



# The Investigation and Assessment Report on Marine Ecology and Environment Status of Huangyan Dao

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**July 2024**

# Table of Contents

**Foreword** ..... 1

**I. Geographical Overview of Huangyan Dao** ..... 3

**II. Environmental Quality of Huangyan Dao Waters** ..... 7

    1. Seawater Quality ..... 7

    2. Marine Sediments Quality..... 8

    3. Pollutant Residues in Marine Fishes ..... 8

    4. Floating Litter Distribution..... 9

**III. Coral Reef Ecosystem of Huangyan Dao** ..... 9

    1. Status of Hard Coral Communities..... 10

    2. Status of Key Coral Reef Ecology Communities ..... 20

    3. Major Pressure and Ecological Risks ..... 25

    4. Coral Reef Ecosystem Health Assessment ..... 27

**Column. The History of Scientific Expedition of Huangyan Dao  
and its Adjacent Waters** ..... 30

**Explanations for Investigation and Assessment** ..... 35



# Foreword

Huangyan Dao (Minzhu Jiao) is located in the southeast of Zhongsha Qundao in Sansha City, Hainan Province, serving as a key traditional fishing area and natural shelter for fishermen of China. It is also a vital “harbor” for maintaining marine biodiversity in the South China Sea, holding substantial ecological significance. Strengthening the ecological investigation, monitoring, and protective research of Huangyan Dao waters is crucial for safeguarding national sovereign security, protecting national marine rights and interests, ensuring the ecological security of the South China Sea, and fulfilling other major strategic functions.

Relevant departments and institutions in China have conducted extensive long-term scientific researches on the ecological environment of Huangyan Dao and its adjacent waters. Building on these efforts, from May to June, 2024, the investigation team from South China Institute of Environmental Sciences, MEE (SCIES), National Marine Environmental Monitoring Center, MEE (NMEMC), Ecological and Environmental Monitoring and Research Center, Supervision and Management Bureau of Ecology and Environment for the Pearl River Watershed and South China Sea, MEE (PSEMRC) *etc.*, systematically conducted on-site investigations of the marine ecology and environment status in Huangyan Dao area. The investigation covered seawater quality, marine sediment quality, marine biological quality, floating litter, as well as coral communities, reef-dwelling fish and other typical biological groups. Over 600 samples were collected, and investigation image data totalled 289 GB. The investigation team further collaborating with Guangxi Laboratory on the Study of Coral Reefs in South China Sea, Guangxi University and Key Laboratory of Tropical Marine Bio-resources and Ecology, South China Sea Institute of Oceanology, CAS, conducted a comprehensive analysis and assessment based on the previous scientific expeditions, research outcomes and satellite remote sensing survey results of Huangyan Dao area.

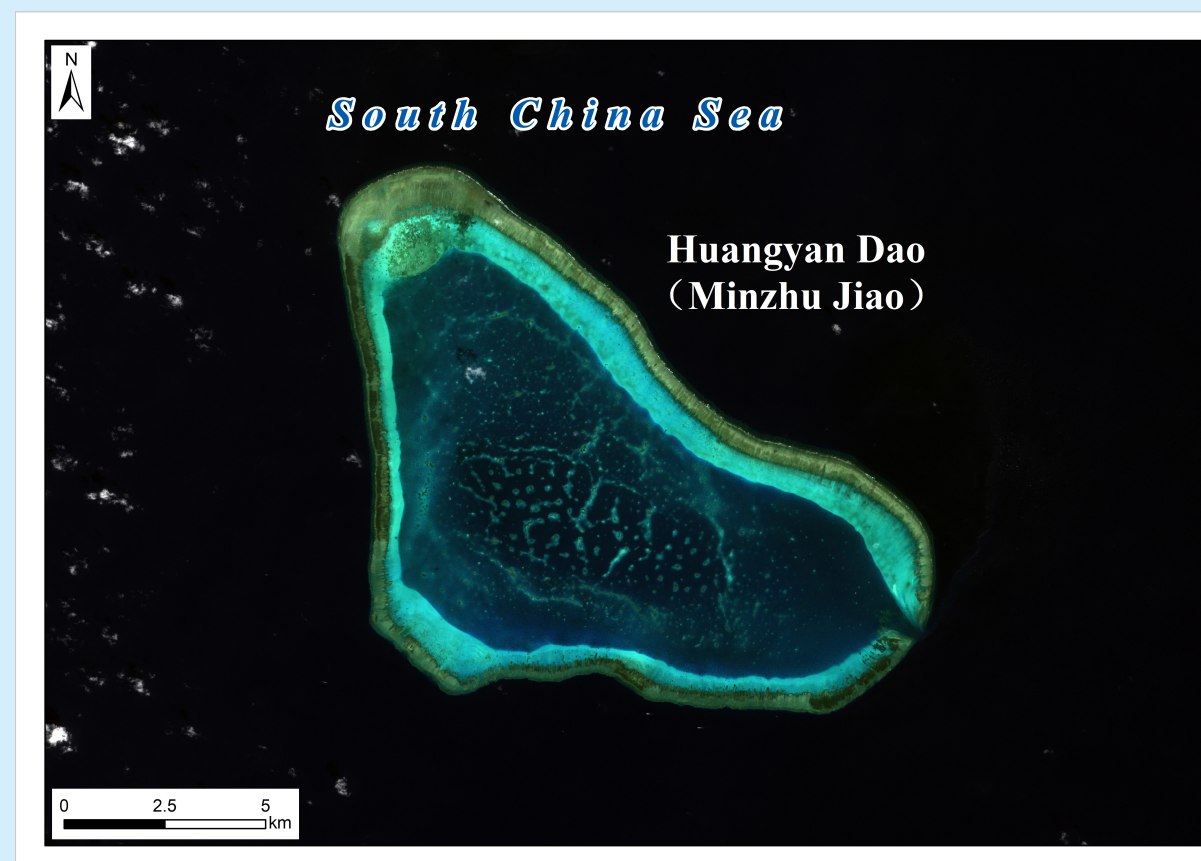
# Foreword

The results of the investigation and assessment showed an **excellent environmental quality of Huangyan Dao area**. The seawater quality and marine sediment quality were both rated as Grade I. The residual level of pollutants, such as heavy metals and petroleum hydrocarbons in fish samples were below the standard limits, and no cyanide detected in sea water, marine sediments and fish samples. The weight density of floating litter was also at a low level. **Moreover, the coral reef ecosystem was in healthy status.** The investigation recorded 109 species of hard corals belonging to 34 genera and 12 families, marking the highest species diversity ever documented. The average hard coral cover reached 28.6%, higher than the investigation results in 2015, with sufficient recruitment of juvenile corals. There is a high biodiversity in coral reef ecosystem, as the investigation recorded 125 species of coral reef fish from 23 families on-site based on the Fish Belt Transect, along with other key groups such as crustose coralline algae, giant clams, blue coral, fire coral and sea anemone. No phase shifts from coral to macroalgae and coral reef diseases have been observed. There was no outbreak of crown-of-thorns starfish. Additionally, Huangyan Dao hard coral communities demonstrate strong resistance and tolerance to rising sea surface temperature, making Huangyan Dao is a habitat for corals and related species in the South China Sea under global warming.

## I. Geographical Overview of Huangyan Dao

Huangyan Dao (Minzhu Jiao) is located in the southeast of Zhongsha Qundao in Sansha City, Hainan Province. The island has a circumference of approximately 55 km and an area of about 150 km<sup>2</sup>. It is situated about 610 km from Yongxing Dao, the administrative center of Sansha City. Huangyan Dao is a grand isosceles triangular atoll, featuring a large

reef rock named “Huangyan” at the northern end of the atoll, covering an area of about 4 m<sup>2</sup>. The largest reef rock near the west side of the lagoon channel is known as “Nanyan”, with an area of about 3 m<sup>2</sup>. On the outer side of the reef flat at the southwestern corner, there are also other large reef rocks. The atoll, encircling a triangular lagoon in the center, with the deepest depth is



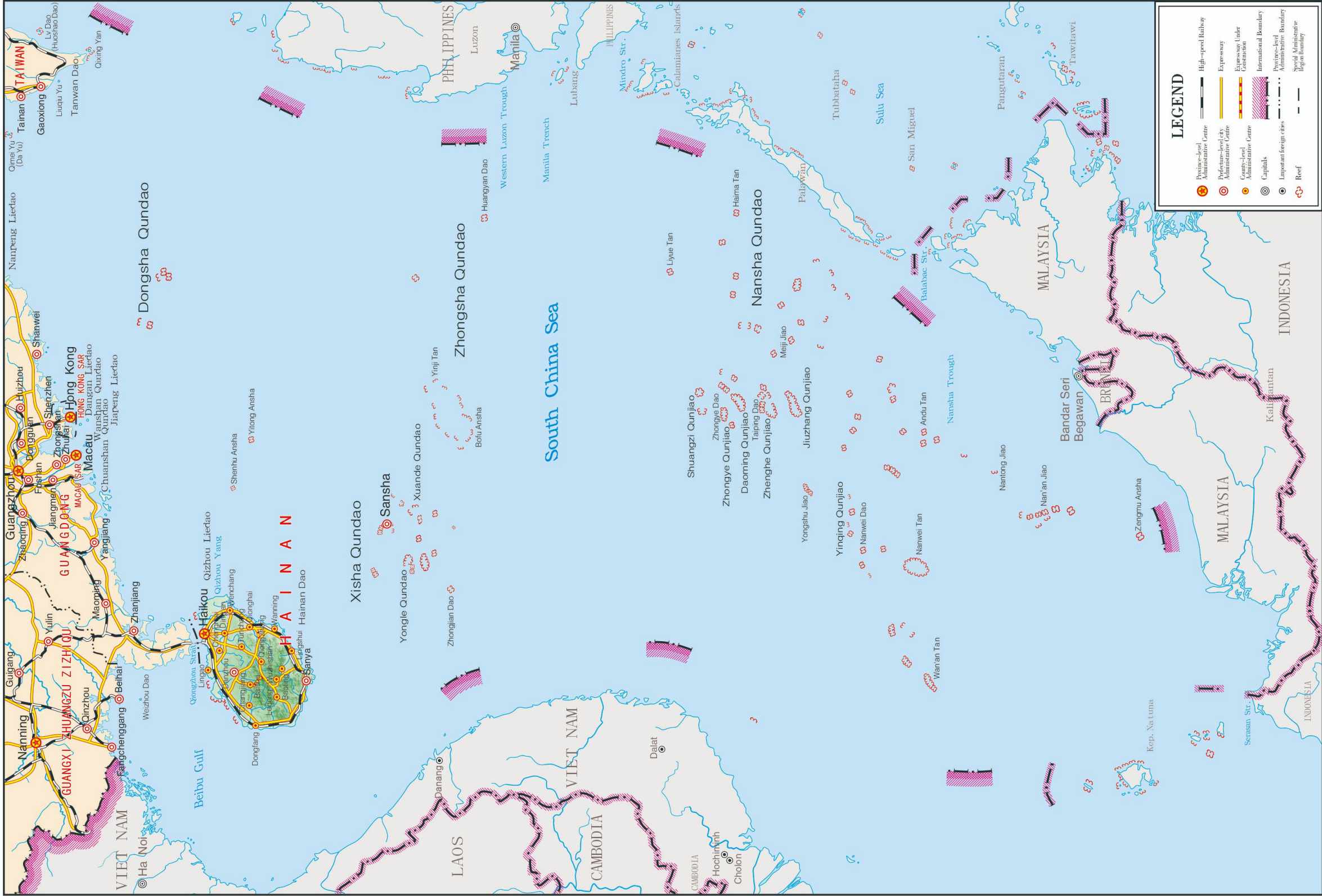
Remote Sensing Image of Huangyan Dao



# I. Geographical Overview

## of Huangyan Dao

Full map of Hainan Province





## I. Geographical Overview of Huangyan Dao

about 20 m. At the southeastern edge of Huangyan Dao, there lies a channel connecting the lagoon to the open sea, with a width of 360 to 400 m and a water depth ranging from 6 to 11 m in the middle. The channel allows water exchange between the lagoon and the open sea, and navigable to small vessels, serving as a shelter for nearby boats and ships.

Huangyan Dao area has abundant hermatypic organisms, fish, and other marine biological resources, serving as a traditional fishing area for Chinese fishermen. Its unique geographical location and superior ecological environment endow it with significant ecological and scientific research value.

## II. Environmental Quality of Huangyan Dao Waters

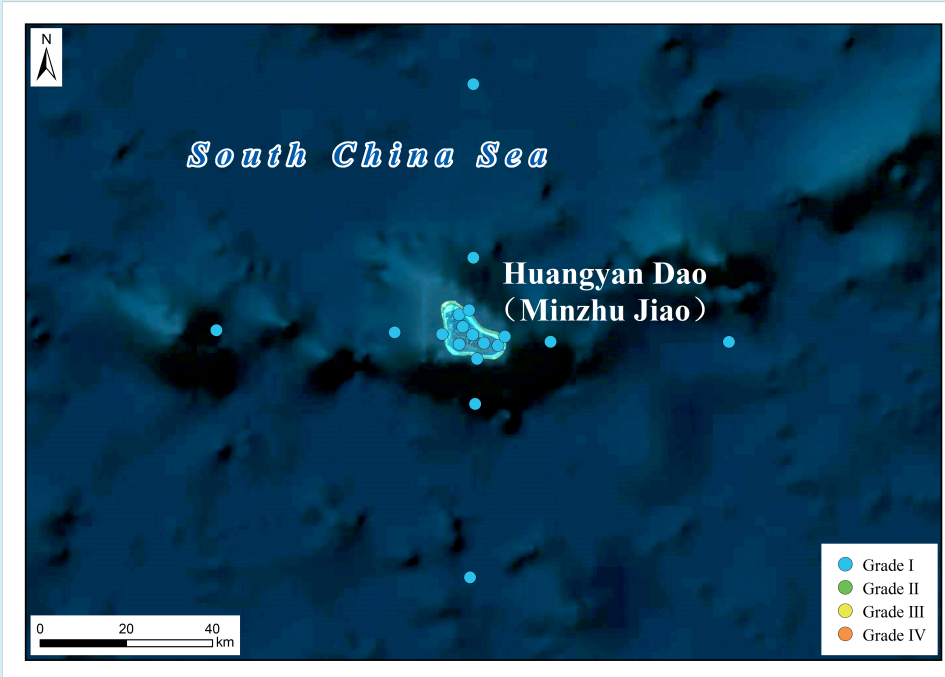
### 1. Seawater Quality

The investigation results conducted from May to June 2024 indicated that the seawater quality in Huangyan Dao area was rated as Grade I. No cyanide, copper, lead, cadmium, total chromium, mercury, or arsenic were detected at any investigation sites. The concentrations of suspended matter, chemical oxygen demand, inorganic nitrogen, reactive phosphate, zinc, and petroleum were all below the limits of the Grade I. It also meets the water

quality requirements for coral growth in the South China Sea.

The eutrophication index at all investigation sites was lower than one, indicating no signs of seawater eutrophication.

Compared to the investigation results of May 2015, the concentration of inorganic nitrogen slightly decreased and the concentration of reactive phosphate in the seawater remained nearly unchanged and, both of which were far below the limits of Grade I.



Seawater Quality Status of Huangyan Dao Area (May to June 2024)



II. Environmental Quality  
of Huangyan Dao Waters

II. Environmental Quality  
of Huangyan Dao Waters

2. Marine Sediments Quality

The quality of marine sediments in the lagoon of Huangyan Dao was rated as Grade I. No cyanide, sulfides, hexachloro-cyclohexane soprocide (HCH), dichloro-diphenyl-trichloroethane (DDT), or polychlorinated biphenyl (PCB) were detected in any of the sediment samples collected at the investigation sites. The levels of total organic carbon, heavy metals, and petroleum were all below the limits of the Grade I.

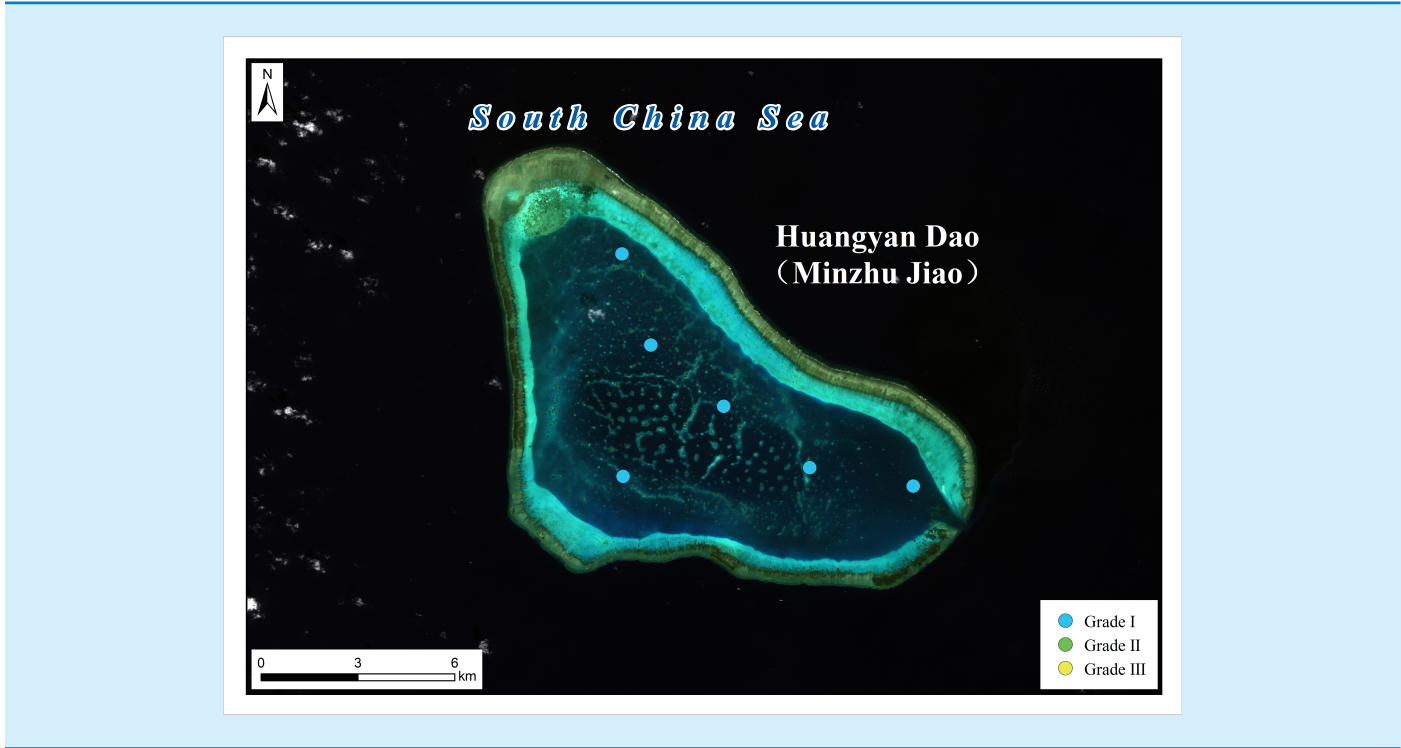
3. Pollutant Residues in Marine Fishes

Samples of fish species, *Heniochus acuminatus*, *Parupeneus barberinus*, *Acanthurus triostegus*, etc., were collected from the lagoon of Huangyan Dao to test various pollutants residual in marine life. The results showed that no cyanide was detected, and the concentrations of copper, zinc, chromium, total mercury, cadmium, lead, total arsenic, and petroleum hydrocarbons were all below the standard limits.

4. Floating Litter Distribution<sup>1</sup>

The average weight density of floating litter by trawling surveys was 2.6 g/km<sup>2</sup> and all the collected litter was

plastic. Compared to similar offshore areas worldwide, the weight density of floating litter in Huangyan Dao area was relatively low.



Marine Sediment Quality Status in the Lagoon of Huangyan Dao (May to June 2024)



Quantitative Distribution of Marine Floating Litter in Huangyan Dao Area  
(May to June 2024, by trawling surveys)

<sup>1</sup> Floating litter by trawling surveys: collecting meso-litter (0.5 cm ≤ diameter < 2.5 cm) and macro-litter (2.5 cm < diameter < 1 m).

III. Coral Reef Ecosystem  
of Huangyan Dao

1. Status of Hard Coral Communities

According to the investigation carried out from May to June 2024, the hard coral communities were in healthy status.

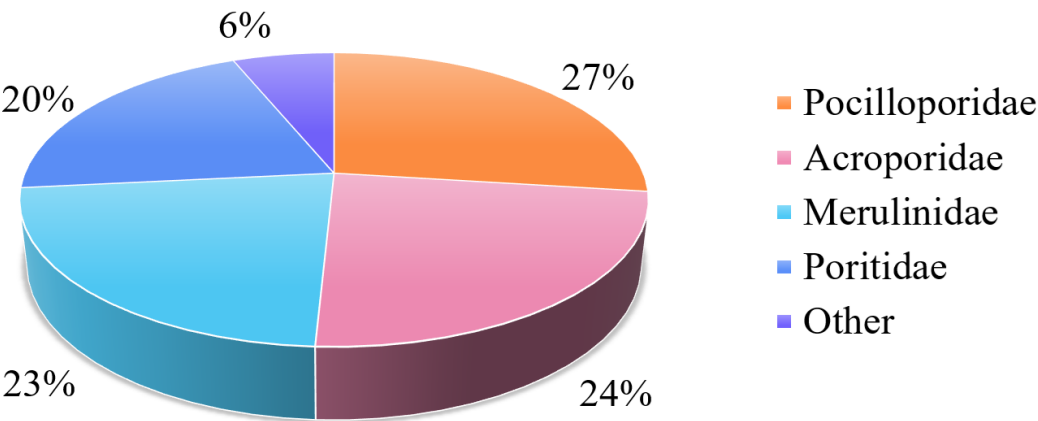
**Live coral cover was relatively high in Huangyan Dao reefs (28.6%).** Among them, **live coral cover** in the northeast part of Huangyan Dao reached as high as 37.1% (with a range of 25.4% to 52.2%).

**Recruitment of juvenile corals was sufficient.** The density of coral recruitment in Huangyan Dao was generally high (>5 per square meter), mainly from the families of Pocilloporidae, Acroporidae, Merulinidae, and Poritidae, which account for 94% of the total. **The species diversity of coral communities was relatively high.** A total of 109 species of hard corals from 34 genera and 12 families were

III. Coral Reef Ecosystem  
of Huangyan Dao

recorded in this investigation, with an increase of 45 hard coral species compared to the investigation findings in May 2015. All the hard coral species are listed as Class II protected wildlife in China in this investigation, with 41 species classified as Near Threatened and 14 species as Vulnerable in the

*International Union for Conservation of Nature's Red List of Threatened Species* (IUCN Red List). The dominant species include *Pocillopora verrucosa*, *Porites lutea*, *Pocillopora eydouxi*, *Porites lobata*, *Porites rus*, *Goniastrea retiformis*, and *Isopora palifera*.



Composition of juvenile corals in Huangyan Dao



### III. Coral Reef Ecosystem of Huangyan Dao

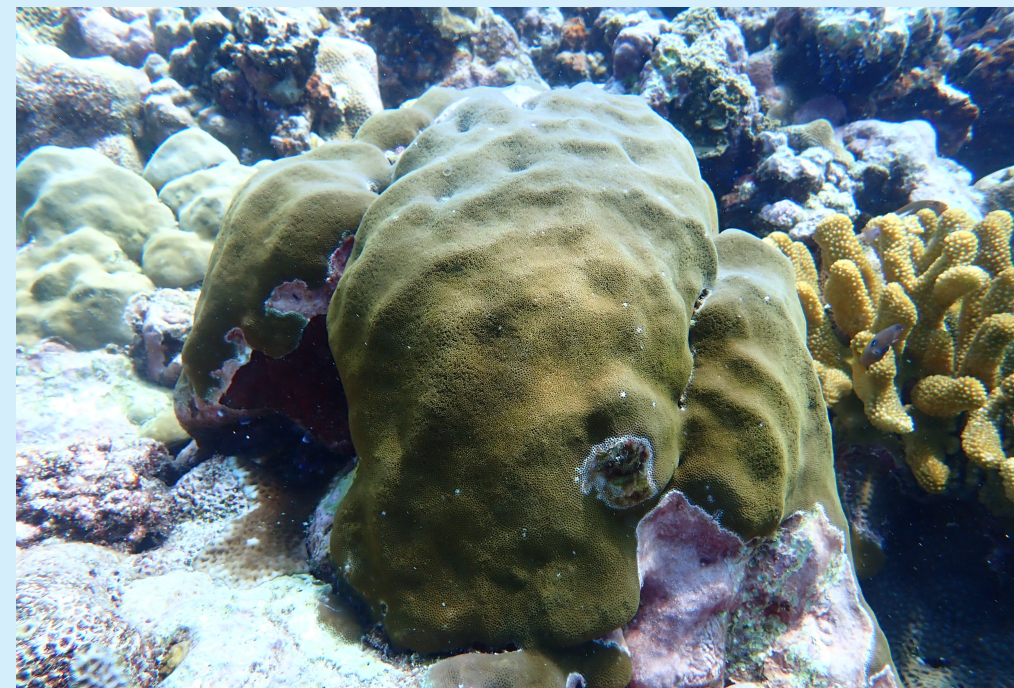
#### 1 *Pocillopora verrucosa*



*Pocillopora verrucosa*, belonging to the genus *Pocillopora*, family Pocilloporidae, is one of the dominant coral species in Huangyan Dao. It is listed as Class II protected wildlife in China. The colonies are typically in bushy forms with upright branches but without sprawling branches and the main branches are similar in size and shape. The living corals are mostly tan and pink. In this investigation, *P. verrucosa* was commonly found in shallow reef areas, especially on wave-exposed reef slopes. The three-dimensional structures of which provide habitats for reef-dwelling fish and small crustaceans.

### III. Coral Reef Ecosystem of Huangyan Dao

#### 2 *Porites lutea*

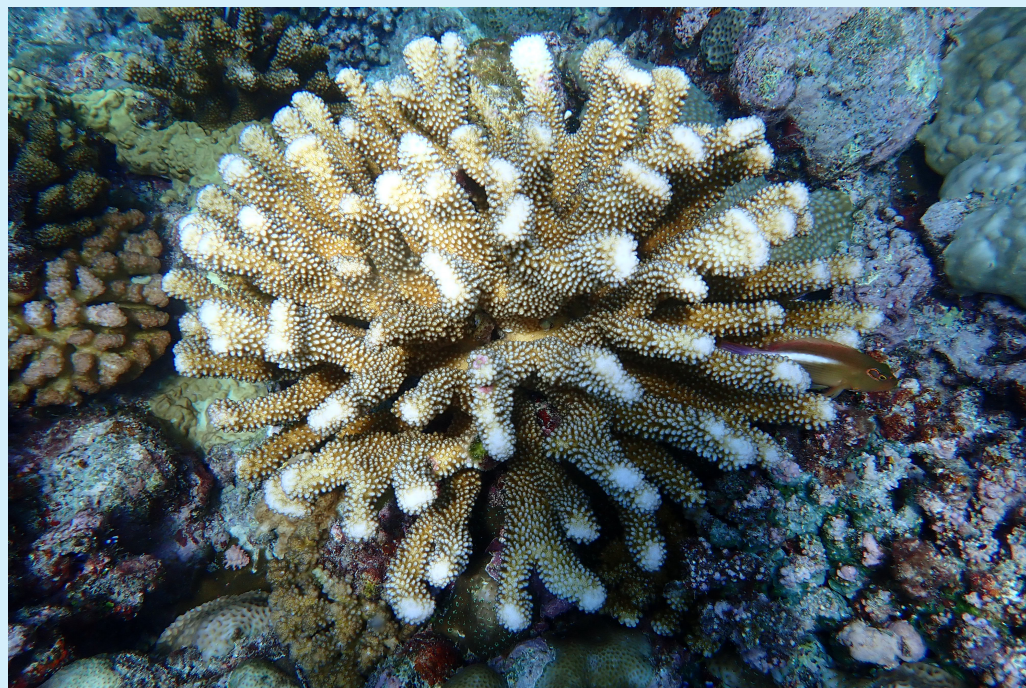


*Porites lutea*, belonging to the genus *Porites*, family Poritidae, is a dominant coral species in Huangyan Dao. *P. lutea* is listed as Class II protected wildlife in China. The colonies are typically in massive, hemispherical, or bell-shaped forms with irregular lumpy protrusions on the surface. Large colonies can grow to several meters in diameter. The living corals are normally brown or cream while brighter in shallow water. As a massive hard coral, *P. lutea* boasts a broader ecological niche compared to branching corals and is adaptable to harsher environments. Thus, it is one of the main dominant species in the coral reef areas of the South China Sea. Furthermore, *P. lutea* is an important recorder of global changes, accurately reflecting changes in the tropical marine environment.



### III. Coral Reef Ecosystem of Huangyan Dao

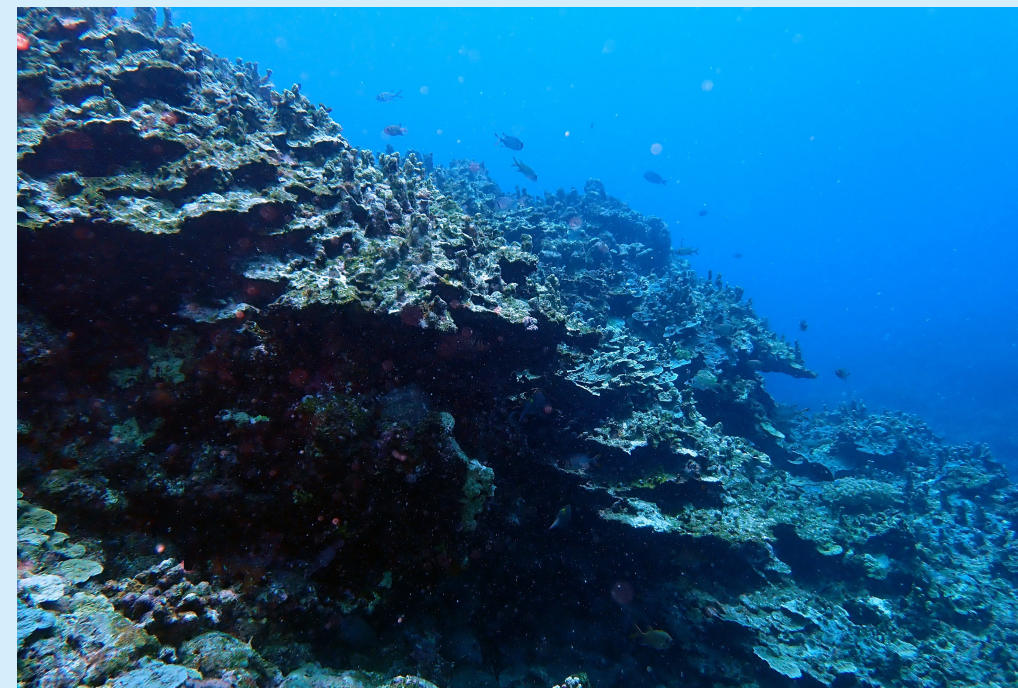
#### 3 *Pocillopora eydouxi*



*Pocillopora eydouxi*, belonging to the genus *Pocillopora*, family Pocilloporidae, is a dominant coral species in Huangyan Dao. It is Class II protected wildlife in China and classified as Near Threatened on the IUCN Red List. The colonies are typically in branched forms with sturdy, upright branches. The colony diameter often exceeds 1 meter, forming extensive monospecific populations. The living corals are normally green, brown, or light pink. In this investigation, *P. eydouxi* was commonly found in the shallow reef areas of Huangyan Dao, particularly in fore reef zones with strong currents or waves. The three-dimensional structures they build provide habitats for reef-dwelling life, further complicating its coral reef structure.

### III. Coral Reef Ecosystem of Huangyan Dao

#### 4 *Porites rus*



*Porites rus*, belonging to the genus *Porites*, family Poritidae, is also a dominant coral species in the coral reef of Huangyan Dao. It is listed as Class II protected wildlife in China. Colonies typically grow into diverse shapes, including crust, horizontal plate, twisted interlinked columnar branches, and irregular massive or sub-massive forms. Colonies often exhibit mixed growth forms, typically with a plate base and columnar fused branches. *P. rus* can develop into large colonies with a diameter of over 5 meters. The branch tops have ridges that converge in a flame-shaped pattern, particularly noticeable underwater, hence the name. The living colonies are usually purple, blue-brown, brown, or cream, with the tips of the branches being lighter. In this investigation, *P. rus* was commonly found on the outer reef slopes in the reef areas of Huangyan Dao. The growth characteristics of its plate base and columnar fused branches create a complex habitat structure, providing abundant living space for marine life.



### III. Coral Reef Ecosystem of Huangyan Dao

#### 5 *Acropora verweyi*



*Acropora verweyi*, belonging to the genus *Acropora*, family Acroporidae, is listed as Class II protected wildlife in China and classified as Vulnerable on the IUCN Red List. Colonies are typically in branching, tree-shaped, finger-shaped, or bushy umbrella-shaped forms. The living corals are generally brown, cream, or light brown in color, with bright yellow axial corallites at the branch tips. In this investigation, *A. verweyi* was commonly found on upper reef slopes and reef flats in the reef areas of Huangyan Dao, especially on the upper-reef slopes with strong currents. Besides, *Acropora* corals are generally fast-growing and are vital reef builders, creating three-dimensional spaces for reef-dwelling life to inhabit and hide from predators. However, they are less tolerant of environmental changes and are susceptible to bleaching and mortality caused by marine heatwaves.

### III. Coral Reef Ecosystem of Huangyan Dao

#### 6 *Acropora abrotanoides*

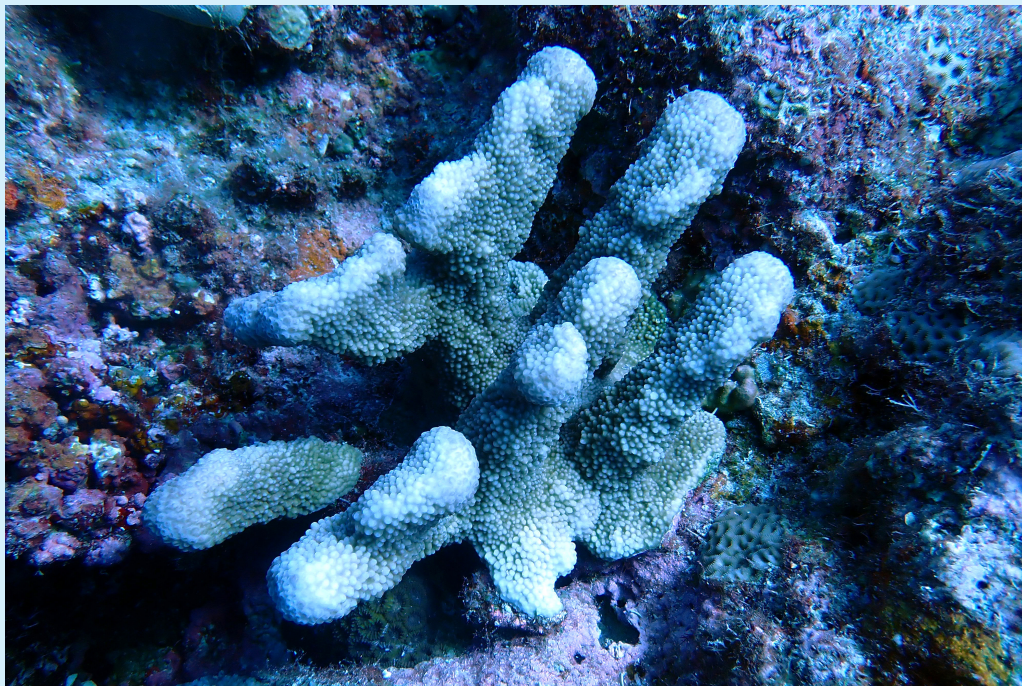


*Acropora abrotanoides*, belonging to the genus *Acropora*, family Acroporidae, is listed as Class II protected wildlife in China. Colonies typically grow into branching table-shaped or sub-branching tree-shaped forms. The branch diameter varies greatly. The stout main branches boast a base of up to 11 centimeters in diameter, normally extending horizontally with numerous short branches at the tips. The living colonies are mostly dark brown or gray-green in color. In this investigation, *A. abrotanoides* was commonly found in the shallow reef areas of Huangyan Dao, especially on the reef edges with strong waves.



### III. Coral Reef Ecosystem of Huangyan Dao

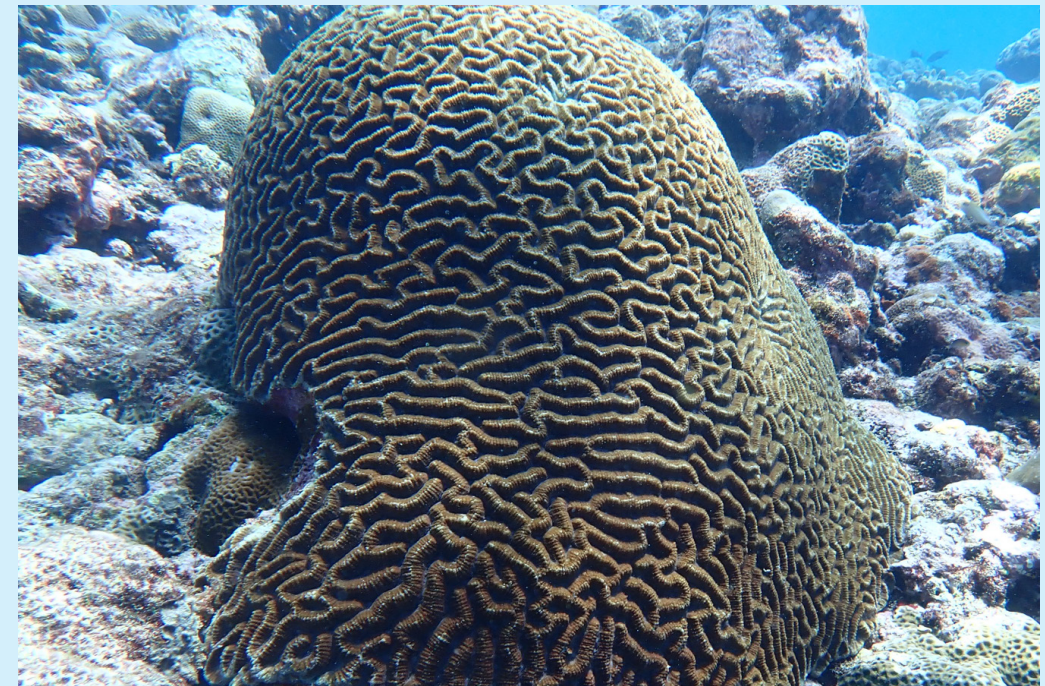
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*Isopora palifera*

*Isopora palifera*, belonging to the genus *Isopora*, family Acroporidae, is listed as Class II protected wildlife in China and classified as Near Threatened on the IUCN Red List. Colonies are composed of long wedge-shaped or blade-like branches, measuring 1.5 to 15 centimeters in length and 15 centimeters in height. The living colonies are generally cream or brown in color. In this investigation, *I. palifera* was commonly found in various coral reef habitats in the reef areas of Huangyan Dao, especially on the upper reef slopes and reef flats.

### III. Coral Reef Ecosystem of Huangyan Dao

8

*Lobophyllia radians*

*Lobophyllia radians*, belonging to the genus *Lobophyllia*, family Lobophylliidae, is listed as Class II protected wildlife in China. Colonies commonly grow into hemispherical or flattened massive, with straight and continuous radiating valleys. They may also have nearly hemispherical growth-forms with irregularly curved valleys, as well as flattened forms with long, straight valleys. The living colonies are generally green, gray, or brownish-yellow in color, with the mouth and corallite walls usually displaying different hues. *L. radians* was commonly found on the upper reef slopes and fringing reef.



### III. Coral Reef Ecosystem of Huangyan Dao

#### 2. Status of Key Coral Reef Ecology Communities

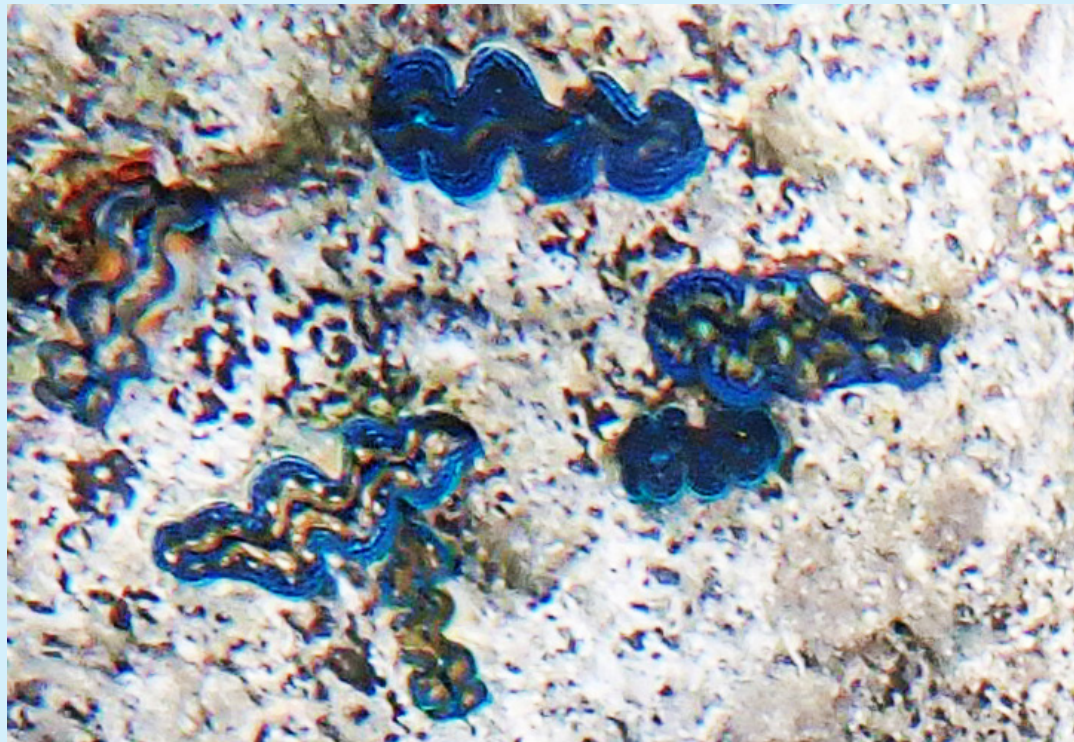
##### 1) Reef Fishes

Based on the Fish Belt Transect, a total of 125 fish species from 23 families were recorded, with an average density of 165 ind/100 m<sup>2</sup>. Aside from their economic value, reef fishes play crucial roles in ecosystems, influencing nutrient cycle and energy flow. They serve as important nutrition sources, as their excreta can promote primary productivity, enhance coral growth,

and adjust ecosystem nutrient balances. Reef fishes can also contribute to diagnosing, protecting and restoring degraded coral reefs by controlling lower trophic levels in the food web.

##### 2) Giant Clams

This investigation revealed a rich distribution of giant clams in the lagoon of Huangyan Dao, with an average density of 25 ind/100 m<sup>2</sup>. Giant clams, the largest marine bivalve inhabiting coral reefs, lives in a sessile form. It is listed as key protected



### III. Coral Reef Ecosystem of Huangyan Dao



Giant clams in the Lagoon of Huangyan Dao



### III. Coral Reef Ecosystem of Huangyan Dao

wildlife in China and included in the IUCN Red List. Similar to hard corals, Giant clams primarily relies on the photosynthates of symbionts to acquire nutrients for growth. Giant clams, as a reef-building organism, contributes to the formation and stabilization of coral reef frameworks, which is essential for supporting coral reef development and maintaining ecosystem balance.

**3) Crustose Coralline Algae**  
Crustose coralline algae are another important reef-building organisms. The crustose coralline algae cover was up to 23.5% in this investigation, which is 5.6% higher than that observed in 2015, indicating healthy development of coral reef ecosystems of Huangyan Dao. As an important resource for coral reef calcium carbonate production, crustose coralline algae



Crustose Coralline Algae of Huangyan Dao

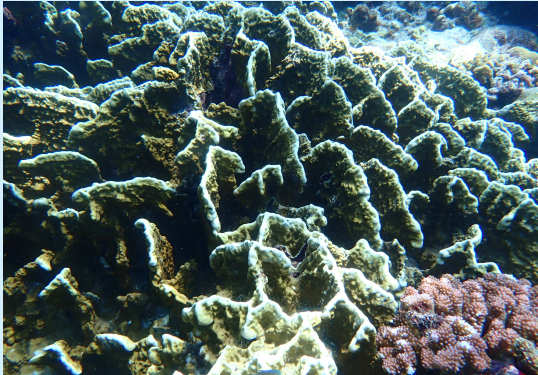
### III. Coral Reef Ecosystem of Huangyan Dao

can integrate carbonate sediments and reef components, filling gaps in the reef and thereby stabilizing its structure. Additionally, crustose coralline algae provide substrates which coral larvae are preferentially attaching to, facilitating the growth and restoration of coral reefs.

**4) Other Typical Benthic Communities**  
Fleshy macroalgae coverage in the coral reefs of Huangyan Dao remained relatively low (<1%) in this investigation. Fleshy macroalgae coexist with coral reefs while limiting mutual expansion. They can squeeze the living space of hard corals by dominating light, shading corals, and physical extrusion, which significantly



Blue coral



Fire coral



Sea anemone



Soft coral

Other Marine Benthos in the Coral Reefs of Huangyan Dao



### III. Coral Reef Ecosystem of Huangyan Dao

impact the survival, existence, breeding and recruitment of coral species. Therefore, the low coverage of fleshy macroalgae in this investigation also reflected a healthy coral reef ecosystem. The investigation also recorded blue coral, fire coral, sea anemone, soft coral and other coral reef ecological communities. These organisms are not only an important component of reef

biodiversity, but also a hot resource of the latest marine natural products and marine medicine. With diverse bioactive compounds, they have great potentials in the development of new drugs, cosmetics and healthy food. In addition, most blue corals and soft corals typically contain a large proportion of calcareous spicules, contributing to the deposition of calcium carbonate in coral reefs.

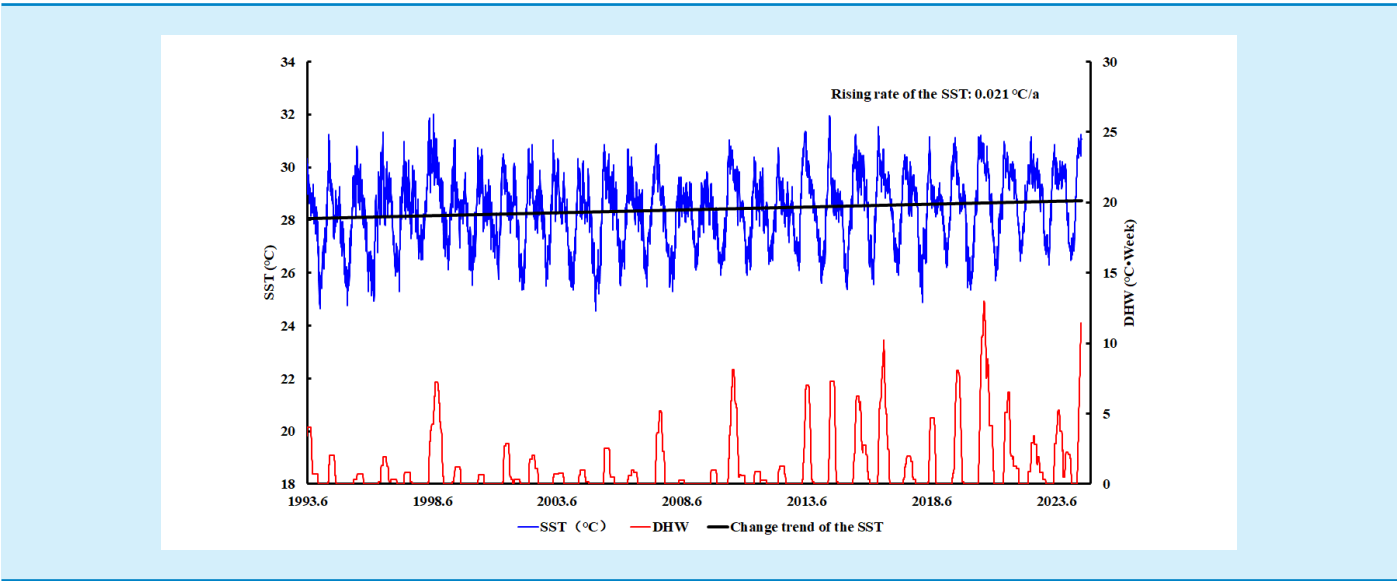
### III. Coral Reef Ecosystem of Huangyan Dao

#### 3. Major Pressure and Ecological Risks

##### 1) Heat Stress from Sea Temperature Rising

After decades of exploration, international scholars generally believe that global warming is the major reason behind the rapid degradation of coral reefs (coral bleaching) on a global scale. According to the investigation results, the bleaching of hard corals in Huangyan Dao remained a low level (<1%). No coral disease was identified, and recent coral

mortality rates also remain low (<1%). According to the satellite remote sensing result, the sea surface temperature (SST) and degree heating week (DHW) of Huangyan Dao waters have increased at an average speed of 0.021°C per year since 1993, and the waters faced high heat stress in 1998, 2010, 2014, 2016, and 2019-2020. This matched the timeline of the reported mass global coral bleaching events (1998, 2010, 2014-2017)<sup>2-3</sup>, suggesting that coral reefs of Huangyan Dao might have experienced the same



SST and DHW Variation Curve of Huangyan Dao (1993-2024)

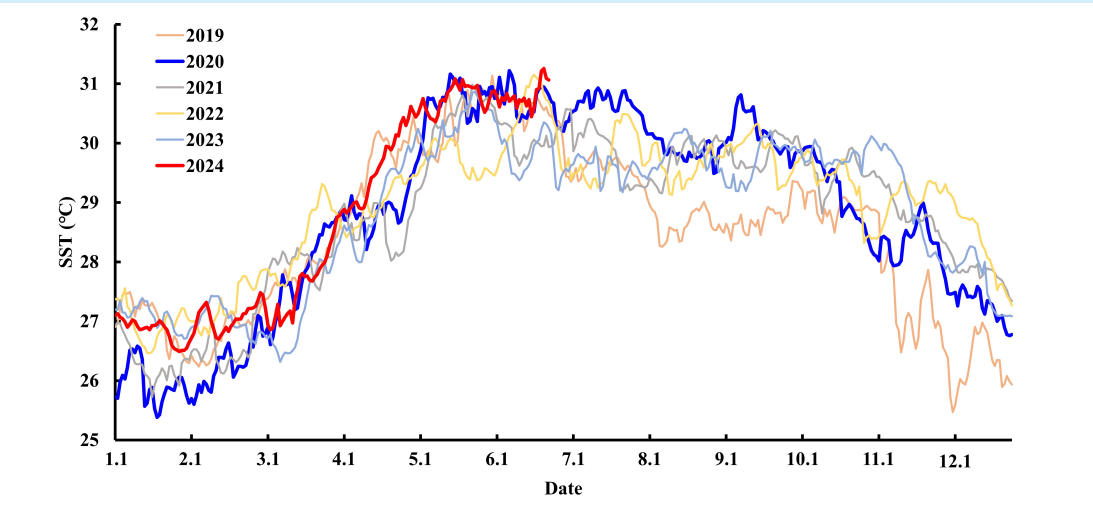
<sup>2</sup> Hughes TP, Kerry JT, Álvarez-Noriega M, et al. 2017. Global warming and recurrent mass bleaching of corals. *Nature*, 543: 373-377

<sup>3</sup> Reimer J, Peixoto R, Davies S, et al. 2024. The Fourth Global Coral Bleaching Event: Where do we go from here? *Coral Reefs*, <https://doi.org/10.1007/s00338-024-02504-w> (online first)

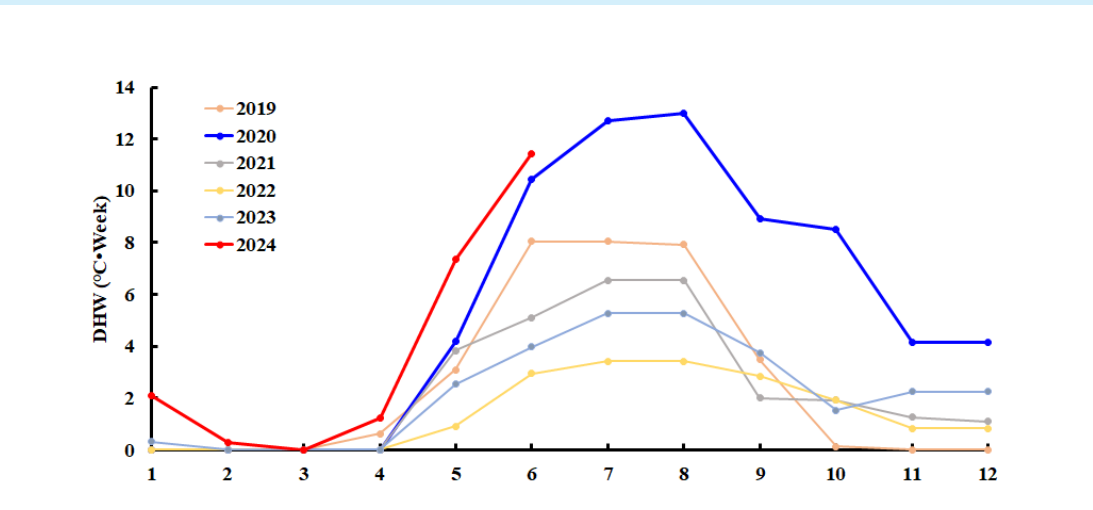
III. Coral Reef Ecosystem of Huangyan Dao

heatwaves. However, the relatively healthy status of the coral communities reflected their resistance and tolerance to global warming. The SST and DHW have risen remarkably since April this year

compared to previous years, indicating that the coral reef ecosystem might experience higher degree of heat stress in this summer compared to previous years.



Comparison of SST Daily Variation Curve of Huangyan Dao (2019-2024)



Comparison of DHW Monthly Variation Curve of Huangyan Dao (2019-2024)

III. Coral Reef Ecosystem of Huangyan Dao

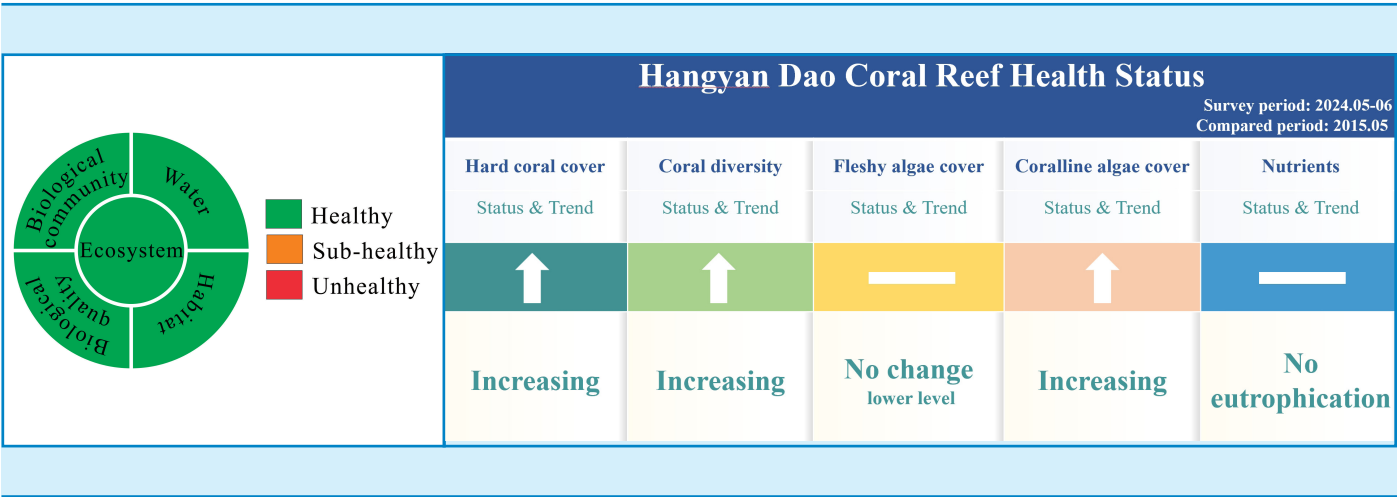
2) Risk of Predator Outbreaks

Crown-of-thorns starfish feeding mainly on hard corals, is one of the main predators of coral reef ecosystems. Each adult crown-of-thorns starfish can decimate hundreds of square centimeters of corals each day. The distribution of over 30 crown-of-thorns starfish per hectare can cause significant degradation of coral reefs. There was no evidence of crown-of-thorns starfish in this quantitative investigation, while only one small crown-of-thorns starfish (15 cm centimeters in size) was found in the qualitative inspection. Additionally, this investigation identified an obvious

increase of live coral cover compared to 2015, indicating a low risk of crown-of-thorns starfish outbreak and a limited influence of crown-of-thorns starfish on the coral reef ecosystems in Huangyan Dao.

4. Coral Reef Ecosystem Health Assessment

Based on the field investigation, a comprehensive assessment of seawater quality, marine biological quality, habitat status and biological community indicated that the coral reef ecosystem of Huangyan Dao was in healthy status. By reviewing the



Health Status and Trend of Coral Reef Ecosystem in Huangyan Dao



### III. Coral Reef Ecosystem of Huangyan Dao

historical data, a gradually upward trend was revealed in the status of coral reef ecosystem, and hard coral community developed well. The assessment using satellite remote sensing images indicated that the area of the coral reef has shown an overall increasing trend since 2012. Compared with the investigation in 2015, the live coral cover has increased, and another 45 species of hard corals were recorded. The coverage of fleshy macroalgae remained at a low level (<1%), and the coverage of crustose coralline algae increased by 5.6% compared to 2015. No eutrophication was identified in Huangyan Dao waters.

### III. Coral Reef Ecosystem of Huangyan Dao



A Glimpse of Beautiful Coral Reefs in Huangyan Dao



## Column. The History of Scientific Expedition of Huangyan Dao and its Adjacent Waters

Scientific researches and investigations on Huangyan Dao have been conducted for a long time in China. According to the researches of historians, in 1279, Guo Shoujing, a famous scientist in the Yuan Dynasty, carried out the “Measurement of the Nation (Si Hai Ce Yan)”, the measurement point in the South China Sea was Huangyan Dao.

During 1973 and 1978, researchers from the South China Sea Institute of Oceanography landed Huangyan Dao twice to carry out comprehensive investigations, covering marine geology, geomorphology, hydrology, meteorology, sedimentation, seawater chemistry, biology, *etc.* In 1980, the former Administration of Surveying and Mapping of China, the China Earthquake Administration and the State Oceanic Administration set up the South China Sea scientific exploration monument on Huangyan Dao. From 1983 to 1985, the former State Oceanic Administration conducted a comprehensive investigation of the central part of the South China Sea, covering the area around Huangyan Dao, which included hydrology, meteorology, marine environment, bio-ecology, substrate and acoustics.

Since 2011, the South China Sea Fisheries Research Institute has repeatedly conducted investigations on the fishery resources in waters around Huangyan Dao, and the South China Sea investigation Technology Center of the State Oceanic Administration, Sun Yat-sen University and other scientific research institutions have conducted numerous investigations on hydro-meteorology, geology and geomorphology of the waters surrounding Huangyan Dao.

From May to July 2015, the South China Sea Institute of Oceanography and Guangxi University, performed a more detailed investigation of the marine environment and coral reef ecology in the south-central waters of the South

## Column. The History of Scientific Expedition of Huangyan Dao and its Adjacent Waters

China Sea, which including Huangyan Dao.

From 2019 to 2021, South China Sea Institute of Oceanology launched a Comprehensive Scientific Expedition of Zhongsha Qundao, during which marine chemistry and bio-ecology investigations were carried out in Huangyan Dao area.

From May to June 2024, South China Institute of Environmental Sciences, National Marine Environmental Monitoring Center, Ecological and Environmental Monitoring and Research Center, Supervision and Management Bureau of Ecology and Environment for the Pearl River Watershed and South China Sea carried out a comprehensive investigation on the marine environmental quality and coral reefs ecosystem in Huangyan Dao area.



Column. The History of Scientific Expedition  
of Huangyan Dao and its Adjacent Waters



Comprehensive Scientific Expedition of Huangyan Dao in 1970s

Column. The History of Scientific Expedition  
of Huangyan Dao and its Adjacent Waters



Comprehensive Scientific Expedition of Huangyan Dao in 2015



Comprehensive Scientific Expedition of Zhongsha Qundao in 2019



## Column. The History of Scientific Expedition of Huangyan Dao and its Adjacent Waters



Ecology and Environment investigation of Huangyan Dao in 2024

## Explanations for Investigation and Assessment

*The Investigation and Assessment Report on the Ecological Environment of Huangyan Dao* is jointly compiled by South China Institute of Environmental Sciences, National Marine Environmental Monitoring Center, Ecological and Environmental Monitoring and Research Center, Supervision and Management Bureau of Ecology and Environment for the Pearl River Watershed and South China Sea, Guangxi Laboratory on the Study of Coral Reefs in South China Sea, Guangxi University, Key Laboratory of Tropical Marine Bio-resources and Ecology, South China Sea Institute of Oceanology, Chinese Academy of Sciences. For the marine environmental quality assessment, the following standards and specifications are followed: *Seawater Quality Standard (GB 3097-1997)*, *Marine Sediment Quality (GB18668-2002)*, *Technical Specification for Assessment of Seawater, Marine Sediment and Marine Biological Quality (HJ 1300-2023)*, and *Guideline for Risk Assessment of Commercial Marine Organism Quality (HY/T 128-2010)*.

The assessment of floating litter follows the *Technical Guide for Monitoring and Assessment of Marine Garbage (tentative) (Hai Huan Zi [2022] No. 13)*.

The assessment of coral reef ecosystem status follows the *Technical Guidelines for the Investigation and Assessment of Coastal Ecosystems, Part 5: Coral Reefs (T/CAOE 20.5-2020)* and references the assessment method of the *Global Coral Reef Monitoring Network (GCRMN)*.





