September 2018
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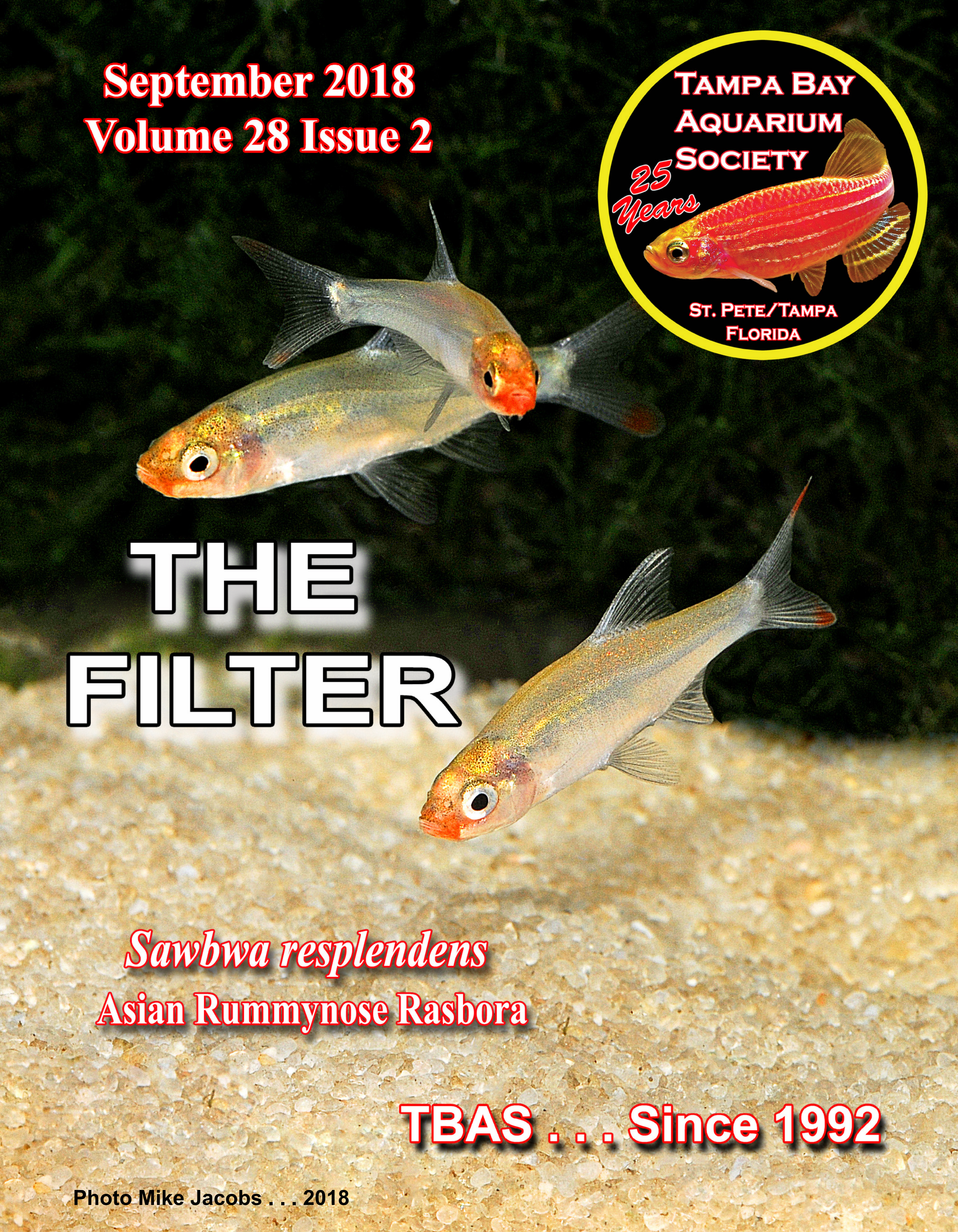
Tampa Bay Aquarium Society
25 Years
St. Pete/Tampa Florida

THE FILTER



Sawbwa resplendens
Asian Rummynose Rasbora

TBAS . . . Since 1992

Photo Mike Jacobs . . . 2018

TAMPA BAY AQUARIUM SOCIETY

"THE FILTER"

Tampa/St. Pete, Florida

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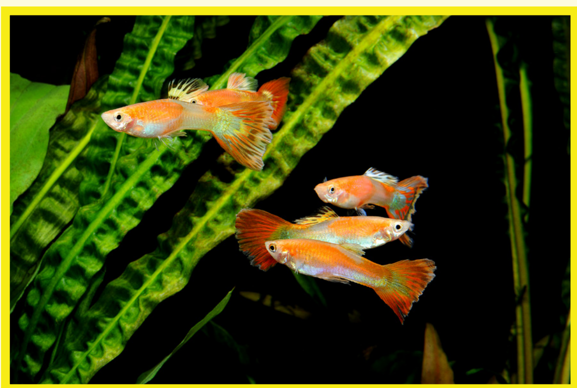
Hi TBAS'ers . . . we now have a new BOD and a new President . . . **Dre Alvarado**. Let's all wish the new group well wishes as the new TBAS year begins again . . . and don't forget to thank Bill Shields for all of his duty with being President of TBAS!!

Ok . . . we have something new in the bulletin this month. **"MEET THE MEMBER"**. I am always looking for articles for the bulletin and I understand the reluctance of most people to not write, but this concept is kinda NEAT . . . to write a 1-2 page article about a club member. We are going to start with the TBAS BOD members but maybe then we are going to branch out and extend our hand to you guys so we can write about you. This is how the "plan" works . . . we are going to put together a genaric sheet of questions about you (the BOD member now). I don't know how many questions yet, because it's still under design . . . but it will be maybe 10-15 questions long and all you have to do is answer them. From there someone will put it together in an article form and there you have it!!! I think it's a GREAT idea and maybe we'll have to tweek it for a couple of months with the BOD people but we think it's gonna work! People are interesting . . . **all of you folks are interesting**, and everyone should know more about the TBAS members. It's NOT going to be personal . . . just nifty . . . I think!!!!!

Mike

Mike Jacobs, Editor TBAS



Poecilia reticulata
Sunray Guppies
Photo by Mike Jacobs 2018

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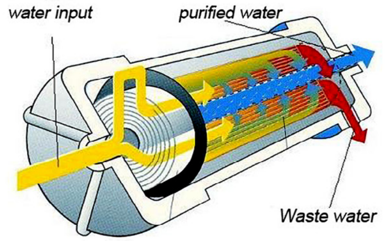
Understanding REVERSE OSMOSIS Part 1

What is it?



by Joe Gargas

Since its introduction to aquarists, reverse osmosis has been spreading rapidly as a filtration system. It is popular among breeders of fish species which require water of low ionic strength for successful fertilization and egg hatching. Among the said species are killifish, dwarf cichlids, members of the genus Apistogramma, and the species Symphysodon, the discus fish with which I am most familiar.

Reverse osmosis is beginning to find application among salt water aquarists to produce salt-free water, which makes up for evaporative losses from the marine aquarium. The saltwater aquarists can then avoid buildup of undesired salts, which occurs if tap water is used to make up for evaporation. The saltwater aquarist adds desalinated water from the reverse osmosis unit to his tank until the specific gravity drops to the desired value.

Breeders of African Rift Lake cichlids can use water from the reverse osmosis unit to make up for evaporative losses the same way. Additionally, the aquarist who maintains Rift Lake cichlids can sometimes use the brine reject water from the reverse osmosis unit, which is very high in dissolved salts, to initially fill his tanks. I kept Rift Lake cichlids in brine reject water of 280 ppm hardness from my reverse osmosis unit and they did quite well. This unit is being fed by Lake Michigan water from my city water utility. As long as tap water does not contain nitrates and the right salts are present, this will work. This article will clear up some current misconceptions about this process and will introduce the design and operation of reverse osmosis and the competing water treatment methods.

Water Characteristics

Water chemists use certain terms to designate important chemical characteristics of water. The most important of these are pH, total hardness, ionic strength and alkalinity. The fish culturist must understand these concepts.

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pH

pH is a measure of water acidity. Since it is the hydrogen ion, H^+, which causes acidity, pH is a measurement of the concentration of the hydrogen ion expressed in a logarithmic form. Actually pH is the negative value of the logarithm of the hydrogen ion concentration (see **Equation 1** below). Since pH is a function of the decimal logarithm, for every unit the pH changes, the hydrogen ion concentration changes tenfold. Knowledge of this is essential to understand the effect pH has on concentrations of toxic molecular ammonia, NH_3, which will increase tenfold for every unit the pH rises, as the non-toxic ionic ammonia, NH_4^+, is converted into its toxic molecular form, NH_3 (see **Reaction 1** below).

Equation 1: pH= -log10(H^+)
Reaction 1: NH_3(toxic) + H^+
= NH_4^+ (non-toxic)

Hardness

Total hardness is the sum of the concentrations of bivalent cations, expressed as ppm of calcium carbonate ($CaCO_3$). The calcium ion (Ca^{+2}) and the magnesium ion, (Mg^{+2}) are the only common bivalent cations. Hardness is important, since spawnings will not often occur in hard water; even when they do occur, the eggs will rarely hatch. Furthermore, a high hardness is usually accompanied by a high carbonate concentration which buffers the pH to a constant value, so that addition of acid does not drop the pH very much.

Alkalinity

Alkalinity is an expression related to the sum of the anions capable of neutralizing acid. For aquaculture this means carbonate (CO_3^{2-}), and bicarbonate (HCO_3^-). Carbonate only exists above a pH 9; at pH values less than 9, it is all present in the form of bicarbonate (HCD_3). As acid is added, the hydrogen ion (H^+) adds to the carbonate ion (CO_3^{2-}) to form (HCO_3) which is biocarbonate (see **Reaction 2** below). If the pH is much less than 9, then acid begins to add to bicarbonate to form carbon dioxide, CO_2, and water (see **Reaction 3** below). At a pH of less than 5.5, most the bicarbonate ion will be in the form of CO_2 (Jenkins and Snoeyink, 1980).

Reaction 2: $CO_3^{2-} + H^+ = HCO_3^-$
Reaction 3: $HCO_3^- + H^+ = H_2O + CO_2$

Based on my experience, fish have respiratory difficulties in the elimination of $C0_2$ in their blood if the $C0_2$ in the water is higher than 25 ppm. For this reason the pH cannot be dropped quickly down to 5.5 unless the bicarbonates are less than approximately 25 ppm. This works out to a total hardness of 40 ppm $CaCO_3$. If the hardness is much higher than this, the pH must be dropped slowly with heavy aeration so that the free CO_3 does not exceed 25 ppm. One cannot drop the pH quickly in water high in carbonates. Hard water will almost always be high in carbonates.

Ionic Strength

Ionic strength is an expression of total salt content in water. Ionic strength equals one-half the sum of the product of each ion multiplied by the square of its charge (Lewis and Randall, 1921). Since it is difficult and expensive to determine total ion analysis of a water sample, a crude approximation can be made from the total dissolved solids (TDS) (see **Equation 2** below) or from the conductivity (see **Equation 3** below) (Jenkins and Snoeyink, p. 76). The TDS meter actually measures conductivity but is calibrated with a sodium chloride (NaCl) solution so that TDS is expressed in ppm of NaCl. Conductivity, on the other hand, is calibrated with potassium chloride but is expressed in micro mho/cm or micro Siemens. (Note a micro mho/cm = a micro Siemen)
(To interconvert TDS and conductivity see **Equations 4 and 5** below).

Equation 2: Ionic strength
= (2.5xl0-5) (TDS)
= (0.000025) (TDS)

Equation 3: Ionic strength
(1.6 x 10-5) (conductivity)
= (0.000016) (conductivity)

Equation 4: TDS
= (0.64) (conductivity)

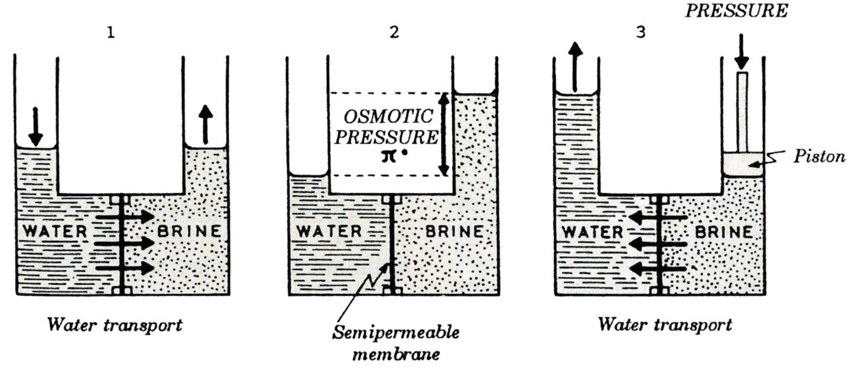
Equation 5: Conductivity
= (1.56) (TDS)

From the foregoing one can see that a measurement of TDS or conductivity gives a crude approximation of the ionic strength. Reverse osmosis drops the ionic strength of feed water by filtering out ions of the dissolved salts present. As a result of this process the hardness is also reduced.

How Reverse Osmosis Works

Reverse osmosis is a process whereby water is forced under pressure through a semi-permeable membrane, thereby filtering out the dissolved salts and most of the organic substances (see Figure 1). Low molecular weight organic compounds and dissolved gases freely pass through the membrane. Dissolved gases will not remain present long enough to create a problem, and organic compounds will not normally be present in tap water from a city water utility. In any case, a carbon filter will always be placed ahead of the membrane to protect it from chlorine.

Figure 1



This carbon filter will absorb most of the organic compounds which are not highly water soluble. The membrane will also filter out such pathogenic organisms as viruses and bacteria. Material which cannot pass through the membrane must not be allowed to accumulate on its surface. It is necessary to continually flush the upstream side of the membrane with a flow of fresh feed water which will vary from two to five times the volume of desalinated water produced. This ratio is set at the factory and will never need end user adjustment. The water flushed off the high pressure side of the membrane is designated as brine reject, since it will be high in dissolved salts.

Common Misconceptions Regarding Reverse Osmosis

1. Contrary to popular belief, reverse osmosis must not be used as an aquarium filter! Such a process would require that aquarium water be fed to the unit, filtered through the membrane, then returned to the tank in a recycle loop. Part of the water would go to brine reject thus continually reducing the volume of water in the aquarium as well as its ionic strength. At some point fish would die of

osmoregulatory stresses or else the tank would run out of water. Also, the membrane would quickly foul without a lot of prefiltering.

2. The second common misconception is that reverse osmosis is a water softening process similar to the common household water softener. Reverse osmosis is a filtering process which removes dissolved salts and molecular compounds present, producing a softer water. Actual water softening is accomplished by the common household water softener which exchanges sodium for the other cations.

3. The third misconception is that fish can live in totally desalinated water produced by a reverse osmosis unit or a deionizer. The fact is that, without some dissolved salts in the water, fish would not be able to retain salts in their blood. They would soon die from osmotic stress, as too much salt-free water entered the fish through the gills and skin.

Spiral Wound Membrane Design

All commercial and residential sized units on the market employ this design. It is the only design the aquarist will ever use. In this design the membrane is spirally wound around a perforated hollow center tube in the same way that paper towels are spirally wound around a hollow axial cardboard tube (see Figure 2).

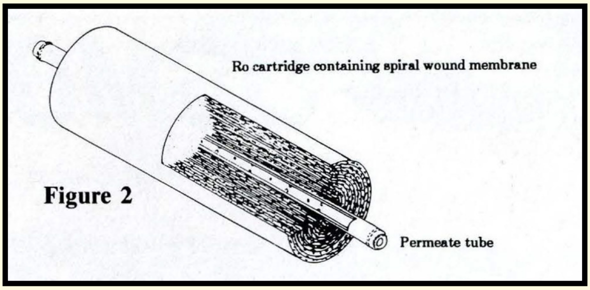


Figure 2

The difference is that there is: 1) a coarsely woven mat for feed water to flow through and 2) a watertight envelope of a semi-permeable membrane enclosing a permeate transport layer through which desalinated water flows (see Figure 3).

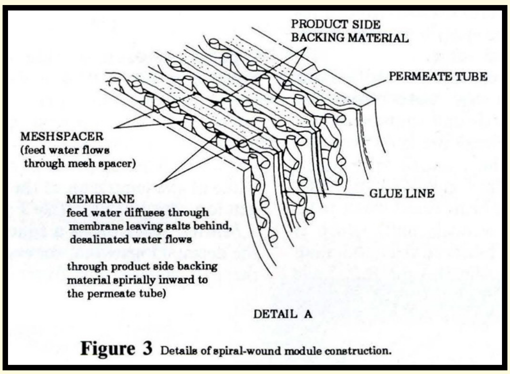


Figure 3 Details of spiral-wound module construction.

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Both are spirally wound together, something like a jelly roll. One layer is the semi-permeable membrane, which is actually two sheets of membrane arranged face-to-face and glued together at their perimeter. This forms a watertight envelope which completely encloses the permeate transport layer. Feed water diffuses inward leaving salts behind on the outside surface of the envelope. The desalinated water then flows through the enclosed permeate transport layer spirally inwards to the center pipe.

Outside the membrane envelope is the feed transport layer; this is a coarsely woven mat serving as a spacer through which feed water can freely flow between the spiral coils and across the outside of the membrane envelope. As feed water is pressured radially inward through the membrane, salts are filtered out and desalinated water flows into the permeate transport layer. Once inside the permeate transport layer, the water flows spirally inward towards hollow center tubes. This filtered water will be discharged from the center pipe as desalinated water (see Figure 4).

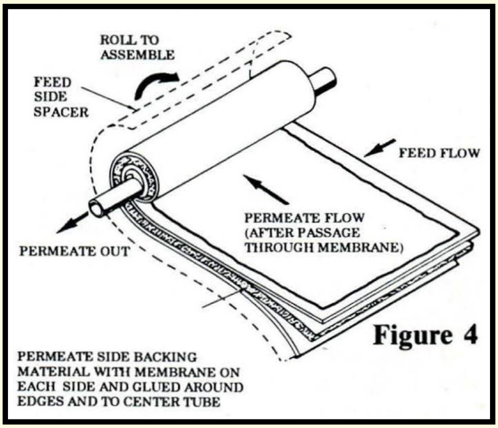

Figure 4

To prevent accumulation of dissolved salts on the surface of the membrane, some feed water flows axially downward through the woven mat of the feed transport layer; that is, it flows parallel to the center pipe to flush accumulating salts from the membrane surface. This axial flow containing accumulated salts is designated as brine reject. On units larger than 25 gallons per day, a feed water pump is required to raise pressure on the upstream side of the membrane so that the volume of brine reject can be reached. On larger units without the feed water pump, brine reject/ desalinated water ratio can be as high as 12 to 1: which means that it would take 13 gallons of feed water to produce 1 gallon of desalinated water, with 12 gallons going to brine reject. Using a feed water pump with a total dissolved solids, TDS, of 2,000 ppm, the brine reject/desalinated water ratio is approximately 2.5 to 1 with 90% to 98% removal of TDS in the desalinated water.

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Membranes

The cheapest membrane is cellulose acetate, but it can be attacked by metabolic activity of bacteria growing upon its surface so that feed water must be sterilized. This is usually done with chlorine. This membrane has an average rejection rate of 80%, and it can operate over a pH range of 5.5 to 8.5 with a maximum of 1,000 ppm TDS in the feed water. The cellulose triacetate membrane costs more; it can tolerate a pH as low as 4 and as high as 8, and it is limited to a TDS of 1,000 ppm in feed water. The cellulose triacetate membrane does not require chlorine for sterilization; however it can tolerate its presence. There is even a polyamide membrane on the market, but its pH range is too limited for our use.

Although there are various types of membranes used for reverse osmosis, the thin film composite is best suited for our purposes. This membrane has a maximum rejection rate of 98% and can take up to 1,500 ppm TDS in feed water; however with a feed water charge pump it can take up to 4,000 ppm TDS. It can operate over a pH range of 4 to 12, but it cannot tolerate more than 0.5 ppm dissolved iron. The only significant limitation of this membrane is that it cannot tolerate chlorine. This is easily corrected by placing a carbon filter ahead of the membrane.

A particulate filter is placed downstream of the carbon filter to remove any particulate carbon before it can reach the membrane. I use a carbon filter ahead of the reverse osmosis unit. Longer membrane life can be achieved by placing a sodium softener upstream of the charcoal filter to the reverse osmosis unit. This is recommended in cases where feed water is higher than 220 ppm $CaC0_3$ total hardness.

When iron in feed water is too high, an iron filter should be installed to prolong membrane life. There are iron filters available containing disposable filter media, and ones which can be cleaned with potassium permanganate in cases where the iron is very high. In cases where an iron filter is necessary, it should be placed ahead of the carbon filter.

Meet the Member!!

Bill Shields

Bill Shields, a lifelong aquarium fish hobbyist who started keeping fish at the ripe old age of six, grew up in South Florida in the 1950's. During his youth, Bill's entrepreneurial streak had him collecting guppies and mollies from the town park's pond and trading them with the local fish store for other fish and supplies. After college and various jobs, Bill finally started working "officially" in the pet trade as a salesman, store manager and then, finally, general manager of three Docktor Pet Centers in the Harrisburg, PA area. During this time, an invitation to attend and join the Susquehanna Aquarium Society in 1974 became his formal introduction into the organized portion of the hobby. Not long after joining, he became Vice-President, President, and then member of the Board of the Directors; later he was named Hobbyist of the Year in 1978. After joining the American Killifish Association (AKA) in 1974, he realized he had jumped to the next level of the hobby.

After a hiatus from the pet trade - during which he was an elephant handler and midwife for 27 Asian elephant births - Bill's avocation became his vocation. His aquarium fish expertise earned him a position as a professional fish breeder at 5-D Tropical Inc, an ornamental fish production and import/export facility, in Plant City, Florida where he worked from 1995 until retirement in 2010. He worked with Yorktown Technologies and with them did the R&D and introduction of Glofish into the American fish hobby. Finding no organized fish club in Tampa, FL, Bill's life came full circle as he and eight other fish keepers founded the Tampa Bay Aquarium Society . . . TBAS in 1992 in 1992. Bill still remains 100% active with the TBAS, Suncoast Killifish Association and NANFA. He has served on the committees for two national AKA

Checking spawns in some of the 2,500 tanks on a Wednesday morning.

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conventions, in 2000 & 2006, as well as the 2009 North American Native Fish Association (NANFA) and the 15th World Guppy Contest 2015 and the Annual Friends of the Florida Fancy Guppy Association BBQ/Auction all held in the Tampa area. In addition, Bill manages the annual Aquarium Beautiful Competition for the Florida State Fair. He also gives talks to aquarium societies all over the country as well as doing pod cast Aquariumania with our own Dr Roy Yanoung and three Blue Zoo Youtube episodes with Frank Reece. As a bucket list trip, Bill travelled to Iquitos Peru in 2009 with seven of his long time fish friends and returned in 2017 with his long time fish friend Brian Skidmore to Puerto Maldanado,Peru collecting and bringing back fish to breed.

My only bottle baby Angel with her mother Sally - 1987

Bill's Photos

Susquehanna Aquarium Society
Bill Shields
1978

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Every once in a while I see a fish I just can't live without. I do have a quarantine tank, but I must admit I have been too lazy to set it up sometimes, and it always seems to cost me heavily. There are a few questions that everyone should ask about the new fish, especially saltwater.

The first question I always ask is how long have they had the fish? In saltwater, if they haven't had the fish for at least one week then don't buy it, no matter how bad you want it. Even with a quarantine tank the chances of losing an expensive fish are high. In freshwater, usually 48 hours is sufficient to tell the health of the fish, except in delicate species like neons and cardinals. Take a close look at all the fish in the tank. If any other fish doesn't look healthy then you must decide why. There are times when the fish are deformed not ill. Sometimes they show poor color because of lack of habitat, more aggressive tank mates, or injury.

You also need to be aware of the type of filter system in the tanks. Some places used central systems where some of the tanks are connected water systems. In these cases you will need to look in all the tanks for unhealthy fish. There are some viruses that only affect one species, like the angel fish virus. If you buy an unrelated fish it can carry the virus to your tank. If the tanks are separate, what method are they using to sterilize their nets? Are there dead fish in the tank? What is the fish eating? Does it look skinny? A skinny fish is not determined by the size of the belly; take a head a head-on look at the fish and look at the backbone. Is it rounded or sunken in? If it is sunken in, it is using its body muscle to stay alive. This is more often a problem with saltwater fish than freshwater. Look closely at the pectoral fins. Usually they are clear, so this is a good area to check for parasites. I should point out here that goldfish get white “spots” when they are ready to breed: the males get them on their gill plates, and the females get them on their tails. Rainbow daces get “spots” on their heads when they are ready to breed.

If you don’t know about the fish see if the store has any books on it and don’t be afraid to look it up. Don’t always expect to get good information from someone just because he or she works at a pet store. It is hard for me to describe everything you should know. Some fish lay on their sides naturally, some even swim upside down. Use your best judgment before buying that special fish, use a quarantine tank, and ask questions. I hope the next time you look at a fish in a store you will look at it differently, because how it appears tells you a lot about the care it has been receiving.

Kind of a new one: photo:Mike Jacobs 2018

Pseudohemiodon apithanos **. . . Chameleon Whiptail**

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Red Scat . . . *Scatophagus argus arromaculatus*

photo: Mike Jacobs 2017

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Supporters of TBAS

Tampa Bay Wholesalers: Tropical Fish

alphabetical order

1) 5D Tropical Fish
2) Segrest Farms

Tampa Bay Tropical Fish Farmers:

alphabetical order

1) Amazon Exotics
2) BioAquatix
3) Carter's Fish Hatchery
4) FishEye Aquatics
5) Golden Pond
6) Imperial Tropicals
7) Lile's Tropical Fish
8) V-W Tropicals

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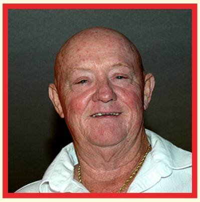
Dre Alvarado



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