



Saved by seaweeds (II): Traditional knowledge, home remedies, medicine, surgery, and pharmacopoeia

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Abstract

Humankind has known the benefits of seaweeds since time immemorial. A number of these applications were likely passed down in the oral histories particularly of coastal dwellers and those using different seaweeds as food and treatments for common ailments. The beneficial use of many types of seaweeds was reported and recorded into some of the first written medical texts. The common benefits of these seaweed concoctions and applications seems to be linked to the presence of hydrocolloids and the various bioactive compounds. We believe this collation brings together, for the first time to our knowledge, a number of excerpts from major medical publications and esteemed writers of the day. It provides a rich background supporting the positive applications of various seaweeds to a multitude of human ailments, from skin to bowel, inside and out and many of the places in between!

Keywords Seaweeds · Folk medicine · Diseases · Oral history

“Those innocent plants ask for nothing more than to nourish or to heal animality. Many of them, the Laminaires, for instance, contain a luscious sugar; and others, as, for instance, the Corsican or Irish Moss, have a health-restoring bitter; and all, without exception, contain a concentrated and most nourishing mucilage, not a few of them saviors to the weak, worn, perishing lungs of presumptuous and ungrateful man. Where we

now exhibit iodine, the English formerly used nothing but a confection of that same Corsican, or Irish, Moss.”

J. Michelet (1798–1874).
Le mer [The Sea] (1861).

“Juana gathered some brown seaweed and made a flat damp poultice of it, and this she applied to the baby’s swollen shoulder [he was stung by a scorpion], which was as good a remedy as any and probably better than the doctor could have done. But the remedy lacked his authority because it was simple and didn’t cost anything.”

John Steinbeck (1902–1968).
The Pearl (1947).

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Introduction

Seaweeds, once defined as creatures *ruda et confusa* (together with fungi and ferns) by the German Botanist von Zalusian (1592) (South and Whittick 1987), are a diverse group of organisms with over 12,000 recorded species that currently inhabit most of the world’s coastal environments (Van den Hoek et al. 1995; Mouritsen 2013; Pérez-Lloréns et al. 2018). Since time immemorial, although to a lesser extent compared to terrestrial plants, various and selected

specific, seaweeds have been foraged and harvested by many coastal inhabitants around the world (e.g., in Chile [14,000 BCE], Japan [13,000 BCE], China [2,700 BCE], Egypt [1,550 BCE], and India [300 BCE]). These marine organisms are integral to traditional, as well as home remedies and folk medicines for the treatment of various prevailing ailments and diseases (Chapman 1950; Schwimmer and Schwimmer 1955; Unschuld 1986; Abdussalam 1990; Abbott 1996; Dillehay et al. 2008; Anggadiredja 2009; Shelar et al. 2012; Pereira 2018a; Dumilag et al. 2022). The use of seaweeds for these purposes adds to the long list of instances where humankind via interaction with seaweeds has been “saved by seaweeds”, e.g., when dealing with crises, conflicts, war, famine, nuclear accidents, unemployment, climate effects, pollution, food supplies, and sustainable eating behavior (Mouritsen et al. 2021).

The earliest known archaeological evidence of the use of seaweeds in food and medicine is dated to ca. 14,000–12,000 BCE from Monte Verde (Chile) where remains of several types of seaweeds were discovered in a midden (Dillehay et al. 2008). However, the first written reference to the healing powers of seaweeds is found in the *Epic of Gilgamesh*, sometimes called “the world’s oldest epic”, written about 2,100 BCE in Mesopotamia. In this yarn the demigod hero-gilgamesh dived to the bottom of the sea to find a life-giving seaweed with stinging spines (stolen by a sea serpent) that had the power to rejuvenate whoever ate it (Freemon 2011; O’Connor 2017).

Traditional seaweed-based treatments and remedies were instinctive as the result of the empirical knowledge transmitted orally amongst coastal dwelling peoples, from generation to generation. Some of this therapeutic knowledge about remedies (derived mostly from terrestrial plants, animals, fungi, and minerals, but also to a lesser extent from various seaweeds) was collected together in several texts called “Materia Medica” such as *Corpus Hippocraticum* (Hippocrates and allies, 600–200 BCE, Greece), *Enquiry into Plants* (Theophrastus, ca. 370–285 BCE, Greece), *De Materia Medica* (Dioscorides, 1st century CE, Greece), *Shennong Bencaojing* (The Classic of Herbal Medicine, ca. 200–245 CE, China), the *Bower Manuscript* (by Buddhist monks, ca. 600 CE, India) or *al-Qanun fi al-Tibb* (Canon of Medicine by Ibn Sina, 980–1037 CE, Persia) (Urdang 1951; Unschuld 1986; Petrovska 2012; Leonti and Verpoorte 2017; Tabajara et al. 2019; Yavuz 2023).

Today, the therapeutic potential of a diet including specific seaweeds (curiously overlooked as part of the future planetary diet described in the EAT-Lancet Commission report by Willett et al. (2019) as well as their naturally bioactive substances, i.e., the so-called “seaweed pharmacognosy” (Shah and Seth 2010), are in many respects accepted in modern medicine, and various types of seaweed-derived extracts are used in the elaboration of medicines

(or pharmacopoeia), the preparation of cosmetics, and therapeutic baths (Shelar et al. 2012; Pereira 2015; 2018a, b). Still, very few scientific studies have been performed quantitatively demonstrating the healing power of whole seaweeds, whereas there is ample evidence that a wide range of the many specific compounds found in seaweeds do have therapeutic and medicinal effects. This review does not focus on the use of bioactive compounds derived from seaweeds in modern medicine and pharmacopoeia as it has been extensively addressed (e.g., Yuan 2008; Shah and Seth 2010; Fleurence and Levine 2016; Pereira 2018a, b; Qin 2018; Grabacki et al. 2023). Rather this paper focuses on the ancient and traditional uses of multiple seaweed species in folk medicine, surgery, pharmacopoeia, and home remedies in different cultures from around the world, documenting some of them as excerpts from classical books, i.e., not easily found by on-line search engines.

Asian countries

The use of seaweeds as foods and traditional medicines by inhabitants of Asian coastlines was an ancient philosophy and teaching which placed disease prevention by way of a healthy diet ahead of the treatment of various diseases by means of drugs (Tseng and Zhang 1984; Hsu et al. 1986; Oh et al. 1991; Yuan 2008; Lin et al. 2011; Collins et al. 2016). In this regard, the health benefits of seaweeds were recognized in ancient Chinese books on herbal medicine such as *Chinese Herbs* (attributed to Emperor Shen Nung in the year 2,700 BCE), *Supplementary Records of Famous Physicians* (by Tao Hongjing, 456–536 CE), *Arcane Medical Essentials from the Imperial Library* (compiled by Tao Wang 670–755 CE), or the *Compendium of Materia Medica* (Li Shizhen, 1518–1539 CE) (Simmonds 1893; Hsu et al. 1986; Oshima 2013; Qin 2018). These treatises on human health recommended eating the specified seaweeds, e.g., raw (in salads); in decoctions, ground into pulp or powder to make tablets; mixed with honey and molded into large tablets to be sucked like candy; or to produce a kind of medicinal wine (Hsu et al. 1986). The *Compendium of Materia Medica* describes an alga as follows (Chapman 1950):

“The whole plant is officinal. Taste bitter and salt. Nature cold. Non-poisonous. It grows in Tung hai [Shantung] in ponds and marshes. It is gathered on the seventh day of the seven month and dried in the sun.”

The Chinese are perhaps the people in Asia who have the most extended use of selected seaweeds traditionally in their medications for human ailments. Amongst the most utilized brown seaweed species by Chinese can be mentioned *Sargassum fusiforme* (Yang Xi Cai), *Sargassum fulvellum* (Wu Lei Ma Wei Zao), *Sargassum henslowianum* (Heng Shi Ma

Wei Zao), *Sargassum thunbergii* (Shu Wei Zao), *Sargassum horneri* (Tong Zao), *Saccharina japonica* (Hǎidài), *Laminaria digitata* (Hǎidài), *Ecklonia kurome* (Kūnbù), *Fucus vesiculosus*, and *Undaria pinnatifida*. Most of these species are a good source of iodine and were mainly prescribed to remedy certain thyroid affections such as goitre. Other common ailments traditionally treated were boils, fever, urination problems, dropsy, lumps, scrofula, haemorrhoids, edema, orchitis, inflammations, etc. cf. Table 1 (Dudgeon 1874; Chengkui and Junfu 1984; Cho et al. 2007; Kandale et al. 2011; Liu et al. 2012; Oshima 2013; Vonthron-Sénécheau 2016). Dudgeon (1874) refers to several therapeutic properties of some Chinese brown seaweeds and the ways of administration:

“This same Herbal [*Compendium of Materia Medica*] mentions various species of seaweed as possessing strong and well-known therapeutic properties, and of special value in the dispersion of hard tumours-goitre, for example. They have long been acquainted with the general virtues of the various species of *Laminaria*, and these varieties are mentioned as occurring along the coasts of the Eastern Sea, the coast of Corea, and the Malayan Archipelago. The great Herbal speaks of seven chief species. The people in the maritime provinces of China eat seaweed plentifully, both medicinally and as a vegetable food, besides using it as a manure; in this custom resembling the inhabitants of our own Hebrides. It is prescribed alone, chiefly in the form of tincture, its saltish taste having been first washed away, or it is mixed up with other medicines in various prescriptions. Chinese books speak in the most positive manner of the discutient properties of seaweed. Of one sort, it is said that tumours as hard as stones can be softened and removed by it. The uses to which the various kinds of seaweed are put correspond with our own uses before the discovery of iodine. It is prescribed also as a diuretic, and its efficacy in demonology is highly extolled (the Chinese in medicine, as in everything else, unite sober fact with childish fable, science with sorcery). It is especially recommended in enlarged testicle and in all sorts of hard, cold, chronic tumours that never suppurate. It is said to cause penile erection. In glandular swellings it is ordered to be sucked or chewed.”

Korean culture attaches great symbolic significance to *Undaria pinnatifida* (Miyeok or Heche) (Kang 1968). This species is prepared for the goddess of childbirth and is well-known as food among nursing Korean mothers. The dried seaweed is offered to the goddess with rice, water, and a thread for four weeks, and people pray every day for the longevity of the baby and the health of the

mother. Almost all Korean women eat it in soup (Miyeok Guk) for one month after childbirth; it is believed that *U. pinnatifida* improves breast milk because it contains a lot of calcium and iodine, which are necessary for the mother's body. It is also very traditional to eat this soup at birthday celebrations as a reminder of the first nourishment that passed from mother to child through the milk, thus attracting good luck for the rest of the year (Sunoo 2006). This species has been also used in Asian countries to treat stomach pain, haemorrhoids, anal fistulas, leucorrhoea, urinary diseases and dropsy (Tseng and Zhang 1984; Oh et al. 1991).

Red seaweeds have also been widely used in traditional Asian pharmacopoeia, medicine, and home remedies. Among the most commonly used genera are the agarophyte *Gracilaria* (to treat goitre, edema, urinary infections, chronic constipation, tuberculosis, testicular swelling, and to prevent ulcers) (Schwimmer and Schwimmer 1955; Vonthron-Sénécheau 2016), the carrageenophyte *Chondrus* (for bronchitis, tonsillitis, asthma, stomach disorders and constipation (Oshima 2013), another agarophyte *Gelidium* (lung diseases, scrofula, constipation, stomach aches and ulcers) (Schwimmer and Schwimmer 1955), *Gloiopeltis* (presumably fucoïdan rich; against diarrhoea, goitre, and scrofula) (Chengkui and Junfu 1984; Zheng et al. 2012), and *Porphyra* (perhaps the sulphated polysaccharide porphyrin; against goitre, bronchitis, tonsillitis, sore throat and cough) (Kandale et al. 2011) (Table 1). A viscous solution (kwanpu or hai tai) derived from the carrageenophyte *Laminaria bracteata* (current accepted name *Gigartina bracteata*) was used by the Chinese for menstrual difficulties (Chapman 1950). In reference to *Porphyra*, the *Chinese Materia Medica* stated (Schwimmer and Schwimmer 1955):

“This algal plant is a sort of laver which is green in the fresh state and purple when dry. It grows on the seashore [...]. It is pressed it into cakes. It is not poisonous, but when taken in excess it produces colicky pains, flatulence, and eructations. It is recommended in diseases of the throat, especially goiter.”

Because of the hygroscopic properties of seaweed phycocolloids (i.e., agar, carrageenan, and alginates) some Rhodophyta (reds) (and Ochrophyta, browns) were used to make extracts for respiratory ailments, especially intractable sinus infections and persistent pneumonias, as well as for gastrointestinal disorders. For example, Chinese monks recommended *Gelidium* boiled into a jelly and sprinkled with ginger and sugar to treat fever attributed to stomach ailments. Likewise, intestinal disorders caused by extreme heat were relieved with a paste of agar and milk flavored with sugar and vinegar. This preparation was particularly appreciated by children (Schwimmer and Schwimmer 1955).

Table 1 Main seaweed species/genera used in traditional medicine, pharmacopoeia and home remedies (AC=Asian countries; EU=Europe, AM=The Americas; OC=Other countries) (¹Anggadiredja 2009; ²Novaczek 2001; ³Zaneveld 1959; ⁴Dumilag et al. 2022; ⁵Chapman 1950; ⁶Chengkui and Junfu 1984; ⁷Dumilag and Javier 2022; ⁸Darah et al. 2014; ⁹Tungpalan 1983; ¹⁰Waaland 1981; ¹¹Titlyanov et al. 2012; ¹²Trono 1997; ¹³Sumayya et al. 2016; ¹⁴Liu

et al. 2012; ¹⁵Hsu et al. 1986; ¹⁶Schwimmer and Schwimmer 1955; ¹⁷Oshima 2013; ¹⁸Oh et al. 1991; ¹⁹Jiménez 1843; ²⁰Culbreth 1896; ²¹Fernie 1897; ²²Martinet 1873; ²³Henry and Guibourt 1930; ²⁴Pratt 1850; ²⁵Bustillos 1856; ²⁶Le Vangie and Soto-Quenti 2008; ²⁷Turner and Clifton 2006; ²⁸Huerta-Múzquiz 1960; ²⁹Lobato-Benítez et al. 2018; ³⁰Smith 1984; ³¹Sigmond 1837; ³²Gómez 1815)

Remedy/ treatment	Ochrophyta	Rhodophyta	Chlorophyta
Antipyretics	<i>Sargassum aquifolium</i> ^{1(OC)} <i>S. polyphyllum</i> ^{1(OC)} <i>S. siliquosum</i> ^{1(OC)} <i>S. tenerrimum</i> ^{13(OC)} <i>Turbinaria conoides</i> ^{1(OC)} <i>T. ornata</i> ^{1(OC)}	<i>Hypnea cervicornis</i> ^{1(OC)} <i>H. musciformis</i> ^{1(OC)} <i>Palmaria palmata</i> ^{21(EU)}	<i>Chaetomorpha linum</i> ^{1(OC)} <i>Ulva</i> spp. ^{6(AC)} <i>U. australis</i> ^{6(AC)} <i>U. lactuca</i> ^{13(OC)} <i>U. reticulata</i> ^{13(OC)}
Antiseptic		<i>Hypnea cervicornis</i> ^{1(OC)} <i>H. musciformis</i> ^{1(OC)} <i>Laurencia obtusa</i> ^{1(OC)}	<i>Chaetomorpha linum</i> ^{1(OC)} <i>Ulva lactuca</i> ^{7(OC)} <i>Valonia aegagropila</i> ^{1(OC)}
Arteriosclerosis	<i>Sargassum fusiforme</i> ^{14(AC)} <i>S. hemiphyllum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. siliquastrum</i> ^{14(AC)}		
Asthma	<i>Pseudochnoospora implexa</i> ^{7(OC)}	<i>Betaphycus gelatinus</i> ^{1(OC)} <i>Chondrus</i> spp. ^{13(OC), 17(AC)} <i>Corallopsis urvillei</i> ^{1(OC)} <i>Eucheuma edule</i> ^{1(OC)} <i>E. serra</i> ^{1(OC)} <i>Gelidium</i> spp. ^{16(AC)} <i>Gloiopeltis furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)} <i>Gracilaria arcuata</i> ^{9(OC)} <i>G. bursa-pastoris</i> ^{29(AM)} <i>G. edulis</i> ^{12(OC)} <i>G. salicornia</i> ^{1(OC), 12(OC)} <i>G. textorii</i> ^{9(OC)} <i>Hydropuntia eucheumatoides</i> ^{9(OC)}	<i>Caulerpa racemosa</i> ^{7(OC)} <i>C. serrulata</i> ^{7(OC)} <i>C. sertularioides</i> ^{7(OC)} <i>Ulva</i> spp. ^{6(AC)}
Blood cloths		<i>Acantophora</i> spp. ^{2(OC)}	
Boils	<i>Sargassum fulvellum</i> ^{14(AC)} <i>S. hemiphyllum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. siliquastrum</i> ^{14(AC)}		<i>Ulva lactuca</i> ^{1(OC)} <i>Valonia aegagropila</i> ^{1(OC)}
Bronchitis	<i>Ecklonia maxima</i> ^{31(OC)} <i>Sargassum fusiforme</i> ^{14(AC)} <i>S. hemiphyllum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. siliquastrum</i> ^{14(AC)}	<i>Chondrus</i> spp. ^{13(OC), 17(AC)} <i>C. crispus</i> ^{20(EU)} <i>Eucheuma</i> spp. ^{2(OC)} <i>Gelidium</i> spp. ^{16(AC)} <i>Gloiopeltis</i> spp. ^{13(OC)} <i>G. furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)} <i>Gracilaria bursa-pastoris</i> ^{6(OC), 29(AM)} <i>Hypnea musciformis</i> ^{13(OC)} <i>Kappaphycus</i> spp. ^{2(OC)} <i>Neoporhyra dentata</i> ^{18(AC)} <i>Phycocladia suborbiculata</i> ^{18(AC)} <i>Porphyra</i> spp. ^{13(OC)}	<i>Ulva</i> spp. ^{6(AC)}
Cervical lymphadenitis	<i>Ishige okamurae</i> ^{13(OC)} <i>Sargassum tenerrimum</i> ^{13(OC)}		

Table 1 (continued)

Remedy/ treatment	Ochrophyta	Rhodophyta	Chlorophyta
Cough	<i>Pseudochnoospora implexa</i> ^{7(OC)} <i>Sargassum fulvellum</i> ^{1(AC)} <i>S. hemiphyllum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. siliquastrum</i> ^{14(AC)} <i>Scytosiphon lomentaria</i> ^{18(AC)}	<i>Betaphycus gelatinus</i> ^{1(OC)} <i>Chondrus</i> spp. ^{13(OC)} <i>C. crispus</i> ^{20(EU)} <i>Corallopsis urvillei</i> ^{1(OC)} <i>Eucheuma edule</i> ^{1(OC)} <i>E. serra</i> ^{1(OC)} <i>Gloiopeltis furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)} <i>Gracilaria arcuata</i> ^{9(OC)} <i>G. bursa-pastoris</i> ^{6(OC), 29(AM)} <i>G. coronopifolia</i> ^{1(OC)} <i>G. edulis</i> ^{12(OC)} <i>G. salicornia</i> ^{1(OC), 12(OC)} <i>G. textorii</i> ^{9(OC)} <i>Hydropuntia eucheumatoides</i> ^{9(OC)} <i>Neoporhyra dentata</i> ^{18(AC)} <i>Porphyra</i> spp. ^{13(OC)}	<i>Caulerpa racemosa</i> ^{7(OC)} <i>C. serrulata</i> ^{7(OC)} <i>C. sertularioides</i> ^{7(OC)} <i>Chaetomorpha linum</i> ^{1(OC)} <i>Ulva</i> spp. ^{6(AC)} <i>Valonia aegagropila</i> ^{1(OC)}
Cuts / burns /wounds (dressing)	<i>Fucus</i> spp. ^{26(AM)} <i>Laminaria</i> spp. ^{26(AM)} <i>Macrocystis pyrifera</i> ^{26(AM)} <i>Sargassum</i> spp. ^{2(OC)} <i>Turbinaria</i> spp. ^{2(OC)}		<i>Ulva</i> spp. ^{2(OC)} <i>U. australis</i> ^{10(OC)} <i>Rhizoclonium riparium</i> ^{18(AC)}
Damped sexual desire		<i>Gracilaria</i> spp. ^{30(AM)} <i>Phycocalidia acanthophora</i> ^{7(OC)} <i>Scinaia hormoides</i> ^{7(OC)} <i>S. moniliformis</i> ^{7(OC)}	
Diarrhoea	<i>Padina australis</i> ^{7(OC)} <i>P. minor</i> ^{7(OC)}	<i>Chondrophycus undulatus</i> ^{7(OC)} <i>Chondrus crispus</i> ^{20(EU), 16(AM)} <i>Eucheuma</i> spp. ^{2(OC)} <i>Gracilaria arcuata</i> ^{9(OC)} <i>G. salicornia</i> ^{1(OC), 12(OC)} <i>G. textorii</i> ^{9(OC)} <i>Hydropuntia eucheumatoides</i> ^{9(OC)} <i>Hypnea</i> spp. ^{2(OC)} <i>Kappaphycus</i> spp. ^{2(OC)} <i>Laurencia okamurae</i> ^{7(OC)} <i>Palisada perforata</i> ^{7(OC)}	<i>Caulerpa sertularioides</i> ^{8(OC)}
Dropsy	<i>Undaria pinnatifida</i> ^{18(AC)} <i>Saccharina japonica</i> ^{18(AC)}		<i>Codium fragile</i> ^{6(AC)} <i>Ulva</i> spp. ^{6(AC)} <i>U. australis</i> ^{6(AC)} <i>U. lactuca</i> ^{1(AC)}
Edema	<i>Ishige okamurae</i> ^{13(OC)} <i>Laminaria</i> spp. ^{15(AC)} <i>Petalonia</i> spp. ^{13(OC)} <i>Sargassum confusum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. hemiphyllum</i> ^{14(AC)} <i>S. pallidum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. siliquastrum</i> ^{14(AC)} <i>S. tenerimum</i> ^{13(OC)}	<i>Gracilaria</i> spp. ^{13(OC), 16(AC)} <i>Neoporhyra dentata</i> ^{18(AC)} <i>Porphyra</i> spp. ^{15(AC)}	<i>Acetabularia</i> spp. ^{13(OC)} <i>Codium</i> spp. ^{13(OC)}

Table 1 (continued)

Remedy/ treatment	Ochrophyta	Rhodophyta	Chlorophyta
Goitre and scrofula	<i>Ascophyllum</i> spp. ^{2(OC)} <i>Canistrocarpus cervicornis</i> ^{1(OC)} <i>Dictyota</i> spp. ^{2(OC)} <i>D. cervicornis</i> ^{1(OC)} <i>D. ciliolata</i> ^{1(OC)} <i>D. dichotoma</i> ^{1(OC)} <i>Ecklonia maxima</i> ^{31(OC)} <i>Fucus</i> spp. ^{19(EU)} <i>Hydroclathrus clathratus</i> ^{1(OC)} <i>Laminaria</i> spp. ^{13(OC), 15(AC), 16(AM), 32(EU)} <i>Padina australis</i> ^{1(OC)} <i>P. japonica</i> ^{1(OC)} <i>Saccharina japonica</i> ^{18(AC)} <i>Sargassum</i> spp. ^{2(OC)} <i>S. aquifolium</i> ^{1(OC)} <i>S. confusum</i> ^{14(AC)} <i>S. fulvellum</i> ^{14(AC)} <i>S. hemiphylum</i> ^{1(OC), 14(AC)} <i>S. ilicifolium</i> ^{1(OC)} <i>S. muticum</i> ^{14(AC)} <i>S. natans</i> ^{16(AM)} <i>S. pallidum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. polyphyllum</i> ^{1(OC)} <i>S. siliquastrum</i> ^{14(AC)} <i>S. siliquosum</i> ^{1(OC)} <i>Turbinaria</i> spp. ^{2(OC)} <i>T. conoides</i> ^{1(OC)} <i>T. decurrens</i> ^{1(OC)} <i>T. ornata</i> ^{1(OC)}	<i>Acanthophora spicifera</i> ^{1(OC)} <i>Asparagopsis</i> spp. ^{2(OC)} <i>Betaphycus gelatinus</i> ^{1(OC)} <i>Chondrus crispus</i> ^{20(EU)} <i>Corallopsis urvillei</i> ^{1(OC)} <i>Eucheuma edule</i> ^{1(OC)} <i>E. serra</i> ^{1(OC)} <i>Gelidium</i> spp. ^{16(AC)} <i>Gloeopeltis</i> spp. ^{7(AC), 13(OC)} <i>G. furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)} <i>Gracilaria</i> spp. ^{13(OC), 16(AC)} <i>G. arcuata</i> ^{9(OC)} <i>G. gigas</i> ^{1(OC)} <i>G. coronopifolia</i> ^{1(OC)} <i>Hypnea charoides</i> ^{12(OC)} <i>Meristotheca papulosa</i> ^{1(OC)} <i>Neoporhya dentata</i> ^{18(AC)} <i>Phycocladia suborbiculata</i> ^{18(AC)} <i>Porphyra</i> spp. ^{13(OC), 15(AC)} <i>Vertebrata nigra</i> ^{22(EU)}	<i>Caulerpa chemnitzia</i> ^{4(OC)} <i>Codium arabicum</i> ^{7(OC)} <i>C. intricatum</i> ^{7(OC)} <i>C. tenue</i> ^{7(OC)} <i>Halimeda incrassata</i> ^{7(OC)} <i>H. macroloba</i> ^{7(OC)} <i>H. opuntia</i> ^{7(OC)} <i>Ulva</i> spp. ^{6(AC), 24(EU)} <i>U. lactuca</i> ^{13(OC)} <i>U. reticulata</i> ^{13(OC)}
Gout	<i>Fucus</i> spp. ^{19(EU)}		<i>Ulva</i> spp. ^{2(OC)}
Haemorrhoids	<i>Petalonia</i> spp. ^{13(OC)} <i>Saccharina japonica</i> ^{18(AC)} <i>Undaria pinnatifida</i> ^{18(AC)}	<i>Betaphycus gelatinus</i> ^{1(OC)} <i>Eucheuma edule</i> ^{1(OC)} <i>Gelidium</i> spp. ^{13(OC)} <i>G. divaricatum</i> ^{18(AC)} <i>Gloiopeltis furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)} <i>Gracilaria coronopifolia</i> ^{1(OC)} <i>Hypnea musciformis</i> ^{13(OC)} <i>Meristotheca papulosa</i> ^{1(OC)} <i>Pterocladia</i> spp. ^{13(OC)}	<i>Ulva</i> spp. ^{6(AC)}
Headache		<i>Centroceras clavulatum</i> ^{18(AC)} <i>Gloiopeltis complanata</i> ^{7(OC)}	
Hastening labor/abortion	<i>Laminaria</i> spp. ^{13(OC)}		<i>Codium</i> spp. ^{13(OC)} <i>Codium fragile</i> ^{6(AC)}
Hearth disease (preventive)	<i>Cladosiphon</i> spp. ^{2(OC)} <i>Colpomenia</i> spp. ^{2(OC)} <i>Dictyota</i> spp. ^{2(OC)} <i>Hydroclathrus</i> spp. ^{2(OC)} <i>Sargassum</i> spp. ^{2(OC)} <i>Turbinaria</i> spp. ^{2(OC)}	<i>Eucheuma</i> spp. ^{2(OC)} <i>Kappaphycus</i> spp. ^{2(OC)} <i>Rosenvingea</i> spp. ^{2(OC)}	
Hypertension	<i>Ecklonia cava</i> ^{18(AC)} <i>Eisenia bicyclis</i> ^{18(AC)} <i>Saccharina japonica</i> ^{18(AC)} <i>Sargassum fusiforme</i> ^{14(AC)} <i>S. hemiphylum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. siliquastrum</i> ^{14(AC)} <i>Undaria pinnatifida</i> ^{18(AC)}	<i>Eucheuma</i> spp. ^{2(OC)} <i>Gloeopeltis</i> spp. ^{13(OC)} <i>Phycocladia suborbiculata</i> ^{18(AC)}	<i>Caulerpa</i> spp. ^{2(OC)}
Indigestion	<i>Sargassum aquifolium</i> ^{7(OC)} <i>S. ilicifolium</i> ^{7(OC)} <i>Turbinaria turbinata</i> ^{7(OC)}	<i>Halymenia durvillei</i> ^{7(OC)}	

Table 1 (continued)

Remedy/ treatment	Ochrophyta	Rhodophyta	Chlorophyta
Insect bite/stings			<i>Ulva</i> spp. ^{26(AM)} <i>U. australis</i> ^{7(OC)} <i>U. lactuca</i> ^{7(OC)}
Laxative (constipation)	<i>Ascophyllum</i> spp. ^{2(OC)} <i>Eisenia bicyclis</i> ^{18(AC)}	<i>Callophycus</i> spp. ^{2(OC)} <i>Centroceras clavulatum</i> ^{5(OC)} <i>Chondrus</i> spp. ^{17(AC)} <i>Eucheuma</i> spp. ^{2(OC)} <i>Gelidium</i> spp. ^{13(OC), 16(AC)} <i>G. robustum</i> ^{28(AM)} <i>Gracilaria</i> spp. ^{2(OC), 16(AC)} <i>Kappaphycus</i> spp. ^{2(OC)} <i>Lithophyllum</i> spp. ^{28(AM)} <i>Palmaria palmata</i> ^{21(EU)} <i>Pterocliadiella</i> spp. ^{13(OC)}	
Menstrual difficulties	<i>Saccharina religiosa</i> ^{18(AC)} <i>Undaria pinnatifida</i> ^{18(AC)}	<i>Gigartina bracteata</i> ^{5(AC)}	
Mumps	<i>Durvillaea antarctica</i> ^{25(AM)}		
Nosebleeds			<i>Ulva lactuca</i> ^{1(OC)}
Refreshing liquid (skin disorders)	<i>Sargassum aquifolium</i> ^{1(OC)} <i>S. fusiforme</i> ^{14(AC)} <i>S. hemiphyllum</i> ^{1(OC), 14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. polyphyllum</i> ^{1(OC)} <i>S. siliquastrum</i> ^{14(AC)} <i>S. siliquosum</i> ^{1(OC)} <i>Turbinaria decurrens</i> ^{1(OC)}	<i>Chondrus crispus</i> ^{20(EU)} <i>Hypnea cervicornis</i> ^{1(OC)} <i>H. musciformis</i> ^{1(OC)}	<i>Caulerpa racemosa</i> ^{13(OC)} <i>C. scalpelliformis</i> ^{13(OC)} <i>C. sertularioides</i> ^{13(OC)} <i>C. verticillata</i> ^{13(OC)} <i>Chaetomorpha linum</i> ^{1(OC)} <i>Ulva</i> spp. ^{6(AC)} <i>U. lactuca</i> ^{1(OC)} <i>Valonia aegagropila</i> ^{1(OC)}
Rheumatism	<i>Fucus</i> spp. ^{19(EU)} <i>F. vesiculosus</i> ^{16(AM), 21(EU)} <i>Macrocystis pyrifera</i> ^{26(AM)} <i>Sargassum natans</i> ^{16(AM)}	<i>Gelidiella acerosa</i> ^{7(OC)} <i>Gloiopeltis furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)}	<i>Caulerpa</i> spp. ^{2(OC)}
Sprains/broken bones	<i>Fucus</i> spp. ^{19(EU)} <i>F. vesiculosus</i> ^{16(AM)} <i>Macrocystis pyrifera</i> ^{26(AM)} <i>Sargassum natans</i> ^{16(AM)}		
Stroke	<i>Dictyota</i> spp. ^{2(OC)} <i>Sargassum</i> spp. ^{2(OC)} <i>Turbinaria</i> spp. ^{2(OC)}	<i>Hypnea</i> spp. ^{2(OC)}	
Stomach ailment (ache)	<i>Ascophyllum</i> spp. ^{2(OC)} <i>Durvillaea antarctica</i> ^{25(AM)} <i>Petalonia</i> spp. ^{13(OC)} <i>Turbinaria conoides</i> ^{1(OC)} <i>T. ornata</i> ^{1(OC)} <i>Undaria pinnatifida</i> ^{18(AC)}	<i>Betaphycus gelatinus</i> ^{1(OC)} <i>Chondrus</i> spp. ^{13(OC), 5(AC)} <i>C. crispus</i> ^{16(AM)} <i>Eucheuma</i> spp. ^{2(OC)} <i>E. edule</i> ^{1(OC)} <i>E. serra</i> ^{1(OC)} <i>Gelidium</i> spp. ^{13(OC), 16(AC)} <i>G. divaricatum</i> ^{18(AC)} <i>Gloiopeltis furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)} <i>Gracilaria</i> spp. ^{30(AM)} <i>G. arcuata</i> ^{9(OC)} <i>G. gigas</i> ^{1(OC)} <i>G. coronopifolia</i> ^{1(OC)} <i>G. edulis</i> ^{12(OC)} <i>G. salicornia</i> ^{1(OC), 1 2(OC)} <i>G. textori</i> ^{9(OC)} <i>Hydropuntia eucheumatoides</i> ^{9(OC)} <i>Hypnea musciformis</i> ^{13(OC)} <i>H. nidifica</i> ^{5(OC)} <i>Kappaphycus</i> spp. ^{2(OC)} <i>Laurencia obtusa</i> ^{1(OC)} <i>Porphyra</i> spp. ^{27(AM)} <i>Pyropia abbotiae</i> ^{27(AM)} <i>Pterocliadiella</i> spp. ^{13(OC)}	

Table 1 (continued)

Remedy/ treatment	Ochrophyta	Rhodophyta	Chlorophyta
Swelling	<i>Laminaria</i> spp. ^{15(AC)} <i>Sargassum confusum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. hemiphyllyum</i> ^{14(AC)} <i>S. pallidum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)} <i>S. siliquastrum</i> ^{14(AC)}	<i>Porphyra</i> spp. ^{15(AC)} <i>Gracilaria</i> spp. ^{16(AC)}	
Tonsillitis	<i>Fucus</i> spp. ^{19(EU), 26(AM)} <i>Laminaria</i> spp. ^{26(AM)} <i>Sargassum fulvellum</i> ^{14(AC)} <i>S. hemiphyllyum</i> ^{14(AC)} <i>S. muticum</i> ^{14(AC)} <i>S. polycystum</i> ^{14(AC)}	<i>Chondrus</i> spp. ^{13(OC), 17(AC)} <i>C. crispus</i> ^{20(EU)} <i>Gloeopeltis</i> spp. ^{13(OC)} <i>G. furcata</i> ^{18(AC)} <i>G. tenax</i> ^{18(AC)} <i>Porphyra</i> spp. ^{13(OC), 15(AC)} <i>Phycocladia suborbiculata</i> ^{18(AC)}	<i>Ulva</i> spp. ^{6(AC)}
Toothache			
Urinary problems	<i>Fucus vesiculosus</i> ^{16(AM)} <i>Ishige okamurae</i> ^{13(OC)} <i>Laminaria</i> spp. ^{13(OC)} <i>Petalonia</i> spp. ^{13(OC)} <i>Saccharina japonica</i> ^{18(AC)} <i>Sargassum aquifolium</i> ^{1(OC)} <i>S. tenerimum</i> ^{13(OC)} <i>S. natans</i> ^{16(AM)} <i>Turbinaria conoides</i> ^{1(OC)} <i>Undaria pinnatifida</i> ^{18(AC)}	<i>Acanthophora</i> spp. ^{2(OC)} <i>Acanthophora spicifera</i> ^{1(OC)} <i>Chondrus crispus</i> ^{20(EU)} <i>Eucheuma serra</i> ^{1(OC)} <i>Gracilaria</i> spp. ^{13(OC), 16(AC)} <i>G. arcuata</i> ^{9(OC)} <i>G. gigas</i> ^{1(OC)} <i>G. coronopifolia</i> ^{1(OC)} <i>Phycocladia suborbiculata</i> ^{18(AC)} <i>Porphyra</i> spp. ^{15(AC)}	<i>Acetabularia</i> spp. ^{13(OC)} <i>Codium arabicum</i> ^{1(OC)} <i>C. edule</i> ^{1(OC)} <i>C. fragile</i> ^{6(AC)} <i>C. spp.</i> ^{13(OC)} <i>Ulva</i> spp. ^{6(AC)} <i>U. australis</i> ^{6(AC)} <i>U. lactuca</i> ^{1(OC), 13(OC)} <i>U. reticulata</i> ^{13(OC)}
Vermifuge	<i>Ascophyllum</i> spp. ^{2(OC)} <i>Hydroclathrus clathratus</i> ^{1(OC)}	<i>Alsidium helminthochorton</i> ^{23(EU)} <i>Caloglossa leprieurii</i> ^{18(AC)} <i>Chondria armata</i> ^{4(OC)} <i>Digenea simplex</i> ^{4(OC), 6(AC)} <i>Ellisolandia elongata</i> ^{13(OC), 22(EU)} <i>Lithophyllum</i> spp. ^{28(AM)} <i>Hypnea cervicornis</i> ^{1(OC)} <i>H. charoides</i> ^{12(OC)} <i>H. musciformis</i> ^{3(OC)} <i>H. nidifica</i> ^{3(OC)} <i>Palisada perforata</i> ^{11(OC)} <i>Palmaria palmata</i> ^{26(AM)}	<i>Codium</i> spp. ^{2(OC)} <i>C. arabicum</i> ^{1(OC)} <i>C. edule</i> ^{1(OC)} <i>C. fragile</i> ^{6(AC)} <i>C. intricatum</i> ^{7(OC)} <i>Dictyosphaeria cavernosa</i> ^{1(OC)} <i>D. versluisii</i> ^{1(OC)} <i>Halimeda macroloba</i> ^{9(OC)} <i>Ulva</i> spp. ^{2(OC)}

The importance of seaweed mucilages for wellness of the Asian people was mentioned by Sauvageau (1920):

“The explanation for the daily use of seaweeds by Chinese, Japanese and Hawaiian people should be sought in their lifestyles. They consume large amounts of fish and rice, therefore seaweed jelly is an additional food whose purpose is undoubtedly to ease intestinal function. When passing through the intestine the mucilaginous material gives the fecal bolus a larger volume and more watery consistency, which in turn increases comfort and regular peristaltic movements.”

Another species sold in Asian pharmacies for anthelmintic purposes is the dried red alga *Digenea simplex* (Hairencao in Chinese and Kaininso in Japanese). After extraction, its extract (tse-koo-ts’oi in Cantonese) was used in the treatment of ascariasis and oxyuriasis (Chengkui and Junfu 1984; Simoons 1991; Vonthron-Sénécheau 2016).

The active anthelmintic agent in *D. simplex*, isolated by Japanese scientists in 1953, was first called digenic acid, but is now known as kainic acid. This compound is a neurotoxin but also an agent so effective as an anthelmintic that it is credited with eradicating ascariasis in Japan after World War II (Takemoto 1978). Kainic acid has an intense anthelmintic effect about ten times greater than that of the universally employed santonin, derived from *Artemisia* and without side effects (Nitta et al. 1958). Tse-koo-ts’oi was also used as a laxative for children believed to have an infection called “womb poison” (Tseng 1935).

Green seaweeds (Chlorophyta) seem to have been used less than brown and red ones in traditional medicine of Asian countries. Amongst those which are used are *Codium fragile* (vermifuge, urinary diseases and dropsy, abortifacient), *Ulva* spp. (for the treatment of goitre, scrofula, anti-pyretic and refreshing, sunstroke, cough, bronchitis, tonsillitis, asthma, urinary diseases, dropsy, and haemorrhoids), cf. Table 1 (Chengkui and Junfu 1984).

European countries

In Europe, seaweeds were exploited somewhat as in the Asian countries, but to a much lesser extent (Schwimmer and Schwimmer 1955). In the Mediterranean, there is a rich and continuous tradition of pharmaceutical writings by ancient Greek, Roman, Byzantine, and medieval European physicians, some of which include seaweeds (de Vos 2010). The Greek poet, physician, and grammarian Nicander of Colophon (2nd century BCE) prescribed in his treatise *Theriaca* certain seaweed species in wine as an antidote against snake venom. He also mentioned red seaweeds as a treatment for the sting of a scorpion (Bostock and Riley 1856). The Roman naturalist and philosopher Pliny the Elder (23–79 CE) recommended in his *Natural History* the use of certain seaweeds to treat gout (Fitton et al. 2008):

“But it is the phycos thalassion, or sea-weed, more particularly, that is so excellent a remedy for the gout [...]. Used before it becomes dry, it is efficacious as a topical application not only for gout, but for all diseases of the joints. There are three kinds of it; one with a broad leaf, another with a longer leaf of a reddish hue, and a third with a crisped leaf, and used in Crete for dyeing cloths. All these kinds have similar properties; and we find Nicander prescribing them in wine as an antidote to the venom of serpents even.”

The Roman physician and pharmacologist Dioscorides (40–90 CE), a contemporary of Pliny the Elder, also mentioned algae in his book *De Materia Medica*, which functioned as the nucleus of Western pharmacopeia until the 19th century. Seaweeds were used fresh, dried, or in preparations (i.e., mucilage extracts) to treat burns, rashes, scurvy, and for the elimination of parasites as recorded, for example, in the book *Herbal Simples Approved for Modern Uses of Cure* (Ferne 1897):

“Pliny and Dioscorides in their days extolled the qualities of certain Sea Weeds; and practitioners of medicine on our sea coasts [British] are now unanimous in pronouncing Sea Weed liniments and poultices as of undoubted value in reducing glandular swellings, and in curing obstinate sprains; whilst they administer the Bladderwrack, etc., internally for alterative purposes with no little success.”

Italian physicians of the Salerno School, such as Ruggiero Frugardi, author of *Chirurgia Magistri Rogeri* (1170), also described the beneficial effects of using dried seaweeds or their ashes to treat goitre (Hunt 1994). In the United Kingdom and Ireland (in Victorian times), as well as in France, seaweed-based treatments were popular as dietary aids (Ferne 1897; Schwimmer and Schwimmer

1955) (Fig. 1). Also, in some French hospitals (i.e., La Charité) patients suffering from pulmonary diseases were successfully treated when the room was sprayed with a solution of chloride of lime and, in addition, with some seaweeds with which the room had previously been covered. Further attempts were made in a small room of the Clinical Hospital to establish an artificial marine atmosphere by means of seaweed. “The results perceived from both of these methods were, to a certain extent, satisfactory; but not so decisive as to induce to follow up the practice” (Scudamore 1847). In Spain, seaweeds were also used as a home remedy as attested by an interview with Pepe Ameal Peña (1915–), a 103-year-old man and last survivor of the Spanish flu (Rego 2018):

“I was very ill. I was brought back to health by Don Ceferino, one of the doctors in the village [Luarca, Asturias], a very kindly man. He gave free treatment to those who couldn't pay and they, as a sign of gratitude, used to present him with a carnation that he then wore on his jacket lapel. [...]. The only remedies available to us were the vapours of seaweeds, that we boiled in wooden barrels, or of eucalyptus oil. They were the Paracetamol of the time.”

All the above cited references did not cite any particular seaweed species, although it can be assumed that kelp (Laminariales) and wrack (Fucales) were the most widely used in Europe, partly because of their large contents of iodine that has an effect in treating certain diseases (e.g., goitrous and scrofulous swellings), mainly related to the lack of this compound in the human diet in some regions. These seaweeds were employed in the form of infusions, pills, tinctures, wines, poultices, and ash or charcoal (medicinally known as “aethiops vegetabilis”, see below) (Gómez 1815; Jourdan 1829; Tamplin 1865; Martinet 1873; Teixidor and Casasa 1877; Simmonds 1893). Martin Tupper's *Proverbial Philosophy* refers to *Laminaria digitata* (sea tangle) (Ferne 1897):

“Health is in the freshness of its savour; and it cumbereth the beach with wealth; comforting the tossings of pain with its violet tintured essence.”

Due to the ability of dried stipes of *Laminaria* spp. to expand their original circumference three to five times after rehydration, “stipites laminariae” (of *L. cloustoni*, *L. flexicaulis*, or *L. digitata*, mainly) were used in surgery to produce non-instrumental mechanical dilation of the cervical canal during childbirth and gynecological treatment, widening of fistulas, scrofulous enlargement of the testicle, wound entrances, etc. (Gómez 1815; Sanchez de Ocaña 1865; Martinet 1873; Jourdan 1829). In this regard, Dr. Collis from Meath Hospital (Dublin) wrote (1864):

“*Vilior alga* is a proverb as old as the days of Horace, and yet this worthless substance has in our days contributed more than one of our most valuable medicines. Iodine, and, more lately, bromine, have taken a place in practical medicine which has deprived the Horatian simile of its truth, and now the domain of surgery is enriched by a contribution from the same source.

Freely growing along our shore, the *Laminaria digitata*, commonly known as the sea-girdles or tangle, supplies admirable material, in its tough perennial stem, for bougies of a superior description [...] by dipping them in warm water and rubbing them between the fingers, their surface will become sufficiently soft and smooth for introduction into the urethra. [...].

The stem of *Laminaria digitata* will probably be found best adapted for surgical purposes; [...]. I have found this a most convenient method of mounting a lancet for opening abscesses of the tonsil. The only other manner in which I have myself used it, is in dilating a sinus, which it effected rapidly and well.

Other surgeons to whom Dr. Sloan communicated his ideas used the tangle in uterine cases, a mode of application to which it is signally adapted from its rapid powers of swelling and comparative freedom from bad smell. [...].

The most important would be the dilatation of stricture of the male urethra. This might be done in two ways; as before mentioned, the substance is purely cellular in structure, so that only the portions directly exposed to moisture expand. [...]. The lachrymal canals and the Eustachian tube seem quite within the reach of this agent. I have found that young plants, from half an inch to an inch in diameter, when fresh, expand more readily and to a greater extent than older specimens.”

Another brown seaweed frequently used in traditional European medicine was *Fucus* spp. Already in ancient Rome, properties were attributed to *Fucus* that could alleviate gout and act as an anti-inflammatory. It was also used in topical applications, as a tincture or liniment, against goitre, sore throats, rheumatism, or sprains (Jiménez 1843). In 1750, Dr. Richard Russell, considered the father of thalassotherapy, elaborated from wrack ashes the “vegetable aethiops”, a black saline powder used as an anti-scrofula cure, and also as a toothpaste (Jiménez 1843) (Table 1). The wide range of medicinal applications of *Fucus vesiculosus* can be appreciated, for example in the excerpts of Simmonds (1893) and Fernie (1897):

“*Fucus vesiculosus* when given as a liquid, diminishes glandular swellings in scrofulous cases, and a teaspoonful is given as an alternative tonic and for reducing obesity. The dose of the extract is from one to two drachms.

From ancient times the juice of sea-weed has maintained a certain degree of celebrity as a remedy in glandular diseases and in general and local debility: at one time being locally extolled, and again sinking into neglect on account of the difficulties attending its use, but never entirely losing its good name, and still continuing to be used, to some extent, by the bathing women and nurses at most watering-places. It has been recommended with wine, as a remedy in diseases of the hip and other bones and joints of children.” (Simmonds 1893)

“These bladders are full of a glutinous substance, which makes the weed valuable both as a remedy for the glandular troubles of scrofula, and, when bottled in rum, as an embrocation, such as is especially useful for strengthening the limbs of rickety or bandy-legged children. For glandular swellings also the weed is taken internally as a medicine, when burnt to a black powder [vegetable aethiops]. An analysis of the bladderwrack has shown it to contain an empyreumatic



Fig. 1 French advertisements appraising marine algae as a marine cure for sick children and elderly. (CC BY 4.0) (<https://bit.ly/3dahBYZ>)

oil, sulphur, earthy salts, some iron, and iodine freely. Thus, it is very rich in anti-scorfulous elements. The fluid extract of this seaweed has the long-standing reputation of safely diminishing an excess of personal fat. It is given for such a purpose three times a day, shortly after meals, in doses of from one to four tea-spoonfuls. The remedy should be persevered with, whilst cutting down the supplies of fat, starchy foods, sugar, and malt liquors. When thus taken (as likewise in the concentrated form of a pill, if preferred) the bladderwrack will especially relieve rheumatic pains; and the sea-pod liniment dispensed by many druggists at our chief marine health resorts, proves signally efficacious towards the same end. Furthermore, they prepare a sea-pod essence for applying on a wet compress beneath waterproof tissue to strumous tumours, goitre, and bronchocele; also, for old strains and bruises; though when these injuries are first sustained, the decoction of bladderwrack applied as a hot fomentation, produces the best effects.” (Ferne 1897)

In some cases, the brown seaweed *Alaria esculenta* was prescribed to strengthen the stomach and restore the appetite when suffering from pica disease or allotrophagia (i.e., an irresistible desire to eat non-nutritive and unusual substances such as soil, chalk, plaster, paper, etc.) (Sauvageau 1920). Alginates were also employed in medicine mostly as laxatives (e.g., “Jubol” and “Normacol”), ointments, and as a binding material in the production of pills and pastilles (Chapman 1950) (Fig. 2).

Among the rhodophytes, *Chondrus crispus* (Irish moss) was probably the most widely used species. It was indicated for bronchitis, cough, dysentery, diarrhoea, kidney and bladder troubles, scrofula, etc. (Stillé and Maisch 1887; Culbreth 1896). It was mostly administered as a decoction or jelly (i.e., carrageen) (Husemann 1878; Simmonds 1893). One recipe even used opium syrup mixed with carrageen (Bouchardat 1845). The addition of wine or lemon juice was prescribed as a restorative for people in poor health and to the disabled (Robertson 1856):

“There was a time when it was a fashionable dish; and it is still, everywhere in France and Great Britain, more or less prescribed as food for invalids. The poor of Brighton use it instead of arrowroot. [...]. An amiable and interesting writer—the late Dr. Landsborough—gives a recipe for cooking it, which is found to be excellent from experience. When used, a tea-cup full of it is boiled in water; this water, being strained, is boiled with milk and sugar, and seasoning, such as nutmeg, cinnamon, or essence of lemon. It is then put into a shape in which it consolidates like blancmange, and when eaten with cream it is so good that many a

sweet-lipped little boy or girl would almost wish to be on the invalid list to get a share of it”.

Chondrus crispus was sometimes prepared as an emulsion of liver oil and as poultices by soaking absorbent cottonwool in a decoction of carrageen and drying it (Schwimmer and Schwimmer 1955). A water-soluble extract obtained from this species was used as an anticoagulant, and a preparation made from this alga was used in World War I to mask the bitter taste of some medicines and an analgesic for the sore throats of soldiers who had been gassed (Chapman 1950). It was also used in thalassotherapy (“balneum algense”) for skin diseases (Squire 1884).

Palmaria palmata (dulse) another rhodophyte, was attributed with blood depurative and anti-scorbutic properties. It was also used chewed by Scottish and Irish peasants against high fever since it caused perspiration, and if it was boiled with water and butter it acted as a purgative (Ferne 1897). A popular saying in Stronsay (Orkney Islands, Scotland) was: “He who eats the dulse of Guerdie, and drinks of the wells of Kildinguie will escape all maladies except the black death” (Pratt 1850).

Corallina officinalis (Rhodophyta) has been used as an anthelmintic in Mediterranean countries since ancient times (Martinet 1873). Jourdan (1829) gives a variety of recipes for powders, pills, syrups, infusions, and decoctions. Some of these recipes incorporate marine wormwood, valerian, rhubarb, honey, sugar, white wine, red wine, Rhine wine, egg white, orange blossom water, lemon juice, sweet almond oil, peach blossom syrup, castor oil, camphor, camphor, and other ingredients. For children, it was administered pulverized often mixed with honey (Aguilon 1845).

The Greek physician Stephanopoli discovered in 1775 that the red seaweed *Alsidium helminthochorton*, present on the rocky coasts of Corsica (and called “Corsican moss”), was an effective vermifuge, and has since largely replaced *Corallina* (Martinet 1873). Corsican moss, besides having *A. helminthochorton*, contained as many as 20 species of seaweed and had a “very strong, swampy smell” (Henry and Guibourt 1830) and “its favorable effect is manifested by the green coloration of the excrements” (Martín de Argenta 1864). It seems that Napoleon, from his exile in St. Helena, informed physicians of the popular use in Corsica of sea moss against scirrhus and ulcerative cancer (Martín de Argenta 1864). *Polysiphonia atro-rubescens* (*Vertebrata nigra*, current name) was used to prepare “Sency Powder” (i.e., a mixture of burnt sponge, ammoniacal salt, and charcoal) to treat goitre (Martinet 1873) (Table 1). Agar was one of the components of “Taxol”, tablets for biological treatment for constipation that also included intestinal glands, bile extract and lactic ferments as components (Fig. 3).

As in Asian countries, very few green seaweeds seem to be used in traditional medicine and pharmacopeia in Europe

Fig. 2 French advertisements of “Jubol”, a laxative based on algae (Public Domain) (A: <https://bit.ly/3xAt4Ez>; B: <https://bit.ly/3YJWPyl>; C: <https://bit.ly/3lxXltT>)

compared to reds and browns. One of them was *Ulva* spp. (Pratt 1850):

“This laver is often brought to table as a stewed seaweed. [...] We suspect it to have been originally contrived with a medical intention, for the benefit of scrofulous patients: how numerous, alas! in the gay circles of the opulent and great. This plant is not, however, the true laver.”

The Americas

The earliest known archaeological evidence of the use of seaweeds as food and medicine dates to about 14,000–12,000 years ago in a late Pleistocene settlement in Monte Verde (Chile). Traces of several seaweeds, specifically *Sargassum*, *Porphyra*, *Durvillaea*, *Gigartina*, *Mazzaella*, *Sarcothalia*, and *Macrocystis*, were found together with a plant called boldo (with hallucinogenic properties) (Dillehay et al. 2008). As in Asian and European countries, brown seaweeds were probably the most employed in medicine. The indigenous inhabitants of south-central Chile (Mapuche people) used *Durvillaea antarctica* (commonly known as cochayuyo) as poultice to treat mumps as well as in gel baths (Bustillos 1856). Today, it is still used to treat anemia and to cure problems related to irritable bowel, intestinal problems, indigestion, ulcers, and gastritis. It is also given to babies to chew during teething to relieve pain (Le Vangie and Soto-Quenti 2008). The inhabitants of the Andean regions of South America sold the stems in shops (known as “palo de bocio” or “palo coto”) of a species of brown seaweed (i.e., identity unknown but perhaps *Laminaria* or *Sargassum bacifferum*; current name: *Sargassum natans*) which they chewed to treat goitre (Sigmund 1837; Pratt 1850; Simmonds 1893). These Indians also used *S. bacifferum* (*S. natans*) and *Fucus vesiculosus* to treat renal disorders, inflammations, sprains, and rheumatism (Schwimmer and Schwimmer 1955) (Table 1).

The Williche people of the Island of Chiloé (South Chile) used the giant kelp *Macrocystis pyrifera* extensively to heal broken bones. This kelp is heated until it turns a bright green color, then mixed with sugar and egg white, and wrapped around the bone. They have used it in the past to help children who have bowlegs: “how I seen it now, this little baby was kind of deformed, the legs were a little deformed, and the mother was carrying it in a papoose cradle and I’ve seen the long seaweed put on both sides of the legs and then bound up, then closed up and kept in the cradle and the



legs were straight” (Le Vangie and Soto-Quenti 2008). This species was furthermore used to cure muscular, joint, and rheumatic pains and to treat burns. Today, this kelp is also used by the Chumash Native American healers of southern California to relieve edema and leg pain by wrapping the legs with the large fronds (Adams and García 2005).

As in some South American territories, seaweeds were traditionally valued as medicine by First Nation peoples (e.g., Sitka, Heiltsuk, Haida, Tsimshian, Kwakwaka'wakw, Tlingit, Mi'kmaq, etc.) inhabiting the eastern and western coasts of North America (Wallis 1922; Turner and Bell 1971; Turner and Clifton 2006; Le Vangie and Soto-Quenti 2008). The Sitka Indian tribes (Alaska) devised an instrument to treat headache; they took the hollow stipe of bullkelp *Nereocystis luetkeana* and placed the thin end in the patient's ear and the other end (i.e., the bulb) against a hot stone to generate steam which rose throughout the hollow stipe into the ear canal (Rigg 1922). The Indians of Neah Bay (Washington, USA) used the split bulb of bullkelp for applications in cases of caked breasts. “It

seems to be soothing and antiseptic” (Rigg 1922). Some Canadian First Nations (e.g., Pacheedaht) used the dried bulb of *N. luetkeana* not properly as a medicine, but as a kind of mold for skin cream made from the fat of a deer. The fat was mixed with the aromatic resin of cottonwood buds or pine pitch and poured into the kelp bud to harden it. The kelp was then peeled off, leaving a bulb-shaped piece of tallow that was used to protect the face from the elements. The Pacheedaht burned stipes of the kelps *Lessoniopsis littoralis* and *Postelsia palmaeformis* and pulverized the resulting charcoal (biochar) to mix with raccoon bone marrow in order to make an ointment that was rubbed on the spines of newborn whalers to make them strong and resilient. The ashes of these species were rubbed on the face of a person having convulsions. The ashes were also mixed with water and taken for medicinal purposes (Pacheedaht Heritage Project 2019). The gelatinous substance from the receptacles of *Fucus* spp. and *Laminaria* spp. (sulphated polysaccharides) was, and still is, used by some Canadian First Nations (e.g., the Mi'kmaq) as a medicine for burns, sores, bruises, hoarse throats, to strengthen the limbs, and as a black eye treatment (Le Vangie and Soto-Quenti 2008) (Table 1).

American doctors used to prescribe *Fucus vesiculosus* as a remedy for obesity (Hale 1880):

“We are often urgently solicited by unfortunate patients, the victims of abnormal obesity, for some remedy that will rid them of their superabundance of fat. If we do not prescribe something they lose faith in our medical skill, and seek elsewhere for remedies which may do them irreparable injury. The Fucus, or Seawrack, while it is comparatively harmless, seems to be a potent remedy for removing abnormal adiposis. Its use should, however, be aided by proper diet, such as abstinence from fats, sugar, and alcohol in any form. This drug was first brought to the notice of the profession by a French physician, M. Duchesne.”

A rather popular medicine in the United States during the second half of the 19th century was “Dr. Schenck's Seaweed Tonic”. It was listed as one of the “Nostrums sold as particularly useful in the treatment of the intemperance” and it was “distilled from seaweed (19.5% of alcohol) in the same manner as Jamaica spirits is from sugarcane. It is therefore harmless, and free from the injurious properties of corn and rye whiskey” (Paterson 1890) (Fig. 4). Some ads at the Harper's Weekly (January 6, 1877) include:

“SCHENCK'S SEAWEED TONIC. This excellent remedy contains no injurious drugs and does not disagree with the most delicate stomach. Its use in cases of debility, dyspepsia, and indigestion will be attended by the most beneficial results. For sale by all druggists.”



Fig. 3 “Taxol”, tablets for biological treatment for constipation containing agar (Advertisement taken from the *Journal of the Royal Army Medical Corps*, 1941)

“AFTER TAKING POWERFUL STIMULANTS there is always a reaction. Schenck’s Seaweed Tonic, being a mild stimulant, does not produce an artificial excitement followed by a state of lethargy, but is of permanent advantage to debilitated persons. For sale by all druggists.”

“FOR DEBILITY, arising from overexertion, sickness, or from any cause whatever, SCHENCK’S SEAWEED TONIC is a valuable remedy, containing the nourishing and life-supporting properties of many natural productions; its strengthening properties are truly wonderful. A single bottle will demonstrate its value.”

“PERSONS who require a stimulant, but who dislike to drink whisky or other strong liquors for fear of becoming drunkards, will find in Schenck’s Seaweed Tonic a beverage which does not create a thirst for alcoholic liquors. It is wholesome and invigorating. For sale by all druggists.”

One of the many testimonials appeared in “Dr. Schenck’s column” in the New York Times (1865) from one of his patients about the “Seaweed Tonic” reads:

“BOSTON, Mass., Jan. 28, 1865.

Dr. J.H. Schenck, Philadelphia, Penn.:

DEAR SIR: I wish to add to your list of certificates my name. It may induce some sufferers to try your Seaweed Tonic and Mandrake Pills. I have been for several years complaining with a dull, heavy languid feeling, not sick enough to lay by, and yet hardly able to attend to my household duties. I had pains all over me, sick headache, low spirits, bowels costive, skin yellow, no appetite, belching up wind and throwing off bile continually. Nothing would digest but lay on my stomach, giving me pain and filling me full of wind. I was all this time taking medicine, but nothing seemed to reach my case until I commenced with your Seaweed Tonic and Mandrake Pills. I have taken five bottles of the tonic and three boxes of the pills and feel like a new being. I live at No. 447 Harrison-av., Boston, and if anyone will take the trouble to call on me, I will explain more explicitly. MRS. JANE HUNTER.”

In relation to red seaweeds, some of the American First Nations tribes (e.g., Gitga, Kwakwaka’wakw, and Salish) used *Pyropia abbotiae* (la’ask) and other *Porphyra* spp. to relieve heartburn and indigestion. It was also used as an anti-septic poultice for deep cuts or swelling (Turner and Clifton 2006). *Palmaria palmata* was also eaten raw as a vermifuge (since it also contains levels of kainic acid) (Le Vangie and Soto-Quenti 2008). The Mayas (from the regions of Sonora and Sinaloa) used calcareous *Lithophyllum* spp. and the red *Gelidium robustum* as laxatives and the former also as vermifuge (presumably aided by the presence of calcium

carbonate in the thallus— Huerta-Múzquiz 1960; Ortega et al. 1997). The red agarophyte, *Gracilaria compressa*, is still sold in local markets of México DF as a treatment for respiratory ailments such as cough, bronchitis, asthma, and colds, administered as an infusion (Lobato-Benítez et al. 2018). Chileans (especially the Williche from island of Chiloé) use *Porphyra columbina* (luche) as a relaxant, “causing a drowsiness with a feeling similar to the drowsiness one feels after eating turkey” (Le Vangie and Soto-Quenti 2008). In the Caribbean countries such as Trinidad and Tobago, Jamaica, and the Grenadines, *Gracilaria* spp. were known in folk medicine for combating male erectile difficulties and healing the digestive tract in both men and women. The polysaccharides (agars) obtained by sun drying *Gracilaria* and then being soaked in hot water are mixed with syrup; nutmeg, vanilla or cinnamon can be added to the mixture, and used as a tonic for men and to combat disease. Chopped fresh fruits such as mango, banana, and sweetsop can be also added to increase energy (Table 1). In addition, bitter herbs like strongback (*Cuphea parsonsia*), cerrasee (*Momordica*



Fig. 4 Chromolithograph advertisement of a tonic prepared from seaweed (CC BY 2.0) (<https://bit.ly/3EmC4AV>)

charantia), and even marijuana (*Cannabis sativa*) can be mixed in to enhance the tonic (Smith 1984).

In United States, phycocolloids were used for various treatments and remedies. For example, concoctions of whisky and carrageenan were prepared and sold in New York Irish pubs as a cough remedy (Chapman 1950). *Chondrus crispus* carrageenan was also advised in cases of general irritability of the alimentary tract, and was prescribed for gastric ulcer, as well as for diarrhoea and dysentery. Irish moss was specially indicated as a domestic remedy for children suffering from constipation, as suggested the following testimonial sent by a reader of the *Babyhood Magazine* (Yale 1888):

“Irish moss has occupied such a valuable place in the dietary of my two babies that I am glad to commend it here. It is nutritious and inexpensive, and is a useful agent in preventing the heavy curd which forms in cow’s milk. I have seen it used as a laxative for a baby four weeks old, who as bottle-fed, with the best results, and for older children it makes a pleasant and innocent variety. I make it into a thin jelly by boiling a small quantity of the nicest and whitest in a pint of water. I keep this in a cool place, and by thinning it with little hot water it is ready at any time to put in the baby’s bottle of milk. A little milk-sugar makes very palatable. The quantity to be used depends, of course, on the thickness of the jelly and the age the child. Two or three babies of my acquaintance have been brought up upon it in preference to any of the patented foods”. M. L. Hingham, Mass.

Some American dispensatories recommended agar as a laxative, eaten in small pieces as cereal with sugar and cream, or in chocolate-coated form (Schwimmer and Schwimmer 1955). Even laxative preparations were also advertised and sold under the brand name of “Agarol” prepared with mineral oil, agar, and phenolphthalein that “softens the intestinal content, lubricates the channel of their passage and gently stimulates peristaltic activity, combining effectiveness with exceptional palatability” (Federal Trade Commission Decisions 1950) (Fig. 5). In fact, Dr. J. H. Kellogg, the originator of cornflakes and initiator of many innovative nutritional habits, served “Laxa”, a combination of sterilized bran and Japanese seaweeds (e.g., *Gracilaria* spp.), at his well-known Battle Creek sanatorium in the late 19th century to stimulate intestinal balance and internal cleansing (Kellogg 1921).

As in other regions, green seaweeds have been used far less in traditional medicine and home remedies in the Americas. *Ulva* spp. have been used in the form of poultices to cure jellyfish stings (by the Mi’kmaq), as facial masks to remove dead skin cells (by the Mi’kmaq, Williche, and Veracruz people), and to remove boils and plantar warts (by the Mi’kmaq and Williche) (Ortega et al. 1997; Le Vangie and Soto-Quenti 2008).

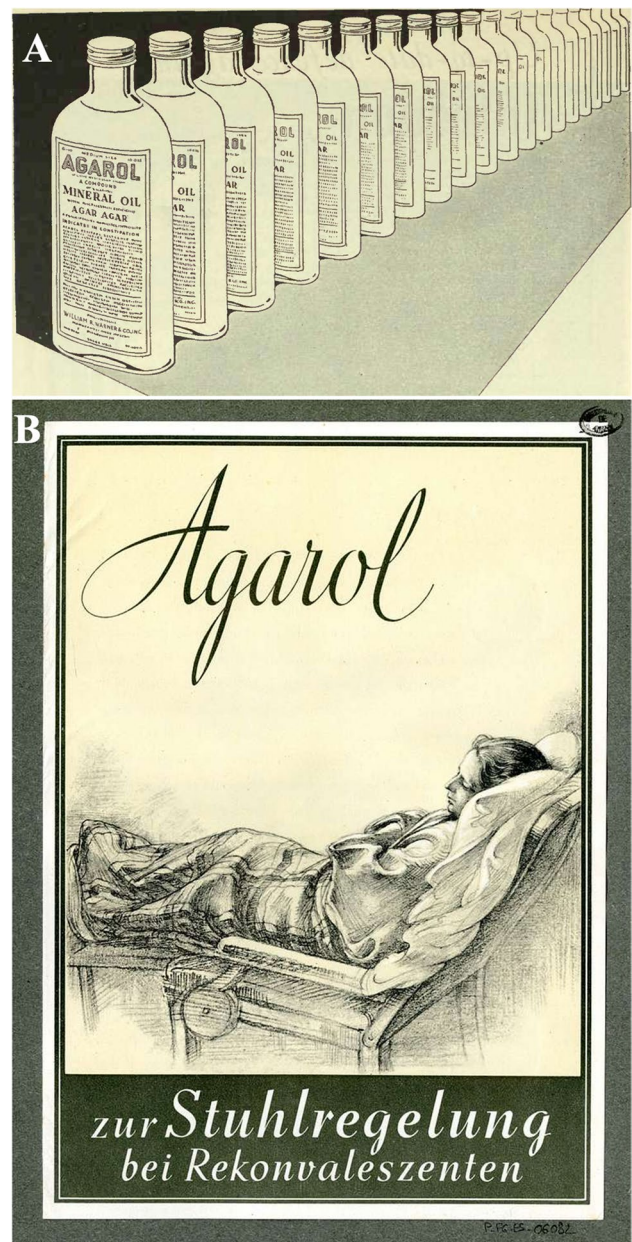


Fig. 5 “Agarol” laxative prepared with agar (Public Domain) (A: <https://bit.ly/3lGe6dV>; B: “Agarol, for stool regulation in convalescents” <https://bit.ly/3lO7pGv>)

Other regions

In some medieval Islamic countries (e.g., Persia) tahaleb (or seaweeds) were included in the second volume (*Mufradat* or Simple drugs) of the Ibn Sina’s five-volume book *al-Qanunfi al-Tibb* (*Canon of Medicine*). It seems that no mention of any identifiable species was made, but the author advises using seaweed for bleeding (“It is styptic for blood in any place it is painted”), tumours and blisters (“It is applied [in cases of] hot tumours, erysipelas tumours, and eczemas.

The lenticular weed, [if used] with fine flour, is similar [in this effect]”, “organs of articulation” (“[It is also applied] on vehement gout and severe arthralgia. When decocted with old olive oil, it softens the nerves”) and excretory organs (“[When] bandaged with it, the haematocele (or hydrocele) of the intestines is atrophied”) (Yavuz 2023).

In the Pacific Islands (e.g., Hawaii, Tonga, Samoa, etc.), as well as in many Indo-Pacific countries (e.g., Indonesia and the Philippines), including India, there is a long tradition in using seaweeds as beneficial health foods, medicines, and home remedies (McCaughey 1916; Kaaiakamanu and Akina 1922; Uhe 1974; Abbott 1978; Cox 1991; South 1993; Novaczek 2001; Ostraff 2003, 2006; Anggadiredja 2009; Sumayya et al. 2016; Dumilag and Javier 2022; Dumilag et al. 2022). The variety of seaweeds used in these countries as herbal medicine and home remedies is enormous, compared to Western countries as well as Asian countries (such as China and Japan). This probably reflects the great biodiversity of seaweeds in this region, as well as a long cultural tradition in the use of marine resources. Members of Rhodophyta and Ochrophyta are the most widely used. The species are mainly used for digestive (indigestion, diarrhoea, stomach aches, etc.), respiratory (cough, asthma, and bronchitis), urinary, glandular (goitre, scrofula, hepatitis), dermatological, and even sexual problems. (Table 1). Depending on the species and the disease to be treated, seaweeds can be used as an alcoholic extract, decoction, infusion, ointment (cream), poultice (cataplasm), or syrup (Dumilag and Javier 2022).

The brown seaweed *Durvillaea antarctica* (rimuroa) was used by Maori tribesmen in New Zealand as an antidote to scabies, as they were accustomed to sharing their dwellings with livestock (Goldie 1904). This species was roasted and eaten as a curative for eczema and intestinal complaints (Brooker et al. 1981). *Durvillaea antarctica* and *Porphyra* spp. (karengo) were also used by Maori as treatments for goitre prevention and as laxatives. In the case of *Durvillaea*, it was mixed and fermented with the juice of the poisonous *Coriaria* spp. (tutu) shrub to make a potent cathartic. The blades of *Durvillaea* were used to treat burns by wrapping them around the affected body region (Schwimmer and Schwimmer 1955). During the World War II, dried *Porphyra* spp. was supplied to the Maori battalion as food during the march, and possibly also for its laxative effects. Chewing seaweed was also found to be more thirst quenching than chewing gum on desert marches (Brooker et al. 1981).

It appears that Aboriginal medicinal uses of seaweeds in Australia were not so extensive as in Pacific Islands or Indo-Pacific countries, or at least it has not been recorded in the archival literature (Thurstan et al. 2018). Some of Aboriginal medical knowledge and the activities of physicians were described by Meyer (1846):

“Nearly every tribe has its own doctor, who has but one remedy for every disease; but every doctor has a different one, and this is the object, animal or vegetable, which he regards as his friend or protector—thus one has a snake, another an ant, another seaweed, &c., &c. The sick man may either go to the doctor, or send for him. If the doctor is prepared, he knocks against the hut with his fingers, and upon the shoulder of the patient; then squeezes the part affected between his hands, and sucks it with his mouth; having done this for a minute or two, he spits out (if this is his protector) seaweed upon the hand of the patient, which he is to keep carefully until it is dry. In the evening the doctor and friends of the patient assemble round him and sing as loud as they can to drive away the disease. The doctor sits in front of the patient with two sticks, one in each hand, beating the air; and the women beat upon kangaroo skins, rolled up, held between their knees. He pretends to have sucked out the seaweed



Fig. 6 Australian advertisement appraising Irish moss (*Chondrus crispus*) for curing infectious diseases like colds and coughs. (Public Domain) (<https://bit.ly/2N7ZqoW>)

Fig. 7 Allen's Irish moss gum jubes delivery van (circa 1946). (No known restrictions) (<https://bit.ly/3xBhwkw>)



from the patient; and if anyone should hint his having previously put it into his mouth he becomes indignant and threatens to send it with the disease into his body.”

Also, in the fourth chapter: “A voyage to the country of Houyhnhms” (south of present-day Australia) in *Gulliver's Travels* (Swift 1870):

“Their [Yahoos, an involuted species of human beings lacking the intellectual level of human beings] fundamental is, that all diseases arise from repletion; whence they conclude, that a great evacuation of the body is necessary, either through the natural passage, or upwards at the mouth. Their next business is, from herbs, minerals, gums, oils, shells, salts, juices, seaweed, excrements, barks of trees, serpents, toads, frogs, spiders, dead men's flesh and bones, birds, beasts, and fishes, to form a composition, for smell and taste, the most abominable, nauseous, and detestable they can possibly contrive, which the stomach immediately rejects with loathing, and this they call a vomit; or else, from the same storehouse, with some other poisonous additions, they command us to take in at the orifice above or below (just as the physician then happens to be disposed) a medicine equally annoying and disgusting to the bowels: which, relaxing the belly, drives down all before it; and this they call a purge, or a clyster.”

Seaweed was also an ingredient in the popular Bonnington's Irish Moss (otherwise known as “Pectoral oxymel of

Carrageen”), a cough mixture in the form of a dark brown, clear syrup made from vinegar and carrageenan extracted from *Chondrus crispus* (Irish moss) sweetened with honey. Its inventor, the Australian-born chemist George Bonnington (1837–1901), invented the remedy for coughs, colds, asthma, influenza, and bronchitis in Nelson (New Zealand) in the mid to late-1850s. He was initially very popular in the town and eventually became a very wealthy man after finding an easy market throughout New Zealand and Australia (Wendy 2011) (Fig. 6). Another Australian company (Allen), founded by Alfred Wagner Allen in 1891, also manufactured Irish moss gum jubes: “You can feel them doing you good!” (Fig. 7).

Seaweeds were also used in Africa, as recorded in the *South African Cape Materia Medica*, inherited from the medicinal practices of very diverse cultural groups such as Khoikhoi (Hottentot) and San (Bushmen) (Van Wyk 2008). *Ecklonia maxima* (Afrikaans sea bamboo) was used as a source of iodine in Cape Dutch herbal medicine for the treatment of goitre, scrofula, or bronchocele (Table 1). The mode of administration varied in the form of pills, ash, charcoal, or infusion (Sigmund 1837; Pappé 1847).

Conclusion

There are many types of seaweeds, and they occupy a huge taxonomic and ecological range spanning considerable geological time. One would expect them to contain

many bioactive substances contributing to their successes in time and space. The uses of varied seaweeds are indeed numerous, but the analysis and information presented in the present paper of traditional oral wisdom and written medical knowledge have been passed down over the ages and inserted in many of the texts of ancient and modern medical tomes. The examples cited here indicate some seemingly common applications of various red, green, and brown algae that have stood the tests of time. In some instances, the benefits can be attributed to iodine and colloids (e.g., agars, carrageenans, ulvans and alginates). In particular, some sulphated polysaccharides (e.g., carrageenans, fucoidans, and ulvans) may have specialist and very specific physiological responses and hence applications for human health. Red seaweeds have often been used as vermifuges and this can be attributed to the presence of calcium carbonate and, in some cases, kainic acid.

Much of the traditional written and in some cases oral knowledge presented here persist in modern cultures as “natural remedies”, yet the properties (active ingredients) of the algae have not transitioned to mainstream pharmaceutical applications. The reasons for this are unclear. Obviously, as various seaweeds have contributed to human health positively in the past, they can do this alongside modern medicine and well into the future. Detailed dissection of modes of actions of various seaweed concoctions may well lead to future phyco-pharma applications.

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Declarations

Competing interest The authors declare no competing interests.

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