The International Journal of Engineering and Science (IJES)
|| Volume || 11 || Issue || 5 || Series I || Pages || PP 06-10 || 2022 ||
ISSN (e): 2319-1813 ISSN (p): 20-24-1805

Sea Urchins Life Cycle and the Effect on the Environment

Nadia Al-Sabah
HITN

----------ABSTRACT----------

Sea urchins are marine animals that have been widely studied due to the environmental implications on their lifecycle, hence a demonstration of the global climatic changes. Although the exact implications are still a point of discussion among researchers, the reproduction of the sea urchins from the production and fertilization of eggs to the growth and development has numerous implications on the environment, just like that of other marine poikilothermic animals. This study showed that the changes in the climatic conditions have a significant impact on the different life stages of the sea urchins. The most fundamental environmental factors are the temperature, pH of the water, winds, precipitation, latitude, and water salinity. Although most of the studies have focused on the larvae stage and the adult stage, it is notable that a certain impact in one stage is likely to affect the next stage.

Keywords: *sea urchins, climatic conditions, life cycle, marine conditions*

Date of Submission: 14-05-2022 Date of Acceptance: 03-06-2022

I. Introduction

The reproduction of marine poikilothermic animals has been considered to be a cyclic physiological process. The hook sentence is placed to grab the attention of the reader about lifecycle of poikilothermic animals. A majority of the invertebrate species mostly produce eggs and sperms into the water columns that facilitate fertilization and the development to the larval stage. Mostly, these organisms, especially the ones that inhabit the temperate climatic zones, have an annual reproduction cycle and show a spawning period that varies seasonally [1] Scientific referencing uses numbers that correspond to the number of the reference list. These changes are noted to be both abiotic and biotic, implying that different factors like temperature, the salinity of the water, and the phytoplankton affect the development and survival of the offspring. Sea urchins are not different from the rest of the marine poikilothermic animals, with their life cycle showing the implication of the environmental factors. Sea urchins are mostly round animals with spiny formations. They are mostly found in oceans. Sea urchins demonstrate many colors, which are associated with nature and the type of their habitat [1]. The reproduction of the sea urchins from the production and fertilization of eggs to the growth and development has numerous implications on the environment, just like that of other marine poikilothermic animals. Background information on the nature of sea urchins. Although these creatures have unique adoption to the environmental variables, the regulation and the timing of the reproduction cycles and the variations among and within the population are not properly understood. Although the environmental implications of the sea urchins life cycle are not properly understood, overwhelming evidence has demonstrated that temperature and the photoperiods are the most fundamental environmental factors that impact and control the succession of the life cycle stages and the timing for spawning processes of different individuals within the population. Thesis statement that provides the answer to the question that is being answered in the paper.

The Sea Urchins Life Cycle

The reproduction of the sea urchins is a unique experience that is characterized by the massive laying of eggs and fertilization, depicting the importance of the favorable environmental factors for the processes to be a success. Generally, sea urchins live in large communities and groups of both males and females. The topic sentence in this paragraph that gives the idea about the environmental factors and implications of reproduction. During the reproduction period, females produce millions of eggs, which makes the males produce sperms in the form of white clouds [1,2]. An in text citation for two sources that provide more information to the topic sentence. Once the eggs have been fertilized, they float at the top of the seawater for about 8 weeks before hatching into larvae. Warmth is important for the eggs of the sea urchins to hatch. However, after they hatch, the larvae require a cooler environment; hence they drop to the floor of the sea and attach on a sucker foot until they mature. It should be noted that the main source of food for the sea urchins is algae. However, these animals are also scavengers, while others consume sand and mud, which enables them to extract the minute amounts of the organic content in the material [2]. Citation provides more evidence to the discussion. At the adult development stage, which takes about four to five years, sea urchins are about three to ten centimeters. Some of the sea

urchins, like the Red Sea Urchin, can live for even more than 30 years depending on numerous environmental factors, including temperature. It is anticipated that some species of sea urchins are in danger of going extinct as a result of the increased popularity and their use as a source of seafood delicacy. The last statement of the paragraph concludes the idea being discussed.

Regional Differences in the Sea Urchin Spawning Schedule

Environmental implications on the reproduction of the sea urchins is demonstrated by the studies concerning the spawning schedules in different regions. Topic sentence provides the idea of the paragraph. It acts as the transition from the previous discussion. The previous studies have focused on the spawning behavior of the sea urchins in the Sea of Japan, the Eastern Pacific Sea, and the Sea of Okhotsk to demonstrate the differences in the behavior of the sea urchins [2]. Citation of the previous studies provide more credibility to the study. In all three locations, it is notable that sea urchins have unique behavior, which can be illustrated by the three patterns. For example, in the Sea of Japan, the sea urchins show a cycle where spawning peaks at around September to October during the autumn period. However, the sea urchins at the Sea of Okhotsk, as well as the Eastern Pacific, demonstrate an extended period of spawning that starts from around June to October. Factual statements demonstrate the depth of the research. This is a characteristic difference in the spawning periods and behavior that is observed in the northern parts of Funka Bay as well as Tsugaru Strait, which show two peaks of spawning throughout the year, with the first peak between April and May and the other one during the autumn period from August to October [2]. The citation shows attribution of facts to the author. This is an illustration that the sea urchins in different geographical locations have different spawning behavior indicating an impact on the environmental factors on their behavior. Generally, it is notable that the species in the Atlantic Ocean spawned once annually while the Mediterranean populations spawned twice. However, it is notable that the varying reproductive cycles for the same sea urchins are not properly understood. Again, the last statement concludes the idea discussed in the paragraph.

Although the differences in the spawning behavior of the sea urchins are not properly understood due to the lack of enough evidence regarding the varying behavior in the same sea species, this behavior is attributed to the regional differences that impact the climatic and environmental conditions. The topic sentence is also an attention grabber and a transition to the next idea. For example, some studies have suggested that the difference is brought about by the latitudinal gradient differences [3]. Example provides more credibility to the research with factual information. The citation demonstrates that it is not guess work. According to this proposition, temperature and the photoperiod differences in different regions are the main environmental factors that regulate the reproductive behaviors and cycles of the sea urchins and other marine invertebrates. Due to the changes in temperature, the sea urchins regulate their behavior leading to changes in the spawning. For example, temperate waters make the sea urchins have a short period of spawning, while the opposite is true for the tropic environmental conditions. Under these conditions, the spawning period is extended, and it is also demonstrated that some of the species can spawn throughout the year [3]. Environmental implications are emphasized. However, there has been a challenge for the scientists to explain why *P. lividus*, a sea urchin species that are mostly found along the West Coast of the Atlantic, has a single spawn period, while the same species located in the Mediterranean region has several spawning peaks, although both locations are within the same latitude. This is an illustration that other environmental factors may be causing the differences in the behavior of the sea urchins located within the same latitude. A conclusive statement.

Environmental Factors that Influence Spawning of *S. intermedius*

The proposition that environmental factors may influence the growth and development of sea urchins triggered the need for more studies, especially focusing on *S. intermedius* and its behavior throughout the growth cycle. This statement provides a background of the subtopic and the ideas discussed in the subtopic provided. Mainly, a focus on the female ones regarding their maturation has been studied to evaluate the factors that influence their behavior. The studies at the Kievka Bay evaluated the nature of the *S. intermedius* throughout six stages of ovarian maturation from immature to over – mature [2,3]. When two or more citations are used they are provided in acceding order. Some of the considerations for the environmental concerns were the depth of the sea, the temperature of the water that they lived in, the salinity of the seawater, and the concentrations of the oxygen that dissolved in the water. Gonadal development was evaluated in 26 sites to evaluate the maturity dynamics and the proportion of the sea urchins that were ready for spawning. According to the studies, sea urchins tend to become mature by August. This is an illustration that they have more potential to spawn anywhere between the month of August and September. This paragraph discusses the findings in different locations. There is a significant difference in the spawning dynamics of the sea urchins in various sites and at various times of the year. This is an indication that the changes in the climatic conditions affect the behavior of the sea urchins and particularly their development.

The changes in the patterns for the spawning event as observed from the *S. intermedius* is an indication of the role of local environmental properties in the spawning periods. This is a transition statement that gives more details about the environmental factors. It is notable that the various external conditions or the favorable combination of different conditions play a role in the behavior of the *S. intermedius.* Some of the factors that have been discussed to impact this behavior include the differences in the weather and the hydrological conditions [4]. These changes regarding the amount of precipitation and also the associated changes in the terrigenous factors affect the manner in which *S. intermedius* grow and behave throughout the year. The paragraph provides more information about the notable changes and effects. When precipitation changes, the levels of salinity change which affects the maturity of sea urchins and hence their productivity. The study at Kievka Bay also suggested that the changes in the wind patterns have a role in the behavior of the sea urchins [2]. An example and a citation give credibility to the discussion. The nature of the seasonal wind affects the temporal variability regarding the distribution of temperature and probably the precipitation rate that affects the saturation of the dissolved oxygen. Other factors noted to have a strong correlation with the behavior of the sea urchins is the concentration of the phytoplankton. With more concentration, more sensitive males start to spawn, and their sperms tend to stimulate and promote synchronous behavior in the rest of the community. The interesting finding is the correlation between the timing of the spawning period and the new and the full moon periods. The natural stimuli of this behavior and its impact on the sea urchins is still a factor of consideration in modern studies, but an interesting demonstration of the environmental factors and growth of sea urchins [4]. The last statement provides a conclusive after thought based on the discussion.

Sea Urchins and Implications on Marine Forests

The growth and developmental behavior of sea urchins have demonstrated a unique implication on marine forests. A new subtopic about marine forests and how they relate to growth of sea urchins. Importantly, researchers have studied the role of maturing sea urchins on the algae community, and particularly the modification of the structure. While many other types of herbivores have been recognized as a part of the grazing agents in these communities, their roles and functions are quite lower or even insignificant when compared to the behavior of the sea urchins. According to Zhadan et al., sea urchins demonstrate a unique browsing behavior with a lot of intensity which leads to the formation of a canopy that can make the macroalgal communities collapse [2]. A citation that gives credibility to the discussion of marine forests. Through the activity of the sea urchins, as they grow and multiply, there is a large transformation and extension of the rocky bottoms. Various studies have proved the behavior of the maturing sea urchins on the environment and the implication of the sea algal. In a study conducted within the Mediterranean Sea, the cover of algal increased by about 50% in the areas where the sea urchins were removed [2]. This was also evidenced in the Northwestern region of the Mediterranean. In this regard, it can be concluded that the patterns of growth and development of sea urchins play a role in the habitat structure for these communities, even the communities that have low echinoid densities. A concluding statement that provides the reader with the overall thought of the topic.

Climate Warming and Ocean Acidification Cross Life History Stages

The anthropogenic uptake of carbon dioxide has a significant impact in altering the chemistry of the seawater, especially leading to a reduction of the seawater pH and also saturation of some minerals, which affect the growth and development of the overall marine ecosystem. The topic sentence is a comprehensive statement that gives the overall background of the idea of climatic warming and other factors that influence sea urchins throughout their lifecycle. The acidification of the ocean coupled with global warming has negative implications on the larvae and the adult sea urchins [5]. It is notable that sea urchins calcify in both the larvae and the adult stage. Therefore, the changes in the nature of the water have an important role in the development of sea urchins and particularly their survival at these stages. It is in this regard that sea urchins have been significantly used by environmentalists in studying the implications of climate change on the marine ecosystem. Supportive statement provides more details about the topic statement. According to Bryne and Hernandez, the increased acidification of the marine water has a stunning effect on the growth of the sea urchins, as demonstrated in the changes in the small larvae as well as the skeletons of adult sea urchins [1]. Citation provides credibility about the changes in environmental conditions and their impacts on sea urchins. This change is attributed to the energetic constraints as well as the reduction of the saturation state. Through moderate warming and also a sufficient supply of food sources, the changes may be reduced among the species. However, it is evident that a variation regarding the acidification is notable, and also the warming within and between the species, which could be an indication of phenotypic plasticity that exists as the species try to adjust to the changes in the climate. There is an increase in acidification resilience and adaptation of the species to the biological systems [5]. However, there is a need to identify the specific species that adapt to the specific climatic stressors in order to understand the echinoid fauna of the future. The conclusive statement provides an afterthought based on the discussion.

The focus of the single life stages and particularly the larvae stage of the marine species and how they demonstrate environmental changes has demonstrated the need to evaluate other life stages to have a better

understanding of the entire process. The topic statement is a transition that demonstrates more discussion about the climatic changes and their effects on the animals. Most of the studies in the past have focused mainly on a single life-history stage which has necessitated the evaluation of different life stages and the consideration of these life stages as a continuum [6]. While these stages can demonstrate some differences and some forms of autonomy in characteristics, they tend to be linked together. The information on stages give credibility to the analogy that various stages are consideration in environmental implications. Therefore, Miles et al. noted that the implications of the environmental changes that cause a particular disturbance in one stage could be transmitted to the next stage [6]. The citation is an emphasis of this argument. For example, it has been demonstrated that there is a significant carry-over on the maternal impact. It is notable that the quality of eggs produced by the female sea urchins depends significantly on the quality of diet, the overall lifestyle, the temperature as well as the concentration of the dissolved oxygen in the water. The example gives credibility to the argument. These carryover effects are also evident in the males and the production of their sperms to the larvae stages. Environmental factors affect the phenotypic traits of the larvae stage. Considering that the organisms can adapt to environmental changes, one factor that is of essence is the time of exposure [6]. The exposure of the organism to various environmental factors can lead to drastic morphological changes or even modified behavior. Such changes are notable of evident in arguably all stages of the growth life cycle of the organisms. The changes discussed are concluded with an overall conclusive idea.

Temperature and acidification of the water are among the most studied factors that impact the growth patterns and behavior of sea urchins. The topic statement provides the climatic conditions being discussed. In their study, Miles et al. illustrated that temperature has a positive impact on their growth. The researchers studied how a temperature above 25^0C affected the growth and development of *Tripneustes gratilla.* The issue of temperature is discussed in details and evidence is given. According to the study findings, such a temperature leads to the development of larger and heavier sea urchins that also demonstrate a heavier skeletal growth. With a more tropical population being noted within the species, it is evident that such observations will be made in different parts. A moderate warmth of the water has a positive impact on the growth of *T. gratilla*. An example of the species is given and how it is affected. However, very high temperatures have a reduced growth rate impact on the species. A transition statement that provides an alternative finding. This illustrates that temperature is a major physiological factor that increases the susceptibility of the animals to the diseases, and hence their mortality [6]. In addition, an increase in acidification leads to a reduced growth rate of the species. While moderate rates of acid in the water are not stressful to the growth of the sea urchins, a very low pH impacts the survival rate and even the body size of the species. However, the duration of exposure to such conditions has a major impact on the species. The more the exposure the more the sea urchins are affected. This is a demonstration that time is of essence for the environmental factors to have a major implication on the growth of the sea urchins. The conclusive statement provides the reader with the overall idea.

II. Conclusion

The analysis shows that while the environmental implications of sea urchins life cycle demonstrates varying results, overwhelming evidence has demonstrated that temperature, pH and the photoperiods are the most fundamental environmental factors that impact and control the succession of the life cycle stages and the timing for spawning processes of different individuals within the population. The first statement in the conclusion is a recap of the idea that was being discussed, and a restatement of the thesis although it does not use the exact words all through. The study showed that the changes in the climatic conditions has a significant impact on the different life stages of the sea urchins. Although most of the studies have focused on the larvae stage and the adult stage, it is notable that a certain impact in one stage is likely to affect the next stage. There is a need to study the implications of specific amounts of temperature and pH on specific body attributes and formation in order to understand the implication of the environmental factors at that particular stage. With the increased climatic changes across the globe, it is notable that sea urchins will change differently. Naturally, most organisms demonstrate phenotypic adjustments, hence it is expected that with the global climatic changes, more sea urchins will continue to demonstrate adjustments to the changes. These statements provides a recap of the major findings from the study. This must be achieved in all the lifecycle stages of sea urchins since they are all affected by different environmental factors. This last statement is the afterthought of the discussion.

References

The sources are arranged in numbers based on how they appear in the paper. Since a specific format was not provided, the author decided to use scientific referencing since this is a scientific research.

[1]. M., Byrne, J.C., Hernandez. “Chapter 16 - Sea urchins in a high CO2 world: Impacts of climate warming and ocean acidification across life history stages.” Science, 43 (2020), 281-297.

[2]. P., Zhadan; M., Vaschenko; T., Almyashova. “Effects of Environmental Factors on Reproduction of the Sea Urchin Strongylocentrotus Intermedius.” Environment to Aquaculture and Biomedicine (2017), 1-5.

[3]. S., Dworjanyn, M., Byrne. "Impacts of ocean acidification on sea urchin growth across the juvenile to mature adult life-stage transition is mitigated by warming." Proceedings of the Royal Society B: Biological Sciences 285(2018): 20172684.
[4]. A., Bernal-Ibanez; E., Cacabelos; R., Melo; I., Gestoso. "The Role of Sea-Urchins in Marine Forests from Azores, Webbnesia, and Cabo Verde: Human Pressures, Climate-Change Effects and Restoration Opportunities." Front. Mar. Sci. (2021), 1-8.
[5]. A., Neto; M., Viera; R., Haroun. "A synthetic overview of marine phycological studies in the Macaronesian archipelagos." Silva Lusitana (2014), 22, 217–244.
[6]. H., Miles; S., Widdicombe; J., Spicer; J., Hall-Spencer. "Effects of anthropogenic seawater acidification on acid-base balance in the sea urchin Psammechinus miliaris." Marine Pollution Bulletin, (2007); 54, 89–96.

XXXXX, et. al. "Sea Urchins Life Cycle and the Effect on the Environment." *The International Journal of Engineering and Science (IJES)*, 11(5), (2022): pp. 06-10.