as the C_6-C_3 intermediates in lignin formation was discussed. Other biochemical contributions of interest dealt with the synthesis in vitro of glycine and the metabolic utilization of C^{14}-ethanol (E. A. Cossins *et al.*, Alberta). N. E. Good (Michigan) discussed the preparation of several new H-ion buffer systems. They were mostly substituted derivatives of *tris* (hydroxmethyl) amino methane covering the *p*H range from 6 to 8 and were claimed to be superior to both tris and phosphate buffers.

Several speakers described the structure and the effects of environment on plant cells as observed with the electron microscope and the light microscope. A. J. Mia and G. Setterfield (Carleton, Ottawa) reported the synthesis of cell wall material by apposition in Rauwolfia sclereids with H^3-glucose pulse labeling. In a session on translocation in the higher plants, researchers from the Biosciences Division (N.R.C., Ottawa) described the experimental control of C^{14}-sugar movement by changing the node temperature (J. A. Webb and P. R. Gorham) and discussed the distinct lack of evidence demonstrating sugar conduction in the sieve tubes (D. C. Mortimer and M. Suzuki). D. S. Fensom and D. C. Spanner (London, England) reported their measurements of microelectrode potentials in the conducting tissue of *Nymphoides* and *Heracleum*; they had calculated that the electroosmotic efficiency was sufficient to maintain sugar flow through partially blocked pores of the sieve plate.

Exogenously supplied giberellins and IAA strongly influence plant development. E. Schneider and F. Wightman (Carleton, Ottawa) showed IAA-2-C^{14} to be metabolized mainly through conjugation to indoleacetyl aspartic acid, indoleacetyl glucose, and 2-OH indoleacetylglucose in barley seedlings over a 24-hour period. A. Winter and K. V. Thimann (Harvard), however, could find no evidence for conjugate compounds over a 2-hour period in *Avena* coleoptiles, and considered exogenously supplied C^{14}-IAA to be physically bound to a protein fraction. N. A. Andreae (Dept. Agriculture, London) showed that conjugate products were formed, with IAA inactivation, when pea roots were pretreated with an excess of IAA and naphthalene acetic acid. An adaptive period of 2 to 4 hours was necessary before the conjugate products were discerned. 2,4-Dichlorophenoxyacetic acid was not conjugated and remained inhibitory regardless of the pretreatment time. J. I. Toohey and C. D. Nelson (Queens, Kingston) reported two new herbicides derived from a soil bacterium inhabiting old pastures. The compounds were toxic to algae and higher plants but not to insects, fish, or mammals. They were isolated and identified as phenazine-1-carboxylic acid, most toxic to higher plants, and the 2-OH derivative, most toxic to the algae.

Officers of the society elected for 1965–66 were president, G. H. N. Towers (University of British Columbia); vice president, D. Simminovitch (Department of Agriculture, Ottawa); secretary-treasurer, D. Canvin (Queens, Kingston); eastern director, A. R. A. Taylor (University of New Brunswick), western director, M. S. Spencer (University of Alberta).

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Hermaphroditic Fish

Functional hermaphroditism is widespread among the bony fish, but until recently so few coordinated data on the subject have been available that it has been ignored by comparative endocrinologists, behaviorists, and ecologists—all of whom should find among these unusual fish exceptions to prove some of their "rules." That hermaphroditic fish are now beginning to get the attention they deserve, however, was apparent from the conference on intersexuality in fishes held on 20–21 May 1965 at the Cape Haze Marine Laboratory in Sarasota, Florida. Specialists and students from the United States, Germany, and Japan attended. Most of the studies reported dealt with species of fish in which the individual functions both as male and female during its life history. Experimentally induced hermaphroditism and other related aspects of piscine sexuality were also discussed. The conference was appropriately dedicated to two recently deceased pioneers in the field—Umberto D'Ancona and G. J. van Oordt.

Most hermaphroditic fish are marine, and marine fish are notoriously loath to exhibit sexual activity in captivity. Moreover, it has been nearly impossible to collect examples in all the different stages of sexual develop-

ment, both ontogenetic and seasonal. As a result, we do not have a single reasonably complete sexual history of an hermaphroditic marine fish. Underwater observations made possible by SCUBA, and careful histological analyses of available specimens are helping to fill in the gaps, however, and an inkling into the hormonal mechanisms is being provided by experiments with sex hormones. In addition, two freshwater hermaphroditic species that thrive in aquariums are now known—the Asiatic synbranchid, *Monopterus albus*, and the neotropical killifish, *Rivulus marmoratus*.

All of the known Florida specimens of *Rivulus* are either males or self-fertilizing hermaphrodites that exhibit female secondary sex characteristics. Fertilization takes place within the ovotestes, and the fish lay eggs that have already undergone some development. Robert W. Harrington (Florida State Board of Health) described the unique mode of reproduction of this small fish. Hermaphrodites about to oviposit repel other hermaphrodites but tolerate the participation of a male in the spawning act, if one is present. Cross fertilization could conceivably occur on the rare occasions when an unfertilized egg, not too old, is laid. Older hermaphrodites sometimes transform into males with functional testes. No males have yet been found in nature, but Harrington can produce them at will by manipulating the environment in which the eggs develop. In contrast, *Monopterus* is protogynous; all individuals function first as females and then, after the complete transformation of the gonad at the age of about 3 years, as males. Karel F. Liem (University of Illinois Medical Center) reviewed his extensive studies on this eel-like inhabitant of swamps, ponds, and paddy fields. Liem found that starvation accelerated sex reversal, and he suggested that this is adaptive since it provides males for the reproduction that follows the termination of the droughts to which this air-breathing fish is periodically subjected.

Sea bass of the family Serranidae exhibit both synchronous and protogynous hermaphroditism, and their ovotestes represent at least five morphological variants on a common theme. C. Lavett Smith (American Museum of Natural History) has found these patterns of sexuality critically important in determining phylogenetic relationships. From a recent histological

study of the gonads of the kelp bass, *Paralabrax clathratus*, Smith obtained evidence indicating that this species is a secondary gonochorist, that is, a species with separate sexes derived from hermaphroditic ancestors. He pointed out that, in a protogynous species in which some of the individuals have come to reverse sex precociously (a phenomenon for which there is good evidence), selection will favor female-functioning fish that delay their transformation, thus leading to a secondarily gonochoristic form. Martin A. Moe, Jr. (Florida State Board of Conservation), has determined that the red grouper, *Epinephelus morio*, does not change from female to male until it is approximately 12 years old, and he emphasized the necessity of understanding the sexual pattern of this important commercial serranid for its proper conservation and management. Eugenie Clark (Cape Haze Marine Laboratory) described the reproductive behavior of *Serranus subligarius*, the only sea bass whose actual spawning behavior has been seen. Although this synchronous hermaphrodite can lay its eggs and more or less immediately fertilize them, oviposition is typically accompanied by courtship and pairing in which one member acts as female, the other as male. Reversal of roles may occur suddenly and within a very short time, but it has not been determined whether, at the moment of spawning climax, a fish emits only eggs or milt, or some of both. Clark could detect no difference between the development of self-fertilized and cross-fertilized eggs. Live *Serranus*, which were spawning in the Sarasota area, were on display in laboratory aquariums.

Rudolf Reinboth (Johannes Gutenberg University, Mainz) compared the protogynous and protandrous porgies of the family Sparidae. Protandrous species lay pelagic eggs and lack sexual dimorphism, and the process of sex reversal from male to female requires several months. Protogynous species lay adhesive eggs, exhibit sexual dimorphism, and change from female to male in as little as 6 weeks. The members of the related family Maenidae (Centracanthidae) are protogynous and they resemble the protogynous sparids in all of these characteristics. With a single injection of androgen, Reinboth was sometimes able to effect essentially normal sex reversal in two protogynous forms, but a series of several estrogen in-

jections produced no sign of gonad transformation in one of the protandrous sparids.

Among the wrasses (family Labridae), protogyny is widespread and is frequently, but not invariably, associated with dimorphic males. For *Coris julis*, Reinboth presented a convincing case that the larger, more brightly colored, and more ornately finned males represent transformed females, while the other type of male, which looks like the female, does not undergo either sex reversal or change in secondary sex characters. Reinboth found that after a single injection of androgen female-colored fish permanently assumed the "high" male coloration, but that many of them did not become sex reversed. An unexpected finding was that the testes of the smaller, dull-colored males are larger and better developed than those of the other morph. A similar observation was made on other species of wrasses by Machteld J. Roede (Zoologisch Museum, Amsterdam). All seven of the West Indian species studied by her showed evidence of protogynous hermaphroditism. John E. Bardach (University of Michigan) reported that preliminary field studies along the shores of Madagascar have revealed a similar situation among the wrasses there, in particular members of the genus *Stethojulis*. Observations in nature indicate that the two types of male wrasse behave quite differently toward other members of their own species. The labrids offer challenging ecological as well as endocrinological problems.

Although hundreds of thousands of pounds of the flathead, *Cociella crocodilia*, are trawled each year in the Yellow Sea and adjacent waters, it was not until 1963 that Tsuneo Aoyama (Seikai Regional Fisheries Research Laboratory) made public his surprising discovery of protandry in this foodfish. Aoyama has now recorded that two other Western Pacific species of flathead are protandrous hermaphrodites, namely *Suggrundus meerdervoortii* and *Rogadius asper*. The addition of the flatheads (family Platycephalidae) brings to 13 the number of families of teleost fish known to have members that normally function as both male and female during their life histories.

Apparently spontaneous sex reversal has been detected in several laboratory strains of three species of gonochoristic fish by means of sex-

linked color patterns and abnormal sex ratios among the offspring of the fish in question. Klaus D. Kallman (New York Zoological Society) analyzed the relatively numerous examples he has found of platyfish, *Xiphophorus maculatus*, with the genotype of one sex and the phenotype of the other. He concluded that previously held ideas about the cause of these sex reversals are no longer tenable; the concept of genic balance, originally developed by Bridges to explain intersexuality and related phenomena in *Drosophila*, cannot, at least by itself, explain the frequency distribution and genetic histories of the many sex-reversed platyfish.

Under certain conditions—unfortunately seldom defined—the teleost gonad seems to show remarkable sensitivity to environmental influences, and ovotestes may appear in considerable numbers of ordinarily gonochoristic fish. Such a case has recently been brought to light by Norbert Simon (Johannes Gutenberg University). Almost 20 percent of the green sunfish, *Lepomis cyanellus*, from a pond near Mainz were hermaphrodites with ovaries that exhibited varying amounts of testicular tissue. Another nearby pond, which undoubtedly had provided the sunfish for stocking the pond in question, when it was dug in 1959, contained no abnormal fish, and this may indicate that some environmental factor was at work. Simon is investigating the possibility that human urine was responsible for the masculinization. In the laboratory, Toki-o Yamamoto (Nagoya University) has developed a technique for completely reversing either sex of the medaka, *Oryzias latipes*, by feeding sex steroids to the fry. During the course of his extensive experiments, however, Yamamoto has produced remarkably few partially transformed individuals; treatment has proved completely effective, not effective at all, or has suppressed gonadal development entirely. Yamamoto described the experimentally produced ovotestes, and he interpreted them as partly the result of a primary antero-posterior gradient of differentiation and a secondary dorso-ventral one. Nobuo Egami and Yasudo Hyodo (National Institute of Radiological Sciences, Chiba) reported that irradiation of developing medaka eggs results in ovotestes in some of the males. By following Yamamoto's method of feeding methyl testosterone to newly hatched fish, Howard P. Clemens (Univer-

sity of Oklahoma) has produced functional sex-reversed *Tilapia mossambica*. When mated to normal females, these fish sired all-female broods. Clemens' success in reversing sex in *Tilapia* and in obtaining unisexual broods opens the way for a practical means of producing large numbers of fish for the monosex culture that must be practiced in order to prevent "runting" in various species of *Tilapia*, since these prolific pondfish soon overpopulate their ponds if allowed to reproduce.

Charles M. Breder (American Museum of Natural History) pointed out how surprisingly similar the reproductive activities of the male and female fish sometimes are. It has occasionally seemed as if only the emission of eggs by one sex and of milt by the other distinguish them. An obvious question is whether this apparent similarity in sexual behavior has facilitated the evolution of hermaphroditism among the teleosts. George W. Barlow (University of Illinois) described his carefully monitored experiments with *Etroplus maculatus*, a member of the family Cichlidae, the group in which males and females have most often been recorded as behaving more or less identically. Barlow pointed out that even when a particular courtship behavior was ostensibly identical in both sexes, analysis revealed it to be strikingly different in its relation to the social events and environmental factors previously experienced by either male or female. Thus, male and female motor patterns that the most careful observations cannot distinguish are nevertheless of different significance in the lives of the two sexes. We now have no reason to believe that the sexes of fish do not differ fundamentally in all aspects of reproductive behavior. In another study of cichlids that was not primarily directed toward hermaphroditism, Hans M. Peters (Tübingen University) described how fruitful a quantitative approach to gonadal function, involving simple parameters like weight and egg size, could be, and he suggested that such studies could profitably be made on hermaphroditic forms.

A recurrent question concerned the identity of the sex steroids of fish. The key role that hermaphroditic fish might play in elucidating the functions of piscine sex hormones was emphasized by J. J. Christian (Albert Einstein Medical Center, Philadelphia), but he and James H. Leathem (Rutgers

University) cautioned against assuming that mammalian and teleostean hormones are the same. Lester R. Aronson (American Museum of Natural History) presented convincing experimental evidence that mammalian or synthetic estrogens cannot be substituted for the natural ones in *Tilapia macrocephala*. He also showed that functioning males occasionally produce significant quantities of estrogens.

Practically nothing is known about the selective advantages that hermaphroditism presumably must confer on the fish exhibiting it. It may be deduced that, all things being equal, a synchronously hermaphroditic species should have a reproductive potential nearly twice that of a gonochoristic one, since the hermaphroditic form has dispensed with separate sperm producers, each of which requires about as much food and *lebensraum* as does an egg producer. If this is true, it might well be asked why all species are not hermaphrodites and what are the special problems that must be met before functional hermaphroditism can be acquired. These and related questions were discussed by Christian, Liem, Barlow, and the conference chairman, James W. Atz (American Museum of Natural History).

After the conference, many of the participants took an extended field trip to the Dry Tortugas where they spent 4 days observing the marine life of the islands. The conference was supported in part by the National Science Foundation.

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Forthcoming Events

November

11–12. **Kentucky** Acad. of Science, Univ. of Kentucky, Lexington. (D. M. Lindsay, Georgetown College, Georgetown, Ky.)

11–13. **Gerontological** Soc., 18th annual, Los Angeles, Calif. (W. D. Obrist, Dept. of Psychiatry, Duke Univ. Medical Center, Durham, N.C. 27706)

11–13. Bases for **Nuclear Spin-Parity** Assignments, conf., Gatlinburg, Tenn. (F. K. McGowan, Oak Ridge Natl. Laboratory, P.O. Box X, Oak Ridge, Tenn. 37831)

12–13. **Clinical Pathology of Infancy**, Assoc. of Clinical Scientists, Washington, D.C. (F. W. Sunderman, 1833 DeLancey Pl., Philadelphia, Pa. 19103)

12–13. Society for **Industrial and Applied Mathematics**, western regional, Seattle, Wash. (B. H. Colvin, Boeing Scientific Research Laboratories, P.O. Box 3981, Seattle)

12–14. Association of **Clinical Scientists**, Washington, D.C. (R. MacFate, 300 N. State St., No. 5322, Chicago, Ill. 60610)

12–15. **Neutrality of Medicine**, 2nd intern. congr., Paris, France. (R. Ellenboger, Ministère des Anciens Combattants et Victimes de Guerre, 37, rue de Bellechasse, Paris 7e)

14–15. National Medical Foundation for **Eye Care**, Chicago, Ill. (L. A. Zupan, Room 6, 1100 17th St., NW, Washington, D.C.)

14–16. Hedrologicum Conlegium, Intern. Soc. for the Study of **Diseases of the Colon and Rectum**, 2nd congr., Tokyo, Japan. (J. F. Montague, 104 E. 40 St., New York 10016)

14–17. Southern **Medical** Assoc., Washington, D.C. (R. F. Butts, 2601 Highland Ave., Birmingham 5, Ala.)

14–18. Mexican **Dental** Assoc., 1st intern. congr., Mexico City. (R. Espinosa de la Sierra, Asociación Dental Mexicana, Sinaloa no. 9, Mexico 7, D.F.)

14–18. **Dental**, Pacific intern. conf., Honolulu, Hawaii. (W. A. Wakai, 291 Alexander Young Bldg., Honolulu 96813)

14–18. Society of **Exploration Geophysicists**, 35th annual intern., Dallas, Tex. (Dallas Geophysical Soc., Dallas)

14–19. American Acad. of **Ophthalmology and Otolaryngology**, Chicago, Ill. (W. L. Benedict, 15 Second St., SW, Rochester, Minn.)

14–21. **Air Pollution**, 1st world congr., Buenos Aires, Argentina. (D. D. Torti, Asociación Argentina Contra la Contaminación del Aire, Sarmiento 680, Buenos Aires)

15–16. **Hypervelocity Techniques**, 4th symp., Tullahoma, Tenn. (J. Lukasiewicz, vonKarman Gas Dynamics Facility, ARO, Inc., Arnold Air Force Station, Tenn. 37706)

15–16. **Science** conf., 4th annual, Belfer Graduate School of Science, Yeshiva Univ., New York, N.Y. (A. Gelbart, Belfer Graduate School of Science, Amsterdam Ave. and 186th St., New York 10033)

15–17. Association of **Military Surgeons** of the U.S., Washington, D.C. (F. E. Wilson, 1500 Massachusetts Ave., NW, Washington, D.C.)

15–18. **Aircraft Design and Technology**, Los Angeles, Calif. (American Inst. of Aeronautics and Astronautics, 1290 Sixth Ave., New York 10019)

15–18. **Information Problems in the Drug Industry**, conf., Philadelphia, Pa. (C. P. Butcher, Graduate School of Library Science, Drexel Inst. of Technology, 32nd and Chestnut Sts., Philadelphia)

15–18. American **Nuclear** Soc./Atomic Industrial Forum, winter meeting, Washington, D.C. (O. J. DuTemple, American Nuclear Soc., 244 E. Ogden Ave., Hinsdale, Ill. 60521)

15–19. **Animal Care Panel**, 16th annual, Philadelphia, Pa. (H. P. Schneider, Hahnemann Medical College, 230 N. Broad St., Philadelphia 19102)

15–19. **Gulf and Caribbean Fisheries** Inst., 18th annual session, Miami, Fla. (Executive Secretary, 1 Rickenbacker Causeway, Miami 33149)