U.S. DEPARTMENT OF COMMERCE
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NOAA Technical Report NMFS SSRF-640

Annotated Bibliography on the Fishing Industry and Biology of the Blue Crab, *Callinectes sapidus*

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SEATTLE, WA.
August 1971

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price $1.00. Stock number 0318-0009

ABSTRACT

References are given on 742 publications, published before 1970, on classification, distribution, abundance, life history, morphology, physiology, ecology, fishery, and industry. Annotations and a subject index also are provided.

INTRODUCTION

We prepared this bibliography to provide scientific and industrial investigators an updated and comprehensive list of references to the literature on the blue crab, *Callinectes sapidus*. No comprehensive summary of blue crab literature has been published since a bibliography on the genus by Cronin, Van Engel, Cargo, and Wojcik in 1957.

Almost all material included has been published except for certain significant theses and mimeographed reports. Relatively few of the industrial trade journals were readily available to us; consequently citations from these sources are least represented. Not included are references to patents (issued by U.S. Patent Office) relating to capture and processing of crabs, newspaper articles, references which only briefly mention or list the species, and general references no longer of current interest (such as announcements of tagging programs).

Authors are listed alphabetically, and each author's works are listed chronologically by year of publication. Works by two or more authors are entered only under the senior author's name. The references were checked, and the contents are annotated. A subject index also is provided.

The reference material, including bibliographic and abstracting sources, of the following libraries was examined for references on the blue crab: National Marine Fisheries Service Center for Estuarine and Menhaden Research, Beaufort, N.C.; Duke University Marine Laboratory, Beaufort, N.C.; and University of North Carolina Institute of Marine Sciences, Morehead City, N.C. Many publications were borrowed from other libraries, particularly from various national libraries in Washington, D.C., and vicinity. The authors were not able to devote the time required for a more extensive survey of the literature, and some contributions undoubtedly were overlooked.

Rathbun (1896) reviewed the taxonomic history of the genus and changed the name of the blue crab from *Callinectes hastatus* Ordway to *C. sapidus*.

REFERENCES

Abbott, Walter.
1967. Unusual climbing behavior by *Callinectes sapidus* Rathbun (Decapoda, Brachyura). Crustaceana, vol. 13, No. 1, p.128.
Observation of a blue crab ascending a clump of saltgrass. It climbed 35 to 40 cm. by grasping bundles of grass with its chelipeds.

Abramowitz, A. A.
1942. Moulting in the blue crab. Woods Hole Oceanographic Institute, Collected Reprints 1941, Report for year 1940, p. 19.
Removal of both eyestalks, or the anterior half of each, resulted in acceleration of molting. The procedure could have commercial possibilities.

Abramowitz, A. A., F. L. Hisaw, and D. N. Papandrea.
1944. The occurrence of a diabetogenic factor in the eyestalks of crustaceans. Biological Bulletin (Woods Hole), vol. 86, No. 1, p. 1-5.
Eyestalk extract of *Uca pugilator* was injected into the blue crab to determine its effect on the resting blood sugar level. A powerful diabetogenic factor was found primarily in the sinus gland of Hanström. The activity of the extracts was interspecific, heat stable, and effective over a wide dilution range.

Ackerman, Edward A.
1941. New England's fishing industry. University of Chicago Press, Chicago, 303 p.
Affect of the blue crab on New England's crab industry (primarily crabs of the genus *Cancer).* Production of crabs reportedly will remain small because the blue crab is at the northern limit of its range in New England and because of the plentiful supply of crab products from Chesapeake Bay and southern areas.

Alexandrowicz, J. S.
1932. The innervation of the heart of the Crustacea. I. Decapoda. Quarterly Journal of Microscopical Science, New Series, vol. 75, No. 2, p. 181-249.
Structure and arrangement of the nervous tissues in the heart, large blood vessels, and pericardium of decapods. The relation of the local cardiac nervous system to the skeletal nervous system.

Alford, John A., and C. S. McCleskey.
1943. A new bacterial species producing a "musty odor." Proceedings of the Louisiana Academy of Science, vol. 7, p. 24-27.
How a new organism, *Achromobacter mucidus*, isolated from crab meat, differs in several reactions from others causing musty odors.

Alford, John A., Leonard Tobin, and C. S. McCleskey.
1942. Bacterial spoilage of iced fresh crabmeat. Food Research, vol. 7, No. 5, p. 353-359.
Bacteria, yeast, mold counts, pH, and changes in the flora, during the spoilage of crab meat.

Allen, J. A.
1966. The rhythms and population dynamics of decapod Crustacea, p. 247-265. *In* Harold Barnes [ed.] Oceanography and marine biology, an annual review, vol. 4. Hafner Publishing Company, New York.
References to the blue crab include its migrations as related to the breeding cycle, its rhythmic color changes, and its accidental introduction into France and Holland.

Allison, J. B., and W. H. Cole.
1940. The nitrogen, copper, and hemocyanin content of the sera of several arthropods. Journal of Biological Chemistry, vol. 135, No. 1, p. 259-265.
After clotting, the sera of *C. sapidus*, *Homarus americanus*, and *Cancer borealis* contained only hemocyanin. The concentration of this protein varied greatly among individuals.

Altman, Philip L., and Dorothy S. Dittmer [ed.]
1964. Biology data book. Federation of American Societies for Experimental Biology, Washington, D.C., 633 p.
References to the blue crab include distribution, data on propagation, life span (3 years), and heart rate (25-84 beats per minute at 22-23° C.).

Amanieu, Michel, and Jean Le Dantec.
1961. Sur la présence accidentelle de *Callinectes sapidus* M. Rathbun a' l'embouchure de la Gironde. Revue des Travaux de l'Institut des Pêches Maritimes, vol. 25, No. 3, p. 339-343. Also in: Bulletin de la Station Biologique d'Arcachon, No. 14 (1962).
Distribution, culture, behavior, economic value, and occurrence in Gironde River, France.

Amberson, W. R., H. S. Mayerson, and W. J. Scott.
1924. The influence of oxygen tension upon metabolic rate in invertebrates. Journal of General Physiology, vol. 7, No. 1, p. 171-176.
Oxygen consumption of the blue crab depends on external oxygen pressures over the whole range tested and therefore has no critical pressure.

Anderson, John D., and C. L. Prosser.
1953. Osmoregulating capacity in populations occurring in different salinities. Biological Bulletin (Woods Hole), vol. 105, p. 369.
Blue crabs and quahogs *(Venus)* from high and low salinities were placed directly into dilutions of sea water. Regulation failed in high-salinity crabs at 0.1 N NaCl equivalent and in low-salinity crabs at 0.04 N NaCl. Blood was hypotonic in 100 percent sea water.

Anderson, William W., and Jack W. Gehringer.
1965. Biological-statistical census of the species entering fisheries in the Cape Canaveral area. U.S. Fish and Wildlife Service, Special Scientific Report-Fisheries No. 514, 79 p.
An account of the year-round commercial fishery and the summer sport fishery for blue crabs at Cape Canaveral. Brief account of the biology of the blue crab (Chesapeake Bay).

Andrews, Emmett.
1947. Crab pot construction (Chesapeake Bay type). U.S. Fish and Wildlife Service, Fishery Leaflet No. 262, 4 p.
Materials and method of construction and how fished.
1948a. The "bob" method of picking blue crabs. U.S. Fish and Wildlife Service, Fishery Leaflet No. 276, 6 p.
Description and step by step pictures of the "bob" method (so named because all the legs are cut off before picking is begun), a rapid way of separating the meat from the shell.
1948b. Trotline construction, operation, and maintenance (Chesapeake Bay type). U.S. Fish and Wildlife Service, Fishery Leaflet No. 291, 5 p.
A detailed account with good illustrations.

Anonymous.
1939. Blue crabs. Time, vol. 34, September 25, p. 61-62.
A discovery by industry of a treatment for blue-crab-meat that prevents discoloration in the canning process and allows the industry to compete with dungeness crab products and foreign imports of crab.
1940a. The occurrence and development of a hyperparasite, *Urosporidium crescens* (Sporozoa, Haplosporidia) which infests the metacercariae of *Spilotrema nicolli*, parasitic in *Callinectes sapidus*. Journal of the Tennessee Academy of Science, vol. 15, No. 4, p. 418-419.
One third of the crabs examined in North Carolina contained metacercariae, and the host metacercarial tissue was often destroyed (masses of dark spores produce a black spot, referred to as "pepper crab"). Spots occur most commonly in fat bodies, digestive gland, and muscles of the crab. Invasion by *Urosporidium* probably occurs before encystment of cercariae.
1940b. Packing crab meat. Fishing Gazette, vol. 57, No. 1, p. 23.
Procedures used by a New Orleans plant to pack crab meat.

1940c. Canning American crab meat. Fishing Gazette, vol. 57, No. 5, p. 23, 46.

Advances in sanitation and canning methods by 1938, allowed the blue crab industry to produce a canned product high in quality and flavor.

1940d. American crab meat now canned. Fishing Gazette, vol. 57, No. 6, p. 27, 35.

Methods employed by the Blue Channel Corp., Beaufort, S.C., to can blue crabs. A special process retains the color and flavor of crabs during canning. Discusses how the new canned product may make the United States less dependent on Japanese crab imports.

1941. Atlantic coast blue crab an important enemy of oysters. Oyster Institute of North America, Trade Report No. 44, 2 p.

Experiments in large outdoor tanks at Pensacola, Fla., indicated the frequency of predation of crabs on oysters and how crabs remove meat from the shells of young and adult oysters.

1945. Fishery resources of the United States. U.S. Congress, 79th, 1st Session, Senate Document No. 51, 135 p.

A short section on the Atlantic blue crab resource and its utilization. The sharp natural fluctuations in crab stocks and possible conservation measures. Life history of the Chesapeake Bay blue crab.

1949. Preserving crab meat. Food Industries, vol. 21, No. 1, p. 170.

Natural flavor and color of crab meat is preserved by canning in a regulating solution that has a continuous buffer action over a wide range of acidity.

1953. Million dollar formula: Research put color in crab: Profit in processing plant. Journal of Southern Research, vol. 5, July-August, p. 34-35.

The pioneering accomplishments of the Blue Channel Corporation, Beaufort, S.C., in the crab-packing industry concerning meat quality, foreign competition, marketing, and supply. Research sponsored by the firm revealed that taste and color of crabmeat can be retained after the canning process by curbing the high copper content with aluminum sulphate.

1954. Deviled crabs: 25,000 daily. Food Engineering, vol. 26, No. 11, p. 99, 176.

A 6-ounce package of frozen deviled crabs that needed only to be heated was marketed by a Philadelphia processor at a rate of 25,000 daily. The six-stage process in the manufacture of the deviled crab is given.

1956. Method maintains quality in crab cakes. Food Engineering, vol. 28, No. 2, p. 92-93.

Describes and illustrates the procedures used (including picking, quality control, and freezing) by a Maryland packing company in making crab cakes and deviled crabs.

1959. Chesapeake, stronghold of blue crab fishery. National Fisherman, vol. 40, No. 10, p. 13, 30-31.

Two-thirds of United States blue crab harvest is from Chesapeake Bay. Operations in the soft crab fishery, types of gear used to catch crabs, life history, growth, enemies, and factors affecting local abundance.

1961. How did it get there? Sea Frontiers, vol. 7, No. 3, p. 186-187.

Distribution of the blue crab in the Mediterranean. In 1948, it first appeared in the Aegean Sea, and for some years has been established along the coasts of Egypt and Lebanon. Biologists do not know how it was introduced.

1965. Invasion. Desperation as blue crabs swamp Nile delta. Fishing News International, vol. 4, No. 1, p. 56-57.

Millions of crabs swamped three major lakes, damaging nets of fishermen and reducing the number of fish available to the nets. Fishery experts considered electrified blockades and chemical ways to eliminate the crabs. No commercial use because Egyptians consider the meat unpalatable. Blue crabs entered the Mediterranean from the Atlantic Ocean and spread north to France, Greece, Turkey, and Italy ; then moved east to Egyptian waters in 1942.

1966a. The blue crab in North Carolina—a resource of great potential. North Carolina Commercial Fisheries Newsletter, vol. 2, No. 3, p. 1-4.

Blue crab predators, life history, industry (soft and hard crab), fishery, and research as they relate to North Carolina.

1966b. Soft shell crab farming. North Carolina Commercial Fisheries Newsletter, vol. 3, No. 1, p. 5-7.

Techniques used at Nags Head, N.C. Crab fykes used to capture soft shells, separation of crab stages, onshore concrete shedding bins, and marketing soft-shell crabs.

1968a. Crab pots borrow boat hulls' idea of sacrificial metals. Fish Boat, vol. 13, No. 6, p. 79, 87.

Tests in the York River, Va., indicated that the service life of blue crab pots can be more than tripled when zinc anodes are attached for corrosion protection.

1968b. Machine picks the picked crab. North Carolina Commercial Fisheries Newsletter, vol. 4, No. 3, p. 4.

The use of a new picking machine at Southport, N.C., that picks parts of the crab that previously were discarded.

1969. Crab watch. North Carolina Tar Heel Coast, vol. 5, No. 3, p. 4.

North Carolina biologists check for signs of the "gray crab sickness." Causes changes in the blood and external color and results in death in about 4 days. Mass blue crab mortalities have occurred irregularly in Georgia and South Carolina since 1964 (crab production decreased 50 percent), and these kills seem to be spreading northward and southward.

Anzulovic, J. V., and R. J. Reedy.

1954. Pasteurization of crabmeat. Fishery Market News, vol. 4, No. 1, p. 3-6.

1954. Pasteurization of crabmeat—II. Fishery Market News, vol. 4, No. 2, p. 9-10.

The two above publications give results of studies on pasteurization of crabmeat; and also specific methods of pasteurization.

Arnold, Augusta Foote.

1903. Genus *Callinectes*, p. 275-276. *In* Augusta Foote Arnold, The sea-beach at ebb-tide. The Century Co., New York.

Distribution, taxonomic description, general habits, and habitat. Second only to the lobster as the most important commercial crustacean.

Ashbrook, Frank G.

1965. The beautiful swimmer. Sea Frontiers, vol. 11, No. 6, p. 334-341.

In 1860, William Stimpson, a taxonomist, named a group of swimming crabs *Callinectes*, meaning beautiful swimmer. Popular account of the fishery, industry, and biology of the blue crab. Sport crabbers catch huge quantities along the Atlantic coast.

Atlantic States Marine Fisheries Commission.

1941-69. Annual reports to the U.S. Congress and to the Governors of Atlantic Coast States.

Various reports contain information on the blue crab industry and on research programs of Atlantic Coast States and the U.S. Fish and Wildlife Service.

Atwater, W. O.

1892. The chemical composition and nutritive values of food-fishes and aquatic invertebrates. U.S. Commissioner of Fish and Fisheries, Report for 1888, p. 679-868.

Composition of edible portion of the blue crab (protein, fat, carbohydrate, ash, and water).

Ayers, John C.

1938. Relationship of habitat to oxygen consumption by certain estuarine crabs. Ecology, vol. 19, No. 4, p. 523-527.

Rates of oxygen consumption of representative species of decapod crabs from different habitats at Beaufort, N.C. The consumption of 10 blue crabs (0.83-1.39 ml. O_2 per g. per hour) averaged higher than less active nonswimming aquatic crabs investigated.

Baley, A., and W. S. Hamill.

1935. Crab resources, p. 47-50. *In* Conservation problems in Maryland. Maryland State Planning Commission, Sub-committee on Conservation.

Crab migrations in Chesapeake Bay between Maryland and Virginia during the life cycle, and how fishing practices in each state affect the supply of crabs and crab meat.

Ballard, Buena Street.

1968. Osmotic accommodation in *Callinectes sapidus* Rathbun. Ph. D. thesis, State College, Mississippi, 1967, 59, [20] p. Dissertation Abstracts, vol. 28, No. 9, p. 3921B.

Crabs passed through a series of salinities

demonstrated good hyperregulatory ability, were nearly homoiosmotic at medium salinities, and approached isoosmoticity at high salinities. Males had lower concentrations than females at salinities less than 20 p.p.t. Seasonal effect. Factors that might affect crab distribution patterns are discussed.

Ballard, Buena S., and Walter Abbott.
1969. Osmotic accommodation in *Callinectes sapidus* Rathbun. Comparative Biochemistry and Physiology, vol. 29, No. 2, p. 671-687.
See Ballard (1968) for summary of content.

Barnes, E. W.
1904. Preliminary inquiry into the natural history of the paddler crab *(Callinectes hastatus)*, with remarks on the soft-shell crab industry in Rhode Island. Rhode Island Commissioners of Inland Fisheries, 34th Annual Report, p. 69-73.
Life history, growth, effect of temperature on growth, migrations, and the soft-shell crab fishery and industry in Rhode Island.

Baughman, J. L.
1949. Crab investigations reveal commercial facts, sex division. Seafood Business, vol. 1, No. 7, p. 36.
Seasonal distribution, abundance, and sex ratio of blue crabs in various bays of the Gulf coast of Texas. Nine percent of females with sponge were infected with a sacculinid parasite.
1950. Potentialities of the Gulf of Mexico fisheries and recommendations for their realization. Proceedings of the Gulf and Caribbean Fisheries Institute, 2nd Session, 1949, p. 118-126.
The fishery for blue crabs, the fourth largest on the Gulf coast, could be increased materially. Texas processes few of its many crabs. Need for research on ecology and location of populations to expand this fishery.

Baumberger, J. Percy, and D. B. Dill.
1928. A study of the glycogen and sugar content and the osmotic pressure of crabs during the molt cycle. Physiological Zoology, vol. 1, No. 4, p. 545-549.
Blue crab one of two species studied. Osmotic pressures, glycogen and sugar contents were reported for hard crab and crab approaching molt, a few hours before molting, during molting, and in soft condition.

Bearden, Charles M.
1967. Field tests concerning the effects of "Dibrom 14 Concentrate" (Naled) on estuarine animals. Bears Bluff Laboratories, Wadmalaw Island, S.C., Contribution No. 45, 14 p.
No significant mortalities of caged blue crabs, shrimp, and fish were observed during 14 days after aerial application of 2 ounces per acre Dibrom 14.

Beaven, G. F.
1956. Crabs eat sea squirts or *Molgula*. Maryland Tidewater News, vol. 13, No. 3, p. 3.
Confined blue crabs ate hundreds of squirts (and barnacles) in preference to oysters.

Beaven, G. F., C. K. Rawls, and G. E. Beckett.
1962. Field observations upon estuarine exposed to 2, 4-D. Proceedings of the 16th North East Weed Control Conference, p. 449-458.
Concentration of 2, 4-D butoxy ethanol ester for the control of *Myriophyllum* in tidal water did not affect (up to 5 weeks after treatment) the percentage mortality of blue crabs, soft-shell clams, and oysters. It was lethal where decomposing mats of *Myriophyllum* caused an anaerobic condition.

Beaven, G. F., and R. V. Truitt.
1939. Crab mortality on Chesapeake Bay shedding floats. Chesapeake Biological Laboratory, Solomons, Md., Contribution No. 33, 14 p.
Death rate ranges from 10 to 75 percent. Describes the molting process and the soft-crab industry. Peeler groups, by degree of instar maturity, were held to determine loss. The effects of breaking the claws, sunshine, and temperature were studied. The main cause of high mortality of shed-

der crabs is due to use of green crabs (early stage of instar maturity) as shedders.

Benarde, Melvin A.
1957a. Heat penetration into precooked frozen crab cakes. Journal of Milk and Food Technology, vol. 20, No. 11, p. 307-311.
Heat penetration tests on commercially prepared precooked frozen crab cakes indicated that wrapper directions for home heating were not adequate for public health.
1957b. Antibiotic residues in shellfish after cooking. Journal of the American Dietetic Association, vol. 33, p. 1145-1149.
Crab and oyster meats treated with various antibiotics contained biologically active residues after frying. Tests on frozen deviled crab and crab cakes indicated that the antibiotics would be retained at the temperature used to prepare the foods for eating.
1957c. Evaluation of Clorpactin WCS-50 as a bactericidal wash for crab and oyster meats. Applied Microbiology, vol. 5, p. 137-140.
The treatment can not be used on blue-crab-meat because a chlorine-like odor and a bitter taste are retained in the product.
1958a. Comparison of tap and distilled water antibiotic dip solutions on storage life of fresh crab meat. Antibiotics Annual, 1957/1958, p. 224-228.
The storage life of the product was not altered by the immersion in antibiotic dip solutions. The reason why crab meat does not readily submit to antibiotic treatment is not known.
1958b. The spoilage of crabmeat. Journal of Milk and Food Technology, vol. 21, No. 11, p. 318-321.
The relations among deterioration, bacterial count, and pH of crab meat were investigated. Measurements of pH did not indicate progressive spoilage.
1959a. Crab processing in U.S.A. Fisheries Newsletter (Canberra, Australia), vol. 18, No. 2, p. 11, 13.
An outline of procedures used in the catching, handling, processing, and utilization of scrap of the blue crab.
1959b. Study finds frozen precooked crab cakes' heating directions inadequate as stated. Quick Frozen Foods, vol. 21, No. 6, p. 43-44.
Center temperature of commercial precooked crab cakes was measured during oven heating, and temperature time curves indicate package directions do not provide adequate heat for public health.
1960. The blue crab industry of the United States, p. 97-101. *In* Harry F. Tysser [ed.] Fisheries year-book and directory, 1960. British-Continental Trade Press Ltd., London.
Procedures used in the blue crab industry for processing, freezing, marketing, by-products, sanitation, and quality control of meat. Early history of the industry. Fishing methods.
1961. A partial bibliography on some crabs of commercial importance. Food and Agriculture Organization of the United Nations, Fisheries Biology Technical Paper No. 17, [10 p.].
Includes 146 references on blue crab biology and industry.

Benarde, Melvin A., and Louis G. Austin.
1958. Bacteriology of crabmeat. Bacteriological Proceedings, Society of American Bacteriologists, 58th General meeting, 1958, p. 17.
Steaming blue-crab-meat removed coliforms and pigmented catalase-negative micrococci; spoilage was obtained by psychrophillic *Achromobacteriaceae.*
1959. Bacterial line-survey of crabmeat processing plants. Bacteriological Proceedings, Society of American Bacteriologists, 59th General Meeting, 1959, p. 9.
In-plant bacterial sampling indicated sources and amounts of recontamination of blue-crab-meat after steaming.

Benarde, Melvin A., and Robert A. Littleford.
1957. Antibiotic treatment of crab and oyster meats. Applied Microbiology, vol. 5, No. 6, p. 368-372.
Treatment of fresh picked blue-crab-meat with antibiotics was effective in extending the storage life.

Benedict, Steve.
1940. Soft crabs—and hard. Louisiana Conservation Review, Spring, p. 11-14, 48.
Popular account of sport fishing for hard- and soft-shell blue crabs and general life history.

Berry, W. R.
1955. Regulation and supervision of fresh crab meat packing plants. Quarterly Bulletin of the Association of Food and Drug Officials, vol. 19, p. 50-54.
A brief account of the life history and food value of the blue crab is presented in addition to a discussion on regulating sanitary conditions in crab packing plants.

Binford, Raymond.
1911. Notes on the life history of *Callinectes sapidus*. The Johns Hopkins University Circular, vol. 30, No. 232, p. 14-16.
A megalops was reared to the sixth crab stage over a period of 41 days. Measurements at each stage.

Birdseye, Clarence.
1932. Probable influence of quick-freezing on the shellfish industries. Transactions of the American Fisheries Society, vol. 62, p. 80-83.
Increase in the amount of frozen crab meat and in the international trade requires intensive application of scientific handling and fish cultural methods. Experiments indicate that soft shelled crabs also can be sucessfully quick-frozen.

Blake, Sidney Fay.
1953. The Pleistocene fauna of Wailes Bluff and Langleys Bluff, Maryland. Smithsonian Miscellaneous Collections, vol. 121, No. 12, 32 p.
Fossil record for the blue crab.

Bliss, A. F.
1942. Derived photosensitive pigments from invertebrate eyes. Journal of General Physiology, vol. 26, p. 361-367.
Visual pigment in the eyes of the blue crab. Wavelength of maximum spectral sensitivity.

Bliss, Dorothy E.
1963a. The pericardial sacs of terrestrial crabs. Proceedings of the 16th International Congress of Zoology, vol. 1, p. 48. Abstract only.
C. sapidus is one of six crabs compared.
1963b. The pericardial sacs of terrestrial Brachyura, p. 59-78. *In* H. B. Whittington and W. D. I. Rolfe [ed.] Phylogeny and evolution of Crustacea. Harvard University, Museum of Comparative Zoology, Special Publication.
The functions and comparative gross morphology of the pericardial sacs are discussed in the blue crab, in two other species of marine crabs, and in three terrestrial forms.

Boroughs, Howard, Walter A. Chipman, and Theodore R. Rice.
1957. Laboratory experiments on the uptake, accumulation and loss of radionuclides by marine organisms, p. 80-87. *In* The effects of atomic radiation on oceanography and fisheries, report of the Committee on Effects of Atomic Radiation on Oceanography and Fisheries of the National Academy of Sciences study of the biological effects of atomic radiation. National Academy of Sciences—National Research Council, Publication No. 551.
Experiments indicated that the body parts of blue crab, shrimp, oysters, clams, and scallops accumulated strontium rapidly from sea water.

Bosc, L. A. G.
1801. Histoire naturelle des crustaces, vol. 1. Chez Deterville, Paris, 258 p.
Data on life history, food habits, and distribution of the blue crab *(Lupa hastata* was Bosc's specific) are presented, p. 212-214.

Boschi, Enrique E.
1964. Los Crustaceos Decapodos Brachyura del litoral Bonaerense (R. Argentina). Boletin del Instituto de Biologia Marina, No. 6, 99 p.
Taxonomy of 25 decapods from the shelf-waters of Buenos Aires, Argentina. The author describes *Callinectes acutidens (C. sapidus acutidens*, Rathbun, 1895) and discusses how it differs from *C. sapidus* in structure and distribution.
1967. Preliminary note on the geographic distribution of the decapod crustaceans of the marine waters of Argentina (South-west Atlantic Ocean), p. 449-456. *In* Proceedings of the Symposium on Crustacea, Part 1. Marine Biological Association of India, Symposium Series, 2.

C. sapidus acutidens occurs in the warm-temperate region of the Argentinian Continental Shelf.

Bouvier, M. E. L.
1901. Sur un *Callinectes sapidus* M. Rathbun trouve a Rochefort. Bulletin du Museum National d'Histoire Naturelle, vol. 7, p. 16-17.
Note on the blue crab's accidental occurrence (possibly carried across the Atlantic in some vessel) in fresh water at Rochefort, France.

Boyden, Alan.
1943. Serology and animal systematics. American Naturalist, vol. 77, No. 770, p. 234-255.
A Libby photronreflector study of crustacean sera, measuring the turbidities due to interaction of precipitin antisera and various antigens. The testing of 14 anti-crustacean sera with the sera of *C. sapidus* and 10 other crustaceans provided a first quantitative estimate of the relative positions of the species to each other.

Brewington, M. V.
1953. Oysters, crabs, and fish, p. 171-189. *In* M. V. Brewington, Chesapeake Bay, a pictorial maritime history. Cornell Maritime Press, Cambridge, Md.
Refers to giant blue crabs commonly found by early settlers. Describes trotlines, pots, and dipnets used to capture crabs. Early and recent methods of marketing soft crabs. Thirteen pages of pictures.

Bromley, Al.
1953. Crustacea. New York State Conservationist, vol. 8, No. 1, p. 18-19.
An account for the general reader on the taxonomy, anatomy, respiration, and food value of the Crustacea. The blue crab is used to demonstrate the growth and development of members of this class.

Brooks, W. K.
1882. Handbook of invertebrate zoology for laboratories and seaside work. Bradler Whidden, Boston, 392 p.
Hard parts of the common crab, p. 168-185; The general anatomy of a crab, p. 190-206; The metamorphosis of a crab, p. 207-223.
1893. The crab, p. 255-260. *In* Maryland, its resources, industries and institutions. Prepared for the Board of World's Fair Managers of Maryland by members of Johns Hopkins University and others, Baltimore.
Information on abundance, distribution, occurrence in fresh water, future conservation, behavior, female migrations, and time of hatching of the blue crab. Discusses canning, by-products, transportation of hard crabs, and fishing methods of sport and commercial fishermen. Emphasizes the soft crab industry: holding pens, handling for market, and recognition of crabs about to shed.

Brown, Frank A., Jr.
1940. The crustacean sinus gland and chromatophore activation. Physiological Zoology, vol. 13, No. 3, p. 343-355.
Comparison of the chromatophoric effect in stalkless *Uca* and *Palaemonetes* after injection of extracts from whole eyestalks of *Callinectes* and six other crustaceans and from injection of extracts from only the sinus glands. The source of the chromatophorotropic substance of the eyestalk was found to be the sinus gland.
1944. Hormones in the Crustacea, their sources and activities (concluded). Quarterly Review of Biology, vol. 19, No. 2, p. 118-143.
Refers to work of other investigators concerning the influence of blue crab eyestalk extracts upon the position of retinal pigment in *Palaemonetes*.

Brown, George Gordon.
1965. Ultrastructural studies of sperm morphology and sperm-egg interactions in the decapod *Callinectes sapidus*. Association of Southeastern Biologists, Bulletin, vol. 12, No. 2, p. 43. Abstract only.
Studies on the morphological and functional aspects of blue crab sperm indicate that it is not as atypical as previously regarded.
1966. Ultrastructure studies of sperm morphology and sperm-egg interaction in the decapod *Callinectes sapidus*. Journal of Ultrastructure Research, vol. 14, No. 5-6, p. 425-440.
Functional and morphological aspects of sperm were examined by light and electron microscopy and by cytochemical methods.

1967. Ultrastructural studies on crustacean spermatozoa and fertilization. Ph. D. thesis, University of Miami, 1966. Dissertation Abstracts, vol. 28, No. 3, p. 1262B-1263B.

Functional and morphological aspects of *C. sapidus* sperm were examined by cytochemical methods and by light and electron microscopy. The spermatozoa of 13 species representing the crustacean subclasses were compared. Sperm morphology was considered useful for study of crustacean phylogeny.

Bullock, Theodore Holmes, and G. Adrian Horridge [ed.].

1965. Structure and function in the nervous systems of invertebrates, vol. 1, p. 1-798; vol. 2, p. 799-1719. W. H. Freeman and Company, San Francisco.

References to the genus *Callinectes:* neuroglia (p. 103), neurosecretion (p. 381, 384), cardiac nerves (p. 988), and death feigning (p. 1132).

Burkenroad, Martin D.

1946. Fluctuations in abundance of marine animals. Science, vol. 103, No. 2684, p. 684-686.

Deals primarily with the starfish but also discusses regular patterns of natural fluctuation in populations of crabs and other species. Surveys suggest that fluctuations of blue crabs in Chesapeake Bay have occurred throughout the history of the fishery and that drastic declines in production may not be due to over exploitation.

Burnett, Frances L., and Dorothy E. Snyder.

1954. Blue crab as starvation food of oiled American eiders. Auk, vol. 71, No. 3, p. 315-316.

Each of two eiders, among 380 killed by oil released at Chatham, Mass., had a blue crab stuck in its esophagus. Most of the dead birds had empty gizzards and had used up their fat supplies.

Burton, R. F.

1967. Ionic balance in the Crustacea. Nature (London), vol. 213, No. 5078, p. 812-813.

The author correlated the concentrations of sodium, potassium, and magnesium in the haemolymph of the blue crab and 30 other marine, terrestrial, or fresh water species of Malacostraca to determine any conditions of optimum ionic balance that did not vary between species.

Busta, F. F., Joyce B. Moore, F. B. Thomas, and W. A. B. Thomson.

1965. Preliminary observations on the bacteriological quality of fresh N. C. crab meat. North Carolina Department of Conservation and Development, Division of Commercial Fisheries, Special Scientific Report No. 6, 8 p.

Studies to select suitable methods for the bacteriological analyses of crab meat products and to determine the levels of bacterial populations in the fresh product immediately after processing and during refrigeration.

Butler, Philip A.

1954. Summary of our knowledge of the oyster in the Gulf of Mexico, p. 479-489. *In* Paul S. Galtsoff [coordinator] Gulf of Mexico, its origin, waters, and marine life. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 55, No. 89.

The blue crab was a common inhabitant of the oyster reef and often was observed cracking open the new growth on oyster shells and eating the meats.

1962. Effects on commercial fisheries, p. 20-24. *In* Effects of pesticides on fish and wildlife: A review of investigations during 1960. U.S. Fish and Wildlife Service, Circular No. 143.

Toxicity of insecticides to crabs causes loss of equilibrium. Experiments indicate that crabs may be paralyzed for weeks before they die. Blue crabs show a differential susceptibility to many control agents.

1963. Commercial fisheries investigations, p. 11-25. *In* Pesticide-wildlife studies: A review of Fish and Wildlife Service investigations during 1961 and 1962. U.S. Fish and Wildlife Service, Circular No. 167.

Bioassays to determine the relative toxicities of pesticides to juvenile blue crabs and other species. The concentrations that caused death or loss of equilibrium to 50 percent of the test population in 24 to 48 hours are given for 24 pesticides.

1965. Commercial fishery investigations, p. 65-77. *In* Effects of pesticides on fish and wildlife, 1964 research findings of the Fish and Wildlife Service. U.S. Fish and Wildlife Service, Circular No. 226.

Blue crabs survived a 5-month experimental exposure to DDT. Preliminary tests showed that a concentration of 1.0 p.p.b. kills crabs in 8 days; crabs survived 0.25 p.p.b.

1969. The significance of DDT residues in estuarine fauna, p. 205-220. *In* Morton W. Miller and George G. Berg [ed.] Chemical fallout: Current research on persistent pesticides. Charles C. Thomas, Springfield, Ill.

Feeding a DDT contaminated diet to blue crab, shrimp, pinfish, and croaker caused deaths among each group of experimental animals.

Butler, Philip A., and Paul F. Springer.

1963. Pesticides—a new factor in coastal environments. Transactions of the 28th North American Wildlife and Natural Resources Conference, 1963, p. 378-390.

In laboratory tests, juvenile blue crabs were about 100 times more resistant than shrimp to chlorinated hydrocarbon insecticides. In field studies, blue crab populations were reduced 10 to 40 percent when exposed to one treatment of DDT, and 95 to 97 percent when multiple treatments were repeated for several years.

Byrd, G. Clifford.

1956. The industry program on crabmeat plant sanitation. Journal of Milk and Food Technology, vol. 19, p. 73-75.

Discusses the regulations and objectives of various regional codes for the sanitary control of handling, packing, and distributing of crab meat, and the need for a national plan for quality standards.

Cable, R. M., and A. V. Hunninen.

1940. Studies on the life history of *Spelotrema nicolli* (Trematoda: Microphallidae) with the description of a new microphallid cecaria. Biological Bulletin (Woods Hole), vol. 78, No. 1, p. 136-157.

The cercaria develops in sporocysts in the digestive gland of *Bittium alternatum. C. sapidus* serves as the second intermediate host. The cercariae penetrate the gills and are passed by means of the blood stream to the tissues.

Carey, Francis G.

1965. Chitin synthesis *in vitro* by crustacean enzymes. Comparative Biochemistry and Physiology, vol. 16, No. 1, p. 155-158.

A chitin synthetase in subcellular particles from crustacean tissues (from the epidermis of molting *C. sapidus* or from *Artemia)* incorporates C^{14} from uridine diphosphate acetyl-C^{14} glucosamine into chitin. C^{14} acetylglucosamine is released from the product on digestion with chitinase.

Cargo, David G.

1954a. Blue crabs tagged in Chincoteague Bay. Maryland Tidewater News, vol. 11, No. 3, p. 1-4.

Returns from a tagging program indicated the general pattern of movements of Chincoteague Bay blue crabs.

1954b. Maryland commercial fishing gear. III. The crab gears. Chesapeake Biological Laboratory, Solomons, Md., Educational Series No. 36, 18 p.

Description of trotline, pot, scrape, dip nets, and lesser gears, and how fished. The crab industry, regulations on the fishery, and catch by gear (1948-52) are reviewed.

1955a. The blue crab in Maryland estuarine waters. Maryland Tidewater News, vol. 12, No. 2, p. 1-2.

Popular account of life history, migrations, industry, fishery and regulations.

1955b. Whereabouts of Maryland crabs in spring revealed. Maryland Tidewater News, vol. 11, No. 12, p. 1-2, 4.

The seasonal movements and locations of juvenile, egg-bearing, adult male, and softshell blue crabs in Chesapeake Bay.

1956a. Tiny blue crab found in Patuxent during December. Maryland Tidewater News, vol. 12, No. 11, p. 4.

Report of capture of a 1/4-inch wide crab, a size rarely collected in the Patuxent River, Md., during winter. The distribution of small crabs in Chesapeake Bay is discussed.

1956b. Sizes of crabs compared. Maryland Tidewater News, vol. 13, No. 3, p. 1, 4.

Lengths of crabs from Atlantic coast estuaries were compared. Chesapeake Bay crabs were among the largest but did not equal those from Delaware Bay.

1958a. Crabs retain dye from stained food. Maryland Tidewater News, vol. 14, No. 2, p. 6, 8.

Small blue crabs were fed fish stained with Neutral Red to indicate if dye is an effective method of marking crabs. After 6 weeks a red color was concentrated in the under surface behind the mouth. The maximum length of time the mark will be retained will be investigated.

1958b. The migration of adult female blue crabs, *Callinectes sapidus* Rathbun, in Chincoteague Bay and adjacent waters. Journal of Marine Research, vol. 16, No. 3, p. 180-191.

Most of 105 female recaptures were south of the release points (three moved northward). Only two were recaptured outside the area. Factors that may influence movements, such as a salinity gradient, are discussed.

1959. Mussels muscling in. Maryland Tidewater News, vol. 15, No. 2, p. 7.

A blue crab had a total of 213 *Mytilus edulis* (3/4 to 1-1/2 inches long) attached. Possibility of using attached organisms as tags to determine migrations.

1960. A megalops of the blue crab, *Callinectes sapidus*, in the Patuxent River, Maryland. Chesapeake Science, vol. 1, No. 2, p. 110.

This record extends the northward intrusion of the megalops stage in the Chesapeake Bay about 65 nautical miles. Salinity was 17.1 p.p.t.

Cargo, David G., and Lewis Eugene Cronin.

1951. The Maryland crab industry, 1950. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 92, 23 p.

Quantity and value of blue crab production by month, gear, and area. Life history and feeding habits are reviewed. Conservation practices discussed were release of "buckram" crabs, not holding shedder crabs for long periods before they are ready to molt, and protection of egg-bearing females.

Carley, D. H.

1968. Economic analysis of the commercial fishery industry of Georgia. University of Georgia, College of Agriculture Experiment Stations, Research Bulletin No. 37, 92 p.

Analysis of the blue crab fishery, catch, and processed products in Georgia. The blue crab makes up 50 to 60 percent of the total of all species caught and 8 to 15 percent of the total value of all species.

Carley, D. H., and C. M. Frisbie.

1968a. The blue crab, oyster, and finfish fisheries of Georgia—an economic evaluation. Georgia Game and Fish Commission, Marine Fisheries Division, Contribution series No. 12, 13 p.

Production and value of the crab fishery of Georgia, structure of selling, fishing effort, and prices received by fishermen. Low prices for crabs have caused little incentive for investment in gear. Crab production decreased 46 percent from 1960 to 1966.

1968b. The commercial fishing industry of Georgia—an economic evaluation. Georgia Game and Fish Commission, Marine Fisheries Division, Contribution series No. 7, 13 p.

Blue crabs rank second in value of Georgia landings. Investment of the fishery for crabs and the extent of wholesaling and processing in Georgia.

Carlisle, David B., and Sir Francis Knowles.

1959. Endocrine control in crustaceans. Cambridge University Press, New York and London, 120 p.

References to studies on blue crab by other investigators include endocrine influence on carbohydrate metabolism, neurosecretory fibres of the sinus gland, termination of growth, and endocrine mechanism for controlling level of blood sugar.

Carpenter, James H., and David G. Cargo.

1957. Oxygen requirement and mortality of the blue crab in the Chesapeake Bay. Chesapeake Bay Institute of The Johns Hopkins University, Technical Report No. 13, 22 p.

Low oxygen concentrations were investigated in the field and laboratory as a possible cause of summer mortalities (1951-53) of blue crabs in commercial pots. Conditions are unfavorable for holding crabs in pots for 24 hours or more

when temperatures are over 28° C. and at oxygen concentrations of less than 0.6 ml. per 1. These conditions could arise when tidal and wind velocities are low and temperatures are high.

Carricaburu, Pierre.
1966. Étude interférométrique des cônes cristallins du crabe *Callinectes sapidus.* Comptes Rendus de l'Academie des Sciences, Paris, Serie D, vol. 263, p. 1408-1410.
Determination of the indices of refraction of the crystalline cones of the eye revealed that the cones are homogeneous. The entire ommatidium is illustrated.

Carriker, Melbourne R.
1951. Observations on the penetration of tightly closed bivalves by *Busycon* and other predators. Ecology, vol. 32, No. 1, p. 73-83.
Experimental cage studies in the field and in sea water systems showed that blue crabs consumed quahogs and other bivalves. Thought to be a significant enemy of bivalves.
1967. Ecology of estuarine benthic invertebrates: a perspective, p. 442- 487. *In* George H. Lauff [ed.] Estuaries. American Association for the Advancement of Science, Washington, D. C., Publication No. 83.
The blue crab, because of its tolerance to low salinities and its great abundance in some estuaries, is discussed as an important predator (even as early juveniles) on very young benthic fauna.

Carson, Rachel L.
1943. Food from the sea, fish and shellfish of New England. U.S. Department of the Interior, Conservation Bulletin No. 33, 74 p.
A short account on the crab industry of New England. Relatively few blue crabs are included in the catch because this species reaches the limit of its range in Massachusetts.
1944. Fish and shellfish of the South Atlantic and Gulf coasts. U.S. Department of the Interior, Conservation Bulletin No. 37, 45 p.
The size and value of the blue crab industry, North Carolina to Texas. General account of the fishery, life history (Chesapeake Bay), growth, and migrations.

Carson, Rachel L., and Katherine L. Howe.
1945. Fish and shellfish of the Middle Atlantic coast. U.S. Department of the Interior, Conservation Bulletin No. 38, 32 p.
The size and value of the blue crab industry, New York to Virginia. General account of the fishery, life history, growth, and migrations. Discusses extreme fluctuations in yield of blue crabs in Chesapeake Bay.

Case, James, and G. F. Gwilliam.
1961. Amino acid sensitivity of the dacytl chemoreceptors of *Carcinides maenas.* Biological Bulletin (Woods Hole), vol. 121, No. 3, p. 449-455.
Responses of crustacean chemoreceptors to amino acids. In addition to *Carcinides*, chemoreceptor activity was demonstrated in the leg nerves of *C. sapidus*, *Libinia*, and *Paguris.*
1963. Amino acid detection by marine invertebrates. Proceedings of the 16th International Congresss of Zoology, vol. 3, p. 75. Abstract only.
The blue crab is one of the invertebrates discussed.

Causey, David.
1961. The barnacle genus *Octolasmis* in the Gulf of Mexico. Turtox News, vol. 39, No. 2, p. 51-55.
Octolasmis lowei clog the gills and gill chambers of the blue crab.

Chambers, Gilbert V., and Albert K. Sparks.
1959. An ecological survey of the Houston Ship Channel and adjacent bays. Publications of the University of Texas, Institute of Marine Science, vol. 6, p. 213-250.
Blue crabs were abundant in the bays of the survey area on the Texas coast and occurred over a wide chlorinity and temperature range. Some crabs were caught at dissolved oxygen concentrations of 1.6-2.0 p.p.m.; at lower concentrations, they were observed on floating objects or ashore.

Chesapeake Biological Laboratory.
1948. Effects of underwater explosions on oysters, crabs and fish, a preliminary report. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 70, 43 p.

Experiments in Chesapeake Bay and the Patuxent River on the effect of underwater 30-pound charges of TNT on certain fish, oysters, and blue crabs. Crabs were held in cages on the bottom at various distances (25-150 feet) from the charge. Data from crabs was somewhat erratic but indicated that lethal damage is limited to a radius of about 150 feet.

1953. The commercial fisheries of Maryland. Chesapeake Biological Laboratory, Solomons, Md., Educational Series No. 30, 45 p.

A section on blue crabs deals with the industry, fishery, life cycle, causes of decline, and problems of management.

Chidester, F. E.

1911. The mating habits of four species of the Brachyura. Biological Bulletin (Woods Hole), vol. 21, No. 4, p. 235-248.

Describes the mating habits of the blue crab before the puberty molt of the female and positions during subsequent copulation.

Chipman, Walter A.

1960. Biological aspects of disposal of radioactive wastes in marine environments, p. 3-15. *In* Disposal of radioactive wastes, vol. 2. International Atomic Energy Agency, Vienna.

Only small amounts of the radioactivity of mixed fission products administered entered the body tissues of blue crab; most was in the internal organs. Stronium radioisotopes accumulated in the shell but not in the muscles. Molting resulted in loss of radioactivity. Caesium-137 was concentrated in the edible meats.

Chisolm, Julian J., II.

1941. Hard shell—soft shell. Natural History, vol. 47, No. 1, p. 50-53.

Eight photographs of the various stages in the molting process of a blue crab with one claw. Illustrates the powers of regeneration of a lost appendage. Shedding is complete after 43 minutes, and shell hardens in 2 to 3 days.

Christmas, J. Y.

1969. Parasitic barnacles in Mississippi estuaries with special reference to *Loxothylacus texanus* Boschma in the blue crab *(Callinectes sapidus)*. Proceedings of the 22nd Annual Conference, Southeastern Game and Fish Commissioners, p. 272-275.

The author concluded that heavy infestation of *Loxothylacus* could appreciably deplete the blue crab population. Infested juveniles were altered sexually and those with externae did not molt. Ventral oyster fouling of parasitized crabs was observed.

Churchill, Edward P., Jr.

1918. Conservation of the blue crab of Chesapeake Bay. Conservation Commission of Maryland, Official Bulletin, vol. 5, p. 9-14.

Depletion of the supply, wastefulness of fishery, legislation and restrictions on fishery. Also includes a brief account of life history.

1920. Crab industry of Chesapeake Bay. U.S. Commissioner of Fisheries, Report for 1918, Appendix 4, 25 p.

Growth and size of blue crab industry, crabbing grounds, seasons, regulations, methods of capture, preparation for market, and prices.

1921. Life history of the blue crab. Bulletin of the U.S. Bureau of Fisheries for 1917-1918, vol. 36, p. 91-128.

An early classical account of distribution, life history, growth, migrations, longevity, and effects of winter temperatures on habits. Molting sequence and internal and external sexual characteristics are illustrated.

1942. The zoeal stages of the blue crab, *Callinectes sapidus* Rathbun. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 49, 26 p.

Zoeal stages obtained by hatching and collecting indicated that the blue crab has a prezoeal and five zoeal stages. The zoea and the megalops are described and pictured. Early stages were most abundant at the surface and the later stages at the bottom of lower Chesapeake Bay. It requires about 1 month for the crab to pass through the zoeal stages.

Cochran, Doris M.

1935. The skeletal musculature of the blue crab, *Callinectes sapidus* Rathbun. Smith-

sonian Miscellaneous Collections, vol. 92, No. 9, 76 p. (Ph. D. thesis of same title, University of Maryland, 1933).

Structure and function of the muscles of the exoskeleton, stomach, and appendages. Comparisons are made with other crustaceans.

Coe, Wesley R.

1902. The nemertean parasites of crabs. American Naturalist, vol. 36, No. 426, p. 431-450.

Descriptions and life histories of various American and European nemerteans. Nemerteans were not found on blue crabs, and there was no infection when worms and crabs were placed together in the same container.

1943. Biology of the nemerteans of the Atlantic coast of North America. Transactions of the Connecticut Academy of Arts and Sciences, vol. 35, p. 129-328.

Summarizes the physiological, ecological, and embryological characteristics of the nemerteans. The distribution and a systematic description of each of 53 species (some are associated with the blue crab).

Coker, Robert E.

1902. Notes on a species of barnacle *(Dichelaspis)* parasitic on the gills of edible crabs. Bulletin of the U.S. Fish Commission for 1901, vol. 21, p. 399-412.

Many blue crabs, particularly females (89 percent), were infested at Beaufort, N.C. No organic connection between the barnacle and host, but the barnacle does cause loss of vitality by impairing respiration. The gills may contain over a thousand. The development of the barnacle is described.

Cole, William H.

1940. The composition of fluids and sera of some marine animals and of the sea water in which they live. Journal of General Physiology, vol. 23, p. 575-584.

Freezing points, pH, and composition of blue crab fluids and of the sea water. Ratios of ionic concentrations in fluids to those in sea water.

Combs, G. F.

1952. Report on ration trial conducted at Maryland's new broiler substation. Fish Meal and Oil Industry, vol. 4, No. 4, p. 22-23, 54-56.

Inclusion of crab meal or menhaden meal in rations for poultry increased the weight of the birds and decreased the amount of food required to feed them.

Commercial Fisheries Review.

1946. DDT. Commercial Fisheries Review, vol. 8, No. 6, p. 30-32.

A warning that care must be taken in applying DDT because of the danger to crabs and other aquatic animals. Dead crabs were observed along Island Beach, N.J., 10 days after the application of only 1/2 pound per acre.

1951. U.S. pack of canned crab meat, 1950. Commercial Fisheries Review, vol. 13, No. 9, p. 15-16.

Quantity and value of the pack of east coast (blue crab) and west coast crab meat, 1940-50. The 1950 pack was the lowest since 1944.

1955a. Chincoteague Bay winter crab fishery. Commercial Fisheries Review, vol. 17, No. 3, p. 32-33.

The December 1 to March 15 dredge fishery (about 35 boats) captured primarily female blue crabs. Studies have shown that the Chincoteague blue crab is probably a genetically stunted race and that adults may become even smaller in the future.

1955b. Crab-meat packing sanitation. Commercial Fisheries Review, vol. 17, No. 6, p. 39-41.

In 1953, cases of food poisoning along the Atlantic coast appeared to be due to crab meat. New York revised the crabmeat regulations after an investigation established corrective measures.

1956. Suggestions for crab meat packers and for transporters of fresh crab meat. Commercial Fisheries Review, vol. 18, No. 7, p. 41-43.

Suggestions by New York Bureau of Food and Drugs to aid in maintaining bacterial quality control when crab meat is prepared, handled, packed, and shipped.

1960a. Maryland samples winter blue crab populations for clues to future harvests. Commercial Fisheries Review, vol. 22, No. 3, p. 20.

Dredging for hibernating crabs (crab activity almost ceases when water cools to 5° C.) as one phase of predicting crab harvests. Crabs preferred bottoms of mud or oyster shells and water 10 to 20 feet deep. None were found below 50 feet.

1960b. Chesapeake Bay blue crabs scarce in 1959/60 winter. Commercial Fisheries Review, vol. 22, No. 2, p. 32.

Size of dredge fishery for blue crabs. Virginia biologists prediction of a near record low harvest based on a small brood the previous year. Winter hibernating crabs bedded down among millions of blue mussels which attached themselves to the crabs.

1960c. Chesapeake Bay shortage ended. Commercial Fisheries Review, vol. 22, No. 9, p. 19.

Predictions of blue crab catches in Chesapeake Bay a year in the future based on the number of small crabs caught with an experimental trawl and from reports of commercial catch of hard and peeler crabs.

1962. New crab-picking machine invented. Commercial Fisheries Review, vol. 24, No. 9, p. 19.

Describes and illustrates a power-driven crab-picking portable machine invented in North Carolina. Believed to be the first of its kind to use a dry process. The crab first must be debacked and sectioned into cupcake sized portions.

1963. Experiments on microwave pasteurization of crab meat promising. Commercial Fisheries Review, vol. 25, No. 9, p. 33.

Account of experiments at (U.S.) Technological Laboratory, Gloucester, Mass., on pasteurizing blue crab meat with high frequency microwaves. Crab meat was heated to a proper internal temperature in 2 minutes in comparison to the 75 minutes required in a hot-water bath.

1965a. Semiautomatic cleaner-debacker machine. Commercial Fisheries Review, vol. 27, No. 5, p. 12-13.

Successful in-plant trials of a machine (illustrated) that cleans and debacks whole cooked blue crabs.

1965b. Plastic container approved by Maryland. Commercial Fisheries Review, vol. 27, No. 10, p. 31.

Provided crab meat protection equal to the metal cans in use. Tests at Crisfield, Md., showed that for storage of meat longer than 4 months, plastic was superior.

1965c. Cleaner-debacker machine to be tested under commercial conditions. Commercial Fisheries Review, vol. 27, No. 12, p. 27.

Machine built by an Alexandria, Va., firm (contract with the Bureau of Commercial Fisheries) was to be tested by industry. The machine eliminates several steps of hand operation and research is underway to develop other attachments to automate further the cleaning process.

1967. Investigates blue crab mortalities. Commercial Fisheries Review, vol. 29, No. 7, p. 30.

Heavy blue crab mortality from Charleston, S.C., to Sapelo Island, Ga. Biologists investigating to determine cause. Mortality the previous year is attributed to bacterial infection of the gills.

1968. Crab industry warned of economic ruin. Commercial Fisheries Review, vol. 30, No. 1, p. 13-14.

Based on report by G. Robert Lunz, Bears Bluff Laboratory, on the decline of crab production in South Carolina (almost 25 percent decline each year, 1964-67). Contributing factors in the decline were two large crab kills of unknown cause, possibly pollution, changes in marshes, pesticides, and adverse weather.

Conant, F. S., and H. L. Clark.

1896. On the accelerator and inhibitory nerves to the crab's heart. Journal of Experimental Medicine, vol. 1, No. 2, p. 341-347.

Anatomical description of the regulatory nerves of the heart of *Callinectes*.

Conn, H. W.

1883. An instance of sexual color variation in Crustacea. Johns Hopkins University Circulars, vol. 3, No. 27, p. 5.

Color variation in the claws of male and female blue crabs.

1884a. Evidence of a protozoea stage in crab development. Annals and Magazine of Natural History, London, vol. 5, No. 13, p. 152. Also in: Johns Hopkins University Circulars, vol. 3, No. 28, p. 41.

Comparative studies on the larval cuticle of

crabs indicated that the protozoea, rather than the zoea, is the ancestral stem from which the decapods have been derived.

1884b. The significance of the larval skin of decapods. Studies of the Biological Laboratory, Johns Hopkins University, vol. 3, No. 1, p. 1-27.

The zoeal forms of the blue crab and other decapods are compared and related to phylogenetic stages. Concludes that all decapods refer back to a form with segmented thorax and abdomen, whose antennae were locomotor organs. In their larval history, the protozoea was modified by the free life of the embryo, resulting in a zoeal stage. The zoeae is a secondary larval modification and not an ancestral form.

Cook, C.

1867. The edible crab in Salem. American Naturalist, vol. 1, p. 52.

Two specimens of blue crab taken near Salem, Mass.

Copeland, B. J.

1965. Fauna of the Aransas Pass Inlet, Texas. I. Emigration as shown by tide trap collections. Publications of the University Of Texas, Institute of Marine Science, vol. 10, p. 9-21.

Collections in a tide trap indicated that peak abundance of blue crabs in the inlet was during late April and May, with a biomass as great as 5 g. per $m.^3$.

Copeland, D. Eugene.

1963a. Glandular cells, possibly osmoregulatory, in the gill leaflets of *Callinectes*. Biological Bulletin (Woods Hole), vol. 125, No. 2, p. 376. Abstract only.

The respiratory platelets of the gill of *C. sapidus* have a cellular patch (morphology given) near the efferent vessel which may account for the absorption of salts by the gills when the crab adapts to fresh water.

1963b. Possible osmoregulatory cells in crab gills. Journal of Cell Biology, vol. 19, p. 16A. Abstract only.

A patch, glandular in appearance, in the respiratory leaflets of the blue crab may account for salt absorption under hypo-osmotic conditions.

1964. Salt-absorbing cells in gills of crabs, *Callinectes* and *Carcinus*. Biological Bulletin (Woods Hole), vol. 127, No. 2, p. 367-368. Abstract only.

The fine structure of the salt-absorbing cells in the gills of fresh-water adapted crabs. This patch of cells and the network of tubules associated with the patch hypertrophied in *Callinectes* on adaption to fresh water.

1966. Septate desmosomes and juxtaposition membranes. Journal of Cell Biology, vol. 31, No. 2, p. 24A. Abstract only.

Morphology of desmosomes of *C. sapidus*, *Physalia*, and *Artemia*.

1967. Modified or "indirect" pinocytosis. Journal of Cell Biology, vol. 35, No. 2, p. 27A-28A. Abstract only.

Salt osmosis by the cells in the respiratory platelets of the blue crab. The structure and action of these cells indicate that they may function in modified pinocytosis.

1968. Fine structure of salt and water uptake in the land crab, *Gecarcinus lateralis*. American Zoologist, vol. 8, No. 3, p. 417-432.

Comparison of the fine structure of the osmoregulatory tissue in gills of *Gecarcinus lateralis* and *C. sapidus*, and discussion of cellular mechanisms of water movement from the ventral setae of each species of crab up to the pericardial sac.

Copeland, D. Eugene, and Austin T. Fitzjarrell.

1968. The salt absorbing cells in the gills of the blue crab *(Callinectes sapidus* Rathbun) with notes on modified mitochondria. Zeitschrift für Zellforschung und Mikroskopische Anatomie, vol. 92, p. 1-22.

Fine structure of an epithelial layer of cells in the respiratory platelets of the crab gill that appear to absorb salt by active transport. Possible correlations between the structural mechanisms and the physiology of active transport.

Cornell, J. H.

1948. Potential by-products of the South Carolina fisheries industry. Bears Bluff Laboratories, Wadmalaw Island, S.C., Contribution No. 5, 10 p.

Because only 14 percent of the blue crab is edible meat, an estimated 1,290 tons of

waste result in the South Carolina production of crab (1947). In addition to poultry food, this highly nutritive potential food should find a ready market as the basis of other animal foods and in the manufacture of products such as chemicals, fertilizers, soaps, oils, and vitamin concentrates.

Costello, Thomas J., Donald M. Allen, and Carl H. Saloman.
1963. Marking spiny lobsters, *Panulirus argus*, and blue crabs, *Callinectes sapidus*, with biological stains. p. 83-85. *In* Biological Laboratory, Galveston, Tex., fishery research for the year ending June 30, 1962. U.S. Fish and Wildlife Service, Circular No. 161.
The color of the stains is visible in the gill filaments of juvenile blue crabs after 40 days. Because the stained gills do not fade with cooking of the crabs, marked individuals can be recovered when the meat is picked.

Costlow, John D., Jr.
1963a. Regeneration and metamorphosis in larvae of the blue crab, *Callinectes sapidus* Rathbun. Journal of Experimental Zoology, vol. 152, No. 3, p. 219-228.
A claw was completely regenerated when autotomy was induced before the 4th day after the final zoeal molt. This was considered indirect evidence for the presence of functional Y organs in the megalops stage.
1963b. The effect of eyestalk extirpation on metamorphosis of megalops of the blue crab, *Callinectes sapidus* Rathbun. General and Comparative Endocrinology, vol. 3, No. 2, p. 120-130.
Endocrines other than the molt-inhibiting hormone of the x organ of the eyestalks and the molt-accelerating hormone of the Y organ appear to be involved in metamorphosis of the megalops and in post-larval molting.
1963c. Larval development. AIBS [American Institute of Biological Sciences] Bulletin, vol. 13, No. 5, p. 63-65.
Various aspects of larval development based on the sequence of developing stages in the Brachyura. Experiments show that although eyestalk extirpation very early in megalops development accelerates post-larval molting in the blue crab, removal of both eyestalks after the first 24 hours of megalops life does not alter the frequency of molting.
1965. Variability in larval stages of the blue crab, *Callinectes sapidus*. Biological Bulletin (Woods Hole), vol. 128, No. 1, p. 58-66.
Three general types of variability: molting without perceptible morphological changes, elimination of a larval stage, and molt resulting in morphological characters normally attributed to two zoeal stages. Possible effects of salinity, light, diet, and malfunction of endocrine mechanisms discussed.
1967. The effect of salinity and temperature on survival and metamorphosis of megalops of the blue crab *Callinectes sapidus*. Helgolaender wissenschaftliche Meeresuntersuchungen, vol. 15, p. 84-97.
Reared megalops were maintained in 23 combinations of salinity and temperature to determine effect on survival and rate of development. In lower salinities survival decreased with temperature. At 15° C. the increase in duration of the megalops with an increase in salinity was pronounced.
1968. Metamorphosis in crustaceans, p. 3-41. *In* William Etkin and Lawrence I. Gilbert [ed.] Metamorphosis, a problem in developmental biology. Appleton-Century-Crofts, New York.
Osmoregulatory ability of larval stages of the blue crab. The effect of salinity and temperature on the time of metamorphosis from the megalops to the first-crab stage. Variability in the morphology and the number of larval stages. Mechanisms that control larval molting and rate of development. Processes that control limb regeneration in larvae.

Costlow, John D., Jr., and C. G. Bookhout.
1959. The larval development of *Callinectes sapidus* Rathbun reared in the laboratory. Biological Bulletin (Woods Hole), vol. 116, No. 3, p. 373-396.
Provides a detailed description of all larval stages and discusses the effects of salinity and temperature on larval development.
1960. A method for developing brachyuran

eggs *in vitro*. Limnology and Oceanography, vol. 5, No. 2, p. 212-215.

The blue crab was one of six species successfully hatched by detaching the eggs from the female, placing them in compartmented boxes, and maintaining them on an Eberbach variable speed shaker at constant temperatures at different salinities.

1964. An approach to the ecology of marine invertebrate larvae. Proceedings of Symposium on Experimental Marine Ecology. University of Rhode Island, Occasional Publication No. 2, p. 69-75.

The blue crab was one of four species used as examples of how salinity and temperature can vary in their effect on larval development. Zoeal development did not occur below 20.1 p.p.t. but experiments indicated that the megalops can complete metamorphosis to the first crab in salinities as low as 5 p.p.t.

1965. The effect of environmental factors on larval development of crabs, p. 77-86. *In* Clarence M. Tarzwell [ed.] Biological problems in Water Pollution, 3rd Seminar. U.S. Public Health Service, Publication No. 999-WP-25.

The blue crab was one of five species studied to determine how salinity and temperature affect larval development. Blue crab larvae hatched at salinity of 20.1 p.p.t. but not at 15.0 p.p.t. Complete larval development occurred only at 25° C. in 20.1, 26.7, and 31.1 p.p.t.

1969. Temperature and meroplankton. Chesapeake Science, vol. 10, No. 3-4, p. 253-255.

Combined effect of salinity and temperature on the time required for metamorphosis of blue crab megalops.

Costlow, John D., Jr., George H. Rees, and C. G. Bookhout.

1959. Preliminary note on the complete larval development of *Callinectes sapidus* Rathbun under laboratory conditions. Limnology and Oceanography, vol. 4, No. 2, p. 222-223.

Larval development in the laboratory showed seven zoeal stages over 30 to 39 days and a megalops stage which persisted from 6 to 11 days before molting into the first crab stage.

Costlow, John D., Jr., and A. N. Sastry.

1966. Free amino acids in developing stages of two crabs, *Callinectes sapidus* Rathbun and *Rhithropanopeus harrisii* (Gould). Acta Embryologiae et Morphologiae Experimentalis, vol. 9, p. 45-55.

Glycine, lysine, and asparitic acid were common in all larval stages of blue crabs. The relative concentration of free amino acids was highest in the eggs and their number decreased after the second zoeal stage. There was little variation in amino acid composition in crabs at different environments.

Cottam, Clarence, and Elmer Higgins.

1946. DDT: its effect on fish and wildlife. U.S. Fish and Wildlife Service, Circular No. 11, 14 p.

Edible crabs died (as many as 150 over one 200-yard stretch) at Island Beach, N.J., after a DDT spray (0.5 pound per acre) for mosquito control. Initial blue crab mortality also was high at Wallops Island, Va., after an area was sprayed with 0.8 pound of DDT per acre.

Couch, John A.

1966. Two peritrichous ciliates from the gills of the blue crab. Chesapeake Science, vol. 7, No. 3, p. 171-173.

Peritrichous ciliates of *Lagenophrys* and *Epistylis* were found on the gill lamellae of blue crabs from Chincoteague and Chesapeake Bays. Many occurred on gills of moribund crabs in holding tanks, but it was uncertain if they contributed to mortality.

1967. A new species of *Lagenophrys* (Ciliatea: Peritrichida: Lagenophryidae) from a marine crab, *Callinectes sapidus*. Transactions of the American Microscopical Society, vol. 86, No. 2, p. 204-211.

Described from the gills of blue crabs from Maryland to South Carolina. Aspects of its host-commensal relationship are reported.

Couch, John N.

1942. A new fungus on crab eggs. Journal of the Elisha Mitchell Scientific Society, vol. 58, No. 2, p. 158-162.

The method of infection and the life history of a new species of fungus,

Lagenidium callinectes, growing as a parasite on blue crab eggs.

Coues, Elliott.
1871. Notes on the natural history of Fort Macon, N.C., and vicinity. (No. 2). Proceedings of the Academy of Natural Sciences of Philadelphia, vol. 23, p. 120-148.
Occurrence of shells, decapods, and some other marine invertebrates. Blue crab shells (cast off in molting) occurred in great numbers in shallow pools in the marsh during April.

Coulson, E. J.
1935. The iodine content of some American fishery products. U.S. Bureau of Fisheries, Investigational Reports, vol. 1, No. 25, 7 p.
Iodine content of crab meal was found to be very high, and therefore, iodine must also be concentrated largely in non-edible portions of crabs.

Cowles, R. P.
1931. A biological study of the offshore waters of Chesapeake Bay. Bulletin of the U.S. Bureau of Fisheries for 1930, vol. 46, p. 277-381.
In a series of cruises, the blue crab was taken infrequently in offshore dredging and trawling in Chesapeake Bay, and most were juveniles. One large catch of crabs was made at a depth of 28 m. at water temperature of 10.1° C.

Cronin, Lewis Eugene.
1942. A histological study of the development of the ovary and accessory reproductive organs of the blue crab, *Callinectes sapidus* Rathbun. M.S. thesis, University of Maryland, 37 p.
Morphology and development of the ovary, germinal cord, eggs, accessory cells, and seminal receptacles. Relation of growth rate of the female crab to ovarian development.
1946. Anatomy of the male reproductive system of the blue crab, *Callinectes sapidus* Rathbun. Ph. D. thesis, University of Maryland, 71 p.
Gross and histological anatomy of the testis, vas efferens, vas deferens, penis, and first and second pleopods.
1947. Anatomy and histology of the male reproductive system of *Callinectes sapidus* Rathbun. Journal of Morphology, vol. 81, No. 2, p. 209-239.
The internal and external organs of the adult male reproductive system are described and illustrated. How they function is also presented.

1949a. Comparison of methods of tagging the blue crab. Ecology, vol. 30, No. 3, p. 390-394.
The best technique for tagging adult crabs employed special Nesbit-type tags wired across the carapace. Various methods were evaluated on the basis of listed assumptions which must be valid before tagging can be successfully used.

1949b. The Maryland crab industry. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 76, 42 p.
Gross statistics on the 1948 blue crab catch by gear and by area. Value of these records. Survey of crab industry to poll opinions on crab conservation and administration.

1950. The Maryland crab industry, 1949. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 84, 41 p.
Statistics on Maryland crabbing in 1949, by gear and by area. Value of these records. Discusses the recent use of the crab pot in Maryland, and the new problems facing the industry as a result of potting.

1952-54. Blue crab studies. University of Delaware Marine Laboratory. Annual Report 1952, p. 44-47; and Biennial Report 1953-54, p. 65-70.
Progress of research on migrations of blue crab in Delaware Bay and on biometric, or size, characteristics.

1967. The role of man in estuarine processes, p. 667-689. *In* George H. Lauff [ed.] Estuaries. American Association for the Advancement of Science, Publication No. 83.
The upstream flow of deep water may be essential to the dispersion of young blue crabs in Chesapeake Bay. This flow provides for the annual redistribution of juveniles to all upstream areas, and is one of the forces contributing to the resiliency of estuaries.

Cronin, L. Eugene, Willard A. Van Engel, David G. Cargo, and Frank J. Wojcik.
1957. A partial bibliography on the genus *Callinectes*. Virginia Fisheries Laboratory, Gloucester Point, Special Scientific Report, No. 8; and, Maryland Department of Research and Education, Reference No. 57-26, 21 p.
Divided into three groups: complete, published references; manuscripts; and incomplete or unchecked references. A subject index is included.

Cummins, Robert, Jr., and Joaquim B. Rivers.
1962. Blue crab trawl fishery of Georgia. Commercial Fisheries Review, vol. 24, No. 3, p. 1-6.
The fishery in bays and sounds is year-round; a double-rigged trawler can average 1,500 to 2,000 pounds of crabs a day. The specially designed 57-foot trawls are described and illustrated.

Darnell, Rezneat M.
1958. Food habits of fishes and larger invertebrates of Lake Pontchartrain, Louisiana, an estuarine community. Publications of the University of Texas, Institute of Marine Science, vol. 5, p. 353-416.
Blue crabs fed principally on mollusks (clams, mussels, and snails), crustaceans (crabs and some barnacles), and to a lesser degree on insects, hydroids, annelid worms, fish, algae, and vascular plants. Foods of young and adults were similar. Blue crabs often were an important food for various fish such as alligator gar, yellow bass, and largemouth bass.
1959. Studies of the life history of the blue crab *(Callinectes sapidus* Rathbun) in Louisiana waters. Transactions of the American Fisheries Society, vol. 88, No. 4, p. 294-304.
Life history, growth, food habits, parasites, physiological rhythms, and periodicity in Lake Pontchartrain.

Dassow, John A.
1963. The crab and lobster fisheries, p. 193-208. *In* Maurice E. Stansby [ed.] Industrial fishery technology. Reinhold Publishing Corporation, New York.
Methods of fishing for blue crabs. Procedures used in the industry for soft-shell, fresh, frozen, and canned blue crab products.

Dassow, John A., S. R. Pottinger, and John Holston.
1956. Preparation, freezing, and cold storage of fish, shellfish, and precooked fishery products. Refrigeration of fish. Part 4. U.S. Fish and Wildlife Service, Fishery Leaflet No. 430, 124 p.
Methods of catching blue crabs, preparation and freezing of picked meat, and preparation of soft-shell crabs. Frozen-storage life of meat is about 1 month.

Daugherty, F. M., Jr.
1952. The blue crab investigation, 1949-50. Texas Journal of Science, vol. 4, No. 1, p. 77-84.
An investigation of the blue crab in Texas waters. Most spawning occurs in the Gulf of Mexico where the eggs hatch. Spawning extends from December to October. A gulfward movement of females reaches a peak in June and July. Crabs were infested (6.9 percent) with *Loxothylacus texanus*.

Davis, Charles C.
1942. A study of the crab pot as a fishing gear. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 53, 20 p.
The crab pot is efficient and easier to fish than the trot-line. From the viewpoint of conservation, it would harm the resource if used in shallow waters rather than in the open Chesapeake Bay, and if there were no restrictions on the number fished. Describes the pot and how fished.
1965. A study of the hatching process in aquatic invertebrates. XX. The blue crab, *Callinectes sapidus*, Rathbun. XXI. The nemertean, *Carcinonemertes carcinophila* (Kölliker). Chesapeake Science, vol. 6, No. 4, p. 201-208.
Hatching mechanisms in the blue crab and in its egg and gill parasite. Crabs escape from the egg membrane as a prezoea. Ecdysis to first zoeal stage occurs after emergence. In *Carcinonemertes*, the larva escapes from the egg membrane by secretion of an enzyme.

Dean, John Mark, and F. John Vernberg.
1965a. Effects of temperature acclimation on some aspects of carbohydrate metabolism in decapod Crustacea. Biological Bulletin (Woods Hole), vol. 129, No. 1, p. 87-94.
Variations in carbohydrate metabolism with temperature acclimation. The blue crab was one of several species, in which physiological factors such as blood glucose, the total reducing sugar in the blood, and hepato-pancreas glycogen levels were determined. Includes a qualitative analysis of blood carbohydrates.
1965b. Variations in the blood glucose level of Crustacea. Comparative Biochemistry and Physiology, vol. 14, No. 1, p. 29-34.
Study on the effect of the reproductive stage of females on the blood glucose level of the blue crab and other Crustacea. The blood glucose of crabs increases twofold as eggs are developed.

Degens, Egon T., Francis G. Carey, and Derek W. Spencer.
1967. Amino-acids and amino-sugars in calcified tissues of portunid crabs. Nature, vol. 216, No. 5115, p. 601-603.
A study on *C. sapidus*, *Ovalipes*, and *Carcinides* to identify the factors in the calcification process of the exoskeleton; the extent of mineralization largely determines the flexibility and hardness. The amino-acid and amino-sugar compositions of representative regions in the exoskeleton were determined and related to calcification.

De Kay, James E.
1844. Crustacea, p. 1-70. *In* James E. De Kay, Zoology of New-York, or the New-York fauna, Pt. 6. Carroll and Cook, Albany.
Description, taxonomy, molting process, distribution, and occurrence in fresh water (100 miles upstream in the St. Johns River, Fla.) of the blue crab (here named *Lupa dicantha).* Said to furnish a cheap and savory food; fried soft-shelled crabs are a particular luxury, and many crabs are caught to feed hogs.

de Oliveira, Lejeune P.H.
1956. Algumas propriedades geométricas propostas como testes auxiliares para identificação dos seres vivos, exemplificadas em siris do gênero "*Callinectes*" (Portunidae, Crustacea). Revista Brasileira de Biologia, vol. 16, No. 1, p. 17-23.
Curves and their equations were derived from geometrical configurations of the external anatomy of six species of *Callinectes* (including *C. sapidus* and *C. sapidus acutidens).*

Devillez, Edward Joseph Michael.
1965. Isolation and characterization of proteinases from the gastric juice of the crayfish *Orconectes virilis* (Hagen). Ph. D. thesis, University of Illinois, 1964. Dissertation Abstracts, vol. 25, No. 8, p. 4791-4792.
Gastric juice extracts of the lobster and the blue crab contained enzymatic activity in the alkaline range on P-toluenesulfonyl-L-arginine methyl ester (TAME), but neither extract contained a component common in electrophoretic mobility with the TAME component from the crayfish.

Donnellon, James A.
1940. Blood clotting in *Callinectes sapidus.* Biological Bulletin (Woods Hole), vol. 79, No. 2, p. 370. Abstract only.
Blood clotting involves both a cellular clot and a plasma clot. Factors that hasten and inhibit clotting are discussed. Plasma clotting is initiated by one or more substances liberated from the cells and also appears to be dependent upon Ca.

Dragovich, Alexander, and John A. Kelly, Jr.
1964. Ecological observations of macroinvertebrates in Tampa Bay, Florida, 1961-1962. Bulletin of Marine Science of the Gulf and Caribbean, vol. 14, No. 1, p. 74-102.
The blue crab is included in an annotated checklist. It occurs throughout the bay and offshore. No ovigerous females were observed and largest specimen collected was 200 mm. wide. Also discusses commercial fishery and crab distribution in relation to bottom type.

Duchâteau, Ghislaine, and Marcel Florkin.
1954. Sur la compisition de l'arthropodine et de la scléroprotéine cuticulares de deux crustaces décapodes *(Homarus vulgaris* Edwards

and *Callinectes sapidus*, Rathbun). Physiologia Comparata et Oecologia, vol. 3, No. 4, p. 365-369.

Arthropodine was extracted and reprecipitated from the cephalothoracic exoskeleton. Cuticular scleroprotein was obtained by further extraction. Amino acid compositions were estimated microbiologically.

Duke, Thomas W., John P. Baptist, and Donald E. Hoss.

1966. Bioaccumulation of radioactive gold used as a sediment tracer in the estuarine environment. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 65, No. 2, p. 427-436.

Accumulation by selected marine animals in the laboratory and field. Only a small portion of the gold placed in the gut of blue crabs was assimilated from the stomach, indicating that more than tracer amounts would need to be ingested rapidly before the gold would concentrate in edible tissues. Blue crabs in sea water containing radioactive gold accumulated more radioactivity than clams, clay, and fish. In a field test, oysters accumulated more gold than did crabs and fish.

Dumont, Wm. H., and G. T. Sundstrom.

1961. Commercial fishing gear of the United States. U.S. Fish and Wildlife Service, Circular No. 109, 61 p.

The crab pound net, trotline, crab dredge, and wooden and wire pots used to capture blue crabs are illustrated.

Dunker, C. F., D. H. B. Ulmer, Jr., and G. W. Wharton.

1960. Factors affecting yield of meat from the blue crab. Proceedings of the Gulf and Caribbean Fisheries Institute, 12th Annual Session, 1959, p. 40-46.

Covers methods of cooking, seasonal yield of various types of meat, effect of length of cooking, comparison of yield of crabs from two locations, effect of cooking temperature, handling after cooking, and summary of optimum conditions for maximum yield.

Dunnington, E. A.

1956. Blue crabs observed to dig soft shell clams for food. Maryland Tidewater News, vol. 12, No. 12, p. 1,4.

Patuxent River blue crabs commonly dug and ate *Mya arenaria*. Both share the same habitat. Adult crabs can dig a hole 4 inches deep and as wide as their body in 20 to 30 minutes. Details of digging, which appears to be a general search for food. Effects of this predation upon the soft shell clam population is not known.

Earle, Swepson.

1924. Maryland's efforts to save the blue crab of Chesapeake Bay. Maryland Conservation Bulletin No. 1, 16 p.

Review of life history and development of the industry. Scarcity and ways to conserve crabs. Scarcity attributed to the capture of egg-bearing females, waste of "buckram" crabs, caging crabs before they are ready to molt, and catching undersized crabs.

1925. Crab conservation. Maryland Conservationist, vol. 2, No. 3, p. 14.

The author reports that because of a marked decrease in the supply of crabs in Maryland, various conservation measures, particularly protection for egg-bearing female crabs in Virginia, must be adopted.

1932a. A blow to the Chesapeake crab industry. Maryland Conservationist, vol. 9, No. 3, p. 9-10.

The reasons why a Virginia bill permitting the taking of egg-bearing female crabs during April, May, and June should not be passed.

1932b. The fisheries of Chesapeake Bay. Transactions of the American Fisheries Society, vol. 62, p. 43-49.

The blue crab was not greatly in demand until about 1900, when refrigerated transport service became available. Discusses production decline to a low of 29 million pounds in 1925 and the conservation measures enacted. Life history reviewed.

Earll, R. Edward.

1887. Maryland and its fisheries, p. 421-448. *In* George Brown Goode [ed.] The fisheries and fishery industries of the United States, Section 2, Pt. 10. U.S. Commission of Fish and Fisheries, Washington, D.C.

Methods of raising and shipping soft-shell blue crabs (started at Crisfield in 1876), and canning and shipping hard crabs.

Empey, W. A.
1954. Fish handling and processing in U.S.A.: Crabs. Australian Fisheries Newsletter, vol. 13, No. 5, p. 15,17.
Summarizes the methods used to prepare soft crabs for frozen and live products, and of hard crabs for canned, iced cooked, and fresh, live products.

Engel, David W.
1967. Effect of single and continuous exposures of gamma radiation on the survival and growth of the blue crab, *Callinectes sapidus.* Radiation Research, vol. 32, No. 4, p. 685-691.
Intensity of behavioral change decreased with decreasing radiation dose. Survival and growth were reduced only at the highest radiation dose. Crabs receiving the lowest dose grew at the greatest rate.

Evans, Prentiss W.
1939. The Chesapeake Bay soft crab industry. U.S. Fish and Wildlife Service, Fishery Market News, vol. 1, No. 6, p. 3-5.
Soft-crab industry extends from Cape Cod to Texas. Season in Chesapeake Bay is from April to November. Magnitude of the industry, methods of capture, and handling (shedding floats, grading, packing, and shipping).
1946. The Chesapeake Bay soft crab industry. U.S. Fish and Wildlife Service, Fishery Leaflet No. 184, 5 p.
A comprehensive summary of the soft-crab industry that includes information on market development, fishing methods, floats, packing, grading, and transportation.

Fairbanks, W. L., and W. S. Hamill.
1932. Crabs, p. 50-55. *In* W. L. Fairbanks and W. S. Hamill, The fisheries of Maryland. Maryland Development Bureau of the Baltimore Association of Commerce, Baltimore.
Economic value of various life history stages in the blue crab industry of Maryland. Crab production in pounds (1880-1929) and catch by gear. Protection of egg-bearing females increased production. Range of the blue crab.

Farragut, Robert N.
1965. Proximate composition of Chesapeake Bay blue crab *(Callinectes sapidus).* Journal of Food Science, vol. 30, No. 3, p. 538-544.
Weight and width, together with the proximate composition of the body meat, claw meat, and offal of crabs from six bimonthly samples were intercorrelated. Seasonal changes in the proximate composition coincided with the mating and spawning seasons.

Faxon, Walter.
1881. On some crustacean deformities. Bulletin of the Museum of Comparative Zoology, Harvard College, vol. 8, No. 13, p. 257-274.
A deformed claw and an abnormal lateral spine of specimens of blue crab are illustrated and described.

Fellers, Carl R.
1940. Research in food technology in the development of our fishery resources. Transactions of the American Fisheries Society, vol. 70, p. 72-76.
Certain technological developments in the crab industry (blue crab was one of the four most important species in the United States) were used to illustrate how research on practical problems in the fisheries yields dividends in new industries, improved products, increased employment, and financial gain. Six years of research led to a method for control of discoloration and objectional taste in the canned product.

Fellers, Carl R., and Sterling G. Harris.
1940. Canned Atlantic crab meat. A new American food. Industrial and Engineering Chemistry, vol. 32, No. 4, p. 592-594.
A method of canning blue-crab-meat is described that stabilizes the copper present in the hemocyanin of the blood and flesh by means of a protective brine dip containing small amounts of aluminum and zinc salts. Protein, fat, and mineral composition of canned meat.

Fernandez y Cossio, Hector Rafael.
1967. A survey of the visual pigments of decapod Crustacea of South Florida. Ph. D.

thesis, University of Miami, 1965. Dissertation Abstracts, vol. 28, No. 1, p. 74B.

The visual pigments from *C. sapidus* and six other decapods were characterized by direct spectroscopy, difference spectra, partial bleaching studies, and chemical identification of the chromophore. The eyes of marine (blue crab) and terrestrial forms yielded one visual pigment, whereas freshwater forms had two. For each species, spectral properties were compared with qualities of the light of the habitat.

Fiedler, R. H.

1930. Solving the question of crab migrations. Fishing Gazette, vol. 47, No. 6, p. 18-21.

Recapture of blue crabs tagged in Virginia and Maryland portions of Chesapeake Bay demonstrated that the stock of crabs in the waters of the two states are interdependent. Review of the history of the fishery, declines in catch, and crab life history.

Fingerman, Milton.

1955a. Rhythms of color change in the blue crab, *Callinectes sapidus.* Anatomical Record, vol. 122, p. 457. Abstract only.

See Fingerman (1955b) for summary of content.

1955b. Persistent daily and tidal rhythms of color change in *Callinectes sapidus.* Biological Bulletin (Woods Hole), vol. 109, No. 2, p. 255-264.

The pigment of the blue crab in the Gulf of Mexico (one high and low tide per day instead of two) displays an endogenous diurnal rhythm with a frequency of 24 hours. A 12.4 hour period of color change is superimposed upon the diurnal one; maximum darkening is correlated with both high and low tides. The crab also exhibits a semilunar rhythm.

1956. Physiology of the black and red chromatophores of *Callinectes sapidus.* Journal of Experimental Zoology, vol. 133, No. 1, p. 87-106.

Dispersion of the chromatophores is determined by an albedo (background) response and daily rhythm. Total illumination and temperature are of secondary importance. Eyestalks and central nervous system organs secrete black-pigment-dispersing and red-pigment-concentrating hormones.

1957. Relation between position of burrows and tidal rhythm of *Uca.* Biological Bulletin (Woods Hole), vol. 112, No. 1, p. 7-20.

Although this work deals with *Uca*, the similarity of rhythms of color change to those of *C. sapidus* is discussed. Tidal rhythmicity in blue crabs operates on the basis of tides 12.4 hours apart even when the crabs are collected in a region where successive low tides are 24.8 hours apart.

Fingerman, Milton, R. Nagabhushanam, and Loralee Philpott.

1961. Physiology of the melanophores in the crab *Sesarma reticulatum.* Biological Bulletin (Woods Hole), vol. 120, No. 3, p. 337-347.

Rhythms of color change in *Sesarma reticulatum* are compared to those of *C. sapidus.*

Finucane, John H.

1969. Antimycin as a toxicant in a marine habitat. Transactions of the American Fisheries Society, vol. 98, No. 2, p. 288-292.

A marine impoundment in Tampa Bay, Fla., was treated with Antimycin A (7 p.p.b.), and effects on fish and invertebrates were observed. Fish of 30 species were killed, but of the invertebrates (including clams, oysters, shrimp, and crabs) only the blue crab appeared to be affected by the toxicant.

Fischler, Kenneth J.

1959. Occurrence of extremely small ovigerous crabs *(Callinectes* sp.) in coastal North Carolina. Ecology, vol. 40, No. 4, p. 720.

Two ovigerous female crabs, believed to be *C. sapidus*, measured 23.3 and 24.1 mm. in carapace length.

1963. Blue crab abundance in the Neuse River of North Carolina, 1958. M.S. thesis, University of Washington, 82 p.

Three methods gave similar estimates of the blue crab population in Neuse River, N. C. Of the 2.1 million pounds of crab estimated as being available to the fishery in 1958, 1.7 million pounds were caught. Also presented is the life history of Neuse River

blue crab, including migrations and growth of juveniles.
1965. The use of catch-effort, catch-sampling, and tagging data to estimate a population of blue crabs. Transactions of the American Fisheries Society, vol. 94, No. 4, p. 287-310.
Part of thesis, Fischler (1963).

Fischler, Kenneth J., and Charles H. Walburg.
1962. Blue crab movement in coastal South Carolina, 1958-59. Transactions of the American Fisheries Society, vol. 91, No. 3, p. 275-278.
Blue crabs were tagged in three estuaries and at two coastal locations in South Carolina. Most of the crabs did not migrate between estuaries, but moved between the lower estuary and adjacent coastal waters.

Fish, Charles J.
1926. Seasonal distribution of the plankton of the Woods Hole region. Bulletin of the U.S. Bureau of Fisheries for 1925, vol. 41, p. 91-179.
A short section is devoted to the Brachyura in this study (June 1922 - December 1923) of the nature of Woods Hole plankton and the physical factors affecting its distribution. Larval forms of *C. sapidus* occurred in surface collections during August, September, and October, reaching peak abundance in mid-September.

Florida Board of Conservation.
1950-69. Summary of Florida commercial marine landings. University of Miami Marine Laboratory, Marine Fisheries Research, Annual Reports to the Florida State Board of Conservation (Various authors, 1950-62). Florida State Board of Conservation after 1962.
Includes summary of blue crab landings on the east and west coast of Florida and often effort data collected in conjunction with the catch records.

Floyd, Hilton M.
1968. A trotline for blue crabs. U.S. Fish and Wildlife Service, Fishery Leaflet No. 616, 5 p.
A method allowing the use of many kinds of bait on a trotline..

Flynn, C. W., and M. C. Tatro.
1966. The application of plastic containers for packing and pasteurizing meat of the blue crab *(Callinectes sapidus).* Journal of Milk and Food Technology, vol. 29, No. 7, p. 218-221.
Plastic containers, packed with crab meat and pasteurized, gave product protection equal to that of metal cans. Gives time and temperature for adequate pasteurization.

FMC Corporation.
1967. Final report blue crab mechanization program analysis contract no. 14-17-0007-817. Report No. R-2629, CEL Project 45442 prepared by FMC Corporation, Central Engineering Laboratories, Santa Clara, California, for U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, 87 p.
A review and evaluation of the Bureau of Commercial Fisheries blue crab mechanization program including evaluation of privately developed machines, a description of experiments in meat picking, and a future mechanization program recommended for the Bureau.

Forrest, C. V.
1956. Crabbing is a million dollar industry in Virginia. National Fisherman, vol. 37, No. 11, p. 15, 41.
Value of the fishery, basic information required for crab conservation (excessive protection of blue crabs could result in a loss to the industry), methods of marketing hard and soft crabs, blue crab life history, growth, and migrations.

Fowler, H. W.
1912. Crustacea of New Jersey. Annual Report of the New Jersey State Museum, 1911, p. 35-650.
Callinectes, p. 416-420. Description and list of previous literature records.

Fraser, Allan, and Allan H. Frey.
1968. Electromagnetic emmission at micron wavelengths from active nerves. Biophysical Journal, vol. 8, No. 6, p. 731-734.
Micron wavelength electromagnetic emission from active live *C. sapidus* nerves compared to inactive live and dead nerves

indicated that the active nerve emission is caused by specific biophysical reactions.

Frye, John.
1969. The problem of automating crab picking continues to defy solution. National Fisherman Yearbook Issue, 1969, vol. 49, No. 13, p. 111-112.
A report (FMC Corporation, Santa Clara) on the progress and effectiveness of crab picking machines developed by the Bureau of Commercial Fisheries and by private industry. Concluded that several private machines could be available for the 1968 season, but that none would pick meat equal to the quality of lump meat picked manually. Comments on the report by various crab packers are included. Outline of a four phase Bureau of Commercial Fisheries program for further development of automated picking.

Futch, Charles R.
1965. The blue crab in Florida. Florida Board of Conservation Marine Laboratory, Salt Water Fisheries Leaflet No. 1, 17 p.
Description of the blue crab and how it differs from similar species in Florida. The author provides data on distribution, life history, growth, food of zoeae, parasites, fishing gear, fishing methods, and production of soft shelled crabs. He also discusses the requirements and the feasibility of raising blue crabs in ponds.

Galtsoff, Paul S.
1964. The American oyster *Crassostrea virginica* Gmelin. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 64, 480 p.
There is no evidence that blue crabs are attracted specifically by oysters, but it is apparent that they destroy small oysters in clusters by cracking their shells.

Gehres, George W.
1956. Sanitary standards for crab plants. Proceedings of the Gulf and Caribbean Fisheries Institute, 8th Annual Session, 1955, p. 6-8.
Florida State Board of Health standards in the form of regulations for the control of the handling, packing, and marketing of crab meat, and the resultant changes in the industry and quality of meat.

George, Carl J., and Victoria Athanassiou.
1965. The occurrence of the American blue crab, *Callinectes sapidus* Rathbun, in the coastal waters of Lebanon. Doriana, vol. 4, No. 160, p. 1-3.
The range of the blue crab in the Mediterranean was extended to the coast of Lebanon on the basis of 13 specimens from St. George Bay, Beirut. Ovigerous females occurred in February and March. The barnacle, *Chelonibia patula* was attached to some specimens.

George, John L., Richard F. Darsie, Jr., and Paul F. Springer.
1957. Effects on wildlife of aerial applications of strobane, DDT, and BHC to tidal marshes in Delaware. Journal of Wildlife Management, vol. 21, No. 1, p. 42-53.
Mortalities of caged crabs and fish, placed in streams and ponds sprayed with insecticide, were noted for 7 days after application. Deaths of adult blue crabs in treated plots were not significantly greater than in untreated plots nor were there differences among any of three treatments. A decline in crab-pot catches indicated an avoidance of sprayed areas.

George, M. J.
1967. Mark-recovery experiments in crustaceans, p. 1284-1295. *In* Proceedings of the Symposium on Crustacea, Part 4. Marine Biological Association of India, Symposium Series, 2.
A review of tags and tagging methods used for mark-recapture studies on the blue crab. Description of a tag, inserted at a point along the splitting line of the crab shell during molting, that is retained through several molts.

George, W. C., and John Nichols.
1948. A study of the blood of some Crustacea. Journal of Morphology, vol. 83, No. 3, p. 425-443.
The clotting mechanism and types and functions of blood cells of the blue crab, the primary species studied. An attempt is

made to harmonize the varying accounts of crustacean blood previously published.

Ghisotti, Fernando.
1966. *Callinectes sapidus* Rathbun nel Mediterraneo. (Crustacea, Decapoda). Natura (Milano), vol. 57, No. 3, p. 177-180.
C. sapidus in the Mediterranean.

Gifford, Charles A.
1962. Some aspects of osmotic and ionic regulation in the blue crab, *Callinectes sapidus*, and the ghost crab, *Ocypode albicans*. Publications of the University of Texas, Institute of Marine Science, vol. 8, p. 97-125. Ph. D. thesis, University of Illinois, 1958. Dissertation Abstracts, vol. 18, No. 5, p. 1905.
Analyses of constituents of body fluids relative to hypo- and hyper-saline environments in the bays of south Texas. The blue crab had limited hyporegulatory ability for total blood concentration, and marked ability to regulate blood magnesium and sulphate in high salinity. Ratios of stomach fluid to blood for magnesium, sulphate, and osmotic concentration were much higher than the same ratios for other ions.

Godman, John D.
1833. Rambles of a naturalist, p. 5-125. *In* John D. Godman, Rambles of a naturalist; to which are added, Reminiscences of a voyage to India, by Reynell Coates. Thomas T. Ash—Key and Biddle, Philadelphia.
Sections on the blue crab (No. 6-7, p. 72-86) include a detailed report on the stages of molting and hardening of the new shell. Effect of temperature and sunshine on the time required to complete the molt. Method of capturing soft crabs for market, centered in Chesapeake Bay (price to fishermen was 2 dollars a dozen). Catching hard crabs with spear, forked stick, and line and hand net. Use of crabs as hog food. Various characteristics of external and internal anatomy.

Goldsmith, Timothy H., and Hector R. Fernandez.
1966. Sensitivity of compound eyes to ultraviolet light. American Zoologist, vol. 6, No. 4, p. 538.
Callinectes is one of the genera discussed.
1968. Comparative studies of crustacean spectral sensitivity. Zeitschrift für Vergleichende Physiologie, vol. 60, No. 2, p. 156-175.
Spectral sensitivity of the eyes of the isopod *Porcellio scaber* and the decapods *C. sapidus*, *Palaemonetes paludosus*, *Orconectes virilis*, and *O. immunis* were measured between 300 and 660 nm by determining the reciprocal number of photons required to evoke a constant size retinal action potential.

Goodyear, C. Phillip.
1967. Feeding habits of three species of gars, *Lepisosteus*, along the Mississippi Gulf coast. Transactions of the American Fisheries Society, vol. 96, No. 3, p. 297-300.
Lepisosteus oculatus preyed extensively on *Uca pugnax* and *C. sapidus* in shallows during rising and high tides.

Goresline, Harry E., and Helen F. Smart.
1942. Microbiological studies on the freezing and storage of soft-shell crabs. Journal of Bacteriology, vol. 43, No. 1, p. 43-44.
Little loss of flavor and texture of soft-shell crabs during 15 months of freezing. Total bacterial count decreased slowly during storage. No definite correlation between the quality of crabs before freezing and the bacterial content of the product after storage in the frozen state.

Gould, Augustus A.
1841. A report on the Invertebrata of Massachusetts, comprising the Mollusca, Crustacea, Annelida, and Radiata. Folsom, Wells, and Thurston, Cambridge, 373 p.
An account of abundance in Massachusetts, description, and the taxonomic confusion about members of the genus are given for the blue crab (here referred to as *Lupa dicantha).*

Gowanloch, James Nelson.
1952. The Louisiana crab fishery. Louisiana Conservationist, vol. 4, No. 9-10, p. 6-9.

Describes gear used to catch blue crabs in Louisiana, and how it is fished. An albino blue crab is illustrated.

Graham, James G., and G. Francis Beaven.
1942. Experimental sponge-crab plantings and crab larvae distribution in the region of Crisfield, Md. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 52, 18 p.
After sponge crabs (460 bushels) were planted, intensive sampling for zoeae indicated no increase in the normally low larval population. Larvae were found to be abundant in other areas. There were only a few returns from tagged sponge crabs. Concluded that it was not feasible to rehabilitate the blue crab resources in the upper Chesapeake Bay by releasing egg-bearing crabs.

Gray, Ellen H., and Curtis L. Newcombe.
1938. The relative growth of parts in the blue crab *Callinectes sapidus* Rathbun. Growth, vol. 2, No. 3, p. 235-246.
Individual variation in the size of certain dimensions and the quantitative nature of the growth dimensional ratios that characterize the blue crab.
1939. Studies of moulting in *Callinectes sapidus* Rathbun. Growth, vol. 2, No. 4, p. 285-296.
Time required to complete expansion, variation in growth increment, sex variation, and number of molts after a width of 20 mm.

Gray, I. E.
1957. A comparative study of the gill area of crabs. Biological Bulletin (Woods Hole), vol. 112, No. 1, p. 34-42.
A comparative study of the size of gill areas of 16 species of brachyuran crabs (including *C. sapidus)* representing land, intertidal, and wholly aquatic habitats. Among wholly aquatic species, the active crabs (portunids) have greater gill area than do sluggish bottom-dwelling species *(Libinia).*

Green, J. C.
1952. Effectiveness of crab traps in South Carolina. Bears Bluff Laboratories, Wadmalaw Island, S.C., Contribution No. 14, 12 p.
Experiments indicated that the crab pot was an effective gear for capturing crabs in South Carolina, and was not destructive of terrapin and fish. Catches indicated that females were lighter than males of similar size.
1968. The biology of estuarine animals. University of Washington, Seattle, 401 p.
References to *C. sapidus* include association with fresh-water forms at low salinities, relation of gill area to habitat, role in estuarine food webs, summary of life history, and the roles of temperature and salinity in life cycle.

Greer, Milton C., Jr., and William S. Hamill.
1933. Suggested plan for marketing Maryland crab meat. Maryland Conservation Department, Conservation Bulletin No. 5, 24 p.
Data on the changes in Maryland's crab industry from 1927 to 1932, an economic survey of the industry, marketing operations, and a proposed plan (prepared by the Maryland Conservation Department) for effecting a larger and more widespread distribution of Maryland crab meat.

Gresham, Claude.
1953. —And crabbing. Louisiana Conservationist, vol. 6, No. 1, p. 15.
Use of crab nets, crab lines, and floats for soft-shell blue crabs. Size of soft-shell and canned meat industry.

Gruger, E. H., Jr., R. W. Nelson, and M. E. Stansby.
1964. Fatty acid composition of oils from 21 species of marine fish, freshwater fish and shellfish. Journal of the American Oil Chemists' Society, vol. 41, No. 10, p. 662-667.
Weight percent of total fatty acids of blue crabs and other species are given by fatty acid chain length and number of double bonds.

Gulf States Marine Fisheries Commission.
1949-69. Annual reports [to the U.S. Congress and to the Governors of Alabama, Florida, Louisiana, Mississippi, and Texas].

Various of the reports contain information on blue crab research programs of Gulf states and the U.S. Fish and Wildlife Service.

Gunter, Gordon.
1938. The common blue crab in fresh waters. Science, vol. 87, No. 2248, p. 87-88.
Blue crabs commonly occur in fresh water of the Atchafalaya River, La., 160 miles upstream from the Gulf of Mexico.
1942. Offatts Bayou, a locality with recurrent summer mortality of marine organisms. American Midland Naturalist, vol. 28, No. 3, p. 631-633.
Mortality of blue crabs, shrimp, oysters, and fish may be due to poisonous dinoflagellate blooms.
1950. Seasonal population changes and distributions as related to salinity, of certain invertebrates of the Texas coast, including the commercial shrimp. Publications of the University of Texas, Institute of Marine Science, vol. 1, No. 2, p. 7-51.
A report on invertebrates, chiefly crustaceans, in collections (1941-42) in Copano Bay, Aransas Bay, and the adjacent Gulf of Mexico. The blue crab was one of the most common species. Abundance related to salinity and temperature. The size of invertebrates generally decreased with decrease in salinity.
1954. Sagacity of a crab. Science, vol. 120, No. 3109, p. 188-189.
An account of a juvenile blue crab avoiding capture by a sheepshead, *Archosargus probatocephalus*, by remaining poised over the tail fin and turning with the fish. Survival value of such behavior is discussed.
1956. Some relations of faunal distributions to salinity in estuarine waters. Ecology, vol. 37, No. 3, p. 616-619.
Numbers of species of fish and large crustaceans (including blue crab) of marine and fresh-water origins in three estuarine lakes in Louisiana. Relative abundance of blue crabs at different ranges of low salinities.
1961. Painless killing of crabs and other large crustaceans. Science, vol. 133, No. 3449, p. 327.
A plea to kill blue crabs and other crustaceans used as food, without pain, by placing them in cool fresh water and steadily increasing temperature to 40° C. The meat of crabs treated in this manner is equal to that of animals killed by scalding.
1967. Some relationships of estuaries to the fisheries of the Gulf of Mexico, p. 621-638. *In* George H. Lauff [ed.] Estuaries. American Association for the Advancement of Science, Washington D. C., Publication No. 83.
Reported that the life history of the blue crab in the Gulf is similar to that in Chesapeake Bay. Discussed crab catch and occurrence in various habitats.

Gunter, Gordon, and Gordon E. Hall.
1963. Biological investigations of the St. Lucie Estuary (Florida) in connection with Lake Okeechobee discharges through the St. Lucie Canal. Gulf Research Reports, vol. 1, No. 5, p. 189-307.
The seasonal occurrence and size of 194 blue crabs captured at trawl and seine stations, together with salinities (range, 0.14 - 29.2 p.p.t.) and water temperatures. Females bearing eggs were taken in January and May.

Gunter, Gordon, and W. E. Shell.
1958. A study of an estuarine area with water-level control in the Louisiana marsh. Proceedings of the Louisiana Academy of Sciences, vol. 21, p. 5-34.
Salinity ranges and catches of blue crabs, other Crustacea, and marine fishes in Grand and White lakes, La.

Gunter, Gordon, Robert H. Williams, Charles C. Davis, and F. G. Walton Smith.
1948. Catastrophic mass mortality of marine animals and coincident phytoplankton bloom on the west coast of Florida, November 1946 to August 1947. Ecological Monographs, vol. 18, No. 3, p. 309-324.
Blue crabs were killed in the red tide *(Gymnodinium brevis)* outbreak.

Gurney, Robert.
1960. Bibliography of the larvae of decapod Crustacea. Larvae of decapod Crustacea. H. R. Engelmann (J. Cramer) and Wheldon & Wesley, Ltd., Weinheim/Bergstr., Codicote/Herts., 123, 308 p.

Reprint and inclusion of two separate works under one cover. A 123 page bibliography (published in 1939) gives seven references on the genus *Callinectes.* Although the genus is not referred to in the second work, Larvae of decapod Crustacea (published in 1942), it does contain pertinent information on development, morphology, locomotion and distribution of decapod larvae in general. The group Brachyura was said to be so large and varied that only a relatively few larvae could be assigned to genus with any certainty.

Habas, Linda Beth.
1965a. Asymmetry potentials, metabolism and ion fluxes in gills of the blue crab, *Callinectes sapidus.* Ph. D. thesis, University of Illinois, 1965. Dissertation Abstracts, vol. 26, No. 5, p. 2837.
Measured were the Na^+ concentration of *C. sapidus* hemolymph in crabs acclimated to different salinities, potentials *in vivo* between blood and medium, potentials and oxygen consumption of isolated gill, and the influxes and effluxes of Na^+ and Cl^- in different preparations.
1965b. Asymmetry potentials and ion fluxes in isolated crab gills. American Zoologist, vol. 5, No. 4, p. 737. Abstract only.
The transepithelial potential inside of isolated blue crab gills with respect to the external medium was measured. Influxes and effluxes of Na^{24} and Cl^{36} were measured in 50 percent, 100 percent, 150 percent, and choline Ringer's solution.

Habas, Linda B., and C. Ladd Prosser.
1963. Effect of acclimation to various salinities on potentials in isolated crab gills. Biological Bulletin (Woods Hole), vol. 125, No. 2, p. 379.
The potential inside the afferent vessel of isolated blue crab gills was measured at different salinities. It was postulated that negative gill potential results from passive loss of sodium, and that positive potential is due to active uptake of sodium exceeding the passive loss.

Haefner, Paul A., Jr.
1961. A blue blue crab. Estuarine Bulletin, vol. 6, No. 3-4, p. 3-5.
A specimen of a true blue color was collected. The chemical compounds responsible for coloration are discussed.
1963. On the growth increment of blue crabs, *Callinectes sapidus* Rathbun, during ecdysis in different salinity waters. Ph. D. thesis, University of Delaware, 1962. Dissertation Abstracts, vol. 23, No. 8, p. 3041.
The percentage length increase for the mature molt of female crabs in three different saline waters and under controlled laboratory conditions indicated that neither the population of the crabs nor the salinity variation resulted in significant difference in length increase. Hemolymph calcium fluctuated markedly during the premolt period, and hemolymph-to-sea-water-calcium ratios differed significantly among molt stages for each salinity.
1964. Hemolymph calcium fluctuations as related to environmental salinity during ecdysis of the blue crab, *Callinectes sapidus* Rathbun. Physiological Zoology, vol. 37, No. 3, p. 247-258.
Water content maintained through the molt in three salinities was similar. Hemolymph calcium fluctuated during the premolt period in three salinities but always fell to a similar postmolt value. Statistical analysis of ratios of hemolymph to sea-water calcium. Length increments showed no significant differences among crabs at various salinities.

Haefner, Paul A., Jr., and Carl N. Shuster, Jr.
1964. Length increments during terminal molt of the female blue crab, *Callinectes sapidus,* in different salinity environments. Chesapeake Science, vol. 5, No. 3, p. 114-118.
Field studies at three different saline environments showed no significant differences in percentage increase in body size among three groups of crabs.

Hall, S. Warren, III.
1939. Tangier Island, a study of an isolated group. University of Pennsylvania Press, Philadelphia, 122 p.

Development and importance of crabbing to residents of Tangier Island in Chesapeake Bay. Methods used to capture the blue crab, and description of the houses which packed crab and also dealt in soft-shell crabs.

Hamer, Paul E.
1955. Old blue claws, summary of the biology of the blue crab, *Callinectes sapidus* Rathbun, and the dredge fishery. New Jersey Outdoors, July, 7 p.
Popular account of life history and the fishery. Reported that there is no indication that the winter dredge fishery in Chesapeake Bay is detrimental to a crab population.

Hammen, Carl S., and Paul J. Osborne.
1959. Carbon dioxide fixation in marine invertebrates: A survey of major phyla. Science, vol. 130, No. 3386, p. 1409-1410.
The uptake of $NaHC^{14}O_3$ from sea water by the blue crab, one of 14 species studied. The blue crab fixed CO_2 into acids of the Krebs critic acid cycle.

Hanström, Bertil.
1935. Preliminary report on the probable connection between the blood gland and the chromatophore activator in decapod crustaceans. Proceedings of the National Academy of Sciences, U.S.A., vol. 21, No. 10, p. 584-585.
Found a significant connection between the position of the blood gland and the x-organ, and the position of the source of the pigment concentrating substance. The distal-dorsal half of the blue crab eyestalk contains the active substance and both the incretory organs.
1939. Hormones in invertebrates. Clarendon Press, Oxford, 198 p.
References to the blue crab include the structure of the sinus gland as related to color change, the pigment-activating hormone in the eyestalks, and the effect of eyestalk extracts on the migration of the eye-pigments of *Palaemonetes.*

Hard, W. L.
1942. Ovarian growth and ovulation in the mature blue crab, *Callinectes sapidus* Rathbun. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 46, 17 p.
A histological study of the ovary, at various periods during the life of the mature crab, revealed that two ovulations occur. A method was developed in which the gross appearance of the ovary is used for determination of the stage (five distinguished) in the reproductive cycle of the crab.

Harrington, Robert W., Jr., and William L. Bidlingmayer.
1958. Effects of dieldrin on fishes and invertebrates of a salt marsh. Journal of Wildlife Management, vol. 22, No. 1, p. 76-82.
After a Florida salt marsh was treated with dieldrin to eliminate sandfly larvae, observations were made in a 5,600- foot ditch to determine the effect on fish and invertebrates. Fish and all aquatic crabs were killed; only a single living blue crab was observed during a 17-week observation period.

Harris, Marvin M.
1932. A bacteriological study of decomposing crabs and crabmeat. American Journal of Hygiene, vol. 15, p. 260-275.
Comprehensive studies using blue-crab-meat indicated the manner in which crabs and crab meat decompose and the role of bacteria (10 genera were isolated) in bringing about such changes. The Nessler ammonia test is proposed to differentiate fresh from spoiled meat, before macroscopic signs of spoilage appear.

Hartnoll, R. G.
1969. Mating in the Brachyura. Crustaceana, vol. 16, No. 2, p. 161-181.
Division of the six superfamilies of the Brachyura into two groups on the basis of the structure of the female reproductive organs. Courtship, copulatory act, and relation of structure to function. Includes mating of the blue crab.

Hartog, C. D., and L. B. Holthuis.
1951. De Noord-Amerikaanse "Blue Crab" in Nederland. Levende Natuur, vol. 54, No. 7, p. 121-125.

An account of the occurrence (the first in 1932) of four *C. sapidus* in Holland. May have been introduced from foreign ships.

Hay, W. P.
1905. The life history of the blue crab *(Callinectes sapidus).* U.S. Bureau of Fisheries, Report for 1904, p. 395-413.
A comprehensive treatment of the Chesapeake Bay blue crab: systematic position and review of its taxonomy, distribution and habitat, habits, food, autotomy, life history, and growth. Stages of juvenile molting are illustrated.

Hay, W. P., and C. A. Shore.
1918. The decapod crustaceans of Beaufort, N.C., and the surrounding region. Bulletin of the U.S. Bureau of Fisheries for 1915-16, vol. 35, p. 369-475.
Taxonomy, recognition characters, abundance, growth, and life history of the blue crab.

Hays, Elizabeth A., Michael A. Lang, and Harold Gainer.
1968. A re-examination of the Donnan distribution as a mechanism for membrane potentials and potassium and chloride ion distributions in crab muscle fibers. Comparative Biochemistry and Physiology, vol. 26, No. 3, p. 761-792.
The adductor muscle of the walking leg of the blue crab was studied with respect to the nature of the resting membrane potential of the muscle fiber and the ionic distributions that contribute to this potential. Cable constants were determined on surface fibers and ion analysis of whole muscles. Results support the hypothesis that the striated muscle fibers are characterized by a Donnan-like distribution.

Heald, Eric J.
1968. Atlas of the principal fishery resources on the Continental Shelf from New York to Florida. Prepared for the E. I. du Pont de Nemours Company, University of Miami, Institute of Marine Sciences, 225 p.
Distribution of blue crabs and location of fishing areas from New Jersey to Florida. Production by State in 1965.

Hecht, Selig.
1914. Note on the absorption of calcium during the molting of the blue crab, *Callinectes sapidus.* Science, vol. 39, No. 994, p. 108.
Calcium used by soft-shell crab for hardening of shell is not present at time of molt, but is absorbed from sea water during hardening.

Hedgpeth, Joel W.
1950. Notes of the marine invertebrate fauna of salt flat areas on Aransas National Wildlife Refuge, Texas. Publications of the University of Texas, Institute of Marine Science, vol. 1, No. 2, p. 103-119.
Collections of invertebrates (1946) made on salt flat areas, in a ditch, and on the bay shore indicated that the blue crab, a peneid shrimp, and a grass shrimp were the most abundant decapod Crustacea. Life history of each species collected is presented.
1967. Ecological aspects of the Laguna Madre, a hypersaline estuary, p. 408-419. *In* George H. Lauff [ed.] Estuaries. American Association for the Advancement of Science, Washington, D. C., Publication No. 83.
Blue crabs, particularly young, are normal residents of these coastal lagoons of Texas and occur in salinities ranging from about 4 to 60 p.p.t.

Hedgpeth, Joel W. [ed.]
1957. Treatise on marine ecology and paleoecology. Volume 1, Ecology. Geological Society of America, Memoir 67, 1296 p.
References to blue crab include their parasites, *Carcinonemertes carcinophila* (indicates the reproductive history of the host), and *Loxothylacus texanus* (causes castration). Also referred to are the frequent summer mortalities of blue crabs, shrimp, oysters, and fish in Offatts Bayou, possibly due to poisonous dinoflagellates. Observations of blue crabs on oyster beds has shown they prey almost entirely on parasitized oysters which cannot close their shells as tightly as normal oysters.

Herke, William H.
1968. Weirs, potholes and fishery management, p. 193-211. *In* John D. Newsom [ed.]

Proceedings of the marsh and estuary management symposium, Louisiana State University, 1967. Thos. J. Moran's Sons, Inc., Baton Rouge.

A 6-month study to determine some of the effects of a large weir (submerged structure in marsh tidal channels to stabilize water levels) on fishery resources. Quantitative sampling indicated that the weir did not serve as a barrier to blue crab movement. Because adults were more numerous above the weir, whereas abundance of young was nearly equal on both sides, the weir must have improved the habitat above it for crabs.

Herreid, Clyde F., II.

1969a. Water loss of crabs from different habitats. Comparative Biochemistry and Physiology, vol. 28, No. 2, p. 829-839.

Evaporative water loss in the blue crab and 10 other brachyuran crabs was related to habitat. Evaporative loss was a function of body weight in all species, and loss increased at higher temperature. Most water loss appears to be through the integument exclusive of the gill chamber.

1969b. Integument permeability of crabs and adaption to land. Comparative Biochemistry and Physiology, vol. 29, No. 1, p. 423-429.

Experiments on blue crabs and seven other species chosen to represent different habitats. Most evaporative loss occurred through the shell; loses from dead and living crabs were about the same. Terrestrial forms were least permeable to water and aquatic species were most permeable.

Herrick, Francis Horbart.

1911. Natural history of the American lobster. Bulletin of the U.S. Bureau of Fisheries for 1909, vol. 29, p. 149-408.

References to the blue crab include the number and size of eggs, detail of tegumental glands of the endopodites, and fixation of eggs to the pleopods (each hair carries about 200 eggs; each egg is glued by a stalk to the hair). Description of zoea. Megalops of *Callinectes* were observed to pick up grains of sand and place them in their ear sacs (statocysts).

Higgins, Elmer.

1941. Can the fisheries supply more food during a national emergency? Transactions of the American Fisheries Society, vol. 71, p. 61-73.

It was estimated that the production of crabs from the South Atlantic and Gulf of Mexico (1938 production, 26 million pounds) had a sustained (ultimate) potential of 50 million pounds if methods of conservation and management were employed.

Hildebrand, Henry H.

1954. A study of the fauna of the brown shrimp *(Penaeus aztecus* Ives) grounds in the western Gulf of Mexico. Publications of the University of Texas, Institute of Marine Science, vol. 3, No. 2, p. 229-336.

Blue crabs (p. 273-274) were absent in some areas but were taken (May-July) from the beach to a depth of 18 fathoms. About one-half of the crabs captured in July were ovigerous. High salinity was thought to explain the sparsity of blue crabs in the shallow water off Sabine, Tex. No males were captured in offshore waters.

Hildebrand, Samuel F.

1939. The Panama Canal as a passageway for fishes, with lists and remarks on the fishes and invertebrates observed. Zoologica, vol. 24, No. 3, 15-45.

Small crabs, *C. sapidus acutidens*, were present in chambers of the locks.

Hite, J. C., and J. M. Stepp.

1969. Economic analysis of the development potential of the commercial fisheries of the coastal plains region. Clemson University, Department of Agricultural Economics and Rural Sociology, South Carolina Agricultural Experiment Station, Economics of Marine Resources No. 1, 78 p.

Concerns shrimp, oysters, blue crabs, and eight principal species of food fish in North Carolina, South Carolina, and Georgia. Examines the importance of commercial fishing in the economy, access to seafood markets, and the supply constraint in the region under current and expected conditions.

Hodgson, Edward S.
1955. Problems in invertebrate chemoreception. Quarterly Review of Biology, vol. 30, No. 4, p. 331-347.
Brief discussion of laboratory studies (electrophysiological technique) on chemoreception in the blue crab, which provide physiological confirmation of the presence of chemoreceptors on the antennules of decapods.

Hoese, H. Dickson.
1960. Biotic changes in a bay associated with the end of a drought. Limnology and Oceanography, vol. 5, No. 3, p. 326-336.
A comparison of the drought-induced high-salinity flora and fauna of Mesquite Bay, Tex., with that present during the low salinities after the drought. Blue crabs were abundant during and after the drought, at salinities from 2.8 to 40.6 p.p.t. A large colony of sea squirts, *Molgula*, was found on the plastrum of a blue crab.

Hoese, H. D., and R. S. Jones.
1963. Seasonality of larger animals in a Texas turtle grass community. Publications of the University of Texas, Institute of Marine Science, vol. 9, p. 37-47.
A drop-net quadrat method for quantitative sampling of larger motile forms indicated that peak abundance of blue crabs occurred in Redfish Bay, Tex., during March and early April.

Holthuis, Lipke B.
1958. An early account of the natural history of Delaware. Estuarine Bulletin, vol. 3, No. 3, p. 4-9.
An account of a book by D. P. de Vries, 1655, refers to the eating qualities and colors of blue crabs in the Delaware Bay region.
1961. Report on a collection of Crustacea Decapoda and Stomatopoda from Turkey and the Balkans. Zoologische Verhandelingen, Rijksmuseum van Natuurlijke Historie, Leiden, No. 47, p. 1-67.
Review of blue crab occurrences in France, Holland, Denmark, Italy, Israel, Turkey, and Greece. Concluded that it must be regarded as indigenous to Europe.

Holthuis, L. B., and E. Gottlieb.
1955. The occurrence of the American blue crab, *Callinectes sapidus* Rathbun, in Israel waters. Bulletin of the Research Council of Israel, vol. 5B, No. 2, p. 154-156.
First report of blue crab occurrence from the Mediterranean. Its frequent occurrence and the presence of ovigerous females indicated that it has been established in Israeli waters. Also found on the Atlantic coast of France, Holland, and Denmark.
1958. An annotated list of the decapod Crustacea of the Mediterranean coast of Israel, with an appendix listing the Decapoda of the eastern Mediterranean. Bulletin of the Research Council of Israel, vol. 7B, No. 1-2, p. 1-126. Also in Bulletin of the Sea Fisheries Research Station, Israel, vol. 18 (1958) 1959, p. 1-126.
Photograph of the blue crab, and records of specimens from Italy, France, Holland, Denmark, and Israel.

Hopkins, Sewell H.
1942. The crab fishery, with suggestions for its improvement in Texas. Texas Game and Fish, February, 4 p.
The potential for crabbing on a larger scale in Texas is discussed. The fishery and industry for blue crabs in Chesapeake Bay is reviewed. Also gives information on life history and migrations.
1943. The external morphology of the first and second zoeal stages of the blue crab, *Callinectes sapidus* Rathbun. Transactions of the American Microscopical Society, vol. 62, No. 1, p. 85-90.
A morphological study of the zoeal stages reared in the laboratory. Most of the first stage zoea died without molting. Some molted 4 or 5 days after hatching when fed a species of dinoflagellate.
1944. The external morphology of the third and fourth zoeal stages of the blue crab, *Callinectes sapidus* Rathbun. Biological Bulletin (Woods Hole), vol. 87, No. 2, p. 145-152.
Detailed description of the third and fourth zoeal stages from reared and captured specimens. Reported that a fifth zoeal stage had not yet been seen.
1947. The nemertean *Carcinonemertes* as an indicator of the spawning history of the host,

Callinectes sapidus. Journal of Parasitology, vol. 33, No. 2, p. 146-150.

Nonovigerous females which have already spawned once can be distinguished from nonspawning females by the examination of their gills for this parasite. Large red worms indicate previous spawning; no worms or only small white worms indicate the crab has never spawned.

Hopkins, Thomas S.

1962a. Sexual dichromatism and the distribution of carotenoids in the chelae of *Callinectes sapidus* Rathbun. M. S. thesis, University of Florida.

See Hopkins (1963) for summary of content.

1962b. Sexual dichromatism in the chelae of the *Asplenium heterochroum.* [sic *Callinectes sapidus* Rathbun]. Association of Southeastern Biologists, Bulletin, vol. 9, No. 1, p. 33. Abstract only.

The color difference of the female blue crab is probably due to the nature of the carotenoid-protein link or to the structure of the protein involved.

1963. Sexual dichromatism in three species of portunid crabs. Crustaceana, vol. 5, Pt. 3. p. 238-239.

Investigation of the carotenoid pigments found in the exoskeleton of the blue crab showed sexual dichromatism. Female has orange fingers on the chelae as compared to the male, whose fingers are white and blue. Also examined, *Ovalipes ocellatus* and *O. quadulpensis.*

Horn, Edward C., and Marilyn S. Kerr.

1963. Hemolymph protein and copper concentrations of adult blue crabs *(Callinectes sapidus* Rathbun). Biological Bulletin (Woods Hole), vol. 125, No. 3, p. 499-507.

There was no correlation between size of adult females, adult males, or females in sponge and mean serum protein or copper concentrations. Means of males were lower than those for all females; sponge females were higher than nonsponge females. In the same width-class, males tended to be longer than females.

1969. The hemolymph proteins of the blue crab, *Callinectes sapidus.* I. Hemocyanins and certain other major protein constituents. Comparative Biochemistry and Physiology, vol. 29, No. 2, p. 493-508.

An analysis of electrophoretic separatory procedures, methods for separating some hemolymph proteins, and observations on the occurrence and the properties of the different proteins in the hemolymph of adult blue crabs.

Hoss, Donald E.

1963. Accumulation of radioactive gold by estuarine animals. Association of Southeastern Biologists, Bulletin, vol. 10, No. 2, p. 30. Abstract only.

Sediment, labeled with radioactive gold, was released into Cape Fear River, N.C., to determine the effect on caged blue crabs, oysters, mummichogs, and Atlantic croaker. Oysters accumulated the most radioactivity followed by crabs and fish. Concluded that the amount of radioactive gold used did not harm the marine community.

Howell, W. H.

1886. Observations upon the blood of *Limulus polyphemus, Callinectes hastatus,* and a species of holothurian. Studies of the Biological Laboratory, Johns Hopkins University, vol. 3, No. 6, p. 267-287.

Chemical and microscopical study of the blood. Coagulation of blue crab blood, albumens of the serum, and various reactions of the serum.

Huggins, A. K., and K. A. Munday.

1968. Crustacean metabolism, p. 271-378. *In* O. Lowenstein [ed.] Advances in comparative physiology and biochemistry, vol. 3. Academic Press, New York.

In this review of more recent work on crustacean metabolism, references to the blue crab include enzymes and inhibitors of the glucuronate pathway system, cause of hyperglycemia in intact or eyestalkless crabs, gill mitochondrial enzymes, and effects of salinity on the rate of oxygen consumption and enzyme activity.

Humes, Arthur Grover.

1941. Notes on *Octolasmis mulleri* (Coker), a barnacle commensal on crabs. Transactions of

the American Microscopical Society, vol. 60, No. 1, p. 101-103.

Inhabits the gill chambers of the blue crab. Northern coast of the Gulf of Mexico.

1942. The morphology, taxonomy, and bionomics of the nemertean genus *Carcinonemertes*. University of Illinois, Biological Monographs, vol. 18, No. 4, p. 1-105.

Includes study of *Carcinonemertes carcinophila* on the gills and eggs of female blue crabs in Louisiana. Host parasite relationship. These nemerteans feed upon the crab eggs. Only sexually ripe worms occur on the egg mass.

Hunter, Albert C.

1934. Need for methods for the bacteriological examination of Crustacea. American Journal of Public Health, vol. 24, No. 3, p. 199-202.

The methods of production, the opportunities for contamination, and the perishable character of crab, lobster, and crayfish products require the development of bacteriological methods. There is a direct correlation between unsanitary methods of production and the incidence of fecal *Bacillus coli* in the finished product. A successful method for the examination of crustacean meat is discussed.

1937. Sanitary methods of crabmeat production. Atlantic Fisherman, vol. 18, No. 4, p. 11.

Covers buildings and equipment, methods of handling crabs, waste disposal, washing facilities for use of employees, and supervision.

1939. Uses and limitations of the coliform group in sanitary control of food production. Food Research, vol. 4, No. 6, p. 531-538.

Relative importance of different types of coliform bacteria as a measure of insanitary practices in the production of crab meat.

Hunter, W. A.

1969. Southeast states undertake project to find cause of blue crab deaths. National Fisherman, May, p. 25-A.

The U.S. Bureau of Commercial Fisheries, and the States of Georgia, Florida, South Carolina and North Carolina are working together to discover causes for recent massive blue crab mortalities and to determine the effect on industry. Some widespread deaths were due to a paramoeba.

Hutton, Robert F., and Franklin Sogandares-Bernal.

1959. Notes on the distribution of the leech, *Myzobdella lugubris* Leidy, and its association with mortality of the blue crab, *Callinectes sapidus* Rathbun. Journal of Parasitology, vol. 45, No. 4, p. 384, 404, 430.

Over one-half of 30 dead crabs in Bulow Creek, Volusia County, Fla., had leeches attached, some penetrating holes in the carapaces (not certain if they caused the holes). They fed on the blood and juices of the host by suction and the anticoagulant action of their salivary secretion. Implicated as a possible factor in mortality of the blue crab.

International Commission on Zoological Nomenclature.

1964. Forty-seven genera of decapod Crustacea: Placed on the official list. Bulletin of Zoological Nomenclature, vol. 21, Pt. 5, Opinion 712, p. 336-351.

The generic name, *Callinectes*, and the specific name, *sapidus*, are numbered and placed on the official lists of names in zoology. Original references for these names are given.

Isaacson, Peter A.

1963. Modifications of Chesapeake Bay commercial crab pot. Commercial Fisheries Review, vol. 25, No. 1, p. 12-16.

The placement of the entrance funnels in the lowest rows of wire meshes in the pot allowed the crab to enter easily. A one-way gate was found to be as effective in crab retention as the standard wire partition, and cheaper and faster to construct.

Iversen, E. S.

1968. Farming the edge of the sea. London, Fishing News (Books), 301. p.

The farming potential of blue crabs (p. 199-201) rates low because of the relatively long time required to raise the young, the large amount of food they consume, and

the difficulty of providing ideal conditions for them in captivity.

Jacob, Neville R.
1969. Blue crab parasite poses threat. National Fisherman, March, p. 23-C.
Loxothylacus texanus infestation of blue crabs in the Gulf of Mexico. An increase in quantities of the parasite could result in a serious and long lasting condition. Method and effects of infestation described.

Jacobs, Morris B. [ed.]
1944. The chemistry and technology of food and food products. Interscience Publishers, New York. 2 vol.
Review of blue crab fishery of the United States by region; gross composition, protein and mineral content of blue-crab-meat, and marketing and quality of meat (Vol. 1, Chapter 14, Fish, shellfish and Crustacea, by M. E. Stansby). Various methods of preservation of crab meat are presented (Vol. 2, Chapters 10 and 13).

Jarvis, Norman D.
1943. Principles and methods in the canning of fishery products. U.S. Fish and Wildlife Service, Research Report, No. 7, 366 p.
A short section on the blue crab gives the size of the pack (never more than 2,000-3,000 cases) and lists obstacles to the development of an Atlantic crab-canning industry.
1944. Crustacea. U.S. Fish and Wildlife Service, Fishery Leaflet, No. 85, p. 259-283. Reprinted from Research Report No. 7, Jarvis, 1943.
Blue crabs account for 90 percent of the production of crab meat in the United States. Obstacles to a larger industry are small size of the crab, the closeness of the fisheries to centers of consumption, and, most important, that the meat is subject to discoloration. A method of overcoming discoloration is reviewed.

Jeffries, H. Perry.
1966. Internal condition of a diminishing blue crab population *(Callinectes sapidus).* Chesapeake Science, vol. 7, No. 3, p. 164-170.
Abundance of the blue crab in Rhode Island has decreased during the last 30 years. Composition of the plasma and muscle was studied to see if abnormalities could be recognized. Groups of correlated tests, such as the inverse relation of the concentration of nonprotein nitrogen and phosphate to chlorinity, were reported to have predictive value and might be applied to the management of the fishery.

Johnson, T. W., Jr., and Rupert R. Bonner, Jr.
1960. *Lagenidium callinectes* Couch in barnacle ova. Journal of the Elisha Mitchell Scientific Society, vol. 76, No. 1, p. 147-149.
The fungus, *Lagenidium callinectes*, from eggs of *Chelonibia patula* (this barnacle develops on the carapace of the blue crab), infected blue crab ova under laboratory conditions.

Johnson, T. W., Jr., and W. C. Pinschmidt, Jr.
1963. *Leptolegnia marina* Atkins in blue crab ova. Nova Hedwigia, vol. 5, No. 3-4, p. 413-418.
Certain morphological aspects of the fungus and its position relative to *Leptolegniella* and *Brevilegniella* are discussed.

Kalber, Frederick A., and John D. Costlow, Jr.
1968. Osmoregulation in larvae of the land crab, *Cardisoma guanhumi* Latreille. American Zoologist, vol. 8, No. 3, p. 411-416.
Osmoregulatory adaptations in larvae of *C. sapidus* are discussed. Newly hatched blue crab zoeae lose their ability to hyperregulate and respond as osmoconformers during the middle of their development but recover hyperregulation within 48 hours and retain it to adulthood.

Kellogg, W. N.
1958. Galvanotropism as an avoidance response. Journal of Comparative and Physiological Psychology, vol. 51, No. 6, p. 652-657.
Tank experiments were conducted with many species of fish, molluscs, reptiles, echinoderms, and crustaceans (including those of the genus *Callinectes).*

Kerr, Marilyn S.
1967. A lipoprotein in the yolk and the hemolymph of the female blue crab, *Callinectes sapidus* Rathbun. Ph. D. thesis, Duke University, Durham, N.C., 1966. Dissertation Abstracts, vol. 27, No. 11, p. 4174-B.
The seasonal quantitative and qualitative variations in hemolymph protein in females appear to be closely related to egg production. Serological studies indicate that at least one of the hemolymph proteins is used directly in the formation of yolk proteins.
1968. Protein synthesis by hemocytes of *Callinectes sapidus:* a study of *in vitro* incorporation of ^{14}C-leucine. Journal of Cell Biology, vol. 39, No. 2, Pt. 2, p. 72A-73A. Abstract only.
Qualitative and quantitative variation in the hemolymph proteins. Muscle, heart, hepatopancreas, whole hemolymph and serum were incubated with leucine-C^{14} in various culture media, and rates of incorporation of radioactivity into total protein were determined.
1969. Hemolymph proteins of the blue crab, *Callinectes sapidus.* II. A lipoprotein serologically identical to oocyte lipovitellin. Developmental Biology, vol. 20, No. 1, p. 1-17.
A gradual increase in hemolymph Cu and protein concentrations in females was coincident with ovarian growth followed by their decrease when the sponge was formed. Oocyte lipovitellin and a lipoprotein from hemolymph serum, found only in adult females, had the same mobilities and staining reactions when subjected to vertical starch gel electrophoresis and were indistinguishable immunochemically.

Kifer, Robert R., and Paul E. Bauersfeld.
1969. Relative chemical composition and nutritive values of king crab, *Paralithodes camtschatica,* and blue crab, *Callinectes sapidus.* Fishery Industrial Research, vol. 5, No. 3, p. 121-131.
King crab meal and blue crab meal were evaluated as to their chemical composition (proximate composition, amino acids, minerals, and glucosamine) and nutritive value when fed to chicks. Both species had high mineral content and relatively high nutritive value.

King, Elizabeth N.
1963. The effects of osmotic changes on respiration in four decapod Crustacea. Ph. D. thesis, Duke University, Durham, N.C., 1963. Dissertation Abstracts, vol. 24, No. 5, p. 2105.
Studied *Carcinus mediterraneus, Callinectes sapidus, Maja verrucosa,* and *Libinia emarginata.* A comparison of intact animals, excised tissue, and isolated mitochondria.
1965. The oxygen consumption of intact crabs and excised gills as a function of decreased salinity. Comparative Biochemistry and Physiology, vol. 15, No. 2, p. 93-102.
The respiratory rate of the intact blue crab (one of four species studied) in dilute sea water compared to that in normal sea water increased 53 percent; in excised gills, the rate increased 10 percent in crabs collected from sea water and 30 percent in those from brackish water. In sea water, gill respiration of brackish water blue crabs was significantly higher than that of marine blue crabs.
1966. Oxidative activity of crab gill mitochondria as a function of osmotic concentration. Comparative Biochemistry and Physiology, vol. 17, No. 1, p. 245-258.
The blue crab was one of four species studied. The specific activity of the gill mitochondrial enzymes increased 200 to 300 percent on diluting the medium from 1.6 to 0.16 osmoles. Oxygen consumption of blue crab gill mitochondria increased 75 percent (brackish-water crabs) or 35 percent (marine crabs) with a similar decrease in osmolarity. A subsequent increase in the osmolarity of the medium reversed the increase in enzyme activity and oxygen consumption.

Kingsley, J. S.
1879. List of decapod Crustacea of the Atlantic coast, whose range embraces Fort Macon. [Beaufort, N.C.]. Proceedings of the Academy of Natural Sciences of Philadelphia, 1878, vol. 30, p. 316-330.

Range of the blue crab in the Atlantic and Gulf of Mexico.

1880. On a collection of Crustacea from Virginia, North Carolina, and Florida, with a revision of the genera of Crangonidae and Palaemonidae. Proceedings of the Academy of Natural Sciences of Philadelphia, 1879, vol. 31, p. 383-427.

Taxonomic grouping of specimens collected by H. E. Webster, Union College, Northampton, Va. Three sterile female blue crabs were collected at Beaufort, N.C.

Kinzelbach, Ragnar.

1965. Die Blaue Schwimmkrabbe *(Callinectes sapidus)*, ein Neubürger im Mittelmeer. Natur und Museum, vol. 95, No. 7, p. 293-296.

Recent blue crab occurrences and its distribution in the Mediterranean. In the last 10 to 15 years the blue crab has established itself in the eastern Mediterranean and can be considered part of the European fauna.

Kleinholz, L. H.

1936. Crustacean eye-stalk hormone and retinal pigment migration. Biological Bulletin (Woods Hole), vol. 70, No. 2, p. 159-184.

Specimens of *Palaemonetes vulgaris* were injected with eyestalk extract from six species of decapod crustaceans. Stalk extracts from the eyes of *C. sapidus* had no effect on the retinal pigments of the test animals.

1942. Hormones in Crustacea. Biological Reviews, vol. 17, No. 2, p. 91-119.

C. sapidus was one of the species from which eyestalk extracts were used to test retinal pigment migrations. References to results of various blue crab studies concerning calcium metabolism and localization of the source of chromatophorotropic hormone.

Kleinholz, L. H., P. R. Burgess, D. B. Carlisle, and O. Pflueger.

1962. Neurosecretion and crustacean retinal pigment hormone: Distribution of the light-adapting hormone. Biological Bulletin (Woods Hole), vol. 122, No. 1, p. 73-85.

The blue crab was one of eight decapod crustaceans whose eyestalks were tested for distal retinal pigment hormone. The various extracts were tested by injection into two species of prawns. In the blue crab, injected sinus gland extracts caused only slight light-adaption, but extracts of eyestalks without the sinus gland produced a response near that obtained with extracts of whole eyestalks.

Kleinholz, L. H., V. J. Havel, and R. Reichart.

1950. Studies in the regulation of blood-sugar concentration in crustaceans. II. Experimental hyperglycemia and the regulatory mechanisms. Biological Bulletin (Woods Hole), vol. 99, No. 3, p. 454-468.

Experiments on *Astacus trowbridgii* and *C. sapidus* which showed the mediation of the sinus gland in cases of physiologically induced hyperglycemia and the resemblance between experimental hyperglycemia in crustaceans and the excitment hyperglycemia of higher vertebrates.

Knowles, Francis G. W., and David B. Carlisle.

1956. Endocrine control in the Crustacea. Biological Reviews, vol. 31, No. 4, p. 396-473.

Included in a section on metabolism of sugar, glycogen, and chitin is a brief summary of the work of various other authors on hyperglycaemic control mechanisms (eyestalk and other tissues) of *Callinectes.*

Knowlton, Frank P.

1942. Observations on the dual contraction of crustacean muscle. Biological Bulletin (Woods Hole), vol. 82, No. 2, p. 207-214.

The quick and slow contractions of the skeletal muscles of *C. sapidus*, *Libinia*, and *Homarus* were investigated and correlated with "twitch" and "contracture" of vertebrate muscle.

Knowlton, F. P., and C. J. Campbell.

1929. Observations on peripheral inhibition in arthropods. American Journal of Physiology, vol. 91, No. 1, p. 19-26.

Studies on the blue crab, lobster, and spider crab indicated that selective excitability and reciprocal inhibition is not limited to claw muscles but is general in the appendages of arthropods.

Kovac, George M.
1954. Size reduction—key to process innovation. Food Engineering, vol. 26, No. 12, p. 73-80.
New equipment and technique for reducing the size of raw material used in the manufacture of food products. One of the applications is making a paste for sauces and salads from lobster and crab shells. Utilizes all the shells and eliminates much hand labor.

Krantz, G. E., R. R. Colwell, and E. Lovelace.
1969. *Vibrio parahaemolyticus* from the blue crab *Callinectes sapidus* in Chesapeake Bay. Science, vol. 164, No. 3885, p. 1286-1287.
First isolation of *V. parachaemolyticus*, from diseased crabs. Strains of this bacteria occurred in lethargic and moribund crabs in commercial tanks during "shedding" of soft crabs. Deaths in some tanks was over 50 percent; dead animals did not have the signs or the etiological agent associated with the "gray crab" disease.

Krough, August.
1939. Osmotic regulation in aquatic animals. Cambridge University Press, London; also, 1965, Dover Publications, Inc., New York, 242 p.
A chapter on Crustacea (p. 65-99) refers to blue crab in regard to osmotic and sugar concentration changes connected with molting.

Kühl, Heinrich.
1965. Fang einer Blaukrabbe, *Callinectes sapidus* Rathbun, (Crustacea, Portunidae) in der Elbmündung. Archiv für Fischereiwissenschaft, vol. 15, No. 3, p. 225-227. [English summary.]
A blue crab caught by a fisherman is the first record for the Elbe River, Germany. This species may emigrate by fouling the bottom of ships, in ballast tanks, or by escaping while being transported for display in aquaria.

Kurtz, Eloise.
1951. Distribution of p^{32} in *Callinectes* during the molting cycle. Biological Bulletin (Woods Hole), vol. 101, No. 2, p. 211-212.
Relative uptake of p^{32} by different tissues at five periods in the molting cycle. Each tissue showed a different pattern of relative uptake.

Kurtzman, Caroline H., and Donald G. Snyder.
1960. Rapid objective freshness test for blue-crab meat and observations on spoilage characteristics. Commercial Fisheries Review, vol. 22, No. 11, p. 12-15.
Results of experiments on lots of blue-crab meat indicated that the picric acid turbidity test (freshness test for shrimp) used with colorimeter readings is satisfactory to measure meat quality. There was no consistent difference in spoilage characteristics whether steaming or boiling was used in processing.

Lambou, Victor W.
1961. Utilization of macrocrustaceans for food by fresh-water fishes in Louisiana and its effects on the determination of predator-prey relations. Progressive Fish-Culturist, vol. 23, No. 1, p. 18-25.
Fish stomachs from three areas in Louisiana were examined. The species studied, the number of stomachs containing food, and (in parentheses) the percentage of stomachs containing blue crab were: alligator gar, 30 (86.7); spotted gar, 22 (55.0); yellow bass, 167 (29.0); largemouth bass, 59 (55.9); spotted bass, 3 (0.0); and blue catfish, 20 (100.0). Sizes of crabs eaten ranged from 0.25 to 5 inches wide.

Lang, Michael Alan.
1969. Volume control in hypotonic saline by muscles of the blue crab, *Callinectes sapidus* Rathbun. Ph. D. thesis, University of Maryland, 1968. Dissertation Abstracts, vol. 29, No. 10, p. 3891-B.
Leg muscle fibers swelled in hypotonic salines undergo a spontaneous volume readjustment toward the initial volumes of the cells in isotonic salines. The active removal of intracellular free amino acids, which constitute the osmotically active substance of muscle fibers, appeared to be the force which produced volume readjustment in these cells.

Lang, Michael A., and Harold Gainer.
1968. Control of cell volume in single muscle fibers. Federation Proceedings, vol. 27, p. 701.
The volumes of muscle fibers from *C. sapidus* in hypotonic salines increased to new steady state levels, but then with time decreased towards their initial volumes in control salines. When returned to control salines their volumes fell below the initial values.
1969a. Volume control by muscle fibers of the blue crab. Volume readjustment in hypotonic salines. Journal of General Physiology, vol. 53, No. 3, p. 323-341.
Single isolated muscle fibers from the walking legs of *C. sapidus* act as Boyle-van't Hoff osmometers with an osmotically inactive volume of 33 percent. Volume readjustment is initiated by the increase in cell volume in hypotonic salines and appears to be dependent on the duration of exposure to external Na, Na concentration, and the pH of the external medium.
1969b. Isosmotic intracellular regulation as a mechanism of volume control in crab muscle fibers. Comparative Biochemistry and Physiology, vol. 30, No. 3, p. 445-456.
Nonprotein ninhydrin-positive substances were lost from blue crab muscles in volume-readjustment in hypotonic sodium salines. Studies indicated that this component is a fraction of the large intracellular pool of free amino acids in crab muscle, and that free amino acids are being actively transported out of the muscles during volume-readjustment.

Lee, Charles F., George M. Knobl, Jr., Robert K. Abernethy, and Emmett F. Deady.
1963. Mechanizing the blue crab industry. Part 2. Measures for immediate relief through worker specialization. Commercial Fisheries Review, vol. 25, No. 8, p. 1-5.
Picking operation can be improved by using each worker's skill maximally, by choosing workers for teams according to special skills, and by improving the method of material transport among workers.

Lee, Charles F., George M. Knobl, Jr., and Emmett F. Deady.
1963. Mechanizing the blue crab industry. Part 1. Survey of processing plants. Commercial Fisheries Review, vol. 25, No. 7, p. 1-10.
Survey of over 60 plants to determine the need for mechanization and the type of machines needed. Concluded that the industry was in serious need of debacking, cleaning, and picking machines to replace hand operations.
1964. Mechanizing the blue crab industry. Part 3. Strengthening the industry's economic position. Commercial Fisheries Review, vol. 26, No. 1, p. 1-7.
Indicates how the economic position of the industry can be strengthened by mechanization, developing additional markets, and increasing the supply of raw crabs.

Lee, Charles F., and F. Bruce Sanford.
1962. Soft crab industry. Commercial Fisheries Review, vol. 24, No. 1, p. 10-12.
Landings and value of soft blue crabs from New Jersey to Louisiana in 1958. Growth of industry in the southern states. "Green" and peeler stages, prior to molting, are defined. Shells begin to toughen within the hour after molting unless removed from the water. Most soft crabs are shipped alive, but an increasing number are being frozen.
1964. Crab industry of Chesapeake Bay and the south—an industry in transition. Commercial Fisheries Review, vol. 26, No. 12, p. 1-12.
The blue crab industry is in the initial stage of change from hand preparation to machine preparation. It also is studying its methods of capturing and marketing crabs.

Leidy, Joseph.
1855. Contributions towards a knowledge of the marine invertebrate fauna, of the coasts of Rhode Island and New Jersey. Journal of the Academy of Natural Sciences of Philadelphia, 2nd Series, vol. 3, Article 11, p. 135-152.
Locations in New Jersey and Rhode Island where the blue crab (listed as *Lupa dicantha)* was found.
1889. Remarks on the fauna of Beach Haven, N. J. Proceedings of the Academy of Natural Sciences of Philadelphia, 1888, vol. 40, p. 329-333.
The blue crab often occurred in the bays in great numbers. A decrease one summer was

attributed by fishermen to a large mortality caused by the severe cold the previous winter. Many isopods, *Cirolana concharum*, fed on dead crabs on the beach.

Lemon, J. M., and R. V. Truitt.
1941. Seafood and the diet. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 42, 11 p.
The mineral and vitamin content and the protein and fat composition of blue crab meat are given.

Leone, Charles A.
1953. Some effects of formalin on the serological activity of crustacean and mammalian sera. Journal of Immunology, vol. 70, No. 4, p. 386-392.
The effect of 0.2 to 10 percent formalin on serological activity was studied with antisera produced against the sera of the blue crab and the cow. Alteration of serological characteristics of antigens by Formalin was a function of its concentration in the systems.
1954. Serological studies of some arachnids, other arthropods, and mollusks. Physiological Zoology, vol. 27, No. 4, p. 317-325.
Deals primarily with serological relationships (obtained with the "ring" or interfacial tests and by turbidimetric tests with a photronreflectometer) among species in the Arachnoidea and between this family and *C. sapidus* and certain other Crustacea.
1956. Normal variation in the amount of protein in the sera of some decapod Crustacea. Proceedings of the 14th International Congress of Zoology, Section 9, p. 331-333.
Includes the blue crab.

Lieberman, Edward M.
1967a. Structural and functional sites of action of ultraviolet radiations in crab nerve fibers. I. The electrophysiological effects of ultraviolet radiations. Experimental Cell Research, vol. 42, No. 3, p. 489-507.
Studied excitable membrane electrical characteristics as a function of membrane structure in single isolated motor nerve fibers of *C. sapidus*.
1967b. Structural and functional sites of action of ultraviolet radiations in crab nerve fibers. II. Localization of the sites of action of UV radiation by experiments with Ca^{2+} and ouabain. Experimental Cell Research, vol. 42, No. 3, p. 508-517.
C. sapidus motor axons were protected from ultraviolet radiations of 255 mμ but not from 285 mμ when suspended in crab physiological solution containing 2.5 times normal $CaCl_2$. Two concentrations of Ca++ increased the light scattering properties of a Cephalin solution. Ouabain had biphasic effects on the repetitive response of crab axons.
1967c. Structural and functional sites of action of ultraviolet radiations in crab nerve fibers. III. The photoinactivation of a Na+-K+- activated ATPase system and its correlation with inactivation of excitability. Experimental Cell Research, vol. 42, No. 3, p. 518-535.
To test the hypothesis of a correlation between the functional state of a membrane related Na+-K+- activated ATPase system and the excitability and electrical characteristics of crab *(C. sapidus)*, the enzyme system (prepared from crab nerve) was subjected to radiations and assayed for ATPase activity.

Lieberman, E. M., R. F. Palmer, and G. H. Collins.
1967. Calcium ion uptake by crustacean peripheral nerve subcellular particles. Experimental Cell Research, vol. 46, No. 2, p. 412-418.
A vesicular membrane system was prepared from peripheral nerve of the blue crab. In vitro Na+ released bound Ca^{2+} and simultaneously stimulated the Na+-K+- activated ATPase system, suggesting a relationship between these two systems and the control of nerve excitability.

Lieberman, Edward M., Margaret S. Perkins, Tadao Tomita, and Ernest B. Wright.
1967. Bioelectric phenomena related to protein-fixed charge in a crab nerve fiber. Science, vol. 156, No. 3772, p. 240-242.
Experiments with single *C. sapidus* axons, where various anions were substituted for chloride in the surrounding medium, indicated that bioelectrical phenomena are related to fixed charges in the membrane.

Lindeman, Verlus F.
1939. The respiratory metabolism of the nerves of the blue crab *(Callinectes sapidus).* Physiological Zoology, vol. 12, No. 2, p. 214-217.
Sections of the claw and walking-appendage nerves were studied for oxygen consumption. Metabolic rate of the walking-leg nerve was about 56 percent greater than that of the claw nerve.

Lindow, C. W., C. A. Elvehjem, and W. H. Peterson.
1929. The copper content of plant and animal foods. Journal of Biological Chemistry, vol. 82, No. 2, p. 465-471.
Copper content of blue crabs was 0.00043 percent for living matter and 0.00144 percent for dry matter.

Littleford, Robert A.
1957a. Retort cooking of blue crabs. University of Maryland Seafood Processing Laboratory, Bulletin No. 1, 16 p.
Ten minutes at 121° C. was the most satisfactory cooking time on a year round basis. Recommendations for proper cooking by use of a retort.
1957b. Studies on pasteurization of crab meat. University of Maryland Seafood Processing Laboratory, Bulletin No. 2, 14 p.
Consideration of the value of an internal temperature of 76.7° C. as a method for extending the shelf life of crab meat for an acceptable time. Recommendations on the meat to be used and on the processing technique.

Livingstone, Robert, Jr.
1965. A preliminary bibliography with KWIC index on the ecology of estuaries and coastal areas of the eastern United States. U.S. Fish and Wildlife Service, Special Scientific Report—Fisheries No. 507, 352 p.
Includes 51 references to *Callinectes.*

Lochhead, John H.
1949. *Callinectes sapidus*, p. 447-462. *In* F. A. Brown, Jr. [ed.] Selected invertebrate types. John Wiley & Sons, New York.
Comprehensive description of anatomy. General life history and some physiology.

Lochhead, Margaret S., John H. Lochhead, and Curtis L. Newcombe.
1942. Hatching of the blue crab, *Callinectes sapidus* Rathbun. Science, vol. 95, No. 2467, p. 382.
Under favorable conditions, 90 percent of the eggs hatched into zoea. The larvae were reared to the second zoeal stage in the laboratory.

Lochhead, Margaret S., and Curtis L. Newcombe.
1942. Methods of hatching eggs of the blue crab. Virginia Journal of Science, vol. 3, No. 2-3, p. 76-86.
Results of laboratory and field experiments on the hatching of detached eggs. Techniques for removing and holding sponges and removing eggs from the sponge. Environmental conditions that are essential for a high hatching percentage. Method of hatching eggs in natural waters. Molting to the second zoeal stage is reported for the first time.

Loesch, Harold.
1953. The Alabama crab. Alabama Conservation, vol. 24, No. 5, p. 14-15.
General account of the life history and growth of the blue crab in Alabama and methods used to capture it.

Loosanoff, V. L.
1948. Crabs as destroyers of oysters, [with] Notes from A. F. Chestnut. Oyster Institute of North America, Trade Report No. 98, 2 p.
Notes on the blue crab feeding on young oysters in experimental tanks; in the York River, Va., and in Delaware Bay.

Louisiana Department of Wild Life and Fisheries.
1944-53. Biennial reports. Louisiana Department of Wild Life and Fisheries, 1st-5th Biennial Reports.
Blue crab catch records and industry.

Lowe, Jack I.
1965. Chronic exposure of blue crabs, *Callinectes sapidus*, to sublethal concentrations of DDT. Ecology, vol. 46, No. 6, p. 899-900.
Juvenile crabs (24-30 mm. wide) fed, molted, and grew for 9 months in sea water

containing 0.25 μg per liter DDT but survived only a few days at a concentration in excess of 0.5.

Lubitz, Joseph A., Carl R. Fellers, and Raymond T. Parkhurst.
1943. Crab meal in poultry rations. Part 1. Nutritive properties. Poultry Science, vol. 22, No. 4, p. 307-313.
Blue crab meal from dried cannery waste was analyzed chemically and assayed, using rats and chickens, for vitamin content.

Ludwig, P. D., H. J. Dishburger, J. C. McNeill, IV, W. D. Miller, and J. R. Rice.
1968. Biological effects and persistence of Dursban insecticide in a salt-marsh habitat. Journal of Economic Entomology, vol. 61, No. 3, p. 626-633.
Application of 0.025 pound per acre had no obvious adverse effects on natural and caged crabs, shrimp, fish, and birds. A level of 0.05 pound per acre resulted in deaths of brown shrimp and some small fish, but larger fish and blue crabs appeared to be unharmed, even when confined in the treated area for 21 days. Also studied the persistence of Dursban in water, silt, and oysters after application.

Ludwig, Paul D., J. C. McNeill, and W. D. Miller.
1967. Preliminary results obtained with Dursban in the biotic community. Down to Earth, vol. 22, No. 4, p. 3-5.
Dursban insecticide, applied to areas of salt marshland in Texas for mosquito control, did not affect mullet and blue crabs confined 21 days to the treated areas.

Ludwigson, John O.
1969. Chesapeake Bay. Oceans, vol. 1, No. 5, p. 6-16.
Points out that the relation between the number of spawning blue crabs and the subsequent population levels was almost inverse, and thus the number of spawners does not explain great annual fluctuations in abundance of marketable crabs.

Lunz, G. Robert.
1947. *Callinectes* versus *Ostrea.* Journal of the Elisha Mitchell Scientific Society, vol. 63, No. 1, p. 81.
Serious predator particularly on young oysters at Wadmalaw Island, S. C. Destroyed more than 80 percent of the young oysters set on collectors.
1958. Notes on a non-commercial crab of the genus *Callinectes* in trawl catches in South Carolina. Bears Bluff Laboratories, Wadmalaw Island, S. C., Contribution No. 27, 17 p.
The abundance of *Callinectes ornatus* in trawl catches threatened the trawl crabbing industry. Restrictive measures aimed at protecting immature blue crabs actually protected *C. ornatus.* The data available did not indicate that *C. ornatus* competed with the blue crab for food and space.
1968. Farming the salt marshes, p. 172-177. *In* John D. Newsom [ed.] Proceedings of the marsh and estuary management symposium, Louisiana State University, 1967. Thos. J. Moran's Sons, Inc., Baton Rouge.
The price of crabs is usually too low to make pond culture economically desirable. In South Carolina, about 100 pounds of crabs were grown annually in a 1-acre pond. Male crabs were very large and most weighed 20 ounces compared with the 3-to-8-ounce weight of the average crab in the commercial catch along the Atlantic and Gulf coasts.

MacGregor, John S.
1950. Some hydrographic conditions found in winter in lower Chesapeake Bay and their possible effects on the blue crab *(Callinectes sapidus* Rathbun) population. M. A. thesis, College of William and Mary, Williamsburg, Va., 56 p.
Experiments on the effect of low temperature with low salinity on blue crab activity and the amount of mortality. Effect of low temperature and light on the burying of crabs. Results were related to hydrographic conditions found during the winter dredge fishery for crabs in Chesapeake Bay.

Manning, J. H.
1957. The effects of hydraulic clam dredging on fish and crabs, p. 18-19. *In* J. H. Manning, The Maryland soft shell clam industry and its effects on tidewater resources. Maryland Department of Research and Education, Resource Study Report No. 11.

Statistical evidence did not support claims that hydraulic clam dredging caused a decline in blue crabs or commercial fishing in the Eastern Bay-Miles River, Md., area.

Manning, John Ruel.
1943. Crab scrap as poultry feed. U. S. Fish and Wildlife Service, Fishery Leaflet No. 29, 3 p.
An experiment on a Maryland farm to determine the value of crab scrap as poultry feed indicated that hen and egg weight increased and plumage was better as a result of crab scrap in the diet.

Mantel, Linda Habas.
1967. Asymmetry potentials, metabolism and sodium fluxes in gills of the blue crab, *Callinectes sapidus*. Comparative Biochemistry and Physiology, vol. 20, No. 3, p. 743-753.
Measured were blood sodium concentrations at various salinities, oxygen consumption of gill pieces, potential differences between blood or isolated gills and medium, and sodium fluxes across the gills.

Manwell, Clyde, and C. M. Ann Baker.
1963. Starch gel electrophoresis of sera from some marine arthropods: Studies on the heterogeneity of hemocyanin and on a "ceruloplasmin-like protein." Comparative Biochemistry and Physiology, vol. 8, No. 3, p. 193-208.
Sera of the blue crab, one of the three main species studied, showed some qualitative and considerable quantitative variation. Parasitization by *Loxothylacus* increases the amount of "fast" hemocyanin and of a certain protein.

Marine Chemurgics, Inc. (Contractor).
1966. Carteret County seafood processing project. Part 1. U. S. Department of Commerce, Economic Development Administration, Technical Assistance Project No. 777. Contract No. Cc6161. 94 p.
A study on the seafood fishery of Carteret County, N.C. Part 1 project was to determine if there are sufficient and suitable raw materials for processing endeavors. Marketing and shipping of whole and processed blue crabs. Catch statistics. Crab meat was one of the products produced by a prototype plant. The quality of plate-frozen meat was good after 60 days of storage. The number of shell pieces in the finished product was reduced.
1968. Carteret County seafood processing project. Part 2. U. S. Department of Commerce, Economic Development Administration, Technical Assistance Project No. 03-6-09022. Contract No. C-194-66. 79 p.
Part 2 project was to determine how to expand the variety and extent, while improving the quality, of Carteret County, N.C., seafood landings. Operations of crab dealers, catching methods, catch by season, prices, fishing grounds, and preparation for shipment. Trawl fishing for crabs suggested as a new local fishing method.

Maryland Board of Natural Resources.
1917-69. Annual reports. Conservation Commission, 1916-1922; Maryland Conservation Department, 1923-1941; Maryland Board of Natural Resources, 1944+ (includes annual reports of Chesapeake Biological Laboratory, Solomons, Maryland, Department of Research and Education, and University of Maryland).
Many of the reports give statistics of the blue crab fishery and progress of research programs on the blue crab.

Maryland Tidewater News.
1944. Spawn, hatch and survive? Maryland Tidewater News, vol. 1, No. 5, p. 2.
Deals with the life history of the blue crab and the appearance of egg-bearing females in upper Chesapeake Bay where newly-hatched crabs die because of low salinities.
1950. Truly a blue crab. Maryland Tidewater News, vol. 7, No. 4, p. 5.
Report of a large male crab caught in Maryland whose back was brilliant blue, the same shade usually found only on the claws and legs.
1953. Concerning loss of crabs in pots. Maryland Tidewater News, vol. 10, No. 1, p. 1-2.
An investigation indicated that blue crab deaths in pots were due to low dissolved oxygen resulting from organic detritus and the influx of deeper waters having little oxygen into areas where pots were set.

May, Robert E.
1936. A preliminary report of regeneration in the blue crab, *Callinectes sapidus.* Proceedings of the Louisiana Academy of Sciences, vol. 3, No. 1, p. 50-53.
The time between autotomy of a cheliped or leg and the beginning of regeneration, rate and manner of growth of the new appendage, and the affects of size and sex of the crab on regeneration.

Mayer, Alfred Goldsborough.
1911. Sea-shore life. The invertebrates of the New York coast and the adjacent coast region. A. S. Barnes Company, New York, 181 p.
The distribution, value, habitat, food, molting, and eggs of *C. sapidus* are included in a section on crabs.

Maynard, D. M.
1961. Thoracic neurosecretory structures in Brachyura. 2. Secretory neurons. General and Comparative Endocrinology, vol. 1, p. 237-263.
Describes secretory neurons, their location in the nervous system, and associated fiber tracts of *Callinectes* and 10 other genera.

McCleskey, C. S., and Albert F. Boyd, Jr.
1949. The longevity of the coliform bacteria and enterococci in iced crabmeat. Food Technology, vol. 3, No. 10, p. 337-339.
Coliform bacteria increased during storage of iced crabmeat but the enterococci did not change. *Escherichia coli* did not increase significantly. There appeared to be no relation between plate count and numbers of coliforms or enterococci, nor between coliforms and enterococci.

McCleskey, C. S., and Leonard Tobin.
1941. Rigid sanitation required in packing fresh crabmeat. Food Industries, vol. 13, No. 8, p. 39-40.
Sources and prevention of bacterial contamination in the processing of crab meat.

McHargue, J. S.
1924. The significance of the occurrence of copper, manganese, and zinc in shellfish. Science, vol. 60, p. 530.
Concentration of iron, copper, zinc, and manganese in the blue crab.

McHugh, J. L.
1967. Estuarine nekton, p. 581-620. *In* George H. Lauff [ed.] Estuaries. American Association for the Advancement of Science, Publication No. 83.
Cites a report of blue crabs killed by a red tide outbreak. Menhaden could consume large numbers of blue crab larvae, because in Chesapeake Bay and other estuaries, eggs of blue crabs hatch at a time and in places where adult menhaden are most abundant. This predation could substantially affect the future abundance of blue crabs. In Chesapeake Bay, 1949-63, great abundance of menhaden usually was associated with low catches of blue crabs 1 year later, and vice versa—but no proof of casual relationship can be inferred.
1969. Fisheries of Chesapeake Bay. Proceedings of the Governor's Conference on Chesapeake Bay, September 12-13, 1968. p. II-135-II-160.
Refers to a series of hearings on the blue crab resource by the House Committee on Merchant Marine and Fisheries. Determination of the optimum size of stock by the examination, over a sufficient period of time, of the relation between the size of the spawning stock and the number of progeny which later enter the fishery. Types of fishing gear for crabs, and trends and problems in the blue crab and other Chesapeake fisheries.

McHugh, J. L., and Robert S. Bailey.
1957. History of Virginia's commercial fisheries. Virginia Journal of Science, vol. 8, No. 1, p. 42-64.
Included are sections on the history of the blue crab fishery and fluctuation in abundance of crabs in Virginia. Three major dips in the annual catch—in the mid-1930's, the early 1940's, and the early 1950's—coincided with periods of relative scarcity of crabs.

McHugh, J. L., and E. C. Ladd.
1953. The unpredictable blue crab fishery. National Fisheries Yearbook, 1953, p. 127-129.

The effect of fishing on blue crab abundance in Chesapeake Bay is not understood. The relation between the numbers of spawners and numbers of young produced can be obtained by tagging, catch records, and an annual measure of spawning success. A tag that is retained after molting is shown. History of supply and the annual landings in Chesapeake Bay since 1890 are presented.

Mendelson, Martin.
1966. The site of impulse initiation in bipolar receptor neurons of *Callinectes sapidus* L. [sic]. Journal of Experimental Biology, vol. 45, No. 3, p. 411-420.
Direct measurement with intracellular electrodes indicated the impulse threshold of the soma region of blue crab propoditedactylopodite bipolar neurons from resting potential. Some responses are accompanied by impulses in the axon. Impulses appear to originate normally in the distal process in response to adequate stimuli.

Menzel, R. Winston.
1943. The catfish fishery of Virginia. Transactions of the American Fisheries Society, vol. 73, p. 364-372.
Stomachs of channel catfish contained small blue crabs; a 9-pound fish had eaten three 50-mm.-wide crabs.

Menzel, R. Winston, and Sewell H. Hopkins.
1956. Crabs as predators of oysters in Louisiana. Proceedings of the National Shellfisheries Association, 1955, vol. 46, p. 177-184.
Along the Gulf of Mexico, blue crabs reportedly kill adult oysters only if the oysters are unhealthy, but they destroy an appreciable number of healthy spat.

Menzel, R. Winston, and Fred W. Nichy.
1958. Studies of the distribution and feeding habits of some oyster predators in Alligator Harbor, Florida. Bulletin of Marine Science of the Gulf and Caribbean, vol. 8, No. 2, p. 125-145.
The blue crab, abundant in Alligator Harbor, killed healthy small oysters and ate weakened large oysters.

Menzel, R. W., and H. W. Sims.
1964. Experimental farming of hard clams, *Mercenaria mercenaria*, in Florida. Proceedings of the National Shellfisheries Association, 1962, vol. 53, p. 103-109.
Blue crabs cracked 90 percent of unprotected small hard clams planted to test the feasibility of commercial clam farming.

Meyer, Marvin C., and Albert A. Barden, Jr.
1955. Leeches symbiotic on Arthropoda, especially decapod Crustacea. Wasmann Journal of Biology, vol. 13, No. 2, p. 297-311.
Myzobdella lugubris commonly infests the blue crab, but it is unlikely that the relationship is parasitic. It was found that oysters and prawns are infested also.

Mills, H. R.
1952. Deaths in the Florida marshes. Audubon Magazine, vol. 54, p. 285-291.
Monthly sprayings of salt marshes with 0.2 pound per acre of DDT caused deaths of blue crabs.

Milne, Robert C.
1965. Crab predation on a duckling. Journal of Wildlife Management, vol. 29, No. 3, p. 645.
An observation of the capture of a gadwall duckling by a 6-inch blue crab in a coastal North Carolina impoundment.

Milne Edwards, Alphonse.
1879. Variétés de la Côte Atlantique, p. 224-227. *In* Alphonse Milne Edwards, Études sur les Xiphosures et les Crustacés de la Région Mexicaine. Mission Scientifique au Mexique et dans l'Amérique Centrale, Recherches Zoologiques, Pt. 5.
Data on distribution and descriptions of external anatomy are given for the blue crab and for other members of the genus.

Miner, Roy Waldo.
1950. *Callinectes sapidus*, p. 521. *In* Roy Waldo Miner, Field book of seashore life. G. P. Putnam's Sons, New York.
Reported to occur from Cape Cod to Florida and around the Gulf of Mexico to the Mississippi River. Color and certain recognitional characters are given.

Monod, Théodore.
1966. Crevettes et crabes de la côte occidentale d'Afrique, p. 103-234. *In* C. S. A. [Scientific Council for Africa] Specialist meeting on crustaceans, Zanzibar, 1964. Memoires de l'Institut Fondamental d'Afrique Noire, No. 77.
Callinectes gladiator, *C. marginatus*, and *C. latimanus* occur on the west coast of Africa. The author presents the biology of the genus using American literature on *C. sapidus* (industry, life history, growth, and food).

Moody, Harold.
1963. St. Johns River. Florida Wildlife, vol. 17, No. 2 and 3, Pt. 1, p. 116-123, Pt. 2, p. 20-27.
The St. Johns River, Fla., supports an important commercial fishery and a sport fishery for blue crabs. The species occurs as far upstream as Lake Harney (190 miles).

Moore, David J.
1969. The uptake and concentration of fluoride by the blue crab, *Callinectes sapidus*. Ph. D. thesis, North Carolina State University, 47 p.
Ecological effects of increased fluoride levels in the Pamlico Estuary, N.C., as a result of phosphate processing. Significant amounts of fluoride accumulated in crab tissues at all experimental water fluoride levels; content in muscle is a potential public health problem. Inhibitory effect of fluoride on crab growth.

More, William R.
1969. A contribution to the biology of the blue crab *(Callinectes sapidus* Rathbun) in Texas, with a description of the fishery. Texas Parks & Wildlife Department, Technical Series No. 1, 31 p.
A survey of the commercial fishery (1965-67) provided data on catch, effort, and reasons for fluctuations in the catch. Biological studies provided data on periods of spawning, occurrence of megalops, growth, migrations, and the effect of temperature and salinity (occurred in salinities over 50 p.p.t.) on distribution of crabs by size, sex, season, and sexual maturity. A large crab kill was attributed to low oxygen concentration and a plankton bloom. Incidences of four parasites and one disease of blue crabs were determined.

Morgulis, Sergius.
1922. A study of the non-protein constituents in blood of some marine invertebrates. Journal of Biological Chemistry, vol. 50, p. 52-54.
A survey of the blood from horseshoe crab, blue crab, spider crab, and lobster. The sugar, nonprotein nitrogen, and uric acid content of the blood from blue crab showed the greatest variability. Blue crabs examined immediately showed a high content, but after 1 day the sugar and nonprotein nitrogen diminished and the uric acid disappeared.

Morrison, George S., and Fletcher P. Veitch.
1957. An investigation of the chemistry of texture changes of frozen blue crabmeat. Commercial Fisheries Review, vol. 19, No. 10, p. 1-5.
Studies of the changes in texture in frozen, stored blue crab meat showed that a low-grade nonenzymatic respiration of tissue continues even at -17° C. Respiratory quotient studies indicated that the Warburg respiration is due to oxidation of tissue carbohydrates.

Muncy, Robert J., and Abe D. Oliver, Jr.
1963. Toxicity of ten insecticides to red crawfish, *Procambarus clarki* (Girard). Transactions of the American Fisheries Society, vol. 92, No. 4, p. 428-431.
Test with methyl parathion in brackish water from the Gulf of Mexico revealed that concentrations of 0.5 p.p.m. remained toxic to young blue crabs for at least 45 days.

Newcombe, Curtis L.
1943. The biology and conservation of the blue crab. Virginia Fisheries Laboratory, Gloucester Point, Educational Series No. 3, 15 p.
Value of the crab fishery (1929-41) in Chesapeake Bay, life history, growth, food, and migrations. Conservation measures discussed include minimum widths on crabs

that can be taken, restrictions on taking sponge crabs, and protection against wasteful methods of handling.

1944. The nutritional value of seafoods. Virginia Fisheries Laboratory, Gloucester Point, Educational Series No. 2, 17 p.

The proximate composition and the mineral and vitamin content of the meat of crustaceans (including the blue crab), fish, and shellfish are compared with those of milk, beef, and other foods.

1945. The biology and conservation of the blue crab, *Callinectes sapidus* Rathbun. Virginia Fisheries Laboratory, Gloucester Point, Educational Series No. 4, 39 p.

Life history, migrations, growth, food of larvae and adults, catch statistics, food value, fishery, and industrial practices for soft shell and hard shell crabs. Affect of legal restrictions, temperature, and salinity on abundance. Function and structure of eyes and other appendages, carapace, hypodermis, gills, stomach, liver, heart, and reproductive organs.

1948. An application of the allometry equation to the study of growth in *Callinectes sapidus* Rathbun. American Naturalist, vol. 82, No. 807, p. 315-325.

Found that the allometric growth formula, $Y = aX^b$, can be used for comparing the rates of growth of the several linear dimensions.

1949. A method for studying growth in different groups of arthropods. Science, vol. 109, No. 2822, p. 84-85.

Studies of *C. sapidus* provided a method for estimating the number of postlarval molts, and also the size of the different instars. A curve was made on the basis of before- and after-molt measurements of crabs of all sizes. Since the mean width of the first postlarval instar was known from laboratory work, it was possible to calculate the widths of the remaining instars.

Newcombe, Curtis L., and Grace J. Blank.

1943. Seafoods: Their wartime role in maintaining nutritional standards. Commonwealth, vol. 10, No. 10, p. 1-11.

The blue crab is one of the species included in an investigation of the composition and mineral and vitamin content of seafoods.

Newcombe, Curtis L., Frank Campbell, and Allen M. Eckstine.

1949. A study of the form and growth of the blue crab *Callinectes sapidus* Rathbun. Growth, vol. 13, No. 2, p. 71-96.

The analysis of linear and weight data for blue crabs includes information on the nature of variation in size and form throughout life, size of instars, prediction equations for estimating linear and weight dimensions from width, and the relations in adult crabs between three selected linear dimensions and six independent weight dimensions.

Newcombe, Curtis L., Allen M. Eckstine, and Frank Campbell.

1949. Weights of the commercial meats and other body parts of the Chesapeake blue crab. Southern Fisherman, 1949 Annual, Vol. 9, p. 153-158, 371-373.

Amounts of meat and other tissues that are in blue crabs of different stages, and the amount of usable meat removed in commercial practice. Changes in body shape accompanying increase in size and comparison of weights of body parts.

Newcombe, Curtis L., and Ellen H. Gray.

1941. Observations on the conservation of the Chesapeake blue crab, *Callinectes sapidus* Rathbun. Virginia Journal of Science, vol. 2, No. 1, p. 1-10.

Observations on crabs in commercial and experimental floats to develop proper methods of handling crabs in the soft crab industry. Molting increments (width and length) and estimated number of molts to adult are shown for postlarval crabs.

Newcombe, Curtis L., and M. Rosalie Rogers.

1947. Studies of a fungus parasite that infects blue crab eggs. Turtox News, vol. 25, No. 9, p. 180-186.

The occurrence and commercial importance of *Lagenidium callinectes* were investigated to determine any relation between this fungus and poor catches of crab in Chesapeake Bay. Includes data on its morphology, development, and the nature of its infection.

Newcombe, Curtis L., Mildred D. Sandoz, and R. Rogers-Talbert.
1949. Differential growth and molting characteristics of the blue crab, *Callinectes sapidus* Rathbun. Journal of Experimental Zoology, vol. 110, p. 113-152.
Growth ratios of five linear dimensions of the first eight post-larval instars in the laboratory. Size increments at each molt and the intensity of growth throughout all instars. Determination of theoretical number of molts.

Nichols, Paul R., and Peggy M. Keney.
1963. Crab larvae *(Callinectes)*, in plankton collections from cruises of M/V *Theodore N. Gill*, South Atlantic coast of the United States, 1953-54. U. S. Fish and Wildlife Service, Special Scientific Report-Fisheries No. 448, 14 p.
Callinectes larvae could not be identified to species. Early stage zoeae were abundant near the beaches, advanced stages and megalops were more common offshore, and combined larval stages were in greatest numbers 20 miles offshore.

Nickerson, John T. R., Gerald A. Fitzgerald, and Richard Messer.
1939. Health problems in packing crustacean products. American Journal of Public Health, vol. 29, No. 6, p. 619-627.
Purification experiments on the blue crab. Many of the fecal organisms present in blue crabs were removed by holding the crabs in sea water, free of these organisms, for 24 to 48 hours. Cooking, chlorine treatments, and control of packing operations were methods of controlling contamination during the preparation of crab meat.

Nicol, J. A. Colin.
1960. The biology of marine animals. 1st edition, Interscience Publishers, Inc., New York, 707 p. 2nd edition (1967), Sir Isaac Pitman & Sons Ltd., London, 699 p.
The osmotic acclimation, the haemocyanin content and oxygen capacity of the blood, conduction velocities in limb nerve fibers, and the composition of the meat of the blue crab are briefly discussed in various chapters.

Nilson, Hugo W., and E. J. Coulson.
1939. The mineral content of the edible portions of some American fishery products. U. S. Bureau of Fisheries, Investigational Report, vol. 2, No. 41, 7 p.
Analysis of commercial packs of blue crab meat showed that the white meat is an excellent source of all the minerals studied; the claw meat contains somewhat less calcium, iron, copper, and iodine.

Oakley, Margarethe, and A. W. Breidenbach.
1950. A rapid method for determining shell in crabmeat under ordinary light. Journal of the Association of Official Agricultural Chemists, vol. 39, p. 531-532.
The number of pieces of shell in more than 200 one-pound samples of retail crabmeat varied from 0 to 350. Presents a dye method for staining the shell so that it may be removed quickly. The advantages of this method over the use of ultraviolet light, which also causes the shell in meat to fluoresce, are given.

Odum, Howard T.
1953. Factors controlling marine invasion into Florida fresh waters. Bulletin of Marine Science of the Gulf and Caribbean, vol. 3, No. 2, p. 134-156.
Natural and transplantation experiments in nature indicated that oligohaline waters and distance from brackish water determine the distribution of blue crabs and other marine forms in fresh water. The range and extent of osmoregulation for the blue crab is shown by blood analyses to account for their ability to make inland invasions.

Olden, June H.
1960. Crab from sea to consumer. U.S. Fish and Wildlife Service, Technical Leaflet No. 29, 35 p.
A comprehensive picture of the crab industry in the United States, including commercial species (dungeness, king, and blue crabs), methods of capture, processing, preservation, marketing, and nutritive value.

Ordway, Albert.
1863. Monograph of the genus *Callinectes*. Journal of the Boston Society of Natural History, vol. 7, No. 4, p. 568-579.
Comparative descriptions of nine species of *Callinectes*. Say's name *hastatus* was given to the blue crab.

Osburn, Raymond C.
1944. A survey of the Bryozoa of Chesapeake Bay. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 63, 55 p.
Triticella elongata, a form commensal in the gill chambers of various species of crabs, occurred in live blue crabs of Chesapeake Bay.

Osman, Evelyn M.
1968. Determination of shell in crabmeat, clams, and oysters. Journal of the Association of Official Analytical Chemists, vol. 51, No. 3, p. 521.
Collaborative results were good, and the method is recommended for adoption.

Osorio, Castro, and Maria Ludmila Reis.
1964. Estudo anatomico funcional das extremidades queladas de *Alpheus* sp. (Crustacea, Decapoda, Alpheidae). Instituto de Pesquisas da Marinha, Rio de Janeiro, Notas Tecnicas, vol. 16, p. 1-19. [English and German summaries.]
The structure and function of the claws of *Alpheus* are discussed and compared with those of *C. sapidus acutidens*.

Palmer, Elra M.
1935. Preliminary report on a possible new species of fossil crab from the Miocene of Maryland. Natural History Society of Maryland, Bulletin, vol. 6, No. 2, p. 7-8.
The author refers to records of fragmentary remains of crabs of the genus *Callinectes* from Miocene and Pleistocene deposits.

Park, John R.
1969. A preliminary study of portunid crabs in Biscayne Bay. Quarterly Journal of the Florida Academy of Sciences, vol. 32, No. 1, p. 12-20.
Collections were made with a hand-pulled dredge to determine population density over various bottom types. About 22 percent of the blue crabs was visibly infected by *Loxothylacus texanus*. Breeding dates appeared to be dependent on the temperature. *C. sapidus acutidens* made up part of the population. *C. ornatus* was the only portunid found with blue crabs, possibly because of competition or predation by the blue crab.

Parkhurst, Raymond T., Marie S. Gutowska, and Carl R. Fellers.
1944. Crab meal in poultry rations. Pt. 3. Laying and breeding rations. Poultry Science, vol. 23, No. 2, p. 118-125.
Blue crab meal was a satisfactory concentrate for laying and breeding hens.

Parkhurst, Raymond T., Marie S. Gutowska, Joseph A. Lubitz, and Carl R. Fellers.
1944. Crab meal in poultry rations. Part 2. Chick and broiler rations. Poultry Science, vol. 23, No. 1, p. 58-71.
The use of blue crab meal as a protein supplement for broilers resulted in fast growth, good appearance, and high food-conversion.

Passano, Leonard Magruder, III.
1948. The effect of eyestalk removal of *Callinectes sapidus* on molt control, color and mating reflexes. B.S. thesis, Harvard University, Cambridge, Mass., 79 p.
The commercial application of molt acceleration, the sinus gland chromatophore control, and the copulatory-inhibition center of the crab central nervous system are dealt with.
1952. The X-organ sinus gland complex of brachyuran crustaceans, a neurosecretory molt controlling gland. Ph. D. thesis, Yale University, New Haven, Conn., 168 p.
Data on the mechanism of eyestalk molt control, on the function of the sinus gland, and on the cytology of neurosecretory inclusions, in *Callinectes* and other genera.
1953. Neurosecretory control of molting in crabs by the X-organ sinus gland complex. Physiologia Comparata et Oecologia, vol. 3, p. 155-189.
Localization experiments on *Uca*, *Callinectes*, and *Sesarma* showed that removal of the X-organ induced accelerated molting,

and that implantation of the medulla terminalis containing the X-organ, prevented or delayed induced molting.

1961. The regulation of crustacean metamorphosis. American Zoologist, vol. 1, No. 1, p. 89-95.

The author refers to the hormone of the Y-organ that controls molting in the blue crab. The change in abdominal shape when sexual maturity is reached at the final molt of the female does not occur in a forced ecdysis following artificial Y-organ activation. The Y-organ remains in the mature female, although she never molts again.

Paulmier, Frederick C.

1903. The edible crab, a preliminary study of its life history and economic relationships. New York State Museum, 55th Annual Report of the Regents, 1901, p. 129-138.

Distribution, abundance, life history, growth of larvae and juveniles, longevity, fishery in New York, industry for soft and hard crabs, and danger of catching egg bearing females to the supply of blue crabs are dealt with.

1904. Crab fisheries of Long Island. New York State Museum, 56th Annual Report, 1902, p. 131-134.

The report deals with abundance of crabs in New York in 1902, gear used by the fishery, methods of shedding crabs, and shipping soft shell crabs.

Payen, Geneviève, John D. Costlow, Jr., and Hélène Charniaux-Cotton.

1967. Recherches sur le rôle de la neurosécrétion dans la différenciation sexuelle du Crabe *Callinectes sapidus* Rathbun. Comptes Rendus de l'Academie des Sciences Paris, t. 264, Série D, p. 2148-2151.

If both eyestalks are removed the first day of the megalops stage, the megalops metamorphose into both male and female. The removal of the neurosecretory complex of the eyestalks before sexual differentiation does not hinder the development of the androgen gland; the principal determinator of sex is the presence or absence of this gland.

Pearse, A. S.

1929. The ecology of certain estuarine crabs at Beaufort, N.C. Journal of the Elisha Mitchell Scientific Society, vol. 44, No. 2, p. 230-237.

Laboratory studies on 10 species of crabs, including the blue crab. Tolerance to diluted sea water, ability to endure desiccation in air, and volume of body in relation to volume of gills of crabs from various habitats.

1936. Estuarine animals at Beaufort, North Carolina. Journal of the Elisha Mitchell Scientific Society, vol. 52, No. 2, p. 174-222.

The occurrence of blue crabs and other estuarine animals at 22 stations near Beaufort (dates and salinities given). In laboratory experiments to determine the length of time that various animals could live when exposed to desiccation in air, blue crabs survived on average of 34.4 hours (maximum 97.3 hours).

1947a. On the occurrence of ectoconsortes on marine animals at Beaufort, N.C. Journal of Parasitology, vol. 33, No. 6, p. 453-458.

The species and numbers of consortes (commensal, symbiont, or parasite) found on 93 blue crabs.

1947b. Observations on the occurrence of certain barnacles and isopods at Beaufort, N.C. Journal of the Washington Academy of Sciences, vol. 37, No. 9, p. 325-328.

Occurrences of barnacles, *Octolasmis mulleri* in blue crab gills and *Chelonibia patula* on the blue crab carapace, legs, and abdomen.

1949. Observations on flatworms and nemerteans collected at Beaufort, N.C. Proceedings of the U.S. National Museum, vol. 100, No. 3255, p. 25-38.

Nineteen blue crabs contained an average of 83 nemerteans, *Carcinonemertes carcinophila*. These were primarily in the gills, but some were among the abdominal appendages.

Pearse, A. S., H. J. Humm, and G. W. Wharton.

1942. Ecology of sand beaches at Beaufort, North Carolina. Ecological Monographs, vol. 12, No. 4, p. 135-190.

Number of blue crabs in collections from seven stations obtained by various

methods. Annotated list of animals found on or in sand beaches. Blue crabs were abundant on beaches and in deep water and ranged into fresh water.

Pearson, John C.
1931. Winter trawl fishery off the Virginia and North Carolina coasts. U.S. Bureau of Fisheries, Investigational Reports, vol. 1, No. 10, 31 p.
The absence of the blue crab from the winter trawl catch indicates that this species probably remains within Chesapeake Bay or close inshore during the colder as well as the warmer months, rather than moving far out to sea during winter.
1942. Decline in abundance of the blue crab, *Callinectes sapidus*, in Chesapeake Bay during 1940 and 1941, with suggested conservation measures. U.S. Fish and Wildlife Service, Special Scientific Report No. 16, 27 p.
Discusses history of blue crab conservation; evidences of depletion; and causes of depletion, including natural factors (fish and jellyfish predators and subnormal water temperatures), intensity of the fishery, and waste in the fishery. A list of nine recommendations to conserve the supply.
1948. Fluctuations in the abundance of the blue crab in Chesapeake Bay. U.S. Fish and Wildlife Service, Research Report, No. 14, 26 p.
Abundance fluctuated in Chesapeake Bay for half a century. Life history and fisheries for hard and soft crabs. No correlation between relative abundance of adult females and their progeny. Effects of temperature and river discharge on abundance.
1951. The blue crab in North Carolina, p. 205-218. *In* Harden F. Taylor, Survey of marine fisheries of North Carolina. University of North Carolina Press, Chapel Hill.
Life history (Chesapeake Bay) and distribution. History of the blue-crab industry in North Carolina, hard- and soft-crab fisheries, and production in North Carolina. Reported an inverse correlation between the annual catch of crabs in Chesapeake Bay and in North Carolina from 1929 to 1942. Future development discussed. Full exploitation had not occurred because of various economic restrictions.

Perkins, Earle B., and Benjamin Kropp.
1932. The crustacean eye hormone as a vertebrate melanophore activator. Biological Bulletin (Woods Hole), vol. 63, No. 1, p. 108-112.
To test the interspecificity of the chromatophore activator found in the crustacean eyestalk and to establish its hormone nature, extracts from *Palaemonetes vulgaris* and *C. sapidus* were injected into tadpoles of *Rana*. Extracts from both crustaceans caused the tadpoles to darken.

Perkins, Margaret S., and Ernest B. Wright.
1969. Crustacean axon. I. Metabolic properties: ATPase activity, calcium binding, and bioelectric correlations. Journal of Neurophysiology, vol. 32, No. 6, p. 930-947.
Na^+-K^+- activated ATPase from microsomal particles of the peripheral nerve of claws and legs of the blue crab were examined.

Perret, William S.
1967. Occurrence, abundance, and size distribution of the blue crab, *Callinectes sapidus*, taken with otter trawl in Vermilion Bay, Louisiana, 1964-65. Proceedings of the Louisiana Academy of Sciences, vol. 30, p. 63-69.
Relative abundance, size distribution, and sex ratio are presented by month for crabs collected from three locations.

Perry, C. A., and A. A. Hajna.
1935. Routine use of a modified Eijkmann medium in examination of crab meat. American Journal of Public Health, vol. 25, No. 6, p. 720-724.
Data is presented on the practical application of a modified medium in the Eijkmann test for *Bacillus coli* in crab meat.

Pew, Patricia.
1966. Food and game fishes of the Texas coast. Texas Parks & Wildlife Department, Bulletin No. 33, 68 p.
C. sapidus was the most abundant food item in stomachs of some spotted jewfish, *Promicrops itaiara*.

Phillips, Philip J., W. David Burke, and Elizabeth J. Keener.
1969. Observations on the trophic significance of jellyfishes in Mississippi Sound with quantitative data on the associative behavior of small fishes with medusae. Transactions of the American Fisheries Society, vol. 98, No. 4, p. 703-712.
During August, mature blue crabs commonly were observed perched on the exumbrellae of swimming sea nettles. They did not feed on the medusae but may scavenge on fish the jellyfish stun or kill. Stomach analyses of sea wasps revealed many crab zoea and megalops larvae.

Piers, Harry.
1923. The blue crab *(Callinectes sapidus*, Rathbun): Extension of its range northward to near Halifax, Nova Scotia. Proceedings of the Nova Scotian Institute of Science, vol. 15, p. 83-90.
Reported 17 blue crabs caught between November 1902 and May 1903 near Halifax. The recorded northern limit of this species; considered a natural rather than an introduced population.

Poole, John C.
1962. Mean-dispositioned but mouth-watering. Conservationist, vol. 17, No. 2, p. 30-31.
Blue crab habits and fishery in New York.

Porter, Hugh J.
1955. Variation in morphometry of the adult female blue crab, *Callinectes sapidus* Rathbun. M.S. thesis, University of Delaware, Newark, 69 p.
Morphometric variations (length, depth, eye-spine, spine, and width measurements) of adult females were studied within an estuary, between yearclasses, and between populations of different bays. It was postulated that low salinity waters permit crabs to attain a larger mature size than do waters of higher salinities.
1956. Delaware blue crab. Estuarine Bulletin, vol. 2, No. 2, p. 3-5.
Distribution, fishery, and food. Life history similar to that in Chesapeake Bay. Size variation between crabs may be due to salinity differences in their environment. Tagging data from the Chesapeake, Chincoteague, and Delaware Bays indicate little mixing between populations in these waters.

Potter, David Dickinson.
1954. Histology of the neurosecretory system of the blue crab *Callinectes sapidus*. Anatomical Record, vol. 120, No. 3, p. 716.
Six types of neurosecretory fiber terminations in the sinus gland of the blue crab were differentiated by staining techniques. They appear to be grouped separately in the sinus gland.
1956. Observations on the neurosecretory system of portunid crabs. Ph. D. thesis, Harvard University, Cambridge, Mass., 267, 16, 14 p., 65 figs.
Most observations were made on *Callinectes ornatus*, *C. sapidus*, and *Carcinides maenas*. Deals with six types of neurosecretory cells in the nervous system, the distribution and structure of these cells in living and fixed tissues, the control of electrical and secretory activity of the cells, and the chemical nature of their hormones.
1958. Observations on the neurosecretory system of portunid crabs. *In* W. Bargmann, B. Hanström, B. Scharrer, and E. Sharrer [ed.] 2nd Internationales Symposium über Neurosekretion, Springer-Verlag, Berlin.
See Potter (1956) for summary of content.

Pottinger, S. R.
1943. Studies on the icing of fresh-cooked east coast crab meat. U.S. Fish and Wildlife Service, Fishery Market News, vol. 5, No. 8, p. 23-25.
Crab meat packed in fiber and tin cans and placed in crushed ice, remained fresh equally long in the two types of containers. The importance to meat quality of proper icing is shown and suggestions for icing are given.
1946. Keeping quality of east coast crab meat in fiberboard containers and in tin cans. U.S. Fish and Wildlife Service, Fishery Leaflet No. 185, 4 p.
Results of laboratory tests using fresh-cooked crab meat in fiberboard and tin

containers showed no appreciable difference in the relative keeping quality during shipping and storage.

Pounds, Sandra Gail.
1961. The crabs of Texas. Texas Game and Fish Commission, Bulletin No. 43, 57 p.
Blue crab anatomy, life history, fishery, and industry. Taxonomic key and diagrams of crabs of Texas.

Powar, C. B.
1969. Musculature of the eyestalk in Crustacea. Acta Zoologica, vol. 50, No. 1-2, p. 127-141.
Types and disposition of muscles of the eyestalks in the blue crab and nine other crustaceans.

Pritchard, Donald W.
1951. The physical hydrography of estuaries and some applications to biological problems. Transactions of the 16th North American Wildlife Conference, p. 368-376.
Studies of the physical structure and circulation of Chesapeake Bay region may explain the unpredictable fluctuations in blue crabs. It may be possible to show that under certain conditions of river flow crab larvae are more likely to be carried out of the Bay and lost.

Proctor, Nathaniel K.
1952. The effects of calcium on isolated arthropod muscle fibers. Biological Bulletin (Woods Hole), vol. 103, No. 3, p. 421-432.
Studies on muscle fibers of *C. sapidus*, *Homarus americanus*, and *Schistocerca americana* to determine if the gelation of the muscle protoplasm is influenced by the calcium ion, to compare the rate of clotting of invertebrate and vertebrate fibers, and to determine if the clotting reaction can be inhibited.

Prosser, C. Ladd.
1955. Physiological variations in animals. Biological Reviews, vol. 30, No. 3, p. 229-262.
Tests on blue crab acclimation and osmoconcentration are included in a review of studies on survival of animals collected at different salinities.

Puncochar, Joseph F., and S. R. Pottinger.
1954. Commercial production of meat from the blue crab *(Callinectes sapidus)*. A study of sanitary requirements of handling operations and suggestions for technological improvements. U.S. Fish and Wildlife Service, Technical Leaflet No. 8, 39 p.
Methods in the production of crab meat along the Atlantic and Gulf coasts, including descriptions of buildings and equipment. Bacteriological studies established the sources of contamination of meat by *Escherichia coli*. Practical aspects of heat treatment on canned meat. Changes in crab meat during storage were ascertained by chemical tests. Recommendations on sanitary preparation.

Puyear, Robert L.
1966. The uridine diphosphate glucose to D-glucuronate pathway in the blue crab, *Callinectes sapidus* Rathbun. Virginia Journal of Science, vol. 17, No. 4, p. 282.
Digestive gland enzymes oxidize uridine diphosphate glucose to uridine diphosphate glucuronate, to form glucuronides and glucuronate-1-phosphate from uridine diphosphate glucuronate.
1967. The glucuronic acid pathway in the blue crab *Callinectes sapidus* Rathbun: The enzymes of the UDPglucose to glucuronic acid portion of the pathway. Comparative Biochemistry and Physiology, vol. 20, No. 2, p. 499-508.
Several enzymes of the glucuronic acid pathway were studied in digestive gland tissue. The enzymes for oxidizing UDPglucose to glucuronic acid appear to be the same as those found in the tissues of mammals.
1969. Molt cycle regulation of nucleotide pyrophosphatase in the hepatopancreas of the blue crab, *Callinectes sapidus* Rathbun. Comparative Biochemistry and Physiology, vol. 28, No. 1, p. 159-168.
Results indicated three nucleotide pyrophosphatases in the hepatopancreas of the blue crab. The activity of these enzymes is related to the stage of the molt cycle, and their possible relation to molt cycle activity is discussed.

Pyle, Robert W., and L. Eugene Cronin.
1950. The general anatomy of the blue crab *Callinectes sapidus* Rathbun. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 87, 40 p.
A presentation of the external and internal anatomy of the adult, accompanied by figures.

Raney, E. C.
1954. Blue crab, p. 154. *In* A. J. McClane [ed.] The Wise fishermen's encyclopedia. Wm. H. Wise & Co., Inc., New York.
Popular account of life history, growth, habitat, fishery, and industry. Reported that 80 million pounds, yielding 14 million pounds of meat, are taken annually.

Rathbun, Mary J.
1893. List of Crustacea collected, p. 89-90. *In* B. W. Evermann, A report upon investigations made in Texas in 1891. Bulletin of the U. S. Fish Commission for 1891, vol. 11, p. 61-90.
Blue crabs (small, except for one large male) collected in Texas waters represented the southernmost records for this species.
1896. The genus *Callinectes.* Proceedings of the U.S. National Museum, vol. 18, No. 1070, p. 349-375.
Review of the taxonomic history of the genus. Author changed name of *C. hastatus* to *C. sapidus* and added a new subspecies, *C. sapidus acutidens.* Analytical key to the genus. The habits, growth, and economic value of blue crabs are discussed. Plates illustrate the various species, crab deformities, frontal outlines, abdominal outlines and appendages, and a fossil *Callinectes.*
1900. Synopses of North-American invertebrates. VII. The Cyclometopus or Cancroid crabs of North America. American Naturalist, vol. 34, No. 398, p. 131-143.
Key to the species of *Callinectes* and their geographical distribution.
1902. The Brachyura and Macrura of Porto Rico. Bulletin of the U. S. Fish Commission for 1900, vol. 20, Pt. 2, p. 1-127.
Included is a key to the Puerto Rican species of the genus *Callinectes. C. sapidus acutidens* is described and its distribution given.
1905. Fauna of New England. 5. List of the Crustacea. Boston Society of Natural History, Occasional Papers, vol. 7, p. 1-117.
Habitat of the blue crab and its occurrence in New England (Massachusetts, Rhode Island, and Connecticut).
1930. Genus *Callinectes* Stimpson, p. 98-132. *In* Mary J. Rathbun, The cancroid crabs of America of the families Euryalidae, Portunidae, Atelecyclidae, Cancridae, and Xanthidae. Bulletin of the U. S. National Museum, vol. 152, 609 p.
Taxonomy and distribution of the various species of *Callinectes.* Description of *C. sapidus* and *C. sapidus acutidens.*
1933. Brachyuran crabs of Porto Rico and the Virgin Islands, p. 1-121. *In* Scientific survey of Porto Rico and the Virgin Islands. New York Academy of Sciences, vol. 15, Pt. 1.
Taxonomic key to species of *Callinectes* (p. 47-49). The distribution of *C. sapidus acutidens,* collected in Puerto Rico, is given as East Florida to Rio de Janeiro.
1935. Fossil Crustacea of the Atlantic and Gulf Coastal Plain. Geological Society of America, Special Paper No. 2, p. 1-160.
Fossil records for the blue crab from various geological epochs.

Rathbun, Richard.
1884. The common edible or blue crab, *Callinectes hastatus* Ordway, p. 775-778. *In* George Brown Goode [ed.] The fisheries and fishery industries of the United States, Section 1, Pt. 5. U.S. Commission of Fish and Fisheries, Washington, D. C.
Distribution, habitat, external characteristics of the hard- and soft-shell state, and the industry on the Gulf and Atlantic coasts.
1887. The crab fisheries, p. 629-658. *In* George Brown Goode [ed.] The fisheries and fishery industries of the United States, Section 5, vol. 2. U. S. Commission of Fish and Fisheries, Washington, D. C.
Distribution of the blue crab, hard and soft state, use as bait, fishery, methods of fishing, canning, and transporting. Severe winters reportedly kill many blue crabs.

Rawls, Charles K.
1965. Field tests of herbicide toxicity to

certain estuarine animals. Chesapeake Science, vol. 6, No. 3, p. 150-161.

Caged blue crabs, oysters, clams, and various species of fish were exposed to different concentrations of herbicides in the field. Of compounds tested, only 2,4-D acetamide appeared dangerously toxic; all caged animals died in the milfoil plot on which it was applied.

Redfield, Alfred C.

1934. The haemocyanins. Biological Reviews, vol. 9, p. 175-212.

Haemocyanin content and oxygen capacity of blue crab blood.

Redfield, Alfred C., Thomas Coolidge, and Archer L. Hurd.

1926. The transport of oxygen and carbon dioxide by some bloods containing hemocyanin. Journal of Biological Chemistry, vol. 69, No. 2, p. 475-509.

C. sapidus was one of six species of four classes of invertebrates used to study the conditions of equilibrium between 0_2, CO_2 hemocyanin, and oxyhemocyanin in the blood.

Redfield, Alfred C., Thomas Coolidge, and Hugh Montgomery.

1928. The respiratory proteins of the blood. II. The combining ratio of oxygen and copper in some bloods containing hemocyanin. Journal of Biological Chemistry, vol. 76, No. 1, p. 197-205.

Includes the blue crab. Demonstrated that oxygen combines with the hemocyanin in the simple proportion of one atom of oxygen for each atom of copper.

Reedy, R. J., and J. V. Anzulovic.

1942. A rapid test for the estimation of *E. coli* in crab meat. Journal of Bacteriology, vol. 43, No. 1, p. 44-45.

A modified Frost "little plate" method incorporating differential media is described. Decreases the time element in testing for pollution *(Escherichia coli)* of crab meat.

Rees, George H.

1963a. Progress on blue crab research in the South Atlantic. Proceedings of the Gulf and Caribbean Fisheries Institute, 15th Annual Session, 1962, p. 110-115.

Progress of crab research, by the Bureau of Commercial Fisheries, which includes population studies in the Neuse River, N.C.; tagging in North Carolina, South Carolina, and Florida; and laboratory and field studies on blue crab larvae.

1963b. Edible crabs of the United States. U.S. Fish and Wildlife Service, Fishery Leaflet No. 550, 18 p.

Popular account of the life history, growth, and fishery for blue crabs. Other species also reviewed.

Regan, Sister Mary Leonide.

1944. Histochemical observations on glycogen in the liver of the blue crab, *Callinectes sapidus* Rathbun. Chesapeake Biological Laboratory, Solomons, Md., Publication No. 62, 14 p.

Glycogen is present in both the diffused and granular form in the liver, almost all in the fat cells. No difference in glycogen content by crab size, but production increased in egg-bearing females. Glycogen content is lowest in hard-shell crabs, and low in soft crabs; it increases before each molt.

Reichard, Sherwood M., and Robert K. Tcholakian.

1966. Sexual alteration in the blue crab *Callinectes sapidus* Rathbun. American Zoologist, vol. 6, No. 3, p. 345. Abstract only.

Alteration due to the sacculinid parasite, *Loxothylacus texanus.*

1968. A differentiating hormone in the male blue crab. Proceedings of the 3rd International Congress of Endocrinology, Series No. 157, p. 116.

The androgenic gland of *C. sapidus* is not the primary source of male sex hormones but appears concerned with the production of a differentiating type of hormone that maintains testicular structure and spermatogenesis.

Reinhard, Edward G.

1950a. An analysis of the effects of a sacculinid parasite on the external morphology of

Callinectes sapidus Rathbun. Biological Bulletin (Woods Hole), vol. 98, No. 3, p. 277-288.
Loxothylacus texanus infests blue crabs in the Gulf of Mexico, upsetting the normal relationship between sex-formative substances and resulting in the loss of ovarian control over the differentiation of the pleopods. Morphologically, immature male hosts resemble females and immature female hosts resemble mature females.
1950b. The morphology of *Loxothylacus texanus* Boschma, a sacculinid parasite of the blue crab. Texas Journal of Science, vol. 2, No. 3, p. 360-365.
The external and internal anatomy of *L. texanus* and how it is attached to the blue crab. In 1948-49, 16.4 percent of the blue crabs in Aransas Bay, Tex., were infested.
1951. *Loxothylacus*, a parasite of the blue crab in Texas. Texas Game and Fish, vol. 9, No. 5, p. 14-17.
Malformation of the abdomen of the blue crab in Texas caused by *Loxothylacus texanus*. Life history of this parasite. The parasitized crab may recover, but probably will be stunted and not able to carry on normal reproductive processes.
1952. Notes on regeneration in the Rhizocephala (Crustacea). Proceedings of the Helminthological Society of Washington, vol. 19, No. 2, p. 105-108.
No regeneration occurred in *Loxothylacus texanus*, a parasite of the blue crab, after the visceral sac was amputated.

Rhoads, Austin Thomas.
1959. Objective determinations for lump meat and skeletal fragments in cooked crabmeat. M.S. thesis, University of Maryland, 21 p.
Evaluated various methods for detecting skeletal fragments in blue-crab-meat and established grades of meat based on the number of fragments per pound. The standard recommended for lump meat (the extrinsic muscle of the swimming appendage) was that 70 percent of the meat be in pieces larger than 1.8 g.

Richards, Horace G.
1938. Animals of the seashore. Bruce Humphries, Inc., Boston, 273 p.
A catalogue of the invertebrate animals of the east coast, particularly New Jersey. The blue crab reportedly occurs all along the New Jersey coast and in bays and harbors. General description of the blue crab and its molting process.

Richardson, Wyman.
1953. Blue crabbing on Cape Cod. Atlantic Monthly, vol. 192, No. 1, p. 64-66.
Popular account of sport fishing for crabs, crab habits, and preparing crabs for the table.

Ringuelet, Raúl A.
1963. Hallazgo de *Callinectes sapidus acutidens* Rathbun en la Ribera Occidental de Río de la Plata (Crust. Brach. Portunidae). Physis Revista de la Asociacion Argentina de Ciencias Naturales, vol. 24, No. 67, p. 86.
The blue crab was found to occur at Punta Lara, Argentina.

Roberts, Morris H., Jr.
1969. Larval development of *Bathynectes superba* (Costa) reared in the laboratory. Biological Bulletin (Woods Hole), vol. 137, No. 2, p. 338-351.
External anatomy of five zoeal stages of *Bathynectes superba* and how these stages can be distinguished from those of *Portunus* and *Callinectes*.

Roberts, Winthrop A.
1905. The crab industry of Maryland. U.S. Bureau of Fisheries, Report for 1904, p. 415-432.
Blue crab industry: statistics, use of crab shells, and methods of catching, preparing, canning, packing, and shipping crabs. Effects of severe winter of 1901 on the 1902 supply of crabs.

Robertson, Roy L.
1938. Observations on the growth stages in the common blue crab, *Callinectes sapidus* Rathbun with special reference to post-larval development. M.S. thesis, University of Maryland, 46 p.
Attempts to hatch the eggs and rear blue crabs through their larval stages were unsuccessful, but crabs were reared from

the megalops stage through the eighteenth post-larval stage. Foods eaten by post-larval crabs are discussed.

Robey, Dorothy M., and Rose G. Kerr.
1956. How to cook crabs. U.S. Fish and Wildlife Service, Test Kitchen Series No. 10, 14 p.
Market forms of hard-shell and soft-shell blue crabs, grades of meat, method of picking the meat, and crab recipes.

Rogers, M. Rosalie.
1945. The occurrence and distribution of the fungus, *Lagenidium callinectes* Couch, on the eggs of the blue crab, *Callinectes sapidus* Rathbun. M.S. thesis, College of William and Mary, Williamsburg, Va.
See Rogers-Talbert (1948) for summary of content.

Rogers-Talbert, R.
1948. The fungus *Lagenidium callinectes* Couch (1942) on eggs of the blue crab in Chesapeake Bay. Biological Bulletin (Woods Hole), vol. 95, No. 2, p. 214-228.
A peripheral infection which does not retard development of crab eggs in the interior of the sponge. Not over 25 percent of the eggs are infected and only about 25 percent of the sponges in samples from the lower Bay were heavily infected. Fungus developed rapidly in salinities from 5 to 30 p.p.t. Forms of *Carchesium*, *Ephelota*, *Chlamydobacterium*, and *Carcinonemertes* also were found living on the sponge.

Rose, William C., and Meyer Bodansky.
1920. Biochemical studies on marine organisms. 1. The occurrence of copper. Journal of Biological Chemistry, vol. 44, p. 99-112.
Copper content was estimated in each of 35 marine animals, prepared by grinding the entire specimen. The amount of copper in crabs and shrimps was between that of oysters and fishes.

Rosen, Baruch.
1967. Shell disease of the blue crab, *Callinectes sapidus*. Journal of Invertebrate Pathology, vol. 9, No. 3, p. 348-353.
A previously undescribed shell disease of unknown cause was investigated morphologically, histologically, and bacteriologically. The disease appears as a superficial necrosis of the exoskeleton that progresses from a few spots into widely necrotized areas. Skeletal tissue is digested and broken.

Rounsefell, George A.
1964. Preconstruction study of the fisheries of the estuarine areas traversed by the Mississippi River—Gulf Outlet Project. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 63, No. 2, p. 373-393.
The channel, by raising salinities, should not greatly affect the fishes of the area but should have an adverse effect on abundance of the blue crab. Younger stages of crab were most abundant in the least-saline waters, decreasing significantly as salinity increased. The project would also result in losses of nursery habitat. Presents estimate of seasonal abundance of blue crab by size and by area.

Rouse, Wesley L.
1969. Littoral Crustacea from Southwest Florida. Quarterly Journal of the Florida Academy of Sciences, vol. 32, No. 2, p. 127-152.
Blue crabs were fairly evenly distributed in estuaries of Everglades National Park, Fla. Ovigerous females were found throughout the year. Crabs ranged in size from 30 to 209 mm. and occurred at salinities from 0 to 55 p.p.t. and at temperatures from 16 to 31° C.

Rust, John D., and Frank Carlson.
1960. Some observations on rearing blue crab larvae. Chesapeake Science, vol. 1, No. 3-4, p. 196-197.
Foods tested were inadequate for rearing the zoeae. Large differences in survival occurred between zoeae from different parents reared under identical conditions.

Saenz, William, David L. Dubrow, and William J. Cerniglia.
1959. Artificial bait for blue crabs. University of Miami Marine Laboratory, Special Service Bulletin No. 16, 6 p.
Traps baited with dry-salted fish caught between 80 and 90 percent as many crabs

as those baited with the more expensive fresh or frozen fish.

Sandholzer, Leslie A.
1945. The effect of DDT upon the Chesapeake Bay blue crab *(Callinectes sapidus).* U.S. Fish and Wildlife Service, Fishery Market News, vol. 7, No. 11, p. 2-4.
The author concluded, from results of experiments in 25-gallon tubs in which hard- and soft-shell crabs were subjected to different concentrations of DDT (1-20 p.p.m.), that the possibility of the blue crab being seriously injured by DDT as it is commonly applied to water (one-half pound per acre) is very remote.

Sandoz, Mildred.
1943. Steps toward crab conservation in Chesapeake Bay. Commonwealth, Vol. 10, No. 7, p. 1-6.
Report on the decline of the crab fishery in Chesapeake Bay which began in 1940. The effectiveness of sanctuaries in Virginia to protect brood stock or shedder crabs could not be evaluated. Experiments indicated that the optimum salinity for hatching of eggs was 23 to 30 p.p.t. at 19 to 29° C.

Sandoz, Mildred, and Sewell H. Hopkins.
1944. Zoeal larvae of the blue crab *Callinectes sapidus* Rathbun. Journal of the Washington Academy of Sciences, vol. 34, No. 4, p. 132-133.
Eggs heavily infected with fungi or bacteria and those kept under unfavorable salinity (outside the range of 23-30 p.p.t.) and temperature (outside the range of 19-29° C.) failed to hatch in the laboratory or hatched into prezoeae. The first three zoeal stages were reared; the third differed markedly from earlier descriptions.

Sandoz, Mildred, and Rosalie Rogers.
1944. The effect of environmental factors on hatching, moulting, and survival of zoea larvae of the blue crab *Callinectes sapidus* Rathbun. Ecology, vol. 25, No. 2, p. 216-228.
Experimental data indicated that hatching generally occurs in 11 to 14 days at optimum salinity of 23 to 28 p.p.t. Eggs did not hatch outside of the range of 19 to 29° C. Identity of three larval stages was established. Food and feeding of zoeae is discussed.

Sandoz, Mildred, Rosalie Rogers, and Curtis L. Newcombe.
1944. Fungus infection of eggs of the blue crab *Callinectes sapidus* Rathbun. Science, vol. 99, No. 2563, p. 124-125.
Identified the fungi as *Lagenidium callinectes*, the primary parasite, and *Rhizophidium* sp. which may be parasitic or saprophytic. Infected egg masses suspended in the York River, Va., failed to hatch.

Sawyer, Thomas K.
1969. Preliminary study on the epizootiology and host-parasite relationship of *Paramoeba* sp. in the blue crab, *Callinectes sapidus.* Proceedings of the National Shellfisheries Association, vol. 59, p. 60-64.
Peeler (pre-molt) crabs were examined in commercial plants during peak mortality, and hard (inter-molt) crabs taken by trawl were examined after the mortality subsided (Chincoteague Bay, Va.). Thirty-five percent (43 of 121) of the peeler and 8 percent of the hard crabs (12 of 156) were positive by hemolymph examination. The rate of infection decreased to a low level after the first period of serious mortality. Histopathologic studies are required to determine whether there is a tissue phase of *Paramoeba* sp.

Say, Thomas.
1817. An account of the Crustacea of the United States. Journal of the Academy of Natural Sciences of Philadelphia, vol. 1, No. 5, p. 65-444.
Lupa hastata = *C. sapidus* (p. 65-67, 443-444): Description, human food value, food and feeding habits, infestation by worms resembling an *Ascaris*, regeneration of legs, and occurrence 100 miles upstream in the St. Johns River, Fla.

Scattergood, Leslie W.
1960. Blue crabs *(Callinectes sapidus)* in Maine. Maine Field Naturalist, vol. 16, No. 3, p. 59-63.

From 1948 to 1956, numerous blue crabs were caught in Maine waters, north of their usual range. No records during 1957-59. During period of occurrence water temperatures were warmer than usual. Migrated from southern Massachusetts.

Scattergood, Leslie W., Parker S. Trefethen, and Gareth W. Coffin.
1951. Notes on Gulf of Maine fishes in 1949. Copeia, 1951, No. 4, p. 297-298.
Records in the Gulf of Maine of two blue crabs and various fish species which usually prefer the warmer waters south of Cape Cod. Probably due to unusually warm waters in the Gulf during the summer of 1949.

Schallek, W.
1945. Action of potassium on bound acetylcholine in lobster nerve cord. Journal of Cellular and Comparative Physiology, vol. 26, p. 15-24.
Acetylcholine content of blue-crab ganglia.

Schöne, Hermann.
1968. Agonistic and sexual display in aquatic and semi-terrestrial brachyuran crabs. American Zoologist, vol. 8, No. 3, p. 641-654.
Review of literature and author's observations on 26 genera. *C. sapidus* was grouped with those crabs characterized by the female carried by the male for some time before copulation. It is not known if the male recognizes the receptive female by means of tactile or chemical stimuli.

Schwartz, Frank J.
1960. Bibliography of Maryland fisheries. Chesapeake Biological Laboratory, Solomons, Md., Contribution No. 144, 35 p.
Includes 82 references (anatomy, biology, fishery, industry, and others) to the blue crab. Subject index.

Scrocco, Virginia M., and John Fabianek.
1969. Symbiosis of *Callinectes sapidus* Rathbun with *Carcinonemertes*, bryozoans, and barnacles. Federation Proceedings. vol. 28, No. 2, p. 526. Abstract only.
The nature of symbiotic relation of blue crabs from waters of various salinities with *Carcinonemertes carcinophila*, *Acanthodesia tenuis*, and *Balanus eburneus*.

Semling, H. V., Jr.
1965. Plastic "can"—one step closer—approved for crabmeat in Maryland. Canner/Packer, vol. 134, p. 36.
Plastic containers for pasteurized crab meat.

Serbetis, C.
1959. Un nouveau crustacé comestible en Mer Egée *Callinectes sapidus* Rathbun (Decapode, Brachyura). Proceedings of the General Fisheries Council for the Mediterranean, vol. 5, No. 72, p. 505-507.
Since 1954, the blue crab has progressively invaded the Greek coasts and probably could be used in the canning industry. It is not known how this species was introduced.

Sette, O. E., and R. H. Fiedler.
1925. A survey of the condition of the crab fisheries of Chesapeake Bay, a preliminary report. U.S. Bureau of Fisheries, Special Memorandum 1607-14, 36 p.
Ascertains the practices of the crabbing industry and presents statistical data showing the downward trend of the fishery. Summary of life history. Recommendations for conserving the supply.

Severy, Hazel W.
1923. The occurrence of copper and zinc in certain marine animals. Journal of Biological Chemistry, vol. 55, No. 1, p. 79-92.
Copper and zinc content of 15 marine animals and one land slug. The legs, the shell, and the minced body (shell removed) of *C. sapidus* were examined.

Shea, Sean, David Sigafoos, and Donald Scott, Jr.
1969. The effect of calcium and potassium on the thermal excitability of a model thermoreceptor. Comparative Biochemistry and Physiology, vol. 28, No. 2, p. 701-708.
Peripheral nerves from the legs of the blue crab respond to a cold stimulus in artificial sea water with an impulse discharge. Preparations maximally excited to spontaneous

discharge in low calcium sea water do not respond to a cold stimulus, but an increase of potassium decreases the rate of discharge and restores thermal responsiveness.

Shuster, Carl N., Jr.
1959. A biological evaluation of the Delaware River Estuary. University of Delaware, Information Series, Publication No. 3, 77 p.
Describes the fishery for the blue crab in Delaware Bay. Food studies showed that the blue crab was eaten by striped bass and that crab larvae (not identified) were a major food of the common anchovy.

Shuster, Carl N., Jr., David H. B. Ulmer, Jr., and Willard A. Van Engel.
1963. A commentary on claw deformities in the blue crab. Estuarine Bulletin, vol. 7, No. 2-3, p. 15-23.
Deviation from symmetry in the external structure of crab claws. Types of claw deformities. Only one injury site is sufficient to produce duplicate parts, and the site and depth of injury determines what kind of abnormality will develop. Genetic mechanism for spine production, change in chemical composition of tissues and urine from tissue damage, and stage in the intermolt cycle, as they relate to deformities.

Siebenaler, J. B.
1955. Commercial fishing gear and fishing methods in Florida. Florida Board of Conservation, Technical Series, No. 13, 47 p.
Construction and methods of fishing two types of traps used in Florida to catch crabs.

Sieling, F. W., and D. G. Cargo.
1955. Maryland's winter crab fishery opens in Chincoteague Bay. Maryland Tidewater News, vol. 11, No. 8, p. 1-2.
Description of the winter crab fishery. Chincoteague crabs average smaller than those from Chesapeake Bay and may represent a genetically stunted race.

Simmons, E. G.
1957. An ecological survey of the upper Laguna Madre of Texas. Publications of the Institue of Marine Science, University of Texas, vol. 4, No. 2, p. 156-200.
Blue crabs in the Laguna Madre (salinity range, 27-78 p.p.t.) increased in winter when salinity was low, but not in December, 1956, when salinity was high. The higher the salinity, the smaller the average size of blue crabs and many other invertebrates.

Sims, Harold W., Jr., and Edwin A. Joyce, Jr.
1966. Partial albinism in a blue crab. Quarterly Journal of the Florida Academy of Sciences, vol. 28 (1965), No. 4, p. 373-374.
Partial albinism of a crab captured in Tampa Bay appeared to be the first case reported from Florida.

Sindermann, Carl J., and Aaron Rosenfield.
1967. Principal diseases of commercially important marine bivalve Mollusca and Crustacea. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 66, No. 2, p. 335-385.
Diseases and parasites of blue crabs include: a disease of undetermined etiology ("gray crab disease"), which causes deaths of crabs in Virginia; the fungus *Lagenidium callinectes*, which parasitized eggs of crabs in Chesapeake Bay; the microsporidans *Nosema* sp. and *Plistophora cargoi*, parasitic in muscles of Chesapeake Bay crabs; ciliates of the genera *Lagenophrys* and *Epistylus* which infested crab gills and caused mortalities in Chesapeake Bay; trematode larvae of *Microphallus nicolli*, which encysted in muscles; the nemertean *Carcinonemertes carcinophila*, parasitic on the gills and eggs; the leech *Myzobdella lugubris*, thought to cause mortality in Florida; and the rhizocephalan *Loxothylacus texanus*, parasitic on crabs from Gulf of Mexico. Refers to extensive blue crab mortalities of unknown cause in North Carolina and South Carolina.

Slocum, Glenn G.
1955. Bacteriology of crabmeat as related to factory sanitation. Quarterly Bulletin of the Association of Food and Drug Officials, vol. 19, p. 43-50.
This study concerns the development of sanitation in the production of crab meat

and compares the incidence of *Escherichia coli* and coliforms in the product with observed sanitary conditions in the plant.

Smith, Geoffrey, and W. F. R. Weldon.
1909. Crustacea, p. 1-217. *In* S. F. Harmer and A. E. Shipley [ed.] The Cambridge natural history, vol. 4. Macmillan and Co., Ltd., London.
The blue crab is listed and illustrated (p. 191) in this taxonomic review of families of Crustacea.

Smith, Hugh M.
1891. Notes on the crab fishery of Crisfield, Md. Bulletin of the U. S. Fish Commission, vol. 9, p. 103-112.
The soft-crab and hard-crab fishery and trade (shipment, market, crab floats), preparation of crab meat, and statistics on the fishery and industry.
1917. Crab industry of Maryland and Virginia. U.S. Commissioner of Fisheries, Report for 1916, p. 60-64.
Statistics, value, and location of the blue-crab fishery and industry (1915).

Smith, Sidney I.
1887. Report on the decapod Crustacea of the *Albatross* dredgings off the east coast of the United States during the summer and autumn of 1884. U.S. Commissioner of Fish and Fisheries, Report for 1885, Pt. 13, p. 605-705.
Compares the size of eggs of deep-water and shallow-water crabs. The diameter of blue crab eggs is given as 0.28 mm. and the number is estimated at 4,500,000.

Snodgrass, R. E.
1956. The Brachyura, p. 58-62. *In* R. E. Snodgrass, Crustacean metamorphoses. Smithsonian Miscellaneous Collections, vol. 131, No. 10.
Life history of the blue crab, growth and description of zoeal stages.

Southern Fisherman.
1950. The synthetic crab shell goes nature one better. Southern Fisherman, vol. 10, No. 10, p. 140-141.
Development of a paper shell (withstands deep fat frying) as a substitute for natural crab shells (undesirable because of bacteria content) in the preparation of deviled crabs.
1952. New method of processing, packing crab meat. Southern Fisherman, vol. 12, No. 8, p. 65-66.
The crabs are steamed, picked, and the meat placed in cans. The canned meat is subjected to a temperature high enough to kill any bacteria. Kept in good condition as long as 2 years (at -1.0 to 4.5° C.).
1955. New metal crab float. Southern Fisherman, vol. 15, No. 2, p. 88-89.
The metal float for ripening soft crabs performed satisfactorily when tested in Maryland. Advantages are simple maintenance, reduction of mortality rates, reduction of losses from capsizing and sinking, and life of 5 to 7 years.
1956. Crab potter has luck with use of zinc anodes. Southern Fisherman, vol. 16, No. 4, p. 163, 165.
When wired to pots in Chesapeake Bay, the anodes prevented corrosion, and the wire pots lasted more than one season, whereas those without anodes eroded away at the rate of three a season.

Speck, Frank G., and Ralph W. Dexter.
1948. Utilization of marine life by the Wampanoag Indians of Massachusetts. Journal of the Washington Academy of Sciences, vol. 38, No. 8, p. 257-265.
Use of marine life by the Indians as early as 1850. The blue crab was the most important species of crab speared for food.

Spence, S. R.
1943. The life story of the blue crab of the Chesapeake. Southern Fisherman, vol. 3, No. 10, p. 16-17, 37.
A general account on life history.

Sprague, Victor.
1965. *Nosema* sp. (Microsporida, Nosematidae) in the musculature of the crab *Callinectes sapidus*. Journal of Protozoology, vol. 12, No. 1, p. 66-70.
Crabs in the Patuxent River and Chesapeake Bay were parasitized. The size, shape, and appearance of the spores are given. Lysis of muscle fibers was noted but

the importance of the parasite as a mortality factor in crabs is unknown.

1966. Two new species of *Plistophora* (Microsporida, Nosematidae) in decapods, with particular reference to one in the blue crab. Journal of Protozoology, vol. 13, No. 2, p. 196-199.

Plistophora cargoi n. sp., found in the muscles of the blue crab, is described. No knowledge of its significance in crab mortalities.

Sprague, Victor, and Robert L. Beckett.

1966. A disease of blue crabs *(Callinectes sapidus)* in Maryland and Virginia. Journal of Invertebrate Pathology, vol. 8, No. 2, p. 287-289.

A characteristic syndrome accompanying mortalities. When viewed ventrally, the body and appendages often have a grayish appearance ("gray crab disease"). Smears of body fluids and sections of different tissues showed many amoeboid cells, each characterized by a pair of conspicuous and dissimilar nucleuslike bodies. These may be blood cells which become infected with a virus while being produced and then continue to grow in the circulatory system.

1968. The nature of the etiological agent of "gray crab" disease. Journal of Invertebrate Pathology, vol. 11, No. 3, p. 503.

No morphological difference observed between *Paramoeba eilhardi*, known only as a free living species, and *Paramoeba* sp., known only as a parasite of the blue crab. The parasite is a common and serious cause of mortalities among crabs held in shedding tanks by dealers in soft crabs.

Sprague, Victor, Robert L. Beckett, and Thomas K. Sawyer.

1969. A new species of *Paramoeba* (Amoebida, Paramoebidae) parasitic in the crab *Callinectes sapidus*. Journal of Invertebrate Pathology, vol. 14, No. 2, p. 167-174.

A new species of *Paramoeba* was distinct from *Paramoeba eilhardi*. The name *P. perniciosa* sp. n. was proposed. It is the cause of a disease syndrome ("gray crab disease") accompanying mortalities of blue crabs in Maryland and Virginia.

Sprague, Victor, Sanford H. Vernick, and Bolivar J. Lloyd, Jr.

1968. The fine structure of *Nosema* sp. Sprague, 1965. (Microsporida, Nosematidae) with particular reference to stages in sporogony. Journal of Invertebrate Pathology, vol. 12, No. 1, p. 105-117.

Stages of *Nosema* sp. in the skeletal muscle of an experimentally infected crab, *C. sapidus*, were observed by electron microscopy.

Springer, P. F., and J. R. Webster.

1951. Biological effects of DDT applications on tidal salt marshes. Mosquito News, vol. 11, p. 67-74.

Applications of 0.25 pound of DDT per acre resulted in a 20 to 40 percent reduction of blue crabs. Crab deaths continued for 7 days after treatment.

Stansby, Maurice E., and Alice S. Hall.

1967. Chemical composition of commercially important fish of the United States. Fishery Industrial Research, vol. 3, No. 4, p. 29-46.

Data on the composition of important American food fish (including the blue crab) are tabulated with respect to proximate composition, content of water, minerals, proteins, amino acids, lipids, vitamins, and other constituents.

Steenis, John H.

1968. Pest plant control with herbicides, p. 140-148. *In* John D. Newsom [ed.] Proceedings of the marsh and estuary management symposium, Louisiana State University, 1967. Thos. J. Moran's Sons, Inc., Baton Rouge.

After treatment to control the growth of water milfoil, toxicological studies with the butoxyethanol ester of 2,4-D on blue crabs, oysters, clams, and various finfish have shown no primary lethal effect on these animals and other associated life-chain organisms.

Stephenson, W., W. T. Williams, and G. N. Lance.

1968. Numerical approaches to the relationships of certain swimming crabs (Crustacea: Portunidae). Proceedings of the U.S. National

Museum, vol. 124, No. 3645, p. 1-26.
Assessed the status and interrelationships of various taxa of American portunids within the genera *Portunus*, *Callinectes*, and *Arenaeus*. Results indicated that *Callinectes* merited generic status.

Stevenson, Charles H.
1899. The preservation of fishery products for food. Bulletin of the U. S. Fish Commission for 1898, vol. 18, p. 335-563.
Contains one section on shipping live hard- and soft-shell blue crabs and a second on canning crabs.

Stimpson, William.
1860. Notes on North American Crustacea, in the Museum of the Smithsonian Institution. No. 2. Annals of the Lyceum of Natural History of New York, vol. 7 (1862), p. 176-246.
Original reference for the generic name *Callinectes*.

Stolting, W. H., M. J. Garfield, and D. R. Alexander.
1955. Fish and shellfish preferences of household consumers. U.S. Fish and Wildlife Service, Research Report No. 41, 115 p.
Results of a nationwide survey (1951) of household consumers' preferences for fish and shellfish. Data presented by regions of the United States. The percentages of consumers (all regions) who usually served crab meat in preference to six other categories of shellfish were 9.0 percent for frozen products, 13.2 percent for fresh, and 30.4 percent for canned.

Sturges, Lena E.
1956. Canning and freezing oysters, crab, shrimp and fish. Florida Agricultural Extension Service, Circular No. 151, 8 p.
Preparation of crabs for home freezing.

Sullivan, Walter E.
1909. Notes on the crabs found in Narragansett Bay. Commissioners of Inland Fisheries of Rhode Island, 39th Annual Report, p. 56-78.
Blue crab fishery and industry of Rhode Island. Distribution and habitat.

Sumner, Francis B., Raymond C. Osburn, and Leon J. Cole.
1913. A biological survey of the waters of Woods Hole and vicinity. Section III. A catalogue of the marine fauna of Woods Hole and vicinity. Bulletin of the U. S. Bureau of Fisheries for 1911, vol. 31, Pt. 2, p. 549-794.
Brief account (p. 672) of the common occurrence of *C. sapidus* along muddy shores and bottoms, and among eelgrass, particularly in brackish water.

Sundstrom, Gustaf T.
1957. Commercial fishing vessels and gear. U.S. Fish and Wildlife Service, Circular No. 48, 48 p.
Includes gear and the type vessel used to catch blue crabs.

Sykes, James E., and John H. Finucane.
1966. Occurrence in Tampa Bay, Florida, of immature species dominant in Gulf of Mexico commercial fisheries. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 65, No. 2, p. 369-379.
Western Florida and Gulf catches of blue crab (1958-60). Size by season of blue crabs in monthly collections in Tampa Bay. Most abundant in winter. The blue crab was the dominant portunid in collections of metamorphosed specimens; larval forms could not be identified to species. Data indicated that Tampa Bay serves as a nursery area for blue crabs.

Szabo, Lorain Z.
1955a. Standards for crab meat. Proceedings of the Gulf and Caribbean Fisheries Institute, 7th Annual Session, 1954, p. 14-18.
An account of food poisoning caused by crab meat in 1953 and its effect upon sales. Sanitary code for crab meat standards and bacteriological quality.
1955b. Quality standards for crabmeat. Southern Fisherman, 1955 Yearbook, vol. 15, No. 10, p. 86, 221.
The part played by the National Fisheries Institute Technical Committee in solving the quality standards problems that arose in 1953 due to some cases of food poisoning attributed to crab meat. Also the development of the voluntary industry code set up by the Blue-Crab Committee.

Tagatz, Marlin E.
1965. The fishery for blue crabs in the St. Johns River, Florida, with special reference to fluctuation in yield between 1961 and 1962. U.S. Fish and Wildlife Service, Special Scientific Report—Fisheries No. 501, 11 p.
Description of the fishery together with catch and effort statistics for 1961 and 1962. Factors responsible for determining the size of the catch. Sex ratio, width, and weight of crabs in the catch.
1967. Noncommercial crabs of the genus *Callinectes* in St. Johns River, Florida. Chesapeake Science, vol. 8, No. 3, p. 202-203.
As possible competitors to juvenile blue crabs in nursery areas.
1968a. Biology of the blue crab, *Callinectes sapidus* Rathbun, in the St. Johns River, Florida. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 67, No. 1, p. 17-33.
Widely distributed in fresh water. Tag returns ranged from Jekyll Island, Ga., to New Smyrna Beach, Fla. Life history. Many females from the ocean returned to estuaries to spawn; some returned twice. Larval *Callinectes* dominant crab form in plankton collections. Postlarval crabs did not appear in the estuary in significant numbers until 6 months after hatching had begun. They entered in waves, after several molts as crabs. Major foods of juveniles and adults were mollusks, fish, and crustaceans.
1968b. Growth of juvenile blue crabs, *Callinectes sapidus* Rathbun, in the St. Johns River, Florida. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 67, No. 2, p. 281-288.
Juveniles were held in wooden floats in salt water and in fresh-water portions of the river. Length-width ratios, molt intervals, relative growth, estimated absolute growth, and effects of season and salinity on growth.
1969. Some relations of temperature acclimation and salinity to thermal tolerance of the blue crab, *Callinectes sapidus.* Transactions of the American Fisheries Society, vol. 98, No. 4, p. 713-716.
Experimental data indicated that crabs were less tolerant to temperature extremes at low salinity; at both low and high salinities, the upper and lower tolerance limits (temperatures at which 50 percent survive for 48 hours) increased as the acclimation temperature increased. Limits for adults and juveniles were similar.

Tan, Eng-Chow.
1962. Studies on osmotic and ionic regulation in the blue crab, *Callinectes sapidus* Rathbun. M.A. thesis, College of William and Mary, Williamsburg, Va., 66 p.
Osmotic concentrations of the blood and the sodium and potassium content and sodium to potassium ratio of the serum of adult crabs exposed to different salinities.

Tan, Eng-Chow, and W. A. Van Engel.
1966. Osmoregulation in the adult blue crab, *Callinectes sapidus* Rathbun. Chesapeake Science, vol. 7, No. 1, p. 30-35.
The blood osmoconcentrations of adult males and females in salinities of 10, 20, and 30 p.p.t. at 20° C. indicated that females were the less efficient osmoregulators in lower salinities. The difference between sexes was partly due to their differential abilities to regulate sodium in the blood.

Tappel, A. L.
1960. Cytochromes of muscles of marine invertebrates. Journal of Cellular and Comparative Physiology, vol. 55, No. 2, p. 111-126.
Comparative spectro-photometric studies of the cytochromes of some crustaceans (including *C. sapidus)* and bivalve mollusks. They were defined qualitatively by difference and low temperature spectra and measured quantitatively from difference spectra.

Taylor, Francis B.
1956. 39 fathoms southeast, North Edisto sea buoy off South Carolina. Bears Bluff Laboratories, Wadmalaw Island, S.C., Contribution No. 20, 15 p.
Experimental trawling to locate populations of commercial fish and shellfish on the continental shelf off South Carolina. An objective was to determine the pelagic movements of the blue crab. Some evidence indicated that blue crabs migrate by sea between rivers and that they sometimes spawn far offshore.

Tcholakian, Robert Kevork.
1967. Sexual differentiation in the decapod crustacean, *Callinectes sapidus* Rathbun and a design for a closed sea water system. Ph. D. thesis, Medical College of Georgia, Augusta, 303 p.
Histological survey of the male reproductive system; androgenic gland and testis of normal and infested (sacculinid parasite) males; transplantation of androgenic glands, testes, or gland and testicular tissues into females; transplantation of ovaries into males; extirpation of androgenic glands from immature males; effects of castration, various suspending media, and mammalian hormones on crab tissues. A second section describes a water system developed for these studies.

Tcholakian, R. K., and K. B. Eik-Nes.
1968. Conversion of progesterone to 11-deoxycorticosterone by the androgenic gland of the blue crab *(Callinectes sapidus* Rathbun). General and Comparative Endocrinology, vol. 12, No. 1, p. 171-173.
A study to determine if the androgenic gland of the blue crab contained steroid biosynthetic enzymes. It was found that this gland can convert progesterone to 11-deoxycorticosterone.

Tcholakian, Robert K., and Sherwood M. Reichard.
1964. A possible androgenic gland in *Callinectes sapidus*, Rathbun. American Zoologist, vol. 4, No. 4, p. 383. Abstract only.
An elongated gland, 200-300 μ wide, that appears to be holocrine in nature was observed on the posterior vas deferens of the blue crab. The gland and gland cells are described for immature and mature crabs.

Telford, Malcolm.
1968. The identification and measurement of sugars in the blood of three species of Atlantic crabs. Biological Bulletin (Woods Hole), vol. 135, No. 3, p. 574-584.
This work is not on blue crabs, but results of other studies on the levels of glucose and reducing substances in *C. sapidus* carrying egg sponges are presented for comparison. Irrespective of the glucose level in the blue crab, its ratio to total reducing substances was constant.

Teuber, Elizabeth Ann.
1969. Membrane potentials and ion distribution in striated muscles of the blue crab, *Callinectes sapidus* Rathbun. Ph. D. thesis, University of Maryland, 1968. Dissertation Abstracts, vol. 27, No. 7, p. 2612-B.
The leg adductor muscle of the blue crab was studied with respect to the nature of the resting membrane potential of the muscle fiber and the ionic distributions that contribute to this potential. Crab muscle was characterized by a Donnan-like distribution.

Thompson, Mary H.
1964. Cholesterol content of various species of shellfish. 1. Method of analysis and preliminary survey of variables. Fishery Industrial Research, vol. 2, No. 3, p. 11-15.
To test a method for determining cholesterol content, eastern and southern blue crabs and six other species of shellfish were analyzed. A seasonal difference in the total cholesterol content of body meat of blue crabs was noted.

Thompson, Mary H., and R. N. Farragut.
1966. Amino acid composition of the Chesapeake Bay blue crab *Callinectes sapidus.* Comparative Biochemistry and Physiology, vol. 17, No. 4, p. 1065-1078.
The body meat, claw meat, and offal material varied in amount of protein amino acids and nonprotein ninhydrin-positive compounds. There were significant differences in the content of certain individual amino acids in the three types of material analyzed.

Thompson, M. T.
1899. The breeding of animals at Woods Hole during the month of September, 1898. Science, vol. 9, No. 225, p. 581-583.
Effect of temperature on *Callinectes* and other Crustacea.

Thompson, Paul E.
1957. Coast waters in danger. Bulletin of the International Oceanographic Foundation, vol. 3, No. 4, p. 210-216.

Industrial and housing developments along the Atlantic and Gulf coasts of the United States destroy marshlands which are important to crabs, mollusks, shrimp, and many migratory fishes during critical periods of their lives. Measures of control are discussed.

Thomson, W. A. B., and F. B. Thomas.
1966. Preliminary studies on the flavor and quality of fresh N. C. blue crab meat. North Carolina Department of Conservation and Development, Division of Commercial and Sports Fisheries, Special Scientific Report No. 9, 10 p.
A study to establish optimum processing conditions for the cooking and pasteurization of crab meat which would best preserve the flavor and texture and yield a product satisfactory from the microbiological standpoint.

Tiller, R. E., and Ernest N. Cory.
1947. Effects of DDT on some tidewater aquatic animals. Journal of Economic Entomology, vol. 40, No. 3, p. 431-433.
Blue crabs, striped bass, and oysters were held in a tidal creek to indicate the effects of DDT (as used for mosquito control) on these animals. When special care was taken to prevent pre-experimental injury, crabs survived DDT applied to the surface of the water as an oil spray and as a water-dispersible emulsion.

Tobin, Leonard, John A. Alford, and C. S. McCleskey.
1941. The bacterial flora of iced, fresh crabmeat. Journal of Bacteriology, vol. 41, No. 1, p. 96-97. Abstract only.
Changes in the total bacterial count, in the predominating species, and in pH, were determined at intervals until spoilage, in a large number of samples of fresh crab meat packed in snap-lock cans at 1 to 5° C.

Tobin, Leonard C., and C. S. McCleskey.
1941a. Sources of pollution of fresh, picked crabmeat. Journal of Bacteriology, vol. 41, No. 1, p. 97. Abstract only.
The bacteriological examination of many samples of fresh crabmeat revealed a high percentage to be contaminated by *Escherichia coli.* Studied sources of contamination and corrective measures in a typical southern picking plant.
1941b. Bacteriological studies of fresh crabmeat. Food Research, vol. 6, No. 2, p. 157-167.
Samples of fresh-iced crab meat were examined for total bacterial count and for *Escherichia coli.* A typical packing plant was investigated for sources of contamination. Sterilization of crab meat reduced bacterial content and increased storage life.

Tomita, Tadao, and Ernest B. Wright.
1965. A study of the crustacean axon repetitive response. I. The effect of membrane potential and resistance. Journal of Cellular and Comparative Physiology, vol. 65, No. 2, p. 195-209.
Large motor or inhibitor axons were dissected from the walking limb or claw of the blue crab or Maine lobster. The transmembrane electrical properties were examined by a new technique which allows for quantitative evaluation of the electrical and excitable characteristics across a microscopic area ("patch") of fiber membrane, by the use of external electrodes. Data from repetitive firing and from nonrepetitive firing fibers were compared.
1966. Slow response of crustacean nerve fibre in a solution deficient in chloride ions. Nature (London), vol. 211, No. 5053, p. 1100-1101.
Single motor-nerve fibres were dissected from the walking limb of *C. sapidus* to show responses to electrical stimulation in solutions free of, or deficient in, chloride ions.

Toney, Marcellus Edward.
1956. The structure and origin of formed elements in the blood of some Crustacea. Catholic University of America, Washington, D. C., Biological Series, No. 35, p. 1-25.
Blood cells of *C. sapidus*, *Cambarus bartoni*, and *Homarus americanus* were studied by phase microscopy. The two main classes of blood cells, lymphoid and explosive refractile granulocytes, were further subdivided into subclasses.

1958. The morphology of the blood cells of some Crustacea. Growth, vol. 22, No. 1, p. 35-50.

The histological characteristics of the formed elements in the blood of the blue crab, *Cambarus*, and *Homarus* were studied in the living state and in fixed and stained preparations. Distinct cell types identified in all three Crustacea were lymphoid cells, monocytes, and explosive refractile granulocytes with large or small refractile granules.

Tortonese, Enrico.

1965. La comparsa di *Callinectes sapidus* Rathb. (Decapoda Brachyura) nel mar Ligure. Doriana, vol. 4, No. 163, p. 1-3. [English summary.]

On the basis of three specimens, the blue crab is reported for the first time from the Ligurian Sea.

Tressler, Donald K.

1927. Lobster, crab, and shrimp, p. 257-277. *In* Donald K. Tressler, The wealth of the sea. The Century Co., New York.

Development and methods used in the blue crab industry. Holding crabs in floats until they shed, and packing soft crabs for market. Gear used to capture crabs. Life history, growth, and the regeneration of lost limbs.

1968. Prepared and precooked shell fish, p. 294-313. *In* D. K. Tressler, W. B. Van Arsdel, and M. J. Copley [ed.] The freezing preservation of foods, Vol. 4. Avi Publishing Co., Inc., Westport, Conn.

Preparation and freezing of shrimp, oyster, crab, and clam.

Tressler, Donald K., and Clifford F. Evers.

1947. The preparation and freezing of shellfish, p. 587-614. *In* D. K. Tressler and C. F. Evers, The freezing preservation of foods. 2nd edition. Avi Publishing Co., Inc., N.Y. [1st edition, 1943].

Location and importance of the blue crab fishery in the United States. Gear used to capture crabs in Chesapeake Bay. Steps in the preparation of canned and frozen crab meat. Freezing soft crabs and packing them live for shipment.

Tressler, Donald K., and James McW. Lemon.

1951. Marine products of commerce. 2nd edition. Reinhold Publishing Corporation, New York, 782 p. [1st edition by D. K. Tressler, 1923].

Composition of the proteins, proximate composition, iodine, thiamine, and mineral content of the blue crab (Chapter 14). Life history and growth; production and value of blue crabs by State; Atlantic Coast blue crab fishery; methods of fishing; marketing, preparation, and storage of crab meat and soft-shell crabs; and analysis of dried blue-crab-scrap (Chapter 29).

Tressler, Donald K., and Arther W. Wells.

1925. Iodine content of seafoods. U.S. Commissioner of Fisheries, Report for 1924, Appendix 1, p. 1-12.

Iodine content of whole soft-blue crab and of meat flakes.

Truitt, R. V.

1919. Maryland's water resources. Official Publication of the Maryland State College, vol. 16, No. 6, 7 p.

A general discussion of man's unwise utilization of crab, fish, and shellfish resulting in their depletion and the need for development of aquiculture.

1932. Scientific fisheries work in Maryland. Transactions of the American Fisheries Society, vol. 62, p. 50-56.

Review of life history. Reported that nearly 75 percent of the world's blue crab supply comes from Chesapeake Bay. Discusses need for crab sanctuaries.

1939. Our water resources and their conservation. Chesapeake Biological Laboratory, Solomons, Md., Contribution No. 27, 103 p.

Extensive coverage on the external and internal anatomy, life history, migrations, food, regeneration, growth, and industrial aspects of the blue crab. Crab fishery, production, and conservation in Maryland.

Truitt, R. V., and V. D. Vladykov.

1936. Striped bass investigations in the Chesapeake Bay. Transactions of the American Fisheries Society, vol. 66, p. 225-226.

Striped bass over 25 cm. long fed on blue crabs; occasionally, as many as 20 to 25 small crabs were found in a single stomach.

Turner, Harry J., Jr., John C. Ayers, and Charles L. Wheeler.
1948. Report on investigations of the propagation of the soft-shell clam, *Mya arenaria.* Woods Hole Oceanographic Institution, Contribution No. 462, 61 p.
Predation of blue crabs on clams in Massachusetts.

Tyler, Albert V., and David G. Cargo.
1963. Size relations of two instars of the blue crab, *Callinectes sapidus.* Chesapeake Science, vol. 4, No. 1, p. 52-54.
The size range of the last two instars of females overlaped considerably. The average crab size for the instars changed significantly with locality and date. Discussed the crab schooling phenomenon.

Uhler, Philip R.
1876. The edible crab of Maryland, &c. *Callinectes hastatus,* Ordway. Field and Forest, vol. 2, No. 5, p. 73-76.
Description of the spawning season, sponge, maturation of the eggs, megalops, and swarms of megalops on the water bottom. The author observed that almost all females die after the eggs hatch. He reported that crabs are eaten by skates, rays, and many large food fish.

Ulmer, David H. B., Jr.
1964. Preparation of chilled meat from Atlantic blue crab. Fishery Industrial Research, vol. 2, No. 3, p. 21-45.
A survey of 180 Atlantic and Gulf crab plants in 1959 provided a description of the practices employed in the production of fresh crab meat. Most plants follow a basic procedure of pressure steaming, cooling, hand picking, and packaging in 1-pound containers.

Ulmer, D. H. B., Jr., Melvin A. Benarde, and Robert A. Littleford; edited by C. F. Dunker.
1959. Processing methods for the preparation of chilled crabmeat from the Atlantic Coast blue crab. University of Maryland, Seafood Processing Laboratory, Crisfield, April Bulletin, 135 p.
Comprehensive coverage of the blue crab industry including history, methods of preparing crab meat, cooking process, by-products, automation, pasteurization, bacteriological control of meat, sanitation, and regulations. Effect of season, environment, and method of cooking on the yield of meat. Statistics on the weight and value of the catch and manufactured product, by State. Bibliography of 134 references on crab meat technology.

U. S. Bureau of the Census.
1911. Fisheries of the United States, 1908. U. S. Bureau of the Census, Special Reports, 324 p.
Quantity and value of blue crabs landed, by gear and by State.

U. S. Bureau of Fisheries.
1904-41. Reports of the Commissioner of Fish and Fisheries. U.S. Bureau of Fisheries, annual reports for years 1902-1939.
Size and value of blue crab landings are given in sections titled either "Statistics of the fisheries of the middle Atlantic states" or "Fishery industries of the U.S."
1929. Crab industry of Chesapeake Bay. U.S. Bureau of Fisheries, Memorandum S-295, 5 p.
Methods and gear used to capture hard and soft crabs. Many fishermen sell hard crabs to "buy boats" which convey catches to the crab houses. Discusses how live soft crabs are packed for shipment; some are boiled and sealed in cans.
1936. Fish and shell fish of the middle and south Atlantic states. U.S. Bureau of Fisheries, Memorandum I-134B, 38 p.
Included is general information on life history, growth, and the blue crab industry.
1938. Life history of the blue crab of Chesapeake Bay. U.S. Bureau of Fisheries, Memorandum I-27, 4 p.
An account of mating, eggs, hatching, larval stages, growth, molt interval, longevity, and winter dormancy of the blue crab.
1939. A review of conditions and trends of the commercial fisheries. U.S. Bureau of Fisheries, Fishery Market News, vol. 1, No. 6, p. 1-2, 7-15.
The blue crab is one of the species discussed. State and regional consideration of fishing areas, methods, and success. Status of industrial operations.

U. S. Fish and Wildlife Service.

1919-69. Fishery statistics of the United States. U. S. Bureau of Fisheries, Fishery Industries of the U. S., 1918-1939; U. S. Fish and Wildlife Service, Statistical Digests, 1939+

Annual summaries of blue crab landings and their value, by State and by region (Middle Atlantic, Chesapeake, South Atlantic, and Gulf Fisheries), and of canned, processed, and frozen blue crab products.

1945. Edible crabs. U. S. Fish and Wildlife Service, Fishery Leaflet No. 71, 4 p.

General references to range, habitat, industry, and life history.

1948. The blue crab, *Callinectes sapidus.* U. S. Fish and Wildlife Service, Fishery Leaflet No. 282, 3 p.

General account of life history and migrations in Chesapeake Bay; also the fishery and industry.

1952-69. Fishery products reports. Production of fishery products in Maryland, North Carolina, and Virginia as reported to Hampton Fishery Market News Office, Bureau of Commercial Fisheries, Market News Service.

Daily, monthly, and annual data on landings, receipts, supplies, prices, imports, and movements of fishery products in local areas; market conditions, and fishery developments.

1957. Canned fish and shellfish preferences of household consumers, 1956. U. S. Fish and Wildlife Service, Special Scientific Reports-Fisheries No. 200, 328 p.

Report on a nationwide survey of 2,543 households pertaining to the use of canned fish and shellfish (crab meat is included) products by consumers and their specific preferences and demands.

1963-69. Annual reports of the Bureau of Commercial Fisheries Biological Laboratory, Beaufort, N. C., for fiscal years ending June 30, 1961-1968. U. S. Fish and Wildlife Service, Circular No. 148, 184, 198, 215, 240, 264, 287 and 341.

Research on blue crab included biological studies on the Newport River, N.C., and St. Johns River, Fla.; tagging program in South Carolina; population studies on the Neuse River, N.C.; and laboratory experiments on survival requirements of larvae, juveniles, and adults.

U. S. Tariff Commission.

1941. Crab meat. Report to the president. U. S. Tariff Commission, Report No. 147, 2nd series, 56 p.

Differences in costs of production of crab meat (including the blue crab) in the United States and in the principal competing country (Japan).

Van Engel, W. A.

1954. Prepared crab products growing in popularity. Frosted Food Field, vol. 18, No. 4, p. 19-20.

The marketing of quick-frozen crab products and the difficulties resulting from fluctuations in the blue crab supply in Chesapeake Bay.

1958. The blue crab and its fishery in Chesapeake Bay. Part 1. Reproduction, early development, growth, and migration. Commercial Fisheries Review, vol. 20, No. 6, p. 6-17.

This comprehensive work on the blue crab includes life history, life history stages, migrations, worldwide distribution, and food of larval and postlarval crabs. Brief references to the hormonal control of molting and the effects of salinity on the growth of larvae and juveniles. Fluctuations in the total catch in Chesapeake Bay, 1880-1955.

1962. The blue crab and its fishery in Chesapeake Bay. Part 2. Types of gear for hard crab fishing. Commercial Fisheries Review, vol. 24, No. 9, p. 1-10.

Pots, trotlines, and dredges are the most suitable gear. Pots account for two-thirds of hard crab catch in Virginia and more than half of catch in Maryland. The dredge is the primary winter gear. Also discusses the development of the crab industry.

Van Engel, W. A., and F. J. Wojcik.

1965a. Catch and value of the Chesapeake Bay blue crab, 1800-1960. Virginia Institute of Marine Science, Gloucester Point, Data Report No. 2, 39 p.

A detailed summary of the catch and value, by gear, of blue crabs captured in Virginia

and Maryland (including the ocean-crab catch).

1965b. License records of the blue crab fisheries, Virginia and Maryland, 1898-1960. Virginia Institute of Marine Science, Gloucester Point, Data Report No. 3, 15 p.

Provides number of crabbers (by gear), buyers, packers, and shippers.

Vernberg, F. John.

1956. Study of the oxygen consumption of excised tissues of certain marine decapod Crustacea in relation to habitat. Physiological Zoology, vol. 29, No. 3, p. 227-234.

The oxygen uptake of gill tissue and midgut gland was determined for terrestrial, intertidal, and below low tide (including the blue crab) animals. A direct correlation between metabolism and basic activity of the organism was evident.

1962. The role of tissue metabolism in the seasonal distribution of decapod crustaceans. American Zoologist, vol. 2, No. 3, p. 455. Abstract only.

The metabolic-temperature curves of tissues from *C. sapidus*, *Cancer irroratus*, *Libinia emarginata*, and *Uca minax* were determined. Seasonal variation in metabolic rates suggested adaptive responses which were correlated with temperature acclimation phenomena.

Vernberg, F. John, and Winona B. Vernberg.

1969. Thermal influence on invertebrate respiration. Chesapeake Science, vol. 10, No. 3-4, p. 234-240.

Temperatures at which there is a change in activity of cytochrome c oxidase in gill, muscle, and midgut gland tissue from cold- and warm-acclimated *C. sapidus*, *Ocypode quadratus* and *Libinia emarginata.*

Vernberg, Winona B., and F. John Vernberg.

1967. Respiratory adaptations in Crustacea from different habitats. American Zoologist, vol. 7, No. 4, p. 765-766. Abstract only.

Cytochrome c oxidase activity was assayed spectrophotometrically to determine differences in the respiratory rate of tissues of crabs from semiterrestrial *(Ocypode quadratus)*, shallow water *(C. sapidus)*, and deep water *(Libinia emarginata)* habitats.

1968. Physiological diversity in metabolism in marine and terrestrial Crustacea. American Zoologist, vol. 8, No. 3, p. 449-458.

Metabolic adaption to increased terrestrialism, considering respiratory adaptions as reflected by comparative cytochrome c oxidase activity in tissues of crabs from aquatic and terrestrial habitats, and the thermal acclimation patterns in cytochrome c oxidase activity in tissues from these crabs. Species of crabs studied were *C. sapidus*, *Ocypode quadrata*, and *Libinia emarginata;* the tissues, gill, muscle, and midgut gland.

Verill, A. E.

1873. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters, with an account of the physical characters of the region. U.S. Commissioner of Fish and Fisheries, Report for 1871-72, p. 295-778.

The character of the fauna of different habitats. The blue crab was common along muddy shores (young, close to shore; adults, among eelgrass away from shore and in brackish waters of estuaries) and also was considered a free-swimming and surface animal. Foods of many species of fish are given; blue crabs occurred only in the stomachs of toadfish. The leech, *Myzobdella lugubris*, reportedly adheres to the legs of the blue crab.

Vinogradov, A. P.

1953. The elementary chemical composition of marine organisms. Sears Foundation for Marine Research, Yale University, New Haven, Memoir No. 2, 647 p.

Concentrations of iron, copper, zinc, and manganese in the blue crab (dry and living matter). Quantities of iodine and water. Lead in the carapace. Copper in the blood. Occurrence of the respiratory pigment, hemocyanin. Calcium metabolism in blue crabs during molting.

Viosca, Percy, Jr.

1953. About crabs. Louisiana Conservationist, vol. 6, No. 1, p. 14, 16-18.

Popular account of blue crab life history, growth, food, and predators.

1958. And crabs. Louisiana Conservationist, vol. 10, No. 1, p. 11, 23.
Popular account of blue crab life history, growth, and food.

Virginia Commission of Fisheries.
1875-1969. Annual reports. Commission of Fisheries of Virginia, 1875+. Division of Purchase and Printing, Richmond. (After 1940, includes the Annual Reports of Virginia Fisheries Laboratory, Gloucester Point, College of William and Mary).
Many report progress of research on the blue crab.

Virginia Polytechnic Institute, Blacksburg.
1933. Commercial fisheries, p. 158-169. *In* Virginia Polytechnic Institute, Blacksburg, Virginia, economic and civic. Whittet and Shepperson, Richmond, Va.
A general review of the fishing industry in Virginia.

Voss, Gilbert L., and Nancy A. Voss.
1955. An ecological survey of Soldier Key, Biscayne Bay, Florida. Bulletin of Marine Science of the Gulf and Caribbean, vol. 5, No. 3, p. 203-229.
Invertebrate and algal life of a small island. Various zones of shallow water are classified according to the most numerous inhabitant. The occurrence of blue crabs, associated species, and plant life in sandy areas of two shallow water habitats is discussed.

Walburg, Charles H.
1959. Edible crabs. U.S. Fish and Wildlife Service, Fishery Leaflet No. 471, 4 p.
General account of distribution, fishery, industry, and value.

Waldo, Ednard.
1958. Crabbing. Louisiana Conservationist, vol. 10, No. 1, p. 10, 12-13, 22.
Specifications for construction of a crab pot.

Wang, L., R. R. Colwell, T. E. Lovelace, and G. E. Krantz.
1969. Isolation of *Vibrio parahaemolyticus* from Chesapeake Bay, U. S. A. Bacteriological Proceedings, vol. 69, p. 1. Abstract only.
C. sapidus food poisoning agent. Serological diagnosis and DNA base composition.

Wass, Marvin L.
1955. The decapod crustaceans of Alligator Harbor and adjacent inshore areas of northwestern Florida. Quarterly Journal of the Florida Academy of Sciences, vol. 18, No. 3, p. 129-176.
Distribution of the blue crab in northwestern Florida. The occurrence of the sacculinid parasite, *Loxothylacus texanus*, beneath the abdomen of the blue crab.

Watase, S.
1890. On the morphology of the compound eyes of arthropods. Johns Hopkins University, Studies from the Biological Laboratory, vol. 4, No. 6, p. 287-334.
Morphology and phylogeny of the ommatidium of *Callinectes* and five other genera. It was viewed as a simple ectodermic invagination of the skin. The retinula cells and ommatidium are diagramed.

Waterman, Talbot H. [ed.]
1960. The physiology of Crustacea. Vol. 1, Metabolism and growth. Academic Press, New York, 670 p.
Chapters that refer to blue crabs: Respiration (oxygen consumption and uptake by tissues, critical pressure, oxygen capacity and affinity of blood); Blood chemistry (inorganic composition and nonprotein nitrogen in blood); Circulation and heart function (hemolymph cell counts); Feeding and nutrition (food of zoea); Vitamins (visual pigment); Osmotic and ionic regulation (in sea water); Ecology and metabolism (oxygen uptake of gills); Sex determination (effect if parasitized by *Sacculina);* and Molting and its control (pigmentary changes).
1961. The physiology of Crustacea. Vol. 2, Sense organs, integration, and behavior. Academic Press, New York, 681 p.
Chapters that refer to blue crabs: Light sensitivity and vision (wavelength of maximum spectral sensitivity); Neurohumors and neurosecretion (acetylcholine content of ganglia); Locomotion (use of paddles);

Physiological rhythms (12.4-hour rhythm of color change with tides); Migrations (for egg-laying, larvae inshore, body mechanisms involved); and Complex behavior (mating habits).

Watson, Vernon K., and Carl R. Fellers.
1935. Nutritive value of the blue crab *(Callinectes sapidus)*, and sand crab *(Platyonichus ocellatus* Latreille). Transactions of the American Fisheries Society, vol. 65, p. 342-349.
A review of various studies on the composition and nutritive value of crab meat. Rat growth tests showed a high biological value for the proteins of both blue and sand crabs.

Watson, W. W.
1949. The blue crab of the Chesapeake. Maryland Department of Tidewater Fisheries, Annapolis, Chesapeake Skipper, vol. 5, No. 2, p. 6, 31.
A general summary of life history, migrations, food, molting, regeneration, and fishing gear.

Weathersby, S. M.
1936. Some observations upon the rate of heart beat of *Callinectes sapidus.* Proceedings of the Louisiana Academy of Sciences, vol. 3, No. 1, p. 54-57.
Crabs from a bay had a higher rate of heart beat than those from a beach. Heart beat of adult males and females from the bay was the same, but of crabs from the beach, males had a higher beat. Small crabs had a slower rate than adults, and sponge crabs had the slowest rate of all.

Webb, N. B., F. B. Thomas, R. E. Carawan, and L. S. Kerr.
1969. The effects of processing on the quality of scallops, oysters and blue crabs. North Carolina Department of Conservation and Development, Division of Commercial and Sports Fisheries, Special Scientific Report No. 19, 25 p.
Experiments to determine if selected food grade additives would improve heat pasteurization, acceptability, and binding properties of pasteurized crab meat.

Webster, Agnes I., and W. T. Conn.
1935. Practical fish cookery. U.S. Fish and Wildlife Service, Fishery Circular No. 19, 26 p.
Includes a section on the preparation of live crabs (hard and soft) and the use of canned crab meat in the home.

Wells, Harry W.
1961. The fauna of oyster beds, with special reference to the salinity factor. Ecological Monographs, vol. 31, p. 239-266.
Blue crabs were common on oyster beds and fed on the oysters in the Newport River, N.C. Young may occupy burrows in soft bottoms between oyster clusters.

Wharton, James.
1949. The clam and the crab. Commonwealth, vol. 16, No. 7, p. 7-9, 26.
A general account of the food of blue crabs, fluctuations in their abundance, the fishery, and the crab meat industry of Chesapeake Bay.
1954. The Chesapeake Bay crab industry. U.S. Fish and Wildlife Service, Fishery Leaflet No. 358 (Revised), 17 p.
Describes eight methods used to capture blue crabs and the various ways the catch is processed and marketed. The historical beginnings of the soft- and hard-shell blue crab industries are reviewed.

Wilde, G. H.
1969. Departing blue claw. Conservationist, vol. 23, No. 4, p. 43.
Blue crab conservation in New York.

Williams, Austin B.
1965. Marine decapod crustaceans of the Carolinas. U.S. Fish and Wildlife Service, Fishery Bulletin, vol. 65, No. 1, p. 1-298.
A section on blue crab is included. Recognition characters, taxonomy, distribution, occurrence in fresh water, fossil record, life history, growth, food, possible negative correlation of size with salinity, barnacles found in its gills, *Loxothylacus* and *Carcinonemertes* parasites, and endogenous rhythm of pigment in the melanophores.

Williams, Austin B., and Earl E. Deubler, Jr.
1968. Studies on macroplanktonic crustaceans and ichthyoplankton of the Pamlico Sound complex. North Carolina Department of Conservation and Development, Division of Commercial and Sports Fisheries, Special Scientific Report No. 13, 103 p.
The megalops of blue crabs were found widely in the upper reaches of the Neuse and Pamlico Rivers, N.C., during a 2-year plankton survey in these estuaries. The samples showed ample evidence of migration into estuaries during the megalops stage and that the recruitment period extends from April to December.

Williams, Austin B., and Hugh J. Porter.
1964. An unusually large turtle barnacle *(Chelonibia p. patula)* on a blue crab from Delaware Bay. Chesapeake Science, vol. 5, No. 3, p. 150-151.
Fouling by barnacles, bryozoans, and hydroids.

Williamson, D. I.
1967. On a collection of planktonic Decapoda and Stomatopoda (Crustacea) from the Mediterranean coast of Israel. Sea Fisheries Research Station, Haifa, Bulletin No. 45, p. 32-64.
The last two zoeal stages of the blue crab occurred in six of 22 plankton samples (1955-56) from the Israel coast.

Williams-Walls, N. J.
1968. *Clostridium botulinum* Type F: isolation from crabs. Science, vol. 162, No. 3851, p. 375-376.
The first time that proteolytic strains of *C. botulinum* Type F have been isolated in the United States. Two strains were obtained from gills and viscera of two blue crabs.

Wolff, T.
1954a. Occurrence of two East American species of crabs in European waters. Nature (London), vol. 174, No. 4421, p. 188-189.
Occurrence (introduced) of the blue crab in Denmark and Holland.
1954b. Tre oestamerikanske Krabber fundet i Danmark. Flora og Fauna, vol. 60, No. 1-2, p. 19-34. [English summary].
Occurrence (introduced) of the blue crab in Copenhagen. Observations of molting.

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CATEGORIES OF SUBJECT INDEX

1. Taxonomy.
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4. Sexual dichromatism.
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a. Explosions:
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