CHAPTER 4
AQUARIA

Figure 1. The dangling moss *Fontinalis antipyretica* (willow moss) adds interest and hiding places in aquaria. Photo by Li Zhang.

Aquarium Bryophytes

In aquaria, mosses not only are decorative, but provide oxygen, hiding places, and egg-laying substrates (Benl 1958). Fish such as danios and killies will lay their eggs in the moss (Tinkerfish). Many taxa can be used, provided the water is not too warm and copper content is low, including common taxa: *Bryum pseudotriquetrum* (Figure 2), *Fontinalis antipyretica* (Figure 1), *Leptodictyum riparium* (Figure 3), *Platyhypnidium riparioides* (Figure 4), *Riccia fluitans* (Figure 5), *Ricciocarpos natans* (Figure 6), *Taxiphyllum barbieri* (Figure 7; Figure 8), and *Vesicularia dubyana* (Figure 9) (Benl 1958; Cook *et al.*, 1974; Takaki *et al.*, 1982; Gradstein *et al.*, 2003; Tan *et al.*, 2004).

One should be aware that scientific names provided by aquarium stores are often wrong. I have seen *Leptodictyum riparium* labelled *Fontinalis* and *Taxiphyllum barbieri* is often misnamed as *Vesicularia dubyana*. 
Figure 2. *Bryum pseudotriquetrum* grows in marshes and in shallow water at lake and stream edges. It can make an interesting small forest on the bottom of an aquarium. Photo by Michael Lüth.

Figure 4. *Platyhypnidium riparioides* (also known as *Rhynchostegium riparioides* and *Eurhynchium riparioides*) is a stream moss that grows in dense clumps. However, some people have succeeded in keeping it as an aquarium moss. Photo by Michael Lüth.

Figure 3. *Leptodictyum riparium* (stringy moss) adorning an unusual aquarium. Photo by Sze Wei Tan.

Figure 5. *Riccia fluitans* can be grown floating or in balls at the bottom of the aquarium in medium soft to hard water, pH 6-8, 15-30°C (Aquatic Community). Photo by Janice Glime.

Figure 6. *Ricciocarpos natans*, a thallose liverwort sometimes used in aquaria. Photo by Janice Glime.

Figure 7. *Taxiphyllum barbieri* (Java moss) provides dimension to the aquarium and permits little fish to hide from larger aggressive fish. Photo by Sze Wei Tan.

Java moss (often incorrectly identified as *Vesicularia dubyana*, Iwatsuki 1970; Tan et al. 2004) is a popular tropical moss that is highly tolerant of a wide array of water chemistries and temperatures and may even help to absorb the ammonia derived from the fish. Singh (in Tan 2006a) describes growing conditions as with or without fertilizer, with or without added CO₂, with or without added light, temperatures to 30°C, and tap water. It grows rapidly and will fill the tank in short order, but is easily removed.


Unfortunately, the name Java moss has been applied to a variety of aquatic mosses sold for aquaria (Tan et al. 2004). The true Java moss (*Taxiphyllum barbieri*; Figure 7) has flattened, oval-oblong leaves arranged on two sides of the stem and branches, and possesses two short costae (Figure 8). Its narrowly oblong leaf cells differ from the shorter ones of *Vesicularia* spp. (Figure 9)

Figure 8. The leaf of *Taxiphyllum barbieri*, the true Java moss, has two short costae and narrowly oblong leaf cells. Photo by Sze Wei Tan.

Figure 9. The moss often mistakenly called Java moss is *Vesicularia dubyana* (Singapore moss) and has shorter cells. Photo by Sze Wei Tan.

The true Java moss is the easiest to grow of all the aquatic mosses (Tan & Leong; Tan 2006). It thrives not only in cool water, but in low light at tropical temperatures of 28-30°C, temperatures that would soon result in the death of the common temperate moss *Fontinalis antipyretica* (willow moss). In my aquarium, I need to remove vast quantities of Java moss approximately every month. It will adhere to driftwood, stones, or rest on the bottom. As an aquarium plant, it provides a nice green, filmy look and provides good hiding places for small fish and fish eggs (Takaki et al. 1982). On the other hand, I have had spiny fish get caught in it and die in the struggle to get free.

Cliff Townsend sent me a short note (22 Nov 2004) that attests to the aggressive nature of this group of "Java mosses," given the right conditions:

“A slant on British 'Java Moss' is given by C. R. Stevenson & E. W. Jones in Journal of Bryology 15: 624-626 (1989). The material of *Vesicularia reticulata*, mentioned by them as having been distributed by me through the B.B.S. exchange in 1962 as *V. dubyana*, was collected from the former orchid pits at Kew (since demolished), where this moss grew in great quantity and fruiting very freely. It still occurs in other greenhouses at Kew, and I was informed by P. J. Edwards of the pteridophyte department in the Kew Herbarium that both this and *Racopilum cuspidigerum* (Schwaegr.) Aongstr. (det. B. O. Zanten from a gathering of mine) are quite valuable for water retention.”

“Fairly recently, this *Vesicularia* was sent to me for opinion by the late Theo Arts, who had collected it in the *Victoria amazonica* house at the Nationale Plantentuin van Belgie, Domein non Bouchout, Meise, Belgium in 1987. I have also received material from the same greenhouse collected by H. Steperare in 1996. It is of interest that I recorded the species from a bank by a millstream near Mogul Gardens, Wah, Pakistan in 1973 in Journal of Bryology 17: 677 (1993). Unfortunately, this and other mosses from the same spot (which included an *Entodon* as yet unidentified) were grubbed up in a hurry and not named until I got home, so there is no means of knowing if the moss was native there (the place is within its area) or was an escape from the gardens, having been introduced to them with planerograms.”

“Gangulee (Mosses of eastern India: 2001) reports *Vesicularia montagnei* as occurring 'on the floors of nurseries in Calcutta and in Howrah National Botanic Garden.' In the description, he cites it as 'forming thin but very extensive mat covering whole nursery floor and brick edging…'. The leaf-shape depicted by Gangulee looks very like that of *V. reticulata*, whereas that given of *reticulata* itself shows the leaves much too narrow. One cannot but wonder if the Calcutta nursery plant is in fact *reticulata*, perhaps even the source from which it has reached other botanic gardens.”

“It would no doubt take more time than it is worth to trace the source from which *V. reticulata* entered the aquarium trade, but it seems very likely that it has been propagated from material occurring as a weed in some nursery or botanic garden.”

The Christmas moss (*Vesicularia montagnei*) is often used to provide a backdrop to aquaria (Tan & Leong). It is semi-aquatic and grows on shaded, wet banks. In an aquarium, it becomes distinctly pinnate to subpinnate, giving a miniature fernlike appearance. Unlike the hanging habit of *Vesicularia montagnei* (Figure 10), the habit of *Vesicularia reticulata* (erect moss; Figure 11) is upright, giving it a different role when tied to driftwood or other substrate under water (Tan & Leong). The true *Vesicularia dubyana* (Figure 12), now dubbed Singapore moss, looks like a smaller version of Christmas moss.
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Figure 10. *Vesicularia montagnei* (Christmas moss) is a hanging moss. Photo by Sze Wei Tan.

Figure 11. *Vesicularia reticulata* (erect moss) works well when tied to driftwood or other substrate. Photo by Sze Wei Tan.

Figure 12. *Vesicularia dubyana* (Singapore moss). Photo by Sze Wei Tan.

Figure 13. *Taxiphyllum alternans* (Taiwan moss) is a pinnately divided moss often sold for aquaria. Photo by Sze Wei Tan.

Many mosses can be grown successfully in an aquarium. The limits may depend on the water quality, whether it is acid or alkaline, on the temperature, and on your ability to keep algae from taking over. Table 1 includes the more common ones available in North America, Europe, and Asian areas. Nevertheless, aquarium stores in other parts of the world sell some of these, and local aquatic mosses may be added to them.

Several liverworts are suitable, including the rare *Monosolenium tenerum* (Figure 14), originally from Asia (Wikipedia). While this species is hard to find in the wild and should be protected, it seems to do well in aquaria and can be easily grown from a small clump of plants.

Table 1. Mosses suitable for aquarium culture (Benl 1958; Cook *et al.* 1974; Takaki *et al.* 1982; Gradstein *et al.* 2003; Tan *et al.* 2004; Tan 2006a).

<table>
<thead>
<tr>
<th>Amblystegium serpens</th>
<th>nano moss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bryum pseudotriquetrum</td>
<td>marsh bryum</td>
</tr>
<tr>
<td>Chiloscyphus polyanthos</td>
<td>square leaved liverwort</td>
</tr>
<tr>
<td>Fissidens fontanus</td>
<td>Phoenix moss</td>
</tr>
<tr>
<td>Fontinalis antipyretica</td>
<td>willow moss</td>
</tr>
<tr>
<td>Glossadelphus zollingeri</td>
<td>Bogor's moss</td>
</tr>
<tr>
<td>Isopterygium sp.</td>
<td>mini Taiwan moss</td>
</tr>
</tbody>
</table>
Leptodictyum riparium  stringy moss  to the aquarium.
Monosolenium tenerum  giant riccia
Platypnidiurn riparioides  beaked water moss
Rhacopilum aristatum
Riccia fluitans  floating crystalwort
Ricciocarpus natans  water star
Taxiphyllum alternans  Taiwan moss
Taxiphyllum barbieri  Java moss
Taxiphyllum sp.  flame moss
Taxiphyllum sp.  giant moss
Taxiphyllum sp.  green sock moss
Taxiphyllum sp.  peacock moss
Taxiphyllum sp.  spiky moss
Taxiphyllum sp.  string moss
Vesicularia dubyaena  Singapore moss
Vesicularia ferrcei  weeping moss
Vesicularia montagnei  Christmas moss
Vesicularia reticulata  erect moss
Vesicularia sp.  creeping moss

> From: Stephan Mifsud  [mailto:labmdp@waldonet.net.mt]
> Sent: 14 December 2007 10:14
> To: 'jmglime@mtu.edu'
> Subject: Aquarium bryophytes
>
> Dear Professor Glime,
>
> I would like to congratulate you for your wonderful e-book on Bryophyte ecology (http://www.bryoecol.mtu.edu/ ) which is becoming undoubtedly the best book on the subject. I am an amateur bryologist, have a terrestrial moss collection and am a rather experienced aquarium keeper (see http://www.aquatic-gardeners.org/elatine.html), so you can imagine my interest in your new chapter regarding aquarium bryophytes. The chapter is also attracting the attention of other aquarium moss growers (eg http://www.killies.com/forum/viewtopic.php?t=3506).
>
> I have grown most of the available commercial bryophytes and others not available commercially, and have regrettably drowned a number of others in the search for new species adaptable

Apparently you have also grown a number of aquarium bryophytes so your interest includes both the scientific and cultural aspects. I find nothing objectionable in your chapter from the scientific point of view but I would like to point out a few points regarding the cultural aspect.

A) Species

1) Please note that the site http://www.aquamoss.net which you have used considerably as a reference point in your article has not been updated for quite some time.

Some species not available commercially and in my opinion of dubious aquarium value are listed in the chapter while the list is missing some important commercially available species,

Fissidens zippelianus (still shown as Fissiden sp. on aquamoss.net) 'Zipper moss'

Fissidens nobilis

Fissidens splachnobryoides 'Doormat Moss'

Hyophila involuta 'Cement moss' (commonly and erroneously sold as Star moss/ Tortula ruralis) on ebay. See http://www.killies.com/forum/viewtopic.php?t=3697 )

I can vouch for all above. There are others like Plagiomnium trichomanes (?) I have not tried yet, available
through ebay. Apparently this makes a very good looking aquarium plant from photographs I have seen.

2) Other mosses not available commercially, which make good aquarium species include Fissidens taxifolius (Italian variety found near streams) and Fissidens crassipes. I'm sure that there are many other aquatic/semi-aquatic Fissidens suitable for the aquarium. Eg Fissidens grandifrons and F. rivularis.


I have also grown Barbula sp. easily. (see http://www.killies.com/forum/viewtopic.php?t=3650&highlight=barbula)

This is probably B. bolleana but I would like a professional bryologist to confirm the ID.

3) To be a good aquarium bryophyte, it not only has to have the ability to grow submerged but should also have an attractive form. I have grown well Rhynchostegiella curviseta, Didymodon tophaceus, Pohlia melanodon, Leptodictyum humile, submerged but these are either too small or take on a stringy look so would have little commercial value.

4) The list of species listed as aquarium bryophytes includes Bryum pseudotriquetrum. In fact it is mentioned first, more than once and you said that it can make an interesting small forest in the bottom of the aquarium. This is very interesting for me since I have been searching for this moss locally for quite some time. It was last recorded here in Malta in the 1800's. My interest was originally piqued by papers describing the species submerged in both Arctic and Antarctic lakes. The temperature may probably be a limiting factor in the aquarium. I have already tried some other semi-aquatic Bryum species such as B. gemmiparum with little success. So it has come as quite a surprise for me that B. pseudotriquetrum has already been proven as good aquarium plant as I have never before found any reference to this moss used as an aquarium plant. Unfortunately the photo shows it growing terrestrially. I would like to ask if its success as an aquarium plant is your own experience or did you have another reference? If you know of someone who can supply this moss I would be greatly interested to try it out myself.

B) Common names.

1) The chapter goes into some detail about the common name Java moss. Unfortunately the story may be a little more complicated. The name was probably used originally and correctly for V. dubyana, but a mix up may have happened later and the name began being used for the faster growing Taxiphyllum barbieri. See the world expert Kristel Kasselmann's side of the argument: http://www.killies.com/forum/viewtopic.php?t=3559

2) Monosolenium tenerum is commonly referred to as Pellia as it was originally misidentified as P. endiviifolia. See http://fins.actwin.com/aquatic-plants/month.200211/msg00055.html and http://www.tropica.dk/article.asp?type=...
I have never seen it referred to or sold as 'giant Riccia', and I have discussed this plant with many people.

Also there is a 'mini Pellia' Riccardia chamedryfolia commercially available and also missing from your list. This is a slow growing species which I have also grown submerged.

C) Cultivation

1) Water parameters. The parameters given for Java moss do not necessarily transcribe to all aquarium mosses even those from tropical sources. Some species require brighter light (eg Erect moss) more than others and inorganic carbon in the form of CO2 greatly enhances the growth of most aquarium plants including mosses. Temperature greater than 26-28C are detrimental to most mosses.

2) Shrimps. Amano/Yamato shrimps actually (Caridina multidentata no longer jap http://en.wikipedia.org/wiki/Caridina_multidentata) will attack mosses only if their numbers are too high in a tank and if they do not find enough food (growing algae or commercial food). They are a great method to keep mosses free from algae. Individuals who start to eat mosses can be removed.

Other shrimps are also very good companions to mosses. Crystal Red Shrimps and Red Cherry shrimps in small aquaria with mosses as the only plants have become quite a fashion amongst aquarists. The shrimps look good among their small plant companions, breed well and also keep them free from debris and algae. (eg http://www.planetinverts.com/Invert%20Tank%20Setup.html)

3) Snails. I'm not sure which species of snail you have used in your tanks that attacked your moss but the Ramshorn Planorbis sp. especially the red variety (http://www.aquahobby.com/gallery/e_Planorbis_Ramshorn.php) is a wonderful companion to mosses. It will not touch any species of moss including Fontinalis and it will eat any sign of cyanobacteria and diatoms before they are even apparent. These algae appear to afflict your Java moss.

I have never had any problems with these algae as long as the ramshorns have been in my aquaria.

4) Siamese Algae Eaters as you said will eat mosses and should not be placed in the same tank.

5) Control of algae: The bleach method as you unfortunately found out is a very detrimental way of going about algae control. It has its uses on tougher plants like Anubias but should not be recommended for any type of aquarium moss.

The best way to control algae is by using the following method, which has kept me free of algae for a very long time.

- Use CO2 at high doses up to 15-30ppm. The mosses will grow better and the lowered pH is detrimental to many types of algae.

-Diatoms and Cyanobacteria are controlled by Ramshorn snails, hair algae by shrimps (Amano are best, Cherry Shrimps reasonably good).
Hopefully you may take these points as positive criticism, and possibly take them into consideration in a future update of the chapter. I am sure that this will help aspiring moss aquarists who read this chapter.

Also I would greatly appreciate any info re Bryum pseudotriquetrum, as discussed previously.

Thank you

Sincerely yours

Stephan Mifsud
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Paola
Malta, Europe

Preparing a Moss Wall

One aquarium website describes a method to make a wall of mosses in the aquarium (Tan 2006b). A plastic mesh of 7-10 mm, preferably black or other neutral color, is used as the foundation (Figure 15). The author suggests cutting the mesh to twice the size of the aquarium, folding it, and putting the moss in between taco style (like a sandwich; Figure 16). The wall can be affixed with suction cups or rocks at the bottom with clamps at the top (Figure 17). The sandwich can be tied together where needed with fishing line so that fish cannot enter and get stuck. Mosses will grow through the mesh and soon fill in the spaces (Figure 18; Figure 19). Mosses can be grown on the bottom in a similar manner, again making sure fish cannot get under the layers of mesh (Figure 20).

To add interest, you might want to add some wood (without bark) where your mosses can grow. The best is wood that has soaked in a lake, then been sun-baked. More fresh wood must be soaked several days to remove the tannins (Sheng). Moss can be tied to the wood with fishing line. Wait a week or so before introducing fauna to give the mosses a chance to attach. Sheng suggests setting the light at 9 watts to slow the growth of the moss (and algae).
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**Maintenance**

The mosses often will grow long and fill a tank, collecting lots of organic matter from the fish. One trick to give them a fluffier look is to keep them trimmed (Jelsoft Enterprises Ltd. 2007).

**Dangers from other Organisms**

Tan (2006a) warns against including the Siamese algae eater (*Crossocheilus siamensis*) in a tank with aquatic mosses (Figure 21). They will devour the moss and leave only a stubble of plants. Another moss scavenger, when the algae and other plants are scarce, is the Yamato Shrimp (Yamato numa-ebi in Japanese), also known as Amano Shrimp, Algae shrimp, or Japanese marsh shrimp (*Caridina japonica*; Figure 22). I would suggest also being careful about including snails, especially with *Fissidens*, as they can likewise consume the mosses, although they seem to avoid *Fontinalis* (Lohammar 1956).

Figure 18. As time passes, mosses grow through the mesh to cover the wall of the aquarium. Photo by Sze Wei Tan.

Figure 19. An established moss wall can extend into the aquarium and provide hiding places for fish and nesting sites for eggs. Photo by Sze Wei Tan.

Figure 20. A modification of the wall idea can be used to anchor mosses such as this *Fissidens fontanus* (Phoenix moss) to the floor of the aquarium. Photo by Sze Wei Tan.

Figure 21. Siamese algae eater (*Crossocheilus siamensis*) eating *Taxiphyllum alternans* (Taiwan moss). Photo by Sze Wei Tan.

Figure 22. The Yamato shrimp (*Caridina japonica*) will eat mosses when algae and other plants become scarce. Photo by Sze Wei Tan.
Algae Problems

Maintaining the moss is not difficult once you have established the right water conditions. However, eliminating the algae that can overgrow the moss is another story indeed. My own Java moss soon became so covered with algae that it no longer looked like a moss (Figure 23). Tan (2006a) recommends using a 5% solution of bleach. The alga-covered moss is placed into the solution and stirred in the solution for about two minutes. When the algae begin to turn white, the moss should be removed and placed into a rinse bucket. It should be rinsed several times in fresh water to remove all the bleach. This method is too harsh for some mosses, and in much less than two minutes, it was the moss Fontinalis antipyretica that I found to be white; the algae, fungi, and bacteria seemed to survive quite well! Be sure to bleach the aquarium also to reduce new infections, and replace the water in the aquarium with clean water. Let these sit for a while to let the chlorine escape before introducing fish, or use one of the agents for removing chlorine.

Sheng (Aquarium Life website) cautions against putting your aquarium where it will receive direct sunlight, as that encourages the growth of algae.

Commercial Fisheries

Little has been published on use of bryophytes for the commercial rearing of fish or use in fish hatcheries. However, persons interested in spawning fish for such purposes might learn something from the aquarium industry. In one of the few studies in the laboratory, Bohlen (1999) describes breeding the spined loach, Cobitis taenia. He used thick tufts of moss on top of gauze-covered plastic boxes as spawning sites. Those eggs that were nonadhesive fell through the gauze into the box. The oviposition occurred in the most dense areas of moss and produced numerous young.

Summary

Mosses in aquaria help to decorate while providing oxygen and hiding places, especially for laying eggs. They can be used to make walls, attached to logs and rocks, or grown from the sand on the floor of the aquarium. Most aquatic bryophytes prefer cool temperatures, low nutrients, and medium light; more light encourages algal growth. Some animals (fish, snails, algal shrimp) may eat the mosses. A mesh wall can hold the mosses or they can be allowed to grow free. Algae can be removed with a weak bleach solution. Use of mosses as spawning grounds for commercial rearing of fish warrants further exploration.

Acknowledgments

Sze Wei Tan kindly wished me to use any pictures I wished from his Aquamoss website.

Literature Cited


Benl, G. 1958. Java moss for decoration and as a spawning medium – a useful aquatic plant which has yet to be seen in Britain. Fish Keeping, Nov.: 655.


Figure 23. Taxiphyllum barbieri (Java moss) is soon densely covered with algae in an aquarium. Photo by Janice Glime.