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CONTENTS

MENAGERIES AND MISSIONS

Would you feature an exhibit with no animals showing? Would you have one in your operation? Is it a matter of your personal choice? What is the reason for your institution?

We are very prompt to assure each other that we are not in the menagerie business, that we are not just keeping animals, that our operation has a mission. Some of us fumble on coming up with purposes.

Does your institution entertain?

Is your institution a repository of animals or of animal knowledge?

To whom do you cater?

Is your selection of animals for your target visitor?

Does your selection of animals stimulate your visitor for more information or present basic principles?

Have you set a policy or goal?

Many animal collections are a sort of personal barony. The inventory and interpretation, if any, represent the whims of the director. Perhaps this is one reason why animal management and interpretation people do not have a strong vehicle of communication. At this time, there is no agency for transmitting and keeping specific professional information. The serious question of professional affinities has not been solved. When are we going to apply ourselves to these problems?

Angus Wilson's new fiction work, "The Old Men at the Zoo," sometimes about the organization and administration of a zoo in the period of 1970-73 discusses raison d'être for collections of animals. Esthetic, research, conservation, civic responsibility and entertainment are mentioned.

This prospect that modern animal keepers will still be searching for modern policies and objectives ten years from now may have much truth to it. Where the hell are we going, boys?

Would you set up an exhibit which did not show the animal in plain view? You would have to if you were giving a presentation of protective coloration or defense mechanisms. But how many of you are interested in presenting biological principles?

In fact, how many zoos and aquariums today tell the visiting public the basic definition of an animal or more specifically of a mammal, bird, reptile or fish?

LCF

SELF-INHIBITION BY CAPTIVE FISHES THROUGH THE WATER IN WHICH THEY LIVE

by

James W. Atz

New York Aquarium

Keeping fishes alive in captivity is much more of an art than a science, and the most valuable attribute an aquarium man can have is a wet thumb. Not until some aquarium puts on its staff, full-time, a biochemist and a microbiologist, both of them solidly grounded in aquatic biology, can we begin to hope to find out what is really going on in our tanks. In the meantime, we shall have to be content with a pragmatic approach that permits us to perform whatever simple experiments and tests are feasible and to try to apply the scientific method scarcely allows us to do otherwise.

A key problem of aquarium management is understanding how fishes affect the water in which they live. In fact, the purpose of most of our water management practices is to maintain "the lifeblood of the aquarium organism" in suitable condition. Aeration is generally sufficient to keep within satisfactory limits the carbon dioxide produced by the fishes and to replace the oxygen consumed by them. As far as non-volatile wastes are concerned, however, the matter is not so simple. For the kind of fishes kept in small, standing, freshwater aquaria, these wastes actually improve the water - up to a point. This is the "conditioned" water so well known to fish fanciers. The improvement of raw tap-water by the addition of salts and the removal of toxic ions of heavy metals by binding to organic substances is understandable, but it is hard to believe that these two processes alone could account for the obvious improvement that tap-water undergoes during its "condition," that is during the time that animals and plants are first living in it. The development of bactericidal or bacteriostatic properties is one of the few well established characteristics of "conditioned" water, although the basis for it is unknown. (This and the tolerance of "tropicals" for accumulated wastes are perhaps the properties that make the maintenance of the so-called balanced aquarium different from that of any other enclosure for captive vertebrates - which may be able to thrive in uncleaned quarters, but in spite of, rather than because of, the accumulation of their wastes.) The possibility remains that there is another, more subtle and, as yet, undescribed factor that these fishes put into the water around them to make their environment more suitable. The distinguished ecologist, W. C. Allee, attempted to come to grips with it during the 1930's, but without success. It has been suggested that specific animal proteins might be involved, but no one has been able to devise an experiment that would distinguish between such specificity-effects and

the many other factors that could act selectively on certain species in, say, a community tank. The recent work of Dr. Herman Kleerekoper and his associates is pertinent here, since they have developed techniques for chemically analyzing the substances that are released into the water (not in the urine or feces) by fishes. Some of these chemicals may be species-specific and some of them may also act as the scent by which lampreys and other predators track their piscine prey.

During the past ten years, another effect of fish waste-products and metabolites has been investigated. Although the effect is inhibitory, and therefore more in line with what one might expect on the basis of typical studies on laboratory populations of invertebrates as well as cultures of microorganisms, it seems to operate in mysterious ways that have intrigued more than one biologist. Dr. H. S. Swingle, who is renowned for his work on pondfish culture, noted that when goldfish, carp and buffalo "were stocked in ponds several months prior to the spawning period, reproduction did not occur when the water temperature rose to the normal spawning temperature. However, upon transfer of these fish into adjacent ponds filled with fresh water, spawning usually occurred within 24 hours," and often within 12. Bluegills produced a substance that appeared to be even more inhibitory on largemouth bass than on themselves. At the same time, but independently, Dr. S. Meryl Rose found that guppies have fewer babies when they are crowded, and that this inhibition could be partially overcome by replacing their tank-water with water from aquaria containing other species of "tropicals." Moreover, simply by adding individuals of other species to the already overcrowded tank, the reproductive capacity of the guppies was improved. In populations of growing guppies, the larger members somehow exert a harmful effect on the smaller ones, eventually killing them - an effect not associated with competition for food, which was supplied in excess, or with bullying, which was never seen. The same phenomenon was observed in the Sumatra barb, White Cloud Mountain fish and brown trout.

What kind of substance causes these effects is a mystery. Fishes are sensitive to at least some of their waste products, especially ammonia (for instance, three parts of ammonia in ten million of water can be seriously toxic to trout), but the peculiar specificities indicated above point to some other substance or substances. On the usual well aerated and filtered water system, the considerable quantities of ammonia produced by the fishes either pass off into the atmosphere or are oxidized to nitrate, and nitrates are known to have accumulated in the freshwater system of at least one public aquarium (London). Nitrates do not seem to be very poisonous to fishes, however; sodium nitrate, for example, is scarcely more toxic than sodium chloride. The presence of this ion cannot account for the unusual conditions just described. Painstaking work on tanks crowded with tadpoles indicated that the larval amphibians were eating fecal material which contained a peculiar cell and that this was what stunted them. But, again, fecal cells do not seem a likely answer to the fish problem.

We know even less about sea water; in fact, we do not know whether the inhibitory effect exists there. The outstanding changes occurring in sea water used for long periods in closed circulations are the lowering of the pH (loss of alkaline reserve) and the increase in nitrate. The latter has been recorded in the Amsterdam Aquarium, the old New York Aquarium at the Battery, the Aquarium in Regents Park, London, and the John G. Shedd Aquarium in Chicago. Nitrates are known to be poisonous to various marine invertebrates, but there are no data indicating any serious effects on fishes. No one has yet found a practical way to get rid of them, except that a combination of a specially encouraged, rich algal growth and filtration by activated carbon was reported to have kept the concentration of nitrate low in a 6,600-gallon seawater system in the zoo in Wuppertal, Prussia. Marked improvement in the invertebrates was noted. Similarly, at the aquarium of the Marine Biological Association of the United Kingdom in Plymouth the last World War dictated an experiment by making it impossible to repair most of the larger tanks when they were knocked out of commission, leading to a much larger ratio of the seawater to the animal life living in it. Delicate organisms now began to survive much longer than before and they sometimes reproduced. Unfortunately, in neither of these cases has anything been written on the improvement shown by the fishes, if any.

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THE NATIONAL FISH HATCHERY AQUARIUM AT WELAKA

by

Craig Phillips

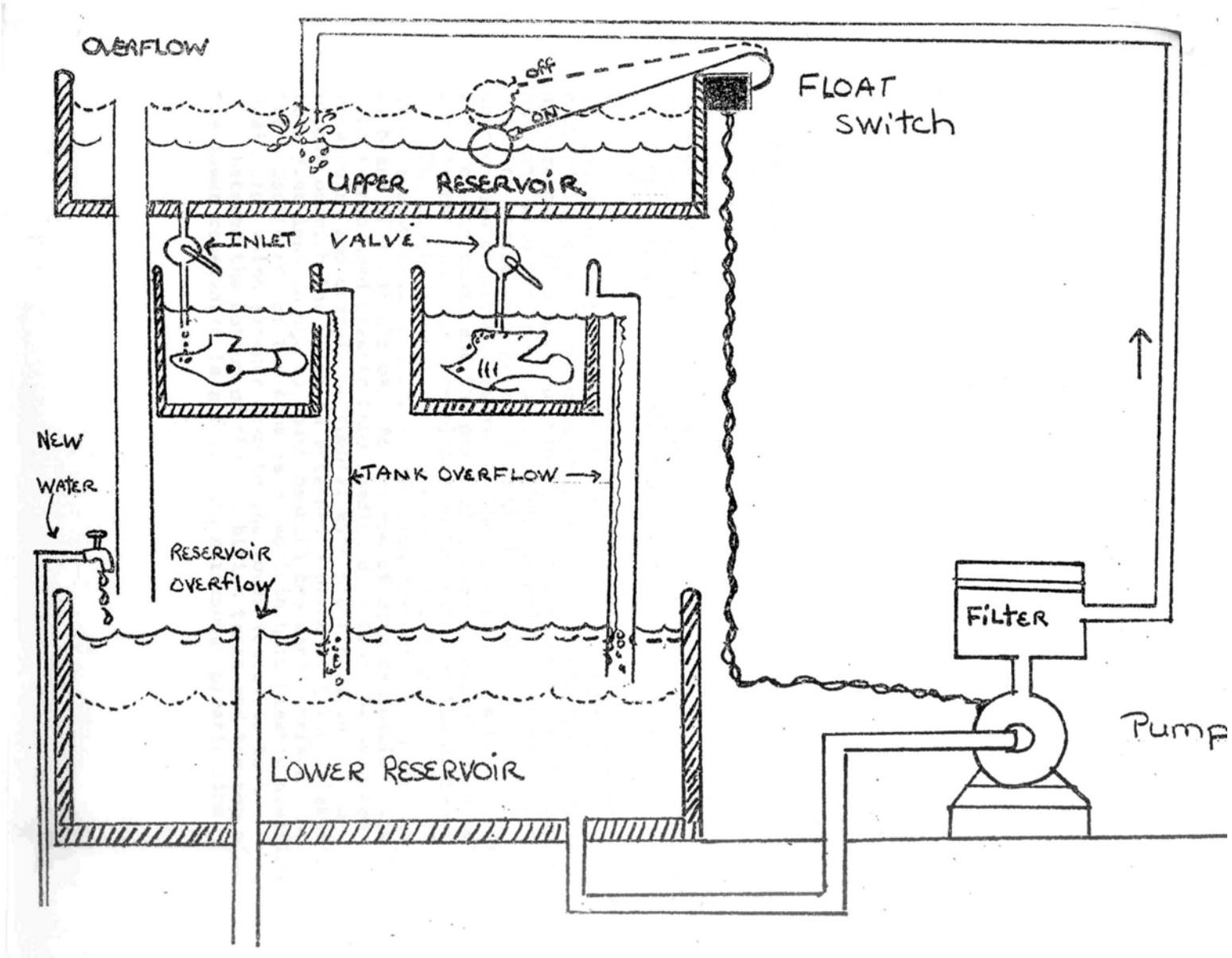
A modern type of aquarium building was recently constructed in connection with the National Fish Hatchery, at Welaka, Florida

The new aquarium was built as a compact unit, with space for twenty different exhibition tanks ranging in capacity 50 gallons to 500 gallons operating under a closed system of circulating fresh water. A system of interconnected overhead reservoirs supplies water to the exhibition tanks by gravity flow, and these in turn overflow into a system of interconnected bottom reservoirs located on the floor beneath the tanks. The water in the lower reservoir system is then drawn by pump and passed through a small pressurized filter of the type commonly used on swimming pools, and returned to the upper reservoir system. Since water is returned to the system at a faster rate than it normally flows through all of the exhibition tanks, the pump works on an intermittent basis, being controlled by means of a float switch in the upper reservoir system.

The exhibition tanks, of approximately 50 gallons, 300 gallons, and 500 gallons capacity respectively, were constructed of three-quarter inch marine plywood coated inside with a layer of blue-green fiberglass and plastic, making them impervious to water. The glasses were not attached to the tank fronts, but instead were designed to rest loosely against a half-inch outer diameter neoprene rubber hose gasket, sealing pressure being afforded by the weight of the water within the tanks.

The tanks were arranged to have both a front and the back glass, with dry curved dioramas behind them, the dioramas being decorated with sand, rock, driftwood, and artificial plants in such a way as to appear to be an extension of the actual tank (by the judicious use of lighting, it was found possible to achieve this effect to a remarkable degree).

Excepting for the pump and the filter, there is not metal in contact with the water system. The upper reservoir system was constructed, as in the case of the exhibition tanks, of heavy plywood lined inside with fiberglass. The lower reservoir system is of concrete, and all pipes, drains, and valves are of heavy plastic or polyethylene tubing. Once in operation, it was planned to provide a constant small flow of new water into the system from a well source located some distance from the building, and the resultant overflow carried to the sewer through a standpipe located in the lower reservoir system. This was considered as perfect and foolproof a circulation system as could be devised at the time, and in practice it has worked very satisfactorily.


OVERFLOW
off
ON
FLOAT
switch
UPPER RESERVOIR
INLET VALVE
NEW
WATER
TANK OVERFLOW
RESERVOIR
OVERFLOW
FILTER
Pump
LOWER RESERVOIR

To supplement the water system when necessary, a system of plastic airlines, each bearing an airstone at the site of each tank, was provided and supplied by an electrically-driven compressor located in the pump room. Temperature control is maintained through having the entire building air-conditioned winter and summer.

Two concrete holding tanks, each about eight feet long, 30" and 32", were located in the area adjacent to the work space behind the exhibition tanks. Each of these is partitioned into three equal parts, removable in the case of one of them. Both are provided with air and water outlets, and it is planned to use these tanks as a reserve for extra specimens, live food, or as a "hospital" as required.

Over each of the exhibition tanks are placed two florescent tubes, one daylight and one cool white. They are located about a foot from the water surface and are tilted forward as to reflect a major portion of the light produced backward off the front glass, which acts as a mirror when the tank is filled. Over each diorama is a single daylight tube. Since a certain amount of warm color is absorbed from the light by the water, the effect on the viewer standing before each tank is to see both the tank and the background illuminated by light of approximately the same value. Excepting at the lower back edge, it is nearly impossible to distinguish the transition between the tank proper and the background when the tank lights are on.

Another optical effect works to advantage here. When an aquarium tank is filled with water, it becomes foreshortened to the eye by about one-third, but at the same time the background area apparently increases, allowing the construction of comparatively narrow dioramas (14 inches or less), which nevertheless appear sufficiently wide when viewed through the water of the tank.

The dioramas were made in three different sizes and curvatures to correspond to the different tank sizes, and three slightly contrasting colors were used to random to add variety to their appearance. They were constructed of curved sheets of untempered masonite with the rough side, which was painted, inward. The masonite sheets were attached at the bottom of a crescent-shaped base of plywood raised to the same height as the inside floor of the tank, and the particular type of gravel, sand, etc., used in the tank was also placed on the floor of the diorama.

The overhead reservoir tanks rest on a series of 2' x 6' cantilevered beams and are in addition fastened to the ceiling by means of metal strips. At one end of each exhibition tank is a half-inch hard plastic tube leading down from the overhead reservoir, and carrying a tumbler-type plastic valve. To a nipple beneath the valve is attached a piece of ½-inch plastic hose just long enough to reach beneath the water surface. At the opposite end of the tank is a two-inch hard plastic overflow drain pipe which extends down to the lower reservoir tank.

Between the bottom of the exhibition tanks and the top of the lower reservoirs is a four-inch horizontal plastic line leading to the sewer and perforated at intervals to permit manual siphoning of the exhibition tanks wherever necessary. It is assumed that a certain amount of uneaten food and other detritus will undoubtedly overflow through the tank drains into the lower reservoir system, but this is not anticipated as a major problem, as most of this will eventually be trapped by the filter screen and removed. It is even thought that several goldfish kept permanently in the lower reservoir

system will function as a “cleanup squad” and keep the bottom stirred up so that no excessive amount of sediment will accumulate in any one place.

The filter, which is of cylindrical shape and about 3 feet high and two and a half feet in diameter, operates under a pressure of approximately 15 pounds, requiring backflushing when the pressure rises to 20 pounds. This is done manually, and involves removing and flushing the screen trap and washing the accumulated filtrate down the drain. Then the filter elements, consisting of a series of nylon-covered wire mesh plates within the filter, are coated with a layer of filter-aid through a suction hose attached to the filter. The valves are then opened and the filter set in operation once more.

Because of its intermittent operation and the fact that the total amount of water in the system is well below the volume of the average swimming pool, it is expected that backflushing can be limited to once every 24-hour period at the most. Backflushing itself requires only a comparatively small amount of water in filters of this type, as opposed to the large quantities of water required by the conventional sand filters used in many aquariums.

Aeration of the water takes place at multiple points in the system, mainly where the water is jetted into the overhead reservoirs and where it overflows into the lower ones. Besides this, a considerable part of the water system is open to the air, so that the water should be more than adequately oxygenated at all times.

Initial setting up of the exhibition tanks was done in the following way: The glasses that were to go on the backs of the tanks were painted around their edges with a one-inch strip of blue to match the tank interior in order to hide the neoprene gaskets from view. Then the gaskets were cemented to the one-inch retaining lip around either face of the tanks and the tanks set upright on their shelves against the window openings to the public area. The sheets of ¾ inch tempered plate glass were set in place and held temporarily either by clamps or by hand as the tanks were filled by a gasoline-operated pump with a two-inch line dropped into the previously filled lower reservoirs.

As each tank was filled in turn, leakage was considerable until the water reached a height of several inches, but as the mounting pressure squeezed the glass more tightly against the gaskets, the leakage became less and less, and in most cases stopped completely when the tank was full. In a few cases a small amount of slow leakage continued at certain points, but within two days after filling, all of this had stopped.

Because of the fact that the exhibition tanks are set on horizontal planking directly over the lower reservoirs, all the leakage water was recovered and the leakage itself was undetectable from the viewing side. The longer a glass presses against a gasket, the more completely a tank is sealed, and yet if necessary, a tank of this type can always be disassembled by draining it completely. In use the tanks cannot be emptied more than two-thirds without risking new leakage, but previous tests over several years of operation have shown that this type of tank never need be fully drained, as they never

require additional painting and the hard plastic interior is more impervious to algae growth than are the glass fronts.

The geographical location of Welaka, situated on the St. Johns River about 35 miles northwest of Daytona, Florida, is admirably suited for an aquarium displaying life of Florida's fresh waters. Not only do warm water food and game fish abound here, but also the many species of native "tropicals" as well as certain salt water species including sting rays, pipefishes, and large flounders which migrate up from the sea and become semi-established in the fresh waters adjacent to Welaka.

We are actively attempting to devise or apply new techniques to our aquarium operation and to construction. As you may know, tentative plans call for a new National Aquarium. In preparation for this we want the latest and most successful designs of displays, water and filtration systems, and other items that go to make up the best. We are trying new techniques and materials and trust that all other aquariums are also progressing.

SOME OPTICAL PROPERTIES OF AQUARIA AND THEIR APPLICATION TO LIGHTING AND DESIGN

A study of the lighting of the exhibit tanks at the Cleveland Aquarium was conducted during the winter of 1958-59. Theoretical considerations indicated that glass sided aquaria (and their water air interface at the surface) behave optically as liquid filled prisms. The following optical effects were determined empirically and by ray tracing methods to be applicable to aquarium lighting and tank design. All angles mentioned are those between a ray of light incident to a surface and a normal perpendicular to the surface at the point of incidence:

1. Light entering an aquarium at an incident angle greater than zero is refracted toward the normal. (figure 1)
2. Light traveling through an aquarium and striking a glass side (or water/air interface) at a large angle is totally reflected internally. (figure 1)
3. Interference colors in fishes (rather than pigmentation), such as the brilliant blue of neon tetras (Hyphessobrycon innesi), and the sparkle of reflections from fish scales display best under point sources of illumination - such as unfrosted incandescent lamps. This effect is well known in the jewelry business and phenomenal gemstones are shown under such light.
4. External light incident to the water/air interface at the surface of an aquarium is mostly reflected if the angle of incidence is very great. (figure 1)
5. Objects in an aquarium not located along the line of a perpendicular from the observer's eye to the surface of the aquarium glass appear to be displaced from their true position away from such a perpendicular by refraction.

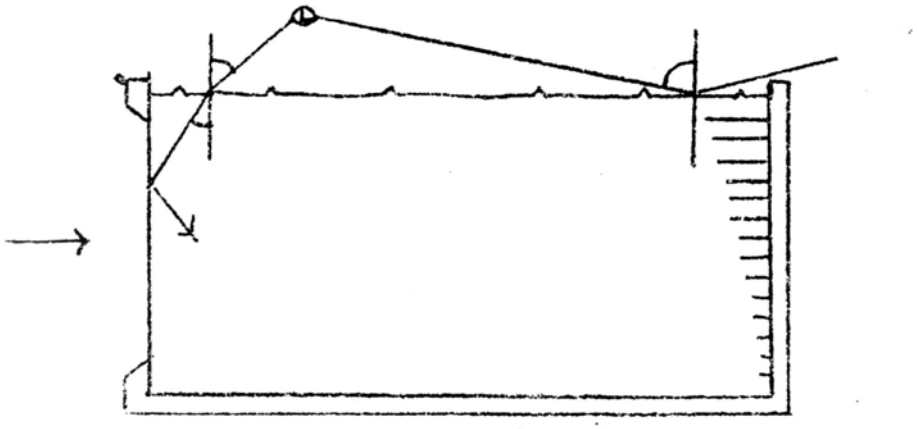


FIGURE 1

These considerations make possible the following lighting systems and tank designs:

1. FRONT LIGHTING OF THE EXHIBIT BY TOTAL INTERNAL REFLECTION

Light falling from above illuminates a fish dorsally but shadows it ventrally. Lighting the fish from the observer's side would eliminate this shadowing. The idea of such side lighting is not new, but attempts to accomplish it by directing light through the sides or front of an aquarium are not very successful. Coates and Atz (1) blamed this failure on a nervous disturbance of the fish and occlusion of the light by a growth of algae over the point of entry. They concluded that a light, or a row of lights, should be placed close to the water and near the front glass. This arrangement is now in general use and lights a fish well in most positions in an aquarium except when the fish is close to the front glass.

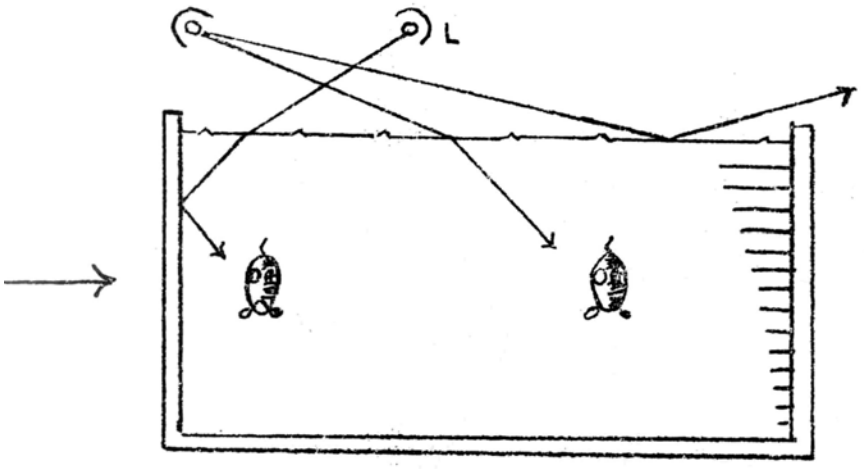


Figure 2

Figure 2 shows this arrangement with and additional light source (L) arranged to transmit light toward the front glass where it is totally reflected internally to the front side of the fish. When the light sources are incandescent lamps (preferably unfrosted bulbs) all of the effects described in 1, 2, and 3 go into operation. A spectacular improvement in appearance of the displayed fishes may result from this arrangement.

II. A DESIGN FOR AN "INVISIBLE" TANK

Coates and Atz further observed that low, front positioning of the lighting would subdue the background. This is a case of effect number 4 wherein the light traveling toward the back

surface of the aquarium strikes the surface at such a large angle that it is mostly reflected externally.

Effect number 5 was anticipated by Garnaud (2). Writing of the construction of tanks at Monaco he said, "…….(tank) sides sloping at about 45^0 are not visible to the public because of refraction."

If we agree that the artificial appearance of a conventional tank shape, giving a sort of "fish in a box" effect, is undesirable; and if it be further agreed that this results to some extent from being able to see the sides, back, bottom and corners of such a tank; then by utilizing the effects described in 4 and 5 we can design a tank that virtually "disappear" when filled with water and lighted properly.

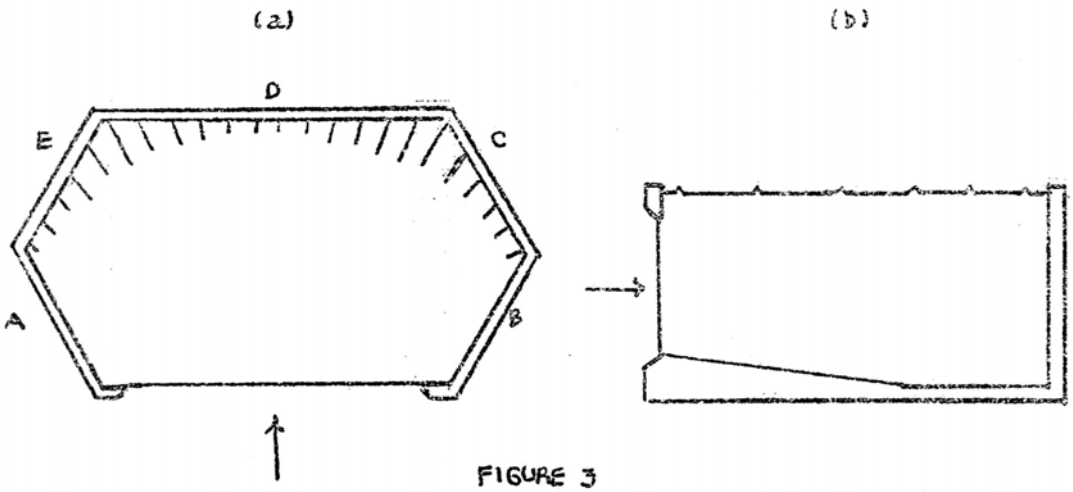


FIGURE 3

Figure 3 shows (a) a top view of such a device constructed as a hexagon and (b) a side view. Walls A and B appear to fold back almost out of sight by refraction. The bottom, with a shallow slope from front to rear, appears very steep ---- also by refraction. The back three walls, C, D and E are nearly unlighted because of effect number 4 and become quite invisible if painted dark. Such an

aquarium, 1300 gallons in size and hexagonal in shape, is now in operation at the Cleveland Aquarium. Hexagonal tanks "nest" well together as shown in figure 4.

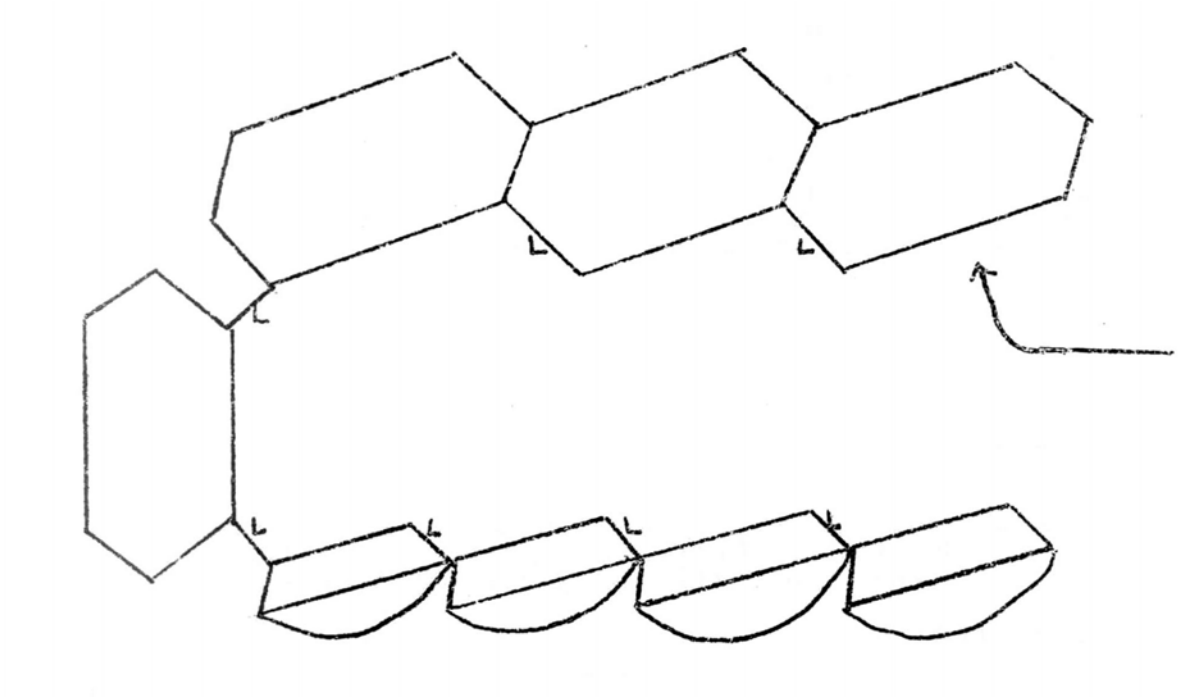


Figure 4.

This arrangement in effect rotates the tanks so that a visitor entering the hall sees the action of the living exhibits in the row of tanks facing him on the right. The tanks on his left face away from him until he has traversed the right hand row, then face toward him on his return. A reasonably effective automatic traffic pattern thus emerges among the epople moving through the aquarium.

The flow rate of visitors through the exhibit is speeded up by using the panels adjacent to the tank fronts (marked L in figure 4) as labeling areas. This allows the occasional studious label reader to stop out of the traffic pattern of people who do not read labels.

An increased length of linear exhibit space plus service access to two rear sides of each tank is also provided by this method of arranging hexagonal aquarium tanks.

The lower part of figure 4 shows smaller tanks, also with 30^0 side walls, equipped with a

curved rear diorama that may be viewed through the layers of glass and water. The layer of water from the viewpoint of a visitor near the front glass gives some magnification of the diorama background. When the background is skillfully arranged to blend in with the aquarium containing living animals in the foreground, a very convincing impression of a large "seascape" may be created.

Since visiting a public aquarium is primarily a visual experience, further investigations of these relationships between the optical properties of aquaria and their design are indicated; and this work may well enhance the appearance of our exhibits.

References:

(1) Coates and Atz. "Lighting the Tank in a Public Aquarium." PARKS AND RECREATION, Vol. 32, No. 8, August 1949

(2) Garnaud. "Structure Nouvelle De L'Aquarium Moderne Et L'Autres Ameliorations Techniques." BULLETIN DE L'INSTITUTE OCEANOGRAPHIQUE DE MONACO, No. 1011, April 1952

Bill Kelley

John R. Clark, Marine Biologist, Sandy Hook Marine Laboratory, P. O. Box 428, Highlands, New Jersey, has requested papers of people who have had experience with designing, constructing, and maintaining sea-water systems for experimental purposes, and to prepare the manuscripts for publication by the U. S. Fish and Wildlife Service. For this publication he would encourage contributors to describe their experiences in solving problems encountered in designing, constructing, and maintaining systems rather than give detailed and comprehensive accounts of complete sea-water systems. Items of particular interest would be unique features employed to meet particular circumstances and suggestions of general application for improving sea-water systems. He would like to have your contribution as soon as is convenient, but not later than January 10. All papers must be in English. Manuscripts should be typed double-spaced on white bond paper, one side only. Illustrations should be original ink drawings or good quality glossy prints. Please furnish an abstract of your paper. Also, be sure to include your laboratory affiliation, your title, and address. It is expected that most contributions will not exceed 10 or 15 pages.

SHEDD AQUARIUM BRIEFS

With the thought that it would not be a complete D. and C.* without a few well chosen words about Chicago's own** (It's just a little Shedd but we like to call it home) I am submitting this, somewhat under the gun, and would like, among other things, to bring you up to date on our four famous apapaimas.*** In Volume 59, Number 7 of the D. and C. (see*) the growth records were given to early 1959. These are herewith repeated plus the latest increments. (Texans take note)

#1	May 4, 1954	-	8"
	Jan 23, 1957	-	45"
	Aug 27, 1958	-	61"
Now	Oct 21, 1961	-	66"

#4	Nov. 6, 1958	-	19"
	Feb. 26, 1959	-	26"
	Apr. 1, 1959	-	33"
Now	Oct 21, 1961	-	46"

#2	R. I. P.		

#5	Nov. 6, 1958	-	22"
	Feb. 26, 1959	-	29"
	Apr. 1, 1959	-	36"
Now	Oct 21, 1961	-	53"

#3	Sep. 17, 1957	-	15"
	Feb. 21, 1958	-	24"
	Apr. 4, 1959	-	38"
Now	Oct. 21, 1961	-	61"

It would seem that their period of most rapid growth occurs between about 20 and 60 inches. Numbers four and five, which seemed to mushroom between the end of February and the beginning of April, 1959, had been transferred to a 6000 gallon tank from a 600 gallon tank at the time the February measurement was made. Apparently the extra room they were given was an important factor in their increased growth rate. As they apparently taper off at a length of about 5 ½ feet, it would be interesting to see what would happen if they were placed in a considerably larger tank, say one of 12 or 15,000 gallons.

In addition the lengths and ages of three fine, outstanding specimens of the tucunare, Cichla ocellaris**** are hereby presented for your admiration and reverence.

#1	Aug. 7, 1956	-	4"	#2	Aug. 7, 1956	-	4"	#3	Aug. 7, 1956	-	4"
	Oct. 21, 1961	-	17"		Oct. 21, 1961	-	18"		Oct. 21, 1961	-	20"

Our electric catfish, which was donated by a hobbyist two years ago when it became too big for his tank, has since doubled its size so that now it is 26 inches long and has a girth of approximately

17 inches. Unfortunately, there is no record of its original size or date acquisition.

On October 15, the Shedd Aquarium was host to about 250 delegates of the Region 7 convention of The International Federation of Aquarium Societies. Escorted through in groups of 30, the delegates were given an opportunity to view the operations, machinery and equipment necessary to maintain a large public aquarium. They seemed primarily interested in what and how much is fed; the filtering system; and of course, the balanced aquarium room. Initial response has been most favorable, indicating that the delegates thoroughly enjoyed themselves.*****

This past spring our collecting crew had a stab at reducing the fish population of Hawaii. Supported in our efforts by Jack Marr of the Honolulu Biological Lab, Mich Takata of the Hawaiian Fish and Game, Spencer Tinker of Waikiki Aquarium and Phil Helfrich of the Hawaii Biological Lab on Coconut Island, we arrived back in Chicago with 1500 specimens.

The people in Hawaii, especially those mentioned above, are the greatest. They leave nothing undone in their efforts to help you. After a while it gets to be embarrassing. Spence parted with many of his prize specimens, including five choice uluas. Unfortunately only two of these large ones survived the trip but they are a fine addition to our exhibits. In a 30 foot tank with tarpons, nurse and lemon sharks and a green turtle, they are the table bosses. Nothing else gets a bite until these two have had their fill.

As this was the first such trip since 1939, our collection received considerable publicity and attracted large crowds during the summer. The most gratifying result of the trip was the visit by a family from Honolulu who were returning to the Islands after spending a year in the East. They were absolutely amazed to find so many fishes from their back yard right here in Chicago.

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* Drum and Croaker. Not to be confused with an operation masquerading under the same initials.

** Frequently referred to as the world's largest and finest.

*** With due respect to the Tupi Indians, pirarucu would obviously destroy the poetic flavor.

**** More correctly, the tucunare-assu, as differentiated from the obviously inferior tucunare-branco, Cichla temensis.

*****Despite what you might have read recently to the contrary, the Shedd Aquarium does cooperate with the hobbyist.

Bill Braker

NOTE NOTES

James Atz is now Curator, New York Aquarium
William Braker is now Assistant Director, Shedd Aquarium
Lawrence Curtis is now Director, Forth Worth Zoo & Aquarium
L. C. Finneran has moved and is now Curator-Director, New England Aquarium, 10 Post Office Square, Boston 9, Massachusetts
Earl S. Herald, (we think), is now Superintendent-Curator, Steinhart Aquarium
Carlton Ray is now Associate-Curator, New York Aquarium

Marineland of the Pacific just keeps rolling along. Their fiscal year ended on April 1, 1961. Their statement of income shows 1,459,954 paid admissions, $2,998,270 in income, $1,510,521 in expenses, and $719,620 in net profit after taxes. Anyone for the commercial aspect?

Rhode Island Oceanarium, Inc., has one in plan for a projected $550,000. This show will be located in Saunderstown, Rhode Island.

Philadelphia Aquarium, Inc. has one in plan for a projected $2,000,000. This show will be located in downtown Philadelphia.

Maine Department of Sea and Shore Fisheries, August, has put out Teacher Aid No. 1-A, "Adapting a Used Refrigerator for Cooling the Classroom Saltwater Aquarium." You find it excellent reference material.

A directory of the public aquariums of the world is being prepared. Contact: Spencer Tinker, Director, Waikiki Aquarium, 2777 Kalakaua Avenue, Honolulu, Hawaii.

Every public aquarist should get to see The Seven Seas Panorama exhibit at Brookfield Zoo in Chicago. It is quite a construction.

Charles L. Wheeler has been appointed Aquarium Director at Woods Hole, Massachusetts. On August 30, 1961, he sent in the following report:

THE BUREAU OF COMMERCIAL FISHERIES OPENS A NEW SUMMER AQUARIUM AT WOODS HOLE

The new marine aquarium of the Bureau of Commercial Fisheries Biological Laboratory at Woods Hole opened its doors to the public on July 1, 1961. During the summer months of this and succeeding years, there will be shown in its 16 tanks a representative collection of local marine fishes and invertebrates, a particular effort being made to include those species which are of importance to the commercial fisheries of New England. A series of dioramas, models, wall panels, and other visual material relating to the work being done at the laboratory and to the living resources of the Western North Atlantic will also be seen by visitors to the new building.

Although new in its physical assets, modern in its architecture and up-to-date in its display techniques, the aquarium is old in tradition and inherits a well-established reputation which dates back to the last quarter of the 19th century. The original Woods Hole Aquarium, to which the present structure is the successor, began its long career in 1886 as part of the old Bureau of Fisheries Laboratory and Fish Hatchery and was closed after 68 years of operation when the late August Hurricane of 1954 seriously damaged its salt water supply system. By that time, however, the facilities of the old station were recognized to be obsolescent and plans had already been started for the construction of an entirely new research headquarters.

A dual-purpose aquarium, which would serve as a public attraction from June to September and provide tanks, running sea water, and other research necessities during the balance of the year, appealed to those responsible for the layout of the new station. Provision for workshop, garage, and storage areas was an obvious necessity, and it was decided to design a single building which would fulfill this multiplicity of needs, the aquarium section being planned as a separate unit,

occupying its own wing. The 3-story laboratory was the first building to be completed and was occupied in March 1960, the aquarium being completed a year later.

The present Woods Hole Aquarium is a 1-story structure with a basement for the housing of the filters, pumps, and reservoir pertaining to the recirculating system. Sea water may be supplied to the tanks either from this system or from a 50,000-gallon standpipe which is automatically kept filled by 3 electric pumps drawing from a point near the bottom of the harbor. Provision is made for heating or cooling the recirculated water and 4 sand filters are employed to remove all matter which would affect its clarity. The piping is polyvinyl chloride plastic and the valves and pumps are of hard rubber, thus eliminating all metals from direct contact with the water supply. The tank section and work space "behind the scenes" is raised 3 feet above the public viewing area in order to place the 16 exhibition tanks at eye level without elevating them on a platform. Feeding and maintenance duties are thus facilitated and observations can be carried on with a minimum of effort. A food preparation room and office complete of operational facilities.

A capacity of 26,000 gallons of water may be held at one time in the aquarium, 13,000 in the recirculating reservoir, 8,800 in the display tanks, and the remaining 4,200 in 8 reserve tanks which are used for a variety of purposes. Outdoors, there is a concrete seal pool on the terrace in front of the building with a capacity of 6,000 gallons.

The indoor public area measures 35 by 82 feet over-all and consists of an L-shaped tank corridor, 70 feet on one leg and 20 feet on the other, and a 27 by 60 foot space for dry exhibits, which supplement the collection of living fish and invertebrates. The seals in the outdoor pool and the dogfish and other large specimens in a 2,800-gallon tank inside have been the most popular items on display this year.

Although the first summer season is not yet over at the time of writing, it appears probable

that the total attendance for 1961 will exceed 175,000. Daily crowds of 2,000 or more are of common occurrence and double this number have been accommodated on rainy days when outdoor activities were curtailed. It is felt by all concerned that this summer's "shakedown cruise: of the new Woods Hole Aquarium has been a success and that the additional display material which will be fabricated during the fall and winter months will make it even more attractive to next year's vacationing public.

Capacities of the display tanks, which are of 8 different sizes, are as follows:

1	2,800-gallons	capacity	
5	750	"	"
1	650	"	"
1	400	"	"
3	250	"	"
3	200	"	"
2	100	"	"

AQUARIA IN JAPAN

by

Sgt. M. L. Jones

The last week of July 1960 was spent in a tour of the major Zoological Gardens of Japan and three of the Aquariums. Japan today has over 45 Zoos and 85 Aquariums in full operation. Many of these are small institutions, however most have been constructed since the cessation of hostilities in 1945, and therefore are quite good and of modern design. There is great public interest in zoos and aquaria, resulting in these places of recreation and scientific learning securing good budgets from the respective city governments. Several of the zoos and many of the aquaria are private operated, many by private railway lines.

During my brief stay to Japan, I was able to visit the Marine Aquarium in the Zoological Gardens at Ueno Park Zoo, Tokyo, the vast Marineland complex at Enoshima, and the new Aquarium at Suma. The fresh-water Aquarium at the new Tama Zoo was poorly made, and was undergoing repairs, as were several other installations at this new Whipsnade like park on the outskirts of Tokyo. Kyoto had a small Aquarium, with both salt and fresh-water exhibits, however since all of the signs were in Japanese, and many of the tanks were dirty, therefore I did not spend any time in examination of the Aquarium.

The Zoological Gardens in Ueno Park, Tokyo are the oldest in Japan. They were founded by one of the old Emperors, more as an amusement for his court, than as a scientific operation, or for the people. In the latter part of the 1800's, however they were given to the city government, and continue under that type of administration to this day. Dr. Koga took control of the zoo, long before the recent war, and therefore has had an active role in the zoos operation for many years. The Marine Aquarium was opened before the war, but the building was severely damaged by bombing raids, and was re-constructed and re-opened just a few years ago, as a temporary measure. A new and more modern Aquarium is in the planning stage, and will be completed by 1964. As the plans are now made, there will be two floors, one for fish and the other as a Reptilarium, much as those at Berlin and Frankfurt.

The Aquarium at present contains about 40 tanks, none very large, with a representative collection of Japanese salt and fresh-water fish. A small collection of tropicals also are shown. However since this is only a temporary aquarium, the collection is not as extensive as one might imagine for Tokyo. One feature that I thought was very good, was a large tank of salt-water turtles. All of these were large specimens, and the tanks was open at the top, the visitors looking down into the tank, instead of through glass. About 15 large specimens were in continual motion all the time, and the water level was less than three feet below the low visitors railing. Yet, they never have any accidents, none of the children visiting the aquarium lean over and try to reach the turtles, or throw

any litter into the tank. Also on show here were two very large specimens of the Erabu Sea Snake, in excellent condition, also always in motion, affording one a good exhibit. I saw these same Sea Snakes at all aquariums, and found them readily obtainable. Most eat well of small fish.

Among the species shown at Tokyo were: Turtles of the species Eretmochelys imbricata and squamosa. Caretta caretta and olivacaes and Chelonia japonica, the Sea Snakes - Laticauda semifasciata, about 200 young Japanese Giant Salamanders, Megalobatrachus, and two good sized ones; the Ray Dasyatis akajei, and the following fish: Seriala quinqueradiata, S. purpurascene, Lateolabrax japonicus, several fine Octopus vulgaris, a common food of the Japanese, Chrysophrys major, Sparsus swinhoeensis, Stephanocephalus cirrifer, Microcanthus strigatus, Navodon modestus, several Parapistipoms, Epinephelus fario and fasciata, Triakis scyllium, Fugu niphobles, Opelgnathus fasciatum, Gonitus zonatus, and about 25 others. Since none of the Japanese Aquaria used English names, I copied the scientific names as shown on the labels or cards.

Enoshima is presently the showplace of Japan, not only in Aquarium-Marineland exhibits, but also in the realm of the summer vacationist. It is comparable to the summer seashore resorts of New Jersey, in having large crowds of bathers, and sun lovers. It is situated about one half-hour from the city of Fujisawa, and less than one hour from Yokohama, or two hours from Tokyo. This gives the area a large potential in number of visitors, and the excellent transport facilities make the journey a pleasant one.

For a moment I feel it is necessary to give a few words on the current prosperity of Japan, and its modernness. Compared to Korea, Japan is like night and day. Compared to the United States, there is little difference. The people dress much as we do, especially the younger set. There is an abundance of small cars, made in Japan that look and operate very well. Nobody looks shabby, the streets are all paved, the highways have that new look, stores are full and consumer goods are plentiful and inexpensive. Everyone seems to have a home and a job. No matter where you go in Japan one sees a well scrubbed look, and a pleasantness over the land. You can almost feel the surging power of the nation, as you walk the streets, or ride the trains. Certainly they have the finest railway system on earth. The old cars even run well, on time, and are clean. The modern trains are the fastest anywhere, and even the shortest line, runs exactly on schedule, despite the millions that use them daily. The National Railway operates over the nation, however there are small branch lines that are independently operated, but with ticket exchange with the National Railway making movement quite easy. Rates are very cheap. You can go all over Tokyo for 15¢. Within Tokyo there are three modern subway lines. Besides this Tokyo has a bus and streetcar line that is smooth and efficient. The movie houses show the latest in Japanese, American and European films. There are several TV channels, the quality of the programs are good, and the reception excellent. Each of the large cities have built huge TV tower complexes, many closely resembling the Eiffel Tower of Paris, but larger and with a complex industrial base. Huge museums, TV studios, hotels, restaurants etc. are located at each tower. No city has more nightclubs, and the rates are cheap. However, the majority of Japanese still live a close family life, going home at the end of the working day, the entire family going to the bath house for a good soak, and then returning for a good meal. Food is plentiful in Japan. Something that one never sees

anywhere in Korea is fresh fruit, a large commodity all over Japan. The Orange and Apple vendors do a landslide business, and the fruits are real, large monsters. The population is a good beer drinker, but the most popular beverages are cold coffee, milk, and Bireleys Orange Drink in that order. Stands selling these drinks are as common as can be. Also the people are well educated, and like Americans seem to "eat" large quantities of magazines and papers, all very economical. Here too change is creeping in, with most magazines starting from front to back, while the old style was back to front in reading, and lower right corner to upper left corner. There are several "thrills" for the tourist, not found in America. One is a ride in a Japanese taxicab, either at rush hour or at night. For one thing the Japanese drive to the left as do the English, this means you sit in a cab, where in the US you would drive. Speed limits in the large cities are non-existent. Rush hour in Tokyo defies description, with thousands of autos, busses, bicycles, motor scooters, and throngs of walkers. Taxi speed in this maelstrom averages 60 to 70 mph. This would be like zooming down Broadway on New Years Eve at 70 mph. Another "thrill" is to walk along what appears to be a quiet side street, about alley size in the US, and suddenly have one of these little cabs come flashing past, and turn a corner a few feet in front of you, and then disappear like lightning. The third is a ride in the new 1st class "speed" trains – Between Tokyo and Osaka along narrow roadbeds, and through crowded stations at a speed of 120 mph, twice normal fast driving speed in the US. While it is not a thrill, for the bachelor, or the interested male, nothing beats Nichigeki Music Hall, something that makes the Follies Bergere look like a picnic. Actually, nothing beats Tokyo or Nagoya night life, at bargain basement prices.

Enoshima on the day of my visit was very crowded with the summer rush. It was very American-like, except for the people. There were the usual street corner vendors of sun lotion, bit hats, beer, and even watermelons. The crowd was in a festive mood, and while US-Japanese relations in Tokyo were poor, I met nothing but good reception everywhere, and I was in uniform.

The Aquarium is in a two story modern tile and brick building, white-washed to create a light air, with a large restaurant in the rear. It is about two blocks from the railway station, and the beach is not quite as close as the New York Aquarium at Coney Island. The admission fee was about 20¢ American. The tanks were all spotless, the water as clear as can be and the fish looking well. The main part of the Aquarium is in a half-moon shape, with tanks on both sides of the visitor gallery. Each is large, I would say about as large as the best at the New York Aquarium. There was a profusion of planting and use of coral in the displays. Most of the fish were identified by a sign, hand painted as are all in Japan. Many of the species seen at Tokyo were again on show here, as well as about one hundred additional. It was unfortunate that several small tanks had only labeling in Japanese. These contained Sea Horses, Corals, Anemones, Sea Stars, etc. Once again here were two Sea Snakes, in constant motion. Among the species shown were: Vellitor centropomus, Trachiurus japonicus, Urolophus aurantiacus, Pompus argenteus, Hoapatongenys sp., Pagrosomus major, Arothron stellatus, Channa argus, several fine Muraena pardalis, a very large Lungfish P. aethiopicus, perhaps the largest of the species that I have seen anywhere, also

some fine Electric Catfish. About 25 species of Tropicals also were shown. On the second floor was an exhibit of pickled fish for scientific use, and a whaling exhibit.

By means of a subway or tunnel one walked to the Marineland part of the exhibit. A separate admission fee is charged, about 50¢ American, quite large for Japan; however the place was well attended. Not having ever seen personally any of the large American Marinelands, except in pictures, my comparison is based only on books. The tank here is large, several hundred feet long, and quite wide. It was oval in shape. It was subdivided into separate pools by the means of heavy nets, which can be moved quite easily, not necessarily by the inhabitants of the pool but by men. At the time of my visit, mid-day, one show of tricks was going on in a circular tour of the pool. To simplify this, each group of Porpoise did tricks, one following the other on a rotational basis. This means that there is always something going on. The below water observation windows were closed as a Porpoise had been born that morning, and they wanted to leave mother and baby alone. I was quite impressed with the installation, however several other Americans have considered it quite poor as compared to Marineland of the Pacific or Florida. However, it is but one of 10 such exhibits in Japan, being the largest. The numbers and species on show were: two fur seals, Callorhinus ursinus, three Grampidelphis griseus, five Tursiops truncatus, five Lagenorhynchus obliquedens, and eight very large and spectacular Delphinus delphis.

There are two decks for observation above the surface of the water, one affording a wonderful view of Enoshima and Enoshima Island, the bay and the beach area. Also there are two seafood restaurants, that seemed quite popular and crowded, prices cheap.

Kobe is the largest seaport of the center of Japan, perhaps doing more business than Yokohama. It also is a very modern city, and has a large number of industries in close proximity. A very tremendous steel mill is located directly on the bay, and was in full 24 hour production last year. Since this was the city that my guide to Japan, Dr. Humio Osaki lived in, I was permitted an overnight stay, at one of the finest Japanese hotels. Apparently this hotel was not frequented by Americans. This was perhaps one of the finest evenings that I spent while in Japan, and the memory of that place will long linger in my mind. If one has never been to a strictly Japanese hotel, differentiated from one like the Imperial or Dai-ichi in Tokyo, it is well worth the experience. You are met at the door by the hotel proprietor's wife, and a series of charming, well versed young ladies, in traditional garb. You choose one, and she is your servant, cook, and waitress for the entire stay at the hotel. Her role is similar to a geisha, in that she is trained to take care of you, your clothes etc., but all in a very proper manner. Immediately as you enter your room, she hangs up the clothes making note of any requiring pressing or washing. You then change from Western dress to a flowing Japanese kimono for men, and sandals. Next item is a bath. This was a resort for spring water and mineral baths. Now I am sure that you are familiar by now with the Japanese habit of communal bathing. It has received so much emphasis in the movies and magazines, but believe me the experience takes time to get used to. Especially if your

servant girl was as well proportioned as mine was. But this was the custom, as they say "When in Rome, do as the Romans do." So in we went. The Japs, though, make a ritual out of bathing. First you soak for about five minutes then soap up and wash out of the water, dipping it out with small wooden buckets. Then back into the pool for a long soak, of say fifteen minutes. It was wonderful. It did get a little distracting when about six young ladies all came down for the same, and in one big outdoor pool. Ah Japan!! Supper is served right in the room, everything being cooked over a small charcoal brazier, by your servant girl. Washed down by some cold Kirin Beer, it was a repast well worth the modest price. Then in the twilight we went to a large room, where some very authentic Geishas were entertaining several businessmen of Japan. The lilting music, and delicate sing-song was a real treat. Later we went down to watch TV, and what was the show, The Yomiuru Giants Ball team for Tokyo. A-1 Ball, too. To finish a wonderful day, a view of the lights of Kobe from the garden terrace, and a cup of sake. Then time for some much needed sleep. It was so-long, for while Americans in general thought the worst, this serving girl was all legitimate, and she had her own little place to repair to. However with the light of dawn, it was quite a surprise to wake up and find hot tea on the stove in the room, and fresh clothes for the day all laid out. The real surprise was when the bill came. Total cost of $10.00. Her share of the bill was, and this was a surprise, $2.00. No tips allowed. I highly recommend any visitor to Japan, go to Kobe, go to the Kobe Kanko Hotel. AAA-1.

Suma Aquarium is the largest in Japan, and the newest at the time of my visit. It was impressive. Located directly on the bay, it took two years to complete, and opened in 1957. It charges a very low rate of admission, however Dr. Osaki and I were the guests of the management. The director, Dr. Inouye spoke some English, and I would like to mention that save for Dr. Koga, few if any Zoo men speak English. One exception was Yamamoto at Kobe Zoo. Dr. Inouye took us to his spacious office, and from here we took a tour of the entire Aquarium, top to bottom, even down in the pump rooms. Suma is one of the cleanest large aquariums that I have ever visited. This cleanliness is to be found over much of Japan, but was very noticeable here. The entrance to the Aquarium is quite large, I would say about five times the size of the entrance to the New York Aquarium when I was there in 1959, tile floor, and several ticket windows. It has a subdued lighting effect and there are color transparencies in the rear of various fish, made many times life size, that look well. To the left of the entrance is a stairwell that takes you to a large auditorium that must seat at least 300 persons in comfort. It has a stage, and full cinemascope screen and projectionist equipment. School groups are taken here first for an orientation to the undersea world, before visiting the aquarium, and may again come here at the conclusion of the visit for the answering of questions. It was a very well made room, and the seating better than in many movie houses. There were adequate fire exits, and lighting.

The normal visitor however enters a large loggia from the entrance, brightly lit and containing several terraria with many salamanders and frogs. However all of them were labeled in Japanese, and I could not make any guess as to species seen. Also there was a swamp type scene with very large giant salamanders, various native and exotic turtles, and a few alligators. To the left was a large number of murals and exhibits on the whaling industry. These were all executed in a very modern style, much like out commercial exhibits. Stuffed King and Emperor Penguins also were shown. Leading off of this room was the first tanks for fish. One went up a half moon shaped ramp very slowly to the second floor. The ramp is both curved and rises very gently, so that one hardly notices going up at all. Only on one side are there tanks, and these are primarily for fresh water fish. Also seen here is what is called "Hokkaido Ball Seaweed," considered to be rare and valuable in Japan. It has been pictured on several postage stamps recently. The name was Huro species.

Upon arrival at the second floor, one first notices several small tanks for coral and clown fish on the left, with overhead illumination shaded red. This creates as nice an atmosphere as possible. One then is in the large room. This is a very huge exhibit hall, I would say several hundred feet long, and over 75 feet wide or more. Each wall is lined with many tanks, all of good size, some very large. The collections are primarily sea fish of Japan, but with good representation from other Pacific areas. I saw no Atlantic species on show. The shark collection was especially fine, with several good species. All of these were well labeled with transparencies, often with actual photos of the fish, instead of painted pictures. The aquarium has a full time photographer on the staff who not only makes still photos, but also some fine underwater shots. He also takes scientific films. In fact, the staff is very large in the scientific field, with a very large and one of the finest equipped laboratories I have ever seen in an aquarium. Actually it took about five large rooms, and we saw about eight men for five women at work. Some of the microscope apparatus was very impressive.

In the main hall there is also a large tank, I would say about 30 feet long, 8 feet wide and 4 feet deep. It was illuminated by underwater spot lights, and open at the top. It contains very large sharks and rays, as well as some turtles and other large fish. One looks down on the specimens, and this results in a rather eerie view, but certainly very interesting. Everything looks much different from this angle, and this was one of the most popular exhibits. Two other exhibits in this room also drew my interest as not having been seen before in an aquarium.

One was a miniature tidepool exhibit, where the water in the course of a day moved and shifted much as it would naturally. Here were small fish and crustaceans, and one gained a very good insight into tidepool life. The rock work was natural from the southern part of Japan. It was amply illuminated with signs giving full explanation in both English and Japanese.

The other was a large tank, with about 100 medium sized Japanese sea fish. This was to all

appearances just an ordinary tank, here again one looked down on the fish, and not through glass. This was a demonstration conducted several times daily, and on the time we saw it, was well attended and
produced a large number of queries from the visitors. Dr. Osaki said that many of the people asked rather complicated questions for an average tourist or visitor. The principle was that the narmla lights (bare bulbs) was turned off, placing the tank in complete darkness. Then at one end of the pool a green light was turned on over the fish. One could see them swarm and go in that direction. They remained under this light, until it was quickly changed from green to red, then they swam away with great rapidity. At the opposite end a green one was put on, and they went to it like rockets. This was done several times, and in each case, even if food was offered it was not touched as long as it was covered by the red light. When both ends were lit with red light, producing an overall red effect, chaotic conditions took place, however as soon as a general green light appeared, calm was resumed very rapidly. A very good, and different display.

Several small tanks in the room also showed Sea Snake and certain rare small fish. There were several sea anemone-clownfish combinations, which looked well. One then ascended a stairwell, modern in design, to a third floor, which had several small tanks for tropicals, electric eel and a piranha, reputedly one of only tow in all Japan. Here possible a good basis for exchange.

All of these tanks used to so called limitless background system, whereby behind the tanks are arranged bits of seaweed, animals etc. to create the effect of a deep tank, while actually it is small. This I have seen tried at several American Aquaria, and normally it is a flop. The secret, as seen here and also once at Milwaukee is keep the sides of the tank under dark cover, so that each exhibit is completely separate from the next. This worked well here.

From here one enters a small restaurant, I would say just a trifle larger than the one at New York Aquarium, but resembling it very much. Shrimps, crab dishes and fish highlighted the menu, all done in typical Japanese fancy style over a huge mound of rice and covered with a gooey concoction that looked and tasted awful. However plain shrimp was good. The view here was over the bay and the shoreline of Kobe, as Suma is quite a good bus ride from downtown Kobe.

The only outside tanks features another very large tank of turtles, ray, etc. This was in Marineland of America style in that you looked through portholes as well as overhead. It was very large, I would say off hand about three times the size of the walrus pool in 1959 at the New York Aquarium and about twice as wide. Yet the water was crystal clear. So clear that one could not only see the visitors looking in on the other side, but could see through those portholes, and see outside the area. All in all the water throughout the aquarium, despite the fact that tanks may have held several hundred specimens of all sizes, was 100% clear. The filtration system was excellent, since they use the water over and over again. All piping is plastic throughout. It is called ESURON. Looks and feels

like metal, but is all gray plastic. Said to be expensive even for Japan but so much better. There is no comparison. Suma has also a large garden, and is used for floor shows and band concerts.

Among the many fish and other exhibits at Suma, I made note of the following:

3 Eretmochelys squamosa
1 Caretta olivacea
1 Amyda japonica
2 Alligator mississipiensis
3 Megalobatrachus japonicus
Thalassoma cupido
Heterodontus japonicus
Girella punctata
Urolophus aurantiacus
about 30 species of Tropicals

Anguilla japonica
Triblossodon sp
Archeilogntahus mariokae
Sebastodes Kawamebori
Plecoglossus sp
Amphiprion percula
Cerianthis filiformis
Lamburus valido
A. vaigiensis
Aulacocephalus temmincki
Lutjianus spilurus
Hypodytes rubripennis
Siganus fuscus
Orectolobus japonicus
Plectropoma sp
Astroconger myriaster
Thalassoma amblycephala

4 Caretta caretta
5 Chelonia japonica
1 Chelus fimbriatus
1 Laticauda semifasciata
many Dasyatis akajei
Therapon oxyrhynchus
2 Electrophorus japonicus
10 Periophthalmus cantonesis
about 40 species of Fresh water Fish
about 40 species of other Saltwater Fish
plus the following:
Channa maculata
Hemibarbus barbus
Gnathopogon sp
Maroco sp
Huro sp
A. fraenatum
8 Pterois lunulata Large good ones
Abudefduf sordidus
Abalistes stellatus
Therapon jarbua
Dermogenys sp
Girella mezina
Mgripristis murdjan
Halaclurus torazame
Cynias griseus
Fissilabris dimidiatus

AN AQUARIUM EXHIBIT WITH POLARIZED LIGHT

BY

William E. Kelley

Considerable visitor interest is generated by public aquarium exhibits of semi-transparent aquatic organisms. We have shown Chandre lala and Kryptopterus species of fishes at the Cleveland Aquarium against a dark-field background. These fishes swimming in their tank reveal internal structural details of the bodies such as vertebrae, the coelom, and the swim bladder.

The present dark-field illuminator consists of a light source diffuser screen polarizer, tank of fishes, and a polarizer in "crossed" position.

In operation the crossed polarizers reduce the brilliance of the luminous background to a very deep sapphire blue. The fishes immersed in the tank between the polarizers rotate the plane of polarization by diffusion and by the anisotropic properties of their tissues—thus showing the internal detail of their bodies brightly glowing against the dark blue background. Intricate patterns of spectral colors may be seen in these areas of tissue birefringence.

It should be considered that this exhibit method will have application to the many other aquatic organisms that are to a degree transparent.

EXPLODED DIAGRAM OF AQUARIUM EXHIBIT UTILIZING POLARIZED LIGHT