Review Article

Exploring the Vital Role of Coral Disease in Coral Reef Sustainability: A Comprehensive Analysis

Abstract:

Coral reefs are one of the most bio diverse ecosystems in the world. These are also regarded as one of the major productive ecosystem. The commonly reported threats to coral health include bleaching, over exploitation of fish stocks, destructive fishing and the rapid man-made development in the coastal areas. These environmental impacts have paved way to the emergence of coral disease. And now the coral diseases are emerging as one of the serious issue of coral reefs deterioration. Many new emerging coral diseases are being reported. Here the following diseases are described elaborately-Black band disease, White band disease, Aspergillosis, Dark spot disease, Stony coral disease, Pink line syndrome, Yellow band disease, Skeletal eroding diseases. These are the major diseases affecting corals across the globe.

Keywords: Coral reefs, scleratianians, zooxanthellae, Mortality, Causative organism

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1. Introduction:

Coral reefs are one of the most productive ecosystems on earth. They constitute a diverse variety of marine organisms. They provide shelter, food, and spawning ground for a wide range of marine organisms (Veron and Hoegh-Guldberg 2009). Coral reefs also play an important role in the protection of shorelines, regulation of carbon dioxide, and support of local and global economies through activities including fishing, recreation, and tourism (Asadi and Andrimida 2017). Coral reefs are distributed throughout the world tropics, even though distributed throughout world the total number of coral species were unknown. Most of the species were distributed in the area of South east Asia, Caribbean regions and Indo pacific regions. Also recorded in Artic, the Antarctic and the deep-sea region. In India 208 species of corals have been recorded, which includes 15 families and 60 genera. Gulf of Kachchh, Lakshadweep, Andaman and Nicobar Islands, Palk Bay and Gulf of Mannar are the major reef areas of India, among these, Andaman and Nicobar Islands are very rich in species diversity. Black band

disease, brown band disease and skeleton eroding band are easily diagnosed diseases on the reefs of Indian region (Venkataraman 2006). Coral diseases in the Indian coastal region are poorly documented and very minimal data is available about the prevalence, distribution, environmental interaction and the pathology of these diseases. Till now,systematic investigations of coral diseases have been conducted. The diseases are being diagnosed in the field by easily observable pathogens and symptoms (Sharma and Ravindran 2020). Coral reef communities are stated as 'disturbance-adapted' ecosystems (Hughes and Connell 1999). For the past 20 to 50 years, the coral reef population has been observed to be declining (Pandolfi et al 2003). The major contributing factor to the decline of coral reefs mainly includes the coral diseases that have been reported recently at an alarming rate. Both the biotic and abiotic factors affect coral health (Abdel-Salam et al 2014). The factors affecting coral health include water pollution, climate changes (Harvel el al 2002), and direct human-imposed stresses such as overfishing, the usage of destructive fishing methods and gears, and the proliferation of exotic species (Jackson et al 2001). These factors lead to worsening the health of the corals. Declining health results in disruption of the coral's normal microbial community or dysbiosis, allowing an increase in the number of primary and opportunistic pathogens (Egan and Gardiner 2016). These outbreaks will affect the coral abundance and diminish the reproductive potential . To date, only a few coral diseases have been characterized and reported in detail (Sharma and Ravindran 2020). The environmental impacts on corals are also not well defined. Most of the studies have been carried out on the identification of causative agents and disease etiology and pathology. Reports on coral disease from an ecological point of view are also scanty.

2. Types of diseases in coral

2.1 Black Band Disease

Black band disease is the first reported disease among coral diseases. It was reported by Antonius (1973) in the corals of Belize, western Carribean. Later, it was reported in gorgonians (soft corals) from the Indo-Pacific and now it is ecumenically distributed (Woodley et al 2016). Globally, 42 species of corals were affected by the black band disease (NOAA http://www.coral.noaa.gov/coral_disease/black_band.html). In particular, 19 species of scleractinians and 2 soft corals were affected along the Carribean coral reefs (Harvell, D et al 2007) . Black band disease is a condition that causes recent tissue loss and leaves a defined strip of pigmented tissue next to the exposed skeleton. They are primarily caused by the consortium of the micro-organisms dominated by Cyanobacteria (*Oscillatoria submembranaceae* also called

Phormidium corallyticum), Marine fungi, Sulfate-reducing bacteria (*Desulfo vibrio*) and Sulfide oxidizing bacteria (Beggiatoa)(as in table 1) (Richardson 1998).

The affected corals show a dark black band with a thickness of 0.5-1cm, present between the healthy coral tissue and exposed skeleton (in fig 1). within the black band, sulfide accumulates up to 800µm due to the sulfidogenesis process in the anoxic microenvironment at the base of the band leading to the destruction of the coral tissue. The disease progression is at the rate of 0.3-1cm per day and the whole colony can be killed in a span of months (Richardson 1998). Increased seawater temperature, high solar irradiance, seawater depth, anthropogenic wastes, and elevated nutrient inflow create favorable conditions for the microbes to cause disease in the corals(Harvell et al 2007).

2.2 White Band Disease

White-band disease (WBD) was first reported by Gladfelter in 1982. It is one of the coral diseases affecting primarily *Acropora cervicornis* and *Acropora palmata* (Gladfelter, 1982). It is a layer of diseased and necrotic tissue (in fig 1) that spreads rapidly from the base of the coral colony at a rate above 1cm per day(Antonius,1981). The syndrome has the existence of two forms, WBD type I and WBD type II. WBD type I occurs throughout the Caribbean and has an association with marine Rickettsia bacteria (Santavy and Peters,1997), While WBD type II occurs predominantly in the Bahamas and putative pathogen *Vibrio charcharii*(as in table 1)has been identified as associates. Type I is widespread throughout reefs of the western Atlantic and type II has only been observed in the Bahamas. Type I exhibits a disease line of active tissue necrosis in which coral tissue can be bleached but not necrotic, whereas type II has a variable zone between active tissue death and exposed coral skeleton (Williams and Bunkley-Williams,1990). Lesions of type II WBD are more frequently found to start at the tips or middle of the branches. The comparison between Tetracycline and Ampicillin treatment suggests that WBD type I is likelyby gram-positive bacteria and less likely by gram-negative bacteria. Gram-negative bacteria havebeen found within healthy and diseased tissue of both *A. cervicornis* and *A. palmata* colonies affected by WBD type I. WBD type II associated with an assortment of gram-negative bacteria always includes the bacterium *Vibrio charcharii*. Possible causal agents of WBD type I are identified using a range of molecular bacterial 16s rDNA techniques.

2.3 Aspergillosis

Aspergillosis is one of the best-characterized coral diseases, identified on the sea fans (gorgonians) of Caribbean and Florida Keys (Toledo-Hernández et al 2008). Nearly 10 species of

octacorals were found to be affected by aspergillosis(Antonius 1981) especially mass mortalities have been observed in the two species of gorgonians such as *Gorgonia ventalina* and *Gorgonia flabellum* (Rosenberg and Kushmaro 2011).The disease was named after the saprophytic terrestrial fungal pathogen *Aspergillosis sydowii,* (as in table 1)which emerged as the sea fungus as a result of the wind transport of dust from the African Sahara desert across the Atlantic or the terrestrial runoff. The deposited organic materials reducing the coral immunity, high quantum of nutrients and elevated temperature became favorable for the pathogens sequelling in increased incidence of the disease in Caribbean reefs (Woodly et al 2016). Aspergillosis is an infectious disease, that can be transmitted by physical contact between the healthy and infected colonies or by the water-borne infection of the hyphae or spores of the fungus from the infected corals (Toledo-Hernández et al 2008). Lesion progression shows Tissue loss patches on the blades surrounded by purple bands devoid of coral polyps and less density of zooxanthellae, tissue necrosis, gall-like structures, (due to the encapsulation of fungus in the cortex of the axial skeleton of the coral), and irregular outgrowths (in fig 1) are the symptoms of this disease (Gil-Agudelo and Garzón-Ferreira 2001). The impact of this disease on the Gorgonians includes partial to complete mortality of the colony and near-complete reproductive failure. The disease progress may stop for some period, when the condition becomes favorable it re-emerges establishing a deep infection within the skeleton (Woodly et al 2016).

2.4 Dark Spot Disease (DSD)

The Purple or brown lesions are defining features of the non-lethal, slowly developing condition known as "dark spots disease." It was first reported in Colombian reefs during the early 1990s. DSD affects numerous coral species and has been observed mainly on the massive corals *Siderastrea siderea, Montastraea annularis*, and *Stephanocoenia interrepta* (Gil-Agudelo and Garzón-Ferreira, 2001) It has been described as small, round, dark spots that grow in size overtime (in fig 1). Some can be associated with a depression of the coral surface and others expand into a ring surrounding dead coral. This disease might decrease the capability of corals spread. In fact, lesions as small as 1cm2 showed no regeneration of tissue during a period of several months.The spreading rate of the disease was prolonged. The average loss of tissue due to the action of DSD was 0.51cm2 per month for *S. siderea* and 1.33cm2 per month for *M. Annularis* (Gil- Agudelo et al,2004). It is not clear if disease signs are present in all species or the result of the same pathogen or whether different disease exhibits similar sign in different coral species.

2.5 Yellow Band Disease

Yellow band disease (YBD), commonly referred to as yellow blotch disease, is one of the most prevalent diseases in the Caribbean. YBD was first noted off the coast of the Florida Keys in 1994 and has since been reported for the *Orbicella annularis* species(in table 1) (Reeves, 1994). It first affects the tissue at the centre of the blotch, becomes darker yellow or brown, and eventually dies, with the remaining affected tissue forming a characteristic circular band of pale yellow tissue 1 to 3cm wide (in fig 1). Disease severity increased over time, due to the appearance of multiple lesions and individual colonies that coalesced with other lesions progressively radiated outward. YBD is characterized by a 1-5cm wide, yellow to white, circular band that radiates outwards. The band has been recorded to spread out 0.6cm per month. Blotches progressively increased in diameter from a few cm up to 15cm. Corvine et al (2004) identified four Vibrio sp. As the putative causative agents for YBD using traditional isolation and culturing techniques(Cervino et.al , 2001). Vibrio-induced diseases such as YBD-infected corals, result in destruction of the symbiotic algae in the animal gastroderm but thermal bleaching where symbiotic algae are released from the tissues of the corals during stress. In the case of vibrio- induced bleaching of *Oculina patagonica*, a prolines-rich P toxin is released by increasing sea water temperature, leading to Zooxanthellaelysis and death. *Montastrae aannularis* colonies are infected more frequently, fewest infections observed in *M. franksi.* Mostly this disease is prevalent in remote locations with a low degree of nutrient pollution, including offshore locations with high clarity and areas removed from the human population(Bruckner and Bruckner , 2003). It is commonly confused with thermal bleaching owing to the paling and coloration changes.

2.6 Skeleton Eroding Band

Majority of the coral diseases appeared to be caused by bacterial pathogens but skeleton eroding band disease is the first reported eukaryotic protozoan disease. For the first time, it was noted on the coral reefs around Motupore Island, Papua New Guinea in 1988 (Moriarty et al 2020) and later it was reported from the Red Sea, Gulf of Aqaba, Great Barrier Reef, Mauritius, and Sinai, and also the Caribbean reefs and now it shows a global distribution. It was recorded in 82 species of scleractinian corals representing 22 genera and 12 families as well as the hydrozoan genus. Millepora, Pocilloporidae, and Acrporidae are the most commonly affected sclerectinian corals (Moriarty et al 2020). *Halofolliculina coralasia*,(mentioned in table 1) a species of folliculinid,

heterotrich ciliate is reported to be the responsible pathogen (Moriarty et al 2020). These sessile folliculinid protists secrete a bottle-like housing called lorica (black test), with two ciliated pericytosomeal lobules that help to feed by extending out, in most cases, the neck of the lorica rises above the surface of the corals. The lorica is found to be embedded in the trabecular limestone skeleton of the corals and break it into splinters by the ciliates. A maximum of 417 individuals of ciliates have been reported (Antonius and Lipscomb 2000). Cell division in the ciliates gives rise to larvae secreting new lorica, the dense aggregation of the lorica resulting in the appearance of a black band separating the diseased tissue (in fig 1) from a healthy tissue. The organic acid of the new lorica in combination with the rapid spinning of the larvae totally destroys the outer layer of the coral exposing the skeleton (Antonius and Lipscomb 2000).The black band appears to be similar to the band caused by the black band disease. The difference is that the exposed skeleton is dotted with empty lorica giving a dirty appearance on the surface. The growth of the band is at the rate of 1mm per week to 1mm per day (Antonius and Lipscomb 2000).

2.7 Pink Line Syndrome:

Pink line syndrome (PLS) is one of the most commonly reported coral diseases in the Papua New Guinea region and the Indian Ocean. It is mainly reported in the two corals species namely, *Porites lutea* and *Porites compressa* (Woodley et al 2016). The pink-line syndrome is also called a “pigmentation response” and “hyper-pigmented irritations” (Winkler et al 2004). Pink-line syndrome (PLS) was first observed in 1996, affecting the hard coral, *Porites lutea* at Lakshadweep Islands in the Arabian Sea and it was first characterized in 2014 (Raymund et al 2008).The affected corals are characterized grossly by the pink band of 3-10 mm appearing between the healthy and dead tissues (in fig 1) on the polyp (Woodley et al 2016). It leads to the weakening of the coral skeleton and they become fragile (Antonius 1981). Around the dead patches of corals, fungi, *Curvularia lunata*, and bacterial mat of cyanobacteria, *Phormidium valderianum* could be seen (Ravindran and Raghukumar 2002) and they release toxins and lead to competition for dissolved oxygen, ultimately resulting in the expulsion of zooxanthellae (as in table 1)(Ravindran and Raghukumar 2002). This cyanobacterium is a common blue-green alga in seawaters, backwaters, and salt pans. It is reported that the prevalence of this disease is higher in the summer than the post-monsoon which indicates that the rise in seawater temperature may facilitate the disease occurrence (Ravindran and Raghukumar 2002). The water temperature

plays a crucial role in the occurrence of this disease.So, PLS-associated coral tissue lysis is aided by both the cyanobacteria and environmental stressors. The presence of cyanobacteria is the trigger of this disease (Woodley et al 2016). Cyanobacterial mats act as a poison for scleractinian corals and deemed to have the probability of killing live coral tissue. Corals can't easily recover from infection with cyanobacteria. It was concluded that the PLS type of disease need not have to be caused by specific pathogens. Any opportunistic cyanobacteria or other agents have the potential to interfere with the host.

2.8 Porites Ulcerative White Spot:

Porites ulcerative white spot (PUWS) is one of the common coral reef diseases in Indo-Pacific region and it is mainly reported in Porites spp. Most commonly species like *P. australiensis, P. lobata, P. lutea*, and *P. solida* were highly susceptible to this disease. This disease was first reported in 1996 in the Philippines (Ravindran and Raghukumar 2002). The main features that is used to identify PUWS are discrete, bleached, round foci, which may either reduce or spreads to full tissue ulceration (in fig 1) and finally result in mortality of the colony (Richardson and Kuta 2003).. The affected coral appears as small bleaching lesions affecting a few polyps and these lesions may result in mortality. Vibrio spp. Is the main causative agent in PUWS and vibrio spp have predominant occurrence in seawater laden with high organic load (Meyer el al 2019). The specific species and strain of Vibrio that cause this coral disease are still left unknown. Also, the surrounding environmental factors greatly influence the spreading of this disease. Research is being continued to identify the causative species.

2.9 Stony Coral Tissue Loss Disease:

Stony coral tissue loss disease (SCTLD) is a atypical white plague that infect the coral reefs throughout the world. It spreads rapidly and cause mortality in the corals. Rapid spreading and high mortality rate have led to significant decreases in overall coral population, coral and its biodiversity. SCTLD represents the most lethal coral disease that increase and worsens the white disease outbreaks (Asadi et al 2019). It was first documented in the USA (Florida) Caribbean in 2014(Asadi et al 2019). It is mainly reported in large groups of scleractinian corals.SCTLD-affected corals rendering the appearance as Acute, Sub-Acute, or Chronic tissue loss lesions (in fig 1) that spread rapidly throughout the colony, and leave the skeleton exposed. Some species also have bleached tissues (Moriarty et al 2020). The causative agent responsible are still

unknown. Recent findings reports that bacterial species of Flavobacteriales, Rhodobacterales, and Rhizobiales(mentioned in table 1) play a vital role in SCTLD (Precht et al 2016). The factors that lead to increases in coral disease outbreaks include increasing thermal stress and frequency of warm temperature. SCTLD spread through direct contact, vector-borne, and through water column (Aeby et al 2019). Till date, there are no diagnostic tools to identify SCTLD making it difficult to determine if all impacted species are suffering (Landsberg et al 2020).

3. Seasonal changes that leads to the emergence of disease in corals:

Nearly one-third of reef-building corals have been facing rapid extinction risk from climate change and other impacts (Carpenter et al. 2008). The most important environmental factor that have a greater impact on declining coral health include: increasing ocean temperature (Harvell et al. 2002), nutrient pollution (Bruno et al. 2003), and over-fishing (Jackson et al. 2001).All the environmental factors that changes seasonally will affect the coral health that increase the chances of disease emergence in the reef ecosystem.

3.1 Water temperature and salinity:

When the temperatures rises in the ocean (increased up to ~30–32 °C), zooxanthella often get detached from corals due to thermal stress caused leading to coral bleaching. Coral bleaching even happens when reactive oxygen species rise due to environmental stress, which ultimately leads to coral death (Gegner et al 2017). A most widespread threat to reef ecosystem is coral bleaching. Some other studies also covered how water temperature can affect coral metabolism.Exposure of corals to high temperature (30 °C) and low salinity (20 psu) leads to stress response, resulting in the bleaching and even death (Glynn et al 1990). Corals are narrow salt tolerant organism,so change in salinity will adversely affect their health and immunity that pave ways for the emergence of diseases (Fitt 2001).

3.2 Water Depth;

Depth is one of the determining factor for coral diseases. In case of Black Band disease, it is caused by a microbial consortium that uses light (Rützler et al., 1983), so that the disease is most common in shallow waters (Antonius, 1981). In the White Plague also the correlation between disease prevalence and water depth has been reported. So water depth is also one of the environment for that affects the coral reefs.

3.3 Rainfall and runoffs:

Declining water quality combined with the effects of climate change are rapidly increasing coral

diseases on reefs worldwide. Rainfall and associated runoff increses the chances seasonal disease outbreaks, by reducing host fitness or by increasing pathogen virulence due to higher availability of nutrients and organic matter. Rainfall and seawater temperatures are increasing due to climate change which lead to decreased health of corals.(Haapkylä et al 2011)

4. Coral diseases in Indian reef ecosystem:

Coral reefs are one of the important ecosystem in Indian waters. The total area of reefs in India is 2,375 km2 (Venkataraman 2007).In Indian waters, the coral reef populations are restrictedly distributed in regions of Gulf of Kutch, Lakshwadeep, Gulf of mannar and Andaman and Nicobar (Sharma and Ravindran 2020). The most commonly found coral species in Indian reefs are Porites sp. and Acropora sp (Chakkaravarthy and Raghunathan 2011). These species of corals are severely affected by various diseases. On overall, 14 different coral diseases have been reported from the Indian coral reefs most of the diseases were common to all regions (Sharma and Ravindran 2020). These includes white band disease, white plague, white pox, patchy necrosis, black band disease, yellow spot or blotch, yellow bamd disease, brown band disease, porites ulcerative syndrome, white spot disease, red plaque syndrome, pink line syndrome, pink spot disease, pink blue disease (Sharma and Ravindran 2020). In Gulf of Mannar, about 11 coral diseases have been reported (Kumaraguru et al 2005).The major drawback is that the coral diseases of the Indian coastal regions are poorly documented and there are no sufficient investigational studies about prevalence, distribution, environmental interaction and the pathology of these diseases.The environmental stress factors such as water pollution (Mitchell and Chet, 1975; Szmant, 2002), warming temperature, decrease in salinity, sea level rise, subsequent changes in ocean circulation (Harvell et al., 2002, Bruno et al., 2007) and over-fishing are responsible for the increase in prevalence of coral disease along with the natural processes including siltation, soil erosion, quarrying corals from the shore and reefs, and sponge attack are factors that leads to increasing susceptibility of corals to pathogens.

In recent years, Corals in the Lakshadweep coast on the Arabian Sea as well as those along the eastern coast of India on the Bay of Bengal are experiencing bleaching. Till to date Lakshadweep islands are the only one reporting widespread bleaching especially in three locations of the Kavaratti island and neighbouring atolls. The bleaching is very higher than that of 2015-2016. The shallow lagoons of these region often host monospecific stands of certain species like *Acropora muricata* and *Porites cylindrical* that are temperature sensitive and also facing lots

of bleaching problem. The bleaching has been extended to the hard corals as well as the soft corals. Also the more stress-tolerant species, such as *Porites lutea* and *Pavona varians* have also begun to bleach.

The ongoing bleaching has been declared as the fourth global mass coral bleaching experienced by the world. Global mass coral bleaching events have been reported in 1998, 2010, 2014 and 2017, according to the United States National Oceanic and Atmospheric Administration.

Since 2023, mass bleaching in coral reefs have been reported in more than 50 areas of the world. However, the high ocean temperatures and El Nino since April 15, 2024 had increased the coral bleaching area and threatening the corals. The current El Nino event is one of the primary contributors to the increased sea surface temperatures, that triggers coral bleaching. The high temperatures of water disturb the symbiosis between corals and zooxanthellae The algae, once separated, make the corals look pale. The corals will never recover from bleaching but long-term bleaching can lead to mass mortality, making them unable to recover.

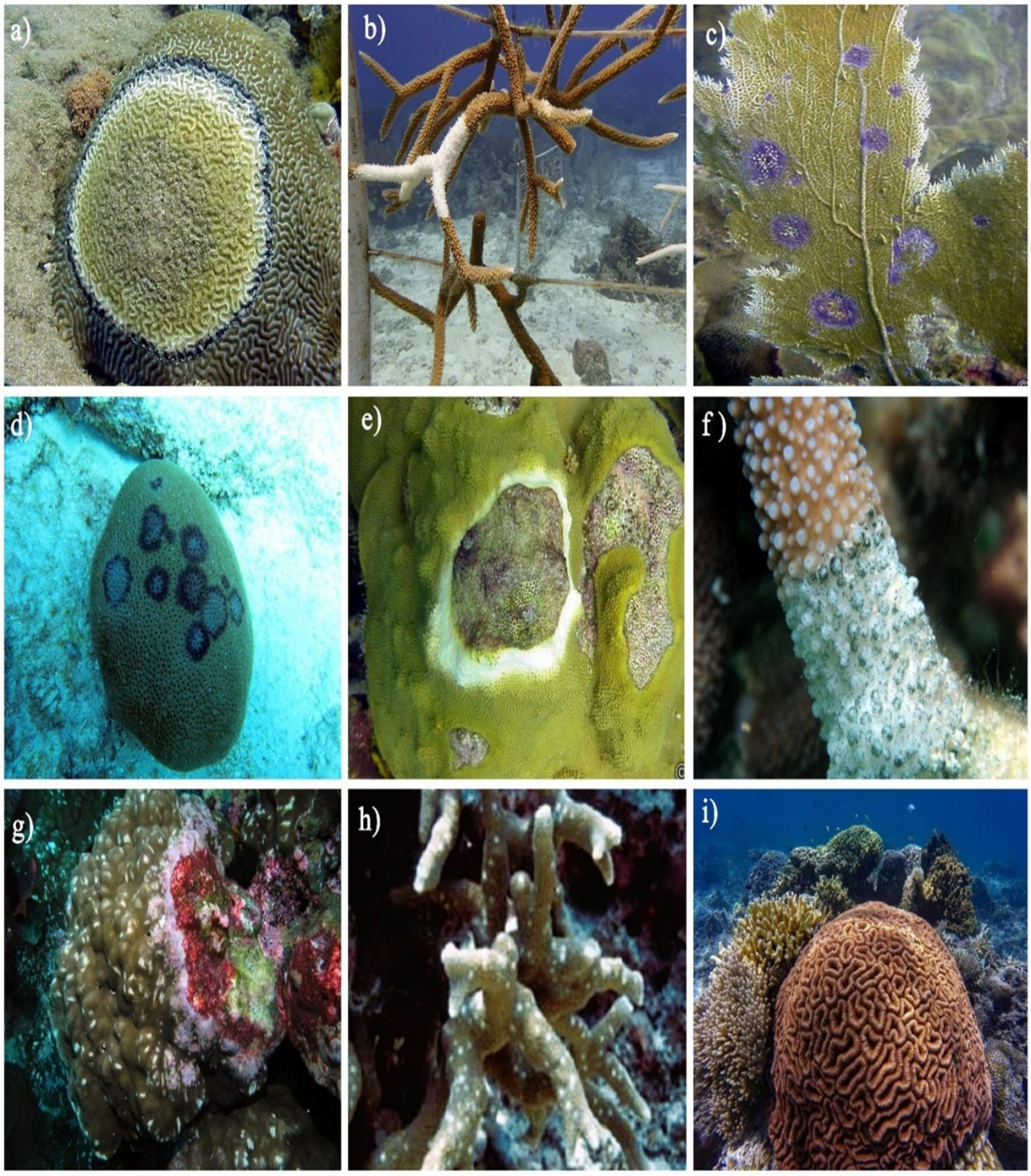

Figure1: Common coral reef diseases. a) Black band disease; b) White band disease; c) Aspergillosis; d) Dark spot disease; e) Yellow band disease; f) Skeleton eroding band; g) Pink line syndrome; h) Porites ulcerative white spot; i) Stony coral tissue loss disease.

Table 1: List of coral diseases, distribution and distinguishing feature

Disease name	First characterized	Distribution	Pathogen and causation	Distinguishing features	Affects which species?
Black Band Disease	1973	Western Caribbean	Cyanobacteria (*Oscillatoria submembranaceae),* Marine fungus, Sulfate reducing bacteria *(Desulfo vibrio)* and Sulfide oxidising bacteria (Beggiatoa)	causes recent tissue loss and leaves a defined strip of pigmented tissue next to the exposed skeleton	Sclerectinian
White Band Disease	1982	Caribbean	*Rickettsia* bacteria, *Vibrio charcharii*	Type I exhibits a disease line of active tissue necrosis in which coral tissue can be bleached but not necrotic. Type II has a variable zone between active tissue death and exposed coral skeleton	*Acropora Cervicornis* And *Acropora Palmate*

Aspergillosis	1995	Caribbean and Florida	fungal pathogen *Aspergillosis sydowii*,	Lesion progression showing Tissue loss patches on the blades surrounded by purple band devoid of coral polyps, polyps and less density of zooxanthellae, tissue necrosis, gall like structures	*Gorgonia ventalina* and *Gorgonia flabellum*
Dark Spot Disease (Dsd)	Early 1990	Colombia		Small, round, dark spots that apparently grow in size overtime.	*Siderastrea siderea*, *Montastraea Annularis* and *Stephanocoenia interrepta*
Yellow Band Disease	1994	Florida	*Vibrio* sp.	It first affects the tissue at centre of the blotch, became darker yellow or brown eventually died, with remaining affected tissue forming a	*Montastraea annularis*, *M. franksi*

				characteristics circular band of pale yellow tissue 1 to 3cm wide.	
Skeleton Eroding Band	1988	Motupore Island, Papua New Guinea	*Halofolliculina coralasia*,	Exposed skeleton is dotted with empty lorica giving a dirty appearance on the surface	Millepora, Pocilloporidae and Acrporidae
Pink Line Syndrome	1996	Papua New Guinea region and Indian Ocean	Fungi, *Curvularia lunata* and bacterial mat of cyanobacteria, *Phormidium valderianum*	The pink band of 3-10 mm appears between the healthy and dead tissues on the polyp	*Porites lutea* and *Porites compressa*
Porites Ulcerative White Spot	1996	Indo-pacific region	*Vibrio* spp	Small bleaching lesions affecting a few polyps and these lesions may result in the mortality	*P.australiensis*, *P.lobata*, *P. lutea* and *P. solida*
Stony Coral Tissue Loss Disease	2014	USA (Florida) Caribbean	Flavobacteriales, Rhodobacterales and Rhizobiales	Acute, Sub-Acute, or Chronic tissue loss lesions that spread rapidly throughout the colony, leaves	Scleractinian corals.

				skeleton exposed.	

Conclusion:

Coral diseases have become the major serious threats challenging the coral reef ecosystem's resilience. As a summary of what is currently known about coral diseases, changing environmental factors and prevailing anthropogenic activities have a greater impact on the outbreak of diseases in corals, resulting in the declining coral reef population. Also, very little data about these diseases and their ecological impact have been reported. There is a necessity to conduct more studies and research to know about their impacts. Also measures to conserve these declining corals and coral restoration should be carried out actively to protect this coral ecosystem. Also the pollution causes decline in the coral population. So proper management action should be taken to reduce the pollution and to protect the coral population. Avoiding active fishing gears usage, destructive fishing in the coral stretches are one of the effective measure to sustain and restore the coral reefs. Also the better management includes the inclusion of coral reef areas in the marine protected areas or fishing restricted areas. Also satellite signals can also be used to analyse the growth and distribution of coral reefs.

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