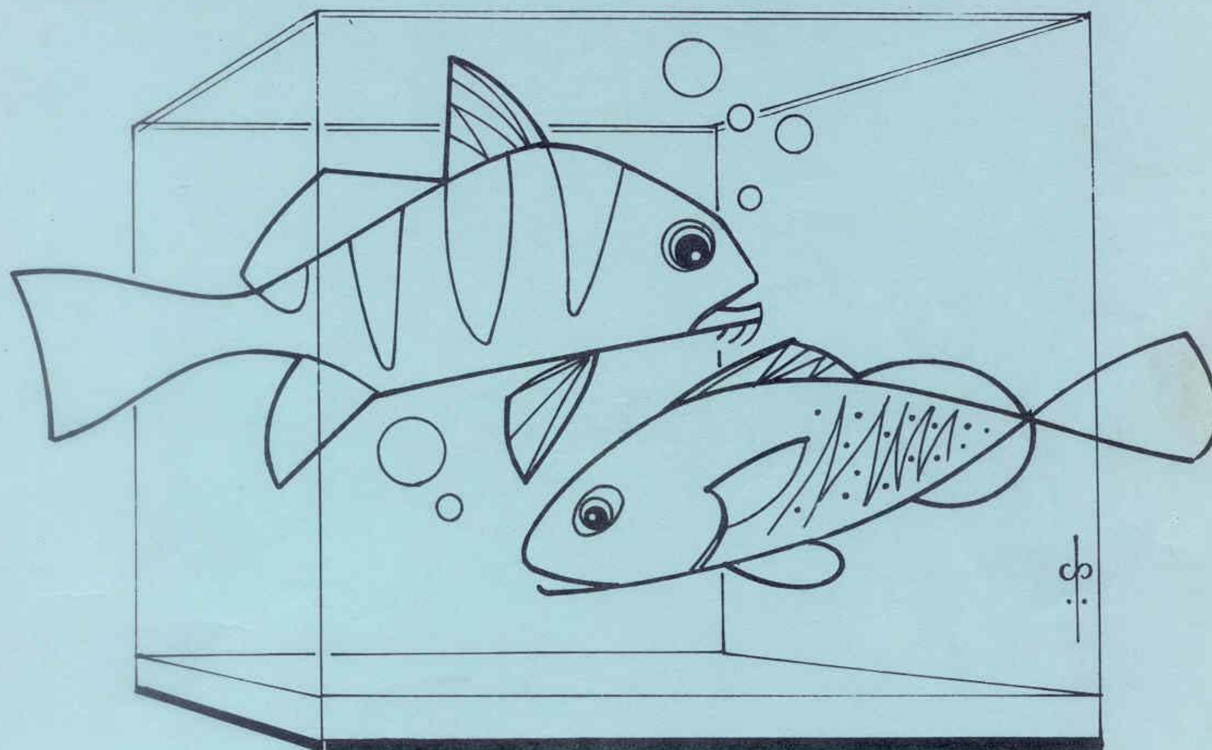
DRUM and CROAKER



Volume LXVIII, Number 1 January 1968

THE INFORMAL ORGAN
OF THE
AQUARIUM RESEARCH SCIENCE ENDEAVOR

Archived as Volume 9, Number 1

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DRUM AND CROAKER

The Informal Organ

of the

Aquarium Research Science Endeavor

Manuscript material received is reproduced with a minimum of editing.

Craig Phillips
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Washington, D. C. 20240

COMMENT

We are not quite sure how the National Fisheries Center came to he charged for the next year with the issuance of the <u>Drum</u> <u>and</u> <u>Croaker</u>. There had to be some sleight-of-hand. We are happy to do our part, but we, like others before us, need help.

We had quite a list of papers but only three are from outside this agency. So we have done the best we can with the material at hand. We hope that many of you will send in material for the next issue, including notes on personnel changes.

<u>What's new with you</u>?

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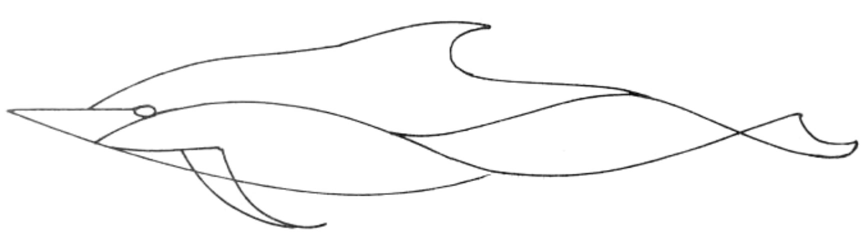


THE USE OF QUINALDINE AS A TRANQUILIZING DRUG FOR AQUARIUM FISHES

Robert P. Dempster
Assistant Superintendent
Steinhart Aquarium
California Academy of Sciences

Large fish at Steinhart Aquarium are seldom handled without the aid of a tranquilizer. A healthy fish that hasn't been tranquilized will so effectively resist capture that often a person trying to catch it will give up in despair. The fish that is being pursued may go into a state of shock resulting from fright, or it may bash itself against the sides of its tank and become fatally injured before it is finally captured. If the aquarist or person involved in catching a fish uses a net and is successful in catching it after much expanded energy on his part, the fish invariably injures itself in the net or in the container that is used to transport it after capture.

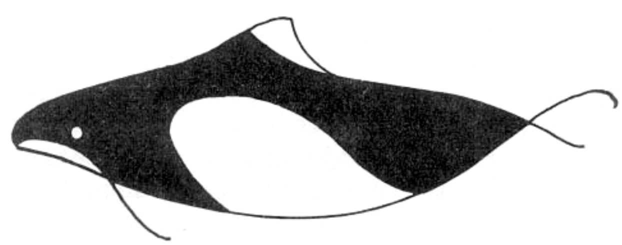
A 10% stock solution of quinaldine in 95% alcohol or acetone, a commonly used tranquilizer for cold-blooded vertebrates, when added to a fish tank at the rate of 0.4 ml per gallon (a quinaldine concentration of 10.5 ppm) will usually cause the fish to become completely relaxed in about five minutes. A fish treated in this manner will not resist gentle handling. It may than be easily lifted or washed into a tub of water and transferred without injury to another tank. After tranquilized fish have been put into untreated water, they quickly revive and in a matter of two or three minutes are swimming normally in their new environment.

The amount of stock quinaldine solution to add to a fish tank varies somewhat with the species of fish that are to be tranquilized. A concentration of 0.4 ml per gallon is usually satisfactory for most marine fishes, although sharks require a somewhat higher concentration (0.6 - 0.7 ml/gal). Most freshwater fishes require up to 0.8 ml per gallon before they become sufficiently relaxed for handling. Fishes subjected to this method of treatment are rarely kept under the influence of the tranquilizing drug for more than 15 to 20 minutes, and almost never for more than 30 minutes.

Tranquilizing drugs are used not only when fish are to be moved from one place to another but also when they are to be examined for disease. If fishes in a tank become languid, develop an increased respiration rate and generally act as though they are ailing, steps should be taken immediately to determine the cause of this abnormal condition. The fish may be harboring a host of parasites, or they may be infested with one or more of the common bacterial or viral diseases that attack fishes. In order to determine the cause of the abnormal appearance of a group of fishes in a tank, microscopic examination is usually necessary. The fishes are put to sleep and two or three specimens are collected at random from the tank for microscopic examination. This will often reveal the cause of trouble and will help the observer to determine the correct treatment procedure to follow. Microscopic examination of a tranquilized fish is relatively simple, whereas microscopic examination of a non-tranquilized specimen is practically impossible.

When a fish refuses food and is in need of medication and vitamin therapy, it is often necessary to put it on a force-feeding schedule for a while at least until its appetite is stimulated sufficiently so that it will eat on its own. Force-feeding and the administration of oral medication to a fish becomes less difficult after it has been relaxed with a tranquilizing drug. Quinaldine is also employed in fish collecting procedures. Fish that live in deep crevices are forced out in the open where they may be more easily caught by divers when tranquilizer is introduced in their cavernous habitats.

Quinaldine has been used for the past four years at Steinhart Aquarium without a single casualty. It is a very useful drug for aquarium procedures, and when correctly administered it has no deleterious affect on aquarium fishes.



BIOLUMINESCENCE IN MARINE VERTEBRATES (FISH)

By
Russell Ramski
(Age 13, Miami, Florida, Science class paper)

Editor's Note:

Natural bioluminescence is produced by the reaction of the enzyme luciferase on the chemical luciferin in the presence of oxygen and water. In nature this action is reversible and is the key to the highly efficient production of "cold light" without energy loss in the form of heat. Since the demonstration of bioluminescence in the aquarium has been relatively unexploited thus far, we consider the following paper to be a timely contribution to Drum and Croaker, if only to stimulate further ideas on the subject.

The great majority of luminescent fishes are bathypelagic and are widely distributed throughout the world. Many types of photophores occur in these fish. They are situated laterally, ventrally, and internally. They are hardly ever found on the dorsal area of the fish. Photophores are also found in some forms on the eyeball, tongue, roof of the mouth, and cheek. The most bizarre of these photophores are on whiplike appendages where they appear to be used as lures.

In these fish, both intrinsic and bacteriological systems of luminescence have evolved. Due to the fact that a non-intermittent nature of bacterial luminescence does exist, those fish that employ these systems have to devise a means of regulating the intensity of the glow, or occluding the photophore completely. Expansion and contraction of cell organs containing screening pigments and situated in front of the photophore is a common device for this purpose. Movable opaque screens and rotatable light organs have also been devised.

Professor E. N. Harvey lists eight Families and one Suborder in which bioluminescence is caused by bacteria. Specimens of the species have been examined and in every form the luminescent organ resembles a gland. These glandular masses are located ventrally in the Families Macrouridae, Gadidae, Monocentridae, Acropomatidae, and Leiognathidae. In the Anomolopidae the gland is situated just below the eye and the Photoblepharon's photophore may be hidden by an opaque screen. In Anomalops the light organ is retractible. The Ceratoid anglerfishes carry glandular masses at the ends of long, modified dorsal fin rays. Bacteria have been demonstrated in and cultured from the glandular masses of all but the Family Cerdalidae. All the bacterial cultures have been luminescent except those from the Anomalopidae.

Among the teleosts possessing self-luminous photophores, Harvey lists two planktonic Suborders; the STOMIATOIDEA and MYCTOPHOIDEA. The location, structure, and mechanism for intensity control are as varied as the forms dependent on bacterial luminescence. Rotatable cheek organs, luminescent tentacles, and simple skin photophores are present. The photophore is directly innervated in all forms on which histological studies were made. In fishes with a serial arrangement of photophores on the head and body wall, the cephalic photophores are innervated by cranial nerves, whereas each of these along the body is innervated by the ventral route of the spinal nerve of the body segment with which it is associated.

The recent observation by J. A. Nicol of luminescence in the Family Alecocephalidae requires they be raised from the level of "Teleosts of Doubtful Luminescence" to the list of self-luminous fishes. The luminescence is extracellular, the only instance of such active secretion in teleosts. In Nicol's observation, a cloud of brilliant bluegreen luminescent particles was discharged into the water from the post-cliethral process when the living animal was handled. The luminescent glands of this fish are dermal. Three types of cells are obvious; presumably representing transitional stages in the transformation of photogenic elements. No biochemical examination was made.

Recent biochemical investigations require the addition of two other Families, the Pempheridae and Apogonidae to the list of self-luminous forms. Two biologists, Haneda and Johnson (1958) demonstrated a luciferin-luciferase reaction with crude extracts of the luminescent glands of Pempheridae but were unable to culture luminous bacteria from the photogenic organs.

Among other Orders of fish that include well known luminescent forms are the ANACANTHINI, BERYCOMORPHI, HAPLODOCI, INIOMI, ISOSPONDYLI, LYOMERI, PEDICULATI, and PERCOMORPHI. Of these deep sea luminous fish the photophores are scattered along their bodies in "phosphorescent portholes." This occurs almost exclusively in the INIOMI and ISOSPONDYLI.

The other fish in these categories have photophores situated on flagella-like organs to lure fish and other prey into their jaws. These fish have large amounts of luminescent material located around their jaws. The Genera with these photophores usually generate their light from within specially constructed tissues and glands. This process differs from the use of colonies of luminescent bacteria or other light-making slime or liquid from special glands in the fish. This produces a great variety and vividness in these light patterns.

It is unfortunate that fish that have luminescent qualities in their natural surroundings usually fail to exhibit these qualities in laboratory or aquarium conditions. Most of these specimens are known to have luminescent qualities but fail to activate their light-producing organs in captivity.

Among those disappointing specimens are the local species of Porichthys or common toadfish [midshipmen--Ed.]. The luminescent powers of the Porichthys species have been known for over half a century. These fish are usually inhabitants of the greater depths, but frequently come to shallow water to breed and are caught. Their reluctance to luminesce under laboratory conditions appeared in the past when C. W. Green found that specimens in the Hopkins Marine laboratory in 1890 failed to show traces of phosphorescence.

In order for these species of fish to produce traces of phosphorescence, they had to be exposed to excessive jolts of electricity. These drastic stimulations would produce a bright white glow that appeared in numerous symmetrical lines of photophores on the undersides and flanks. Rubbing the skin of these fish also produced noticeable luminescent effects as did the addition of sufficient amounts of ammonia to the sea water in which they were contained. These facts indicated that luminescent flashes resulted from reflex actions and were not under direct control of the fish's nervous system. The mechanism of this reflex was associated with the glandular substance or hormone secreted in the body of the fish, for this luminescence, once stimulated, faded quite slowly. This suggested a bodily substance gradually absorbed or exhausted rather than a nervous action which can instantly turn the photophores on or off.

Some, but not all, of the ELASMOBRANCHII, or lowest branch of fish, are luminescent. The first group is the PLEUROTREMATA, including all true sharks and dogfish. All luminescent species within this group are SQUALOIDEA and under that is the Family called Squalidae. Included are six luminescent Genera: Centroscyllium, Paracentroscyllium, Euprotomicrus, Isis, Laemargus or Somniosus, and Spinax or Etmopterus. The first shark scientifically established as bioluminescent was I. brasiliensis, generally found in waters off Brazil. This shark, when kept in the dark, was described by F. D. Bennett "to be covered with a greenish phosphorescent gleam." This gleam was brightest at the head and faded from the abdominal region first and gradually from the rest of the body. Bennett noted the luminescence lingered the longest around the jaws and fins. In the case of rays, skates, and torpedoes, luminescence has been reported only in the Family Torpedinidae under the NARCOBATOIDEA.

With sensitive motion pictures, we might, in the future, view bioluminescent fish in their own natural habitat. Until then, only a small percentage of these phosphorescent wonders of the deep will be viewed by biologists.

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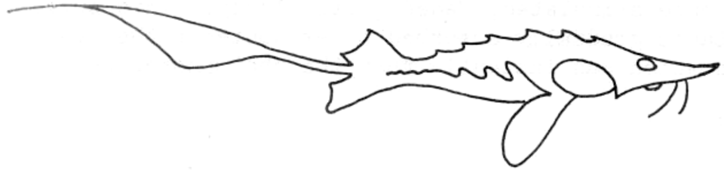
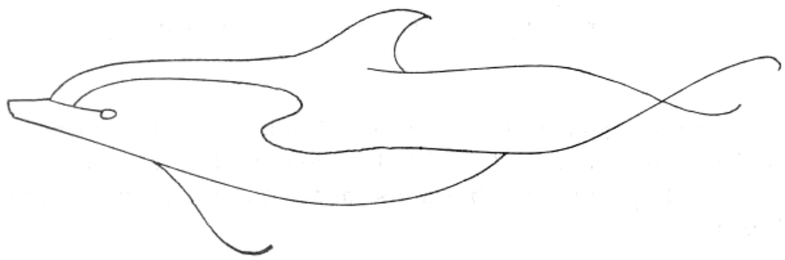


THE OSBORN LABORATORIES OF MARINE SCIENCES

The laboratories adjoining the New York Aquarium were dedicated in October 1967. Both facilities are under the direction of Dr. Ross F. Nigrelli, who has been associated with the Aquarium for more than 30 years.

Probably no other public aquarium has made greater use of its facilities for research. The new facilities are a continuation and extension of a history of scientific research that has been an integral part of the New York Aquarium for some 40 years. The availability of aquatic organisms places the laboratories in a most favorable position for research in the field of marine biology.

The laboratories have a staff of thirteen resident scientists and research associates concerned with as many disciplines in marine biology, but especially concerned with the biomedical aspects. The research facilities of the laboratories and the aquarium are available to visiting scientists and graduate students.



AN IMPROVED TYPE OF PLYWOOD FOR USE IN AQUARIUM CONSTRUCTION

by
Edward J. Peterson
National Fisheries Center and Aquarium

The use of plywood as a construction material in aquariums has been somewhat limited in past practice by the inherent weakness of the laminated plies when they are exposed to moisture over an extended period. Generally the plywood must be coated with fiberglass to insure durability, but since even the later material is not totally moisture-proof, the wood will frequently tend to swell and the plies separate after several years of extended use.

Employees at the National Aquarium have found commercially available plastic impregnated and coated plywood which has excellent potential for application in the aquarium field. This material is known as "GPX 60/60 high density plywood" and is manufactured by the Georgia Pacific Plywood Corporation. We have used this plywood for three years now in construction of filter boxes, holding tanks, display tanks, brineshrimp hatching trays, manhole covers and dollies. All of these items have been subjected to intermittent or constant exposure to both fresh and salt water and the wear on the material has been negligible to date.

GPX 60/60 can be worked as easily as other plywoods, needs no additional protective coating, and appears to be nontoxic to fish and invertebrates.

For a cost comparison a 4 x 8 sheet of regular 3/4" plywood is $8.64; fiberglass cloth 25¢/sq. ft. or $8.00; resin at $4.00/ gal./2; and about 2 -an hours labor (mounting to about $7.00 in our case) giving a total of $27.64 while GPX costs about $20.00 for a 4 x 8 x 3/4" sheet.

MECHANICAL TESTING AND BIOASSAY OF ADHESIVE/SEALANTS FOR USE IN AN AQUATIC ENVIRON14ENT

by
Walter L. West
National Fisheries Center and Aquarium

and
Philip A. Butler
Director, Biological Laboratory
Bureau of Commercial Fisheries

In 1965, specific tests were begun to determine the material best suited and commercially available as an adhesive/ sealant for large and small scale aquarium use. In most cases, the materials were not initially intended for aquarium or underwater uses.

The testings were designed for two purposes:

1. Determine the toxicity of the materials to aquatic organisms.

2. Determine the suitability of the materials to seal hair-like cracks on the water side of concrete tanks, ease the removal of algae, and determine if these materials could be used to seal the periphery of viewing glass.

The testing under (1) above was done under contract at the Steinhart Aquarium, San Francisco and at the Gulf Breeze, Florida, laboratory of the U. S. Bureau of Commercial Fisheries. The testing under (2) above was by the NFCA staff and the National Fish Hatchery, Pisgah Forest, North Carolina.

Of the many products tested, it was concluded that the following are satisfactory, are not toxic after curing, and will provide a lasting moisture seal:

Dow-Corning No. 92-018 (a one-component adhesive/sealant)

Dow-Corning No. 93-046 (a two-component adhesive/sealant)

Hercules Powder Company "Penton," a polymer, when used as a lining for pumps, valves and rigid pipe.

Devcon Corp. "Devcon Epoxy," when used as a concrete moisture seal.

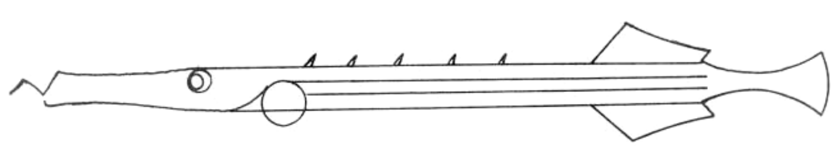
Devcon Epoxy has been used for approximately three years at the Rhode Island Northeast Shellfish Sanitation Center with no deleterious effects on specimens. All of the above are toxic to aquatic organisms until they are fully cured.

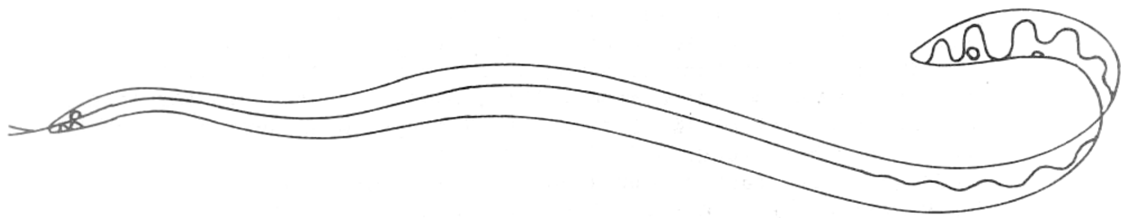
Initial compression testing eliminated many of the caulking compounds. In shear tests some of the rubber cement sealants failed cohesively and a few of the silicone sealants were eliminated because of extensive polyp-like extrusions on the surface following abrasive tests. The compounds listed above passed these tests and others, including ultra-violet aging and submersion. As a side dividend, General Electric's "Traffic Topping" proved to be an excellent seal and non-skid surfacing material for floors that are usually wet.

After more than one year of testing Devcon Epoxy on the sidewells of a new concrete trout raceway at Pisgah Forest, the epoxy is still firmly attached, not chipped or peeling, and it is reported that the removal of algae is comparatively easy.

The technology of adhesive sealants is progressing and many new products are becoming available.

Ed. Note: Aquarists testing sealants are requested to report results in Drum and Croaker





SOME UNUSUAL AQUATIC SNAKES

by
Craig Phillips
National Fisheries Center and Aquarium

This article is devoted to certain of those exotic snake species which the writer has chosen to term "exclusively aquatic," meaning that they seldom it ever leave the water under ordinary circumstances, having undergone certain modifications in body structure and habits adapting them to an underwater life. (The North American watersnakes of the Genus Natrix and the water moccasin Agkistrodon do not fall into this category since they show few, if any, morphological characters induced by their aquatic environment, and, provided that food is available, will live out of the water indefinitely.)

The world's truly aquatic snakes, however, are mainly divided among three groups, all of which have their primary headquarters in Asia. The first of these is the Homalopsinae, or rear-fanged watersnakes, many of which bear a superficial resemblance to certain members of the Genus Natrix, while others (the more aquatic ones) are highly unique. All however share the common trait of having slightly eliptical pupils and upward-directed nostrils which may be closed by means of valves. The second group is the Acrochordidae, or elephant-trunk snakes, consisting of two genera, each with a single species. These likewise have valvular nostrils and the belly scutes (which normal snakes use for locomotion) have entirely disappeared, and there is a finely scaled median ventral skin-fold or keel in their place. The final group is the Family Hydrophidae, or true seasnakes which are closely allied to the family (Elapidae) that includes the venomous cobras, kraits, and coral snakes. At the present time the Hydrophids appear to be the most difficult of the aquatic forms to keep in captivity, although one species which will shortly be considered, appears to be a notable exception to this rule.

Returning for the moment to the rear-fanged wateranakes, by far the most unusual of these (and the one most modified for an aquatic life) is the tentacled snake, Erpeton (Herpeton tentaculatum. Three specimens, two of them from South Viet Nam, were obtained by the National Aquarium in December, 1966, where they thrived for several months on a diet of small fishes.* The specimens were each about a foot and a half long, and of a very singular appearance. The body and neck were greatly depressed, a cross-section of which could be approximated by a very flattened rectangle. The belly scutes were greatly reduced and the body scales heavily keeled, almost file-like in texture. The ground color was brownish-gray with irregular crossbands (longitudinal streaks on one specimen) of a lighter color, and the snout of each bore a pair of scaled appendages about a quarter of an inch in length, the function of which remains unknown at the present time. Although each "tentacle" was movable at the base, there was no evidence that they might be under muscular control, and normally they projected forward at all times. When first handled, the snakes made no attempt to bite, but went into a pseudocatatonic state where the body was held perfectly straight and rigid for a number of seconds.

The three specimens were placed in a ten-gallon glass aquarium covered by a screen top and fitted with an under-gravel filter. Water temperature was maintained at about 82 degrees fahrenheit. Almost immediately the snakes twined about the stems of water plants and portions of driftwood in the aquarium with the forward portion of the body projecting stiffly in a horizontal direction, usually with the head turned slightly like a letter "J" lying on its side. Small fishes were captured with a quick snapping movement to the side (the depressed body form appeared to facilitate this) and the prey rapidly manipulated into swallowing position by movements of the jaws. Although examination of the snakes' mouths had previously revealed the presence of a pair of slightly enlarged teeth at the rear of the upper jaw, there appeared to be no paralytic effect on fish that were manipulated by the jaws for some time, or on those occasional specimens that managed to break free after being seized.

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*In an early account of Erpeton once read by the Writer, it was speculated that this snake might feed to some extent on plant material, though no evidence to substantiate this remarkable claim was presented in the article. However, the first live specimen of Erpeton examined by the writer (at Ross Allen's Reptile Institute at Silver Springs, Florida in 1966) and which was at first mistakenly thought to be gravid, suddenly defecated an object that resembled a soggy cigar butt. Subsequent examination of this revealed it to be the remains of an unknown water plant with closely rolled leaves. Since the Erpetons kept at the National Aquarium fed exclusively on fish (although various floating and rooted plants were kept in the tank with them) it is concluded at the present time that the plant ingestion must have been accidental.

Although the Erpeton specimens all fed readily and appeared well-suited to aquarium display, all of them contracted a fungus-type infection which resisted various types of treatment and affected mainly the eyes, mouth, nostrils, and tentacles, resulting in the loss of all three after four months in the aquarium.

In contrast to Erpeton, the Acrochordids have an exceedingly supple body covered with a thick, wrinkled hide consisting of many rows of tiny, rasp-like scales which give them their common name of elephant-trunk snakes. In August 1966 a young specimen of the brackish-water species Chersydrus granulatus (collection locality unknown) was placed in a tank of one-half strength artificial seawater, where it lived for several weeks but refused all food. In its juvenile coloration this specimen was black, marked with a large number of pale yellowish rings and fairly slender in body form. The head was blunt with terminally-placed nostrils and small eyes and the short tail vertically compressed, though not to the extent seen in the true seasnakes. As in its relative Acrochordus, Chersydrus shows a remarkable motility of the segmental body muscles so that not only is the belly skin capable of being moved backward and forward, but also the skin of the back and sides as well, so that when the creature was grasped in the hands the effect was like trying to restrain a large and very active earthworm. In addition, portions of the body could be flattened sideways to an extreme degree and these flattened areas could then be moved either backward or forward in a peristalic fashion with great rapidity while the snake was resting on the bottom, this apparently having nothing to do with the other "earthworm" type of movement which served to move the creature along the floor of the tank when not actively swimming through the water.

Attempts at force-feeding the Chersydrus proved futile because of the rapid powers of regurgitation afforded it by the peristalic body movements. A liquid mixture of strained beef and egg yolk run into the stomach through a tube was quickly and invariably expelled, as were small fish and pieces of meat shoved down its throat with a forceps.

Two 18-inch juveniles of the Java elephant-trunk snake Acrochordus javanicus) obtained in March 1957 fared much better, one still living at the time of this writing. The scales of the babies (which eventually reach a length of five feet) were so small and numerous as to give them a velvety texture. The body was grayish, irregularly mottled and striped with dark brown, and the blunt head with its large eyes presented a singular appearance, often likened to that of a miniature seal by visitors to the aquarium. The tongue is remarkable for its large size and excessive slenderness, while the body form is much stouter than in Chersydrus and there is no vertical flattening of the tail as is apparent in the latter species.

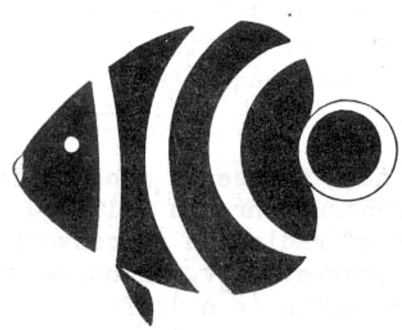
Live fishes were readily attacked by the snakes, who quickly enveloped them in their body coils after seizing them in their jaws. Although no constriction seemed to be attempted, the rasplike scales appeared to be employed to good advantage in holding the struggling prey until it could be swallowed. The swallowing process itself was remarkably rapid, with even large fish being engulfed in a matter of seconds.

The National Aquarium to date has obtained no specimens of the true seasnakes or Hydrophids, although a few of the species have been kept (usually without much success) by various zoos and aquariums around the country. Most of them refuse to feed and eventually starve under captive conditions, although one species, the yellowbellied seasnake, Pelamis platurus, has proved to be an exception to this. Two dozen specimens, ranging from one to three feet in length, were obtained from the Gulf of Panama (this is the only seasnake that ranges into the Western Hemisphere) by the Writer in 1958 at the Miami Seaquarium. Placed in a 500-gallon tank, most of them readily accepted surface swimming Fundulus fish which were readily available in the area. Although the reptiles' movements appeared fairly slow, they proved surprisingly adept at capturing the swimming fish with a sideways movement of the head and neck. Although the specimens did reasonably well at first, within two months most of them had succumbed.

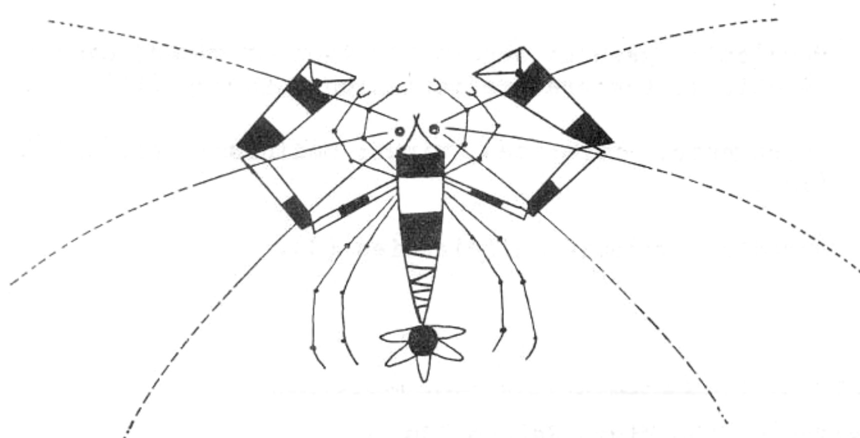
This experience led to the assumption that something might be amiss in the artificial environment, and the further speculation that they might have done better either in an out-of-doors pool or in a tank exposed (at least part of the time) to full sunlight or ultraviolet light. Pelamis is one of those specialized Hydrophids which are highly pelagic, ranging far out to sea and spending most of their time swimming or actually resting at the surface. Under these conditions the reptiles are undoubtedly accustomed to receiving a large amount of direct sunlight, and it might follow that this daily amount of solar radiation (or its equivalent) is necessary to their well-being.

Unfortunately, loss of specimens prevented an opportunity to test this hypothesis at the time, but a recent (September 20) communication from Mr. Warren Zeiller, Curator of the Seaquarium, offers some evidence toward its possible validity, lie reports that two Pelamis brought to the Seaquarium on May 25 are thriving in a 60-gallon tank at the present time under ultraviolet light. According to this report, an F40BL tube was placed directly across the tank, which is filled to the halfway mark. The light is kept on from 8 o'clock to 5 o'clock daily and the specimens fed on a daily ration of about a dozen black mollies and swordtails. The snakes have been molting their skins every ten days or so and seem to be in very good condition.

From the foregoing, it may be seen that we still have much to learn concerning the life requirements of many of these interesting snakes, and as more and more kinds become accessible through increased collecting, aquarists as well as zoo herpetologists will have greater opportunities to study and test them in various artificial habitats. It is to be hoped that readers of this article may in the future offer additional data and suggestions along this line.



An excellent aid to the aquarist is "Parasites of North American Freshwater Fishes," by Glenn L. Roffman, parasitologist at Eastern Fish Disease Laboratory of the Bureau of Sport Fisheries and Wildlife. Available at $15.00 from the University of California Press, Berkeley, California, 94720.



ULTRAVIOLET IRRADIATION OF MARINE AQUARIA[1]

by
Billie M. Bevan
Electronic Specialist

and
Warren Zeiller
Curator of Fishes
Miami Seaquarium

The comparatively high degree of penetration of the ultraviolet Portion of the light spectrum through filtered water is well documented (15). This area of radiation is conventionally divided into two segments; near, or longwave u.v. encompasses wavelengths between 3,200 and 4,000 angstrom units (a.u.); far, or short wave (considered germicidal) 3,200 or less a.u. This paper is concerned with near u.v. and observations on its effects on marine specimens.

In an effort to maintain variety among display aquaria, a search was begun to locate marine species which fluoresce under ultraviolet light (16). The display is still incomplete as a result of development of more important factors.

One of these concerns the disease exophthalmus commonly called popeye, swollen eye, or gas-bubble disease [an excellent pathological description is given by Westgard (13)]. Interrelated causes and factors contributing to the incidence of exophthalmus can be categorized as:

1. Physical: gaseous supersaturation of water; osmotic reactions; temperature variations; injury (11) (12).

2. Pathogenic: parasites; virus, oodinium; etc. (1) (10) (12).

3. Organic: vitamin deficiencies (4).

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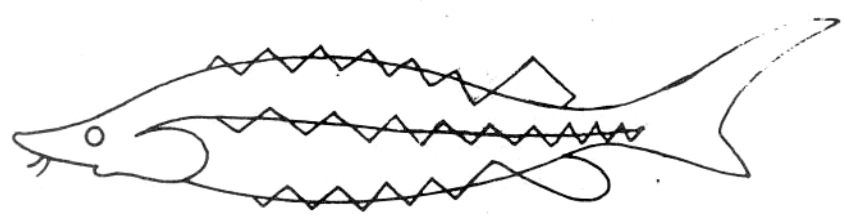
[1]Publication of the Miami Seaquarium

Available literature contains sufficient material to establish design criteria to prevent outbreaks of exophthalmus, but data on its successful large scale treatment is non-existent. Treatment of individual fishes requires time consuming methods, i.e.; isolation, puncture of the distended area, direct medication, and increase of water temperatures in the high 70 degree and sustained 80 degree F. range.

One treatment proven successful in early stage cases is gaseous desaturation of water through turbulent aeration (8). A second is accomplished by longwave ultraviolet irradiation. Preliminary observations in regard to the latter were of individual diseased specimens isolated in ten gallon closed-system aquaria. Each was irradiated with longwave F40BLB Blacklight, radiation in a band from 2,900 to 4,400 a.u. with a major peak at 3,660 a.u. Exposures were varied until it was determined that fifteen minutes per day for five days would effect a cure in a closed system. One exception, a Lionfish (Pterois volitans), had progressed to opacity on both eyes. These areas fluoresced under treatment and required ten days to clear, after which the fish was returned to its display, with constant turbulent aeration, all swelling receded in forty-five days.

In large, open-system aquaria, one cannot isolate the many cases that may develop during the danger period. They must be treated in situ without detriment to other vertebrate or invertebrate forms. Continuous ultraviolet exposure of the total aquarium environment has proved to be an effective cure of, and preventive measure against advanced exophthalmus. Efforts in this direction were begun by placing two longwave u.v. tubes six inches above the water surface of each of a series of 300-gallon and 500-gallon open-system display aquaria (flow rate, 400 gal./hr.). Among these aquaria, varying periods of two, four, and eight hours of daily irradiation were tried. Eight hours was most effective; diseased fishes returned to near normal in an average of ten days. To date, no deleterious effects on other creatures in the aquaria have been observed.



The beneficial results of daily irradiation having been indicated, a method of practical application without need for special lighting fixtures was determined. Longwave P40BL tubes lacking the dark blue filter of the original Blacklights were obtained. These replaced one or two of the white fluorescent tubes in the three-tube fixtures suspended three feet above each aquarium with little loss of display illumination. Aquaria are illuminated twelve to fifteen hours per day. Inclusion of the near u.v. lights in these fixtures assures a daily dose of radiation to serve as a preventive measure against exophthalmus and other maladies. Indications are that the additional hours per day over and above eight have been neither detrimental nor more beneficial. Although the eyes of some specimens do swell under this continued treatment, they do not develop corneal opacity; eyes recede to normal after varying lengths of time, and fishes no longer die from this illness.

An obvious result of the above work is increased specimen longevity. One 500-gallon aquarium contains puffers (Tetraodontidae), trunkfishes (Ostraciidae), and porcupinefishes (Diodontidae). High losses in these families had been attributed mainly to dietary deficiencies. Mortalities in this group have been near zero since addition of longwave u.v. to the standard aquarium lighting. Each day it is more apparent that these, and possible all aquatic creatures, require the ultraviolet portion of the spectrum denied them in artificially lighted aquaria. John Ott, Sc.D. of the Environmental Health and Light Research Institute has proven this in plants and terrestrial animals (9).

A variation of work on fishes was conducted with sea turtles. These constantly suffered open wounds over the eye bulge from biting each other during feedings. Even lengthy medication of the damaged areas could not accomplish a lasting cure. A single F40BL was introduced above the aquarium. Within three days, damaged areas on all turtles were improved markedly and healed in one week.

In summary, drastic reduction of mortalities among aquatic creatures has been achieved by adding ultraviolet light of given angstrom unit range and peak (3,660 a.u.) to the normal fluorescent illumination of aquaria (Optima, gro-Lux , cool white, etc.). Reductions are due in part to lessening of the incidence of disease and infection. Tissue damaged from handling, equipment, and other creatures, heals cleanly and with unusual rapidity; this is a particularly important point in favor of newly captured specimens. Additional aspects which may account for increased longevity have been determined. Optimum combinations, if any, of u.v. and types of florescent or incandescent lamps are also undetermined.

In view of the above, it is fascinating to contemplate the role of this vital range of total light energy. Think of the innumerable variables and possibilities involved that already are in practical application! What are the u.v. intensities in the zones in the sea? What biological need does this portion of the spectrum fulfill? How does u.v. affect recuperative efforts of organisms, and are there limits of radiation tolerance? How does longwave differ in its effects from the familiar short wave light? Exactly how has this long overlooked factor proven immensely beneficial to marine creatures in an artificial environment? What requirements do marine creatures have for the full light spectrum in captivity -- and in the sea?

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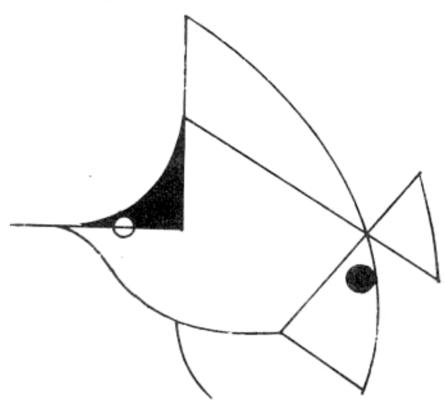
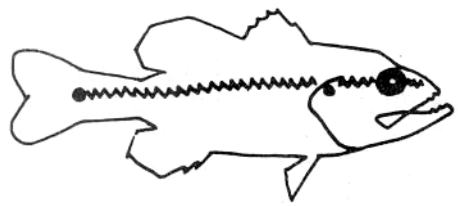


A recent 124 page well-illustrated publication by the Bureau of Sport Fisheries and Wildlife should be of interest to aquarists. Underwater and Floating-Leaved Plants of the United States and Canada, by Wildlife Biologist Neil Hotchkins, Resource Publication 44, may be purchased for 65 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.



A MEAL-GELATIN DIET FOR AQUARIUM FISHES[1]

by
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Rayburn C. Robinson[3]
National Fisheries Center and Aquarium

and
Harvey Willoughby[4]
Bureau of Sport Fisheries and Wildlife

The use of animal gelatin to bind mixture of foods for aquarium specimens has led to the formulation of a new basic diet for most of the aquatic animals displayed at the National Aquarium.

Gelatin-bound diets have been described by Halver (1957), DeLong at al. (1958), and Reichelt and Joyner (1965), but were first used at the National Aquarium in 1964. Gelatin, when dissolved in hot water and blended with such varied ingredients as beef liver, clams, shrimp, crabmeat, or meals, congeals upon cooling and binds the ingredients together. This rubbery mass can be refrigerated and later chopped into any desirable size and shape prior to feeding.

After the physical properties of gelatin-bound mixtures had been tested and found to be satisfactory for our aquarium conditions, efforts were made to formulate a diet which was both economical and nutritionally sound.

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(1) Presented at Aquarium Symposium of the American Society of Ichthyologists and Herpetologists, Miami, Florida, June 21, 1966.
(2) Assistant Curator, National Aquarium, Washington, D.C.
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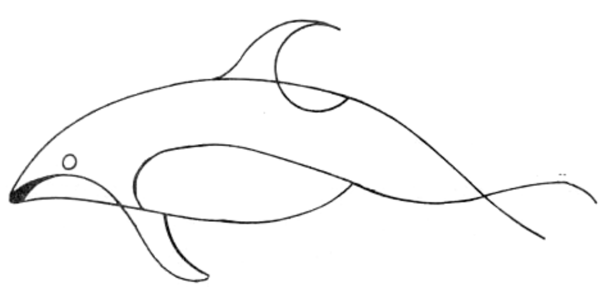
Basic to the formulation of an animal's diet is a knowledge of its nutritional requirements and these have been best established for trout and salmon. Diets have been formulated for them using common feed-mill ingredients, and it was decided therefore to use such a meal mixture as the base for the aquarium diet. These meals, with various formulae, are available from a number of trout food manufacturers. Supplements in the form of fresh ground liver, clams, shrimp, or crabmeat were added primarily for taste appeal, and can be either fresh, frozen, or canned. Vitamin A and D feeding oil, available from feed mills or chemical supply stores, was added to raise the caloric level, and gelatin, which had been previously dissolved in hot water, was added to bind the mixture together. The resulting formulation is listed below, along with mixing directions for a 3,000 gram mix:

	Percent	Quantity
Water	48	1440 cc
Trout diet in meal form (Appendix I)	25	750 gm.
Liver, shrimp, or clams	12	360 gm.
Animal gelatin (commercial grade)	10	300 gm.
Vitamin A and D feeding oil	5	150 cc.

1. Drain flavoring ingredients and blend these with feeding oil in a Waring blender. Add 200 cc. water or liquid drained from flavoring ingredients.
2. Dissolve animal gelatin in 1240 cc. hot water (200˚F.), beating with electric mixer until a smooth, lump-free mixture is attained while the mix cools to 150˚F.
3. Add flavoring ingredients (step 1 above) and meal to the dissolved gelatin. Mix at low speed. Other ingredients, such as food coloring, special nutrients, or antibiotics, can be added at this time.
4. Pour into shallow trays and cool. Store in refrigerator until needed. The mixture is quite rubbery, and can be shredded or chopped into appropriate sizes for feeding.



Some useful modifications of the above are:

1. Addition of 5% bone meal to help maintain shell firmness in turtles.

2. Replacing flavoring ingredients with carbohydrates in the form of corn or wheat flour to help improve body condition in carp.

3. Addition of 50 cc. of red food coloring to increase visibility, and to facilitate the removal of uneaten food from the aquarium.

4. Addition of 25 grams of vitamin pre-mix to restore the vitamin level of the mix to that of the trout meal.

The meal-gelatin diet has the following advantages over the live fish, meat, and dry-food diets previously employed:

1. It binds well, aids in reducing tank turbidity, and helps to insure near-maximum delivery of nutrients to the specimens.

2. Its flexible texture results in increased acceptance by the animals.

3. It is easy to cut, shred, and store.

4. It helps to decrease the need for live food, and thus reduces associated holding and disease problems.

5. The controlled open formula is easily modified.

6. It is relatively inexpensive (about 15¢ per pound).

Cutthroat trout, Salmo clarki, which had been fed only this diet for over a year, spawned successfully at the National Aquarium in 1965 (Peterson, 1966). Also, after two years' experience with the diet, it has been found that fishes which generally require live food, such as largemouth bass, black crappie, white bass, and others, can be trained to accept, and appear to thrive on, the gelatin mix.

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(more)

The little piked whale or lesser rorqual (Balaenoptera acutorostrata), may well be the first of the whalebone whales that will eventually withstand captivity in an aquarium. Reaching a length of about 35 feet, this species is capable of eating small fish as well as plankton and frequently small numbers of them will become "landlocked" in small pools surrounded by solid ice during the polar winters. Under these conditions an ingenious way might be developed to capture them unhurt and transport them to an oceanarium or other suitable quarters.

APPENDIX I

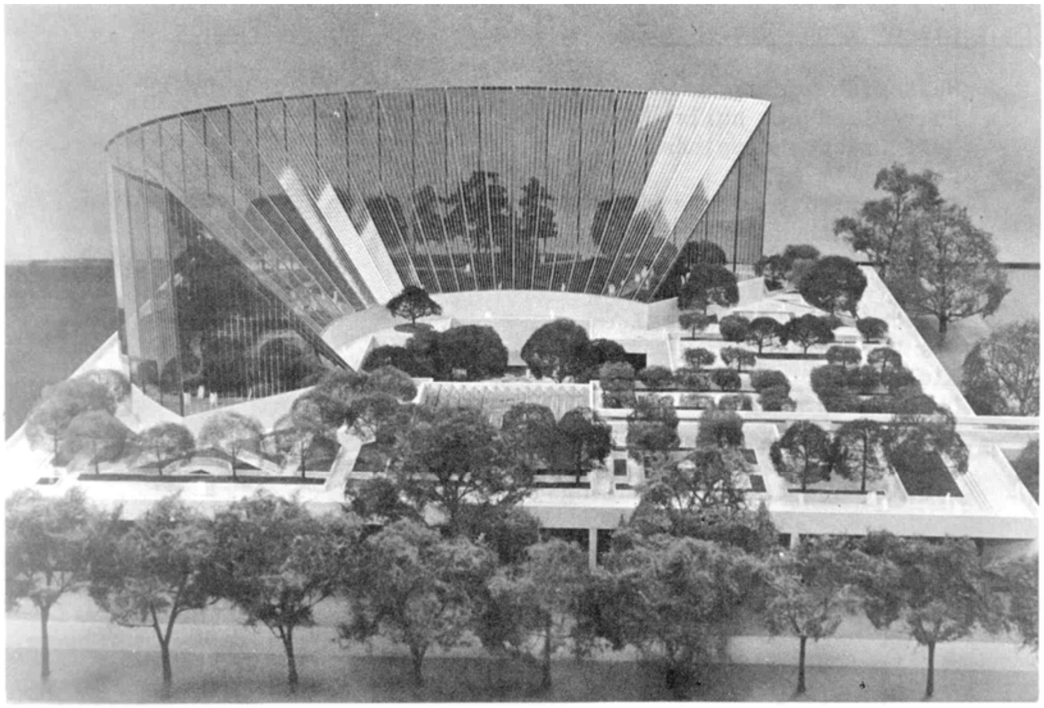
Contents of Trout Diet Meal[1]

Pounds	
Whitefish meal	28
Pulverized oat hulls	12
Gulf Coast shrimp meal	10
Dried skim milk	10
Steam-dried brewer's yeast	9
Dried condensed fish	5
Defatted soy flour	5
Corn fermentation solubles	5
Dehydrated alfalfa meal	4
A & D feeding oil	4
Blood flour	2
Dried kelp meal	2
Vitamin premix (vitamins listed below in a carrier of standard wheat middlings)	4

	Milligrams in 4-lb. premix
D. calcium pantothenate	2,400
Pyridoxine	1,200
Riboflavin	2,400
Choline chloride	160,000
Niacin	10,000
Folic acid	400
Thiamine	300
Inositol	25,000
P-aminobenzoic acid	1,000
Biotin.	20
Vitamin B-12	1
Menadione sodium bisulfite	500
Ascorbic acid	12,000
D-alpha tocopheral acetate	8,000

(1) Adequate approximation available off-the-shelf from trout food manufacturers.

NATIONAL FISHERIES CENTER AND AQUARIUM

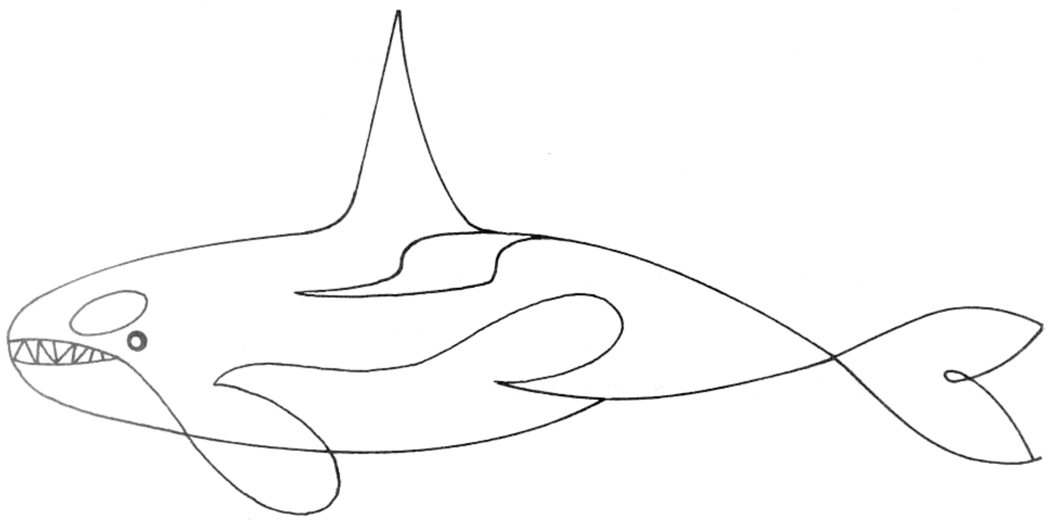


To be constructed in East Potomac Park, on the Potomac River, Washington, D. C., the structure is 375 feet on each side and 140 feet high.

Currently in the advanced planning stage, the building is essentially of one floor with a parklike roof with pools and resting areas, upon which is a "greenhouse" containing a tropical swamp and two tidal pools representing the east and west coasts.

The first floor will house orientation theatres, trout stream, coral reef community, and a large number of exhibits explaining, among others, locomotion, perception, schooling, symbiosis, etc. On this first floor also will be the administrative offices, research laboratories, and the operating area.

It is anticipated that construction of this facility will begin in late 1969 and will be open to the public in the spring of 1972.



Long considered to be one of the most dangerous of sea creatures, the killer whale (Orcinus orca), has proven to be remarkably tractable in captivity, exhibiting the same intelligent affinity to man that has been repeatedly observed in its smaller relatives. A female whitesided dolphin (Lagenorhynchus obliquidens) placed in the same tank with the captive killer whale "Skana" at the Vancouver Aquarium was immediately accepted as a companion by the latter, and now, after more than six months of association, both animals are still doing fine. This does not, however, prove that the killer's habits may not be quite different in the wild, as there are authentic records of seals, penguins, dolphins, porpoises, and the remains of larger whales having been taken from the stomachs of slaughtered killer whales.

S0 YOU THINK YOU HAVE PROBLEMS?

Hutchinson (1954) reports that the known or estimated numbers of larger ungulates (elephants, giraffes, tapirs, rhinoceroses) produce 45 X 10^{12} g. of methane annually by enteric fermentation. He also remarks that ammonia is the most widespread nitrogenous product of metabolism.

No estimate follows as to the production of gaseous or fixed ammonia by elephants and their kin, probably because of the truly formidable technical problems involved in direct sampling, especially in the wild.

Thus concludes our first effort. Let us have your criticism, comment, papers, problems solved, improved methods, personnel changes, and whatever else comes to your mind. Send all to:

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