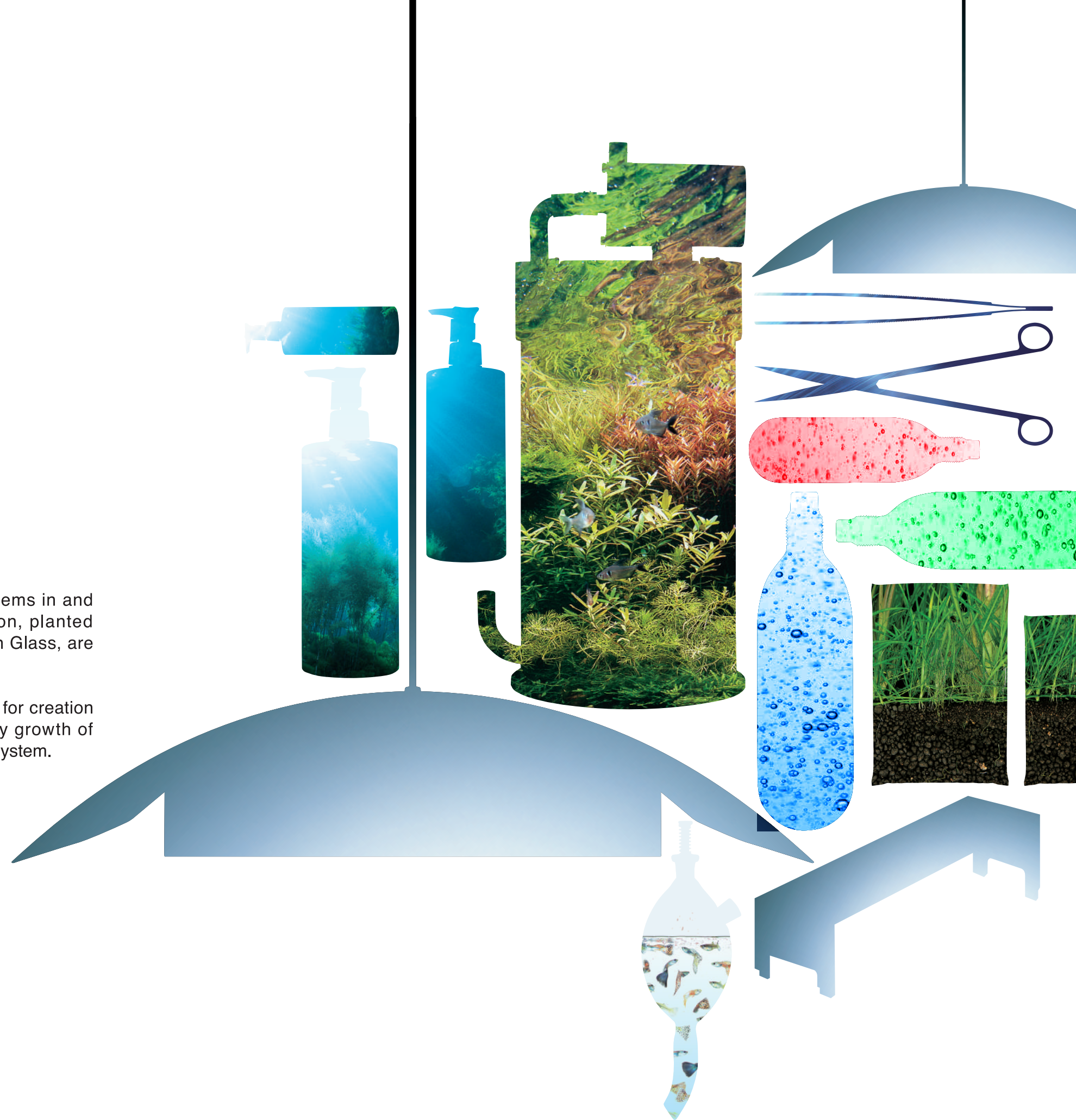


SUIKEI RESEARCH

Lush, beautiful Nature Aquarium™ is created with help of various systems in and around the aquarium such as lighting and CO2 systems. In addition, planted aquarium products we are using daily, including AQUASKY and Pollen Glass, are equipped with various effects and features.

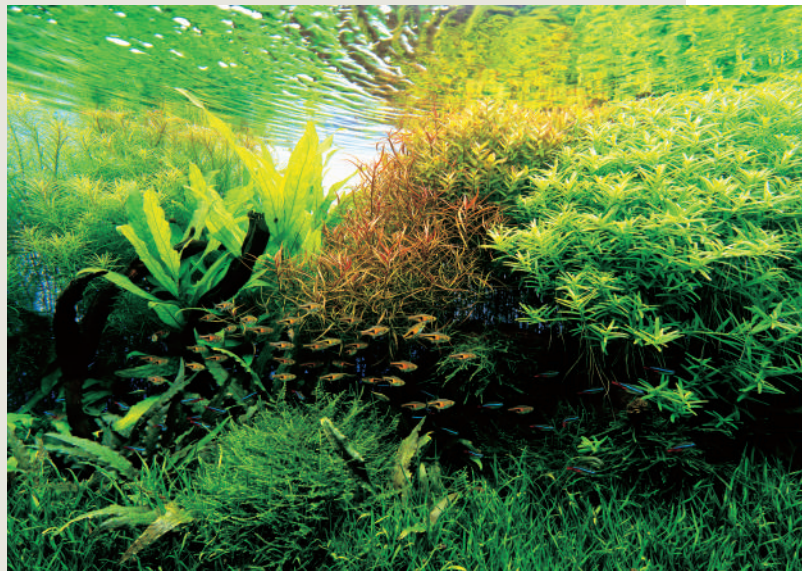
This article introduces the detailed research data on the systems used for creation and maintenance of aquascape by showing some secrets of healthy growth of aquatic plants and creation of beautiful aquascape with ADA Aquarium System.

Text by Masatoshi Abe / Tsuyoshi Oiwa



RESEARCH 01

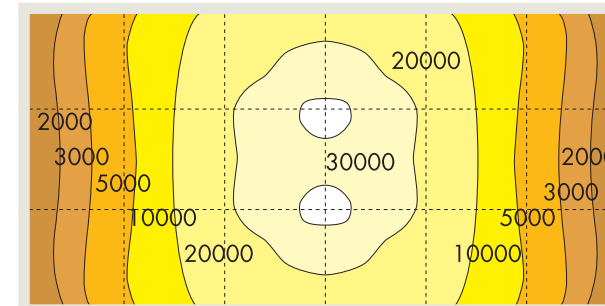
LIGHTING SYSTEM



There are two types of lighting system for Nature Aquarium™: a suspended pendant type such as Solar I and an install-on-the-tank type such as AQUASKY. First, let's do a research on light distribution of pendant-style lighting.

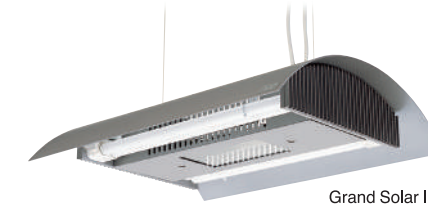
The lighting system for Nature Aquarium plays the roles of promoting photosynthesis of aquatic plants and enhancing the attractive look of aquascape. Light intensity and color temperature are significant factors for photosynthesis while the brightness and color rendering properties are important to make the aquascape look attractive. Metal halide lamp and twin fluorescent lamp used for the Solar Series provide sufficient light intensity as well as optimum color temperature and color rendering properties to promote plants' photosynthesis. The light housing unit of the Solar series is basically installed away from the water surface. A research was conducted on the light distribution of each model under this series.

Light distribution of Grand Solar I

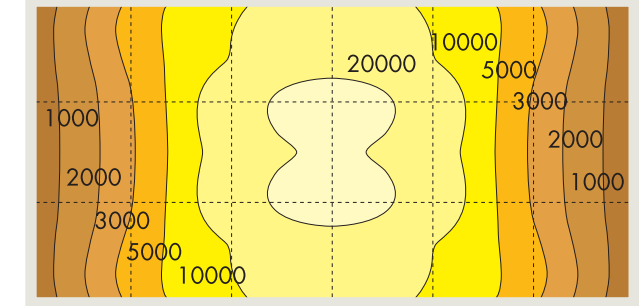


W90xD45cm Distance from Water Surface: 30cm (lux)

Metal halide lamp emits particularly strong light and thus the light intensity immediately below Grand Solar I and Solar I tends to be very high at the center of the aquarium.



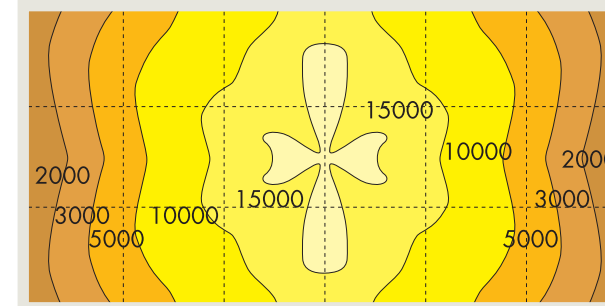
Light distribution of Solar I



W90xD45cm Distance from Water Surface: 30cm (lux)

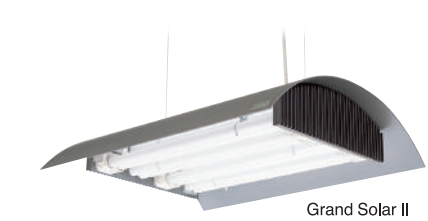


Light distribution of Grand Solar II

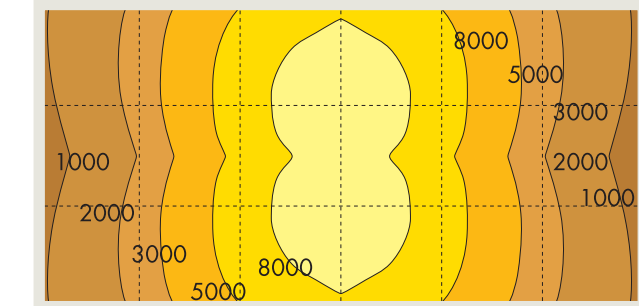


W90xD45cm Distance from Water Surface: 30cm (lux)

Twin fluorescent lamp emits relatively soft light which covers the entire aquarium and therefore provides superior brightness uniformity. Solar II is originally designed for use in 60cm tanks.



Light distribution of Solar II



W90xD45cm Distance from Water Surface: 30cm (lux)



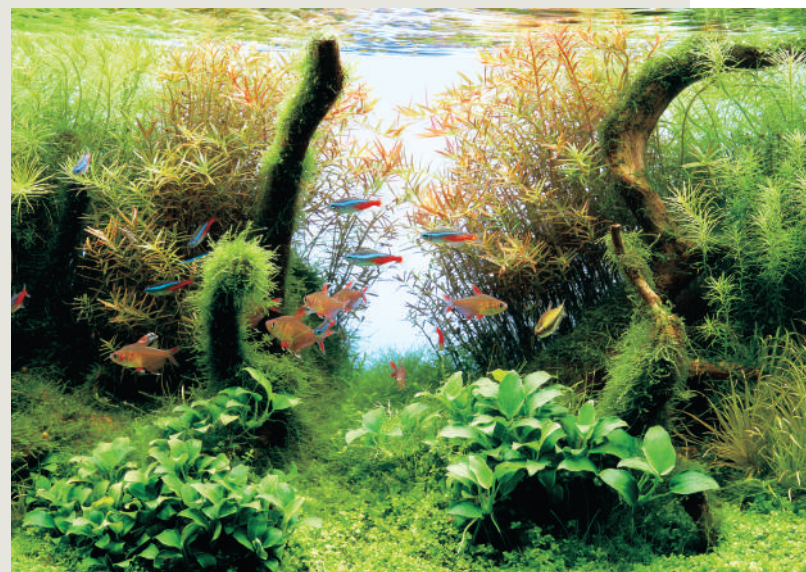
! This is the Key Point

“Pendant type lighting system adds an open impression to the aquarium.”

“The greater the distance between the lighting system and water surface, the more even the brightness becomes.”

“It is optimal to install Solar II 10cm away from the water surface of 60cm tank.”

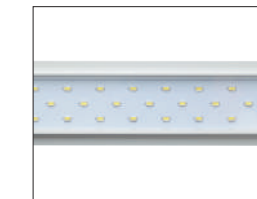
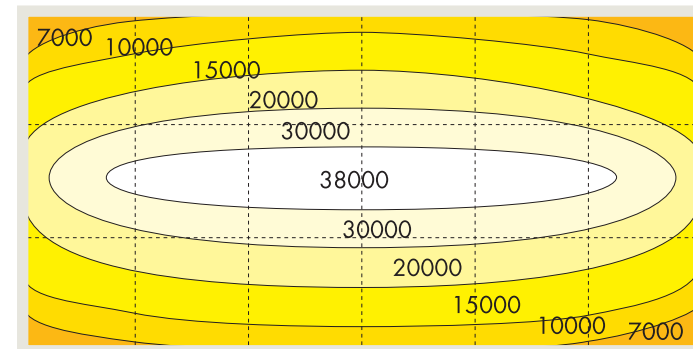
LIGHTING SYSTEM



The lighting system which is directly installed on the aquarium comprises **AQUASKY** and its variation **AQUASKY MOON**. Adopted white LED lights, they provide sufficient light intensity for plant growth. Now let's do a research on their light distribution.

White LED is relatively new type of light. When aquarium LED lights began to be marketed, there was no product that offers adequate performance for plant growth. At that time, there was even a rumor saying that aquatic plants do not grow under LED lights as they did not provide sufficient brightness and appropriate color temperature for plant growth. However, the circumstance has changed drastically with the advent of **AQUASKY**, the world's first LED lighting system developed specifically for planted aquariums. The **AQUASKY** series are equipped with many high luminosity LEDs that provide appropriate color temperature and achieve enough brightness for plant growth. This section features the research conducted on the light distribution of the major **AQUASKY** models.

Light distribution of **AQUASKY 602**



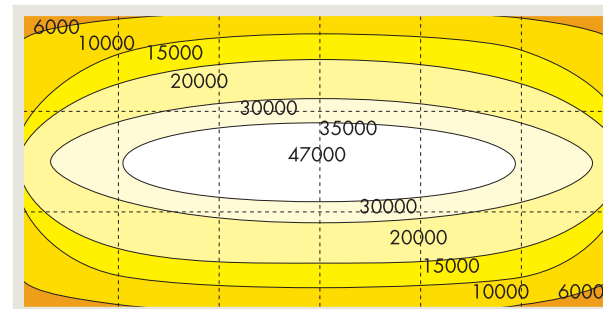
The brightness of **AQUASKY 602** overwhelms LED lights from other aquarium manufacturers. Aquatic plants in the entire aquarium grow healthy under **AQUASKY 602** offering excellent light distribution.

W60xD30cm Distance from Water Surface: 10cm

(lux)

Lamp unit (high-luminosity white LEDs)

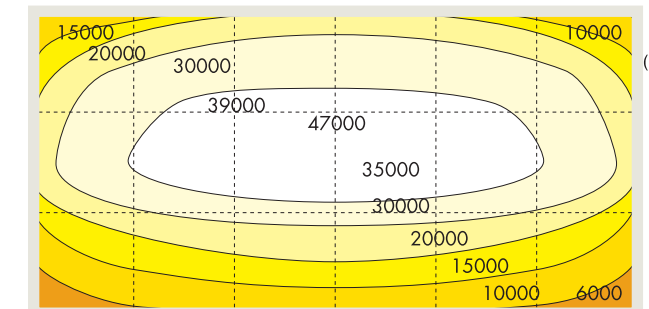
Light distribution of **AQUASKY MOON 601 (without MIRROR UNIT)**



W60xD30cm Distance from Water Surface: 10cm

(lux)

Light distribution of **AQUASKY MOON 601 (with MIRROR UNIT)**

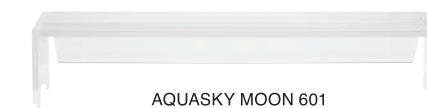


W60xD30cm Distance from Water Surface: 10cm

(lux)

▲ Rear (MIRROR UNIT installed)

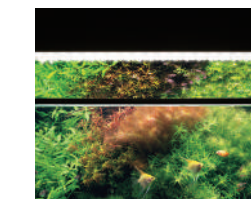
▼ Front



AQUASKY MOON 601 MIRROR UNIT set



Lamp unit (approx. 1.5 times brighter than regular AQUASKY models)



With MIRROR UNIT installed

AQUASKY MOON 601 features enhanced brightness. By installing the **MIRROR UNIT**, the light luminosity level at the rear side of the tank (background area) is further increased.

! This is the Key Point

“The **AQUASKY** series achieved sufficient light intensity for plant growth.”

“All you have to do is to place **AQUASKY** on a compatible tank to install.”

“The brightness is further enhanced by installing the **MIRROR UNIT**.”

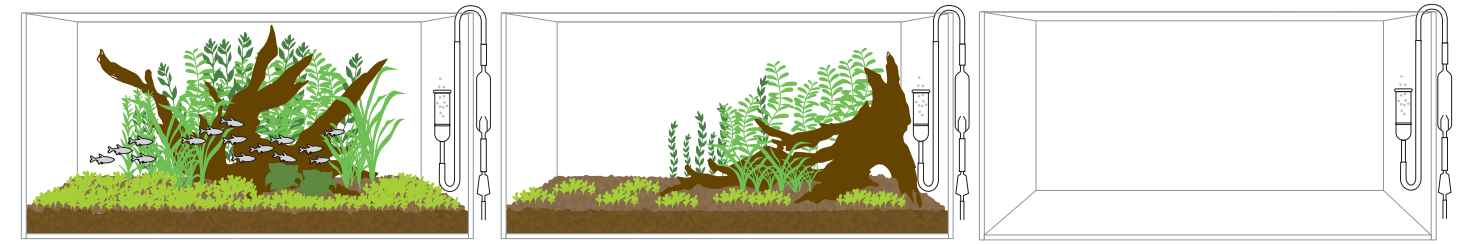
CO₂ SYSTEM



Aquatic plants need carbon dioxide (CO₂) to perform photosynthesis with light. They grow through photosynthesis and release abundant oxygen (O₂) in water. In the condition of insufficient CO₂, aquatic plants do not thrive. Now let's do a research on CO₂ in aquarium tanks.

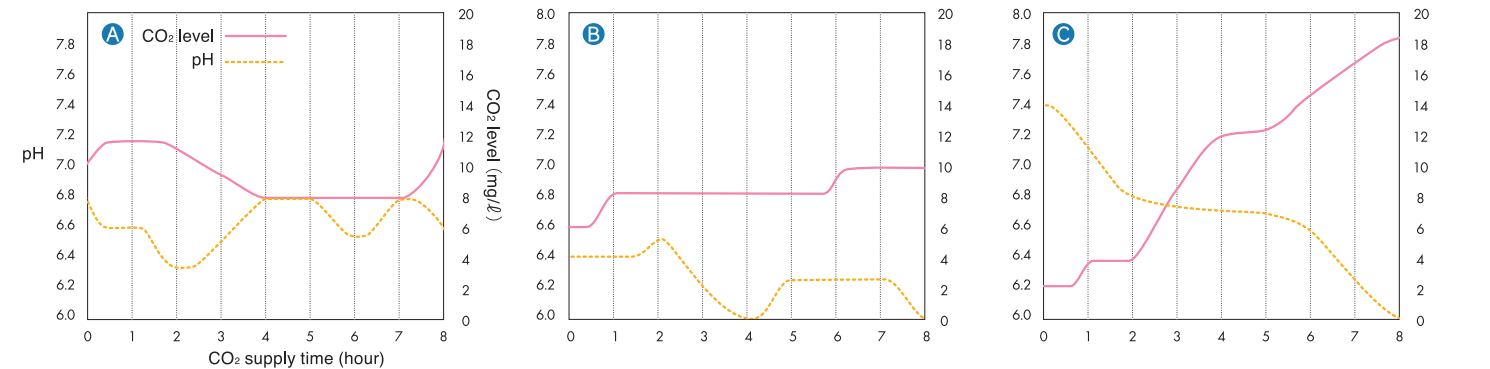
CO₂ supplied to the aquarium has the property of lowering the pH level when dissolved in water. When the CO₂ level of the water increases, the pH level decreases and the water becomes more acidic. In contrary, CO₂ in the water decreases by aeration and photosynthesis of aquatic plants and as a result, the pH level increases and the water becomes more alkali. Based on these facts, there is a close relationship between CO₂ and pH levels of water. Using this relationship, it is possible to find out the approximate CO₂ level of aquarium water just by observing the pH level easily measured by tools such as pH Kit and Drop Checker. This section discusses the research mainly on the changes in CO₂ and pH levels.

Comparison of Changes in CO₂ Level

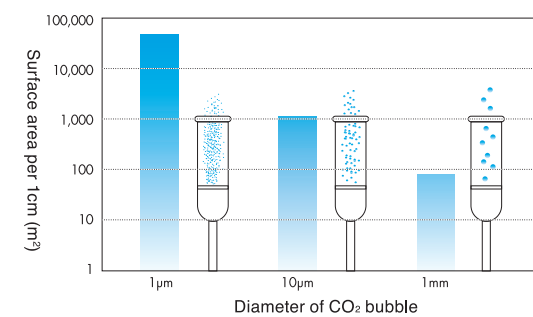


A 4 months after aquarium setup
B 1 week after aquarium setup
C Bare tank

In the aquarium with thriving aquatic plants, the amount of CO₂ supply and CO₂ absorption by aquatic plants are balanced.
 Newly set up aquarium tends to be subjected to excessive CO₂ buildup due to a smaller amount of photosynthesis taken place in the tank.
 Bare tank with no aquatic plants shows a strong inverse correlation between CO₂ and pH levels.

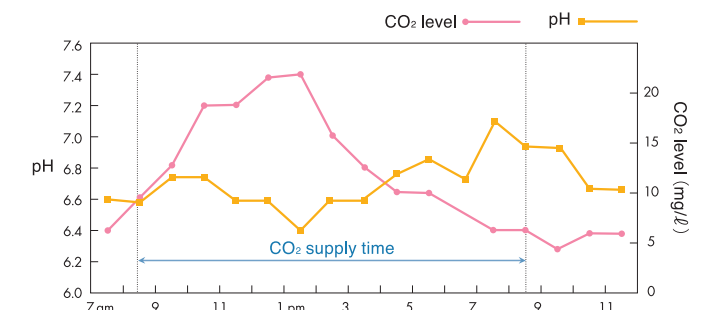


Changes in Size of CO₂ Bubbles and Total Surface Area per 1ml



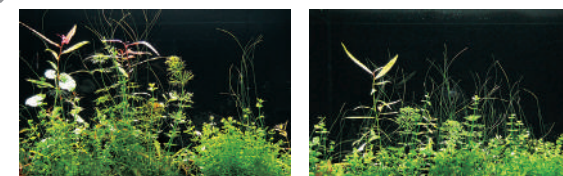
With the same amount of CO₂, the bubbles of smaller size have a larger surface area and thus dissolve readily in water.

CO₂ Supply in 60cm Tank



Photosynthesis of aquatic plants slowly becomes active after the lights are turned on and the CO₂ absorption also increases accordingly.

Growth Comparison of Wabi-Kusa with and without CO₂ Supply



With CO₂ supply (after 1 week)
 CO₂ / Pollen Glass, one bubble per second with CO₂ Bubble Counter
 Lighting / NA Lamp 20W ×4 lighting for 9 hours a day

Without CO₂ supply (after 1 week)
 CO₂ / No CO₂ supply
 Lighting / NA Lamp 20W ×4 lighting for 9 hours a day

Growth of aquatic plants significantly differs between aquariums with and without CO₂ supply. Of course, aquatic plants grow better and green and red leaves become more vivid with CO₂ supply.

This is the Key Point

“There is a close relationship between the amount of CO₂ supply and pH level.”

“CO₂ dissolves better in water if bubbles are smaller.”

“Aquatic plants grow faster with CO₂ supply.”

FILTRATION SYSTEM



Filtration system cleaning Nature Aquarium™ water consists of the combination of filter unit and various types of filter media. There are two different types of filter media: biological and chemical media. Now let's do a research on the characteristics of each filter media from a micro point of view.

There are various types of filters to clean aquarium water. For Nature Aquarium, which is to grow aquatic plants, we mainly use external filter that offers high filtration capacity and retains CO₂ supplied in the aquarium. The Super Jet Filter series is the external filter specifically developed for Nature Aquarium and available in many different models which are suitable for respective aquarium sizes. Each type of filter media offer different level of filter bacteria colonization and contaminants absorption due to their different surface structures. In this section, we look into the research on the Super Jet Filter series and the features of each type of filter media.

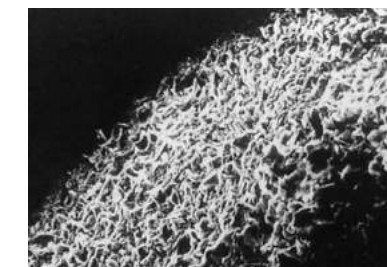
Comparison of Super Jet Filter models

Below is the comparison by flow rate and canister capacity (i.e., the capacity of filter media). In general, the filtration capacity becomes higher as the canister capacity and flow rate increase.

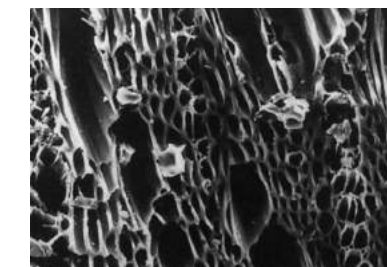
Product name	Flow Rate (50Hz)	Canister Capacity	Suitable Aquarium Size (Total Water Content)	Water circulation per hour
ES-600	5.5 ℓ / min	6 ℓ	W60xD30xH36cm tank (Approx. 65 ℓ) ~ W90xD45xH45cm tank (Approx. 182 ℓ)	5.0-1.8 times per hour
ES-600 EX	5.5 ℓ / min	9 ℓ	W60xD30xH36cm tank (Approx. 65 ℓ) ~ W90xD45xH45cm tank (Approx. 182 ℓ)	5.0-1.8 times per hour
ES-600 EX2	5.5 ℓ / min	12 ℓ	W60xD30xH36cm tank (Approx. 65 ℓ) ~ W90xD45xH45cm tank (Approx. 182 ℓ)	5.0-1.8 times per hour
ES-1200	16 ℓ / min	12 ℓ	W90xD45xH60cm tank (Approx. 243 ℓ) ~ W120xD45xH60cm tank (Approx. 324 ℓ)	3.9-2.9 times per hour
ES-1200 EX	16 ℓ / min	18 ℓ	W90xD45xH60cm tank (Approx. 243 ℓ) ~ W120xD45xH60cm tank (Approx. 324 ℓ)	3.9-2.9 times per hour
ES-1200 EX2	16 ℓ / min	24 ℓ	W90xD45xH60cm tank (Approx. 243 ℓ) ~ W120xD45xH60cm tank (Approx. 324 ℓ)	3.9-2.9 times per hour
ES-2400	27 ℓ / min	24 ℓ	W180xD60xH60cm tank (Approx. 648 ℓ) ~	2.5 times per hour
ES-2400 EX	27 ℓ / min	36 ℓ	W180xD60xH60cm tank (Approx. 648 ℓ) ~	2.5 times per hour
ES-2400 EX2	27 ℓ / min	48 ℓ	W180xD60xH60cm tank (Approx. 648 ℓ) ~	2.5 times per hour

Pump flow rate differs depending on the power supply frequency.

Electron micrograph of filter media surface



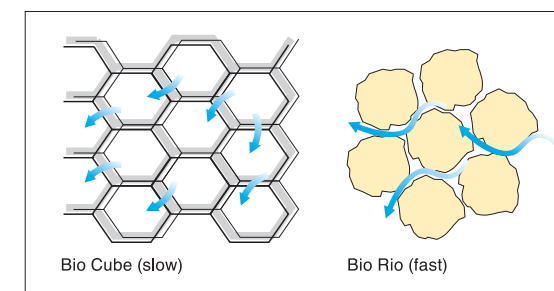
Surface of Bio Rio (×450)



Surface of Bamboo Charcoal (×300)

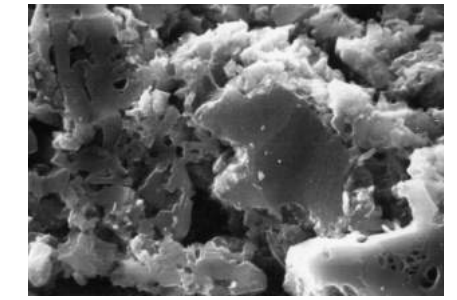
We can find countless numbers of bumps, dents and tiny pores on the Bio Rio and Bamboo Charcoal surface when observed with an electron microscope. Filter bacteria colonize in these areas.

Relationship between filter media shape and water flow rate



Bio Cube features superior colonization of filter bacteria but it easily clogs. On the other hand, Bio Rio hardly clogs.

Surface of NA Carbon

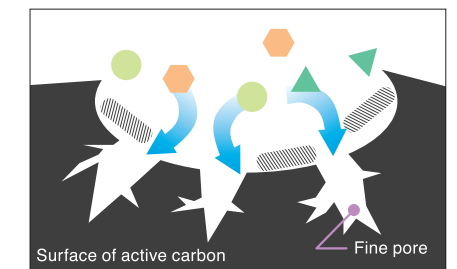


(×1000)

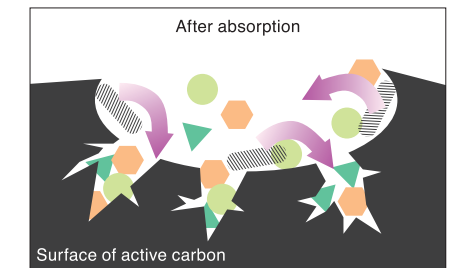
There are countless fine pores on the surface of NA Carbon, a high-performance active carbon.

Absorption capacity of active carbon

Microorganisms such as bacteria
Organic compounds



Contaminants in water such as organic compounds are attracted to the surface of active carbon and absorbed in the fine pores.



Absorbed organic compounds will eventually be broken down by filter bacteria.

This is the Key Point

- “Select the model suitable for tank size.”
- “Water flow rate differs depending on filter media’s structure.”
- “NA Carbon also functions as biological filter media.”

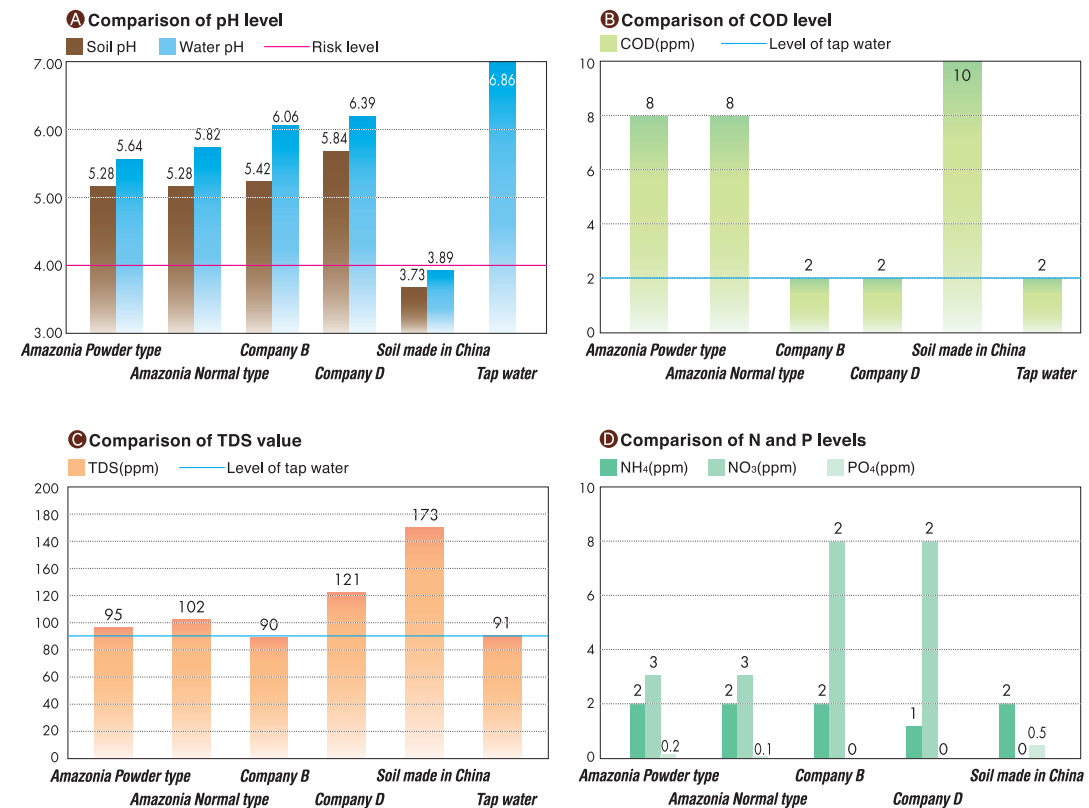
SUBSTRATE SYSTEM



Substrate where aquatic plants spread their roots is the most important element of Nature Aquarium™. In view of this fact, we have been making research on the materials used for substrate over many years and developed substrate materials such as Aqua Soil. Now let's do a research on the difference between Amazonia and other substrate materials.

Unlike the present time with advanced technologies in growing aquatic plants which has made the thriving planted aquarium a common sight, there was once a time when it was very hard to grow lush aquatic plants within an aquarium. Following the development of CO₂ systems and effective lighting system such as NA Lamp which has enabled aquatic plants to grow in aquarium, the development of Power Sand and Aqua Soil has brought great innovation to planted aquarium. Especially thanks to Aqua Soil-Amazonia, the growing of aquatic plants has become a lot easier and even the beginner hobbyists can now easily create a planted aquarium entirely covered with lush aquatic plants. This section features the research on the characteristics of Amazonia and other substrate materials.

Comparison of properties of substrate materials



A Aqua Soil-Amazonia lowers the pH value around neutral to acidic (pH 6.0 or below) by natural organic acid.

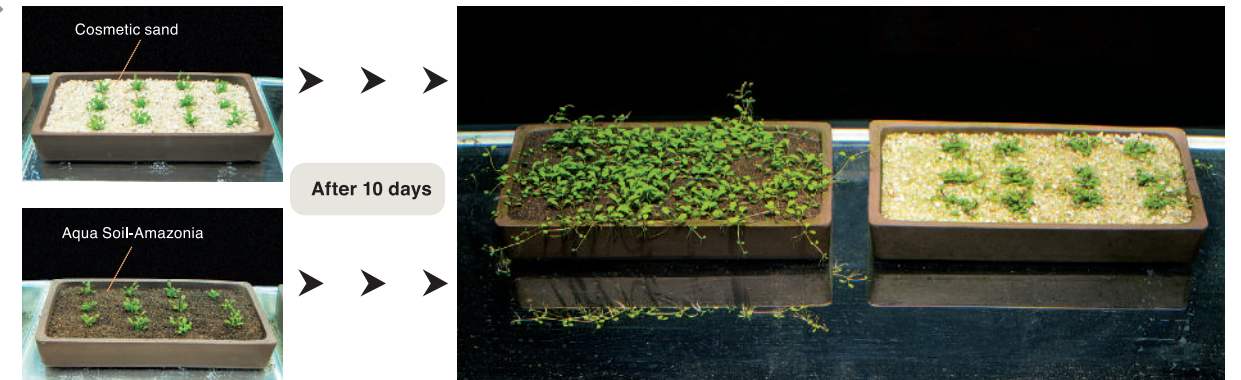
B Aquatic plants grow better when planted in Aqua Soil-Amazonia with rich organic nutrition. COD shows the amount of organic compounds.

C TDS shows electrical conductivity. Aqua Soil-Amazonia hardly contains chemical compounds.

D Aqua Soil-Amazonia contains rich nitrogen as ammonia (not nitrite nitrogen) and organic nutrient.

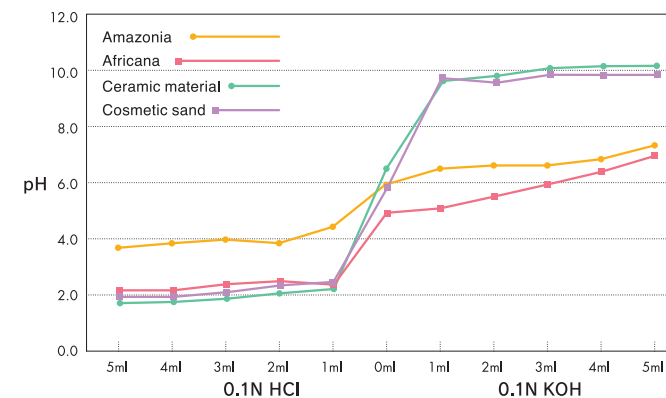
*Comparison of water quality is made in a small container. The value/level may vary from the case when the comparison is made in an actual aquarium tank. In addition, the products using natural soil as the ingredient may show different value/level for each individual product. The data is a reference for the trend in water quality.

Growth difference of foreground plants by substrate material



Foreground plants grow vigorously in nutrient-rich Aqua Soil-Amazonia. In contrast, the plants hardly grow in cosmetic sand.

Buffering effect of major substrate materials to prevent change in pH level



Compared to other substrate materials, Aqua Soil-Amazonia has a good property in preventing changes in pH (pH buffering capacity) even when acid or alkali is added.

! This is the Key Point

"Aqua Soil-Amazonia lowers the pH level and has a superior buffering capacity."

"Aquatic plants grow well with rich nitrogen content."

"Natural organic nutrients are safe for fish and shrimp."

LIQUID FERTILIZERS & ADDITIVES

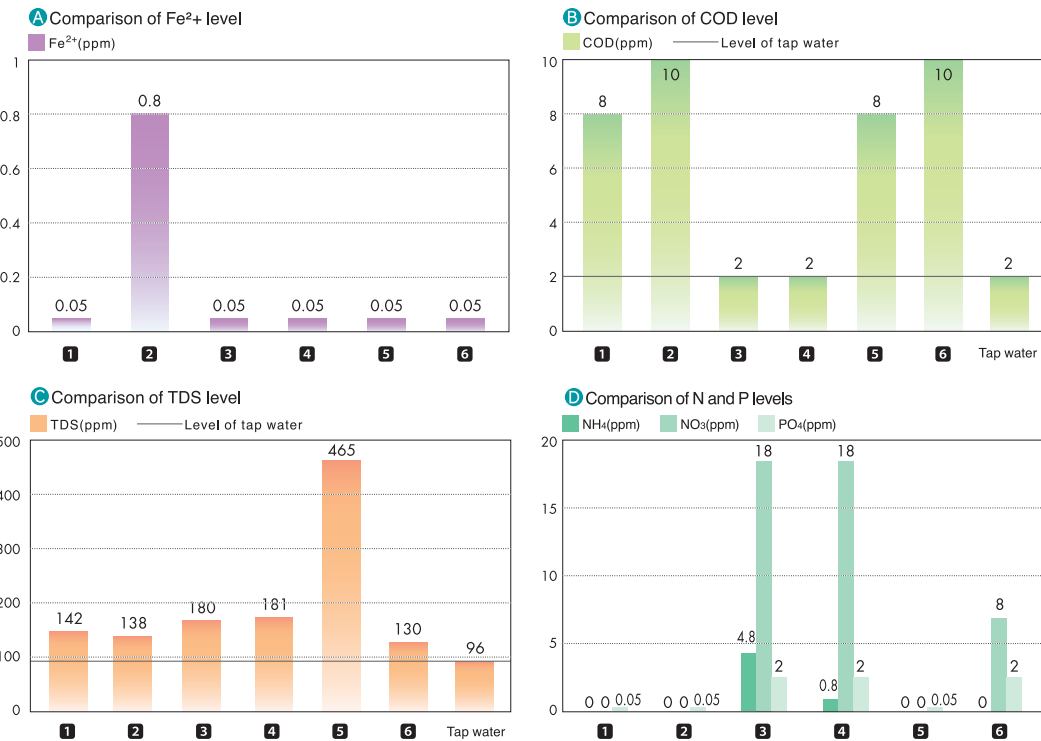


It is advisable to supply potassium and trace elements needed for healthy growth of aquatic plants by using liquid fertilizer. It is effective to supply nutrients that often become insufficient in an aquarium on a daily basis as these elements are quickly absorbed by aquatic plants. Let's do a research on what is provided by the liquid fertilizer.

In addition to CO₂ used for photosynthesis, nutrients including nitrogen, phosphorus, and potassium and trace elements such as iron are necessary for growth of aquatic plants. Although these elements are supplied by the substrate and produced by fish waste products, the absolute amount of potassium and trace elements are small. Thus these elements tend to be scarce in planted aquarium. That is why daily application of liquid fertilizer is important. With liquid fertilizers, potassium and trace elements are directly supplied into aquarium water and absorbed through the plant leaves, which provide instant results. This section reviews the research on the changes in planted aquarium with application of liquid fertilizers.

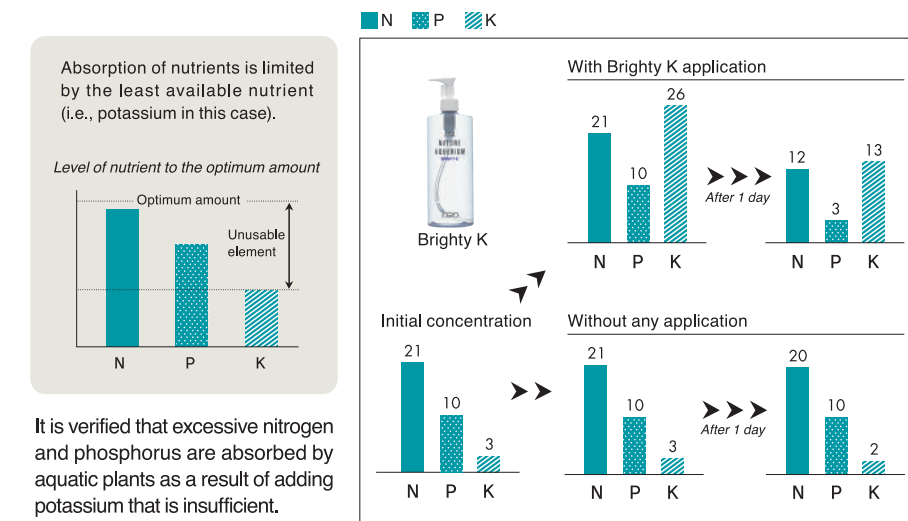
Comparison of properties of liquid fertilizers

- A** Green Brighty STEP 2 contains rich bivalent iron (Fe²⁺) that can be absorbed by aquatic plants.
- B** COD also responds to trace elements which are easily oxidized. Higher COD level shows a larger amount of trace elements contained.
- C** TDS shows electrical conductivity. TDS value increases in response to potassium.
- D** It is found that Green Brighty SPECIAL particularly contains high amount of nitrogen and phosphate.



*Measurement of each parameter cannot be performed with the agent used due to extremely low concentration in the case where the specified dosage is directly applied to an aquarium. For this reason, the concentration is increased to 100 times of the original concentration in this comparison for experimental purposes.

Concept of the Law of the Minimum and Experiment of Brighty K Application

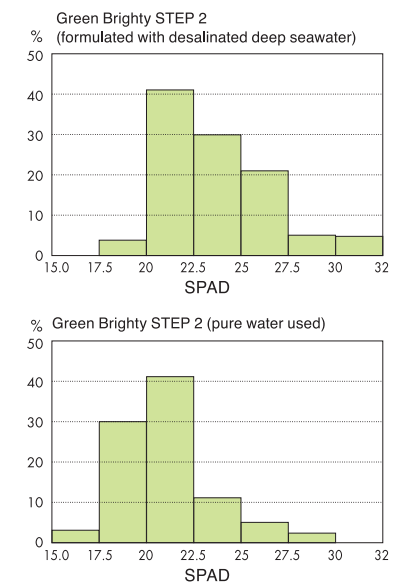


! This is the Key Point

“Each liquid fertilizer features different main nutrients.”

“Leaf color of aquatic plants is enriched with minerals of desalinated deep seawater.”

Effect of Desalinated Deep Seawater



The Green Brighty series formulated with desalinated deep seawater contains rich minerals and has effects of enriching the plant leaf colors. SPAD shows the foliar chlorophyll concentration.

LAYOUT & MAINTENANCE TOOL

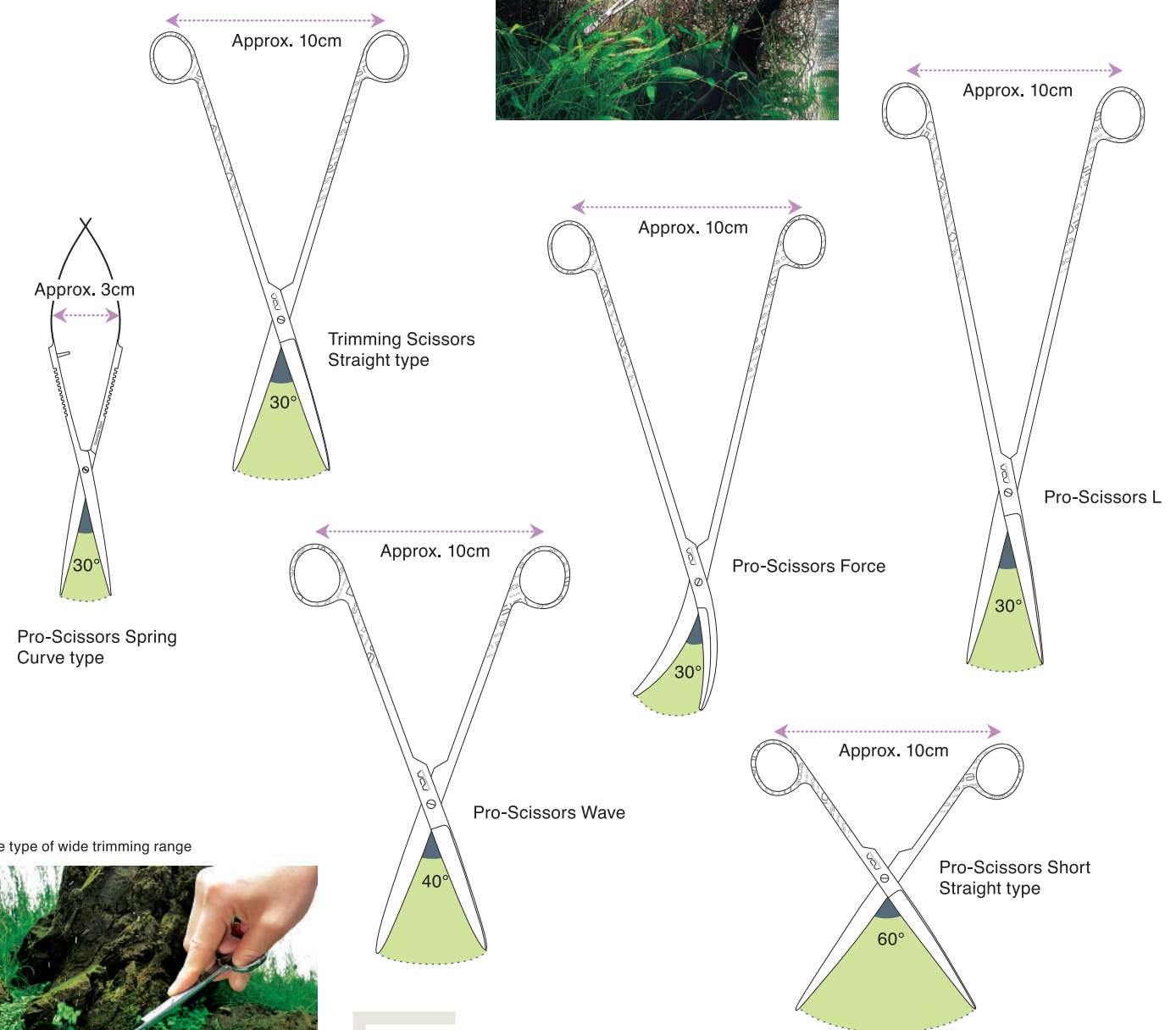


Scissors are the tools essential for creation and maintenance of meticulous layouts. There are many different types of scissors available for use in different approaches of trimming for different types of aquatic plants. Let's do a research now to find out the features of each scissors.

In Nature Aquarium, various types of tweezers and scissors are used for creation and long-term maintenance of meticulous layouts. Among the layout tools, scissors, in particular, are available in a variety of size and shape options to cater for various situations of layout creation and maintenance. Some of the scissors like Pro-Scissors Wave and Spring used for Nature Aquarium have unique shapes which are significantly different from ordinary scissors. How are these scissors specifically different? This section features the research on the opening angle and usability within the aquarium for each type of scissors.

Comparison of opening angle of scissors

Trimming range



A The type of wide trimming range



The scissors with long handles have a narrow opening angle but offer the optimal operability in trimming of plants in intricate layouts.

B The type of wide trimming range



The scissors having short handles and a wide opening angle allow you to conduct trimming efficiently for a wide area, such as foreground plants in an open space.

! This is the Key Point

“Use the scissors with different shapes for their respective suitable areas and purposes.”

“The scissors with long handles are best suited for intricate layouts.”

“The scissors with wide opening angle are efficient for trimming of foreground plants in a wide area.”