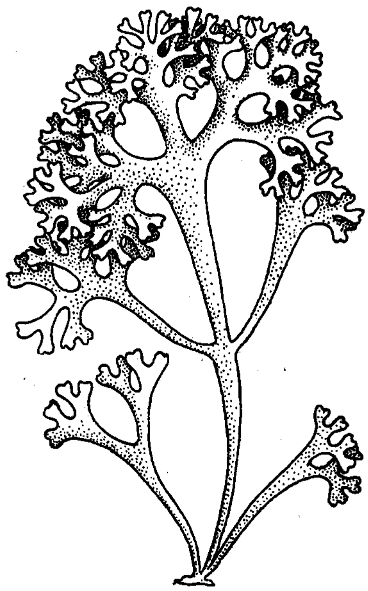


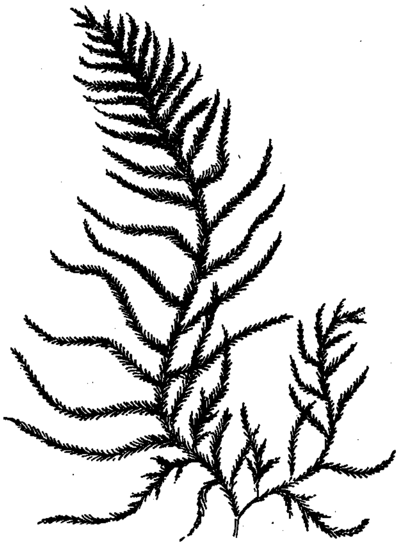
IRISH MOSS

This is the thirty-eighth in Nature Magazine's series of educational inserts.

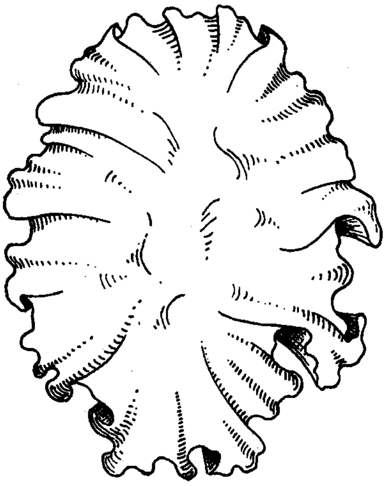
Marine Algae, or "Seaweed"

By E. LAURENCE PALMER

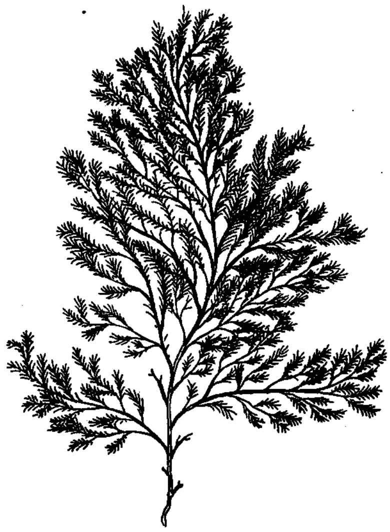
Illustrated by Elizabeth Burckmyer



CHENILLE-WEED



LAVER



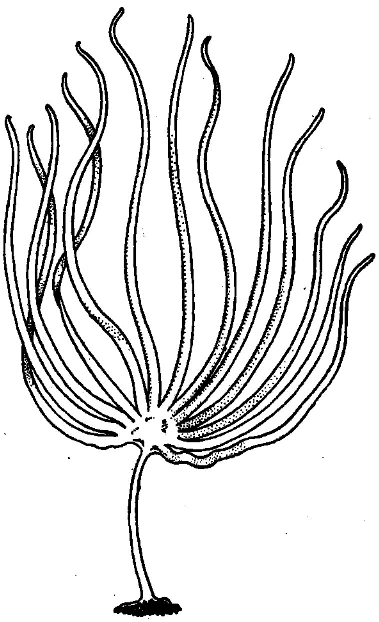
POLYSIPHONIA

MY first-hand experience with marine algae dates back almost thirty-two years to a day from the time this will appear in print. I had just taken over the botany work at Iowa State Teachers College, and among the first things I found there was a beautiful collection of marine algae, donated by someone and wholly unclassified. The collection so interested me that I remember giving up two whole days of my first vacation to name and arrange the collection, with the help of literature from a university library. There was nothing worthy of the name in the college library.

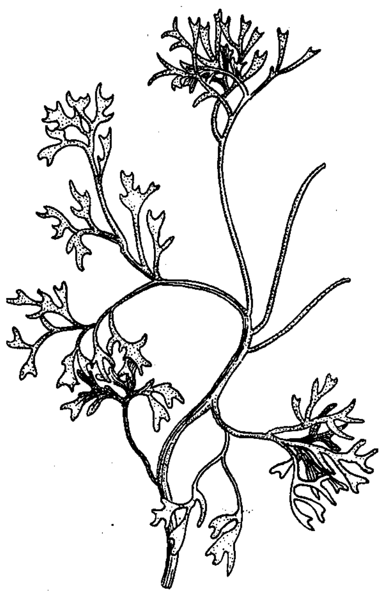
So interested did I become in these beautiful plants, the like of which I had never seen in Nature, that I made up my mind that some day I would know them better, and some day I would write an article that would help others get some idea of their worth. I married a Ph.D. beachcomber, who, for more than twenty years, has made me happy combing the beaches of our coasts from Canada to Mexico, on both oceans, and on Cuba, Hawaii, Jamaica and other areas. And while I have lugged heavy and smelly shells for her, I have also surreptitiously learned much of the real plants whose dried representatives so strongly gripped my interest late in 1913.

It is high time that I write the article I promised myself, because interest in marine algae is increasing tremendously, and there is little popular literature on the subject. In 1940, there was a single factory in the United States making one of the products of marine algae and producing, in that year, only 24,000 pounds. In 1945, there were four factories producing more than 200,000 pounds of the same substance. That alone should challenge the interest of

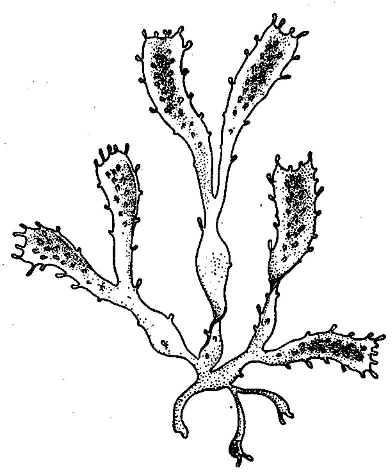
DULSE



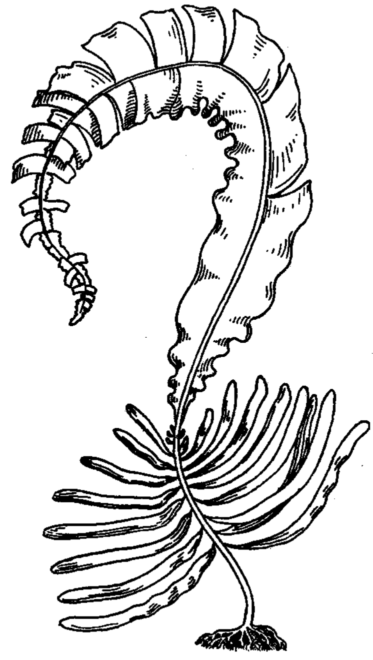
FAN KELP



PHYLLOPHORA



BATTERS



HENWARE

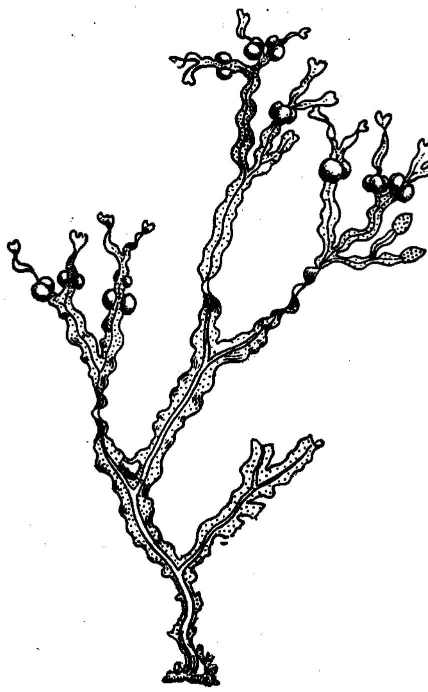
some readers. In normal times, Europe harvested some 400,000 tons of green seaweed, from which it got 175 tons of iodine, 10,000 tons of potassium salts, 3000 tons of crude salt, and 7000 tons of crude washing soda. On the other side of the globe, in Japan, seaweed culture had reached such a point that nearly a thousand acres of suitable water had been set aside for seaweed production, and the returns from this area had arisen from $156 an acre in 1901 to $300 an acre in 1938. The financial value of two standardized seaweed products in the United States in 1941 exceeded two million dollars at a time when the industry was operating on a much smaller scale than at present. The Chinese merchants of Hawaii alone imported, in one year, some 70,000 pounds of one seaweed product worth $12,000 before the war. So, from an economic basis alone, and on an international scale, the seaweed business is something on which the average citizen should be reasonably well informed. If we are going to force the Japanese, who are unquestionably ingenious, to live on four main islands, we may expect them to develop seaweed culture to a previously unimagined degree, if they are to survive. And whether we like them or not, we know that they are versatile and persistent. Who knows what their investigations may bring to light?

GULF WEED

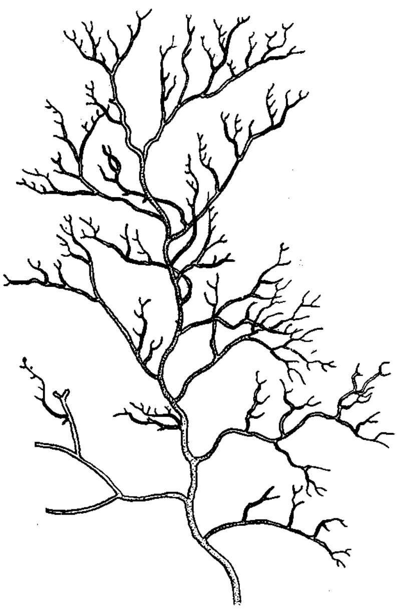
ROCKWEED

With the development of a new industry based on a previously undeveloped natural resource we may find ourselves face to face with some new conservation problems. A few generations ago we were told that the soil of the mid-West was inexhaustible; that the forests of the North would always yield in great abundance; that salmon from the Columbia would always be a major asset of the Northwest. Now, we are told of marine jungles that have not been touched, and that are so immense that they, too, are inexhaustible. But we know that they are confined to relatively limited areas where the depth and bottom are suitable, and we know practically nothing of the role they play in supplying basic food for many standard marine resources. What effect would the destruction of great seaweed beds have on fish, on seals, and on other marine resources? We do not know, because we have never had to face any such problem. We will have to face it in the relatively near future. These assets grow for the most part in areas at least partially remote from regions controlled by particular nations. Who is to say what nation shall have the right to harvest the resources, and who is to supervise the harvest so that a continued yield may be maintained? This may fall in the realm of politics, or of social science, but it will be real, nevertheless, and intelligent judgments can be passed only by those well informed on the facts. Since no one knows all the facts, we have a challenge to the research scientist, the teacher, the industrialist, and the politician or statesman.

But you may say that you are "too small punkins" to be interested in the great



BLADDER WRACK



CEYLON MOSS

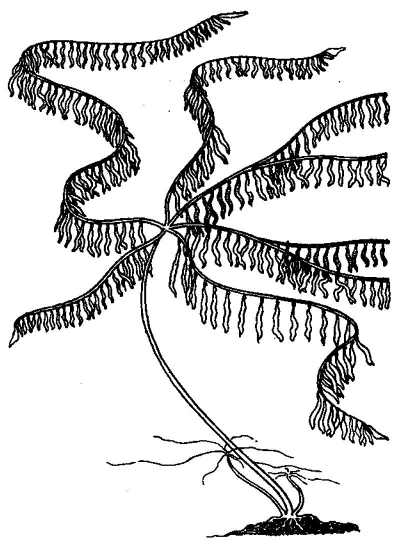
financial and international aspects of such a problem. Let us see if that is quite true. My most recent personal experience with marine algae dated to a few minutes before I began writing this article. It is a hot day and to clear the decks before beginning to write I dropped in at my favorite drug-store soda fountain with my head spinning as to how I should begin the article. As usual, I ordered a chocolate malted milk in spite of the fact that a young man to my right seemed to be enjoying a rather droopy looking cone of ice cream. On my left was a young lady looking into the mirror while she "fixed up her mouth" following her soda fountain spree. Down the aisle a few feet away, I heard a customer at the small prescription counter ask for some agar. And draped over the mirror behind the counter were some American flags, so well "sized" that they stuck out straight from their sticks, in spite of the fact that there was no wind to hold them in that position. I tell you this because every one of those observations was possibly associated with some seaweed, and I have mentioned only a few of the many relationships I recognized.

The chocolate in my malted milk did not settle immediately to the bottom of my glass because a colloidal substance from a seaweed was mixed in it and kept the chocolate in suspension until I had time to drink it. The ice-cream next to me did not melt on this hot day because mixed in it was a gelatin that might well have come from a seaweed. The lady who "fixed her mouth" after her soda may well have been using a rouge made from the seaweed *Dilsea.* In fact, a general name for cosmetics in England is "fucus," which happens to be the generic name for the common bladder wrack of so much of our coastline. The gentleman who ordered agar from the prescription counter (there really is one in this drug store) got a material extracted from seaweed. This agar has the ability to take up water and is not particularly digestible so it serves the purpose of lubricating an obstreperous alimentary canal without interfering with the diet. The little flags over the soda fountain counter may well have been "sized" with a gelatin from seaweeds. So, taking all things into consideration, seaweeds do play a rather important part in our lives.

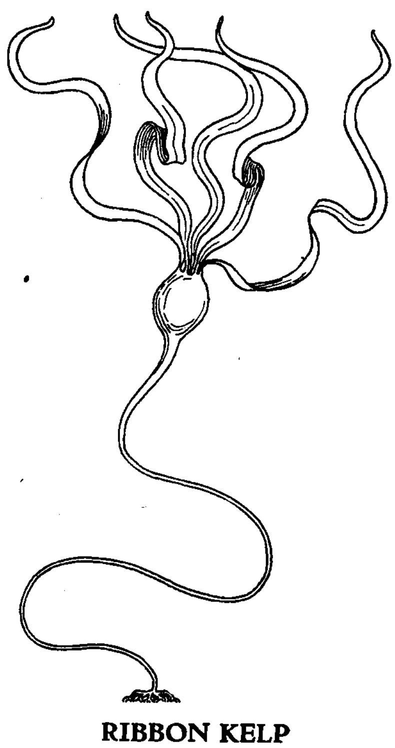
We might go on and list a few of the other every-day things we use or see or do that depend on seaweeds. My son once dropped a jack-knife into some hot water and was surprised to see its hard handle melt quickly into a jelly. This was because the handle was nothing more than a seaweed gelatin that melts at a relatively low temperature, but is hard and attractive at ordinary temperatures. Combs, some buttons, and a host of other commonplace things are made of seaweed gelatins.

One field of human interest that creates a demand for seaweeds is that associated with food. We like foods that look right. Soggy things do (Continued on page 88)

TENGUSA



VINE KELP



RIBBON KELP

COMMON NAME SCIENTIFIC NAME	SEA LETTUCE *Ulva lactuca*	SEA COLANDERS *Agarum cribrosum*	RIBBON KELP SEA-OTTER CABBAGE *Nereocystis lutkeana*	GIANT KELP VINE KELP *Macrocystis pyrifera*
DESCRIPTION	Length: to over 2 feet. Width: to over 6 inches. Broad, thin, with lobed, folded edges and thickest at base. Attached with inconspicuous holdfast. Bright green. Highly variable in shape, with related *U. latissima,* appearing as floating pale green sheets to 10 feet long and nearly as broad.	Blade: to over 9 feet long and 1 foot wide, abundantly perforated, heart-shaped at base when mature and with a medium midrib to 1½ inches wide at the base. Stalk: stout, cylindrical, to 2 inches long and 1/3 inch through. Blade unrolls from 2 cone-like scrolls and looks tattered. Holdfast: slender, spreading.	Length: probably not over 150 feet despite published reports of larger size. A single large globular float is developed at the end of the long flexible stem and at the base of the relatively few but long flat leaf-blades. Stem shows outer layer of colored cells around a storage area that surrounds a central pith.	Length: reported to 1,500 feet making it probably the longest plant in the world. Blades: bearing thin, wrinkled olive leaflets with egg-sized bladders at point of attachment. Stem: rarely over ¼ inch in diameter. Leaves: 2 to 4 feet long and 3 to 4 inches wide. Holdfast: branched; about 1 bushel.
CLASSIFICATION AND RANGE	Green alga (Chlorophyceae). Order Ulotrichales. Family Ulvaceae. Related *Monostroma* of single cell layer, with *Ulva* a double layer, and *Enteromorpha* with layers separated to make a hollow. *Ulva* on exposed rocks or wood from tropic Gulf of California to Alaska, and Gulf of Mexico to James Bay. Pacific Coast species, 13.	A brown alga (Phaeophyceae) Order Laminariales. Family Laminariaceae. Appears in closely related forms on Atlantic and Pacific Coasts. This species from Bering Sea to San Juan Island, Washington, with the related *A. fimbriatum* from Puget Sound to San Pedro. *A. cribrosum* from Massachusetts to Ellesmere Island.	Brown alga (Phaeophyceae). Order Laminariales. Family Laminariaceae. Found on our Pacific Coast and is definitely associated with rocky shoals and reefs, found in water from 10 to 100 feet deep but at its best where there are strong currents or heavy wave action. Found from Aleutians to California.	Brown alga (Phaeophyceae). Order Laminariales. Family Laminariaceae. Grows in water 20 to 70 feet deep, forming dense beds where conditions are right. Restricted to Pacific Coast from California to Alaska and on to Asia and Kamchatka. Bladder-supported leaves may float to surface.
REPRODUCTION	Some reproduction by fragmentation. Asexual reproduction through freeing 4 to 8 swimming spores from cell. Sexual reproduction by union of 2 similar swimming cells 8 of which come from a single cell. United cells germinate into irregularly thread-like plants that develop. Sporophyte stage differs from smaller-celled gametophyte stage.	Fruiting areas are irregular in shape and placement and appear darker and thicker than the regular vegetative tissues, usually more abundant near the midrib. Spore cases: in general elliptical in outline. Forms found growing in shallow water or tide pools are dwarfed in comparison with deep water plants.	Gamete-bearing cells are found in dense masses on certain parts of the plant. The freed gametes were formerly taken for zoospores or asexual spores but apparently they produce small plants that yield the regular sperms and eggs from which the huge plant develops after the egg is fertilized.	Named from the relatively large floats. Yields new plants in essentially the same manner as was described for *Laminaria.* Some areas may be well populated by fragmentation of the huge plants with the floats supporting the fragments where they may continue growth.
HABITAT	*Ulva* is chiefly marine but may occur in brackish water. Related *Enteromorpha* grows well on bottoms of river boats that alternate between fresh water and salt water. Some of the family grow in brine lakes where salinity is much higher than in the ocean. *Ulva* survives considerable temperature range.	The common name probably refers to the fact that the blade resembles the kitchen colander in its sieve-like appearance. Another common name, devil's apron, probably refers to the general apron-shape of the whole blade. The genus *Agarum* refers to the Malayan word agar-agar or "edible seaweed."	*Nereocystis* beds yield potash. Of the dry weight of the plant, about 25% is potassium chloride that at the outbreak of World War I was worth $40 a ton, but which has since found greater values. The plants have some value as food for cattle as well as for raw fertilizers.	Yields the phycocolloid algin, alginic acid and sodium alginate, ammonium alginate, calcium alginate and chromium alginate, also much potash and iodine. Of the whole plant, some .28% is iodine. Algin was first separated in 1883, sodium carbonate being used to digest the plant material.
RELATION TO MAN	*Ulva* may foul shores causing bad odor after storm. May be boiled and seasoned and eaten as green laver or green slack although as food it is vastly inferior to other algae here discussed. Apparently the commercial possibilities of sea lettuces have not been studied exhaustively.	While the plant no doubt has many of the uses recognized for its close relatives, literature does not frequently list it as a commercially valuable plant. It should be assumed from its generic name that it is edible and that it may be important as a source of agar agar.	The common names include bladder kelp and the scientific name refers to Nereis, the daughter of the sea god, Neptune. So closely are the plants associated with rocky reefs that fishermen and sailors using shallow-draft boats recognize them as important navigation guides.	Is harvested commercially in California. In 1941, there were four United States concerns that produced $1,500,000 worth of algin from *Macrocystis* and *Laminaria,* while a few years earlier none was produced on an extensive commercial basis.

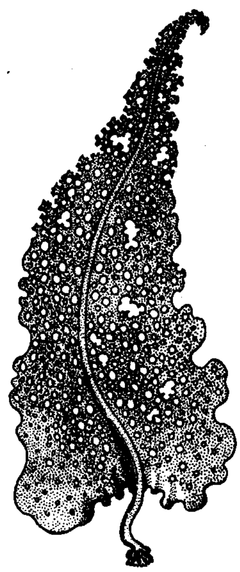
HENWARE BADDERLOCKS *Alaria esculenta*	FAN KELP *Laminaria digitata*	ROCKWEED *Ascophyllum nodosum*	BLADDER WRACK ROCKWEED *Fucus vesiculosus*	GULFWEED *Sargassum filipendula*
Blade: broad, leathery, to 10 feet long and 10 inches wide, with small, lateral, wing-like leaflets below the broad, terminal blade, the leaflets being without midribs. Blade commonly with wavy margins torn and broken to the midrib. Stem: compressed, to 1 foot long and ½ inch wide. Holdfast: branched and rather elaborate.	Blade: of to 30 or more fingerlike segments each to 3 or 4 feet long or shorter and growing from a common point or expanded area at the end of a stout stalk that is to 5 feet long, flattened above and in section 5 feet long, flattened above and in section showing concentric growth rings but no mucilage ducts. Holdfast: fibrous.	Length: to nearly 10 feet but usually much smaller. Erect from a disc - shaped holdfast. Main stem and main branches: flattened, with egg-shaped air - filled bladders to over an inch long and 2/3 as wide, with usually but one to a branch. With flattened, club-shaped branches to an inch long, solitary or grouped.	Length of sprays: to 2 feet, with distinct midrib through all of the branches, rather regularly forked, flattened, olive green, with swollen bladderlike structures filled with gelatin. Fronds: tough, flexible, leathery. Holdfasts: branching, rootlike, leathery, with suckerlike ends.	Length: to nearly 1 yard. Erect, with main stems smooth, sparingly forked and bearing alternate, stalked leaves that are to 3 or 4 inches long and 1/3 inch wide, thin and sometimes forked but usually with saw-tooth edges. Stems also bear spurs that end in bladders that are to 1/5 inch in diameter. Holdfast: conical, spreading, lobed.
Brown alga (Phaeophyceae). Order Laminariales. Family Laminariaceae. Differs from *Laminaria* in possession of midrib in blade. Essentially northern. Commonest on exposed rocky coasts below tide levels. From Long Island north to Hudson Bay and Newfoundland. Nine Pacific Coast species from California to Alaska.	Brown alga (Phaeophyceae). Order Laminariales. Family Laminariaceae. At least 10 species on Pacific Coast of United States with *L. sinclairii* found from Vancouver Island to Obispo County, California. *L. digitata* ranges from Staten Island to Hudson Bay, Nova Scotia and New Brunswick, most commonly on exposed rocky bottom below lowtide levels.	Brown alga (Phaeophyceae). Order Fucales. Family Fucaceae. Commonly found growing with *Fucus* on rocky coasts or on rocks emerging from muddy bottoms below the tide levels. Ranges from New Jersey to Newfoundland and Baffin Island, Labrador and Cumberland Sound. Also in Bermuda.	Brown alga (Phaeophyceae). Order Fucales. Family Fucaceae. One of the world's most widely distributed plants, being found in the Arctic and temperate oceans of the world but this species not found much south of New York on our Atlantic Coast, although it appears from North Carolina to Newfoundland and Baffin Bay.	Brown alga (Phaeophyceae). Order Fucales. Family Fucaceae. This species grows attached to shells and stones in relatively quiet water from lowtide level to 100 feet deep. There are some 150 species of *Sargassum* in the world mostly about Australia and Japan and 17 on Pacific United States. This species, Florida to Nantucket.
Perennial, but each year blade is replaced by new growth. Ordinary plant seen is sporophyte or spore-producing, the sexual plants being microscopic and bearing either male or female sex organs with the female filaments being the simpler and usually bearing one terminal egg that on being fertilized develops into the sporophyte.	Perennial. The asexual zoospores and the sexual gametes are essentially alike. For some time it was not believed that sexual reproduction took place in *Laminaria* but this is now well established, the male and female sex cells being essentially alike.	In reproduction, the branchlets change into or are replaced by the sexual reproductive tissues that are either male or female, are yellowish, which drop from the main plant in spring following the winter's fruiting, and are replaced by new branchlets. The eggs and sperms are different in size and 4 eggs are in each egg sac.	Apparently there are no asexual spores produced. Sexual reproduction results from union of sperms and eggs produced on different plants from autumn to spring in the southern part of the range. Male receptacles are reddish when opened while the females are olive green but both are near branching tips.	Probably perennial, bearing fruit at maturity that arise from union of different sized sex cells with but one egg to an egg cell. Fruiting bodies are cylindrical and more or less forked. *S. fluitans* and *S. natans* of our Atlantic seas reproduce only by fragmentation, no fruiting bodies being known.
Named *Alaria* from the Latin "ala" meaning wing and referring to the wing-like leaflets below the blade. The sporophylls that bear the spores that take part in asexual reproduction are shed annually. Sporangia are borne on the margins of the sporophylls. The sexual plants do not resemble each other closely.	Named from Latin "lamina" meaning leaf or blade. Yields phycocolloid laminarin, a reserve carbohydrate, and fucoidin, a water soluble carbohydrate of no recognized commercial value. Rich in iodine, which constitutes .49% of whole plant; also considered high in certain vitamins and minerals.	In quiet water, these plants are more slender than in rough water. It occurs in salt marshes and in brackish water entangled with other plants or poorly attached to shells and other such objects. The plants appear as if made of cartilage. The broken or shed fruiting branches often are found in great numbers.	Yields the phycocolloid fucoidin, a polysaccharide first extracted by Kylin from *Fucus* and *Laminaria* in 1913. Like laminarin it as yet has no well established commercial value. It probably occurs in nature as a calcium salt and on hydrolysis it gives rise to fucose. Because of mucilage, plants do not dry quickly.	Name comes from the Spanish "sargazo" meaning floating seaweed. The traditional South Atlantic Sargasso Sea is not composed primarily of *Sargassum*. This sea, famous as dead spot in days of sailing, lies between lat. 25°-31° N. and long. 40°-70° W. Yields the phycocolloid algin, alginic acid and alginates of sodium ammonia, calcium and chromium.
Yields the food known as "kombu" from the northernmost Japanese Islands where it is used with meats and sauces or poured over rice or used as tea. Is eaten in Iceland and in Scotland and in Ireland and is known as henware, murlins, badderlocks and daberlocks in these areas.	In 1941, four United States concerns made $1,500,000 worth of algin from *Laminaria* and *Macrocystis*. Japanese who eat it are free of goiter. Dried known as "kombu"; shredded and dyed green, as "ao"; crisped over fire, as "hoira kimbu," with sugar icing, as "kwashi." Tons harvested in Japan and Russia for fertilizer.	Of little or no economic importance so far as the literature is concerned, although it is possible that it has some value as fertilizer. The plant turns black on drying, has larger air chambers than *Fucus* and is in general tougher than *Fucus*, as might be indicated by its larger size.	Plants are collected by seashore farmers and spread on the ground for use as fertilizer. Has some value as a source of iodine and at one time was an important source of commercial potash. A medicine used in curing obesity has been taken from *Fucus* and it has been used to some extent in the making of cosmetics.	Japanese fishermen eat the tender tips of the floating plants of their region. Because of relatively small size of this species it is not likely to be of great commercial value compared with other algin producers such as *Laminaria* and *Macrocystis* and similar plants.

COMMON NAME SCIENTIFIC NAME	LAVER *Porphyra umbilicalis*	TENGUSA *Gelidium corneum*	CEYLON MOSS *Gracilaria confervoides*	PHYLLOPHORA *Phyllophora membranifolia*
DESCRIPTION	When young, narrow, but when mature like a broad, somewhat elastic membrane, fragile, often only one cell in thickness, purple to olive to brownish purple, but always with a smooth, satiny sheen. Attached by a small obscure holdfast at the center. Edges frilled or wavy in appearance. Whole plant appears slippery.	Frond: flat and horny, to 4 inches high, narrow, erect, branching in one plane being 2 to 3 times pinnate and with sections composed of somewhat compressed cylinders. Very variable in shape, size and color, being red to reddish brown, to purplish red and when exposed becomes a dirty white. Tip of the branchlets are club-shaped.	Frond: bushy, arising from a disc-like holdfast that frequently breaks, freeing the whole plant. Branches: to .1 inch in diameter dividing repeatedly and variously but not so conspicuously evenly as in some close relatives. Firm and fleshy and tapering to fine tips at the free ends. Dull purple red to purple, to green.	Fronds: to 20 inches long but usually shorter, with short stubby, wedge-shaped, forked or cleft branches each under an inch long. Several fronds arise from a single disc-shaped holdfast, sometimes as many as 20 arising from a single disc. Like a firm membrane that is dull purple or clear red but with some brighter areas.
CLASSIFICATION AND RANGE	Red alga (Rhodophyceae). Order Bangiales. Family Bangiaceae. On rocks or piling from the low-tide to mid-tide lines. This species from New Jersey to Hudson Bay and Newfoundland; closely related forms are in both hemispheres from Polar regions to Mediterranean, Australia, Tasmania, Cape Horn, and Cape of Good Hope.	Red alga (Rhodophyceae). Order Gelidiales. Family Gelidiaceae. The Atlantic Coast species is *G. crinale,* which reaches a height of 3 inches while the West Coast *C. corneum* is an inch higher. Grows in tufts on mud-covered rocks and on other algae. Most abundant on West Coast from California to Baja California, Mexico.	Red alga (Rhodophyceae). Order Gigartinales. Family Gracilariaceae. This species in shallow, warm, quiet bays attached or loose near bottom from the tropics and Florida to Prince Edward Island. *G. multipartita* or *G. foliifera* is much branched and found on both coasts. Other relatives in Africa, Australia, Britain.	Red alga (Rhodophyceae). Order Gigartinales. Family Phyllophoraceae. Found commonly growing on stones in shallow tidal pools or in water several feet deep, but mostly in warmer waters. This species ranges from New Jersey to New Brunswick, Prince Edward Island and Cumberland Sound.
REPRODUCTION	Asexual reproduction by means of spores freed to swim from rather large continuous areas of the blade. Sexual spores freed from plants that may be either male or female or both; in the latter case, the male and female portions being generally separated, with the males coming from a marginal band, and the females from over the surface.	Asexual spore cases are found in the surface of rather special areas or on special branches. Sexual plants are like those bearing asexual spores in general, with the male elements produced from the surface of considerable areas, and the female borne on inner tissues and spread through the general nutritive tissue.	Asexual spores borne in structures scattered over the branchlets, these structures being oval in shape and developed definitely from surface cells. Male element also produced from surface cells. Female element borne on structures on special branches but after fertilization these develop into conspicuous numerous hemispheres.	Asexual spores produced in rather large, slightly raised spots near the bases of the blades with surrounding cells obviously radiating. Male element produced on small, brightly colored blades and attached to the edges of these blades. Female element borne in stalked structures attached usually to stem.
HABITAT	An annual plant that may be found at almost any time of the year. The name is derived from a word meaning purple dye. The pressed plant does not adhere to paper when dry. Used in England as food as "laver"; in Ireland as "slack", in Hawaii as "limu," and in Japan as "amanori" or "amori." Boiled and eaten with lemon juice, spice or butter.	Yields agar (gelose), a phycocolloid, agarinic acid, and the salts sodium agarinate, potassium agarinate, calcium agarinate and magnesium agarinate. In Japan the species of most importance has been *G. amansii.* Gelidium agar in 1% water solution sets at 35°-50° C. to form firm gel and melts at 80° to 100° C.	In the New England area, the plant is crisply bushy. Yields gracilaria agar, agarinic acid, and the salts sodium agarinate, potassium agarinate, calcium agarinate and magnesium agarinate. *Gracilaria* was the original source of commercial agar whose uses have been discussed elsewhere in this section.	A perennial plant. Found throughout the year but commonly fruiting in autumn and winter. Yields an agaroid that is possibly a kind of agar though it apparently has not been studied exhaustively or put into much commercial use in the United States. At least three species represented on our Atlantic Coast.
RELATION TO MAN	Chinese grocers in Hawaii have imported in a year 70,000 pounds of laver worth about $12,000. Japanese cultivate nearly a thousand acres by thrusting in bamboo bundles on which algae grow to be harvested in 3 to 4 months. In 1901, such plantations yielded $156 an acre, but now yield as much as $300 an acre.	Probably the most important of all the agarophytes as source of agar necessary for bacteriological work, as medicine to relieve constipation, as food in form of jellies, soups, sauces and desserts. Gives rigidity to soft canned fish improving marketability after shipping. Known as "kauten" and "Oriental isinglass."	*Gracilaria* is the chief commercial source of agar produced in the vicinity of Beaufort, North Carolina, and no doubt figures in commercial activities elsewhere. It is used in bacteriological work, in dental impressions, in health foods and in baking. In 1940, one U. S. agar factory produced 24,000 pounds; in 1945, 4 produced 200,000 pounds.	From Odessa and the Black Sea it is reported that a species close to ours yields a kind of agar, but as to any further commercial use we are not informed.

IRISH MOSS CARRAGEEN *Chondrus crispus*	BATTERS *Gigartina stellata*	DULSE *Rhodymenia palmata*	CHENILLE-WEED *Dasya pedicellata*	POLYSIPHONIA *Polysiphonia fibrillosa*
Fronds: to about 6 inches high, arising in clumps from a disc-like holdfast with flattened stems that divide and subdivide to form rather broad fans there being 5 or 6 subdivisions and the divisions taking place when the stems are about 1/8 to 1/2 inch wide. Stems: thick, tough, leathery, olive to dark purple to jet black.	Fronds: from 6 inches high to 2 inches broad, in thin, flat, gelatinous, leathery, wavy, wedge-shaped divisions that fork at the base only to subdivide again in the same plane at a high level. Unlike Irish moss has tufted protuberances on the concave side of the fronds. Dark purple to black and rigid when dried.	Frond: to nearly 2 feet long, with an inconspicuous stalk arising from a small disc-like holdfast and bearing blades that break into two or more divisions with the forks to 6 inches wide but usually narrower. Like leathery membranes that are purple or red in color. Frequently shows numerous smaller fronds near base.	Fronds: to 10 feet long, with the cylindrical stem covered with fine hairs that give the whole plant a velvety appearance. Stems: long and sinuous rather than bushy, with branches sparingly divided. Color: elegant "lake red" or pink, but when taken out of water appears like strings of purple jelly in masses.	Fronds: to 10 inches or slightly more long, appearing like pinkish or reddish, slippery "worms" hanging attached to exposed rocks at low tide or erect or weakly floating in shallow water. Profusely and irregularly branched, coarse at the base but fine at the tips. Light or dark brownish red to black.
Red alga (Rhodophyceae). Order Gigartinales. Family Gigartinaceae. Most abundant on our Atlantic Coast from Maine to Carolina but also common on to Newfoundland growing throughout the year on wood, shells and rocks from mid-tide line to considerable depth. Does well in highly varied environments.	Red alga (Rhodophyceae). Order Gigartinales. Family Gigartinaceae. Common in the tropics and from Massachusetts north to Nova Scotia and Newfoundland, growing with Spanish moss in shallow tide pools, on exposed rocky shores but always rather near low-water mark. Found at any time of the year.	Red alga (Rhodophyceae). Order Rhodymeniales. Family Rhodymeniaceae. Found from the mid-tide zone to deep water but in the southern part of the range restricted to the deeper water. This species ranges from New Jersey to Baffin Bay and Ellesmere Island and in Europe is found south to the Mediterranean.	Red alga (Rhodophyceae). Order Ceramiales. Family Dasyaceae. Found just below the low-tide mark usually in protected waters where the tide flows. This species ranges from Florida to Nantucket and extends on south into the tropics. It is rather abundant in the New York Bay area.	Red alga (Rhodophyceae). Order Ceramiales. Family Rhodomeliaceae. Over a hundred species found both on our Atlantic and our Pacific coasts, most commonly seen on stones and vegetation in shallow water but may be found in deep water as well. Not an abundant alga and in some New England areas is rare. New Jersey to New Brunswick.
Asexual spores produced in obvious cases formed below the surface of the tissue. Male elements borne in obvious cases on the surface of young branches with the female elements borne on other branches from the inner surface with the fruiting bodies to .1 inch across and swollen laterally.	A perennial. Asexual spores borne from immersed, irregular cases of the inner surface. Male elements appear from cases in terminal, closely branched stems and from surface cells. Female elements borne in special crowded clumps or branches and from areas under the surface and when fertilized develop into fleshy units.	Asexual spores are produced in scattered cases that appear as darker spots on the blade and are also indicated by a thickening of outer layer. These structures appear in winter season. In this species, no true sexual reproduction seems to have been discovered. Related species have a sexual reproduction that results in a swollen fruit with a loose case.	Fruits from midsummer to autumn. Individual plants produce either asexual spores or the male element or the female element. The asexual spores are borne in distinctive curved structures. The male cells are slender, pointed and usually filament tipped. The egg bearing units are usually stalked and .1 inch through.	Asexual reproduction through spores borne on somewhat spirally distorted branchlets. Male elements borne in spindle-shaped structures at the ends of the branchlets. Female elements borne in short-stalked, egg-shaped or spherical structures and forming a relatively large fruiting structure. Fruits in summer.
Fruiting occurs during the summer with the asexual activity more common in late autumn. Color varies from pale in shallow pools to purple in deep pools to iridescent in the sun. Named from Greek meaning cartilage. Extracted carrageen in 3% water solution gels at 27°-30° C.; and in 5% solution at 40°-41° C. Ash, 20%.	Fruiting takes place in winter. Dried plants do not adhere to mounting paper. Yields the phycocolloid, carrageenin and carrageenic acid and the salts, potassium carrageenate and calcium carrageenate and with Irish moss is the principal source of these materials. Known as the polysaccharide carrageenic extract.	When dried this plant has a faint odor of violets. It is eaten in widely separated parts of the world. Icelanders dry it, make a flour of it, eat it raw or boil it in milk. Scots use it for chewing tobacco, as a relish, for medicine, or boiled in milk as food. Irish know it as "dillesk," boil it in milk, chew it and eat it with fish.	The plant sticks to paper well when mounted as an herbarium specimen but because of its delicate nature should be subject only to light pressure. It is considered a good late autumn alga and in the Woods Hole area is obvious as late as October. *Dasya* means hairy and the name is appropriate for this plant.	This is a summer annual that favors or rather does best in warm bays. The genus is represented by many species of which approximately a dozen are found along our Atlantic Coast and in which the differences are rather obvious and based on type of branching, stoutness and types of fruiting areas.
Of the water-free matter, 65% is gelatin. Used in making gloss soaps, jellies, puddings, cosmetics, shaving soap, shoe polish, curing leather, sizing cloth and blanc mange pudding. Industry centers at Scituate, Massachusetts. Yields phycocolloid, carrageenin. In 1944, industry in United States yielded about $500,000.	Carrageenin from *Gigartina* and *Chondrus* has a higher ash content (20%) than agar and requires 3% rather than 1% concentration in water to gel. It gels at a lower temperature than agar. In 1944, three United States firms produced $500,000 worth of carrageenin in a standardized form.	In time of famine in Ireland, dulse and potatoes formed a diet that saved this important part of the world's population. In Norway, it is known as "sheep's-weed" because sheep are extremely fond of it, and seek it when it is exposed at low tide.	Apparently there is no obvious economic value to be attached to this plant unless one recognizes the beauty it certainly adds to what might otherwise be an uninteresting bit of environment. It is probably good for some marine animals and provides them with some shelter from their enemies.	Apparently there is little economic importance that can be attached to this rather beautiful red alga. It merely helps make a tidal area look as we think such a region should be. Mounted on paper a peculiar "mist" appears to surround the plant probably because of fine hair-like coverings not obvious otherwise.

(Continued from page 83) not have an appeal, so bakers and cooks use seaweed gelatins to put some "backbone" and some glossy appearance on certain foods they offer for sale. These materials may not improve the nutritive quality of what they sell, but they certainly improve their marketability. We cannot dismiss these substances with the idea that they have no food value, however, but we should not accept them as substitutes for certain essential foods. Let us look at a few of these.

SEA LETTUCE



SEA COLANDERS

Goiter is practically unknown to the Japanese, who use many seaweeds in their diets. This is explained by the fact that seaweeds are usually high in iodine content, and iodine helps prevent goiter. Apparently we can get our iodine through eggs or milk from poultry or cows that have been fed certain seaweeds. In this sense we can truthfully say that these plants may constitute a health food. There is no doubt that they are relatively high in such minerals as iron, calcium, sodium, phosphorus, potassium, manganese, aluminum, copper, zinc and chlorine, and some of these may be in a usable form. They also yield vitamins A, B, D, and E, often in attractive forms. Ordinarily, we do not expect these plants to yield energy-producing foods, but that need not disparage their value.

The biochemists have classified some of the substances they extract from seaweeds. Among the more important of these are the following: Agar is important largely for bacteriological work as a culture medium that has a low ash content, produces a firm gel in a 1 to 2 per cent aqueous solution, is soluble in hot water but not in cold, melts at convenient temperatures, and, as a gel, is practically transparent. It also finds a place in health foods and in baker's products.

Carrageenin from Irish moss has a higher ash content than agar and a different melting point. It gels at a different point, but it is excellent in certain soups and jellies, and it is the substance that kept the chocolate in my malted milk in suspension. It finds a place in some kinds of soaps.

Algin was first extracted from seaweeds in 1883 by digesting the weed with sodium carbonate. In 1941, it was the basis of a half-million dollar United States industry, and it kept my neighbor's ice cream cone from drooling over him on a hot day, in all probability. Other substances would include funorin, from a Japanese seaweed that figures largely in the sizing they used for cheap textiles. It would include iridophycin from a California seaweed, laminarin from a weed off our Northwest coast, and a number of others, many of which are treated in greater detail in the tables accompanying this section. Not all of these are gel-formers, and most of them are not as yet completely understood. Few apparently are thoroughly appreciated.

And still we have said nothing of the material most botany texts give us on these plants. Since the texts say much we will here say little, and try to keep that intelligible to the lay reader. Enough is given in the tables to show how highly varied the plants are in structure, appearance, growth habit and in reproduction, but it must be recognized that here we have only slightly scratched the surface. Possibly we can be criticized here for the meagre amount of orthodox morphology and phyllogeny we have given, but, if so, we can be equally critical of the small amount of material on the uses of these plants that appears in the texts. We are forced to neglect consideration of the emotional effect one gets when getting tangled in seaweed while swimming, or the fun of exploring weed beds with a glass-bottomed observation box. Some of these ideas will be considered later in this series.

Since we cannot do justice to this whole subject we can only hope that some readers will wish to explore seaweeds on their own. These kindred spirits will find a number of books and pamphlets that will be useful. Some are out of print and must be consulted in a library. Important among the books are the following:

Augusta Foote Arnold. *The Sea-beach at Ebb-tide.* The Century Company, New York. 1903.

John Merle Coulter, Charles Reid Barnes and Henry Chandler Cowles. *A Textbook of Botany.* The American Book Company, New York. 1910.

Nathaniel Lyon Gardner. *The Genus Fucus on the Pacific Coast of North America.* University of California Publication, Volume X. 1922-24.

A. B. Hervey. *Sea Mosses.* Estes and Lauriat, Boston. 1881.

Albert F. Hill. *Economic Botany.* McGraw-Hill Book Company, New York. 1937.

C. J. Hylander. *The World of Plant Life.* The Macmillan Company, New York. 1939.

George Murray. *An Introduction to the Study of Seaweeds.* The Macmillan Company, New York. 1895.

William Albert Setchell and Nathaniel Lyon Gardner. *Marine Algae of the Pacific Coast of North America. Parts I, II and III.* University of California Press. 1919-20 and 1925.

Gilbert M. Smith. *The Fresh-water Algae of the United States.* McGraw-Hill Book Company, New York. 1933.

William Randolph Taylor. *Marine Algae of the Northeastern Coast of North America.* University of Michigan Press, Ann Arbor, Michigan. 1937.

Lewis Hanford Tiffany. *Algae, the Grass of Many Waters.* Charles C. Thomas, Springfield, Illinois. 1938.

C. K. Tseng. *The Terminology of Seawood Colloids.* "Science," June 15, 1945.

Josephine E. Tilden. *The Algae and Their Life Relations.* The University of Minnesota Press, Minneapolis, Minnesota. 1935. An outstanding book on the sea weeds and one any student will wish to possess.