Outbreak and Prevention of Drupa and Drupella

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Abstract. In order to effectively control the outbreak of Drupa and Drupella and protect the coral reef ecosystem, the biological characteristics, outbreak period, damage degree and causes of Drupa and Drupella were summarized. At the same time, based on the investigation and analysis of the South China Sea, the control measures are put forward. The results show that the main food of Drupa and Drupella is Acropora. Drupa and Drupella has the characteristics of small individual, long breeding cycle and clustering, and its outbreak seriously damages the coral reef ecosystem. There are signs of Drupa and Drupella outbreak in South China Sea and Hong Kong. The main reasons include hurricane transit, global warming and the reduction of natural enemies. Measures such as natural enemies, artificial cleaning, tracking monitoring and early warning can be used to control Drupa and Drupella.

Keywords: Drupa, Drupella, Ecological system, Coral reefs.

Drupa and Drupella, belonging to Muricidae, Rapaninae [1], warm sea products, living in rocky reefs and shallow coral reefs near the mid-tide line [1,2]. This kind is distributed in my country’s Qiongzhou Strait [3], Taiwan, Fujian, Guangdong, Guangxi, Hainan Island[4~8], the Paracel Islands and the Nansha Islands, and is widely distributed in the Indian-Western Pacific waters such as Japan, the Philippines, Australia [7]. Since the 1980s, stone fruit snails and small stone fruit snails have had large-scale outbreaks in major sea areas around the world [9~11], resulting in the degradation of coral reef ecosystems, reduction of marine biodiversity, reduction of marine fishery resources, and coastal erosion And a series of ecological problems [12~16], which in turn led to a series of social and economic problems. In this regard, many scholars have carried out extensive research, and related research in my country is still in its infancy.

1. Ecological characteristics of stone fruit snails
The genus Drupa [17~19] includes D. ricius ricinus, D. r. hadari, D. elegans, D. morum morum and D. morum iodostoma, D. rubusidaeus, D. Speciosa, D. clathrata clathrata, D. c. miticula, D. lobata, D. grossularia (D. grossularia) Roland discovered a new species in the waters of Western Australia: Drupa denticulata. Among them, the model species is Drupa morum Roeding [20], also known as purple mouth rock snail [1, 21, 22]. The individual is small, the shell is about 2.5 cm long, and the shell is thick, slightly fist-shaped or hemispherical. The spiral tower is low, the surface of the shell is gray and white, the protrusions are dark brown, the spiral layer and the body layer are blue-black, with 4-5 thick horn-like
spines; the shell mouth is narrow but smooth, blue-purple, with rough rows of tumors. There are 3-4 rib teeth on the inner lip shaft; irregularly arranged small teeth on the inner edge of the outer lip [23~24].

Including Drupella cornus [7], Drupella rugosa, Drupella margariticola [23~25], Drupella fragum, Teeth white conch snail [17, 18] D.eburnea and so on. The shells of the type species [7] of the small stone snails are nearly fusiform, smaller than the stone snails, and the spiral part is higher. The shell surface usually has small granular nodular protrusions. The shell mouth is small, with a row of small teeth on the inner edge of the outer lip. There are 3-4 rib-like teeth on the inner lip axis of the snail, and the surface nodules are prominent; the color of the shell of the snail is white, dark brown or reddish, and the surface nodules are rosary-like. There are 5-7 small teeth in the outer lip; the nodules on the surface of the berry fruit snail are not prominent and relatively smooth. There are 5 small teeth on the inner edge of the outer lip, the inner lip is smooth, and there are 2-3 weak folds under the axial lip. Ple [1]; the color and pattern of the shell surface of the pearl snail, black brown or off-white, lavender or off-white in the shell, thick outer lip, with 5-7 grainy teeth on the outer edge; 2 in the inner lip 3 granular teeth, the lower end and bandage form a false umbilicus [24].

Both Sclerotium and Sclerotium are carnivorous animals [19], in the range of 1.84-2.68 [26] in the trophic level, the main food [19, 27] is branched coral [28], reef-building stones Coral [11,29], oyster mother-of-pearl [7], etc., but not very interested in types such as Favia, Leptastrea, and Pavona [28]. Scientists analyzed the gastrointestinal contents of 7 species and 2 subspecies of stone snails living in the Red Sea, and found that their diets are different, and they can be called diet experts [19]. A number of studies have shown that the predatory characteristics of drupe snails will change with changes in their habitats, such as increased temperature, decreased salinity, damage or coral disease, or coral bleaching, etc. Some scholars have found that after severe bleaching of corals, the dietary preferences of stone snails will change from Acropora and Pocillopora to fungiid corals, and their feeding types and feeding rates It will change according to the size and structure of the individual and age: the feeding rate of juvenile and very large stone snails is very low, and the feeding rate of medium-sized adult stone snails is very high.

Hoeksema also observed in experiments that the snails of the genus Sclerotium will prey on corals, and Fuad A. Al-Horani also found in the study that the snails will prey on Acropora (Acropora), and some scholars Large amounts of zooxanthellae are flushed out in the intestines of the snails [23]. Drupella rugosa preys on the tissues of Platygyra acuta and Platygyra carnosus [24]. Pinctada snails have predation selectivity in predation [23]. Peng Fumin’s research pointed out that Pinctadas snails will choose to feed on corals when the number of clams in the Philippines decreases, and they will also choose among coral species; Brain Discovery [13]: They were also found to be redistributed in other coral groups when they lacked their preferred food.

The food intake and destructive power of drupe snails are amazing. Cumming proposed that the rate of 6.40/m² of drupe snails consumes corals at the same rate as 68 crown-of-thorns starfish per hectare. They hide under coral reefs during the day and come out to hunt at night. Their predatory activity at night is much higher than that during the day. It is not too much to call them nocturnal predators. It has been recorded that the most serious outbreak of stone snails reduced the coverage of live coral by 75% of the Ningaloo Reef in Western Australia [9], with an average density of 19.4/m². Some scholars have also dealt with serious corals. After bleaching, as many as 250 stone snails were found on the surviving coral reefs. The massive accumulation and predation of stone snails severely damaged the local coral reef ecosystem, and also affected other local coral reefs. Living marine creatures and colonies [9].

The physiological cycle of stone fruit snails is currently seldom studied. Taking the pearl fruit snail as an example [23], the dioecious, gonadal maturity period can be summarized from April to September. Stone snails often hide under coral reefs and can easily move from one coral to another to continue feeding [28]. The combination of dominant stone snail species in different habitats is different. For exposed reef peaks, exposed reef slopes, sheltered reef peaks and sheltered reef slopes, different combinations of stone snails can be found in each habitat [9]. Juvenile stone snails have higher requirements for habitat and prefer to stay on live corals, and the impact of juvenile stone snails on coral ecological communities is different from that of adults: juvenile stone snails are only found in the
recessive microhabitats of branched staghorn corals. However, the adult stone snails will use various microorganisms and feed on corals to maintain normal life activities. Verena research pointed out that the adult stone snails and juvenile stone snails will attract each other and gather together, and the survival rate of juvenile stone snails will increase when the adult is present.

2. The outbreak of stone fruit snails and its harm to coral reefs
In a healthy coral reef ecosystem, the habitat of benthic organisms is an important part of the coral reef ecosystem [4]. Corals and stone snails should exist at the same time, and their abundance should be maintained under a series of environmental and biological factors. In the dynamic balance of, and some scholars have pointed out that the feeding activity of a normal number of stone fruit snails is unlikely to cause excessive damage to the coral reef. By selectively destroying certain adult corals, stone fruit snails can act as a shaping. The selective power of coral community structure. However, under the pressure of some biological or non-biological factors, the large number of stone snails will cause extremely serious damage to the coral reef. In the case of high density of stone snails [9] Corals cause great harm.

2.1. Outbreak cycle
Reports since the 1980s show that [9] the seas of Japan have experienced four stone snail outbreaks during the 20 years from 1980s to 1990s. Until 2004, traces of stone snail ingestion were found in the waters at that time. The spread of stone snails in the waters between the Indian Ocean and the Pacific Ocean is more serious [9, 20]. When the value of $6.4/m^2$ [9] is exceeded, the densely gathered stone snails will affect the ecological community of corals. According to recent reports on the Great Barrier Reef [9], the Red Sea [10, 13], the South China Sea[12], Western Australia, the Indo-Pacific Sea[9, 20] The collation of the research results of the nearby stone snail outbreaks revealed that the stone snails have great damage to the coral reefs but are not very regular. Once they lack the first choice of food, they will begin to transfer to other communities and eat again [19].

2.2. Degree of damage
Juvenile stone snails will have a greater impact on coral communities through high-density gathering. Some scholars have found that adult stone snails migrate frequently because they are afraid of being predated by natural enemies, and often prey on corals at different densities. However, the foraging activities of juvenile stone snails will cause significant death of some coral communities, which will cause a substantial decrease in the coverage of live corals and changes in species composition.

In addition, it has been suggested that there is a correlation between the abundance of stone fruit snails and disease, and these can be spread between affected and healthy corals by coral worms. Research by K. J. Nicolet pointed out that stone snails may act as a medium for the transmission of coral diseases through ingestion, such as the transmission of brown band disease (BrB) and coral disease. Coral white syndrome (WS) and stone snail outbreaks interact with each other. The bleached coral attracts greedy predators, and the predation of stone snails will cause a more serious blow to the already fragile coral system and be attacked by stone snails. The recovery of coral communities will be greatly reduced [13], which will slow the growth of many artificially transplanted corals.

2.3. Domestic and foreign investigations
Drupes significantly affect the coral reefs living in the waters of the Indo-Pacific Ocean, Western Australia, and Asia, as well as the organisms that live on the coral reefs. Based on the collection of research data over the past few years, researchers have also found outbursts of stone snails in my country’s Xiaodonghai, the inner bay of Qinzhou Bay in Taiwan, and the waters of Hong Kong[12]. The coral reefs are severely damaged. In 2016, a large outbreak of stone snails caused by the bleaching of coral reefs in the Maldives increased the pressure on the coral ecosystem.
3. The cause of the outbreak of stone fruit snails

According to the existing results, the outbreaks of stone fruit snails mainly include climatic and biological reasons.

(1) Regarding the outbreak of stone snails in Hong Kong waters, some scholars believe that it is due to the lack of natural enemies of stone snails—red-throated helmet fish [10], portunus, etc., so this lack of "top-down" The control mode provides an excellent living environment for our stone fruit snails. In contrast to the situation of drupe snails in Hong Kong, on the southern coast of Etra [10], the natural enemies of drupe snails prevent us from seeing these "rampant" predators feeding on corals during the day. Many places where the number of drupe snails has surged are overfished by fish, balistids, labrids, and other natural enemies of invertebrates.

(2) Environmental changes: The accumulation of stone snails in Daya Bay is closely related to the seasonal changes of nutrients and water environment in the sea. In spring, the rain is abundant and the temperature rises, and the rainfall brings certain exogenous nutrients to the coral reef area, which leads to an increase in the dominant position of the stone fruit snails, and the increase in the number of stone fruit snails will cause a large-density outbreak, which will affect the sea area. Coral ecological community. As the sea temperature rises, the growth of stone snails and corals are affected at the same time; global warming will not only increase the ocean temperature, but also increase the opposite effect of the low temperature limit frequency. Corals that are under low temperature stress are more likely to Predation by stone snails, poor staghorn corals in the occasional cold winter are more predatory by stone snails. Some external local and global pressure sources can cause a large reduction in live corals, and corals that are broken, tissue damage and disease affecting survival will attract stone snails to prey.

(3) The interference of some catastrophic abiotic factors. For example, after the hurricane hit, the gathering of stone snails and small stone snails was also observed. Due to the impact of human activities, such as diving, snorkeling, etc., there are many stone snails in heavily polluted places.

4. How to prevent

(1) Biological control, according to the environment of each sea area, put the natural enemies of the genus Drupe and the snail [10]; according to their spawning and breeding periods [23] put predators that eat their larvae and eggs, the time for the adult stone snail predator to be placed before the stone snail lays eggs.

(2) Manual cleaning, the technical content of manual cleaning is low, but it can quickly control small-scale stone fruit snail outbreaks. According to the results of this investigation, there are only signs of stone snail outbreaks in the waters near Hong Kong in the South my country Sea. Therefore, manual cleaning methods can be used to control them. Local fishermen can be encouraged to carry out clean-up work, and the government will uniformly landfill it. The time is appropriate before June to August each year to avoid the threat of stone snail spawning in other sea areas.

(3) Underwater drug administration, leading fishermen to inject drugs into the group of stone snails under water. The injected drugs mainly include sodium bisulfate, bile salt, lemon bile salt sucrose thiosulfate (TCBS) and acetic acid.

(4) Follow-up investigations, in order to protect the ecosystem of the coral reefs in the South my country Sea, the follow-up monitoring of drupe snails should be carried out regularly, and analysis should be conducted based on the results of the follow-up monitoring, early warning of the sea areas where drupe snail outbreaks may occur, and corresponding effective measures should be taken to respond. To prevent another outbreak of stone snails. Since it is challenging to effectively control the Drupella population, long-term monitoring of coral reefs and a deeper understanding of Drupella's outbreak mechanism and reproductive strategies are very important.

(5) Rehabilitation of coral reefs that have been gnawed. The coral reef ecosystem has a certain ability to recover. However, when the gnawing rate of stone snails is greater than the recovery rate of the coral reef, the ecosystem will face collapse. Therefore, while detecting the density of stone snails within the outbreak threshold, artificial treatment of the coral reef is also required. Repair it.
5. Conclusion
In order to effectively control the outbreak of stone snails and protect the coral reef ecosystems in the South my country Sea, this study summarizes the biological characteristics of the genus Drupe and the genus Drupe, as well as the outbreak period, damage degree, and causes of the outbreak. It is also based on the correlation to the waters of the Paracel Islands in my country. Investigate and analyze, and put forward control measures. The results of the study show that the main foods of the genus Drupe and the snail are branched corals and reef-building corals, which are characterized by large numbers and fast growth, and their outbreaks severely damage the coral reef ecosystem; there is an outbreak of Drupe snails in the South my country Sea The main reasons include typhoon crossing, over-nutrition, global warming, and reduction of natural enemies; measures such as the introduction of natural enemies, manual cleaning, tracking, monitoring and early warning can be adopted to strengthen the prevention and control of stone snails.

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