LIBRARY AND INFORMATION SERVICES DIVISION

D-40

Current References
(97-1)

SCIENTIFIC STUDIES ON DRY TORTUGAS NATIONAL PARK:

An Annotated Bibliography

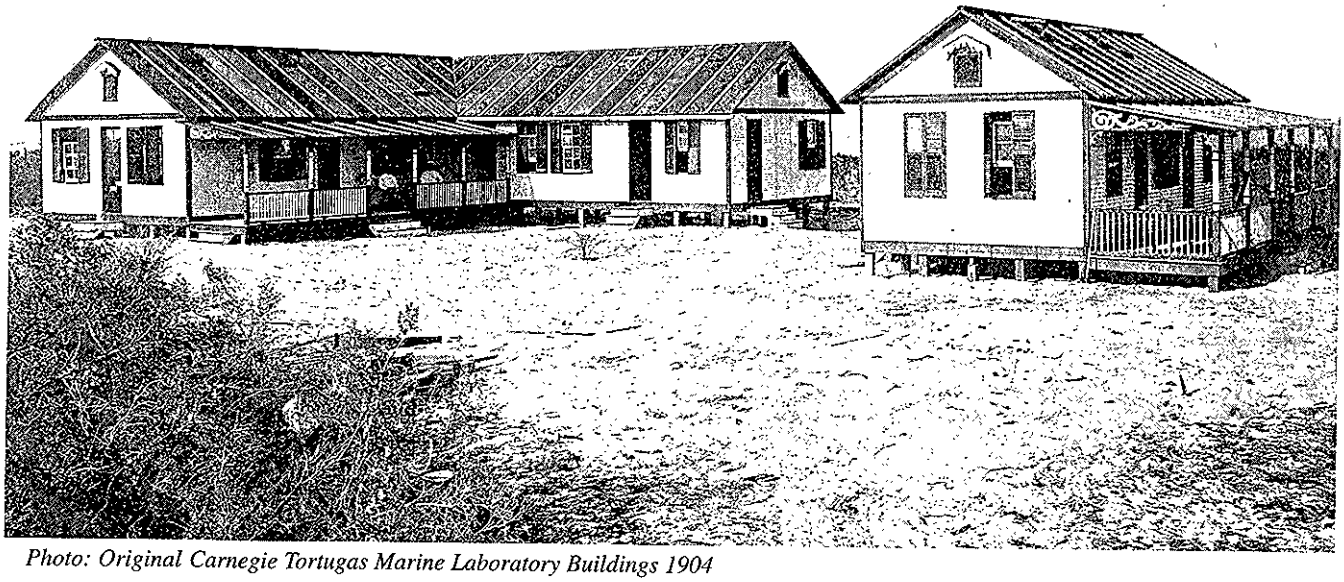


Photo: Original Carnegie Tortugas Marine Laboratory Buildings 1904

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration,
National Oceanographic Data Center and Department of the Interior
National Park Service

1997

PLEASE RETURN TO:

TECHNICAL INFORMATION CENTER
DENVER SERVICE CENTER
NATIONAL PARK SERVICE

Scientific Studies on Dry Tortugas National Park: An Annotated Bibliography

by

Thomas W. Schmidt
Marine Biologist
National Park Service
South Florida Natural Resources Center
Everglades National Park
40001 State Road 9336
Homestead, Florida 33034

Linda Pikula
NOAA Regional Librarian
NOAA Regional Library
4301 Rickenbacker Causeway
Miami, Florida 33149

Table of Contents

Acknowledgments
Abstract
Background
Purpose
Methodology
Literature Cited
Maps of Dry Tortugas National Park
Bibliography
Author Index
Subject Index

Acknowledgments

This report has benefited from the help of many people over the past 6 years. The original project was prompted and supported by Dr. Michael Soukup during his tenure as Director of the South Florida Natural Resources Center. Wayne Landrum, Facility Manager and Carolyn Brown-Wiley, Chief Ranger at Dry Tortugas National Park provided logistical support and took special interest in providing guidance to the pertinent files at Fort Jefferson. Ray Bowers, John Strom, and Pat Craig of the Carnegie Institution in Washington, D.C. permitted us to search their Tortugas Laboratory files, assisted in duplicating activities, and provided insightful discussions and original photographs of the Marine Laboratory.

We thank George Stepney and Maria Bello of NOAA's Regional Library in Miami for acquiring many interlibrary loans. Special recognition goes to the staff of the South Florida Natural Resources Center including Marnie Lounsbury for photocopying and collating much of the Carnegie texts, Barry Wood who produced the map figures, and Mario Alvarado who expertly produced the author and subject indexes using PROCITE. Dr. William B. Robertson, Jr., United States Geological Survey/Biological Resources Division contributed numerous references and provided encouragement during the earliest stages of the project

Valuable comments were provided by Elaine Collins of the NOAA Central Library, Silver Spring, MD and Bob Hamre, former technical editor for the US Forest Service, assigned to the Beard Center under the NPS "Volunteer-in-Parks." program.

Finally, our thanks to Carol Watts, Chief of the NOAA Libraries and Information Science Division, Janice Beattie, Chief of NOAA Libraries Public Services Division, Dr. Tom Armentano, Chief of Biological Resources, South Florida Natural Resources Center, and Dr. Caroline Rogers, United States Geological Survey/Biological Resources Division for their financial support and encouragement.

Abstract

Dry Tortugas National Park, located 110 km west of Key West, Florida, is an elliptical, atoll-like, coral reef formation, approximately 27 km long and 12 km wide with shallow water depths ranging from 12-20 m in channels between reefs. In 1935, the area was designated Fort Jefferson National Monument, the World's first underwater National Park unit. Central to the area is Fort Jefferson, America's largest coastal nineteenth century masonry fort. In 1992 it was re-designated Dry Tortugas National Park. Because of the islands' unique location, the first tropical marine biological laboratory in the Western Hemisphere was established on Loggerhead Key by the Carnegie Institution of Washington, Washington, D. C. Following the closure of the Tortugas Laboratory in 1939, aperiodic marine biological assessments have been conducted in response to man-made and natural environmental perturbations. This annotated bibliography is an attempt to provide researchers and resource managers with access to the rapidly accumulating body of information on the park's natural resources. A total of 424 references (published and unpublished) on scientific studies in, (and what later became) Dry Tortugas National Park were annotated and indexed according to major scientific topics. Studies from a wider area were included if they also sampled in Dry Tortugas National Park.

Background

Seven small islands composed of coral reefs and sand in the eastern Gulf of Mexico, approximately 110 km west of Key West, Florida comprise Dry Tortugas National Park. The Tortugas, an area known for its bird and marine life and shipwrecks, are an elliptical, atoll-like, coral reef formation, approximately 27 km long and 12 km wide with water depths ranging from 12-20-m in channels between reefs.

The Dry Tortugas, discovered by the Spanish explorer Ponce de Leon in 1513 and named The Turtles, *Las Tortugas*, were soon read on early nautical charts as "Dry Tortugas" to indicate they lacked fresh water. Central to the area and located on Garden Key is Fort Jefferson, America's largest coastal nineteenth century masonry fort. Work was begun in 1846 and continued for thirty years but was never finished. As part of the United States coastal fortification buildup after the War of 1812, Fort Jefferson was considered critical for protecting Gulf trade and ports (Murphy, 1993).

Following the Fort's use as a military prison during the Civil War (where the infamous Dr. Mudd was imprisoned after President Abraham Lincoln's assassination in 1865), and its abandonment by the Army in 1874, the area was proclaimed a wildlife refuge in 1908, to protect sooty tern rookeries from egg collectors. In 1935, the area was designated Fort Jefferson National Monument, the World's first underwater National Park unit. In 1992 it was redesigned Dry Tortugas National Park to preserve and protect both historical and natural features.

Early descriptive observers of Dry Tortugas natural resources include Louis and Alexander Agassiz during the 1850's, and the research vessel Blake in 1877 and 1878. Their visits resulted in a detailed map of the islands, and a description of benthic marine communities by Agassiz in 1888.

In 1903, Alfred G. Mayer, under the auspices of the Carnegie Institution of Washington, recommended that a tropical marine biological research laboratory be established at the Tortugas (as opposed to other Caribbean sites) because of their isolation from continental land masses, lack of commercial fisheries, lush reefs, clear waters and proximity to the Gulf Stream. In 1904, Mayer selected Loggerhead Key as the site for Carnegie's Tortugas Marine Laboratory, the first tropical marine laboratory in the Western Hemisphere. Following the closure of the Laboratory in 1939, relatively few investigations were conducted in the Tortugas until the National Park Service (NPS) began in 1975, a series of cooperative, bench-mark studies to evaluate long-term changes in marine resources in combination with the earlier Carnegie Laboratory studies. Since the initial Tortugas Reef Atoll Continuing Transect Studies (TRACTS) work of 1975-76, aperiodic biological assessments have been conducted in response to man-made and natural environmental perturbations

Purpose

The primary purpose of this annotated report is to provide researchers and resource managers with a readily accessible document on the rapidly accumulating body of information on the natural resources of the Dry Tortugas. With the recent implementation of the Florida Keys National Marine Sanctuary, adjacent to the Park's boundary, there is a dire need for a scientific database that is centrally located, coherently organized, and directly related to the future and ongoing management and regulation of marine resource activities.

No complete bibliography of the scientific studies on the park's marine and terrestrial natural resources has been undertaken. In this report we have attempted to list published and unpublished reports from many fields which we feel will be useful as a starting point for natural science studies to be conducted at the Dry Tortugas for decades to come.

Methodology

The present bibliographic database containing 424 references was compiled using PROCITE software, and covers the period of approximately 1878-1996, with the exception of one report dated 1820. Most 1996 papers were listed through August. Arrangement is alphabetical by senior author and title. Entries are numbered in sequence, and each includes a complete bibliographic citation with abstract or summary While some attempt has been made to achieve uniformity in style, in many cases the terminology, spelling, capitalization, and phraseology of the original author or abstractor have been retained. Abstracts obtained from the Carnegie Institution of Washington's publication citations were adapted from the author's summaries of results. This bibliography includes books, book chapters, scientific articles, theses and dissertations, workshop and conference proceedings, reports, and government publications. No attempt was made to include articles from newspapers or popular boating or sport magazines Several maps and charts are cited, however.

Research citations were indexed by broad fields of study, specialty sub-headings, and by both senior and joint authors. Each citation is listed under as many subject headings as is appropriate for the cited article. This cross indexing system was constructed using PROCITE.

The geographic boundaries for citations in this bibliography are that the work was done either completely or partially within the Park boundary, which is the 60' contour line. Recently, a few studies were undertaken adjacent to or on the Park boundary, they were included also. Although all Carnegie Institution of Washington published studies were included if they were conducted at the Dry Tortugas, those studies that were conducted and identified as solely in the "Gulf Stream" or at satellite marine laboratories in Jamaica, Trinidad, Puerto Rico, Bahamas, or in the tropical Pacific were not included

A broad range of marine and terrestrial topics were found, including vegetation, marine algae, invertebrates, sea water composition, and geology. The major topics were sub-divided into those specialty areas that are shared most often among the studies examined. For example, sea water composition was sub-divided into salinity and temperature, the parameters measured most often. In many cases, inclusion or exclusion of a given reference within a major topic area or specialty sub-heading was a subjective decision.

Literature Searched

The bibliographic search was predominantly done at South Florida Natural Resources Center Library, Everglades National Park, Homestead, Florida, and at the NOAA Regional Library, Miami, Florida. No starting date was established for the references in this compilation. The senior author began assembling marine archival materials (e.g., raw data sheets, correspondence, maps, etc.) and published and unpublished research results from major scientific studies conducted by NPS scientists and contractors working at the Tortugas. Pertinent record files were also searched at Dry Tortugas National Park

The Park Library contains a complete 35 volume set of the Carnegie Institution of Washington's Tortugas Laboratory Papers. Volumes 1-6 were titled "Papers from the Tortugas Laboratory of the Carnegie Institution of Washington" (1908-1914), while volumes 7-14 were "Papers from the Department of Marine Biology of the Carnegie Institution of Washington" (1915-1926), Volumes 15-29 were issued as "Papers from Tortugas laboratory of Carnegie Institution of Washington" (1928-1936) and volumes 30-35 were titled "Papers from Tortugas Laboratory" (1936-1942). Each volume was given a separate publication number by the Carnegie Institution.

The Year Book Series of the Carnegie Institution, which contains annual summaries by individual investigators on observations and results obtained during their visits to the Tortugas, were searched at the University of Miami's Richter Library, Coral Gables, Florida. The Richter Library contains volumes 1-12, and 20-32. Copies of annual investigator reports for volumes 13-19 and 33-39 were obtained from the Carnegie Institute of Washington, Washington, D.C. In nearly all cases it was found that the principal investigators published their final evaluations and conclusions in "Papers", while the Year Book contained mostly duplicative, preliminary, or unsubstantiated observations. For these reasons, and due to time constraints, we decided to cite only Year Book contributions for investigators who did not complete and publish their conclusions in the "Papers" series. For example, W. H. Longley published in both series, but is only cited in this bibliography under "Papers" (however, his Year Book citations can be found in the "literature cited" section of his contributions to "Papers"). S. Yamanouchi, however, only published in the Year Book, and is cited here as such.

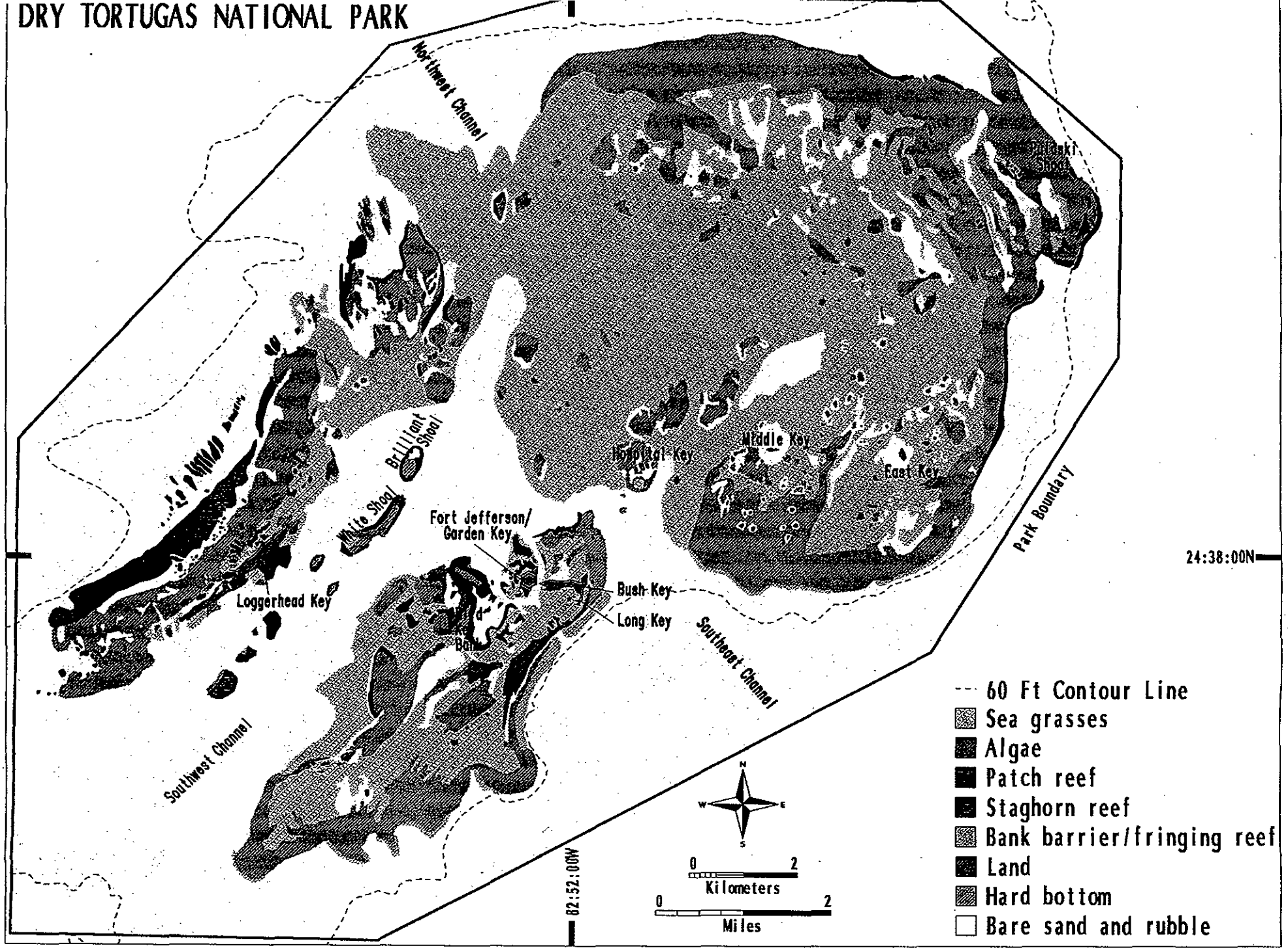
We searched documents regarding the Tortugas Laboratory during two visits to the Carnegie Institution in Washington D.C. Work conducted at the Tortugas Laboratory has been published in a wide range of journals. For example, a list of scientific writings produced by activities at the Laboratory during Mayer's directorship can be found in Papers Tortugas Laboratory 19:80-90. Many publications continued to appear in the literature following the closure of the Laboratory in 1939.

On-line database searches were conducted during 1993-96 at the NOAA Miami Regional Library. Subject index terms such as coral reef, geology, vegetation, marine algae, fish, etc., were used to search on a variety of DIALOG electronic databases including the following: BIOSIS PREVIEWS, Dissertation Abstracts, Oceanic Abstracts, SCISEARCH, Ei Compendex, INSPEC, and GEOBASE. These individual CD's were also searched: Aquatic Sciences and Fisheries Abstracts, Life Sciences Collection, Earth Sciences, GeoRef, NTIS (National Technical Information Service), GPO (Government Publications Office), and the OCLC (Online Computer Library Center) on-line catalog.

Pertinent theses, dissertations, and journals identified in the abstracted literature were obtained via interlibrary loans.

This current compilation undoubtedly does not list all available literature that might be useful in conducting research, monitoring, and resource management of the park's natural resources. There may be as many as 100 additional scientific papers generated from the Carnegie era. We would greatly appreciate additional references to the Tortugas literature, and if a sufficient number of additional articles become available, we will produce an addendum to this report.

Map compiled by G.E. Davis, Everglades National Park, Homestead, FL, 1976; published by New Orleans Outer Continental Shelf Office, BLM, 1979.


DRY TORTUGAS NATIONAL PARK
Northwest Channel
Pulaski Shoal
Brilliant Shoal
White Shoal
Hospital Key
Middle Key
East Key
Fort Jefferson/
Garden Key
Bush Key
Long Key
Loggerhead Key
Southeast Channel
Southwest Channel
Park Boundary
24:38:00N
82:52:00W
N
W
E
S
0
2
Kilometers
0
2
Miles
60 Ft Contour Line
Sea grasses
Algae
Patch reef
Staghorn reef
Bank barrier/fringing reef
Land
Hard bottom
Bare sand and rubble

ANNOTATED BIBLIOGRAPHY

1. Agassiz, A.. 1888. The Florida reefs. *Three cruises of the United States Coasts and Geodetic Steamer 'Blake' in the Gulf of Mexico, in the Caribbean Sea and along the coast of the United States, from 1877 to 1880.*, V. I, Chapter 3, pages 52-92. Houghton, Mifflin and Co. New York. 314 pp.
   While the Steamer "Blake" was mostly involved in deep water dredging operations in the Gulf of Mexico and the Caribbean Sea (1877-78), a five-week visit to Fort Jefferson (Dry Tortugas) provided the author with an opportunity to work in a laboratory-like situation, to examine carefully the topography of the different groups of corals characteristic of the Florida reefs and to give an extended account of the Florida reefs in a special chapter of this book. The Tortugas, as described by Agassiz, form the most recent of the cluster of the Florida reefs, and it is here where he begins a topographical sketch of the Florida reefs from the Tortugas to Cape Florida.

2. ———. 1888. The Tortugas and Florida Reefs. *Memoirs of the American Academy of Arts and Sciences, Philadelphia.* Centennial ed., V.II, :107-132.
   V.II entitled "Explorations of the surface fauna of the Gulf Stream, under the auspices of the United States Coast Survey".
   Agassiz reports on the formation of the Florida Reefs, commenting on the theories of Darwin, LeConte, and Hunt on this subject. At the time of this article it was believed that the elevation of the Florida Plateau, from Cape Florida southward to the Dry Tortugas and the Yucatan Banks, was based on the accumulation of coral sands, as well as animal debris brought to it by great Atlantic equatorial oceanic currents, the Gulf Stream and prevailing winds, and at which time, reef-building corals could flourish and a reef would be formed. They speculated that corals could not thrive below 6 or 7 fathoms, because siltation ooze would sink to the bottom and choke the corals. Coral reef formations were assumed to be established near strong equatorial currents which were suppliers of food for the reef-building corals. It was assumed that corals grow towards the surface as fast as the ooze deposited has closed up the circulation of the lower levels. At the time of Darwin little was known of limestone deposits formed by the accumulation of animal decay. Thus explanations of reef formation other than elevations as a result of submerged mountains and subsidence were not investigated. The Tortugas Reefs probably are newly developed, as they have not been above the sea long enough to have received the flora and fauna characteristic of the Keys north of Key West.

3. Andres, B. A. 1991. Migration of sharp-shinned hawks in the Dry Tortugas, Florida USA. *Wilson Bulletin* 103, no. 3: 491-93.
   Some species of hawks have been found to make long water crossings during migration. One of the species, the sharp-shinned hawk *Accipiter striatus*, seldom undertakes water crossings of >125 km. However, large numbers of sharp-shinned hawks are observed every fall in the Florida Keys including the Dry Tortugas, where water crossings are quite common. No information, however has been gathered concerning their migration after reaching the Tortugas. Based on wind speed, wind direction, and binocular observations made on Garden Key of six species of hawks (sharp-shinned hawks dominated the observations), it was found that sharp-shinned hawks are deliberately initiating an over-flight across the Gulf of Mexico directly to Central America.

4. Austin, O. L. Jr., W. B. Robertson Jr. and G. E. Woolfenden. 1972. Mass hatching failure in Dry Tortugas sooty terns, *Sterna fuscata. Proceedings of the International Ornithological Congress.* 627. Netherlands.
The author attributes a mass hatching failure among 50,000 pairs of sooty terns (*Sterna fuscata*) nesting on the Dry Tortugas to damage caused by sonic booms from low-flying military aircraft. Theoretically, eggshells and embryonic tissues should withstand pressures much greater than those generated by even the most intense sonic booms.

5. Bailey, E., G. E. Woolfenden and W. B. Robertson Jr. 1987. Abrasion and loss of bands from Dry Tortugas sooty terns. *Journal of Field Ornithology* 58, no. 4: 413-24.
During the past 25 years more than 400,000 sooty terns (*Sterna fuscata*) have been banded at Dry Tortugas, Florida, with size 3 aluminum bands of several different alloys. Based on large samples of bands removed from the terns, regression lines were established for each of four alloys. Differences in the slopes of the regression lines for certain of the four alloys demonstrated differences in rates of abrasion. Band loss was evident for bands of the fastest abrading alloy (2-SO) that were carried more than 20 yrs by terns banded as chicks because all band weights fell above an extension of the regression line. For this alloy, the plots of weight loss showed that band loss becomes significant at 86% of original weight. Bands of alloy 2-SO began reaching 86% of original weight at age 14 when placed on adults and 20 when placed on chicks. The regression lines for the other 3 alloys suggest that loss is likely after 17-28 yrs for bands placed on adults and after 20-25 years for bands placed on chicks. Band loss probably occurs through abrasion of the inner surface, which increases the inner diameter until the band can slip over the toes. Any gap that develops would hasten loss.

6. Bailey, P. L. 1938. Regeneration in sabellids. *Carnegie Institution of Washington, Year Book* 37: 84-85.
Sabellid worms collected in the moat on Garden Key proved to be suitable for fixation techniques needed to conduct various regeneration experiments to determine the effects of chemical solutions on the cells.

7. Baker, B. 1994. Partitioning the National Marine Sanctuary. *Bioscience* 44, no. 7: 497.
A management proposal is described to establish five zones in the Florida Keys National Marine Sanctuary: replenishment reserves, sanctuary preserve areas, research-only zones, wildlife management zones, and special-use zones. The Sanctuary encircles the Florida Keys, including the Dry Tortugas, for 2800 square nautical miles.

8. Ball, S. C. 1918. Migration of insects to Rebecca Shoal Light-Station and the Tortugas Islands, with special reference to mosquitoes and flies. *Papers Tortugas Laboratory* 12: 193-212. Carnegie Institution of Washington Publication Number 252.
The circumstances which suggested the desirability of such investigations were the repeated experiences of Dr. Mayer and other scientists at Tortugas, Florida, in connection with the occurrence there of mosquitoes. These insects were abundant on Loggerhead Key only after northerly winds of several hours' duration, under conditions favorable to their migration from the mainland of Florida. Rebecca Shoal light-station was chosen as the study site, because of its isolation from the mainland and other keys, and because of its freedom from all except easily controllable breeding-places for mosquitoes. It was found that large numbers of mosquitoes and house-flies are carried by northerly and southerly winds to Rebecca Shoal light-station and the Tortugas Islands from Florida and Cuba. Easterly winds bring a few of these, as well as smaller numbers of blow-flies, horse-flies, and gnats from islands east on the Florida Reef. Occasionally Odonata, Neuroptera, and Lepidoptera are carried by the winds to these parts of the reef. Sarcophagidae breed in land crabs at Tortugas .

9. Ballantine, D. L. 1996. New records of benthic marine algae from Florida. *Gulf of Mexico Science* 1: 11-15.
Seven species of benthic marine algae are newly reported from the Dry Tortugas, Florida. These are *Halimeda hummii* Ballantine (Chlorophyta), *Audouinella ophioglossa* Schneider, *Botryocladia uynnei* Ballantine, *Champia viellardii* Kutzing, *Monosporus indicus* Borgesen, *Hypoglossum rhizophorum* Ballantine et Wynne, and *Rhodogorgon ramosissima* Norris et Bucher (Rhodophyta). *Monosporus indicus* is reported for the first time from the Atlantic Ocean. The Dry Tortugas represents the northern distributional limit for the remaining species reported, except *Audouinella ophioglossa* and *Botryocladia uynnei.*

10. Bartsch, P. 1919. "The bird rookeries of the Tortugas." *Smithsonian Institution Annual Report for 1917*, 2512. Smithsonian Museum.
The author states that the most interesting island of the Tortugas group is Bird Key (circa 1908). Of the 32,810 birds listed for the islands, 31,200 center about that Key. A numerical listing of the summer birds is given. These rookeries were first brought to the attention of ornithologists by John Audubon in his ornithological biographies. He gives an account of a visit in May 1832. A first list of birds observed in the Dry Tortugas is given by W.E.D. Scott in his paper on birds observed during parts of March and April 1890. Drs. John B. Watson and K.S. Lashley of Johns Hopkins University made an extensive study of the wild bird colonies there, hoping to throw light on the homing instinct. The article ends with an extensive listing of bird sightings in the Tortugas up to 1919.

11. ———. 1920. Experiments in the breeding of Cerions. *Papers Tortugas Laboratory* 14: 1-55. Carnegie Institution of Washington Publication Number 282.
Breeding experiments were conducted to determine if various forms of *Cerion* colonies were fixed forms, that is, will generations yield the same mode in measurement, or will changes in the local environment from season to season affect the developing organisms to such an extent as to produce an unending series of slight variations? Introduced forms were placed where native species existed. Colonies of these land snails were planted on Keys in the Dry Tortugas in 1914, 800 in 1915 on Loggerhead Key, and a third planting in 1916 of 8,317 specimens. A comparative anatomical discussion of the five species of *Cerion* involved in the breeding experiments is given.

12. ———. 1915. Report on the Bahama Cerions planted on the Florida Keys. *Papers Tortugas Laboratory* 8: 203-12.
Carnegie Institution of Washington Publication Number 212.
A study is made of the two races of Bahama *Cerion* transplanted to the Florida Keys in 1912. The conditions of the *Cerion* colonies are described.. Illustrations show the extent of the changes between the first generation and the parent generation. Changes that have taken place in the second generation in shell, color and sculpture are discussed.

13. ———. 1919. Results in *Cerion* breeding. *Proceedings of the Biological Society of Washington,* 32. *Journal Washington Academy of Science* 9:657 (abstr.)
A short account is given of Dr. Paul Bartsch's report on the breeding of Cerions transplanted from Andros Island in the Bahamas to the Dry Tortugas.

14. ———. 1916. Visit to the *Cerion* colonies in Florida. *Smithsonian Explorations* 66, no. 17: 41-44.
The author visited the Dry Tortugas through the auspices of the Carnegie Institution and the U.S. National Museum to observe the transplanted Bahamian *Cerion* colonies. He reported finding many adult specimens of the first Florida generation. No adult second generation specimens were found. Four hybrid specimens between the native *Cerion incanum* and the transplanted Bahama stock were obtained.

15. Bellow, T. and C. Winegarner. 1975. Nesting of brown pelicans *Pelicanus occidentalis* on the Dry Tortugas, Florida. *Florida Field Naturalist* 3, no. 2: 47-48.
On 14 June 1974 on Bush Key, Dry Tortugas, Florida T. Bellow and C. Winegarner found 5 Brown Pelican nests about 12 feet above ground in the white mangroves (*Laguncularia racemosa*) along the north shore. Nineteenth-century records of pelicans breeding on the Dry Tortugas are ambiguous. It appears that a few pairs did breed on the Tortugas in the mid-1800's, but by late in the century none did so. This record is the first reported nesting of this species in the 20th century on these ornithologically well-known islands. Three of the nests found in 1974 contained 2 eggs each, one nest was empty, and the fifth was not checked.

16. Bellow, T. H. 1979. A cardinal at the Dry Tortugas, Florida. *Florida Field Naturalist* 7, no. 2: 31.
The southern range of the nonmigratory cardinal (*Cardinalis cardinalis*) extends through the Florida Keys, but is considered rare in Key West. An April observation of a cardinal on Garden Key represents the second published record of this species at the Tortugas.

17. Bennett, F. M. Commander. 1909. A tragedy of migration. *Bird-Lore* 11: 110-113.
On, April 14, 1909 a violent storm hit the Florida Keys, including the Dry Tortugas. An apparent bird migration was in progress at the time of the storm. On April 20th the author went to the Dry Tortugas and observed hundreds of dead birds, and tens of thousands of injured and exhausted birds. A listing of the types of birds observed is given.

18. Berrill, N. J. 1938. Budding in polystryelid ascidians. *Carnegie Institution of Washington, Year Book* 37: 85.
The area of the budding rudiment relative to the size of the parent zooid was closely related to the size of the parent zooid, and the general nature of the colony.

19. Blinks, L. R. 1926-1929. Electrical conductivity in *Valonia. Carnegie Institution of Washington, Year Book.*
Note published as follows: 1926, v. 25, p. 240; 1927, v. 26, p. 217-18; 1928, v. 27, p. 270-71; 1929, v. 28, p. 280.
This study makes use of the good supply of *Valonia* at Tortugas for studies on the variability of electrical resistance in protoplasm. Causes of uncertainty are discussed.

20. Bohnsack, J. A., D. E. Harper and D. B. McClellan. 1994. Fisheries trends from Monroe County, Florida. *Bulletin of Marine Science* 54, no. 3: 982-1018.
Fishing is an important activity in the Florida Keys National Marine Sanctuary (FKNMS). Concern exists that excessive fishing could be deleterious to individual species, disrupt marine ecosystems, and damage the overall economy of the Florida Keys. We examined data from commercial, recreational, and marine life fisheries in Monroe County, Florida. Invertebrates comprised the majority of commercial landings. In 1992, the total reported commercial landings were composed of 54% invertebrates (4.09 x 10 kg) 28% reef fishes (2.19 x 10 kg), and 21% non-reef fishes (1162 x 10 kg). In the recreational headboat fishery, reef fishes accounted for 92% of 0.107 x 10 kg average total annual landings from the Dry Tortugas and 86% of 0.201 x 10 kg landed from the Florida Keys since 1981. Average annual landings for other recreational fisheries were estimated at 1.79 x 10 kg for reef fishes (45%) and 2.17 x 10 kg for non-reef fishes (55%) from 1980 through 1992. Estimated landings from the Dry Tortugas did not show distinct trends and were highly variable. Finer resolution of catch and effort data are needed, especially for recreational fisheries. Landings for some species varied greatly over time. The most conspicuous declines were for pink shrimp, combined grouper, and king mackerel, while the most conspicuous increases were for amberjack, stone crab, blue crab, and yellowtail snapper. Landings of spiny lobster have remained constant. Fisheries closed to harvest included queen conch, Nassau grouper, jewfish, and stony corals. Effective fishing effort has increased over time with more participants and more effective fishing technology. Since 1965, the number of

registered private recreational vessels has increased over six times, while the number of commercial and headboat vessels has remained stable. The number of management actions have continually increased and become more restrictive with increased fishing effort. Comparison of fisheries was complicated because different fisheries targeted different species and different sized organisms. Also, landings were sometimes reported by numbers and sometimes by weight. Measures of reproductive value and spawning potential are suggested as useful parameters for comparing effects of different fisheries. The new FKNMS provides a unique opportunity to shift management emphasis from a species approach to an ecosystem and habitat based approach.

21. Bortone, S. A., P. Rebenack and D. M. Siegel. 1981. A comparative study of *Diplectrum formosum* and *D. bittatum* (Pisces: Serranidae). *Florida Scientist* 44, no. 2: 97-103.
Specimens of the simultaneously hermaphroditic fish species *Diplectrum formosum*, the sandperch, and *D. bivittatum* , the dwarf sandperch, were collected near the Dry Tortugas, Florida, by means of shrimp trawl during December 1976. Stomach contents of 326 *D. formosum* (100 empty) and 325 *D. bivittatum* (131 empty) revealed little or no differences in their food habits relative to number and volume of food items, size of food items or the contribution, in grams each food item makes to each fish. Both species primarily consumed amphipods, shrimp, crabs, fish, and polychaetes. Temporally, both species fed at the same 2 diurnal periods. Species were collected sympatrically but there were areas where each species dominated in relative abundance.

22. Boschma, H. 1929. On the postlarval development of the Coral *Maeandra aerolata* (L.). *Papers Tortugas Laboratory* 26: 129-47.
Carnegie Institution of Washington Publication Number 391.
During six weeks in July and August 1925, the author studied *Maeandra areolata* for researches on the food of reef-corals at the Carnegie Laboratory in the Tortugas. Many of the colonies contained ripe larvae and the author reared these for the study of their development. The author concludes the development of the endotentacles which appear constantly in two successive groups of three, resembles in some way the facts recorded by de Lacase Duthiers (1872) in *Actinia mesembryanthemum,* some stages of which show a marked tri-radial arrangement of the tentacles. The data in the literature on the development of other coral polyps seem to prove that this successive development of the endotentacles in two groups is an exceptional case. The bilateral arrangement of the septa in the oldest stages is in accordance with that found by Duerden (1904) in *Siderastrea.* As in the majority of corals in which the young stages are known, the septa in *Maeandra* develop in two cycles, first the six endosepta and soon afterward the six exosepta.

23. Bowles, A. E., F. T. Awbrey and J. R. Jehl. 1991. *Effects of high-amplitude impulsive noise on hatching success: a reanalysis of the sooty tern incident*, HSD-TR-91-0006. BBN Laboratories, Inc., Canoga Park, California.
This article attempts to refute the Austin article which attributed a mass hatching failure among 50,000 pairs of sooty terns (*Sterna fuscata*), who had nested on the Dry Tortugas to sonic boom damage from military aircraft. Theoretically, eggshells and embryonic tissues should withstand pressures much greater than those generated by even the most intense sonic booms. An experiment was conducted to test whether impulsive noise could be responsible for the hatching failure. Four pest control devices were exploded near chick eggs in various states of development: 20 chicken and 20 quail eggs. The mean peak flat sound pressure level 177.3 db re 20 upa; mean CSEL of 139; mean frequency 620 Hz. No cracking damage similar to that of the Dry Tortugas eggs occurred. Hatch rates and weights between control and exposed embryos were not significantly different.

24. Bowman, H. H. M. 1918. Botanical ecology of the Dry Tortugas. *Papers Tortugas Laboratory* 12: 109-38.
Carnegie Institution of Washington Publication Number 252.

As the name of these islands indicates, their vegetation is characteristically xerophytic, although the rainfall is sufficient to assure the plants the necessary amount of water. The plants are very interesting when a close study is made of their individual characteristics. The opportunity for such study was given the writer during the summers of 1915 and 1916, while pursuing another line of botanical research at Loggerhead Key, where a marine laboratory is maintained. The Tortugas are really the westernmost of all the Florida Keys, but are more detached from them and have different geological and botanical aspects. Species distributional maps were created for each of the eight islands of the Tortugas Atoll. In this treatment of the species in the Tortugas it has been aimed to give some idea of the character of the dry-climate plants inhabiting these islands, their distribution, and particularly the changes which have occurred on the various keys since Lansing's 1904 survey, with an attempt to analyze the reasons for such changes. Notes on the marine ecology of the Tortugas also are presented, along with descriptions of dominant submergent vegetation.

25. Boyden, A. 1934-1939. Serological study of the relationships of some common invertebrata. *Carnegie Institution of Washington, Year Book.*
Note: published as follows: 1934, v. 33, p. 248-49; 1936, v. 35, p. 82; 1939, v. 38, p. 218.
Preliminary results obtained through the study of the antigens collected from various major groups of animals at Tortugas were summarized. Blood relationships within Mollusca and Crustacea were emphasized.

26. Bradbury, R. C. 1992. First Florida record of variegated flycatcher *Empidonomus-varius* at Garden Key, Dry Tortugas. *Florida Field Naturalist* 20, no. 2: 42-44.
The variegated flycatcher occurs throughout most of South America east of the Andes. The species migrates northward between September and February after breeding in the middle and southern part of the continent. It winters in the Guianas, northern Brazil, Venezuela, Colombia, and eastern Peru. This article describes observations of a variegated flycatcher in Florida, representing the first record in Florida and the third in the United States.

27. Breder, C. M. Jr. 1934. On the habitats and development of certain Atlantic Synentognathi. *Papers Tortugas Laboratory* 28: 1-35 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 413.
In this paper data presented are intended to form a basis for further inquiry into the comparative development and life habits of the Synentognathi, which includes the familiar Belonidae (needlefish), Hemiramphidae (halfbeaks), and Exocoetidae (flying fish). The data on which the present paper are based represent some field studies and laboratory work on material gathered in the Dry Tortugas, Florida during May and June 1929 The feeding habits, leaping, and flight during the presence and absence of light, eye specialization, enemies, and ontogeny and phylogeny are discussed. A new species, *Strongylura longleyi* is described. A key to the Tortugas Synentognathi is provided, along with tables, beak measurement and eye development. The Exocoetidae form the major item of diet of a variety of sea birds, about the Tortugas at least. Young Exocoetidae pass the most dangerous part of their day when the sun is low, at which time they are unable to see their predacious enemies coming from below because of light conditions. The eyes of Belonidae are provided with elaborate equipment to protect them from the brilliance of their environment.

28. Breder, C. M. Jr. and J. E. Harris. 1936. Effect of light on orientation and stability of young plectognath fish. *Papers Tortugas Laboratory* 29: 23-36 (issued Nov. 1935).
Carnegie Institution of Washington Publication Number 452.
Under certain circumstances some plectognath species will respond to a strong beam of light by violent gyrations. This was first observed by Breder (1929) at the Tortugas Laboratory. The mechanism by which these movements are effected, their relationship to the intensity and duration of the stimulus, and the disappearance of the phenomenon with advancing age

of the animal give rise to a number of interesting problems concerning the action of the receptor-effector system in these fish. This paper is an attempt to explain this feature of fish behavior. It was found that small specimens of *Monocanthus* and *Lactophrys,* if exposed to a beam of light, frequently exhibit somersaulting or rotational movements of great rapidity. Somersaulting is produced by passing the locomotor waves in opposite direction along the dorsal and anal fins. The rotational movement is accompanied by the deflection of the dorsal and anal fins to the opposite sides of the body, the direction of motion of the undulations being usually antero-posterior in both fins. Various combinations of fin and tail movements may occasionally give other twisting gyratory movements. The primary response to light is always an attempt at reorientation of the animal so that the light is incident upon the dorsal surface. In fish kept in complete darkness and "sensitized" by repeated stimuli, gyrations may continue after the light has been removed, and even mechanical stimuli may initiate similar paroxysms, the equilibrating system apparently being more or less permanently deranged. Specimens of *Monocanthus* over 50 mm. in length do not usually display this behavior, and species other than plectognaths show it very feebly or not at all. The integration of gravitational stimuli into the behavior pattern is apparently not perfectly attained until a comparatively late stage in development, and light is the primary orienting factor. The gyrations are apparently due to instability, consequent upon overcorrection.

29. Brinley, F. J. 1937-1938. Studies on the implantation of embryonic fish tissue, with notes on the spawning habits and development of four species of fish. *Carnegie Institution of Washington, Year Book.*
Note: published as follows: 1937, v. 36, p. 86; 1938, v. 37, p. 86-7.
Livers and spleens were transplanted from embryos of the hard head shiner to other embryos of the same age. No apparent effect on the host was noticed. Eggs of *Pomacentrus* and parrot fish were collected for observation, along with nurse shark embryos. Additional work was performed on the origin of muscular movement in these species.

30. Brooks, H. K. 1962. Reefs and bioclastic sediments of the Dry Tortugas (abs.). *Geological Society of America. Special Paper* 73: 1-2.
Many miscomprehensions exist relative to origin of the Florida Reef track and, in particular, its southwestern extremity-the banks, shoals, and reefs known as the Dry Tortugas. They are not an atoll as stated by Vaughan (1914). The component physiographic features rise from a shallow limestone platform 80 to 100 feet below sea level. Relief features are banks and shoals of bioclastic sands. Their genesis and circulation distribution are related to the prevailing seasonal storm patterns. Large patches of *Acropora cervicornus* (Lamark) are widely distributed through the area in water less than 60 feet deep. Live coral on these patches is sparse. Proliferation of the staghorn corals is slow, but cumulative growth has produced a magnitude of skeletal remains. The coralla are preserved and are ultimately indurated into a porous rocky mass by the luxuriant growth of *Lithohamnion* and its cognate encrusting associates. The shallow reefs of Garden and Loggerhead Keys, populated by calcareous algae, alcyonarians, and scleractinians, etc., originate upon a foundation of the remains of these organisms. This can be seen where erosion in surge channels has exposed the underlying materials.

31. Brooks, W. K. 1908. *Salpa floridian* (Apstein) Part II in the Pelagic Tunicata of the Gulf Stream. *Papers Tortugas Laboratory* 1: 75-89.
Carnegie Institution of Washington Publication Number 102.
This rare *Salpa* about which little is known, has been noted in this paper. Mature specimens of both stages of *Salpa* were found, in May 1906, on the surface in the vicinity of the Marine Biological Laboratory at Tortugas, Florida; and an opportunity was afforded to study and sketch them while alive, and thus to make additions to, and some slight-corrections of, the count of the species..

32. Brooks, W. K and C. Kellner. 1908. On *Oikopleura tortugensis*, n.sp. a new appendicularian from the Tortugas, with notes on its embryology in Part IV, The Pelagic Tunicata of the Gulf Stream. *Papers Tortugas Laboratory* 1: 73-95.
Carnegie Institution of Washington Publication Number 102.

This species was found in abundance near the Marine Laboratory. The specimens are from 5 to 8 mm. long and occur in great swarms at the depth of 5 to 6 fathoms. A description of the species is provided.

33. Brown, D. E. S. 1935. Cellular reactions to high hydrostatic pressures. *Carnegie Institution of Washington, Year Book* 34: 76-77.
Physiological studies were carried out on the muscles of crabs and fish collected in deep (100 fathoms) and shallow water of the Tortugas.

34. Brown, W. Y. and W. B. Robertson Jr. 1975. Longevity of the brown noddy. *Bird-Banding* 46, no. 3: 250-251.
Despite its abundance and pantropical range, little published information exists on the longevity of the brown noddy (*Anous stolidus*). Woodward (Atoll Research Bull, 164: 280,1972) reported a maximum known survival of 10 years for brown noddies banded as adults on Kure Atoll , Hawaii. Brown noddies on Manana Island, Oahu, Hawaii (*A. s. pileatus*) and the Dry Tortugas, Florida (*A. s. stolidus*), are among the few populations that have been banded over a period long enough to provide quantitative data on longevity. Twelve of the brown noddies banded on Manana before 1948 were recaptured dead or alive before 1960, the longest interval from banding to recapture being 13 years. On 23 May 1972 Brown recaptured on Manana a brown noddy that had been banded there as a juvenile on 12 June 1947, 25 years earlier.

35. Bullington, W. E. 1940. Some ciliates from Tortugas. *Papers Tortugas Laboratory* 32: 179-221 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 517.
During the summers of 1930, 1931, and 1935, during a special study of spiraling in certain species of ciliates at Tortugas, there appeared in the author's cultures from time to time many other species which seemed to be new or little known. There are now fifteen species, either new to science or little known, about which it is believed sufficient information is available to justify their description or redescription. Five of the fifteen species have previously been described, but none of them is well known. Ten were described as new. They were characterized by amazing shades of color, yellow and red predominating. The species here discussed and described constitute only a few of those which have been seen at Tortugas at one time or another, but these are all the author feels justified in discussing, at the present time, with the information at hand.

36. Burkenroad, M. 1929. Studies upon plankton and the mechanism of sound production in Haemulidae. *Carnegie Institution of Washington, Year Book* 28: 283-90.
Daily tows were made from May 31 to August 19 near Loggerhead Key. The variety of species and numbers of individuals found disputed the notion that the Tortugas region "once noted for the variety and richness of its floating life, has gradually become in recent years an almost desert sea."

37. Caira, J. N. and M. H. Pritchard. 1986. A review of the genus *Pedibothrium* Linton, 1909 (Tetraphyllidea Onchobothriidae) with a description of two new species and comments on the related genera, *Pachybothrium* Baer and Euzet, 1962 and *Balanobothrium* Hornell, 1912. *Journal of Parasitology* 72, no. 1: 62-70.
A review of the genus *Pedibothrium* Linton, 1909 is based on type and voucher specimens. The type species, *Pedibothrium globicephalum* Linton, 1909 is redescribed. Descriptions

of *Pedibothrium brevispine* Linton, 1909 and *Pedibothrium longispine* Linton, 1909 are emended. Two new species are described, the generic diagnosis is emended, and a key is provided.

38. Calder, D. R. 1992. Similarity analysis of hydroid assemblages along a latitudinal gradient in the Western Atlantic. *Canadian Journal of Zoology* 70, no. 6: 1078-85.
Shallow-water (0-100 m depth) hydroid faunas reported from 26 locations along the western North Atlantic coast between the high Canadian Arctic archipelago and the Caribbean Sea were compared. Species numbers varied widely between locations, but were highest in the tropics and subtropics, lowest in arctic and subarctic waters, and intermediate in mid-latitudes. Percentages of species producing free medusae were lowest in high latitudes, intermediate in low latitudes, and highest in mid-latitudes (especially in estuaries). In a numerical analysis, similar hydroid faunas were identified at locations (i) between the high Canadian Arctic islands and the Strait of Belle Isle off western Newfoundland; (ii) between the Gulf of St. Lawrence and Chesapeake Bay; (iii) between North Carolina and southeastern Florida (south as far as St. Lucie Inlet), and including the northern Gulf of Mexico; (iv) in the Caribbean Sea, together with Dry Tortugas and the oceanic island of Bermuda. The greatest change in hydroid species composition along the coast appeared to occur around Cape Hatteras.

39. Carrier, J. C., H. L. Pratt Jr. and L. K. Martin. 1994. Group reproductive behaviors in free-living nurse sharks, *Ginglymostoma cirratum. Copeia* 3: 646-56.
Mating events of the nurse sharks were observed in a nine-day period in the Dry Tortugas islands. There were four stages of mating: precoupling, coupling, positioning and alignment, and insertion and copulation. Films were made of four of the mating events. Seminal fluid released into the water was obtained following one of the copulations. It showed the presence of free, nonpackaged sperm cells. Of the fifty mating events observed, ten of these involved multiple males attempting to copulate with single females.

40. Carrier, J. C. and H. L. Pratt Jr. 1997. Habitat management enclosure of a nurse shark breeding and nursery grounds. *Fisheries Research* (In press).
Based on nurse shark breeding studies conducted at Dry Tortugas, a sanctuary for nurse shark reproductive and nursery activities is being established at Dry Tortugas National Park.

41. Cary, L. R. 1915. The *Alcyonaria* as a factor in reef limestone formation. *Proceedings of the National Academy of Science* 1: 285-89.
In many areas of the Floridean-Antillean region, Gorgonaceae rather than stony corals make up the most characteristic feature of the lime-secreting organisms permanently attached to the bottom. In this paper, data are presented on the amount of material contributed to reef formation by gorgonians. Three factors were taken into consideration: spicule content (the amount of lime held as spicules in the colonies), distribution of gorgonians on the Tortugan reefs (the bulk of the gorgonians on any reef area) and disintegration of the coenenchyma of the colonies and the addition of their spicules to the reef building materials. Using line surveys and the weight and percentage of spicules in the colonies, it was found that the amount of lime held as spicules in the tissue of living gorgonians per acre of reef area is 5.28 tons. Next to the destruction of the colonies by wave action (storms), the greatest mortality of the colonies is from overgrowth of tissues by other organisms. The destruction of Tortugan gorgonian colonies was nearly complete in the hurricane of October 1920. It has been estimated that nearly one-fifth of the gorgonian colonies are destroyed annually.

42. ———. 1918. The Gorgonaceae as a factor in the formation of coral reefs. *Papers Tortugas Laboratory* 9: 341-62.
Carnegie Institution of Washington Publication Number 213.
An important constituent of the limestone of coral reefs is the calcium carbonate secreted in the skeletal structures of Anthozoa and marine calcareous algae. Representatives of the

Hydrozoa were important reef formers in past geological epochs, but in the formation of modern reefs they constitute a minor factor. Representatives of the Anthozoa, the stony and flexible corals, are among animals the only important agents in the formation of the modern reefs. The results of this study show that over large reef areas, in the Tortugas at least, the gorgonian fauna is by far the most important element contributing to the formation of reef limestones. The amount of spicules in the tissues of gorgonian colonies would average at least 5.28 tons to the acre for all of the reefs in the Tortugas group. The figures given represent only a potential contribution to reef formation but a study of the normal cycle of changes in the gorgonian fauna of this region has shown that at least a fifth of this amount of calcium carbonate, as spicules, will be added to the reef limestones annually .

43. ———. 1934. Growth of some tissues of *Ptychodera bahamensis* in vitro. *Papers Tortugas Laboratory* 28: 195-213.
Carnegie Institution of Washington Publication Number 435.
Nearly all refinements and expansions of the technique of tissue culture have taken place with warm-blooded animals as the experimental material. This line of development has, no doubt, been followed because of its possible medical application. Technical difficulties extending this method to invertebrates, where the necessary asepsis is more difficult to attain, have also played a part. The writer developed a technique which was successfully applied to some tissues of eleven species of marine animals belonging to seven phyla. In all cases, both migration and cell multiplication were obtained. Two organisms seemed to offer particularly favorable material for tissue culture. One was the gastropod *Astroea longispina;* the other was the enteropneustan *Ptychodera bahamensis.* This being the most convenient material with which to work, investigations in 1932 were confined to the tissues of this species alone. The technique of a method, using either hexyl-resorcenol or ultraviolet radiation in amounts harmless to the tissues, for growing in vitro the cells of marine invertebrates is described. Because of their structure, members of the Enteropneusta lend themselves especially well to the obtaining of explants composed of one or of several types of tissue. The growth and reproduction of cells from the caecal portions of the intestine are recorded in detail. The changes undergone by muscle cells when removed from the body of an animal show a characteristically reversible series of stages peculiar to this type of cell. The bearing of the observations on *Ptychodera* cells to broader problems of cytology is considered .

44. ———. 1915. The influence of the marginal sense organs on functional activity in *Cassiopea xamachana. Proceedings of the National Academy of Science* 1: 611-16.
The influence of sense organs (nervous system) on the rate of regeneration was examined at the Dry Tortugas using the disks of the rhizostomous medusa *Cassiopea*, which can be separated from the oral arms and kept in dishes of seawater for an indefinite period. Pairs of disks were examined from which all of the thopalia were removed, while from the other equal amounts of tissues were removed from the bell margin between the thopalia. In all instances, the disks where the half on which the thopalia remained regenerated at a more rapid rate than the inactive half. Other experiments focused on influence of sense organs on the rate of metabolism as measured by production of carbon dioxide. Carbon dioxide produced was always greater for the normal disk containing sense organs. It was concluded by the author that in this type of experiment there is some other form of metabolic activity which is of greater importance as a source of CO_2 and which is more directly under the influence of the sense organs than is the activity of the muscular system.

45. ———. 1916. The influence of the marginal sense organs on the rate of regeneration in *Cassiopea xamachana. Journal of Experimental Zoology* 21, no. 1: 1-31.
Studies were conducted on accepting the view of the direct or indirect influence of the nervous system on regeneration in *Cassiopea xamachana* collected from the Fort Jefferson moat at Dry Tortugas. Experiments conducted to determine the influence of sense organs on the rate of regeneration were inconclusive, when testing entire disks with sense organs

removed, compared with specimens where the sense organs remained because of wide differences in physiological activity between different individuals. Half disks with sense organs regenerated more rapidly than those half disks without sense organs. Other experiments involving electrical stimulus by induction shocks on disk halfs, with and without sense organs, indicated regeneration is faster in the activated half, than from the inactive disk. These experiments indicate the rate of regeneration is simply one expression of the general metabolic activity of an animal, and as such is subject to the influence of the nerve centers, as are many of the functional activities.

46. _____1914. Observations upon the growth-rate and ecology of gorgonians. *Papers Tortugas Laboratory* 5: 79-90.
Carnegie Institution of Washington Publication Number 182.
This report provides a record of observations extending over a 3-year period on the growth rate of *Gorgonia flabellum* and *Plexaura flexuosa* on the reefs around the Dry Tortugas, Florida. Ecological observations are supplemented by observations made in Jamaica. For effective attachment of the planule, the presence of depressions or cracks into which the planule could settle appears to be the most important factor. In comparison with young coral polyps the gorgonian colony has an obvious advantage, in that is most rapid growth is perpendicular to the surface, which permits its most rapidly growing part to secure food and oxygen. Wave action during very severe storms is by far the most destructive agent to which *Gorgonia* are subjected. It appears that the greatest destruction by storms comes from the tearing of the *Gorgonia* colonies from the substrate rather than laceration of tissue.

47. _____ 1917. Studies on the physiology of the nervous system of *Cassiopea xamachana. Papers Tortugas Laboratory* 11: 121-70.
Carnegie Institution of Washington Publication Number 251.
In this paper are gathered the results of several distinct lines of experimentation. They deal with some phase of the physiology of the nervous system of *Cassiopea* and represent portions of a general program of research on the nervous system of the lower animals. On account of its ability to live under adverse conditions and to withstand practically any type of operation, *Cassiopea* is an especially favorable form for experimentation and has been used as a subject for many researches. The experiments with entire disks, when the rates of regeneration of specimens on which the sense-organs remained are compared with those of specimens from which all sense-organs are removed, are inconclusive because of wide differences in physiological activity between different individuals. When we compare the insulated halves of a disk, on one of which the sense-organs remain, while all of them have been removed from the other half, it is found that the half-disk with sense-organs always regenerates most rapidly. When all the sense-organs are removed from a disk and the halves insulated, the regeneration is faster from the activated than from the inactive half-disk. These experiments indicate that the rate of regeneration is simply one expression of the general metabolic activity of an animal, and as such is subject to the influence of the nerve-centers, as are many other functional activities. Briefly summarized, the results of the observations made on the starved *Cassiopea* are as follows: In general the smaller *Cassiopea* loses relatively more in weight than does the larger *Cassiopea.* The percentage of water found in the entire body is nearly the same in all sizes of *Cassiopea.* The nitrogen-content of the entire body is higher in the small than in the larger *Cassiopea.* However, the absolute amount of nitrogen found in the starved *Cassiopea* is considerably higher than in the normal having the same bodyweight. The loss in weight of the different parts in the starved *Cassiopea* remains the same proportionately to those in the normal *Cassiopea.*

48. ———. 1918. A study of respiration in Alcyonaria. *Papers Tortugas Laboratory* 12: 185-91.
Carnegie Institution of Washington Publication Number 252.
Although the respiration of many species of invertebrates has been studied, the only references to that of Alcyonaria are those given by Montuori (1913), who studied two species, *Alcyomeum pallidum* and *Gorgonia cavolinii.* In these experiments the total weight

of the colony was taken as the basis of comparison without taking into account the proportion of inert skeletal material- the spicules in the first species and the spicules and chitinous axis in the latter. The observations recorded were made as part of a study of the ecological factors determining the distribution of Alcyonaria on the coral reefs of southern Florida. All the species of the genus *Gorgonia* and the closely related *Xiphigorgia*, which have as a group the highest rate of respiration, are next to *Briareum* the most resistant to increased temperature. Taken all together these observations indicate that some other factor is the controlling agency in the ability of a marine organism to withstand high temperatures. The acidity of the water at the close of the heat experiments was always greater than in respiration experiments carried on at 27.5° C. This may be only an expression of the abnormality of their metabolism at high temperatures, or have a causal relation to the death of the organism.

49. Cate, C. N. 1978. New species of Ovulidae and reinstatement of *Margovula pyrulina* (A. Adams, 1854) (Gastropoda). *Nautilus* 92 , no. 4: 160-167.
Eight species of living Ovulidae are described as new, and the species *M. pyrulina* is reinstated. The 8 new species are listed as follows: *Prionovolva castanea* from the Gulf of Oman; *Aperiovula testudiana* from Mukaishima, Japan; *Primovula santacarolinensis* from Mozambique; *P. uvula* from Moreton Bay, Queensland, Australia; *Crenavolva periopsis* from Java, Indonesia; *Speculata advena* from off Sand Key, Florida; *Cyphoma rhomba* from Fort Lauderdale Reef, Florida; and *Psudocyphoma gibbulum* from off the Dry Tortugas Islands, Florida.

50. Chambers, E. L. 1937. The movement of the egg nucleus in relation to the sperm aster in the sea-urchin, *Lytechinus varigeatus. Carnegie Institution of Washington, Year Book* 36: 86-87.
With the aid of a camera, 30-second observations on the positions (rate and direction of movement) of the egg nucleus and sperm aster of *Lytechinus* were made.

51. Child, C. A. 1992. Shallow-water Pycnogonida of the Gulf of Mexico. *Memoirs of the Hourglass Cruises* 9, no. 1: 1-86.
This paper treats 11 species in 8 genera of the Pycnogonida that were collected during the Hourglass Cruises, a sampling program conducted on the central West Florida Shelf for 28 months during 1965-1967. Five benthic stations in depths from 6 to 72 m were sampled monthly with dredges and trawls among each of two transects. Treatments of 20 more species in 6 additional genera from other shelf collections are also included to offer a comprehensive survey of species (a total of 31 species in 14 genera) known from the continental shelf of the Gulf of Mexico, excluding the Dry Tortugas and the Florida Keys. Three of these species were previously unreported from the Gulf. Two new species, *Ascorhynchus crenatum* and *A. horologium*, are described from the Hourglass material, and an additional new species, *Anoplodactylus dauphinus,* is described from the other material. Artificial taxonomic keys are provided for all Gulf of Mexico families and species, and checklists are provided for all species known or expected to occur in the Gulf. All species are diagnosed and illustrated, and their distributions are given. Only four species were taken during the Hourglass Cruises with sufficient frequency to allow analysis of their distributions and abundances.

52. Clapp, R. B. and W. B. Robertson Jr. 1986. Nesting of the masked booby *Sula dactylatara* on the Dry Tortugas, Florida. The first record for the contiguous United States. *Colonial Waterbirds* 9, no. 1: 113-16.
In both 1984 and 1985 masked boobies (*Sula dactylatra*) attempted to nest on sandy islets at the Dry Tortugas, Florida. Nesting attempts failed because the nest sites were washed away by summer storms. It seems likely that this species will eventually nest there successfully and will establish a small breeding population. This is the first documented nesting by this species in the contiguous United States.

53. Clark, H. L. 1919. The distribution of the littoral echinoderms of the West Indies. *Papers Tortugas Laboratory* 13: 49-74.
Carnegie Institution of Washington Publication Number 281.
The purpose of this investigation was to determine if the distribution of littoral echinoderms varied among various northern West Indian islands bounded by Bermuda to the North, Tobago to the South, and the Tortugas to the west. Five classes of echinoderms are discussed, including Comatulidea (feather-stars), Asteroidea (sea-stars), Ophiuroidea (brittle-stars), and Echinoidea (sea urchins). The number of species and numbers of individuals of the classes are discussed. Of the island areas investigated, the Tortugas appears to be the richest in the number of species found with 76 littoral echinoderms, with 70 available to collect by hand. The sea urchins, *Echinometra lacunter* were reported to be excessively abundant on many reefs, actually occurring by the thousands. The number of echinoid species found throughout the region and Florida are compared with comments provided on the origin of echinoids in the West Indies. Next to brittle-stars, holothurians were considered to be the most abundant of the littoral echinoderms.

54. Clark, L. B. and W. N. Hess. 1942. Swarming of the Atlantic palolo worm, *Leodice fucata* (Ehlers). *Papers Tortugas Laboratory* 33: 21-70 (issued Oct. 1940).
Various organisms show reproductive activity coinciding with the lunar cycle. At the Dry Tortugas, swarming observations were recorded during 1937-39 on the Atlantic palolo worm, in association with the quarter-moon phase. Other important factors determining the time when the worms reproduce, include the maturity of the animal and the amount of water turbulence. It was concluded that: (1) the stimulating effect of the first-quarter moon is less than that of the third-quarter, (2) the worms increase in sensitivity to the stimuli inducing the swarming as they become sexually mature, and (3) wave action and water turbulence above a certain level induced by an 8 mph wind decreases or prevents swarming at the Dry Tortugas.

55. Cole, L. J. 1906. Ant Studies. *Carnegie Institution of Washington, Year Book* 5: 110.
To investigate the biology of ants at the Tortugas, specimens were collected, and observations were made.

56. Collie, M. R. 1979. A Sabine's gull at the Dry Tortugas. *Florida Field Naturalist* 7, no. 2: 28.
A photographic observation was made by the author during August 1978 of a Sabine's gull at Garden Key, Dry Tortugas. There are four other records of this species in Florida along the Atlantic coast, however this sighting represents the first record of the Sabine's gull at the Tortugas.

57. Colman, J. 1931. The superficial structure of coral reefs: animal succession on prepared substrata. *Carnegie Institution of Washington, Yearbook* 30: 395.
Plant and animal successions were examined on concrete cubes planted in the water at three sites: Fort Jefferson moat, an iron wreck east of Loggerhead Key, and northwest of loggerhead Key. Also, a detailed ecological survey of Long and Bush Keys was made.

58. Conger, P. S. 1924-1935. Diatom studies. *Carnegie Institution of Washington, Year Book.*
Note: published as: 1924, V. 23, p. 220; 1925, v. 24, p. 221; 1926, v. 25, p. 240; 1927, v.26, p. 220; 1928, v. 27, p. 271; 1929, v.28, p. 283; 1930, v. 29, p. 323.
Diatom studies were conducted in association with A. Mann. Narrative same as in reference no. 218.

59. Conklin, E. G. 1908. The habits and early development of *Linerges mercurius*. *Papers Tortugas Laboratory* 2: 153-70.
Carnegie Institution of Washington Publication Number 103.
The jellyfish, *Linerges mercurius*, Scyphomedusa, was investigated at Tortugas and Nassau

Harbor. The sudden appearance in great numbers of this species at Tortugas was noted, followed by their rapid disappearance. Normal movements of the medusae are described as well. Other phases of early development, including egg-laying, egg structure, maturation and fertilization, first cleavage, second, and later cleavages, and blastula, gastula, and planula are described. Experiments on isolation of blastomeres and centrifugalized eggs are presented. The organization of the egg of *Linerges* and mechanics of cell division are described.

60. ———. 1908. Two peculiar actinian larvae from the Tortugas, Florida. *Papers Tortugas Laboratory* 2: 171-86.
Carnegie Institution of Washington Publication Number 103.
During middle-of-the-day sampling tows at the Tortugas in May 1905, two peculiar larvae were collected. They did not undergo metamorphasis in aquaria. Natural history notes on living larvae are provided. Based on literature description, they were probably Zoanthidae of the Order Hexactinia. A band of strikingly brilliant, locomotor cilia was noted as most peculiar for these larvae. Their size, shape, and coloration are described. Yellowish-green symbiotic algae occur in both types and are hypothesized to be associated with their metabolism and play an important role in their nutrition. The morphology and histological character of these two types are similar but minor differences are described. Although these types have only been collected a few times world-wide, they are not considered rare at Nassau and the Dry Tortugas.

61. Coonfield, B. R. 1940. Chromatophore reactions of embryos and larvae of *Pomacentrus leucostictus*. *Papers Tortugas Laboratory* 32: 169-78 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 517.
Interest in the origin of the changing color patterns of fishes and certain other vertebrates, together with certain questions that have been raised by the work of investigators in their study of this problem in embryos of vertebrates, prompted an investigation of the color mechanism in developing fishes. Both embryos and larvae of *Pomacentrus leucostictus*, which is found in abundance in the Dry Tortugas, were used in this study. It was concluded that melanin granules migrate within the melanophores of *Pomacentrus* embryos as soon as these pigmentary bodies are completely formed. The melanophores of embryos a few hours of age contract in response to pressure applied with forceps and to a temperature of about 8°C. The melanophores of a majority of developing embryos, from their beginning up to a few hours before hatching, are found to be in a stellate state regardless of whether these young are over a white or a black background or are in total darkness. A few hours before hatching, the melanophores contract when the embryos are over a white background, expand when they are over a black background, and contract when they are in total darkness. This response continues in these young on through the hatching period and for a few hours after hatching. Larvae of two or more days after hatching do not show any conclusive response to different backgrounds or to the absence of light. The eyes of these young fish are believed to have no function in controlling their melanophore responses. The evidence is in favor of the release of a hormone within the capsule just before the embryos hatch. This agency either permits or directly causes the melanophores to respond to various environments.

62. ———. 1940. The chromatophore system of larvae of *Crangon armillatus*. *Papers Tortugas Laboratory* 32: 121-26 (issued May 1940).
Carnegie Institution of Washington Publication Number 517.
The ability of certain animals to imitate the color in their background is so striking that is has received the attention of investigators for a considerable period of time. This feature has been observed principally in fishes, amphibians, and reptiles of the vertebrates, and in crustaceans of the invertebrates. This paper adds to this field of study the results of observations on the reactions of the chromatophore system of larvae of *Crangon armillatus*. The erythrophores of normal larvae of *Crangon armillatus* react as follows according to

different backgrounds: the pigment is dispersed when the animals are kept in a white illuminated bowl. The erythrophores of enucleated specimens show the following conditions when subjected to different backgrounds: the pigment becomes concentrated when the specimens are kept over a white illuminated background; the pigment is dispersed when these specimens are subjected to black illuminated bowls. The time required for concentration of pigment in the erythrophores is much longer than that required for its dispersion. Ablation of the eyes permits the erythrophores to react directly to stimulations caused by different backgrounds .

63. Coutiére, H. 1910. The snapping shrimps (Alpheidae) of the Dry Tortugas, Florida. *Proceedings of the United States National Museum* 37: 485-87.
The Alpheidae collected by Dr. McClendon at the Tortugas in 1908 are discussed. The Alpheidae are referable to eight different forms, including one new species and one new subspecies: *Alpheus formosus* Gibbes. *Alpheus cristulifrons* Rathbun and *Alpheus armillatus* H. Milne-Edwards.

64. Cowles, R. P. 1908. Habits, reactions, and associations in *Ocypoda arernaria. Papers Tortugas Laboratory* 2: 1-41.
Carnegie Institution of Washington Publication Number 103.
On Loggerhead Key, investigations were made on the behavior of *Ocypoda arernaria.* It was found that adult ghost crabs build two kinds of burrows. One consists of a single tunnel extending down in the sand for 3 to 4 feet. The other is similar, except that it is shorter and has a passage branching off from it, which is used for escape. Young ocypodas make short burrows, only a few inches long, which often extend vertically downward. Breeding in the region of Loggerhead Key probably occurs in the spring and early summer. *Ocypoda* is a scavenger and a cannibal. The eyes do not seem to play an important role in the detection of food, but they undoubtedly lead individuals to objects which may be food. That *Ocypoda* is stimulated by odors was not conclusively shown, but certain experiments point strongly in that direction. The eyes are highly developed, so far as crustacean eyes are concerned; they are quite sensitive to large differences in the intensity of light; they do not react to different colors; they aid much in the search for food, in the detection of enemies, and in the accuracy of locomotion. Ghost crabs probably do not have vision such as that of the human eye, nor do they see the color and finer characters of the surface of an object, but they undoubtedly see its outlines and possibly some of the more evident irregularities of the surface made evident by differences in lighting. The color-pattern seen through the carapace of *Ocypoda* changes in intensity under different conditions of temperature and light. In the absence of light when the temperature is anywhere between 22° C. and 45° C., and undoubtedly when it is even lower or higher, a light coloration occurs. Generally in diffuse light and even direct sunlight a dark coloration appears, provided the temperature is not too high. Usually at low temperatures, not above 35° C., a light coloration is the rule, and it occurs independently of the intensity of light. At high temperatures, above 35° C., a light coloration is the rule, and it occurs independently of the intensity of light. No indication of audition was observed in *Ocypoda.* The so-called "auditory organs" are equilibrating organs. *Ocypoda* has a stridulating ridge on the palm of its large chela.

65. ———. 1911. Reaction to light and other points in the behavior of the starfish. *Papers Tortugas Laboratory* 3: 95-110.
Carnegie Institution of Washington Publication Number 132.
Experiments were designed to test the reactions of starfish to light. Two species were used *Echinaster crassispina* and *Astropecten duplicatus*. Both are migratory and are found in open waters over sandy bottoms, in areas generally exposed to light. In the Tortugas laboratory, starfish were placed in aquaria wooden boxes and tested for movement up in response to light, inclines, vertical walls, and tilted floors. Every specimen reacted positively, moving toward bright light. Even with eye-spots removed, movements towards light are positive, but not as quick as in normal individuals. When tested in different

degrees of water temperature the reaction to light was positive at ordinary temperatures. Quality of light was tested using various color screens (UV, violet, blue, green, yellow, orange and red) in a box with closed and open ends. The source of light was sunlight. In a series of 10 tests with varied orientation and handling, in nearly every test starfish moved toward light without hesitation.

66. Criales, M. M. and T. N. Lee. 1995. Larval distribution and transport of penaeoid shrimps during the Tortugas Gyre in May-June 1991. *Fishery Bulletin* 93: 471-82.
As part of the Southeast Florida and Caribbean Recruitment (SEFCAR) project, penaeoid shrimp larvae were collected during the spring and summer cruise of the RV Longhorn in the Lower Florida keys and Dry Tortugas from 29 May to 30 June 1991. Larvae of the pink shrimp, *Penaeus duorarum,* and the rock shrimp, *Sicyonia sp.*, were distributed inshore close to the Dry Tortugas Grounds adjacent to the boundaries of Dry Tortugas National Park, whereas larvae of the oceanic shrimp *Solenocera* sp. showed mainly an offshore distribution. Significant concentrations of *Solenocera* sp., *Sicyonia* sp. and *P. duorarum* larvae at the Tortugas transect in early June were found within and above the seasonal thermocline, while the cold cyclonic Tortugas Gyre was intensively developed. For *Solenocera* sp., which spawn on the outer ridge of the gyre followed by onshore Ekman transport. *Penaeus duorarum,* which spawn in the shallow Tortugas Grounds, showed a mode of zoea II-III progressing to postlarvae I at the Tortugas Grounds during the 15 days in which the drifter Halley recirculated in the interior of the Tortugas Gyre. Retention of *P. duorarum* larvae by the internal circulation of the gyre at the spawning grounds may be an important mechanism for local recruitment of these shrimp to the nursery ground of Florida Bay, Everglades National Park.

67. Cushman, J. A.. 1922. Shallow-water Foraminifera of the Tortugas region. *Papers Tortugas Laboratory* 17: 1-85.
Carnegie Institution of Washington Publication Number 311.
The paper gives the results of a study of collections made in the waters about the Tortugas Laboratory of the Carnegie Institution of Washington. Collecting was done largely from the boats, the most satisfactory method that was used with the Darwin. Collecting in the moat at Fort Jefferson in shallow water on Long Key, as well as on the reefs and flats, was done by hand. The Tortugas region presents an ideal spot for studying the shallow-water tropical Foraminifera of this particular region. It is removed from influence of shore conditions; the water is at all times warm and pure, so that ecological conditions that are present are constant. The twenty stations from which bottom samples were studied in the preparation of this paper, together with collections from reef flats and from the eel-grass, give a considerable range of conditions. The only stations at which *Rotalia* was found are two in the moat at Fort Jefferson and the other in a very shallow lagoon at Long Key, where the water was warm at low tide in June. By most authors, these specimens would ordinarily be referred without question to *Rotalia beccarii* (Linnaeus). There are differences from northern material, and in probability the Tortugas specimens belong to different species. On the banks of dead coral which become exposed at spring tides, great masses of attached Foraminifera develop. Of these, the most abundant is *Homotrema*, which makes an appreciable contribution to the mass of material. With it, in crevices of the dead coral, was a new species of *Haliphysema*. On the eel-grass (*Posidonia*), which forms in shallow water inside the reef, there is *Iridia, Planorbulina, Discorbis, Orbitolites,* with a peculiar miliolid which spreads over the surface. The mass of these must add appreciably to the amount of carbonate of lime added to the bottom. The forms are rapid in their growth, as the leaves of *Posidonia* are quickly covered in their growth by Foraminiferea and other encrusting animals.

68. Cutright, P. E. 1937. Studies on the development of the dorsal spine of sting rays. *Carnegie Institution of Washington, Year Book* 36: 90.

This report describes the collection of southern sting rays for a histological examination of the stinging mechanism.

69. Dall, W. H. 1889. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico 1877-78 and in the Caribbean Sea (1879-80), by the U.S. Coast Survey Steamer "Blake":, Lieutenant Commander C.D. Sigsbee, U.S.N., and Commander J.R. Bartlett, U.S.N. Commanding. XXIX- Report on the mollusca . Part II Gastropoda and Scaphoda. *Bulletin of the Museum of Comparative Zoology at Harvard College* 18: 1-492, with thirty one plates.
This listing of Mullusca collected by the "Blake" is supplemented by the southern dredgings of the U.S. Fish Commission Steamer "Albatross" and other material collected from the region. A systematic description and account of the gastropods and scaphopods is given and illustrated. Nomenclature is discussed and rectified in several cases.

70. Darby, H. H. 1934. The mechanisms of asymmetry in the Alpheidae. *Papers Tortugas Laboratory* 28: 347-61 (issued Feb. 1934).
Carnegie Institution of Washington Publication Number 435.
In 1901, Przibram reported a series of striking experiments on the regeneration of chelae of *Alpheus dentipes, A. platyrhynchus* and *A. ruber*. There is a pronounced quantitative and qualitative difference between the right and left chelae. One chela is several times as large as the other. Przibram showed that if the snap-claw is removed, at the next molt the pinch-claw is changed into a snap-claw and a new pinch-claw is regenerated on the stump of the old snap-claw. This unusual reversal of asymmetry was confirmed by Wilson (1903) and Zeleny (1905). It was also shown that if both chelae are removed at the same time, they regenerate in their original positions. These experiments seem to indicate that the final degree of morphological expression of the gene may in certain cases depend on the environment. In *Crangon armillatus,* an asymmetrical individual, it is symmetrical ten days later. The morphological expressions of the gene are so concrete that it is difficult to realize that the gene may also be the controlling agency in the production of definite chemical substances, whose presence is manifested only by their physiological reactions. Environment from that point of view can quite easily be thought to control the amount of a substance produced. Changes might well be induced by radiation, due to the ionization of the cell. *Crangon* has shown itself to be an organism in which studies on development as an expression of the activity of the gene can be undertaken with some hope of success. The nature of the regeneration of chelae in two members of the family of Alpheidae has been studied; in particular, in *Crangon armillatus*. It has been shown that at certain stages in the development of the chelae, a state is reached that permits the determination of which side is to have the large chela, or snap-claw. Equal chelae have been produced experimentally and are of three varieties: (l) both small (pinch-claws); (2) both large (snap-claws); (3) both intermediate .

71. ———. 1940. Symmetry in normally asymmetrical crustacea. *Papers Tortugas Laboratory* 32: 61-64 (issued Oct. 1939).
Carnegie Institution of Washington Publication Number 517.
A symmetrical specimen of *Crangon armillatus* was found in nature with two snap claws. These claws differed in no way from snap claws produced experimentally and reported previously.

72. Darby, H. H., E. R. F. Johnson and G. W. Barnes. 1937. Studies on the absorption and scattering of solar radiation by the sea: spectrographic and photoelectric measurements. *Papers Tortugas Laboratory* 31: 191-205 (issued Oct. 1936).
Carnegie Institution of Washington Publication Number 475.
A considerable amount of work has been done in recent times on the penetration of radiation into sea and lake water. The importance of this work, in such matters as plant and animal metabolism and under-water photography, is obvious. The amount and spectral

distribution of scattering, and the penetration of the ultraviolet component, are two phases of the subject which have received scant attention. These studies were made from the yacht, *Elsie Fenimore at* the Tortugas Laboratory. A comparative study has been made of two methods of evaluating the transmission of various wave lengths of light through sea water: (1) photometry by means of photoelectric cells, and (2) photographic spectrophotometry. Bertel's observation that ultraviolet light penetrates a considerable distance into the sea has been confirmed. The extent of penetration is greater than would be expected from the laboratory data of Hulbert and Sawyer. A rough evaluation of the transmissive exponent from 4500Å to 3250A was made, which indicates the magnitude of the disagreement. Scattering was found to be selective, becoming greater with decreasing wave length. The spectral distribution of scattered radiation is indicated. The importance of these observations for biological systems is outlined.

73. Davis, G. E. 1977. Anchor damage to a coral reef on the coast of Florida. *Biological Conservation* 11: 29-34.
Twenty percent of an extensive staghorn coral *Acropora cervicornis* has recently been damaged by boat anchors in Fort Jefferson National Monument, Dry Tortugas, Florida. It is suggested in this article that this type of damage may occur in other coral reef sanctuaries unless anchor-sensitive areas are identified and closed to anchoring. Alternatively, mooring buoys should be provided by sanctuary managers.

74. ———. 1982. A century of natural change in coral distribution at the Dry Tortugas, Florida USA. A comparison of reef maps from 1881 and 1976. *Bulletin of Marine Science* 32, no. 2: 608-23.
Changes in coral reef structure and composition at Dry Tortugas, Florida were compared over a 95-year interval from benthic maps prepared in 1881 and 1976. Living hermatypic corals occupied less than 4% of the 23,000-hectare area mapped, and showed little change in area during the interval between maps. However, major changes in coral species distributions and reef types were apparent. In 1976, a lush 220-hectare *Acropora cervicornis* reef occupied what had been octocoral dominated hard bottom in 1881. The 44-hectare swath of *A. palmata* on the reef crest in 1881 was reduced to two small patches totaling less than 600 m^2 in 1976. More than 90% of the extensive thickets of *A. cervicornis* at Dry Tortugas were killed during the winter of 1976-77, apparently as a result of thermal shock. These changes in coral distribution and abundance demonstrated the natural dynamic nature of coral reefs, and showed the important role occasional short-term extreme climatic events can play in shaping coral reef structure and species distribution. The importance of protecting living corals and the value of ecosystem level sanctuaries as dynamic standards are discussed.

75. ———. 1977. Effects of recreational harvest on a spiny lobster, *Panulirus argus* population. *Bulletin of Marine Science* 27, no. 2: 223-36.
A commercially unfished population of *Panulirius argus* was studied in Fort Jefferson National Monument at Dry Tortugas, Florida, from April 1971 to July 1975. For 29 months all harvest was prohibited, then an experimental sport harvest (hand caught by recreational divers) was allowed in 50% of the area for a period of 8 months, followed by 16 months of complete protection for assessment of recovery. Data on the size, abundance, and natural history of the lobsters were collected using SCUBA, and commercial trapping techniques. A total of 4,257 lobsters, with a mean carapace length of 101 mm, was tagged and released at Dry Tortugas. The existence of a resident adult *P. argus* population was demonstrated by the recovery of all recaptured lobsters (7.3%) with 10 km of their respective capture sites up to 104 weeks after release. Immediately following the experimental sport harvest, the population in the sport harvested area showed a 58% reduction in trap catch rate and dispersed to 42% of its pre-harvest lair occupancy density, while the population in the unharvested control area remained essentially unchanged. The catch rate in the sport harvested area recovered to 78% of its pre-harvest level after 1 year of complete protection

from harvest, and the lair occupancy rate recovery was 71% after 16 months of post harvest protection. The pre-harvest standing crop was estimated at 58.3 kg/ha, wet weight.

76. ———. 1977. Fishery Harvest in an Underwater Park. *Proceedings, Third International Coral Reef Symposium*, 605-8 no. 2. RSMAS, Univ. Miami, Coral Gables, Florida.
There is a potential conflict between park management for preservation of maximum species richness and fishery harvest in parks. The recreational harvest of spiny lobster, *Panulirus argus*, at Ft. Jefferson National Monument, Dry Tortugas, Florida, demonstrates the nature and extent of the conflict. An eight-month-long diver harvest, limited by a daily bag limit of two lobsters, reduced the previously unfished population by 585 and significantly altered the local lobster distribution. Growth and natural recruitment did not restore the population to its 58.3 kg/ha pre-harvest level, even after 16 months with no additional harvest. The trophic status of spiny lobsters as high level carnivores and current ecological theory combined with the harvest impact observed at Dry Tortugas suggests that community structure and species richness would be significantly altered by the harvest.

77. ———. 1975. Minimum size of mature spiny lobsters, *Panulirus argus*, at Dry Tortugas, Florida USA. *Transactions of the American Fisheries Society* 104, no. 4: 675-76.
Of 1,594 female spiny lobsters examined during April 1973-1975 at the Dry Tortugas, 55% were bearing eggs (berried). The specimens ranged in carapace length from 39 mm to 140 mm. No berried females were found with carapace lengths less than 78mm. Maturity was reached by one half of the females in the 86-95 mm size class. The current minimum legal size for sport and commercial lobster fishing in Florida is 76-mm carapace length.

78. ———. 1974. *Notes on the status of spiny lobsters, Panulirus argus, at Dry Tortugas, Florida*, SUSF-SG-74-201. State University (Florida) System. Sea Grant Program. Publ..
Until mid-1971, sport harvest of spiny lobsters, primarily *Panulirus argus*, was permitted in the 19,000 hectares underwater preserve created in 1935 which included the Dry Tortugas atoll. At that time there was a two lobster per person per day limit. Few visitors reached the isolated atoll during the first 20 years, with an average of some 1,200 people per year. Annual visitation increased to over 21,000 in the late 1960's and early 1970's. Concern was expressed for the protection of the quality and quantity of the lobsters found in the area. The primary objective of the study was to assess the impact of human harvest on a natural unperturbed lobster population.

79. ———. 1981. On the role of underwater parks and sanctuaries in the management of coastal resources in the southeastern United States. *Environmental Conservation* 8, no. 1: 67-70.
Aquatic resources in parks and reserves are not as adequately protected as comparable terrestrial resources. Thus the values of protected aquatic ecosystems as standards for comparison, reservoirs of genetic materials, and 'emotional' reserves, are apt to be greatly diminished. Even seemingly static ecosystems such as coral reefs are dynamic, changing dramatically in response to natural short-term environmental variations. Such ecosystems require protected natural areas as dynamic standards that will allow distinctions to be drawn between effects of exploitation or pollution and normal variation. Furthermore, fisheries harvests may reduce the size at which exploited species mature, and reduce the amount and variability of genetic material produced by exploited populations. The seven underwater parks or sanctuaries established since 1935 (Dry Tortugas) in Florida and the U.S. Virgin Islands exhibit wide variations in the degree of protection accorded to aquatic resources, a range being apparent from nearly complete protection in the first parks to be established to virtually no protection at all in the recently established parks. The consequences of permitting consumptive uses of aquatic resources in parks and reserves need to be objectively evaluated. Unless these consumptive uses are severely curtailed or eliminated, the primary values of the parks and reserves may never by realized.

80. ———. 1980. *Spiny lobster series.* Gary E. Davis (ed.), 27 pgs. American Fisheries Society: Bethesda, MD.
This series of papers regarding spiny lobster management represents the efforts of a broad cross section of the scientific fisheries community. Not only is there a diverse array of disciplines from biochemical genetics to ecology and economics, but nearly every source of research endeavor is represented. Members of two federal agencies (National Marine Fisheries Service and National Park Service), a state agency (Florida Department of Natural Resources), a public university (University of Florida), a private university (Nova University), and a private company (Science Applications, Inc.) have combined their efforts on a common subject that has already spawned thousands of scientific papers and countless popular articles.

81. Davis, G. E. and J. W. Dodrill. 1989. Recreational fishery and population dynamics of spiny lobsters, *Panulirus argus,* in Florida Bay, Everglades National Park, 1977-1980. *Bulletin of Marine Science* 44, no. 1: 78-88.
Florida spiny lobsters *Panulirus argus*, occupied the southern two-thirds of Florida Bay in Everglades National Park. Field studies of 3,570 tagged lobsters revealed that they pass through Florida Bay, using it for less than three years as juveniles, between their planktonic larval stages in the open ocean and adulthood on coral reefs. Lobsters from the bay support commercial and recreational fisheries outside of Everglades National Park from Dry Tortugas to Pacific Reef near Miami. Growth rates of juvenile lobsters in Florida Bay are the highest on record, which may be a reflection of optimum habitat with abundant food and shelter.

82. Davis, G. E. and J. W. Dodrill. 1980. Marine parks and sanctuaries for spiny lobster fisheries management. *Proceedings of the Gulf and Caribbean Fisheries Institution*, pp.194-207, 32nd Annual Session.
National parks and sanctuaries with significant marine resources can play important roles in effective fisheries management. However, if fishery resources are exploited and not protected to the same extent terrestrial resources are protected in parks and sanctuaries, they may not be available to provide the dynamic standards for comparison, reproductive/genetic reserves, unique educational opportunities, and recreational escape. Observations of more than 15,000 specimens of *P. argus* tagged at the National Park were analyzed to provide data on migration patterns, natural mortality, reproduction and development. Main factors affecting these populations were seasonality, stress in juveniles, and sexual proportions in adults. Studies in non-exploited populations gave good estimates of natural mortality. Size at first maturation was greater in non-exploited populations than in exploited populations. Juveniles of *P. argus* show an extensive directional migration pattern of 200 KM, while adults exhibit a restricted pattern for about two years. Returned tags during the 1977-78 season in Florida came from sports fisherman (49%), from commercial fisherman, (51%), and commercial traps (11%). This return proves that sports catches were only 9% of the total in the northern part of the Florida Keys (if all the tags were reported). The average of lobsters escaping from traps that were never recovered was 1.2% daily, during the fourteen days that these were in operation.

83. Davis, J. H. Jr. 1940. The ecology and geologic role of mangroves in Florida. *Papers Tortugas Laboratory* 32: 303-412 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 517.
The mangrove swamps of the low-lying coasts and islands of central and southern Florida were studied during five seasons to determine the ecology of these unique littoral swamps, and to obtain some idea of their importance as geologic agents in extending the coasts and forming islands in the shoal-water regions. Five coastal and insular regions of the peninsula were selected and a number of stations established in each for observations and experimental studies. The report is divided into two parts. The "Ecology of the Mangroves" is concerned with the types of plant communities of the mangroves and associated

vegetation, and the successional relationships of some of these communities. "The Geologic Role of the Mangroves" considers the accretions of sedimentary and cumulose soils in connection with the different agents that bring them about, and more significantly, the role of the different mangrove communities in forming soils at higher and higher levels. The most apparent succession of the mangrove communities consists of a pioneer *Rhizophora*, a mature *Rhizophora consocies*, an *Avicennia* salt-marsh associes, not always, flooded by salt or brackish water, a *Conocarpus* transition associes, seldom if ever flooded by water, and a tropical or semitropical forest association, which is the actual climax of the region. Besides *Rhizophora,* the Tortugas Keys have a young swamp of *Laguncularia* around a pond on Bush Key, some young plants of *Avicennia* on Bush Key, and a few old ones on Garden Key. *Concocarpus* was established on both Garden Key and Bush Key. How these species got to the Tortugas and to many of the most isolated of the Florida Keys is not certain, but should be considered.

84. ———. 1942. The ecology of the vegetation and topography of the Sand Keys of Florida. *Papers Tortugas Laboratory* 33: 113-95 .
Carnegie Institution of Washington Publication Number 524.
This is a study of the vegetation and some of the physiographic features of about thirty islands of the Florida Keys, in an area extending west from Key West, Florida, and including the Dry Tortugas Keys. About thirty islands of the Florida Keys beyond Key West were investigated during the summer of 1940 and winter of 1942, and to some extent during the summers of 1937 and 1938. These studies were concerned with the topography and vegetation of these small, relatively isolated, and partly tropical islands. These islands are here termed the Sand Keys because most of the parts above high tide are composed of coarse calcareous sands, and also because this name was used by Willspaugh (1907). A few of the Marquesas and Tortugas Keys have changed a great deal. The strand areas on a number of islands seem to be increasing at the expense of the mangrove swamps. The mangrove swamps have spread over wide areas in some instances and seem to be aiding in building up the islands. Most of the constructional processes are, however, due to maritime factors such as the ocean currents and tides. This paper is also a part of a series of studies of the plant ecology of southern Florida. This and the author's study of mangrove vegetation together describe most of the coastal and insular vegetation of that region.

85. Davis, R. A. Jr. and C. W. O'Neill. 1979. Morphodynamics of East Key, Dry Tortugas, Florida. *in Guide to Sedimentation for the Dry Tortugas,Fort Jefferson National Monument Florida Southeast Geological Society Publication* 21: 7-13.
East Key is comprised wholly of biogenic sand and fine gravel. It lacks beachrock or bedrock which may act as a stabilizing agent such as on Loggerhead Key. During the past two centuries, maps and charts documented the size, shape, and location of East Key. The Key moved in a generally southeasterly direction across the shallow carbonate bank. East Key was preserved, unlike some other islands, because of its easterly position with respect to the deep lagoon. Those islands west of the lagoon moved easterly and disappeared into the lagoon (O'Neill, 1976). East Key has decreased markedly in size during its southeasterly movement. In addition there appears to be a change in morphology which is related to seasonal changes in predominant wind direction.

86. de Laubenfels, M. W. 1936. A discussion of the sponge fauna of the Dry Tortugas in particular and the West Indies in general, with material for a revision of the Families and Orders of the Porifera. *Papers Tortugas Laboratory* 30: 1-225.
Carnegie Institution of Washington Publication Number 467.
Sponge specimens were collected near the Dry Tortugas by scientists affiliated with the Carnegie Institution of Washington, or working at the laboratory maintained on Loggerhead Key. These were sent to the U.S. National Museum to be studied by the author. The West Indian region has long been known as one of the richest collecting grounds for sponges in the world, and the Dry Tortugas offers a representative sample of it. The author identified

several new families and in many cases proposed new names for families already in use. Representatives of each of the species discussed in this paper have been deposited in the United States National Museum. Each new species is described in detail.

87. ———. 1934. Physiology and morphology of Porifera exemplified by *Iotrochota birotulata* Higgin. *Papers Tortugas Laboratory* 28: 37-66.
Carnegie Institution of Washington Publication Number 435.
The experimental work upon which this article is based was carried on during the summers of 1927 and 1928 at the Tortugas Laboratory. A taxonomic description of the sponge was provided. It was found that a hyaline ground mass or slime plays a very important role in the life of Iotrochota and perhaps numerous other sponges. Judging only by items visible in living *Iotrochota* cells, which were kept track of by conspicuously colored inclusions, new sponges resulted from disassociated cells without intermediate differentiation and respecialization. Reproductive bodies (gemmules) seem to result in *Iotrochota* by the migration together of cells previously specialized for the purpose. Bispecific conglomerations could be secured between *Iotrochota* and other species, and these remained alive for two weeks or more, but whatever cell motility occurred within them tended toward the ultimate segregation of the two species after somewhat the manner in which animal gratings finally terminate. Amebocytes of *Iotrochota* sometimes ingested flagellates which subsequently appeared as intracellular inclusions, and perhaps became the symbionts whereby there occurred a certain amount of photosynthesis, the existence of which was indicated by experimentation.

88. ———. 1953. Sponges of the Gulf of Mexico. *Bulletin of Marine Science of the Gulf and Caribbean* 2, no. 3: 511-77.
In 1948, a collection of sponges was made by the Marine Laboratory of the University of Miami in the eastern Gulf of Mexico. Twenty-two stations were studied, at depths from 6 to 20 meters, in the area between Dry Tortugas and the northeastern part of the Gulf. The collection comprises 52 species in 41 genera, all within the class Demospongea. Of these 11 species are new. Additional description is provided for a number of species. An analysis of the sponge collection by stations is included.

89. de Renyi, G. S. 1934. Studies of nerve cells of invertebrates. *Carnegie Institution of Washington, Year Book.* 33: 250.
The nerve tissue (neuroplasm) of gastropods (*Strombus gigas), Aplysia protea, Olivia litterata, Cypraea exanthema, Casio cameo*), decapods (*Panulirus argus, Crangon armillatus, Ocypoda albicans*), and hemichordates (*Ptychodera bahamensis*) were studied. The neoplasm of the Gastropoda and Hemichordata exhibited viscosity, and a certain degree of elasticity, whereas decapodean neuroplasm was liquid.

90. Deflaun, M. F. 1987. "The distribution and molecular characterization of dissolved DNA in aquatic environments." University of South Florida. Ph.D. Dissertation
The distribution of dissolved DNA in oceanic, estuarine and freshwater environments in southwest Florida and the Gulf of Mexico was determined by using a method for the measurement of dissolved DNA based on the fluorescence of Hoechst 33258-DNA complexes. Oceanic concentrations of extracellular DNA ranged from 0.2 to 19 decreasing as a function of distance from the shore and depth in the water column. Samples of the mucus-rich coral surface microlayer (CSM) collected on reefs in the Dry Tortugas had dissolved DNA concentrations from 1.8 to 11.7 times that in the overlying water. Estuarine concentrations, measured at three stations in Tampa Bay, FL over a 15-month period, followed the seasonal trend in concentrations in offshore environments, while variations in the estuary were significant, with maximum concentrations in nighttime samples. Although concentrations of dissolved DNA in the eutrophic Alafia River were generally higher than those in the oligotrophic Crystal River, values as low as 1.14 were measured in the Alafia. A wide range of molecular weights (determined by agarose gel

electrophoresis) was found for extracellular DNA concentrated from various aquatic environments. These results indicated that dissolved DNA is in a size range sufficient to contain gene sequences, which may be important in natural transformation of microbial populations. A model system for probing extracellular DNA from aquatic environments was developed using the plasmid containing the herpes simplex thymidine kinase (TK) gene. Plasmid DNA and the TK gene fragment added to artificial seawater were concentrated and labeled TK to establish percent recovery and detection limits for the method. The degradation of plasmid DNA added to a natural seawater sample was monitored over a 36 h period by probing with the TK gene probe. Intact plasmid was detected for up to 4 h and DNA hybridizable to the TK probe was detected for up to 24 h. These methods were used to probe for the TK gene in environmental samples of extracellular DNA. Hybridization to the TK probe was detected in both freshwater and estuarine samples.

91. Dinsmore, J. J. 1972. Sooty tern behavior. *Bulletin of the Florida State Museum of Biological Science* 16, no. 3: 129-79.
A four-year study of the breeding behavior of sooty terns (*Sterna fuscata*) was made at Bush Key, Dry Tortugas in the southeastern Gulf of Mexico. The results are compared with the behavior of other terns and the differences discussed, particularly in regard to the pelagic environment the sooty tern inhabits. sooty terns have a lower clutch size, longer period of development of the chick, and first breed when older than most other terns, many of which feed in marshes and coastal waters. These characteristics of sooty tern breeding biology are similar to those of many other pelagic birds. A distant food supply and high adult survivorship apparently have contributed to these differences from other terns.

92. Dinsmore, J. J. and W. B. Robertson Jr. 1972. Sooty tern feeding on moths. *The Auk* 89, no. 2: 440.
While banding sooty terns (*Sterna fuscata*) at Bush Key, Dry Tortugas, Florida on June 28, 1970, an adult tern regurgitated two moths 1.5 to 2 cm long together with several unidentified fish. The moths were identified to the family Noctuidae. Although the food of sooty terns at the Dry Tortugas has not been studied in detail, sizable collections of food regurgitated show that this population feeds on fish and squid. In 13 years of tern banding, this is the first time an insect has been found as part of the sooty tern's diet .

93. Dole, R. B. 1914. Some chemical characteristics of sea water at Tortugas and around Biscayne Bay, Florida. *Papers Tortugas Laboratory* 5: 69-78.
Carnegie Institution of Washington Publication Number 182.
The chemical tests at Tortugas were performed by the writer in June 1913, in the Marine Biological Laboratory, Tortugas, Florida, for the primary purpose of ascertaining what soluble effect, if any, carbon dioxide in sea-water might have on coral and other deposits of calcium carbonate. The tests of waters from Biscayne Bay were made to ascertain the differences in concentration of sea-water in the bay and the diluting effect of Miami River. The salinities of the three samples taken outside the reefs agree closely with each other and with the salinity of Gulf water at Tortugas, Florida (36.01 ppt), which is somewhat greater than that of standard ocean water (35.02 ppt.). The water in the south part of the bay is somewhat more concentrated having salinities of 36.73, 36.64, and 36.64 ppt., respectively. This evidence that the water in this part of the bay is concentrated by evaporation during its retention in the shallows serves further to indicate that circulation there is not very rapid and that the greater bulk of the water inside the keys is not thoroughly mixed or shifted by the tides. Sample 1 has a salinity obviously higher than the pure water of Miami River alone may be expected to have, and represents admixture with bay water; carbonates are absent from it, but bicarbonates are much higher than in the normal drainage from the Everglades and may be attributed to reaction of the carbon dioxide that the river water carries.

94. Domeier, M. L. Speciation in the Serranid fish *Hypoplectrus*. *Bulletin of Marine Science* 54, no. 1: 103-41.

Research was conducted to determine the species status of individual color morphs of fishes in the genus *Hypoplectrus* (family Serranidae). Crossing two morphs of *Hypoplectrus* (*H. unicolor x H. gema*) in the laboratory produced an F1 generation with an intermediate phenotype to that of the parental types. This intermediate morph cannot be assigned to any known morph and is thus termed a hybrid. Individuals of several *Hypoplectrus* morphs were found to select only individuals of the same morph as a mate when provided a choice. Individual fish can sometimes be forced to mate with an individual of a different morph by not providing a choice of mates. The occurrence of hybrids was found to be low in the field, corresponding to the low occurrence of mixed matings in the field. Some differences in distribution were found between the different hamlet morphs. The new data provided by this study, which includes specimens collected from the Dry Tortugas, indicate that the different color morphs warrant full species rank. It is hypothesized that speciation in *Hypoplecturs* was driven by the rise and fall of sea level during the last ice age.

95. Donaldson, H. H. 1916. Experiment on the feralization of the albino rat. *Carnegie Institution of Washington, Year Book* 15: 200-201.
Domesticated albino Norway rats were released on East Key to determine if changes in brain weight occur over successive generations in a wild state. Since the rats were unmarked, it was impossible to ascertain if differences in weight were from new breeds or from animals in the original colony.

96. Doyle, W. L. 1936. Cytology of *Valonia. Papers Tortugas Laboratory* 29: 13-21 (issued Nov. 1935). Carnegie Institution of Washington Publication Number 452.
For a number of years algal cells with large vacuoles have been the subject of research on the permeability of the plasma membrane. Prominent among forms investigated is *Valonia.* This paper describes the cytology of *Valonia ventricosa* and *Valonia macrophysa* with particular emphasis on structures of significance in physiological investigations. The cells were collected on Bush Key Reef and from the moat at Fort Jefferson and kept in finger bowls in the laboratory. The morphology of the various structures in the cytoplasm of *Valonia macrophysa* and *V. ventricosa* is described. The plastids produce starch and lipoid granules and are sufficiently numerous as to constitute two-thirds-of the volume of the cytoplasm. There are approximately three hundred nuclei per square millimeter of cell surface in the coenocytes. Mitosis is intranuclear. In the development of the rhizoidal hapteron cells of the aplanospores, the mitochondria arise from plastids of the coenocyte in which the aplanospores were formed. The large central vacuoles of the coenocyte arises by fusion of small vacuoles formed in the cytoplasm. Double vital staining of artifact vacuoles is noted.

97. ———. 1940. The structure and composition of *Valonia ventricosa. Papers Tortugas Laboratory* 32: 143-52 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 571.
The physiology of *Valonia* has been dealt with extensively by numerous authors. Cells were collected from Long Key and the adjacent reef and brought to the laboratory, where they were kept in large glass jars of sea water which was changed daily. Measurements have been made of the relation of the volume and thickness of the cytoplasm and cell wall to the size of the coenocyte. The specific gravities of various cell constituents and of cells of various sizes have been measured. From a consideration of the results presented it would appear that the level of metabolic rate in *Valonia* is of a low order, but not necessarily of a different order of magnitude from that of the barley-root and potato-slice systems.

98. Doyle, W. L. and M. Metcalfe Doyle. 1940. The structure of zooxanthellae. *Papers Tortugas Laboratory* 32: 127-42 (issued May 1940).
Carnegie Institution of Washington Publication Number 517.
The structure of the zooxanthellae in various invertebrate reef organisms under various conditions was investigated at the Dry Tortugas in 1934, 1935 and rechecked in 1939. Ten

species of corals and foraminifera were studied in their living conditions, as well as after fixation. Zooxanthellae in foraminiferans, were examined for the effects of light in normal gas tensions, in increased carbon dioxide tensions, and on specimens in oxygen and hydrogen; while in corals the comparative cytology of zooxanthellae was studied. For the large heads of the *Orbicella (Madrepora)*, the amount of light present at the top and bottom of the corals determined the natural variations in the amount of calcium oxalate crystals in zooxanthellae. Increased levels of crystals were found at the bottom in darkness, while no crystals were found at the top. Similar results were found in foraminiferans. The converse is true for the amount of starch present. The zooxanthellae in corals under the most intense natural light conditions contains little starch, but abundant oil droplets. It was concluded that, overall, for the greater part of the day, the zooxanthellae, as well as the corals, are in need of oxygen.

99. Drew, G. H.. 1914. On the precipitation of calcium carbonate in the sea by marine bacteria, and on the action of denitrifying bacteria in tropical and temperate seas. *Papers Tortugas Laboratory* 5: 7-45.
Carnegie Institution of Washington Publication Number 182.
The investigations described in this paper were made in the summers of 1911 and 1912 under the auspices of the Carnegie Institution of Washington. The intent was to study the action of marine denitrifying bacteria in tropical seas. The discovery that these denitrifying bacteria also possess the power of precipitating calcium carbonate from soluble calcium salts present in sea-water has overshadowed the primary object of the work. The observations so far available are few, and the area they cover too small, to attempt to make broad generalizations. However, it can be stated that the very extensive chalky mud flats forming in the neighborhood of the Florida Keys are now being precipitated by the action of the bacterium *calcis* on the calcium salts present in solution in sea-water. The investigation can at most be considered to offer a mere indication of the part played by bacterial growth in the metabolism of the sea. To obtain a real insight into the question, it would be necessary to make more extensive bacterial and chemical observations in tropical, temperate, and arctic waters, to study the bacteriology of other areas where calcium carbonate is being precipitated from the sea, and to make further investigations in the laboratory into the chemistry of the reactions that can be brought about by various species of marine bacteria.

100. Dustan, P. 1985. Community structure of reef-building corals in the Florida Keys , Carysfort Reef, Key Largo, and Long Key Reef, Dry Tortugas. *Atoll Research Bulletin* 282-292: 1-29.
This communication is the result of two parallel studies on the distribution of reef-building corals on Carysfort Reef, Key Largo and Long Key Reef, Dry Tortugas. The aim of the projects was to characterize the species composition of reef-building corals from the northern and southernmost localities of the Keys, and through comparison attempt to identify the impact of man on the reefs in the Key Largo area of the northern Florida Keys.

101. Dustan, P., W. Jaap and J. Halas. 1976. The distribution of members of the Class Sclerospongiae. *Lethaia* 9, no. 4: 419-20.
The Sclerospongiae play an important and sometimes major role in the construction and infilling of reefs in tropical waters. Modern sclerosponges are limited to dark, quiet, sediment-shaded habitats. This study describes the distributions of sclerosponges in the Bahamas and the Florida Reef Tract. The sponges were found in the Grand Bahamas. After extensive SCUBA diving in Pennekamp Park and the Dry Tortugas, no Sclerospongiae were found. Cold water temperature, or alternatively few, if any larvae to colonize the reef tract are possible explanations for the lack of Sclerospongiae in the Florida Reef Tract.

102. Edmondson, C. H. 1908. A variety of *Anisonema vitrea*. *Papers Tortugas Laboratory* 1: 191.
Carnegie Institution of Washington Publication Number 102.

Notes are provided on the protozoan, *Anisonema. Anisonema vitrea* (Dujardin) is a flagellated protozoan, elongate-oval in form, the anterior end broadly rounded, the posterior more acutely rounded. *Anisonema vitrea* is distinguished from other species of the genus by eight furrowed surfaces extending in a slightly spiral manner from one end of the body to the other. During the summer of 1906, while working on marine Protozoa at the Tortugas, Fla., the author studied a form considered as a variety of the above species entitled *Anisonema vitrea* (Duj.) var. pentagona. A description of the difference between the species and variety is presented .

103. Erseus, C. and M. R. Milligan. 1988. A new *Bathydrillus oligochaeta* Tubificidae from the eastern Gulf of Mexico. *Bulletin of Marine Science* 42, no. 2: 292-95.
Bathydrilus natabilis is described from 4-58.5 meter depths off Crystal River and Dry Tortugas in the eastern Gulf of Mexico. The species is characterized by large, finely pectinate, penial setae in segment 11 and entally curved, single-pointed, spermathecal setae in segment 10 which distinguish it from all congeners.

104. Farfante, I. P. 1980. A new species of rock shrimp of the Genus *Sicyonia penaeoidea,* with a key to the western Atlantic species. *Proceedings of the Biological Society of Washington* 93, no. 3: 771-80.
Sicyonia olgae, new species, ranges from Dry Tortugas Islands, Florida, to Surinam. It differs from *Sicyonia typica* (Boeck, 1864), its closest western Atlantic relative, in possessing sublateral carinae on the carapace, and in lacking posterior pleural sulci on the first three abdominal somites. Also distinctive are the sharply pointed, mesially directed, distomesial projections of the petasma in the male, and in the female the pair of long, slender spines on sternite XI and rounded posterolateral processes of the median plate of sternite XIII. A key to the western Atlantic species of *Sicyonia* is supplemented by synopses of their geographic and depth ranges which include many extensions of previously known limits.

105. Feinstein, A. A. A. R. Ceurvels R. F. Hutton and E. Snoek. 1955. "Red tide outbreaks off the Florida West Coast." *Report to the Florida State Board of Conservation of Marine Laboratories* .
A compilation of reports of red tide on the west coast of Florida from 1844 to January, 1955 is given. Also included are two working diagrams of incidence of red tide, suggesting that red tide occurs more frequently in the months of August through January, and that individual red tide outbreaks are part of larger outbreaks, which seem to move from south to north, and summer outbreaks appear to originate mostly north of Venice, winter and spring outbreaks further south. Further data are required to give complete support. If this is substantiated, control may be exerted by action in a limited focal area or areas of origin. Otherwise, the problem of control may be of the greatest difficulty, since it will require action over a much wider area.

106. Field, R. M. 1919. Investigations regarding the calcium carbonate oozes at Tortugas, and the beach rock at Loggerhead Key. *Carnegie Institution of Washington, Year Book* 18: 197-98.
Calcium carbonate accumulations in the shallow lagoons and channels between the reef flats were examined to ascertain their origin. Carbonate ooze hardens rapidly when exposed to air and when flooded with saltwater, mud-cracked zones can be formed similar to those in the geologic record, as in the Stones River limestone formation. An account is given on the origin of the "beach rock" found between the high and low water marks on Loggerhead Key.

107. ———. 1920. Origin of "beach rock" (coquina) at Loggerhead Key, Tortugas (abs.). *Bulletin of the Geological Society of America* 31: 215.
A study was made to discover the origin of the "beach-rock" or cemented shell-sands which occur between high and low tides. By means of a stand-pipe and pump, it was found that during heavy rains a shell key acts like a reservoir, and the meteoric water dissolves $CaCO_3$ on its way through the loose shell sands. The ground water was found to contain 40 per cent

more $CaCo_3$ in solution, or colloidal suspension, than the normal sea water. This concentrated solution of $CaCo_3$ has a strong cementing value, and is probably an important factor in the formation of the "beach-rock" where the ground water flows out through the beach sands, between tides.

108. Fisk, E. J. 1976. Black phoebe sighted at Dry Tortugas. *Florida Field Naturalist* 4, no. 2: 39.
An observation of a black phoebe on Loggerhead Key, Dry Tortugas on April 13, 1976 is recorded. This is the fourth sighting and only spring record for Florida of a black phoebe.

109. Gauld, G. 1820. *An accurate chart of the Tortugas and Florida Keys or Martyrs, surveyed by George Gauld, A.M. in the years 1773, 1774, 1775*. London, W. Faden.
First nautical chart of the Dry Tortugas is produced.

110. Gee, H.. 1934. Lime deposits and the bacteria. I. Estimate of bacterial activity at the Florida Keys. *Papers Tortugas Laboratory* 28: 67-82 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 435.
Aerobic organisms were collected from the Florida Keys. Viable counts indicate that open areas are only thinly populated with these forms, but that sheltered areas may permit increased activity. Conditions in the mud are such as to favor the growth of anaerobes. There is a possibility that specific groups, such as the purple sulphur organisms are at work in addition to the conventional aerobes.

111. Gee, H. and C. B. Feltham. 1934. Lime deposition and the bacteria. II. Characteristics of aerobic bacteria from the Florida Keys. *Papers Tortugas Laboratory* 28: 83-91 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 435.
General bacterial conditions at the Florida Keys during the 1930 season have been discussed by Gee (1932). There was reported a collection of 138 representative aerobic organisms recovered from the water and mud of Bird Key harbor between Bird and Garden Keys, of the Marquesas lagoon, and of one vertical one in the vicinity of the Gulf Stream. Preliminary examinations were made of them at the Tortugas laboratory. The strains were found to be Gram-negative rods, ammonia-producing, and possibly fermenting. The collection was subsequently studied exhaustively at the Scripps Institution during the winter of 1930-31. When freshly isolated, these bacteria displayed considerable variation in size, in colony features and color, and in their degree of physiological activity.

112. Gersh, I. 1935. Studies on the anterior pituitary gland of the nurse shark. *Carnegie Institution of Washington, Year Book* 34: 81.
Experiments were planned on the nurse shark to determine which of the activities of the anterior pituitary gland are referable to the eosinophile cells.

113. Gilmore, R. G. and R. S. Jones. 1988. *Lipogramma flavescens*, a new grammid fish from the Bahama Islands with descriptive and distributional notes on *L. evides* and *L. anabantoides*. *Bulletin of Marine Science* 42, no. 3: 435-45.
In 1981, dredge collections made north of the Dry Tortugas by Continental Shelf Associates under contract with the Bureau of Land Mangement documented the first continental record of *L. anabantoides.*

114. Ginsburg, R. N. 1953. Beach rock in south Florida. *Journal of Sedimentary Petrology* 23: 89-92.
The rapid intertidal lithification of beach deposits in the coral seas has received the attention of numerous investigators. Study of beach rock from the Dry Tortugas shows that the aragonite cement is precipitated from the sea water remaining in the beach sands at low tide. High temperatures, rate of beach drainage, and the permanence of the beach control the

localization of beachrock. The recognition of beachrock in the fossil record is briefly discussed.

115. Goldfarb, A. J. 1913. Changes in concentration of sea-water and their influence upon regeneration. *Proceedings of the Society for Experimental Biology and Medicine* 10, no. 3.
The regeneration under changed densities of sea water was observed under conditions that endured the elimination of uniformity of associated factors such as size of medusae, volume, surface and depth of solutions, extent of injury, level of amputation, temperature, crowding, aeration, etc. Dilutions were made with water containing a known quantity of sea salts, and concentrated solutions were made by slow evaporation, which corrected certain errors in previous experiments. Results were compared with those of Loeb. It was found that both the hydroid *Eudendrium* of Woods Hole as well as *Cassiopeia* of Dry Tortugas differed radically from the Loeb experiments, in respect to the range of solutions in which animals lived or regenerated, the optimum solutions, the normality of the regenerated parts and the character of the curve. It is stated that Loeb's curve probably is limited to *Tubularia* of Naples, and does not represent the behavior of organisms to changes of density of sea water, and that the differences in the behavior of these three organisms can hardly be correlated with the differences in concentration of the sea water in which they normally live.

116. ———. 1914. Changes in salinity and their effects upon the regeneration of *Cassiopea xamachana. Papers Tortugas Laboratory* 6: 83-94.
Carnegie Institution of Washington Publication Number 183.
Cassiopea xamachana, a large scyphomedusa, is very abundant in the very shallow waters of the moat at Fort Jefferson, Dry Tortugas, Florida. The present report considers to what extent changes in salinity influence regeneration in *Cassiopea,* and the results of the investigation are compared with those previously obtained with the hydroid *Eudendrium ramosum* of Woods Hole, Massachusetts and with the observations of Loeb with the hydroid *Tubularia* of Serino Bay, Italy. The object of this investigation was to ascertain to what extent changes in salinity affected *Cassiopea xamachana* normally subject to relatively great variation in the concentration of the sea-water, and to compare the results with those of the hydroid *Eudendrium* and the hydroid *Tubularia.* The following variable factors were uniform for the series: size of medusae; volume, surface, and depth of the solutions; extent of injury; level of amputation; temperature; crowding. Injurious or other variable factors were guarded against. *Cassiopea* lived in solutions ranging from 40 to 153 per cent sea-water solutions. Regeneration occurred in solutions containing 50 to 133 per cent sea-water. Normal regeneration of the arms occurred within much narrower range, namely 75-105 per cent. Beyond these limits regeneration was atypic .

117. ———. 1918. Effects of aging upon germ cells and upon early development. Part II. *Biological Bulletin* 34, no. 6: 372-409.
In a previous preliminary experiment it was shown that freshly liberated eggs of different females of three different species of sea urchins (*Toxopneustes* and *Hipponoe* collected from the Tortugas, and *Arbacia* from Woods Hole, Mass.) varied in respect to size, jelly layer, membrane formation, and cleavage. In this paper the same technique and the same three species of sea urchins were used to determine the physiologic condition of the germ cells, and then determine the nature of the changes in the eggs as they became increasingly overripe. As eggs in good physiologic condition aged, their volume increased until they became smaller than the norm. Eggs in poor condition were reduced in size., in all three species, there was a loss in jelly layer with age, depending on the condition of the egg. In all three species, as the eggs aged, the membrane appeared closer to the surface, becoming thinner until none was formed. The rate of decrease in cleavage with age was greater in *Toxopneustes* and *Hipponoe* than in *Arbacia.* Overall, the change in size, jelly membrane, and cleavage with aging of germ cells are accurate, convenient and corroborative indices of physio-chemical and morphologic changes in the eggs as they age, and afford convenient measures of loss in vitality, or physical deterioration.

118. ———. 1914. Experimentally fused larvae of echinoderms with special reference to their skeletons. *Papers Tortugas Laboratory* 6: 103-21.
Carnegie Institution of Washington Publication Number 183.
The early work of Loeb, Morgan, and Herbst on the production of multiple embryos from a single egg suggested the reverse experiment of grafting or reuniting several fertilized eggs into on embryo. In 1912, the writer repeated these experiments with the American form *Arbacia punatulata* and succeeded only after slightly modifying Driesch's method. Subsequently, in the performance of other experiments, it was discovered that eggs could be agglutinated and fused quite as readily by a very different method, which was not only simpler but free of certain objections that might be urged against previously known methods. The new method consisted in using an isotonic or slightly hypotonic NaCl solution diluted with varying quantities of sea-water.

119. ———. 1913. The influence of the central nervous system in regeneration of an annelid worm. *Proceedings of the Society for Experimental Biology and Medicine* 10, no. 3. np.
(No abstract available).

120. ———. 1914. Regeneration in the annelid worm *Amphinsoma pacifica,* after removal of the central nervous system. *Papers Tortugas Laboratory* 6: 95-102.
Carnegie Institution of Washington Publication Number 183.
In a previous publication, the writer found that the head of the earth-worm *Lumbricus* was regenerated in the entire and permanent absence of the nerve-cord from the amputated region. The marine annelid worm *Amphinoma pacifica* readily regenerated a head at all levels except the distal eighth of the worm. Regeneration may be prevented by a severe injury, either to the digestive tract or to the central nerve system; the greater the injury the more likely will regeneration be inhibited. Many pieces did not regenerate after removing the alimentary tract from five or more segments nearest the amputated level. Many pieces, about one-third, failed to regenerate after removing the nerve-cord by the forceps, i.e., with little injury to adjoining tissues. All failed to regenerate after removing the nerve-cord by the "window" method. The operated worms were examined in serial sections. In one group a regenerated nerve-cord connected the regenerated "brain" and commissures with the old intact nerve-cord. In a second group the regenerated nerve-cord approached and in instances reached the amputated level, yet no head was formed. In a third group, the nerve-cord had regenerated, but several segments nearest the amputated end were yet without any nerve-cord or ganglia. These worms nevertheless had regenerated a head with its typical brain and nerve-commissures.

121. ———. 1917. Variability of eggs and sperm of sea-urchins. *Papers Tortugas Laboratory* 11: 71-87.
Carnegie Institution of Washington Publication Number 251.
A clear understanding of the variability in normal fresh eggs and sperm is necessary in order to appreciate and to evaluate the changes that take place in overripe germ-cells. This paper deals exclusively with the qualitative and quantitative differences of such freshly collected sea-urchin eggs and sperm and with the differences in their early development.

122. ———. 1917. Variability of germ cells of sea urchins. *Proceedings of the National Academy of Science* 3: 241-45.
Three different species of sea urchins (*Toxopneustes* and *Hipponoe* collected at the Dry Tortugas, *Arbacia* collected at Woods Hole, Massachusetts) were used to determine the normal variability of sea urchin germ cells. Having determined the optimum and constant conditions of germ cells, studies were conducted to examine variations in size and shape of eggs, the jelly layer of eggs, membrane formation, and cleavage among the three species. Amazingly large variations were found in fresh germ cells among species, thus suggesting that among other investigators of the varying behavior of the eggs, a large part of the variation was probably due to the physiologic conditions of the eggs which these investigators used.

123. Goodrich, H. B. 1935. Color patterns in fish. *Carnegie Institution of Washington, Year Book* 34: 81.
Studies were carried out to investigate internal conditions which may control the development and maintenance of color patterns in fish by transplanting scales and tissues from one type of pigment area to another.

124. Gordon, M. 1933. The internal pigment systems of fishes. *Carnegie Institution of Washington, Year Book* 32: 268.
The internal pigmentary systems of major taxonomic groups were examined. *Halichores bivittatus* and *Lutjanus griseus* showing possibly neoplastic growths were collected for study.

125. Goy, J. W. 1982. West Indian Stenopodidae. 2. Occurrence of *Richardina spinicincta* Crustacea, Decapoda, Stenopodidea off the Dry Tortugas. *Bulletin of Marine Science* 32, no. 1: 344-47.
An examination of *Richardina spinicincta* collected by W.L.Schmitt in August of 1932 is made. It is concluded that this specimen is truly *R. spinicincta*, that this is the sixth known specimen of the species, and the first record of the genus in the Western Atlantic. The occurrence suggests that the genus occurs at shallower depths than those recorded in previous literature.

126. Grave, C. 1934. The *Botryllus* Type of Ascidian larva. *Papers Tortugas Laboratory* 28: 143-56 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 435.
Free-swimming larvae of at least three well-defined types are found in life cycles of ascidians; one, characteristic of species of *Molgula (Grave* '26) and related genera, that has one sense organ only, a statolith, in its sensory vesicle. The nerve cord lies in a mid-dorsal position above the notochord, the caudal fin is expanded vertically in the median plane and adhesive papillae are lacking. In the text the structural organization of a type of larva characteristic of species of *Botryllus* and related genera is described. The body is egg shaped, its depth being approximately the same as its width. Three conical sensory papillae arranged in the form of an equilateral triangle are borne at the anterior smaller end of the body, two located on either side of the median plane dorsal to the central body axis, one in the median plane ventral to the central axis. The same gross parts found in the central nervous system of larvae of other types are present. The anterior end of the visceral ganglion bends to the right and expands to form the sensory vesicle, which, in contrast with that of larvae of other types, does not project to the level of the dorsal surface of the body but retains an interior position relatively far below the surface.

127. ———. 1936. Metamorphosis of ascidian larvae. *Papers Tortugas Laboratory.* 29: 209-91 (issued Dec. 1935).
Carnegie Institution of Washington Publication Number 452.
The studies of metamorphosis of larvae of ascidians were made during the summers of 1927, 1930, and 1933 at the Tortugas Laboratory with the purpose of finding methods of accelerating and controlling metamorphosis and thus of discovering something of the fundamental nature of the internal mechanism involved and the environmental conditions with which it is causally related. The observations made in the course of this investigation are interpreted as follows: The ascidian larva is a dual organism, the action system of the larva being quite separate from the action system of the ascidiozooid. Metamorphosis advances by three stages; (a) changes in the adaptive responses of the larva to light and gravity; (b) the attachment of the larva to the surface of some foreign object; (c) the disruptive phase during which the entire larval action system is destroyed. Swimming activity causes the production and concentration of some metabolic product in the larval tissues that is essential to the induction of metamorphosis. The presence in the larval tissues of metabolic products resulting from swimming is not alone sufficient to induce metamorphosis, but another substance with which this metabolic product may react is

equally necessary. The great variability of ascidian larvae of the same species in the duration of their free-swimming period is apparently due to variability in the time of formation of the susceptibility substance and hence to the time of differentiation of the larval organ that produces it. Metamorphosis may be induced artificially by diverse chemical and biological substances placed in sea-water with groups of larvae in lactic acid. Metamorphosis is rapidly and consistently induced in the larva of *Phallusia nigra.* The activating agents extracted from the fresh ascidian tissues that were so specific in their effects may also be endosymes of a highly specialized kind, each found only in a single species of ascidian. The mechanism of metamorphosis is comparable in its organization to that of development of an egg, which also may be activated by numerous and diverse chemical and physical agencies.

128. Grave, C. and P. A. Nicoll. 1940. Studies of larval life and metamorphosis in *Ascidia nigra* and species of *Polyandrocarpa. Papers Tortugas Laboratory* 32: 1-46 (issued Oct. 1939). Carnegie Institution of Washington Publication Number 517.
Experimental studies made during the summer of 1933 (Grave, 1936) demonstrate that sea-water extract of pharyngeal, atrial, or mantle tissues of adult *Ascidia nigra* is effective in inducing 100 per cent metamorphosis in groups of Ascidia larvae within 3 hours after hatching and that similar extract of tissues of *Polyandrocarpa* induces 100 per cent metamorphosis in groups of *Polyandrocarpa* larvae within 42 minutes after liberation from the parent colony. These observations led to a search during the summers of 1935 and 1936 for a specific chemical substance in the tissues of these ascidians having the properties required for the rapid acceleration of the process of metamorphosis. An account of the methods and results of this work is given in this paper. It was found that the amino acids l-histidine, leucine, glycine, cysteine, and d,l-alanine, in the form received from the laboratories in which they were prepared, accelerated metamorphosis in groups of larvae of both types. A sea-water extract of free-swimming larvae or of late embryonic stages of *Ascidia* has the same accelerating effect on metamorphosis of *Ascidia* larvae as an extract made from tissues of the adult ascidian. Heating adult *Ascidia* tissue or releasing distilled-water extracts of the tissue for several hours does not destroy the accelerating substance. Non-toxic concentrations of copper, iron, and aluminum salts induce early metamorphosis to a marked degree. The duration of the free-swimming period of *Ascidia* larvae is longest at the beginning of the breeding season of the species and becomes gradually shorter as the season advances.

129. Gudger, E. W. 1921. Notes on the morphology and habits of the nurse shark, *Ginglymostroma cirratum. Copeia* 98: 57-59.
A physical description of the nurse shark as observed by the author for several summers in the southern Florida Keys and Dry Tortugas is given.

130. ———. 1929. On the morphology, coloration, and behavior of seventy teleostean fishes of Tortugas, Florida. *Papers Tortugas Laboratory* 26: 149-204.
Carnegie Institution of Washington Publication Number 391.
In the course of work at the Tortugas, 70 teleosts, belonging to 28 families, have been studied. Habits have been recorded herein that stand out prominently to the taxonomist. First, basing the classification of tropical fishes on coloration is a very dangerous thing. Most of the fishes in Tortugas have from two to five color phases in life and, even when studying the fish in a state of comparative quiet in an aquarium, it is very difficult to determine which is its normal color. When a fish dies, its color changes either entirely or in its intensity, so that the coloration of the dead fish is markedly different from that of the live fish. It is equally dangerous to describe and classify a tropical fish from a single specimen, since these fishes are so very variable in the number of fin rays, in the relative proportions of the body, in scale count, and in the many details which help to distinguish one species from another..

131. ———. 1918. On the use of the diving helmet in submarine biological work. *American Museum Journal* 18: 135-38.
The use of the diving helmet for research at the Dry Tortugas was initiated in 1915 by Longley and Carey, for fish observations and photography. Its use was declared new for underwater work. However, such is not the case. The use of the helmet alone replaced cumbersome diving suits (scaphanders) used by the commercial spongers out of Tarpon Springs, Florida, and early workers on the construction of the overseas railroad, The Florida East Coast Railway Extension from Homestead to Key West, Florida. The diving helmet in biological work dates back to around 1845, when M. Milne-Edwards conducted bottom surveys off the coast of Sicily. In 1679, pressurized air was first supplied to Borelli, who attached a simple air compressing pump to a leather diving helmet. These devices are all refinements of the crude diving helmets used back in ancient times by Alexander the Great, while recording plant and animal observations. These are some of the earliest underwater biological observations ever recorded. The earliest account of any type of diving apparatus is found in Aristotle and dates back to about 1000 B.C.

132. ———. 1918. *Sphyraena barracuda*; Its morphology, habits, and history. *Papers Tortugas Laboratory* 12: 53-108.
Carnegie Institution of Washington Publication Number 252.
This article provides a general description of the great barracuda, *Sphyraena barracuda* made at the Tortugas Marine Laboratory, based on local collections and an examination of 12 large individuals using length/weight measurements, color and markings, jaws and teeth, internal organs, foods and feeding, and manners of breathing. Additional information is presented on their habits, how they may be caught, and parasites. An interesting historical side of the paper compiled from around the world includes verbatim quotes and descriptions of their great size, ferocity, fossil forms, nomenclature, habitats, and food poisoning in man. Accounts of their poisonous flesh in the West Indies date as far back as 1667. Largest sizes of West Indies individuals approach 8-10 feet in length, with some highly "dubious" reports of specimens reaching sizes of 18-20 feet in length.

133. ———. 1913. Uterine gestation in the nurse shark, *Ginglymostoma cirratum. Journal of the Elisha Mitchell Scientific Society* 29: 8.
Also, in Science, 1913, v.37, p.993.
The breeding habits and embryology of this shark were studied at the Tortugas Laboratory in the summer of 1912. A brief account was published in the Year Book for 1912, p. 148-150.

134. Halley, R. B. and R. P. Steinen. 1979. Groundwater observations on small carbonate islands of southern Florida . *In Guide to sedimentation for the Dry Tortugas.* Compiler R. B. Halley, p. 82-89. Tallahassee, Florida: South East Geological Society Publication.
Observations are reported on the unusual hydrology of Loggerhead Key, a sandy key in the Dry Tortugas in comparison with observations on Cluett Key, a mud key which lies 200 km NE of Loggerhead in western Florida Bay. The ground water of Loggerhead and Cluett Keys differs significantly from the surrounding sea water, despite the relatively small size of the island. Climate alone does not determine the character of these ground waters; for example, Loggerhead Key is underlain by less saline ground water than Cluett Key despite the fact that it receives less rainfall. Ground water under such small islands such as these is formed from topography, sediment character, vegetation, and many more parameters that are themselves interrelated. They conspire to form ground water that not only differs from sea water, but also can react with the island sediments to change the character of the ground water. In this manner, island ground waters serve as geologic agents, hastening the alteration of marine carbonate sediments to limestone and dolomite.

135. Hanlon, R. T. and R. F. Hixon. 1986. Behavioral associations of coral reef fishes with the sea-anemone *Condylactis gigantea* in the Dry Tortugas, Florida USA. *Bulletin of Marine*

Science 39, no. 1: 130-134.
Over 30 small West Indian reef fishes dwell within the tentacular sphere of anemones, mainly to avoid predation. Most species swim carefully to avoid the stinging tentacles, but some species also have a physiological adaptation (skin mucus alteration) that allows them to be in full and vigorous contact with the tentacles in a manner similar to Indo-Pacific anemonefishes such as *Amphiprion, Dascyllus* and *Premnas.* The authors report herein six species of reef fishes that are facultative associates of the sea anemone *Condylactis gigantea* (Weinland) in the Dry Tortugas Islands. The fishes were not found associated with other anemones. One species, *Labrisomus gobio,* is a new record of a fish with both the behavioral and physiological adaptations to dwell unharmed among the stinging tentacles of *Condylactis gigantea.*

136. Hargitt, C. W. 1911. *Cradactis variabilis:* An apparently new Tortugan Actinian. *Papers Tortugas Laboratory* 3: 49-53.
Carnegie Institution of Washington Publication Number 132.
The author believes this species of actinian has never before been described, and names it *variabilis.* The specimens seem to have the capacity to move about more or less freely, and the frond-like organs situated about the margin of the oral disk and outside the outer cycloe of tentacles aid in such movement. The color is pale olivaceous-green to brownish; tentacles somewhat lighter; foliose organs darker, even brownish, with flake-white pads. The body is highly contractile, with a weak or diffused sphincter. The reproductive season seems to be in the spring and early summer. The habitat is chiefly in holes, crevices, or similar secluded places in the coral reefs or about the shoals where protection is available.

137. Harrington, B. A. and J. J. Dinsmore. 1975. Mortality of transient cattle egrets at Dry Tortugas, Florida. *Bird-Banding* 46, no. 1: 7-14.
This article examines the idea presented by Browder (1973) that cattle egrets pass through the Dry Tortugas with seasonal regularity, and that large numbers die after landing. This study concludes that regular spring movement occurs with many egrets stopping at the island, and that many of the egrets that stopped apparently died from starvation, especially in late June and in early July. The mortality in 1968 was higher that in 1970.

138. Harris, J. E. 1937. The mechanical significance of the position and movements of the paired fins in the Teleosti. *Papers Tortugas Laboratory* 31: 171-89 (issued Oct. 1936).
Carnegie Institution of Washington Publication Number 475.
In the course of the evolution of the modern teleostean fish, a series of fairly well-defined changes has taken place in the body form and in the shape and position of the fins. The present paper discusses the mechanical factors concerned in the evolution of the teleost type of fish. A comparison of this type with the dogfish suggests that the development of an air bladder has been the primary factor involved in the change in general body form. The reduction in specific gravity of the fish, consequent upon this primary change, has removed the need for a lift force on the body during free swimming. The asymmetrical (heterocercal) tail has therefore disappeared. For the same reason, the pectoral fins are no longer needed as elevating planes, and become free to move up toward the mid line of the body to act as brakes in stopping and turning movements. The forward motion of the pelvic fins is a mechanism for producing a balanced vertical force and a balanced pitching moment. These fins are normally used in conjunction with the pectorals. The independent movements of the pectoral fins are then discussed. All types of movement so far observed are variations on a fundamental form, in which the metrachronal oscillation of the fin rays generates an undulating fin surface. The observed variations in form of the fin beat can be produced by varying the phase difference between the beat of successive rays, and also by making the oscillation of the fin ray asymmetrical. The characteristics of the pectoral musculature associated with such variations are pointed out, and illustrated by reference to a number of fish types.

139. Hartman, C. G. 1931. The hypophysis of fishes. *Carnegie Institution of Washington, Year Book* 30: 381-82.
Studies on the influence of the hypophysis on menstruation and various forms of uterine bleeding in sharks were carried out.

140. Hartmeyer, R. 1911. *Polycistor (Eudistoma) mayeri* nov. sp. from the Tortugas. *Papers Tortugas Laboratory* 3: 89-93.
Carnegie Institution of Washington Publication Number 132.
A new species *Polycitor (Eudistoma) mayeri* , a new ascidian collected in 1907 at the Tortugas is described as the largest and most beautiful ascidian of the Tortugas. It was collected in the deeper water of the Southwest Channel near Loggerhead Key, on sandy bottoms, where it is abundant. The color is pale yellow, with a reddish or violet tint. From the western Atlantic only five species of this genus have been described, and all of these are mentioned by Van Name from the Bermudas, but all these species have four rows of stigmata in the branchial sac and are in many other respects quite different from this species.

141. ———. 1908. Reisebilder aus Westinidien mit besonderer Berucksichtigung der korallenbildungen. *Deutsch. Gessel. Fur Volkstumlich Natuirkunde or Same Title in Meereskunde Jahrg. 3, Heft 2, 40 Pp* 3, no. 2: 1-40. (No abstract available)

142. Harvey, E. N.. 1911. Effect of different temperatures on the medusae, *Cassiopea*, with special reference to the rate of conduction of the nerve impulse. *Papers Tortugas Laboratory* 3: 27-39.
Carnegie Institution of Washington Publication Number 132.
During the summer of 1909 a study was made of the effects of water temperatures on the nerves and muscle tissue of *Cassiopea*. Temperatures in the moat at Fort Jefferson ranged from 27°C to approximately 32-33°C. Activity limits and thermal death points of nerve and muscle were measured. It was found that nerve conduction rates fall off in rate with rise of temperature to a definite maximum, similar to that for enzyme action and for other life processes.

143. ———. 1914. The relation between the rate of penetration of marine tissues by alkali and the change in functional activity induced by the alkali. *Papers Tortugas Laboratory* 6: 131-46.
Carnegie Institution of Washington Publication Number 183.
The present study, made at Tortugas in the summer of 1911, is a continuation of permeability investigations undertaken at Columbia University in 1910 to 1911. The author's aim has been twofold. First, to compare the permeability of the cells and tissues of salt-water organisms with those of fresh-water forms. Second, to determine the relation between the rate of penetration of the alkali and the appearance of structural or functional changes in the cell. The author thinks that the presence of a sufficient number of OH ions within the egg may aid in breaking down the granules and that this breaking down increases also the degree of swelling of the egg. Cytolysis in *Holothuris* appears to be largely of this type, since NaOH enters before the increase in volume begins. From this point of view both theories of cytolysis contain an element of truth. Swelling of marine eggs is due both to an increase in permeability of the surface and also to the breakdown of lipoid or protein granules within. The latter tends to increase the swelling pressure or the osmotic pressure of the egg, but is secondary to the increase in permeability of the surface.

144. ———. 1921. Studies on bioluminescence XIII: Luminescence in the Coelenterates. *Biological Bulletin* 61: 280-287.
(No abstract available).

145. ———. 1923. Studies on bioluminescence. XV. Electroreproduction of oxyluciferin. *Journal of General Physiology* 5: 275-84.

This work was on the light-producing reaction in the luminous crustacean, *Cypridina.* Oxyluciferin may be reduced to luciferin at cathodes when an electric current is passed through the solution, or at cathodes formed by metal couples in solution, or at cathodes of oxidation-reducation cells of the NaCl - Pt - Na_2S type. It is also reduced at those metal surfaces (Al, Mn, Zn and Cd) which liberate nascent hydrogen from water, although no visible hydrogen gas separates from the surface. Molecular hydrogen does not reduce oxyluciferin even though very finely divided, but will reduce oxyluciferin in contact with palladium. Palladium has no reducing action except in the presence of hydrogen, and apparently acts as a catalyst by virtue of some power of converting molecular into atomic hydrogen. Conditions are described under which a continuous luminescence of luciferin can be obtained. This luminescence may be used as a test for atomic hydrogen. It is suggested that the steady luminescence of bacteria is due to continuous oxidation of luciferin to oxyluciferin and reduction of oxyluciferin to luciferin in different parts of the bacterial cell.

146. Hatai, S. 1916. Changes in the chemical composition of starving *Cassiopea xamachana. Carnegie Institution of Washington, Year Book* 15: 206-7.
Studies were conducted on chemical changes occurring in *Cassiopea* during starvation. The constancy of water content suggests that *Cassiopea* is largely a jelly-like mass, and remains so throughout its life. In contrast, mammalian body-water content varies by age.

147. ———. 1917. On the composition of *Cassiopea xamachana* and the changes in it after starvation. *Papers Tortugas Laboratory* 11: 95-109.
Carnegie Institution of Washington Publication Number 251.
For this study eight freshly caught normal *Cassiopea,* having different body weights, were subjected to starvation by placing the animal in filtered sea water. The results were as follows: 1. In general the smaller *Cassiopea* loses relatively more weight than the larger. 2. The percentage of water found in the entire body is nearly the same in all sizes of *Cassiopea.* However, the values of water content in the starved appear to be slightly higher than those found in the normal *Cassiopea.* 3. The nitrogen content of the entire body is higher in the smaller than in the larger *Cassiopea.* 4. The absolute amount of nitrogen found in the starved *Cassiopea* is considerably higher than in the normal having the same body weight. It was noted that although high when compared with the normal, equal in weight to the starved animal, it is very low for the initial body weight of the starved animal. This shows that the nitrogen also has been consumed during the period of starvation. 5. The nitrogen contents for the different parts of the body are similar in their relations to those found in the normal *Cassiopea.* 6. The loss in weight of the different parts is of such a character that their proportions in the starved remain similar to those in the normal *Cassiopea.*

148. ———. 1917. On the composition of the medusa *Cassiopea xamachama. Proceedings of the National Academy of Science* 3: 22-24.
In this study, an examination was made of three different parts of *Cassiopea,* mouth-organs, umbrella, and velar margin to determine whether starving specimens lose weight uniformly, or whether the loss is dissimilar in the three parts. Results indicated that the smaller *Cassiopea* loses relatively more weight than does the larger *Cassiopea.* The percentage of water is similar through the entire body, the nitrogen content is higher in the smaller than the larger individuals, and nitrogen is much higher in the starved *Cassiopea* than in the normal specimen with the same body weight. Results are compared with Mayer's experiments, which showed nitrogen loss to be constant during the entire period of starvation. Differences may be due to the size of animals used in his studies, as larger individuals show little variation in nitrogen loss, whereas small Cassiopeas show large variations in nitrogen loss due to body size.

149. Hayes, F. R. 1932. Nitrogen in echinoid ontogeny. *Carnegie Institution of Washington, Year Book* 31: 284-85.

The chemical embryology of the echinoid egg was investigated, as well as variations in two sources of energy available in the egg: protein and lipins.

150. ———. 1934. Variation in size and in nitrogen requirements during early development of the sea-urchin, *Echinomtera lacunter. Papers Tortugas Laboratory* 28: 181-93 (issued Mar. 1933). Carnegie Institution of Washington Publication Number 435.
After the penetration of a spermatozoon, the developing echinoderm egg receives nothing from the outside except water and salts, until the comparatively advanced larva begins to eat. The morphological phenomena of ontogeny can be brought about only by the expenditure of energy, which must come from materials already present in the egg at the time of fertilization. The problems of chemical embryology include (a) a determination of the amount of energy required to produce structural changes, and (b) an investigation of the chemical transformations taking place. The work here reported deals with a certain phase of the chemical embryology of a common tropical sea-urchin, *Echinometra lacunter.* Studies of the first 24 hours of development of the eggs of this form were carried on during the summer of 1932 at the Tortugas Marine Station of the Carnegie Institution. Eggs of the sea-urchin, *Echinometra lacunter,* were concentrated with a hand centrifuge and then diluted with 500 times their volume. Analyses of primary amino nitrogen groups and of total nitrogen were made, and the ratio of the former to the latter calculated. From 4 hours onward the ratio of primary amino groups to total nitrogen increases. This does not mean, however, a synthesis of the former at the expense of the latter, but rather that in the combustion which provides the developing embryo with energy, some source of nitrogenous fuel other than NH_2 groups is being used. There is a marked loss in the quantity of nitrogen per egg during the period of development succeeding the first four hours. One million eggs contain some 13 milligrams of nitrogen, of which about 28 per cent is in the form of NH_2 groups.

151. Heard, R. W. and D. G. Perlmutter. 1977. Description of *Colomastix janiceae*, new species. A commensal amphipod (Gammaridea Colomastigidae) from the Florida Keys, U.S.A. *Proceedings of the Biological Society of Washington* 90, no. 1: 30-42.
During November of 1968 and 1973 and June of 1970 more than 100 specimens of an undescribed commensal amphipod belonging to the genus *Colomastix* Grube, 1861 were collected from loggerhead sponges, *Spheciospongia vesparia* (Lamarck), in the lower Florida Keys. Additional specimens of this new species, collected from Dry Tortugas, Florida were borrowed from the Division of Crustacea of the U.S. National Museum of Natural History for examination.

152. Helwig, E. R. 1933. Regeneration in *Iotrochota birotulata* (Porifera). *Carnegie Institution of Washington, Year Book* 32: 271-73.
The development and formation of cells over time was examined, from cross-sections made from the branches of the sponge, *Iotrochota birotulata.*

153. Hendee, E. C. 1931. Formed components and fertilization in egg of the sea-urchin *Lytechinus variegatus. Papers Tortugas Laboratory* 27: 99-105.
Carnegie Institution of Washington Publication Number 413.
This investigation of the eggs of *Lytechinus variegatus* collected during the summer of 1925 at the Tortugas was undertaken to determine if any substance of the egg was involved in fertilization. Certain cytoplamic substances (macrosomes, hyaloplasm, chondriosomes, fat droplets, and extra-nuclear basophilic granules) were demonstrated both before and after fertilization. Lipid granules, present in the mature unfertilized egg, disappeared upon fertilization.

154. Hendrix, S. A. and R S. Braman. 1995. NOx variation in the southeastern Gulf of Mexico. *Florida Scientist* 58, no. 3: 292-97.
An automated system capable of providing speciation and concentration information for

several atmospheric NOx compounds was used to obtain diurnal and location variation data during a five-day research cruise in the southeastern Gulf of Mexico approximately one mile west of Fort Jefferson, Dry Tortugas between May 18 and May 22, 1987. Speciation of these nitrogen compounds was achieved by selective preconcentration onto a series of chemically coated glass hollow tubes. Analysis was performed by thermally desorbing the collected analytes into a chemiluminescence detector providing sub parts-per-billion level determination.

155. Hess, W. N. 1937. Reactions to light in *Ptychodera bahamensis*. *Papers Tortugas Laboratory* 31: 77-86 (issued Aug. 1936).
Carnegie Institution of Washington Publication Number 475.
Little attention has been given to the study of light reactions in any of the Enteropneusta, and nothing is known, apparently, concerning the distribution or even the existence of photoreceptors in this important group of animals. The purpose of this investigation was to continue work on reactions to light and the photoreceptors in animals, using at this time a more highly evolved species than the earth-worm on which the earlier work was done. During the study, *Ptychodera bahemensis* responded negatively to ordinary intensities of light. The movements of *Ptychodera,* when exposed to light were slow and deliberate and there was little evidence of trial and error movements. The entire surface of the body was sensitive to light, the most sensitive regions being on the proboscis and collar. Removal of different parts of the body involving the central nervous system caused little if any decrease in the percentage of negative responses to light. The reaction time of the proboscis was greatly increased when it was removed from the rest of the animal. This is taken to indicate that the central nervous system functions to speed up responses greatly, but is not essential for responses. Removal of the proboscis together with the basal peduncle makes it impossible for the animal to orient when stimulated by light. This would seem to suggest that the peduncle contains a coordinating center for certain bodily movements, or that the animal has been rendered incapable of orienting, due to removal of that portion of the body containing most of the notochord.

156. ———. 1940. Regional photosensitivity and photoreceptors of *Crangon armillatus* and the spiny lobster, *Panulirus argus*. *Papers Tortugas Laboratory* 32: 153-61 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 517.
Crayfish from which the eyes have been removed are sensitive to light in the region of the sixth abdominal segment, but no responses occurred when other regions were illuminated. The discovery that freshly molted *Crangon armillatus* are sensitive to light in other regions of their bodies, in addition to the sixth abdominal segment, led to this investigation. Results of this study indicated that *Crangon armillatus* is usually sensitive to light in many regions of its body, irrespective of how much time has elapsed since the last molting period. Freshly molted spiny lobsters (*Panulirus argus*) are sensitive to light in many regions of their bodies. Old spiny lobsters, with hard exoskeletons, from which the eyes have been removed are usually not sensitive to light of the intensity used in these experiments. The margins of the uropods of freshly molted *Crangon armillatus* and spiny lobsters are not sensitive to light, but the basal two-thirds of these appendages are sensitive to light. Adult *Crangon armillatus* and recently molted spiny lobsters react when illuminated from above after the sixth abdominal ganglion has been shielded by black cardboard and also after the ventral nerve cord has been cut between the fifth and sixth abdominal segments. This shows that photosensitivity in these eyeless animals is not limited to the sixth abdominal ganglion. Newly hatched *Crangon armillatus* with normal eyes swim toward the light with their caudal ends foremost irrespective of the number of abdominal segments that have been removed. *Crangon armillatus* and spiny lobsters from which the eyes have been removed do not usually orient to light, but respond by random movements. When their bodies are heavily pigmented, or if they are in poor physical condition, they do not respond at all. However, if they do respond their responses are usually much slower than those of freshly molted animals in good physical condition. The sixth abdominal segment of these eyeless

spiny lobsters and crayfishes is the most photosensitive region of their bodies. However, in *Crangon armillatus* and the American lobster *Homarus americanus* all the abdominal segments appear to be equally sensitive to light. On the basis of regional photosensitivity of the uropods, it seems probable that the cell bodies of the neurons which connect with the peripheral spines are sensitive to light and hence function as photoreceptors.

157. Hoffman, W., and Jr. and P. C. Patty W. B. Robertson. 1979. Short-eared owl on Bush Key, Dry Tortugas, Florida. *Florida Field Naturalist* 7, no. 2: 29-30.
The short-eared owl (*Asio flammeus*) is an uncommon but regular winter visitor to Florida. This record represents the second summer record of *Asio flammeus* in Florida, and the first record for the Dry Tortugas. The authors suggested that the bird in question had been on Bush Key for some time, subsisting on the abundant tern chicks.

158. Holmes, C. W. 1984. Carbonate fans in the Florida Straits. *Society of Economic Paleontologists and Mineralogists Annual Meeting (Abstracts)* 1: 39.
No abstract available.

159. Hooker, D. 1911. Certain reactions to color in the young loggerhead turtle. *Papers Tortugas Laboratory* 3: 69-76 and illustrations.
Carnegie Institution of Washington Publication Number 132.
During the summer of 1907 observations and a series of experiments were made on the habits and early life history of young loggerhead turtles, which identified reactions to color and geotropism as the determining factors for the causes of young hatchlings to reach the water. Based on day/night experiments on Loggerhead Key, hatchlings did not orient towards the sun or the odor of the water, but exhibited positive phototropism by responding to large surfaces of light of low intensity. After entering the water, the animal swam out to sea apparently attracted by the darker blue of the deeper water. Young turtles displayed positive geotropism when all possible negative geotropic reactions had been exhausted.

160. Hopkins, D. L. Locomotion/physiology of marine amoebae. *Carnegie Institution of Washington, Year Book.*.
1929,v.28,286-288: 1930, v.29,335-337.
The chemical and physical factors in the locomotion of marine amoebae collected from the tidal pools at Tortugas and cultured in the laboratory were examined. Relationships between sea-water salt and locomotion were determined by concentration and dilution. Highest rates of locomotion were found in normal sea-water and could be a useful criterion in classification and determining physiological condition in amoebae.

161. Jaap, W. C. 1985. An epidemic zooxanthellae expulsion during 1983 in the Lower Florida Keys coral reefs: hyperthermic etiology. *Proceedings of the Fifth International Coral Reef Symposium* , 143-48. Moorea, French Polynesia: Antenne Museum-Ephé.
Extensive reef coral zooxanthellae expulsion occurred from Key Largo to Dry Tortugas, Florida, during September 1983. Coral bleaching was intensive between Pelican Shoal and Sand Key Reef off Key West. Coral discoloration extended to depths exceeding 14 m but was especially severe in shallow (1-2 m) spur and groove habitats. Approximately 75-95% of all *Millepora complanata* and *Palythoa caribaeorum* were bone white, but most colonies remained viable. Affected *M. complanata* (bladed fire coral) retained the ability to inflict pain from dactylzooid nematocysts. Some individuals (5 to 10%) had fine algal growth indicating death on all or parts of their skeletons. Although 15 species of cnidarians, principally Scleractinia, were affected, some species (*Madracis mirabilis, Porites porites, Montastraea cavernosa, Dendrogyra cylindrus*) appeared to be immune. A quantitative sample at Eastern Sambo Reef on 6 October documented 11 species and 209 colonies; *M. complanata* comprised 32.5% of all colonies. Transmission eletromicrographs did not reveal epidemic pathogenic organisms in affected coral tissues. Warm, calm weather prior

to the expulsion was conducive to elevated seawater temperature. A seawater thermograph deployed off Marquesas Key recorded temperatures of 32.3 degrees C. during the period.

162. ———. 1980. Stony coral community structure at Long Key Reef, Ft. Jefferson National Monument, Dry Tortugas, Florida. (abs.). Florida Scientist 43 (Suppl. 1).
Stony coral populations at Long Key Reef were studied during summers of 1975-76 under National Park Service sponsorship. Plotless line transects (13, 25 m L) were sampled in depths of 0.5-21.3 m. Abundance, cover, and diversity were greatest in depths greater than 8 m. Of 34 species encountered, only 23 were censused quantitatively. *Montastraea annularis* contributed 20% of all colonies and 37% of cover. Species richness was highest (11) on transects in 7.6-12.5 m depths. Shannon-Weiner diversity values H' log SUB-2 computed by transects for individual colonies ranged from 1.0-3.0. Pielou's eveness (J') values ranged from 0.36-1.00. Community relationships based on Morisita index values detected an assemblage dominated by *M. annularis* in 8-13 m and a *M. cavernosa* community in 18-21 m depths. Temporal comparison using the Morisita index revealed strong community stability during 1975-76.

163. Jaap, W. C. and J. Wheaton. 1992. Summary of preliminary results, long-term ecological coral reef studies, Ft. Jefferson National Monument, Dry Tortugas. Prepared for the National Park Service Workshop, 28-30 April 1992, Miami, Florida.
Coral reefs exist over time scales of thousands of years. Processes of change in the geological-time context occur slowly, e.g. sea level change correlated with glacial and interglacial periods. The etiology of change is often poorly understood. For example, in 1878 a perturbation identified as, "black water" decimated *Acropora* spp. at Dry Tortugas. Determining what black water was may never be known. Long-term ecological research seeks to uncover processes that occur slowly or in which effects lag years behind the causes. In the absence of long-term research, serious misjudgments can occur in attempts to manage the environment. The National Park Service was interested in developing a reef resource monitoring plan for Dry Tortugas reefs and collaborated with the Florida Marine Research Institution in a joint study of reef resources. The goals of these studies included testing methods, acquiring a data base on coral reef benthic and fish communities to better understand the etiology of change, and isolating natural from anthropogenic changes. Five study sites were selected in 1989. Repetitive sampling was executed as precisely as possible using several different methods. These methods included: transect sampling, video sampling, quadrat sampling, photographic sampling, recruitment sampling, and environmental sampling. Results indicated that eleven octocoral, 22 scleractinian, and one milleporan species were enumerated on transects, while quadrats indicated 29 octocoral, 26 scleractinian and 1 milleporan species over the study's three year duration. Octocorals were consistently most diverse at Pulaski Shoal (20-21 species). Only 42 of 212 plates recruited scleratinian corals. This yielded an average of 0.35 recruit per plate. A total of 187 milleporan corals recruited to 212 plates for an average of 0.88 recruit per plate (34.9/m^2). The only octocoral recruit recorded was the gorgonacean *Briareum asbestinum*, whose common name is corky sea fingers.

164. ———. 1994. Summary of preliminary results, long-term ecological coral reef studies, Ft. Jefferson National Monument, Dry Tortugas. *Bulletin of Marine Science* 54, no. 3: 1-10.
Narrative same as in reference no. 163.

165. Jaap, W. C., J. L. Wheaton and K. B. Donnelly. 1990. Materials and methods to establish multipurpose, sustained, ecological research stations on coral reefs at Dry Tortugas. *Diving for Science... 1990. Proceedings of the American Academy of Underwater Science, Tenth Annual Science Diving Symposium*, 193-203. American Academy of Underwater Sciences: Costa Mesa, California.
Sustained research requires precise, repetitive data acquisition to accurately evaluate patterns of change in species abundance and community structure. Permanent reference

markers are essential to resample stations over time. The methods described here use solid markers from which several sampling devices can be deployed. A hydraulic drill is used to core 18-in deep holes into rock. A square stainless steel stake is inset, aligned, and cemented into each hole. Quadrats, photogrammetric and video apparatus, and recruitment arrays are deployed on or in reference to the stakes. Transects are extended between stakes. The method is suitable for coral reef and other hard-bottom investigations.

166. Jaap, W. C., J. L. Wheaton , K. B. Donnelly, B. J. Kojis and J. E. McKenna Jr. 1994. A three year evaluation of community dynamics of corals at Ft. Jefferson National Monument, Dry Tortugas, Florida. *Bulletin of Marine Science* 54, no. 3: 1077.
Narrative same as in reference no. 167.

167. Jaap, W. C., J. L. Wheaton, K. B. Donnelly, B. L. Kojis and J. E. McKenna Jr. 1993. A three-year evaluation of community dynamics of corals at Ft. Jefferson National monument, Dry Tortugas, Florida, USA. (abs.). *Proceedings of the 7th International Coral Reef Symposium*, page 164. Guam: University of Guam.
A study to evaluate methods and begin a long-term ecological research program at Ft. Jefferson was initiated at five reef sites in May 1989. Benthos was mapped and photographed within quadrats (5 x 2.56 m^2 per site). Attached biota and substrates were measured along 20- to 25-m transects (3 per site). Recruitment arrays were constructed of PVC pipe, flat stock, and ceramic tiles (10.8 x 10.8 cm) and were secured to the reference stakes. A carriage-mounted video camera, suspended on cables between two "T" poles secured to the stakes, was pushed the length of a transect. Results implied relative stability of the reef communities over three years. Dominant biota as determined by abundance and cover remained similar. Classification analyses of station time-series also corroborated relative stability. Recruitment of *Millepora*, Octocorallia, and Scleratinia was variable; most recruits were found in cryptic refuge. The heterogeneity, high-relief, and multi-layered canopy of these coral reef habitats restricts the usefulness of medium and long distance (>1.5m) photography and video. We conclude that multiple sampling methods are superior to a single sampling procedure.

168. Jaap, W. C., W. G. Lyons, P. Dustan and J. C. Halas. 1989. Stony coral (Scleractinia and Milleporina) community structure at Bird Key Reef, Ft. Jefferson National Monument, Dry Tortugas, Florida. *Florida Marine Research Publication* 46: 1-31.
Stony coral community structure at Bird Key Reef was investigated during 1975 using 30 continuous 25-m line transects in depths of 0.5 to 21.3 m. Thirty-two species, 872 colonies, and 198 cm of coral cover were sampled quantitatively. Most species, colonies, and live coral cover occurred seaward of 8-m depths on spur and groove substrate. *Montastrea annularis, M. cavernosa,* and *Siderastrea siderea* constituted more than 50% of all cover. Species diversity (Shannon index, log sub (2)) ranged from 1.0 for individual transects. Diversity and envenness values computed from cover data were generally lower than values computed from abundance data, reflecting *M. annularis* dominance. Numerical community classification (Czekanowski's quantitative coefficient) revealed three groups and an ecotone, each related to depth and substrate: 9 transects in 1 to 6 m depths dominated by *Porites asteroides* and *Diploria clivosa;* an ecotone of 6 transects in 5 to 6 m depths; 5 transects in 6 to 9 m depths dominated by *S. siderea;* and 10 transects in 8 to 21 m depths dominated by *M. annularis.*

169. Jacobs, M. H. 1914. Physiological studies on certain protozoan parasites of *Diadema setosum. Papers Tortugas Laboratory* 6: 147-57.
Carnegie Institution of Washington Publication Number 183.
It has been shown by the author and others that different species of protozoa have certain physiological characteristics, often almost as stiking as their morphological ones, and which are probably of considerable significance in the interpretation of their habits of life and their relation to their environment. It occurred to the author to test a series of forms which

naturally live under essentially the same environmental conditions, and which may be assumed to have done so for many past generations, in order to see whether they show greater likenesses than a number of forms selected at random, or whether each has preserved its individuality in spite of the similarity of its environment. The general results of the experiments performed show surprising differences in the resistance of the parasites of *Diadema* to various unfavorable conditions. In some cases the most resistant form may live several hundred times as long as the least resistant one. Comparing all of the results obtained, it is therefore seen that the similar habit of life of the four forms in question has not brought about physiological similarity except in certain adaptive characters which are a sine qua non for continued existence in the same host (e.g. ability to resist the digestive juices of the latter, etc.). In other respects they are just as different as almost any four free-living forms that might be selected and the evidence of these experiments shows that the physiological characters of an organism are not merely the result of its environment, but may be as fundamental and characteristic as its morphological ones.

170. Jefferson, J. P. J. Y. Porter and T. Moore. 1879. On the destruction of fish in the vicinity of the Tortugas during the months of September and October 1878. *Proceedings of the U.S. National Museum, Smithsonian Institution Press* 1: 244-46.
The information in this report is relative to the die-off of large numbers of fish due to a black water event in the Gulf of Mexico during the months of September and October 1878.

171. Jennings, H. S. 1909. Behavior of sea-anemones. *Journal of Experimental Zoology* 2: 447-72.
The study of the behavior of sea anemones (*Stoichactis helianthus* and *Aiptasia* spp.) was made at the Carnegie Research Laboratory, Dry Tortugas using specimens collected in the shallow waters near Fort Jefferson. Changes in behavior due to varying states of metabolism for *S. helianthus* were examined using red meat, crab hard parts and filter paper as food. After satiation, food is rejected through various reactions dependent upon internal processes. Descriptions of food ingestion are described. For *Aiptasia* spp., experiments suggested that when the animals were hungry, they took both red and filter paper; when satiated they took neither. Other topics of study included climatization to stimuli (light), and reactions modified as a result of past experiences of the organism. Results are compared to other lower groups of animals.

172. Jindrich, V. 1972. "Biogenic buildups and carbonate sedimentation, Dry Tortugas reef complex, Florida." Ph.D. Dissertation, Geology, State University of New York at Binghamton.
The Dry Tortugas, a horseshoe-shaped complex of carbonate banks and coral reefs, is located at the southern terminus of the Florida limestone shelf. The complex rises to the surface waters from a drowned Pleistocene surface that forms a circular platform having a general depth of 17-21 m. Three basic biogenic buildups (facies) comprise the reef complex: 1) detrital lagoonal bank, 2) *Montastrea* reef bank and, 3) *Acropora palmata* reef. These facies lie adjacent to one another and are also present in vertical succession as individual growth stages of varying thickness and lateral extent. A zone of *Acropora cervicornis* is developed as a transition between the *Montastrea* and *A. palmata* growth stages. The present organic assemblages and topography bear evidence of dominantly lateral progradation and cumulative storm effects that are linked to the slow eustatic sea-level rise for the past several millennia. Long-continued storm degradation is manifested by 1) continuous removal of *A. palmata* and its replacement by storm-resistant coralline algae and *Millepora* sp. to produce truncated rocky surfaces, 2) abundant reef rubble, 3) erosion of spur-grooves, and 4) development of intertidal rubble reef flats. Sediments ranging from cobble-sized rubble to medium silt are composed of *Halimeda*, coral and mollusc grains; coralline algae and foraminifers are present in minor amounts. Variations in texture and constituent particle composition are interpreted to be mainly a result of mode of sediment transport and effect of grain shape. Broadly-defined grain size populations produced by three modes of transport have characteristic assemblages of constituent particles. The populations include a gravel-sized surface creep population, sand-sized saltation population,

and very fine sand-to silt-sized suspension population. Strong mixing occurs between the gravel and sand population on the storm-degraded shoals, and between the sand and silt population on the lagoon bottom. Sand flanking the reefs and reef banks shows minimum mixing hence good degree of sorting. Incongruous mixtures of the in-place fraction and varying proportions of the transported populations constitute detrital lagoonal banks as a substrate stabilized by seagrass and coral growth. The gravel-sand and sand-silt mixtures are related to deposition under highly variable energy conditions. Variability in energy conditions does not cause strong population intermixing on beaches. For the same reason, beach sediments show a high degree of sorting in all size grades from cobbles to fine sand.

173. Jones, N. 1938. Investigations on ascidians. *Carnegie Institution of Washington, Year Book* 37: 84.
The summer of 1938 was devoted to the study of the structure, development, budding, and colony formation of Ecteinascidia tortugensis, a new ascidian species. The small ascidian, one of the commonest during the season, occurred in large numbers on the under sides of rocks just below low-water mark on both Bush Key and Long Key. Data report provided by Plough and Jones, pp 97-98.

174. Jones, R. D. 1991. An improved fluorescence method for the determination of nanomolar concentrations of ammonium in natural waters. *Limnology and Oceanography* 36, no. 1: 814-19.
An improved fluorescence method is described for measuring nanomolar concentrations of NH_4 in natural waters. This method is based on the conversion of NH_4 to NH_3 and subsequent diffusion of NH_3 across a microporous hydrophobic Teflon membrane into a flowing stream of 0-phthaldialdehyde reagent to produce a fluorescent adduct. The product is detected fluorometrically with a lower detection limit of better than 1.5 nM. Up to 30 determinations h-1 can be made. The method works well in freshwater or salt water. Field tests of the method in the Dry Tortugas and Gulf Stream gave NH_4 concentrations that ranged from 18.0 nM in Gulf Stream waters to 2,254.7 nM in interstitial waters from coralline reef sands. The method can be used to measure near real-time NH_4 concentrations in situations where it was previously difficult or impossible.

175. Jones, R. S. and M. J. Thompson. 1978. Comparison of Florida reef fish assemblages using a rapid visual technique. *Bulletin of Marine Science* 28, no. 1: 159-72.
Species composition, species diversity, and relative abundance of 4 coral reef fish communities in John Pennekamp State Park, Key Largo, Florida, are compared with 4 communities at Fort Jefferson National Monument in the Dry Tortugas using the species-time, random-count technique. The technique is similar to species-area methods, but time replaces area. Fish communities at Pennekamp Park showed the highest overall number of species and scores (reflecting species abundance, and species diversity). Two artificial reefs (shipwrecks) included in the study both show closer relationships to adjacent reefs than to wreck-specific species.

176. Jordan, D. S. 1904. Notes on fishes collected in the Tortugas Archipelago (by Dr. Joseph C. Thompson). *Bulletin of the United States Fish Commission for 1902* 22: 539-44.
An additional sixteen species of fish are described for the Tortugas based on collections made by J.C. Thompson while on the northward cruise of the steamer Chesapeake.

177. Jordan, D. S. and J. C. Thompson. 1905. The fish fauna of the Tortugas Archipelago. *Bulletin of the United States Bureau of Fisheries for 1904* 24: 229-56.
The shallow water fishes of the Tortugas, as suggested by A.G. Mayer to David Starr Jordan, are unsurpassed in variety and abundance anywhere along the Atlantic coast of the United States, and based on the nearness of the Gulf Stream and the winds and currents, pelagic fish from all over the Gulf of Mexico and the West Indies may be drifted by the Tortugas. Collections made by Thompson while on duty as a medical doctor at the Garden

Key Naval Station resulted in an annotated fish list containing 218 species known to occur at the Dry Tortugas at the time.

178. Jordan, H. E. 1908. The accessory chromosome in *Aplopus mayeri. Anatomischer Anzeiger Bd* 32: 284-95.
The purpose of this paper is to trace the accessory chromosome in the phasmid, *Aplopus mayeri* from material collected from Loggerhead key, Florida. The accessory chromosome appears in the resting stage of the secondary spermatogonia as a chromatin nucleolus characteristically close to the nuclear wall. Both the primary and secondary spermatogonia have a metaphase group of 35 chromosomes. The accessory chromosome can be traced as a specific structure from the resting stage of the last order of spermatogonia through all the various phases of synapsis and maturation, until it disintegrates in the head of the ripening spermatozoa.

179. ———. 1917. Aortic cell clusters in vertebrate embryos. *Proceedings of the National Academy of Science* 3: 149-56.
Aortic cell clusters are described among various animal groups (pig and chick) and compared to 12-day loggerhead turtle embryos and mongoose embryos. Various aspects of the hemogenic activity of embryonic endothelium are described consequent to the inherent capacity of endothelium to produce hemoblast, and not in connection with an associated toxic substance.

180. ———. 1917. Atresia of the esophagus in the embryo of the loggerhead turtle, *Caretta caretta:* A normal developmental condition. *Papers Tortugas Laboratory* 11: 345-60.
Carnegie Institution of Washington Publication Number 251.
A series of 26 embryos of the loggerhead turtle were collected and used originally for a study of the history of the primordial germ-cells. It was noticed that the esophagus was solid for a greater or less extent, approximately from the point of origin of the respiratory anlage to its bifurcation into the bronchi, from the eleventh to the thirty-second day of incubation. Points of special significance in regard to this material are: (1) the relatively longer persistence of the occlusion than has yet been described for any other form; (2) the absence of contributory yolk in the stenosed area; (3) close relation to the point of origin of the respiratory anlage, which fact may disclose its possible functional significance .

181. ———. 1917. Embryonic history of the germ-cells of the loggerhead turtle (*Caretta caretta*). *Papers Tortugas Laboratory* 11: 313-44.
Carnegie Institution of Washington Publication Number 251.
The wide discrepancies in the published accounts of the origin and early history of the germ-cells in vertebrates provided the stimulus for this investigation. Twenty-five embryos of the loggerhead turtle (*Caretta caretta*), ranging from the second day (5 somites, 2mm. length) to the thirty-second day of incubation, were employed in this investigation. Results indicate that the primordial germ-cells migrate during the second day from the yolk-sac endoderm, where they are widely scattered caudally, into the lateral border of the area pellucida on each side of the embryonic disk. The germ-cells migrate by amoeboid activity. The migration period is not sharply limited. A certain number of germ-cells migrate out of the regular germ-cell route and go astray. The total number of primordial germ-cells counted in a 12-day embryo is 352. Occasional cells may divide by mitosis, or undergo degeneration, at any stage of their history or at any point of the route. No germ-cells were found contributing to the formation of the Wolffian duct. The germ-cells do not differ from young somatic cells in the character of their mitochondrial content. No transition stages between coelomic epithelial cells and germ-cells appear up to the 32-day stage. The evidence derived from a study of the *Caretta* embryos is in complete harmony with the idea of a single uninterrupted line of sex-cells from primordial germ-cells to oögonia and spermogonia, and with the hypothesis of a vertebrate Keimbahn or continuous germinal path.

182. ———. 1908. The germinal spot in echinoderm eggs. *Papers Tortugas Laboratory* 1: 1-12.
Carnegie Institution of Washington Publication Number 102.
This paper reports the results of further studies of the prematuration stages of echinoderm eggs of additional species of echinoderms, a star-fish (*Echinaster crassispina*), and a brittle-star (*Ophiocoma pumila*). In *Echinaster crassispina* the chromosomes are derived exclusively from the nucleolus. In *Ophiocoma pumila* the chromosomes arise exclusively from the nuclear reticulum. In some species the chromosomes arise from a chromatin-nucleolus, in others from a chromatic reticulum, and in still others in part from one source and in part from the other. The eggs of different forms differ in that some have only a chromatin-nuleolus, without distinct plastin ground-substance, resting in an achromatic nuclear reticulum (*Echinaster*); others possess both chromatin-nucleolus and plasmosome as well as a chromatic nuclear reticulum (*Ophiocoma*); and still others possess a double nucleolus (chromatin nucleolus and plastin ground-substance), with the chromosome complex gathered in a mass in the achromatic reticulum (*Asterias*). The function of the germinal spot then appears, in part at least, to be that of a storehouse of material which is to contribute to the formation of the chromosomes .

183. ———. 1917. The history of the primordial germ cells in the loggerhead turtle. *Proceedings of the National Academy of Science* 3: 271-75.
This study attempts to trace germ cell history in the loggerhead turtle and compare it to observations for other vertebrates. Embryos were collected for study from specimens taken on Loggerhead Key, Dry Tortugas during the Summer of 1914. The germ cell history of *Caretta* is very similar to that first described for *Chrysemys* and to that described for dogfish.

184. ———. 1917. The microscopic structure of striped muscle of *Limulus*. *Papers Tortugas Laboratory* 11: 273-90.
Carnegie Institution of Washington Publication Number 251.
The study of the skeletal muscles of Limulus was undertaken with two chief objects in view: to test a conclusion suggested by earlier studies on the intercalated disks of vertebrate cardiac muscle, namely, that these disks are properly interpreted as "irreversible contraction bands" and to seek additional evidence in further refutation of the recently revived hypothesis that striped muscle can be interpreted in terms of "muscle-cells" and intercellular myofibrillae. It was found that both the skeletal and the cardiac muscles of *Limulus* consist of trabeculae of finely granular sarcoplam. In cardiac muscle the main trabeculae and their branches form a loose-meshed syncytium. Neither type of muscle contains mesophragmata. Very rarely an intercalated disk of the simple-comb type appears in the cardiac muscle. Both types are very similar in respect of the presence and arrangement, in the same phase of contraciton, of Q and J disks, and the telophragmata. The evidence is unequivocal against an interpretation of structure in terms of "muscle-cells" and intercellular myobibrillae. The nuclei of the growing muscles multiply by amitotic division. In essential structure the cardiac and skeletal muscles of *Limulus* are closely similar, indicating a close functional similarity. The structure serves, moreover, as a splendid illustration of the "law of biogenesis," in that it is practically identical with a stage in the early histogenesis of striped muscle of teleosts .

185. ———. 1908. The relation of the nucleolus to the chromosomes in the primary oöcyte of *Asterias forbesii*. *Papers Tortugas Laboratory* 1: 37-72.
Carnegie Institution of Washington Publication Number 102.
The primary object of this investigation was was to contribute to the subject of the relation between nucleolus and chromosomes during maturation. In summary, synizesis occurs in the oöcyte of the first order at the very beginning of the growth-period (size of nucleus 5 microns). The growth-period is passed through rapidly. During the latter half of the growth-period all the chromatin, with the exception of what is held by the chromosomes, becomes stored in the enlarging nucleolus. The nucleolus consists of a plastin ground-

substance infiltrated and covered over with chromatin. The chromosomes do not arise out of the nucleolus. The number of chromosomes in the prophase of the first polar mitosis is 18. They vary somewhat in size (one is considerably larger than the rest), all have a characteristic dumb-bell shaped appearance, and some are clearly double (bivalent). The two maturation divisions effect a double longitudinal fission of the original bilobed chromosomes. The reduced number of chromosomes is again 18. Observations on *Hipponoë esculenta* agree in essential points with those made on *Asteria forbesii* and support the conclusions regarding the origin of the chromosomes, the function of the nucleolus, and the reduction phenomena.

186. ———. 1908. The spermatogenesis of *Aplopus mayeri. Papers Tortugas Laboratory* 1: 13-36. Carnegie Institution of Washington Publication Number 102.
The object of the present investigation is primarily to trace the history of the accessory chromosome through the various stages in the process of spermatogenesis in the phasmid *Aplopus mayeri.* The material upon which the investigation is based was obtained from the Loggerhead Key, Florida. Primary spermatogonia divide both mitotically and amitotically. In the latter instance cell-division is frequently not consummated and a bi- or multi-nuclear cell results. In the first order of the secondary spermatogonia the accessory chromosome appears in the resting-stage. During synapsis the accessory chromosome lengthens into a club-shaped structure attached by its lesser end to the presynaptic thread, undergoes partial longitudinal division, closes up again during the height of synapsis, and returns again to its previous characteristic form and location in the nucleus of the growing primary spermatocyte. The second maturation division is equational, effecting a longitudinal division of univalent chromosomes. The accessory also divides equationally in the cells containing this element. A dimorphism of spermatozoa results; the accessory chromosome possessed by one-half probably represents a sex-determinant. The history of the accessory chromosome gives evidence that it at least possesses a strict morphological and probably also a physiological individuality.

187. Kaas, P. 1972. *Polyplacophora* of the Caribbean region. P. Wagenaar and L. J. Van Der Steen Hummelinck, 1-162. Studies on the Fauna of Curacao and Other Caribbean Islands, ed. P. Wagenaar and L. J. Van Der Steen Hummelinck. The Hague: Martinus Nijhoff.
This paper includes Tables of Distribution of Polyplacophora of the Caribbean . The author took into consideration the whole of the Florida coast as far north as Fernandina, E. Florida and the Keys, the Dry Tortugas, W. Florida, the Gulf of Mexico, and also the Bermudas. Thiele's description of his single 5.5 specimen of *Ischnochiton hartmeyeri* from Bird Key Reef is translated into English here by Kaas.

188. Kale, H. W. 1985. Florida birds - Dry Tortugas. *Florida Naturalist* 58, no. 2: 6.
A sighting of a great black-backed gull is made at the Dry Tortugas, and a scarcity of land birds is reported.

189. Kellner, Carl. 1907. Embryology of the appendicularian, *Oikopleura. Zoological Anzeiger, Bd.* 31: May.
The appendicularia of the Dry Tortugas specimens of Salpae were collected. Appendicularia of the genus *Oikopleura* and their "houses" were examined and found in surface waters. Their anatomy and histology are described.

190. Kille, F. R. 1936-1937. Regeneration in holothurians. *Carnegie Institution of Washington, Year Book.*
Note: published as follows: 1936, v. 35, p. 85-86; 1937, v. 36, p. 93-94.
Histological studies were conducted on sea-cucumbers of the genus *Holothuria,* to determine the manner in which the digestive system is reconstituted following autotomy by means of electrical stimuli.

191. Kopac, M. J. 1936. Electrical resistance of *Valonia*. I. Changes in the resistance with time in impaled coenocytes. *Papers Tortugas Laboratory* 29: 359-86 (issued Mar. 1936).
Carnegie Institution of Washington Publication Number 452.
During the summers of 1933 and 1934 the author worked at the laboratory of the Carnegie Institution located on Loggerhead Key, Dry Tortugas, Florida. Several species of *Valonia* were found growing abundantly on the various coral reefs of the Dry Tortugas. A study of the electrical resistance of impaled *Valonia* coenocytes by using a technique more highly refined that that employed by previous investigators was initiated. Although only *V. ventricosa* was used in this study, the methods developed and used here may be extended to the study of other species of *Valonia*. Glass microcapillaries, with tips ranging from 0.025 to 0.1 mm. in diameter and filled with vacuolar sap, served as microsaltbridges leading from the vacuole to a calomel half-cell. A larger glass tube (the macrosaltbridge), filled with sea-water, was used as a saltbridge leading from the sea-water surrounding the coenocyte to another calomel half-cell. The *Valonia* coenocytes were impaled on the tip of the microsaltbridge with the aid of a micromanipulator. It was found that coenocytes with a high chloroplastid density have a constant Rp several times higher than coenocytes with a low chloroplastid density. It is postulated that only the inter-chloroplastidal protoplasm is capable of conducting a current. The average initial Rp in type A punctures was 60 to 65 per cent of the constant Rp. In some coenocytes a constant Rp was reached in a few minutes. This increase in Rp is caused largely be the redistribution of those chloroplastids around the microtip which were disturbed by the puncture. The average initial Rp in type B punctures was 2 to 3 per cent of the constant Rp. After the chloroplastids are redistributed in this hyaline zone, the disintegrated chloroplastids are extruded, and the tiny vauoles are eliminated, no further increase in Rp takes place .

192. Kunkel, B. W. 1934. The selective action of certain adverse environmental conditions on the hermit crab (*Clibanarius tricolor* Gibbes). *Papers Tortugas Laboratory* 28: 215-44 (issued Aug. 1933).
Carnegie Institution of Washington Publication Number 435.
The problem of selection is undoubtedly a very complex one. The characters which enable one organism rather than another to survive are difficult to ascertain; a favorable variation of one part may be accompanied by an unfavorable variation of another, so that selection may have no effect upon the first feature. The present study has to do with a phase of the selection problem which, on the whole, has received rather scant attention from investigators. The selective effect of certain adverse conditions on a population has been studied. The problem is that of determining how a given species may respond to a change in environment, of determining the morphological difference between those individuals which succumb to a certain change in the normal environment and those which are able to withstand the change. The material upon which the present study is based was collected and the experiments were made at the Tortugas Laboratory. The small hermit crab *Clibanarius tricolor* Gibbes was selected for the experiments.

193. Le Compte, M. 1937. Some observations on the coral reefs of the Tortugas. *Carnegie Institution of Washington, Year Book* 36: 96-97.
Particular attention was paid to the distribution and adaptation of the corals on the reef west of Loggerhead Key. A baseline of about 2500 yards is verified, documenting large heads of *Orbicella (Madrepora) annularis*, extensive growths of *Acropora,* and areas of gorgonians and algae. Beach rock development, coral feeding habits, and the effects of boring animals on corals are discussed.

194. Leitch, James L. 1936. The water exchanges of living cells. III. The application of a photographic method to the determination of the non-solvent volume of the eggs of *Echinometra lacunter*. *Papers Tortugas Laboratory* 29: 349-58 (issued Mar. 1936).
Carnegie Institution of Washington Publication Number 452.
Photography has been applied to the study of living cells and tissues. Leitch raised the

question of the feasibility of a photographic method in the study of the osmotic behavior of cells. The present paper outlines such a method and discusses some of the factors involved in the study of the water exchanges of the eggs of the sea-urchin, *Echinometra lacunter,* using measurements of photographs of eggs at equilibrium in dilute sea-water solutions. It was shown that photography can be employed in the study of the water exchanges of living cells. The non-solvent volume of the eggs of *Echinometra lucunter* is 36 per cent when calculated after from 60 to 90 minutes' exposure to experimental solutions. Longer exposures to the experimental solutions result in a higher non-solvent volume of 48 per cent which is associated with pronounced vacuole formation. The appearance of vacuoles after the attainment of the first equilibrium is discussed and three different explanations proposed.

195. ———. 1937. The water exchanges of living cells. IV. Further studies on the water relations of the eggs of the sea-urchin, *Echinometra lacunter. Papers Tortugas Laboratory* 31: 53-70 (issued July, 1936).
Carnegie Institution of Washington Publication Number 475.
The application of a photographic method to the determination of the non-solvent volume of the eggs of the sea-urchin, *Echinometra lacunter*, and also the effect on the non-solvent volume determinations of the length of time of immersion of eggs in diluted sea-water solutions, was demonstrated in another publication (Leitch,1936). The present paper considers the utilization of this photographic method for the study of the swelling and shrinking of the eggs of the same sea-urchin, the effect on the water relations of these cells of the time between that of spawning and that of introducing the eggs into the experimental solutions, and an analysis of equations which have been developed and applied by several investigators to explain the kinetics of water exchanges of living cells. Results showed that an analysis of the equations developed to interpret the kinetics of water exchanges of cells the so-called permeability "constants" are not constant for the eggs *of Echinometra lacunter* but vary with the dilutions of sea-water used and also with different intervals of time in the same dilution. The permeability constants for swelling and shrinking do not coincide, being between 0.250 and 0.650 for the former process and between 0.180 and 0.580 for the latter. The introduction of the correction for the non-solvent volume into the equations does not produce a better agreement between the constants for the two processes. The use of the photographic method (Leitch,1936) is further substantiated for the determination of non-solvent volumes and is extended to the study of the swelling and shrinking of eggs. Approximately two hours from the time of spawning the non-solvent volumes is greatly increased, from 30 to 53 per cent of the initial volume. There is a slight retarding effect on the water exchanges of the eggs brought about by standing. The time at which the effect of standing at room temperature appears in the values of the non-solvent volume and rate of penetration of water is correlated with a sharp decrease in the percentage of development, a slight increase in the volume of the eggs and a cytolysis-like phenomenon which finally ends with the complete disintegration of the eggs. The production of fertilization membranes as a criterion of non-injury of the egg cell is shown to be inadequate and the percentage of development of normal larvae is urged as a better test of normality .

196. Lessios, H. A., D. R. Robertson and J. D. Cubit. 1984. Spread of *Diadema* mass mortality through the Caribbean. *Science* 226: 335-37.
Populations of the ecologically important sea urchin *Diadema antillarum* suffered severe mass mortalities throughout the Caribbean. This mortality was first observed at Panama in January 1983; by January 1984 it had spread to the rest of the Caribbean and to Bermuda. The sequence of mortality events in most areas is consistent with the hypothesis that the causative agent was dispersed by major surface currents over large distances. However, some of the late die-offs in the southeastern Caribbean do not fit this pattern. Several lines of indirect evidence suggest that the phenomenon is due to a water-borne pathogen. If so, this is the most extensive epidemic documented for a marine invertebrate.

197. Linton, E. 1908. Helminth fauna of the Dry Tortugas. I. Cestodes. *Papers Tortugas Laboratory* 1: 157-90.
Carnegie Institution of Washington Publication Number 102.
This report is based on data collected at the Marine Biological Laboratory, Tortugas, Florida, June 30 to July 18, 1906. A list of the hosts which were examined for parasites, and a summary of the results of that examination, together with a few food notes are presented. A few extracts from notes made at the time the material was collected are presented. Acanthocephala are presented. The species found in the frigate mackerel was *Echinorphynchus pristis.* Few nematodes were found in the nurse-shark. New species of parasites are described.

198. ———. 1910. Helminth fauna of the Dry Tortugas. II. Trematodes. *Papers Tortugas Laboratory* 4: 11-98.
Carnegie Institution of Washington Publication Number 133.
The collection here described was made at the Marine Biological Laboratory, Tortugas, Florida, in the summers of 1906, 1907, and 1908. The fishes examined were from the shallow waters of the reef. The distribution of parasites together with food notes have already been published in the Year Book of the Carnegie Institution of Washington for the years above named. This paper includes a list of Tortugas trematodes and their hosts, key to the genera and species described, and descriptions of species, habitats, etc, including: trematodes from loggerhead turtles and from fish.

199. ———. 1907. Note on the habits of *Fierasfer affinis. American Naturalist* 41, no. 481: 1-4.
Observations of the *Fierasfer affinis* entering its host, tail first are made.

200. Lipman, C. B. 1929. The chemical composition of sea water. *Papers Tortugas Laboratory* 26: 249-57.
Carnegie Institution of Washington Publication Number 391.
In his studies on marine bacteria and related subjects, the author realized the need for more accurate and complete analytical data on the inorganic components of sea-water and determined to obtain them.. Two samples were analyzed from the Atlantic area and they were both from the Gulf Stream, and taken near Loggerhead Key in the Tortugas. The data render it clear that a large part of the ions important to algae are removed from solution in sea-water by a rise in pH of that medium, which is well within the range of daily rise in pH of sea-water carrying an active algal flora under the proper conditions of light and temperature.

201. ———. 1924. A critical and experimental study of Drew's bacterial hypothesis on $CaCO_3$ precipitation in the sea. *Papers Tortugas Laboratory* 19: 179-91.
Carnegie Institution of Washington Publication Number 340.
Based on a series of experiments to explain the precipitation of $CaCO_3$ in sea water, it was found that there are several ways to explain $CaCO_3$, where it occurs in seawater, without introducing Drew's hypothesis or any other bacterial hypothesis. These explanations of the phenomenon seem adequate to account for the qualitative and quantitative differences in $CaCO_3$ as found under different conditions in seawater. Changes in water and air temperatures, and marine plant activity, which Drew and others clearly appreciated and understood, yet have introduced a purely gratuitous bacterial hypothesis based on what appears to be sound experiments.

202. ———. 1929. Further studies on marine bacteria with special reference to the Drew hypothesis on $CaCo_3$ precipitation in the sea. *Papers Tortugas Laboratory* 26: 231-48.
Carnegie Institution of Washington Publication Number 391.
Bacterial populations in the open sea are very small. Mixed or pure cultures of organisms isolated from sea-water are incapable of precipitating $CaCO_3$ from sea-water to which no salts have been added, or even in the presence of added KNO_3. Mixed or pure cultures of

such organisms are incapable of precipitating $CaCO_3$ in a sea-water medium if KNO_3 and organic matter as the sugars or similar forms free from calcium are added to the medium. Upon the basis of evidence in this and in earlier papers the Drew hypothesis is shown to be untenable, and at the very least uproved. This strong probability is reemphasized in the purely physical-chemical nature of $CaCO_3$ precipitation on a large scale in nature.

203. Locker, S. D. A. C. Hine and E. A. Shinn. 1991. Sea level geostrophic current control on carbonate shelf-slope depositional sequences and erosional patterns, South Florida platform. *AAPG Bulletin* 75, no. 3: 623.
High-resolution seismic reflection profiles across the shelf-slope margin between the Dry Tortugas and Key West, Florida, indicate that sea-level fluctuations and the eastward flowing Florida Current are major controls on late Quaternary sequence stratigraphy. The study area, a transition zone between the open south Florida shelf and the lower Florida Keys island/reef system, is typified by a shallow shelf with reef margin adjacent to a deeper lower-shelf/slope. The lower-shelf/slope is composed of stacked or prograding sequences that downlap and pinchout on the Pourtales Terrace. Strike oriented stratigraphic sections exhibit many sea-level controlled features such as lowstand erosion, transgressive unconformities, and highstand system tracs. Lowstand reefs, notches, or barriers are observed as deep as 150m below present sea level. Depositional styles change along-slope from west to east. The western portion of the study area is characterized by thick, low amplitude prograding sequences related to abundant supply of sediment through off-shelf transport during high sea-levels as well as along-slope reworking by the Florida current. Part of this section has been severely eroded by along-slope current producing localized cur and fill structures and widespread erosional unconformities. To the east, a thinner section of high-amplitude reflections is common seaward of the lower Florida Keys reef tract system. Again, along-slope current erosion and winnowing of sediment supplied by the adjacent margin is evident. This study provides new evidence of how a strong geostrophic boundary current along with fluctuating sea levels have interacted to control depositional sequences on a carbonate slope in the Florida/Bahamas platform complex.

204. Longley, W. H. 1917. Changeable coloration in Brachyura. *Proceedings of the National Academy of Science* 3: 609-11.
Studies on changes in the color of brachyuran crabs (*Ocypoda* and *Callinectes* sp.) at the Marine Laboratory, and in the field on Loggerhead Key, Dry Tortugas, demonstrate adaptive coloration based on temperature variations and the color of the substratum upon which the specimen is resting. It is expected that in future studies the same general rules of adaptation for fishes will apply to crabs.

205. ———. 1918. Haunts and habits of tropical fishes. *American Museum Journal* 18: 79-88.
Observations are recorded at the Dry Tortugas using underwater photography. Habits of the shallow water reef species were photographed in water less than 10 feet deep. Emphasis is placed on the biological significance of color in fishes with their surroundings. Fish color change may be evoked by offering them food by hand at different locations. The foods and feeding habits of reef fish are discussed in this report.

206. ———. 1918. Marine camoufleurs and their camouflage: the present and prospective significance of facts regarding coloration of tropical fishes. *Smithsonian Report* (1920): 475-85.
Fish are used as an example of an animal which uses color patterns, not as a struggle for existence as hypothesized by Darwin, but as a means of expressing its biological significance by displaying a natural system of camouflage. Some colors in fishes are not changeable, but seem to be correlated to definite habits. In the case of those that are changeable, there is conclusive evidence that they are displayed under specific conditions. For example, transverse bands are shown when the species is inactive. However, upon movement the bands are replaced by stripes.

207. ———. 1916. Observations upon tropical fishes and inferences from their adaptive coloration. *Proceedings of the National Academy of Science* 2: 733-37.
The conception that species have been multiplied by divergent evolution of related strains is based on many observations. If the Darwinian hypothesis is true, the character of organisms should be largely of an adaptive sort, but its adherents have been content to support this position by inputting utility to structure and habits. It has not been proved in fishes that some color combinations ward off enemies nor that pigmentation is functionally conspicuous. Many of the brightly colored fishes of the Tortugas have been studied to evaluate their coloration objectively. Most species exhibit countershading with darkest shading on the upper surface and lighter shading on the mid-ventral or lower line. Thirteen species of fish studied exhibit color changes based on their surroundings observed from boats or from the bottom using diving equipment and photography. Correlation of color with habitat has been documented. Some examples suggest that red fish are rarely seen during the day, gray fish with diurnal activity patterns are found near large coral heads, lighter blue fish are habitually found swimming well above the bottom in moderate depths, and those species largely found over grass beds are of green color or have a green color phase. As far as this class of animals is concerned, Longley postulates that there is no ground for the belief that bright color is correlated any way with armament or distastefulness. Problems of mimicry resemblance are unresolved, however the observations presented in this abstract undermine many speculative explanations of animal coloration in terms of natural selection and replace them with something which may not be dismissed from consideration.

208. ———. 1936. Species studies and the species problem. *American Naturalist 70:* 97-109.
(No abstract available).

209. ———. 1917. Studies upon the biological significance of animal coloration. I: The colors and color changes of West Indian reef fishes. *Journal of Experimental Zoology* 23: 536-601.
Studies were carried out at the Dry Tortugas to determine the biological significance of changes in color of reef fishes. It was found that fishes are countershaded; color changes, which are common even among the most gaudy, tend to assimilate them with their environment; and in general, their colors repeat those of their surroundings. Specially defended types are not unlike others in pigmentation, nor inferior to them in their ability to effect adaptive color adjustments. Finally, there is no evidence that brightly colored species enjoy greater immunity from attack than their fellows, for they constitute a large proportion of the food and may be readily identified in the stomach contents of predaceous forms. These statements, which rest upon a great body of verifiable observations, are consistent with the Darwinian hypothesis, but inconsistent with the assumption that animals of high color possess more than minimal conspicuousness under natural conditions. They impel one to reject the hypotheses of warning and immunity coloration, signal and recognition marks, and sexual selection, at least in so far as they may ever have been supposed to apply to these forms. Upon the contrary, they confirm Thayer's conclusions regarding the obliterative function of color and pattern, emphasize the common occurrence of adaptive characters among animals, and suggest that their evolution has been guided throughout by natural selection.

210. ———. 1917. Studies upon the biological significance of animal coloration. II: A revisional working hypothesis of mimicry. *American Naturalist* 51: 257-85.
In this report, various hypotheses proposed by the author and other investigators relating changes in animal coloration in relation to habits are discussed. The author postulates that bright colors of tropical fishes are correlated with the animal's habits from work achieved at the Dry Tortugas. Other coloration hypotheses are provided dealing with butterflies and lizards, as well as warning coloration in bright and dull-colored insects. These ideas submitted by the author constitute working hypotheses to be tested by other biologists.

211. Longley, W. H. and S. F. Hildebrand. 1940. New genera and species of fishes from the Tortugas, Florida. *Papers Tortugas Laboratory* 32: 223-85 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 517.
Thirty new genera and species of fishes described in these pages resulted from studies carried on for many years, principally at Tortugas, Florida, by the late Dr. William H. Longley, whose untimely death occurred before he had fully completed a study of his collections and a manuscript embodying a complete account of his field observations. The present writer has made further studies of the Tortugas collections, and has endeavored to extract interesting facts from Dr. Longley's notes on those species not treated in his unfinished manuscript.

212. Longley, W. H. and S. F. Hildebrand. 1941. Systematic catalogue of the fishes of Tortugas, Florida; with observations on color, habits, and local distribution. *Papers Tortugas Laboratory* 34: 1-331.
Carnegie Institution of Washington Publication Number 535.
Observations on the fishes of the Tortugas Atoll were made by the senior author spanning a period of over 25 years. An inventory of 442 species is included, covering a wide range of habitats: bare sand, seagrass beds, coral reefs, channels between the keys, and deep waters over 600 feet in depth a few miles southward. Over 300 species were associated with coral reef habitat. This study represents the first fish survey conducted on the Florida Reef Tract. Field observations were made largely with the use of a diving helmet, which enabled the investigator to observe and photograph the fish in their native habitat, and to give information as to their behavior, feeding and habits, and especially adaptive coloration. Much of Longley's work is documented by the world's first underwater color photography. Following the death of Dr. Longley, Dr. Hildebrand undertook the editing and the completion of the manuscript. Material added by him bear his initials.

213. Lucké, B.. 1937-1938. Studies on the tumors of fishes (of the snapper family Lutjanidae) . *Carnegie Institution of Washington, Year Book.*
Note: published as follows; 1937, v.36, p. 98-99; 1938, v.37, p. 92-94.
Certain kinds of tumors found on thirty nine fish belonging to several species of snappers closely resemble human neoplasms arising from nerves. They arise in the subcutaneous tissue and appear as flattened oval masses. No tumors of this kind were found on other species of fish. Epithelial growths were found in thirty specimens of *Halichores radiatus*, from a total of six thousand fish observations. Multiple papillomas of the skin and the eye were reported in a green turtle caught off Cape Sable.

214. ———. 1942. Tumors of the nerve sheaths in fish of the snapper family (Lutjanidae). *Archives of Pathology* 34: 133-50.
Fish of the snapper family Lutjanidae are commonly afflicted with tumors which resemble the nerve sheath tumors of man called variously neurinoma, neurolemmoma, schwannoma, or neurofibroma. Neoplasms of this kind have been observed in 76 fish of three species, the gray snapper (*Lutjanus griseus*), the dog snapper (*L. jocu*), and the schoolmaster (*L. apodus*). Most of the fish were collected from the Dry Tortugas. Many other fish families were examined, however no tumors of the kind were found. The tumors generally were found along the course of the subcutaneous nerves, particularly of the head and dorsal regions, as solitary or multiple, relatively large firm white masses. Like human neoplasms, the tumors of fish are usually composed of two kinds of tissue: one compact and richly fibrocellular; the other loose reticulated and poorly cellular. The component cells and intercellular fibers of the tumors appear to be essentially the same, and arranged in similar patterns, in fish and man. Unlike human tumors, the fish tumors, though well circumscribed, are usually not encapsulated. Nerve sheath tumors appear to be more common in certain fish species than in man. The frequency of occurrence of these tumors, which can be maintained for long periods in marine aquariums, renders them favorable material for studies of neoplasms.

215. Lucké, B. and H. G. Schlumberger. 1949. Neoplasia in cold-blooded vertebrates. *Physiological Reviews* 29, no. 2: 91-126.
This review complements an earlier review to source material, abstracts of all the reports in the literature dealing with tumors in fishes, reptiles, and amphibians. In regards to fishes of the Tortugas, a review is presented on the senior author's work on tumors of nerve tissue, as described in Lucke (1942, reference no. 214).

216. Lynts, G. W. 1968. Analysis of recent foraminiferal fauna from the Dry Tortugas, Florida. (abs.). *Geological Society of America Special Paper* 101: 128-29.
This analysis of total foraminiferal population is based upon 16 samples collected in 1960 from the Dry Tortugas, Florida. Fourteen samples represent reoccupation of stations sampled by Cushman (1922) in his original description of the foraminiferal fauna. Q-modal factor-vector analysis indicates that the fauna is characterized by three assemblages (factors) which account for 89 per cent of the total information (sum of squares of all entries in data table). In general, these assemblages are characterized by a few dominant species. One of the assemblages, Assemblage III, is directly related (r= +0.911) to depth of water. The total population of the 14 samples representing reoccupation of Cushman's stations were compared with the total population indicated by Cushman (1922). Comparison was made using F-ratios and percentage of number of species occurring in both samples (Sc). F-ratios estimate degree of variation between samples, whereas Sc measures variation in species composition. F-ratios indicated that at seven of the 14 stations there were significant differences in total population between the 1919 and 1960 collections. Sc's ranged from 18.3 to 56.9 per cent and showed no relationship to degree of variation estimated by F-ratios. This variation in foraminiferal fauna between collections may represent either real changes in populations or apparent variations. If variations are real, they reflect changes in the ecosystem over the 41 years. If variations are apparent, they may represent either inability to resample microhabitats or vagaries in taxonomic discrimination.

217. Lyons, W. G. 1980. Polyplacophora of Dry Tortugas Florida with comments on *Ischnochiton hartmeyeri. Bulletin of the American Malacological Union, Inc.* 46: 34-37.
450 specimens and 14 species of chitons were collected during 1978-79 from a station near Garden Key. Only *Acanthochitona* sp. and *Stenoplax purpurascens* were relatively common.

218. Mann, A. 1936. Diatoms in bottom deposits from the Bahamas and the Florida Keys. *Papers From the Tortugas Laboratory* 29: 121-28.
Note: This is Appendix 1 to Calcareous shallow water marine deposits of Florida and the Bahamas by Eldon Marion Thorp .
The twenty-four samples of calcareous sand collected by Doctor Vaughn in 1914 between Cape Florida and Key West and at Tortugas were examined at the time these samples were received. A list of stations at which diatoms were collected is given, including Tortugas, with a list of the diatoms found. Species of the genus *Mastogloia* are very abundant in these Florida samples, and the author has found them to be so in all collections from Florida Waters. In other parts of the world they are relatively much less abundant.

219. Manter, H. W. 1942. Gasterostomes (Trematoda) of Tortugas, Florida. *Papers Tortugas Laboratory* 33: 1-19 (issued June, 1940).
Carnegie Institution of Washington Publication Number 524.
A report of the Gasterostomatus trematodes collected in 1930, 1931, and 1932 is given here. Fifteen species are reported; nine are considered new.

220. ———. 1934. The genus *Helicometra* and related trematodes from Tortugas, Florida. *Papers Tortugas Laboratory* 28: 167-80 (issued Mar. 1933).
Carnegie Institution of Washington Publication Number 435.
Observations on the trematode genera *Helicometra, Helicometrina* and a new related form

are based on material collected at the Carnegie Biological Laboratory at Tortugas, Florida. The genus *Helicometra* is represented at Tortugas by three species, *H. execta, H. torta*, and *H. fasiata*. The characteristics of each of these are described. A key is given to the species of the genus. *H. execta* is recorded from 6 additional hosts, making a total of 10. A mutilated specimen of *H. torta* showed this species has little or no power of regeneration. *Helicometra fasciata* from three hosts at 50 to 60 fathoms is reported for the first time from America. Metacercariae of *Helicometrina nimia* are described encysted in the muscles of the shrimps, *Lysmata intermedia* and *Crangon formosum*. Cercariae from *Columbella mercatoria* identified as Cercaria J of Miller were found to encyst readily in the muscles of *Lysmata intermedia*. *Helicometrina parva,* a new species is described.

221. ———. 1934. Some digenetic trematodes from deep-water fish of Tortugas, Florida. *Papers Tortugas Laboratory* 28: 257-345 (issued Jan. 16, 1934).
Carnegie Institution of Washington Publication Number 435.
The parasitic fauna of ocean depths is practically unknown. Extensive fish population occurs at all depths, very little study has been made on the helminths of these fish. During the summers of 1930, 1931, and 1932 collections were made of parasites from fish trawled from depths varying from 40 to 582 fathoms at Tortugas, Florida. Most of these hauls were made about 10 miles south of Loggerhead Key. Fish taken from these depths were commonly parasitized by helminths and especially by trematodes. It was found that the trematode fauna of the deep-water fish is practically as abundant and as varied as is the rich trematode fauna of the reef fish. A description is given of 49 species of trematodes collected from approximately 90 species of fish from depths of 40 to 582 fathoms. 721 individual fish were examined. Approximately 80 per cent of the host species were infected with trematodes, a percentage comparable with the degree of infection found in fish of shallow water. One new subfamily (of the family Heterophyidae), 11 new genera and 33 new species are described. Seven species of trematodes, from deep water only at Tortugas, are identical with forms well known from northern regions. Studies from shallow water at Tortugas show practically no similarity to northern forms. The deep-water trematode fauna is more like the surface fauna of Maine, Great Britain or Norway than like the shallow-water fauna at Tortugas, only a few miles away. This tendency to resemble surface trematodes of cold-water regions suggests that temperature is an important factor in the distribution of marine fish trematodes. This study emphasized the fact that a gradient of changing environment (such as depth) is reflected not only in the free-living population of a region but also in their parasites.

222. Marsh, G. 1940. The effect of light on the inherent E. M. F. of *Valonia ventricosa. I.* Intensity and time relations. *Papers Tortugas Laboratory* 32: 65-84 (issued Oct. 1939).
Carnegie Institution of Washington Publication Number 517.
The interpretation of the electrical changes produced in green plants by light has been retarded by the confused nature of the published results. In order to interpret electrical changes in a tissue in terms of some underlying process it is essential to obtain precise information concerning the distribution of E.M.F. within the tissue and the conditions of summation of the potentials of the individual cells included in the electrical circuit. The present paper reports the effect of visible light at known intensities upon the inherent E.M.F. of the coenocytic alga *Valonia ventricosa*. Results indicated that when the intensity of incident light is altered, the inherent E.M.F. of an impaled *Valonia* cell undergoes a characteristic cycle of change with definite time relations, following which a steady level is reached. The steady level of E.M.F, plotted against the logarithm of the light intensity rises from the dark potential along a sigmoid curve to a maximum at about 250 foot-candles, then descends along a similar curve toward the dark potential. The decline in potential with light intensity beyond the maximum was reversible. No injury was detected at any intensity. The effect of intermittent light with equal light-dark periods was similar to that of continuous light of half the intensity, save in one experiment, wherein the effect was similar to that of

continuous light of increased intensity. It is concluded that the effect of light on the E.M.F. is due primarily to the release of oxygen in photosynthesis.

223. ———. 1940. The effect of light on the inherent E. M. F. of *Valonia ventricosa.* II. The relative energy absorption spectrum. *Papers Tortugas Laboratory* 32: 99-120 (issued May 1940). Carnegie Institution of Washington Publication Number 517.
The interest in the relative effectiveness of different wave-length bands of visible light upon bioelectric potentials centers about the question of the nature of the agent in the living cell which absorbs the radiant energy, and its contribution to the electromotive mechanism. For the green plants three principal lines of evidence have been adduced to support the conclusion that chlorophyll is the photosensitive agent. Results indicated that the steady E.M.F. of impaled *Valonia ventricosa* illuminated with light of limited spectral composition was matched with white light. The ratio of the intensity of white to that of filtered light for an E.M.F. match was independent of the magnitude of the E.M.F. matched and of the absolute intensities. The relative energy absorption is shown to compare fairly well for the filter series with the relative absorption of chlorophyll mixtures over the same spectral range calculated from the determinations of the absorption coefficient published by Zscheile. It is concluded that chlorophyll is the photosensitive material absorbing the radiant energy responsible for the effect of light upon the protoplasmic E.M.F. in *Valonia.* The chlorophyll system is, therefore, an intimate part of the electromotive mechanism.

224. ———. 1937. Effect of temperature upon the inherent potential of *Valonia. Papers Tortugas Laboratory* 31: 1-16.
Carnegie Institution of Washington Publication Number 475.
The effect of temperature upon the potential is of prime importance in the determination of the nature of the underlying electrochemical process. The electromotive force of a system in thermodynamic equilibrium (including the diffusion potential) is proportional to the absolute temperature (Q 10 of 1.04 or less within the biological range of temperatures). The E.M.F. found across the protoplasmic layer of *Valonia* is not a thermodynamic one. It is produced by an oxidation-reduction system in flux equilibrium at phase boundaries within the cell. The E.M.F. is not primarily determined by the external medium. The influence of the salt content of the sea-water upon the inherent potential is fundamentally no different from the influence of the composition of the medium upon any other biological process, as respiration, irritability, contractility, etc., where specific electrolytes in different proportions condition, but do not cause, the process.

225. Mast, S. O. 1911. Behavior of the loggerhead turtle in depositing its eggs. *Papers Tortugas Laboratory* 3: 63-67.
Carnegie Institution of Washington Publication Number 132.
The nesting behavior of a single loggerhead turtle is described.

226. Matthai, G. 1915. Preliminary report on the comparative morphology of the recent *Madreporaria* around Tortugas. *Carnegie Institution of Washington, Year Book* 14: 209.
General observations were recorded on the common corals of the Tortugas. The only species that extruded larvae was *Favia fragum.*

227. Mayer, A. G.. 1908. The annual breeding swarm of the Atlantic Palolo. *Papers Tortugas Laboratory* 1: 105-12.
Carnegie Institution of Washington Publication Number 102.
The habits of the "Atlantic palolo" are quite similar to those of the palolo worm of Samoa and the Fiji Islands. The worms are, however, specifically different, the Atlantic palolo being *Eunice fucata* Ehlers, and the Pacific worm *E. viridis* Gray. The annual swarming of the Atlantic palolo has been observed only at Tortugas, Florida, although the worm is abundant in the Bahamas and other parts of the West Indies.

228. ———. 1911. The converse relation between ciliary and neuro-muscular movements. *Papers Tortugas Laboratory* 3: 1-25.
Carnegie Institution of Washington Publication Number 132.
A series of experiments on marine invertebrates were conducted beginning at the Tortugas Laboratory, and later at Woods Hole, Mass, and the New York Aquarium involving the effects of ions of blood salts, magnesium, sodium, calcium, ammonium, potassium, and hydrogen on neuro-muscular systems in relation to maintaining ciliary movements. In each case they are the exact apposite of their effects upon ciliary movements of invertebrates studied. Studies were carried out on invertebrate organisms abundant at Tortugas including annelid larvae, *Limulus,* veligers , actinian larvae, larvae of the Atlantic palolo worm, *Eunice fucata,* and ctenophores, *Cassiopea.* Preliminary reports of the research were published in the Biological Bull., Woods Hole, v. 17 (341-342); in the Proceedings of the Soc. for Experimental Biology and Medicine, 1909, No. 7, (19-20), and in the Carnegie Year Book for 1909, p. 152.

229. ———. 1914. The effects of temperature upon tropical marine animals. *Papers Tortugas Laboratory* 6: 1-24.
Carnegie Institution of Washington Publication Number 183.
Tropical marine animals commonly live within 5° C. of their temperature of maximum activity and within 10° to 15° C. of their upper death temperature. In marine tropical forms even a few degrees of heat or cold cause a marked depression in movement. In tropical Scyphomedusae this depression of movement appears to augment about as the square of the change in temperature from that of the optimum. Time is an important factor in these experiments, for animals can withstand a higher degree of heat if the temperature be raised quickly than if it be raised slowly. It appears that the reef corals at Tortugas, Florida, live in water which is commonly within 10° C. of their upper death-temperature, and if the ocean were heated to 38° C. (100.4° F.) only one species, *Siderastraea radians*, could survive. Next to *Siderastraea radians* the most resistant coral is *S. siderea.* It is associated in its habitat with *Orbicella annularis* one of the most sensitive of the reef corals, which is killed at 14.1° and 36.8° C. In general, however, the corals of the shallow-reef flats, such as *Siderastraea radians*, *Porites furcata,* and *Maeandra areolata,* are the most resistant both to heat and cold, while those of deep water, such as *Madrepora palmata* , *Eusimilia knorri,* and *Oculina diffusa,* are the least resistant. As a result, we are led to conclude that were the water cooled by an exceptionally prolonged norther to 13.9° C. for 9 hours, *Siderastraea radians* , *S. siderea,* and *Maeandra areolata* would survive without apparent injury while *Porites furcata, P. clavaria, Maeandra clivosa,* and *Favia fragum* would also survive, but with more or less injury. This temperature would be fatal to *Orbicella annularis, Porites astraeoides,* and *Madrepora muricata (cervicornis).*

230. ———. 1922. Hydrogen-ion concentration and electrical conductivity of the surface water of the Atlantic and Pacific. *Papers Tortugas Laboratory* 18: 61-85.
Carnegie Institution of Washington Publication Number 312.
The hydrogen-ion concentration of sea-water was determined by placing 0.4 c.c. of 0.1 per cent of the red dye thymolsuphonemphthalein in 70 per cent alcohol, in a test-tube of resistance glass, 24 mm. in caliber, then adding sea-water so as to make up 30 c.c. of solution. A series of such tubes, ranging from 7.95 to 8.3 pH, was standardized by Professor J.F. McClendon and presented to the author who restandardized these tubes at intervals of two years by comparison with determinations of pH made by a Leeds and Northrup potentiometer. In order to avoid writing negative exponents, the symbol "pH" to indicate the negative logarithm of the hydrogen-ion concentration was devised. Despite its artificiality, one soon finds that the pH system gives a clearer idea of the alkalinity or acidity of a solution than does a direct expression of the hydrogen-ion concentration. In testing water, pH 7 would indicate practical neutrality; pH above 7, alkalinity; and below 7 acidity. The carbon-dioxide tension of the sea-water was calculated from the pH and the temperature by the method devised by McClendon, Gault, and Mulholland (1917, Carnegie

Inst. Wash. Pub. No. 251, p. 36). McClendon found that the pH of sea-water falls 0.01 for 1° C. decline in temperature. The salinity of the sea is expressed in grams of total salts per 1,000 grams of sea-water, and was determined by the well-known method of using a standard $AgNO_3$ solution with K_2CrO_4 as an indicator, and testing against a sample of standard sea-water obtained from Professor Martin Knudsen. Upon being taken from the sea, the water was tested for temperature and pH, and a sample was preserved for determination of salinity. In connection with these tests of hydrogen-ion concentration, the electrical conductivity of the sea-water off Tutuila, Samoa and Tortugas, Florida was determined by Kohlrausch's method. At Tortugas, Florida, the conductivity of sea-water having 20.06 grams of chlorine in 1,000 grams of water, corresponding to a salinity of 36.24, was determined by the same apparatus, and with a portion of the same KCl solution used in Samoa. In lagoons such as that of Tortugas, Florida, and in closed shallow areas, McClendon found there was a diurnal variation in the pH, the water becoming more alkaline by day and relatively acid during the night. This was attributed to the effect of photosynthesis by plant life, which is active in daylight but ceases during the night. Over shallow regions, where the water may become impounded in tide-pools at low tide, the effect of photosynthesis is often very marked, the pH changing greatly while the temperature may change but little. The rise in pH was due to the loss of Co_2 resulting from photosynthesis.

231. ———. 1914. The law governing the loss of weight in starving *Cassiopea*. *Papers Tortugas Laboratory* 6: 55-82.
Carnegie Institution of Washington Publication Number 183.
The medusae were always starved in the purest sea-water which was either dipped from the ocean in glass or canvas buckets or pumped into glass reservoir tanks through hard-rubber pipes by means of a hard-rubber pump. The medusae were starved side by side in one and the same glass aquarium, but when this was impossible the aquaria were of similar size and form and were placed side by side, so as to be subjected to similar environmental changes. The decline in weight of two normal medusae of *Cassiopea xamachana* starved each in one liter of sea-water, changed once in 24 hours, and kept in the diffuse daylight of the laboratory at Tortugas, Florida, from June 8 to 20, 1913. One medusa, A, was starved in sea-water which had been passed through two glass funnels each holding two sheets of Chardin filter paper. The other medusa, B, was starved in sea-water, which, in addition to having been filtered through the Chardin Filters, was also filtered through a bacteria-proof porcelain filter. It appears that all food had been removed from the water by Chardin filters and the medusa in the bacteria-free sea-water starved more slowly than the one in the sea-water which had not been passed through the porcelain filter.

232. ———. 1908. Marine laboratories, and our Atlantic coast. *The American Naturalist* 42: 533-36.
In this general article by Dr. Mayer concerning the importance of marine laboratories along our Atlantic Coast, the Tortugas is mentioned as having a certain remoteness from the busy world and consequent freedom from interruption peculiarly favorable to the conduct of research.

233. ———. 1915. The nature of nerve-conduction in *Cassiopea*. *Proceedings of the National Academy of Science* 1: 270-274.
Narrative same as in reference no. 234.

234. ———. 1917. Nerve-conduction in *Cassiopea xamachana*. *Papers Tortugas Laboratory* 11: 1-20.
Carnegie Institution of Washington Publication Number 251.
By means of Professor E.G. Conklin and the authorities at Princeton the author used the facilities at the Biological Laboratory in Guyot Hall, where the kymograph records taken at Tortugas were studied and the results tabulated. The object of this research was to obtain an accurate quantitative determination of the rate of nerve-conduction in natural and in diluted sea-water at constant temperature, and also to estimate the effects of various artificial sea-

water solutions containing all or some of the sodium, magnesium, calcium, and potassium cations of sea-water. The effects of temperature upon nerve-conduction are also of great importance. These studies were carried out in June and July 1916, upon *Cassiopea xamachana,* a thizostomous scyphomedusa which is abundant in the salt-water moat surrounding Fort Jefferson at Tortugas, Florida. In summary, nerve-conduction is due to a chemical reaction involving the cations of sodium, calcium, and potassium. Magnesium is non-essential. Observations do not support the "local action" theory of Lillie (1916).

235. ———. 1918. Nerve-conduction in diluted and concentrated sea-water. *Papers Tortugas Laboratory* 12: 179-83.
Carnegie Institution of Washington Publication Number 252.
Ring-shaped strips of subumbrella tissue of the scyphomedusa *Cassiopea xamachana* were deprived of marginal sense-organs and placed in concentrated sea-water in order to determine the effect of concentration of electrolytes upon their rate of nerve-conduction. Experiments made in 1917 upon *Cassiopea* found that the rate has increased while the electrical conductivity has diminished. The injurious effects of concentrated sea-water upon regeneration and growth have been studied by Loeb, and by Goldfarb (1914), and there is a general resemblance between their curves and those in this paper for the rate of nerve-conduction, excepting that for regeneration somewhat dilute sea-water seems to be more favorable than normal sea-water, whereas in nerve-conduction the highest rate is obtained in slightly concentrated sea-water .

236. ———. 1908. A plan for increasing the efficiency of marine expeditions, marine laboratories and our Atlantic coast. *American Naturalist* 42: 533.
Narrative same as in reference no. 232.

237. ———. 1914. The relation between the degree of concentration of electrolytes of sea water and the rate of nerve conduction in *Cassiopea. Papers Tortugas Laboratory* 6: 25-54.
Carnegie Institution of Washington Publication Number 183.
If sea-water be diluted with distilled water, or with a 0.9 molecular solution of dextrose, thus preserving its normal osmotic pressure but reducing the concentration of the cations of sodium, magnesium, calcium, and potassium, the rate of nerve-conduction increases as dilution proceeds, becoming most rapid in 90 per cent sea-water + 10 per cent distilled water or dextrose. The sodium cation is an active stimulant for nerve-conduction. Experiments with the magnesium cation show that it is not a stimulant for nerve-conduction. In very slight excess the potassium cation produces a permanently stimulating effect, as does sodium, but in denser concentration it produces momentary stimulation of the rate of nerve-conduction followed by depression. In all essential respects the effects of potassium are similar in kind, but more marked in degree, to those of sodium.

238. ———. 1908. Rhythmical pulsation in Scyphomedusae.II. *Papers Tortugas Laboratory* 1: 113-31.
Carnegie Institution of Washington Publication Number 102.
The following paper presents the results of a continuation of studies, the first report of which appeared in publication No. 47 of the Carnegie Institution of Washington, 1906. The present paper aims to correct certain errors in the previous report, and to announce some new results. Conclusions presented suggested that sea-water is a balanced fluid neither inhibiting nor stimulating pulsation in *Cassiopea xamachana.* The stimulus which causes pulsation is due to the constant formation of sodium oxalate in the terminal entodermal cells of the marginal sense organs. This sodium oxalate precipitates calcium, as calcium oxalate, thus setting free sodium chloride and sulphate which act as nervous stimulants. Pulsation is thus caused by the constant maintenance at the nervous centers in the sense-organs of a slight excess of sodium over and above that found in the surrounding sea-water. In *Cassiopea* the pulsation-stimulus is conducted by the diffuse nervous network of the subumbrella, and is independent of the muscles which may or may not respond to its presence by contraction. Strong primary nervous and muscular excitement followed by

exhaustion and sustained muscular tetanus is produced in *Lepas* or in *Cassiopea* by a solution containing the amounts and proportions of $NaCl+KCl+CaCl^2$ found in sea-water.

239. ———. 1900. Some medusae from the Tortugas, Florida. *Bulletin of the Museum of Comparative Zoology at Harvard College* 37, no. 2: 1-82 .
This extensive article on the medusae of the Dry Tortugas includes an alphabetical list of species described, table showing the wide geographical range on some Tortugas Medusae, and comparisons of the Tortugas Fauna with that of Southern New England, the Tropical Atlantic, Fiji Islands and Tropical Pacific.

240. ———. 1902. The Tortugas, Florida as a station for research in biology. *Science (Washington, D.C.)* 17: 190-192.
The advantages of establishing a tropical research marine biological laboratory in the Dry Tortugas over other Caribbean sites are discussed. The nearness of the Florida Current, an extension of the Gulf Stream, to the Tortugas is a distinct advantage over other sites because of its richness in pelagics, especially small juveniles and larvae during the summer. Other sites are richer in coral, such as Jamaica, but they are further from the Gulf Stream and are impacted by land runoff.

241. ———. 1918. Toxic effects due to high temperature. *Papers Tortugas Laboratory* 12: 173-78. Carnegie Institution of Washington Publication Number 252.
The experiments cited below appear to indicate that death from high temperature may be due to the accumulation of acid in the tissues. Reef corals from Tortugas, Florida, were kept at a constant temperature in warm ocean-water for 60 minutes in a thermostat, in the dark the temperature remaining constant within about 0.1° C. throughout the hour. In this manner the temperature was found that is just sufficient to kill the coral. The results are as follows: *Acropora muricata* 34.7, *Orbicella annularis* 35.6, *Porites astraeoides* 35.8, *Porites clavaria* 36.4, *Maeandra areolata* 36.8, *Porites furcata* 36.85, *Favia fragum* 37.05, *Siderastrea radians* 38.2. It is apparent that those corals which live in cool, relatively agitated water, free from silt, are those that can not withstand high temperatures, whereas those which live in the hot, silt-laden shallows near shore are, generally speaking, forms which can resist high temperature. *Favia fragum* is however an exception. It seems possible that death from high temperature may be due to the accumulation of acid (possibly H_2CO_3) in the tissues, the rate of formation of this acid being related to the rate of metabolism of the tissues. Thus animals of the same class having a high rate of metabolism, as measured by oxygen consumption, are more sensitive to heat and to CO_2 than those having a low rate of metabolism.

242. ———. 1922. The tracking instinct in a Tortugas ant. *Papers Tortugas Laboratory* 18: 101-7. Carnegie Institution of Washington Publication Number 312.
Monomorium destructor Jerdon, a tropicopolitan ant of East Indian origin, was identified in Florida . It is a small, reddish-brown ant, a great pest in the wooden buildings of the Tortugas laboratory. These pests have killed rats confined in cages within 24 hours. The experiments described were made on the flat wooden floor of the laboratory. To attract the ants, a number of recently killed houseflies were impaled upon a pin. The pin with its lure of flies was then thrust into the floor in front of a foraging ant, which would often pass within 0.25 inch of the lure without perceiving the flies; but if its course were such that it came appreciably nearer than 0.25 inch, the ant suddenly turned toward the flies, and without apparent excitement appeared to "inspect" them, spending a half minute or more crawling over them and stroking them with its antennae. This "finder ant" soon leaves the flies without carrying off any piece of them, but instead of moving off in the erratic and tortuous path it was pursuing before it found the flies, it now goes in a fairly straight path toward some crevice in the floor, out of which there soon pours an excited swarm of its nest-mates, who proceed toward the flies in a fairly straight path. When an ant returns to the nest it pursues a fairly straight path which is more or less right in direction, but when the ant has

gone the correct distance, it begins to wander in more or less tortuous courses until it finds the nest.

243. McClendon, J. F. 1917. Diurnal changes in the sea at Tortugas, Florida. *Proceedings of the National Academy of Science* 3: 692.
The only diurnal change noted in the Gulf Stream was a change in temperature of about 1 degree C and the resulting change in oxygen tension. However, marked differences were found in temperature, pH, CO_2, and O_2 concentration in shallow water where light could reach the bottom. The temperature, O_2 concentration and O_2 tension were lowest and the CO_2 concentration and CO_2 tension highest at 5 A.M. The temperature, O_2 concentration and O_2 tension were highest and CO_2 concentration and CO_2 tension were lowest at 3 P.M. during July at Dry Tortugas. The magnitude and exact time of minima and maxima varied from day to day, and varied a great deal with station location. Studies on the effects of these changes on organisms were made. The limiting factor for plants was nitrogen, while the limiting factor for animals was food and oxygen.

244. ———. 1917. Effect of oxygen tension on the metabolism of *Cassiopea*. *Proceedings of the National Academy of Science* 3: 715-16.
Experiments on the effect of oxygen tension on the metabolism of *Cassiopea* were carried out at the Tortugas Laboratory by using the umbrella of *Cassiopea* to maintain a layer of cells in seawater at 30 degrees C. The metabolism varied with oxygen concentration. This may be true for all animals, however there is a distinction between the metabolism of vertebrate cells and *Cassiopea*. Vertebrate cells give out lactic acid when asphyxiated whereas *Cassiopea* may remain without oxygen for seven hours without giving out CO_2 or any other acid. Although details of the experiments will be published elsewhere, it was concluded that changes in the threshold of stimulation of the respiratory and basomotor centers may affect metabolism in man and animals.

245. ———. 1917. The effect of stretching on the rate of conduction in the neuro-muscular network in *Cassiopea*. *Proceedings of the National Academy of Science* 3: 703.
The experiments on *Cassiopea* collected at the Dry Tortugas, tend to support the conclusions reached by Carlson, that stretching the nerve does not change the rate of the nerve impulse, and that the conducting substance itself, can be stretched and relaxed.

246. ———. 1917. The equilibrium of Tortugas sea water with calcite and aragonite. *Proceedings of the National Academy of Science* 3: 612-19.
This report provides information on the continuing controversy on the solubility of Calcium chloride in sea water. The precipitation of $CaCO_3$ at Tortugas was studied by T.W. Vaughan, R.B. Doyle, and G.H. Drew. Drew observed that denitrifying bacteria, *Pseudomonas calcis* obtained from sea water was capable of changing calcium nitrate to calcium carbonate in culture media, and supposes that a similar process occurs in seawater. This study attempts to determine the nitrates or nitrites. If the pH is maintained (by plants) at 8.2 at the Tortugas, the introduction of calcite crystals would result in a lowering of the calcium content of Tortugas seawater by about 4.5%.

247. ———. 1914. Experiments on the permeability of cells. *Papers Tortugas Laboratory* 6: 123-30. Carnegie Institution of Washington Publication Number 183.
One of the most important steps in the analysis of life was the discovery of oxygen. Ever since that time it has been known that animals absorb free oxygen and give it out in a combined form. In this experiment three methods of procedure were followed: (1) the use of cell masses as partitions (on eggs of *Lytechinus*); (2) the use of quantities of eggs suspended in a liquid medium (on eggs of *Fundulus*); (3) experiments on individual eggs (of *Arbacia*). The permeability of the egg to ions and perhaps some other substances increases on fertilization. The unfertilized egg is perhaps in a dormant condition and the increase in permeability probably allows a rapid interchange with the surrounding medium necessary

for activity (development). Whereas this supposed significance of permeability has not been proven, the sea-urchin;s egg is not an exception. The relation of permeability to oxidation can hardly be determined until more is known about the mechanism of animal oxidations. These seem to depend on structure since complete oxidations cease when structure is completely destroyed. Reference is made only to oxidations resulting in the formation of CO_2. Oxidizing enzymes such as tyrosinase, which are independent of structure, do not completely oxidize the substances acted on.

248. ———. 1911. On adaptations in structure and habits of some marine animals of Tortugas, Florida. *Papers Tortugas Laboratory* 3: 55-62.
Carnegie Institution of Washington Publication Number 132.
This article discusses the habits of some marine animals of the Tortugas. Many of these animals were thigmotactic and remained in glass tubes rather than in the open. They learned to find the tubes when removed from them. Such was the case with five species of the Alpheidae, one of the Pontoniidae, *Typion tortugae* Rathbun, and *Gonodactylus aertedii*. All the anemones were thigmotactic on their bases. These same animals were heliotropic. The crustaceans were negatively heliotropic and the anemones kept their bases from the light, while *Cradactis variabilis* Hargitt hid all but the tips of the fronds and tentacles from the light. In removing its base from the light, *Stoichactis helianthus*, which lives on coral heads, makes snail-like movements similar to *Metridium*, while *Cradactis*, which lives in holes in decayed coral heads, crawls on its tentacles.

249. ———. 1918. On changes in the sea and their relation to organisms. *Papers Tortugas Laboratory* 12: 213-58.
Carnegie Institution of Washington Publication Number 252.
The sea and air form the circulating media for the living organisms of the world. The local composition of the sea is distinctly affected by living organisms. The local changes in the composition of the sea are the subject of the present paper. These changes are due chiefly to organisms, but partly to meteorological causes. The water evaporated is returned with addition of fixed nitrogen from electric discharges or falls on the land and is returned with various salts, chiefly $CaCO_3$, and with fixed nitrogen and other products of organisms. Various seaweeds absorb CO_2 thus leaving an excess of $CaCO_3$, which has a very low solubility and is constantly being precipitated in certain warm seas, and is precipitated within the bodies of organisms in the surface waters of all seas. In working out the relation of H-ion concentration (pH) to the solubility of $CaCO_3$ in sea-water, it was found that all sea-water is supersaturated with $CaCO_3$, and will lose some of it if shaken with calcite or aragonite crystals. The pH is influenced by plant and animal life and arises at Tortugas to 8.35 during the day over well-lighted bottoms rich in vegetation, and falls to 8.18 during the night. It may be said, therefore, that conditions in shallow water over eelgrass or other seaweed or corals (with symbiotic algae) favor the precipitation of $CaCO_3$. The question arises whether the occasional high pH of Tortugas sea-water is sufficient to explain the precipitation of $CaCO_3$. The author's experiment showed that if the pH of sea-water should be maintained (by the action of plants) at 8.2 while it was agitated with calcite crystals, the loss of $CaCO_3$ would be about 0.001 N, or 0.0005 M, or 0.1 gram per liter. This would cause a deposit of 10 kg. per square meter of bottom in water 100 meters deep. This would cause a lowering of the total calcium content of Tortugas sea-water by about 4.5 per cent. The actual precipitation of $CaCO_3$ was most noticeable in the Marquesas lagoon. At 4 p.m., July 30, the pH was 8.46 and there was a precipitate of $CaCO_3$ coming down in the water and encrusting the eel-grass.

250. ———. 1917. The standardization of a new calorimetric method for the determination of the hydrogen-ion concentration, CO_2 tension and CO_2 and O_2 content of sea water, of animal heat, and of CO_2 of the air, with a summary of similar data on bicarbonate solutions in general. *Journal of Biological Chemistry* 30: 265-88.
Experiments were conducted on pH, CO_2 tension, CO_2, and oxygen content of Dry Tortugas

seawater and seawater from other oceanic areas using a Leeds & Northrup potentimeter and a 0.1 KCL calomel electrode. It was found that neither the salinity nor the alkaline reserve in seawater of the tropical or temperate oceans change sufficiently to noticeably change the relation of pH to CO_2 tension, although the alkaline reserve does change sufficiently to affect the total CO_2 greatly.

251. McClendon, J. F., C. C. Gault and S. Mulholland. 1917. The hydrogen-ion concentration, CO2 tension, and CO2 content of sea water. *Papers Tortugas Laboratory* 11: 21-69.
Carnegie Institution of Washington Publication Number 251.
Narrative same as in reference no. 250.

252. Meeder, J. F. 1979. Corals and coral reefs of the Dry Tortugas, Florida. *in Guide to sedimentation for the Dry Tortugas.* R.B. Halley (Compiler), 46-47. S.E. Geological Society Pub.
This paper presents a description of the corals from two localities in the Dry Tortugas, on a back reef environment of a fringing reef near Garden Key, and the second, a series of patch reefs off Loggerhead Key. The general setting, ecology, distribution, and types of corals are discussed for each locality. Forty-one of the forty-two species of corals reported at the Tortugas are covered in a field key and later described in this paper.

253. Miller, H. M. Jr. 1926-1929. Behavior of trematode larvae. *Carnegie Institution of Washington, Year Book.*
Note: Published as follows: 1926, v.25, p. 243-244: 1929, v. 28, p. 295.
Anatomical/morphological descriptions of six larval tremeatodes infesting the mollusk, *Cerithium litteratum*, taken from Bird Key Reef *Porites* beds, were provided. Percentages of occurrence of the 6 cercariae were given. The behavior of the members of this morphological group are described in detail, including aspects of their life history.

254. Miller, R. A. and H. B. Smith. 1931. Observations on the formation of the egg of *Echinometra lacunter. Papers Tortugas Laboratory* 27: 47-52.
Carnegie Institution of Washington Publication Number 413.
The study of the ovaries of *Echinometra* was undertaken in the hope that by the use of some of the newer cytological methods, it might be possible to extend our knowledge of the processes of oögenesis, particularly of those concerned in the formation of yolk in the chinoid egg. This paper presents the observations that have been made, and the conclusions that have been drawn. It was found that in *Echinometra lancunter*, undifferentiated cells along the wall of the ovary are uniform in appearance, although they are destined to develop into two entirely different kinds of cells. As development proceeds, some of the cells become oögonia, while others enlarge and disintegrate to form deutoplasmic bodies. These are more coarsely granular than was the cytoplasm from which they were formed. The granules exhibit different affinities for stains. Fully formed nutritive spheres are of two kinds, granular and non-granular. The former are composed entirely of cytoplasmic, or of both cytoplastic and nuclear material. The nutritive spheres group themselves around the oögonia in a follicular arrangement. Eventually the nutritive spheres enter the egg and disappear as such, forming the yolk content of the cytoplasm, which becomes homogeneous and evenly granular. The deutoplasmic granules are smaller and more diffuse in the mature eggs than in the oöcytes. The nutritive spheres have been shown to be composed of phospholipins suspended in a homogeneous medium. It is probable that they are largely lecithin in content. Their origin is not known.

255. Millspaugh, C. F. 1907. Flora of the sand keys of Florida. *Columbian Museum* 118, no. (Bot. Ser. 2): 191-245.
A list of species and details of vegetation, as well as elevational descriptions and size dimensions of sand keys westward of Key West, including the Tortugan group, were compiled by the author during the winter through spring of 1904.

256. Mitchell-Tapping, H. J. 1981. Particle breakdown of recent carbonate sediment in coral reefs. *Florida Scientist* 44, no. 1: 21-29.
Skeletal particles of the major components of the carbonate sediment of the reef shoal environment were examined using the scanning electron microscope. This examination revealed no set pattern of skeletal breakdown according to microarchitectural structure, as postulated by the Sorby principle, but that such a breakdown depends on mineralogical composition, wall thickness, grain size and pattern, density, and the amount of cementation and bioerosion. To investigate general particle-size abundances and deficiencies in carbonate sediment, samples were taken from the reef crest, back-reef-rubble and open-sand ecozones of the reef shoal environments of sites from the Bahamas, Dry Tortugas, Lower Florida Keys, Grand Cayman Island and the U.S. Virgin Islands. Size analyses of these samples showed that the sediment is moderately sell-sorted, coarsely-skewed and leptokurtic. Although particle-size abundances (or modes) exist in each individual site, there is no particular particle-size abundance that is common to all the sites. It is inferred that the particle abundances (or modes) for each site are a product of the sorting potential of the wave energy and that this sorting potential is the major control of the breakdown of sand-sized skeletal particles rather than the microarchitectural structure as proposed by the Sorby principle.

257. Moritz, C. E. 1936. Embryology of the sea-hare, *Aplysia protea* and of *Crangon armillatus*. *Carnegie Institution of Washington, Year Book* 35: 90.
Observations from aquaria are recorded on the early development of *Aplysia*, from embryo to 5 days beyond hatching. Adults were collected from the moat on Garden Key and Bird Key Reef.

258. Multer, H. G. 1975. Field guide to some carbonate rock environments; Florida Keys and Western Bahamas. *Fairleigh Dickinson University* 40: 175 pp.
This report presents the most recent compilation on Holocence sediments in the western Bahamas and in the Florida Keys including the Dry Tortugas. Selected geologic literature pertinent to local environments is noted within the text, with full bibliographic citations following each subject area. Carbonate sand beach and beach rock environments from the Florida Keys, Bimini, and Loggerhead Key are compared. In summary, Holocene sediments of these areas today present a vast array of textures and constituent particles characteristic of environments which have been subjected to fluctuating sea levels and storm action. Such data may be used to interpret ancient environments.

259. ———. 1971. Holocene cementation of skeletal grains into beachrock, Dry Tortugas, Florida. *Carbonate Cement.* O. P. Bircker. Baltimore, Maryland: Johns Hopkins Press.
A discussion is presented on the origin of beach rock at Loggerhead Key, Dry Tortugas. Present evidence suggests that cementation is due to alternate wet and dry salt water spray conditions with skeletal grains providing nuclei for precipitation from a supersaturated calcium carbonate solution. The limited ground water conditions and lack of grain solution for providing aragonite cement are two evidences in favor of the above cited evaporation origin for the cement in this rock. Ginsburg (1953) reached similar conclusions for beach rock in the same area.

260. Murphy, L. E. 1993. *Dry Tortugas National Park, Submerged Cultural Resources Assessment*, L. E. Murphy. Submerged Cultural Resources Unit, Southwest Region, National Park Service, Santa Fe, New Mexico.
This volume describes and assesses the known and potential archeological resources in Fort Jefferson National Monument, later redesignated Dry Tortugas National Park. The emphasis is on submerged cultural sites, particularly shipwrecks. The importance of linking the natural resources with submerged cultural resources is provided by identifying the biological influences on the cultural resources. The Dry Tortugas and South Florida geological development and environmental succession is summarized with focus on the

postglacial development of the Florida-Reef Tract, depositional environments, coral reef and sand key development as well as Late-glacial and Postglacial succession of environments. An overview on the physical oceanography of the eastern Gulf of Mexico concentrating on the Dry Tortugas with emphasis on currents and climate that affect shipping vessel casualties and site preservation is provided. Recommendations for future research and resources management are given.

261. Nance, J. M., E. F. Klima and F. J. Patella. 1986. *Review of the Tortugas pink shrimp fishery from May 1984 to December 1985*, Galveston, Texas, NOAA/NMFS, Southeast Fisheries Center, Galveston, Texas. NOAA Tech. Memo.177.
Commercial pink shrimp fishing data from the Tortugas (Dry Tortugas Islands, Florida) fishery were reviewed for biological year 1984 (May 1984-April 1985) and the first 8 months of biological year 1985 (May 1985-December 1985). Pink shrimp landings were just over 11.0 million pounds in biological year 1984 with 17,000 days of fishing expended. This computed to a CPUE value of 643 pounds per day. Pink shrimp landings for biological year 1985 are estimated to be around 9 million pounds with 15,000 days of fishing expended. The predicted CPUE value for 1985 should be around 600 pounds per day. Biological year 1984 experienced two extended periods of pink shrimp recruitment into the Tortugas fishing grounds.

262. O'Neill, C. W. 1976. Sedimentology of East Key, Dry Tortugas (abs.). *Florida Scientist* 39 (Suppl. 1), Fortieth Annual Meeting of the Florida Academy of Sciences at Eckerd College, St. Petersburg, Florida March 18,19,20, 1975: 10.
East Key of the Dry Tortugas rests on a large crescent shaped bank and oscillates about a stable core in response to seasonal variations. A simple strand/dune plant community is largely responsible for short term stabilization of this central core. Historical studies covering 200 years show that East Key varies in its bank position on long term basis and has in the past been of much greater areal extent. In addition, historical records show the Dry Tortugas group has decreased in extent from 11 keys to the present seven. This effect is thought to be due to a combination of eustaic sea level change and storm degradation.

263. ———. 1976. "Sedimentology of East Key, Dry Tortugas, Florida." University of South Florida. Ph.D. Dissertation.
The Dry Tortugas platform is a complex of reefs, banks, and shoals which lie 65 nautical miles west of Key West, Florida. This reef platform most closely resembles the resorbed reef of Maxwell's (1968) classification. A review of historical records covering a 463-year period indicates that the Dry Tortugas island group is undergoing progressive degradation and has been reduced from 11 rocky islets in 1513 to 7 at present. This reduction is thought to be due to the combined effect of episodic events and the Holocene transgression. East Key maintains a position on the windward segment of the Tortugas group. Short-term changes to the key are basically in response to regular seasonal variation and cause the island to oscillate to the north and south about a plant-stabilized core. Long-term changes reflect the effect of episodic events and entail inundation, major shifts inposition, and changes in the orientation of the key. Mean grain size of East Key sediments is near 0.900 or coarse sand. The sediments are nearly without exception moderately well sorted with an average value of 0.570. The mean skewness value is -0.22 (coarsely skewed). Texture was compared to morphology. The most striking correlation occurred on the foreshore where there is a distinct tendency for sediments to become coarser moving seaward from the berm. The average percentage composition of East Key sediments, by constituent, was found to be 52 percent *Halimeda*, 35 percent coral, 6 percent Mollusca, 3 percent coralline algae, 1 percent Foraminifera, 1 percent echinoid fragments and 2 percent miscellaneous plus unknown. The most significant correlation between composition and morphology occurred on the foreshore, where percent *Halimeda* generally increased seaward from the berm. This general increase in percent *Halimeda* correlates with a tendency for sediments to become coarser moving seaward from the berm.

264. Ogden, J. C., W. C. Jaap, J. W. Porter, N. P. Smith, A. M. Szmant and D. Forcucci. 1993. SEAKEYS: A large scale interdisciplinary study of the Florida Keys Reef Tract (abs.). *Proceedings of the Seventh International Coral Reef Symposium*, v. 2. Mangilao, Guam: University of Guam Marine Laboratory.
The SEAKEYS program has established a research framework which encompasses the large geographic and long time scales of natural marine processes and ecosystem variation. The core of the program is a series of instrumented, satellite-linked monitoring stations which span the 220 mile coral reef tract. Mesoscale physical oceanographic studies are concentrated in the major channels potentially linking Florida Bay and the population centers of the Keys with the reef tract. Simultaneously, nutrient studies are probing the possibility of sewage and agrichemical contamination, complicated by natural sources of nutrients. A series of long-term photomosaic stations have tracked coral community dynamics for more than 5 years. The design of the SEAKEYS program may provide an example for long-term research on coral reefs elsewhere.

265. Osburn, R. C. 1914. The Bryozoa of the Tortugas Islands, Florida. *Papers Tortugas Laboratory* 5: 181-222.
Carnegie Institution of Washington Publication Number 182.
In the summer of 1908 the writer had the privilege of spending the month of June at the Carnegie Institution Laboratory of Marine Biology on Loggerhead Key of the Tortugas Islands. The entire period was devoted to a close search for the bryozoa inhabiting the shallow waters about the reefs, on the piles of the old government dock on Garden key, in the moat of old Fort Jefferson on the same key, and in dredging the shallow waters about the islands down to 22 fathoms. Comparatively little work has been done on the bryozoa of the Florida and West Indian regions. By comparing with lists from other regions where the bryozoa have been carefully worked, it will be seen that the bryozoan fauna of the Tortugas and of the Florida-West Indian regions is fairly rich in species and fairly representative of tropical and semi-tropical regions.

266. Payne, F. 1937. Early development of *Ptychodera bahamensis*. *Papers Tortugas Laboratory* 31: 71-76 (issued July, 1936).
Carnegie Institution of Washington Publication Number 475.
The author records some observations made on *Ptychodera bahamensis* during the summer of 1933 while working at the Carnegie Laboratory at Tortugas, Florida. The animals were found most abundantly on the coral reef near Fort Jefferson in water which at low tide was from one to two feet deep. The larvae described by Weldon, Morgan, and Stiansy and assigned to *Ptychodera bahmensis* do not agree with the author's own observations of the larvae of *Ptychodera bahamensis* which have been followed from the fertilized egg. It seems conclusive that more than one species is involved or that errors have been made on the part of someone. Even though the author has not followed development through to metamorphosis, it seems clear that the tornariae, described by Weldon and Morgan are different from the tornaria of *Ptychodera bahamensis,* assuming his identification is correct.

267. ———. 1933-1938. Embryology and cytology of the balanoglossid, *Ptychodera bahamensis... Carnegie Institution of Washington, Year Book.*
Note: published as follows: 1933, v. 32, p. 277-78; 1938, v. 37, p. 84.
Embryological work was conducted on the supposed protochordate, *Ptychodera bahamensis*, starting with the fertilized egg. Development was followed as far as the tornaria.

268. Pearse, A. S. 1934. Animals in brackish water ponds and pools at Dry Tortugas. *Papers Dry Tortugas* Laboratory 28: 125-42 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 435.
During the summer of 1931 two ponds and three pools were studied on Long and Garden Keys, Dry Tortugas. Because of the remoteness of the Dry Tortugas, the animals which live

in these isolated habitats are of particular interest. Results were as follows: Five brackish water pools and ponds were studied on Long and Garden Keys. These were variable in salinity and temperature, and limited in extent. They showed various stages of evolution from sea to fresh water and conditions of life in them were more or less severe. The animals in the ponds and pools were resistant to environmental variations. They lived in salinities between 0.6 and 6.4 per cent and endured temperatures above 42° C. Some of the small bodies of brackish water on Dry Tortugas contained curious mixtures of marine and fresh-water animals. *Callianassas*, marine snails, mullets, and needle-fishes lived with dragon-fly nymphs, water boatmen, surface bugs, aquatic beetles and midges. Lists of the animals collected and observed in each pond or pool are given. Each pond or pool contained certain characteristic animals, which had become dominant in that particular habitat. As the small pools trended toward fresh water, insects were increasingly dominant in them. Insect populations show great pressure and spread into all available habitats. When small pools are cut off from the ocean and are gradually transformed into fresh-water habitats, insects are the pioneers and soon become dominant.

269. ———. 1934. Freezing points of bloods of certain littoral and estuarine animals. *Papers Tortugas Laboratory* 28: 93-102 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 435.
It is well known that the bloods and body fluids of marine invertebrates and elasmobranchs have about the same osmotic pressure as the ocean water in which they live, though the salt content of such fluids is usually a little less than that of the surrounding medium. Those of teleost fishes (marine, fresh-water and land) and of fresh-water and land animals generally have osmotic pressures which are much below those of sea-water. Littoral crustaceans and fishes are of particular interest because they represent various stages of adjustment to life on land. At Tortugas, conditions are particularly favorable for the study of such adjustments for the littoral group. The observations cited in this paper appear to justify the conclusion that crabs and fishes which take up terrestrial life or air-breathing have bloods of lower osmotic pressures than comparable marine or fresh-water animals. The attainment of land life by marine animals is apparently associated with a reduction in salinity and stabilization of the contents of the blood.

270. ———. 1934. Inhabitants of certain sponges at Dry Tortugas. *Papers Tortugas Laboratory* 28: 117-24 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 435.
Many sponges are veritable living hotels. Their canals are densely populated with a variety of animals and some species have not been found elsewhere. During the summer of 1931 the writer studied the animals which occurred in five species of sponges at Dry Tortugas. The number of animals which live in big sponges is enormous. Though each sponge appears to be occupied to its full capacity, the number of animals per cubic centimeter of sponge is apparently influenced by depth and the size of the sponge itself. In loggerheads there are relatively more guests in smaller sponges and in deep water. Among the species of small sponges there are striking differences in the number of animals present and these may be due to inherent qualities. For example *Stematumenia foetida* (Schmidt) contained very few animals, whereas the slightly smaller *Spongia officinalis* L. was crowded.

271. ———. 1918. Notes on certain amphipods from the Gulf of Mexico, with descriptions of new genera and new species. *Proceedings of the U.S. National Museum* 43, no. 1936: 369-79.
This is a report on a portion of the amphipods from the Gulf of Mexico in the collection of the United States National Museum. The collections are from several sources and extend over a long period of years. The greater part of them had not yet been examined. Those described were taken chiefly by the steamers Fish Hawk and Albatross of the United States Bureau of Fisheries.

272. ———. 1929. Observations on certain littoral and terrestrial animals at Tortugas, Florida, with special reference to migrations from marine to terrestrial habitats. *Papers Tortugas Laboratory* 26: 205-23.
Carnegie Institution of Washington Publication Number 391.
In the past, various types of animals have migrated from the ocean into fresh-water streams or lakes, and from there gained a foothold on land. On the shores of all oceans, animals may be found which are partially adjusted to life in fresh water or on land. The Dry Tortugas contain no fresh water, and therefore offer an excellent opportunity to study littoral animals which have no immediate contact with fresh-water habitats. In summary, at Tortugas certain reef, beach and land animals were studied with reference to migrations from sea to land. Hermit crabs which have become more or less adjusted to life on land show a progressive reduction in the number of gills. Crabs which have migrated landward show a progressive lessening of gill-volume. Beach animals which show any landward trend usually live longer when kept in air than when kept in fresh water. Animals which have attained some degree of ability to live on land have often also acquired a greater degree of ability to resist the extraction of constituents of body fluids into fresh water. Animals which migrate from the sea and become established on land do not do so on account of one "lure" or one "danger." Each habitat has certain advantages and certain disadvantages. A continually changing animal must continually make adjustments to a continually changing environment, and when it migrates to a new habitat, must make many compromises between new advantages and dangers, old necessities and new requirements, and old habits and new abilities.

273. ———. 1934. Observations on the parasites and commensals found associated with crustaceans and fishes at the Dry Tortugas, Florida. *Papers Tortugas Laboratory* 28: 103-15 (issued Dec. 1932).
Carnegie Institution of Washington Publication Number 435.
During the summer of 1931 the writer had opportunity to conduct post mortems on various crustaceans at Dry Tortugas from June 3 to August 22. Dr. Waldo Schmitt furnished and identified many of the specimens. The following parasitic isopods were taken from fishes: 2 *Cymothoa oesturm* (L.) from the gill cavity of *Caranx ruger* (Bloch), July 26; 1 *Rocinela signata* Schioedte and Meinert from the gills of *Promicrops itaiara* Lichtenstein in July and 1 from the gills of *Lutianus analis* (Cuvier et Valiencennes), June 27; 8 *Excorallana tricornis* (Hansen) from the nose of *Promicrops itaiara* Lichtenstein, July, and 31 from the gill cavity of *Epinephelus moro* (C. et V.). The occurrence of the parasites and commensals associated with crustaceans depends upon a variety of factors - host specificity; habitat; habits, structure and physiology of hosts and parasites, etc. In general the greatest number of species of parasites occurred in or near the littoral zone. However, great numbers of parasites per host were encountered among some land crustaceans.

274. ———. 1929. Two new mites from the gills of land crabs. *Papers Tortugas Laboratory* 26: 225-30.
Carnegie Institution of Washington Publication Number 391.
During July and August 1928, mites were found at Dry Tortugas on the gills of the land hermit crab, *Cenobita diogenes* (Latreille), and on the Nassau crab, *Gecarcinus lateralis* (Freminville). These crustaceans visit the ocean only once each year when they hatch out their young. No mites were found on the gills of the ghost crab, *Ocypoda albicans* (Bosc), which often visits the ocean and bathes its gills. Mixed or pure cultures of bacterial populations are incapable of precipitating $CaCO_3$ in a sea-water medium if KNO_3 and organic matter as the sugars or similar forms free from calcium are added to the medium. A number of different forms of bacteria in the sea possess the power of precipitating $CaCO_3$ in appropriate media containing a large excess of soluble salts, but only under such conditions. Among such organisms there is great variability to perform the task in question, depending on the composition of the medium.

275. Perkins, H. F. 1908. Notes on the medusae of the Western Atlantic. *Papers Tortugas Laboratory* 1: 133-56.

Carnegie Institution of Washington Publication Number 102.
The Marine Biological Laboratory in the Dry Tortugas is well situated for the study of many of the lower marine animals, their behavior, and the conditions of life, particularly the coelenterates. One quite unique feature occurs in the Tortugas in the presence of the old fortification and surrounding moat of Fort Jefferson. The moat affords remarkably favorable conditions for the growth and multiplication of the lower forms of plants and animals sheltered by the sea-wall, its shallow water warmed by the sun and kept from stagnation by the agitation and partial change of the tides. The writer has for several years been interested in the causes of migration and segregation of Medusae and has had the privilege of examining specimens of this genus from Jamaica, and has studied the characteristics of the specimens found in the Bahama Islands and at the Tortugas. There was less of peculiarity in all the surroundings, the temperature of the water, storm influence, and food supply being normal for the shores of coral islands. The only points of difference to be noted in the medusae are with reference to size and color-pattern. The main features of the two species, *Cassiopea xamachana* and *Polyclonia frondosa* are presented.

276. Petrovic, C. A. and J. King Jr. 1973. Bird records from the Dry Tortugas. *Florida Field Naturalist* 1, no. 1: 5-8.
During a visit March 25 to April 4, 1967 to the Tortugas, a total of 70 species of mostly land birds were recorded. Detailed observations on twenty specimens rarely seen at the Tortugas are presented.

277. ———. 1972. Common elder and king rail from the Dry Tortugas Florida. *Auk* 89, no. 3: 660.
The authors watched the early spring migration at the Dry Tortugas Islands, which lie in the Gulf of Mexico about 70 miles west of Key West, Florida, and recorded 70 species, the majority land birds. The two records reported here represent significant additions to the species known distribution .

278. Phillips, A. H. 1917. Analytical search for metals in Tortugas marine organisms. *Papers Tortugas Laboratory* 11: 89-93.
Carnegie Institution of Washington Publication Number 251.
This study concerns the problem stated in Year Book no.14, page 193 of the Carnegie Institution of Washington. A large number of specimens were collected to be analyzed for metals. The metals determined were iron, manganese, zinc, copper, and lead. For the determination of zinc, copper, and lead, when the dried material was sufficient, 20 grams were used as a sample; when it was not possible to use 20 grams, the results are all calculated to 20 grams..

279. ———. 1922. Analytical search for metals in Tortugas marine organisms. *Papers Tortugas Laboratory* 18: 95-99.
Carnegie Institution of Washington Publication Number 312.
Included in the material collected at the Tortugas and analyzed for metals (some of the results of which were reported in the annual report of the Carnegie Institution for 1917) was a brown spotted holothurian, *Stickopus mobii*, which was analyzed by the methods there indicated. The element vanadium was found in the holothurian material and heretofore has never been reported from seawater. Vanadium has been reported from freshwater and in the blood of an acidian from the Bay of Naples. This vanadium content of the blood does not seem to be a characteristic of all acidians, as two other species from the Tortugas yielded no vanadium, neither did two other species of holothurians yield vanadium. Two species, a chordata and a echinoderm contained vanadium, indicating that other forms may use vanadium as an oxygen carrier in their vascular systems. The source of vanadium in sedimentary rock and coals has always been somewhat of a puzzle. It is possible that such forms as *Stickopus mobii* may concentrate vanadium and that in depth, could easily be fixed and held as a constituent of the sedimentary rocks thus formed. Another possibility of the

fixation of vanadium under the above conditions is the presence of hydrogen sulphide which is constantly liberated from muds of mangrove lagoons.

280. ———. 1918. A possible source of vanadium in sedimentary rocks. *American Journal of Science* 46: 473-74.
Narrative same as in reference no. 279.

281. Pichard, S. L. and J. R. Paul. 1991. Detection of gene expression in genetically engineered microorganisms and natural phytoplankton populations in the marine environment by messenger RNA analysis. *Applied Environmental Microbiology* 57, no. 6: 1721-27.
A simple method that combines guanidinium isothiocyanate RNA extraction and probing with antisense and sense RNA probes is described for analysis of microbial gene expression in planktonic population. Probing of RNA sample extracts with sense-strand RNA probes was used as a control for nonspecific hybridization or contamination of mRNA with target DNA. This method enabled detection of expression of a plasmid-encoded neomycin phosphotransferase gene (nptII) in as few as 10 super(4) *Vibrio* cells per ml in 100 ml of seawater. We have used this method to detect expression of the ribulose-1, 5-bisphosphate carboxylas large-subunit gene (rbcI) in *Synechococcus* cultures and natural phytoplankton populations in the Dry Tortugas, Florida. During a 36-h diel study, rbcL expression of the indigenous phytoplankton was greatest in the day, least at night(1100, 0300, and 0100 h, and variable at dawn or dusk (0700 and 1900 h). These results are the first report of gene expression in natural populations by mRNA isolation and probing.

282. Pitts, R. F. 1936. Clearance values of sucrose and creatinin in the kidneys of the red grouper, *Epinephelus striatus. Carnegie Institution of Washington, Year Book* 35: 90-91.
Studies were made on the excretion of urinary creatine nitrogen from the red grouper, *Epinephelus striatus*.

283. Plan Development Team, Reef Fish Management Plan South Atlantic Fishery Management Council. 1990. *The potential of marine fishery reserves for reef fish management in the U.S. southern Atlantic*, Coastal Resources Division.
Marine fishery reserves (MFRs), areas with no consumptive usage, are recommended as a viable option for management of reef fisheries in the U.S. southern Atlantic region. MFRs are designed to protect reef fish stocks and habitat from all consumptive exploitation within specified geographical areas for the primary purpose of ensuring the persistence of reef fish stocks and fisheries. Fishery reserves are intended to protect older and larger fishes. This will benefit reef fisheries by protecting critical spawning stock biomass, intra-specific genetic diversity, population age structure, recruitment supply, and ecosystem balance while maintaining reef fish fisheries. The MFR concept is easily understandable by the general public and possibly more easily accepted than some other management strategies. Fishery reserves provide some insurance against management and recruitment failures, simplify enforcement, and have equitable impact among fishery users. Data collection needs solely for management are reduced and management occurs without complete information and understanding about every species and interaction. Use of fishery reserves will establish U.S. leadership in producing model strategies for cooperative international reef resource management in the Caribbean. Large resident fishes that wander out of reserved can help maintain certain trophy fisheries. MFR sites with natural species equilibrium will allow measurement of age, growth, and natural mortality for fisheries purposes and will provide a basis for other educational, economic, and scientific benefits. Because there is no fishing within MFRs, impacts of hook and release mortality are eliminated and the temptation for incidental poaching is reduced. A mixed management strategy is recommended where 20% of the shelf is MFR, while the remaining 80% is managed for optimal yield by any of several traditional options. Coordinated fishery reserve efforts in state waters would enhance the benefits of MFRs. Obstacles to fishery reserves include automatic resistance to new approaches in U.S. marine fisheries, opposition by some local special interests near

proposed reserves, and uncertainty concerning the size, location, and number of reserves necessary to ensure persistence of the reef fish fisheries. The incentive for deliberate poaching may be increased within the reserves; thus, at-sea surveillance and enforcement may be necessary. New artificial reefs may be needed to replace those lost by inclusion within fishery reserves. Other fishery management plans should be coordinated to control trolling and other fishing activities within reserves that may impact reef fishes. The short-term impacts on total harvest caused by placing fishing habitat into fishing reserves should be compensated for by long-term fishery benefits. The Dry Tortugas is listed as a potential marine fishery reserve site.

284. Plantier, T. L. 1988. "A comparison of reproductive success in early and late breeding sooty terns *Sterna fuscata* in the Dry Tortugas." MS.Thesis, Florida Atlantic University, Boca Raton. Evidence indicates that earlier-nesting birds are often older, choose preferred nest sites, and have greater reproductive success than those nesting later. The sooty terns at Bush Key appear to follow a similar pattern. The first birds arrive at the west end of the breeding grounds three weeks earlier than birds at the east end and behaviorally appear to be older and more experienced. The west birds settled in the more desirable habitats (the west end was cooler than the east end) and laid larger eggs, hatched larger chicks, enjoyed greater hatchability, fed their chicks at a lower frequency when they were young, and had greater reproductive success than birds in the east. This was accomplished through a combination of choosing physically and thermally more favorable habitat, which was more centrally located, being more persistent incubators and brooders, and, by nesting earlier, having larger, less-easily eaten chicks by the time avian predators arrived on the island.

285. Plough, H. H. and N. Jones. 1940. *Ecteinascidia tortugensis*, species Nova; with a review of the perophoridae (Ascidiacea) of the Tortugas. *Papers Tortugas Laboratory* 32: 47-60 (issued Oct. 1939).
Carnegie Institution of Washington Publication Number 517.
During the season of 1936 at the Tortugas Laboratory the senior investigator undertook a study of the regeneration of pieces cut from the growing stolons of several species of the family Perophoridae (Ascidiacea Phlebobranchia), which grow in profusion at many places in the Tortugas area. A new member of the family Perophoridae is described and named *Ecteinascidia tortugensis* from its type locality, the Dry Tortugas Key, Florida. It is shorter than other *Ecteinascidia*, lies on the ventral side attached along the test, has the siphons on the dorsal side widely separated and opening in opposite directions, and possesses a marked secondary loop in the intestine. This species reaches sexual maturity early in July at the Tortugas, about two weeks later than *E. conklini*. A brief account of the development is given. The structure and growth habits of *E. tortugensis* indicate that it is intermediate between *E. turbinata* and *Perophora*. They suggest a relationship of the Perophoridae with the Ascidiidae.

286. Porter, J. W. 1977. *Pseudorca* strandings. *Oceans* 10, no. 4: 8-16.
This article provides information and observations surrounding the stranding of thirty false killer whales (*Pseudorca crassidens*) on the Dry Tortugas Islands near Florida in July 1976. The herd appeared to be protecting an injured male, as evidenced by aspects of social behavior and agnostic behavior directed at sharks and the author. Among other suggestions, the author postulates that the injured male was unable to feed due to parasitic infestation of the ears and consequent impairment of echolocation, which caused the whale to beach in order to avoid drowning in its weakened state. Other strandings are discussed in light of the information obtained.

287. Porter, J. W., J. F. Battey and G. J. Smith. 1982. Perturbation and change in coral reef communities. *Proceedings of the National Academy of Science* 79, no. 5: 1678-81.
Ninety-six percent of surveyed shallow-water Dry Tortugas reef corals died during the severe winter of 1976-77. Data from skeletal stains indicate that death occurred during the

mid-January intrusion of 14 degree C water onto the reef. In deeper water, community parameters such as percent cover, species number, and relative abundance showed no significant change. However, an analysis of competitive interactions at the growing edges of adjacent colonies reveals a 70% reduction in space competition during this environmental disturbance. These results can explain high variability in the growth rate of Floridian reefs and demonstrate the importance of obtaining long-term spatial information to interpret successional dynamics of complex communities.

288. Porter, J. W., O. W. Meier, L. Chiang and T. Richardson. 1993. Quantification of coral reef change (Part 2): the establishment and computer analysis of permanent photostations in the Florida SEAKEYS survey (abs). *Proceedings of the Seventh International Coral Reef Symposium*, v.1. Mangilao, Guam: University of Guam Marine Laboratory.
Photostations in five of six locations in the Florida Keys reveal a decline of monitored coral reef resources during the 1980's when up to 40% of the coral died in some protected areas. Reductions in the number of species and extraordinary shifts in the pattern of species abundance occurred in addition to loss of live coral cover. While normally associated with catastrophic physical disturbances, this coral mortality occurred during a period without major hurricanes in Florida. Relocatable photostations reveal a multiplicity of causes for this decline. These include: (1) mortality due to "white band" and "black band" disease, (2) direct and delayed mortality from "coral bleaching," caused by abnormally elevated sea temperatures, (3) some mechanical damage, and (4) an increase in cover by algae. The establishment and sequential analysis of remote sensing data acquired from permanent photo-stations will be described in detail, as well as limits to the interpretability of these photogrammetric data.

289. Potthoff, T. and W. J. Richards. 1970. Juvenile bluefin tuna, *Thunnus thynnus* (Linnaeus), and other scombrids taken by terns in the Dry Tortugas, Florida. *Bulletin of Marine Science* 20, no. 2: 389-413.
The identification and seasonal distribution of juvenile scombrids in the waters near the Dry Tortugas, Florida, are described. Specimens were collected (1960 through 1967) from regurgitated food of terns. Fishes identified were *Thunnus thynnus, Thunnus atlanticus, Euthynnus alletteratus, Auxis spp.*, and *Katsuwonus pelamis*; sizes ranged from 24-146 mm. standard length. For the first time, juvenile bluefin tunas are reported in the Dry Tortugas region; their presence may indicate that spawning of the species takes place in the area. Identification methods are discussed, with special emphasis on features of the axial skeleton and the number of gillrakers over the ceratobranchial bone of the first gill arch. A method is presented for estimating the standard length of damaged specimens on the basis of the length of the vertebral column.

290. Powers, P. B. A. 1933. Ciliates infesting the tortugas echinoids. *Carnegie Institution of Washington, Year Book* 32: 278-79.
Based on studies conducted on the ciliates of the Tortugas sea-urchins, Echinoida, it was found that when sea-urchins were infested, they made excellent reservoirs for certain species of ciliates in which to conduct detailed studies of their internal morphology, cytoplasmic inclusions and neuromotor apparatus.

291. ———. 1936. Studies on the ciliates of sea-urchins: a general survey of the infestations occurring in Tortugas Echinoids. *Papers Tortugas Laboratory* 29: 293-326 (issued Dec. 1935). Carnegie Institution of Washington Publication Number 452.
With the accumulation of data concerning the ciliate infestations of the alimentary tract of echinoids, it became of increasing interest to have a complete record of the ciliates infesting sea-urchins about Tortugas. The writer spent the summer of 1933 at the Tortugas Laboratory. During this time twelve well-defined species of ciliates were found distributed among seven species of sea-urchins. The present paper gives a complete account of the general morphology of these ciliates, as well as a description of the various associations

encountered. Twelve species of ciliates are described which infest the alimentary tract of seven species of sea-urchins from the region about the Dry Tortugas. Eight of the twelve are new. Only five of these twelve species show any marked host specificity. The remaining seven species all show a definite host preference. All of these ciliates are associated with their host when the latter are found occurring near the tide line. In sea-urchins taken below a depth of ten fathoms, only four species of ciliates are found : *Cryptochilidium bermudense, Anophrys elongat, Cohnilembus coeci* and form M. The nature of this infestation is one of endocommensalism, there being no present evidence to indicate pathogenic tendencies for any of its members. Data concerning the geographical distribution of the ciliates infesting sea-urchins from the localities of Beaufort, North Carolina, Bermuda and Tortugas have been summarized. It is suggested that the center of this infestation will be found in the sea-urchins from the region of the Lesser Antilles and that this infestation has been carried northward along with its host, through the agency of the Gulf Stream.

292. Pratt, H. S. 1910. *Monocotyle floridana,* a new monogenetic trematode. *Papers Tortugas Laboratory* 4: 1-9.
Carnegie Institution of Washington Publication Number 133.
The genus *Monocotyle* was established by Taschenber, in 1878, for a worm which he had found on the gills of the eagle-ray *(Myliobatis aquila)* at Naples, and which he named *Monocotyle myliobatis.* The only other known species is *Monocotyle ijimae*, which was discovered in Japan in the mouth of *Trygon pastinacea*, and described by Goto in 1894. The worm herein described makes the third member of the genus and was taken from the gills of the whip-ray (*Myliobatis freminvillei*) in the Gulf of Mexico and studied at the Marine Biological Laboratory at Dry Tortugas, Florida. It differs in certain features from the two other species of the genus, but in the general shape and size of the body, the form and structure of the suckers, down to the smallest details, and the general arrangement of the genital organs it shows a close relationship to them, especially to *M. ijimae.*

293. ———. 1910. Parallel transport in tropical trematodes. *Science* 31: 471-72.
The digenetic trematodes, as well as other internal parasites, have probably in their phyletic history followed somewhat different rules of descent from those of other animals. The fact that they live inside of other animals and have a very complex life history must affect their phyletic development, in that migrations are very much limited, and their structure is very uniform in the parasites themselves. It is probable that where there are apparently related species of digenetic trematodes living in widely separated localities, they possess the same or similar structural features. This does not necessarily indicate that there is a close genetic relationship between them. These facts are well illustrated by the several species of digenetic trematodes belonging to the genus *Helicometra*, which were found in certain fishes of the Tortugas, Florida, and also occur in the Meditteranean Sea. The species of this peculiar genus are thus taken as an indication, not that they necessarily bear a close genetic relationship to one another, but that similar or identical environmental conditions exist for them in these places, so that they have come to possess in the course of time a structure so similar that they are included in one and the same genus.

294. ———. 1916. The trematode genus *Stephanochasmus* Looss in the Gulf of Mexico. *Parasitology* 8, no. 3: 229-38.
Two species of the genus *Stephanochasmus* were found in fishes examined for parasites at the Dry Tortugas: *S. casus* Linton and *S. sentus* Linton. The anatomy of these worms have several interesting and unique features. *S. casus* Linton is described in this article.

295. ———. 1913. The trematode parasites of the loggerhead turtle. *Science* 37: 264-65.
The studies of trematode parasites of the loggerhead turtle in the Mediterranean and the Gulf of Mexico, Dry Tortugas are briefly discussed and compared. Nineteen species occurred in the turtles of the Gulf of Mexico. Eight of these species also occur in the

Mediterranean Sea. The most numerous trematode occurring in the Dry Tortugas is *Cymatocarpus undulatus*. A more detailed discussion is found in the Archives de Parasitologie article by Pratt.

296. ———. 1912. Trematodes of the Gulf of Mexico. *Verhandlungen des VIII Internationalen Zoologen- Kongresses*, 780-781. Jena, G. Fischer.
This is a discussion of the article written by Pratt in no. 133 Carnegie Institution of Washington, listing the trematodes collected at the Dry Tortugas and the hosts they live in.

297. ———. 1916. Trematodes of the loggerhead turtle (Caretta caretta) of the Gulf of Mexico. *Archives De Parasitologie*: 411-27.
Five species of trematodes are discussed in this paper. Reference is made to the studies of Linton (1910), as well as studies made in the Mediterranean Sea. The five trematode species were found in turtles captured on Loggerhead Key in the Dry Tortugas: *Wilderia elliptica, Pachypsolus tertius,* and *Rhyditodes secundus, Pelsiochorus cymbiformis* and *Cymatocarpus undulatus.*

298. Raim, A. W., W. Cochran and R. D. Applegate. 1989. Activities of a migrant merlin during an island stopover. *Journal of Raptor Research* 23, no. 2: 49-52.
Activities of a radio-tagged merlin (*Falco columbarius*) which was trapped and identified as an adult female by George Allex and Daniel D. Berger, were observed from 10-16 April 1977 on Loggerhead Key.

299. Reighard, J. 1908. An experimental field-study of warning coloration in coral-reef fishes. *Papers Tortugas Laboratory* 2: 257-325.
Carnegie Institution of Washington Publication Number 103.
This paper embodies a search for the biological significance of the conspicuousness which it attempts to show characterizes many of the coral-reef fish of the Tortugas region. After showing that this conspicuousness is not a secondary sexual character and that it serves neither for protective nor aggressive resemblance, its value as a warning character is subjected to experimental test. Experimental evidence is presented to show that the gray snapper, the commonest predaceous fish, discriminates certain colors, forms associations with rapidity, and retains these for a considerable time (memory). If any of the coral-reef fishes possess a combination of consicuousness with such unpleasant attributes as render then unpalatable, the gray snapper should have learned to avoid them at sight and their conspicuousness would then have a warning significance. It is shown that when *atherina*, an inconspicuous fish which serves normally as the food of the gray snapper, is given an artificial warning color and at the same time rendered unpalatable, it is after a brief experience, no longer taken as food by the gray snapper. Artificially colored atherinas thus come to have a warning significance for the gray snapper and are avoided, even when not unpalatable, although normal atherinas are still readily eaten. The conclusion is thus reached that the existence of a warning coloration or of warning conspicuousness in coral fishes is easily possible. The conclusion is reached that the conspicuousness of coral-reef fishes, since it is not a secondary sexual character and has no necessary meaning for protection, aggression, or as warning, is without biological significance. The coral-reef fishes have no need of aggressive inconspicuousness because their food consists of invertebrates, chiefly fixed. They have no need of protective inconspicuousness because the reefs and their agility afford them abundant protection. Selection has therefore not acted on their colors or other conspicuous characters, but these have developed in the absence of selection and through internal forces. They are the result of race tendency unchecked by selection .

300. ———. 1907. The photography of aquatic animals in their natural environment. *Bulletin of the United States Bureau of Fisheries* 27: 41-68.
This paper describes the photography of aquatic organisms in their native environment and

under normal conditions by carrying the camera into the field. Photos and diagrams are provided for cameras and apparatuses that remain above the surface of the water and cameras that are submerged.

301. Reynolds, J. E. III and J. C. Ferguson. 1984. Implications of the presence of manatees, *Trichechus manatus* near the Dry Tortugas Islands, Florida USA. *Florida Scientist* 47, no. 3: 187-89.
Two West Indian manatees (*Trichechus manatus*) were observed 61 km northeast of the Dry Tortugas Islands, a location not normally considered to be part of the species range. When spotted, the animals were swimming in a soutwesterly direction, away from Florida. Observations such as this, of manatees far from freshwater, raise the question of whether manatees require regular access to freshwater for osmoregulation, as suggested in the literature.

302. Reynolds, J. E. III and J. C. Steinmetz. 1983. Dry Tortugas: products of time. *Sea Frontiers* 29, no. 2: 66-75.
This article discusses the general formation of the islands and their history.

303. Richards, O. W. 1934-1936. Growth studies in the ascidian, *Phallusia nigra*, and hermit crab, *Caenobita clypeatus. Carnegie Institution of Washington, Year Book*
Note: published as follows 1934, v. 33, p. 261; 1936, v. 35, p. 92.
The early growth and development of the ascidian *Phallusia nigra* was recorded over time using motion and still photography. Claw size ratios to body size of the hermit crab, *Coenobita clypeatus,* were examined by correlation methods.

304. Ricklefs, R. E. and S. C. White. 1981. Growth and energetics of chicks of sooty tern, *Sterna fuscata* and common tern, *Sterna hirundo. Auk* 98, no. 2: 361-78.
The energy budgets of chicks of the common tern (*Sterna hirundo)* were measured on Great Gull Island, New York. Also measured were the sooty tern (*S. fuscata*) on the Dry Tortugas, Florida The respiratory energy requirement was determined by measuring oxygen consumption in a closed system. The growth energy requirement was calculated from the lipid and protein contents of a series of chicks spanning the range between hatching and fledging. Energy budgets calculated for the two species differed in several ways. (1) Maintenance metabolism was lower in the sooty tern owing to its warm environment. (2) Sooty terns allocated more of their energy intake to lipid accumulation from an earlier age. (3) In the sooty tern, the allocation of energy to growth initially was high, but its absolute amount decreased steadily throughout the growth period. In the common tern, both growth and maintenance energy allocations increased rapidly during the first half of the development period. (4) In sooty tern chicks energy metabolism approached its maximum rate (135 kJ/day) by the end of the first third of the development period, after which it leveled off. In the common tern, energy metabolism increased from about one-quarter of its maximum during the first five days after hatching to its maximum of 200kJ/day during the third week of the postnatal development period. Although these observations support the hypothesis that slow growth in pelagic seabirds is selected to reduce the energy requirement of the chick, the energy budgets also suggest that a doubling of the growth rate by the sooty tern would increase the maximum energy requirement of the chick by only 20% and the total feeding requirement of the adult by only 5%. Moreover, the levels of water in muscles suggest that the sooty tern develops mature function earlier than does the common tern, which in itself might be sufficient to account for the slower growth of the first species.

305. Ricklefs, R. E. and S. C. White-Schuler. 1978. Growth rate of the brown noddy on the Dry Tortugas Florida USA. *Bird-Banding* 49, no. 4: 301-12.
Growth rates within seabird species can vary with locality, season, and year. In this study noddy tern checks captured on Bush Key, Dry Tortugas, June, 1972, were weighed and measured. Growth increments were used to calculate a composite wing length growth curve to estimate the ages of chicks. A logistic curve was fitted to describe the relationship

between weight and age. Growth constants of the fitted curve (growth rate K = 0.153, asymptote A=160 grams, and age at inflection ti=14.0 days) were similar to values reported for the brown noddy on Kure Island and Manana Island, Hawaii. Also reported are outer primary and rectix lengths and body temperatures of nestlings and adults.

306. Riley, G. A. 1938. Study of the plankton in tropical waters. *Carnegie Institution of Washington Year Book* 37: 98.
The small quantity of plankton in tropical waters as contrasted to higher latitudes is investigated, and when compared to a similar survey underway in Long Island, N.Y., the indication is that chlorophyll and plant pigments are one-twenty-fifth the amount found in New York.

307. Riska, D. E. 1986. An analysis of vocal communication in the adult brown noddy, *Anous stolidus. Auk* 103, no. 2: 359-69.
The author analyzed vocal signals of marked adult Brown Noddies (*Anous stolidus*) throughout their nesting season in the Dry Tortugas, Florida from 1979 to 1982. The basic unit of the adult repertoire is a wide-band click, less than 4 msec duration, ranging in frequency from 200 to 3,300 Hx. He identified nine temporal arrangements of these clicks, which form the notes of the calls. These calls differ little in frequency range, but they differ in the mean frequency of the most intense sound energy band, in note duration, in the number of clicks per note, and in internote interval. These calls are used in different contexts, which sometimes overlap. Frequency, note duration, and length varied among individuals for some calls. No tonal elements characteristic of calls of brown noddy nestlings remain in the adult repertoire.

308. ———. 1986. "Communication behavior of the brown noddy (*Anous stolidus)* and sooty tern (*Sterna fuscata*), Dry Tortugas, Florida (vocalizations, laridae, signals, colonial, breeding)." Ph.D. Dissertations, University of California at Los Angeles.
The basic unit of the adult repertoire is described as a wide-band click, less than 4 msec duration, in the frequency range 200 to 3300 Hz. Nine calls differ in temporal arrangements of clicks, mean frequency of the most intense sound energy band, note duration, number of clicks per note, and inter-note interval. Frequency, not duration, and inter-note interval do not differ between sexes. The nestlings of the brown noddy produce three structurally different vocalizations within one day after hatching. Postures of chicks and contexts in which these signals are used differ. The repertoire is composed of frequency-modulated tonal elements and broad-band bursts of sound with little resemblance to the adult repertoire. Juvenile bush-nesting noddies begin flying when 40-48 days old, after which they are still fed at their nests. Adult noddies accept a substituted nestling differing from their own in size, color and plumage stage, up to at least 20 days post-hatching. The adult Sooty Terns produce eight structurally different vocalizations, and nestlings produce three, in the frequency range 300-7000 Hz. Postures differ for each call, but contexts in which these are used overlap. The range of frequencies in which young birds call extends higher than that of adults, but the frequency-modulated tonal elements characteristic of nestling vocalizations remain complex in the adults.

309. Rivas, L. R. 1951. Preliminary review of the western North Atlantic fishes of the family Scombridae. *Bulletin of Marine Science of the Gulf and Caribbean* 1, no. 3: 213-30.
This paper brings up to date the taxonomy of the western North Atlantic mackerels and tunas. In addition to a key to the genera and species, a complete synonymy, a diagnosis and pertinent comments are given under each species.

310. Roberts, H. H., L. J. Rouse Jr., N. D. Walker and J. H. Hudson. 1982. Cold water stress in Florida Bay and northern Bahamas, a product of winter cold air outbreaks. *Journal of Sedimentary Petrology* 52, no. 1: 145-55.
During January 1977 three consecutive cold fronts crossed south Florida and the northern

Bahamas which depressed shallow-water temperatures below the lethal limit for most reef corals. Digital thermal infrared data acquired by the NOAA-5 meteorological satellite, in situ water temperatures, and meteorological data were used to study the thermal evolution of Florida Bay and Bahama Bank waters. The third and most important frontal system depressed Florida Bay water below 16 degrees C, a thermal stress threshold for most reef corals, for 8 days. Coral mortality at Dry Tortugas was up to 91 percent during the 1977 event. Coral and fish kills were also reported from other parts of the Florida Reef Tract and northern Bahamas. Study results show that cold-water stress conditions can exist over vast shallow-water areas and have residence times of several days.

311. Roberts, H., H. Lawrence , J. Rouse Jr. and N. D. Walker. 1983. Evolution of cold water stress conditions in high-latitude reef systems: Florida Reef Tract and the Bahama Banks. *Caribbean Journal of Science* 19, no. (1-2): 55-60.
Thermal depression of shallow bank and bay waters accompanying the passage of severe cold fronts can stress high latitude coral reef systems, such as those of the Florida Reef Tract and northern Bahama Banks. Laboratory and field experiments suggest that sustained temperatures below 16 degrees C are detrimental to most reef-building corals. Time-series satellite imagery provides a data base for assessing the thermal variability of waters interfacing with reef systems. Digital thermal infrared data acquired by the NOAA-5 meteorological satellite were used to study thermal evolution of Florida Bay and Bahama Bank waters during a succession of three cold-air outbreaks (January 1977). These studies indicate that the temperature of subtropical bank and bay waters is subject to depression below 16 degrees C accompanying the outbreak of unusually cold air. This superchilled water can have a residence time of days. The cooling process creates water masses that are out of density equilibrium with warmer ocean water. Offshelf movement of the cold, dense water occurs at particular sites, as shown by time-series satellite data. The absence of coral reefs opposite tidal passes in the Florida Keys is attributed to this process, which has probably limited development of the entire reef tract.

312. Robertson, W. B. Jr. 1978. Species of special concern sooty tern. *Birds* 2, no. Edited by H. Kale: 89-90.
A description, range, and habitat of the sooty tern are given along with its life history and ecology at the Dry Tortugas. Its classification is based not on its abundance, but it is because the Dry Tortugas colony is a major Florida wildlife resource. Aside from the Tortugas no other location in Florida is suitable for sooty tern nesting. This colony affords a means of monitoring the general health of offshore Gulf waters of southern Florida.

313. ———. 1964. The terns of the Dry Tortugas. *Bulletin of the State Museum , Biological Science* 8, no. 1: 1-95.
New information from unpublished sources and from published records hitherto overlooked permit a re-evaluation of the history of the Dry Tortugas and of the terns that inhabit them. The geography and ecology of the 11 keys that have variously comprised the group since it was first mapped in the 1770's are described and their major changes traced. The recorded occurrences of the seven species of terns reported nesting on the Keys are analyzed in detail. The sooty tern colony has fluctuated from a low of about 5,000 adults in 1903 to a reported peak of 190,000 in 1950; for the past four years it has remained steady at about 100,000. The brown noddy population, which reached a peak of 35,000 in 1919, was reduced by rats to about 400 adults in 1938; it is in the neighborhood of 2,000 today. A colony of 150 to 450 roseate terns has nested in most years from 1917 to the present. About 500 least terns nested regularly from 1918 to 1932, then unaccountably dwindled to a few pairs by 1937 and shortly afterward disappeared. Royal and sandwich terns nested abundantly in the mid-19th century, and a colony of royals may have existed as late as 1890. Both species are believed to have been extirpated from the Tortugas by egging. No verifiable evidence exists for the nesting of the common tern, which has been reported

several times. The black noddy, first reported for the continental United States at Dry Tortugas in 1960, has been found there each summer since.

314. ———. 1969. Transatlantic migration of juvenile sooty terns. *Nature* 222: 632-34.
From 1959 to 1968, 70,000 adult and 130,000 juvenile sooty terns (*Sterna fuscata*) were banded at Bush Key, Dry Tortugas, Florida. By December 1968, 29 juveniles were recovered in West Africa. It appears that the primary biological function of the transatlantic migration is to avoid intraspecific competition and this adaptive value becomes evident when the migration of juveniles is seen in the context of the rigidly structured sooty tern population. It may be evidence for a successful evolutionary mechanism.

315. Robertson, W. B. Jr. and B. Given. 1980. Ruddy quail dove *Geotrygon montana* again at Dry Tortugas Florida USA. *Florida Field Naturalist* 8, no. 1: 23-24.
About noon on December 15, 1977, a cold day with severe northwesterly squalls, Given found and photographed a large, reddish dove on the second tier of Fort Jefferson, Dry Tortugas, Florida. This record is the fifth report of the species from Florida and the second from Dry Tortugas.

316. Robertson, W. B. Jr. and C. R. Mason. 1965. Additional bird records from the Dry Tortugas. *Florida Naturalist* 38: 131-38.
Sprunt (1962-63) summarized what was known about the occurrence of birds at the Dry Tortugas through the Summer of 1962. In this paper the authors report on recent bird records up to April 1965. Comments relate to 12 species new to the list or those known from either one or two records. Sprunt listed 227 species of birds for the Tortugas, the authors add 12 to bring the total to 239 species.

317. Robertson, W. B. Jr. and L. C. Below. 1975. A red-headed woodpecker at Dry Tortugas. *Florida Field Naturalist* 2, no. 1: 20.
On May 5, 1973 Mr. and Mrs. G.H. Perbix of Cincinnati and Mrs. Below, members of the tern-banding party then at Dry Tortugas, visited Loggerhead Key and at once noticed an adult red-headed woodpecker (*Melanerpes erythrocephalus*) in the large Australian Pines (*Casuarina equisetifolia*) near the dock. We find only one other report of the red-headed Woodpecker at Dry Tortugas. Howell (1932:308) wrote that the species was unknown in the Florida Keys "...except for a single occurrence on the Tortugas - a bird seen there on a number of days early in June." The red-headed woodpecker is not known to occur outside the United States but the present record inevitably raises the question: was the bird migrating across the Gulf or was it merely a vagrant?

318. Robertson, W. B. Jr. D. R. Paulson and C. R. Mason. 1961. A tern new to the United States. *Auk* 78: 423-25.
This note provides a description of the black noddy, *Anous tenuirostris* collected at Dry Tortugas. This is the first of this species collected in the United States. Two specimens were taken from Bush Key during July 1960. The bird occurs nearly world-wide in the warmer seas, but is absent from most of the Atlantic Ocean north of the equator and most of the Caribbean Sea.

319. Robinson, A. H. 1976. Marine, island and coastal parks in the United States National Park system: A review and progress report in 1975. *International Conference on Marine Parks and Reserves.*, pp. 226-27. Gland, Switzerland: IUCN.
This paper provides a basic introduction to critical marine habitats and the planning and management of marine parks and reserves, including interpretation and environmental education in marine parks. Progress in the creation of marine parks and reserves is reviewed, and a special report on marine park systems in the Pacific region is included. Fort

Jefferson National Monument is discussed as the first underwater preserve established in the United States.

320. Schaeffer, A A. 1925. Experiments on the influence of temperature and dilute and concentrated sea-water on ameboid movement. *Bulletin of the Ecological Society of America*: 11.
The reactions of various species of amoebas to different concentrations of sea-water have been used during the past several years at Tortugas as important aids in the identification and fixation of species. The rate of movement of several species was studied in various concentrations of sea-water indicating that the optimal concentration of sea-water is below the norm in every case when measured by the rate of cell-coordinated movement.

321. ———. 1926. Taxonomy of the amebas: with descriptions of thirty-nine new marine and freshwater species. *Papers Tortugas Laboratory* 24: 1-116.
Carnegie Institution of Washington Publication Number 345.
The purpose of this report is to set forth a description of 39 new species and 11 new genera of amebas (Amoebaea), and to propose a preliminary system of classification of the amebas, based on their general morphology. General observations on structure, physiology, distribution, and methods of investigation are provided. The changes of form which amebas undergo is a fundamental morphological characteristic of amebas, and forms the basis of a natural classification. For the purpose of quickly recognizing a species other characteristics are more valuable, such as the nucleus, vacuoles, crystals, resistance to dilutions and concentrations of sea-water, etc. A brief discussion of these characteristics with reference to specific descriptions is given along with colored drawings and photographic text-figures.

322. Schmitt, W. L. 1924-1932. Systematic-ecologic studies of the decapod crustacea. *Carnegie Institution of Washington, Yearbook.*
Note: published as follows: 1924, v.23, p. 200-201; 1925, v.24, p. 230-231; 1930, v.29, p. 343; 1931, v.30, p. 389; 1932, v.37, p. 279.
Very striking color characteristics/variations affecting chela, and often the appendages, are noted among snapping shrimp, *Synalpheus,* and giant isopod crustaceans. Bathymetric distribution of decapods are investigated.

323. Schnell, G. D. 1974. Flight speeds and wing beat frequencies of the magnificent frigate bird. *Auk* 91, no. 3: 564-70.
Wingbeat frequencies and flight speeds of magnificent frigatebirds were recorded with a Doppler radar in the Dry Tortugas, Florida. The flapping rate averaged 2.84 beats per second (SD 0.14) and was not significantly correlated with flight speed, providing further evidence that the birds' wingbeat frequency is essentially constant within species. The flapping rate is somewhat higher than predicted from the theory of mechanical oscillators when the distance from the end of the wing to the first articulated joint is used as an estimate for the average effective wing length. Flight speeds of birds in a flat calm averaged 22.55 mph. The highest average ground speed of 30.17 mph was obtained from frigatebirds flying in a 6 to 8 mph wind, and the lowest of 16.00 mph for birds flying into the 65 mph wind. Airspeeds were greater for frigatebirds flying into the wind than for those moving across or with the wind.

324. Schreiber, R. W., W. B. Robertson Jr. and T. Bellow. 1976. Nesting of brown pelicans, *Pelecanus occidentalis,* on the Dry Tortugas, Florida. *Florida Field Naturalist* 3, no. 2: 47-48.
On June 14, 1974 Bush Key, Dry Tortugas Ted Bellow and C. Winegarner found 5 brown pelican nests about 12 feet above ground in the white mangroves (*Laguncularia racemosa*) along the north shore. Nineteenth-century records of pelicans breeding on the Dry Tortugas are ambiguous. ...on the Tortugas (1860) it thus appears that a few pairs did breed on the Tortugas in the mid-1900's, but by late in the century none did so. Our record is the first reported nesting of this species in the 20th century on the ornithologically well-known

islands (Robertson and Mason, 1965). Three of the nests found in 1974 contained two eggs each, one nest was empty, and the fifth was not checked.

325. Schroeder, P. B. and J. H. Davis. 1971. Ecology vegetation and topography of the Dry Tortugas updated to 1970. *Quarterly Journal of the Florida Academy of Science* (Suppl 1): 12-13.
The half-dozen islets of the Dry Tortugas have been ecologically studied periodically since the turn of the century. In November and February a year ago, a field party from the University of Miami made a topographical and vegeational study of several of these keys. The pertinent information gathered at that time is now available and provides continuity with the studies of Millapaugh (1907), Bowman (1918) and Davis (1942). The keys studied have changed from barren coral and sand to substantial islets largely covered with vegetation. The configuration of one of these has been completely altered. All the keys have been changed considerably in shape. Vegetational communities have shown similar changes and maturity. Mangrove areas (red and white) have become established and enlarged. Australian pines and other exotics, introduced to Loggerhead Key, have spread over much of the island and now are found on Bush Key.

326. Scott, W. E. D. 1890. On birds observed at the Dry Tortugas, Florida, during parts of March and April, 1890. *The Auk: A Quarterly Journal of Ornithology* 7, no. 4: 301-14.
The list of birds observed at the Tortugas includes eighty species, fifty seven of which were land birds. The author states that no land birds breed on any of the keys group, and that the stay of any land bird is of very short duration.

327. Seaman, W. Jr. and D. Y. Aska. 1974. *Research and information needs of the Florida spiny lobster fishery.* State University System of Florida Sea Grant Program, Miami FL. 64 pgs.
In response to a number of fishermen in South Florida, the State University System of Florida Sea Grant Program became involved in research on the spiny lobster, *Panulirus argus.* When additional research needs were expressed, Florida Sea Grant decided to become better informed on the subject, and evaluate its potential for service to the persons dependent on this fishery resource. A meeting of persons and organizations involved in the biology and/or utilization of the spiny lobster fishery in Florida was called to identify broadly the problems and information needs of persons dependent on the spiny lobster resource, to assess existing sources of information and their possible applications, and to identify priorities and actions needed to resolve user problems.

328. Shinn, E. A., J. H. Hudson , R. B. Halley and B. Lidz. 1977. Topographic control and accumulation rate of some Holocene coral reefs: South Florida and Dry Tortugas. *Proceedings, Third International Coral Reef Symposium,* RSMAS, Univ. of Miami, Coral Gables FL. p.1-7.
Core drilling and examination of underwater excavations on 6 reef sites in south Florida and Dry Tortugas revealed that underlying topography is the major factor controlling reef morphology. Carbon-14 dating of coral recovered from cores enables calculation of accumulation rates. Accumulation rates were found to range from 0.38 m/1000 years in thin Holocene reefs to as much as 4.85 m/1000 years in thicker buildups. Cementation and alteration of corals were found to be more pronounced in areas of low buildup rates than in areas of rapid accumulation rates. *Acropora palmata*, generally considered the major reef builder in Florida, was found to be absent in most reefs drilled. At Dry Tortugas, the more than 13-meter thick Holocene reef did not contain *A. palmata.* The principal reef builders in this outer reef are the same as those which built the Pleistocene Key Largo formation, long considered to be a fossilized path reef complex.

329. Shinn, E. A. 1984? Geologic history, sediment, and geomorphic variations within the Florida Reef Tract. *Advances in reef sciences, abstracts and schedule of presentations: a joint meeting of the Atlantic Reef Committee and the International Society for Reef Studies* , 113-14. Miami, Florida: University of Miami.
A combination of core drilling, high resolution seismic profiling, and constituent particle

analysis reveal these major aspects of Holocene reef development and sediment distribution within the Florida reef tract: (1) reef distribution and shape are controlled by underlying Pleistocene limestone topography; (2) accumulation of sand and rubble occurs in forereef and backreef areas; and (3) composition of sediment and coral distribution are controlled by the reef tract trend relative to prevailing wind and exposure to Gulf of Mexico water.

330. Shinn, E. A., B. H. Lidz, R. B. Halley, J. H. Hudson and J. L. Kindinger. 1989. Reefs of Florida and the Dry Tortugas: Miami to Key West, Florida, July 2-7, 1989 . *28th International Geological Congress*. Field Trip Guidebook (American Geophysical Union), no. T176. Washington, D. C.: American Geophysical Union.
This field guide concentrates on explaining the distribution of Holocene coral reefs, the relationship between topography and Holocene sea-level rise, and the compositional and thickness variation of sediments produced in and adjacent to the reefs. A discussion and speculation of the future of the reefs under a stable sea, and a lowered sea-level is included. Also attached is a key to the Stony Corals of the Florida Keys and Dry Tortugas, a species list, illustrations of geologic cross-sections, aerial and underwater photographs of reefs and coral.

331. Shoemaker, C. R. 1934. Two new genera and six new species of Amphipoda from Tortugas. *Papers Tortugas Laboratory* 28: 245-56 (issued Nov. 1933).
Carnegie Institution of Washington Publication Number 435.
New genera and species of Amphipoda are described from specimens collected at the Tortugas, including *Socarnes concavus, Gitanopsis tortugae, Heterophilas seclusus, Pontogeneia longleyi, Ampithoe divursia, Leucothoides pottsi* (new species); and *Heterophlias, Leucothoides* (new genera).

332. Silberman, J. D., S. K. Sarver and P. J. Walsh. 1994. Mitochondrial DNA variation and population structure in the spiny lobster *Panulirus argus. Marine Biology* 120: 601-8.
Adult spiny lobsters (*Panulirus argus*) were collected from nine locations including the Tortugas, throughout the tropical and subtropical northwest Atlantic Ocean and examined for mitochondrial DNA (mtDNA) variation. 187 different mtDNA haplotypes were observed among the 259 lobsters sampled. Haplotype diversity was calculated to be 0.986 and mean nucleotide sequence-diversity was estimated to be 1.44%; both of these values are among the highest reported values for a marine species. Analysis of molecular variance (AMOVA) and phenetic clustering both failed to reveal any evidence of genetic structure within and among populations of *P.argus* The present data are consistent with high levels of gene flow among populations of *P.argus* resulting from an extended planktonic larval stage and strong prevailing ocean currents.

333. Smayda, T. J., Y. Shimizu, C. R. Tomas and D. G. Baden. 1993. The influence of phosphorus source on the growth and cellular toxin content of the benthic dinoflagellate *Prorocentrum lima. Toxic Phytoplankton Blooms In The Sea.*, 565-70.
The relationship between toxin content and nutritional status of the toxic marine phytoplankton species *Prorocentrum lima* was examined in a clonal culture isolated from the Dry Tortugas, Florida, grown with inorganic phosphate and glycerol phosphate enriched media. Growth, alkaline phosphatase activity and okadaic acid content were measured. Phosphate enriched cultures exhibited rapid growth rates(0.75 div/d), moderate terminal densities of 134,779 cells/ml and low alkaline phosphatase activity (<14 fg/cell/min). Cells grown with glycerol phosphate had lower growth rates, between 0.16 and 0.45 div/d, but higher maximal densities, >200,000 cells/ml, and had alkaline phosphatase activity an order of magnitude greater than those grown in inorganic phosphate. When comparing toxin levels at 20 and 30 days, cells grown on the organic phosphate enrichments had consistently higher per cell values (11.2 and 14.2 pg/cell, respectively) than those with inorganic phosphate (7.5 and 8.9 pg/cell), respectively). Phosphorus source effected growth, maximal densities, and okadaic acid content of *P. lima.*

334. Smith, H. G. 1937. Contribution to the anatomy and physiology of *Cassiopea frondosa. Papers Tortugas Laboratory* 31: 17-52 (issued July 1936).
Carnegie Institution of Washington Publication Number 475.
This research was undertaken to extend our previous scanty knowledge on the physiology of feeding and digestion in the Scyphozoa. *Cassiopea* was selected as the experimental material for two reasons, it is a member of the Rhizostomeae in which the mode of feeding is particularly interesting owing to the sub-division of the mouth, while certain species, including the one studied, possess zooxanthellae. Other aspects of the structure and physiology of species of this genus have been extensively studied, notably at the Tortugas Laboratory, by Mayer and others. It was originally intended to work on *C. xamachana*, which was very abundant at one time in the moat at Fort Jefferson. Recent changes in the conditions in the moat, the result of silting up, have caused the complete disappearance of the species although from this locality. In the absence of this species, *C. frondosa* was investigated and this although less hardy than *C. xamachana*, proved satisfactory material. Experiments have been made on the effect of starvation in light and in darkness on the medusae. In light, specimens were kept alive for 15 days, and in darkness for 7 days. Numerous algae were ejected by way of the gastric filaments and plaited membranes at the base of the filaments and the medusae became brown in color. They also shrank considerably in size. The effect of the zooxanthellae on phosphorus excretion has been studied, the amount of phosphorus in the sea-water surrounding one specimen being reduced to zero within 24 hours. Finally, feeding, digestion and symbiosis in *C. frondosa* have been discussed. It has been suggested that the variation in pH in the coelenteron affects the activity of the jellyfish. The association with zooxanthellae is probably similar in nature to that which occurs in the *Madreporaria.*

335. South Florida Area : Synthesis of available biological, geological, chemical, socioeconomic and cultural resource information. 1990. OCS Study, MMS 90-0019. U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Regional Office.
This study summarizes the available biological, geological, chemical, and socioeconomic information in south Florida in relation to the potential effects of offshore gas and oil exploration and development. The synthesis will help Federal and state policy makers make informed decisions about future lease offerings and environmental restrictions on offshore oil and gas operations. The Dry Tortugas is included as part of the South Florida Reef Tract. In summary it would be very difficult to protect the mangroves, reefs, seagrass beds and their associated assemblages from large oil slicks. Severe weather would make it impossible. The Dry Tortugas experienced an oil spill from the beaching of *Brother George* in 1964. Birds were killed . Some coral may have been killed around the Tortugas from the 3,100 barrel spill, but it did not affect other areas further to the east of the site. If a large oil spill did occur here it would take 100+ years for the oldest coral heads to regrow and achieve the same level of pre-spill structural complexity. The effects of an oil spill on other flora and fauna of the Florida Reef Tract can only be guessed.

336. Spence, J., and O. W. Richards. 1940. Native cellulose in the ascidian *Phallusia nigra. Papers Tortugas Laboratory* 32: 163-67 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 517.
Many organic compounds of high molecular weight are readily identifiable from the characteristics of the X-ray diffraction diagrams. Cellulose and its derivatives have been extensively examined by X-ray diffraction methods in the search for a complete solution of the structure and crystallite arrangement of the cellulose molecule. From the analytical standpoint, X-ray diffraction diagrams not only confirm the initial chemical identification of cellulose by Schmidt (1845), but they also show the presence of crystallites and their orientation. The *Phallusia nigra* was collected in the moat of Fort Jefferson and the tunic was removed on return to the Tortugas Laboratory. The result, namely, the recognition of native cellulose and the preferred orientation of the crystallites in *Phallusia nigra*, is

naturally anticipated from previous observations on other ascidian tests. This method provides a useful analytical "tool" for use in zoological investigation.

337. Sprunt, A. Jr. 1963. Birds of the Dry Tortugas. *Florida Naturalist*: 22-26, 52-53.
This is a continuation of the listing from the 1962 series on listings of birds of the Dry Tortugas.

338. ———. 1962. Birds of the Dry Tortugas 1857-1961. *Florida Naturalist* 35: 35-40, 82-85, 129-32.
A brief discussion of the history of bird studies of the Dry Tortugas is given. Special attention is paid to the migratory birds passing through the Dry Tortugas in hope of shedding light on trans-Gulf migration.

339. ———. 1947. Blizzard of birds: the Tortugas terns. *National Geographic Magazine* February: 213-30.
This article gives a history of the Tortugas terns up to 1947. Boobies and noddies are included also.

340. ———. 1950. Bridled tern, *Sterna a. Melanoptera*, taken at Dry Tortugas. *Auk* 67, no. 4: 514.
This article provides an account of the first *Sterna melanoptera* recorded at the Dry Tortugas, and the fifth specimen recorded in Florida.

341. ———. 1950. A list of birds of the Dry Tortugas Keys, 1857-1949. *Florida Naturalist* 23: 49-60, 73-78, 105-11.
A listing of the birds of the Dry Tortugas is given. Land birds-pigeons through vireos-including warblers through sparrows and water birds.

342. ———. 1951. Some observations on the fall migration at Dry Tortugas. *Auk* 68: 218-26.
The author arrived at the Tortugas following a hurricane August 26-27, which seemed to have no effect on the Tortugas, or the birds there. He found the birds to be in good physical condition, with no signs of exhaustion. Birds were tame and could be approached. A listing of the birds sighted is given.

343. ———. 1948. The tern colonies of the Dry Tortugas keys. *Auk* 65: 1-19.
The first post-war (1945-46) status report on tern populations inhabiting the Keys of the Dry Tortugas is presented in this paper. A brief history on population counts dating back to 1832 by Audubon is given, as well as a description, mostly vegetative, on Keys utilized by terns for nesting activities. Tern springtime arrival and summer departure are discussed, along with numbers of eggs produced, nesting locations and tern behavior. Based on the square-yard unit system, it was determined that the population count for Sooties was 97,200, while a count of 550 was found for the noddies by numbers of nests. The tern populations have suffered virtually no damage during the occupation of the islands by naval forces. Aside from weather, predation by natural enemies includes sand-crabs and man-o'-war-birds. The tern colonies appeared safe, but certain topographical changes, such as the recent increase in vegetation may be problematical.

344. Stevenson, J. O. 1938. The tern colonies of Dry Tortugas. *Bird-Lore* 40, no. 5: 305-9.
This article describes briefly the history of the tern colonies of the Dry Tortugas. The author visited the Tortugas on May 24, 1937, two years after a hurricane swept through the islands destroying Bird Key, the historic breeding grounds for thousands of sooty and noddy terns.

345. Steward, F. C. 1940. The growth of *Valonia ventricosa* J. Agardh and *Valonia ocellata* Howe in culture, with a note on the sap composition of *Valonia ocellata* Howe at Tortugas. *Papers Tortugas Laboratory* 32: 85-98 (issued Oct. 1939).

Carnegie Institution of Washington Publication Number 517.
So much physiological work has been done using species of *Valonia* that their mode of development has special interest. Living material of *V. ventricosa* and *V. ocellata* was collected at the Dry Tortugas, Florida. These species were chosen because of the difference in their morphology. *Valonia ventricosa* J. Agardh and *V. ocellata* Howe have been kept alive for over two years from their original collection. Vesicles of considerable size (*V. ventricosa*) and with all the characteristics of the plant in nature have been grown attached to a suitable substratum. The development of the vesicle and rhizoids from aplanospores is illustrated by a series of photographs. *V. ventricosa* also produces filaments which penetrate the substratum and from which close clusters of vesicles arise as they do in the normal habitat. The appearance of the aplanospore and growing vesicle between crossed Nicols is described and its bearing on the structure of the wall indicated. *Valonia ocellata* produces pear-shaped vesicles, cylindrical rhizoidal processes (which it is shown may become long and branched), and apparently proliferated masses composed of small cellular segments. The growth and development of all these structures from aplanospores, or the product of "segregative division" have been observed and are recorded by photographs.

346. Steward, F. C. and J. C. Martin. 1937. The distribution and physiology of *Valonia* at the Dry Tortugas, with special reference to the problem of salt accumulation in plants. *Papers Tortugas Laboratory* 31: 87-110 (issued Oct. 1936).
Carnegie Institution of Washington Publication Number 475.
This paper presents the results of a survey, made during the summers of 1933 and 1934 of the physiological behavior of the two species of *Valonia* which are most abundant at Tortugas, Florida. One may well ask what justification there can be for yet another paper on *Valonia*. Whatever the legitimate claims which may be made for such attention, they are somewhat counterbalanced by the inaccessibility of *Valonia*, which has prevented that examination by a variety of investigators which is the best safeguard against overemphasis. *Valonia macrophysa* occurs at Tortugas only in the moat of old Fort Jefferson. This organism demands complete protection from the effects of swell and surf. The growth obtained on a horizontal ledge is luxuriant; that on an inclined or vertical surface sparse and irregular. In the protected locations it demands, *V. macrophysa* is exposed to and withstands, a wide range of light conditions and diurnal fluctuations in the composition of the external medium. *Valonia ventricosa* is abundantly obtained on Bird Key Reef. The distribution of *V. ventricosa* is complementary to that of *V. macrophysa,* and the solution of the problem whether the species are distinct, raised thereby , must await adequate transplant experiments. The range of sap composition which *V. ventricosa* and *V. macrophysa* exhibit at Tortugas in sea water is described. Differences occur in the composition of the sap of *V. macrophysa* grown in different parts of the moat of Fort Jefferson. The principal causal factor appears to be the light condition which it obtains during growth. In general the conditions which produce the most abundant growth of *V. macrophysa* likewise produce the greatest concentration of potassium and lowest concentration of sodium.

347. Stockard, C. R. 1908. Habits, reactions, and mating instincts of the "Walking Stick," *Aplopus mayeri. Papers Tortugas Laboratory* 2: 43-59.
Carnegie Institution of Washington Publication Number 103.
This investigation of a protectively adapted insect is important to show definitely whether the actions of such an animal are coordinated with its protective structure. It is concluded that the habits of *Aplopus mayeri* on its food-plant *Suriana maritima* are as truly protectively adapted as is its singular stick-like appearance.

348. ———. 1911. The influence of regenerating tissue on the animal body. *Papers Tortugas Laboratory* 3, no. 41-48.
Carnegie Institution of Washington Publication Number 132.
It is stated that when the adult animal body begins to regenerate new tissue in order to replace a lost part, or when abnormal secondary growths arise, the condition of growth-

equilibrium is disturbed and such a disturbance is followed by changes which affect the usual physiological condition of the body. The question as to whether the changes following normal regenerative growth are in any way similar to those effects resulting from malignant or abnormal secondary growths arises.

349. ———. 1908. Studies of tissue growth. I. An experimental study of the rate of regeneration in *Cassiopea xamanchana* (Bigelow). *Papers Tortugas Laboratory* 2: 61-102.
Carnegie Institution of Washington Publication Number 103.
The author responds to the studies of Zeleny (1903 and 1905) in which he suggested that the greater the degree of injury within limits, the more rapid the rate of regeneration. Zeleny suggested that the animal with the greater number of appendages removed might exercise the regenerating ones more than the animal with less: activity should increase the rate of regeneration in animals. The author tests the influence of rest and activity on regenerating tissues of medusa and finds no increase in the regeneration rate from activity. Rate of regeneration was also tested against food consumption, distance of cuts from the margin of the medusa disks, cuts from different parts of variously shaped surfaces, removal of oral epithelium of different sizes and at different distances, and the influences of changed chemical conditions on regeneration.

350. Stoddart, D. R. and F. R. Fosberg. 1981. Topographic and floristic change, Dry Tortugas, Florida, 1904-1977. *Atoll Research Bulletin* 253: 1-56.
Topographic and floristic surveys of the Dry Tortugas Keys in 1904, 1915, and 1937 have been used in discussions of the changing relationships between area and floristic diversity on small islands over time, and of the processes of colonization and extinction. It is shown that earlier topographic surveys are in general too unreliable to be so used. A list of Dry Tortugas plants, including all published records was as well as new collections made in 1962 and 1977, is presented, together with maps of the keys made in 1977. The total flora of about 130 species includes at least 35 native species, including 5 species of sea-grasses and 4 species of mangroves. Introduced species are largely confined to the two largest islands, and the floras of the smaller keys are dominated by a small number of native species.

351. Stone, R. G. 1931-1932. Effect of irradiation by radium upon regeneration in marine annelids. *Carnegie Institution of Washington, Yearbook.*
Note: published as follows: 1931, v. 30, p. 395; 1932, v. 31, p. 279.
The effect of combined beta and gamma radiations upon regeneration in polychaetes is studied. Histological material is being used to determine the source of new tissue in regenerated segments and to discover what tissues are affected by radiation.

352. ———. 1934. Radium radiation effects on regeneration in *Euratella chamberlin. Papers Tortugas Laboratory* 28: 157-66 (issued Jan. 1933).
Carnegie Institution of Washington Publication Number 435.
Regeneration in the polychaete annelids has been investigated in some instances but the histological changes are not so well known as in the oligochaetes. The influence of X-rays and radium upon regeneration in various animals has been demonstrated, but the polycheates have seldom been used in these investigations. It has been found that the effects of radiation are often limited to specific tissues; by reason of their greater susceptibility they may be injured or destroyed by the exposure. During the summers of 1931 and 1932 the author was able to study the effects of radiation upon polychaete regeneration at the Tortugas Laboratory. In the sabellid *Euratella chamberlin*, posterior regeneration of abdominal segments is rapid and complete. Regeneration is inhibited by sufficient exposure to the beta and gamma rays of radium. Similar exposure to gamma rays alone has no effect upon the amount of regeneration. No structural changes were observed in the radiated worms to account for this change. It is suggested that ionization induced by the beta rays is responsible for the failure of regeneration .

353. ———. 1936. Regeneration in the cirratulid *Cirrineris*. *Papers Tortugas Laboratory* 29: 1-12 (issued Nov. 1935).
Carnegie Institution of Washington Publication Number 452.
There has been considerable study of polychaete regeneration , but the observations are not as extensive as those among the oligochaetes. This investigation of *Cirrineris* was undertaken to determine the extent of segment replacement and the source of the new tissues. Material was secured at the Tortugas Laboratory. In summary a head region and six to seven segments posterior to it are regenerated when more than this number are removed. Posterior regeneration is rapid and complete; the approximate number of segments removed is replaced. Wound closure is effected in the same manner at both ends of *Cirrineris*. The edges of the everted intestine unite with the epidermis to close the body cavity. New nervous tissue arises by proliferation and inward migration of cells from the adjacent epidermis. The old nerve cells do not participate in regeneration. Material for regeneration of the intestinal lining arises by proliferation within the gut epithelium. Mesodermal structures regenerate from old mesodermal tissues. Replacement material is supplied by (a) nuclei and cytoplasm from muscles cells and connective-tissue elements after degeneration of their differentiated cytoplasm; (b) peritoneal cells which furnish most of the new material.

354. Stoneburner, D. L. and C. S. Harrison. 1981. Heavy metal residues in sooty tern, *Sterna fuscata* tissues from the Gulf of Mexico and North Central Pacific Ocean. *Science of the Total Environment* 19, no. 1: 51-58.
The comparison of mean cadmium, mercury and selenium concentrations in the eggs, feathers and body tissues of breeding sooty tern (*Sterna fuscata*) from the Dry Tortugas, Florida, and Lisianski Island, Hawaii, supports the hypothesis that a physiological mechanism exists which functions in the detoxification of heavy metals. The data collected from two geographically isolated populations of this pelagic bird indicate that the mechanism responds in a uniform manner to widely different environmental levels of heavy metals. The data and observations suggest that the mechanism evolved in response to natural fluxes of heavy metal concentrations in the marine ecosystem, not in response to recent injections of heavy metal laden industrial wastes.

355. Stoneburner, D. L., P. C. Patty and William B. Robertson Jr. 1980. Evidence of heavy metal accumulations in sooty terns. *Science of the Total Environment* 14, no. 2: 147-52.
Sooty terns from the population that nests at Bush Key, Dry Tortugas, Florida, had substantial burdens of Cd, Hg and Se. Analysis of selected tissues, feces and eggs by neutron activation techniques showed highest levels of Hg in eggs, feathers, and blood; of Cd in kidney and bone; and of Se in kidney, liver, and feathers. The concentrations of Cd, Hg, and Se in the eggs suggests that the heavy metals are being transmitted to succeeding generations. The significance of the concentrations, their effect on the reproductive success of the population, and the question of whether or not the metals transmitted to eggs represent "bio-magnification" merit further work.

356. Strom, R. N., R. S. Bramen , W. C. Jaap, P. Donan, K. B. Donnelly and D. F. Martin. 1992. Analysis of selected trace metals and pesticides offshore of the Florida Keys. *Florida Scientist* 55, no. 1: 1-13.
Trace metal and pesticide contents of sediments and producer and consumer organisms were analyzed from samples taken from eighteen stations off the Florida Keys from Biscayne National Park to the Dry Tortugas. Samples were analyzed for total mercury, tin (inorganic and organic), arsenic (inorganic and methylated), lead, copper, cadmium, and halogenated pesticides. Pesticide concentrations were below detection limits. In general, concentrations of trace metals increased from sediments to producers to consumers at each station. Though the concentrations tended to be low, some deviations were ascribed to human inputs. Fewer significant correlations were observed than expected, possible because of the dependence of the uptake mechanism upon the ability of the system (sediment, producer, consumer) to

remove trace metals from particular materials. Sponges have this ability and may represent a useful means of monitoring the quality of the environment on a sustained basis. The results are generally consistent with a relatively clean environment with some localized anthropogenic effects.

357. Stromsten, F. A. 1911. A contribution to the anatomy and development of posterior lymph hearts of turtles . *Papers Tortugas Laboratory* 3: 79-87
Carnegie Institution of Washington Publication Number 132.
This article concludes that the development of the posterior lymph hearts of turtles is initiated by he vacuolation of the postiliac mesenchymal tissue during the middle and latter part of the second week of development of the loggerhead turtle. The spongy tissue thus formed is then invaded by capillaries from the first two or three dorsolateral branches of the caudal portion of the postcardinal veins. The final stage in the development of the posterior lymph hearts is reached by the dilation and confluence of these veno-lymphatic sinuses, from before backward, forming a pair of sac-like organs, each with a single central cavity.

358. ———. 1910. The development of the posterior lymph hearts of the Loggerhead turtle *Thalassochelys caretta. Proceedings of the Iowa Academy of Science* 17: 227-28.
Observations made on the lymphatic systems of turtles indicates their origin is more or less independent of the venous system. Later investigations confirm this view, suggesting that posterior lymph hearts of the loggerhead turtle are developed from embryonal cappillaries, which have been captured and modified by the mesenchymal spaces of the post-iliac regions of the body.

359. Tandy, G. 1931. The superficial structure of coral reefs; plant succession upon prepared substrata. *Carnegie Institution of Washington, Year Book* 30, 32: 395; 265.
Plant and animal successions were examined on concrete cubes planted in the water at three sites: Fort Jefferson moat, an iron wreck east of Loggerhead Key, and northwest of Loggerhead Key.

360. Tartar, V. 1938-1939. Regeneration in the starfish *Linckia* and in the protozoan *Condylostoma. Carnegie Institution of Washington, Year Book.*
Note: published as follows: 1938, v. 37, p. 99-102; 1939, v. 38, p. 230-31.
Regeneration experiments were conducted on starfish with and without arms and isolated arms. Under normal conditions polarity of arms is not altered by isolation. Tube feet cell differentiation was examined in relation to color changes. In the ciliate, *Condylostoma,* the normal form and typical arrangement of cytoplasmic differentiations may easily be altered.

361. Tashiro, S. 1914-1915. Further studies on CO_2 in sea water and CO_2 production in tropical marine animals. *Carnegie Institution of Washington, Year Book.*
Note: published as follows: 1914, v. 13, p. 170; 1915, v. 14, p. 217-19.
Studies were conducted on the presence of "free CO_2 in sea water." A rapid method to estimate amounts of CO_2 produced in sea water by marine animals was devised.

362. Taylor, J. B. 1981. Premetamorphic veligers of Fort Jefferson Dry Tortugas, Gulf of Mexico, and Beaufort Inlet, North Carolina. *Bulletin of the American Malacology Union, Inc.* 50: 29-30. (No abstract available).

363. Taylor, W. R. 1928. The marine algae of Florida, with special reference to the Dry Tortugas. *Papers Tortugas Laboratory* 25: 1-219.
Carnegie Institution of Washington Publication Number 379.
The study of marine vegetation of the Dry Tortugas was originally undertaken to provide a simple check-list of algae of the islands for use of persons visiting the Carnegie Laboratory there, with a description of the more important ecological features and records of the

locations where plants of experimental importance might be found. When it was discovered that information about Florida algae in general was scanty, the study extended to a thorough study of all available Florida material. Records of the occurrence of marine algae on the east coast of Florida and the Florida Keys were collected. This is the first time, since Harvey, Farlow and Melvill, that an attempt was made to list completely the Florida algae.

364. ———. 1925. The marine flora of the Dry Tortugas. *Revue Algologique* 2: 113-35.
The marine algae of the Dry Tortugas are listed, and a description of the distribution is given of the important types throughout the area.

365. Teas, H. J. and P. B. Schroeder. 1971. Vegetation analysis in the Dry Tortugas by remote sensing. *Quarterly Journal of the Florida Academy of Science* 34, no. (Suppl 1): 13.
Detailed ground truth observations were carried out on the four large islands in the Dry Tortugas using aerial photography and 12S image enhancement equipment. Several vegetation associations (strand-beach, strand-dune, strand-scrub) are distinguished and a number of plant species identified (*Rhizophora, Laguncularia, Bursera, Conocarpus, Casuarina, Cocos,* and *Phoenix*).

366. Tennent, D. H. 1911. Echinoderm hybridization. *Papers Tortugas Laboratory* 3: 117-51.
Carnegie Institution of Washington Publication Number 132.
The *Toxopneustes* female x *Hipponoë* male and the reciprocal cross Hipponoë female x *Toxopneustes* male were easily made after allowing the eggs to stand in sea-water for some hours before fertilization. In the embryos of both crosses made in ordinary sea-water, which was alkaline, the *Hipponoë* influence showed a tendency to predominate. It is suggested that the variations in the alkalinity of the sea-water, which have been brought about artificially, may correspond to normal seasonal changes. The results of this and of other investigations show species tendencies toward different grades of temperature and of alkalinity. The explanation of the preponderance of one character over another in echinoderm hybrids seems to lie in the reaction of the species toward a complex of factors.

367. ———. 1920. Evidence on the nature of nuclear activity. *Proceedings of the National Academy of Science* 6: 217-21.
The author describes the results of the *Arbacia* eggs and other materials examined. Basophilic bodies found are not in the nature of chromidia, but are the result of indirect nuclear activity.

368. ———. 1942. The photodynamic action of dyes on the eggs of the sea urchin, *Lytechinus variegatus*. *Papers Tortugas Laboratory* 35: 1-153.
Carnegie Institution of Washington Publication Number 539.
The work recorded in this paper was begun as a study of the experimental modification and control of cell division in the egg of the sea urchin, *Lytechinus variegatus*. Early in the investigation the photodynamic effects of the dye neutral red were found to be striking and it was decided to undertake a study of the effects produced by other dyes. Transmission of visible light by some of the filters was so low that the intensity of the light transmitted was not sufficient to produce photodynamic effect. With dyes that produced a photodynamic effect, irradiation of a solution of the dye resulted in the formation of a photocompound. This photocompound was the active agent in the production of the photodynamic effect. The threshold for violent surface reaction (blister cytolysis) of *Lytechinus* eggs in 1:150,000 solution of neutral red in sea water lay at about 2500 foot-candles. From this point to about 4300 foot-candles violent surface reaction usually stood at about 2 per cent. Between 7000 and 7500 foot-candles it increased to 20-25 per cent, and between 800 and 9500 foot-candles it increased to 75-90 per cent. At intensities from 300 to 10,000 foot-candles there was a regular increase in the violence of the surface reaction and complete inhibition of the cleavage processes. Irradiation in some of the solutions of dye at temperatures above 32° C. resulted in injury from which the eggs did not recover. In blister cytolysis the formation of

blisters starts at a single point. Adjacent blisters come into contact with one another until the entire surface is covered. The content of these blisters is liquid, is clear on the living egg, and in the fixed egg seems to be the same as the cytoplasm of the egg with all formed components removed. It is conceivable that these components could be filtered out, but there is no evidence of the accumulation of granules at the point where the cytoplasm might have been extruded .

369. Tennent, D. H. and V. H. Keiller. 1911. The anatomy of *Pentaceros reticulatus. Papers Tortugas Laboratory* 3: 113-16.
Carnegie Institution of Washington Publication Number 132.
This account is a description of the anatomy of *Pentaceros reticulatus*. Figures are used to illustrate the organs which are described. Those which seem of greatest interest are the intestinal caeca. These were found in some instances to be greatly distended, stimulation causing their contraction. In this behavior we support the idea of the analogy of the intestinal caeca of the starfish to the respiratory trees of the holothurian, an idea which has been based upon the similarity of position of these organs.

370. Tennent, D. H., C. V. Taylor and D. M. Whitaker. 1929. An investigation on the organization in a sea-urchin egg. *Papers Tortugas Laboratory* 26: 1-104.
Carnegie Institution of Washington Publication Number 391.
In this report the eggs of the sea urchin, *Lytechinus,* were studied from samples taken at the Tortugas. The differentiation of ectoderm-forming substance over the entire surface of the egg begins before fertilization by the exclusion of the endoderm-forming material from the superficial layers of the egg. The number and relative distribution of micromeres is independent of the plane of section and of the size of the fragment. There is no localization of micromere-forming material.

371. Tennent, D. H., M. S. Gardiner and D. E. Smith. 1931. A cytological and biochemical study of the ovaries of the sea-urchin *Echinometra lacunter. Papers Tortugas Laboratory* 27: 1-46.
Carnegie Institution of Washington Publication Number 413.
The investigations upon which this paper is based constitute a new method of attack on the problem of the functional significance of chondriosomes, Golgi bodies and other "inclusions" in protoplasm. In 1926 a definite research program for histochemical and biochemical study of the eggs and ovaries of the sea-urchin *Echinometra lacunter* was begun. Summarizing: analytical figures for the percentage of lipids and of glycogen are given. The amount of the latter, 12.42 per cent, and 12.72 per cent of the dried extracted tissue is high. In addition, the presence of cerebrosides and sphingomyelin are indicated. The lipid composition of this tissue seems to be complex. The unsaturation of several preparations used in the study of staining reactions was determined, to find out if there was any correlation between unsaturation and staining with osmic acid (see Section I). On the whole the lipids are probably more unsaturated than similar preparations from mammalian tissues.

372. Thiele, J.. 1916. Molluskenfauna Westindiens. *Zoologische Jahrbucher* Supplement II: 109-32.
A listing of the mollusks of the West Indies is given and a preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States. This article is in German.

373. Thompson, M. J. and T. W. Schmidt. 1977. Validation of the species/time random count technique sampling fish assemblages at Dry Tortugas. *Proceedings of the Third International Coral Reef Symposium, No.1:283-288.* Miami, Florida: RSMAS, University of Miami.
Ichthyofauna at four coral reef sites in Fort Jefferson National Monument, Dry Tortugas, are compared during summers 1975 and 1976. Samples were taken using the species/time random count technique, a newly developed visual censusing method based upon the rate at which species are encountered by a free swimming observer. Data were collected by

different observers during the two years' sampling. Within nine fish families dominating the Tortugas ichthyofauna, the rank of five did not vary at all between 1975 and 1976 samplings. Among the four families exhibiting changes in abundance, only the Serranidae showed a variation greater than 10.0%. The marked variation of 25.8% within this family is attributed to identification problems within the genus *Hypoplectrus*. Overall numbers of species and relative species abundances within each sampled coral reef area showed minimal variation between years. The species rank correlation coefficient (Spearman's r s) between two years of observations was 0.92. High correlation between results from two different observation teams shows the species/time random count technique to be a highly reliable method of comparing coral reef fish assemblages.

374. Thorp, E. M., A. Mann, T. W. Vaughan and F. J. Haight. 1936. Calcareous shallow-water marine deposits of Florida and the Bahamas. With appendices: 1.Mann, A. Diatoms in bottom deposits from the Bahamas and the Florida Keys; 2. Vaughn, Thomas Wayland. Current measurements along the Florida Coral Reef Tract with notes on current observations, Florida Keys, June, October, November, 1914. See separate entries for Appendices. *Papers Tortugas Laboratory* 29: 37-143 (issued Dec. 1935).
Carnegie Institution of Washington Publication Number 452.
Determinations of the quantities of material derived from organic and inorganic sources have yielded the following results: Coralline algae, collectively, are shown to be the organic group that makes the largest contribution of organically secreted calcium carbonate. Next in order of magnitude are the mollusks, followed in descending order by foraminifera, madreporarian corals, alcyonarian spicules, worm tubes, crustacean fragments, and Bryozoa. The principal non-calcareous mineral is quartz. Quantitative counts of alcyonarian spicules show that they are relatively minor components of the sediments, being exceeded by madreporarian fragments in a ratio of about 2.5 to 1. Terrigenous minerals are remarkable scarce. A very small amount of volcanic glass and a few species of heavy minerals occur well distributed over the region. The sources of all the volcanic glass and some of the heavy minerals are thought to be distant and that they are wind blown. Coal and ashes brought from outside sources by human agencies have been introduced into the sediments of Tortugas lagoon, and, in smaller quantities, in a few other places.

375. Tomas, C. R. and D. G. Baden. 1993. The influence of phosphorus source on the growth and cellular toxin content of the benthic dinoflagellate *Prorocentrum lima*. *Fifth International Conference on Toxic Marine Phytoplankton*, 565-70. St. Petersburg, Florida: Florida Marine Research Institution.
The relationship between toxin content and nutritional status of the toxic marine phytoplankton *Prorocentrum lima* was examined in a culture from the Dry Tortugas, grown with inorganic phosphate and glycerol phosphate. Phosphorus source affected growth, maximal densities, and okadaic acid content of *Prorocentrum lima*.

376. Torrey, H. B.. 1927-1928. Effect of thyroxin on division rates of various cells. *Carnegie Institution of Washington, Year Book.*
Note: published as follows: 1927, v. 26, p. 228-229; 1928, v. 27 , p. 287.
Thyroxin depressed cell division and differentiation in eggs of sea-urchin (*Echinometra lacunter*), ascidians (*Phallusia nigra*), and hydroids (*Pennaria tiarella*), collected at Tortugas.

377. Treadwell, A. L. 1911. Eunicidae of Tortugas. *Bulletin of the American Museum of Natural History* 30: 1-12.
Systematic accounts of six species of polychaetous annelids are provided from specimens collected in the dead coral rock around Fort Jefferson during 1908. Some species are redescribed because of their earlier incomplete descriptions. Brief notes on their abundance and distribution are included.

378. Treadwell, A. L. 1921. Leodicidae of the West Indian region. *Papers Tortugas Laboratory* 15: 1-131.
Carnegie Institution of Washington Publication Number 293.
A systematic study based on specimens of the family Leodicidae is presented. Collections were made at the Dry Tortugas and Key West region of Florida, and in Bermuda, Porto Rico, Montego Bay, Jamaica, and Tobago. Collecting was done along shore or in comparatively shallow water. The Leodicidae are a well-defined family in which the most constant structures are internal rather than external. There is always a well-developed jaw apparatus, composed of bilaterally arranged series of chitinous plates developed in a pharyngeal pouch, and capable of protrusion for feeding purposes through the mouth. The structure of these jaws was used by Ehlers as a basis for classification, though the external organs are a more convenient means of recognition.

379. ———. 1917. Polychaetous annelids from Florida, Porto Rico, Bermuda, and the Bahamas. *Papers Tortugas Laboratory* 11: 255-68.
Carnegie Institution of Washington Publication Number 251.
This paper is a preliminary description of some new species belonging to the Polychaetous annelids, as well as new species of other families which have been collected incidentally in this work, including a new sabellid belonging to the collection of the American Museum of Natural History.

380. Ubelacker, J. M. 1982. Review of some little-known species of syllids (Annelida: Polychaeta) described from the Gulf of Mexico and Caribbean by Hermann Augener in 1924. *Proceedings of the Biological Society of Washington* 95, no. 3: 583-93.
The types of six little-known syllid species described by Augener in 1924 from the Dry Tortugas, Florida, and from St. Thomas and St. Croix in the West Indies, were reexamined. *Haplosyllides floridana* is a sexual form herein synonymized with it. *Eusyllis antillensis* and *Syllis (Typosyllis) tigrinoides* are synonyms; the latter name is retained. *Syllis (Typosyllis) fuscosuturata* has previously been synonymized with *Branchiosyllis exilis corallicoloides* and remains a valid species.

381. Vaughan, T. W. 1914. The building of the Marquesas and Tortugas Atolls and a sketch of the geologic history of the Florida Reef tract. *Papers Tortugas Laboratory* 5: 55-67.
Carnegie Institution of Washington Publication Number 182.
The study of the geology and the geologic processes of the Florida reef tract, and especially of the Tortugas and the Marquesas, has been continued since 1910. It is now possible to outline the salient geologic episodes in the history of the entire Florida Reef tract and to Institution comparisons with other coral-reef areas.

382. ———. 1910. A contribution to the geologic history of the Florida Plateau. *Papers Tortugas Laboratory* 4: 99-185.
Carnegie Institution of Washington Publication Number 133.
This paper is the outgrowth of the author's association with two organizations, the United States Geological Survey and the Carnegie Institution of Washington. The author has visited all the principal keys between Miami and Key West, to collect and study bottom samples, particularly the deposits accumulating behind the keys, and to examine several important living coral reefs around the Tortugas. The scope of the paper was enlarged to trace the geologic history of the Floridian Plateau from Oligocene to Recent time. This is to be regarded as only a sketch of the geologic development of the Floridian Plateau, as many problems need solution and many phases of its history need further investigation. Perhaps its principal value may be in directing attention to some of the unsolved problems. It is necessary to know more accurately the amount of water discharged by the streams and the quantities of solids borne by them to the sea. The chemical processes of precipitation have not been sufficiently studied. There is also great need for more extensive studies of the marine bottom deposits within the 100-fathom curve. The deep wells recently put down on

Key Vaca, Big Pine Key, and Key West have given valuable data, but deep wells are also needed on the Marquesas, and the Tortugas, in order to discover what underlies the surface formations. It is hoped this paper may serve as a convenient summary of the present knowledge of the geologic history of this interesting region, perhaps present an interpretation somewhat different from those preceding, and be a stimulus to further investigation.

383. ———. 1915. Coral-reefs and reef corals of the southeastern United States; their geologic history and significance. *Bulletin of the Geological Society of America* 26: 58-60.
The geologic history of the extensive coral reefs of the southeastern United States and near-by West Indian Islands was outlined, and the bearing they have on the theory of coral reef formation was indicated. The author stated his conclusions regarding the Florida coral reefs as follows: (1) Corals have played a subordinate part, usually a negligible part in the building of the Floridean plateau; (2) every conspicuous development of coral reefs or reef corals took place during subsidence; (3) in every instance the coral reefs or reef corals have developed on platform basements which owe their origin to geologic agencies other than those dependent on the presence of corals. The conclusions in this report are summarized as follows: Critical investigations of corals as constructional geologic agents are bringing increasing proof that they are not as important as was believed. All known modern offshore reefs which have been investigated grow on platforms which have been submerged in Recent geologic times. No evidence has been presented to show that any barrier reef began to form as a fringing reef and was converted into a barrier by subsidence. There were platforms in early Teritiary time on the site of many of the present-day platforms, and evidence has yet been adduced to prove long-continued, uninterrupted subsidence in any coral-reef area. The width of a submerged platform bordering a land area is indicative of the stage attained by planation movement. The importance of coral reef studies to geology suggests they are only a conspicuous incident in time.

384. ———. 1936. Current measurements along the Florida coral reef tract. *Papers Tortugas Laboratory* 29: 129-41.
Carnegie Institution of Washington Publication Number 451. Note: This is Appendix 2 to Calcareous shallow water marine deposits of Florida and the Bahamas by Eldon Marion Thorp.
During June and July 1914, while studying the phenomena associated with the Florida Coral-Reef Tract the author initiated a series of current measurements by using Ekman current meters. South of the Tortugas a non-tidal current toward the west is clearly indicated. The data here presented are inadequate for positive conclusions regarding the Counter Current.

385. ———. 1915. The geologic significance of the growth rate of the Floridian and Bahamian shoal-water corals. *Journal of the Washington Academy of Science* 5, no. 17: 591-600.
The object of this investigation has been to aid in understanding the amount of work stony corals may do as constructional geologic agents, and especially in the formation of coral reefs. This subject needs to be studied from at least five different view points , e.g.: (1) the quantity of material contributed by corals and that contributed by other agents must be estimated and the respective proportions determined; (2) in coral reef areas the ratio of the area covered by corals to that not covered by corals should be estimated; (3) the relations of coral reefs, continuity and discontinuity must be determined; (4) marine bottom deposits must be analyzed according to the source of the material, and the percentage of the calcium carbonate contributed by the differing agents estimated; (5) the rate of growth of corals needs to be known. There is no single formula for the growth rate of corals, as it varies by species and ecologic conditions. Observations/experiments on the growth rates of Tortugas corals are as follows: (1) Colonies obtained from the planule whose history was known, and were planted off the moat wall and on the NW side of Loggerhead Key; (2) Colonies cemented to tiles and planted at the same sites as above; Colonies naturally attached at sites

described above. The reef species of greatest concern and importance is *Orbicella (Montastrea) annularis* followed by in importance, *Maeandra strigosa, M. labyrinthiformes,* and *Siderastrea siderea.* The upward growth is critical of the massive heads *Orbicella (Montastrea) annularis* which form the strong framework of the reef and averages 1 foot in 43.54 years or 7 mm /year and which might form a reef 150 feet thick in between 6500 and 7600 years. A table on the average annual growth rates of corals from the Florida region is provided.

386. ———. 1914. The platforms of barrier coral reefs. *Bulletin of the American Geographical Society* 46: 426-29.
The author states that there are three kinds of coral reefs: fringing or shore reefs which occur along the strand line, barrier reefs which occur at varied distances off shore and have lagoons from one to as much as forty fathoms depth between them and the strand line, and atolls, which are ring-like and enclose lagoons. As the relations of barrier reefs and atolls to the platforms on which they stand constitute the essential part of the theory of development of Recent reefs, the discussion of coral reef theory has been waged over the interpretation of these relations. The object of this paper is to point out the relations of barrier coral reefs to the last dominant change in position of the strand line and to indicate the organisms forming Recent barrier reefs have played in building the reef platforms.

387. ———. 1914. Preliminary remarks on the geology of the Bahamas, with special reference to the origin of the Bahamian and Floridian Oolites. *Papers Tortugas Laboratory* 5: 47-54. Carnegie Institution of Washington Publication Number 182.
The author presents a preliminary summary of the information compiled (to 1914), on the origin of calcium carbonate sediments in south Florida, and the Bahamas, using various hypotheses developed by the leading geologists of the time. These geologists included Alexander and Louis Agassiz, Sanford, and Drew who worked in the Dry Tortugas and believed the precipitation of calcium carbonate was due to the effects of denitrifying bacteria.

388. ———. 1916. The results of investigations of the ecology of the Floridian and Bahamian shoalwater corals. *Proceedings of the National Academy of Sciences* 2: 95-100.
This paper presents a summary of the knowledge on the ecology of shallow water corals in the Florida-Bahamian region, with a detailed description of new information on food preferences of corals, and salinity and water temperature tolerances, based on studies conducted at the Dry Tortugas and the upper Florida Keys area. Mayer, at the Tortugas Laboratory, found that temperatures of 13.9 °C would exterminate the principal Floridean corals; similar results were found for corals around Australia. Light experiments at Fort Jefferson suggested vigorous coral growth in well lit wharf areas, and little growth in piling areas of perpetual shading. Tests conducted at the Marine Laboratory suggested that corals could survive at salinities of 27-38 ppt, but not as low as 19 ppt. Other conditions necessary for vigorous coral growth are maximum water depths of 45 meters and rocky or firm bottoms, without silty deposits. The growth rate of corals was determined by planting planulae in the laboratory, by measuring colonies which had been cemented to disks, and fixed on heads of stakes driven into the sea bottom. Measurements of colonies naturally attached were also made. Plantings at the Tortugas were made at Loggerhead Key, and around Fort Jefferson. The more massive the coral, the slower the growth; while the more ramose (*Acropora palmata*) and the more porous the skeleton, the more rapid the growth. The growth rate of the principal reef builders (massive corals) in the Florida region, *Orbicella (Montastrea) annularis* is from 5-7 mm per year and would form a reef of 150 feet in thickness from 7620 to 6531 years. *A. palmata* may build a similar thickness in 1800 years.

389. ———. 1914. Sketch of the geologic history of the Florida coral reef tract and comparisons with other coral reef areas. *Journal of the Washington Academy of Sciences* 4: 26-34.

The author presents the two hypotheses for the formation of atolls: one attributes atolls to the submarine solution of the interior of a mass of limestone; the other accounts for them by constructional agencies. The author believes the solution theory is disproved by a chemical examination of sea-water from a Tortugas lagoon. He believes the Marquesas and the Tortugas are constructional phenomena and owe their configuration to the prevailing winds and currents.

390. ———. 1918. The temperature of the Florida Coral-Reef Tract. *Papers Tortugas Laboratory* 9: 319-39.
Carnegie Institution of Washington Publication Number 213.
The temperature data presented were assembled primarily for their bearing on the effect temperature exerts on the bathymetric and geographic distribution of coral reefs. Temperature is also one of the most important factors in determining the geographic distribution of sea-level and near sea-level reefs.

391. Vaughan, T. W., M. A. Goldman, J. A. Cushman, M. A. Howe and others. 1918. Some shoal-water bottom samples from Murray Island, Australia, and comparisons of them with samples from Florida and the Bahamas. *Papers Tortugas Laboratory* 9: 235-97.
Carnegie Institution of Washington Publication Number 213.
The present paper is a preliminary contribution to the study of the marine bottom deposits in three coral-reef areas: Murray Island, Australia; the Bahamas, and southern Florida. Mechanical analyses have been made of all samples except those obtained in 1915, and the results of the chemical analyses of a selected set are presented. An attempt has been made to outline a method of studying calcium carbonate bottom deposits, in the hope that progress may be made toward an adequate classification of such sediments. The Tortugas Lagoon samples are coarser than those in Marquesas Lagoon, and those from the latter locality are coarser than the Bahama sample from South Bight and the west side of Andros Island. Some terrigenous material, mostly quartz sand, is washed into Biscayne Bay, Florida, and into the sounds south of it, but otherwise practically none reaches the key and reef region. The Florida area is therefore a perfect example of limestones forming in shoal water near a land area which is not crossed by large streams. The Fe_2O_3 content of the Florida samples seems somewhat higher, up to about 0.37 per cent, than that of the Bahama samples. Reconsideration of the evidence bearing upon the precipitation of $CaCo_3$ in tropical and subtropical waters and the possibility of its re-solution by ocean-water leads to the conclusion that precipitation is resulting from both organic and inorganic agencies, and that no appreciable re-solution is taking place in the water.

392. Visscher, J. P. 1930-1931. Distribution of barnacles with special reference to behavior of larvae. *Carnegie Institution of Washington, Year Book*
Note: published as follows: 1930, v. 29, p. 346; 1931, v. 30, p. 397.
A study of the barnacles was made, more than twenty species being found. Several species appear to be new to science. Behavior of larvae appeared to vary depending on habitat, as certain barnacles were found on crabs, others above the tide on pilings, still others only on coral and on the spiny lobster, *Panulirus argus.*

393. Vukovich, F. M. 1988. On the formation of elongated cold perturbations off the Dry Tortugas. *Journal of Physical Oceanography* 18, no. 7: 1051-59.
The life cycle of a cold perturbation on the boundary of the Loop Current in the Gulf of Mexico was studied over the period of 18 March to 22 May 1984, approximately a 60-day period. The study focused on the behavior of the surface and subsurface area of the cold perturbation as it moved along the boundary of the Loop Current. The area of the perturbation was defined by an alongflow-scale length, which is the scale length parallel to the unperturbed flow of the Loop Current, and the crossflow-scale length, which is the scale length perpendicular to the unperturbed flow of the Loop Current.

394. Vukovich, F. M. and G. A. Maul. 1985. Cyclonic eddies in the eastern Gulf of Mexico. *Journal of Physical Oceanography* 15, no. 1: 105-17.
Cold-domed cyclonic eddies juxtaposed to the cylconic shear side of the Gulf Loop Current are observed in simultaneously obtained hydrographic, current meter mooring, and satellite data as cold perturbations on the northern extreme of the current and grow either into a cold tongue or a quasi-stable meander off the Dry Tortugas, Florida. Areal shipboard surveys show closed isopleths of temperature and salinity, and surface geostrophic current speeds relative to 1000 db are in excess of 100 cm s super(-1). The diameter of the cold domes varied from 80 to 120 km.

395. Wallace, W. S. 1908. A collection of hydroids made at the Tortugas during 1908. *Carnegie Institution of Washington, Year Book* 7: 136-37.
At least fifty species of hydroids were collected. A tentative list of those identified is provided.

396. Wartman, W. 1929. Studies on Echinometra. *Carnegie Institution of Washington, Year Book* 28: 277.
(No data report provided).

397. Watson, J. B. 1908. The behavior of noddy and sooty terns. *Papers Tortugas Laboratory* 2: 187-255.
Carnegie Institution of Washington Publication Number 103.
The work presented in this report is preliminary in nature. Following a general description of the two species, a geographical situation and present history of the tern colony at the Tortugas is given. All observations were recorded during the nesting season on Bird Key, a small coral island covered in part by bay cedar, mixed with cactus in the central western parts of the island, with little vegetation elsewhere. Observations on their foods and feeding habits indicated that the birds usually feed in groups, never swim nor dive, but skim along the surface picking up small fish being attacked by larger fish. Feeding distance from the Key was estimated between 4 and 10 knots. Mating has been suggested prior to arriving at the Tortugas, although some indications of sexual activity occurred for the noddies, but not the sooties. Noddies nest in vegetation, while sooties build nests in sand. Usually one, sometimes two eggs are laid, with a period of incubation for the noddy from 32 to 35 days. The parents alternately feed the young at intervals from 1 to 4 hours; their general conduct does not greatly change at the arrival time of the young. However, two days after the arrival, the parents are more ferocious; both species return to normalcy as the chicks gain strength. The birds become exhausted caring for their young, and collect upon the beach for "sunning". Egg coloration tests indicated that neither species recognized its own egg. As for the noddy's nest environment, it could be disturbed without affecting the bird, as long as the egg position was not changed. Tests conducted using Porter's learning maze indicated that noddy's were slower than sooties, because of their longer standing time. Further maze tests using darkness and maze rotation were inconclusive. Other in captivity tests showed that the sooty is highly excitable and nervous, whereas the noddy is stolid and indifferent.

398. Watson, J. B. and K. S. Lashley. 1915. Homing and related activities of birds. *Papers Tortugas Laboratory* 7: 1-104.
Carnegie Institution of Washington Publication Number 211.
The present series of studies on the behavior of birds is a direct outgrowth of an investigation made on the noddy and sooty terns nesting on Bird Key, Tortugas, Florida. The homing "instinct" is the central topic in all the papers. In the 1907 investigation the fact appeared that terns possess a homing sense, behaving exactly as do homing pigeons when sent away from their nests and young. The 1907 investigation already referred to is concerned largely with instincts in terns-those of feeding, nesting, brooding, etc. In general the problems of proximate orientation are relatively simple and straightforward. On the island of Bird Key the terns make their adjustment to the nest, mate, young, etc., on the basis largely of visual habits. There is no evidence of any remarkable or unusual sensitivity,

nor of the functioning of any hypothetical sense-organ. The present paper seems to call for a separation between proximate orientation and distant orientation. Mathematical considerations show that at such distances the goal can not possibly (directly) visually stimulate the bird, even granting absolute visual acuity and complete absence of haze, etc. This work has shown further, in the terns at least, that there is no special Spürsinn-special tactual or olfactory mechanism situated in the nasal cavity which may function in homing. The task of explaining distant orientation is an experimental one, which must yield positive results as soon as proper methods are at hand. Two lines of investigation offer hopeful results: the rearing of homing pigeons in a cote, or the rearing of the birds in a wire-covered yard attached to a cote. We could tether individual birds to the top of the cote by cords which would permit a view only of the neighborhood immediately surrounding the cote. With these experiments upon homing, work upon the sensory equipment of the homing pigeon should be carried on. It is just possible that these animals possess on certain parts of the body, tactual and thermal mechanisms which may assist them in reacting to slight differences in pressure, temperature, and humidity of air columns. The experiments and conclusions on homing proper can be found on pages 59 and 60. These results, which not settling the question of the sensory mechanism by means of which the birds return to the nests, do remove all doubts about the fact that the noddy and sooty terns can return from distances up to 1,000 miles in the absence of all landmarks. The problem of homing has thus become defined, and experimental work of a definite kind is needed for its solution.

399. Wells, R. C. 1922. Carbon-dioxide content of sea water at Tortugas. *Papers Tortugas Laboratory* 18: 87-93.
Carnegie Institution of Washington Publication Number 312.
It is generally considered that the carbon-dioxide content of sea-water may be increased by accessions from the air, by animal life, by the decay of organic matter in the sediments on the bottom or elsewhere, by the solution of carbonate rocks, by the contributions of rivers, and by gas vents beneath the sea. Sea-water may lose carbon dioxide to the air, to plants, and in the formation of carbonate rocks and the carbonaceous parts of organisms. Mere evaporation and precipitation also alter the carbon-dioxide concentration somewhat if other conditions remain unchanged. The writer made determinations on sea-water from Tortugas, Florida, in June 1919 taken directly from the sea at various points about Loggerhead Key, which reveal unmistakable diurnal variations. The water has sufficient contact with plants and sea-weeds to show the effect of photosynthesis on its CO_2 content. There is a loss of CO_2 by day and a gain by night. Plant life appears to be the chief agency in causing a daily variation in the CO_2 content. Determinations of CO_2 should probably be made soon after the time the samples are collected, on account of the possibility of the decay of organic matter, such as algae, in preserved samples. The average "excess base" found at Tortugas corresponds to a normality of 0.00239. This titration includes everything that consumes acid; it represents chiefly bicarbonate, about 0.00183, some carbonate, about 0.00041, and other substances that contribute to the alkalinity, about 0.00015. The methods used in arriving at these figures were provided along with a record of determinations made at Tortugas and the relation between the carbon-dioxide content of the water and time of day.

400. Westinga, E. and P. C. Hoetjes. 1981. The intrasponge fauna of *Spheciospongia vesparia* (Porifera, Demospongiae) at Curacao and Bonaire. *Marine Biology* 62, no. (2-3): 139-50.
The infauna of 35 individuals of *Spheciospongia vesparia* (Lamarck,1814) of different volumes and from different sites and depths have been inventoried and compared. The number of sponge-inhabiting taxa is logarithmically related to sponge volume. Biomass and total number of the animals contained in the sponge are directly proportional to sponge volume. Numerical and taxonomic composition of infaunas from different sampling sites is fairly constant. Biomass and total number of sponge inhabiting animals is not significantly different for any of the four sampling sites. Several taxa, however, are more abundant in sponges from one or more localities. The ratio of total biomass to total number of intrasponge fauna is found to be significantly smaller for sponges collected in deep water

than in shallow water. Differences from and similarities with Pearse's results (1932,1950) on the infauna of the same sponge species at Dry Tortugas and Bimini are discussed. The relation of the number of contained taxa and the volume of a sponge is compared with the relation of island size and number of taxa present according to MacArthur and Wilson's island theory (MacArthur, 1972). Finally the erratic occurrence of some taxa as opposed to the highly regular occurrence of some other taxa is discussed. It is concluded that the composition of the sponge-infauna in specimens larger than 11 is highly constant and that the sponge-inhabiting fauna constitutes an ecological community.

401. Westrum, B. L. and P. A. Meyers. 1978. Organic carbon content of seawater from over three Caribbean reefs. *Bulletin of Marine Science* 28, no. 1: 153-58.
Seawater samples from transects crossing three Caribbean coral reefs, including the Dry Tortugas, showed variations in concentrations of organic carbon. Total organic carbon increased substantially over two fringing reef crests. Most of this increase occurred in the particulate fraction at the seaward edge of the crest but in the dissolved fraction at the landward edge. Back reef levels of total organic carbon were lower than those seaward of the reef. These observations support the hypothesis that organic carbon can be physically removed from the benthos at the turbulent reef crest and be subsequently utilized in backreef areas. The reef-flat formation studied in January 1975 in the Dry Tortugas was situated off the western shore of Loggerhead Key. This study indicates that organic matter contributed at the crest is available as a resource to only a limited portion of the backreef community - that part located directly behind the crest. The observed decrease in TOC levels implies quick biological utilization or loss through physical processes. Thus, despite continual input, no net accumulation of organic matter occurs in the backreef area, and this region can be described as being relatively depleted in organic carbon. If large coral formations are present, as at the Dry Tortugas location, they can contribute organic matter to the surrounding seawater.

402. Wheaton, J. 1980. Ecology of gorgonians (Octocorallia: Gorgonacea) at Dry Tortugas, Florida . *Florida Scientist*, 43 (suppl. 1), 20.
This study reports the species composition and distribution of the gorgonian fauna of Long Key Reef, Dry Tortugas during the summers of 1975-1976. 23 species were recorded. Additional samples increased the number of species to 35. Most shallow reef gorgonians were *Plexaura*.

403. Wheaton, J. L., W. C. Jaap, B. L. Kojis, G. P. Schmahl, D. L. Ballantine and J. E. McKenna Jr. 1993. Transplanting organisms on a damaged reef at Pulaski Shoal, Ft. Jefferson National Monument, Dry Tortugas, Florida, USA: An experiment to enhance recruitment. (abs.). *Proceedings of the Seventh International Coral Reef Symposium*, p. 639. Mangilao, Guam: University of Guam.
Grounding of the 475-ft. freighter, Mavro Vetranic, at Pulaski Shoal Reef, Dry Tortugas, on 30 October 1989, damaged 3,465 m^2 of reef surface. After one year, minimal recruitment of macrobenthos, principally the alga *Dictyota,* had occurred. An experiment was designed to test effects of adding relief and transplanting sponges, octocorals, and scleractinian corals on recruitment of biota to the damaged area. In Sept. 1991, one control and two experimental sites, each 9-m^2, were selected, marked, mapped, and photographed. Large reef rocks were placed in one experimental plot to provide relief and refuge. More than 185 organisms (73 species of algae, Porifera, and Cnidaria) were transplanted and cemented into five of the nine square-meter subunits in the other experimental plot. Transplanting was labor intensive, requiring 64 man-hours to collect, move, and cement organisms. We then rephotographed and mapped the plots. Sites will be monitored to determine if recruitment of macrobenthic organisms is enhanced.

404. Whitaker, D. 1926. Organization of echinoderm egg, and a measurable potential difference between the cell interior and outside medium. *Carnegie Institution of Washington, Year Book* 25:

248-55.
Egg development, investigated in the sea-urchin, *Lytechinus,* suggested that the differentiation of ectoderm begins before fertilization by the exclusion of the endoderm-forming substances from the superficial layers of the egg. Micromere-forming substances do not differentiate before fertilization.

405. White, S. C., W. B. Robertson Jr. and R. E. Ricklefs. 1976. The effect of Hurricane Agnes on growth and survival of tern chicks in Florida. *Bird-Banding* 47, no. 1: 54-71.
In June, 1972 Ricklefs and White were studying the energetics of nestling growth in sooty terns (*Sterna fuscata*) at the Dry Tortugas, when Hurricane Agnes passed west of the area. High winds, heavy rain, rough seas, and low temperatures prevailed for more than a week. Robertson worked in the colony from 28 June, about a week after the storm subsided, to 6 July. It is reported here the effects of Hurricane Agnes on the growth and survival of young sooty terns and brown noddies (*Anous stolidus*).

406. Wichterman, R. 1942. Cytological studies on the structure and division of three new ciliates from the littoral earthworm of Tortugas. *Papers Tortugas Laboratory* 33: 83-103 .
Carnegie Institution of Washington Publication Number 524.
During the summer of 1939 this study of Protozoa inhabiting the intestine of the littoral earthworm *Pontodrellus bermudensis* Beddard, was begun. The study revealed three previously undescribed ciliates: *Hysterocinita pontodrila*, n. s.p.; *Anoplophyra macroneucleata,* n. sp.; and *Maupasella leptas*, n. sp. This paper describes the ciliates and gives an account of fission in each species. Of the 230 worms examined, 64% were infected with the ciliates. Generally a worm was parasitized with two different species. Observations on the length of life of the ciliates in seawater were recorded. Encystment was not encountered. The presence of stages in the life history of acephaline gregarines and nematodes was noted.

407. ———. 1942. A new ciliate from a coral of Tortugas and its symbiotic zooxanthellae. *Papers Tortugas Laboratory* 33: 105-11 .
Carnegie Institution of Washington Publication Number 524.
A new ciliate was found on the coral *Eunicia crassa* E. and H. and is described as *Paraeuplotes tortugenesis,* n. gen. and n. sp., and is placed in the family Paraeuplotidae, n. fam. The coral it was found on is a member of the Alcyonaria fauna, and is commonly found in the Caribbean, and is abundant on the reefs of the Tortugas. The morphology of the ciliate is discussed, as well as the presence of zoozanthellae. The question is posed "what is the nature of the symbiosis between the protozoan and the zooanthellae it contains?".

408. Williams, O. L. 1932. Studies on the nematodes of Tortugas fishes. *Carnegie Institution of Washington, Year Book* 31: 291-92.
Observations of more than 800 fishes representing about 175 species during the summer of 1932 demonstrate that the incidence of infestation with nematodes is lower in fishes of the Tortugas than in the cooler, shallow waters found farther north.

409. Willier, B. H. 1936. A study of the early embryology of the Loggerhead sea turtle and of sharks. *Carnegie Institution of Washington, Year Book* 35: 92.
The embryological development of the Loggerhead turtle (*Caretta caretta*) was examined from the time of egg laying to within a few days of hatching. Significant observations are presented.

410. Wilson, C. B. 1936. Parasitic copepods from the Dry Tortugas. *Papers Tortugas Laboratory* 29: 327-47 (issued Dec. 1935).
Carnegie Institution of Washington Publication Number 452.
Two collections of parasitic copepods contained in the present paper were made at the

Marine Laboratory of the Carnegie Institution in the Dry Tortugas, involving the handling of a large number of the local fishes. In addition to the specific objects of investigation it was soon noted that the fish were more or less infested with parasitic copepods and isopods. Upon identification, seven of the species are new to science, and two others have been made the types of new genera. The other species have been obtained before either in the waters around the Dry Tortugas, the Bahamas, the Bermudas or the West Indies.

411. Winegarner, C. E., W. B. Robertson and W. Hoffman. 1984. *Anolis sageri sageri* (brown anole) USA: Florida: Monroe Co: Dry Tortugas, Garden Key. *Herpetological Review* 15, no. 3: 77-78.
Three males and one female specimen were taken on a large pile of bricks and rubble just east of the moat surrounding Ft. Jefferson, April 8-10 1983. Population currently seems limited to this small portion of the island, so introduction may have been very recent. A construction barge moored adjacent to the collection site from October 1981 to June 1982 possibly was a source of colonizing individuals. However the regular arrival of Park Service boats and private vessels are other possibilities.

412. Wolfe, C. A. 1989. "Growth of the Brown Noddy (*Anous stolidus*) in the Dry Tortugas (Florida)." Master of Science, Florida Atlantic University, Boca Raton.
The author discusses the slow growth rate of the brown noddy nestlings in the Dry Tortugas as to what would be predicted based on adult body size and mode of development. This prolonged growth pattern is typical of tropical pelagic seabirds. An intraspecific comparison of growth rates among several populations of brown noddies , indicates that growth of body mass of the Tortugas noddies is significantly faster, the development period shorter, and the asymptotic size smaller than in Pacific populations. However, there were no differences among the populations in the rates of wing or culmen growth. The Bush Key nestlings appear to receive a higher quality diet that contains proportionally more fish, while Pacific nestlings receive substantial amounts of squid. The Pacific nestlings also seem to be subjected to a thermally more stressful microclimate, which may necessitate the allocation of proportionally more of their total energy to thermoregulation and less to growth.

413. Woolfenden, G. E. and W. B. Robertson Jr. 1991. A banded red knot seen at the Dry Tortugas. *Florida Field Naturalist* 19, no. 4: 106-7.
The red knot (*Calidris canutus*) is a locally abundant and winter visitor on both coasts of Florida, however it is rare at the Dry Tortugas, with only three sightings prior to a sighting made by the authors during May-June 1988. It was suggested that all sightings at the Tortugas represented birds of a knot population that winters along the Atlantic coast of Patagonia in South America.

414. ———. 1975. Least terns nest at the Dry Tortugas. *Florida Field Naturalist* 2, no. 1: 19-20.
On July 1, 1973, as members of the tern-banding party landed on Middle Key, Dry Tortugas, they saw 4 adult-plumaged Least terns and one fledged juvenile in the company of 8 adult-plumaged Roseate Terns, *Sterna dougallii.* Search of the island, a barren sand bank with only a small area above high tide, revealed 2 Least Tern nests, one with 2 eggs and the other with one egg, and 4 Roseate nests, each with 2 eggs. It is of interest that Least Terns have again attempted to nest at Dry Tortugas after an absence of almost 25 years.

415. Woolfenden, G. E., S. C. White, R. L. Mumme and W. B. Robertson Jr. 1976. Aggression among starving cattle egrets. *Bird-Banding* 47, no. 1: 48-53.
Cattle egrets (*Bubulcus ibis*) flying over the Gulf of Mexico often land at the Dry Tortugas. Food suitable for cattle egrets is scarce locally and many egrets die at the Dry Tortugas, presumably from starvation. In June 1975 an infestation of a sea grape tree by caterpillars of the moth *Sarasota Plumigerella* Hulst. provided a natural, albeit limited, food supply at which we observed cattle egret behavior. From several observers, we were able to compare aggression, feeding frequency, plumage condition and death weights of the starving birds.

Of special interest was the opportunity to test relationships between aggressiveness and feeding frequency under the unusual circumstances of starving birds competing for a concentrated, but limited food supply.

416. Woolfenden, G. E and W. B. Robertson Jr. 1975. First nesting of the house sparrow at Dry Tortugas. *Florida Field Naturalist* 3: 23-24.
This paper describes the first occurrence of the House sparrow at the Dry Tortugas. During mid-June 1974, nest building and copulation was observed in a coconut palm east of the moat bridge on Garden Key. Four eggs were found later, but no further inspections were made. House sparrows that reach the Tortugas are considered true migrants or birds from the West Indies that accompanied north-bound migrants of other species.

417. Yamanouchi, S. 1929-1935. Life histories and cytology of marine algae. *Carnegie Institution of Washington, Year Book*.
Note: published as follows: 1929, v. 28, p. 297; 1930, v. 29, p. 346; 1931, v. 30, p. 371; 1932, v. 31, p. 259; 1933, v. 32, p. 265; 1934, v. 33, p. 263; 1935, v. 34, p. 75.
Local populations of marine algae, Phaeophycae and Chlorophyceae were studied with emphasis on *Caulerpa*. Reproductive phases of many specimens were collected for later morphological and cytological study.

418. Yonge, C. M. 1936. Studies on the biology of Tortugas corals. I. Observations on *Maenadra areolata* Linn. *Papers Tortugas Laboratory* 29: 185-98 (issued Dec. 1935).
Carnegie Institution of Washington Publication Number 452.
Maenadra areolata is one of the commonest corals of the Caribbean and Florida reefs. It is a highly specialized species adapted for life in a restricted environment. It thrives best on the flats behind the reefs. It has no firm basal attachment, it can not resist the impact of the waves of rough seas. At the Tortugas it is very common in sheltered areas on the inner side of the circle of reefs where wide stretches of sand occur. The best collecting ground is the lee of Bird Key Reef. Feeding is entirely by means of the tentacles, there is no reversal of ciliary currents. Not only is sediment removed very rapidly from the surface, but colonies can completely uncover themselves within twelve hours after being buried in the sad. Unlike *Fungia* which uncovers itself by the exclusive action of cilia, *M. areolata* first distends the tissues with water. Distension for cleansing is essentially different from expansion for feeding. Planulation, so far as can be determined at present, has a lunar rhythm, culminating about the time of new moon. After an initial stage when upward and outward growth are about equal, outward growth predominates, an oval or rounded colony with a small basal attachment being finally produced. The stage at which detachment occurs must vary with environmental conditions. Colonies may be formed from a single planula or from the fusion of several. *M. areolata* is a species highly adapted for life on sand occupying in the Atlantic, the same habitat occupied by the Fungiidae in the Indo-Pacific. Adaptability in reef-building corals is discussed.

419. ———. 1936. Studies on the biology of Tortugas corals. II. Variation in the genus *Siderastrea*. *Papers Tortugas Laboratory* 29: 199-208 (issued Dec. 1935).
Carnegie Institution of Washington Publication Number 452.
This paper presents data on stony corals on the Tortugas reefs. The genus *Siderastrea* is represented at the Tortugas by the two species, *S. siderea* and *S. radians*. *S. siderea* forms larger rounded colonies which were not observed above the level of low-water springs. *S. radians* is essentially a shore-living species possessing the physiological adaptations characteristic of all shore-living animals. *S. radians* is capable of great modification both in the form of the skeleton as a whole and also in the size and shape of the corallites and in the number, slope and thickness of the septa. This species has been enabled, as a result, to occupy a variety of habitats, the extremes being represented by the surf region on the beach rock on the one hand, and by the still, sediment-laden water in the moat at Fort Jefferson on the other. The relation between form and environment in corals is discussed and the general

conclusion reached that the great success of the Madreporaria is probably due to the presence of species highly specialized for a particular environment and also of others which can be modified for existence in a variety of different environments.

420. ———. 1937. Studies on the biology of Tortugas Corals. III. The effect of mucus on oxygen consumption. *Papers Tortugas Laboratory* 31: 207-14 (issued Oct. 1937).
Carnegie Institution of Washington Publication Number 475.
Experiments are described which indicate that a large proportion of the apparent utilization of oxygen by corals is actually due to oxidation of mucus secreted by them during the course of the experiment. The amount of mucus varies greatly in different genera and may also be increased at certain times, e.g. during planulation. In view of this source of error it is impossible to accept their face value figures which claim to represent either the absolute or the comparative rates of respiration in different corals, or general conclusions which are based on these figures. Oxidation of mucus may be expected to affect the apparent rate of respiration in all aquatic animals which normally secrete mucus.

421. Yonge, C. M. and H. M. Nicholas. 1940. Structure and function of the gut and symbiosis with zooxanthellae in *Tridachia crispata* (Oerst.) Bgh. *Papers Tortugas Laboratory* 32: 287-301 (issued Sept. 1940).
Carnegie Institution of Washington Publication Number 517.
During the visit of the senior author to the Tortugas Laboratory in the season of 1934, a number of specimens of a very interesting and beautiful species of opisthobranch mollusk were collected a low tide on the surface of the reefs. Examination revealed the invariable presence of brown unicellular algae, or zooxanthellae, within their tissues. *Tridachia crispata is* an elysoid opisthobranch with the body extremely flattened dorsoventrally and extended into undulating body folds laterally and terminally. It occurs under stones on the reefs of the Torugas group and elsewhere in the West Indies. The feeding and digestive systems are described. These have the typical elysoid structure with modifications, notably in the digestive diverticula, correlated with the excessive flattening of the body. Like the other members of the Elysiidae, *T. crispata* is a highly specialized herbivore. Zooxanthellae are habitually present in a restricted zone a short distance from the margin of the body fold. They occur freely within the connective tissue and increase by division. There is no evidence that the animal normally consumes them, but reasons are given for the suggestion that they may be of value to the animal by removing waste products of metabolism produced within the body fold.

422. Zeleny, C. 1907. The effect of degree of injury, successive injury, and functional activity upon regeneration in the scyphomedusan *Cassiopea xamachana. Journal of Experimental Zoology* 5: 265-74.
This study is part of a series of experiments at the Dry Tortugas Marine Lab on the internal factors controlling regeneration in *Cassiopea* and other forms, including the degree of injury and successive removal of a part and rhythmical pulsations of the disk. The removal of 6 to 8 arms constitutes the most favorable degree of injury for the regeneration of each arm. When comparing the rate of regeneration of disks, where the disk was made to pulsate rhythmically with cases without pulsation, there is no advantage in favor of the pulsating ones, but rather a retardation. Other tests of successive injury upon regeneration were made on chelae of the gulf-weed crab, *Portunus sayi*, which reveal that the second regeneration is greater than the first. However, when the age factor is removed the two are exactly alike.

423. ———. 1908. Some internal factors concerned with the regeneration of the chelae of the gulf-weed crab (*Portunus sayi). Papers Tortugas Laboratory* 2: 103-38.
Carnegie Institution of Washington Publication Number 103.
The primary object of the experiments described was twofold: the quantitative determination (1) of the effect of successive removal of an organ upon its power to regenerate and (2) of the character of the changes, if any, produced in the uninjured parts of

the animal by such removals. It was found that (1) individuals of *Portunus sayi* with a cephalo-thoracic length between 3-9 and 14.5 mm. show but a slight correlation between the length of the molting period and the size or age of the animal. (2) The amount of regeneration of the right chela between the same limits of size is likewise but slightly correlated with the length of the molting period, but is very closely correlated with the size of the animal. (3) The specific amount of regeneration of the right chela increases slightly with increase in size or age of the animal.(4) The specific length of the left chela in uninjured individuals increases slightly with increase in size or age of the animal.(5) The proportion between the amount of regeneration of a chela and the length of the chela in uninjured individuals of the same size is constant, uninfluenced by the size of the animal. (6) In single individuals the third regeneration is greater than the second and the second is greater than the first. (7) When the correction for change in the power of regeneration with size or age is made, it is found that successive removal neither retards nor accelerates the regeneration of the right chela. (8) The right chela is slightly larger that the left in a great majority of the individuals. (9) The removal and regeneration of the right chela produces no change in the growth of the uninjured left chela.

424. Zheng, W. and E. S. Van Fleet. 1988. Petroleum hydrocarbon contamination in the Dry Tortugas USA. *Marine Pollution Bulletin* 19, no. 3: 134-36.
The present study extends a previous work westward to the point where Florida Keys island chain intersects the Gulf Loop Current. Since the Dry Tortugas are located in this unusual area, they provide an ideal location for examining the fate of petroleum discharged into the eastern Gulf of Mexico. Beach tar samples were collected along 1 m wide transects at 18 stations according to the procedures established by CARIPOL (1980). The distribution of Dry Tortugas beach tar ranged from 0.6 g m super (-2) to 22.1 g m super (-2) dry weight with an average of 9.2 plus or minus 7.8 g m super (-2). There appear to be no strong correlations between Dry Tortugas beach tar concentrations and either predominant wind direction or major Gulf Loop Current circulation patterns.

Author Index

Agassiz, A., 1, 2
Andres, B., A., 3
Applegate, R. D., 298
Aska, D. Y., 327
Austin, O. L. Jr., 4
Awbrey, F. T., 23

Baden, D. G., 333, 375
Bailey, E., 5
Bailey, P. L., 6
Baker, B., 7
Ball, S. C., 8
Ballantine, D. L. 9, 403
Barnes, G. W., 72
Bartsch, P., 10, 11, 12, 13, 14
Battey, J. F., 287
Bellow, T. H., 15, 16, 324
Below, L. C., 315
Bennett, F. M., 17
Berrill, N. J., 18
Blinks, L. R., 19
Bohnsack, J. A., 20
Bortone, S. A., 21
Boschma, H., 22
Bowles, A. E., 23
Bowman, H. H. M., 24
Boyden, A., 25
Bradbury, R. C., 26
Braman, R. S., 154
Bramen, R. S., 356
Breder, C. M. Jr., 27, 28
Brinley, F. J., 29
Brooks, H. K., 30
Brooks, W. K., 31, 32
Brown, D. E. S., 33
Brown, W.Y,. 34
Bullington, W. E., 35
Burkenroad, M., 36

Caira, J. N., 37
Calder, D. R., 38
Carrier, J. C., 39, 40
Cary, L. R., 41- 48
Cate, C. N., 49
Ceurvels, A. R,. 105
Chambers, E. L., 50
Chiang, L., 288
Child, C. A., 51
Clapp, R. B., 52
Clark, H. L., 53
Clark, L. B., 54
Cochran, W. W., 298
Cole, L. J., 55
Collie, M. R., 56
Colman, J., 57
Conger, P. S., 58
Conklin, E. G., 59, 60
Coonfield, B. R., 61, 62
Coutiére, H., 63
Cowles, R. P., 64, 65
Criales, M. M., 66
Cubit, J. D., 196
Cushman, J. A., 67, 391
Cutright, P. E., 68

Dall, W. H., 69
Darby, H. H., 70-72
Davis, G. E., 73- 82
Davis, J. H., 325
Davis, J. H. Jr., 83, 84
Davis, R. A. Jr., 85
de Laubenfels, M. W., 86- 88
de Renyi, G. S., 89
Deflaun, M. F., 90
Dinsmore, J. J., 91, 92, 137
Dodrill J. W., 81, 82
Dole, R. B., 93
Domeier, M. L., 94
Donaldson, H. H., 95
Donan, P., 356
Donnelly, K. B., 166-168, 356
Doyle, M. M., 98
Doyle, W. L., 96-98
Drew, G. H., 99
Dustan, P., 100, 101,163

Edmondson, C. H., 102
Erseus, C., 103

Farfante, I. P., 104
Feinstein, A. A., 105
Feltham C. B., 111
Fenimore Johnson, E. R., 72
Ferguson, John C., 301
Field, R. M., 106, 107
Fisk, E. J., 108
Forcucci, D., 264
Fosberg, F. R., 350

Gardiner, M. S., 369
Gault, C. C., 251
Gee, H., 110, 111
Gersh, I.. 112
Gilmore, R. G., 113
Ginsburg, R. N., 114
Given, B., 316
Goldfarb, A. J., 115-122
Goldman, M. A., 391
Goodrich, H. B., 123
Gordon, M., 124
Goy, J. W., 125
Grave, C., 126-128
Gudger, E. W., 129-133

Haight, F. J., 374
Halas, J. C., 101
Halley, R. B., 134, 328, 330
Hanlon, R. T., 135
Hargitt, C. W., 136
Harper, D. E., 20
Harrington, B. A., 137
Harris, J. E., 28, 138
Harrison, C. S., 354
Hartman, C. G., 139
Hartmeyer, R., 140, 141
Harvey, E. N., 142-145
Hatai, S., 146-148
Hayes, F. R., 149, 150
Heard, R. W., 151
Helwig, E. R., 152
Hendee, E. C., 153
Hendrix, S. A. 154
Hess, W. N., 54, 155, 156
Hildebrand, S. F., 211, 212
Hine, A. C., 203
Hixon, R. F., 135
Hoetjes, P. C., 400
Hoffman, W., 157, 411
Holmes, C. W., 158
Hooker, D., 159
Hopkins, D. L., 160
Howe, M. A., 391
Hudson, J. H., 310, 328, 330
Hutton, R. F., 105

Jaap, W. C., 101, 161-168, 264, 356, 403
Jacobs, M. H., 169
Jefferson, J. P., 170
Jehl, J. R., 23
Jennings, H. S., 171
Jindrich, V., 172
Jones, N., 173, 285
Jones, R. D., 174
Jones, R. S., 113, 175
Jordan, D. S., 176, 177
Jordan, H. E., 178-186

Kaas, P., 187
Kale, H. W., 188
Keiller, V. H., 369
Kellner C., 32, 189
Kille, F. R., 190
Kilma, E. F., 261
Kindinger, J. L., 330
King, J. Jr., 276, 277
Kojis, B. J., 167, 168, 403
Kopac, M. J., 191
Kunkel, B. W., 192

Lashley, K. S., 398
Le Compte, M., 193
Lee, T. N., 66
Leitch, J. L., 194, 195
Lessios, H. A., 196
Lidz, B. H., 328, 330
Linton, E., 197-199
Lipman, C. B., 200- 202
Locker, S. D., 203
Longley, W. H., 204-212
Lucké, B., 213-215
Lynts, G. W., 216
Lyons, W. G., 163, 217

Mann, A., 218, 374
Manter, H. W., 219-221
Marsh, G., 222- 224
Martin, D. F., 356
Martin, J. C., 346
Martin, L. K., 40
Mason, C. R., 316, 318
Mast, S. O., 225
Matthai, G., 226
Maul, George A., 394
Mayer, A. G., 227-242
McClellan, D. B., 20
McClendon, J. F., 243-251
McKenna, J. E. Jr., 167, 168, 403
Meeder, J. F., 252
Meier, O. W., 288
Meyers, P. A., 401
Miller, H. M. Jr., 253
Miller, R. A., 254
Milligan, M. R., 103

Millspaugh, C. F., 255
Mitchell-Tapping, H. J., 256
Moore, T., 170
Moritz, C. E., 257
Mulholland, S., 251
Multer, H. G., 258, 259
Mumme, R. L., 415
Murphy, L. E., 260

Nance, James M., 261
Nicholas, H. M., 421
Nicoll, P. A., 128

O'Neill, C. W., 85, 262, 263
Ogden, J. C., 264
Osburn, R. C. , 265

Patella, F. J., 261
Patty, P. C., 157, 355
Paul, J. R., 281
Paulson, D. R., 318
Payne, F., 266, 267
Pearse, A. S., 268-274
Perkins, H. F., 275
Perlmutter, D. G., 151
Petrovic, C. A., 276, 277
Phillips, A. H., 278-280
Pichard, S. L., 281
Pitts, R. F., 282
Plan Development Team, Reef Fish Management Plan, South Atlantic Fishery Management Council., 283

Plantier, T. L., 284
Plough, H. H., 285
Porter, J. W., 264, 286-288
Porter, J. Y., 170
Potthoff, T., 289
Powers, P. B. A., 290, 291
Pratt, H. L. Jr., 39, 40
Pratt, H. S., 292- 297
Pritchard, M. H., 37

Raim, A., 298
Rebenack P., 21
Reighard, J., 299, 300
Reynolds, J. E. III, 301, 302
Richards, O. W., 303, 336
Richards, W. J., 289
Richardson, T., 288
Ricklefs, R. E., 304, 305, 405
Riley, G. A., 306
Riska, D. E., 307, 308
Rivas, L. R., 309
Roberts, H H., 310, 311
Robertson, D. R., 196
Robertson, W. B. Jr., 4, 5, 34, 52, 92, 157, 312-318, 324, 355, 405, 411, 413-416
Robinson, A. H., 319
Rouse, L. J. Jr., 310, 311

Sarver, S. K., 332
Schaeffer, A. A., 320, 321
Schlumberger, H. G., 215
Schmahl, G. P., 403
Schmidt, T. W., 373
Schmitt, W. L., 322
Schnell, G. D., 323
Schreiber, R. W., 324
Schroeder, P. B,. 325, 365
Scott, W. E. D., 326
Seaman, W., Jr., 327
Shimizu, Y., 333
Shinn, E. A., 203, 328-330
Shoemaker, C. R., 331
Siegel, D. M.., 21
Silberman, J. D., 332
Smayda, T. J., 333
Smith, G. J., 287
Smith, H. B., 254
Smith, H. G., 334
Smith, N. P., 264
Snoek E., 105
South Florida Area Study 335
Spence, J., 336
Sprunt, A. Jr., 337-343
Steinen, R. P., 134
Steinmetz, J. C., 302
Stevenson, J. O., 344
Steward, F. C., 345, 346
Stockard, C. R., 347-349
Stoddart, D. R., 350
Stone, R. G., 351-353
Stoneburner, D. L., 354, 355
Strom, R. N., 356
Stromsten, F. A., 357, 358
Szmant, A. M., 264

Tandy, G., 359
Tartar, V., 360
Tashiro, S., 361
Taylor, C. V., 371
Taylor, Jane B., 362

Taylor, W. R., 363, 364
Teas, H. J., 365
Tennent, D. H., 366-371
Thiele, J., 372
Thompson, J. C., 177
Thompson, M. J., 175, 373
Thorp, E. M., 374
Tomas, C. R., 333, 375
Torrey, H. B., 376
Treadwell, A. L., 377-379

Ubelacker, J. M., 380

Van Fleet, E. S., 424
Vaughan, T. W., 374, 381-391
Visscher, J. P., 392
Vukovich, F. M., 393, 394

Walker, N. D., 310, 311
Wallace, W. S., 395
Walsh, P. J., 332
Wartman, W., 396
Watson, J. B., 397, 398
Wells, R.r C., 399
Westinga, E., 400
Westrum, B.L., 401
Wheaton, J., 164-168, 402, 403
Whitaker, D. M., 371, 404
White, S. C. 305, 405, 415
White-Schuler, S. C., 304
Wichterman, R., 406, 407
Williams, O. L., 408
Willier, B. H., 409
Wilson, C. B., 410
Winegarner, C. E., 15, 411
Wolfe, C. A., 412
Woolfenden, G. E., 4, 5, 413-416

Yamanouchi, S., 417
Yonge, C. M., 418-421

Zeleny, C., 422, 423
Zheng, W., 424

Subject Index

Accipiter striatus, 3
Acropora, 241
Acropora cervicornus, 30, 73, 74, 193
Acropora palmata, 74, 172, 328, 388
Actinian, 60, 136
Alcyomeum, 48
Alcyonaria, 48, 407
Alpheidae, 63, 70, 248
Alpheus, 63, 70
Amphipods, 151, 271, 331
Anchor damage, 73
Animal succession, 57
Anisonema vitrea, 102
Annelids, 119, 120, 228, 351, 352, 353, 377, 378, 379, 380
Anous stolidus, 34, 307, 308, 405, 412
Ants, 55, 242
Aplopus, 178, 186, 347
Aplysia protea, 257
Ascidians, 18, 126, 127, 128, 140, 228, 285, 303, 336, 376
Asio flammeus, 157
Astroea longispina, 43
Astropecten duplicatus, 65
Atlantic palolo (Worm), 227, 228
Atmospheric compounds, 154, 249
Audouinella ophioglossa, 9
Audubon, 10
Avicennia, 83

Banded red knot, 413
Barnacles, 392
Bathydrilus oligochaeta, 103
Beach rock, 106, 107, 114, 259
Beach tar, 424
Belonidae, 27
Bioluminescence, 144, 145
Bird history, 338, 339, 343, 344, 397
Birds, 4, 5, 10, 17, 108, 137, 157, 316, 326, 335, 337, 338, 339, 341, 342, 344, 413
Black noddy, 313, 318
Black phoebe, 108
Black water event, 163, 170
Blood relationships, 25
Bluefin tuna, 289
Botanical ecology, 24
Brackish-water ponds, 268
Breeding, 11, 13, 14, 284, 308
Briareum, 48, 163
Brown anole, 411
Brown noddy, 34, 305, 307, 308, 313, 397, 398, 405, 412
Brown pelican, 15, 324
Bryozoans, 265
Bubulcus ibis, 415

Calcium carbonate, 99, 106, 107, 201, 202, 246, 249, 259, 274, 385, 391
Calidris canutus, 413
Cardinal, 16
Cardinal cardinalis, 16
Cassiopea, 44, 45, 47, 142, 228, 237, 244, 245, 334
Cassiopea xamachana, 116, 146, 147, 148, 231, 234, 235, 238, 275, 334, 349, 422
Cattle egrets, 137, 415
Caulerpa, 417
Cerions, 11, 12, 13, 14
Chart, 109
Ciliates, 35, 290, 291, 360, 406, 407
Clibanarius, 192
Cnideria, 22, 41, 42, 46, 48, 59, 98, 135, 146, 147, 148, 161, 162, 168, 171, 172, 193, 228, 231, 234, 235, 237, 241, 244, 245, 334, 349, 395, 402, 403, 418, 419, 422
Coelenterates (Cnideria), 144, 275
Color patterns, 61, 62, 123, 130, 204, 205, 206, 207, 209, 210, 299
Common tern, 304
Condylactis gigantea, 135
Conocarpus, 83
Coral bleaching, 161, 288
Coral growth, 335, 385, 388
Coral mortality, 287, 288, 310, 311
Coral polyps, 22
Coral reef, 1, 2, 57, 73, 161, 162, 163, 165, 167, 168, 252, 264, 287, 288, 310, 311, 359, 381, 382, 383, 384, 385, 386, 387, 390, 403
Coral reef sampling, 165, 167, 288, 359, 403
Coral reef structure, 74, 79, 100, 168, 172, 335, 385, 387, 389, 391
Corals, 98, 226, 229, 241, 248, 252, 287, 383, 402, 403, 418, 420
Crabs, 33, 71, 192, 204, 257, 274, 303, 422, 423
Crangon armillatus, 62, 70, 71, 89, 156, 257
Crustaceans, 66, 71, 75, 78, 81, 89, 104, 125, 145, 151, 156, 192, 204, 248, 261, 274, 303, 322, 331, 410, 422, 423
Cultural resources, 260
Currents, 384, 389, 393, 394, 424
Cytology, 33, 43, 50, 59, 87, 96, 97, 98, 117, 118, 121, 122, 143, 149, 150, 152, 153, 178, 179, 180, 181, 182, 183, 184, 185, 186, 191, 194, 195, 222, 223, 224, 244, 247, 254, 257,

266, 267, 320, 321, 336, 345, 346, 349, 353, 360, 366, 367, 368, 370, 371, 376, 404, 406, 409, 417

Diplectrum vittatum, 21
Diadema, 196
Diatoms, 58, 218
Diplectrum formosum, 21
Diporia clivosa, 168
Diving helmet, 131
DNA,90, 332
Dove, 315

Echinaster, 65, 182
Echinoderms, 53, 118, 121, 122, 149, 150, 153, 182, 185, 190, 194, 195, 196, 247, 254, 280, 290, 291, 360, 366, 368, 369, 370, 371, 376, 404
Echinometra lacunter, 53, 150, 194, 195, 254, 371, 376
Ecology, 83, 84
Effect of light on organisms, 28, 65, 72, 155, 156, 159, 222, 223, 334, 346, 368
Effect of photosynthesis, 230, 246
Effects of radiation, 351, 352
Effects of temperature on organisms, 224, 229, 234, 241, 244, 287, 310, 311, 388, 390, 393, 394
Empidonomus varius, 26
Epinephelus, 282
Epinephelus morio, 273
Evolution, 138
Exococetidae, 27

Fish, 21, 27, 28, 29, 33, 36, 39, 61, 68, 94, 112, 113, 123, 124, 129, 130, 132, 133, 135, 138, 139, 170, 176, 177, 205, 206, 207, 209, 210, 211, 212, 213, 214, 215, 221, 273, 282, 283, 289, 299, 309, 373, 408, 410
Fish communities, 175, 212, 283, 373
Fish kill, 310
Fish sampling techniques, 175, 205
Fish tumors, 213, 214, 215
Flight speed (Birds), 323
Florida Keys National Marine Sanctuary, 7, 20
Food habits, 21, 92, 171, 205, 397, 421
Foraminiferae, 67, 216
Frigate birds, 323

Gastropods, 89
Geologic history, 381, 382, 383
Geology, 30, 83, 106, 107, 114, 134, 172, 203, 256, 258, 259, 260, 262, 263, 302, 328, 329, 374, 381, 382, 383, 385, 391
Ginglymostoma cirratum, 39, 112, 129, 133
Gorgonacae, 41, 42, 46, 402
Gorgonia, 48, 402
Great black-backed gull, 188
Growth, 303, 304, 305, 346, 348, 405, 412

Habits, 64, 132, 133, 248, 272, 273, 275, 347, 398, 418, 419, 421
Haemulidae, 36
Halichores, 213
Halichores bivittatus, 124
Halimeda, 263
Halimeda hummii, 9
Hatching success, 23
Hemirhamphidae, 27
Histology, 190
Holothuria, 190, 279, 280, 369
Homing instinct, 10, 398
House sparrow, 416
Hydroids, 38, 116, 376, 395
Hydrology, 134
Hypoglossum rhizophorum, 9
Hypoplectrus, 94, 373

Insects, 8, 347
Invertebrates, 6, 8, 11, 12, 13, 14, 18, 22, 25, 32, 35, 37, 38, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 53, 54, 55, 58, 59, 60, 62, 63, 64, 65, 66, 67, 69, 70, 71, 73, 74, 75, 76, 77, 78, 80, 81, 82, 86, 87, 88, 89, 98, 100, 101, 102, 103, 104, 117, 118, 119, 120, 121, 122, 125, 126, 127, 128, 135, 136, 140, 142, 143, 144, 145, 146, 147, 148, 149, 151, 152,.153, 155, 156, 161, 162, 169, 171, 172, 178, 182, 183, 185, 186, 187, 189, 190, 192, 193, 195, 196, 197, 198, 199, 217, 219, 220, 221, 227, 229, 231, 235, 238, 239, 242, 244, 245, 246, 247, 248, 253, 254, 261, 265, 266, 267, 270, 271, 272, 275, 279, 280, 285, 290, 291, 293, 294, 295, 296, 297, 303, 322, 331, 334, 347, 351, 352, 353, 360, 366, 367, 368, 369, 376, 377, 378, 379, 380, 392, 395, 400, 402, 408, 418, 419, 421, 422
Iotrochota, 87, 152
Ischnochiton, 187, 217

Land-birds, 3, 16, 26, 276, 277, 315, 317, 326, 341, 415, 416
Larval shrimp, 66
Launcularia, 83
Least terns, 414
Leodice fucata, 54
Limulus, 184, 228
Linckia, 360
Lipogramma anabantoides, 113

Littoral, 269, 272
Loggerhead turtle, 159, 179, 180, 181, 183, 198, 295, 297, 357, 358, 409
Long Term Ecological Research (LTER) 163, 167, 225, 264
Longevity, 34
Lutjanus griseus, 124, 214
Lytechinus variegatus, 50, 153, 247, 368, 370, 404

Maeandra aerolata, 22, 229, 241, 418
Maps, 1, 74
Manatees, 301
Mangrove, 83, 325, 365
Marine algae, 9, 19, 96, 97, 191, 222, 223, 224, 345, 346, 363, 364, 417
Marine amoebe, 160, 320, 321
Marine bacteria, 99, 110, 111, 202
Marine fishery reserves (MFR), 283
Marine Laboratory, 232, 236, 240
Marine parks, 79, 319
Masked booby, 52
Mastogloia, 218
Mating, 39
Medusae, 44, 45, 228, 231, 234, 239, 275, 349
Merlin, 298
Metals in organisms, 278, 279, 280, 354, 355, 356
Migration, 17
Millepora complanata, 161, 172
Mites, 274
Mollusks, 11, 12, 13, 14, 49, 69, 89, 187, 217, 253, 372, 392, 421
Monocotyle, 292
Monosporus indicus, 9
Montastrea annularis, 162, 168, 172, 241, 385
Montastrea cavernosa, 168
Morphodynamics, 85, 192
Mosquitoes, 8
Myliobatis, 292

Nematodes, 408
Neoplastic growths, 124
Nesting, 15, 324, 343, 397, 414, 416
Nurse shark, 39, 40 112, 129, 133, 197

Ocypoda, 64
Oikopleura, 189
Oil spill, 335
Ophicoma, 182
Orbicella (Madrepora), 193, 229, 241, 388
Osmotic pressure, 269
Owl, 157

Panulirus argus, 75, 77, 78, 89, 156, 327, 332
Parasitic copepods, 410
Parasitic isopods, 273, 410
Parasitic worms, 37, 197, 198, 199, 219, 220, 221, 253, 292, 293, 294, 295, 296, 297
Pedibothrium, 37
Penaeus duorarum, 66, 261
Pesticides, 356
PH, 230, 250, 251, 334
Physiology, 47, 97, 111, 135, 160, 169, 334, 345, 346, 357, 358
Phytoplankton, 333, 375
Plankton, 306
Plectognath, 28
Plexaura, 46
Pollution, 335, 424
Polycistor, 140
Polyplacophora, 217
Pomacentrus, 29
Pomacentrus leucostictus, 61
Porites, 229, 241
Porites asteroides, 168
Portunus sayi, 422, 423
Promicrops (Epinephelus) itajara, 273
Protozoan, 102, 160, 169, 406, 407
Pseudocyphoma, 49
Ptychodera, 43, 89, 155, 266, 267
Pycnogonida, 51

Rails, 277
Rat, 95
Recreational headboat fishery, 20
Red-headed woodpecker, 317
Red tide, 105
Reef fishes, 20
Reef formation, 2, 41, 42
Reefs, 30
Regeneration, 6, 44, 45, 47, 115, 116, 120, 152, 190, 235, 285, 348, 349, 351, 352, 353, 360, 422, 423
Replenishment reserves, 7, 20, 283
Rhizophora, 83
Richardina spinicincta, 125
Roseate terns, 313, 414

Sabellids, 6, 352, 379
Sabines's gull, 56
Salinity, 93, 116
Salpa floridian, 31
Scleractinia, 161
Scyphomedusa (jellyfish), 59, 234
Sea-birds, 4, 15, 23, 34, 52, 56, 91, 92, 188, 284, 298, 304, 305, 307, 308, 312, 313, 318, 323, 324, 340, 341, 354, 355, 397, 398, 405, 412, 414
Sea-cucumber, 190

Sea-level change, 203, 258, 262, 263
Sea turtles, 159
Sea-urchin, 50, 117, 121, 122, 150, 153, 194, 195, 196, 247, 254, 290, 291, 366, 368, 370, 371, 404
Sea-water composition, 72, 90, 93, 115, 174, 200, 201, 202, 230, 235, 237, 238, 243, 246, 249, 250, 251, 281, 320, 361, 389, 399, 401
SEAKEYS, 264
Sedimentation, 85, 172, 256, 258, 259, 262, 263, 329, 374
Sharks, 39, 139
Sharp-shinned hawks, 3
Sicyonia penaeoidea, 104
Siderastera, 168, 229, 241, 385, 419
Snapping shrimps, 63, 322
Sooty terns, 4, 5, 23, 91, 92, 284, 304, 312, 313, 314, 354, 355, 397, 398, 405
Speculata advena, 49
Spheciospongia vesparia, 151, 400
Sphyraena barracuda, 132
Spiny lobster, 75, 76, 77, 78, 80, 81, 82, 156, 327, 332
Sponges, 86, 87, 88, 101, 151, 152, 270, 400, 403
Sport harvest, 75, 76, 78, 79, 81, 82
Starfish, 65, 360, 369
Starvation, 231, 334, 415
Stephanochasmus, 294
Sterna fuscata, 4, 5, 91, 92, 284, 304, 314, 354, 405
Sterna hirundo, 304
Sterna melanoptera, 340
Sting ray, 68
Storms, 17, 405
Sula dactylata, 52
Syllids, 380
Synentognathi, 27

Topography, 1, 84, 325, 328, 329, 343, 350
Transatlantic migration, 314
Transplanting organisms, 403
Trematodes, 220, 221, 253, 292, 293, 294, 295, 296, 297
Trichechus, 301
Tunicata, 31, 32

Valonia, 19, 96, 97, 191, 222, 223, 224, 345, 346
Vanadium, 279, 280
Variegated flycatcher, 26
Vegetation, 24, 84, 255, 325, 350, 365
Vessel groundings, 335, 403
Vocal signals, 307, 308

Worms, 6, 54, 103, 119, 120, 155, 197, 198, 220, 253, 292, 293, 294, 295, 296, 297, 352, 353, 377, 378, 379, 380, 408

Zooxanthellae, 98, 334, 407, 421