Updating *Ecology of the Planted Aquarium*

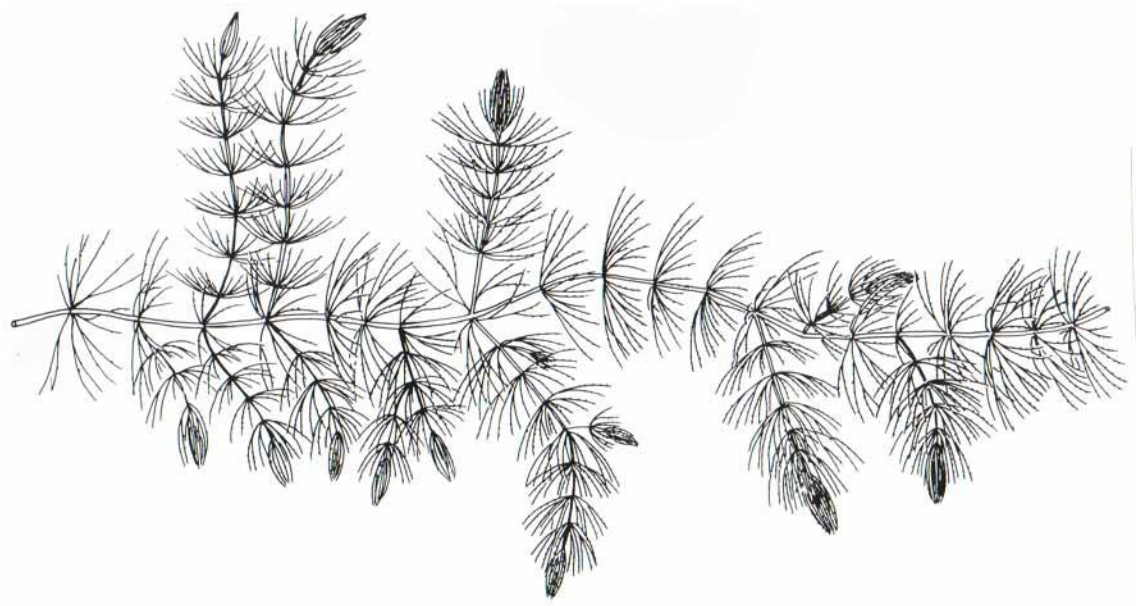
In July 2018, I contracted with the printers and eBook preparers to replace 4 pages of my book. With the advent of LED lighting, I thought changes on the subjects of lighting and plant daylength were warranted. Otherwise, the book will be IDENTICAL to the 3rd Edition (2013). These changes will probably not wind their way through the "book system" until 2019.

The four replacement pages, which follow this announcement, are summarized below:

- Page 178 and 179: Updated sections on Lighting and Daylength

- Page 185: Included the new scientific reference by M. Sultana (2010)

- Additional Information Page: Added new article titles to the list of the author's supplemental articles



2. Light *[Section revised in 2018 and Fig. XI-1 (of clamp light) deleted.]*

Advice on lighting often degenerates into a baffling muddle of technical terms. With the advent of LEDs, we now get a regurgitation of old definitions along with a "pile-on" of new information. Many hobbyists—and not just beginners—are left whirling in confusion.

I purposely left my section on fluorescent lighting in the book to show that plants can adapt to sub-optimal spectra. In the 1990s, cool-white fluorescent bulbs were severely criticized. True, these lights with their greenish cast left a lot to be desired in terms of aesthetics. Yet these inexpensive, readily available lights would grow plants both for scientists and less-demanding hobbyists. Supplemented with window light, they served me well for many years. The main problems were clumsy fixtures and squeezing enough light bulbs over the tank. The situation improved dramatically with the advent of CFLs.

In 2017, I began switching to LEDs. They have become the norm in the aquarium hobby. Strip-type lamps containing 2-3 rows of diodes are now readily available and reasonably priced. Lamps are lightweight, sleek and provide plentiful light without the need for reflectors.

I choose LED lamps designed for growing terrestrial plants or aquarium plants and having a color temperature between 5000K to 6700K. However, this is not a requirement. 10,000K will still grow plants and the light rendition is not that bad. I know because I mistakenly ordered several 10,000K lamps and found that both the plants and I could live with them.

Given a choice, I would select fixtures with some red diodes, because white diodes are deficient in red wavelengths. The only lamps that I would avoid buying are those designed for marine reef tanks. These lamps have far more light intensity and blue light than what is required by aquarium plants. Most submerged plants are basically shade plants; they need much less light than many terrestrial plants, emergent/floating plants, and marine corals. Excess light only stimulates algae.

The inexpensive LED fixtures that I currently (2018) use [e.g., Beamswork and the Feit (GLP24FS/12W/LED)] produce more than enough light for my 10 and 20 gal tanks, which are only 12" (30 cm) high. In general, more expensive brands produce brighter light. They are better suited for deeper tanks or those supplemented with CO_2 injection.

I cover most of my tanks with glass lids. In the past, I used glass rectangles prepared by the local glass cutters. Now, I have found that glass covers for aquariums are readily available.

I use "low-tech" light timers from the hardware store to automatically control the lighting regimens for my tanks.

a) Daylength *[Section revised 2018]*

The daylength (i.e., photoperiod) currently used by aquarium hobbyists for their tanks varies dramatically—from 8 to 14 hours.

Aquatic plants in their native habitats receive 12 to 14 hr of light per day during the growing season. Shorter daylengths—after a period of several weeks—signal the onset of winter, the dry season, etc. They trigger a hormonal change within the plant. Plants enter a dormant state, characterized by decreased photosynthesis and increased leaf senescence.

However, plant species vary widely in their daylength requirements. Moreover, environmental factors can change those requirements. For example, one experimental study with the submerged plant *Potamogeton wrightii* [1] showed that plants grown under an 8 hr daylength

collapsed after 56 days. In contrast, when the investigators grew plants under reduced N and P nutrients, the '8 hr plants'—while growing slower than the '12 hr plants' and '16 hr plants'—did not collapse.

Plants in the aquarium receive far different lighting than plants in the natural world. In streams and ponds, light intensity depends on time of day, presence of overhanging trees, etc. In the aquarium, plants get the same intensity from artificial lighting all day long. And with the advent of LEDs, that intensity has increased greatly. This may explain why a short daylength of 8-9 hr works well for many hobbyists, whether their tanks are "high-tech" or "low-tech." Indeed, intense light with daylengths longer than 8-9 hr can cause severe algae problems.

I maintain a daylength of 12-14 hr, but with a dark period (i.e., "siesta") of 2-4 hr at midday. One advanced hobbyist runs his "high-tech" tanks with a 12.5 hr daylength containing both a morning siesta (1.5 hr) and an afternoon siesta (3 hr).

Siestas help control algae, especially in tanks without CO_2 injection. For with continuous intense light, plant photosynthesis depletes most of the CO_2 by late morning. This means that during the afternoon, plants are competing for an ever dwindling supply of CO_2. Algae, which is much more adept than plants in taking up CO_2, gains an advantage over plants.

I surveyed several of my tanks and found that CO_2 levels invariably rose during a midday dark period. For example in one of my tanks, CO_2 rebounded almost to pre-dawn levels during a 4 hr siesta (**Fig XI-2**). I believe that the dramatic CO_2 recovery was due to rampant photosynthesis following the siesta. Morning photosynthesis oxygenated the water, and in turn, stimulated bacterial metabolism and decomposition. Bacteria quickly started pumping out CO_2.

Siesta regimens reduce algae's "afternoon advantage" over plants and provide a natural daylength for plants—all while consuming less electricity. It's a "win-win."

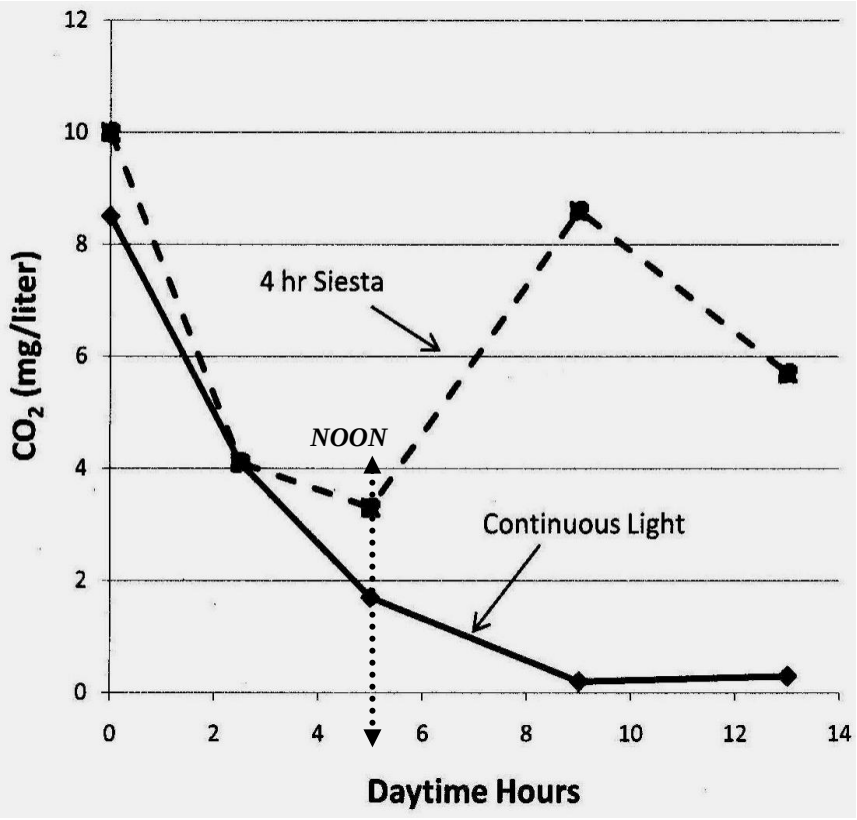


Figure XI-2. Effect of an Afternoon Siesta on CO_2

I measured CO_2 levels in my tanks using a LaMotte test kit and the titrimetric method for free CO_2.

For 'Continuous Light', lights were on from 7 AM ('0' Time Point on graph) to 9 PM ('14' hr Time Point). I made my last CO_2 measurement at 8 PM, one hour before the lights shut off.

For '4 hr Siesta', I monitored the same tank again the next day, except that the overhead lights were off from noon to 4 PM.

I obtained similar results with my other tanks. Window light received during the siestas did not seem to alter the general pattern.

Plant fertilization- Artificial fertilization with CO_2, trace elements, and macronutrients is unnecessary if the tank contains a soil substrate, the fish are fed well, and nutrients are not removed by over-zealous tank cleaning.

Table XI-1. Water Hardness Categories

Classification	ppm or mg/l $CaCO_3$	GH or °dH
Very Soft	0-70 ppm	0-4
Soft/Hard	71-140	5-8
Medium Hard	141-320	9-18
Very hard	>321	>18

Note: Water hardness (combined Ca and Mg concentrations) is reported by water treatment plants as ppm $CaCO_3$. Hobbyist test kits, however, usually quantify water hardness as GH, German degrees of water hardness. (One GH = 17.8 $CaCO_3$)

Water hardness- Water should not be too soft. Softwater is depleted of several important major nutrients. Plants may do poorly or even die (see page 114). **Table XI-1** categorizes water hardness. Hobbyists with excessively softwater (GH less than 4) and poor plant growth may need to increase water hardness (see pages 86-87).

Chloramine- Municipal water may contain chlorine or chloramines. Fish can tolerate traces of chlorine; excessive amounts can be easily removed by degassing. Chloramine detoxification requires specific water conditioners. Some advanced fish breeders have installed water purification systems in their fish rooms to prevent sporadic fish kills due to chloramine.

Snails- Although snails are frequently disparaged, they do not eat plants and are actually quite useful. Snails clean plant leaves of debris, algae, and bacteria. They speed decomposition, so that nutrients recycle more quickly to plants. Malaysian Trumpet snails tunnel into the substrate, thereby aerating the substrate. Many fish (Clown loaches, Bettas, etc) relish snails and can be used to control excessive snail populations. I keep snails in all my aquariums.

Temperature- The temperature in my tanks varies from 70-85°F degrees depending on the season, heater, etc. During summer, I turn the heaters off and open up the glass covers so hot air can escape. After switching to the Siesta regimen and LED lighting, my tanks have had less problems with overheating.

REFERENCES

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2. Richards K. July 1987. The effects of different spectrum fluorescent bulbs on the photosynthesis of aquatic plants. *Freshwater and Marine Aquarium*, pp. 16-20.
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5. MacRae TH and Pandey AS. 1991. Effects of metals on early life stages of the brine shrimp, *Artemia*: a developmental assay. *Arch. Environ. Contam. Toxicol.* 20: 247-252.
6. Barr T. Dec 2009. Dry-Start Method. *Freshwater and Marine Aquarium*, pp. 54-61.

Additional Information

- **Author's website:**

<http://www.dianawalstad.com>

The 'Aquarium Plant' page of the above website contains articles by Ms. Walstad. (They can be downloaded for free.)

- "Mycobacteriosis in Aquarium Fish"
- "Small Planted Tanks for Pet Shrimp"
- "Nitrogen Uptake in Aquatic Plants"
- "Treating Fish for Camallanus and Other Nematodes"
- "Parasite Surveys of Aquarium Fish" (2018)
- "Flukes and Sick Guppies" (2018)
- "Hatching and Growing Brine Shrimp (2018)

Website also offers a preview of her latest book *Family History (1860-1950) of a Doctor's Daughter*. This 2017 book follows the lives of the author's ancestors beginning with their 19th century emigration from Scandinavia and The Netherlands to America. The family tale is fleshed out with tidbits of European, Chinese and American history. For those wishing to write an authoritative story of their ancestors, this 241 page paperback provides a worthy example.

1946 photo shows author with her father and the SS *Monterey* at a dock in San Francisco Bay. He was a medical officer on his way to Australia to bring "war brides" and their babies to America. Another immigration story…

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