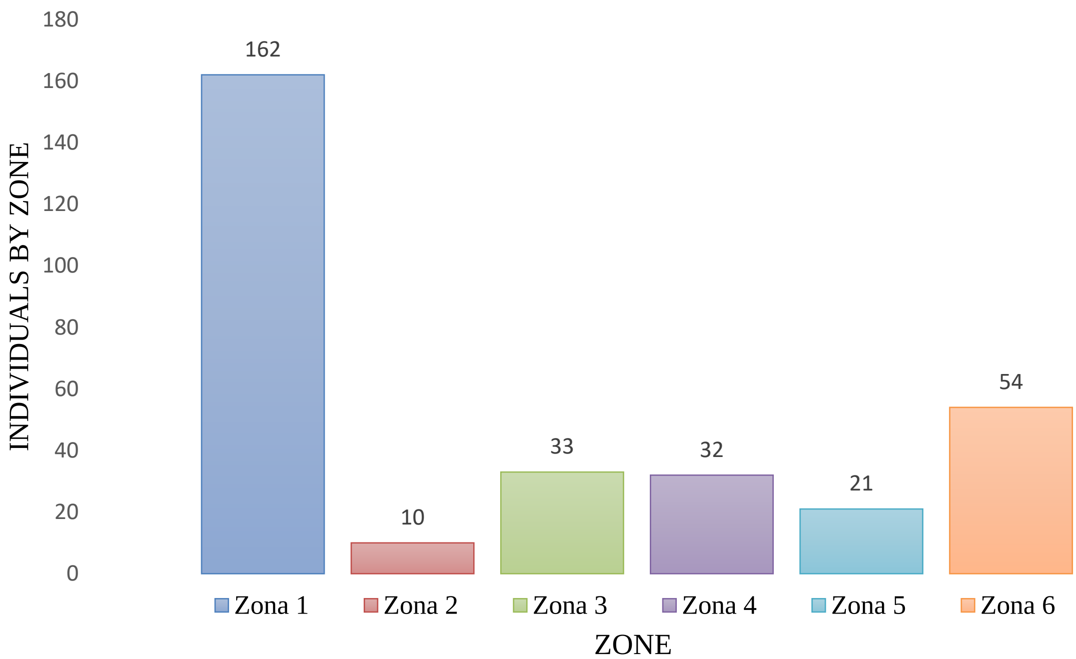
Graphic 2 Individuals by region on olive ridley.

3.4 Individuals by Corporal Zone

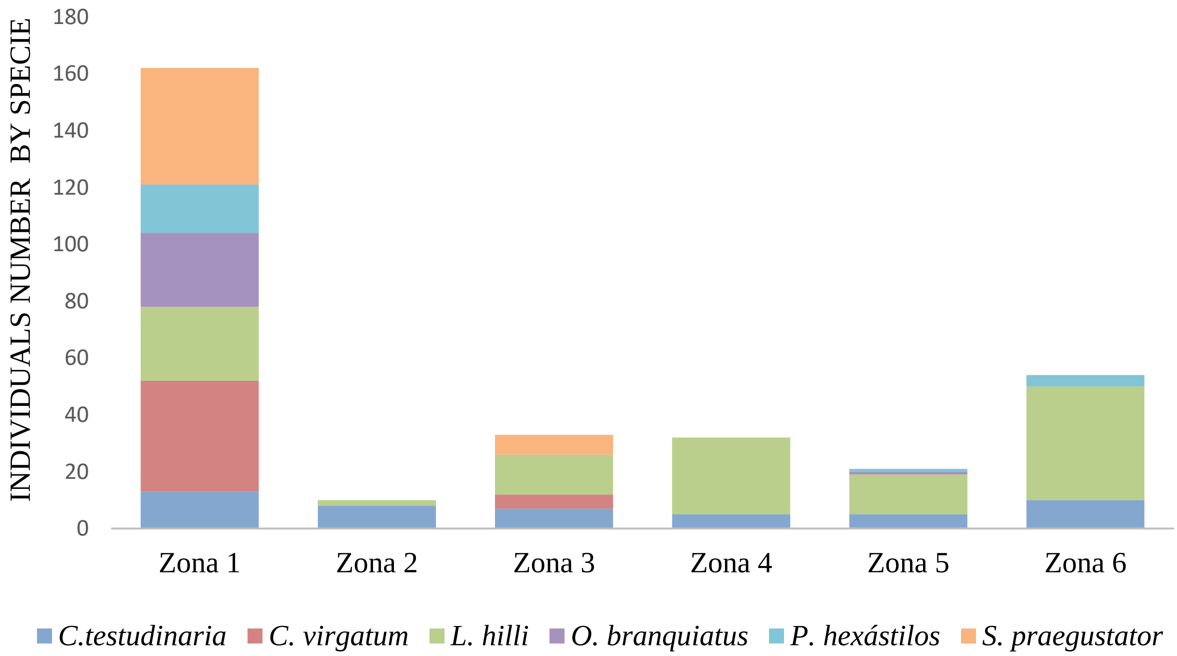
In the dorsal region, the zone greater number of the individual was zone 1 (162) and, moreover, that all species were found; the zone lower number of the individual was the zone 2 (10) (Graphics 3-4). In the ventral region, the zone greater number of the individual was zone 6 (41), the zone lower number of the individual was zone 3 (zero) (Graphics 5-6).

The significance was in zone 2, 3, 4, 5 and 6 (P = 0.001, P = 0.006, P = 0.006, P = 0.002, P = 0.032), while in the ventral region didn't show significance.

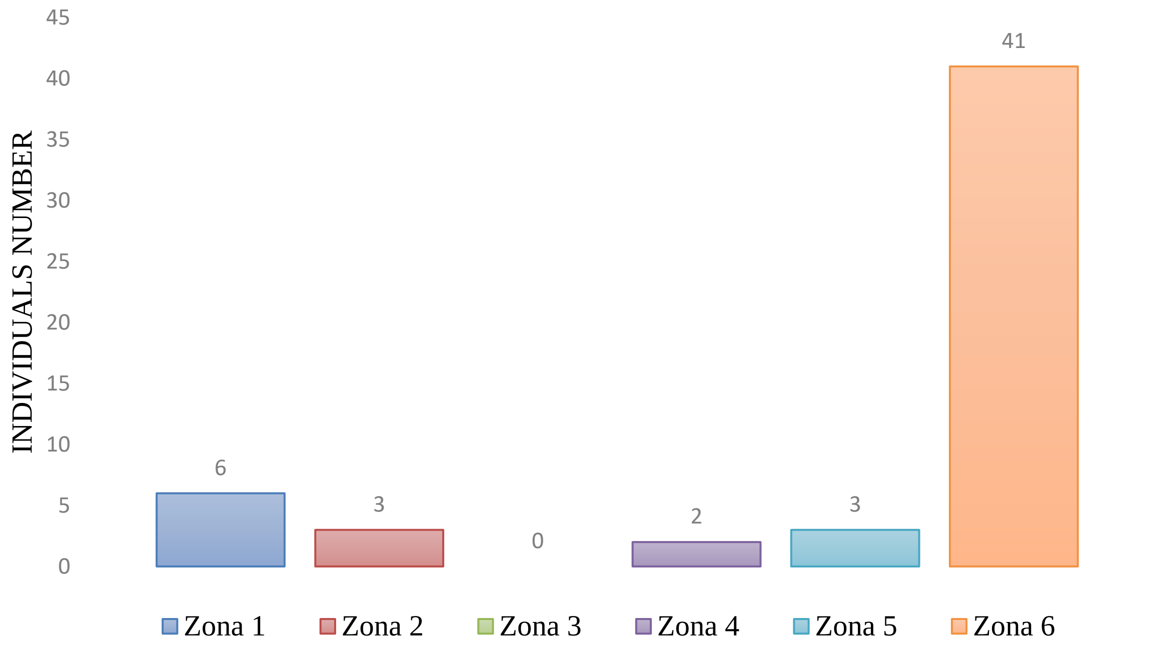
The epibionts' distribution is a result of many factors: water, dynamic, recruitment, change the communities, etc. [15]. Our results coinciding with Frazier (1989) [21], Álvarez and Díaz (1993) [19], Hernández and Valadez (1998) [8], Ayala and González (2006) [20] and Angulo et al. (2007) [10], who described some aspect to epibionts' distribution in females and males' olive ridley. The presences of *O. branchiatus* in front region, soft parts, principally in the neck is because there is major concentration of blood, their principal food [21], for this reason, the relation between leeches and sea turtles is considering as parasitic [15] and in



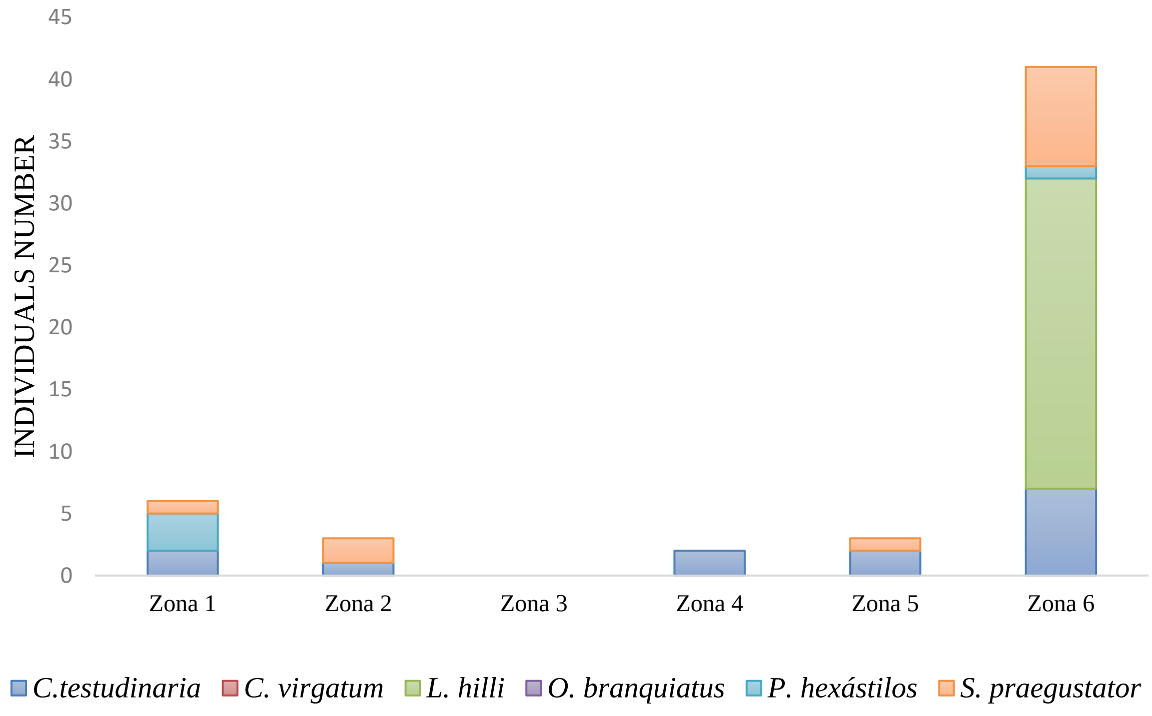
Graphic 3 Individuals by corporal zone in dorsal region on olive ridley.



Graphic 4 Individuals by specie in corporal zone, dorsal region.



Graphic 5 Individuals by corporal zone in ventral region on olive ridley.



Graphic 6 Individuals by specie in the six corporal zones, ventral region on olive ridley.

occasion, *O. branchiatus* could participle as a vector in fibropapilomas [11]; in this study didn't establish the presence or absence of this problem in the sea turtle sampling. The *S. praegustator* needs soft parts because a part of him is embedded in the sea turtles skin, these conditions are present in flippers and neck. We also have the presence of *C. testudinaria* in the zone 1 in lower number as a result of the different requirement;

this balanus is the biggest epibionts so need a hard and large surface, which could found in the carapace [8].

Moreover, the presence of *C. testudinaria* in all zones (1-6) in dorsal and ventral region (Graphics 4, 6) is evidence of this epibiont is a specific commensal and primary colonizer [15], also the presence of *L. hilli* and *C. virgatum* in him (Fig. 8) indicates that could be a basibiont; this information also has been registered in Angulo et al. (2007) [10] and Lara et al. (2019) [18].

Finally, the preference of zone 1, dorsal region, reaffirms the idea that olive ridley swings raising the hind area [21], this induces that the front area spends most of the time submerged into the sea, this means that the zone has better conditions for the epibionts. Also, the olive ridley spends 20% of its time floating and 40% at depths less than 40 meters [22]. This idea also explains the preference of the algae to the hind area [20, 21] which is exposed to the Sun.

4. Conclusion

This is the first study focus in olive ridley's epibionts on Colima, México, getting 5 new epibionts reports to the area study: *C. virgatum*, *L. hilli*, *O. branchiatus*, *P. hexastylos*, and *S. praegustator*. With these new results, we can infer that the females' olive ridley in the sampling came from oceanic/pelagic areas. The dorsal region is preferred by the majority of epibionts, also, zone 1, in the same region, has better conditions that allow to epibionts develop. All information serves to infer olive ridley's behavior but is necessary to do studies with a major duration on sampling, in different seasons and compare feeding, reproductive and nesting zones if we want to infer in other aspects of olive ridley.

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References

[1] R. Márquez Millán, *Las tortugas marinas y nuestro tiempo*. (3rd ed.), FCE, CONACYT, SEP, 2002.

[2] E. B. Peralta and M. T. Luna, *Tortuga Golfina, (capítulo 4)*, Las tortugas marinas en México: logros y perspectivas para su conservación, *Procer. Conanp* (2016) 83-101.

[3] R. Márquez Millan, Sea turtles of the world, *FAO Fisheries Synopsis* 11 (1990) (125) 81.

[4] N. Varo-Cruz, C. Monzón-Argüello, M. Carrillo, P. Calabuig and A. Liria-Loza, Tortuga olivacea – Lepidochelys olivacea, in: Salvador A., Marco A. (Eds.), *Enciclopedia Virtual de los Vertebrados Españoles*, Museo Nacional de Ciencias Naturales, Madrid, 2015.

[5] U. C. Lara and R. C. Mota, Las tortugas marinas cargando un mundo: flora y fauna epibionte, *Bioagrociencias* 7 (2014) (2) 21-28.

[6] A. Liria Loza, Ecosistemas errantes: epibiontes como indicadores biogeográficos de tortugas marinas de Canarias, Tesis Doctoral, Dpto. de Biología. Facultad de Ciencias del Mar. Universidad de las Palmas de Gran Canaria, 2011.

[7] Rossi, De cerca: Epibiosis, Investigación y Ciencia, 2001, p. 39.

[8] V. S. Hernández and G. C. Valadez, Observaciones de los epizoarios encontrados sobre la tortuga golfina Lepidochelys olivacea en la Gloria, Jalisco, México, *Ciencias Marinas* 24 (1998) 119-125.

[9] S. Gámez Vivaldo, D. Osorio Sarabia, C. Peñaflores Salazar, A. García Hernández and J. Ramírez Lezama, Identificación de parásitos y epibiontes de la tortuga Golfina (Lepidochelys olivacea) que arribó a las playas de Michoacán y Oaxaca, México, *Veterinaria México* 37 (2006) (4) 431-440.

[10] L. Angulo, D. Nava and M. Frick, Epibionts of Olive Ridley Turtles Nesting at Playa Ceuta, Sinaloa, México, *Marine Turtle Newsletter* 118 (2007) 13-14.

[11] J. R. Greenblatt, T. M. Work, G. H. Balazs, C. A. Sutton, R. N. Casey and J. W. Casey, The Ozobranchus leech is a candidate mechanical vector for the fibropapilloma-associated turtle herpesvirus found latently infecting skin tumors on Hawaiian green turtle (Chelonia mydas), Virology 321 (2004) 101-110.

[12] G. A. Jiménez Ramón, A. J. Mendoza Morales, J. C.

Chávez-Comparán, R. M. Guzmán-Barrera and B. Lara-Chávez, Descripción de los ecosistemas en la zona costera. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), in: *La Biodiversidad en Colima. Estudio de Estado* (1st ed.), 2016, pp. 139-170.

[13] O. Hammer, D. A. T. Harpe and P. D. Ryan, PAST: Paleontological statistics software: Package for education and data analysis, *Paleontologia Electronica* 4 (2001) (1) 9.

[14] S. Gámez Vivaldo, L. J. García Márquez, D. Osorio Sarabia, J. L. Vázquez García and F. Constantino Casas, Patología de las tortugas marinas (Lepidochelys olivacea) que arribaron a las playas de Cuyutlán, Colima, México, *Veterinaria México*40 (2009) (1) 69-78.

[15] M. G. Frick and J. B. Pfaller, Sea turtle epibiosis (Chapter 15), The biology of sea turtles, Vol. 3, in: Wyneken J., Lohmann K. J. and Musick J. A. (Eds.), *Boca Raton*, FL: CRC Press, 2013, pp. 399-426.

[16] I. Sosa Cornejo, D. I. Montaño Valdez, M. Bucio Pacheco, F. Enciso Saracho, J. G. Sánchez, Zazueta and E. Fierros Pérez, Determination of epibionts of the Marine Turtle Lepidochelys olivacea (Eschscholtz, 1829) nesting in Ceuta Beach, Sinaloa, México, *Journal of Agricultural Science and Technology* B 2 (2012) 1190-1194.

[17] E. A. Lazo Wasem, T. Pinou, A. Peña de Niz and A. Feuerstein, Epibionts Associated with the Nesting Marine Turtles, Lepidochelys olivacea and Chelonia mydas in Jalisco, México: A review and field guide, *Bulletin of the Peabody Museum of Natural History* 52 (2011) (2) 221-240.

[18] M. M. Lara Uc., C. Trejo Méndez, E. Reséndiz Morales, J. M. López Vivas, G. Hinojosa Arango, F. Gumeta Gómez, D. Ramos Ávila, V. Lucero Silva and C. Mota Rodríguez, Fauna asociada a tortuga amarilla, Caretta caretta, tortuga verde del Pacífico Oriental Chelonia mydas, tortuga golfina Lepidochelys olivacea, en la región península de Baja California y Pacífico Norte, (Capítulo 21), 2019.

[19] E. Álvarez Tapia and N. L. Díaz Herrera, Contribución al conocimiento de los epibiontes en tortugas marinas Carey (Eretmochelys imbricata), Golfina (Lepidochelys olivacea) y Laúd (Dermochelys coriacea) que anidan las playas mexicanas. Seminario de Investigación II. Unidad de Ciencias Biológicas y de la Salud, Hidrobiología. Universidad Autónoma Metropolitana, Iztapalapa, 1993.

[20] M. Ayala Díaz and I. González Contreras, Epibiontes de Tortuga Golfina (Lepidochelys olivacea) en las Costas de San José del Cabo, Baja California Sur. Tesis profesional de licenciatura. Departamento de Biología Marina. Área Interdisciplinaria de Ciencias del Mar. Universidad Autónoma de Baja California Sur, 2006.

[21] J. G. Frazier, Análisis estadístico de la tortuga golfina, Lepidochelys olivacea (Eschscholtz) de Oaxaca, México, *Ciencia Pesquera, Instituto Nacional de Pesca Seria, Pesca México* 4 (1989) 49-75.

[22] J. J. Polovina, G. H. Balazs, E. A. Howell, D. M. Parker, M. P. Seki and P. H. Dutton, Forage and migration habitat of loggerhead (Caretta caretta) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific Ocean, *Fisheries Oceanography* 13 (2004) (1) 36-51.