Relocating the Reef Aquarium

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Researchers and hobbyists studying ocean life invest much time, effort, and money into the aquatic venture. At some point in this marine endeavor, people are forced to ship large quantities of fish or invertebrates. The reasons for the move vary: exchanging specimens amongst institutions; importing new study samples; or, relocating the entire aquarium system to a new site.

The single most important objective in any move is to minimize the shock on the animals. The best way to ease transit stress is to maintain water chemical and thermal stability. To achieve these goals practically, the relocation process must be customized both to the organisms involved and to the nature of the move. Relocation may generally be regarded as either short or long duration. The measures are handled differently as discussed in the following sections.

Short transport

When moving organisms, not only is geographic distance considered, but more critically the time involved. Therefore, a short transport is one that is completed within a day and is hand-couriered by the aquarist/associated persons. Preparations begin with consideration of the aquarium water. Although a minimum of 50% of the original tank water will be transported to the new destination, have at least 75% of the total system water volume mixed and waiting at the new locality. This excess quantity comfortably allows for any contamination of transferred water (for instance, never reintroduce bagged water for transporting the organisms to the aquarium due to polluting animal mucus or excrement), volume miscalculations, or spillage. Store any unused water for future water changes. Mix the new water several days in advance, having the salinity and pH equivalent to the original aquarium water. Use the same type/brand of salt mix, in addition to any buffers, as previously employed during water changes. With a heater and submersible water pump to sustain a uniform temperature, warm and maintain the new salt water at the same temperature as presently in the aquarium. If the aquarium is a temperate system or otherwise requires lower than ambient temperatures, connect a cooling unit to large volumes of water. Alternatively, place sealed, cold packs in the water just prior to establishing the new aquarium, so long as the temperature is monitored assuring a proper level. Never directly expose ice to cool aquarium water. Even if the ice is from a chlorine-free source, melting may seriously alter the salinity level or the ice will harm organisms it physically contacts.

The next step is to acquire an ample supply of insulated crates and polyethylene bags to move all of the animals and rock. Preferable containers are insulated plastic or metal picnic coolers, since they are usually strong, sturdy, easy to clean, and reusable. If such containers are unavailable, heavy-duty cardboard boxes lined with at least one centimeter of Styrofoam insulation are adequate. Always use properly reinforced Styrofoam containers because the bottoms may collapse under the weight of water and rock. Since waiting for favorable conditions (temperatures near 25°-27°C) will likely prove impractical, implementing heat or cool packs might be necessary for journeys lasting more than several hours or under greater thermal extremes.

On the day of the move, do not feed any of the organisms. Doing so, the animals are less likely to expel larger quantities of waste en route thereby not polluting themselves in the confined transit space. Residual food particles will contaminate transferred water.

The first point in packaging the aquarium is turn off any lighting units, heaters, and water pumps. Once the lights have cooled, remove the light bulbs, wrap them in padding, and carefully place the bulbs in a dedicated box. The electrical lighting components are placed in a protective box. Keep the unplugged heater in the water for at least 15 minutes. That time allows the heat to dissipate into the water thereby preventing heater breakage. Double-line the polyethylene aquarium-grade transfer bags, even if the walls are deemed thick, because most of the spontaneous ruptures occur along weak seams. Never use plastic garbage bags, freezer bags or the like since they readily leak or may have contaminants harmful to the animals. Place a folded newspaper sheet between the two bags for insulation and, when used with fish, for stress reduction. If the rock or stony coral has especially sharp protrusions, consider either a triple or quadruple bag or a water-tight hard plastic container. Large (20-25 L) bags are placed into the transfer boxes. After partially filling the bag, position one or more pieces of live-rock (including coral) into the bag, then add sufficient water to comfortably submerge the rocks and any attached organisms. To avoid stinging in a confined space, limiting a bag to a single species is preferred. Due to the nature of reef aquariums, a rock is commonly colonized with multiple species. In such a situation, package the rock intact since removing the polyps or coral heads from the rock and bagging each species separately will produce a greater stress. Snails, sea cucumbers, and other slow, mobile invertebrates may be left on the rock. For short durations, multiple rocks containing compatible species may be placed in the same large bag (Figure 1A). The water volume is sufficiently large to accommodate durable, placid species. Enclose sea anemones, aggressive coral such as *Catalaphyllia plicata* (elegance or elegant coral), and other potentially hostile organisms individually. Though many cniderians remain retracted throughout the journey, they may release mucus or stinging discharges into the water thereby irritating other animals. If space is a premium, pack base rock in newsprint drenched with aquarium water prior to sealing the bags. This method is commonly used when shipping live rock from the ocean, but any fragile organisms, such as sponges, colonizing the rock will likely perish. The dead matter may prove problematic to water chemistry at the new site if a large portion is affected; to avert such trouble, remove the animals before packing. To assist in re-assembling the aquarium, load rocks from a single locality in a box and labeled with species names or original placement, such as “Right Front of Tank.”

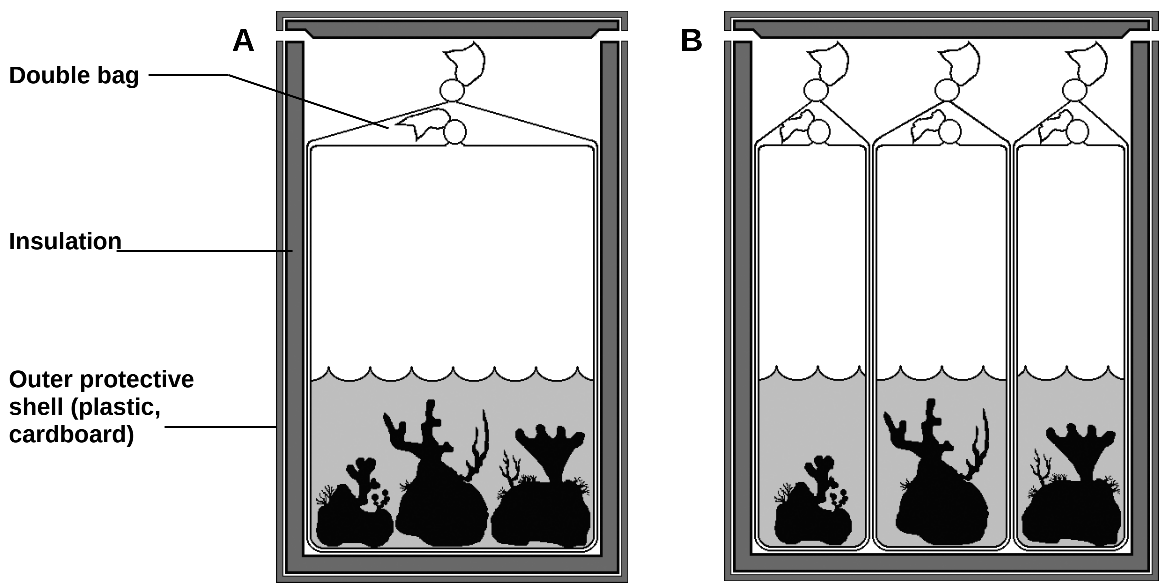

Figure 1. When moving an aquarium a short distance under careful supervision, multiple pieces of live rock may be organized in a large bag (A). Place such a bag in the insulated transport crate before adding water, then carefully arrange the rock. For a long-distance relocation, consider dividing or packaging major live rock pieces individually in separate, smaller bags (B). The latter grouping will allow the pieces to fair better should the crate be tipped.

Difficulties may be encountered if coral has grown and spread across the aquarium glass. Simply scrape soft corals and colonial polyps from the sides with a sharp razor blade. Hard corals, such as *Acropora* sp. and *Porites* sp., will prove more troublesome depending on specific species, the method or adhesives employed to initially attach the colony, and the consequent development. These scenarios vary greatly, and in cases where the piece appears impossible to displace, the aquarist faces the unfortunate decision between the coral or the aquarium. The specimen might be salvaged only at the expense of damaging the aquarium. However, a fragment can often be freed and used for recolonization once the aquarium is reestablished at the new destination.

Employ one of several methods to prevent delicate coral from jarring injuries during transport. If the coral is small to medium size, fasten the piece with rubber bands or fishing line onto a small Styrofoam block (Figure 2A). The secured coral will safely float upside down in the bag of water. In the event of rocks having a rounded base or the coral branches being especially large and fragile, use pieces of base rock or foam slices to secure the piece. A more drastic measure (though effective for larger, more cumbersome pieces) is mounting the rock onto a temporary stabilizing platform (Figure 2B). The platform is some type of flat, inert slab, such as a ceramic tile with any sharp corners removed. Simply remove the subject from the water, blot dry the basal region to be connected to the platform, and place several drops of cyanoacrylate glue on the semi-dried surface. The gel glues are easier to control than the fluid forms and the exact amount required depends the rock size and stability desired. Avoid excessive glue since, upon completing the move, the additional glue will hinder removal from the platform. After pressing the platform and glue base together and provided a 20 second adhesion time, briefly dip the piece in a portion of aquarium water and the rock is ready to return to the aquarium. Once reaching the destination, chisel free the platform. To facilitate operations during the move, attach any platforms (if at all required) in the days pending the move.

After the rock(s) are secured in the bag, add air prior to closing. Air content is vital to maintaining a relatively stable dissolved oxygen content. Beside the respiratory importance, dissolved oxygen content also increases the redox levels of the water, thereby buffering animal wastes. Factors increasing the

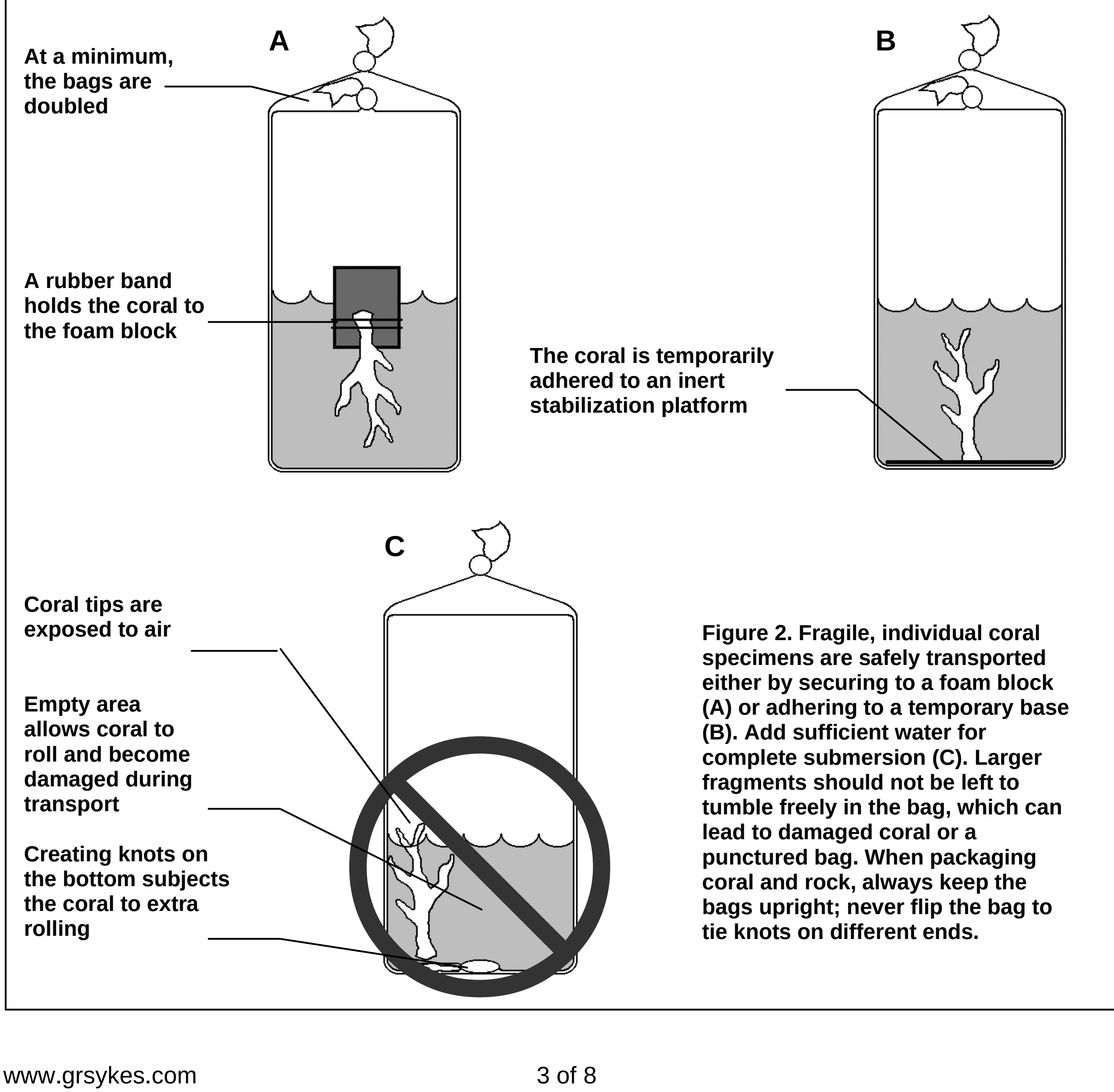

Figure 2. Fragile, individual coral specimens are safely transported either by securing to a foam block (A) or adhering to a temporary base (B). Add sufficient water for complete submersion (C). Larger fragments should not be left to tumble freely in the bag, which can lead to damaged coral or a punctured bag. When packaging coral and rock, always keep the bags upright; never flip the bag to tie knots on different ends.

dissolved oxygen saturation point are decreased salinity, reduced temperature, and elevated atmospheric pressure (Weiss 1970). Medical-grade (99.5%) gaseous oxygen is highly recommended for maintaining the most stable environment for fish, but any coral tips or live rock surfaces contacting the highly reactive air for prolonged periods will suffer damaged tissue. The enriched air acts as an oxygen sink—a source for this gas to continue dissolving into the water and maintain a stable, oxygen-saturated environment over a long time period. Though the initial purchase of the small, compressed gas canister is expensive, future refills are comparably economical. Under extremely supervised sessile invertebrate relocations, the authors have used medical-grade oxygen accompanied by the above-mentioned thermal stability resulting in excellent success (by day's end coral polyps were fully emerged throughout the aquarium as if they had never been moved)! Medical-grade oxygen is advocated since the animals will endure a longer time period before exhibiting the effects of oxygen deprivation. Initially, invertebrate oxygen deficits often manifest in cloudy, tinted water, in which case an immediate change of water is the remedy. Symptoms displayed by fish are gasping at the surface or lethargy. Later symptoms include swimming upside down or loss of equilibrium with rapid gasping. Symptom onset requires immediate action (such as opening the bag and re-packing). The best efforts might not save the fish since symptom onset occurs in the later stages. Whether or not the air is oxygen-enriched, allow for 50-65% of the bag to be filled with air. For enriched air, remove the natural air via gently squeezing the bag. Release the gas into the bag and tie the bag shut. Never blow into a bag when filling with air since breath is high in carbon dioxide. Avoid battery-operated air pumps to continuously pump air into the bag as an aeration substitute. This method causes a mess as water escapes, the pumps break or battery dies, and mortality rates increase; it simply does not work. Retain the battery-operated air pump for established aquariums during power outages if a generator is not available.

An alternative to boosting dissolved oxygen levels for transport is with hydrogen peroxide. Traditionally, hydrogen peroxide is used as a short-term remedy for various catastrophes, such as extended power outages, severe chemical imbalances resulting in low redox levels (known in the aquarium trade as a "tank crash"), or both air and water pump failure (Thiel 1989). No more than two milliliters of a 3% hydrogen peroxide are used per five liter per three hours. In reference to aquarium moves, care must be taken not to overdose the transport water with hydrogen peroxide or the animals will suffer burns if not die. Assuming the appropriate dose is administered, the oxygen will become rapidly consumed. Except for contributions by natural air, all of the oxygen entering the water is already in that liquid body before sealing the bag. Unlike the oxygen-enriched air approach, the hydrogen peroxide method does not have an oxygen sink. Between the difficulty in gauging a proper dose and the relatively short oxygen benefit, the hydrogen peroxide technique is not recommended.

Fish are nearly impossible to catch in a fully established reef aquarium. They are usually more accessible once most of the coral, rock, and water is already removed. Capture the fish capture using a clear, wide-mouth plastic container. After placing this container in the aquarium, use a net only to corral the fish through the opening. This technique both reduces emotional stress on the fish and prevents physical damage associated with net entanglement. Place the fish in a double bag (Figure 3A) or, if the fish has extraordinarily sharp spines, a triple or quadruple bag if a hard, water-tight case is unavailable. Another option is to contain the spiny fish (sharp coral or the like) in a plastic, hole-drilled container which in turn is sealed in a bag (Figures 3B and 3C). Use containers with smooth corners since sharp ones may puncture the bag. Drill holes in a plastic container to a density of one or two 0.5cm diameter holes per $4cm^2$ of container wall. Smooth any shards around the new holes, and fill the bag with adequate water to fully submerge the fish. Depending upon the fish, the bag size need not be as large as those used for the live rock and coral, but should be one third full of water and two thirds full of oxygen-enriched air. To alleviate stress, expediently place the captured fish in the lidded box or other dark area. With few exceptions (such as with *Chromis* sp.), place each fish in separate bags; the most peaceful community fish may become aggressive when cornered and stressed. When placing fish in the box, position the bag knot-side down since poor seals are more likely to leak than the tied knot. This precaution cannot be readily implemented with bags of coral and rock without damaging the animals or breaching the bag. Handle shrimp, crabs, and other non-sessile invertebrates in the same manner as fish. Since shrimp ship best when they are holding onto a substrate, add a 2x2 cm section of fiberglass screen per shrimp.

The exception to waiting until much of the aquarium has already been dismantled before fish capture is in instances when the fish species is extremely timid and literally can be stressed to death. Under such a circumstance, place the container mouth at a cave entrance or the swim path favored by the fish. Should this strategy fail, the default plan is to slowly and gradually remove rocks thereby allowing easier accessibility.

Remove the substrate after extracting all fish and rocks. A good method to transport live sand is by siphoning it into a bag. Coarse gravel/shell mixes are shoveled from the bottom. A substrate depth less than four centimeters (two centimeters is optimal) across the bag will prevent any pockets from rapidly becoming anaerobic. Though substrates develop microbial environments dependent upon low oxygen, preserving these layers is not practical for the move, especially since they will form again at the new locality. Apply medical-grade oxygen, though make certain the substrate is completely submerged in aquarium water to protect the affiliated biota. If oxygen-enriched air is not used, ship the sand moist, without additional water—a consideration if shipping weight plays a major factor.

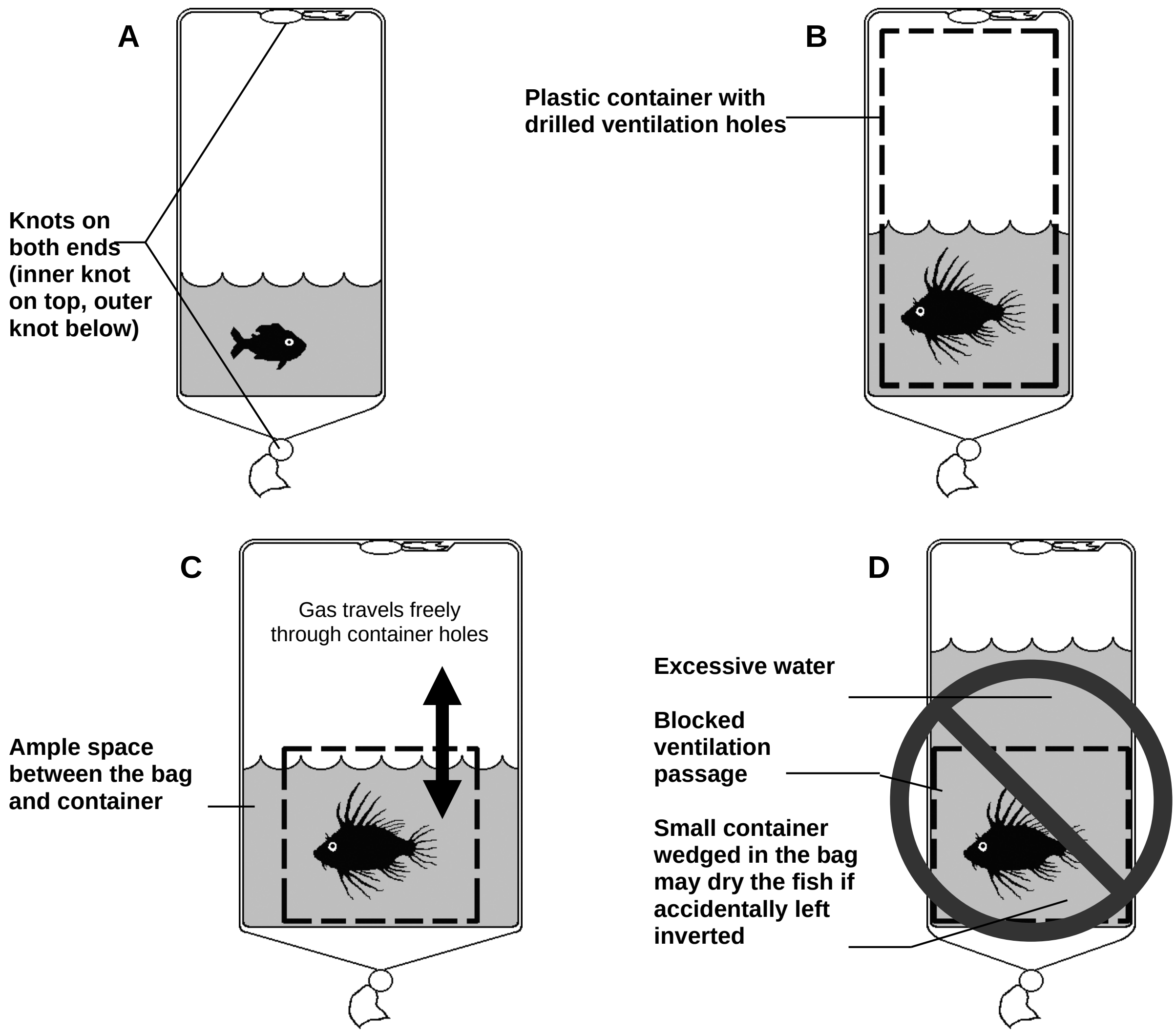

Figure 3. When bagging fish, always use double bags even if the fins are soft (A). For increased durability, the bags may be tied such that a knot is on either end. Knots are often stronger than bag seams, so the outer tie is preferably on the bottom. Implement special packaging precautions for fish with sharp spines, such as a drilled plastic container protecting the bags from the spines (B). Should a large lining container not be available, smaller units will work provided they are in an oversized bag and the fish comfortably fits (C). The space between the bag and container is important for water and gas circulation and permits the container and fish to flow with the water when inverted. Avoid packaging with excessive water, cramming the fish, or wedging the container into the bag (D).

Once all of the aquarium contents are packaged, one may become tempted to drain the filter, discard the carbon and resins, rinse the filter pads and sponges, and clean the system. However, any one of these activities potentially alters the pH, water chemistry, and beneficial denitrofication microorganisms, whereas the goal of a successful relocation is to minimize change. Keep the sponges, carbon, and resins moist in a plastic bag. Place the media from wet/dry or trickle filters in another plastic bag; if the biological filter is convenient to move and the media is secure, move the entire unit for a short duration as is. However, partially clean the aquarium. Since much of the algae growing on the sides will dry and die in transit, remove these mats and encrustation to avoid polluting the newly established system with excessive debris. A light rinse with aquarium water (not tap or fresh water) follows scraping of the sides. At this point, the aquarist can subjectively evaluate the health of the system: a healthy system should have a strong, clean ocean smell to it while an ailing system will smell of rot or sulfur. If the aquarium remains upright throughout the move, the bottom of the aquarium need not be scraped and left with a half centimeter of aquarium water to maintain that lower biofilm. The packaged aquarium is now ready for a short distance transport.

Long transport

The same, basic care applies in preparing an aquarium for long distance moves—those involving overnight delivery—as for shorter deliveries. The differences lie in creating a more robust package. The insulated carrier crates must be durable and, if commercially mailed or flown to a new destination, have a lock with recessed handles. When using commercial flights, question the airline as to specific crate types and dimensions approved by that airline. Make certain the bags remain in a pressurized cabin or compartment, otherwise the bags will rupture at high altitudes. Also, ask if any special arrangements are needed well in advance of the move. Most importantly, arrange for someone to receive the packages upon arrival. Since shipping weight and returning the crates usually become influential factors over long distances, foam-insulated cardboard boxes sealed with packing tape are commonly employed in such instances. Clearly label the boxes as “FRAGILE—LIVE TROPICAL FISH,” including any applicable language translations, to alert the carriers. Since unexpected delays may add more hours to an already enduring journey, seriously consider using heat/cool packs, again depending on the organisms and the temperatures of the current location, transport vehicle, and destination.

Upon packaging the various reef inhabitants, enriched air application is strongly encouraged for fish and mobile invertebrates. Natural air is recommended for coral, live rock, or any other immobile entity. As previously mentioned, prolonged exposure to super oxygenated air will damage tissue. Assume that freighted boxes will not be as carefully handled by shipping workers as by the owner and the contents may roll (despite the best preventative measures). When loading coral and live rock, take care that the pieces are supporting one another or insert wedges thereby stopping the rocks from tumbling (Figure 1B). A minor consolation for large, awkward pieces is that many times, coral (especially species becoming exposed at low tide) will survive exposure to natural air for several hours if the surface remains moist. Again, though the volume of air is actually more important than the water, add sufficient water to completely submerge the coral.

Completely rinse and dry the disassembled filtration unit. Any organisms residing on the walls are not likely to endure the extended voyage, even if the components are wrapped in moisture-sealing bags. However, the bacteria growing on filtration media are more likely to survive the journey since the large surface area retains more moisture and maintains a humid environment similar to the wet/dry filter. Seal this media in a bag. Also transport the carbon, resins, and other elements to minimize water chemistry change. If space is limited, sacrifice these latter items.

Shipping the aquarium itself may be a rather daunting feat, depending on the size or glass construction. Unlike the scenario presented in the short relocation, completely empty the aquarium, including all encrusting algae, and dry all walls. Simply prepare a Plexiglas or small glass aquarium by placing it in a foam-lined crate. Alternatively, attach sheets of Styrofoam to the walls and encasing the unit in heavy cardboard covering. Do not place items inside the aquarium during shipping since the added weight may add further moving difficulty to an already massive object. One must also remember that although the aquarium is designed to hold heavy loads, that weight is supported by an even-surfaced stand which is not available in transit. Also, any loose objects may damage the aquarium. A more economical alternative for large tanks may be to purchase the exact same aquarium, including any custom drill holes, in advance at the destination point. Some of the expenses may be recuperated by locally selling the old aquarium at a discount. The aquarist must consider these factors to arrive at the best solution for that particular case.

Setup at the destination point

Implement the care exercised during the packing and shipping process through to the reestablishment. Ideally, the destination is an aquarium with a complete filtration system circulating set-temperature sea water for over a week. In such a case, the transported aquarium water will substitute at least 50% of the new aquarium water and the old resins and filtration media replaces that currently in the units (save the new material for the next scheduled maintenance event). Arrange substrate and base rock in the new aquarium. Chemically and thermally acclimated the organisms to the new aquarium by opening and allowing the bag to float for 15-30 minutes. During this time, at 5-10-minute intervals, remove a third of the bag water and replace it with an equal volume of new aquarium water. Repeat this water replacement three times during acclimation. After acclimation, release the organism itself, but none of the bag water, into the aquarium. As previously mentioned, add none of the water used to transport the organism to the tank since the animal has likely polluted those temporary confines with mucus and excrement. Alternatively, the fish are first introduced to a quarantine tank so any stress-related ailments can be more easily cured.

Usually the setup process is more involved. Check the animals and, if the water temperature cannot be reliably maintained from this point until release, create a water bath from a tub or other large container. The bath may be freshwater and mixed from the hot/cold tap to set the temperature to that of the desired aquarium temperature. Allow the bags to soak in this water, but prevent the animals from contacting it (dechlorinate the water in case of minor, accidental contact). Inspect the aquarium and all filtration unit components for damage. Assuming no catastrophes have occurred, assemble the various units, but do not activate any pumps, heaters, or other submersible equipment. Once the system appears unbroken or any damage is mended (have quick-curing marine-grade epoxy available), place the used biological media, carbon, resins and other consumable filtration material in the appropriate chambers.

Despite all of the best efforts to maintain thermal stability for the transit organisms, a major menace to these attempts may be the aquarium itself. This irony is especially pronounced in colder temperatures as the glass or Plexiglas cools to a thermal equilibrium. The best way to combat this problem is to maintain a 26°-27°C climate at each step of the moving process. If that option is unavailable, at least maintain a warm temperature at the destination. The time for the aquarium to warm will vary depending on the wall thickness and the degree it has cooled. The aquarium may take over an hour to warm coming from a more extreme environment. A self-adhering aquarium thermometer will help to determine the wall temperature. Hairdryers are not efficient and directed heat from space heaters or heat guns may damage the walls and seals or crack the glass; refrain from these alternatives. An effective means to expedite warming the aquarium is to fill it with warm water (ranging from 30°-35°C). This warm water technique becomes rather awkward when involving medium to large aquariums due to 1) the unwieldy nature of warming, moving, then removing such volumes; and 2) any attempt to keep algae, bacteria, or other growth alive will likely be for naught due to thermal shock, even if using salt water. Hot or boiling water may crack or otherwise harm the aquarium.

Regardless of any inconvenience involved with implementing the suggested procedures for a warm aquarium, some action is required. Without any preventative measures, aquarium water warmed to 26°C will immediately plummet several degrees when added to an aquarium equilibrated to the 20°C room temperature. Depending on the number of heaters and the wattage, warming the aquarium to a safe 25.5°C may take hours and time is not a commodity for the organisms awaiting release. Never introduce tropical animals to an environment below 24.5°C since such temperatures may weaken fish to increased disease susceptibility. The ramifications are widespread in invertebrates ranging from polyps remaining retracted during the subsequent days to bleach coral (the host animal expelling the symbiotic zooxanthellae or associated pigments).

With the aquarium walls at a correct temperature, the aquarium situated in the new locality, and the filtration system reassembled, begin adding the old aquarium water. As the tank fills, arrange the substrate, frames, base rock, and other such pieces lacking ornamental growth in the aquarium. Once this water is depleted, top the system with the new salt water mix. After properly adjusting the filtration system water level, prime the pumps and begin to circulate water. To avert breakage, turn on the heaters on only after they have acclimated to the running water for at least 15 minutes. Thermostat-regulated heaters should not require any different setting adjustments from the original location.

The aquarium temperature should be close to the desired setting if the above-mentioned protocols were properly observed. Initiate the acclimation procedure for the coral after the aquarium reaches the set temperature. Remove any excess water from the aquarium as it is displaced by the coral and rocks. After all of the ornamental rocks are positioned in the aquarium, acclimate and release the fish, shrimp, and other such creatures. The aquarium lights are now turned on. If the rocks are arranged in relatively the same place as in the prior location, the fish will feel more readily at home and, consequently, enjoy a quicker stress recovery than if using some other organization. The move is now complete and the true success can be appreciated as the organisms make minimal adjustments to their newly placed old home.

Discussion

Using this guide, most types of systems and sea creatures can safely be moved. The aquarist owning a system surrounded by extenuating circumstances may wish to discuss the specifics with a regional aquarium authority or hire a professional aquarium mover. If such movers are the chosen route, they usually are employees of an aquarium specialist store, but they operate the moving/maintenance business independently from the establishment. Talk to several reputable companies/individuals and inquire as to experience, the techniques employed, mortality rates, any insurance (livestock is rarely covered), and references. The knowledge and experience of a mover can be revealed through the course of the conversation. Hiring movers are expensive. Unless the aquarium is extremely uniquely designed or surrounded by other special circumstances, the bid or hourly fee can be estimated based on information provided over the telephone. Often asked are facts such as aquarium size, basic system equipment, approximate live rock weight, livestock type and quantity, and whether or not coral has adhered to the aquarium. After the call, the mover will calculate the costs and mail the estimate within several days. Try to get at least three bids. The price differences can be broad; the highest bid may be several fold that of the lowest estimate. When pondering bids, the middle bidder is usually a good choice: extremely low bidders may lack experience; over priced bidders are often people who do not want to be bothered with the process unless lured by a large incentive.

Indeed, relocating any aquarium can be an intimidating task. The key is to have a well-thought, organized strategy complete with several backup alternatives. Instead of tackling the project as a single unit, break it down into sequential steps. Most importantly, keep in mind the fundamental goal of the move: sustaining a stable temperature and water chemistry from start to finish. Implementing this philosophy into practice will allow the healthy aquarium, which has evolved over years of hard work, to thrive at the new location.

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