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The invasion of jellyfish and its impact of the world's economy

Introduction

Every summer I look forward to swimming in the warm sea of the Mediterranean surrounding the Islands of Malta, until a few summers ago, when more often than not the sea was infested with jellyfish, particularly the mauve stinger (*Pelagia noctiluca*). This jellyfish created havoc among the Maltese and also affected the tourism and so the University of Malta and the IOI kids (from the International Ocean Institute) came up with the "Spot the Jellyfish" program which encourages children, teachers, parents and tourists to keep an eye out for different species of gelatinous monsters around the Maltese Islands. It was quite a surprise when other tropical species turned up such as the blue button (*Porpita porpita),* the cigar jellyfish (*Olindias phosphorica*), the comb jellies (ctenophores) and the jelly-like invertebrate, the Portuguese Man o' War. People started to wonder what caused this gelatinous monster invasion and so did I.

Fig.1. The upside down jellyfish is another uncommon species recently discovered around the Maltese islands through the 'spot the jellyfish' program.

Fig. 2.The Portuguese man-o-war (Physalia physalis) lives on the surface of the ocean but as of 2010, was also spotted around the Maltese islands.

While watching the discovery channel, I came across a documentary about the increase of other jellyfish around the world, particularly in the seas of Japan and China. I was astonished to realize what damage these jellyfish are causing outside tourism, and journals about such issues helped me understand more what human interference has done to the marine ecosystem.

Method:

The jellyfish discussed is the giant jellyfish (*Nemopilemanomurai)* which can weigh a maximum of 204kg, having a bell measuring up to 7ft in diameter and a long trail of poisonous tentacles. These monsters are floating into the coast of Japan everyday, damaging the fishing industry. But Dr. Shin-Ichi Uye, a specialist in giant jellyfish from the Hiroshima university, Japan 'recently identified Chinese coastal waters as the probable source of the giant jellyfish by surveying jellyfish populations as he rode on ferries travelling from China to Japan. During these ferry trips, Dr. Uye documented the movement of young giant jellyfish from Chinese waters into the Sea of Japan on currents, and the growth of these jellyfish along the way.' (Lily Whiteman, National Science foundation, 09 March 2011, 'research in action: giant jellyfish jam the seas of Japan').

Fig 3. ‘A diver is dwarfed by a giant jellyfish.’
CREDIT: Yomiuri Shimbun

In the light of a research article called “Environmental Control of Phase Transition and Polyp Survival of a Massive-Outbreaker Jellyfish” by Laura Prieto, Diana Astorga, Gabriel Navarro, Javier Ruiz, one could also observe the effects of temperature on polyp survival and strobilation in the Mediterranean Sea on *Cotylorhiza tuberculata* also known as the fried egg jelly fish.

Fig 4. An adult medusa of *Cotylorhiza tuberculata*.

They carried out numerous experiments using the water from the Mar Menor (western Mediterranean Sea) as a medium while changing temperature, light, salinity and food availability. Different stages of development were observed such as the settlement of planulae on hard substrate (transition from pelagic to benthic stage) and the formation of polyps which will later become ephyrae and divide asexually or form medusae (transition from benthic to pelagic stage).

Results :

With reference to the research article mentioned above by Laura Prieto, Diana Astorga, Gabriel Navarro, Javier Ruiz, one can see that low temperatures on planulae settlement was ineffective and so does not change the number of well developed polyps in the end of summer. Lower temperatures do however affect the time it takes for the planulae to develop into polyps. This means that the planula is a phase that appears to be insensitive to environmental changes including salinity and light exposure, therefore they can survive until they find suitable conditions to settle and transform into polyps.
Once polyps are fixed on a hard surface they must survive until the next spring when strobilation occurs. Results show that low temperatures had a harsh effect on polyps and the number of survivals decreased with a decrease in temperature.
A sudden increase in temperature will induce strobilation (the higher the temperature the higher the rate of strobilation) and the polyps develop into ephyrae which may reproduce asexually. But polyps and ephyrae do not do well in high temperatures and so must develop into medusae to survive the hot summers we've been exposed to lately. This is the adult stage with poisonous tentacles which is causing all these problems in today's economy.
Therefore one can realize that it's not just the hotter summers, but it's also the milder winters that are indirectly increasing the number of adult jellyfish, since more polyps are surviving until spring for strobilation.

Cause:

1) Habitat modification

A large number of ports and dams (amongst other structures) have been built along the coast of China, which increased the habitat for jellyfish polyps. These need a hard surface to attach to while growing.

2) Translocation

Keeping the above fact in mind, large hulls and ships are also a suitable habitat for polyps. This is a source of transport for foreign species into different locations where the conditions are better for developing into free swimming jellyfish.

3) Overfishing

Many species of fish and other animals such as the leatherback turtle feed on jellyfish, most of which are dramatically reduced in number or even endangered. As a result of overfishing and hunting a large number of competitors and predators are removed from the ecosystem and so jellyfish species have the chance to thrive in number. While catching these predators from the bottom of the sea by trawlers, the polyps are able to seek refuge in rocky outcrops which are missed by the nets.
Many fish compete for the same source of food (zooplankton) as jellyfish. Therefore when these fish are caught by fisherman, more food is made available for jellyfish which contributes to their growth. (It is important to note that some jellyfish are able to reduce in size when food is scarce so the above mentioned point is only referring to size and not quantity).

4) Eutrophication

Unfortunately, fertilizers and sewage, containing high amount of nutrients such as nitrogen and phosphorus, is still being expelled into the coastal waters,. This provides great conditions for phytoplankton (e.g. Flagellates) to proliferate and replace diatoms (zooplankton). This food chain doesn't support animals such as marine animals and seabirds while jellyfish are able to survive due to their wide range of prey (including flagellates) and also thrive due to the high amount available in these regions. Large amounts of phytoplankton can sometimes sink to the seabed leading to bacterial degradation (which may need oxygen) and causing local hypoxia (low oxygen level). This is another condition jellyfish are tolerant to and may also reproduce in, while fish cannot.

5) Global warming

According to the article 'Jellyfish swarm northward in warming world' by Michael Casey (2009), the temperature of the water has increased by around 1.7 degrees Celsius in the past few decades. This also increased the range of tropical jellyfish which can now live in temperate zones including Japan, China and as aforementioned- the Mediterranean Sea.

The increase in temperature also enhances water column stratification which in turn causes nutrient poor water at the surface of the sea. Since flagellates are able to migrate vertically into deeper waters, they can survive while diatoms don't leading to the same consequences as eutrophication.

In the article, 'The jellyfish joyride: causes, consequences and management responses to a more gelatinous future' by Anthony J. Richardson, Andrew Bakun, Graeme C. Hays, and Mark J. Gibbons, it is mentioned that a recent study in the central North Sea showed that as a result of increased atmospheric carbon dioxide a decrease of the ocean's pH occurred and this improved the conditions for polyp reproduction. On the other hand other studies suggested that calcified statoliths (important for attachment of polyps) are dissolved in acidic pH. These theories are both under study and have yet to be proven.

Consequences

1) Reduction in fish prices

The price of goods depends on supply and demand. Since the jellyfish has changed the consumer preferences, concerns about the quality of fish has led to a decline in price. Consumers are scared that the fish are poisoned by these invasive jellyfish which are usually caught with the fish in the fishing nets. Also, when the 200kg giant jellyfish are trapped in these nets, the nets may break, causing financial losses. This in return has led to a loss of revenue for the fishermen who have now decided to change jobs.

2) Endangering lives

Some jellyfish are not only a treat to fish but also to human beings. At Chesapeake Bay, Michael Casey states that a study undertaken in 2008 showed that over 500,000 individuals were stung by jellyfish. Another study showed that 20-40 inhabitants in the Philippines die each year.

Due to the weight and size of certain jellyfish, they may endanger lives by attacking boats or capsizing trawlers when pulling up the nets.

3) Decline in tourism

The danger done by these gelatinous monsters threatens both domestic and foreign tourism. This may result in a decline in foreign earnings and employment in the tourism industry (which is a major issue in Malta too).

Fig.4. Nomura Nemopilema nomurai clogging fishing nets in Niu, Fukui Prefecture (Japan), October 2003

Solutions

1) Control pollution

Since pollution leads to eutrophication, it is necessary to reduce the amount of sewage expelled in water, which will in turn reduce food supply for jelly fish and increase the number of fish which feed on these gelatinous creatures. Also, since green house gasses are the reason for global warming and the increase of the temperature of water, actions should be taken in reducing the amount of the said gasses.

2) Newly designed nets

Nets which contain two layers have been introduced; the first layer will trap jelly fish while the fish pass through and are trapped in the second layer of the net unharmed. Using cutting nets may also help in reducing jellyfish, but certain ongoing studies suggest the possibility of regeneration in some species.

Although a good idea, few fishermen afford new technology.

3) Controlling fishing

The government should introduce quotas to control the amount of fishing and this will increase the number of predators that feed on jelly fish. This will also help in increasing endangered species which are depleting due to overfishing.

4) Hull and artificial hard structures cleaning protocols

Another idea is the development of environmentally benign chemicals and other measures which kill polyps that settle of ports and hulls. This can help in decreasing jellyfish production and translocation.

Conclusion

In reality the only way we can solve this problem is by everyone being proactive. The result of jellyfish infestations isn't the fault of the fishermen, factories and coastal buildings in China and Japan alone, but is also the fault of the rest of the world's pollution. We need to make people more aware of the dangers and effects of jellyfish, and make them realize that this is our fault! It is hard to understand why people who experience the trouble brought about by jellyfish firsthand don't work on solving the problem too. It might be because there isn't enough awareness as this has been proving to be a nuisance only for the past few years. It is probably safe to say that if we do not do something about this now, the jellyfish and jelly like species will one day rule the marine world. A quote from Daniel Pauly, one of the most widely sited marine biologist, portrays the future if we do not act proactively to put this jellyfish invasion to a stop : 'My kids will tell their children: Eat your jellyfish!'.

References

Pictures :

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