

**CALIFORNIA PROFESSIONAL
DIVERS ASSOCIATION...BMP COMMITTEE**



**DIVERS HULL CLEANING
BEST MANAGEMENT PRACTICES
CERTIFICATION MANUAL**

**TYPES OF FOULING GROWTH
FLORA AND FAUNA
FOULING PROGRESSION**

**FLORA AND FAUNA
AND
FOULING AND FOULING PROGRESSION OBJECTIVES**

1. Have a basic understanding of three classifications of Algae.
2. Be able to distinguish between the two groups of flora and fauna.
3. Know the four stages of fouling progression.
4. Be able to describe the factors affecting fouling progression

THE FLORA AND FAUNA OF HULL CLEANING

During a typical workday, a diver encounters many forms of sea life that affect his job. Having first hand knowledge of these organisms is not only good to know for your own benefit, but also is helpful when speaking with customers, explaining the hull conditions, or for filling out work orders. Since there are thousands of sea life forms, only those affecting hull cleaning will be discussed. These can be broken into two groups; algae and sea animals.

ALGAE

Algae are plants that are without vessels and use photosynthesis for food production. There are three classifications for algae, all of which we encounter. These three are known as the Chlorophytes, Phaeophytes, and Rhodophytes - or - *green, brown and red algae*. All algae live in the part of the ocean called the "photic zone." This is the area of the ocean that receives sunlight. These algae attach themselves to the hull with a "holdfast." These holdfasts are not roots for nutrition but for physical support. As the algae grow, the holdfasts dig deeper into the paint causing the quality to degrade quickly.

CHLOROPHYTES- Green Algae require the most amount of sunlight to grow. This is why you will usually see it grow in areas that are well lit with sunlight. They lack a special pigment, so they must be in full light in order to produce photosynthesis.

PHAEOPHYTES- Brown Algae are higher evolved algae. Due to a special pigment, they can utilize lesser amounts of sunlight for photosynthesis. This is why you find brown algae at all levels of a boat, from the waterline to the keel.

RHODOPHYTES- Red Algae are the most evolved algae and can utilize extremely small amounts of light. The protein that allows this is phycobilin. Red algae have been discovered at depths of up to 879 feet. The red alga that concerns hull cleaning is called Lithophyllum (Greek for stony leaf). Lithophyllum is an algaE that is able to deposit calcium within its tissues, causing it to be extremely hard. A scraper or steel wool is always required to effectively remove these algae.

SEA ANIMALS

The sea animals we encounter are simple multi-cellular organisms. Although relatively unintelligent, they still pose as a formidable obstacle towards a clean hull. The two that affect hull cleaning the most are the Polychaeta and the Tunicate.

POLYCHAETA - Probably everyone's least favorite is the Polychaeta, also known as coral worm. Polychaeta are tenacious animals and like the Rhodophyte algae, use calcium from the ocean. However, they do not use it for their tissue, but to form calcareous tubes in which they dwell. These tubes can attach deeply to a hull rather quickly causing rapid degradation of paint integrity.

TUNICATE - Tunicates, or sea squirts, are the semi-clear sponge like organisms that usually occupy areas around struts, under trim tabs, and especially inside out drive mechanisms. If you pick one off and feel it, you will notice its extremely tough outer cover. This "tunic" is how the Tunicate got its name. If you look closer you'll see its two openings and a digestive tract. Tunicates can populate large areas of a hull over a period of time. Since there are so many organisms that affect hull cleaning, these were only the basics. Hopefully you have gained a better understanding of the life that you encounter in our ocean.

MARINE FOULING

Fouling refers to the growth of various marine organisms on submerged surfaces. Fouling organisms commonly found in marinas include the tube-building polychaete worms or “tube worms,” encrusting bryozoans or “moss animals,” algae, small sponges, tunicates, barnacles, and other sessile organisms (Johnston, 1990). Fouling can be seen on any surface that has been submerged in marina waters for 10 days or more, and can grow to a substantial bulk if left undisturbed for a prolonged period of time.

FOULING PROGRESSION

Fouling appears to follow a progression of colonization on submerged surfaces. According to Wahl (1989), from whom the following description is taken, this fouling progression is characterized by four fairly distinguishable phases: 1) biochemical adsorption; 2) bacterial colonization; 3) unicellular eukaryotic colonization; and 4) multi-cellular eukaryotic colonization.

BIOCHEMICAL ADSORPTION

Biochemical conditioning begins as soon as surface is submerged. Dissolved chemical compounds (primarily glycoproteins, proteoglycans, and polysaccharides) in the seawater are electrochemically attracted to the newly introduced surface. Adsorption of their compounds reaches equilibrium about 1 hour after emersion of the surface, at which time bacterial colonization begins (Wahl, 1989).

BACTERIAL COLONIZATION

Bacterial colonization takes place over a period of days and is best described by looking at the process by which a single bacterium colonized the surface. The physical forces of currents and turbulence bring the colonizing cell very near the surface to be colonized, Brownian motion and micro turbulence move the cell closer still to the surface. At this point, both the surface of the cell and the macromolecules covering the submerged surface are negatively charged and tend to repel each other. The cell then produces fibrils that attach to the biochemically-conditioned surface and pull the cell in, allowing it to attach firmly and begin to proliferate. This phase will not attain an equilibrium, due primarily to the transitory nature of bacterial populations (Wahl, 1989).

UNICELLULAR EUKARYOTIC COLONIZATION

Unicellular eukaryotic colonization begins several days after immersion and involves colonization by unicellular eucaryotics such as yeasts, protozoa, and diatoms, with diatoms being the dominant colonists and having the greatest subsequent impact on the submerged surface. These unicellular eucaryotics, their bacterial counterparts from the previous phase, along with all of the secretions and decay materials produced, comprise the slime layer or primary film that covers virtually every exposed surface in the sea (Wahl, 1989).

MULTICELLULAR EUKARYOTIC COLONIZATION

The settlement of multicellular organisms on the submerged surface comprises the fourth phase of the fouling progression. Depending on the biological activity of the water around the submerged surface, macro fouling can begin as early as several days up to weeks after immersion. At this stage, the surface will usually be supporting a well-differentiated micro biotic community with a three-dimensional structure. Upon this base, mesoplanktonic larvae and algal spores begin to settle. This process overlaps with continued recruitment and evolution of the micro fouling community.

REFERENCES

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2. www.cerarna-tech-int.com/in
3. www.yachtpaint.com/USA/userguide
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5. Port Supply Catalog, 2000
6. Powerboat Reports, April 1992

FLORA AND FAUNA, FOULING PROGRESSION QUESTIONS

1. **Chlorophytes flourish in deep cold water.**
TRUE or FALSE
2. **Rhodophytes are highly evolved and grow in depths of 800 feet.**
TRUE or FALSE
3. **Phaeophytes possess a special pigment requiring less sunlight for photosynthesis than Chlorophytes.**
TRUE or FALSE
4. **List three (3) characteristics of the Polychaeta worm.**
5. **Which end of the truncate attaches to a fixed object?**
6. **Tunicates have two siphons. What are their names?**
7. **List the four (4) stages of fouling progression, in order.**
 - 1.
 - 2.
 - 3.
 - 4.
8. **Biochemical adsorption begins:**
 - a. within two hours of submersion
 - b. within five months of submersion
 - c. immediately after submersion
 - d. only occurs in a controlled environment
 - e. both c. and d.
9. **The process of bacterial colonization refers to the phase in which the organism(s) attach to a submerged object.**
TRUE or FALSE
10. **A three dimensional fouling structure is present in which stage of fouling progression?**