Algal Turf Scrubber™ Technology Comes of Age for Freshwater Aquariums

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by

Elmer A. Guerri

8401 North Lakewood Place, West Terre Haute, IN 47885, marc1230@aol.com

One of the most important developments over the past few years to help aquarists create biotope aquariums involves algae water quality control and Algal Turf Scrubber (ATS™) technology. The use of this algae-based technology creates both freshwater conditions which approximate natural physical parameters, and realistic complex organism and ecosystem dynamics with many advantages over traditional aquarium systems that use undergravel filters, protein skimmers, and other conventional or commonly used filtration equipment. What's more, since conventional filters remove plankton and the swimming reproductive stages of many aquatic organisms, it's virtually impossible to simulate complete ecosystems using such equipment.

In short, algal turf technology enhances water quality, and stabilizes parameters such as pH, dissolved oxygen, oxidation reduction (ORP), etc., permitting greater species diversity and heavier bioloads than conventional aquaria.

Dynamic Aquaria: Revisiting the Vision

Work with ATS™ began in 1980 with Walter H. Adey and Karen Loveland at the Smithsonian Institution. In their book, *Dynamic Aquaria* (Academic Press, 1991), Adey and Loveland presented a plausible technology for modeling complex living ecosystems using controlled communities of algae to duplicate the numerous photosynthetic nutrient-fixing roles that algae plays in water quality control in natural environments. In discussing the primary difference between bacteriological filtration and the algal turf scrubbing process, Adey and Loveland wrote:

"The algal turf scrubber duplicates the balancing and nutrient cycling process found in the wild, and is effective in full-salt, brackish, and freshwater systems from tropical, temperate, and cold-water environments. Unlike the bacteriological filter, which, in return for the removal of ammonia and some particulates, returns to an aquarium water depleted in oxygen and plankton and high in dissolved nitrates and carbon dioxide, the algal turf scrubber keeps oxygen near or above the saturation point and effectively removes all classes of dissolved animal wastes."

Adey points out that the word "filter" should not be used to describe the Algal Turf Scrubber.™ Filters remove particulates, whereas ATS™ principally manages water quality (in an aquarium context) by removing carbon dioxide, nitrogen and phosphorous, and returning oxygen.

Perhaps the most appealing benefit to hobbyists is that ATS™ systems do not require partial water changes.

Commercial Success Stories: Lessons for Hobbyists

Two commercial operations use full-scale ATS™ closed systems as part of a tank-raised fish and marine life format—Aquatic Technologies/Inland Aquatics of Terre Haute, Indiana, and the Aquatic Wildlife Company of Cleveland, Tennessee. Both companies develop ATS™ systems for aquarium hobbyists.

Aquatic Wildlife's John C. Walch explains ATS™ technology in terms of his practical experience: "The algal turf is exactly that. It is a turf algae. The many species of algae that comprise the term 'turf algae' are
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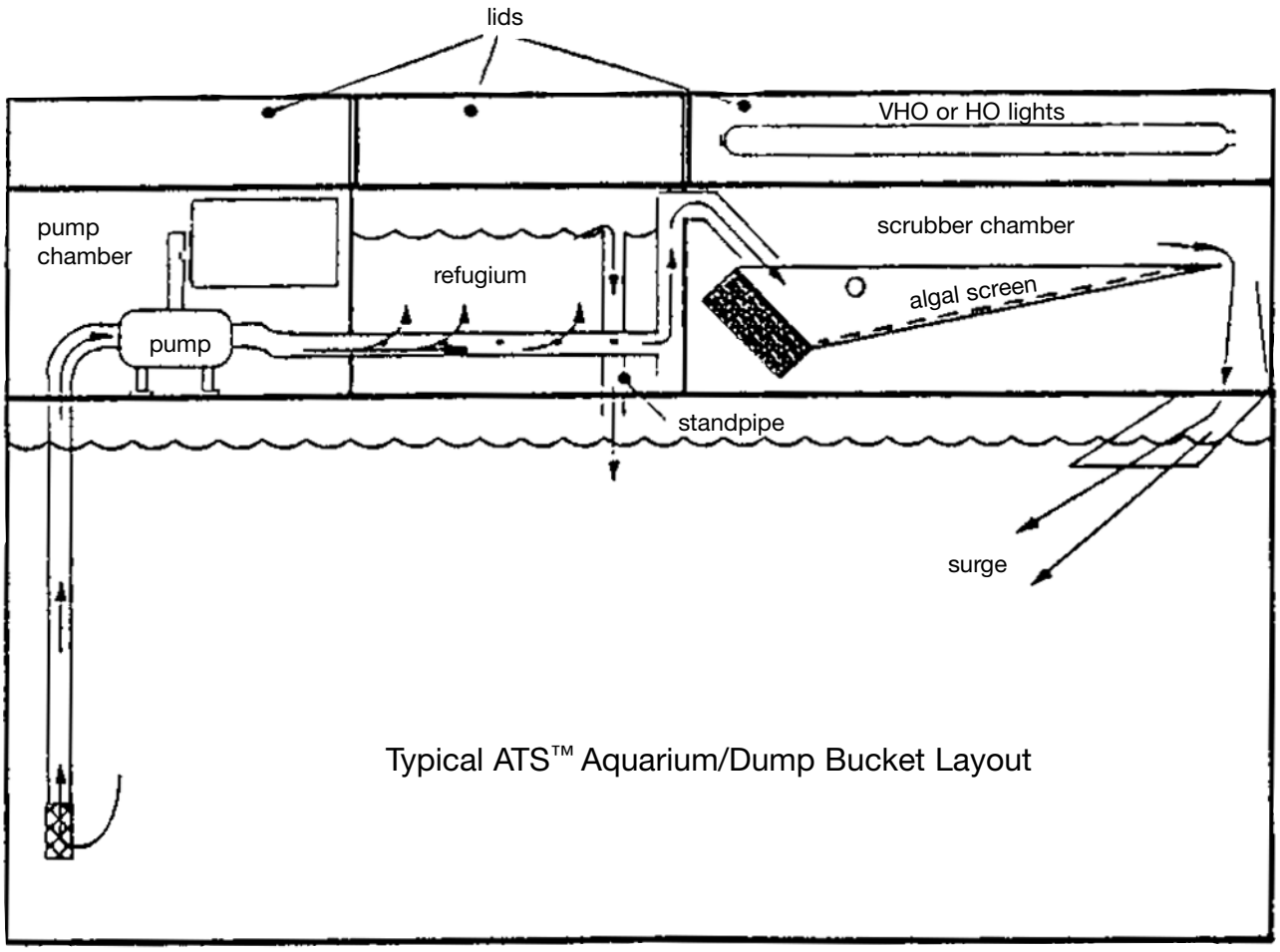


Typical ATS™ Aquarium/Dump Bucket Layout

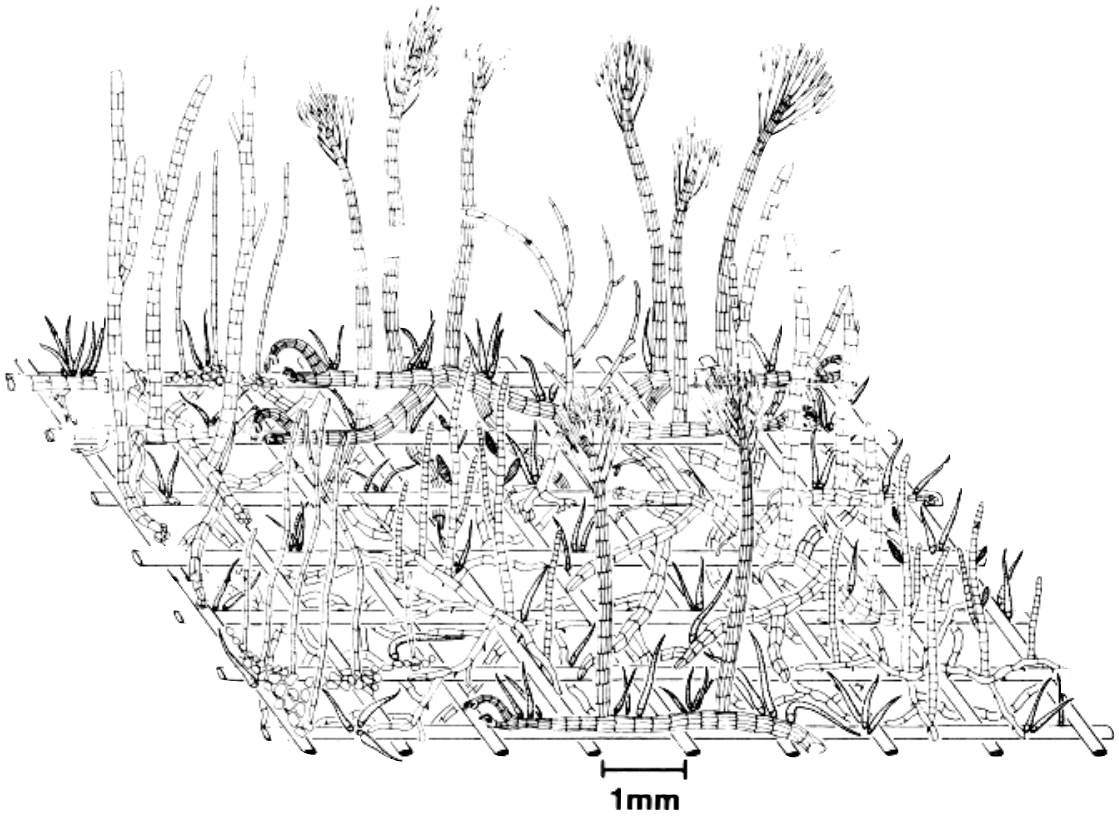
much more efficient than other macroalgae and filamentous algae groups."

Both companies incorporate a reverse day/night cycle into their systems. This nature-mimicking feature is part of the ATS™ technology patented by Adey and Loveland. The screens that have the turf algae growing on them are contained within dump buckets—their own "cabinets," of sorts (see above diagram). These cabinets also have their own built-in lights. When the lights are off over the rest of the system (water column), the lights are on over the scrubbers. This same technology has now been incorporated into smaller hobbyist-size systems called ecoTariums® and ecoReef® units. Since photosynthesis is taking place continuously, the result is a more stable pH, saturated levels of dissolved oxygen (D.O.), and lower carbon dioxide.

The reverse-daylight cycle "is one of the reasons why we have a lot fewer problems with external parasites than I've noticed in other systems," Walch says. "I think high pH and saturated D.O. levels not dropping during the night help prevent the fish from having to experience the normal evening stress conditions. This allows the immune systems of the fish to combat the bacteria and parasites present that might become fatal in a stressful condition."

Whether it's in commercial macroenvironments or in hobby ecoTariums® (many of which have operated for several years), ATS™ has proven to sustain higher density populations and multi-taxa populations of fish and other animals by providing a much more forgiving water quality buffer. Morgan Lidster of Aquatic Technologies/Inland Aquatics concurs.

"In our large algal scrubber facility system," Lidster says, "we seldom test water quality because the system is so stable and so well buffered against any significant changes. Natural systems, such as algal scrubber systems, can take a little tweak here and there and not risk catastrophic nutrient snowballing as a result. Scrubbers permit the higher density populations, and they are much more forgiving because they provide a buffer in regards to slight variations within the systems."



The Algal Turf Scrubber™

The Algal Turf Scrubber™ employs the most efficient photosynthetic components of wild ecosystems and concentrates their activity under optimal conditions. The scrubber, which contains primarily algal turfs, is a separate unit, in the form of a trough or dump bucket, installed in the aquarium's water-circulation line and lighted in a cycle opposite to that of the main ecosystem. While the microcosm is in darkness, the algae in the scrubber are photosynthesizing, insuring a continual supply of oxygenated water, and rapidly removing CO_2 and nitrogenous waste just when it is abundant. The rate of oxygen production and the uptake of nitrogenous wastes can be controlled by changing the length of time the turf algae are lighted. The scrubber duplicates the balancing process found in the wild.

Turf algae are grown on fine-mesh plastic window screen or on a 2 x 4 mm black polyethylene screen stretched on a frame that fits in the bottom of the trough. The screen can be seeded by suspension in an established aquarium or in a natural environment. An alternate, though equally satisfactory, approach is simply to stock the ecosystem first with algal turf substrate and, once the scrubber is operating, add the remainder of the community. Because water in the trough is shallow, the turf-bearing screen is situated at or near the surface, and receives maximum light, which otherwise would be filtered through the water column.

Above: Typical tropical algal turf growing in a 1-mm mesh plastic screen. Source: Dynamic Aquaria, *p. 232.*

The ecoTarium® system has built-in refugia—kind of a "tank within a tank"—to provide an isolated safe harbor for delicate and vitally necessary organisms. It shares the same water as the main tank and serves as a protected breeding area for smaller, more vulnerable organisms, while at the same time allowing some of these organisms to enter the main tank as natural live food. In freshwater systems, organisms that can be kept in refugia include microcrustaceans, newts, crayfishes, shrimps and minnows. (In addition to imitating conditions in nature, refugia also help provide the increased buffer capacity and enhanced stability Lidster mentioned.)

For freshwater ecoTarium® biomes, the refugia can imitate the border marshes or large flats of large natural lakes and ponds, or small streams or alluvial areas contributing to larger bodies of freshwater. The refugia, in effect, act as natural sediment traps, and as "geological" and "biological" storages for fine organic particulates and organisms. Refugia represent "mini-biomes" operating in conjunction with the "macro-biomes"—just as they do in nature.

As I've already mentioned, ATS™ systems allow aquarists to keep more species, and more of them. "The algal scrubbers allow a much higher length-of-fish-to-aquarium-volume ratio than would otherwise be achieved with traditional filtration systems," says Lidster. "The drive is toward maintaining many more fish than would occur in that natural space in the wild. One of the advantages of the algal turf technology is that we have an incredibly strong and effective nutrient export tool. This allows aquarists to import ammonia and simultaneously to pull it out of the system such that they maintain a nutrient poor environment, although they are exchanging quite a bit of nutrient."

The ability of the aquarist to provide heavy loads of nutrients and food organisms, and the efficiency of the aquarium's inhabitants to convert these sources into energy and growth, provide optimum quality water, a higher quality of life for the animals, and more enjoyment for the hobbyist, who has less maintenance to perform.

Power failures or interruptions often have significant impacts upon hobbyist aquariums which use undergravel filters, bubble aerators, simple skimmers and biowheels. According to Lidster, these same interruptions are likely to have much less of a significant impact upon ATS™ systems. "When the power goes down," he says, "the two critical factors are waste generation and oxygen. The ATS™ system's oxygen saturation provides the maximum amount of time before there will be an oxygen problem. Also, since we still have all of our bacterially active *Nitrosomonas* and live bottom substrates, we don't have any major problems. Many algal-scrubbed environments have gone a day or two without power, and some others have gone 40 hours or so without power, without problems."

ATS™ algal-scrubbed environments also appear to minimize the stressful effects a change of seasons can have upon aquarium animals. Lidster provides enlightened comparisons from his many years of experience with traditional hobbyist systems: "We don't see a seasonal stress effect on a facility level or in hobby ecoTariums,® but I have seen a lot of that on a traditional hobbyist-level systems over the years. As environmental changes occur, humidity and barometric pressures also change, as do evaporation rates and room temperature. Hobbyists aren't always quick to react to how these changes may be affecting their tanks, even though they may be making changes or adjustment for their own personal comfort—heavier sweaters or lighter shirts, and so forth."

Summary

The success with Algal Turf Scrubber™ technology has already made a positive impact upon the aquarium hobby, and it promises to offer even greater benefits for the future. This technology—combined with the aquarist's ability to provide a proper level of nutrients, and the system's efficiency in converting these nutrient sources into energy and growth—provides three attractive benefits: Superb water quality, thriving animals, and no water changes.

Clearly, there is little hope that we can do any job as well as it is done in nature, but it is satisfying to know that with ATS™ technology we are getting one step closer to being less dependent on mechanical methods for removing carbon dioxide, nitrogen and phosphorous from our aquariums, while increasing the amount of oxygen.

Note: Aquatic Technologies/Inland Aquatics maintains a 200-gallon freshwater ATS™ ecoTarium.® It houses a large, diverse population of freshwater fishes and other organisms. An article on the history of that ecoTarium® will appear in the next issue of American Currents.

Win an ecoTarium®
at the NANFA National Convention!

A complete ecoTarium® system will be awarded as a raffle prize at the NANFA National Convention in Champaign-Urbana, Illinois. Buy your tickets now for this excellent, state-of-the-art system. You need not be present to win. If you did not receive any tickets in the mail, contact Elmer Guerri.

In addition, a *separate* ATS™ unit will be raffled off for Convention attendees only. *You must be present to win this prize.* Tickets will be available at the Convention, August 6-8, 1999.