First Report on the Diversity of Epizoic Algae in Larval of Shellfish Gastropod *Aliger gigas*

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**Abstract**

Epibiosis occur frequently on the shells of some marine crustaceans, which often serve as substrate for various species of algae, there is few information on the associations between these. The objective of this study was to determine if the gastropod mollusk *Aliger gigas* (formerly *Lobatus gigas*) in larval had some sort of the association with algal. To the above was carried out collecting egg masses in the environment, the larvae were cultivated in seawater filtered 5 μm. The algal material found was observed in electron microscopy, for its identification and quantification. We analyzed 60 larvae aged 2–44 days for analyzing the structure of the shell and its epibionts. Of the larvae analyzed, 50 larvae presented epizoic. The algae community consisted of 28 taxa, and composed of 25 diatoms (Bacillariophyta) and three cyanophytes (Cyanobacteria). The $H'$ diversity values fluctuated between 0.2 a 1.2. The dominant and frequent species were formed by diatoms: *Nitzschia panduriformis var. minor*, *Halamphora* sp. and *Cyclophora* sp.

**Keywords:** cyanophyte, diatom, epibiont, *Aliger gigas*

**1. Introduction**

Epibiotic is a type of association in which an organism lives on the surface layer of another organism called basibiont, these nonparasitic organisms are known as epibionts [1, 2]. The shells of gastropod and bivalve mollusks represent a suitable habitat for the settlement of various species of algae, viruses or fungi [3–6]. Different studies have focused on epiphytic diatoms of grasses and marine macroalgae [7–9]; in copepods of the species *Farranula gibbula*, the epibiotic diatom *Pseudohimantidium pacificum* has been observed [10]. Very little information exists on symbiotic associations between algae and crustaceans or marine planktonic mollusks, being able to cite what was observed in *Peringia ulvae* (formerly *Hydrobia ulvae*) and diatoms *Cocconeis placentula* and *Achnanthes lemmermannii*, also cyanophytes and bacteria in its Shell [5]. Based on the above, the objective of this work was to identify epizoic species present in the shells of the larval stages of the marine gastropod mollusk, *Aliger gigas*. 
2. Material and methods

An egg mass of *Aliger gigas* was incubated in filtered seawater with a 5 μm mesh, until hatching. Later, the larvae were cultured with seawater filtered with a 50 μm mesh and fed with *Nannochloropsis oculata* (Ochrophyta, Eustigmatophyceae) at a concentration of 1000 cells per larva, at a density of 100 larvae/L. The larvae were fixed in glutaraldehyde, cacodylate and dehydrated in alcohols from 70 to 100% and dried at a critical point. The shells of 60 larvae between 2 and 44 days old were processed. The specimens were observed in a JEOL field emission scanning electron microscope (JSM-7600F), of the National Laboratory of Nano and Biomaterials of Cinvestav IPN Mérida, the presence of epizoic algae was analyzed and to its quantification was carried out. For the identification of phytoplankton, the works of [11–16], among others. The AlgaeBase system was consulted to verify accepted taxonomic names [17].

To obtain the relative abundance index, the proportion of abundance of each species (organism number) was quantified in relation to the total abundance of organisms counted in each larva of different ages [18]. The contribution of the abundance of the epizoic algae species of each larva was determined by means of the SIMPER analysis [19]. This analysis determines the species that most contribute to the similarity between sample. A cumulative similarity discrimination value of 90% was applied. Based on the composition and abundance of the epizoic algae species, the community was characterized by the following descriptors: to evaluate the diversity, the species richness of Margalef (S), the Shannon-Wiener index (H’) and Pielou’s equity (J’) considering to accord with [20], through the ODI program of the Interdisciplinary Center for Marine Sciences, Department of Plankton.

To obtain dominance of the species, an Olmstead & Tukey test was used [21]. The dominant, constant, occasional and rare species were determined from the relationship between the densities of the organisms and their frequencies of appearance. The statistical programs used were Primer-E and R.

3. Results

Of the 60 specimens of *A. gigas* larvae analyzed, 83% presented epizoic algae. The epizoic algae community consisted of 28 taxa, made up of 25 diatoms and three cyanophytes. It should be noted that one of the recorded diatom species *Cylindrotheca closterium* is considered a species that can be harmful and forms algal blooms (Table 1).

3.1 Specific diversity

The diversity values H’ fluctuated between 0.9 and 1.2. The 28-day-old pre-metamorphic larval shells presented the highest value of H’ 1.2 with an equity of J’ 0.4, and a species richness of S 14. These values of H’ 1.2 with a J 0.5 and an S 9, were slightly higher in the 30-day-old larvae, which already had foot formation. For the 20-day-old larvae, H’ was 1.1, J’ was 0.4 and S was 11 and in the 18-day-old larvae, H’ was 0.9, J’ was 0.4 and S was 9 species (Figure 1, Table 1). Following the same behavior, the youngest veliger larvae, 8 days old, presented the lowest diversity with values of H’ of 0.2, J’ of 0.42 and S of 4 species (Figure 1, Table 1).

3.2 Dominant species

Based on the Olmstead and Tukey test, the epizoic algae community consisted of 17 rare species, followed by five common, three abundant and three dominant
| Larva age in days | 8  | 15 | 16 | 18 | 20 | 26 | 28 | 30 | 36 | 42 | %FR | At. |
|-------------------|----|----|----|----|----|----|----|----|----|----|-----|-----|
| Number of larvae analyzed | 4  | 2  | 9  | 1  | 2  | 2  | 10 | 2  | 6  | 6  |     |     |
| Bacillariophyta    |    |    |    |    |    |    |    |    |    |    |     |     |
| Amphora sp.       | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2.5| 0  | 0  | 10  | R   |
| Cocconeis lineata | 0  | 0  | 0  | 0  | 0.1| 1.5| 0  | 3  | 0  | 0  | 30  | R   |
| Cocconeis scutellum| 0  | 0  | 0  | 0  | 0.1| 2  | 0.1| 0  | 0  | 0  | 30  | O   |
| Cercoptostauropsis| 0  | 5  | 0  | 0  | 0  | 0  | 12 | 0  | 0.1| 0  | 30  | R   |
| Cyclotella sp.    | 0  | 66 | 10 | 3  | 5  | 1.9| 0.3| 15 | 76 | 70 | 90  | D   |
| Cylindrotheca closterioides| 1 | 7.5| 1.5| 5  | 4.4| 1.3| 0.3| 11 | 8.5| 4  | 80  | C   |
| Entomoneis paludosa| 0 | 0  | 19 | 3.6| 7  | 17 | 16 | 11 | 8.5| 4  | 80  | C   |
| Halamphora affinisfors | 0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0.1| 0.1| 20  | R   |
| Halamphora sp.    | 0  | 1.7| 47 | 30 | 10 | 7  | 0.2| 0  | 0  | 0  | 70  | D   |
| Heslau tsukamotoi | 0  | 0  | 0  | 0  | 1  | 0  | 75 | 0  | 1  | 40 | 10  | R   |
| Hyposphaira pseudospiculata| 0 | 0  | 0  | 0  | 54.3| 0  | 0  | 0  | 0  | 10 | 10  | R   |
| Hydyosphaera sp.  | 0  | 0  | 0  | 0  | 0  | 0.4| 0.1| 0  | 0  | 1.2| 30  | R   |
| Licmophora sp.    | 0  | 0  | 0  | 0.3| 0  | 0  | 0  | 0  | 0  | 10 | 10  | R   |
| Navicula radiosa  | 0  | 0  | 0  | 2.6| 0  | 19 | 1  | 9  | 0  | 0  | 40  | O   |
| Nitzschia dissipata| 0 | 0  | 0  | 0  | 0.1| 0.1| 0  | 0  | 0  | 20 | 20  | R   |
| Nitzschia inconspicua| 0 | 0  | 0  | 0  | 0  | 8  | 0  | 0  | 0  | 2.8| 20  | R   |
| Nitzschia linearis| 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0.3| 10 | 10  | R   |
| Nitzschia microcephala| 0 | 0  | 0  | 0.4| 0  | 0  | 0  | 0  | 0  | 20 | 20  | R   |
| Nitzschia panduriformis var. minor| 64| 18 | 8  | 51 | 9  | 4.5| 1.1| 20 | 7.5| 0.2| 100 | D   |
| Nitzschia sp.     | 0  | 3.6| 4  | 5  | 0  | 0  | 0  | 0  | 0  | 30 | 30  | O   |
| Neurosigma sp.    | 5  | 0  | 0  | 0.5| 0  | 0  | 0  | 0  | 0  | 20 | 20  | R   |
|                          | 0  | 0  | 2.2 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 10 | R |
|--------------------------|----|----|-----|----|----|----|----|----|----|----|----|----|----|----|---|
| **Psammodictyon panduriforme** |    |    |     |    |    |    |    |    |    |    |    |    |    |    |   |
| **Pseudachnanthidium sp.**   |    |    |     |    |    |    |    | 0.3|    |    |    |    |    | 0  | 0  | 10 | R |
| **Scalariella sp.**             |    |    |     |    |    |    |    |    |    |    | 0  | 0  | 0  | 0  | 0  | 0  | 30 | R |
| **Stephanodiscus minutulus**     |    |    |     |    |    |    | 0  |    |    |    |    |    | 0  | 0  | 0  | 10 | R |
| **Cyanophyta**                   |    |    |     |    |    |    |    |    |    |    |    |    |    |    |    |   |
| **Haloleptolyngbya sp.**          |    |    |     |    |    |    | 0  |    |    |    | 0  | 0  | 0  | 0  | 5  | 32 | 68 | 30 | 7.6| 20 | 60 | C |
| **Richelia intracellularis**      |    |    |     |    |    |    | 0  |    |    |    |    |    | 0  | 0  | 0  | 2  | 0  | 0  | 10 | R |
| **Arthrospira sp.**               |    |    |     |    |    |    | 0  |    |    |    | 0  | 0  | 0  | 0  | 0  | 4.1| 0.6| 0  | 0  | 0.3| 40 | R |
| S                          | 4  | 6  | 10  | 9  | 11 | 14 | 14 | 9  | 7  | 11 |    |    |    |    |    |   |
| H'                          | 0.2| 0.7| 0.4 | 0.9| 1.1| 0.7| 1.2| 1.2| 0.5| 0.7|    |    |    |    |    |   |
| J'                          | 0.2| 0.4| 0.2 | 0.4| 0.4| 0.3| 0.4| 0.5| 0.3| 0.3|    |    |    |    |    |   |

**Table 1.**  
Percentage of the relative abundance of the epizoic algae community in the shells of *A. gigas* larvae. % FR: Percentage of the relative frequency. At: Attribute, D: Dominant, C: Constant, O: Occasional and R: Rare. S: Species richness, H': Diversity and J': Equity.
species (Table 1). The dominant species were made up by the diatom Nitzschia panduriformis var. minor, whose highest relative abundance was 68% in 8-day-old larvae; Hippodonta pseudacceptata with a relative abundance of 54% in 20-day-old larvae; Halamphora sp. with a relative abundance of 47% in 16-day-old larvae and Cyclophora sp. with 70 and 76% in larvae of 36 and 44 days respectively (Figure 2, Table 1). In addition, of the cyanophyte Haloleptolyngbya sp. with a relative abundance of 68% in 28-day-old larvae (Figure 2, Table 1).

3.3 Characteristics of Aliger gigas larvae, observed in the development of this work

The two to five-day old larvae have a shell formed by two turns in a spiral presenting small granule at the apex and a velum characterized by having two lobes and the right tentacle, corresponding to a young veliger larva. The shell of eight-day-old
larvae is characterized by having three coils, showing well-defined lines of ornamentation on the body of the shell. As regards its development; the velum has four lobes; with the right tentacle well differentiated and the formation of the left tentacle.

The 15–18-day old larvae have a carapace with three and a half turns in the spiral, the body has four parallel lines ending at the end of the siphon channel and is highly ornamented. The velum has six lobes, tentacles, and proboscis. In larvae from 20 to 28 day of development, their shell has three and a half turns, with a band of uniform striations on the body of the shell, the radula is already observed and the velum begins the process of reabsorption therefore the larva begins to have a creeping shape beginning its benthic phase. It is a stage known as a precompetent larva. Regarding larvae between 30 and 44 days old, at this stage the larvae are ready to metamorphosis (30 days). Post-metamorphic larvae or post larvae of 44 days, present a foot with an active crawling behavior. The shell is characterized by presenting four turns, with a well-developed band of striae, the proboscide and the radula are present and active, as is the foot with its operculum.

4. Discussion

Diatoms have been reported in the literature as the main group of epizoic microalgae species attached to different types of animals that can be copepods [10, 22–24]; cladocerans [25], hydrozoans [26–27], krill [28] even in whales [29–30]. Diatoms are also present in diving birds [31–32] and reptiles such as crocodiles [33].

As mentioned by [34], the first phase of the colonization of a substrate occurs mainly by bacteria with diatoms, fungi and protozoa; which generate a film on the surface of the basibiont. The results of this study showed that the shells of larvae of the marine gastropod mollusk, *Aliger gigas*, provide an adequate and frequent substrate for the settlement of epizoic microalgae, in the case of diatoms and cyanophytes. A dominance of diatom species was also observed. *Nitzschia panduriformis var. minor* was reported in 8-day-old larvae, *Halamphora* sp. was present in 16-day-old larvae, *Hippodonta pseudacceptata*, in larvae of 20 days and *Cyclophora* sp., in larvae of 36 and 44 days. Obtaining low values of diversity $H'$ (0.2 to 0.9) and $J'$ (0.2 to 0.5), in these phases of the larvae. [35] mentions that diversity is low when there is a dominance of some species.

Likewise, it was found that the diatom and cyanophyte populations were not stable. It is interesting to note that, although the larvae were under the same culture conditions, in the larvae of different ages, the structure of their epizoic microalgae community changed. In larvae less than 20 days old, the cells of the dominant microalgae
were shed from the larvae shells allowing the colonization of other microalgae; on the other hand, in larvae of 20 to 30 days a higher H’ diversity of 1.0 to 1.2 was reported. In another study with gastropods, carried out by [6] reviewed the shells of seven gastropods (Alvania lineata, Bittium reticulatum, Clanculus cruciatus, Columbella rustica, Gibbula adansonii, Nassarius incrassatus and Jujubinus striatus), reporting a richness of 19 to 25 species and a high J’ equity of 0.70 to 0.80 and [36] in Lepidochelys olivacea (olive ridley) shells, recorded a diversity of 1.1 to 2.1 and a high J’ equity of 0.56 to 0.86.

From what was observed in this study, the size and structure of the shell of A. gigas larvae on the different days of development provide a substrate for the epizoic microalgae.

The two to five-day old larvae did not have microalgae, the size of the shell is small, thin, smooth, the shell is formed through a transient amorphous calcium carbonate that acts as a precursor in the aragonite crystallization sequence [37–38]. In addition, the time for colonization is still short.

In the case of larvae from 26 to 44 days, the highest species richness was reported, the shell is larger about 1 200 μm with greater ornamentation and with greater adhesion surface. Especially the 44-day-old larvae present a periostracum, outermost layer of the shell composed of an organic matrix [38–39], which offers a better substrate, rich in proteins, which permit the growth of epizoic microalgae. In 28-day-old larvae, the number of spirals and shell ornamentation may be the factors that support the presence of Haloleptolyngbya sp., in addition to the mucus secreted by the microalgae themselves to adhere to the substrate. The 30 to 36-day old larvae showed a lower species richness and a dominance of Cyclophora sp. This diatom forms colonies in a zigzag shape, occupying the entire larva shell and preventing other microalgae from adhering. In several studies they have agreed to point out that gastropod shells are good microenvironments, due to their different structures and sizes. [6] Size does influence the colonization of epizoic microalgae, observing that the largest shells (Bittium reticulatum, Gibbula adansonii, Columbella rustica and Clanculus cruciatus) presented greater abundance and the small shells (Alvania lineata, Nassarius incrassatus and Jujubinus striatus) higher species richness, unlike what was found in this work.

Some microalgae produce allelopathic substances that inhibit the growth of others [40]. This could explain why some larvae had fewer epizoic microalgae than others, or for the fact that some had successfully colonized earlier and no longer left space for the colonization of more species. In addition to the changes in the abundances of the epizoic microalgae community, it is important to study the physical and chemical factors that influence their succession and to analyze whether A. gigas larvae fed on the epizoic microalgae reported. Epizoic microalgae associated with the velum of the larvae analyzed in this study were reported, Cylindrotheca closterium, Hippodonta pseudacceptata and Cyclophora sp.

The ecology studies of epizoic microalgae on the larvae of A. gigas, allows to know which species of phytoplankton or phytobenthos are present in the system where these larvae inhabit of the Mexican Caribbean. There are few studies focused on the study of diatoms and even less if they are found as epizoic microalgae. As the knowledge of the factors that regulate the competitive ability of the different epizoic microalgae species increases, the degree of interaction between them and their basibiont will also be understood.

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References

[1] Wahl M, Marine epibiosis. I. Fouling and antifouling: some basic aspects. Marine Ecology Prog. Serie. 1989;58:175-189. DOI:10.3354/MEPS058175

[2] Lincoln RJ, Boxball GA, Clark PF, Diccionario de ecología, evolución y taxonomía. ed. México, D.F.. México: Fondo de Cultura Económica; 1995. 676 p. ISBN: 9786071600417

[3] Green J, Parasites and epibionts of Cladocera. Journal of Zoology. 1974;32:417-515. DOI: org/10.1111/j.1096-3642.1974.tb00031.x

[4] Ho J, Perkins PS, Symbionts of marine copepoda: An overview. Bulletin of Marine Science. 1985;37:586-598. URL: https://www.ingentaconnect.com/content/umrsmas/bullmar/1985/00000037/00000002/art00020#

[5] Gillan D, Cadée GC, Iron-encrusted diatom and bacteria epibiotic on Hydrobia ulvae. Journal of Sea Research. 2000;43:83-91. DOI: 10.1016/S1385-1101(99)00041-6

[6] D’Alelio D, Cante MT, Russo GF, Totti C, De Stefano M, Epizoic diatoms on gastropod shells. When substrate complexity selects for microcommunity complexity. In: Seckbach J, Dubinsky Z, editors. All Flesh Is Grass, Cellular Origin, Life in Extreme Habitats and Astrobiology, 1st ed. Springer: 2011. p. 16:345-364. DOI: 10.1007/978-90-481-9316-5_16

[7] Siqueiros-Beltrones DA, Ibarra-Obando S, Loya-Salinas, D, Una aproximación a la estructura florística de las diatomeas epífitas de Zostera marina y sus variaciones temporales en Bahía Falsa, San Quintín, B.C. Ciencias Marinas. 1985;11:3:69-88. DOI: org/10.7773/cm.v11i3.479

[8] Siqueiros-Beltrones DA, Serviere-Zaragoza E, Argumedo-Hernández U, Epiphytic diatoms of Macrocystis pyrifera (L.) C. Agardh from the Baja California Peninsula, Mexico. Oceánides, 2002;17:1: 31-39. URL: http://www.repositoriodigital.ipn.mx/handle/123456789/15141

[9] Siqueiros-Beltrones DA, Argumedo-Hernández U, Florística de diatomeas epífitas en laminales apicales de Macrocystis pyrifera (L.) C. Agardh. Oceánides, 2005;20:1,2:37-63. URL: https://oceanides.ipn.mx/index.php/cicimarocceanides/article/view/21

[10] Gárate-Lizárraga I, Muñetón-Gómez MS, Primer registro de la diatomea epibionte Pseudohimantidium pacificum y de otras asociaciones simbióticas en el Golfo de California. Acta Botánica Mexicana. 2009;88:33-47. URL: http://www.scielo.org.mx/pdf/abm/n88/n88a3.pdf

[11] Cupp EE, Allen WA, Plankton diatoms of the Gulf of California. Allan Hancock Pacific Expedition. 1938;35:61-99. URL: http://digitallibrary.usc.edu/cdm/ref/collection/p15799coll82/id/14856

[12] Moreno JL, Licea S, Santoyo H. Diatomeas del Golfo de California. 1 ed. Universidad Autónoma de Baja California Sur: SEP FOMES PROMARCO; 1996. 273 p.

[13] Cox E, Variation in patterns of valve morphogenesis between representatives of six biraphid diatom genera. Journal of Phycology. 1999;35:1297-1312. DOI: org/10.1046/j.1529-8817.1999.3561297.x

[14] Siqueiros-Beltrones DA, Diatomeas bentónicas de la Península de Baja California; diversidad y potencial ecológico. Oceánides. 2002;15:1:35-46. DOI: 10.7550/rmb.43748
[15] Komárek J, Anagnostidis K, Cyanoprokaryota 2. Teil/2nd Part: Oscillatoriales. In: Büdel B, Krienitz L, Gärtner G, Schagerl M, editors. Süßwasserflora von Mitteleuropa 19/2, Elsevier GmbH, München: 2005. p. 81-90. ISBN: 978-3-8274-1914-9

[16] Ashworth MP, Ruck EC, Lobban CS, Romanovicz DK, Theriot EC, A revision of the genus Cyclophora and description of Astrosyne gen. nov. (Bacillariophyta), two genera with the pyrenoids contained within pseudosepta. Phycologia. 2012;51:6:684-699. DOI: 10.2216/12-004.1

[17] Guiry MD, Guiry GM, AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. 2020. http://www.algaebase.org; searched on 30 October 2020.

[18] Sullivan MJ, Similarity of an epiphytic and edaphic diatom community associated with Spartina alterniflora. Transactions of the American Microscopical Society. 1982;101:84-90. DOI: 10.2307/3225573

[19] Clarke KR, Gorley RN. PRIMER v7: User Manual/Tutorial (Plymouth Routines in Multivariate Ecological Research). 2nd ed. PRIMER-E Ltd, Plymouth; 2006. 300 p. URL: http://updates.primer-e.com/primer7/manuals/User_manual_v7a.pdf

[20] Magurran AE. Diversidad ecológica y su medición. ed. Védra. Barcelona, España; 1989. 200 p. ISBN: 9788487456008

[21] Sokal R, Rohlf FJ. Biometry. The principles and practice of statistics in biological research, 2nd ed. W.H. Freeman and Co., San Francisco; 1981. 859 p.

[22] Fee EJ, Drum RW, Diatoms epizoic on copepods parasitizing fishes in the Des Moines River, Iowa. The American Midland Naturalist. 1965;74:318-324.

[23] Hiromi J, Kadota S, Takano H, Diatom infestation of marine copepods (Review). Bulletin Tokai Regional Fisheries Research Laboratory. 1985;117:37-45.

[24] Winemiller KO, Winsborough BM, Occurrence of epizoic communities on the parasitic copepod Lernaea carassii (Lernaeidae). The Southwestern Naturalist. 1990;35:206-210. DOI: 10.2307/3671543

[25] Gaiser EE, Bachmann RW, The ecology and taxonomy of epizoic diatoms on Cladocera. Limnology and Oceanography. 1993;38:628-637. DOI: 10.4319/lo.1993.38.3.0628

[26] Round FE, Crawford RM, Mann DG. The diatoms. Biology, Morphology of the Genera. ed. Cambridge University Press, Cambridge. 1990. 747 p.

[27] Romagnoli T, Bavestrello G, Cucchiari EM, De Stefano M, Di Camillo CG, Pennesi C, Puce S, Totti C, Microalgal communities epibiontic on the marine hydroid Eudendrium racemosum in the Ligurian Sea during an annual cycle. Marine Biology. 2007;151:537-552. DOI: 10.1007/s00227-006-0487-x

[28] McClatchie S, Kawachi R, Dalley DE, Epizoic diatoms on the euphausid Nyctiphanes australis: consequences for gut-pigment analyses of whale krill. Marine Biology. 1990;104:227-232. DOI: 10.1007/BF01313262

[29] Hart TJ, On the diatoms of the skin film of whales and their possible bearing on the problems of whale movements. Discovery Reports, 1935;10:247-282. URL: https://www.icrwhale.org/pdf/SC01199-132.pdf
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[30] Holmes RW, The morphology of diatoms epizoic on cetaceans and their transfer from Cocconeis to two new genera, Bennettella and Epipellis. British Phycological Journal. 1985;20:43-57. DOI: 10.1080/00071618500650061

[31] Croll DA, Holmes RW, A note on the occurrence of diatoms on the feathers of diving seabirds. Auk, 1982;99:765-766. URL: https://sora.unm.edu/sites/default/files/journals/auk/v099n04/p0765-p0766.pdf

[32] Holmes RW, Croll DA. Initial observations on the composition of dense diatom growths on the body feathers of three species of diving seabirds. In: D.G. Mann. ed. Proceedings of the 7th International Diatom Symposium. Koenigstein. O. Koeltz; 1984. p. 265-277.

[33] Cupul-Magaña FG, Cortés-Lara MC, Primer registro de epibiontes en ejemplares juveniles de Crocodylus acutus en el medio silvestre. Caldasia. 2005;27:1:147-149. URL: https://revistas.unal.edu.co/index.php/cal/article/view/39319

[34] Wahl M, Goecke F, Labes A, Dobretsov S, Weinberger F, The second skin: ecological role of epibiotic biofilms on marine organisms. Frontiers in Microbiology. 2012;292:1-21. DOI: 10.3389/fmicb.2012.00292

[35] Margalef R. Ecología. ed. Enciclopedia temática Planeta. Planeta. Barcelona. 1981. 252 p.

[36] Majewska R, Santoro M, Bolaños F, Chaves G, De Stefano M, Diatoms and Other Epibionts Associated with Olive Ridley (Lepidochelys olivacea) Sea Turtles from the Pacific Coast of Costa Rica. PLoS ONE. 2015;10:6:1-15. DOI: org/10.1371/journal.pone.0130351

[37] Brito-Manzano N, Aldana-Aranda D, Cruz-Lázaro EDela, Estrada-Botello MA, Organogenesis larvaria de Strombus gigas (Mesogastropoda: Strombidae) en el arrecife alacranes durante el periodo máximo de su época reproductiva. Universidad y Ciencia Trópico Húmedo. 2006;22:1:75-82. URL: https://www.redalyc.org/pdf/154/15402206.pdf

[38] Chávez-Villegas JF, Enríquez-Díaz M, Aldana-Aranda D, Efecto de la temperatura y la acidificación en larvas de Strombus gigas (Mesogastropoda: Strombidae). Revista de Biología Tropical. 2017;65:2:505-515. DOI: 10.15517/RBT.V65I2.25504

[39] Enríquez-Díaz MR, Volland JM, Chávez-Villegas JF, Aldana-Aranda D, Gros O, Development of the planktotrophic veligers and plantigrades of Strombus pugilis (Gastropoda). Journal of Molluscan Studies. 2015;81:3:335-344. DOI: org/10.1093/mollus/eyv011

[40] Tanaka N, Asakawa A, Allelopathic effect of mucilage released from a brown alga Sargassum horneri on marine diatoms. Nippon Suisan Gakkaishi. 1988;54:1711-1714. URL: https://www.jstage.jst.go.jp/article/suisan1932/54/10/54_10_1711/_pdf