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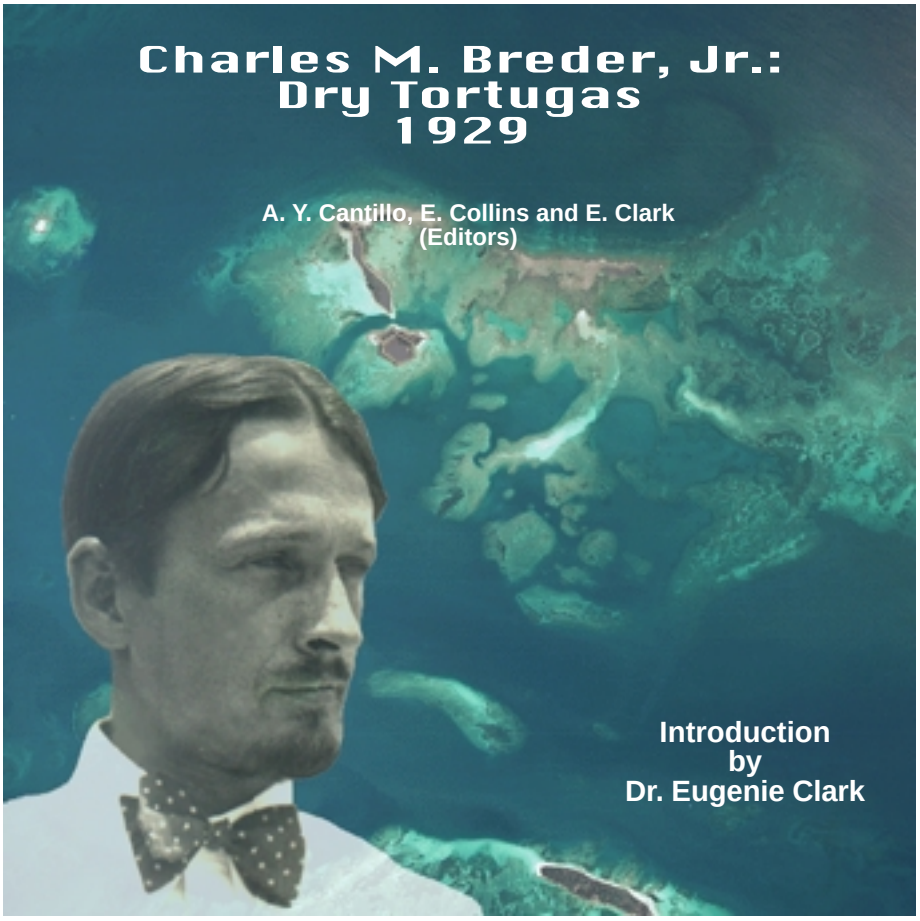

December 2001

US Department of Commerce
National Oceanic and Atmospheric Administrion
Silver Spring, MD

Mote Marine Laboratory
Sarasota, FL

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Charles M. Breder, Jr.: Dry Tortugas 1929

A. Y. Cantillo
NOAA National Ocean Service

E. Collins
NOAA Central Library

E. Clark
Mote Marine Laboratory

(Editors)

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United States Department of Commerce	National Oceanic and Atmospheric Administration	National Ocean Service
Donald L. Evans Secretary	Scott B. Gudes Acting Under Secretary	Margaret Davidson Acting Assistant Administrator

For further information please call or write:

NOAA/National Ocean Service/National Centers for Coastal Ocean Science
1305 East West Hwy.
Silver Spring, MD 20910
301 713 3020

NOAA Central Library
1315 East West Hwy.
Silver Spring, MD 20910
301 713 2600

Mote Marine Laboratory
Arthur Vining Davis Library
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Sarasota, FL 34236
941 388 4441

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A. Y. Cantillo, E. Collins[Δ] , E. Clark[◊]
(Editors)
NOAA National Ocean Service
Silver Spring, MD

ABSTRACT

During the summer of 1929, Dr. Charles M. Breder, Jr., employed at that time by the New York Aquarium and American Museum of Natural History, visited the Carnegie Laboratory in the Dry Tortugas to study the development and habits of flying fishes and their allies. The diary of the trip was donated to the Mote Marine Laboratory Library by his family. Dr. Breder's meticulous handwritten account gives us the opportunity to see the simple yet great details of his observations and field experiments. His notes reveal the findings and thoughts of one of the world's greatest ichthyologists. The diary was transcribed as part of the Coastal Estuarine Data/Document Rescue and Archeology effort for South Florida.

INTRODUCTION by Dr. Eugenie Clark

C. M. Breder, Jr. truly was an awesome scientist. Practically single-handedly, he produced 4500 pages of scientific publications during a lifetime in which he spent more than a month in the field each year while he was serving 43 years as a principal administrator of his institution. How did he manage to accomplish such a Herculean effort? Although not in any way a recluse, Breder's very private nature would have made anything autobiographical impossible, but the recent discovery that he apparently was an inveterate diarist, with at least 30 diaries to his credit, raises the possibility that clues to his modes of thought or sources of motivation might be found in them.

It is a rare opportunity and privilege to be able to look at the original diary kept by Dr. Breder on his trip to Dry Tortugas in 1929. His meticulous handwritten account gives us the opportunity to see the simple yet great details of his observations and field experiments. His notes reveal the findings and thoughts of one of the world's greatest ichthyologists.

The Dry Tortugas conjures up magical memories for those of us fascinated by the early history of field research at marine laboratories. The rich marine life, especially fishes, living in tropical waters off southern Florida, the Gulf of Mexico and the Caribbean was first documented with underwater photography at the Dry Tortugas Laboratory.

Dr. William Longley initiated his remarkable fish studies and underwater photography in 1917 at the Tortugas Laboratory. As the executive officer of this small laboratory on Loggerhead Key, sponsored and started by the Carnegie Institution in Washington in 1904, he began the marine research that was continued and expanded by scientists who came here to do field research, including Dr. Charles M. Breder, Jr.

[Δ] NOAA Central Library, Silver Spring, MD.

[◊] Mote Senior Scientist, Trustee Emerita, Center for Shark Research, Mote Marine Laboratory, Sarasota, FL. Professor Emerita, University of Maryland., College Park, MD.

In 1965, I made a pilgrimage to the hallowed historical site of this Laboratory and stood on the ruins of what had once been a landmark for marine biologists. I hosted a group of scientists sponsored by the Mote Marine Laboratory (then called the Cape Haze Marine Laboratory) attending the first international conference on intersexuality and hermaphroditism in fishes that was held in Sarasota, Florida. Through the kindness of Rita Kip, a local resident, we were able to take more than 20 participants, many of whom came from great distances, on a post conference field trip to the Dry Tortugas, where we snorkeled over the lush coral reefs and marveled at the abundance and variety of fish. Dr. Toki-o Yamamoto, famed fish geneticist from Japan, although advanced in years, amazed us by climbing coconut trees to bring down refreshing drinks of coconut milk to Sylvia Earle and me. The highlight of this expedition was to explore Loggerhead Key and to stand on the historic site of the world-renowned Tortugas Laboratory that during its short existence (1904 - 1939) had provided the base for seminal studies that led to many scientific publications and inspired the creation of marine biological laboratories.

In 1947 and 1948 I had the chance to study with Dr. Breder at the newly opened "Lerner Marine Laboratory" on the island of Bimini, Bahamas. Dr. Breder, who was Chairman and Curator of Fishes at the American Museum of Natural History in New York created the idea for this marine laboratory and was its director. At the laboratory he fascinated us by showing how much could be learned from observing the fish and invertebrates off the Lab's dock during the day and at night (with a light), from a small boat by towing plankton nets, and dip netting drifting batches of Sargasso weed from the sea surface to sort out the captivating marine creatures that live in this unique "merry-go-round" ecosystem. We learned how to set up simple experiments, make observations in aquaria, and a hundred ways to utilize the field facilities of a small tropical marine laboratory.

While reading Dr. Breder's account of his trip to Dry Tortugas in 1929, I began to understand how the Tortugas Laboratory had inspired him to continue his field studies at Palmetto Key (a short-lived, 1935 to 1942, field station on the west coast of Florida that belonged to the New York Aquarium, then headed by Dr. Breder) and, ultimately, to create the "Lerner Marine Laboratory".

Dr. Breder's early field research at the Dry Tortugas and Palmetto Key led to his scientific articles and monographs on the behavior, morphology and reproduction of fishes, notably members of the flyingfish and needlefish families, and to complex, theoretical essays on the development and locomotion of fishes and the geometry of their scales. As an aside to his studies on reproduction of fishes, he figured out the equation that describes the classical egg shape, a mathematical feat that had eluded Einstein, who congratulated Breder when Einstein learned about Breder's solution. Like many great minds, Breder approached solving complex scientific problems almost simplistically at first, then delved into the complexities. His diary shows clearly, in an easy to read almost casual manner, his first thoughts and approaches to intricate problems he later solved, often using complex mathematics. Some of his monographs are difficult to read e.g., "An analysis of the geometry of symmetry with especial reference to the squamation of fishes" (published in 1947), or "Observations on the occurrence and attributes of pentagonal symmetry" (published in 1955). The beginnings of such publications are revealed in his observations in the field and in the precise but simple measurements of fishes and other animals he collected during the day and studied at night in the small facilities of the Tortugas Laboratory.

His diary records simply "Turned out" (anywhere between 5:00 and 6:30 AM and that meant up and dressed and ready to start work) and "Turned in" (that meant leaving his lab or field work anywhere from 8:30 to 10:30 PM). The only indication of play time in his long days of the "work" he obviously loved to do was his reference to taking a swim before dinner. I remember well how he regularly went for a short swim at the Lerner Lab, just long enough to nearly

finish his cigarette. He was a chain smoker. He swam, or more often floated leisurely on his back smoking until he had to get out to his pack of cigarettes and light up his next cigarette with the one he took swimming. He had a barely perceptible, light brown groove on the right corner of his mouth where his cigarette dangled. When his doctor told him it was dangerous he stopped "cold turkey". He then lived well into his eighties and died from Alzheimer's at 86. But until this unfortunate disease started to limit the workings of the mind of a genius, he continued to observe the fish off his dock and in the little two room field lab, with aquaria, that he built next to the house where he retired in Englewood, Florida. His last publication, in 1976, presented a fresh analysis of the schooling behavior of fish. It was his eighth major paper on this forever fascinating subject.

What went on during the happy, prodigious time, of this most extraordinary man, between "Turned out" and Turned in" is carefully documented in this wonderful diary with delightful sketches of his first hand observations and his thoughts on everything from the dynamics of fish locomotion to the extinction of dinosaurs. This is only one of the thirty diaries he kept. It is a complete story of an almost two month interlude in his life that reveals much about a man who devoted a lifetime of experiences to profoundly analyzing the ways of fishes.

BIOGRAPHICAL INFORMATION

The first two excerpts are from the program presented at the establishment of the Charles M. Breder Chair at Mote Marine Laboratory. The obituary is printed with permission of Copeia.

Tribute to Charles M. Breder, Jr. by Dr. Eugenie Clark

Dr. Charles M. Breder was my friend, teacher and mentor. He was the greatest influence in my life. As a graduate student, my career as a marine biologist and my decision to accept the challenge to start a small marine laboratory in Placida, Florida, in January 1955. In the early development of the Cape Haze Marine Laboratory, now the Mote Marine Laboratory, I constantly sought his advice. He visited the Lab often, helping me over the rough spots in its administration and scientific development, constantly encouraging and helping me.

On his first visit to see me in Placida, Florida (1955) to see how I was coming along as 'Executive Director' of the tiny new Cape Haze Marine Lab, I asked him about this strange little grouper colony I found where all the individuals were females, their bellies swollen with ovulated eggs and no males were around to fertilize them. I showed him a female I had just dissected, with a big bilobed ovary full of eggs, some oozing out of the oviduct. The ovary had a white wavy band around it, which on my drawing I labeled 'fat?'

"You make such good drawings", Breder commented. "Why don't you look at a pinch of the 'fat' under a microscope in a drop of sea water?" It was swarming with spermatozoa. I discovered where the 'males' were and began a study of the amazing mating behavior of a functional hermaphrodite. Dr. Breder continued to be my teacher in his gentle way that pointed out my errors, as always, in a most complimentary way that made me feel good while still learning. His great insight into the ways of fishes and his humble informal way of teaching and encouraging me always touched me. I worshipped him, as did many of his students.

To my delight, Dr. Breder and his wife, Ethel, bought a charming house on the bay on Manasota Key in Englewood, Florida, across the road from where my husband and I were living on the beach and raising our small children. When he retired in 1965 from the American Museum of Natural History in New York, he moved permanently to Englewood where he continued his research on fish behavior full-time in our Lab or at the small laboratory he built next to his

house. Dr. Breder was a constant inspiration and help in the development of the Lab. He was a Mecca for his students and colleagues from New York, many of whom came to research at our Lab, to hear and discuss fish problems with Dr. Breder. I never made a major decision concerning the Lab without consulting him. He was also a friend and inspiration to my children and believed every child's interest in living creatures should be encouraged and treated with respect.

Once Dr. Breder approached a young visitor at our Lab who was looking at a fish in a jar. "What do you think that fish is, young feller?" Dr. Breder asked him. The boy told him authoritatively, "Well, according to Breder it's --," and he took out his copy of the famous Field Book of Marine Fishes of the Atlantic Coast, a best seller that Breder whipped out for "boy scouts" during his long train commutes from his home in New Jersey to his office in New York where he conducted and published his scholarly and ichthyological research papers. His field book was widely used by children and ichthyologists. He could talk about complex ichthyological phenomena in such simple terms a child could grasp the meaning. My children adored Dr. Breder. The twinkle in his eye and his unique sense of humor got to each of them. They took it for granted that he was a genius. My oldest child, Hera, is still inspired by her early associations at the Lab. "How many seven year olds got to work as an assistant to Dr. Breder?" she recently asked. With her keen eyes she collected tiny 'blackfish' from floating Sargassum weed that came to shore near our house at Point of Rocks on Siesta Key where we had moved to be near the new location of the Lab and my husband's work at Sarasota Memorial Hospital. Dr. Breder published his innovative studies on the paradoxical camouflage of fish that could turn black over white sand and could change their behavior to look like a piece of drifting flotsam. He acknowledged Hera's help in this scientific publication. Today Hera is a graduate student at Texas A&M University studying fishes for her Ph.D. The Lab was not only a place to do scientific research but was often visited by budding biologists, a place where visiting scientists could bring their children while they worked at the Lab, and where we could have programs that included children, which I am happy continues to this day.

During his lifetime, Dr. Breder's accomplishments have never been equaled by any other experimental or behavioral ichthyologist. In 160 papers and books, covering thousands of pages he recorded an unparalleled array of field and laboratory investigations, systematic and distributional studies. He was born Charles Marcus Breder, Jr., in Jersey City, New Jersey, on 25 June 1897 and was raised in nearby Newark. His earliest publication, written at 18, concerned photography of local birds with the aid of a long distance electromagnetic shutter-tripper he developed from a seven-dollar plate camera he owned. By age 21, he had published 15 popular articles and notes and had started his remarkable theoretical and experimental studies on fish locomotion. His first job at 22 was with the U.S. Bureau of Fisheries in Washington, DC where he was hired as a scientific assistant. With only a high school education, he claimed that all he learned about biology and ichthyology was from the Newark Public Library. He joined the New York Aquarium in 1921 holding many positions which led to his appointment as its Curator in 1937. He was awarded an honorary doctorate degree by the University of Newark, which was later incorporated into Rutgers University.

Dr. Breder became a visiting professor to the Graduate School of Arts and Sciences at the New York University in 1941 and continued to teach until 1950. He taught a graduate course in ichthyology, which is where I first met him in 1943. He saw nothing wrong about a young woman wanting to spend her life studying fishes. I dedicated my second book, The Lady and the Sharks, to him, In the prefaces to the second and third editions of this book and in several chapters (published by Mote Marine Laboratory) I express in detail what it meant to me and my children to know this brilliant ichthyologist, whose life was devoted to studying the behavior, morphology and ecology of fishes. In 1944, he became curator and chairman of the development of ichthyology at the American Museum of Natural History in New York. He had two desks in his

big office next to his lab. He laughingly told us he wore two hats and tried to change them once a day to switch his thinking from administration to ichthyology.

Dr. Breder also served as the administrative director for the Lerner Marine Laboratory on North Bimini island in the Bahamas from 1947 to 1957 where Perry Gilbert did his first experimental field studies on shark behavior. Many other biologists including Drs. Bill and Margaret Tavolga, Dr. Phyllis Cahn and I did many studies on fish behavior at this Lerner Lab. After 1957, most of his work was done on the west coast of Florida. He served as an advisor to the Board of the Cape Haze Marine Laboratory and later as a senior research associate at the Mote Marine Laboratory.

Dr. Breder married Ruth B. Demarest November 18, 1918, by whom he had two sons, Charles Marcus Breder III and Richard Frederick Breder. On April 17, 1933, he married Ethel Lear Snyder, and when Ethel died of cancer, we were concerned about his lonely life. But a few years later at a meeting of the American Society of Ichtlyologists and Herpetologists in Miami he renewed his friendship with his ex-student, lab assistant and colleague at the American Museum of Natural History, Priscilla Rasquin and they were married January 3, 1967. Priscilla painted the herons, raccoons and habitat around their bay house in their idyllic setting among mangroves and palmetto trees. Every time I visited him, we walked out onto his pier and looked out over the side at schooling mullets or other fish phenomena that occupied Dr. Breder's thoughts. Dr. Breder avoided publicity all his life and never wanted to cooperate with newspaper articles and radio or TV interviews. In his mellow 80's however, I coaxed him to participate in a Japanese TV program which I told him could be to my advantage. It was filmed mainly on his pier unobtrusively as the cameraman zoomed in on his face. The Japanese told me that his blue eyes stole the show as he naturally talked about fishes with profound insight and a wonderful sense of humor.

Priscilla took care of Dr. Breder for the rest of his life and became a firm supporter of Mote Marine Laboratory. In 1991 she probably joined him and his followers in some spot in heaven where fish talk and theories about animal behavior could be discussed endlessly with this Socrates of fish philosophy. And where I hope someday to join them.

The Autumn Years by Dr. Perry W. Gilbert

When Genie Clark left the Cape Haze Marine Laboratory she had founded and so ably directed, she asked a talented and energetic phycologist, Dr. Sylvia Earle, to serve as interim director for 1966. Sylvia accepted the appointment for one year and continued her fine work with algae at the Cape Haze Marine Laboratory. The splendid collections she developed, housed in two large cabinets, are in constant use today. She trained Susi Dudley, with the help of Sylvia's mentor, Dr. Harold Humm, to carry on with the collections and add to the fine algae herbarium.

For the first six months of 1967 the highly acclaimed retired ichthyologist, Dr. Breder, agreed to direct the activities of the Cape Haze Marine Laboratory until I came aboard on July 1, 1967.

I first met Dr. Breder in 1956 at the American Museum of Natural History in New York and discussed with him the possibility of working at the Lerner Marine Laboratory on Bimini, Bahamas. Dr. Breder had built the small laboratory in 1948, where he made several important scientific observations on fishes living in those crystal clear waters, and had published several significant papers on his work. He was obviously the man to talk to about my proposed research, and I was delighted when he assured me that I would be a welcome investigator at the Lerner Marine Laboratory.

On my way to Bimini in 1957, I stopped off at the Cape Haze Marine Laboratory to discuss my programs of research with sharks with Genie Clark and Dr. Breder who was spending the summer at the Cape Haze Marine Laboratory. Genie arranged for us to stay in one of the Vanderbilt mansions adjacent to the Cape Haze Marine Laboratory, and I shall always remember that pleasant evening spent with the Breders in those palatial surroundings, sipping gin and tonics, discussing fish and fishing far into the night.

It was kind, indeed, of Dr. Breder to agree to serve as interim director of Cape Haze Marine Laboratory for the first six months of 1967, for he disliked administrative chores wholeheartedly. All went well, however, and on July 1, 1967, I became the Cape Haze Marine Laboratory's executive director. Within a year the Cape Haze Marine Laboratory was renamed the Mote Marine Laboratory in honor of its principal benefactor, William R. Mote. For the next eleven years Mr. Mote and I worked closely together, sharing in all important decision making, and making sure all five major programs of research prospered as the laboratory attained both national and international recognition.

Freed from administration duties, Dr. Breder's programs dealing with fish schooling and the coloration of teleost also flourished with the able assistance of his understudy, Patricia Bird. This latter study resulted in Dr. Breder's classic monograph "On the relationship of teleost scales to pigment patterns". This monograph initiated the first of a series we published entitled "Contributions from the Mote Marine Laboratory".

Our weekly luncheons at the Mote Marine Laboratory with Dr. Breder and his wife Priscilla, were high points in the daily routine for all of us who crowded around the small kitchen and listened to his reminiscences. Dr. Breder was always the consummate dignified gentlemen with an inexhaustible supply of information on fishes and early ichthyologists who studied them.

As Mote Marine Laboratory grew, visiting investigators from Cornell and other universities came to work, at their own expense, for varying periods of time and they too enjoyed the company of a great ichthyologist. In short, Dr. Breder became not only a source of encyclopedic information, but also a great inspiration to our entire staff and our visiting investigators.

My discussions with Dr. Breder were most helpful in managing not only the problems of running the laboratory, most of which were handled tactfully and efficiently by my after ego, Patricia Morissey, but also the larger issues of maintaining a balance between basic and applied research. Both of us agreed that the programs that would generate lasting recognition for our laboratory were in the area of basic research for which support at that time was forthcoming from both the National Science Foundation and the Office of Naval Research. But this support was hardly enough to meet the increasing expenses of our growing laboratory. We were fortunate, therefore, to obtain financial assistance from a number of generous Mote Marine Laboratory members as well as from several private foundations. We also received support from several commercial companies geared to the application of some of the basic research programs we sponsored.

In later years, my conversations with Dr. Breder touched on the philosophy of science and the high priority each of us placed on scientific integrity. He was an admitted agnostic, but I always believed, to paraphrase a statement Emma Darwin made about her Charles, "Charles Breder did not believe in God, but God believed in Charles M. Breder, Jr."

The candle of Dr. Breder's life burned low in his final years while Priscilla tenderly cared for him, and on a quiet day in late October 1983, it flickered and went out. For those who knew him, his life will continue to be an inspiration and his immortality is assured in his achievements and distinguished record of more than 160 publications.

Obituary by Dr. James W. Atz

[Reprint of Atz (1986) with permission of Copeia and Dr. Atz.]

The accomplishments of Charles M. Breder, Jr. (1897 - 1983), as recorded in the scientific literature, have never been equaled by any other experimental or behavioral ichthyologist. In 160 papers, occupying more than 2275 journal pages, he recorded an unparalleled array of field and laboratory investigations. To these must be added 609 more pages, as well as a 369 page book, devoted to 39 systematic and distributional studies. A 956 page monograph review and some 300 pages of popular pieces, most of which contain original data of scientific merit, complete his prodigious professional output.

All this was made possible by the happy concatenation of an extraordinary mind, which almost never failed to couple each keen observation with at least one original interpretation, a resolute desire to make all of these ideas known to the scientific community, and an almost totally unimpeded access to the publications of three organizations devoted to the furtherance of zoology. These were Zoologica (Scientific Contributions of the New York Zoological Society), Novitates, the Bulletin of the American Museum of Natural History and Copeia. With today's inexorable trends toward higher and higher publication costs and more and more intense competition for publication space, it is extremely unlikely that such productivity ever again could find a way of getting itself publicly expressed.

He was born in Jersey City, New Jersey, on 25 June 1897 and he grew up in nearby Newark. Until the time he retired, he was domiciled in urban or suburban neighborhoods in or around New York's metropolitan area, but his desire to get out into the field was strong, and he managed to do so on many occasions despite the administrative duties for which he was responsible almost all of his career. Before finishing high school, Breder had established a pattern of investigative activity to which he would adhere the rest of his life: the observation of animals and plants, either in nature or a laboratory setting, followed by a published description of what he had observed and what were his thoughts on the subject. He frequently made use of apparatus that he had constructed himself, and his articles were often illustrated by his own drawings and photographs. His earliest publication, which was written when he was 18, concerned the photography of local birds with the aid of a long-distance, electromagnetic shutter-tripper he had built for his seven-dollar, second-hand, 4 x 5 Eastman plate camera. By the time he was 21, he had published 15 popular articles and notes, more than half of them on home aquaria.

Breder was truly a self-made biologist. He once was reported to have said that everything he knew about biology and ichthyology, at the time he got his first job, he had learned at the Newark Public Library. In fact, Breder was a 22 year old youth with a high school education when he was hired as scientific assistant by the U.S. Bureau of Fisheries. His doctorate was an honorary one that was awarded to him in 1938 by the University of Newark (now the Newark campus of Rutgers University).

Although his short period of employment with the Bureau of Fisheries was professionally successful (17 scientific publications resulted from it), he wished to be more free to pursue his own interests and was pleased, in 1921, to accept the position of Aquarist at the New York Aquarium) (a branch of the New York Zoological Society) with its large collection of fishes and ambitious plans for a new laboratory. Things did not turn out as expected, however; Charles Haskins Townsend, the Aquarium's Director, had a sharply ambivalent view of scientific research, in a public aquarium, and for the next 16 years, he and Breder skirmished intermittently over the number and kind of investigations Breder wanted to carry out. Judged by his productivity, Breder must have won more contests than he lost, even though the chronic stress took its toll. Not only did he take advantage of the many opportunities to make

worthwhile observations that were presented by the institution's diverse fish population, he also conducted successful experiments, despite its limited facilities. More over, he arranged to spend significant periods of time in the field: 1924, three months on the Rio Chucunaque in eastern Panama; 1929, two months on the Dry Tortugas; 1930, 1932, and 1933, two months in the Bahamas, especially Andros; 1934, one and one-half months aboard the Atlantis in the Sargasso Sea and Caribbean; 1938-42, several months on the Florida coast; 1940, one month in San Luis Potosi, Mexico; and 1942, one month in the Gulf of Guayaquil. A particularly noteworthy accomplishment of Breder's research program was the development of a simple method of controlling the progressive acidification of seawater that occurs in all closed circulation of aquariums without ready access to the unpolluted ocean; recent studies have shown this procedure, the periodic addition of sodium bicarbonate, to be the only practical way of keeping recirculated seawater alkaline enough for delicate captive marine animals. When Townsend retired on 1 Nov. 1937, Breder was appointed Acting Director and 27 months later, Director.

Early in his career, Breder did his share of professional chores, such as participating in the affairs of scientific societies, but as time went on, he became less willing to do so. Although not indifferent to peer-recognition, he wanted no part of any of the public activities that so often came with it. In 1925 the New York Academy of Sciences awarded him the A. Cressy Morrison Prize for his pioneering and penetrating analysis of fish locomotion, and during 1939-45 he served as Secretary and as President of the Academy's Section of Biology and as a member of its council. When, however, it became apparent that he was on the way to becoming the President of that prestigious organization, Breder resigned from it. Conversely, he served as President of A.S.I.H. in 1932, but thereafter attended less than half a dozen of its annual meetings. In 1941 he reluctantly became an adjunct professor in the Graduate School of Arts and Science of New York University; through the years he taught a successful course in ichthyology and sponsored a small number of doctoral candidates. To those who were fortunate enough to maintain good relations with him, he was a never-ending source of ideas and inspiration.

In the autumn of 1941, the building that housed the New York Aquarium was closed, ostensibly to make way for the new Brooklyn Battery vehicular tunnel, and Breder was invited to carry on his scientific investigations in the Department of Animal Behavior of the American Museum of Natural History, while the Aquarium itself moved into the lion house of the Bronx Zoo. The Museum's Director, Albert E. Parr, who had briefly worked under Breder at the Aquarium when he first arrived in the United States, believed that the future of natural history museums lay more in their contribution to public education and scientific research than in their role as repositories of systematically maintained and studied collections, and he was attracted by Breder's wide-ranging ichthyological investigations. Parr offered an expectant Breder the chairmanship of the Department of Fishes, to begin in 1944, but when Breder, during a policy meeting, came to the defense of the beleaguered curators of aquatic invertebrates and their charges, he suddenly found himself responsible for a newly created Department of Fishes and Aquatic Biology that included, along with the fishes, all the extant invertebrates except the insects, spiders, and their terrestrial relatives. Not until 1960 was he relieved of this non-ichthyological responsibility, It was the Lerner Marine Laboratory, located on the island of North Bimini in the Bahamas, however, that made the most serious demands on Breder's time and energy. From 1947-57 he was its administrative director, planning its laboratories, establishing its standard operating procedures, and supervising a series of resident directors.

From 1957 to the end of his scientific career, Breder conducted his field work almost entirely on the west coast of Florida; it was based either at the laboratory he built next to his beach home in Englewood or at the Cape Haze Marine Laboratory (later to become the Mote Marine Laboratory) in Placida and Sarasota. After he retired in 1965, Breder continued to pursue his investigations until the disabilities of old age made research no longer possible.

A couple of comments on Breder's name are in order. Every so often, it has been misspelled Breeder. This situation was brought about by the way he pronounced his surname: "breeder," not "brayder" as the original German would require. Perhaps the ultimate error of this kind was perpetrated by the ichthyologist who honored him with a new halfbeak species, *Ichthyacus breederi*. Secondly, although his father died when Breder was in his forties, he continued to use the "Jr." for the rest of his life-on all of his publications as well as on many other occasions.

Breder is probably best known for his work on the reproductive, schooling, and other social behaviors of fishes, as well as the evolution and behavior of blind cave characins from Mexico. The investigations that gave him the greatest satisfaction, however, were the off-beat ones unexpected productions of an ichthyologist that involved unusual observations and techniques and led to original, speculative conclusions. Such subjects were the various hypotheses on the origin of life, the possible significance of tissue culture and explanation in nature, the role of cancerous growths in evolution, and the geometry of biological symmetry and its relation to scale and pigment patterns of fishes. Breder's scientific interests were both eclectic and catholic. He did, however, harbor a dim view of taxonomy, with which he appeared to equate systematics. This he tended to regard as a necessary evil, a point of view common among experimentalists and ecologists of his generation. Nevertheless, he himself described at least five new genera and 23 new species. Although he often discussed the phylogenetic distribution of the piscine characteristics he studied, he seriously worked on but one phylogenetic tree, that of the synentognaths.

Scientific research was C. M. Breder's principal aim throughout his adult life. He seemed to treat everything else as an unwelcome diversion. Administrative and public duties, as well as personal responsibilities, were not to be shirked, but unless they furthered some scientific investigations, they seldom were embraced with any enthusiasm. Although he was an intensely private person, Breder never hid his dedication to a scientific way of life, a life governed, as much as possible, by the intellect. The great body of his published research stands as the most important consequence of that answering dedication.

DRY TORTUGAS

The Dry Tortugas are located approximately 70 nautical miles west of Key West (Figure 1). The islands were discovered by Ponce de Leon in 1513. Early Spanish explorers found a large turtle ("tortugas") population but no water, thus the name Dry Tortugas. The seven largest islands are Loggerhead, Garden, Bush, Long, Hospital, Middle and East Keys. These islands are very small and can change in contour or completely disappear as the result of the passage of hurricanes. A series of shoals and reefs surround the keys. Most of the bottom surrounding the keys and shoals is covered with seagrasses and hard bottom communities. Fort Jefferson, America's largest coastal nineteenth century masonry fort, occupies most of Garden Key.

CARNEGIE LABORATORY

The Department of Commerce and Labor and the U. S. Light House Board granted the Carnegie Institution a license for a suitable site for the laboratory on Loggerhead Key, Dry Tortugas, in 1904 (Mayer, 1905) (Figure 2). Construction of portable buildings designed to be cool, well lighted, and "capable of affording to a limited number of investigators unrivaled facilities for the study of the marine life of the tropical Atlantic" began the same year on Loggerhead Key. The laboratory complex consisted of a main laboratory, one small detached laboratory, a kitchen, a windmill for pumping salt water and air, a dock, a shipways, two small outhouses, and a cistern for rain-water (Figures 3 - 5). Tropical palms were planted upon the cleared

Figure 1. Aerial photograph of Dry Tortugas. (Ft. Jefferson is the hexagon that occupies most of Garden Key. Middle and East Key are not shown.) [Aerial photograph 5WGK2337, 1991. Scale 1:48000, azimuth 203.5, 24.61083° N, 82.87583° W. (Coastal Aerial Photography, NOAA/National Ocean Service, <http://mapfinder.nos.noaa.gov/>, <http://mfproducts.nos.noaa.gov/images/photos/5wgk2337.gif>.]

Figure 2. Dry Tortugas Lighthouse, Loggerhead Key, Dry Tortugas (19--). [Fort Jefferson on Garden Key may be in the distance.] [Photonegative, black and white (4 x 5 in). N046233. DBCN: AAJ-1185. General Collection, Florida State Photo Archive. <http://fpc.dos.state.fl.us/>]

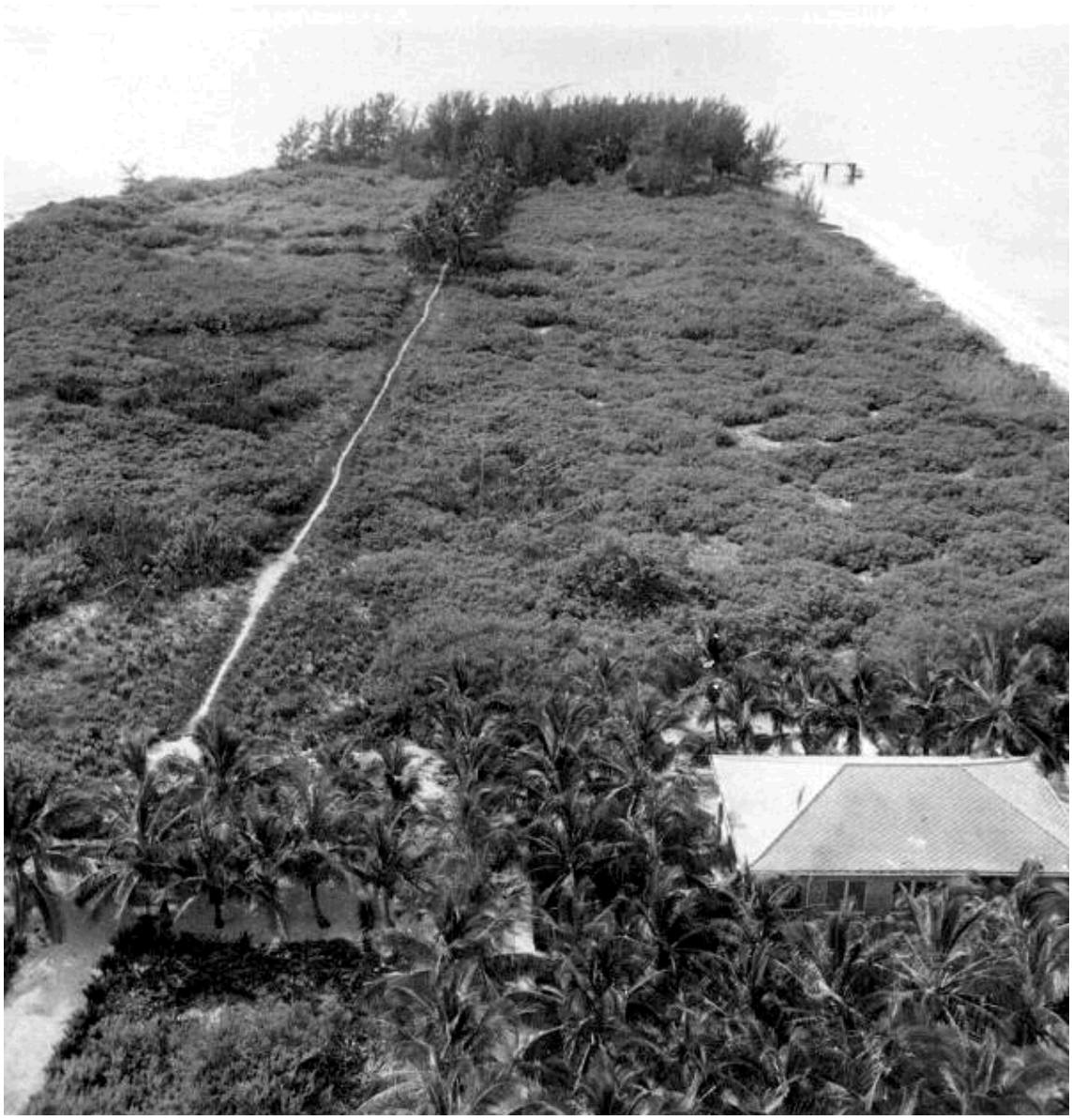

Figure 3. Carnegie Laboratory on Loggerhead Key, Dry Tortugas (1939). [Photograph taken from the lighthouse.] [Photonegative, black and white (4 x 5 in). Photographer: John Henry Davis (1901-1978?). GE1586. DBCN: AAG-6113. Florida Geological Survey Collection, Florida State Photo Archive. <http://fpc.dos.state.fl.us/>]

Figure 4. Carnegie Laboratory on Loggerhead Key, Dry Tortugas (1939). [Photograph taken from the lighthouse in opposite direction.] [Photonegative, black and white (4 x 5 in). Photographer: John Henry Davis (1901-1978?). GE1585. DBCN: AAG-6098. Florida Geological Survey Collection, Florida State Photo Archive. <http://fpc.dos.state.fl.us/>]

Figure 5. The Marine Biological Laboratory at Tortugas, Florida, July 28, 1904 (from Mayer, 1905).

Figure 6. The *Physalia* (from Mayer 1905).

ground, in order to shade the buildings, afford protection in the event of hurricanes, and beautify the site.

The laboratory was provided with the *Physalia*, a sea-going vessel of light draft, capable of making headway against the strong currents of the coral reefs and the Gulf Stream (Figure 6). The vessel was equipped with a full set of trawls, dredges, deep-sea and surface nets, chemicals, glassware, and apparatus for the study of marine life. The cabin was designed to provide ample room for such laboratory at sea. Further details about the vessel can be found in Mayer (1905).

Dr. William H. Longley, of Goucher College, served as executive officer of the Tortugas Laboratory during the summer of 1929 by invitation of the Trustees of the Carnegie Institution (Carnegie Institution of Washington, 1929). Mr. John W. Mills, chief engineer, remained in charge of all equipment. During the previous season the Laboratory's vessel, the *Anton Dohrn,* was equipped with new lifeboats, and tanks were erected at the Laboratory for the purpose of greatly increasing available supplies of both fresh and salt water. The following investigators studied at the Laboratory during the 1929 season.

L. R. Blinks (Rockefeller Institute)
Resistance of potential measurements across the protoplasm of *Valonia ventricosa.*

C. M. Breder Jr. (New York Aquarium and American Museum of Natural History)
Development and habits of flying fishes and their allies.

Martin Burkenroad (Tulane University)
Studies upon Plankton and the mechanism of sound-production in Haemulidae.

Paul S. Conger. Carnegie Institution.
Diatoms of Tortugas.

Caswell Grave. Washington University.
Stimuli inducing metamorphosis in Ascidian larvae: Plankton studies.

Dwight L. Hopkins (Duke University)
Locomotion in marine amoebae.

W. H. Longley (Goucher College)
Habits of fishes and feeding habits of noddy and sooty terns.

Oliver R. McCoy (Johns Hopkins University)
Experimental studies on trematode life histories.

H. M. Miller Jr. (Washington University)
Behavior of trematode larvae.

D. H. Terment (Bryn Mawr College)
Studies on Echinometra.

William Wartmann (University of Pennsylvania Medical School)
Studies on Echinometra.

Shigeo Yamanouchi (University of Tokyo)
Life histories and cytology of marine algae.

Figure 7. The *Anton Dohrn* at Tortugas, Florida, July 4, 1911 (from Mayer, 1912).

Figure 8. The *Anton Dohrn*, July 1911 (from Mayer, 1912).

Reports by these scientists can be found in Carnegie Institution of Washington (1929). The observations made by Breder were summarized in Year Book 28 of the Carnegie Institution (Breder, 1929).

The yacht *Anton Dohrn* was built in Miami in 1911 and was named after the director of the Stazione Zoologica of Naples, Italy (Mayer, 1912) (Figures 7 and 8). The Captain of the yacht was John Mills. Details of the yacht can be found in Mayer (1912).

1929 DIARY AND TRANSCRIPTION

The handwritten diary of Dr. Charles Breder's visit to the Carnegie Institution's Laboratory in the Dry Tortugas in 1929 was bequeathed to the Mote Marine Laboratory by Dr. Breder's family. The diary was written in a bound black and brown notebook in ink (Figures 9 and 10). Illustrations were done in pencil. Some of the illustrations were colored using colored pencils. Several photographs were found loose within the diary. No information related to the photographs was found. Some of the photographs were reproduced in Breder (1929).

The diary was transcribed by hand. Minor editorial changes, such as closing parenthesis were made. Indecipherable entries were noted with "[?]". Editorial comments such as current names of species were noted in brackets and/or capital letters. Numbers outside the margin of the transcribed text are the page numbers of the original notebook. The photographs found loose inside the diary were scanned and numbered arbitrarily (Appendix I). Whenever possible, the subject of the photograph based on Breder (1929) was included in the caption. Additional photographs from the Breder material provided by the Mote Marine Laboratory were included in the Appendix.

ACKNOWLEDGMENTS

The editors wish to thank the Breder Family; Susan Stover of the Mote Marine Laboratory Library; M. J. Bello, S. Baker and L. Pikula of the National Oceanic and Atmospheric Administration; and the staff of the Mote Marine Laboratory for their assistance. We also thank Copeia and Dr. James W. Atz of the American Museum of Natural History for permission to reprint Dr. Breder's obituary. The transcription is part of the Coastal and Estuarine Data/Document Archeology and Rescue (CEDAR) Project funded by NOAA/COP for the South Florida Ecosystem Restoration, Prediction and Modeling Program and the South Florida Living Measurements Resource Program.

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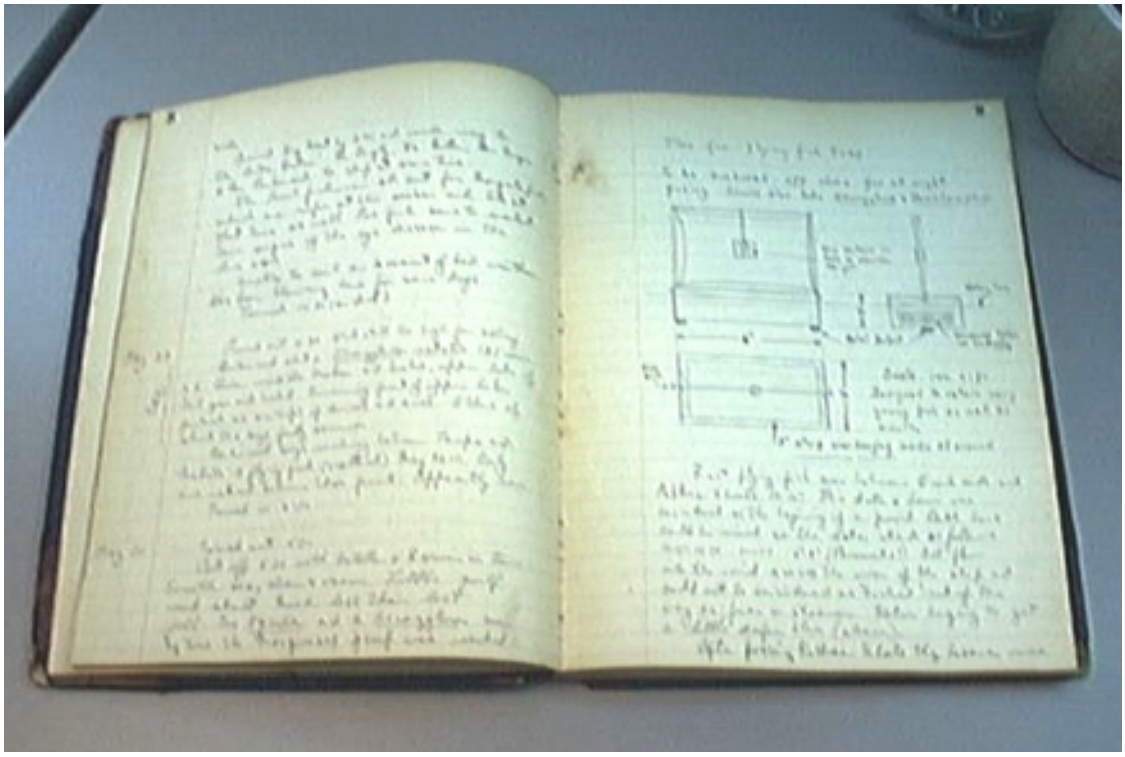


Figure 9. Charles Breder 1929 Dry Tortugas diary opened to pages 8-9.

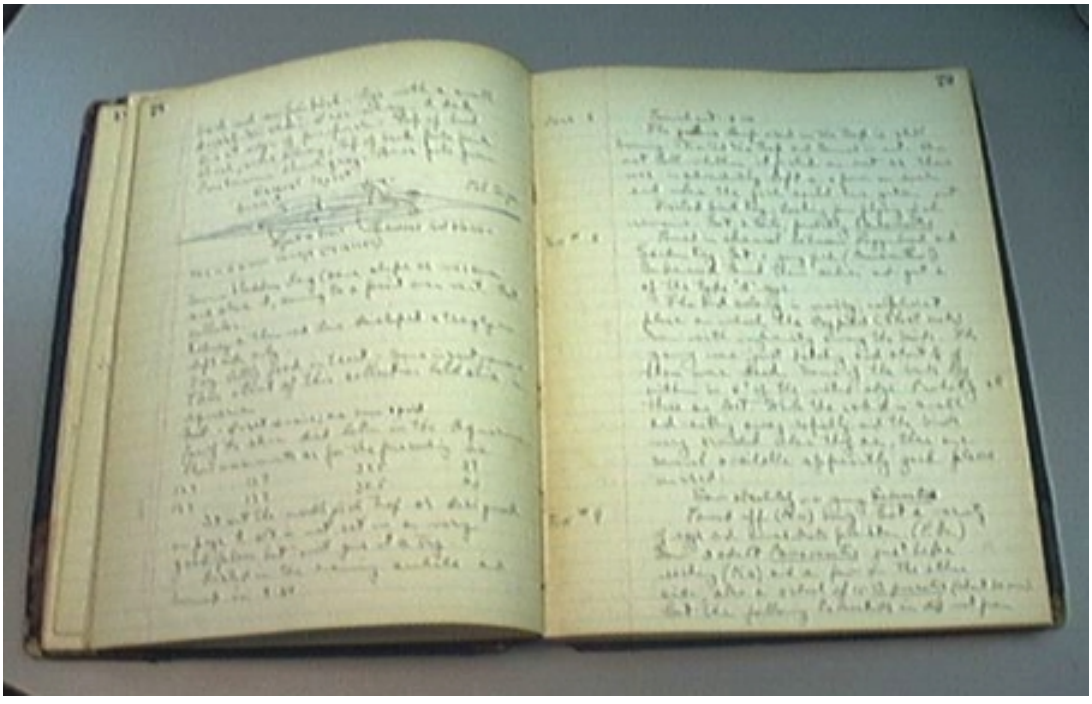


Figure 10. Charles Breder 1929 Dry Tortugas diary opened to pages 28-29.

Trip to Dry Tortugas, Florida
1929
Carnegie Institution

May 25 S.S. Algonquin cast off 12:00 noon (day light saving time). Passed Scotland 1
Lightship 1:30 P. M. (cast over log). Light southerly breeze, warm. Sea smooth, no ground swell. Changed to standard time 3:00 P. M. All time following are Eastern Standard Time.

A whale (finback-?) off the starboard bow 3:55 P. M. log read 55 knots from Scotland Light, just out of site of the N. J. shore. This whale showed itself but little but rose to blow (barely) about every 30 seconds.

Breeze stiffening and getting chilly.

For distribution calculations.

S.S. Algonquin: Length 402', Beam 54'. Draft 20', speed (average) 16 knots.

A.cabbage butterfly (white) sighted 5:20 P. M. 77 knots from Scotland Light.

Turned in 10:00 P. M.

May 26 Turned out 5:00 A. M.

Statistical observation (1) at 5:35 (median).

Calculated population less than 1.

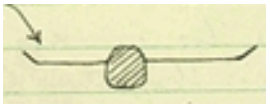
Gulls which were seen all day yesterday not with us this morning.

Statistical observation (2) at 8:45 (median).

Toward the end of the second period we cut abruptly into the Gulf Stream. The sequence of events follows.

Tursiops truncatus	4	8:47	2
	12 +	8:50	
Parexocoetus mesogaster	1	8:57	
	2	8:57+	
	3	8:59	
Sargasso(small torn bunches)		8:59+	
Blue water		9:00 sharp	

Statistical observation (3) at 9:27 (median). Passed Diamond Shoal Light Ship during it (9:17). On entering second half of period Sargasso became very irregular, the water was sometimes green and sometimes blue and often intermediate. Apparently the first was a small "arm" of the stream and considerable mixing is in progress making a very ragged edge. This may well account for the low count of the second period as the wind was nearly dead ahead. During this period was also seen as a large *Pterophryne* (?) clinging to a piece of gulf weed smaller than itself and a very small pale *Physalia*. Passed inside of Light Ship RELIEF.



One of the *Parexocoetus* gave the distinct appearance of having the wing tips flexed upward. Can this be done or was it an abnormal specimen in which the deformity did not interfere with flight? The flight looked normal and proper.

3 Distribution of Exocoetidae. S.S. Algonquin

[NOTE: Table was reproduced in two parts for clarity.]

Observation	Date	Hour (middle of)	Latitude (north)	Longitude (west)	Wind Velocity	Wind Direction Port	Wind Direction Star.	Barometer
1	May 26	5:35 AM	75:03	36:06	0	-	-	30.14
2	"	8:45 AM	75:18	35:09	0	-	-	30.18
3	"	9:27 AM	75:19	35:05	2	WNW	-	34.24
4	"	11:06 AM	75:21	34:41	2	-	-	30.25
5	"	1:23 PM	75:26	34:07	1	NW	-	30.24
6	"	2:55 PM	75:29	33:42	1	-	-	30.24
7	"	4:42 PM	75:36	33:16	1	-	-	30.22
8	"	5:55 PM	75:44	33:38	1	SW	-	30.24
9	May 27	6:05 AM	77:35	30:31	2	ESE	-	30.26
10	"	8:32 AM	77:56	29:55	3	-	-	30.28
11	"	10:31 AM	78:13	29:27	3	-	-	30.30
12	"	11:54 AM	78:25	29:06	3	-	-	30.28
13	"	1:31 PM	78:37	28:43	4	-	-	30.26
14	"	3:23 PM	78:52	28:17	4	-	-	30.22
15	"	4:40 PM	79:03	27:59	4	-	-	30.20
16	"	5:40 PM	79:12	27:44	4	-	-	30.20

Temp. Air	Temp. Water	Ship's Course	Ship's speed (knots)	No. of fish counted Port	No. of fish counted Star.	Estimated lengths of fishes (inches) Port	Estimated lengths of fishes (inches) Star.	Calculated population
63	63	SxW$\frac{3}{4}$W	16.0	-	-	-	-	<1
70	66	S$\frac{3}{4}$W	15.0	-	5	-	6-8	52.6+
74	-	SxW$\frac{1}{4}$W	16.0	20	2	6-8	6-8	217.15
77	80	SxW$\frac{1}{4}$W	16.0	-	8	6-	6-8	78.96+
80	80	SxW$\frac{1}{2}$W	15.0	2	7	4-8	4-8	94.7+
80	80	SxW$\frac{1}{2}$W	15.0	3	3	4-8	4-8	63.1+
80	80	SxW$\frac{1}{2}$W	15.5	1	6	8	3-8	71.5-
78	80	SWxS	16.0	38	43	1-8	1-8	799.5+
75	79	SWxS	16.0	33	1	1-8	7	346.4+
78	78	SWxS$\frac{1}{2}$S	16.0	8	12	2-8	2-8	197.4+
76	78	SWxS$\frac{1}{2}$S	16.0	8	4	2-8	2-7	118.4+
78	78	SWxS$\frac{1}{2}$S	15.5	25	8	1-7	1-8	335.1+
79	80	SWxS$\frac{1}{2}$S	16.0	22	3	2-8	2-8	246.8-
79	82	SWxS$\frac{1}{2}$S	16.0	8	2	4-8	6	98.7-
79	82	SWxS$\frac{1}{2}$S	16.0	36	16	2-8	$\frac{1}{2}$-6	513.3-
79	82	SWxS$\frac{1}{2}$S	16.0	9	-	4-8	-	88.8+

Factors for division on this ship $[(D + \frac{B}{2}) \cdot T \cdot K]$

K = 15 knots -577.5
15.5 -596.75
16 -616

Statistical observation (4) at 11:06 (median). 4

At beginning of this observation the gulf weed was scattering and the water not very blue. Toward the end of it there was more weed and a good deep blue. With this the Exocoetids began to show up.

Two *Tursiops truncatus* see[n] off the port side 11:30 A. M.

Statistical observation (5) at 1:23 (median).

Statistical observation (6) at 2:55 (median).

In observation 2 specimens may have been *Hirundichthys rufipinnis*. All others *Parexocoetus*. Water blue, weed scattered.

One specimen was observed to hit the forepart of its flattened belly near the crest of a wave ricocheting upward like a stone being "skipped".

Statistical observation (7) at 4:42 (median) with water blue and weed sparse.

Statistical observation (8) at 5:55 (median) with blue water and an abundance of weed. Very small specimens (up to 2") became common. Do they seek shelter of weed up to this size? These appeared to be mostly *Parexocoetus* but they varied in color but were too small to really see well. A small *Physalia* tangled in weed. A *Strongylura* sp. of about 10" in length swan energetically away from the boat's wash. Another long slim fish made a short leap skipping a couple of times on its side. It may have been *Ablennes* or *Euleptorhamphus*?. The color was very dark, nearly black. One of the small (2") flying fish landed in a thick mat of sargasso but near the edge. It made considerable fuss before it got clear of the weed. May it be that all these small fish are of the last spawning (last year?) and this general area represents a breeding ground or have they all drifted here together. The latter seems more likely for the eggs and very young would certainly drift with the weed. They may at this size be just beginning to work their way back? 5

Moon came up at 10:00. Turned in at 10:30.

May 27 Turned out 5:30. Ships data for yesterday as follows. May 26: 24 48/60 hours. 389 miles. Lat. 34° 28' N. Long. 75° 25' W. Bar. 30.25. Air temp. 77°. Miles from NY. 389. Miles from Miami 611. Commander J. W. McKenzie, Chief Engineer C. P. Kennedy, Chief Officer J. A. Ohlund.

Statistical observation (9) at 6:05 A. M.

Stiffer breeze and a greater difference from side to side apparent.

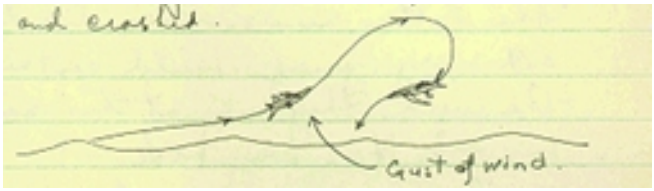
Statistical observation (10) at 8:32 A. M.

Few petrels or other birds about.

Statistical observation (11) at 10:31 A. M.

The gulf weed is all arranged in long [lines] parallel to each other and the direction of the wind. They remained this way through the (12) at 11:54 and part of the (13) at 1:31. Then the lines broke up and some of the largest clumps of gulf 6

weed I ever saw appeared (half an acre in extent). The first 2" fish of the port watch of period 13 was caught by a gust of wind and overturned so that it landed on its back white belly up. It looked like a plane that failed to complete an inverted loop and crashed.



Statistical observation (14) at 3:23 P. M. (median).

By this time practically all the gulf weed had disappeared. Never saw so little before.

Statistical observation (15) at 4:40 P. M. (median).

Weed again in lines parallel to wind but irregular.

Statistical observation (16) at 5:40 P. M. (median).

None seen on starboard (west) side.

Some very tiny fish were seen on that side during (15). They were $^{1}/_{2}$" and less, just large enough to be recognized as flying fishes.

May it be that Exocoetids require warm clean water but congregate about the
7 edge of the Gulf Stream to pick up food animals from the Labrador Current which is richer in life on account of the shore contact and higher protein content (more plankton)? These should be weakened by contact with the warm Gulf water and unable to stem a flow could not pick the places they want as could a flying fish.

Noon position May 27. 24 $^{12}/_{60}$ hours - 368 miles. 29° 05' N. 78° 26' W. 243 miles to Miami. 757 miles from NY. Bar 30.28. Air 78°.

Turned in 11:00.

May 28 Turned out at 5:30 just turning into Miami Harbor. Some gulf weed is about but the water is green and rather turbid with shore effluvium. No fish seen of any kind. Docked 7:30.

After shifting baggage visited the.Miami Aquarium built in an old hulk. Discussed plans with Mr. Ferguson about getting material to the .NY Aquarium. There was nothing of an unusual nature in the collection but the place was odd and picturesque.

Got the 10:45 F. E. C. train for Key West.

Spent most of the time talking with a Mr. Perky of Perky, Fla., a holder of much Key property. Saw 2 White heron and little else of interest except the landscape. Saw a *Strongylura* in a ditch by the rail road side.

8 Arrived at Key West by 3:45 and made way to the "Anton Dohrn". Dr. Longley, Dr. Miller, Mr. Conger,and Mr. Burkenroad to ship at the same time.

The local fishermen all out for Margate fish which are ripe at this season and bite at that time as well. Roe fish come to market. Saw signs of the eye disease in the live cars [?].

Unable to sail on account of bad weather. Had been blowing here for some days.

Turned 10:30 (on deck).

May 29 Turned out 6:30. Wind still too high for sailing.

Burkenroad shot a *Strongylura notatus* 135 mm s. l. Lower mandible broken and healed, upper lobe of tail gone and healed. Remaining part of upper lobe pinkish as are tips of dorsal and anal. Others of about this size fairly common.

Burkenroad says midway between Tampa and Mobile 3 flying fish (scattered) May 9 and 10. Only ones noticed between these points. Apparently rare.

Turned in 8:30.

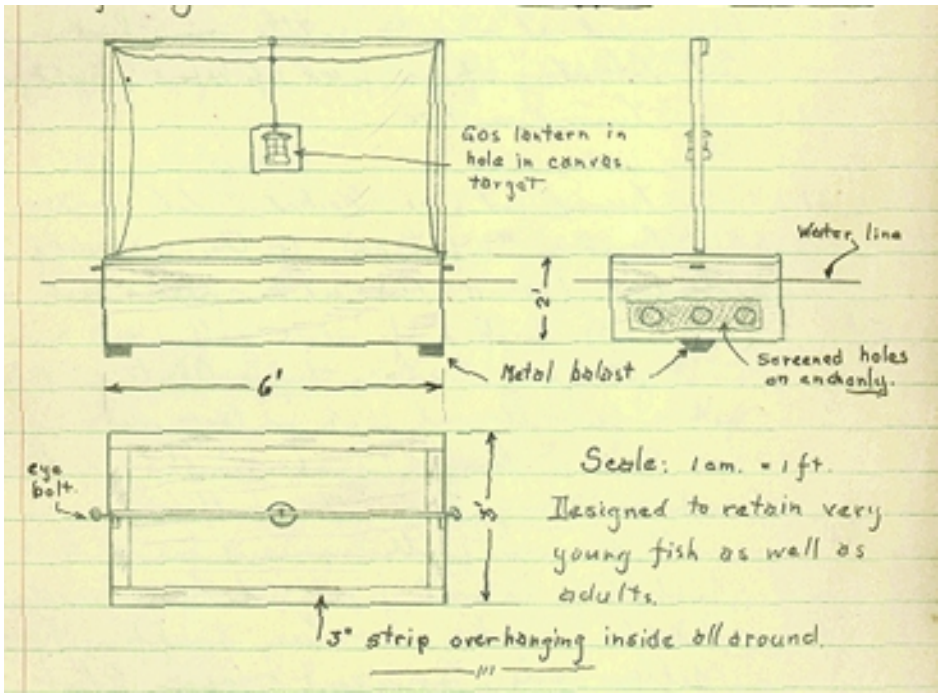
May 30 Turned out 5:30.

Cast off 6:20 with Velella and Darwin in tow. Smooth sea, clear and warm. Little gulf weed about. Much less than last fall. Two *Physalia* and 2 *Strongylura* seen by time the Marquesas group were reached.

9

Plan for Flying Fish Trap

To be anchored off shore for all night fishing. Should also take *Strongylura* and *Hemirhamphus*.



First flying fish seen between Quick Sands and Rebecca Shoals. 10:15. This date and hour was considered as the beginning of a period. Both hours could be viewed so the data stands as follows. 10:15 - 10:30 1-1-1 6" - 8" (*Parexocoetus*?) All flew into the wind across the nose of the ship and could not be considered as "kicked" out of the way as from a steamer. Water beginning to get a little deeper blue (cleaner).

After passing Rebecca Shoals they became more abundant. Some schools of 12 10
or more being seen. They continued up to the channel buoy apparently all *Parexocoetus* of from 5" - 8". Docked at Loggerhead Key 3:00 P. M. and proceeded at once to settle ourselves.

Got laboratory space fixed up before nightfall.

Turned in 9:00.

May 31 Turned out 6:00. Worked in lab to 7:00.

Tow #1 Towed a #1 foot net to the wreck off the lab dock (10 - 11 A. M.). Got 4 species fish eggs (A, B, C and D). Dipped up some gulf weed and in it got young *Monacanthus* and *Alutera*. Also got a few larval fish in tow net.

Saw a larger (10') *Carcharhinus* (?) a *Hemirhamphus* (?) and 2 *Strongylura*. The bottom here is well grown with various forms but the fish life is not particularly abundant. At the wreck saw gray snapper, porkfish, yellow tails, sergeant major, chub, jack and 2 barracuda (4').

After lunch worked on fish eggs from tow. Found another species of fish eggs (E). All of (C) hatched before I could photograph them but got drawings.

After dinner saw a 4' barracuda hanging about the dock. Photographed it. Collected some sargassum stuff at the dock in a seine. Got more *Monacanthus* and a *Syngnathus* (preserved with those taken in a drifting weed this A. M. Also took a Pterophryne. Kept alive (1"). Saw a number of Belonidae which I believe to be *Ablennus* but could not catch them (6 - 10").

11

Records. Temp. Sp. G. etc.

Date	Hour	Locality	Temp. Air	Temp. H_2O	Sp. G.	pH	Bar	Wind Vel	Wind Dir
May 31	6:45 A.	Laboratory	79	81	1.025	8.6+	36.2	light	SE
June 1	10:45 A.	"	84	81.5	1.025	-	35.8	fair	SE
June 2	6:30 P.	"	83	81.5	1.025	8.4+	35.6	strong	SW
June 3	-	-	-	-	-	-	-	fair	SW
June 4	10:00 A.	Laboratory	82	-	-	-	36.1	calm	-
June 5	12:00 A	"	86	84	-	-	36.2	dead calm	-
June 7	10:00 A	"	83	85.0	1.025	8.6+	36.2	light	SW
June 8	12:00	"	82	-	-	-	36.4	cloudy	squawls
								light	SW
June 14	-	-	-	-	-	-	-	strong	E
June 15	9:00 A.	Laboratory	84	83	-	8.4+	37.4	light	E

12 Tow #2 Made Tow #2 just at dusk, near to shore from the lab dock to the light house and back. Noticed myriads of small forms and fishes about our light.

Turned in 8:45.

June 1 Turned out 6:00. Worked on material collected yesterday. Made photomicrographs, etc. The eggs of Tow 1 were in the frequency C, A, B, D, E. Those of Tow 2 C, E, A, D, B. Spent afternoon of further work of same sort.

Some Belonidae at dock seem to surely be *Ablennes*. They are covered with a black leach-like parasite.

Collected some more young triggerfish, a young *Neomaenis*[*] *apodus* or *jocu* (2 cm) in gulf weed in the light of the dock [?]. Dipnet.

Tried out a night light at the end of the dock. It worked well except for the fact that the water was too rough for such work. Got the usual small stuff including some small *Apeneus maculatus* (?) in the silvery stage. Three Belonids, each of a different species.

Turned in 9:30.

[*] NOTE: Could be *Lutjanus apodus* (schoolmaster) (Longley and Hildebrand, 1941). *Neomaenis* and *Neomesoprion* are old names for *Lutjanus* snappers.

13

Pelagic fish egg characters - Dry Tortugas

	Color	Dia	Shell Char.	Decoration	Shape	Oil globules
A	Transparent *Sphyraena*	1.0 mm	Reticulated	Small spines	Spherical	None
B	Transparent	3.0 mm	Gelatinous capsule	None	Spherical	None
C	Transparent	1.9 mm	Smooth	None	Elliptical	One
D	Pale yellowish *Sparisoma*	1.2 mm	Smooth	None	Spherical	Cluster
E	Transparent	0.7 mm	Smooth	None	Spherical	One pale
F	Transparent	0.65 mm	Gelatinous cluster	None	Spherical	One deep yellow
G	Transparent	0.8 mm	Smooth	None	Spherical	None
H	Semi-transparent	1.6 mm	Smooth	None yolk with [?]	Spherical	One
I	Transparent *Cypselurus*	1.6 mm	Pimpled	None	Spherical	None
J	Transparent	2.2 mm	Smooth	None	Spherical	None
K	Transparent *Pterophryne*	1.3 mm	Smooth	None	Spherical	One pale yellow
L	Transparent	1.1 mm	Gelatinous cluster	None	Spherical	One deep yellow

June 2 Rained hard in night, wind still high and sea rough, breakers outside. Turned out 6:00. 14

An eel taken last night (*Myrophis*?) swam violently when placed in formalin and when somewhat weakened reversed itself and swam just as actively in reverse (about 2 minutes or more) until the death sphasms of knot tying ensued. (A complete reversal of the integrated reactions.) The Belonids appear to be as follows *S. ardeola*; *S. raphidoma* and *S. notatus*. Hereafter they will be referred to accordingly pending a latter check.

Went to Garden Key. Examined the moat about the fort for fishes. It is very barren of fish life only four species bring found. *Hepsetia* (100±), *Eucinostomus* 10, *Pomacentrus* 2, *Lutjanus griseus* (2 - 10" fish).

Spent the rest of the morning studying *Strongylura* from the end of a dock (at Garden Key). A school of about 100 stood over a group of broken piles. About 10 were *S. raphidoma* (8 - 10") and the remainder *ardeola* (12 - 16"). The former may be at once distinguished by the short beak and reddish dorsal of produced rays which lays over to one side. The latter when not over 12" are very slender as is their beak. Later this gives way to a short beak (relatively) up to 16" looking much like a *S. marinus* which indeed these larger fish may be. The appearance of a 20" *raphidoma* caused them all to leave, returning only after the larger fish had gone. *L. griseus* dashing about below them had no such effect.

Black parasites were seen only on *ardeola*. One *ardeola* had the last $^1/_5$ of the body, on one side only a vivid indigo blue. This is likely some pathological condition as seen in hatchery Salmonidae. A few were noticed with broken beaks. Several 15

times small sections of the schools would make excursions into adjoining school of *Hepsetia* for feeding. They feed essentially as described in 'Copeia'.

The vaulting of these fishes was experimented with. Small sticks from 4 to 12" long were thrown in (about $^1/_8$" square). *Ardeola* paid most attention to these and several looked them over and usually a few jumped over the stick and sometimes
16 several times, back and forth, until it drifted out of the school's area. Most often they would slide their bill up over the stick and then give a little leap scratching their bellies as they went or turning left or right to scratch their sides. The inference is obvious that they probably do this to remove parasites (possibly the large black ones) and take advantage of floating material (part of their environment [?]) as a bottom fish uses a rock. They performed in a similar manner with slender pieces of dried grass drifting by naturally. At times they would strike only the "chin" leaping clear the rest of the way giving much the appearance of a clean jump, at others they would latteral[ly] slide over for their entire length. A few counts were made in a statistical manner as follows.

Stick length	Fish size	No. of fish	No. of jumps
4"	12"±	2	1 each
12"	14"±	1	1 (tried 3 times before he made it)
8"	12"±	4	1 each
Piece of weed about 6" long	12"±	1	3 back and forth 

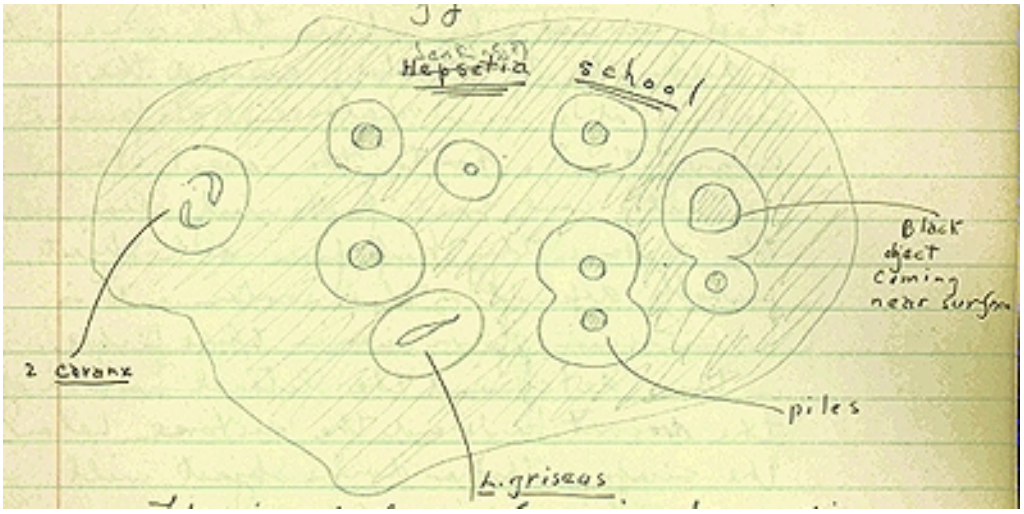
Tried some pieces of string but they refused to hurdle it. Several attempted it but when it gave way and began to sink under their beak gave up.

Raphidoma also did this trick but less frequently and apparently with much more physical effort.

Two nurse sharks (4'±) and a barracuda (5'±) were seen not far away feeding
17 on other fishes.

The eye Gudger mentions as being this shape  is the same  in all our species. The little tab seems to be a 'sunshade'.

Many *Jenkinsia* were seen in great schools of tens of thousands and more. These were mostly under a dock and arranged themselves accordingly - somewhat as below.



This is similar to Gudings observations about gray snappers but differs in that they leave such an open space about any dark object coming near or rising through the surface as shown above. This simple means that they behave as does any schooling fish according to .Parr's theory plus that they probably will not approach a dark object any further than they can see it distinctly. Parr's theory plus a 18
corollary of negative reaction to any other vision except one of their own kind would explain this phenomenon entirely. A gray snapper rising from a depth of greater than their distance (horizontally from a dark object) caused them to disperse and form another vacuity. The exactness of the distance from any dark object was remarkable as was the evenness of concentration of the school, varied only where the movements of dark objects (fishes) caused the seeking of a new balance (dispersion on congragation). Due to the recent storms the water was not particularly clear here. The distance they keep from dark objects probably depends on their color and is a measure of vision in these fishes. This in turn determines the lateral width of the vacant bands and the distance below the surface that a dark object will cause their dispersal.

Some of the other men collected some fishes for me from Bird Key reef. The usual run of reef stuff. Kept in aquaria.

Tow 3 Made a surface tow near the dock at Garden Key, got very little (only some "C" eggs and larvae and 1 egg "E").

Another made by Burkenroad off the point of .Loggerhead Key contained a few of the same and one "E".

Took some photos of *S. ardeola* leaping over sticks.

Worked on material in P. M. and set up some aquaria.

After dark worked with the submerged light on the far side of the Key. Got the usual assortment of plankton. 3 *Strongylura* came to the light but we could not capture them. A shark (*Carcharhinus*?) 5' swam by and some eel as well. Used the plankton to feed the fishes with.

Turned in 9:30. 19

June 3 Turned out at 6:30.

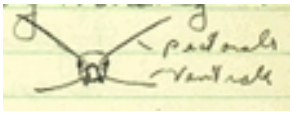
Tow 4 Visited .Bush Key. Did some towing Tow #4 between it and Garden Key. Could find no fish eggs or larvae. Does the recent bad weather account for this?

A seine brought in the usual stuff including one *S. raphidoma*. Preserved.

Spent the P. M. taking photographs, examining catch, etc.

A small "lake" in the middle of Bush Key held some *Eucinostomus* (?) of about 6". Nothing else.

Just before supper examined the fringing reef on the rear of the Key where we usually swim. The following species were seen. *L. griseus*, *L. synagris*, *Abudefduf saxatilis*, *Pomacentrus leucostictus* (?), *Pomocanthus paru*, *Diplodus holbrooki* (?), *Auchenopterus* nox (?), *Labrisomus nuchipinnis* (?), *Hepatus caeruleus* (with pale patch on caudal peduncle), *Hepatus* [?] (bright uniform golden the Golden Tang or a phase of the blue? Dr. Longley is also undecided). *Haemulon sciurus* (young), *Chaetodon ocellatus*, *Halichoeres bivittatus*, *Sparisoma flavescens* (?). Also several others. The *Auchenopterus* was encircled with vivid red and black, a striking fish as it moved over the coral rock.



Had light over lab dock. Caught a *Cypselurus furcatus* 27 mm s. l. It was weak when taken. In an aquarium it still displayed a positive phototaxis. The swimming movements were unexpected. The pectorals and ventrals were held out stiffly and locomotion was accomplished by rapidly vibrating the tail through a slight arc. It died before the evening was over. Other stuff taken was preserved. 20

Turned in 10:00.

June 4 Turned out 6:30.

Spent A. M. working on lab stuff.

Last night the colors of the *C. furcatus* were similar to those painted by Isabel Cooper but paler and less vivid.

After lunch went to Garden Key. Sea smooth. On the way there saw about 12 *Cypselurus furcatus* of the size taken last night. Took movies of both *Strongylura raphidoma* and *ardeola* vaulting over sticks. (Also a Barracuda cruising about Caught a *Seriola dorsalis* on a spinner. Its proportions follow in mm. s. l. mm 750, depth 225; head 240; eye 31; max. 87; pectoral fin 100. maxillary reaches first quarter of pupil; dorsal VI - I, $30^{1}/_{20}$. Anal III, $21^{1}/_{2}$. The stomach contained a single fish, not identifiable.

21 At least 8, 4-5 Tarpon were feeding about the Garden Key dock.

On the way back tried to catch some of the small *Cypselurus* with a dip net. No success as they rose too far away from the boat and were very active. One flew at least 6 feet and the flight is very insect like, not like the adults at all. Wing motion seems to be there.

Saw numerous smaller silvery fishes which did not fly but swam rapidly. Caught one (*Parexocoetus mesogaster*) about 15 mm. The wings are very stubby and apparently they are unable fo fly as yet. Also got a small *S. raphidoma* and 2 young *Alutera*.

Took the "Velella" out at dark with light for young Exocoetidae half way between.Loggerhead and.Garden Key. Saw a few *C. furcatus* but they would not come close enough to net. Also saw numerous *S.* sp. (large 18"+) and what were probably *Hemirhamphus*.

Got some plankton (preserved the fishes).

Turned in 10:30.

June 5 Turned out 6:30.

Tows #5, Went to East Key in the A. M.

22 5a, 6 Did some towing there but got no fish eggs. Later towed between Loggerhead and *Garden Key* with similar luck. Tows # 5 and 6. Nearly every piece of gulf weed harbored one or more small *Monacanthus*.

Saw several small *Cypselurus* and *Parexocoetus* but was unable to get any. They did not seem as numerous as yesterday P. M. Got a better view of a small *Cypselurus* and it appeared to soar, not fly. A tiny *Parexocoetus* of the size taken yesterday flew about 18" to escape my net. At that size they are probably just beginning to fly. Got a splendid view of a *Hemirhamphus* skittering and leaping (exactly as in my "Locomotion of Fishes".)

A large barracuda took one hook and was trailed close behind by an even larger Jewfish. The barracuda shook out the hook on being landed.

The *Strongylura raphidoma* taken yesterday which was then a nearly uniform tan the color of the gulf weed it was in has now the following colors in an aquarium.

Deep solid black below up to the mid-line, where there is a bright golden streak above which the back and upper parts are an olive tan. The mandibular flaps are black. These sometimes swing out when the fish swims forward and when the mouth is opened. They may have some control over these (?). Possibly they assist in holding food (?).

23 Rowed out to deep water and gulf weed after dark with night light. There found some annelid like a palola in swarms turned them over to P. Conger. These worms were about 3" long and came rapidly to the light discharging their products in clouds. They then got a 'kink' in the tail and broke it off the remaining part

swimming away in a much contorted form. Nothing else except plankton was seen here besides a squid of about 12".

A little further in, where bottom could be seen, the snapping of the reef was very loud. Doubtless this could be used as a guide as Mowbray claims for sailing vessels.

Still further in great schools of large needlefish were encountered 18" - 3'. One passed over the boat just ahead of where I sat. Another landed in my lap but was off again before I could gather my wits. Still another passed close in back of me. It is very easy to see how fishermen get hurt by these things at night. After awhile I began to duck involuntarily

At the middle station got some kind of an Atherinid with a black tipped tail. 24
Three, in all were, seen in fairly deep water.

Turned in 10:30.

June 6 Turned out 6:45. One of the men reported seeing 2 large schools of small flying fish and 2 large individuals where we looked for them yesterday.

Tow #7 Went out on the Velella past the (N.10) west buoy (about 7 miles) from the dock. Made some tows (#7). Got fish eggs and some very young flying fish. Saw numerous adults (*Parexocoetus*).

Took a well developed ♀ *Gymnosorda alleterata* with large roe. The measurements in mm follow. s. l. 480; depth 130; head 138; eye 18; maxillary 52; pectoral length 77; ventral length 50. Dorsal XIV-I, II-8; anal III, 10-7. Iris silvery, 4 dark round spots just in back of corslet between ventral and pectoral. Dorsal pattern fragmentary.

Visited Porites [?] bed in P. M. Saw absolutely no Exocoetids on way there or back. A little wind rippled the surface, which may account for it.

The eggs taken in the A. M. are as follows. Types A, B, D, E. "C" was absent. A new type which may be *Pterophryne* "7" was present.

25 Species of fish identified - Dry Tortugas

[MODERN COMMON NAMES LISTED IN LEFTMOST COLUMN. MODERN SCIENTIFIC NAMES IN BRACKETS.]

1	*Parexocoetus mesogaster*	Flyingfish
2	*Cypselurus furcatus*	Spotfin flyingfish
3	*Strongylura raphidoma*	Houndfish
4	*Strongylura ardeola*	Keetail needlefish
5	*Strongylura notatus [notata]*	Redfin needlefish
6	*Sphyraena barracuda*	Great barracuda
7	*Tarpon atlanticus*[*]	Tarpon
8	*Neomaenis griseus*	-
9	*Neomaenis synagris*	-
10	*Haemulon sciurus*	Bluestriped grunt
11	*Abudefduf saxatilis*	Sergeant major
12	*Angelighthys isabelita*[Δ]	Isabelita
13	*Pomocanthus arcuatus*	Gray angelfish
14	*Pomocanthus paru*	French angelfish
15	*Seriola dorsalis*	Yellowtail amberjack
16	*Hemirhampus brasiliensis* [*Hemirampus*]	Ballyhoo
17	*Lactophrys bicaudalis*	Spotted trunkfish
18	*Lactophrys tricornis*	Trunkfish
19	*Sphoeroides spengleri*	Bandtail puffer
20	*Sardinella macrophthalmus*	-
21	*Jenkinsia stolifera*	Shortband herring
22	*Halisoma bifasciatum*	-
23	*Halochoerus radiatus* [*Halichoerus*]	Puddingwife
24	*Syngnathus mackayi*	-
25	*Syngnathus floridae*	Dusky pipefish
26	*Pterophryne histria* [*histrio*]	Sargassumfish
27	*Monacanthus hispidus* [*Monocanthus*]	Planehead filefish
28	*Stephanolepis ciliatus*	-
29	*Alutera [Aluterus] schoepfi*	Orange filefish
26 30	*Promicrops itaiara* [∞]	Jewfish
31	*Teuthis caerulus* [◊]	-
32	*Teuthis crestonis*	Yellowfin surgeon fish
33	*Pomacentrus fuscus*	Dusky damselfish
34	*Pomacentrus leucostictus*	Beaugregory
35	*Auchenopterus nox (?)*	-
36	*Eucinostomus californiensis*	Mojarra cantilena
37	*Sparisoma flavescens*	Mud parrotfish
38	*Cryptotomus beryllinus*	Parrotfish
39	*Diplodus holbrooki*	Spottail pinfish
40	*Hepsetia stipes*	-

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[*] NOTE: Scientific name has changed since 1929. Species could be *Megalops atlanticus* (tarpon).

[Δ] NOTE: This is probably *Holacanthus isabelita*.

[∞] NOTE: New name could be *Epinephelus itajara*.

[◊] NOTE: Could be *Acanthurus caerulus* (now *coerulus*) (blue tang) (Longley and Hildebrand, 1941).

41	*Upeneus maculatus* ‡	Spotted goatfish
42	*Ocyurus chrysurus*	Yellowtail snapper
43	*Anisotremus virginicus*	Porkfish
44	*Calamus arctifrons*	Grass porgy
45	*Archosargus unimaculatus*	Western Atlantic seabream
46	*Kyphosus sectarius [sectatrix]*	Bermuda chub
47	*Microspathodon chrysurus*	Yellowtail damselfish
48	*Chaetodon ocellatus*	Spotfin butterflyfish
49	*Synodus foetens*	Inshore lizardfish
50	*Alectis ciliaris*	Threadfish, African pompano
51	*Apogonichthys stellatus*	-
52	*Gymnosorda alleterata*	-
53	*Amia* sp.	Bowfin
54	*Coryphaena hippurus*	Dolphin
55	*Psenes* [sp.]	Driftfish
56	*Ogilbia cayorun*	Key brotula
57	*Angelichthys ciliaris*Δ	Queen angelfish
58	*Hippocampus punctulatus*	Horsefish
59	*Doratonotus megalepsis* [*megalepis*]	Dwarf wrasse

Rested in the evening. 27
Turned in 10:00.

June 7 Turned out 6:30.

Worked in lab on material collected yesterday.

Got some specimens of *Strongylura notatus*. Photographed some alive for purposes of record.

Spend the afternoon working on more laboratory material.

The following data on *Strongylura notatus*. (Measurements in mm)

s. l.	t. l.	Snout from eye	Mandible from eye
132	143	39	41.5
137.5	149.5	42	43.5
137	147	40.5	42.0
131	141	41	43.5
150	160.5	45	47
122	132	37	39

Color: Greenish on back with a dark central stripe and 2 narrower ones on either side.

A bluish lateral streak from upper axil of pectoral to center of caudal. Below this silvery green overlayed with rows of punctulations diagonally down and back, following metameral depressions. Belly almost pure silvery. Upper tip of caudal anterior tip of dorsal and anal brick red to pinkish. Eye with a small dorsal "sun shade". Iris silvery. A dark line at edge of preopercle. Top of head bluish; sides silvery; tip of beak pale pink. Peritoneum bluish gray. Bones pale green.

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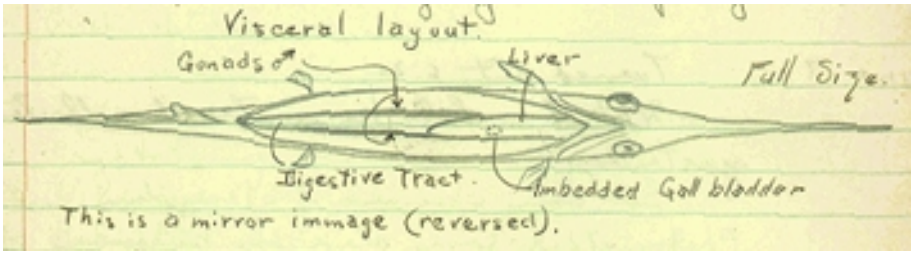
‡ NOTE: New name could be *Pseudupeneus maculatus*.

Δ NOTE: Could be *Holacanthus ciliaris* (Queen angelfish) (Longley and Hildebrand, 1941).



28 Swim bladder long (same shape as viscera and above it), coming to a point over vent. Not cellular.

Kidney a thin red line developed strongly on left side only.

Very little food in tract. Some insect remains.

Three others of this collection held alive in aquaria.

Food: Insect remains; one 1 mm squid.

Two of the above died later in the aquarium.

Their measurements as for the preceding six.

127	137	37.5	39
127	137	38.5	40

Set out the needle fish trap as designed on page 9. It is not set in a very good place but will give it a try.

Rested in the evening awhile and turned in 9:30.

29 June 8 Turned out 6:00.

The gasoline lamp used in the trap is still burning. Visited the trap and turned it out. Can not tell whether it fished or not as there was inadvertedly left a space on each end where the fish could have gotten out.

Visited Bird Key, looking for flying fish remains. Got 2 tails, probably *Parexocoetus.*

Tow #8 Towed in channel between.Loggerhead and.Garden Key. Got 1 young fish (*Monacanthus*?). Burkenroad towed there earlier and got 2 of the type "A" eggs.

The bird colony is noisy unpleasant place on which the Ocypodes (ghost crabs) run with impunity among the birds. The young were just hatching and about $^1/_4$ of them were dead. Some of the birds lay within in 6" of the water's edge. Probably all these are lost. While the island is small and cutting away rapidly and the birds very crowded where they are, there are several available apparently good places unused.

Saw absolutely no young Exocoetids.

Tow #9 Towed off (N.10) buoy. Got a variety of eggs and invertebrate plankton (P. M.) Saw 3 adult *Parexocoetus* just before reaching (N.10) and a few on the other side, also a school of 15 *C. furcatus* (about 30 mm). Got the following Exocoetids in dip net from the bow of the "Darwin".

30 *Cypselurus furcatus* (about 6 mm) s. l.

One was tan (gulf weed color) and the other reddish brown.

Parexocoetus mesogaster

1 (about 9 mm s. l.), 2 (4 and 5 mm s. l.). These all lack the high dorsal and its black tip. The 2 small show the larval fin fold and are only recognizable because of the series. Apparently at this size they do not fly at all. The pectorals are tiny and little developed.

The following eggs were present. Some of "A", one of the "B", some "C" and larvae, some of "E" (?) or new (?); and 2 new types "G" and "H". "C" and "E" in

earlier stages than before taken. Does this mean they spawn in the morning (?). See figures on egg papers.

Moved Exocoetid trap down beach and fixed it up a little.

Tried night light over board and got the usual run of plankton at dock.

Turned in 9:00.

June 9 Turned out 5:30.

The fish trap caught nothing (?). The needle fish last night were found around the far side of the island last night only however.

Worked on the developing eggs for a while. 31

Tow #10 Visited southwest channel. Did some towing. Got 3 young Exocoetids in tow and 3 more by dip net as follows.

Parexocoetus furcatus - 4 as yesterday. These may not all be *furcatus*. Closer study is necessary. One very tan in color had reddish ventrals. One kept alive for some time. Swam by rapid movements of tail. Still had vestige of larval fin fold.

Got a young *Hemirhamphus* (29.5 mm s. l.) and saw about 8 of similar size. Their activity in the water resembles that of an elongate flying fish and not that of a *Strongylura*. The long light straw colored fragments (stems of something not Gulf weed) figures in these fishes environment. Although silvery from the side they resemble it strongly from in both form and color. All seen were closely associated with it, usually taking a position parallel to it.

A rather high westerly wind interfered with work considerably.

Worked over the material after lunch.

The short sticks in which *Hemirhamphus* was found is Manatee grass or stick weed, (Cymodocea) and when along shore according to Dr. Longley harbors small *S. raphidoma*. This I have not see as yet.

This tow contained "A", "B" advanced, "C" advanced and hatched, "D", "E" (?), 32 and new "I" and "J".

Spent the evening resting a bit.

Turned in 9:00 P. M.

June 10 Turned out 6:15.

Could not try the Exocoetid trap last night as it was partly destroyed by wave action. Will have to wait for new lumber. The yacht "Anton Dohrn" left for Key West this A. M. taking Mr. Paul Conger back.

A high sea running - worst seen here so far. Visited Bird Key. Took movies and stills. One noddy nested on a shelf in the abandoned wardens house. The terns constantly fight and pick viciously at other than their own young when ever they wander near.

Dexter says these birds feed to a considerable extent on flying fishes.

In the afternoon seined on the flats at the far side of the island. Little was gotten as a surf was running even here. The bottom is hard and covered with grass and algae of various kinds.

Spent the remainder of the P. M. in photographing the layout and in laboratory 33 work.

Used the night light without much success from the dock.

Turned in 10:00.

June 11 Turned out 6:45.

Looked for flying fish in the gulf weed blowing in by the recent wind in the vicinity of Buoy N.10. Got a 2" *Cypselurus* and some smaller, also young stages of *Hemirhamphus*?

Returned in the P. M. and got more. Tangled in the weed they are simple to catch (*Cypselurus*). The young *Parexocoetus* stay more to the open water and are

all smaller. Brought back 47 *Cypselurus*. 20 were preserved and 27 kept alive in an aquaria; [aquarium] although they differ most markedly they certainly are all stages on the development of *C. furcatus*. Some are whitish (milk white) others brick red, yellow, nearly black, vandyke brown, etc. They all agree in resembling the various colors of gulf weed in various phases. All but the smallest as previously noted fly but no wing movements could be detected. They are the most delicate diaphanous and fairy-like of fishes.

34 Also took young *Strongylura raphidoma* and *Hemirhamphus* (?). Saw numerous schools of these more primitive Synentognathi. Probably the fishes of this weed are common in the following order. *Monacanthus*, *Alutera*, *Strongylura*, *Cypselurus*, *Parexocoetus*, *Hemirhamphus* and then others much less so such as Carangidae (small), Sphoeroides, etc.

In the evening took a row around with a night light to see what might be blown in. Nothing of real interest was uncovered.

A few *Strongylura* leaped.

Turned in 9:30.

June 12 Turned out 6:30.

Most of the *Cypselurus* are still alive and active.

Went out in the morning to try to get more. Went beyond black buoy "C". No relatively large ones could be caught but altogether 67 *Cypselurus* and *Parexocoetus* were caught. About 10 were of the latter species. Of the former 39 were kept alive and the rest preserved. This species while fragile is much more rugged than *Parexocoetus* none of which I have been able to bring to the laboratory alive.

35 Also took a variety of *Strongylura*. *S. raphidoma*has has an exceedingly short beak when young, with the jaws about equal, the flaps of the mandible are evident but not black. All these range from about 25 to 60 mm. Another species, very thin and with a long lower jaw was steel blue with 4 encircling spots of brilliant silver (one on top of the head). They were about 30 mm. (*S. ardeola*?). Another about 10 mm was in some cases solid dark brown, nearly black, steel blue, brick red. This may be (*S. notatus*) or even a *Hemirhamphus*. The young *S. raphidoma* in an aquarium show a violent dislike to the latter fish snapping at them viciously whenever they happened to come near.

Worked on this material in the P. M. Tried to photograph the *Cypselurus* but when placed in a dish with <u>sufficient</u> light for photography (instantaneous) they showed violent heliotropism and were in danger of injuring themselves in their response. The movies and stills I got may not be much good as I had to replace the fishes in their tank for fear of injury. In their aquaria they show a strong heliotropism but nothing like that when the sunlight strikes them. Made sketches of their characteristic poses.

36 The "Anton Dohrn" came back today with Dr. Yamanouchi aboard.

Wrote some letters and rested in the evening. Played at chess.

After dark flashed the electric spot light on the *Cypselurus*. They were all hiding <u>in</u> the gulf weed but came out in response to the light. They are certainly markedly phototropic. It would appear that these fishes are heavier than water both from their actions and the results of behavior. e.g., On death or lack of control of the fins they invariably sink. Fin clipping should be of interest. It seems that they actually roost in the gulf weed lying on the lower strands of it. In health sinking is slow as the fins are constantly being "warped" and they may keep up not unlike a turkey buzzard. Here weight is of significance as it would be in flight. On removal from water the rather stiff looking wings collapse into filmy "rags" that hang about the fish in a shroud-like manner.

In flight the longer small examples (40 mm and over) all look a rich brown. It is doubtless a blending of the various colors due to motion.

Turned in 10:00. 37

June 13 Turned out 5:15.

Fed the *Cypselurus* some plankton. They feed fairly well on the miscellaneous organisms it contains but they seem to be mostly too large (the plankton - #1 net). The actions in feeding are like that of a *Fundulus* (when the food is presented below the surface as in the present case). At times these fishes swim up to the surface and rest with the large pectorals in contact with it. It would seem that they become caught in the surface film and are thus able to rest, which they do not seem to be able to do when below it. They may thus take advantage in dead calms of what is often disastrous to the smaller plankton organisms. This action is not noted by the smaller fishes, only those of 20 mm and over.

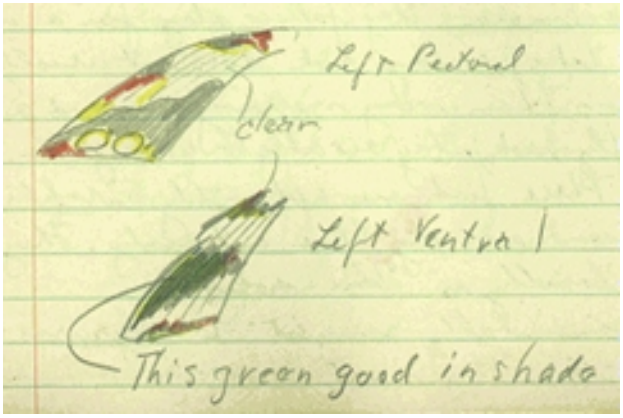
Tried angling for *Strongylura* between the two docks. They are difficult. If a bait is trolled (*Jenkinsia*) they follow along for a ways and then take, a large hook does not usually engage in their very narrow jaws and a small one (a fly hook) they are able to straighten. Caught none. These fish are apparently *S. raphidoma* (15 - 20") and are very blue anteriorly. They are known locally as "blue noses".

Accidentally caught 12 *Ocyurus chrysurus* from 8 - 15". They must be very common. Saw a number of *Thalassoma bifasciatus* just about the color of the plate in "Marine Fishes Atlantic Coast".*

Got 2 gray snappers at the dock. For some reason not clear there were easy to 38
catch. Also got a *Kyphosus sectatrix*. These are hard to get and have to be "jigged".

Went over to Garden Key trolling for barracuda. Got nothing! Tried fishing for *Strongylura* but here they would not even take "chum". Some of the same bait used this A. M. We were on the windward side of Garden Key instead of the lee side of.Loggerhead.

A *Cypselurus* flew aboard a row boat after dark on the windward side of the island. 71.5 mm s. l. The colors are similar to those of the Cooper plate but the pattern is very different - as indeed are all of the present ones. In all cases the pectorals of the present series are much more spotted.



This fish rather "dizzy" and probably will not live. 39

A light suddenly flashed on the others after dark revealed but one "perched" in the gulf weed. The others were drifting about.

They all feed well on plankton - both dead and alive today.

---

* NOTE: Probably C. Breder's book written in 1928 and published in 1929.]

Turned in 10:00.

June 14 Turned out 6:30.

The 71.5 mm *Cypselurus* had died in the night - preserved - others O. K.

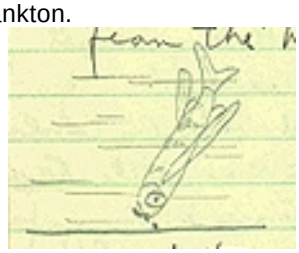
Worked in the lab on material. A strong easterly wind spoiled collecting small flying fishes or fishing for needlefish.

In the P. M. visited.Bird Key to look for flying fish remains. Got 8 complete *Parexocoetus* 12 - 14 cm t. l. and about twice as many fragments and one 'torso' of *Cypselurus*. A few *Monacanthus*, *Alutera* and Carangidae. A few *Monacanthus*, *Alutera* and Carangidae. By far the most left by these birds is Exocoetid. It would seem that they would naturally eat such succulent fishes and that the action would not be especially selective. On the other hand the filefish one would expect to find more numerous in the disgorge* .

Trolled there and back: no luck. Capt. Mills, son "Billie" caught a small barracuda, 505 mm s. l. 589 t. l. It had but one mandibular tooth and a space for its mate.

40 Set out the improved model Exocoetid trap. - built on an old skiff. The wind was too strong to tow it satisfactorily.

Fished with the night light and got only invertebrate plankton.



The largest *Cypselurus* in the aquarium was noted to feed from the bottom of the tank - doubtless an acquired habit. It tipped straight up and down and finally leaned over backward in its efforts to pick things (live plankton that had settled) from the bottom of the tank. Others did the same thing but were not forced to assume such an extreme position. Their mandibular barbels seemed to come into play and they reacted to touching them to something much as do other fishes with exterior taste buds. While these acts are doubtless abnormal may it not be (coupled with the fact that they sometimes "roost" in gulf weed) that here fishes (and probably others with mandibular barbels) feed <u>in</u> the weed and assume varying

41 positions in their efforts to pick off adherent organisms? At least *Parexocoetus* which does not have them and the adults of *C. furcatus* which has lost them are not so intimately associated with the gulf weed as are these young *S. raphidoma* which <u>lays</u> in the weed as opposed to the young of other species which simply hang around it (for shelter?) goes through a similar performance in growing up and finally looses its flaps and grows a larger beak (which it does not have when young) comparable to all sizes of other species not so closely associated with the weed. This and similar circumstances may explain the entire Synentognath barbel complex on an adaptive basis.

Eggs "J" first taken in the tow June 10 tow #10 measuring 2.09 mm in diameter with reddish embryos (to naked eye) no "hairs" and large well advanced "Fundulus-like" embryos appear to be the young of *C. furcatus* on hatching. Only 3 eggs were taken, the larvae of 2 were preserved on death and 1 is still living. If this is a correct interpretation this is the first Exocoetid egg (Synentognath egg?) without filaments. However as *Cypselurus furcatus* is a rather "over specialized" member of the group it may have lost them?

Turned in 9:45.

42 June 15 Turned out 6:00.

The new model Exocoetid trap caught nothing - but then the light went out. The *Cypselurus* hatched from an egg is still living.

---

* Breder's fusion of the words "disgorge" and "discard".

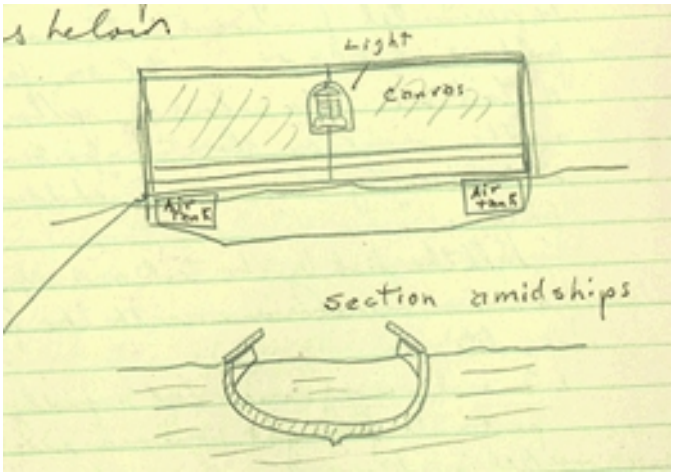
Tow #11 Took the Darwin out to southeast channel. It was altogether too rough (tide and wind opposed) but managed to make a tow. There was very little in it and nothing of interest to me. Much gulf weed has drifted in between.Garden and.Loggerhead Key. In it are some small *Cypselurus* but the sea was too choppy to do anything with them. Saw 2 5" *Parexocoetus* just off the tip of Loggerhead Key. There should be good collecting there if the wind dies down a little.

In the P. M. tried collecting in the gulf weed which is all around. It was practically barren. One little *Hemirhamphus* taken. Then tried diving with a hood for the first time. It is all that has been said for it. Something every ichthyologist should try. The lateral view of turning [?] coral heads etc is decidedly different than water bucket views. Saw the following species in about 5 minutes. *Pomocanthus arcuatus*, *Lutjanus griseus*, *Thalassoma bifasciatum* (young and old), *Chaetodon capistratus*, *Ocyurus chrysurus*, *Scarus taeniopterus*, *Halichoeres bifasciatus*, *Bathystoma striatum, Haemulon sciurus, Haemulon parra*, *Upeneus maculatus*, all playing about my feet.

Billy caught a barracuda s. l. 815 mm t. l. 935 mm. The right tooth was missing. Saved the head and kidney. 43

The largest flying fish died this afternoon as did the one hatched from the egg.

Anchored the Exocietid trap on the edge of the channel half way between.Loggerhead and.Garden Key. The water is rather rough but it rode well, with the keel taken off and towed stern foremost. The construction is as below.



It should work here if it is going to work at all, Hemirhamphids, Belonids, and Exocoetids have been seen hereabouts and much gulf weed is in now. While we were gone one of the men saw a flying fish from the dock.

Turned in 10:00. 44

June 16 Turned out 6:45.

The Exocoetid trap "caught" a lot of sargasso weed but no fish. The water is as rough as I have seen it here.

Worked about the lab both A. M. and P. M. Too rough for outside work. Found out that the reason the largest flying fish died last night was that the water had been cut off. The next largest was weak this A. M. for the same reason. Used it for experimental purposes. It measured as follows. s. l. 24 mm. t. l. 32, pect 12, vent 11 [or II?] tail 6.5. The colors of yellow and green on the wings on close inspection are just those of the back of "children's transfer pictures."

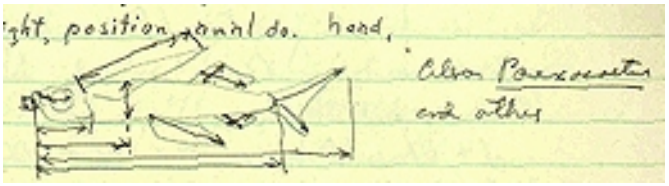
Held the fish by the tail and applied current from an inductorium with the following results.

1. General nerve areas. Tail rapidly vibrated, pectorals brought forward and then ventral. All in this order in quick succession.

2. Pectoral base. Pectorals brought forward, trembled slightly through a "micro-arc" and then frozen in absolute rigidity and held that way as long as current lasted. The trembling was neither large enough to be seen without a glass, lasted long enough or could conceivably be great enough to have any locomotor thrust even if of the proper form.

45 Closet work for the winter based on material collected here

1. Taste buds in *Cypselurus* barbels (also others)
2. Plot proportions of young *Cypselurus* in regard to flight and development.
s. l., t. l., pect. l., vent. l., caudal l., (both lobes) eye, placement of fins, depth, etc.
(slide rule work) Forms. in mm.
s. l., t. l., upper caudal, lower caudal, pect. l., vent. l., pect. pl., vent. pl. depth, place of depth, eye, width, snout, length barbels. max, peduncle, dorsal length, height, position, anal do. head.



3. Area of wings in selected examples of above series.
4. Stomach contents.
5. Arrangement of organs (visceral) with development (selected series)
6. Similar data on other Synentognathi.
7. Myology of pectoral system (also ventral).
8. Innervation of girdles (hood) [?].
9. Development of brain (figure).
10. Development of hypurals.
11. Cross sections of wings with ribs. Also "combing" of wings if any.
12. Angle of vision and placement of eyes.

46 3. Ventrals behaved essentially as Pectorals. Every now and again the tail would give a wiggle as the current slopped over to the general system.

The fish died with the current on and the fins froze in that position. They seem to be cambered slightly. (Pectoral fins.)

Preserved in Bouins sol. for taste buds in barbels and kidney.

It should be noted that the large fish that died yesterday floated, all others including the present sank.

In the evening tried an experiment with various young fishes as a follow up from an observation made the evening before on the apparent derangement of equilibrium in *Monacanthus*, *Lactophrys*, etc when in the presence of a strong light.

Watched these fishes all day to see that they really were normal. Then after dark made the following definite experiments.

Exp. 1.

The regular night light was immersed before dark so as not to worry the fishes (turned off). After dark 8:00 P. M. It was suddenly flashed on. The smallest
47 *Monacanthus* started to gyrate (15 mm s. l.) and then the larger ones took it up. This occurred up to a size of 50 mm where little effect was noted. The last to react was a *Lactophrys bicaudalis* (15 mm s. l.) but the action was very violent. A small

Haemulon sciurus 30 mm s. l., 5 *Pomacentrus leucostictus* 25 mm s. l. and a *Scarus* sp. 25 mm were unaffected.

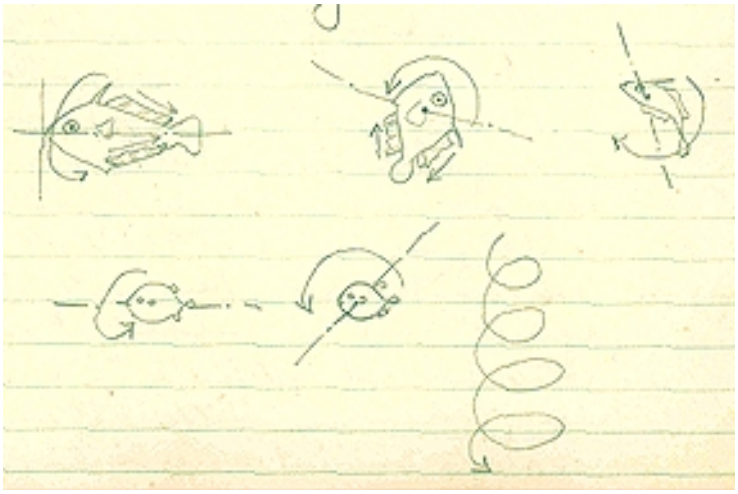
After the light was extinguished and the fishes viewed in a dull red light which had little effect they continued to gyrate and were not really normal before 15 minutes. Then the process could be repeated. After 5 such trials either the fish fatigued or became somewhat adjusted to the conditions.

The mechanics of these unusual locomotor effects may be described as follows.

The commonest one may be considered a boring [?]. The fish rotates on its long axis moving forward slowly until it strikes something solid such as the wall of the tank or stand pipe. Here, with its nose against such as support it continues to rotate for an indefinite time either very slow or with extreme rapidity or intermediate. It 48
may rotate in either direction, head to or away from the light as [?] straight down (on the bottom). It may stop and suddenly reverse. Some times the long axis may gyrate as a "top" about to stop spinning. The motion is affected by bending the dorsal to one side, the anal to the other and undulating these.

The next common one is a rotation about a transverse axis and is much more common in the very small than in the larger. It too may reverse its direction at any time and is apparently induced by driving the undulations of the dorsal opposite to those of the anal. Any position, vertical, horizontal or diagonal.

The least common may be a combination of the two with the body somewhat arched. It is not clear just how this is done.



Between times it is not uncommon for the fish to swim back down or circle the 49
light back towards it.

The *Lactophrys* rotates violently in either of two planes, spirals their combination or "loops". How it is done is not clear, or how it is possible for such speed to be obtained?

The light was tried on various other fishes including large *Lactophrys* (70 mm) and *Monacanthus* (20 mm) without result. The others include *Callionymus* sp., *Synodus foetens*, *Scarus* sp., *Calamus arctifrons* (20 mm), *Calamus calamus* or proridens? (20 mm), *Apogonichthys*, *Syngnathus mackayi*[*]. The only other to show this reaction was a few *Haemulon sciurus* in a tank of 50 or more in which about 4 rotated on their long axis for a time. It is not clear how they did it.

[*] NOTE: *Syngnathus mackayi* could be *Syngnathus floridae*, also known as *Siphostoma mackayi* (Longley and Hildebrand, 1941).

The fishes seemed to none the worse for the experience although they were utterly uncontrolled during the period, constantly dashing into the sides etc.

Some of the unaffected fishes e.g., (*Pomacentrus*) tended to take up a position with the dorsal surface to the light. It suggested that possibly the effect is rooted in the tendency to lie with the light over them and as gravity has so little effect on these fishes that "which side up" is effected largely by the direction of light.

50 Tried the light in various positions, inside, outside above, below etc. with similar effect. The effect decreased with withdrawal of the light (decrease in intensity).

Turned in 10:30.

June 17 Turned out 6:30.

Fishes experimented on last night O. K. and normal this morning.

The electric method of determining wing motion in flying fish will not work as it must be a series of coordinated impulses and the current simply "freezes" one or more. *Monacanthus* dorsal treated in the same manner "freezes" a "wave" at the point of the needle which will follow the needle along the back cramping each muscle in sequence. Application to the bran itself simple brings all locomotion muscles into play flexing the wings forward as before.

Worked further on reactions to light as follows.

51 Experiment 2.

Lactophrys (1) in jar in dark room. Reacted at once to light used for set although brought from the light outside room.

Let 10 min in total darkness. (9:10 - 9:20 A. M.).

Reacted at once to dim red light. This continued for 1 min 20 sec. when white light was turned on. More violent reactions followed.

Subsided and returned to normal swimming after 35 sec of this (stabilized).

White light off 2 min.

Immediate reaction on turning it on.

21 "turns" in 10 sec when stability was reached.

Light off 9:25. On 9:35 (10 min)

No reaction this time by 2 minutes.

Returned to day light when it showed half a dozen turns before becoming stabilized.

Experiment 3.

Monacanthus (15 mm s. l.) (1). Same as above.

Swam upside down in response to dim red light but did not gyrate.

White light further (red light off) response but no gyration. Looked as though they were going to set in for failed to after 5 min.

Left in total darkness. 9:54 - 10:15 (21 min).

White light flashed on. Went into immediate paroxysms (16 turns). Stabilized in 50 sec. Red light added 70 sec. No further reactions (2 minutes).

52 Returned to daylight (about 12 turns and then stability).

These experiments are not nearly as satisfactory as the simple night observations.

The high wind in the night upset the Exocoetid trap, carried away the sail and messed things up generally. Had to be towed in for repairs.

Took the Velella out in the afternoon. Went out a little beyond buoy N.10. In the lee of.Loggerhead Key the water is smooth, there is scattered weed but it is barren of Exocoetids. Outside of this it is rough, there is virtually no weed and no small Parexocoetids. Two "pairs" of adult Parexocoetids were seen. Fairly large ones.

Tow #12 A tow was made which contained eggs A, B, C, D, and E.

Got the Exocoetid trap fixed up again and anchored out in front of lab as a high sea and wind are active. In the evening experimented further with the light as affecting small fishes.

Experiment 4.

2 *Monacanthus* (7 mm s. l.), 1 *Alutera* (30 mm s. l.). Failed to react under any stimulus. Too small?

Experiment 5.

Lactophrys (10 mm to 20 mm s. l.). Only the old one (15 mm) used in experiment "one" reacted. The others failed to respond.

One of 5 *Pomocentrus* 20 mm reacted violently for a short time. Then resumed 53
normal swimming, while the rest hid in corners as usual.

One *Monacanthus* (18 mm) with one eye missing acted essentially as did those with 2 good eyes. If there is a difference it could not be distinguished.

Many would react violently for a time and then became normal only to react again.

With the light above the water one *Monacanthus* swam upside down for a long time near the surface upsetting the idea of orientation with the light to the back of the fish.

Turned in 9:30.

June 18 Turned out 6:15.

The Exocoetid trap caught nothing, but then again it was a bad night with much wind, sea and rain.

Tried further experiments with light and fishes.

Experiment 5. [NOTE: THIS IS THE SECOND EXPERIMENT 5.]

In day light. Blackened eyes of *Monacanthus* with vaseline and lamp black. At first it gyrated a little and then swam in a confused manner, sidewise, upside down and otherwise indifferently. When one patch fell off it turned to that side and when the other fell off became completely normal.

Same with *Lactophrys* 20 mm. Confused but not unstabilized. Turned to 54
uncovered eye continually when one patch fell off and returned to normal actions, turning sharply to the other side when the second eye was uncovered.

Took the "Darwin" out to buoy N.10. No weed was seen, excepting some tiny fragments. It was dead calm when we started but a heavy squall blew up with a high sea, rain and lightning.

Rained off and on all day. Spent the P. M. in the lab. Dissected a *Cypselurus* of 13.75 mm s. l. and 16.75 t. l. for wing and tail structure. Made microscopic mounts of some. Sectioned one fin.

Made a further experiment with light reactions.

Experiment No. 6.

Applied light before darkness (well before intensity dropped to point where reactions occurred). Left on until well after dark. No reactions occurred (no gyrations) although several sailed back to light (which was submerged) or belly to surface (possibly in response to brightly lit bottom of tank).

55

Experiment No. 7.

Covered tank completely with dark cloth and left for over night.

Turned in 9:30.

June 19 Turned out 6:45.

Removed black cloth 8:00 A. M. (suddenly). One *Monacanthus*, the smallest, went into gyrations and several of the others did to a lesser extent. This lasted for about 5 minutes, before equilibrium was reached.

Apparently these reactions are to light intensity itself.

The last *Cypselurus* died yesterday.

Visited Bird Key with the "Velella". Gathered a pail full of fishes, mostly Exocoetids. These were composed as follows (all more or less frequently [?]). (Fresh) *Cypselurus furcatus* 7; *Parexocoetus mesogaster* 22; (Dried) Exocoetids mostly *Parexocoetus* $2^{3}/_{4}$ mason jars full; other fishes mostly *Coryphaena* and Carangidae 1 mason jar full.

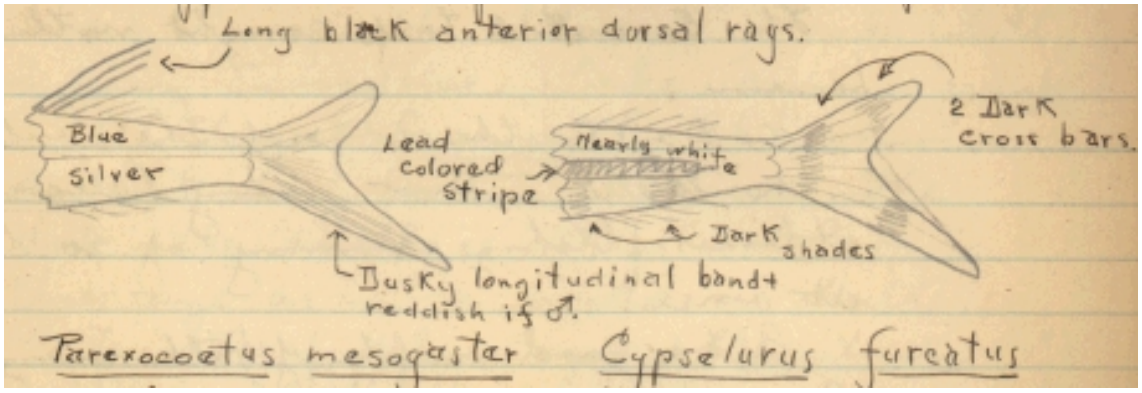
Notes on *Parexocoetus*: Nearly all of the fresh material was entirely enough to sex. All sexed were ripe (♂ & ♀). The males had a rosy tint to their ventrals and caudals and a ruddy diffuse band along the side just below where the silver meets the blue. The females were plain blue and silver meeting sharply on the line of
56 demarcation between the dorsal and ventral myomeres. The fish were plain, slightly dusky. One male had living sperm. The females eggs looked new but could not be fertilized. Figured the expressed eggs which agree well with the Bingham article as to size but the "hairs" are fewer. There appears to be a patch where there are none (point of attachment to the folicle?). It would seem that these eggs form their "hairs" very shortly before extrusion as most had none althought well advanced mature eggs. Also the one figured has various "sprouts" also figured.

The stomach contents of one female (the only one examined) contained the remains of copepods. Most of the food as was noted in others was reduced to a bright brick red paste and the feces was the same color.

Some much more fragmentary remains of *Cypselurus furcatus* were taken also. These showed the larval pattern up to a large size. Only a few showed the mature silver and blue. From these may be reconstructed a size of change.

Even the simple remains of a bit of tail suffice to separate these 2 species.

57



This combination of characteristics will separate them at any size and usually the pattern on the caudal fin itself is sufficient alone.

The young birds on the island are beginning to feather. The noddy on the shelf has hatched and seems O. K.

Tow #13 Made a tow between Bird Key and Garden Key. A perfect blank for fish eggs.

The Exocoetid trap caught nothing last night.

Worked on some ripe *Sparisoma* ♂ cyanolene [?] & ♀ *xystrodon* (*S. hoplomystax*)*. Could not fertilize the eggs but they appear clearly to be egg "E" of

* NOTE: Same as *Sparisoma radians* (Longley and Hildebrandm 1941).

the tow. (They are identical with the second lof ot "E" which may be different than the first. The ♂ has a red and blue line from eye to mouth. The ♀ has green around the pectoral base which slops over to the edge (and on it) of the gill cover.

Turned in 9:00. Weather still unsettled.

58

June 20 Turned out 6:15. Dead calm.

The Exocoetid trap caught nothing however.

Went out to the edge of the Gulf Stream in the "Velella". Saw many *Parexocoeteus*, at times flushing as many as 20 large ones at once!

Got a good sample of both young *Parexocoeteus* and *Cypselurus furcatus*. Got 3 young *Coryphaena hippurus* by dip net, 2 *Amia* sp. (red in color - why here?), 1 young *Sphyraena*. Saw a few young *Strongylura raphidoma*.

Tow #14 The tow was very interesting. Got eggs A, B, D, E, and a new one K. Egg "B" is identified as *Sphyraena barracuda*. Got a series of very young in the tow. "E" is *Sparisoma hoplomystax*. "K" may be another scarid (?). Also took a number of young swordfish (?) and some Carangidae.

The markings of the young *Coryphaena* are interesting. They are barred vertically and show considerable change of color. The ground color is metallic, silvery, brassy or bronzy (changeable).

They one figured attacked and successfully engulfed a *Cypselurus* 12 mm long. It swallowed it tail first, folding the soft wings back as it gulped. Apparently these are enemies at the youngest stages imaginable. Place in colored plate of young Exocoetidae. (Make museum group?)

The largest *Parexocoetus* taken show a distinct wing pattern (figured). The 59
dark of the dorsal is not as extensive in this size as in the smaller or adults.

Tried to fertilize eggs of *Doratonotus* (♂s had very little gonads and ♀ had not eggs mature but graded down from almost mature to minute). It would seem these fish spawn a few at a time instead of all at once. This may also be true of *Sparisoma hoplomystax*. (See yesterday's entry.)

The little *Pterophryne* living in dead gulf weed has become almost coal black, except for a few white patches of pattern. On the introduction of new (light yellow) gulf weed it deserted the old and became light in a few minutes. Later it went back to the dead (dark) weed and became black again. It has nearly doubled in size since capture.

Dr. Longley got an *Ogilbia cayorum** which gave birth to 6 young. Viviparous!

Capt. Mills designed a floating trap for me out of wood, cork and wire as follows.

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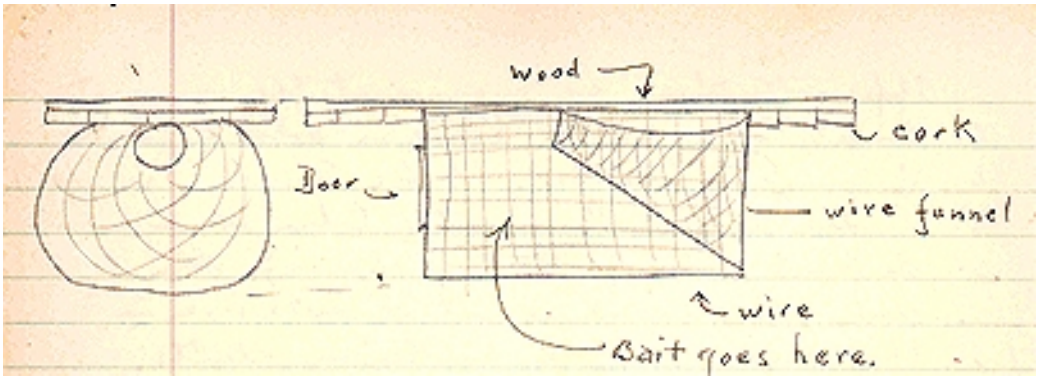
* NOTE: According to Longley and Hildebrand (1941) *Ogilbia cayorum* is synonymous with *Dinematichthys cayorum*.

60



It was set on the channel buoy at 6:30 with rotten crayfish for bait and intended for flying fish drawn by the plankton induced by the rotting fish. It may work for other things at least.

Took the Exocoetid trap (with light) out to beyond the wreck by slowly towing after the "Darwin". The expectation being that a moving light might stimulate activity. Nothing happened however so left the trap anchored out beyond the wreck to fish by itself.

Tow #15 Made a tow near the wreck. Its invertebrate fauna was very different from the days. Strangely there were no fish or fish eggs at all. At least the latter, do not have diurnal migrations.

Turned in 10:00 P. M.

June 21 Turned out 6:30 A. M.

Took the "Velella" out to the floating bait trap in the channel. As it was headed into the current the mouth was crammed with gulf weed. Turned it around.

Fishes seen at Dry Tortugas
Continued from page 26)
[MODERN COMMON NAMES LISTED IN LEFTMOST COLUMN. MODERN SCIENTIFIC NAMES IN BRACKETS.]

60	*Calamus calamus*	Saucereye porgy
61	*Epinephelus morio*	Red grouper
62	*Callionymus bairdi*	Lancer dragonet
63	*Lagodon rhomboides*	Pinfish
64	*Ginglymostoma cirratum*	Nurse shark
65	*Epinephelus adscensionis*	Rock hind
66	*Diplectrum formosum*	Sand perch
67	*Priacanthus altus*◊	-
68	*Abudefduf taurus*	Night sargeant
69	*Mapo* [*Bathygobius*] *soporator*	Frillfin goby
70	*Selar crumenophthalmus*Δ	Bigeye scad
71	*Mycteroperca bonaci*	Black grouper
72	*Epinephelus striatus*	Nassau grouper
73	*Kyphosus incisor*	Yellow chub
74	*Hypoprion brevirostris*	Yellow shark
75	*Priacanthus arenatus*	Bigeye
76	*Sphyrna tiburo*	Bonnethead
77	*Trachinotus falcatus*	Permit
78	*Euleptorhamphus velox*	Flying halfbeak
79	*Cephalacanthus volitans**	Flying gurnard
80	*Halocypselus evolans*	Caribbean flying fish
81	*Carcharhinus platygodon*	Gulf shark
82	*Strongylura acus*∞	Agujon
83	*Sphyrna zygaena*	Smooth hammerhead
84	*Bathystoma rimator*	Calsar
85	*Halichoeres bivittatus*	Slippery dick
86	*Sardinella sardina*	West Indian sardine
87	*Scorpaena brasiliensis*	Barbfish
88	*Scorpaena plumieri*	Spotted scorpionfish
89	*Gnathypops mystacinus*	Pensacola jawfish

◊ Possibly *Pristigenys alta* (short bigeye) or *Pseudopriacanthus altus* (deep bigeye).

Δ NOTE: Could be *Trachurops crumenophthalma* (Longley and Hildebrand, 1941).

* NOTE: *Cephalocanthus* is the young of *Dactylopterus* (Longley and Hildebrandm 1941).

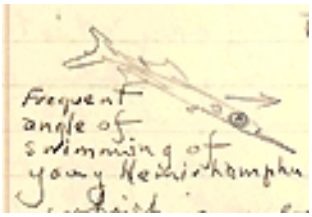
∞ Now *Tylosurus acus*.

62 [BLANK PAGE]

63 From this position on out the weed yielded a good series of *Cypselurus* of small size. Some schools of 40 or more were seen. All these schools from such size down to a few were always composed of fishes of identical size as near as could be told from the deck.

Attention was paid to the manner of flight of these and *Parexocoetus*. In neither could anything be detected that could be considered by any stretch of the imagination as wing flapping or vibrating. These small fish leave the water abruptly in a leap and seldom "skitter" at all. Probably they are too small as compared with the waves they mount. The large *Parexocoetus* do vibrate their wings but for perfectly obvious mechanical reasons. Viewed end on from close to the water it can be distinctly seen that they are rocked from side to side by their tail section. An arc of some 10° is struck by the wings from the center of rotation of the body. One goes up as the other goes down as in the accompanying diagram. The pelvics are held to the body until the moment that they tail leaves the water. Probably they operate to lift the tail.

64 One fish was seen in the distance which may have been a *Halocypselus* (?).



Small Hemirhamphids and *Strongylura* were common. Got a good series of the former. They swim more or less head down in both the weed (seen on several occasions) and in the aquarium. Possibly this is correlated with their method of feeding? Study. The caudal fin of these young *Hemirhamphus* is decidedly Hypobatic* like and Exocoetids and not like *Strongylura* which is usually homocercal at these sizes. Also there is a progressive similarity in pattern. Most young Belonids show a tendency to vertical bars on sides. These in Hemirhamphids are continued below and tend to meet below. In other words they are midway between Belonids and Exocoetids. *Parexocoetus* probably has specialized young which leave the weed on hatching. See color sketches. *S. raphidoma* is predacious on these other froms of slightly smaller size. They removed a pectoral form a *Cypselurus* and were previously noted to feed on the small silver and green *Strongylura* sp.

65 A *Tursiops truncatus* played around the Velella in the channel.

Saw a school of 8 large *Gymnosorda alleterata* and one large 10" *Hemirhamphus*. It skittered as did various "blue-noses" (large *S. raphidoma*). They do have a distinctly blue beak.

Got eggs "L" with a dip net. (Probably *Pterophryne*). The odd eggs "F" should be a Pediculate. This would leave *Ogcocephalus* as a likely possibility.

Tow #16 Made a tow far out. It contained little.

Picked up a dead glass eye snapper in the weed.

The *Cypselurus* with the missing wing seems little embarrassed in locomotion. Apparently they have more than ample stabilizing planes, for these fins are only used under water for "warping".

The tow #16 held 1 egg "A" about 6 "E" and about 20 "C" larvae. Why were there none yesterday? The tow was in nearly the same place as #14.

Worked over the stuff in the P. M.

66

* Refers to the larger lower lobe of the caudal fin. Usually referred to as "reverse heterocercal".

After supper went to the fort to catch barracuda. No luck. A *S. raphidoma* was shot [?] (in two). Little else of interest was seen.

Rowed around the island in the evening. Beautiful full moon. Turned in 10:00.

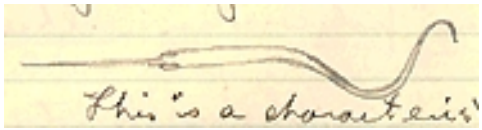
June 22 Turned out 6:00.

Took the Velella out through southwest and back through south-east channel. The water was a little too rough to get Exocoetids. Many small *Cypselurus* were seen about 3' below the surface - just out of reach of wave action and dip net. A few *Coryphaena* of the size taken yesterday were seen.

Tow #17 A tow was made which was poor.

There are 3 types of young *Strongylura* in the collection, 1 *Raphidoma* and the others probably *notatus* and *ardeola*. (Colored sketches.)

Made some observations on the young *Hemirhamphus* which are living well in the aquarium. They take plankton as well as the young *Cypselurus*. They will approach an organism from any direction and take it from below usually while in the angle figured on page 64. Apparently they respond to a visual stimulus. The only use the beak was put to that could be determined was that in some cases the food was not taken but was allowed to "roll" along the beak (away from the mouth) which was aided by the fish backing off slightly. Possibly there are taste buds in the beak as sometimes they recovered the particles after such performances.



67

A small *Cypselurus* was induced to fly about half the length of the aquarium. It simple soared, leaving the water in a leap as might any fish, spreading its fins and gliding.

The fish marked *S. ardeola* (?) in the colored plate gives much more flexures to the body that the other more robust species and occasionally swims backward (eel-like) to back out of a piece of weed.

This is a characteristic pose just as they dart ahead or move backward relatively slowly.

68

The tow had only a few eggs of type "D" and some larval *Hemirhamphus*.

Data on Loggerhead Turtles.

According to the men the loggerheads come to Tortugas any time after the first full moon in May and spawn on into July. Each ♀ lays 3 times in the same place. After first laying a period of 13 or 14 days, which seems to be definite insues. They depend on this to get the ♀ with ovarian eggs (yellow eggs) which are much more valued than the shelled eggs (white eggs). Neither are much good!

Gulf weed taken at Tortugas.

Sargassum hystrix buxifolium. Large coarse leaves. Little of this.

Sargassum fluitans. Large jagged leaves. Little of this.

Sargassum polyceratium. Soft decomposed looking. Not seen.

Sargassum natans. Small finely divided. (A sample of this preserved.) Common.

Sargassum polyceratium. Abundant.

Opened 2 *Halichoeres bivittatus.* about 140 mm. They were both ♂ with mature gonads. Preserved. May be recognized by cut vertebral columns. This finished Meek and Hildebrand[Δ] synonymy with. *H. radiatus*. Dr. Longley says he knows the young of the latter also.

Spent the P. M. in the lab.

Δ Meek and Hildebrand (1923).

About 6:30 a violent wind storm blew up but no rain. By 7:30 it had died down just as suddenly.

69 Last night one of the young *Hemirhamphus* spun on his beak under the influence of light as do the *Monacanthus* generally. The rest, about 6, showed no reaction. They are, however, positively phototropic and spend most of the daylight hours with their beak against the light side of the aquarium.

Opened some *Lactophrys bicaudalis* about 80 mm s. l. They were immature, as expected.

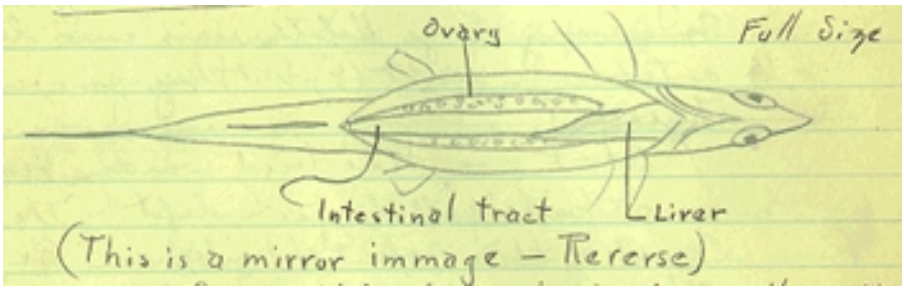
Turned in 9:30. Weather stormy.

June 23 Turned out 7:00. Weather still threatening. Worked in the lab. Storms, rains, clouds all day. Wrote some letters as the mail goes tomorrow. Some very large *Holothurians* were left in a tub over night (8) but they gave up no Fierasfers.

About noon the bird warden brought in 2 pails full of fish left by the birds. Most of these (about $1^1/_2$ pails) were Exocoetids. These were all preserved. The rest were mostly Carangidae (small), *Psennes*, *Pricanthus*, *Jenkensia*, *Monacanthus*, and 1 *Diplectrum*. A few of the *Parexocoetus* were very fresh. Three which were whole Mr. McCoy examined and found each to contain *Scalex polymorphus*. He says the adults should be expected in predaceous fishes and the young in Copepods but in either case their morphology would do nothing to identify them. *Scalex polymorphus* (an immature tape worm) probably represents a stage in many species which would be hard to differentiate. It occurs in a wide variety of fishes.

70 *Parexocoetus* shows sexual dimorphism in color at least. The males have reddish on fins and sides. (Figured). This persists for some time after preservation and increases in intensity somewhat after the fashion of *Leuciscus* (described in Copeia).

Drew the soft visceral anatomy of *Parexocoetus.*



The gut in these fishes is a straight simple tube as in the Belonids.

The fishes examined by McCoy and 3 others contained a red paste made up of Copepod remains, as far as could be determined.

Tried to extract oil from the livers of several without much success. The liver is very small as fish livers go and does not seem to be very oily.

71 Work on this material consumed the P. M.

Turned in 10:00.

June 24 Turned out 7:00. The "Anton Dohrn" left for.Key West this A. M.

Tow #18 The sea is still running too high to do any outside work. Made a tow from the wreck to the dock. It contained little in the way of eggs. One post larval Hemirhamphid.

Fed a quantity of this plankton to the aquarium.

The *Hemirhamphus* acted again as described on page 64. The beak certainly is of little if any importance in the mechanical part of eating. More of a hindrance, if anything. The young *Strongylura ardeola* (?) which is essentially half beak in form

fed in a manner similar, even to the angle of usual attack. The larger beak seemed even more awkward. This fish stays relatively deep in the aquarium in contrast to the smaller *S. notatus* (?) which is constantly at the surface. The latter varied this by coming down to feed. Why it should do this is not clear as the plankton was very evenly distributed throughout the tank. This fish with its longer upper jaw acted in a manner intermediate between those just described and the average adult Belonid which takes its food "end on" (as described in Copeia).

Neither trap has caught any thing as yet although the Exocoetid trap has not been lit for 2 nights. 72

Went diving off the Key in rather deeper water. Saw stuff very similar to that seen the last time.

On the second time down a school of school masters and yellowtails suddenly disappeared and on glancing up there was a 5' barracuda. He poised about 15' away ogled his eye and then with a quick swim came up about 5'. While probably not dangerous, having seen them out this way before attacking I climbed out and "called it a day".

In the afternoon went to Buck Key on a seining party. Got little but great quantities of *Jenkinsia stolifera*. Preserved a series even the smallest of which were ripe. Most of the school was male, aout 25 to 30 for each female which had eggs well advanced but not ready to fertilize. (Figured eggs).

Two large *Ginglymostoma* were close to shore probably mating. They were about 6' long apiece. One was pulled out on the beach by its tail. Weighed in the neighborhood of 200 lbs a piece.

This occurred about 100 feet from where the cast up "egg shells" of the same species was found some time ago. 73

A high wind rose higher and higher amounting almost to the proportions of a gale at times.

Turned in 10:30.

June 25 Turned out 7:00.

High wind still with us.

Spent the morning in the laboratory.

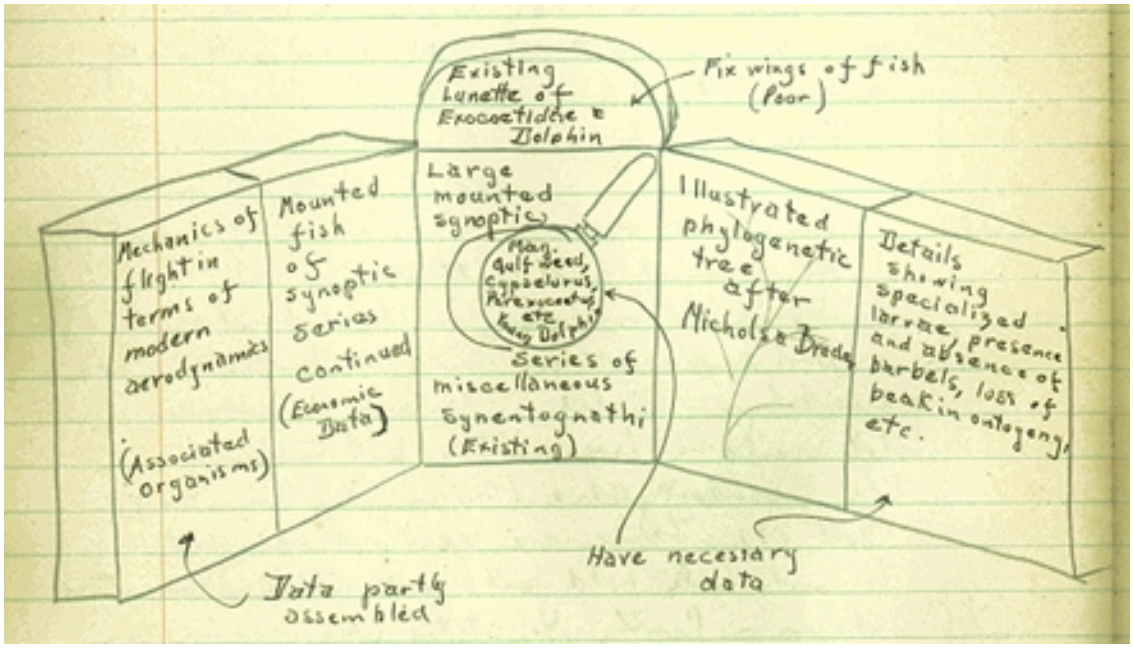
Had a discussion with Dr. Miller on the parasitology of fishes. The only trematodes that would be transmitted fish to fish are the Gyrodactylidae (Monogenetic trematodes) Pratt 177. These are easily diagnosed by two fish-hook holdfasts and other characters shown in Pratt. He states they occur on the gills but Dr. Miller says they may be other places as well. (So far as known all internal trematodes, on fishes, are digenetic.)

Dr. John E. Guberlet, Univ. Wash., Seattle, has dope on control of these trematodes in aquaria. Write.

All fish cestodes have intermediate hosts. However these may come in on fishes used for food. Freezing however should destroy all such. Examine intestinal tracts for *Scalex* and muscle tissue to see if they are living or not.

74

Plan for Amer. Museum Synentognath Exhibit



Tentative scheme of arrangement of Synentognath alcove showing Phylogeny, Ontogeny, and mechanics of Exocoetidae and related families. Room has been left for expansion. All except the mechanical part has the necessary data for starting work and planning. That, in part is assembled.

75 In the P. M. examined the gulf weed which had drifted into the lee of the island where it was smooth enough to work in. Absolutely nothing could be seen in the way of fish life however. Much of the weed was dead however and probably had been recently killed by being stranded on some nearby beach. This stuff I suppose did not have time enough as yet to pick up a new fauna of any size.

Spent the rest of the afternoon making color notes etc. of aquarium material.

While swimming before supper a 50 mm *Cypselurus* flew past me about a foot from my face. Coming, dead ahead, and going no wing movement could be detected although it was headed into a strong breeze and a heavy sea was running. It must have been in the air for at least 25 ft. Probably a stray individual that drifted in with the weed that was being tumbled in the surf.

Turned in 10:00.

June 26 Turned out 7:00.

Tow #19 Worked around lab fixing up odds and ends. Went out to buoy N.10 on Velella and made a tow - too rough for dip net work. A large number of bluish medusa *Aquaria* (*floridiana*?) were seen. Mr. Burkenroad dipped one up which had a *Cypselurus* in its tentacle. The fish was about 9 mm s. l. and the medusa 80 mm in diameter. Another enemy of Exocoetids.

76 The Exocoetid trap which certainly was a failure, in this environment at least, has disappeared. Probably the line parted in some of the recent rough weather.

The tow contained a very few A, B, and E eggs.

The *Pterophryne* which has lived so long in the aquarium measured 31 mm s. l. Unfortunately it was not measured at the start but it has clearly nearly doubled its length. This could be checked by photographs taken long ago.

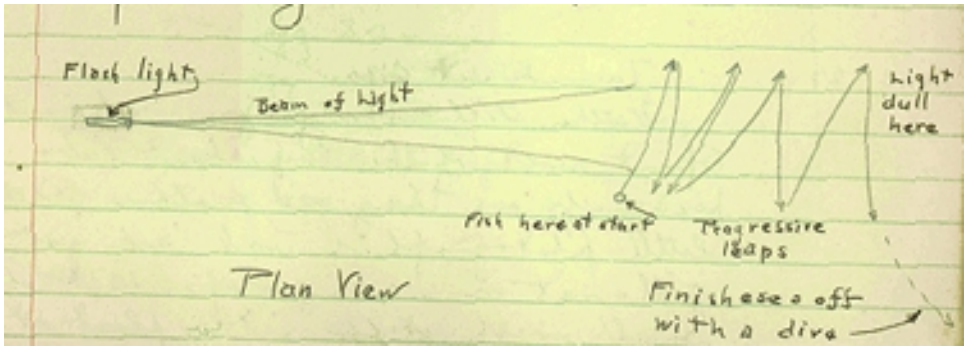
The bird warden brought in two pails of fish from Bird Key. They were about as before in assortment. Some *Cypselurus* were relatively fresh. Two examined by McCoy contained *Scalex polymorphus*, one having 8 individuals. The stomach contents was a red paste - probably all copepods. Figured one of the *Cypselurus* in color - immature 98 mm. s. l. The silvery "belly-bands" were still present on a dirty white translucent ground. The adult wing pattern was not quite yet attained. The two caudal bands are yellowish in life and both lobes dark tipped. The dorsal has a little dark at its origin. Both specimens with undeveloped gonads.

Preserved some of the better material. Am holding nearly a pail and $^1/_2$ of 77
fragments.

The Dohrn arrived 3:00 with Dr. Blinks and Grave aboard.

After dark rowed around the island. *Odontosyllis* [?] is in evidence again as it is the dark of the moon once more.

McCoy has a new and unusually brilliant flash light. Casting it about on the water in such a dark night explains why the Exocoetid trap did not work. The Strongylurids react violently to the light but not in the way anticipated. The lept at once on the light striking them but for most part leap transverse to its beam slowly working away from it. Thus a diagram of the action of one fish may be as below.



When an entire school acts in this manner they usually all jump in one direction 78
at a time - that is they remain essentially in a school. There are always stray individuals which leap otherwise - these give a "spread" of statistically normal curve. Every once in a while one jumps for the light. It is almost certainly these (ends curve of variation) that cause the occasional damage that results from one jumping "at" a light.

These fish appear always in the lee of the island. That is they leap and are active where the water is slick. They may move around the Key with the change of winds but more probably simply those that happen to be (on to live) on the side favored by the weather are active.

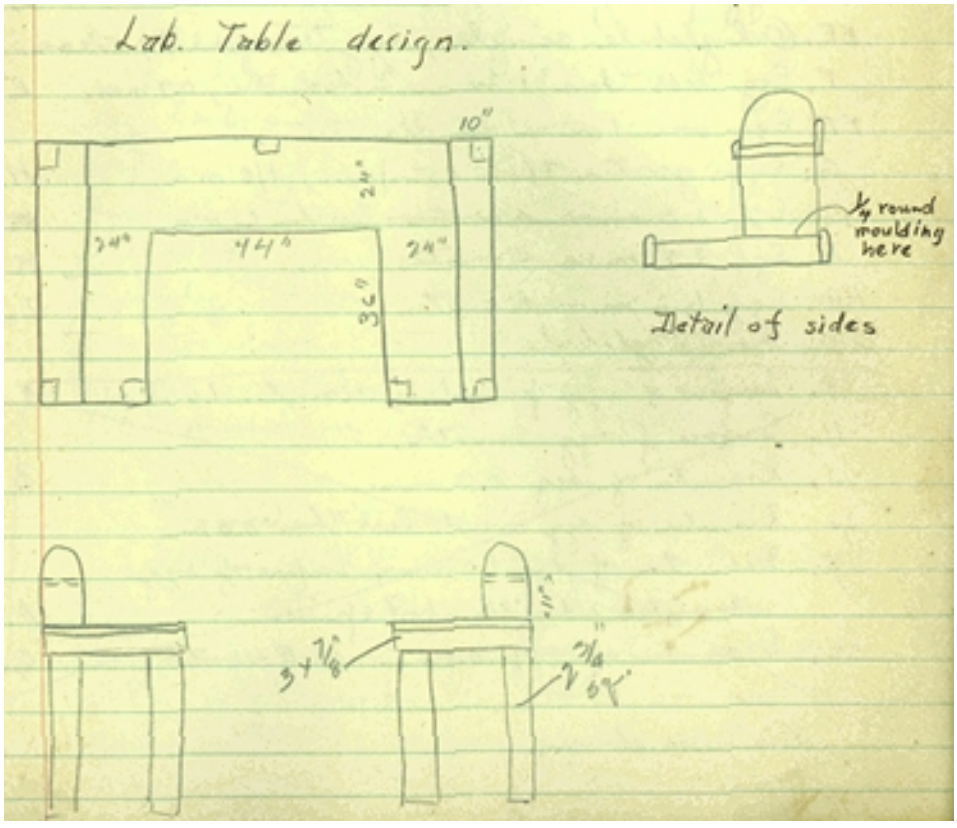
Turned in 10:00.

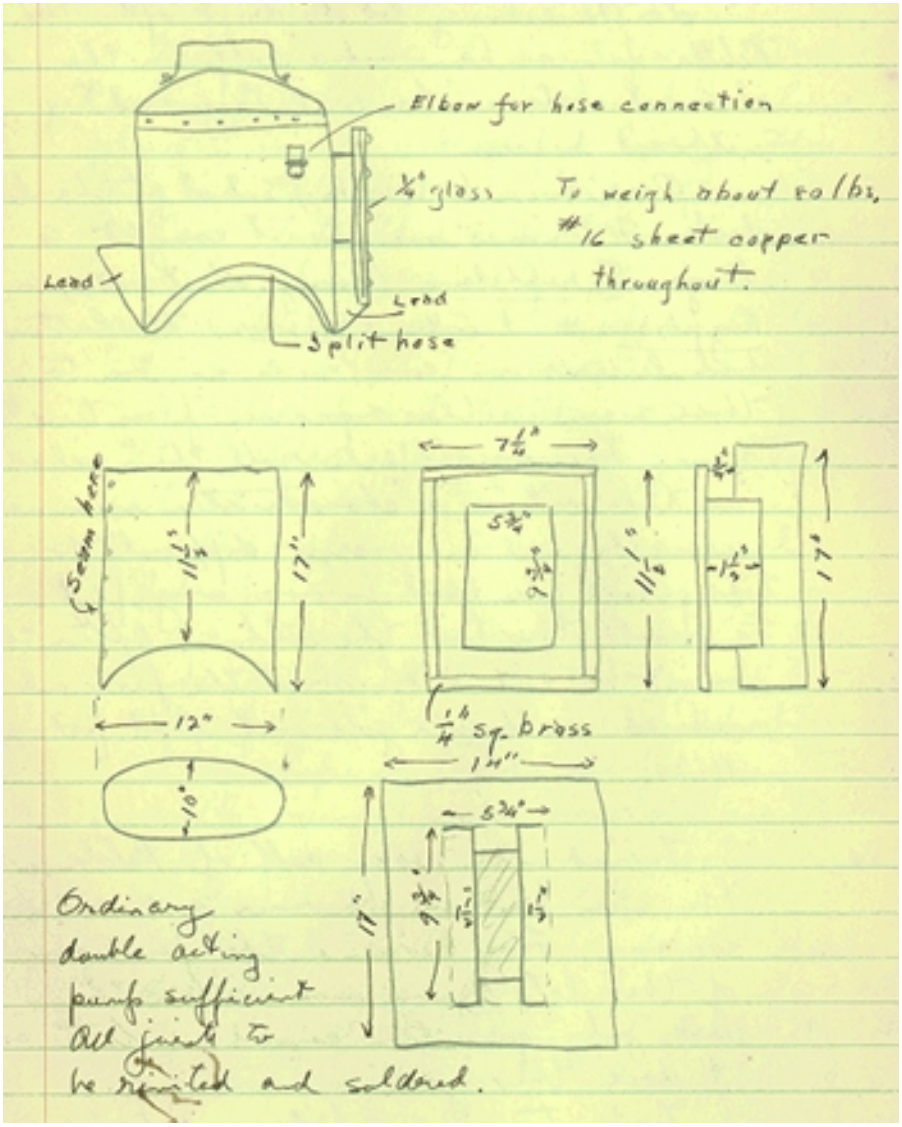
June 27 Turned out 6:30.

Weather still too windy for work outside. Spent most of the day about lab fixing up one thing and another. Did a little photographic work and got the gill net in working shape. 150 ft of small mesh stuff set to float at the surface for Exocoetids etc.

79 Key to pelagic fish eggs taken in tow

	A.	Eggs in gelatinous cluster, one oil globule present.	
	B.	Egg diameter 1.1 mm.	L. 1
	BB.	Egg diameter 0.65 mm.	F. 2
	AA.	Eggs single, not in a cluster oil globules present or absent	
	C.	Egg elliptical, long axis 1.9 mm, over two times short axis, one oil globule	C. 3
	CC.	Egg spherical	
	D.	Oil globule present	
	E.	Oil globule multiple, diameter of egg 1.2; entire egg pale yellow	D_1 4
	EE.	Oil globule single; egg transparent, clear.	
	F.	Eggs less than 1 mm in diameter, 0.7 mm.	E 5
	FF.	Egg over 1 mm in diameter.	
	G.	Egg greater than 1.5 mm, 1.6 mm	H 6
	GG.	Egg less than 1.5 mm	
	H.	Egg 1.3 mm diameter	K 7
	HH.	Egg 1.2 mm diameter	D_2 8
	DD.	No oil globule.	
80	I.	Surface of egg ornamented	
	J.	Surface of egg reticulated and covered with short spines, diameter of egg 1.0 mm.	A. 9
	JJ.	Surface of egg pimpled, diameter of egg 1.6 mm	I. 10
	II.	Surface of egg smooth, without ornamentation	
	K.	Diameter of egg less than 1.0 mm, 0.8 mm	G. 11
	KK.	Diameter of egg over 2.0 mm	
	L.	Diameter of egg 2.2 mm	d. 12
	LL.	Diameter of egg 3.0 mm	B. 13





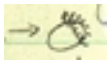
In the evening let it drift after the Velella for an hour and a half in the channel between Garden and Loggerhead Keys without success. 82

On return (10:00 P. M.) set it at the lab dock. Within 5 minutes it caught 6 large *S. raphidoma* (average about 2 ft), 2 *Kyphosus* and 1 *Lutjanus griseus*. The latter had lesions on each side similar to those seen in the aquarium from time to time. The needlefish roll themselves in the net in a characteristic manner usually and are very difficult to remove. They roll the head in one way, flip over, and roll the tail the other. Often they must be cut out. Iced the fish and retired with the gill net left fishing. 11:30.

June 28. Turned out 5:30 on call of Palola worms. The sun beat us however and did not see any. They swarm on the first quarter of the late June moon when the first July quarter comes as late as it does this year.

[NOTE ON MARGIN: These palolas swarmed 5 nights successively! Something is wrong!]

Took ten *S. raphidoma*, 2 *Kyphosus* out of the gill net. The former were all similar to last nights. They were all immature, 2 ♂ and 14 ♀. Their stomach contained little food - all fish remains. Examine in detail later.

83 Nearly all contained quantities of Cestodes. Preserved a few. One contained a large "filaria"? in its undeveloped ovary. This may even represent a new group - given to McCoy. Two others contained smaller undeveloped ones in their ovaries (?). The mature one gave "birth" to quantities of small larvae  when in a dish. This worm was all of a foot in length but less then 0.5 mm in diameter. The *Cestodes* also gave up quantities of ciliated larvae in a dish.

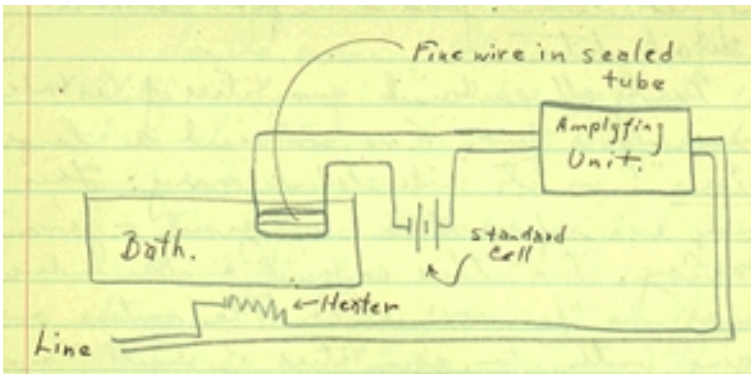
There appears to be no sexual diamorphism showing up as yet in these fishes. Totally lacking or due to the undeveloped state of the gonads? Figured one in color. There is a remarkable change in the shape of the dorsal fin from the really young fish. How old are these 2 ft. specimens and when do they mature? Preserved the entire lot.

Spent the A. M. tending to these details.

Useful laboratory gas stove. Propane bottled gas. Propane Corp., Eire, Pa.

Idea for a thermostat on following page.

84



With a fixed flow of current the resistance in the submerged part of the circuit varies with the current. This stepped up can be used to vary flow through heating element in inverse order.

Went out past Buoy N.10 in the Velella to look for young Exocoetids. Searched through the usual area in large beds of loosely compacted weed. No Exocoetids whatever and but 1 small, 1 large *Strongylura* and 1 *Monacanthus*. This weed was unusually clear and fresh look[ing]. There was no "stick weed" at all just a pure culture of *Sargassum*. This may in part account for it because on the return shoreward of the wreck a small like of mixed stick weed and sargassum was passed and a single young *Cypselurus* noted. Also on the days of the really big catches of little flyers much "stick weed" was about. It is inferred that the abundance of *Cypselurus* young, at least, is in direct proportion to the amount of stick weed associated with the basic sargassum for stick weed alone seems not to be very productive and pure sargassum absolutely negative.

85 In the clear places the usual number of adult *Parexocoetus* were seen.

Much dead sargassum is drifting off the point and forming a 400 ft ribbon about 200 ft off shore on this same side of the island. It, too, naturally is barren of fishes.

Examined some of the "other fishes" from.Bird Key. one *S. raphidoma* and several of what appear to be *Euleptorhamphus*. Preserved and pickeled for study.

While working on the above compared with a *S. raphidoma* taken on June 1 found several argulids (?) on it. Removed and preserved. They were on dorsal, sides and both pectorals.

Set the gill net near the dock after dark and caught 10 *S. raphidoma* in a few minutes of the same size as last night. Reset the net and retired at 10:00.

Good weather ahead?

June 29 — Turned out 6:00. Got 6 more *S. raphidoma* in the gill net and 1 *Caranx ruber*. 86
The following data was taken from the *S. raphidoma*.

	Sex	s. d.	t. l.
1	♂	505	567
2	♀	605	670
3	♀	620	694
4	♂	480	540
5	♀	554	625
6	♂	513	575
7	♂	557	577
8	♀	525	598
9	♀	530	560
10	♀	560	575
11	♀	560	627
12	♀	530	560
13	♀	517	589
14	♀	532	565
15	-	not measured (average)	
16	-	not measured (average)	

More *Filaria* were found, in the ♀ ovarian lumen in the connective tissue covering the kidney and one in the muscle tissue of the back. Those in the kidney connective tissue were covered by a sac probably produced by the fish like a plant gall.

Cestodes were common in the intestinal tract.

Saved some heads and tails. Made some osteological preparations.

87

Color notes assembled

		No. figs.
Parexocoetus mesogaster	13 to adult ♂ & ♀	3
Cypselurus furcatus	15 to 98	7
Strongylura raphidoma	65 to 555	3
Strongylura notatus	30 to 175	12
Strongylura ardeola	60 to 300	2
Hemirhamphus brasiliensis	8 to 35	3
Coryphaena hippurus	26	1
Sphyraena barracuda	24	1

Kidneys preserved in Bouin

Sphyraena barracuda large and small
Lactophrys bicaudalis
Strongylura raphidoma
Caranx ruber
Strongylura notata

88 The men caught a number of *S. ardeola* by seine. These were taken exactly where a number of *S. notatus* were before. Each time a pure culture. This checks with the schools swarming about us as noted from the government dock previously. Figured in color. This fish had its intestinal tract packed with "palola" worms which swarmed last night. Dr. Groves observed this. The night before was not a full swarm. The *S. raphidoma* contained none showing that the swarm occurred prior to their capture. Some of these fish also contained the *Scalex polymorphus* as usual.

The *S. ardeola* were all packed with Palola. All were males (12) except 2 which were mature ♀. The mature fish measured as follows.

♀ 327 mm s. l.
♀ 263
♂ 301, 288, 280, 283 mm s. l.

From these down to the smallest 201 they were all immature but rapidly coming to it.

The iris of this species is even more peculiar than those of the other two. If
89 this is the fish Gudger◊ called "*marinus*" he missed most of it. There is of course the dorsal "sunshade" as described by him which is fixed but the eye colors from below so that in a strong light the pupil is as below. [ILLUSTRATION A] This can be seem in an aquarium and apparently protects from the light reflected from the light sandy bottom over which these fish lay. In a dim light or relaxed in death the eye opens up as below. [ILLUSTRATION B] There is a point of bending or fracture that the iris operates from indicated by the 2 arrows and the position of the 'stopped down' eye. This doubtless protects the eye from glare and at the same time still gives the greatest amount of light possible in watch for gray enemies in a blue haze such as *Sphyraena*. Other species ot the very young of these were not observed to possess this feature.


[ILLUSTRATION A]


[ILLUSTRATION B]

Made photographic records of *S. raphidoma* and *ardeola* in regards eye condition and *Filaria* incysted [?] in the kidney mesentery.

Spent the entire day working on this material.

In the evening took the Velella over to the fort where Belonids were known to be common. Set the gill net. Not a *Strongylura* could be seen by light or were any caught. It would seem they move off from here at night. Some *Selar crumenophthalmus* were caught. A very large *Sphyraena* was seen under the dock.

90 Turned in 11:30.

◊ [1929 reference.]

June 30 Turned out 6:00.

The men attempted to catch some more needlefish by seine in the place they got *S. ardeola* yesterday. No success however.

Spent the A. M. in the lab. making osteological preparations, etc.

Two pail fulls of fish came from Bird Key at noon. Again about $^3/_4$ were Exocoetids of the 2 species. The rest were made up of the usual miscellaneous stuff.

The men collected 6 *Strongylura ardeola* where they tried this A. M.

♀	248	mm s. l.
♂	260	
♂	258	
imm.	228	
imm.	220	

The floor of the mouth of all of these is a brilliant blue (like the upper beak of *S. raphidoma*). The following data was taken on the *Cypselurus furcatus* brought in from Bird Key.

110 mm s. l. - coloration as in the copperplate [?] 91

110 mm s. l. (another) still showed white belly, bands and wings not completely with adult pattern.

98 mm and under all definitely immature.

Tried to fertilize eggs of *S. ardeola* but they were too green even to water harden properly.

Spent the P. M. in the laboratory doing the above and making more osteological preparations.

One of the men brought in a *Sphyraena barracuda* 516 mm s. l. 602 t. l. imm. ♂. Prepared head and tail for osteological studies.

In the evening set the gill net on.Brilliant Shoal. No luck. A single small shark bumped into the net while it was being set but no other fishes were noted.

The sun showed "the.green flash" as it went down tonight very well.

Odontocellus were particularly abundant on.Brilliant Shoal first lighting up on the bottom and then rising to the surface for purposes of mating. Wonder if this is the reason for the name of the shoal?

Turned in 11:00 with the wind rising a trifle.

July 1 Turned out 7:00. 92

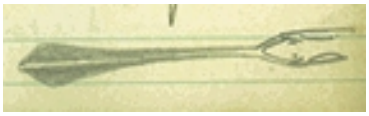
Spent the A. M. in the lab working on various minor details.

In the afternoon took the Velella out past buoy N.10 in search of Exocetids. Little gulf weed was seen but a fair number of very small *Cypselurus* were gathered. Also a good series of very small *Parexocoetus*, some *Hemirhamphus* and some *Strongylura ardeola* (all small).

One *S. ardeola* of 41 mm s. l. had the silver spots of the color plate almost gone.

The largest *Hemirhamphus* was colored essentially as shown in the color plate but the bars were broader and reached from dorsal to ventral surface and bolder. The sides were generally more silvery and the tail more brilliantly red. There was a dark median band down the belly from throat to tail. The beak had flaps essentially like those of *S. raphidoma* at the apex of their development. Unfortunately this beak was broken and lost in transport but it looks from above as follows. One specimen at the length of 13 mm s. l. had largely lost its strictly juvenile coloration and was approaching the next phase, just discussed.

93 Saw but one adult Parexocoetid.



Kyphusus incisor and *sectatrix* are valid species. *Incisor* has a forked tail and *sectatrix* a slightly lunate one. The dorsal of incisor is also higher and there are other minor differences. Apparently we have been getting *incisor* at the aquarium under the name of *sectatrix*. The incisor lives all around the reefs and *sectatrix* is known only from the immediate vicinity of the lab dock.

Set the gill net about 1 hour before sunset. At 7:30, about, 15 minutes after sunset, it had caught 1 needlefish although it was still light. By 9:00 after it was dark it had caught 6 more. By 8:00 although still a weak light they could be seen jumping in large numbers. This it is indicated that they migrate shoreward just as soon as the light begins to fade which is sooner under water than above of course, also that absolute darkness is not necessary for the working of the gill net.

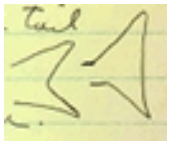
94 Billy Mills caught a *Hypoprion brevirostris* 1255 mm long off the dock late at night.

Turned in 10:30.

July 2 Turned out 7:00.

Over night the gill net caught little, 1 *Strongylura*, 1 *Haemulon sciurus*, 1 basket star and a small crab. The star wrapped the net up as a long cord which accounts for the poor catch of needlefish.

Spent the A. M. working over material. Tried to inject a needlefish without much luck.



In the afternoon took the Velella out heading for Pulaski Shoal but found such an abundance of weed near the red buoy between Loggerhead and Garden Keys that the afternoon was spent there. Got a great series of *Hemirhamphus* in the various young stages as well as the usual Exocoetid material.

Picked up a *Halocystis* [?] for Dr. .Blinks. Preserved about half of the fish material. The rest alive in the aquarium. The water was dead calm and very hot. Collecting was easy sometimes as many as 10 young *Cypselurus* being taken at one dip of the net; as many as 30 young *Hemirhamphus*. *Strongylura ardeola* (?) young seem always to be solitary. Saw a *S. raphidoma* at least at least a foot long colored rather like the small weed inhabiting stage. The body was tan and the beak, where blue in the larger freer forms, was brick red. Smaller specimens than this, not in the gulf weed but around docks (8" or less) resemble the larger ones much more than did this.

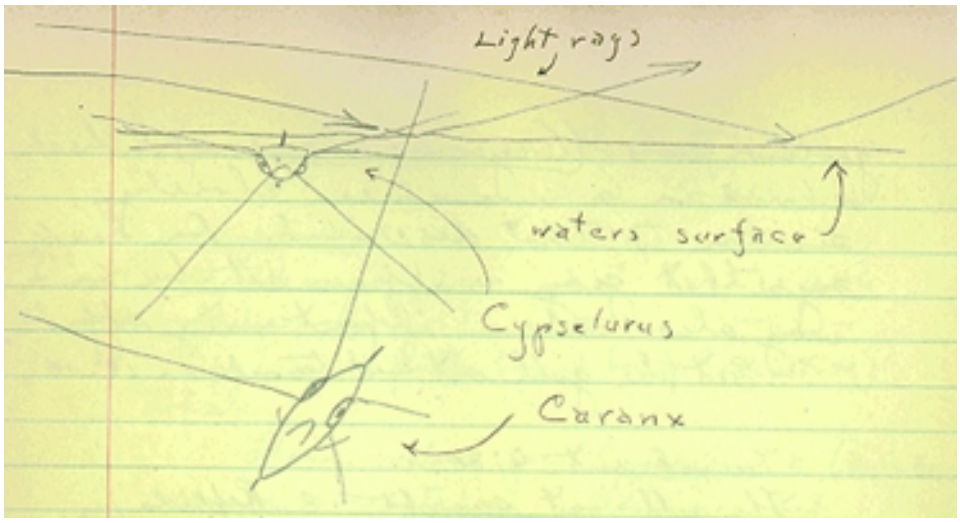
95 To all intents and purposes the little *Hemirhamphus* ($1\frac{1}{2}$ - 2") "fly" almost as well as $\frac{1}{2}$" *Cypselurus.* (Or are these young *Euleptorhamphus*?)

After supper went out to the same place in the "Darwin". Got some similar material but not so much of it and made the following observations.

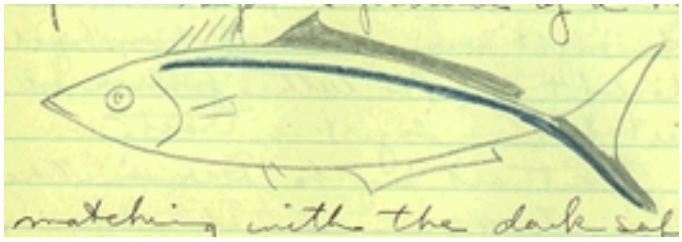
As the light becomes very oblique just before sunset the schools of small *Hemirhamphus* and *Cypselurus* break up and they appear as scattered individuals searching the shelter of the weeds. This checks with aquarium observation. At this same time schools of *Caranx* became active. They played all about the boat and made much trouble for the little Synentognathi. They were seen to catch many. On several occasions they "flushed" some of the larger (2 - 3") *Cypselurus* and followed them along in a pack underwater only to gobble them up when their aerial excursion was spent. More frequently the *Cypselurus* would dash into a bit of weed and elude pursuit but even here they were not entirely safe as if the *Caranx* were close on their "back" they would tear right into the weed and dislodge the flyer.

All this is interpreted as follows. Parr's hypothesis* about the breaking up of schools holds here in this group in which the schooling habit is not very strongly developed. As soon as the light begins to fade this occurs and the shelter of the weed is sought. The flying fish being at the surface cannot see down into the water any too well at this time of day with the nearly horizontal light rays reflecting from its surface whereas the Carangids further down looking upward can see the Exocoetids silhouetted against a still relatively bright sky. This time of day is an especially weak chaing for the young Synentognaths despite their downwardly directed eyes. 96

A figure of the conditions follows.



The Carangidae (*Caranx ruber*) showed a definite ruptine pattern of a black and blue line as shown here the lower caudal lobe matching with the dark soft dorsal in black and with a sub-dorsal band in blue. This was not previously noted. 97



Two large Exocoetids swam close to the boat (7 - 8"). They are exceedingly fast. 98

A small *Seriola* was taken in the weed.

Shortly after the sun actually sets there is little activity and things settle down pretty much.

While making these observations we drifted over a shallow reef - 10-15'. The *Caranx* disappeared but were replaced by a large school of yellow tails (*Ocyurus chrysurus*) which behaved in a manner closely similar to that described. Dr. Longley says that gray snapper act the same way also when opportunity affords.

Set the gill net and turned in 10:00.

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* [1927 reference.]

July 3 Turned out 6:30.

The gill-net caught 3 *Raphidoma,* 1 *Haemulon sciurus*, 1 *Sphyrna tiburo*. Data on the latter ♀ 922 mm. The right ovary contained 4 embryos and the left 5. The latter preserved intact. Cestodes in digestive tract.

Went out on the Darwin in the channel again searching for Synentognathi. None could be seen. The weed was still about but no fish. A slight breeze had spun up and the surface was rippled. Why this sudden disappearance? Got one young *Trachinotus falcatus*. In the floating trap were 2 young *Caranx ruber* about 4' s. l.

Two buckets of fish came from Bird Key again. This time there seemed to be a larger proportion of non-Exocoetid material than previously. An attempt was made to get a little statistical data on the frequency of species. The data follows.

99

	Whole	Head	Middle	Tail	Total
Cypselurus furcatus	52	5	7	69	133
Parexocoetus mesogaster	92	25	21	246	384
Halocypselus evolans	1	-	-	-	1
Scraps (unidentified beyond being Exocoetids)					60
Total					578

These values for *Cypselurus* and *Parexocoetus* may be corrected as follows. Let:

A = whole fish
B = tails
C = heads
D = middles

B must represent whole fish. C and D may or may not on a 50% probability therefore - $^1/_2$ of them.

$$A + B - \frac{C + D}{2} \text{ for each species}$$

To this add a proportional part of the scraps on the assumption they occur in the same frequency.

By this means the following corrected values.

Cypselurus	164
Parexocoetus	450

The other fishes are being studied by Dr. Longley.

The single *Halocypselus* is a new record for the Tortugas. Two small *Cephalacanthus* of about 1" were also taken.

Spent the P. M. engaged on this work. Set the gill net about sunset.

100 Turned in 9:30.

July 4 Turned out 7:00.

Billy Mills caught a *Carcharhinus platyodon** ♀ 905 mm t. l. The description checks but the first dorsal base is not extended backward further than the pectoral tip. Probably a young character.

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* NOTE: May be *Carcharhinus leucas*, the bull shark. Its invalid name was *Squalus platyodon*.

The gill net caught 3 *S. raphidoma* and 1 *S. acus* and 1 basket star. The catch of the night before also held an *acus*. These fish are colored almost exactly like *S. raphidoma*. If anything a little bluer in tint on the back. This is doubtlessly variable however. The gonads of the fish caught today are well advanced ♀ and probably this species mature at an earlier size than *raphidoma*. All of yesterday's and today's preserved in alcohol except the following of which the heads and tails were preserved in formalin.

S. raphidoma.

♂ 550 mm s. l.
♂ 530
♀ 535
♀ 526
♀ 498
♂ 479

101

Spent the A. M. working over this stuff.

In the P. M. visited Bird Key Reef. Collected a quantity of invertebrates as souvenirs. Went over reef with water glass.

Saw the young of *Pomacentrus fuscus*. They have brick red backs and blue points on their faces. Very different from *P. leucostictus*. They also have a dark ocellus on the dorsal.

The young of *Halichoerus radiatus* has 2 yellow stripes on the lower sides and light blue cross bands across the back and a dark saddle in the middle of it. Very handsome.

Spent the evening cleaning up the souvenirs

Set the gill-net by the dock and retired 10:30.

July 5 Turned out 6:45.

The gill-net held:

1 *Trachionotus falcatus* (2' s. l.). This had an odd injury - a huge bite out of the anal and body just past the vent which had healed completely but over which scales had not grown - just smooth skin.

3 *Strongylura raphidoma* 580 mm s. l. ♀; 510 mm ?; 640 mm ♀. The ventricle vary in between caudal and back of eye to $^1/_2$ its diameter further back.

1 *Selar crumenophthalmus*[*] [?]

102

1 *Sphyrna zygaena* 2,200 mm t. l. This contained a mature ♀ *S. raphidoma* bitten in two pieces. The head piece measured 446 mm and the 358 mm s. l. making a fish 804 mm s. l. ±. The ovaries were dead ripe. The ovarian eggs measured 3.7 mm ± in diameter on the average.

1 *Bathystoma rimator*

Spent the morning working over this stuff.

The men collected 6 *S. notatus* and 1 small *S. raphidoma* (230 mm) near the lighthouse dock.

Watson, J. B. "The Behavior of Noddy and Sooty Terns." Paper Tortugas Lab., Pub. No. 103 - VIII says Man-of-war birds live chiefly on flying fish.

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[*] NOTE: Could be *Trachurops crumenophthalma* (Longley and Hildebrand, 1941). There is also a valid species named *Selar crumenophthalmus.*

An octopus about 6" long ate one of the *S. notatus* in the aquarium. It cleaned off the vertebral column and ate the eyes leaving a good skull.

Spent most of the P. M. packing things together for shipping.

Set the gill-net.

Turned in 10:30. A nurse shark played around the dock in very shallow water.

103 July 6 Turned out 7:00.

It rained during the night.

The gill-net contained 1 *Strongylura acus* only! 660 mm s. l. nearly spent ♀. Only right ovary could be found. Badly inflamed far posterior half. Would appear to have just spawned. Curious whitish green bodies present - break down products of *Filaria*?

Took the Velella out and got a very small series of Synentognaths. The weed, both sargassum and stick weed was abundant but relatively little was in it. Took some pictures of the stuff.

Shoved off the VanDyke after lunch

Went to Bird Key reef in the P. M. Collected some shells, etc. Saw a *Scorpaena plumieri* caught in a tide pool.

Set gill net.

Turned in 11:00.

July 7 Turned out 7:00.

Gill net caught a *Pricanthus* and one *Strongylura raphidoma* ♀ mm 632 mm s. l.

Spent the A. M. finishing packing. Rain in the night - sea rough.

One half a pail of fish came from Bird Key in the P. M. Half of this was Exocoetid. The rest misc. One *Hyporhamphus unifasciatus*. Apparently the birds are not so wastefull when the young get larger. Probably the little ones are more able at picking up and more alert. All of this material was dried. None fresh and doubtlessly represents old accumulations.

104 Visited the light house and took some pictures from its top.

Took a last swim before supper and finished packing after it.

A storm seems to be blowing up.

Staid up till 2:00 A. M. with the boys before departing.

July 8 Left Dry Tortugas 8:00 A. M. on the "Anton Dohrn". The storm came up and it got very rough. Was genuinely sea sick for the first time in my life. Was "afraid I was going to live". No flying fish were seen whatever. Apparently altogether too rough for them to fly. Rain most of the way.

Arrived Key West 3:00. Still raining - steadily - which is unusual for this place. Took the Havana Special for Miami 6:00 P. M. Arrived 10:35. Put up at the Hotel "MacAllister" - all in.

105 July 9 Spent A. M. and P. M. looking Miami over - All right but not very wonderful - that is the city. Got aboard the "S.S. Mohawk". She set sail 4:45. Made an Exocoetid observation just outside the channel as the taffrail log was set - about 10 miles from shore.

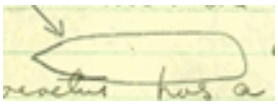
These observations may be listed as follows pending further expansion later.

	Date	Hour	Count Port	Count Star	Port	Star	Remarks
1	July 9	5:45 P.M.	5	19	5-8"	5-8"	Strong wind on Star. Little gulf weed.
2	July 10	11:50 A. M.	1	15	7	5-8	
3	July 10	2:45 P. M.	2	6	5-8	4-8	
4	July 10	5:35 P. M.	2	7	7	5-8	
5	July 11	8:45 A. M.	-	-	-	-	
6	July 11	11:45 A. M.	8	8	5-8	5-8	Wind dead ahead
7	July 11	2:20 P. M.	-	-	-	-	

Feel better from yesterday's experience but am still weak and have sore "insides" and throat. 106

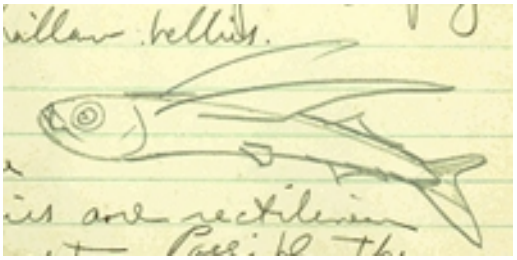
Turned in 10:00.

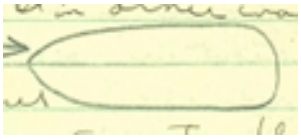
July 10 Turned out 7:15.



Spent most of the A. M. working up notes for a report of the work etc. The weather is rough and squally and Exocoetids are scarse.

Made observation #2 at noon. The wind was on the starboard bow as diagrammed. With the benefit of recent studies I can now say that Parexocoetid has a blue back and slightly dusky pectorals whereas *Halocypselus* has a green back and its tiny ventrals can be seen way up under the pectorals and standing out just the same. Its body tends to droop caudad - (because of the lack of posterior support -?) It really looks like a sick fish in flight with a hollow belly. This gives an idea whereas the other species are rectilinear from fore to aft. Possibly the 2 species of *Halocypselus* may be separated in flight on a basis of light and dark wings. This one had chiefly dusky wings and consequently should be *H. evolans*.





A few *Tursiops truncatus* were seen. 107

Made observation #3 at 2:45. The wind had shifted (or the course was altered) as below. In other words nearly dead ahead. Note differences in figures. Few were seen to fly ahead of the ship as might be expected, with such a wind. A *Cypselurus furcatus* (probably *furcatus*?) [?]. still in the mottled phase that looks brown in the air were seen.

Sargassum is scarse but in wind rows. These are in all cases perfectly parallel to the wind. Explain that!

Took a rest in the P. M.

Conditions static when observation #4 was made.

Read in the evening.

Turned in 9:30 P. M.

Ships data 12:00 noon. Bar 30:32. 82 °F. 79° 06 W 31° 14' N.

July 11 Turned out 7:30.

Made statistical observation #5 at 8:45. No fish seen. Water greenish. No gulf weed. Passed out of stream? Wind now on port bow.

108 Whales reported but not seen.

Later got a good close up view of a large sperm (?) whale.

Made observation No. 6 at 11:45. Fish have appeared again and the water is bluer - it would appear that we are in some northward diversion of the.Gulf Stream again. Note that the count is exactly even - 8 each side and the wind absolutely dead ahead.

Petrels about in a few numbers.

Made observation #7 at 2:30. No fish, weed absent and water greenish again. Finally out of the Gulf Stream. Ship's position at noon. 36° 32' N 74° 20' W. Bar. 30:32 82 °F.

More whales were reported. Porpoise about in large numbers.

Took a rest in the P. M.

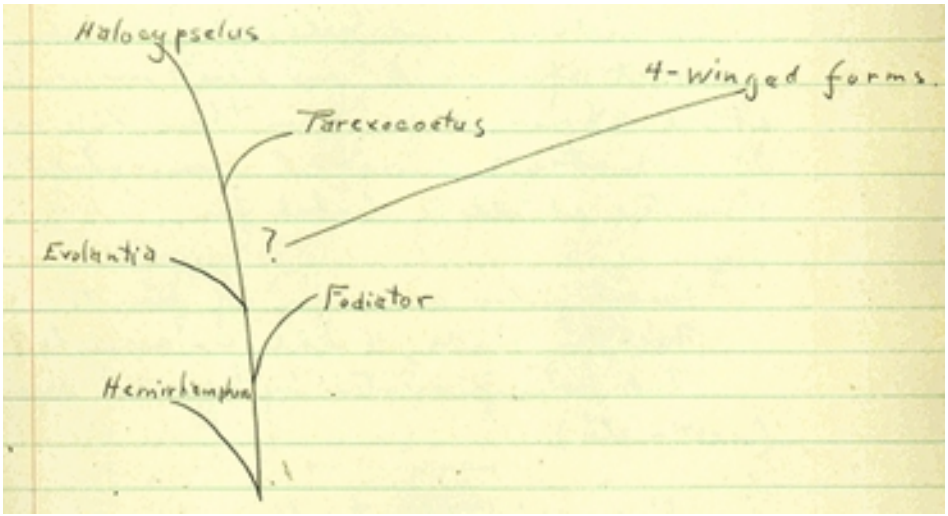
Turned in 11:30.

July 12 Turned out 5:30.

Docked 6:00 (7:00) daylight time.

109 Some General Considerations

Parexocoetus with its unspecialized young probably represents an ancestral type. *Cypselurus* with its highly specialized young a late modification taking advantage of the *Sargassum* (adaptive radiation). The young of *Parexocoetus* more nearly resembles the young of *Hemirhamphus* than it does *Cypselurus* (both in behavior and appearance). A series of larval forms? *Hemirhampus*, *Fodiator Evolantia Parexocoetus Halocypselus***?**



The following extremely tentative hypothesis may be considered in connection with this matter of the specialization of larval fishes as opposed to the primitive condition of the young in many other groups. Animals may be:

110 Most specialized or most numerous at the weakest links in their life history (or put another way - at the time when protection is needed most - specialization a direct function of the disadvantageous factors of the environment).

E.g.

Pelagic larvae very specialized or exceedingly numerous.

Adult birds most specialized.

Tadpoles not specially protected often specialized.

Considered inversely animals may be:

Least specialized or least numerous at the strongest point in their life history. At such stages ancestral non-adaptive characters should be looked for.

E. g.

Larval fishes cared for by parents.

Nestling birds, suckling mammals.

Tadpoles protected by special arrangements (nest - etc.)

Supporting this to have a grain of true in it as modified by other factors let us carry it over into phylogeny.

Then it would follow that groups of animals may be:

Least specialized when aggression and the xxx [?] "selection" etc is weakest (the species strongest time).

Most specialized when aggression is strongest (the species weakest time) measured by an increase in specialization and numbers - failure to do this means virtual extinction. 111

Dinosaurs etc most numerous in species and numbers just before extinction in response to the changing environment which they finally could not keep up with.

s. l. mm *S. notatus* June 7, 1929
129, 125, 134, 127, 126, 120, 135 Loggerhead Key

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Record for S.S. Mohawk.

Observation	Hour (Middle of half hour observation period)	Date	Latitude (North)	Longitude (West)	Wind Vel.	Wind Direction Rel.	Wind Direction Stat.	Barometer	Temp Air	Temp Water	Ship's Course Specific. ~~Gr~~	pH value Ship's Speed	No of fish counted Rel.	No of fish counted Stat.	Est. length of fishes (inches) Rel.	Est. length of fishes (inches) Stat.	Calculated Population
1	5:45 P.M.	July 9											5	19	5-6	6-8	
2	11:50 A.M.	July 10											1	15	7	5-8	
3	2:45 P.M.	July 10											2	6	4-5	4-8	
4	6:35 P.M.	July 10											2	7	7	5-8	
5	8:45 A.M.	July 11											—	—	—	—	< 1
6	11:45 A.M.	July 11											8	8	5-6	5-8	
7	2:30 P.M.	July 11											—	—	—	—	< 1