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## Art and science of aquascaping

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### Abstract

Aquascaping is an ancient art of creating aquatic environments with modern trend by including living aquatic plants and ornamental fish in glass jar. Three-dimensional sculptures submerged in water in an artificial biological environment are aquatic environments that are continually evolving. Passionate people have created aquariums with plants and fish since the Victorian era. It is a technique for aesthetically placing floating rocks, stones, driftwood and aquatic plants in an aquarium. Purpose is to create waterfalls, discoveries, jungles and other ambiguities within indoor facility inside the aquarium. In simple term, Aquascaping is gardening in fish tank. It need little bit of patience and skill, but if you keep it up, it can be one of the most rewarding hobbies. Involvement in care and maintenance of aquascape is known to have a significant impact on mental health and well-being. Aquascapes come in a variety of styles, including Dutch, Japanese, natural, rock formation, jungle, biotope, and pardalium. The main goal of aquascaping is to create an artistic aquatic landscape, but the technical aspects must also be taken into consideration. These include substrates, water quality, plants, fish, aquacaping ornaments and proper aquacaping maintenance. Aquarium closures require many factors that need to be weighed to ensure successful aquacaping. In this review paper, different type of aquascape, creation and maintenance of aquascape as well as aquatic plants and ornamental fishes has been discussed in detail.

**Keywords:** aquascape, ornamental fish, aquatic plants, aquascaping, aquarium lightening

### Introduction

Aquascaping is the art of arranging and planting aquatic plants, stones, rocks, or driftwood in an aesthetically pleasing style within an aquarium (Martin *et al.*, 2013) [27]. In other words it is landscaping and gardening under water. An aquascape is an ecosystem in which every living and nonliving item used contributes not only to aesthetic beauty of the aquarium, but also to the biological and chemical balance that allow the plants and animals to live inside the closed aquatic environment. Robert Waringt on build the first stable aquarium. In his experiment he had used 13-gallon glass container, in which he had put eelgrass, goldfish, and snails. In the early 1900's Mr. Takashi Amano pioneered the "New aquarium" style by supplying them with lighting, high levels of CO<sub>2</sub> and nutrient rich substrates that was suited to plant growth. The planted tank hobby really took off when the Dutch style aquarium was born in 1930's.

### Styles of aquascaping

Aquascaping styles are constantly developing and the designs are not only incredibly beautiful to look at, but are also a form of intellectual art combining the imagination and the ideas of their authors and the ability to create a viable biological system. There are several distinct styles of aquascaping such as Dutch style, Japanese style, natural style, iwagumi style, jungle style, biotype style and paludarium (Fig. 1). Of all these styles iwagumi style is one of the most popular aquascaping styles today.

### Dutch style

Linear rows of plants running left to right are referred to as "Dutch streets." This style was developed and started in Netherlands in the 1930s, during which period freshwater aquarium equipment became commercially available. The Dutch aquarium follows an orderly, often symmetrical arrangement, in which multiple types of plants having diverse leaf colour, sizes and textures are displayed in much the same way as terrestrial plants are shown in a flower garden. It displays plants located on terraces of different heights, but these displays omit rocks and driftwood often. Tall growing plants that cover the back glass originally served the purpose of hiding bulky equipment in the tank. Plant rows do always give a positive visual effect. Good plants for Dutch style plants rows are *Lobelia cardinalis*, *Linnophila sessiflora*,

*L. aqualicum*, most *Ludwigia sp.*, *Michrantemum micrantemoides* and *Umbrosum sp.* Java ferns and java moss can also be a good choice if they are exhibited with terraces. In Dutch style a plant must never grow taller than a plant behind it. Larger fish like Congo tetras or Angelfish are always a good choice for this style.

### Nature aquarium style

This style was introduced in the 1990s by Takashi Amana of Japan who made this style very popular with his three-volume series of books 'Nature Aquarium World' and in his aquascaping competition. Because of this style of aquascaping he is regarded as the most influential aquascaper in the world. Amana's compositions draw on Japanese gardening techniques that attempt to mimic natural landscapes by the asymmetrical arrangement of masses of relatively few species of plants, and carefully selected stones or driftwood. The Nature Aquarium Style is designed to keep aquascapes simplistic and natural looking. Plants with small leaves are usually selected, with more limited colours than in the Dutch style, and fish or freshwater shrimp are usually selected to complement the plants and to control algae. In simple nature aquarium there are three visual styles you can try out.

#### 1. The concave shape

The positioning and height of the plants decreases to some central low point so that the final display offers the impression of open space in the middle.

#### 2. The convex shaped style

This layout is often referred to as an island because plants are trimmed lower on either side and higher in the middle, which is very nice aesthetically and can be obtained with rocks to make a mountain looking scape.

#### 3. The triangle shaped aquascape

This type of layout creates very balanced visuals; the height of the plants slopes gradually from high on one side of the aquarium to low on the other side.

### Zen/Japanese aquascaping

Japan has been known for Ikebana (Japanese flower arranging) and Bonsai for ages. However, now planted aquaria are coming on to the scene. To the westerner, a planted tank might just be used for biological balance and not just for aesthetic virtue. In contrast, for the Japanese, the art of planted aquaria must be structured, organised, and disciplined. Takashi Amano and Doshin Kobayashi are among a few Japanese aquarists that have made it into the western culture.

These men alone have raised the quality of planted freshwater aquaria. In order to explain the design and style of Japanese planted aquaria, one must know Japanese Buddhist religion, society and culture at least to the extent needed. Many aspects of religion, namely Zen Buddhism are incorporated into fresh water plant arrangement and placement. For instance, large stones that are used in the aquarium should always be in odd numbers, i.e. 1, 3, 5 and so on. Zen itself draws a lot from nature, so it is no surprise that Zen has an influence on aquascaping.

### German open style/paludariums

This style is more known as a combination of immersed and sub - immersed sets up. This is also known as German Open Style, as a biotype or a type of Paludarium. The aquascapers of these layouts often start out with aquatic plants growing submerged and then allow them to grow immersed outside of an aquarium. The intended goal is to create a slice of nature that is more indicative of what you would find in a riparian environment, like at the edge of a waterway in the Amazon jungle.

### EI natural style

The EI Natural Style is designed and promoted by Diana Walstad who is a well-known ecologist and author. This style is sharply different from other aquascaping layouts. Although the EI Natural Style is more of a plant growing technique that involves using natural light, potting soil, and few water changes, these aquaria often have their own flavour and aquascaping style.

### Taiwanese style

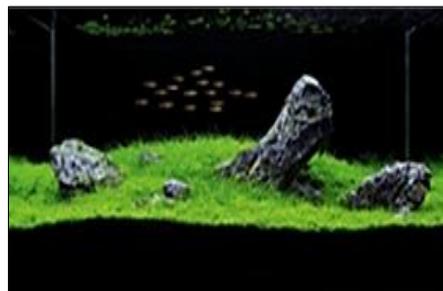
This style is another style that has been overshadowed and lost over the years. The Taiwanese style draws from Dutch Gardens, Zen Gardens and Amana's Nature Style to create aquascapes with high terraces and depth. Besides the terracing, small figurines, structures or other objects placed in the aquascape are also telling of when this style is employed. The overall goal is to create a living landscape.

### Wabi-Kusa style

Another style with roots from Japanese Aquascapers, the Wabi-Kusa style focuses on creating a submerged immersed garden. Imagine taking a bonsai garden and submerging half of it under water. The plants in this style are grown and centered on a ball of soil, and then placed in a container. Many Wabi-Kusa aquascapers create an island ball of plants surrounded by open water.



*Dutch aquarium*



*Iwagumi aquarium*



*Japanese aquarium*

**Fig 1:** Styles of aquascaping

## Elements of aquascaping

Various elements of aquascaping are discussed under suitable heading:

### 1. Aquatic plants for aquascaping

In different style of aquascaping, different size and form of aquatic plants are planted by keeping in mind the principal and element of landscaping and aquascaping. Aquatic plants for various use and style according to their plant height are as follow.

#### Aquarium plants for carpeting (1 to 10 cm height)

Creating a beautiful carpet of plants in an aquarium can simulate vast open fields, provide grazing, cover for shrimp and overall has a unique appeal to aquarists. Picking the right plant to create your carpet can make all the difference, as some are more difficult to grow and maintain than others and they all provide a slightly different look and feel within the aquascape. Some of such plants are Pygmy chain sword (*Echinodorus tenellus*), Dwarf hairgrass (*Eleocharis parvula*), crystalwort (*Riccia fluitans*), Java moss (*Vesicularia dubyana*).

#### Small aquatic plants (1-20 cm height)

The plants suitable are Dwarf Anubias (*Anubias nana*), Afzeli Anubias (*Anubias afzelii*), Green Wendtii Catacomb (*Cryptocoryne wendtii*), Brown Wendtii Crypt (*Cryptocoryne wendtii*), Undulated Crypt (*Cryptocoryne undulata*), water barricade (*Didiplis diandra*), Needle Dart Rush (*Eleocharis acicularis*), Pearl Grass (*Hemianthus micranthenoides*), Whorled Marsh Pennywort (*Hydrocolyle verticillata*), Baby Gashes (*Micranthemum umbrosum*), Water cabbage (*Samolus parviflorus*).

#### Medium aquatic plants (15-30 cm height)

These plants are suitable for mid-ground, example of medium size aquatic plants are: Amazon Frogbit (*Limnobium laevigatum*), Giant Anubias (*Anubias barten*), " Coffee Leaf" Anubias (*Anubias barteri' coffeefolia'*), Blyxa (*Blyxa echinosperma*, *Blyxa japonica*), African Water Fern (*Bolbitis heudelotii*), Cyperus (*Cyperus helfen*), Porto Alegre Sword (*Echinodorus portoalegrensis*), Eusteralis (*Eusteralis stellata*), Broad Leaf Flame Ivy (*Hemigraphis colourata' broad sheet'*), Brazilian Pennywort (*Hydrocotyle leueocephala*), Lobelia (*Lobelia cardinalis*), Golden Moneywort (*Lysimachia nummularia' Aurea'*), Java Fern (*Microsorium Pteropus*), Whorly Rotala (*Rotala wallichii*), Dwarf Sagittaria (*Sagittaria subulata*), Lizard's Tail (*Saururus emuus*).

### Tall aquatic plants (31+ cm height, thin)

The plants suitable are: Ghost echeveria (*Echeveria lilacina*), Bog Scarlet Hygro (*Alternanthera sessilis var. Rubra*), Pink Ammannia (*Ammannia gracilis*), " Hairy " Bacopa (*Baeopa lanigera*), Dwarf Bacopa (*Baeopa monnieri*), Green Cabomba (*Cabomba Caroliniana*), Chinese Ivy (*Cardamine yrata*), Elodea (*Egeria Densa*), Stargrass (*Heteranthera zosterifolia*), Dwarf Hygrophila (*Hygrophila polysperma*), Sunset Hygro (*Hygrophila polysperma' Rosanervig'*), Dwarf Ambulia (*Limnophila sessiflora*), Needle Leaf Ludwigia (*Ludwigia arcuata*), Narrow Leaf Ludwigia (*Ludwigia repens x arcuata*), Creeping Red Ludwigia (*Ludwigia repens*), Red Ludwigia (*Ludwigia mullertii*), Tilted Red Ludwigia (*Ludwigia inelinata*), Oval Ludwigia (*Ludwigia ovaJis*), Glandular Ludwigia (*Ludwigia glandulosal perennis*), Madagascar Lagarosiphon (*Lagarosiphon madagascariensis*), Mayaca (*Mayaca fluviatilis*), Brazilian Milfoil (*Myriophyllum aquaticum*), Western Milfoil (*Myriophyllum hippuroides*), RedStem Milfoil (*Myriophyllum matogrossensis*), Southern WaternympII (*Najas guadalupensis*), Gayii (*Potamogeton gayii*), Mermaid Weed (*Proserpinaca palustris*), Dwarf Rotala (*Rotala rotundifolia*), Giant Red Rotala (*Rotala maerandra*), Tonina (*Tonina Toninasp.*), " Corkscrew " Val (*Vallisneria spiralis var. tortissima*).

### Large aquatic plants (31+ cm height, wide)

Madagascar Lace slice (*Aponogeton madagascariensis*), Orchid Lily (*Barelaya longifolia*), Water Sprite (*Ceratopteris thalietroides*), BroadLeaf Water Sprite (*Ceratopteris comuta*), Eichhornia (*Eiehhomia azurea*), Amazon Sword (*Eehinodorus amazonicus*), Ruffled Amazon Sword (*Eehinodorus martii*), Ozelot Amazon Sword (*Echinodorus Ozelot*), Giant Hygrophila (*Hygrophila corymbosa*), Water Wisteria (*Hygrophila difformis*), Red and Blue Water Lily (*Nymphaea stellata*), Rubra Water Lily (*Nymphaeasp. "rubra"*), Small Flower Water Lily (*Nymphaea micrantha*), Banana Plant (*Nymphoides aquatiea*), Vid Lawn (*Vallisneria spiralis*). These can be replaced with Indian plants of similar form.

### Floating aquatic plants

These plants grows and float on the surface of water and provide shades to ornamental fishes. The suitable plants are - Duckweed (*Lemna sp.*), Water Lettuce (*Pistia stratiotes*), Aldrovanda (*Aldrovanda vesiculosa*), Azolla (*Azalia filiculoides*), Floating Watermoss (*Salvinia natans*), Eared Watermoss (*Salvinia auriculata*), Asian Watermoss (*Salvinia cueujlata*).

Important aquatic plants along with their morphological characters is mentioned in table 1.

**Table 1:** Aquatic plants for aquascaping

S. No.	Botanical name	Common name	Family	Colour of foliage	Flower colour	Plant type	Method of propagation	Reference
1	<i>Hygrophylla polysperma</i>	Indian swampweed	Acanthaceae	Light green to brown leaves	White	Dwarf	Pinch off segment	Nault and Mikulyuk, 2009 [33]
2	<i>Hygrophylla corymbosa</i>	Gaint hygro	Acanthaceae	Bright green leaves that can reach a length of 5" under water	Pink to purple	Dwarf	Stem cutting	Mora-Olivo <i>et al.</i> , 2018 [30]
3	<i>Hygrophylla difformis</i>	Water wisteria	Acanthaceae	The mint like foliage	Lavender	Dwarf	Cutting	Horiguchi, Genki, <i>et al.</i> , 2019 [20]
4	<i>Hygrophylla costata</i>	Glush weed	Acanthaceae	Papery flowers are borne in small luster in leaf forks.	White	Dwarf	Cutting	Csurhes, 2008 [11]

5	<i>Ruellia simplex</i>	Mexican petunia	Acanthaceae	deep purple foliage	White, pink, red, purple	Dwarf	Seeds and rhizome	Adams <i>et al.</i> , 2014 <sup>[1]</sup>
6	<i>Fittonia albivenis</i>	White nerve Plant	Acanthaceae	deep green leaves vein colour is silvery white	Yellowish – white, ara reddish	Dwarf	Leaf cutting	Brummitt, (1979) <sup>[7]</sup> .
7	<i>Nomaphilla stricta</i>	Gaint hygrophilla	Acanthaceae	deep green colour	Green	Gaint	Stem cutting	Mora-Olivo <i>et al.</i> , 2018 <sup>[30]</sup>
8	<i>Nomphilla siamensis</i>	Hygrophilla corymbosa	Acanthaceae	The top of the leaves is dark green in colour while the bottom part is silver leaves	Purple	Dwarf	Stem cutting	Mora-Olivo <i>et al.</i> , 2018 <sup>[30]</sup>
9	<i>Acorus calamus</i>	Sweet flag	Acoraceae	green	Reddish	Dwarf	Rhizomes	Bogner, (2001).
10	<i>Alisma subcordatum</i>	Water plantain	Alismataceae	dark green White	-	Rhizomes, tubers, corm, Bulb	Michaels, (2009) <sup>[28]</sup> .	
11	<i>Baldellia ranunculoides</i>	Water plantain	Alismataceae	slender dark-green leaves	White	-	Seeds	Kozlowski <i>et al.</i> , 2008 <sup>[26]</sup>
12	<i>Damasonium alisma</i>	Star fruit	Alismataceae	green.	White	rhizomes, tubers, corm, bulb, offsets	Charlton, W. A. (2004) <sup>[8]</sup> .	
13	<i>Sagittaria sagittifolia</i>	Arrow head	Alismataceae	green	White	Dwarf	Seeds	Dorken., <i>et al.</i> , 2003 <sup>[12]</sup>
14	<i>Sagittaria subulata</i>	Dwarf sagittaria	Alismataceae	deeper green.	white	Dwarf	runners	Sutton, (1990) <sup>[37]</sup> .
15	<i>Azolla filiculoides</i>	Mosquito fern	Azollaceae	green, blue-green, or dark red	-	Dwarf	Seeds	Kitoh, S., <i>et al.</i> , 1993 <sup>[24]</sup>
16	<i>Azolla pinata</i>	Mosquito fern	Azollaceae	bright green colour.	-	Dwarf	Division	Rai, (2008) <sup>[34]</sup> .
17	<i>Azolla microphylla</i>	Mosquito fern	Azollaceae	green to red	-	Dwarf	Seeds	Fiogbé., <i>et al.</i> , 2004 <sup>[16]</sup>

## 2. Imagination

Imagination is the key to aquascaping. Get the pictures of available plants and accessories into your mind. Try to combine them in several ways. If not possible, it is better to start with copying a tank you like. With time you will find it easier to do your imaginative work.

## 3. Background

There are some different ways of choosing a background like cork, others wood, some paint the background and some use self-adhesive foliage. If the tank is not kept in the middle of the room it is better to give the background as it will be very unnatural to see the wall with all the hoses and cables shining through the tank. When painting, or using foliage: it is best to use black or blue. This will give the tank a wonderful contrast and also make it easy to concentrate on the tank itself. The use of dark colours like red should be avoided. Red colour will dominate the natural theme of aquascaping or aquatic plants.

## 4. Substrate

It is unlikely that aquascape will look natural when you use pink, blue or bright green gravel. Better to choose neutral colour gravel (brown, gray or black) for maintaining natural look of aquascape. There are many different types of substrates commercially available that will assist the plants growth. Some of the substrate that can be used are; sand, clay, aquatic soil, gravel, soil, peat, ADA's aquatic soil and crushed coral. Sand, gravel and clay are inert substrate whereas soil, fluorite, peat and crushed coral are active substrate. Crushed coral raise the pH of media whilst peat moss lowers the pH. Therefore before using substrate we need to have knowledge about the chemical properties of substrate. This is one of the basic components of aquascaping and gives foundation to aquascape. Substrate is required to provide supports to large

size plant, rock and drift wood placed in aquascape. It also nourishes the aquatic plant.

## 5. Layout

Aquascape can be composed in many styles. Before placing the substrate, driftwood, stone, pebble and rock, one should have proper layout design. There are several composition types: The concave setup (high on either side or low in the middle), the convex setup (the opposite of the one above, so low on either side or high in the middle), the triangular setup (high on one side, getting lower to the other) and the rectangular setup.

## 6. Accessories

Aquarist generally looks for the perfect and beautiful piece of driftwood or stone. Especially when making a setup with stones it is much more important to use different sizes of the same type, than just take one very beautiful stone. One single stone in a tank will always look artificial, but when you place two or more, that's what usually seen in nature.

## 7. Focal points

It is one of the very important elements of aquascaping that draw the viewer eye. To get a smooth aquascape you need to set one or at maximum two focal points. This is usually something that pleases the eyes; either a stone, or a piece of driftwood, or a beautiful (group of) plant(s). Some time we can use a vibrant red plant as a focal point. This is where the golden ratio comes in. If the most beautiful plants are placed in the middle of the tank, it may not look present because when there is a symmetrical aquascape eyes tend to wander from left to right and back, forth. This is not the relaxed atmosphere you are looking for when you sit in front of your tank and watch it for hours. It is not wise to have two centerpieces in relatively small tanks (under about 60 gal).

Never try to create more than 2 focal points.

### 8. Foreground, Midground, Background

To get some depth into the tanks it is most important to use low growing plants. It is not particularly necessary to have high growing plants as well, because you can have hills or higher stones and driftwood that fulfill their demand. If there is no stones, hills (terraces) or driftwood, higher plants is needed to give a fine background. *Riccia fluitans* and *Glossostigma elatinoides* can be used as background. While the second one can really be a challenge sometimes even for experienced aquascapers, *Riccia* is quite easy to cultivate. It is a floating plant that needs a little care.

### 9. Planting

First the focal point to be planted and later followed by the low growers and mid growers and in the end the high plants and always to be planted very densely. Many small leaved species, such as *Micranthemum micranthemoides*, *M. umbrosum*, *Mayaca sellowiana* or *Rotala indica* can easily be trimmed to a desired shape and have to be with two to three stems together with a difference of around one inch, and so on with the help of tweezers. The denser you plant in the beginning, the faster the plants will grow, especially in the initial stage it is wise to cut the tops, replant the cuttings between the old ones and better to leave the rooted parts in the substrate and hence propagating the plants easily. The rooted parts will bud new shoots within short time.

It is always wise to use plants with different leaf size and/or colour. This again will create more depth and naturalness. If the tank is not too big (under 60 gallon) it is wise to mainly use plants with smaller leaves which will make it look much bigger than it actually is, especially red plants can help you give your tank more contrast. But be aware: If you use one single red plant it will again work as a focal point and if already the stone is chosen to be a focal point, it may get too much tension into the scape and the eyes will wander from one focal point to the other, hence such type of arrangements to be avoided.

### 10. Fishes

Fishes are last entrant in aquascaping. It is always better to choose schools of small fishes (like Tetras, Rasboras etc.) than just a few different big ones. The school of fishes should not be too huge and the fishes should not disturb the aquascape. Some fishes are small when introduced and may easily grow to larger size such fishes to be strictly avoided.

### Maintenance of aquascape

Setting up an aquascape is one thing, but maintaining and enhancing its beauty is completely different. Only regular pruning and water changing as well as getting the right balance of nutrients/light/CO<sub>2</sub> will make you achieve your goal. Sometimes when the plants grow there may be need for change in group of plants if it does not look like the original imagination. Small shrimps like Amano Shrimp (*Caridina multidentata*), Red Cherry Shrimp (*Neocaridina heteropoda*) can be introduced to control algal growth.

### 1. Aquarium lighting

Aquarium lighting is important for plant growth and fish health in the aquarium. It is especially important in planted and aquascaped tanks when caring for demanding plant species with high light requirements. In nature the sun is the

sole source of lighting for freshwater plants and replicating this requires very bright light fixtures. Recently LED lights have become widespread, available and affordable. LED lights utilize the latest technology allowing for lower wattage with the same output. They release less heat and use less power, an excellent choice for the modern aquarist. 1w+ per gallon of LED lighting is sufficient for a planted aquascape. Light bulb temperature should be kept between 6700k and 10,000k. These temperatures will more closely match sunlight and give the plants the required light spectrum needed to grow.

Metal Halides are very bright ranging from 100-400 watts. Due to halides being a single source of light they can give a shimmering effect in the aquarium which is sometimes desirable. The downside to metal halides is they become very hot while in use and need to be placed above the tank. It has a advantage of very bright light and therefore useful for deep tanks. On the other hand this light becomes very hot and can increase tank temperature.

T5 –Fluorescents is a newer technology than metal halide. They are the thinner and brighter sibling of T8 fluorescent bulbs. For their size they can output high wattage that is evenly distributed to the aquarium. This will aid in improving the overall healthiness and growth of your plants in all areas of the aquarium.

There will be no rippling effect in the aquarium but rather an even glow from corner to corner. T5's fixtures are reasonable however specialized globes can be quite expensive. They also need to be replaced far more often than LEDs as the bulbs spectrum can change over time contributing to algae growth.

### 2. Carbon dioxide

Carbon dioxide is essential to plant growth. Carbon dioxide in its purest form is a gas, but like oxygen it can be readily dissolved in water. Aquatic plants utilize this dissolved carbon dioxide to photosynthesize in a similar way that grass or a tree in a garden would do. In the aquarium water, CO<sub>2</sub> artificially creating the perfect environment for aquascaping.

In the same way as garden plants, aquatic plants need lighting, fertilizers and CO<sub>2</sub>. These are essential factors governing the speed of growth and health. With the addition of modern T5 or LED lighting systems and liquid/substrate fertilizers aquariums can become unbalanced. CO<sub>2</sub> is required by these plants to balance the aquarium otherwise algae can quickly take over the tank.

There are many different ways to deliver carbon dioxide in the planted aquarium *viz.*: Pressurized CO<sub>2</sub>, DIY CO<sub>2</sub>, CO<sub>2</sub> liquids, CO<sub>2</sub> tabs, Electronic CO<sub>2</sub>. These avenues differ in price, difficulty, success and maintenance.

### 3. Fertilizers

The last major determining factor in the health of your planted aquarium is the addition of liquid fertilizers. The amount of liquid fertilizers necessary will depend on the strength of the aquariums lighting and amount of additional CO<sub>2</sub> being used. There are two main groups of fertilizers that will be utilized by plants. The first is Macronutrients, these are – Nitrogen Potassium and Phosphorous. The majority of these elements occur naturally in the water and are usually supplied from fish waste, excess feeding and plant decay. With lots of plants in the aquarium there will be an imbalance of macronutrients and extra will need to be added depending on plant requirements.

The micronutrients are all the other elements used by plants

that aren't macronutrients. These are Iron, Boron, Calcium, Chloride, Copper, Iron, Magnesium, Manganese, Molybdenum, Sulfur and Zinc. These can usually be dosed with commercial fertilizers. Most general commercial liquid fertilizers will contain a good ratio of these micronutrients in the necessary combination for the aquatic plants, viz.; Seachem Flourish and NPK, PMDD, Iron additives, Dupla fertilizers. In some cases, especially with red plants extra Iron may be needed to suffice the needs of some plants.

#### 4. Trimming

Trimming aquatic plants is necessary to maintain the health and visual beauty of aquarium. In the right conditions aquarium plants will grow very quickly. Speed of growth is dependent on the type of plant. Stem plants will grow the fastest, followed by foreground plants, potted plants and then ferns and moss will be the slowest.

#### Conclusion

Aquascapes are more than just aquarium maintenance and are becoming more and more important in today's world. The coexistence of aquatic flora and fauna creates an atmosphere in the home, which also relieves mental stress. In India, the aquarium industry is still dormant. Most of the accessories used in aquacapes are imported and they are so expensive that they affect the growth of aquacapes in India. With increasing demand in the domestic market, Indian aquariums and related industries need to be strengthened.

#### Reference

- Adams, Carrie Reinhardt, Christine Wiese, Leah Cobb C. Effect of season and number of glyphosate applications on control of invasive Mexican petunia (*Ruellia simplex*). *Ecological restoration* 2014;32(2):133-137.
- Amano T. How to improve your Iwagumi layout, *The Aquatic Gardener* 2009;22(1):37-41.
- Axelrod, Herbert R, Warren Burgess E, Neal Pronek, Glen Axelrod S, David Boruchowitz E. *Aquarium Fishes of the World*. Neptune City, N.J.: Tropical Fish Hobbyist. Publications 1998, 718. ISBN 0-7938-0493-0.
- Brummitt RK. *Fittonia albivenis*. Curtis's botanical magazine. New series 1979.
- Charlton WA. Studies in the Alismataceae. XII. Floral organogenesis in *Damasonium alisma* and *Baldellia ranunculoides*, and comparisons with *Butomus umbellatus*. *Canadian journal of botany* 2004;82(4):528-539.
- Csurhes S. Pest plant risk assessment: Glush Weed, *Hygrophila costata*. Queensland the Smart State 2008.
- Dorken ME, Barrett SC. Gender plasticity in *Sagittaria sagittifolia* (Alismataceae), a monoecious aquatic species. *Plant Systematics and Evolution* 2003;237(1):99-106.
- Dulger E, Hussner A. Differences in the growth and physiological response of eight *Myriophyllum* species to carbon dioxide depletion. *Aquatic Botany* 2017;139:25-31.
- Fiogbé ED, Micha JC, Van Hove C. Use of a natural aquatic fern, *Azolla microphylla*, as a main component in food for the omnivorous – *Phytoplanktonophagous tilapia*, *Oreochromis niloticus* L. *Journal of Applied Ichthyology* 2004;20(6):517-520.
- Haridas H, Saravanan K, Praveenraj J, Sontakke R, Gladston Y, Ajina SM *et al*. Training Manual on Freshwater Ornamental Fish Breeding and Aquascaping Techniques 2019.
- Horiguchi, Genki, Kyosuke Nemoto, Tomomi Yokoyama, Naoki Hirotsu. Photosynthetic acclimation of terrestrial and submerged leaves in the amphibious plant *Hygrophila difformis*. *AoB Plants* 2019;11(2):plz009.
- Khairnar SO, Kaur VI. Quantitative and qualitative differences in morphological traits of fresh water ornamental aquatic plant water wisteria, *Hygrophila difformis* under different organic substrate. *Journal of Entomology and Zoology Studies* 2018;6(1):1664-1667.
- Kitoh S, Shiomi N, Uheda E. The growth and nitrogen fixation of *Azolla filiculoides* Lam. in polluted water. *Aquatic botany* 1993;46(2):129-139.
- Kozłowski G, Jones RA, Nicholls-Vuille FL. Biological flora of central Europe: *Baldellia ranunculoides* (Alismataceae). Perspectives in Plant Ecology, Evolution and Systematics 2008;10(2):109-142.
- Martin M. *Aquascaping: Aquarium landscaping like a pro*. Ubiquitous publishing, USA 2013, 129.
- Michaels NN, Sass GG. *The Nature Conservancy's Emiquon Preserve: Fish and Aquatic Vegetation Monitoring Annual Report* 2008.
- Mora-Olivo A, Alvarez-Vazquez LA, Requena-Lara GN, Uriel L. New record of *Hygrophila corymbosa* (Blume) Lindau (Acanthaceae) for Mexico, a highly invasive aquatic weed. *BioInvasions Records* 2018;7(4):375-379.
- Nault ME, Mikulyuk A. East Indian *Hygrophila (Hygrophila polysperma)*. Publications 2009, 718. ISBN 0-7938-0493-0.
- Rai PK. Phytoremediation of Hg and Cd from industrial effluents using an aquatic free floating macrophyte *Azolla pinnata*. *International journal of phytoremediation* 2008;10(5):430-439.
- Sanaye SV, Tibile RM. The fine art of aquascaping. *Fishing Chimes* 2009;29(7):44-47.
- Sutton DL. Growth of *Sagittaria subulata* and interaction with *hydrilla*. *Journal of Aquatic Plant Management* 1990;28:20-22.
- Whitby P. *The Aesthetics of Aquascaping*. UltraMarine Magazine 2014;46:41.