COMPLIMENTARY

Instant Ocean®

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Advancing the Hobby of the Marine Aquarist

SeaScope is back by popular demand—with the same information-packed issues coveted by marine aquarists everywhere since 1983. Each newsletter brings you a variety of topical articles, including reviews, product information, practical ideas, important case studies, and interesting points of view—all to keep you in the know and at the forefront of the marine hobby. ***Instant Ocean****, the world's most widely used aquarium sea salt for more than 40 years, is proud to sponsor the SeaScope series. We hope you enjoy this issue, and we welcome your comments and input.*

Microbial Balance in Natural Aquaria

By Bob Goemans, author, speaker, and marine aquatics consultant

Most marine aquarists today credit Lee Chin Eng, a businessman and hobbyist living in Indonesia during the late 1950s and early 1960s, with the creation of the first all-natural system. He called it "Nature's System," since it used sunlight and local unfiltered seawater, ocean sand, live rock, invertebrates, plants, and fishes. Its water circulation came from rising air bubbles escaping from airstones and open-ended air hoses. Live rock had sponges and any other unsustainable animal or plant matter removed before it was placed in his aquarium. He also carefully controlled its bioload, so system-incoming nutrients such as foodstuffs and animal waste would not, he hoped, exceed the processing capacity of its internal bacteria. Today we refer to that balanced approach as *equilibrium*—a state of balance between interacting or opposing energies that results in an energy-efficient environment. Nevertheless, I find many in the hobby thinking of balance/equilibrium as more an illustrative issue, as they want their slice of the ocean to depict a vision of an actual area in the wild.

Tangs in a natural grazing environment.

In fact, such was the case about 100 years prior to Eng's aquarium, when a *balanced* aquarium was thought of as an enclosure containing visible substances in proportions that would equal those found in the wild. Therefore, with the proper choices of sand, rock, and plants, the enclosure could then represent the local conditions where its animals originated. Unfortunately during these early aquarium-keeping decades, many attempts at natural systems failed because ongoing maintenance depended on plants to remove some of the toxic results of animal wastes and water changes.

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Invertebrates thrive with a focus on natural balance.

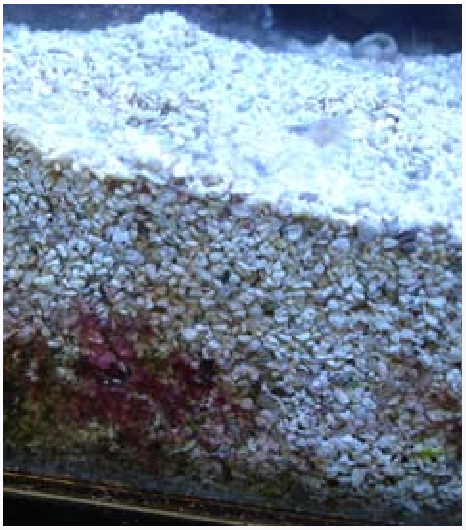
Sadly, Eng's system was considered too chancy, because there was no visible "filtering" equipment. Those who did try it, failed because they did not properly prepare the live rock or they simply exceeded the system's natural biological carrying capacity. As mentioned earlier, equilibrium is often thought of more as an illustrative issue than as a filtration process. And to confuse the issue further, many people understand the word filtration differently! To me it is what protein skimmers and activated carbon accomplish—they filter out or remove elements and compounds from the bulk water. On the other hand, bacteria use metabolism to transform elements and compounds into energy for reproduction and other forms of elements or compounds—some desirable, some not. It is these microbes that are Mother Nature's frontline troops in maintaining a healthy and balanced environment. And since there are various microbial processes that normally dwell in the aquarium, it's important to understand their significance. In fact, it could be said that bacteria are the true foundation of every aquarium system. How well they function depends on the aquarium keeper's knowledge of their existence and requirements.

As for aquarium equilibrium or balance, it has nothing to do with equal sums or the replication of organisms found in the wild. To be truly successful, aquarium water quality is the key issue needing our full attention. And in what are termed *Natural Aquaria*, where more emphasis is placed upon natural filtration methods, the water's microbial foundation should contain the correct proportions or volumes of certain microbial processes that adequately use the incoming energy and nutrients so accumulation does not occur. Simply, this means that what goes into the system in the way of energy—which includes food, animal wastes, water, and light—should be used totally, so that no leftovers from all processes accumulate in the bulk water or substrate. Easier to say than to achieve, of course, and I doubt most closed systems could ever attain that goal. Yet we should be aware of some thoughts on how possibly to move in that direction.

To do so, it is helpful to look back to the mid-80s, when the reef hobby blossomed. That's actually when more attention began to be paid to nitrate accumulation. A few years later, the Berlin method came about and utilized live rock and efficient protein skimming to help lower nitrate concentrations. That was a major stepping stone in the field of aquarium husbandry. A few years later, an intriguing technique to reduce nitrates—devised by Dr. Jean Jaubert, and aptly called the Jaubert Plenum Method(1)—began to draw much attention. Both methods appeared to reduce nitrate accumulation, but exactly how that occurred was not fully understood by many aquarists.

In 1992, I established my first Jaubert system, and over the following six years, with the help of marine scientist Sam Gamble, it became evident there was much more to understand than just the nitrification process! We researched the microbial processes in all types of sandbeds, whether in the wild or in closed systems(2). Beds of different depths, consisting of material of various grain sizes, were also explored. One of the many things learned was that more focus needed to be applied to several classes of bacteria, and how they may affect overall system balance.

Among the more commonly known important microbes are the aerobic heterotrophs that live in oxygen-rich areas and break down organic matter, such as some waste products and dead animals. The inorganic results, such as ammonia, are then utilized by aerobic autotrophs living in the upper level of substrate, which reduce them to less toxic substances, such as nitrite and then nitrate. The resulting nitrate is then acted upon in a lower area of the substrate that contains little or no oxygen, generally referred to as the anaerobic area. It is there that we found two different classes of bacteria following two different paths—one path reducing nitrate to ammonium only (the primary alga nutrient), and the other reducing it to nitrogen. This caused us to question the long-standing aquarist understanding of the denitrification process. Along with many other aquarists, I had always thought that with nitrate being an alga-encouraging nutrient or water-quality issue, its reduction in so-called *anaerobic* areas virtually always resulted in its being reduced to a nitrogen gas and harmlessly dissipating upwards through the substrate or water column.



Looking for anoxic areas rather than anaerobic.

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But what if a more important alga nutrient (i.e., ammonium) may be produced in this anaerobic area? And if so, could this nutrient diffuse upward in the substrate and sediment and enter the bulk water, or again be oxidized back into nitrite or nitrate, which may also diffuse upward into the bulk water(3)? Therefore, it became necessary to look more closely at what is called the anaerobic area or process, and to define the logistics associated with its bacteria since we knew it may be something needing further consideration in the quest for a more balanced closed-system environment.

Further research showed that facultative anaerobic heterotrophs live in an area that contains a small amount of oxygen (i.e., approximately 0.5–2.0 mg/l; per Sam Gamble and defined in our writings as the *anoxic* area). They generate "dissimilatory denitrification," where nitrate is reduced to its basic elemental form—nitrogen gas. In an area of lower oxygen content, more precisely called the anaerobic area, obligate anaerobic heterotrophs existed and the end result of their process, technically called assimilatory denitrification, is ammonium. This is generally referred to as the ammonification process(4). The continuing reprocessing of this ammonium, produced in the lower anaerobic level of the substrate, back into nitrite and nitrate in the upper reaches of the substrate, is quite feasible. With any of them—ammonium, nitrite, nitrate—leaching back into the bulk water is quite possible!

It now became evident, in our opinion, that if a closed system, no matter what its physical size (home or public aquarium), contained more anoxic area than anaerobic area, as defined in our writings, its bulk water may possibly contain fewer inorganic nitrogen-laden products. And we must keep in mind that these substances are often seen as *green algae*, since they are quickly incorporated into its structure. Now armed with this information, I often wonder if aquarists have miscalculated the value of deep sandbeds and the use of an excessive amount of live rock to reduce nitrate concentrations, since both substances contain the same processes. In fact, a question often asked of me is why are there increasing amounts of unwanted green algae in some reef aquaria where nitrates appear low? Answer: a possible ammonium source from a deep bed or from too much live rock, since it's undetectable and quickly incorporated into the color green.

This leads me to believe it's important for aquarists to give more thought to the *volume of area* that houses facultative and obligate anaerobic heterotrophs in closed systems. It should be evident that the denitrification path in an anoxic area is of far greater value than the denitrification path in anaerobic areas. Since the volume of area accomplishing nitrification is usually fixed in closed systems—near the surface area of live rock and upper level of the sandbed—in my opinion it's wise to concentrate on how to enlarge the volume of anoxic zones and reduce the volume of anaerobic zones. Some possibilities to consider would include shallow sandbeds and use of coarse-grained sand (i.e., 2–5 mm). Minimizing the use of live rock also should be considered. The Jaubert Plenum method is another approach, since it helps maintain the greater portion of its sandbed in an anoxic condition(5). In fact, it has been used with great success in both public and private aquaria worldwide, either as part of a new installation or in an interconnected system(6 & 7).

For more information, please review the works referenced in this article or visit my Web site at www.saltcorner.com, where References 5, 6, and 7 are posted.

References

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A CONTINUING SERIES

Introduction to the Science Behind Synthetic Sea Salts

From the Labs of Instant Ocean

Dr. Timothy A. Hovanec

Abstract

The advent of a synthetic sea salt formula that closely replicated the major characteristics of natural seawater (NSW) and proved successful for the care, spawning, and rearing of many types of marine organisms was pioneered by the founders of Aquarium Systems in the 1960s with the introduction of Instant Ocean®. Since that beginning, Instant Ocean (IO) has become the de facto standard synthetic sea salt formula and is used throughout the world in public aquaria, research institutes, and home aquaria. Manufactured to strict quality control standards, IO is a homogeneous mixture that is fast-dissolving and produces a seawater closely matching NSW, but with increased buffering ability and a low total organic carbon concentration.

OUTLINE

1. Introduction

Seawater is more than a liquid medium for marine fish to swim in or for invertebrates, such as corals, to grow. Seawater is a chemical soup with a stable broth of basic chemical ions seasoned with a splash of almost every element in the periodic table, along with a pinch of organic compounds.

For the marine aquarist, it would seem natural to use real seawater from the ocean in their aquaria. However, there are potential problems associated with this approach. One major problem is the lack of access to the ocean for aquarists not living along a coastline. Another is filtering the seawater to remove sand and other solids. One also has to consider the collection location on the coastline and pollution: is the location near a sewage outfall, or an industrial plant, and what about algae and bacteria in the water? The fact is that for most marine hobbyists seawater from the ocean is not a viable option. This is also true for many public aquaria.

Almost from the beginning of marine aquarium keeping, the formulation of an alternative to natural seawater, or synthetic sea salt, has been desired. Gosse presented a couple of formulas for making seawater with chemical compounds in his 1854 book *The Aquarium: An Unveiling of the Wonders of the Deep Sea*, which many consider to be the first book on marine aquaria (Taylor 1993). The number of formulas grew such that a complete book listing 186 formulations for sea salt was published in 1985 (Bidwell and Spotte 1985).

Unfortunately, many of these formulas for synthetic sea salts failed. They failed in the sense that that animals did not live long or reproduce. However, the exact reasons for failure were not known. What was known was that the organisms kept in many artificial mixtures did not prosper as long as they did in natural seawater.

Today, the most successful and well-known synthetic sea salt is Instant Ocean®. Its beginnings go back to the desire to provide research scientists with a viable alternative to natural seawater: a synthetic sea salt that not only kept organisms alive, but also in which the organisms could reproduce. Today, after more than 40 years of research and use in research institutions, and public and private aquaria, Instant Ocean® has proven to be the scientifically based synthetic sea salt in which fish and invertebrates can grow and prosper in marine aquaria.

This is the story and history of Instant Ocean®: the science and research behind it, and why it is the best sea salt available for use in marine aquaria.

PUBLICATION INFORMATION

SeaScope® was created to present short, informative articles of interest to marine aquarists. Topics may include water chemistry, nutrition, mariculture, system design, ecology, behavior, and fish health. Article contributions are welcomed. They should deal with pertinent topics and are subject to editorial reviews that in our opinion are necessary. Payments will be made at existing rates and will cover all author's rights to the material submitted.

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