behind Germany, where patches of moors or woods are preserved as natural monuments on much the same ground as an earthwork or a cathedral. It is fortunate, however, that the New Forest is a charge of the State and will be preserved for the enjoyment of visitors and residents for ever. The only fate to be feared for this sanctuary of nature is that of spoliation by too active naturalists who may visit it.

Townsend's Grass or Ricegrass

(Spartina Townsendii).

By Dr. O. Stapf, F.R.S., Sec.-L.S.

Delivered as a General Lecture at Trinity Hall, January 25th, 1913.

DURING the last forty years a grass made its appearance on the Hampshire coast. It came no one knows whence; it gained ground at first slowly and unobtrusively, then it spread all at once rapidly and, in places, to a truly amazing extent, so much so indeed, that it altered completely the aspect of wide stretches of the foreshore and the estuarine reaches of the rivers from Chichester Harbour in the East to Poole Harbour in the West. It was collected first at Hythe, near Southampton, in 1870, but mistaken for another grass until, in 1880, it was recognised as a distinct and new species by the brothers Henry and James Groves, who named it *Spartina Townsendii*, after Frederick Townsend, the well-known author of an excellent flora of Hampshire. Up to six or seven years ago it was rather a botanical curiosity. But when, in 1907, Lord Montagu, of Beaulieu, called the attention of the Royal Commission for Coast Erosion to the startling rapidity with which it took possession of the foreshore of Beaulieu River, and its possible use as a land reclaiming agent, it became soon an object of public interest, under the popular name of " rice-grass." This name had been picked up by Lord Montagu from some people who told him that a few years previously the grass was introduced accidentally by a ship that foundered in the Solent. There is, however, no confirmation of the story, nor is the name " rice-grass " appropriate, as the grass has nothing to do with any of the cultivated or wild rices. In books, it has also been called " Townsend's cord-grass," cord-grass being the English equivalent of " *Spartina*" (from *Spartum*, Latin for Esparto grass or a cord made from it). But this again is a misnomer, traceable to a confusion with a kind of rush used for making cords.

Townsend's Spartina, or Townsend's grass—as it might briefly be called—belongs to a small genus of grasses which are mostly natives of the Atlantic coast of America. Only one species, *Spartina stricta*, is really indigenous to Europe, where it occurs here and there in littoral marshes from Lincolnshire and

Spartina alterniflora, quarter natural size.

Photo by C. P. Raffill, Esq.

Holland to the Straits of Gibraltar, and in an isolated area at the head of the Adriatic. Two other species of well-known American origin have become established in Europe since the end of the eighteenth or the beginning of the nineteenth century, *S. juncea* in the Mediterranean and *S. alterniflora* in the innermost corner of the Bay of Biscay and in Southampton Water. Townsend's grass differs from all of them, and at the same time it has not been recorded from anywhere outside its English area, excepting two French stations near Cherbourg, where it has made its appearance within the last two or three years.

It is a vigorous, stout, stiff grass, standing usually about 2-2½ feet high, but occasionally much dwarfed, or drawn out and then attaining a height of from 3-4 feet. It grows mainly in the soft ground of the mud flats which are so common on the Hampshire coast and the adjoining portions of the coasts of Dorset and Sussex and in the tidal reaches of their rivers. It anchors itself in the mud by long vertically descending roots, whilst another set of roots, short but abundantly divided and interlaced, spreads all round from the base of the stems and the nodes of stolons close to the surface of the mud. It grows in tufts* which often assume great dimensions and a remarkably circular shape. Such circular patches, or clumps, may measure anything between 3 and 15 feet in diameter and even more. The grass owes this peculiar growth to the production of numerous underground branches or stolons, which grow out from the buried stem bases radially, and measure from a few inches to several feet. Inequality in the density of the mud, admixture of sand, pebbles or larger stones and other conditions may favour development in one or the other direction, when the circular shape of the clumps gives way to irregular shapes, or it may be that two or more clumps meet in the course of expansion and fuse, and finally many clumps may unite and form regular meadows with a dense matted growth. The leaf-blades are rigid, long and long-pointed, standing off at angles of 60 to 70 degrees, and bright green or slightly glaucous. Like all the Spartinas it has the spikelets closely arranged in stiff, one-sided spikes which spring from a common axis and are erect, so that they are almost or quite applied to each other. There are usually 4-7 of them, but starved specimens may have only two, and luxuriant specimens as many as eleven. The very pretty, feathery, white stigmas appear before the anthers, and persist a long time, apparently in a fresh condition. The grass begins to flower in the latter part of July, and the flowering is most profuse in August and September. Some individuals, however, lag much behind, and may be found in bloom as late as the end of December. As each spikelet contains only one flower, it also has only one grain, which remains tightly enclosed in its husks. The grain has a very thin shell and an unusually large, green embryo, which frequently grows out and pierces the shell,

*See plates I. and II. accompanying Mr. Sherring's note on Spartina Townsendii in Proc. Bournemouth Nat. Sc. Soc. iv., p. 49.

or pericarp. The spikelets become easily detached when ripe, drop into the water and leave the bare spindles standing up stiff like spears until they break down along with the stems, which gradually decay during the winter and spring. The ripening of the grains takes place mostly in October. Abundant as the flowering is year after year, the fruiting is very uncertain. In October, 1907, I found only few perfect grains of Townsend's grass in the Isle of Wight, whilst after the hot summer of 1911 there must have been millions of them in the Lymington beds alone. In front of the Pylewell Estate and to the east of it, there was, at high water-mark, a long band of chaff, which, on examination, consisted almost entirely of spikelets of the grass. A good handful taken up at random numbered 1882 spikelets, of which, however, only 193, or a little over 10 per cent. contained apparently sound grains. They were spikelets cast out. Most of those which had good grains must have sunk on the mudflats. Samples taken up from 1-1½ feet below highwater-mark showed a percentage of over 60 good grains in the 100. 1912 was again a bad year for the maturing of the grains. The bottom of the mudflats is overrun with a delicate film of filamentous Algæ, and it is by their fine threads that the spikelets when sinking are caught and gradually so fixed that they remain there until they germinate, when the seedling becomes quickly and firmly established by the rapid growth of the roots.

The presence of mud is an important factor in the formation of colonies of Townsend's grass. It need not be necessarily pure mud, although the grass is most generally and abundantly found on such, but if there is an admixture of shingle and sand it must not exceed a certain amount. As all the mudflats are formed in comparatively quiet waters, we find the grass confined to these and entirely outside the zone of heavy surf and strong tides. On the flats themselves the limit to which the grass can spread is determined by the depth at high tide. Although the grass can stand much submersion, 2½-3 feet of water at ordinary high tide seem to be the maximum it can bear. This 2½-3 feet line determines the outer limit suitable for the grass. The inner or landward limit lies close to, but still clearly below highwater-mark. This is also true of backwaters and the estuaries of rivers. Within those limits the grass has a practical monopoly in so far as flowering plants are concerned, no other species associating with it, except in places *Spartina alterniflora*.

The area occupied by the grass on the South Coast of England extends at present from the entrance to Chichester Harbour, near West Wittering in the East to the Southern and Western shores of Poole Harbour in the West, covering several thousand acres, the largest beds being those on the West side of Southampton Water, in Lymington Harbour, in Hurst Castle Bay, and at the mouth of Beaulieu River. The Spartina bed between Hythe and Calshot Castle, probably the oldest and the most compact, is about five miles long and 400-600 yards wide, and covers over

Plate II.

Spartina stricta, 3-10 natural size.

Photo by C. P. Raffill, Esq.

800 acres. That of Lymington is of a triangular shape, with a maximum length of six miles and a maximum width of almost one mile. Including the waterways and so-called "lakes," or open sheets of water, it may be estimated at between two and three square miles.

It has already been stated that the first record of Townsend's Spartina dates back to 1870, when it was collected near Hythe, but mistaken for the old English *Spartina stricta*. The extent of the Spartina beds near Hythe as they were then, cannot be estimated exactly, but they cannot have been either very large or old, as no botanist could have overlooked them. Later on, in the seventies and about 1880, it was stated by the brothers Groves to occur in considerable abundance on the mudflats above and below Hythe, where it was conspicuous among colonies of *Spartina alterniflora*. In 1883 it had not yet travelled beyond Cracknore Hard, two miles north of Hythe Pier, but in 1887 it was already recorded from Southampton. Then, towards the end of the eighties, something occurred that favoured the spreading of the grass. For in 1893 several strong patches of it were observed by the brothers Groves near Yarmouth, and in the same year it made itself noticeable at the mouth of Newton River. Two years later it was found by Stratton in little creeks on the west side of Medina River. All this was in the Isle of Wight. But it also travelled eastwards. In 1899 it was, for the first time, collected near Bosham and Chichester, in 1900 in Hayling Island and near Havant and Emsworth, in 1901 in Thorney Island. This was at the eastern end of the area. On the western side we find it first recorded from the Lymington area in 1903. Two years later Dr. J. Cosmo Melvill found the salt marsh near Keyhaven (in the same area) overrun with it, although nine or ten years previously there was no trace of it there. By that time it had also established itself in Beaulieu River. By 1907 it had run up the river to within half-a-mile of Beaulieu village, forming in places dense beds. In Poole Harbour it appeared in 1899, when Mansel-Pleydell pointed out a single small clump in the roadstead of Poole. In 1905 it was found in some quantity by the Fever Hospital, whereas in 1907 it was described as occurring in the Harbour in hundreds of clumps. There was then little of it to the south-east of Parkstone Bay, and the last clump was observed in a sheltered position where West Road comes down to the shore. To-day it has advanced almost to the Haven. In 1907 the clumps could be counted in Hole Bay. Since then they have multiplied enormously, and in many places run together. Mr. Sherring also traced it all over the western bays and creeks of Poole Harbour. The grass also occurs on the North Coast of the Isle of Wight, from King's Quay to near Binstead, in the Hamble River, and in a few other places on the east side of Southampton Water, and in Portsmouth and Langston Harbours. Some six or seven years ago a small colony was reported from Little-

stone, in the Romney Marshes; but, owing to the banking-up of the creek where it was found, it has since disappeared. The latest addition to the area was made by the discovery of some colonies in the estuaries of the Rivers Saire and Vire, in the Peninsula of Cherbourg, about 100 miles due South of the Isle of Wight.

The dispersal of the seeds is, no doubt, mainly due to the action of the water into which the spikelets fall when detached. Once in the water they would float about until waterlogged. Some would sink in the neighbourhood of the parent plant, but many would be carried by the tides or currents either to the shore or along the shore, or even across estuaries and straits before they sink, and, under favourable conditions, start, in due course, new colonies. Birds may also have been dispersing agents, although it is doubtful that they ever played an important *rôle* in that respect, except in so far as they may have carried spikelets to localities which, by the ordinary action of tides and currents, could not be reached. The same may be said of man and his shipping. But apart from seeds, dispersal may also take place through detached pieces of stolons, such as are found floating or cast out on the shore after heavy gales.

Various theories have been advanced to explain the first appearance of the grass in the English flora. The most plausible would seem to be that it was due to accidental introduction from a foreign country; but our present knowledge of the genus and its distribution does not support it. Another suggestion is that Townsend's grass arose as a sport or mutation from *Spartina stricta*, which formerly used to grow on the shores of Southampton Water. *Spartina stricta* is, however, a singularly uniform and conservative species throughout its area, rather receding than advancing, and slow in adapting itself to changed conditions. It is evidently not the material from which one might expect sports or mutations to spring, so distinct and vigorous as Townsend's grass.

There is, however, a third theory which is more plausible. According to it, Townsend's Spartina arose from a cross between *S. alterniflora* and *S. stricta*. S. *stricta* does not at present occur in the neighbourhood of Southampton or in Southampton Water; but we know for certain that it did so not very long ago. *S. alterniflora* is common in the Itchen River and also found in various places at the head and on both sides of Southampton Water. There was, no doubt, sufficient opportunity for the two species to hybridise. Unfortunately it has not been possible so far to produce artificial hybrids of *S. alterniflora* and *S. stricta*. The evidence in favour of this theory is, therefore, necessarily circumstantial. It rests partly on the structure and the general behaviour of the grass, and partly on the occurrence of a natural hybrid between the same two parents in another part of the world and its extreme similarity to Townsend's grass. As to structural characters, there is no doubt that

Plate III.

Spartina Townsendii, quarter natural size.

Photo by C. P. Raffill, Esq.

many of them may be considered as intermediate between those of *S. alterniflora* and *S. stricta*, although they are frequently, more or less, obscured by the remarkable readiness with which Townsend's Spartina responds to external conditions, now dwarfing down to the modest size of *S. stricta*, now running up to and even exceeding the height of fine examples of *S. alterniflora*. Similarly, its remarkable vigour, its pronounced instability, and its varying fertility, very much enhanced in certain years and almost suppressed in others, may be adduced in favour of the hybrid nature of the grass, as those conditions are traits frequently observed in hybrids. But the strongest evidence seems to be in the following fact:—*Spartina alterniflora* and *S. stricta* meet outside their English area only in one other place, namely, the estuary of the Bidassoa River, South of Bayonne, in the Bay of Biscay. There they grow intermixed, and among them has been found their hybrid. Foucaud described it in 1895, and named it *Spartina Neyrautii*, after its discoverer, Neyraut. Now this *S. Neyrautii* is so similar to *S. Townsendii* that Foucaud proclaimed both as hybrids from the same parents, explaining such differences as there are by the assumption that *S. alterniflora* was the female parent in the case of the Bidassoa cross, and *S. stricta* in that of the English plant. The fact is very remarkable, and the argument deducible from it for the hybrid origin of Townsend's grass has almost the force of experimental proof.

Thanks to its vigour and occasional fertility, Townsend's grass has, in a comparatively short time, conquered thousands of acres of bare mud-land, it has invaded and, in places, much reduced the beds of *Spartina alterniflora* in Southampton Water, and even attacked the marshes which so far have been the home of *Spartina stricta*. However, its principal domain is and will probably for ever be the mudflats from one to three feet below high water-mark. Here the changes brought about by Townsend's grass are remarkable. It is not only that the aspect of the flats is altered, the eye meeting great expanses of green comparable to meadows or cornfields, where there was previously a monotonous sheet of grey at low- and half-tide, also the animal life on the flats and their physical character is undergoing a change. To mention only a few economically interesting effects on the fauna: in more than one place the larger molluscs which were collected for food have disappeared; with the arrival of the grass, eel-spearing has been seriously interfered with, whilst even duck shooting has been spoiled owing to the birds finding a welcome cover in the dense grass belts. But the most important change concerns the physical conditions of the flats. It is obvious that the copious systems of roots and stolons must contribute to the stabilisation and solidification of the mud. In addition to this binding action the stems and lower leaves and leaf-bases act as a very effective strainer on the water, which is charged with solid particles brought down by the streams, catching and precipitating them. The result is an accelerated and increased

deposition of mud over the area tenanted by the grass. The level of the mudbank becomes raised, the mud itself firmer. Further, the decay of each year's growth enriches gradually the mud with nitrates and sulphides and other salts, and prepares it for the reception of types of vegetation which were until then excluded from it. On the landside of the Spartina belt, where there is only a foot of water at high-tide, a growth of *Aster Tripolium* and *Obione portulaccoides* springs up among the grass, the first heralds of the reclamation of land that has set in. If the process continues the muddy foreshore will gradually be replaced by *terra firma*. But another effect is more immediate, that of the protection which the grass affords to the shore behind it against the erosive action of the sea. The stems of the grass opposing themselves in their millions to the onrushing tides, to currents and the wind-driven sea act like a natural breakwater to the shore behind them. It might be feared that the grass would become a nuisance to navigation by blocking up the waterways, but this is not the case . Bound to shallow water, it is not likely to invade the deeper water channels. On the contrary, the consolidation and gradual elevation of the grassgrown flats along them tends to increase the scouring action of the currents and tides on the sides and bottoms of those waterways, making their banks steeper and increasing their depth.

There is no reason why artificial plantations of Townsend's grass, under conditions corresponding to those of its native habitat, should not be successful. Propagation by division is easy, and the grass takes on well and grows rapidly, as experiments made in the Medway River and in New Zealand show.

When the grass is young the leaves and stems are succulent and sweetish, and cattle and horses relish it. Several American species of Spartina are cut and fed to horses and cattle on a large scale. Analyses of Townsend's grass, made on behalf of the Board of Agriculture, show that for nutritious qualities it is quite equal to its American allies, and may be classed as a good average fodder grass. Other uses to which the grass has been put and might be put on a larger scale are for thatching, and, above all, for mulching. It has even been tried for paper-making, but with doubtful success.

The Native Plants of Britain and Germany: A Comparison.

By Miss C. Agnes Rooper.

Read before the Botanical Section, March 13th, 1913.

IN beginning my paper, I wish to say that the authority for the statements I am about to make is Herr Drude. This eminent German botanist, in company with other Continental and American botanists, made a tour through the greater part of the British Isles during the summer of 1911. The tour was under the auspices of the British Vegetation Committee. Herr Drude's criticism on the British Flora in contrast with that of Germany was that, although it possesses but few indigenous plants which do not also belong to the German Flora, yet it is a very interesting one, for it represents the Flora of Germany at the close of the Baltic Ice Age, when the British Isles still formed part of the Continent and, consequently, shared its vegetation. After the separation had taken place and the British Islands had been formed their distance from the mainland had this effect on their Flora, that it remained purer than that of Germany which was so exposed to extraneous influences as to be much modified and altered by them. Examples of the survival of this very ancient Flora in all its integrity are not wanting, but are scattered here and there over our islands. For instance the shore of the Bay of Galway is covered with the shrubby Potentilla which is also a native of Germany and of Central Europe. Herr Drude in fact states it as his opinion that in modern times the conditions of vegetation over the larger portion of the British Isles are so uniform as to furnish the conditions for the development of characteristic forms in their somewhat extensive area from the general stock of the west and north European Flora which has been present or invaded these islands since the Ice Age. At least on the lower hills up to a height of about 100 metres a uniformity is apparent markedly differing from what we find in mid Germany in the English, Scottish, and to some extent also in the Irish Flora. The woods of the south and east English vegetation region show a striking deficiency as compared with those of the German plains and hills in the absence of *Pinus sylvestris*. This tree though very abundant on sandy soils is not generally regarded as a native in the south-east of England, though it was apparently general in early post glacial times. It owes its prevalence in some of the New Forest heaths to its introduction into Ocknell Clump in 1776, though there is some evidence of its much earlier occurrence in the district. In a general way the trees and shrubs of the British Islands offer a great difference from those of Germany. Our woods and coppices do not present the same variety as the German. In England there is lacking that delightful mixture of various trees offered by a mid German valley, where behind Alders (*Alnus glutinosa*, *Alnus incana*) absent from England, *Carpinus Betulus* (Hornbeam) is mixed with *Acer platanoides* (Norway Maple), *Ulmus* (Elm), *Tilia* (Lime) and others on the valley sides, giving place to Beechwoods with *Picea* and *Abies*, and making way for *Pinus sylvestris* (Scotch Pine) on the steeper and drier slopes. On the other hand our Heathlands, more especially those of the New Forest apparently possess a richer and more beautiful Flora than those of mid Germany. *Erica Tetralix*, *Narthecium* (Bog Asphodel) and *Hypericum Elodes* (Marsh St. John's Wort), the masses of which adorn our heaths are