As our Members will know, S*f*AM is governed by an Executive Committee (EC), a decision-making body that oversees and contributes to the work of the Society, helping to shape its strategic direction. The Officers and ordinary Executive Committee Members work with senior staff Members to advise on the delivery of the Society's strategic objectives. At regular meetings, the EC also receives reports from subcommittees and considers their recommendations.

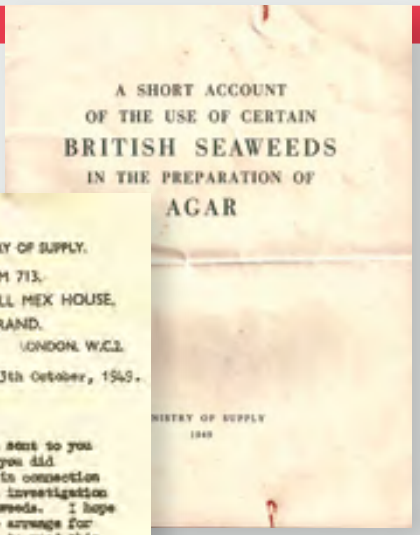
Service on the Executive Committee requires a commitment to S*f*AM for a minimum period of 3 years and positions on the Committee are advertised annually to all Members.

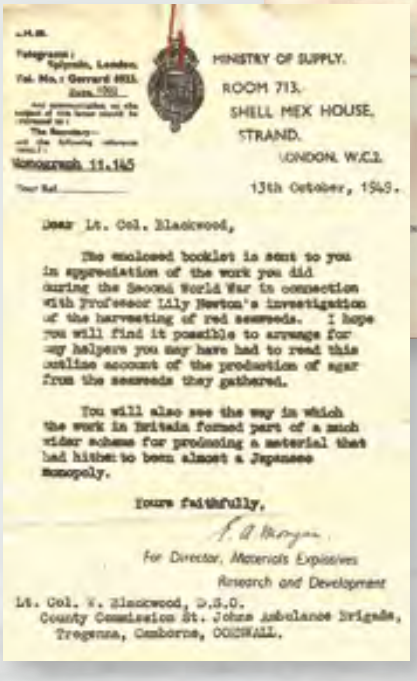
Stephen Forsythe joined S*f*AM's Executive Committee for the opportunity to be actively involved in a Society which he joined at the start of his PhD back in 1980. As Stephen is also now semi-retired, he felt he would also have some time to provide a mentoring role to our many Early Career Scientists at S*f*AM conferences and meeting.

sfam MEMBERS' EDITION

BRITISH SEAWEED

My late great-uncle Vic Baker was a senior figure in the district council of Falmouth (Cornwall), the local St John's Ambulance and the Sea Scouts. What has that to do with microbiology? Well, I have inherited a report from the Ministry of Supply which he was given in 1949 due to his contribution to the war effort. It is entitled '*A short account of the use of certain British seaweeds in the preparation of agar*'. As microbiologists, using agar for growing bacteria on a solid medium is something we take for granted. However, during World War Two that dependence became a national problem as microbiological agar was primarily sourced from Japan where it was extracted from their seaweed. The conflict therefore resulted in the direct lack of bacteriological agar. Yet without agar plates, think of all the things that would not be possible; growing bacterial cultures in pure culture in hospitals for identification etc. would be problematic and even life-threatening. In fact, the problem was even larger, as agar plates were required for growing cultures for vaccine production and for evaluating the strength of penicillin production. The report documents how during the war they evaluated alternative seaweeds from around the shores of the UK. These were collected by


A SHORT ACCOUNT
OF THE USE OF CERTAIN
BRITISH SEAWEEDS
IN THE PREPARATION OF
AGAR


MINISTRY OF SUPPLY.
ROOM 713.
SHELL MEX HOUSE.
STRAND.
LONDON. W.C.2.
13th October, 1943.

Dear Lt. Col. Blackwood,

The enclosed booklet is sent to you in appreciation of the work you did during the Second World War in connection with Professor Lily Newton's investigation of the harvesting of red seaweeds. I hope you will find it possible to arrange for any helpers you may have had to read this outline account of the production of agar from the seaweeds they gathered.

You will also see the way in which the work in Britain formed part of a much wider scheme for producing a material that had hitherto been almost a Japanese monopoly.

Yours faithfully,

For Director, Materials Explosives Research and Development

Lt. Col. W. Blackwood, D.S.O.
County Commission St. Johns Ambulance Brigade,
Tregenna, Camborne, CORNWALL.

local voluntary organizations such as the Scouts, Sea Scouts, Junior Red Cross, lighthouse keepers, RAF, schools and individuals.

The report is 16 pages in length and I have retained the original country names and seaweed species names as given. I recognize that both will have changed over the past 70 years, but prefer to quote as per the original source material. Although it is entitled '*A short account of the use of certain British seaweeds in the preparation of agar*' it has quite a lengthy introduction before it begins the 'British' aspect of looking for sources of agar for microbiology during WWII.

The introduction starts by covering the general properties of seaweed agar and its history, which accredits the gelling recipe of Frau Fanni Eilsshemius Hesse (wife of the bacteriologist Walther Hesse) for solidifying microbiological growth media. Frau Hesse had this passed down from her mother, who in turn had obtained it from a Dutch family living in Java (Indonesia) where seaweed was used domestically. It is generally believed that the seaweed she used was *Gelidium corneum*. However, an alternative of *Eucheuma murcatum* is also given as a possibility. The uses of agar in medical practice are given briefly, followed by a more descriptive coverage of uses in the food industry.

However, it is its use in microbiology that is given as crucial for the country. The specific reasons detailed as being of the highest importance are (i) the preparation of vaccines and (ii) the growth of *Staphylococcus aureus* and other sensitive bacteria to test the potency of penicillin solutions (using a porous porcelain cylinder). The key issue being that until 1939, bacteriological agar was produced in Japan from *Gelidium corneum*, as well as smaller amounts from other red seaweeds. However, the conflict with Japan led to many countries needing alternative sources of the agar and therefore their own harvesting of relevant seaweeds.

The hunt for agar in World War Two

COUNTRY	SEAWEED	ADDITIONAL DETAILS
Britain	*Gigartina stella* (95%) and *Chrondrus crispus* (5%).	July – September. No drift material. Wet weight 60 – 70%. Air-dried to 20% in local premises.
USA	*Gelidium cartilagineum.* Also low grade from *Gracilaria confervoides.*	Low tide down to 30 feet or more. Length 18 inches. Point Conception, Californian coast & Mexico. May – November. Six hours diving to harvest 1 ton. Manual.
Canada	*Gracilaria* spp., also *Chondrus crispus* for food use.	
New Zealand	*Pterocladia lucida* & *P. capillacea.*	
Australia	*Gracilaria confervoides.*	
South Africa	*G. confervoides* most profitable, followed by *G. cartilagineum* & *Suhria vittata.* Possibly *Gelidium corneum.*	Alngebaan and in Hout Bay. Also drift seaweed.
India	*Gracilaria lichenoides.*	Essential for preparation of cholera and typhoid vaccines.
Malaya & Netherlands East Indies	*Gracilaria lichenoides*, also *Eucheuma denticulatum.*	
Ceylon	*Gracilaria lichenoides* & *G. confervoides.*	Harvested at the time of the south-west monsoons.
Eire	*Gelidium pulchellum* & *G. latifolium.*	Galway, Clare, Kerry and Cork.
France	No recorded details, though possibly *Chondrus crispus.*	
Russia	*Ahnfeltia plicata* & *Phyllophora rubens.*	Black Sea. 33-44,000 lbs collected.
China	*Gelidium* spp.	Ningpo, Tsingta & Chefoo.
Germany		Pre-war stocks and recovery methods used.
Portugal	Most likely *Gelidium* spp.	
Spain	*Gelidium corneum*, also *C. crispus.*	
Italy	*Gracilaria* spp.	Lagoons near Venice.

Table 1 *Production details for various countries*

Since the best gelling properties were agars from red seaweeds, it meant the plants naturally grew either near the low-water mark of ordinary spring tides, or at a greater depth. This limited their access to short periods each day or a few days each fortnight. Other factors that needed considering were the seasonality of growth and weather conditions that would affect their collection. Countries that had never produced agar before, had to find their best native seaweeds and ensure their stocks were not over-harvested, which would result in deficiencies the following season. The introductory section of the report reviews the approach of various countries for four pages, before coming to 'Britain'. For simplicity, I have tabulated the information for the individual countries in Table 1. The document gives more data for some countries than others, but for the sake of this article I have greatly reduced the information for some countries, especially the USA and New Zealand.

As the lack of bacteriological agar was recognized as a national emergency, the large-scale harvesting of seaweeds in Britain for agar manufacture started in 1942 before the production procedures could be optimized. Preliminary investigations suggested that the most promising red seaweeds were *Gigartina stella*, *Chondrus crispus*, *Ahnfeltia plicata*, *Gracilaria* spp. and *Gelidium corneum*. Of these, *G. stella* and *C. crispus*, which together are generally known as 'carrageen', were selected for further study and of which *G. stella* predominated (95%). These seaweeds largely grow on rocky shores near the low-tide mark, and had a history of being gathered in the Hebrides, Pembrokeshire, and Anglesey and Eire for making milk jellies, and various medicinal purposes. Detailed surveys from coastal regions of Britain were undertaken to determine where large quantities could be harvested, which are shown in Figure 1. The main region of interest became the west coast of Britain, as well as a restricted area in Northumberland. Northern Ireland was not considered due to transportation issues. Furthermore, there were many problems inherent in using non-specialists for the harvesting: (1) polymorphism of the seaweeds leading to identification issues, (2) timing of harvesting to ensure sustainability and (3) gel strength variation according to the age of the seaweed. Subsequently, the ecology of the seaweeds needed to be studied. Explanatory sheets to teach those harvesting how to differentiate the two species, *G. stella* and *C. crispus*, from other seaweeds were produced, and included how their morphologies varied in different locations and environmental conditions. Studies on the seaweeds' life cycle and the effect of harvesting period on the subsequent year's abundance were determined in preliminary studies. In addition, records were kept of the vegetative growth periods, fruiting periods and when spores were released.

Initially, the harvesting period was May to September when there was a spring tide, and the harvesters had to collect no more than half the seaweed in order to preserve stocks. Collection after September was not undertaken due to the autumn gales and this was when *Gigartina* released its spores. The collection instructions gradually changed as more became known about the plants' growth cycles and factors affecting the agar gel strength. Consequently, the start of collection was delayed until July as this improved the gel strength, and collecting two crops per year using the longer harvesting period was not beneficial. Also, all material was collected by hand picking and not shearing, as sufficient regrowth occurred from the plants' holdfast and regeneration from old thalli. In Scotland, the *Gigartina* would grow in such large masses that some would be washed off the rocks. However, this drift material was not harvested as it was important for spore dispersal.

The water content of harvested *Gigartina* was ~60% and that of *Chondrus* ~70%. The wet material could be stored for no more than five days before deterioration occurred. Air-drying reduced the water content to 20%. The seaweed was dried locally, which included bakeries, kilns, biscuit factories and greenhouses. The seaweed was largely transported by private cars due to the lack of lorries. The use of dried seaweed for any purposes other than agar production was prohibited by an Order of the Council. The total harvest quantities where known for 1943–1945 are given in Table 2. Given the labour-intensive collection of material by volunteers it is noted that no serious accidents were recorded.

WEIGHT OF GIGARTINA AND CHONDRUS HARVESTED ANNUALLY IN BRITAIN, 1943-1945

	1943		1944		1945	
	WET lbs.	DRY lbs.	WET lbs.	DRY lbs.	WET lbs.	DRY lbs.
ANGLESEY	—	2,629	—	4,153	—	1,468
CORNWALL	14,296	125	—	14,064	—	14,594
DEVON	1,014	1,989	—	5,108	—	1,140
DORSET	—	38	—	109	—	51
GLAMORGAN	2,730	—	—	—	—	—
NORTHUMBERLAND	—	1,293	—	389	—	684
SCOTLAND	12,015	27,115	123,229	3,721	129,630	2,542

*Further notes on the commercial drying station at Airdrie are contained in the Ministry of Supply Permanent Record Monograph, No. 11.145. (Appendix C).

Table 2 *UK collection volumes*

With respect to named main contributors to the study, credit is given to various establishments too lengthy to list here. However, it only seems appropriate to repeat the special mention of the key botanical guidance by Dr Lily Newton (University College Wales), and Drs S.M. Marshall and A.P. Orr (Scottish Marine Biological Association) for their chemical analysis. There is no specific listing of the main microbiologists involved, but as best I can tell they were: Mrs MacNaughtan (University of Edinburgh), Dr V.D. Allison and Dr B. Hobbs (Emergency Public Health Department, Ministry of Health, Cardiff), Professor C.H. Browning (University of Glasgow) and Dr R. Cruickshank (North Western Group Laboratory, London). It would be interesting to know if any readers can contribute anything more regarding these microbiologists or related information; please send to **communications@sfam.org.uk**.

Figure 1
Production around UK shores

Steve Forsythe
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Nottingham Trent University