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Summer 2000

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Report Card

Well, we have both seen the first issue of *Planted Aquaria Magazine*. It was more than I had hoped for, but it was less too. I had hoped for great content, and we sure had that.

But I had hoped for crystal-clear sparkling pictures, and they weren't as good as I had wished. The fault lies not with the photographers, who did great work, but with the processors. Once I can sort this out I will let you know more.

The ads prove that the printer was doing his job.

The issue's late appearance was due to a string of problems. The last of these was the mailer's failure to mail the copies. He had no excuse for this; he "lost the job". My partner and I ended up addressing, stuffing, stamping, and bulk-mailing the copies to you all. We did this overnight.

The authors were fantastic. Karen Randall on styles in aquascaping and Neil Frank on chain swords offered serious content, while Steve Dixon's piece on Tom Barr gave us a glimpse of a name we see often on the *Aquatic Plant Digest*. Jay Lenahan took us inside the serious academic world of aquatic plant literature with a great extract of a long paper on submerge growth physiology.

All in all, I give myself a C+ on the first issue. I hope the one you are holding now is at least a B+. We are all working hard to address the problems that made the first issue less than perfect.

This month we feature an in-depth look at algae by Brad Metz and a thorough appraisal of substrates by Jamie Johnson. John Glaeser tells how he started a planted tank club. And there is a bit of humor from Lori Shimoda; great news of the promotion of Claus Christensen at Tropica, a firm friend of the hobby world-wide; news of the first planted aquarium workshop at Chattanooga this fall; and some bloopers from the first issue.

Soon we will have a fine article on

chemistry for planted aquarists, a feature on the genus *Otocinclus*, a look inside the Tennessee Aquarium and its huge planted tanks, as well as more features to keep you posted on the human side of our hobby.

Now a word about the economics of a publication like this: it takes about 20 ads and 1,000 subscribers to break even at forty pages. With 24 ads and 1,500 subscribers, we could go to 48 pages. And with more ads and subscribers, we could have even more pages. I would like to have 64 pages, with 32 ads and 32 pages of editorial material.

You can help this happen. Make sure all your planted tank friends know about the magazine. If they need to know how to subscribe, mention our website. Or tell me and I will let them know. Or get them started with a gift subscription. And talk to the vendors you respect. Tell them about the splendid opportunity our reasonably priced ads represent. Together we can make a good magazine great!

Finally, I want to thank our patient subscribers. They suffered through the birth pangs of *Planted Aquaria* as much as anyone. And their perseverance is responsible for much of what you hold in your hands. If you are not yet a subscriber, check out the info on the previous page and see how easy and inexpensive it is to get *Planted Aquaria* regularly in your mailbox.

Have fun with your planted tank!

Dave
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Looking for *Cryptocoryne aponogetifolia* in the Philippines

Jan D. Bastmeijer

The strongly blistered, long-leaved *Cryptocoryne aponogetifolia* is a rather well-known aquarium plant. Hobbyists worldwide have cultivated this plant for many years. It is easy to grow and prefers hard water, is quite resistant to the feared “crypts-disease” and may develop luxurious foliage. Last year, I visited the Philippines to see the places it grows in nature. From the literature and herbarium studies these sites are well known, but I was glad to have a guide. Herson Morco from Morco International, Manila, accompanied me on the trip to southeast Luzon, where the plant grows in the Albay and Sorsogon provinces. The Morco firm has been involved for many years in shipping aquatic plants from the Philippines—not only *Cryptocoryne aponogetifolia*, but also *Cryptocoryne pygmaea* and the beautiful *Cryptocoryne usteriana*. The trip was a success; we found *Cryptocoryne aponogetifolia* at several localities. We must be a bit lucky, for these crypts grow in rather fast-running rivers and can be observed and collected only when the water level is low.



with view of the Mt. Bulosan volcano. *Cryptocoryne aponogetifolia* grows in several streams. This landscape is dominated by coconut palms.

Biotope

Southeast Luzon Island (the main island of the Philippines) is strongly volcanic. In the Sorsogon province, Mount Bulosan dominated the view wherever we searched for these crypts. Even more impressive is the Mayon volcano in the Albay province near Camalig. This ever active volcano—a perfect dome—erupted shortly after our

stay! The rivers where we found *Cryptocoryne aponogetifolia* were low during our stay. Many tropical rivers rise very quickly during rainfall, one or two meters rise in half a day. Under this risk, collecting crypts is a dangerous undertaking, even if you could find them. We found *Cryptocoryne aponogetifolia* flowering abundantly in a relatively small river with crystal clear water and could easily walk through the water to observe



A crystal clear stream in Sorsogon with big patches of *Cryptocoryne aponogetifolia* (at right). The depth of the stream is about 40 to 60 cm; one can walk easily on the sandy bottom of the riverbed.

them closely in the stream bed. In another river the water was very cloudy and deep, and we found the plants along the edges and on banks (even partly emersed because the water was extremely low). They are fully exposed to the sun at least a part of the day. The landscape is not a primary forest; the land along the rivers is used for low-intensity agriculture. But change to more intensive forms of agriculture would probably destroy *Cryptocoryne aponogetifolia* in a short time.

Appearance

Cryptocoryne aponogetifolia can grow tall, but the maximum size of about one meter long by 8 cm wide in nature is seldom seen in an aquarium. More often it is 50 to 60 cm long and 5 cm wide, depending on circumstances. The leaf blade is permanently deeply blistered in a couple of rows. Both the

upper and lower side of the leaves are bright green, without any purple. A well grown specimen in a fish tank can have more than 10 leaves, the stems upright and the leaves spreading over the water surface.

Culture

Though it is possible to grow *Cryptocoryne aponogetifolia* emersed in a pot (the plant does not then exceed 20 cm), for full development one has to use a tall aquarium. The water should be hard, as in the Philippines the plants grow between basalt rocks and in limestone areas. Another hard water crypt is *Cryptocoryne affinis* from West Malaysia; the two form a good couple to cultivate together in an aquarium. Lighting for *Cryptocoryne aponogetifolia* should not be too intense. When using fluorescent tubes, don't use too many; two or three suffice for full-grown plants.

Limb of the spathe of *Cryptocoryne aponogetifolia*. The plants in Sorsogon were flowering abundantly in May.

The spathe in *Cryptocoryne aponogetifolia* is a rather long tube, only the top emerging from the water. The very tiny flowers are down under the tube. Pollination is by small flies which enter the tube.



Substrate presents no special problems. Normal aquarium gravel with some clay added will be fine.

Identifying Crypts

The name *Cryptocoryne aponogetifolia* means “the crypt with leaves like an *Aponogeton*”. *Aponogeton* is another genus of aquatic plants and one of its species has similar foliage with strongly blistered leaves. There is little other similarity between the species. In botanic history, many authors had problems naming newly discovered plants, and this problem continues

today. Until the 1980s most botanists believed that *Cryptocoryne aponogetifolia* was the same plant as *Cryptocoryne asteriana*. That name is often used for our plant. But it has been shown that *Cryptocoryne asteriana* is another plant, also from the Philippines, with broader leaves, less blistered, and an almost wine-red lower side of the leaves.

My visit to the Philippines was a great adventure and I look forward to returning soon—perhaps to chase another of the elusive cryptocorynes.

Sunrise in a small village in the Sorsogon province



Herson Morco with a pair of full grown *Cryptocoryne aponogetifolia*. The whitish spathes reach half of the full length of the plant. The Morco firm has shipped these plants for over 25 years from a nearly natural farm, giving employment for a lot of people.

Preparing dinner at sunset in Camalig, one had to choose among traditional foods. This was one of the most exciting experiences of the trip.



View of the mighty Mayon volcano in Albay province (Luzon) from a limestone cave. In February 2000 there was a big eruption, causing the evacuation of the whole area. *Cryptocoryne aponogetifolia* grows in several streams in the surroundings.



In the dry season, the water level is low. On the banks *Cryptocoryne aponogetifolia* grows emersed. The leaves are short and the rhizome is deeply buried in the stony soil.



Cryptocoryne aponogetifolia in the Sorsogon province growing in slow running water. Photo by Josef Bogner.



An emersed cultivated specimen of *Cryptocoryne aponogetifolia*. The leaves are as blistered as in nature, but much smaller. The rockwool substrate is only for 'high tech' cultures and is not recommended for hobbyists.



The limb of the spathe of a cultivated *Cryptocoryne aponogetifolia* can vary from yellow to deep purple.



The lower part of the tube is called the 'kettle', contains the female (lower) and male flowers (above) on the spadix, the middle part is naked, a typical structure for the Aroid family



A rather big river in the Albay province. The water level is very low. Despite this one could hardly 'walk through' the river because of the depth and the current. For miles, very big patches of *Cryptocoryne aponogetifolia* grow along the banks. Note the grayish water.

Aquatic Gardeners Conference

**Tennessee Aquarium,
Chatanooga, TN
Nov. 3-5, 2000**

Mark your calendars! The Aquatic Gardeners Association announces the first full weekend of activities for lovers of planted aquariums! Enjoy the fellowship of other aquarist interested in this fast-growing segment of the hobby while learning from some of the top aquatic gardening experts in the U.S. Explore the Tennessee Aquarium in the privacy of an exclusive after-hours tour, and experience the beauty of autumn in Tennessee while dining aboard a riverboat.



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- Neil Frank - Alternative Ways to Keep Plants in Home Aquaria
- Paul Kromholz - Growing Aquatic Plants
- David Lass - Lighting Options for the Planted Aquarium
- Charlene Nash - Aquarium Plants in the Public Aquarium setting
- Karen Randall - Meeting the Nutritional Needs of Aquarium Plants

Other activities:

- Get acquainted banquet in the Aquarium exhibit area
- Private tour of the Tennessee Aquarium lead by Charlene Nash, aquatic horticulturist
- Silent auction of rare plants
- "Ask the Experts" panel discussion
- Planning committee meeting for Summit 2001
- Riverboat cruise

Pre-registration WILL BE REQUIRED

For more information, contact:
Charlene Nash
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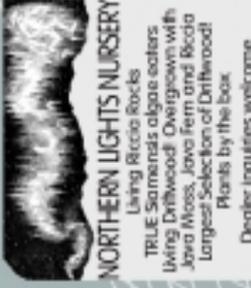
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Substrates for the Planted Aquarium

Jamie S. Johnson

There is a wide variety of substrates for use in today's planted aquarium. Due to the growth and popularity of aquatic plants, new products are being introduced all the time. This is good for us gardeners, but it only adds to the confusion over which product is best. These new varieties, along with old standards, have given us many choices.

Some people stick with proven recipes, while others experiment with new, and sometimes untested, ideas. A lot of real world data exists to substantiate the value of commercial substrates and additives, as well as homemade peat, vermiculite, and soil blends. It's all up to the needs of the individual aquarist. Some like the simplicity of commercial products, while others enjoy preparing the substrate they believe is most productive.

No single substrate can be labeled as the best, but some perform better than others. Many factors affect the type of substrate needed: types of plants, appearance, and growth rate desired; maintenance one will tolerate; chemical properties; budget; and availability. As you can see, there are many parameters that go into deciding the optimal substrate. The purpose of this substrate analysis and overview is to help narrow down some of those parameters—especially physical and chemical properties.

Purpose

The substrate serves many purposes in the planted tank—probably more than in any other type of aquarium. It provides a place where mineral and organic nutrients are stored. These nutrients are released to root-feeding plants as needed. It also provides a bed for the growth of beneficial bacteria. These bacteria are responsible for breaking down wastes.

Bacteria also cause reduction of nutrients, making them available for uptake by the plants. Iron, along with other nutrients, needs to be in the reduced state to be used by plants. Reduction turns the common oxidized

ferric iron (Fe+3) into ferrous iron (Fe+2). The negatively charged sites in the substrate attract and hold the positive ions until taken up by the plant's roots.

Bacteria also break down fish and plant wastes and excess food. When new tanks are set up, bacteria are just beginning to establish themselves. This is usually what causes the phenomenon "new tank syndrome". The aquarist may experience high ammonia and nitrite spikes until the tank stabilizes. It may be beneficial to seed your new tank with some gravel from another trustworthy tank. This will give the bacteria a jump-start.

As well as being a good anchoring medium, a substrate must be aesthetically pleasing. Fish and plant colors will appear deeper and richer with a dark substrate. This is a good choice for a soft-water, Amazonian aquascape. A tank with a top layer of sand usually resembles a shallow shoal—bright and alive. Fish may be more timid with a washed-out colored bottom.

Commercial and homemade substrates must have correct size granules. If the particles are too large, waste will settle down deep, clogging the substrate and inhibiting nutrient exchange. If the particles are too small, the substrate may settle and compact. A compacted substrate will not allow for the growth of small, delicate roots. It also impedes the flow of nutrients throughout the bed. Eventually, in both cases, growth slows and plants suffer.

Consider the buoyancy of the substrate; it should sink and stay sunk. If it doesn't, cover it with a top dressing of sand or gravel. Materials like pumice, peat, humus, and vermiculite tend to float if given the chance. Boiling these before use tends to saturate them, helping them stay down until covered.

Try to avoid using fine-grained sands, such as beach sand. Choose the largest grade available. Gravel size should be 2 to 5mm; fortunately, these are the most popular sizes.

The gravel and sand need to be chemically inert. This will insure the pH

and other water parameters aren't affected by the substrate. Before application, add a drop of hydrochloric acid to the material in question. If it fizzes or foams, do not use it, or be aware it may alter your water chemistry.

Installation

If you use a commercial product, follow preparation instructions. Wash sand and gravel thoroughly before use to remove dust and trash. Thoroughly rinse these products because they can contain a lot of fine dust that can initially cloud the water and settle on your plants.

If your substrate contains shells, it will increase the hardness and alkalinity over time. Be sure to include this effect in your aquarium management plan.

You can even experiment; there are endless possibilities. Calcined clays, lateric rock, and zeolite can be used as complete substrate beds or mixed up to fifty percent with other products. Plain gravel makes a good mixer but should be avoided as a stand-alone substrate. Lateric soils, redart clays, and soils need to be mixed with gravel and put in the lower third of the substrate. These types cannot be rinsed beforehand, and will easily mix into the water column if left too close to the surface.

Collected soils can be sterilized in an oven at 300F for one hour and then sifted to provide the highest quality soil. Be careful not to collect near heavily traveled areas or areas that could be easily contaminated. Aquariums are closed systems, so quality is paramount. Peat, vermiculite, and other additives would also be mixed in the lower layer. Cover the lower layers with a top layer of gravel or sand.

You are now ready to plant. Tanks are most appealing if the substrate is terraced from back to front. A minimum depth of three inches in the front to a minimum of five to six inches in the back is best. This allows for the entire surface of the substrate to be viewed: from the small foreground plants (glossos and chain swords) to the larger, heavy feeders (swords and crypts). It's up to the individual to decide on the final look, but remember to provide

sufficient material for proper root development.

If you use substrate heating cables, you need a small base (0.5 to 1 inch) for the cables to rest on. Place the cables in the correct layout for optimal effect: flat with clearance on all sides. Cover and complete the substrate as normal.

Problems/Maintenance

Regardless of the substrate you choose, problems can arise. They may be built-in problems (too rich or organic) or they may gradually appear (lack of nutrients or compacting). The built-in problems can be controlled, to an extent. You can use peat, manure, or leaf debris in moderate amounts. With the advances in today's fertilizers, manure's disadvantages may outweigh its advantages. Peat and leaf debris decompose to form noxious, low pH environments. Laterites and clays are rich in minerals but not in organics. These minerals are stored within the substrate and are not as readily available to the plants as the organics.

High mineral concentrations rarely cause problems, but lack of certain minerals may. Too little or too much of anything is bad. That's why it's important to know what minerals are present and in what concentration. You can add nutrients to the substrate to correct deficiencies. You can moisten clay balls and bake them at 250°F until hard, then insert them under the plants that show problems or are heavy feeders. Mulm can't always provide the nutrients needed for a fast-growing tank, but time-released fertilizers (Osmocote) or plant spikes (Jobes) can keep things in balance. They need to be low in phosphorus (middle number of N-P-K), so they won't promote algae growth if leached from the substrate.

As time goes on, your substrate may compact. The plant roots alone can amass, causing problems in addition to physical compacting. Vacuuming the gravel lightly will help to prevent compaction and give the tank a cleaner appearance. Care must be taken not to disturb additives or fertilizers. Mulm is removed, and more oxygen is supplied to the roots. Vacuuming is another one

Continued on page 22

Substrate Types/Additives

Gravel - pH-inert, natural or epoxy-coated; loose rounded fragments of rock, usually >2mm in size. Most gravels have no nutrient or CEC value. Gravels are cheap and have good anchoring properties.

Sand - sediment particles; common form is silicon dioxide (SiO_2); size 0.05 to 2mm; no nutrient or CEC value; pH-inert.

Laterite - a low-grade ore similar to bauxite, but containing much less aluminum oxide (Al_2O_3); residual product of rock decay; usually highly weathered tropical clay with high concentrations of iron oxides and aluminum hydroxides; comes in powder/granular form (used in new set-ups) and chunks for use in established tanks; relatively low CEC.

Zeolite - any of various hydrous silicates of aluminum that are analogous in composition to the feldspars; contains either sodium or calcium or both of the type $\text{Na}_2\text{O}_2 \cdot \text{Al}_2\text{O}_3 \cdot x\text{SiO}_2 \cdot x\text{H}_2\text{O}$; can act as ion-exchanger; has high CEC.

Arcillite - calcined, montmorillonite clay, this may be a commercial brand name.

Montmorillonite - one of the major components of bentonite and fuller's earth; hydrous aluminum silicate with a considerable capacity for exchanging part of the aluminum for Mg and bases; high natural adsorptive power; good CEC.

Redart clay - high in iron; similar iron content and CEC to laterite (but not a laterite): usually finely ground.

Peat - semicarbonized residue of plants formed in watery environments; high organic content; releases tannins when wetted, forms acidic water; can absorb calcium from water column; high CEC.

Vermiculite - micaceous material; hydrated magnesium-iron-aluminum silicates resulting from expansion of granules of mica at high temperatures; lightweight, highly water-absorbent material; crystalline structure; high CEC.

Soil - inorganic matter derived from weathered rocks and organic matter from decayed vegetation; if 45 to 50% sand, 20 to 28% clay called loam; if >50% sand called sandy; if >28% clay called clayey; varying CEC.

Clay - hydrated aluminum silicates and other minerals, generalized formula of $\text{Al}_2\text{O}_3\text{SiO}_2 \cdot x\text{H}_2\text{O}$; component of soils in varying percentages; fine irregular shaped crystals from <1 micron (colloidal) to 150 microns; reddish-brown to pale, depending on iron content; absorbs water, plastic when moist, hard when fired; can be thixotropic (property of various gels of becoming fluids when disturbed); good CEC.

Calcined clays - clays that are heated to a high temperature to cause an extreme hardening and oxidation; can be crushed into smaller pieces to be used as a primary substrate base; very porous upon firing, and provide many nutrient binding sites; chemically and physically stable; good CEC.

Illite - group of clay minerals having the structure $\text{KAl}_3\text{Si}_3\text{O}_{10}(\text{OH})_2$; colorless to pale brown potassium mica; high CEC.

Mica - any of several silicates of varying chemical composition but with similar physical properties and crystalline structures; cleaves into thin, flexible and elastic sheets; good CEC.

Bentonite - colloidal clay of aluminum silicate compound; composed chiefly of montmorillonite; sodium bentonite (western US), high swelling capacity with water; calcium bentonite (southern US), negligible swelling capacity; forms colloidal suspensions in water with strong thixotropic properties; good CEC.

Fuller's earth - porous, colloidal aluminum silicate clay mineral that lacks plasticity and is often used as an adsorbent, filter medium, carrier for catalysts; high adsorptive power; gray to yellow color; good CEC.

Ceramic - a product manufactured by heat acting on earthy raw materials, in which silicon and its oxide and complex compounds known as silicates occupy a predominate position within the material; varying CEC.

Sample Descriptions

Substrate Cons

- Substrate Gold** - Schoeler Enterprises, USA - lateric soil mined in the US; comes in granular and stick forms; deep, orange-red; silt-5mm in size; no organic matter; will cloud water
- Yolo loam/vermiculite** - Yolo County, CA, USA - local loam/vermiculite blend; unknown percentages of ingredients; homogenized; shiny, brown, mica appearance; very small amount of organic matter; will cloud water
- Danish redart clay** - Danish pottery, Denmark - powdery; brick red dust; no organic matter; will cloud water
- Finland local clay** - Viikki, Helsinki, Finland - silty; dusty; light-beige; silt-5mm in size; easily crumbled; no organic matter; will cloud water
- Finland pine/fir forest** - Eno, Northern Carelia, Finland - sand and silt; beige-orange; homogenized; small amount of organics; will cloud water.
- Finland mixed forest** - Helsinki, Finland - sand and silt; powdery; brown; will cloud water
- First Layer Pure Laterite** - Aquarium Pharmaceuticals, USA - hard lateric soil and rock; mining location unknown, possibly US; deep, brown-red; <1 to 5mm in size; no organic matter; will cloud water
- Profile** - Profile Products LLC/Shultz, USA - illite and fuller earth kiln-fired to ceramic granules; dark gray with beige specks; 1mm; no organic matter; this is the older, "fine" formulation.
- Ontario preglacial subsoil** - Don River Valley Brickworks, Toronto, Canada - powdery with small rocks; light gray; homogenized; silt-5mm in size; no organics matter; will cloud water
- Ontario postglacial topsoil** - mixed hardwood lot, Don River Valley, Toronto, Canada - sand and silt; dark gray-brown; homogenized; some organic matter; will cloud water
- Terralit** - Aqualine Buschke, Germany - zeolite-based; very hard; multi-colored (white, brick red, black); resembles small aquarium gravel; 2-5mm in size; no organic matter
- AquaTerra** - Natural Aquarium and Terrarium, USA - powdery, highly organic blend—possibly peat and laterite; dark red-brown; homogenized; will float and cloud water
- Hartz pH 5 cat litter** - Hartz, USA - possibly type of arcillite; hard, will not break down in water; light beige to cream; 1-3mm in size; no organic matter
- Cedar Heights redart clay** - Resco, USA - powdery; brick-red dust; no organic matter; will cloud water
- Dupralit G** - Dupla, Germany - lateric soil commonly mined in Sri Lanka; deep orange-red; silt-2mm in size with some larger granules; very small amount of organic matter; will cloud water
- Turface** - Profile Products LLC, USA - medium hard

| Sample # | Al | Ba | Ca | Co |
|----------|-------|------|--------|------|
| 1 | 6410 | 14.6 | 718 | 2.5 |
| 2 | 30500 | 556 | 6210 | 30.1 |
| 3 | 11000 | 235 | 16900 | 7.6 |
| 4 | 27200 | 210 | 4060 | 20.9 |
| 5 | 14800 | 20.6 | 338 | 4 |
| 6 | 3680 | 10.5 | 812 | 2 |
| 7 | 5110 | 12.1 | 181 | 3.6 |
| 8 | 9940 | 311 | 12800 | 5 |
| 9 | 13400 | 108 | 132000 | 8.7 |
| 10 | 4180 | 21.1 | 829 | 2 |
| 11 | 33100 | 34.8 | 12700 | 0 |
| 12 | 13300 | 71.9 | 1380 | 13.2 |
| 13 | 8150 | 23.5 | 169 | 9.7 |
| 14 | 13400 | 89.9 | 1470 | 15 |
| 15 | 14600 | 92.3 | 728 | 27.8 |
| 16 | 6590 | 124 | 3640 | 2.6 |
| 16a | 10500 | 119 | 5310 | 3.5 |
| 16b | 5070 | 20.4 | 2680 | 3.1 |
| 17 | 5980 | 11.6 | 14300 | 2.7 |
| 18 | 9740 | 217 | 2560 | 4.2 |
| 19 | 6820 | 133 | 527 | 3.4 |
| 20 | 5730 | 156 | 5810 | 2.6 |
| 21 | 43.3 | 0 | 0 | 0 |
| 22 | 1140 | 5.1 | 1040 | 0 |
| 23 | 443 | 0 | 172000 | 0 |
| 24 | 4710 | 30.5 | 9950 | 2.9 |
| 25 | 39400 | 132 | 2360 | 60.2 |

arcillite and other clays—possibly kiln fired; light beige; resembles aquarium gravel; 2 to 5mm in size; no organic matter

16a. Turface (dark color, new)

16b. Jersey Greensand - Greenall, E B Stone and Son, Suisun CA 94585 - glauconite (finely-divided (200um) micaceous clay); does not cloud water; does not compact; no organic matter

17. Special Kitty cat litter - Walmart, USA - soft, crushable clay pieces; possibly bentonite and montmorillonite; light gray; 2 to 5mm in size; no organic matter; will cloud water

Constituent Analysis Table

| Element (mg/Kg) | | | | | | | | | | | |
|-----------------|------|--------|-------|--------|------|-------|------|------|------|-----|------|
| Cr | Cu | Fe | K | Mg | Mn | Na | Ni | V | Zn | pH | CEC |
| 143 | 13.3 | 41700 | 423 | 528 | 30.9 | 220 | 6.5 | 111 | 9.2 | 4.9 | 18.4 |
| 512 | 35 | 29700 | 15600 | 36200 | 488 | 751 | 104 | 74.4 | 95.7 | 6.7 | 33.7 |
| 25.2 | 12.5 | 24300 | 3590 | 5130 | 334 | 146 | 18.9 | 27.3 | 46.3 | 8.8 | 23.7 |
| 66.8 | 43.4 | 46100 | 11100 | 14500 | 629 | 762 | 35.4 | 83.8 | 103 | 6.7 | 27.3 |
| 20 | 5.9 | 12600 | 337 | 1640 | 61.5 | 0 | 8.1 | 24.1 | 15.8 | 4.7 | <.1 |
| 5.9 | 1.8 | 6070 | 389 | 1380 | 116 | 0 | 3.1 | 11.6 | 14.4 | 7 | <.1 |
| 110 | 24.5 | 118000 | 0 | 140 | 65.9 | 0 | 12.6 | 258 | 8.4 | 5.7 | 2.7 |
| 36.4 | 4.9 | 13200 | 3920 | 4220 | 106 | 339 | 16.2 | 14.9 | 49.6 | 7 | 33.2 |
| 20.4 | 19.6 | 17300 | 3070 | 9160 | 444 | 386 | 17.9 | 28.1 | 42.6 | 9.1 | 21.4 |
| 5.3 | 8.9 | 6060 | 306 | 613 | 81.3 | 171 | 4.6 | 11.4 | 27.9 | 5 | 9.8 |
| 0 | 71.4 | 2790 | 12200 | 3680 | 1240 | 3090 | 0 | 1.6 | 48.1 | 5.7 | 44.6 |
| 18.9 | 17.7 | 27300 | 3170 | 4660 | 159 | 157 | 43.4 | 44.3 | 57.4 | 4.4 | 41.3 |
| 68 | 7.7 | 9480 | 1060 | 1590 | 20.1 | 61.9 | 13.9 | 28.3 | 41.2 | 4.7 | 43 |
| 21 | 16.9 | 37500 | 3280 | 4890 | 174 | 257 | 49.5 | 51.5 | 64 | 8.3 | 11.5 |
| 107 | 53.9 | 80100 | 359 | 672 | 1570 | 68 | 30.3 | 141 | 91 | 6.3 | 16.2 |
| 15.8 | 4.1 | 10700 | 3210 | 2730 | 96 | 574 | 11.8 | 10.4 | 33.4 | 6.2 | 29.8 |
| 39.5 | 5.2 | 12600 | 3980 | 4130 | 61.1 | 353 | 14.8 | 18.7 | 50.5 | 6.1 | 41.1 |
| 45.2 | 3.5 | 11300 | 4150 | 1110 | 75.1 | 605 | 9.5 | 5.5 | 65 | 3.5 | 26.2 |
| 29.6 | 12.6 | 14500 | 2170 | 3760 | 47.5 | 395 | 21.1 | 12.3 | 70.5 | 6.1 | 27 |
| 27.1 | 2.1 | 14300 | 3500 | 3150 | 104 | 642 | 8.3 | 10.3 | 30.6 | 6.7 | 34.6 |
| 6.2 | 13.8 | 9610 | 1710 | 1490 | 85.5 | 444 | 8 | 8.8 | 33.5 | 5.5 | 1.7 |
| 10 | 73.2 | 11500 | 433 | 995 | 136 | 570 | 4.1 | 24.5 | 248 | 4.8 | 24.3 |
| 0 | 0 | 65.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | <.1 |
| 4.2 | 2.1 | 4170 | 205 | 193 | 103 | 0 | 0 | 3.1 | 0 | 9.8 | 6.7 |
| 2.1 | 2.1 | 2920 | 376 | 106000 | 65.5 | 0 | 3.7 | 2.9 | 0 | 9.6 | 1.3 |
| 12.5 | 30.4 | 14200 | 1630 | 1900 | 79.1 | 10700 | 10.5 | 5.5 | 20 | 3.2 | 83 |
| 166 | 218 | 114000 | 642 | 1970 | 1390 | 72 | 60 | 458 | 49.5 | 6.2 | 17.2 |

18. Natural River Rock - (manufacturer unknown) - very hard calcined clay; light beige; resembles aquarium gravel; 2 to 5mm in size; no organic matter

19. Flourite - Seachem, USA - fractured, stable clay; very hard; multi-colored (brown, red-brown, black); resembles aquarium gravel; no organic matter

20. South Carolina topsoil - South Carolina, USA - sand and silt; large amounts of dark humus; soft and powdery; orange-brown; will float and cloud water

21. Play sand - Lowe's, USA - clean, no visible trash; white and clear; 1mm in size; no organic matter.

22. CaribSea Tropic Isle Laterite - CaribSea, USA - very hard lateritic rock; deep brown-red; resembles large

aquarium gravel; 2-10mm in size; no organic matter

23. Onyx gravel - Seachem, USA - naturally source-fractured substance; appears to be porous clay or rock; very hard; light and dark gray; resembles large aquarium gravel; 2-10mm in size; no organic matter

24. Tetra Initial Sticks - Tetra Products - substrate additive; medium hard, will crumble; dark gray; 5 to 10mm pellets; large amount (>20%) of organic matter; will float and cloud water

25. India local laterite - Northern Nune, India - powdery; deep brick-red; silt-2mm in size; very small amount of organic matter; will cloud water at least temporarily

of those individual decisions. There are good arguments on both sides. Some people allow fish and food wastes to remain, providing food for snails, bacteria, and plants. However, a clogged substrate is not a healthy substrate, so a periodic light vacuuming may not be a bad idea. Most problems can be resolved before your tank needs a total breakdown.

Life Cycles

As with most things, there is a break-in period for substrates. Newly planted tanks may take a few weeks or several months to stabilize. Ammonium, nitrite, and nitrate levels will bounce around until the bacteria are established. Meanwhile the plants will then start establishing themselves and your tank will approach a balanced condition.

As with potted house plants nutrients can become exhausted over a period of time. The planted aquarium also has a life span, so you may need to replace nutrients or the whole substrate. Reverse undergravel filters/undergravel filters (RUGFs/UGFs) and heating cables can affect the life span of the substrate. They cause a greater flow of nutrient water through the bed, improving nutrient exchange rates. It is not known if this increases life span by making a more efficient bed, or decreases life span by using up the nutrients more rapidly.

Heating cables can be used with most substrate choices, but RUGFs/UGFs need to be used with well-consolidated substrates such as hard, calcined clays or lateric rock, and not with laterite dust. Heating cable flow is determined by the amount of heat being used; more heat causes faster flow. The right wattage should be used to get a slow, gentle flow. Undergravel filters present the same issue, again slow and gentle. Too much flow may increase unwanted nutrient levels in the water column.

Testing

One analyst did all the testing. The same instruments were used for all samples, and testing took approximately one week to complete. This is important since methodologies used by individuals may vary. I initiated the research with a

request for testing materials via The Aquatic Plants Digest (<http://www.actwin.com/fish/aquatic-plants/index.cgi>). I had several substrates of my own to start but tested a total of 25, consisting of commercial products, local soils/clays, and homemade blends, a very good representation of available candidates.

Testing consisted of measuring the soils' pH, total leachable metals, and cation exchange capacity (CEC). Soil pH is important because it can influence the pH of your aquarium. Total metals are bound in crystalline structures. Materials release their metals at different rates, depending on the details of these structures. The hard, calcined clays have the ability to retain nutrients longer than the soft, moldable clays.

The CEC determination helps gardeners know which substances are more efficient at nutrient binding. CEC measures a reversible chemical reaction between a solid and a fluid in which ions may be interchanged from one substance to another. The values are expressed in milliequivalents per 100g and are the total sum of exchangeable cations of a substance. As long as a material has a measurable CEC, it should work well in an aquarium's fertile environment.

The pH determination was done with equal amounts of test material and deionized water. The samples were shaken to mix thoroughly and allowed to settle before testing. Testing was done with an Orion 720A pH/conductivity meter. Total metals were analyzed on TJA61E inductive coupled plasma (ICP) instrument. Acid digestion of samples was done according to EPA SW-846 Method 3050A. CEC determinations were done by Method 9081A of EPA SW-846. CEC extractions were also analyzed on the ICP. Samples were analyzed in their original forms. Care was taken to analyze them as they would be used by aquarists. Note that crushing would increase the surface area and may change the parameter values here.

Data Analysis

The table on pages 20 and 21 contains the data from the chemical

analyses of the substrates tested.

Iron/Minerals

Aquatic plants demand a critical supply of iron for proper development. The search for iron sometimes dictates the substrate choices we make. Macro-nutrients like calcium, magnesium, and potassium are also important in plant growth. Zinc, copper, manganese, etc. must be present in small amounts to provide essential micronutrients. First Layer Laterite has the highest amount of iron, a strong 11.8%. The local Indian laterite was right behind, with 11.4%. These values are a good approximation of total amounts. All the lateric soils have good iron content. The redart and natural clays had medium iron content. All others had medium to low amounts. If iron levels are low in your substrate, just amend it with clay or laterite balls. The Yolo loam/vermiculite blend gets an honorable mention for total mineral content.

pH

A majority of aquarists prefer a neutral to acidic substrate. Bacteria often have peak productivity at a pH of about 5.5. Plants best use macronutrients at a neutral pH, while micronutrients work best at a lower pH.

Even though collected a world apart, the two redart clays were similar and had alkaline pHs. The preglacial Ontario clay had a lot of calcium carbonate (CaCO_3) and its pH reflects this. It was very different from the Finish clay, which resembled it in color and composition. The Onyx gravel reinforced its buffering claim with a high pH, but the big surprise came from the CaribSea Laterite, which posted an even higher pH of 9.8. It does not seem to contain any calcium carbonate (CaCO_3).

The organic matter present in some of the samples would seem to dictate low pH values, and that is exactly what I found. The Tetra Initial Sticks had the lowest pH. They would work on new set-ups by getting an acidic bed started, allowing for a quicker exchange of nutrients. Nitrifying bacteria work better in these low pH environments. AquaTerra also contained a large amount

of organic matter and was a close second to the Tetra Sticks. All other samples had close to neutral pH values.

Cation Exchange Capacity (CEC)

Some gardeners swear by CEC values, while others grow aquatic plants with disregard for CEC. It is interesting to know the actual parameters of each substrate, but I've seen plants grown in plain sand and gravel.

The samples that lacked at least some organic matter or clay had slightly lower CECs. The big surprises here were Terralit and Tetra Initial Sticks. The zeolite composition of Terralit provides an excellent ion-exchange medium and has good mineral concentrations. The Tetra Sticks, with their high organic and mineral content, also had a high CEC. The sandy samples had very poor CECs.

Conclusion

The longer you look at the data tables, the more you notice. The numbers provide the aquatic gardening community an invaluable resource. The table can help narrow decision-making and clear up some of the confusion associated with substrate choices.

I hope this analysis and overview has provided a good starting point for a successful planted aquarium. Regardless of data or arguments, it is still up to the individual to decide what's best for his needs. I have grown plants in sand, gravel, Flourite, and litter. All substrates gave good growth, given all other parameters were optimal. It's true some were more attractive, had higher iron levels, or contained more organic matter, but all can be used if set up and maintained properly.

About the Author

Jamie S. Johnson is a trace metals chemist and has been in the aquarium hobby for more than 15 years. He has been growing aquatic plants for about five years. Jamie is a member of the Aquatic Gardeners Association and The Aquatic Plant Digest. He can be reached via email at jjirons@greenwood.net

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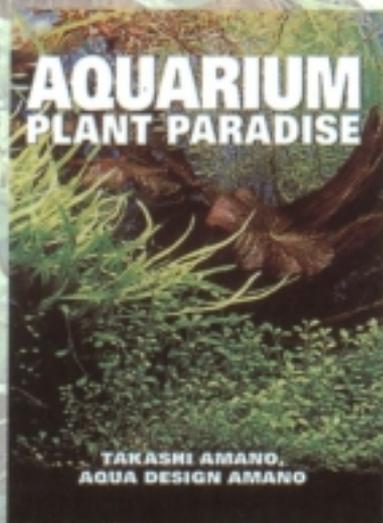


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Starting an Aquarium Club

John Glaeser

Purpose, plan, action, and momentum are key ingredients that help in establishing an aquarium club. These were the common threads found when comparing two recently established associations. They both happen to be planted aquarium groups. One started in San Francisco in late 1998. Another in Madison, Wisconsin began January 2000. The fact that they evolved differently emphasizes there is no single way to start a group. Blending influences of good examples with the creative potential of your group and community seems to offer a most promising pathway for developing your own club.

Our two examples had something in common in the beginning. They both had a frustration so pronounced they could not deny the urge to confront it boldly. Dave Gomberg says things in San Francisco became almost visceral. He was aware that Karen Randall, a distinguished aquarist and author, was planning a speaking tour including the Pacific Northwest. Why not a stop at San Francisco? After all, many Bay Area hobbyists were into aquarium plants. This should have been easy. It wasn't. When Dave asked if any one of the three clubs in the area could host this expert, each club had reasons not to. We will see how this led to forming a club a little later.

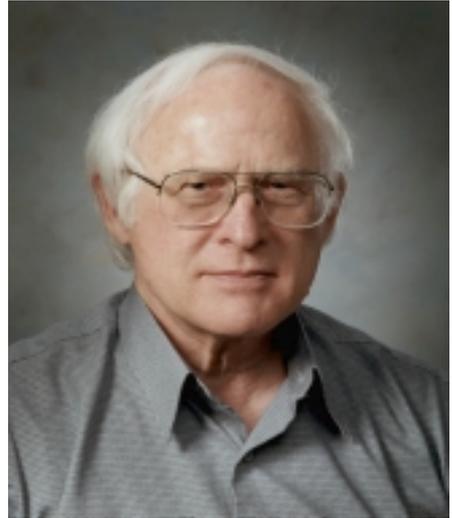
So what bugged me in Madison? The frustration could not have been more different. I saw small pet stores going out of business because of the growing number of mega chains. Quality plants were hard to find. If I got to the stores three days after the plant delivery day, the stock looked bad. No wonder. Plants in tanks with aggressive aeration will not survive. The CO₂ is removed! The hobby in the community was going down hill fast. I started volunteering time at the neighborhood aquarium store to promote the idea of live planted aquariums. The store soon got an artistically composed 75-gallon show tank and two 55-gallon sales tanks—all CO₂-fertilized and loaded

with a wide variety of healthy stock. Word-of-mouth did the rest; in came eager novices and experienced aquarium plant lovers alike wanting to buy plants and learn how to create beautiful, algae-free aquascapes.

One customer said, "What this town needs is an aquarium club."

Another asked, "How about one with an emphasis on aquarium plants?"

We'll see if anything came from this in a moment. For now, let's pop back to Dave's dilemma and look at the surprising plan he had up the sleeve.



John Glaeser wrote this article and founded the Madison Aquatic Gardeners.

The first of September came. Time was running out. Dave and aqua plant friends needed to find a way to have Karen make a stop in San Francisco. With a nudge from his plant buddy Steve Dixon, Dave made what he says was an "an executive decision" on September 2, his birthday. He would guarantee the expenses of the guest's appearance. Plans and actions followed quickly. A host site was needed, and the San Francisco Bay Area Aquatic Plant Society (SFBAAPS) was formed and became the sponsoring organization. No stopping the momentum now. An

Internet list helped identify the 15 local members needed to break even at a \$20 annual membership fee. Steve Dixon's lovely home was available for the first meeting. Support was solicited from vendors and Seachem was the first with a generous gift of Flourish line fertilizers.

Members got a lot done in the first meeting: selected eight officers, had a delightful guest give a wonderful presentation, and took in a collection of plants to sell to help support the society. What a turn around. Angst into blooms of happiness!

Back in Madison, though the customers could leave behind the frustration of not being able to find good plants they still needed something. They missed having the opportunity to grow in knowledge through fellowship. I made my big decision. It took the persistent urging of one earnest plant enthusiast to push me onto the starting line. By the end of December, a poster announcing the organizational meeting for the Madison Aquatic Gardeners Club was tacked up next to the show tank in Aquatic Specialties, a great aquarium store. The event would happen January 27 at Olbrich Gardens, a local horticulture site. I got the word to more than thirty people with whom I had great conversations about planted aquariums.

Seventeen showed up at the beautiful Olbrich Botanical Society facility to get things started. After round-the-table introductions and details of where each was with aquarium plants, we jumped to one big brainstorming session based on a list of potential goals and activities that could define a club and keep it vital. This was exhausting. Creative chaos!

We obviously needed to get focused. As it happened, that is what occurred during our next meeting. Having just enough formality to keep things on track is what is working for us at this time. Once folks get to know each other better and as needs for leadership in various areas become evident, I think people will come forward. We will see about electing officers after a bit and collect dues at the end of the year. A development grant to the organization covers on-going expenses relating to mailings, copying, refreshments, lending library acquisitions and research projects.

With a history of only two meetings at this writing, Madison Aquatic Gardeners is still testing the waters. The second meeting had 20 attendees, including nine new faces.

The group identified a strong focus and created patterns for the future. We had an exceptional book review presentation on the title: *Dynamic Aquaria: Building Living Ecosystems* by Adey & Loveland.

The club may have an opportunity to put some of these theories into practice soon. We have a chance to install an aquarium for the Olbrich conservatory and horticultural staff. They want to learn more about this gardening niche. Future expansion of the facility calls for a major planted aquarium venue, and they want to be prepared. What a club opportunity! Building a lending library is in progress, water testing service will be offered and a website is in the works. We plan to make detailed accounting of technical discussions occurring at each meeting so those missing can keep up with the conversation. Having 12



will grow.

This beautiful planted tank graces the Aquatic Specialties Store in Madison, Wisconsin, an early support of the Madison Aquatic Gardeners.



Aquatic Specialties, a focal point for the growing hobby movement, showed the first poster of the

meetings a year seems right, and we will try some form of open house aquarium viewings now and then. A twice-monthly e-mail bulletin keeps news flowing between meetings. Traditional mailings go to those without a computer. It is too early to know how things will turn out. We do expect success.

SFBAAPS has established a sure strategy to carry them forward. A nice webpage with links keeps everyone informed. Folks meet in the homes of members. Five formal meetings a year and five open fish rooms are on the calendar. As aquarium experts pass through their area, the club is in a good position to net a few for guest presentations.

“If you already have a local general club, start there and work with them. You will all benefit from the synergy involved. If there is no local club, or if the local club won’t support the interests of the ‘plant people’, then get a few people together in someone’s living room, enjoy each other’s company, and see where it goes from there. Don’t get too caught up in what the group ‘should’ be doing or what other clubs do. Keep it fun, and people will keep coming back”, says Karen Randall.

And I would conclude: Talk about

where you would like to go with the group. Put to paper a wish list of things you want to do and how to achieve them. Consider making some letter-sized posters and club information sheets. Visit local pet stores and garden centers and get them interested in supporting your club idea. Most won’t mind displaying the poster and handing out information sheets to interested customers. As your numbers increase, some stores might even want to support the association by providing a modest discount to club cardholders. There might actually be a store delighted to have your new club set up a gorgeous planted ecosystem and have you take care of it. If the local newspaper has a garden and home section, perhaps they could write a small article with a picture of this unique aquatic venue at the store. This would be a way of telling readers about the joy of keeping aquariums with live plants and informing them that there is a club in town that can help them learn more about this fascinating hobby.

Beginnings can be modest. Starting small instills an initial confidence as you look toward the future. Ideas and possibilities will emerge during this incubation period and your organization

New Managing Director at Tropica, Denmark

Claus Christensen, Tropica's deputy director for the past five years, takes over as managing director of the company on May 1, 2000.

Tropica's owner, Holger Windeløv, who founded the company exactly 30 years ago, will be continuing as chairman of the board. Windeløv will now concentrate on the development of new aquarium plants.

Christensen will continue the close links between Tropica's management and the aquarium hobby world. Since his youth, he has been an aquarium plant enthusiast and in great demand as a lecturer worldwide. He has traveled widely, collecting and learning about plants from tropical rivers and lakes.

Forty-five-year-old Christensen was originally trained as a teacher of physics and chemistry. He started his career at Tropica in 1981 in the production department, has managed project work and sales, and since 1995, served as deputy director of the company.



Claus Christensen

Tropica's web site:
<http://www.tropica.dk>

Errata and Addenda

The following are errata and addenda for *Planted Aquaria Magazine* Spring 2000.

Photos, page 9. The "Mizukusa Club" is not a club. The tanks are the artistry of Mr. Minol Watanabe, the aquarium plant store's owner,

Photo, page 10, top. This is a tank by Jeff Kropp of Oakland, CA.

Page 26. The first American book to show the pygmy chain sword was the 12th edition of *Exotic Aquarium Fishes* published in 1951.

Photo, page 27, left. The plants in the foreground are the micro leaf variety of *E. tenellus* ("tenellus" was occasionally misspelled "tennellus").

Photos, page 27, bottom and p. 28, top. The captions were reversed.

Page 33. The reference to Mühlberg 1982 should have been to Rataj 1975.

Photo, page 34. Plant name was misspelled. It is *Eleocharis baldwinii*, also called *E. parvulus* and sold as dwarf "hair grass".

Page 34. "*Echinodorus tenellus* var. *parvulus*" is no longer a valid name; the reference is to the "larger form" of *E. tenellus*.

Page 34. The correct name for the plant sold as *Lilaeopsis novea-zelandiae* is *L. brasiliensis*.

Photos, page 35. Plant names were misspelled. Correct names are *Lilaeopsis brasiliensis* (left) and *L. carolinensis* (right).

Love The Algae

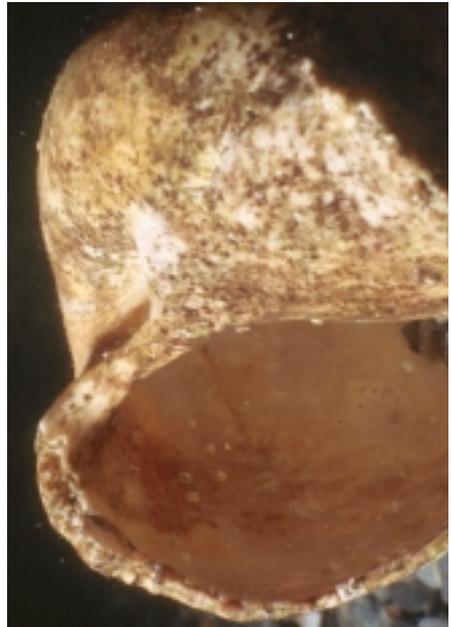
Brad Metz

I have a bumper sticker that reads, "Love the Algae." There, I've said it. How can one find love in the most hated denizen of planted aquaria? It's quite easy; actually, algae have many redeeming characteristics. They provide the Earth with 50 to 60 percent of its oxygen. Though algae can be found in the most diverse habitats, they are probably the most misunderstood organisms we are likely to encounter.

Before my conversion, I, too, wondered what made the brown slime give way to the red and green slime and why some of the worst words in the language were "bloom", "brush", "beard" and "bunch". Usually the appearance, disappearance, and recurrence of algae are linked to some biological factor. Under favorable conditions, a given alga will appear and multiply (the day before guests arrive) until conditions that were once suitable become unfavorable. At this point you think, "OK, unfavorable equals death?" Well, if it were that easy, would the word "algae" send quivers down your spine? No. Actually, unfavorable conditions can sometimes mean death, but usually just trigger the alga to reproduce. Hence, the "thing" you were trying to eliminate returns in greater numbers if conditions continue to favor it. By the end of this article, you will better understand what algae are, how they are characterized, what types we are most likely to encounter, and how to roughly identify them; and at the same time, have a more patience with the lovely algae.

How and where algae fit into the whole organization of living things has been debated for quite some time. While botanists say, note that algae photosynthesize (make sugars from CO₂ and water with light as an energy source), zoologists say, "Watch them swim and react to a stimulus." In the five kingdoms of living things, we have bacteria (Monera), animals (Animalia), plants (Plantae), Fungi, and Protista. You may have been putting a mental picture with the first four as you read the names; what did you put with the last one? If you pictured any of the algae, then

you're right! The protists are a funny group. This group seems to be a catchall when something does not fit somewhere else. For example, there are animal-like protists; like flagellates, ciliates, and amoebas; fungus-like protists that are not fungi because they lack chitin and have different life cycles, for example slime molds; and finally plant-like protists formerly classified as plants. It is these plant-like protists we refer to as algae. Very simply put, algae are photosynthetic protists and are not grouped with plants because they do not protect the product of sexual fertilization (seeds) and do not have true roots,



Shell encrusted with diatoms (so-called brown algae).

stems, and leaves.

Algae, the photosynthetic protists, are characterized and subdivided into groups based on primary and secondary (accessory) pigmentation, modes of reproduction, and photosynthetic storage products. Though they do reproduce in our aquaria, the chances of collecting and then identifying a given alga based on mode of sexual reproduc-

tion is slight. Sexual reproduction is used more for description than identification. If we focus on the primary and secondary pigmentation we can go a long way toward determining the alga (singular) or algae (plural) found in our systems. Then we can use gross morphological characteristics to further identify the alga in question.

Primary pigmentation comes from chlorophyll. Chlorophyll is the light energy receptor in photosynthesis and what gives “drier” plants their green color. Three types of chlorophyll are present to some extent in the algae. Chlorophyll *a* occurs in all photosynthetic eukaryotes (organisms whose cells have membrane-bounded organelles) and in cyanobacteria (formerly called blue-green algae) and is considered essential for photosynthesis in these groups. Chlorophylls *b* and *c* act as “accessory” pigments to chlorophyll *a* by broadening the light absorption capabilities of a given alga or bacteria. They also help the alga or bacteria live in more diverse conditions because light of different spectral qualities can be used for photosynthesis. Though chlorophylls *b* and *c* can harness light energy at different wavelengths, they still have to transfer the energy they capture to chlorophyll *a* before it can be transferred to chemical energy “permanent” storage.

The next set of accessory, or secondary pigments, are carotenoids. Carotenoids are red, orange, or yellow and absorb light in the complement of their color. In some cases, the secondary pigment, which is not directly used in photosynthesis, can be in such quantity that the green color of chlorophyll is “masked” or “blended”. A couple of good examples are diatoms with a golden yellow coloration and some of the saltwater red algae.



Oedogonium on *Vallisneria* leaves

The last group of accessory pigments is the phycobillins. They are found in red algae and cyanobacteria. Two of these pigments predominate: phycocyanin (blue) and phycoerythrin (red). Again, these pigments help to broaden the usable photosynthetic spectrum and allow algae or bacteria to live in more diverse habitats.

Cyanobacteria, or blue-green bacteria, are photosynthetic bacteria that are often confused with algae. Blue-greens photosynthesize and grow in similar fashions to some of the algae but have a prokaryotic (bacterial) cell type. Though they use light to make food, they do not have a membrane-bounded chloroplast. But they do have chlorophyll *a*, carotenoids, phycocyanin, and phycoerythrin. In addition, blue-greens do not have a membrane-bounded nucleus or many of the organelles found in eukaryotic cells. Blue-greens are found in both freshwater and saltwater and are differentiated mainly by morphology (pertaining to shape and form) characteristics. The most common cyanobacteria we are likely to encounter is *Oscillatoria*. This genus contains many species that are identified by lack of a sheath or mucus layer surrounding the filament, cell size and proportions, and morphology of the apical (pertaining to the growing tip) region. The genus



Oedogonium on a *Vallisneria* leaf, micrograph.

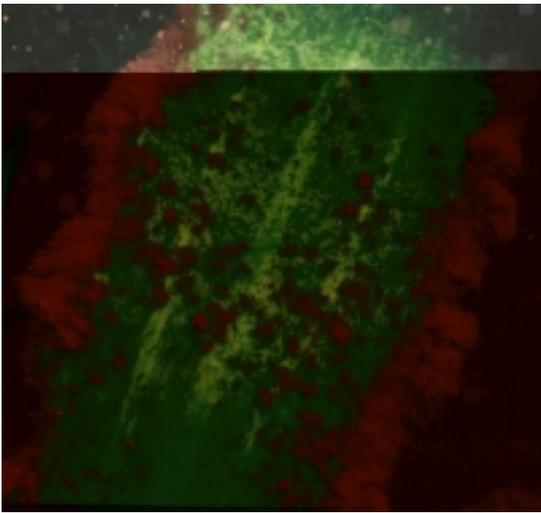
Oscillatoria consists of bacteria with unbranched filaments that differ in diameter, height-to-width ratio of the cell, and variations in the growing tip. Due to lack of other physical characteristics, this genus is difficult to identify. If the sample is not clearly a blue-green color, it may appear red, yellow, orange, blue, or green. It can be differentiated from the green algae with an iodine-based stain that will turn dark in the presence of starch from the green alga but not change in the presence of the blue-green. One of the redeeming characteristics of the blue-greens from our perspective is the fact that they usually occur epilithically (growing on the substrate) and are easily removed or eliminated with antibiotics. Use this latter method for removal with caution because it could have ill effects on some fish or plants, or you may select for an antibiotic-resistant strain of blue-green.

Diatoms (Chrysophyta) are in the class Bacillariophyceae (diatoms) and represent a large portion of the phytoplankton in both freshwater and saltwater environments. Diatoms are mostly unicellular and have both

chlorophylls *a* and *c* along with the carotenoid fucoxanthin that gives the cell its yellow-brown color. Though unicellular, diatoms can form chains and appear as filaments that look more morphologically complex. One way to find out is to look at them under a microscope—even at low power. They will appear golden-brown and be either centric (radially symmetric, usually marine species) or geometric (square or hexagonal, for example) in shape. This morphology is sustained by silicon dioxide and water polymerized to form a shell or frustule. The occurrence of diatoms is directly linked to the presence of silica in the aquaria. Diatoms can only divide if silica is present to make the new frustule during cell division. Once diatoms

appear, the best remedy is to let them run their course or find the source of silica and remove it. In most cases, diatoms “starve” themselves for silicate over time. In a laboratory setting, diatoms can be eliminated from a culture by supplementing germanium dioxide into the media. Diatoms use the germanium instead of silicon dioxide, and cell division remains incomplete. I will test the effect of germanium dioxide on plants, fish, and inverts and the proper dose for aquaria in the near future.

Green algae (Chlorophyta) are the direct ancestors of land plants. Green algae, unlike any other group except land plants, have chlorophylls *a* and *b* and store their food reserves in the plastid as starch. With more than 7,000 species, most of which occur in freshwater, we will only discuss the most common in our systems. Two of the families have representatives that occur in freshwater and saltwater aquaria, one commonly known as “cluster algae” and the other, a relatively new introduction, *Cladophora*. Cluster algae, or *Ulothrix*, is a filament that does not branch; has chloroplasts that are cylindrical, plate-like, or ribbon-like; and cells that are wider than they are



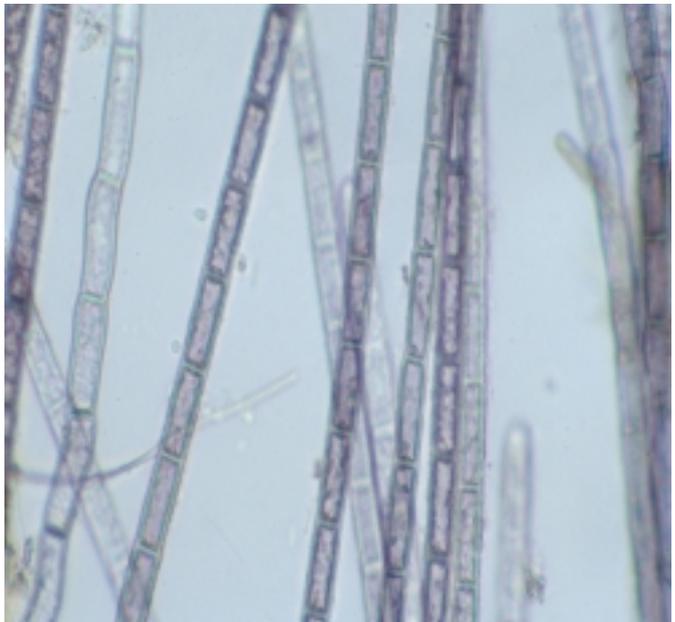
Black brush algae, *Rhodocorton*.

tall or long and cylindrical. A cell's height is measured along the apical axis (axis through the apex) and the width is measured at right angles to this axis. Cluster algae usually occur as entangled masses that do not seem to attach. *Cladophora* occurs in both freshwater and saltwater and is found in the ocean as a green clump that is coarse in appearance. Much like its relative in the ocean, *Cladophora aegagropila* grows as a ball-like clump that is green and coarse in appearance. Though new to the hobby, it should be easily propagated and could find a niche in almost any aquarium (see cover).

Another green algae we are likely to encounter is from the same family as *Cladophora* and is commonly referred to as "bunch algae". Bunch algae, or *Pithora*, appears similar to

Cladophora but does not have the "balling" habit. Instead, it grows in open spaces (as branching filaments) and interwoven among plants. Branching in *Pithora* is different from *Cladophora* because it occurs at right angles to the main axis, and in *Cladophora*, it occurs at acute angles. *Pithora* generally grows as an epiphyte (growing on other plants) on aquarium plants and forms short bunches that resemble a bad, green haircut. *Oedogonium*, pelt algae, can be confused with *Pithora* because they both grow as epiphytes and have a similar growth habit. The easiest way to tell them apart is by the branching pattern; the

previously mentioned *Pithora* has right-angled branching while *Oedogonium* does not branch. The lack of branching gives *Oedogonium* a "neater" appearance when compared to *Pithora*. *Spirogyra*, a filamentous green alga, at first glance could be confused with



Rhodocorton at 20x magnification.



Algal fauna. Algae play host to many small animals.

Ulothrix. But one look under the microscope differentiates the two. *Spirogyra*, as the name implies, has chloroplasts that spiral around inside the cell.

Red algae (Rhodophyta) have chlorophyll *a*, phycobillins, and carotenoids that mask the usual green color of chlorophyll. In freshwater, red algae usually do not appear red but as shades of green, gray, and black. Red algae are the most ancient of the algae, and evidence exists that suggests that the red algal chloroplast came from a symbiotic event with a blue-green bacterium. Reds are predominant in saltwater where they outnumber the rest of the seaweeds combined with more than 4,000 species. In freshwater, however, only about 100 species are known. Two are found commonly in planted aquaria: beard and black brush algae. Beard algae, or *Compsopogon*, form relatively thick, frequently branched filaments that attach epilithically (growing on rocks/gravel) or epiphytically. Of all the algae men-

tioned, this one is largest in diameter. Cortical cells develop and surround the axial filament. *Compsopogon* also grows longer than other algae that attach as epiphytes, and although it is a red, it often appears grayish-green. *Rhodochorton*, black brush algae, is a short-branched filament with one disc or ribbon-like chloroplast. Most commonly found as an epiphyte on plants, it can also grow on wood and rocks. As its common name suggests, when in good health it appears black.

Now that we've covered the most common algae, let's talk about why they appear and why some are easily removed while others "hang on" forever. This first question is quite easy. Think of our aquaria as a garden for wet plants; in a garden, how often do you find weeds? Right before the gardening club shows up, you find quite a few. They are a natural part of the terrestrial garden; algae are the "weeds" of the planted aquaria.

Just think of all the light, nutrients (CO_2 , NO_3 , NH_4 , etc.), and habitable substrate we provide. Since algae use the same light receptors, have similar demands for water quality, and most grow on a surface we provide, it would be almost a miracle not to see them. How can we limit their growth? Like plants, algae can only grow as fast as the limiting resource allows. In a simplified example, if an alga and a plant need trace elements A and B in equal proportions to grow maximally, and only 50 units (a small amount) of A are available, then only 50 units of B can be used. If this persists for any period, the plant may become unhealthy and die where the alga may reproduce in hopes that some of its "spores" find a more habitable environment. If, at this time, you perform a water change, an unhealthy plant may not bounce right back while the algal spores will start dividing quickly to exploit the new conditions. Although this is a simplistic scenario, I have seen many situations just like this. As a side note, a plant does not have to

look bad for it to be unhealthy, and an alga, in the eyes of most, are unsightly to start; so when do they actually look bad?

The second question deals with an alga's strategy for survival that has evolved, in some cases, for about 100 million years! In general terms, an alga has a life history strategy as in the above example where the alga reproduces in times of nutrient stress. Each alga has its own strategy that allows it to inhabit a given niche. If that niche is duplicated in the aquaria and the alga is present, it will colonize the space. Once colonized, the alga has many strategies for survival that allow it to persist.

As all of us have noticed, some algae appear and grow like crazy, while others just seem to persist and spread at a gradual rate and others have a rough texture between your fingers. These are signs of strategies that algae use to grow and reproduce in certain environments. Each one of these strategies has some cost/benefit to it, and evolution shifts the value toward the maximum. An alga that grows quickly can reproduce at a relatively young age but does not have the "time or energy" to protect itself from predation. Generally filamentous greens take on this strategy and try to outgrow herbivory. In a natural setting, this works just fine but ten *Otocinclus* and five Siamese algae eaters in a 20-gallon tank is not quite natural. This may be part of the reason the greens are innocuous. The diatoms, on the other hand, also grow

quickly but have a defense mechanism of forming a frustule. This limited strategy still allows them to grow at a decent pace but at the same time offers some form of protection. Again, when conditions are right, diatoms can appear "overnight" and persist for some time. This combination of strategies allows diatoms an advantage over evolutionary time. Finally the reds appear, spread slowly (compared to greens), and persist for what seems forever. Reds have the ability to produce secondary compounds (ones that are not mandatory for growth) that deter herbivory by making themselves taste bad to herbivores. As a cost for producing compounds that are not needed for its own cells, the alga grows slower and takes longer to sexually mature. This explains why it's hard to find a fish or snail that just loves that black brush alga.

Now that you have a better understanding of what algae are, where they fit biologically, the most common ones we are likely to encounter, and why they persist and grow the way they do, I hope you will have more patience with algae. And maybe someday, as you look at your prized *Cladophora* in the center of your family room show tank, you'll think to yourself, "I love the algae."

Finally I'd like to thank my wife, Saint Kari, for letting me fill the basement with tanks; my parents, Al and Cyndie, for the same; and Kathy Watson and David Lass for donating their aquaria.

High Tech



Cartoon by Lori Shimoda



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