

NORTHWEST DIVISION OF THE
AMERICAN RED CROSS

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SPHAGNUM AS A SURGICAL
DRESSING

BY

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INTRODUCTION

The truth of the old adage that "necessity is the mother of invention" is particularly noticeable in times of great emergency such as is now stimulating the thought of scientists the world over. It is the present war emergency that has occasioned the original thinking and inventiveness that is seen in the extraordinary recent development along certain lines of chemistry, aeronautics, submersibles, etc., to an extent never thought possible.

In no less striking a manner has this same ingenuity been seen in the marvelous skill and proficiency of surgery, not only in the method of treatment of wounds, which has been astounding, but also in the material used for dressings. War had been declared only a few months when it was seen that there was likely to be a shortage of absorbent cotton, and in an effort to avert such a calamity experiments were begun with a kind of moss known as Sphagnum, or peat moss, as a substitute. At the present time surgical and non-surgical dressings made from Sphagnum are being used in the war hospitals, not only in Great Britain, but in France, Malta, Alexandria, Salonika, Italy and Palestine—practically on all the allied fronts.

DISTRIBUTION OF SPHAGNUM

Sphagnum is widely distributed throughout the world. All the species are low plants which are differentiated into stem, branches, leaves and rhizoids or root-like structures. There are no true roots such as are found on higher plants. This moss grows in abundance in low, marshy, undrained places, especially in and around cranberry bogs, but it may occur in other than swampy locations. It thrives best, however, in the damp, humid climate of the colder parts of the temperate zone in Europe, Asia and America. Sphagnum is found abundantly on the moors of Scotland and Ireland, and also in the countries surrounding the Baltic Sea, where the land is low and in general has an excessive amount of moisture, producing a very humid atmospheric condition.



Figs. 1 to 4

Photographs of four species of *Sphagnum*; the first two are suitable for surgical dressings, the last two are not.¹ 1, *Sphagnum imbricatum*. 2, *Sphagnum palustre*. 3, *Sphagnum recurvum*. 4, *Sphagnum fuscum*. Natural size.

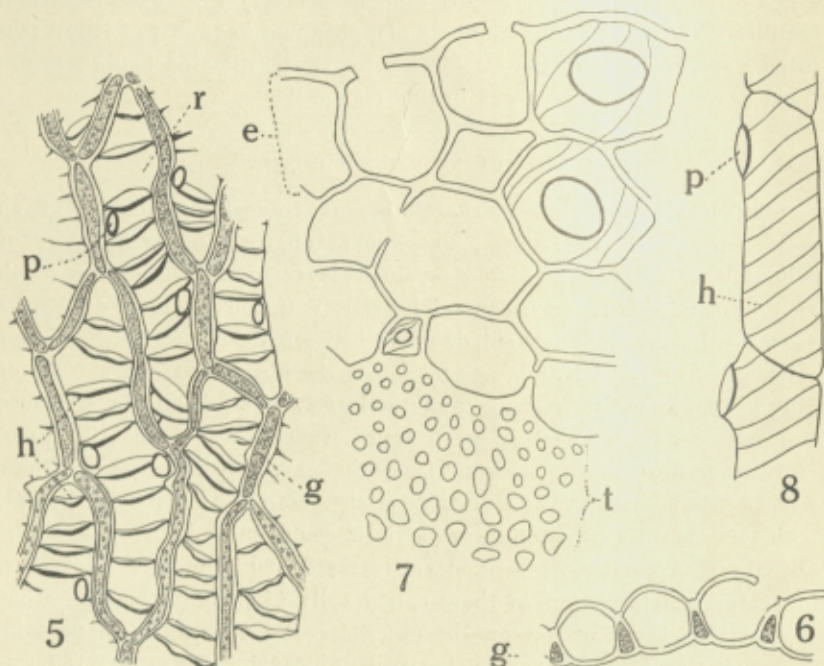
In north America it occurs most commonly along the northeast coast from New England to Labrador, and along the northwest coast from Oregon to Alaska. In the interior of North America large bogs also occur, especially in the region of the Great Lakes. These bogs, however, are gradually being drained, but considerable desirable moss may yet be found in certain localities. There are large numbers of *Sphagnum* bogs in western Washington, especially along the Pacific coast. It is estimated that there are 25,000 acres of cranberry bogs in this region.

STRUCTURE OF SPHAGNUM

The leaves of *Sphagnum* are always arranged spirally about an erect stem and its branches. They do not have veins as do those of higher plants. They consist of a single layer of cells, some of which are green and others colorless. The cells that contain the green color are small, narrow and elongated, while between them occur much larger and longer empty cells, whose function is the absorption and storage of water. Consequently the surface of the leaf (*Fig. 5*) has the appearance of a network, the elongated, green cells forming the net and the large, empty reservoir cells the meshes. Since the leaves are only one cell thick (*Fig. 6*), these empty cells extend from one side of the leaf to the other, so that if there is any water available it could enter both sides of the cells, thus making the absorption fairly rapid and complete. Moreover, there are small openings in these empty cells (*Fig. 5, p*), some on one side of the leaf and some on the other, to allow the water to pass in. These cells are strengthened by transverse thickenings (*Fig. 5, h*), forming a sort of band or hoop-like structure that prevents the cells from collapsing. The openings leading into the large cells are merely capillary in size, so that when once the water enters it does not readily come out unless some pressure is exerted. Similar absorbent cells, often retort-shaped, occur in the outer cortex of the stem (*Fig. 8*). They are also devoid of protoplasm, and often have open communication with each other and the outside by means of small capillary pores similar to those of the leaf (*Fig. 8, p*). It is these large empty cells in the stem and leaf that serve as reservoirs for holding and conducting water. Their effect is like that of a sponge, thus making these plants valuable for surgical work. The leaf, however, is the main organ of absorption and the part of the plant that is the most valuable for surgical dressing. Every precaution therefore should be taken to prevent any loss. The leaves are very

The writer wishes to acknowledge his indebtedness to Prof. T. C. Frye for the photographs used in Figs. 1 to 4; to Prof. G. B. Rigg for those in Figs. 9 and 10; to Mr. G. H. Martin for those in Figs. 12 to 17 inclusive; to Miss Agnes Carlson for the drawings in Figs. 5 to 8; and to the Northwest Division of the Red Cross for Fig. 11.

minute and mostly on the clustered lateral and terminal branches. Some of these branches hang down and adhere closely to the side of the stem, others are horizontal, while those at the top of the stem range from almost vertical to horizontal and form a more or less rosette structure (Fig. 4).



A. Carlson, Del.

Figs. 5 to 8

Sphagnum palustre

e, epidermis

g, green cells, containing chlorophyll

h, hoop-like bands

p, pores or openings into the reservoir cells

r, reservoir cell

t, thick-walled cells that constitute the wiry center of the stem

Fig. 5. Surface view of a portion of a leaf. x 300.

Fig. 6. Part of a transverse section of a leaf. x 275.

Fig. 7. Part of a transverse section of the stem. x 300.

Fig. 8. Reservoir cells from the epidermis of a branch. x 225.

SPHAGNUM BOGS

The term "Sphagnum bog" is applied to a low, marshy place in which peat moss and usually certain evergreen shrubs are growing. The brown, fibrous peaty bog material often extends several feet deep. It is readily distinguished from a common swamp by the presence of Sphagnum. Many of the bogs in Washington are found in clear open

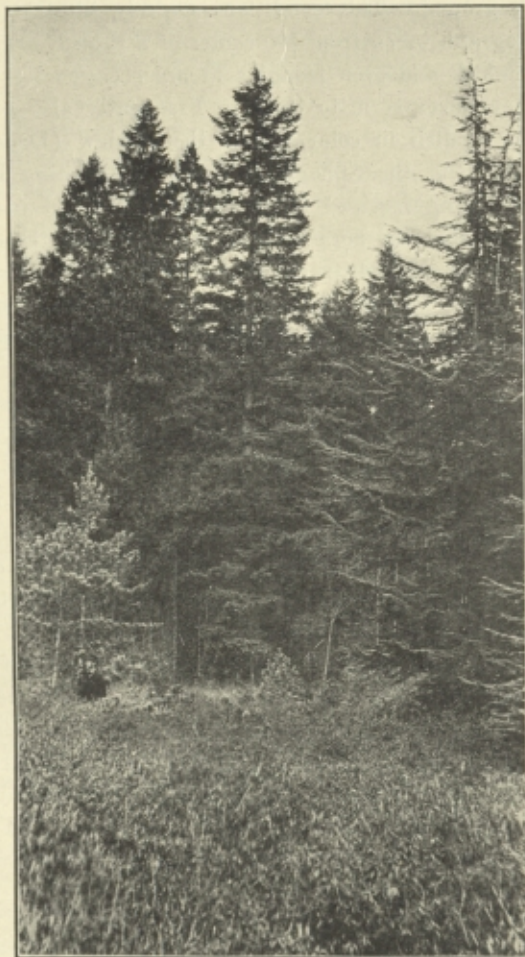


Fig. 9

A typical peat bog. In the foreground is Sphagnum, Labrador tea, cranberry and swamp laurel. In the background are conifers with certain deciduous shrubs between.

spaces in the dense forest, with or without an open lake in the center. In Alaska, however, they are frequently found on treeless plains.

On examination of a typical Washington Sphagnum bog, one may observe in the center Sphagnum mixed with cranberry (*Oxycoccus oxycoccus*), swamp laurel (*Kalmia polifolia*) and Labrador tea (*Ledum groenlandicum*). Around the margin, just outside the area where the Sphagnum grows and usually a little lower and consequently wetter, may be found willow, alder, aspen, wild crab, hardhack, etc.; while conifers fringe the high ground. This condition is nicely illustrated in Fig. 9, which is a photograph taken from the center of a typical bog.

Stunted hemlock and even Douglas fir are occasionally found out in the bog, but they never seem to thrive. Frequently also a pretty little flat plant, often reddish in color, called the sundew (*Drosera rotundifolia*) is found among the Sphagnum. It is interesting because it is insectivorous, obtaining most of its food from captured insects. It is interesting to note that the flora of peat bogs, at least those of western Washington, is almost entirely xerophytic, that is, "the plants characteristic of these bogs show such structural character as we would expect in plants growing in dry places, in spite of the fact that the substratum in which they grow is wet."²

The bog water is usually acid. This acidity tends to inhibit the growth of certain bacteria. Although this is true, bog waters as a rule are not very strongly antiseptic. Large numbers of bacteria have been found in peat bogs by different investigators, but no pathogenic forms have ever been reported. This, however, has little bearing on the usefulness of the moss for surgical dressings, since these are all sterilized before being used. The point of interest is that there is absolutely nothing harmful present that sterilization will not remove. True, some species, as has been said, produce coarse, wiry stems which, if used, might penetrate the pad and cause irritation of a wound. Such material, however, is not only not recommended for surgical pads but is constantly rejected. It has been demonstrated, also, that there is a toxic substance in bog water that affects plants, preventing some, like the common Wandering Jew (*Tradescantia*) from developing root-hairs and possibly to a limited extent inhibiting the growth of bacteria.

USES OF SPHAGNUM

Sphagnum is frequently called "peat moss" because it, with other plants growing in undrained bogs, eventually makes peat, which is used extensively for fuel in some countries. Sphagnum is very commonly used

²George B. Rigg. A summary of bog theories. Plant World, Vol. 19, pp. 310-325. 1916.

by nurserymen and others for packing, especially is it desirable about the roots of plants when moisture is required for a considerable length of time. A number of varieties of orchids thrive as well in *Sphagnum* as in their native haunts. This moss makes an excellent insulator, much better than sawdust or even cork, but of course it cannot be used where it is exposed to moisture. It excels sawdust as a medium for packing and shipping raw fruit, like grapes, because when one bunch "goes bad" the moss immediately absorbs the moisture and prevents the infection from spreading. In Sweden some of the coarser kinds of paper, like wall paper, wrapping and building paper, are made from this moss. It is used in Alaska and other places where it is abundant to bind up wounds of domestic animals, particularly when there is some discharge. In such cases the moss is applied directly to the wound. When dried it is often used as bedding for horses and other animals. This moss also has been used in Scotland and Ireland as a home remedy for absorbing the discharge from boils or other suppurating wounds. The American Indians made use of dried *Sphagnum* for diapers for their babies. In Alaska they still do it. More recently it has been used for surgical dressings. This is not entirely the outcome of the present war, although the perfecting of such dressings and their extensive use have been.

Early in the present century a school called "*Svenska Statens Torfskola*" was established at Markaryd, Smoland, Sweden, for the study of peat and peat bogs. Although the main emphasis is placed on peat as a fuel in this institution, yet some consideration is also given to the possibility of *Sphagnum* as a surgical dressing.

Like many other great discoveries and inventions, the use of *Sphagnum* as a surgical dressing was discovered by accident. "In the early eighties of last century a workman at one of the outlying peat moors in north Germany accidentally sustained a severe lacerated wound of the forearm. In the absence of anything better to apply to the wound, his fellow-workman wrapped it up with fragments of peat which were lying near, and after an interval of ten days he arrived at the surgical clinic at Kiel with the original dressing undisturbed. It was feared that the wound when exposed to view would be found in a very unsatisfactory state, but on the contrary when the peat dressing was removed the wound was found to have healed in a most satisfactory manner. The unexpected result obtained with a dressing material which at first sight seemed so unpromising led to a very careful inquiry into its nature and properties. An investigation was made from the physical, chemical and bacteriological points of view of the growing plant on the surface of the moor downward through the various stages of decay to the brown amorphous depths

below."³ The practical outcome of this inquiry was that the value of Sphagnum as a surgical dressing was found to be due to its marvelous power of absorbing fluids. It was found that the growing plant collected and dried had this power at the maximum, but the light brown layers of semi-decayed moss which lie above the peat proper retain great absorptive powers also. It is probable that it was from this partly decayed material that the temporary dressing just mentioned was taken. This account was given by Neuber,⁴ a German surgeon, in 1882. It was followed by a number of other articles on the same subject by other writers.

Sphagnum was first employed in a large way during the Russo-Japanese war, in which the Japanese used it quite extensively as a first-aid dressing. Many of the wounds thus dressed were not inspected again until the patient reached Japan, which often took ten days, but almost invariably the wound was in good condition; much better it is said than when cotton was used.

Although the value of Sphagnum as a surgical dressing was known perhaps to the majority of the surgeons of Germany, it was not used to any great extent until the present war began.

WHAT THE BRITISH HAVE DONE

Shortly after the war broke out in 1914 Dr. C. W. Cathcart, an Edinburgh surgeon and a lieutenant-colonel in the medical corps of the British Army, began experimenting with it in one of the Scottish war hospitals. The first published account of these experiments together with the general account of the moss as a surgical dressing appeared in *The Scotsman* of November, 1914.⁵ Dr. Cathcart then formed an organization for collecting and preparing the peat moss for surgical pads in Edinburgh. This was the first organization formed for this purpose among the allied nations. In September, 1915, a second one was formed in the South of Ireland by the Marchioness of Waterford. The work thus begun was so promising that new organizations sprang up all over Scotland and Ireland under the directions of the War Dressings Supply Organization in Edinburgh, and the Irish War Hospital Supply Depot in Dublin. During this experimental stage there was considerable opposition to this kind of surgical pad, but as time went on and the method of making the dressings was improved, this opposition disappeared. Thus in February, 1916, the British War Office accepted them as "Official" Dressings, placing all the

³Charles W. Cathcart. Cheap absorbent dressing for the wounded. *British Medical Journal*, July 24, 1915, pp. 137-139.

⁴Erfahrungen über Iodoform und Torf-Verbande. *Arch. f. Klin. Chir.*, Vol. 27, p. 757. 1882.

⁵Charles W. Cathcart & I. Bayley Balfour. Bog Moss for Surgical Dressings. *The Scotsman*. Nov. 17, 1914.

volunteer organizations under a Director-General of the Voluntary Organizations with Sir Edward Ward at its head. With this recognition and organization the work rapidly increased. "The total British output of dressings from Sphagnum, amounting to barely 250 per month in September, 1915, had reached 150,000 per month a year later, and exceeded 200,000 from officially organized bodies alone by the last of the year.⁶ Since then the output of Sphagnum dressing has gradually increased so that at the present time (1918) the British are making 1,000,000 pads a month. It has been estimated that if absorbent cotton were used exclusively in the hospitals the cost would be not less than \$200,000 per annum for Great Britain alone, while the cost of the moss is practically negligible.

The Sphagnum work in America has been more recent than that in Europe. During the summer of 1916 Dr. J. B. Porter of McGill University became interested in peat moss for surgical dressings. Samples were collected in eastern Canada, especially Nova Scotia, and sent to Britain for approval. It was late in the season before definite reports could be obtained from these samples, so comparatively little was done before the bogs were frozen.

In the spring and summer of 1917 this work was continued⁶ by the Canadian Red Cross under the direction of Dr. Porter. Although no very large number of dressings was made, yet the organization was extended and perfected, and the bogs containing the desirable moss located so that if the demand became more urgent the production of this kind of dressing could be rapidly pushed. This demand came in January, 1918, in the form of an order from the British War Office for 20,000,000 Sphagnum surgical dressings. The Canadian Red Cross is thus planning extensive work along this line during 1918.

HOW THE WORK BEGAN IN THE UNITED STATES

After the United States entered the war more interest was taken in this work by Americans. During the summer of 1917 the late Harry James Smith, acting under the direction of the National Surgical Dressings Committee of New York, visited eastern Canada and worked with Dr. Porter. Through Mr. Smith's generosity Sphagnum was gathered and shipped from Nova Scotia to New York City and there made into surgical dressings similar to those made by the Canadians. During the fall this committee made up about 2,000 pads and sent them directly to France. However, when the American Red Cross undertook this work early in January, 1918, the National Surgical Dressings Committee dis-

⁶John B. Porter. Sphagnum surgical dressings. *Internat. Jour. Surg.*, May, 1917.

continued it, and Mr. Smith entered the National Bureau of Development, with *Sphagnum* dressings as his special work.

While this was going on in the East, similar work was started in the West. Early in July, 1917, a request came from the French Relief to the President of the University of Washington, at Seattle, to ascertain if suitable moss for surgical dressings grew in this region. This communication was handed to the writer, who immediately collected samples from various bogs in the vicinity of Seattle and sent them to the French Relief Committee at Chicago, where Mrs. J. Gordon Wilson, who had just returned from France and had seen the value of these pads at first hand, was attempting to form an organization to make these dressings. The samples presented were declared suitable for surgical work, but the supply of moss was too far away from the people of Chicago for them to handle the work. The writer obtained working directions from this committee, and also from Dr. Porter of Montreal, so that by the time the University opened in October sufficient information had been accumulated from various sources to warrant going ahead and making some of the dressings. The directions followed were those obtained from Canada, as the American Red Cross had, as yet, no definite instructions for this phase of Red Cross work.

As soon as the University opened, the Faculty Wives' Club undertook to make the pads for the French Relief, and any success that has been attained is largely due to their co-operation. The faculty men collected the moss. The students and interested persons in the neighborhood of the University sorted it. During the first six weeks 2,264 pads were made and shipped direct to France through the French Relief. At the end of that time it was thought best that this club be identified with the American Red Cross, consequently a local auxiliary of the Seattle Chapter was formed. Since then and up to March 1, 1918, this auxiliary has made over 10,000 surgical dressings and 460 ambulance pillows. These have been accepted by the Red Cross and shipped through the regular channels. During this time four other auxiliaries began making these pads under the writer's direction, one at Aberdeen, one at Olympia, one at Everett and the Faculty Women's Club of the University of Washington. Up to March the first, these auxiliaries made about 2,000 pads.

Realizing the possibilities of this Red Cross work, the War Emergency Committee of the University of Washington appointed a sub-committee on *Sphagnum* with the writer as chairman. It was felt desirable and even necessary to know where the best moss was located. To this end the sub-committee sent a circular letter to all the botany teachers in the high schools of western Washington, the principals of public schools, to the forest rangers and to other persons who might be able to give infor-

mation as to the location of peat bogs and the approximate amount of moss in them. In this survey large numbers of bogs were located, estimated at 25,000 acres. The first estimate of the quantity of moss in individual bogs was frequently found to be greatly exaggerated. In many of these the character of the moss rendered it absolutely useless for surgical work. The next step then was to locate bogs containing desirable moss, and, when possible, to instruct some local person how to distinguish and collect this material. To accomplish this small samples from each bog that was reported were called for. In cases in which it seemed necessary the writer visited these bogs and gave instructions as to collecting and shipping. In most instances the instructions could be given by samples and letter. In this search for *Sphagnum* the Mountaineers of Seattle, Tacoma and Everett rendered a splendid service.

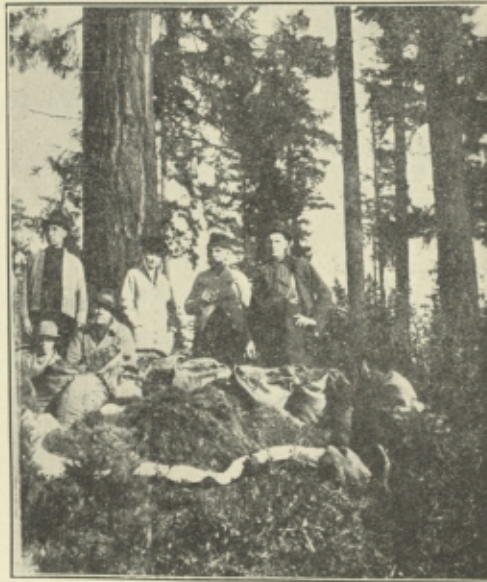


Fig. 10

A group of moss pickers with the result of their labors.

It was soon ascertained that although there were large quantities of *Sphagnum* in the vicinity of Seattle, there was very little that could be considered high grade and suitable for surgical dressings. The first bog containing the better species of moss (*Sphagnum palustre*) was located in the vicinity of Buckley. There the public school and the local Red Cross auxiliary organized to gather and ship it to the University. Later

large quantities of this better grade were found along the west side of Hood Canal from Port Ludlow to Potlatch, mostly *Sphagnum palustre*. Very desirable moss has also been located around Shelton, Matlock and other places in Mason County. In Snohomish County, although large numbers of bogs occur, only isolated ones containing good material have thus far been located, near Stanwood, Tulalip and Silver Lake. Several bogs containing high grade moss have been reported from Whatcom County, near Sumas, Custer and Ferndale as well as just across the border in British Columbia near Sumas.

The largest and most promising supply of usable moss has been located in Pacific County, especially in the southwestern part of it. The species found in the neighborhood of Ilwaco is largely *Sphagnum imbricatum*, while north of Willapa Bay, where the moss is plentiful, the species is mostly *Sphagnum papillosum*. Farther north along the coast, both north and south of Grays Harbor, desirable *Sphagnum* in large quantities has been located. These regions have been organized for volunteer collection of moss, and it is expected considerable quantity will be gathered during the summer, the surplus amount being stored for any sudden demands.

Samples have been obtained from several places in Alaska; *Sphagnum palustre* and *Sphagnum papillosum* from the Tongass National Forest near Ketchikan, *Sphagnum imbricatum* from Sitka. Desirable moss has also been received from Anchorage, Skagway, Matanuska, Juneau and other places. It is estimated that there are millions of tons of moss suitable for surgical dressings scattered over the tundras of Alaska.

On March 1, 1918, *Sphagnum* was officially recognized by the National Red Cross of America and authority given the Northwest Division to make *Sphagnum* dressings of the new type. (The three auxiliaries meeting on the campus of the University of Washington, Seattle, were the first organizations in the United States to undertake this work under the direct authority of the National Red Cross. A preliminary order for 50,000 pads was given the Seattle Chapter, and these are being made at the workrooms on the campus. The instruction in making these new pads was given by the late Harry James Smith, who had come from New York City to investigate the amount of suitable moss available on the Pacific Coast and to introduce the new surgical dressings.

The Faculty of the University of Washington, feeling the importance of this phase of War Emergency work and wishing to assist in completing as rapidly as possible this large allotment of pads, voted to require all women of the first and second years in the University to register for two hours a week for moss work during the Spring Quarter. The request for this work came originally from the women themselves through the



Fig. 11

The late Harry James Smith gathering moss in a bog
on the Pacific coast.

Dean of Women. They felt that since the men were required to devote eight hours a week to military drill without university credit, the women also should do some definite war work under University supervision. It is confidently expected that the first allotment of *Sphagnum* surgical pads will be completed at the University before June 15th.

It is interesting to note that the base hospital at Camp Lewis is using *Sphagnum* dressings instead of absorbent cotton. The moss is collected and sorted by the Tacoma Mountaineers and the nurses at the hospitals make the pads, which have proved highly satisfactory to the surgeons and saved the institution hundreds of dollars.

COLLECTING AND SORTING

Before beginning to collect *Sphagnum* one should know exactly what is needed. Samples of the moss should be submitted to headquarters and approved before any collection is undertaken. It is often wise to carry a

sample of approved *Sphagnum* for comparison until one is quite familiar with the work.

It has been found that a great deal of time can be saved by a little care in collecting this moss. The cleaner it is gathered, the more valuable it becomes by saving time in sorting. It is best to take a small handful at a time, shake to get rid of most of the foreign matter, such as twigs, roots, etc. If wet, squeeze out as much water as possible before putting it in the bag, but do not wring it, as that will break and injure the stem. In some instances, especially with *Sphagnum imbricatum*, the moss may be removed in large masses with a fork if too much foreign material is not obtained in doing so.

The depth to which usable moss extends varies with the species and environment. In many cases beds of *Sphagnum imbricatum* may be worked to advantage a foot to 18 inches or even farther, depending on whether the plants remain intact or whether a partial decay has begun. In general, whenever the plants begin to break up as a result of the first stages in decay, they must be discarded; but as long as they remain intact, with the stem fairly well crowded with lateral branches, they may be used, the color playing little or no part in determining the suitability. While gathering moss it is wise to secure all the good material in a given space before proceeding to another, because after a growth has once been disturbed the adjoining plants usually deteriorate and sometimes die.

After it is taken from the bog the moss still contains a large amount of water. If possible it should be taken to some shelter near by and spread out to dry. This may be done on the grass if the weather is fine, otherwise on racks similar to the one shown in Fig. 12. While it is thus drying the coarser and more conspicuous foreign material may be removed. Before it becomes perfectly dry it is repacked loosely in clean gunny sacks and shipped to the workrooms, where the sorting is completed. In an emergency the moss may quickly be made ready for shipment by passing it carefully through a clothes wringer the rollers of which should be as loose as possible. The moss should be lightly enclosed between strips of burlap as direct contact with the rollers will cause considerable breakage.

The collection of the moss is one of the most important phases in the making of *Sphagnum*. Much depends upon the condition of the moss when it reaches the sorters if their work is to be most efficient. It has been found that carelessness or thoughtlessness on the part of the collector often decreases the efficiency of the sorter exceedingly. The Canadian Red Cross has emphasized this point in its printed instructions to collectors: "It is impossible to exaggerate the importance of care in collecting the raw moss. In ordinary localities it is impossible at best

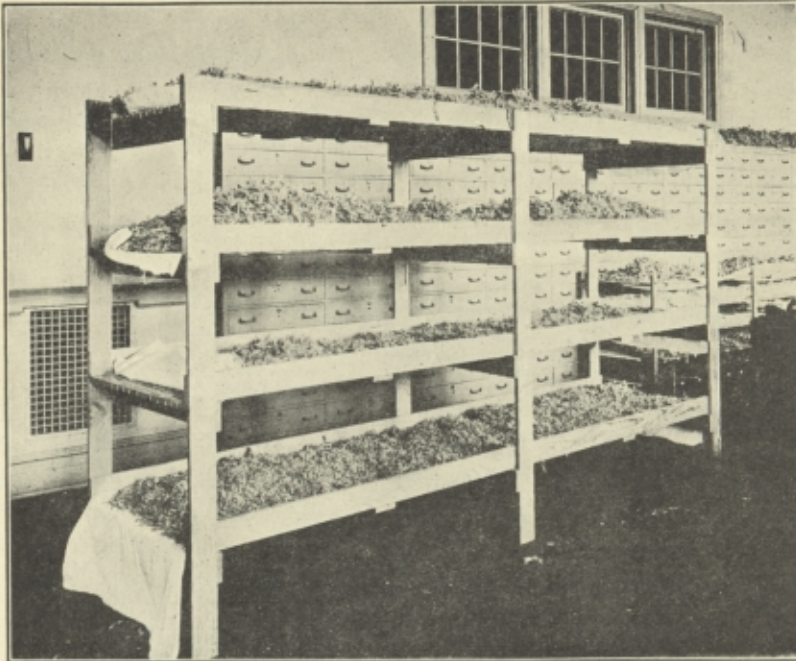


Fig. 12

A rack for drying moss. The rack is 30 feet long, 27 inches wide and 6 feet high, the shelves 18 inches apart. The bottom of each shelf is chicken wire; the sides 4 inches deep. The wire is covered with unbleached muslin, which may be drawn out when the moss is dry.

to avoid collecting considerable proportions of poor moss, and a certain amount of grass and weeds, and it must be remembered that such foreign material not only takes the place of useful moss in the sack, but also that it all has to be laboriously removed by hand when the stuff is sorted. Practical experience has shown that carelessness on the part of the collector often decreases the efficiency and output of the sorter to an enormous extent and not infrequently renders an otherwise useful supply of moss worthless for practical purposes." It should be the aim, therefore, to make a record for the quality, not for the quantity.

The moss should be collected in clean gunny sacks. If the sacks have been used for potatoes or similar material, they should be boiled at least one hour and then dried before using. If gunny sacks are not available packing boxes of convenient size might be used.

The most tedious part of making *Sphagnum* pads is picking over and

sorting the moss. This should be done in some central place and completed before the moss becomes dry. In fact, when making the British pad, it is best not to allow it to get perfectly dry until after it is made into the dressings, because the moss becomes brittle and the small leaves, which are the most valuable part of the plant, break off and are lost. If inadvertently the moss becomes too dry, spread it out in a gentle rain for a short time or sprinkle with water and lay an oilcloth over it.

Besides removing all the foreign material like leaves, twigs, small roots, etc., the moss is usually separated into at least two grades, the first consisting of the softest, most elastic and absorbent plants used for surgical dressings, while the second consists of coarser and less absorbent moss which is suitable for bed pads. The second grade material may also be used for pillows, which are lighter than the ones made from clippings. It is not wise, however, to gather second grade moss for making bed pads and pillows, since sufficient material for this purpose is ordinarily obtained from picking over the first grade. Fig. 13 is a photograph of a group of women sorting moss in the work-rooms at the University of Washington.

HOW SPHAGNUM DRESSINGS ARE MADE

Like many other things in connection with this war, the directions for making surgical dressings from *Sphagnum* have not been static, but progressive. From time to time valuable suggestions as to where the pads could be improved have been received from surgeons at the front who have been actually using them. Acting on these suggestions, the British have gradually increased the efficiency of their moss dressings. More recently the American Red Cross, after some experimentation under the direction of Dr. John A. Hartwell, has adopted a different dressing, which promises to be even more efficient than those authorized by the British War Office. But the last word has not yet been said on *Sphagnum* for surgical dressings. Both the British and American methods of making them will be briefly discussed.

The present British method of making *Sphagnum* pads is to put the moss into small bags or pillows of definite size. The material used for this purpose is an English long cloth of fairly fine weave, but of the lightest possible weight. Any other material will do equally well, provided it has a close enough weave to prevent the fine particles of moss from coming through. Gauze or cheese cloth is too open for this work. Whatever cloth is used, it must be laundered to get rid of the sizing or stiffness before it is made into pads, otherwise the rapidity with which the liquid passes through the cloth is greatly reduced.

It is very difficult to give exact instructions regarding the weight

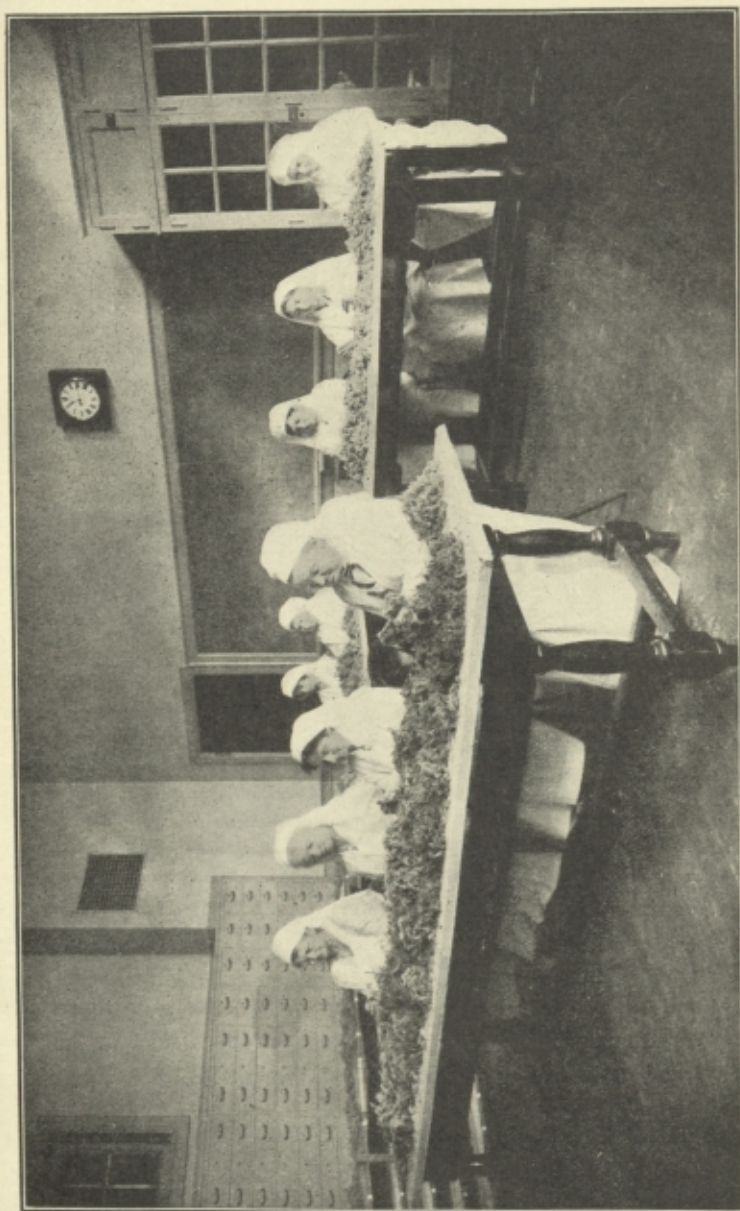


Fig. 13. Sorting moss in the work-rooms at the University of Washington, Seattle

and thickness of these pads because not only do different species of *Sphagnum* vary greatly, but there are wide differences between specimens of the individual species themselves from different localities. Under these circumstances no attempt is made to specify exact weights, but merely to give approximate figures. A rough and ready test which may be used is to hold the dressings up to the light. They should be sufficiently full to cut off nearly, but not quite, all the light. The object is to see that the pad is sufficiently thick to serve its purpose and yet as loose and light as possible without sacrificing the absorbent power. This is slightly different from the directions given for oakum pads, into which sufficient material is put to completely shut out all the light. Fortunately, minor difference in thickness and weight are not of great importance, but the accompanying figures may be a guide.

The following table of sizes and weights of *Sphagnum* dressings are those recommended by the Canadian Red Cross and accepted by the British War Office.

TABLE 1. *Approximate weights and sizes of Sphagnum dressings*

6x 6 inch surgical pads	10	grams or $\frac{1}{2}$ oz. approximately
6x 8 " " "	14.5	" " $\frac{3}{4}$ " "
8x 8 " " "	18	" " $\frac{3}{4}$ " "
8x12 " " "	28	" " 1 " "
12x15 " " "	53	" " 2 " "
18x18 " " "	106	" " 4 " "
18x18 dysentery pads	160-200	grams or $5\frac{1}{2}$ -7 oz.
12x12 pillows or elbow pads	80	grams or $2\frac{3}{4}$ oz. approximately
6x19 inch splint pads	25	" " 1 " "

It should be remembered that the weights are only approximate. The best qualities of moss are, generally speaking, lighter and fluffier than material of poorer grade. The first-class moss will be usually lighter than the second class. For the splints, bed pads and pillows either the same long cloth or unbleached muslin may be used.

When *Sphagnum* dressings are undertaken for the first time, samples are sent to the Red Cross headquarters for approval before any large number is made. These are returned with appropriate criticisms.

To obtain uniformity it has been found quite advantageous to allot to one or two workers the responsibility of cutting out the dressings. After tearing off the selvages and allowing for seams, etc., the cloth is torn lengthwise the required width. For the cross cuts, the thread is usually drawn at twice the required length of each pad. These are doubled and the sides are stitched on a sewing machine; the seams are

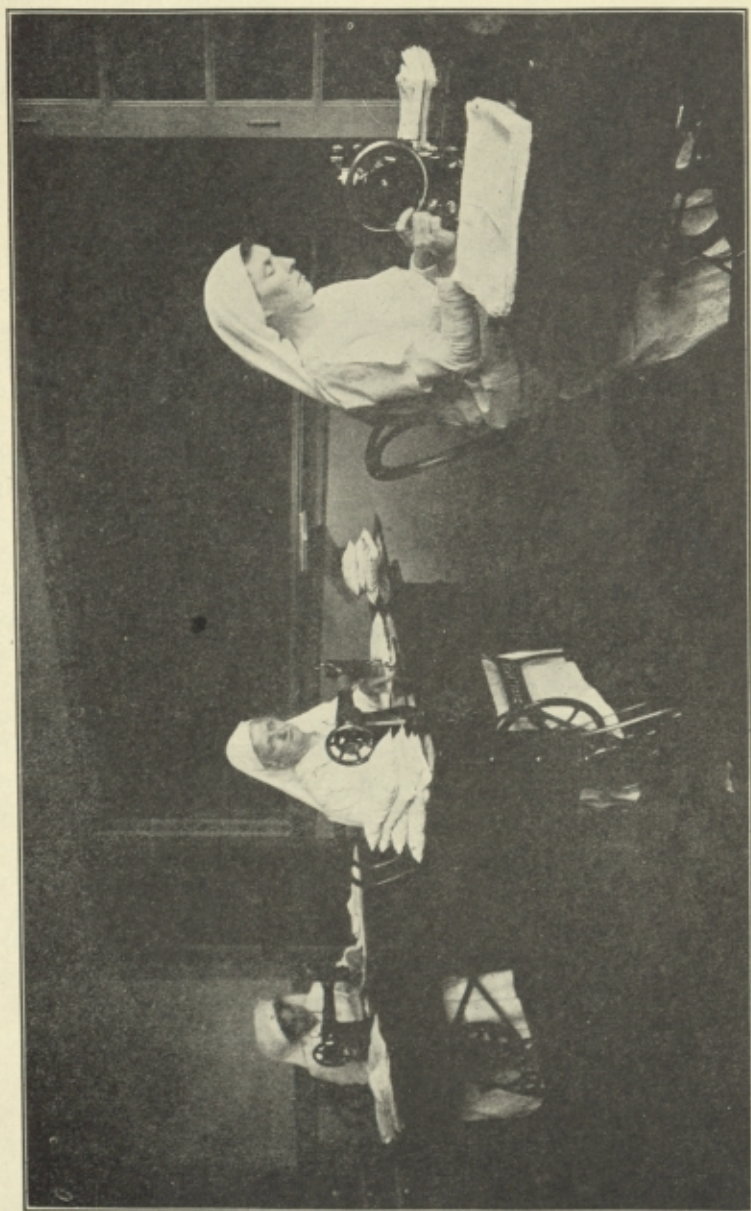


Fig. 14. Sewing surgical pads in the work-room at the University of Washington

between one-eighth and one-sixteenth of an inch inside the ravellings. The bags are then turned inside out and filled with the required amount of moss. A group of women sewing these pads is shown in Figure 14. Since the moss is not perfectly dry when it is put into the pads it has been found best to baste the top and leave them until they are dry or nearly so, since frequently they need a little additional moss under these conditions. Figure 16 shows a rack for drying these pads. They are finally stitched either on the machine or by hand. The bastings and all ravellings are removed. The pads should not be dried by artificial heat, if it is possible to avoid it. When perfectly dry, they should be tied up in packages of 10, 15 or 20, pressed tightly together, bound with strips of cotton or the selvedge that has previously been torn off, and the size and number of pads marked on the outside of each package. Nearly 15,000 of these pads have been made by the different Red Cross auxiliaries in the State of Washington.

Although the dressings just described are of great value at the front, there are certain criticisms of them offered by American surgeons. In spite of these, however, the British continue to use them at the rate of 1,000,000 a month; and as has already been said, the Canadians have recently received an order for 20,000,000. One of the psychological objections is that they do not look like the pads that American surgeons have been accustomed to using, so there is more or less prejudice against them merely on account of their general appearance. Besides this, when a suppurating wound is dressed with one of these pads, there is nothing to prevent the discharge from soaking through the bandage and soiling the bedding. This undesirable condition is often increased by the manner of applying the pad. As the dressing is drawn over the wound, frequently the center of the pad, which is the part covering the discharge, has the least Sphagnum, most of it being pushed to the two ends, so that the bandage becomes wet long before the moss has finished its work. Looking toward a solution of some of these objections, Dr. John A. Hartwell, Director of Surgical Dressings for the National Red Cross, assisted by the late Harry James Smith, began a series of experiments in New York City during the fall of 1917. These experiments have proved so highly satisfactory that a new type of pad has been introduced. An actual test in the city hospitals of New York has shown that it is a very marked improvement over the official Sphagnum dressings used by the Allies. These experiments are still under way, and any directions that may be given at this time must be construed as merely tentative, since minor changes will probably be made from time to time. Thus far, however, results are quite promising, and it is confidently expected that this new dressing will be a decided contribution toward the efficiency of Sphagnum dressings.



Fig. 15. A load of Sphagnum pads on the way to the packing rooms

These pads are quite different from the British type just described. They are composed of gauze, a thin sheet of wood pulp paper, non-absorbent cotton and Sphagnum. There is no sewing in connection with them, but simply a process of folding somewhat similar to the familiar gauze dressings which they resemble in appearance.

The sizes of the dressings will vary from time to time as the War Department may recommend. The following are the sizes being made at the present time. Of these, 8x12 is considered the standard size and the one of which the most are made.

No. 1.	6x 8 inch	Sphagnum absorbent pads; first grade moss.
No. 2.	8x12	" " " " " " " "
No. 3.	11x18	" " " " " " " "
No. 4.	11x24	" " " " " " " "
No. 5.	16x24	" " " " " " " "
No. 6.	11x18	" Sphagnum paper-backed pads; second-grade moss
No. 7.	16x24	" " " " " " " "

In making one of these dressings, a piece of Scot tissue⁷ of appropriate size is placed on the table and on it a wooden frame corresponding to the particular size to be made. After the frame, which is about three-quarters of an inch deep, is filled evenly with moss it is removed and a thin layer of non-absorbent cotton is put over the Sphagnum. The margins of the tissue are then folded over the cotton and Sphagnum. It is usually convenient to use spring clothes-pins to hold the ends in place. In order to keep the outside covering free from particles of moss it is best to remove this incomplete pad to another table where there is no moss. Here it may be finished by the same worker or by another. A piece of gauze of appropriate size is spread out on the table and the incomplete pad is placed in the center of it, with the non-absorbent cotton up. A thicker layer of cotton is then put over the pad, extending about a quarter of an inch beyond the edges. The gauze is folded over the pad so that the long fold is on the back, that is on the side next the non-absorbent cotton.

The open ends are folded in "muff-wise", first folding the under side up over the tissue-envelope, then folding the upper side to correspond and adjusting the "muff-end" carefully. The pad is patted more or less vigorously to make sure the Sphagnum is evenly distributed throughout and then passed through a clothes-wringer. If, when held up to a strong light, "holes" are detected in the pad too little moss has been used. If the pad is solid and harsh, there is probably too much moss.

⁷Scot tissue is a very thin wood-pulp paper used to envelop the Sphagnum and prevent it from shifting.

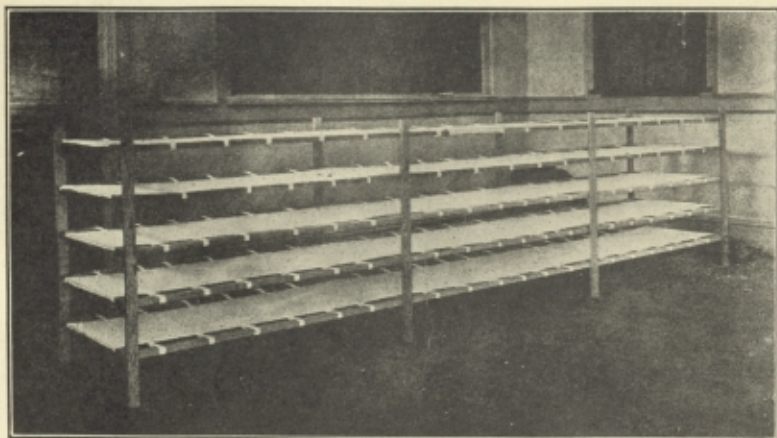


Fig. 16. A rack for drying the British type of pad

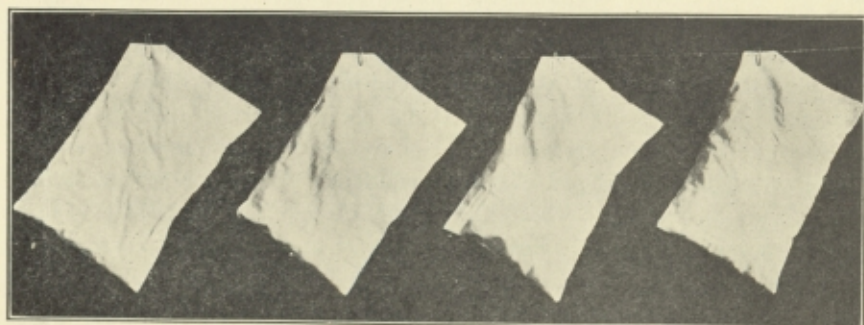


Fig. 17. Pads hanging up to drip when testing the absorbency

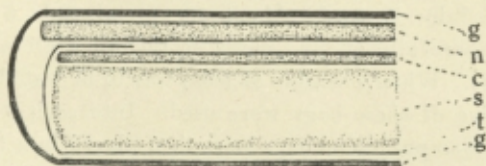


Fig. 18

A diagram showing a portion of a cross-section of a Sphagnum dressing; *c*, inner non-absorbent cotton; *g*, gauze; *n*, outer non-absorbent cotton; *t*, Scot tissue; *s*, Sphagnum.

Figure 18 is a portion of a cross-section of one of these dressings, illustrating the relative position of the different parts. The gauze (g) on the outside holds everything in place and exposes a soft absorbent surface to the wound. Immediately above it is the Scot tissue which partially envelopes the Sphagnum and the thin layer of cotton. The Sphagnum (s) is the absorbing agent, the thin layer of cotton (c) just above it tends to keep the moss from shifting, while on the back of the pad the packing of non-absorbent cotton (n) prevents the discharge from soaking through the bandages.

The paper-back pads, which are of two sizes, are bed pads used largely for dysentery patients. They are made in a manner similar to the ones just described, except that a second grade of moss is used instead of the first grade and that five thicknesses of newspaper, cut to the specified dimensions of the pad, are sewed to the back of it with large "over-and-over" stitches. In the larger size, the pads should be caught down once to the newspaper at the middle of each side.

ABSORBENCY OF SPHAGNUM

In order to obtain some definite information regarding the absorbency of the various species of Sphagnum found on the Pacific Coast, a series of tests have been undertaken. It has been observed that the same species of Sphagnum frequently varies considerably when found under different environmental and climatic conditions. Wherever possible tests were made to determine what effect these different conditions had on the absorbency of the plants. *Sphagnum palustre* in particular is susceptible to variation due to local influence. Species found in somewhat shallow places in the bog, or in bogs that have a limited supply of water, especially if they are partially drained, are so different in general appearance from those found where conditions are more favorable that one would hardly suspect that they were identical.

The method adopted for testing the absorbency is practically the same as that used by Porter.⁶ About 30 special pads 6 inches square were made very carefully of long cloth, so that they all weighed exactly the same, 5 grams. When a sample of moss was to be tested, at least three and sometimes five of these bags were used. Into each 5 grams of air-dried Sphagnum was put. The bags were then placed in a tray containing distilled water, about one centimeter deep, and the time it took the moss to become saturated was observed. More distilled water was added to the tray from time to time as it was needed. When the moss was saturated the bags were hung up to drip. This was done either by attaching them by the corner to a string stretched across the room (Fig. 17), or more

often the pads were pinned to the edge of a table. They were allowed to remain in this position until they ceased dripping, after which they were weighed, and the contents immediately emptied and the wet bag weighed. The difference in the weight of the saturated bag of moss and the saturated bag alone gave the weight of saturated moss. The absorbency is obtained by dividing this number by five. A few of the tests are given in Table 2.

TABLE 2. *Showing the absorbency of Sphagnum*

KINDS OF MOSS	Where Obtained	Wt. of Dry Moss	Wt. of Sat. Moss	Absorbency
<i>Sphagnum palustre</i>	Nahcotta, Wash. ...	5	102	20.4
" "	" "	5	103	20.6
" "	Buckley, Wash. ...	5	93	18.6
" "	Tulalip, Wash.	5	77.6	15.5
" "	" "	5	79.8	15.9
" "	Stanwood, Wash. ..	5	88	17.6
" "	" "	5	84.5	16.9
<i>Sphagnum imbricatum</i>	Ilwaco, Wash.	5	91	18.2
" "	" "	5	90	18
" "	Sitka, Alaska	5	84	16.8
" "	" "	5	83.7	16.7
<i>Sphagnum papillosum</i>	Ketchikan, Alaska..	5	72	14.4
" "	North Cove, Wash.	5	77.6	15.5
" "	" "	5	79.8	15.9
" "	" "	5	71	14.2
<i>Sphagnum fuscum</i>	Grayland, Wash. ...	5	59.8	11.96
" "	" "	5	59	11.8
" "	Belmore, Wash. ...	5	58.5	11.7
" "	" "	5	58	11.6
" "	Grayland, Wash. ...	5	54	10.8
" "	" "	5	67	13.4
" "	" "	5	71.5	14.3
" "	" "	5	70	14
<i>Sphagnum recurvum tenue</i>	Covington, Wash....	5	43.5	8.7
" " "	" "	5	42.5	8.5
" " "	" "	5	36.5	7.3
" " "	" "	5	39	7.8
<i>Sphagnum capillaceum tenellum</i>	Belmore, Wash. ...	5	56	11.2
" " "	" "	5	61.4	12.3

SPECIES OF SPHAGNUM SUITABLE FOR DRESSINGS^{*}

There are about 50 species of *Sphagnum* in America. Of these only about four can be depended upon for surgical dressings. Along the coastal regions of the Pacific northwest 23 species are found. Among these are the four suitable for surgical dressings; namely, *Sphagnum palustre*, *S. papillosum*, *S. imbricatum* and *S. magellanicum*. All of these are high in absorbency (table 2), varying from 14 to 20. Thus it will be seen that there are a large number of species of *Sphagnum* which are of little or no use for surgical dressings, and great care should be exercised to insure that the most suitable species are obtained. The qualities of suitable *Sphagnum* are softness, flexibility, elasticity and an absorbency which is not less than 10.

The above mentioned species most frequently fulfill these conditions, although occasionally even these have to be discarded on account of not measuring up to some of these requirements, due largely to the influence of some local environment. This is particularly true of *Sphagnum palustre*, in which under certain conditions a more or less wiry stem is developed which sometimes becomes so pronounced as to render it useless. On the other hand not infrequently we find that other species which are usually avoided for surgical work, when grown under favorable conditions, prove quite satisfactory, fulfilling practically all the requirements. Thus, the distinction between suitable and unsuitable material for surgical pads is not entirely a difference of species, but often a difference in the condition of growth.

The plants belonging to these four species are low, compact and robust. They are usually somewhat green but occasionally tinged with brown, reddish-brown or pink. They have comparatively large leafy stems which give the plants a soft, fluffy appearance comparable, in some cases, to the softest plumage.

They vary considerably in their general appearance, however, under different conditions of growth so that it is impossible to distinguish them at all times by their external appearance. The method of identifying these species is largely by the character of the internal structure of the leaves, which is not readily subject to change by external conditions.

They all have spiral thickenings in the cortical cells of the stem and branches. If a cross-section of a leaf is made, such as is seen in Figure 6, it will be found that in *Sphagnum magellanicum* the green cells are elliptical or oval, and usually not exposed on either surface of the leaf, or if at all only slightly on the inner surface. The walls of the hyaline cells are smooth where they come in contact with the green cells. The stem

^{*}The writer is indebted to Prof. T. C. Frye for the identification of the species of *Sphagnum*.

leaves are wide at the apex. This species, which is probably the least valuable of the four, is found abundantly along the straits of Magellan, hence the name. It occurs very sparingly in Washington.

In the case of *Sphagnum papillosum* the green cells appear lenticular to truncately elliptic, usually about the same amount of exposure on both sides of the leaf. The walls of the large hyaline cells are smooth to densely papillose where they come in contact with the walls of the green cells. The stem leaves are narrow at the apex. Extensive bogs containing *Sphagnum papillosum* are located north of Willapa Bay in Pacific County, and also along the coast in Grays Harbor County.

The green cells of *Sphagnum palustre* in cross-section (Fig. 6, g) appear as isosceles triangles which are narrower than an equilateral triangle and exposed only on the inner surface of the leaf. The walls of the large hyaline cells are smooth where applied to the green cells. The stem leaves are wide at the apex. This species is the most abundant in Washington. It is found well distributed over the Olympic peninsula, along Hood Canal, in Mason, Grays Harbor and Pacific Counties. It is also found in the vicinity of Sumas, Custer, Ferndale, Stanwood and Buckley.

In *Sphagnum imbricatum* (Fig. 1) a cross-section of a leaf shows the green cells as equilateral triangles which come to the surface of the leaf only on its inner side. The walls of the hyaline cells are strongly papillose where they come in contact with the green cells. The stem leaves are rather narrow at the apex. *Sphagnum imbricatum*, which is perhaps the most desirable species of the four, usually occurs in dense hummocks, often valuable moss extending a foot below the surface. The main source of supply of this species is in the vicinity of Ilwaco and certain regions of Alaska.

Among the species of *Sphagnum* that are less desirable are a few that might be mentioned. There is a small, slender, delicate species, *Sphagnum fuscum* (Fig. 4), which is usually compactly matted together in small hummocks. The plants are normally brown, but sometimes with only a trace of this color. Another species, *Sphagnum capillaceum*, resembles it in texture and general appearance except that it is red or has a reddish tinge rather than a brown. Both of these species, but particularly the former, are abundantly distributed throughout Washington and northward to Alaska. The most serious drawback to these species is a tendency to break up or crumble when dry. Even with very careful handling the leaves and small lateral branches break off and are lost. This is a somewhat serious objection, because it lessens the efficiency of the moss, since it is these leaves that do the major part of the absorption. Further, their absorbency is comparatively low, ranging from 10 to 13. These two

features prevent them from being used alone for surgical dressings. However, they are soft, flexible and fairly elastic, so that when mixed with about two-thirds of the better grade of moss they make quite satisfactory pads. Another species found commonly in the vicinity of Seattle is *Sphagnum recurvum* (Fig. 3). These plants are quite robust and have fairly long stems which are usually brittle and green in color. Their absorbency is low, ranging from 7 to 9. Even with the most careful selection of material it seldom runs over 10. This is partly due to the fact that the leaves are not only small and sparingly developed, but the cortical cells of the stem do not have pores, as in *Sphagnum palustre*. Moreover, this species when dry becomes very brittle and also produces a fine dust similar to that of *Sphagnum fuscum*.

STERILIZATION

The sterilization of all *Sphagnum* pads is done in France just prior to their use. This is accomplished by means of an autoclave in which the pads are placed and subjected to steam pressure of 15 to 20 pounds for 20 minutes. This high heat and pressure tend to make the moss brittle and to lessen its absorbency, but not to such an extent that it is entirely destroyed or even seriously impaired.

Early in his experiments Dr. Cathcart of Edinburgh discovered this effect on the moss when heat was applied. In an effort to overcome this difficulty he tried a number of experiments, using corrosive sublimate to sterilize. The strength adopted for moss was that commonly used for absorbent cotton, namely, one-quarter of one per cent. In order to determine the strength of the solution in which to soak the moss he first found what would be a convenient quantity of water to be left in the moss after the surplus had been wrung out of the pads. This depended, among other things, on the efficiency of the apparatus for squeezing out the water. The exact quantity left in the moss does not matter as long as the method adopted in making the calculations is not varied. In the apparatus used by Cathcart, which was a common clotheswringer, it was convenient to leave 20 oz. of the fluid for every pound of moss. That is, 16 oz. of dry moss weighed 36 oz. after having been soaked and wrung. The pads being thus treated were hung up to dry, after which they were ready for use.

In the experiments carried on by the writer, autoclaving had little or no effect on the rate of absorption, and the total reduction was so slight that it was not a serious objection. Moreover, in actual practice it is probable that seldom, if ever, does a *Sphagnum* pad reach the limit of its absorptive power, so that if only a small decrease in the maximum

occurs its usefulness is not seriously reduced. This is particularly true with the high grade moss such as is recommended for surgical work.

IN CONCLUSION

As already mentioned, the last word has not been said regarding *Sphagnum* for surgical work. Experiments are constantly going on, looking toward improvement in these dressings.

It should also be pointed out in conclusion that although *Sphagnum* for surgical dressings has been largely the result of the present war, a makeshift for a necessity that has arisen, yet there is every reason for believing that it is not going to be discarded when the war ends. The inexpensiveness of the moss, its high absorbency, its abundance in certain parts of the country and its undoubted superiority over gauze and absorbent cotton for some purposes, clearly indicate that it is too important as a hospital equipment to let die with the war. When the war is over it will probably take its place as a regular commercial product called for by the modern hospital.

This opportunity is taken for paying the highest tribute to the memory of the late Harry James Smith of New York City, who was killed in an automobile accident near Murrayville, B. C., March 16, 1918, where he had gone in search of *Sphagnum*. Mr. Smith was "a full-time volunteer" connected with the National Bureau of Development of the American Red Cross with *Sphagnum* Dressings as his special work. He arrived in Seattle two weeks previous to his death to investigate the *Sphagnum* situation and to ascertain if sufficient desirable moss was available in this Division to warrant the expansion of the work. Besides this he gave instructions in the method of making the surgical pad referred to above. His untimely death has been a serious blow to the cause of moss dressings and a great loss to his country, for which many more years of patriotic service might well have been expected.