HOW TO KNOW THE SEAWEEDS

E. YALE DAWSON

How To Know
THE SEAWEEDS

An illustrated manual for identifying the more common Marine Algae of both our Atlantic and Pacific coasts with numerous aids for their study.

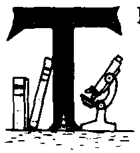
THE PICTURED-KEY NATURE SERIES

"How to Know the Insects," Jaques, 1947
"Living Things—How to Know Them," Jaques, 1946
"How to Know the Trees," Jaques, 1946
"Plant Families—How to Know Them," Jaques, 1948
"How to Know the Spring Flowers," Cuthbert, 1943, 1949
"How to Know the Mosses," Conard, 1944
"How to Know the Land Birds," Jaques, 1947
"How to Know the Fall Flowers," Cuthbert, 1948
"How to Know the Immature Insects," Chu, 1949
"How to Know the Protozoa," Jahn, 1949
"How to Know the Mammals," Booth, 1949
"How to Know the Beetles," Jaques, 1951
"How to Know the Spiders," Kaston, 1952
"How to Know the Grasses," Pohl, 1953
"How to Know the Fresh-Water Algae," Prescott, 1954
"How to Know the Western Trees," Baerg, 1955
"How to Know the Seaweeds," Dawson, 1956

In Both Spiral and Cloth Binding
Other Subjects in Preparation

Manufactured by WM. C. BROWN CO. INC., Dubuque, Iowa
Printed in U. S. A.

FOREWORD



THE most recent comprehensive monograph of the marine algae of the combined Atlantic and Pacific coasts of the United States is a splendid one, printed in quarto and with some of the finest colored plates in the literature. The work is the more impressive when one realizes that the author, W. H. Harvey, did his field work without the aid of an automobile or a motor driven boat, made his microscopic examinations without the aid of an electric light, and made his own drawings on lithographic limestone. The time,—a century ago. From the four hundred odd kinds of algae enumerated by Harvey from the American shores the number of known species has grown to about two thousand, with many still to be recognized and named. Yet, with all of this expansion of knowledge there has come no single modern monograph treating the North American seaweeds. More conspicuous to many is the lack of any handbook designed to aid the amateur and the elementary student in identifying the commoner kinds of marine algae. It is toward filling a part of this need that this little book is offered.

Inasmuch as the coasts of the United States are so very extensive and the range of habitats and climates so varied, both on the Atlantic and Pacific sides of the continent, a treatment of all of the species of seaweeds in a small volume is impossible. Space does not permit even a representative illustration for each of the many genera. However, our purpose is to provide a useful tool for the elementary student of phycology, and with his needs in mind a selection has been made of those plants which he is most likely to encounter wherever he may be along the coasts of the United States. Algae which are very small, or are of rare or localized occurrence, are omitted. Likewise, in the preparation of the key an effort has been made to present those features which apply to the mature, well developed plants rather than to juvenile or stunted forms which are not characteristic.

The author does not expect that the student will be completely satisfied with the treatment, for occasionally there will be times when the plant at hand is not to be found in this book, or when the illustration does not look very much like a particular specimen brought in for study. On the other hand he does hope that this handbook will serve the student in a large majority of cases to determine the names of the seaweeds he has collected, wherever he lives or travels along American Shores.

With few exceptions the illustrations have been drawn by the author from actual specimens. The preparation of these was greatly facili-

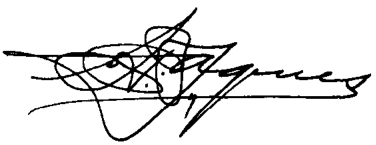
tated by the herbarium material available at the Allan Hancock Foundation, University of Southern California.

Los Angeles, California
October, 1955

E. Yale Dawson

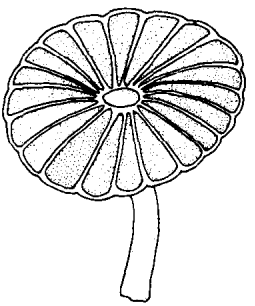
Almost every one who walks along an ocean beach wonders about the plant debris left by the waves. The need for a book offering ready identification of the more evident species of marine algae is apparent.

It is truly timely that Dr. Dawson, with his splendid experience with these interesting plants, has given us this much-needed identification manual.



Editor

CONTENTS



THE VEGETATION OF THE SEA

FOUR-FIFTHS of the surface of our globe is covered by salt water, and since all of the multitudes of animal inhabitants of this vast aquatic environment are ultimately dependent upon the photosynthetic plants, we may say that in one sense the marine plants are the most important of all the groups of organisms on earth.

In the sea, extremes of climate are modulated by the water medium, and the vastly predominant environment is one of monotonous darkness and cold. Accordingly, the diversity of living things on the whole is less than on the land, and while some groups are poorly represented, others are entirely lacking. Thus, whereas the highly developed mammals are sparsely represented in the sea and the insects not at all, in the marine vegetation the seed plants and fungi are few and the ferns and mosses absent. On the other hand, some of the phyla of organisms present in the sea are absent on land, or much less richly developed there. This is true of the several groups of plants known as algae of which the great bulk of the marine vegetation is composed.

With the exception of the bacteria and of a few parasitic and saprophytic fungi, virtually all of the marine plants are autophytic, that is to say, independent and capable of providing their own food by means of photosynthesis. To do this they need two primary raw materials, namely, water, which is seldom in short supply, and CO^2. Energy for the process of photosynthesis must be supplied by sunlight which, however, is largely absent in the sea. Most of the marine environment is totally lacking in sunlight which penetrates, even in the most exceptionally clear water, only to as much as three or four hundred feet. Accordingly, these autophytic plants are restricted in the

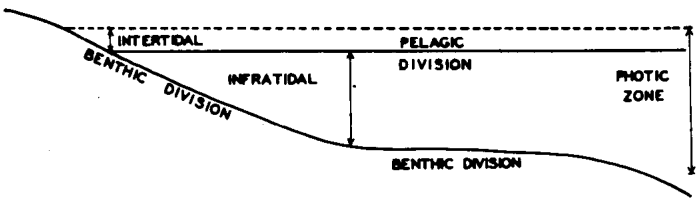


Fig. 1. Diagram of the general habitats of the plants of the sea.

immensity of the oceans to a relatively thin layer of illuminated surface water and to the narrow intertidal and infratidal fringe within this photic zone. In these places, however, they may be remarkably abundant.

The general habitats of the plants of this illuminated portion of the sea may be diagrammed as in Figure 1. The vegetable inhabitants of the pelagic division, that is, of the water mass itself, are the phytoplankton, while those of the benthic division, or the sea floor, are what we may call the seaweeds, or attached algae.

The phytoplankton consists of free floating, unattached plants which move about only as their water medium moves. With few exceptions they are unicellular forms of microscopic size requiring quite high magnification to render them visible (Fig. 2). Despite their small size, their habitat in the surface waters of all of the oceans is so vast and their numbers so great that they actually account for more than 95% of the vegetation of the sea.

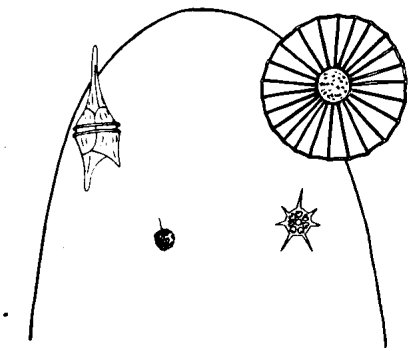


Fig. 2. Some representatives of the phytoplankton.

A. A dinoflagellate, *Ceratium*. B. A diatom, *Planktoniella*. C. A coccolithophore, *Pontosphaera*. D. A silicoflagellate, *Distephanus*. All are drawn to the same scale (X 225) and are shown against a heavy outline which represents the point of a dissecting needle.

Several different kinds of organisms make up the phytoplankton (Fig. 2) of which may be mentioned the diatoms, the pigmented dinoflagellates, the silicoflagellates, the coccolithophores and a few blue-green algae. Most abundant of these constituents are the diatoms, of which several million may sometimes occur in a single quart of sea water. These are unicellular members of the division Chrysophyta whose protoplasm secretes a beautifully sculptured, bivalved, silicious shell (Fig. 3). The shell is basically like a pill-box in structure, but often is marvelously modified for flotation where perpetuation of a species depends upon the ability to remain in the photic zone.

Because of the tremendous numbers of these tiny plants in the sea, and of the perpetual rain of their insoluble silicious shells on the bottom, great deposits accumulate which may be hundreds of feet deep. Some of these deposits have been raised above sea level and form the beds of diatomaceous earth such as occur at Lompoc, California, and are exploited commercially for the making of fine scouring compounds.

On account of the very small size of the phytoplankton organisms, the high magnifications needed for viewing them, and the special methods required in collecting, preserving and examining them, they do not lend themselves readily to study by the amateur or elementary student and will not be treated further in this account.

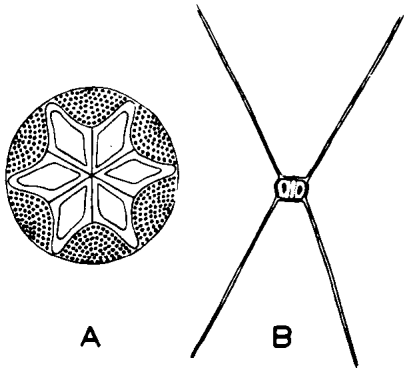


Fig. 3. Examples of two different forms of planktonic diatoms.

A. *Asterolampra*, a broad, flat, disc-like form. B. *Chaetoceras*, a very small-bodied form with long hair-like modifications of the silicious frustule to aid in flotation. Both X 200.

Unlike the vegetation of the surface water masses of the oceans, that of the illuminated sea floor and of the shore consists mostly of readily visible plants of which some reach large size. Among these, to be sure, there are many microscopic forms, including littoral diatoms (Fig. 4) and minute blue-green algae (Fig. 5) which sometimes form more or less conspicuous macroscopic colonies. These must be neglected here, however, in favor of the three main groups of seaweeds with which we need be concerned, namely, the Green Algae (Chlorophyta), the Brown Algae (Phaeophyta) and the Red Algae (Rhodophyta). The seed plants, although of very few kinds, are exceedingly abundant in many coastal habitats and will be accounted for and illustrated at the end of this book.

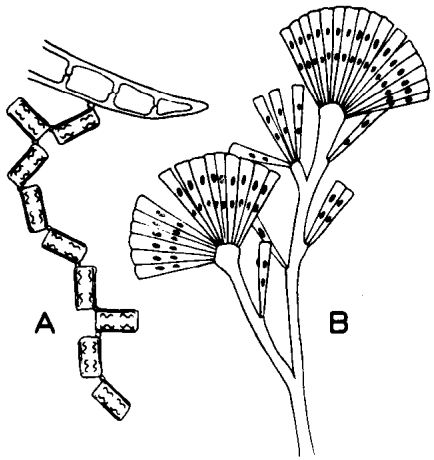


Fig. 4. Two examples of different forms of littoral diatoms.
A. An epiphytic, chain form, *Grammatophora*.
B. A stalked form, *Licmophora*.

These three groups of algae which make up the vast majority of the seaweeds are named because of the predominant colors which their members commonly assume, and are technically distinguished by the chemistry of their pigments. Thus, the Green Algae are characteristically pigmented only by green chlorophyll, while the Brown and Red Algae have their chlorophyll masked by other pigments. On this account the Green Algae almost always appear green in color, while the others may be neither brown nor red, depending upon the relative dominance of the chlorophyll or of the masking pigments. When the color is such as to leave one in doubt as to the group to which a plant may belong, other characters must be taken into account in identification. Because of the difficulty experienced by most students in recognizing according to color the main group to which a seaweed belongs, the present key treats all of the Green, Brown

and Red Algae together, separating them from each other without particular regard to color.

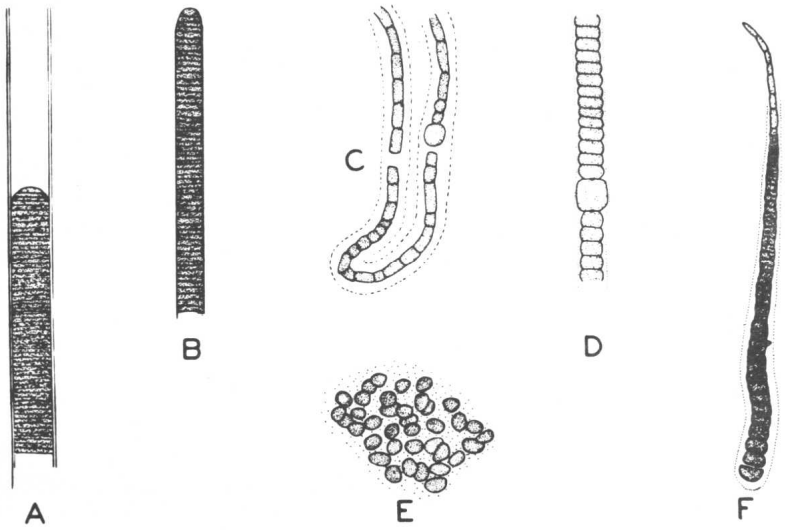


Fig. 5. Some examples of Blue-Green Algae.
A. *Lyngbya* sp., X 193. B. *Oscillatoria* sp., X 200. C. *Brachytrichia* sp., X 275.
D. *Hormothamnion* sp., X 330. E. *Entophysalis* sp., X 500. F. *Calothrix* sp., X 275.

HOW TO COLLECT SEAWEEDS

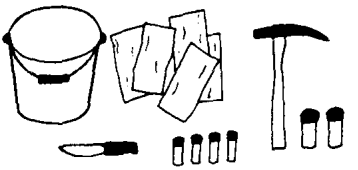
SEAWEEDS rarely grow in the free floating state, but instead are fixed firmly at their bases and remain stationary throughout life. Only in the Sargasso Sea northeast of the Caribbean and in the Gulf of Thailand are there sizable quantities of the brown alga *Sargassum* (see Fig. 141) living in the free floating state. Elsewhere the seaweeds grow attached to the bottom or to each other. Since an unstable bottom such as one of sand or mud is unfavorable to the attachment of seaweeds, they are usually absent from such substrates except in quiet bays and lagoons where agitation is slight. On surfy shores the algae are essentially confined to rocky places where their firm attachments give them resistance to wave shock. This is especially true along the rugged, wave-swept Pacific Coast where the collector rarely encounters the richly vegetated quiet bays or estuaries such as occur so frequently along the Atlantic Coast.

The coasts of the United States offer a diversity of marine habitats scarcely equalled by those of any other nation. This diversity is so great that no single set of directions can be made suitable for a collector among the Florida keys, another on Cape Cod and another on Puget Sound. One can only make a few general remarks and suggestions, leaving the rest to the adjustability and ingenuity of the American individual wherever he may be.

At the outset it is clear that one must get to the seashore to collect seaweeds, but this is not always as simple as it may seem. Many of our rocky shores abounding in algae are subject to surf of varying intensity whereby collecting is made difficult or impossible except at times of lowest water. Accordingly, it is necessary to select a suitable time for the collecting trip, depending upon the state of the tide. Tide tables issued by the U. S. Coast and Geodetic Survey or by various sporting goods houses for the use of fishermen should be consulted for the times of suitable low water. The so called "minus tides" are the best, but even with only moderately low water much can be done if the surf is not too severe. The collector should plan to begin work at the shore at least two hours before the time of low tide in order to work the clearer water of the falling tide and to select his material successively from higher to lower levels while the plants are freshly exposed and still wet and unshriveled from desiccation.

Collecting equipment on a rocky shore should consist of a pail or two for carrying the specimens, a quantity of plastic bags for separating

the larger species, and a number of small, screw-cap vials provided with 3% formalin into which small but important specimens may be preserved from loss or mixing. For removing small plants from rock surfaces a heavy knife or other scaping tool is used, while encrusting forms which adhere too firmly may be obtained by using a geologist's hammer for cracking off pieces of the supporting rock.



Collecting Tools.

At the upper levels one will find a number of minute species on the exposed rock surfaces, including various crustose forms which the initiate may overlook unless they are pointed out to him. Lower down, depending upon the amount of exposure to desiccation, one will encounter larger and smaller fleshy, clumping forms grading into the densely matted turfs, or heavy, continuous beds of algae at the lowest tide levels. It will not be enough to look superficially over the array of seaweeds to obtain a good collection, for many species will be hidden under others or will occur only in particular pools, in certain shaded crannies, along the edges of surging tideways, or on the exposed faces of outermost rocks subject to the heaviest surf. Many species will be found growing only as epiphytes or as parasites on other, larger species and should be obtained by selection of suitable portions of the host plants. Algal turfs consisting of many species may be brought back as a mass to be examined for their individual constituents in the laboratory. At lowest water level the collector will profit by wading out (in hip boots in cold areas) to look under overhanging rocks, in crannies and pools for the various species which can endure only momentary exposure to the atmosphere.

When the tide has begun to flow one must hasten to finish the work at low levels before retracing steps inward. With the incoming tide time may be taken to seek special pools and rocky habitats at higher levels which have been passed over before, and there to find additional species. Shaded cliffs subject to spray, the walls of sea caves, the under edges of rocks in tide pools, high, warm pools polluted by guano, and other such diverse habitats will all yield different species. Even pieces of dead shell or coral may exhibit a greenish cast indicating the presence of boring green algae.

After the selection of the attached algae from the intertidal rocks has been completed there is yet another source of specimens which should not be passed by. Especially at times of unfavorable tides one

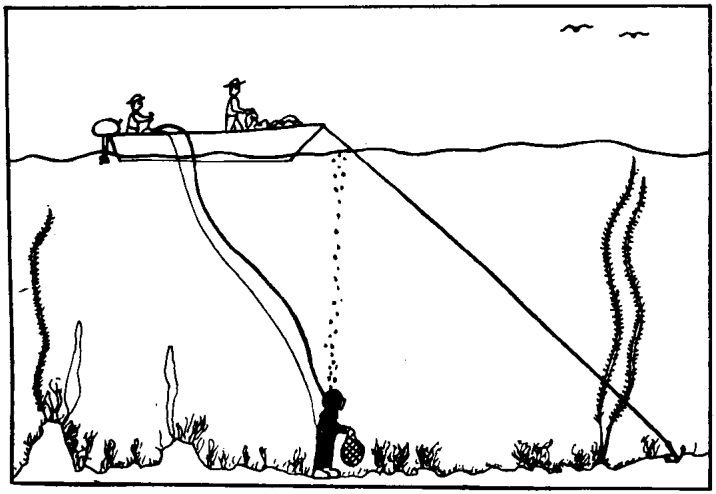
may profit much from examining the beach drift which often accumulates in quantity in coves or along sand beaches adjoining rocky areas. It is among these cast specimens that many of the species of the deeper, infratidal waters may be found and selected with much greater ease than through the use of a boat and dredge. If driftweed is examined after a storm while the material is still fresh and has not been exposed long to the bleaching and drying action of the sun and air, many specimens in good condition may be selected.

Apart from rocky shore habitats the algologist finds many other situations in which seaweeds may be found. Many areas in which surf is light or absent, such as the sandy or muddy shores of bays, lagoons and estuaries, will yield specimens. Such quiet habitats are especially well populated in tropical regions, and within the range of the mangrove the algal flora of its roots is an interesting one which should not be overlooked. The piling of wharves and the rock or concrete of artificial breakwaters will yield many species. Indeed, along the vast sandy stretches of the Gulf of Mexico, these will be the principal algal habitats. Even mobile objects may have their seaweed floras. Thus, boat hulls will yield several species as may also the backs of sea turtles and several kinds of crabs. Particular species have even been found attached to the intersegmental grooves of isopods parasitic on certain fishes.

Beyond the level of low tide, and apart from those cast ashore in drift, the algae of infratidal waters must be obtained by means of diving or by some manner of dredging. In very quiet, surfless waters a collector may wade about observing the bottom by means of a glass-bottom bucket and reaching specimens with ease. In depths of more than three feet, observation is best afforded by a face plate and collections made by placing specimens in a skiff as they are obtained by the diver. In depths of more than ten feet the diver must be provided with breathing apparatus in order to spend the time below the surface necessary for the selection of specimens. The "aqua-lung" has recently become popular with skin-divers and its use may readily be learned in most any area of warm, quiet water where these sportsmen thrive. In colder waters the diver must be provided with the standard heavy diving suit and helmet. It is this heavy suit which is normally used by the commercial seaweed collectors who harvest *Gelidium* and other agar-yielding seaweeds from the infratidal beds along the Pacific Coast.

Apart from those areas where skin-diving may be done comfortably, the collecting of infratidal algae is best accomplished by the use of a dredge handled by a powered winch on shipboard. The use of various devices of this sort is described by Sverdrup, Johnson &

Fleming, The Oceans, Prentice-Hall, Inc., 1942, and may be observed on ships operated by the several oceanographic institutions of the country.

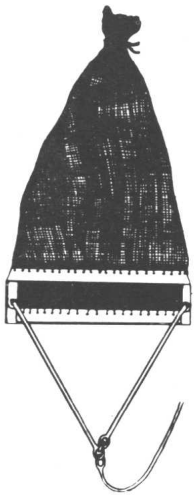


HARVESTING *GELIDIUM*.

PRESERVATION OF SEAWEED COLLECTIONS

WHEN the day's collecting has been completed the specimens should be preserved as quickly as possible to prevent unnecessary deterioration. This is best accomplished at the shore by means of one or more five-gallon tin cans. Sea water should be brought up in a bucket and mixed with commercial 40% formaldehyde to obtain approximately a 3% solution. The various plastic bags into which specimens have been separated may then be partly filled with the preservative and tied. These bags, together with bulkier materials as well as small bottles of specimens may all be placed in the can in preservative and provided with an appropriate label. The tin of specimens may be closed and kept for months without deterioration of the specimens or loss of color, while the same specimens kept in glass jars exposed to light would be bleached and largely worthless in a few days. The tin may, indeed, be sealed with solder and boxed for shipment with ease and without fear of damage to the contents.

Of utmost importance in the preparation of any collection is the provision of adequate field data in the field collection notebook, and the careful preparation of labels. For this purpose all pertinent observations on the character of the habitat, size and aspect of the various dominant species, the major associations, water temperature, substrate type, exposure, etc., should be recorded before leaving the field. These data should be incorporated in the permanent book of field notes, in which a consecutive series of collection numbers is tabulated.



A Dredge.

Upon return to the laboratory the preparation of specimens may begin at once, although it is preferable to leave the material in preservative for a few days time. This applies particularly to certain species which when fresh are damaged by being immersed in tap water, but which are not harmed by the same treatment after having remained a few days or weeks in the formalin- sea water solution.

It will be found most convenient to obtain one or more large porcelain trays and a number of wide-mouthed jars of various sizes into which to sort the specimens. After quickly washing with tap water the various species should be separated into the jars, each species receiving a number which is listed in the field notebook beneath the field data previously recorded. Of each of the species, especially the smaller or more delicate forms, appropriate portions should be placed in small vials (4 dram shell vials) for future use in making preparations for microscopic examination. These, of course, also receive in each case the same field number assigned to the remaining material of a given species.

After the segregation of all of the species into separate containers the drying may begin. Two methods may be employed depending upon the nature of the specimens. Crustose specimens which have been brought from the shore along with pieces of their substrate may be dried directly in the air and preserved in the dry state in small boxes of suitable size. Articulated, calcareous algae which are so fragile and (or) so three dimensional as to suffer badly from pressing, should be treated in the same way, or, preferably, soaked for several days or weeks in a solution of about 40% glycerine in 3% formalin before being dried and placed in the small boxes. Most of the remainder of the algae may be dried in a standard plant press.

Inasmuch as the algal specimens should ultimately be mounted on standard 11½ by 16½ herbarium paper,[1] whole sheets or suitably sized pieces of this paper may be used for the next step which is the backing of the specimen as it is floated out for drying.

Mounting may best be done in a broad, shallow tray large enough to accommodate a full size herbarium sheet. The sheet of paper to be used in each instance should be immersed in water in the bottom of the tray. The water should be of the least depth suitable for floating out the particular specimen at hand and spreading it on the paper. After the plant has been spread out in a natural appearing manner on its suitably sized sheet in the water tray, the sheet should be lifted carefully from one side to allow the water to drain off gradually and to leave the specimen spread out and undisturbed on the sheet. A device for affecting this drainage may be made from a piece of galvanized sheet metal by bending down the corners to form short legs. These will permit the middle to be depressed slightly for spreading a specimen and released to allow the water to drain off evenly.

1. This and other herbarium supplies, press materials, paste, packets, etc., may be obtained from herbarium supply houses such as Bonestell & Company, San Francisco, California; General Biological Supply House, 8200 South Hayne Ave., Chicago 20, Ill., or Ward's Natural Science Establishment, 3000 Ridge Road East, Rochester 9, N. Y.