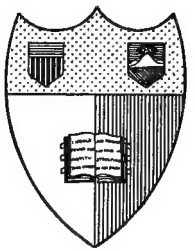
FUTURE FOREST TREES



FUTURE FOREST TREES

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OR

THE IMPORTANCE OF THE GERMAN EXPERIMENTS IN THE INTRODUCTION OF NORTH AMERICAN TREES

BY

A. HAROLD UNWIN

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To

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FROM WHOM SO MUCH HELP IN ITS WRITING

WAS RECEIVED, THIS LITTLE BOOK

IS GRATEFULLY DEDICATED

BY THE AUTHOR.

PREFACE

THE following work appeared originally in German in the "Austrian Forestry Magazine," and in view of the increased interest taken in forestry in England an English translation may perhaps be acceptable in this country.

The writer's object is to present in the most concise manner the results of numerous experiments, chiefly made in Germany, with some American trees, most of which are known as ornamental specimens, but have not received due attention in forest plantations here. A great deal of misapprehension exists as to their value, and as Germany has done most of the experimental forest-tree planting, it is instructive to hear the consensus of opinion of that country.

A. HAROLD UNWIN,

Asst. Conservator of Forests, Southern Nigeria, late of the Forestry Branch, Department of the Interior, Canada.

ROYAL COLONIAL INSTITUTE,
June 1905.

CONTENTS

ILLUSTRATIONS

INTRODUCTION

THE extraordinarily successful results which agriculture and horticulture attained through the introduction of foreign plants awakened the idea in Germany, more than a hundred years ago, of introducing foreign forest trees, both for ornament and for commercial purposes, and to increase the value of forests in quality and quantity.

Attention was first directed towards East America, whence the story came of extraordinary timber wealth and of especially valuable trees. Under the direction of Burgsdorff, Wangenheim, Bechstein, and others, about three hundred species of trees were finally chosen, at the end of the eighteenth century, for experimental planting in the woods.

Nevertheless these introductions did not attain forestal or economic importance because the experiments were carried out without plan or protection, *i.e.*, without a knowledge of

the sylvicultural peculiarities and requirements of the timber species, and most of them have disappeared from the forest. Damage due to deer-browsing, which to-day chiefly causes the weakening and disappearance of so many foreign trees, was no doubt then also the chief reason of the backwardness and killing of foreign trees, while indigenous trees were scarcely or not touched at all.

From that time nothing was done for about a century, but the few remnants which managed to hold their own in parks protected from deer have become important objects for the study of the American tree species in Germany. There is certain proof that the trees from the colder part of East America are capable of being grown in Germany, that they correspond, from the forest point of view, to their new requirements as in the end they reach tree dimensions in not longer periods than do native German species.

The desire to have timber species which in their soil requirements were more modest, or which were more frost-hardy, than the indigenous species, as also the desire to cultivate something rare and foreign which perhaps would yield a more valuable timber than the indigenous trees, caused attention to be turned to new experiments. And the steady, rapid increase of importations of American timber, which came into

successful competition with home-grown timber, led new experiments in the cultivation of foreign trees in Germany to be put speedily into practice.

Austria and Switzerland have followed the example of Germany; in France there is an apparent holding back. In England and Scotland a great many experiments have been tried, but owing to lack of system not with the best results.

So far as the German experiments, after a twenty-year trial, can be summed up, the results are undoubtedly of great forestal value. The new introductions during this period have brought trees to Germany which excel the German species in modesty as to soil requirements, in frost-hardiness, and in rapid growth; which partly equal the German species in timber production, partly surpass them; so that there is a promise that Germany will produce, in the course of the next century, as much of the splendid American hickory, walnut, Douglasia, and white pine wood at home as she requires. Of course the cultivation of other timber species, such as pitch pine, must be reserved for warmer foreign lands. Should the above promise not be realised, the blame must not be laid on the foreign trees, nor on the German soil, nor on the German climate, but rather on German foresters who

mishandle their exotics or leave them to the mercy of the animals of the forest.

German foresters have tried, not only by experimenting under the most different conditions, but also by studying and travelling in the home of the exotics, to find a natural scientific basis as quickly as possible, and thus make the planting trials a success and save time, money, and material.

In this respect the travels of Prof. D. Heinrich Mayr to America and Asia were decisive. The results of these travels appeared in the "Waldungen von Nord Amerika," 1890 ("Forests of North America," 1890).

These studies in America, as well as the results of European plantation experiments during the last twenty years, have brought so many scientific facts to light concerning a large number of American species that even American foresters may now improve their knowledge of the sylvicultural peculiarities of their own trees through these studies.

The object of the following little work is to show what timber from America is put on the German market, and, further, to show with what success the economic and sylvicultural question of the introduction of American trees is being solved, particularly in Germany.

My warmest thanks are due to Mr. Wilson,

Deputy Consul of the United States in Munich; to Mr. R. H. Campbell, Assistant Secretary and Treasurer of the Canadian Forestry Association; and to the Chamber of Commerce for Upper Bavaria, for their ample help in the loan of books, &c.

PART I

The German Timber Imports from the United States and Canada.

A. TIMBER IMPORTS INTO HAMBURG.

THE following statistics are taken from the annual returns of Hamburg's "Handel und Schiffahrt," as these best reflect the varying conditions of the timber market. It is often difficult to find from what trees the various timbers are obtained.

1. ASH FROM *FRAXINUS AMERICANA*.

The quantities imported are small, cheaper price rather than superior quality being the only reason for the demand at all.

Year.	Logs.		Sawn Material.		Contents of both in Cubic Metres.
	Number.	Contents in Cubic Metres.	Number.	Contents in Cubic Metres.	
1890	6	—	153	—	10.28
1891	—	—	—	—	—
1892	28	22.17	—	—	22.17
1893	32	30.00	132	5.40	35.40
1894	—	—	—	—	—
1895	74	146.82	—	—	146.82
1896	284	284.83	—	—	284.83
1897	190	117.00	24,400	—	—
1898	537	323.18	16,189	469.00	792.18
1899	1,200	453.96	48,779	440.00	893.96
1900	453	287.10	11,087	230.00	517.10

2. RED CEDAR.

Two species of tree are included under this name as coming from America, namely—

(*a*) PENCIL WOOD FROM *JUNIPERUS VIRGINIANA*.

Year.	Number of Logs.	Weight in Kilogrammes.	Contents in Cubic Metres.
1890	1,479	176,500	307.7
1891	2,157	230,000	414.0
1892	1,189	134,000	241.2
1893	—	—	—
1894	6,371	538,000	968.4
1895	9,930	765,000	1377.0
1896	6,886	667,000	1200.6
1897	8,358	705,000	1269.0
1898	8,909	684,000	1231.2
1899	2,156	235,000	423.0
1900	2,359	251,800	453.24

From the above figures a decrease in the quantities imported during the last two years is apparent, due, according to the market reports, to poor quality and small size being sent. The quantities given by no means indicate the amount really imported and used in Germany, as one factory alone, that of John Faber in Nuremberg, uses 210,000 cubic feet, or 2,500,000 feet B.M.,[1] per year ; and another, A. W. Faber, in Stein, about 50,000 cubic feet. A great deal is imported into Bremen under the general heading of "cedar," so that it was impossible to find out what kind.

(*b*) CIGAR-BOX WOOD FROM *CEDRELA ODORATA*.

Imports from the United States.

Year.	Number of Logs.	Contents in Cubic Metres.
1890	11,487	3476.56
1891	19,716	5606.86
1892	8,030	2620.00
1893	9,047	3683.96
1894	9,981	3813.68
1895	6,343	1927.36
1896	12,585	5200.76
1897	14,830	5305.09
1898	17,615	6813.84
1899	7,608	3470.24
1900	10,497	3760.34

This table does not show a steadily increasing quantity imported, as large amounts are received from the South and Central American countries. Besides this, ready-made cigar-box boards are also sent, and tend to equalise the varying supplies of logs from all sources. It is, perhaps, of interest to note the quantities imported from other countries.

[1] B.M. = Board measure, 1 ft. square, 1 in. thick.

Country.	1896.		1897.		1898.		1899.		1900.	
	Amount in Cubic Metres.	Value in Marks.	Amount in Cubic Metres.	Value in Marks.	Amount in Cubic Metres.	Value in Marks.	Amount in Cubic Metres.	Value in Marks.	Amount in Cubic Metres.	Value in Marks.
Argentine	1063.37	154,770	1,130.38	147,770	24.90	2,700	209.15	20,000	—	—
Columbia, Atlantic Coast	294.85	45,140	824.61	112,480	228.88	32,980	162.24	23,470	70.97	8,970
Columbia, Pacific Coast	—	—	—	—	—	—	—	—	26.69	2,390
Costarica	3983.78	445,320	6,350.10	709,390	4051.93	353,840	1884.20	198,820	8,342.52	879,240
Cuba	1132.04	173,200	—	—	—	—	587.00	81,300	1,659.24	261,520
St. Domingo	—	—	50.68	7,760	91.50	15,670	191.61	27,500	110.13	14,480
British Honduras	—	—	13.71	1,850	29.27	2,770	25.24	2,350	5.00	600
Republic Honduras	—	—	—	—	—	—	190.20	19,540	142.46	12,120
Jamaica	—	—	21.57	3,300	—	—	—	—	—	—
Mexico, Atlantic Coast	12.81	2,000	1,113.44	114,140	180.67	16,150	489.69	51,180	1,072.09	110,860
Mexico, Pacific Coast	696.08	101,280	—	—	—	—	263.41	20,630	—	—
Nicaragua	1846.84	182,810	1,256.82	130,780	794.90	57,720	464.46	45,100	1,018.77	106,900
Trinidad	—	—	615.02	—	6.09	540	443.52	43,550	1,908.14	177,130
Total	9029.77	1,104,520	11,376.33	1,280,740	5408.13	482,370	4,910.72	533.440	14,356.11	1,574,120

Costarica appears to send the largest quantity. During the last few years the price per cubic metre has been as follows :—

Year	1886–1890	1891–1895	1897	1898	1899
Mark	121	123	115	174	187

3.

CHERRY WOOD FROM *PRUNUS SEROTINA*.

Only very small quantities appear in the market reports.

Year.	Number.	Contents in Cubic Metres.
1890	28	29.83
1891	39	—
1892	Quantity not mentioned	
1893	89	77.00
1894	24	15.83
1895	73	69.72
1896	49	38.41
1897	221	147.56
1898	66	39.21
1899	30	24.25
1900	9	5.27

4.

DOG WOOD AND PERSIMMON FROM *CORNUS ALTERNIFOLIA* AND *DIOSPYRUS TEXANA*.

These two are not separated statistically, although the former is superior to the latter.

Year.	Pieces.	Weight in Kilogrammes.	Contents in Cubic Metres.
1890	—	—	—
1891	—	—	—
1892	1,045	—	—
1893	—	—	—
1894	—	—	—
1895	—	400,000	720.0
1896	—	1,000,000	1,800.0
1897	—	700,000	1,260.0
1898	3,466	179,000	322.2
1899	2,226	221,000	397.8
1900	8,141	740,000	1,332.0

5.
HICKORY FROM *CARYA ALBA*.

This very elastic wood is imported in increasing quantities as spokes and half-manufactured material rather than in the log, as in this form it more rapidly spoils.

Year.	Logs.	
	Number.	Contents in Cubic Metres.
1890	94	47·34
1891	348	—
1892	13	9.16
1893	325	170.00
1894	71	48.03
1895	247	125.47
1896	399	201.77
1897	310	190.35
1898	178	115.70
1899	52	24.51
1900	523	243.36

6.
MAPLE.

Year.	Logs.		Planks and boards.		Total contents in Cubic Metres.
	Number.	Contents in Cubic metres.	Number.	Contents in Cubic Metres.	
1890	a little,	no details	as to ki	nd and con	tents.
1891	—	—	—	—	—
1892	54	31	—	—	31
1893	64	38.17	—	—	38.17
1894	6	—	618	—	—
1895	2	—	—	—	—
1896	—	—	—	—	—
1897	45	—	—	—	—
1898	—	70	1824	42	112
1899	7	3·5	—	—	3·5
1900	54	66.43	1215	29	95.43

This comes for the most part from *Acer sacharinum*, a sugar maple, in the form of Bird's-eye Maple. A little is obtained in Canada, but the greater quantity from the United States.

7. OAK.

This is obtained almost exclusively from the white oak, *Quercus alba*. Greater quantities are imported every year, as apparently the output of the home forests is not sufficient to cover the demand. Then, too, the American material is cheaper, and some say poor, but the manufacturers do not share this opinion. The coopers say the American wood is the best for staves. It is interesting to note, too, that a much larger quantity of ready-cut wood is imported than rough unsawn logs. About 10,000 cubic metres of parquet wood was also imported.

Year.	Logs.		Planks and boards.		Total in Cubic Metres.
	Number.	Quantity in Cubic Metres.	Number.	Quantity in Cubic Metres.	
1890	—	—	—	—	—
1891	—	—	—	—	—
1892	23	31.22	7,542	53.54	84.76
1893	74	121.00	8,700	115.00	236.00
1894	—	—	—	—	—
1895	—	—	32,858	—	—
1896	60	114.24	120,000	2,700.00	2,814.24
1897	216	325.63	403,300	11,032.00	11,357.63
1898	1,384	1,894.89	167,000	4,328.00	6,222.89
1899	2,635	3,384.90	290,666	7,211.40	10,596.30
1900	675	978.00	163,159	4,000.00	4,978.00

8. POPLAR, WHITEWOOD, FROM *LIRIODENDRON TULIPIFERA*.

This timber, which is used as backing for furniture, is imported to cover the indequate German supply of softwood. From the table below it will be seen that the quantities brought are increasing each year.

Year.	Logs.		Sawn Material.		Total in Cubic Metres.
	Number.	Quantity Cubic Metres.	Number.	Quantity Cubic Metres.	
1890	1,685	3,221.27	—	—	3,221.27
1891	1,457	2,710.00	9,145	—	—
1892	1,999	3,911.40	9,938	189.53	4,100.93
1893	1,469	2,673.92	362	15.54	2,689.46
1894	1,681	3,101.83	1,674	71.00	3,172.83
1895	2,241	4,133.83	9,169	322.18	4,456.01
1896	4,479	7,935.61	38,505	900.86	8,836.47
1897	3,484	6,551.43	114,063	3,689.31	10,240.74
1898	2,392	4,477.52	103,080	3,526.00	8,003.52
1899	6,141	9,870.03	33,000	900.00	9,960.03
1900	3,298	5,762.24	31,183	940.00	6,702.24

Much the same applies to—

9.

POPLAR, COTTONWOOD, FROM *POPULUS MONILIFERA*,

although it is only in recent years that it has been imported at all.

Year.	Logs.		Sawn Material.	
	Number.	Quantity Cubic Metres.	Number.	Quantity Cubic Metres.
1895	—	—	—	—
1896	—	—	88,000	2,210.00
1897	—	—	—	—
1898	—	—	—	—
1899	—	—	154,141	3,704.00
1900	32	55.72	156,354	4,293.08

10.

SATIN WALNUT.

This timber is very much in demand for furniture-making. The table below does not, however, indicate this, especially during the last year, which is due, no doubt, to the general economic depression then existing in Germany.

Year.	Logs.		Sawn Material.		Total Cubic Metres.
	Number.	Quantity in Cubic Metres.	Number.	Quantity in Cubic Metres.	
1890	—	—	—	—	—
1891	81	92.74	—	—	—
1892	176	197.50	—	—	197.50
1893	222	248.50	516	15.18	263.68
1894			no quantities given.		
1895	51	—	2,084	—	—
1896	265	380.00		little ; no quantities given.	
1897	431	663.79	13,883	423.11	1,086.96
1898	267	447.15	30,755	958.00	1,405.15
1899	1,966	3,058.67	79,195	1,865.00	4,923.67
1900	235	374.88	62,000	1,747.00	2,121.88

Besides all these, small quantities of elm, chestnut, plane, cypress, and birchwood were imported into Hamburg, the last, from *Betula lutea*, being brought in the largest parcels

11. WALNUT, MOSTLY FROM *JUGLANS NIGRA* (BLACK WALNUT).

Year.	Logs.		Planks and Boards.		Scantling.		Total.	
	Number.	Contents in Cubic Metres.	Number.	Contents in Cubic Metres.	Number.	Quantity in Cubic Metres.	Quantity in Cubic Metres.	Price per Cubic Metre.
1890	21,571	10,414.00	123,956	1,701.00	1,722,000	17,220.00	29,335.00	225[1]
1891	23,245	11,341.00	178,939	2,668.00	750,000	7,500.00	21,509.00	
1892	14,453	6,993.00	158,914	2,375.00	687,000	6,870.00	16,237.00	
1893	33,152	15,005.78	502,628	7,240.54	813,416	8,134.16	30,380.48	202
1894	18,235	9,314.01	98,333	1,713.73	599,369	5,993.69	17,021.50	
1895	24,504	12,412.31	190,885	3,445.43	483,533	4,835.33	20,693.07	
1896	26,167	11,525.73	473,669	7,358.30	888,300	8,883.00	22,767.03	
1897	38,660	15,925.77	950,870	14,553.90	1,217,935	12,179.35	42,657.02	199
1898	18,853	8,025.00	389,900	5,520.00	138,855	1,388.55	14,933.55	197
1899	28,681	11,918.30	489,179	7,299.83	978,760	9,787.60	29,005.73	199
1900	36,905	13,777.69	721,548	9,613.00	1,662,270	16,622.70	40,013.39	

This table shows an increase in the imports simultaneously with a slight decrease in the price of the timber, 3d. per cubic metre. Compared to America, the imports from other countries are unimportant, so that the following table[2] just shows the quantities from America compared to the total imports of walnut into Hamburg.

[1] From Hamburg's "Handelszustände," July, 1890–1900.
[2] Hamburg's "Handel und Schiffahrt," 1890–1895.

Year.	American Walnut.		Total Import.	
	Cubic Metres.	Value in Marks.	Cubic Metres.	Value in Marks.
1890	15,639.57	3,311,720	17,509.76	3,874,640
1891	17,269.93	3,455,070	19,451.30	4,137,440
1892	11,331.00	2,136,740	12,839.06	2,591,880
1893	25,285.15	4,865,820	27,057.53	5,433,050
1894	15,473.30	2,899,300	17,403.23	3,524,290
1895	19,541.83	3,564,130	21,126.09	4,036,760

From this it will be seen that America sends 90 per cent. of all the walnut imported into Hamburg, though the lower value of it makes only 84 per cent. judged by a financial standard.

Russia and Turkey are the other most important countries exporting walnut (*Juglans regia*), although India and several others send small quantities, hence only the figures referring to the former are appended.

Year.	Russia.		Turkey.	
	Cubic Metres.	Marks.	Cubic Metres.	Marks.
1890	872.83	313,580	38.24	7,800
1891	847.84	327,010	128.04	23,750
1892	763.19	271,390	151.51	44,600
1893	1145.40	417,520	88.33	24,350
1894	1086.23	418,010	118.45	32,720
1895	735.62	283,660	133.46	27,980

B. TIMBER IMPORTS INTO BREMEN.[1]

1. CEDAR, *CEDRELA ODORATA* (?)

As the quantities are not differentiated, it is impossible to know from what tree the timber mentioned here is obtained.

Year.	Import.		Export.		Excess Import.	
	Quantity Cubic Metres.	Value Marks.	Quantity Cubic Metres.	Value Marks.	Quantity Cubic Metres.	Value Marks.
1890	14,118	2,126,088	8,727	1,317,456	5,391	808,632
1891	12,406	1,691,520	7,763	1,144,680	4,643	546,840
1892	9,271	1,337,928	7,126	1,106,002	2,145	231,926
1893	15,479	2,257,078	8,173	1,282,687	7,306	974,391
1894	14,251	1,945,579	5,491	767,969	8,740	1,177,610
1895	17,617	2,103,824	7,526	1,025,474	10,191	1,078,350
1896	18,290	2,559,122	10,869	1,204,109	7,421	1,355,013
1897	26,034	2,944,993	11,897	1,656,863	14,137	1,288,130
1898	18,814	1,618,296	10,153	1,268,593	8,661	349,703
1899	12,075	1,422,877	6,855	957,769	5,220	465,108
1900	25,244	2,849,897	13,201	1,618,347	12,043	1,231,550

As the table indicates, other timbers, besides that used in the cigar-box industry in the neighbourhood of Bremen, are mentioned.

2. PITCH PINE FROM *PINUS PALUSTRIS*.

Year.	Quantity.	
	Standard.	Cubic Metres.
1890	439	2,019·4
1891	102	469·2
1892	810	3,726·0
1893	1,747	8,036·2
1894	2,535	11,661·0
1895	3,185	14,651·0
1896	3,019	13,887·4
1897	5,045	23,207·0
1898	4,295	19,757·0
1899	6,318	29,062·8
1900		

This is only of interest as an indication of the rapid increase in the consumption of pitch pine, which is not only true of Germany, but elsewhere, especially England, if only figures to prove this could be found.

[1] "Berichte der Handelskammer," 1890–1900.

C. GEESTEMÜNDE.

PITCH PINE, *PINUS AUSTRALIS.*

The following quantities, which represent just a fifth of the total timber imports into this port, are the only ones differentiated in the market reports. All other timbers are classed together.

Year.	Standard.	Quantity in Cubic Metres.
1890	2,465	11,339.0
1891	3,273	15,055.8
1892	3,895	17,917.0
1893	2,433	11,191.8
1894	1,175	5,405.0
1895	1,417	6,518.2
1896	1,542	7,093.2
1897	1,855	8,533.0
1898	1,762	8,105.2
1899	2,653	12,203.8
1900	5,400	24,840.0

D. KIEL.[1]

BUILDING TIMBER.

Year.	Quantity in Cubic Metres.
1895	2,632
1896	3,620
1897	5,704
1898	1,620
1899	3,309
1900	14,585

E. LÜBECK.[2]

PLANKS AND BOARDS.

Year.	Quantity in Cubic Metres.
1885	78
1890	4,548
1895	25,410
1899	35,502
1900	76,735

No details were given in the reports as to kind, so that the figures are only an index that American timber is gradually being imported. Of course these last figures with regard to pitch pine and other soft woods by no means represent all that is brought, as a great deal is sent up the Rhine to Mannheim and other ports.

[1] "Bericht der Handelskammer," 1896–1900.
[2] Ibid., 1900.

Goods.[1]	1896.		1897.	
	Quantity.[2]	Value in Marks.	Quantity.	Value in Marks.
Building timber	2,382	22,100	350	2,800
Stave wood	98,639	1,133,360	320,393	3,703,380
Yellow wood	1,850	7,700	248	2,610
Cedar wood	m³ 772.37	115,370	m³ 818.16	128,840
Mahogany	m³ 842.74	189,120	m³ 11.24	3,800
Walnut	m³ 20,594.96	3,751,290	m³ 28,673.75	5,303,270
Lignum vitæ	—	—	675	8,480
Other hard woods	248,988	2,365,820	403,129	3,656,610
Cigar-box boards	7,674	390,500	7,576	318,810
Veneers	70	8,940	22	2,910
Wood pulp	673	13,730	2,924	55,950
Wooden nails	3,159	91,760	3,613	186,440
Cane baskets	19	3,990	20	4,350
Wood for parquetry	—	—	22,229	247,750
Rough wooden ware	19,165	533,570	20,392	608,830
Fine wooden ware	2,976	245,210	2,603	263,280
Waggons and waggon parts	1,151	129,720	888	122,240
Cooperage	1,623	167,590	—	—
Wooden boats	—	—	—	—
	—	—	—	—

In this general summary it is interesting to note that cedar and walnut are the most importance. The former is obtained from *Juniperus virginiana* and *cedrela*, and the lat timber, pine, and spruce from *Pinus strobus* or *resinosa*, and *Picea alba* or *nigra*.

[1] From Hamburg's "Handel
[2] Kilogrammes unless otherwise

1898.		1899.		1900.	
Quantity.	Value in Marks.	Quantity.	Value in Marks.	Quantity.	Value in Marks.
—	—	14,983	102,740	—	—
339,135	3,832,190	185,254	2,430,970	121,838	1,398,530
—	—	2,657	26,010	—	—
m³ 3,851.56	1,200,280	m³ 2,288.29	832,350	m³ 1,628.95	550,910
m³ 305.50	114,330	m³ 127.25	54,590	m³ 38.82	6,700
m³ 15,801.49	2,801,680	m³ 22,735.55	4,305,490	m³ 26,683.15	5,148,880
1,718	21,970	283	2,030	—	—
453,221	3,486,450	655,497	4,902,240	799,855	6,557,360
—	—	—	—	—	—
44	5,480	54	5,820	47	6,590
4,720	6,800	9,587	175,580	16,196	321,170
6,159	187,660	5,686	181,800	4,603	129,320
15	2,790	—	—	30	5,010
67,401	745,020	—	—	—	—
21,917	705,760	61,623	1,204,520	38,871	976,240
3,762	388,520	4,687	483,610	4,548	573,540
718	85,250	986	141,100	1,745	195,390
—	—	4,744	450,230	4,943	477,200
—	—	55	2,720	153	7,600
—	—	22	5,500	46	16,760

ost largely imported timbers, and that manufactured articles are quite secondary in atter from *Juglans nigra*. Stave wood is probably oak from *Quercus alba*, building

und Schiffahrt," 1896–1900.
ise mentioned.

To face page 26.

The following Table, giving similar results with regard to Canada, is of less economic importance, as the quantities given are small, though later on may be just as large, if not larger.

Goods.[1]	1896.		1897.		1898.		1899.		1900.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Walnut	—	—	m^3 12.43	3,170	m^3 12.42	2,650	m^3 56·40	12,300	—	—
Other hard wood	—	—	q 2,974	33,100	q 1,373	15,230	q 634	8,080	q 5,802	78,540
Wooden ware (fine) ...	—	—	q 28	6,240	q 207	8,750	q 625	28,110	—	—
Waggons and parts	—	—	q 20	3,400	—	—	—	—	—	—
Wood pulp	—	—	—	—	q 240	4,430	q 810	15,390	q 17,563	288,600
Stave wood	100 kg.	—	—	—	—	—	—	—	q 817	3,730
Building timber	1,167	4,050	—	—	—	—	—	—	—	—

In this, wood pulp is the chief item of interest, and in the near future should be more so, as Germany is using more than she can possibly produce.

[1] From Hamburg's "Handel und Schiffahrt."

F. EXPORTS FROM CANADA.

	I. TO GERMANY.[1]		II. TO GREAT BRITAIN.	
	1900.		1900.	
Lumber—	St. Hd.[2]	Dollars.	St. Hd.	Dollars.
Deal.....	19 ...	650	69,392 ...	3,223,585
Pine	— ...	—	— ...	—
Deal ends..	1 ...	39	19,028 ...	543,055
	m. ft.		m. ft.	
Planks and boards...	109 ...	6,920	86,500 ...	1,165,605
Timber (Square)—				
	Tons.		Tons.	
Birch	5 ...	60	22,147 ...	209,270
Wood Manufactures—				
Furniture...	— ...	813	— ...	238,657
Wood pulp	— ...	5,312	— ...	562,178
	1901.		1901.	
Lumber—	St. Hd.		St. Hd.	
Basswood..	64 ...	1,250	951 ...	17,540
Deal (pine)	55 ...	2,157	67,086 ...	2,698,508
	m. ft.		m. ft.	
Planks and boards...	204 ...	1,580	117,074 ...	1,532,860
Shooks ...	— ...	436	— ...	148,332
Match blocks...	— ...	6,606	— ...	972
Timber—	Tons.		Tons.	
Sq. Ash ...	62 ...	630	4,239 ...	56,977
Wood Manufactures—				
Furniture..	— ...	100	— ...	163,538
Matches & match ...	— ...	480	— ...	81,387
Splints.....	— ...	—	— ...	—
Wood pulp	— ...	18,736	...	914,722

[1] Tables of the Trade and Navigation of the Dominion of Canada, 1900, 1901, 1902.

[2] St. Hd. = Standard Hundred.

F. EXPORTS FROM CANADA (*continued*).

	I. TO GERMANY.[1] 1902.		II. TO GREAT BRITAIN. 1902.	
Lumber—	m. ft.	Dollars.	m. ft.	Dollars.
Basswood	184	5,050	558	16,754
Planks and boards	2,419	37,383	114,622	1,623,292
Timber (Square)—	Tons.		Tons.	
Pine, Red	18	330	2,105	27,689
Wood Manufactures—				
Door, sashes, blinds	—	243	—	231,770
Matches & match splints	—	600	—	45,887
Wood pulp	(Not detailed).		—	818,580

The Canadian statistics show rather different figures, but still they go to prove that Germany will, no doubt, take more from Canada, but still very little compared to Great Britain. Only the same kinds have been mentioned as are sent to Germany, as naturally Great Britain imports many others besides these.

As it is impossible to draw comparisons between the German imports of American timber and the American exports of timber to Germany, only a single year's figures are given, as showing that the quantities are much larger than the German statistics would indicate. It will be observed in the accompanying Table that the Americans do not classify the various timbers at all, so that one can only surmise roughly only what is even soft and hard wood, much less say which is spruce or pine.

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[1] Tables of the Trade and Navigation of the Dominion of Canada, 1900, 1901, 1902.

G. UNITED STATES.[1]

July 1, 1903—June 1, 1904.

EXPORTS OF TIMBER TO GERMANY.

Timber and Unmanufactured.				Logs and
Sawed.		Hewn.		other.
M. ft.	Dollars.	Cubic ft.	Dollars.	Dollars.
22,335	339,000	139,247	23,973	1,230,703

TIMBER.

Boards, Deals, and Planks.		Joist and Scantling.		Box Shooks.
M. ft.	Dollars.	M. ft.	Dollars.	Dollars.
77,086	1,785,832	250	3,785	413

LUMBER.

Staves.	Value.	Heading.	All other.
No.	Dollars.	Dollars.	Dollars.
4,317,659	303,392	19,439	113,872

MANUFACTURES OF

Furniture.	Hogsheads and Barrels Empty.	Trimming, Moulding.	Wooden Ware.
N.E.S.	Dollars.	Dollars.	Dollars.
159,497	7,514	6,794	75,533

Wood Pulp.		All other.
Pounds.	Dollars.	Dollars.
2,991,161	58,688	364,871

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[1] From "The Foreign Commerce and Navigation of the United States." Department of Commerce and Labour, Washington, D.C.

PART II

General Results of the Plantation Experiments with American Trees in Germany, Austria, Great Britain, and Switzerland.

A. East American Broad-leaved Trees.

1. *Acer dasycarpum*, Ehrh., White Maple, Soft Maple, Silver Maple.

Introduced into Europe in 1721, this tree has not attained importance in the forest, but is liked as an ornamental tree in parks. Its rapidly-grown wood is coarse-grained, soft, and of small value.

2. *Acer negundo*, Linné, Boxelder, Ash-leaved Maple, Manitoba Maple.

The forestal value of this tree species is no greater than the former. A variety of the tree with one or two-year-old shoots, covered with white bloom, *Acer negundo violaceum*, also called *Acer californicum*, has been used for planting

experiments a good deal in Germany [1] and also in Austria,[2] owing to its rapid growth. For what purpose the soft, low-valued wood is to be used is unknown. The ornamental value of the tree is great, though it is very liable to be broken by wind and snow in the late autumn.

3. *Acer sacharinum*, Wanghm., Zuckerahorn, Hard Maple, Sugar Maple.

According to Booth,[3] this tree was introduced into Germany in 1735.

This tree was brought into the planting experiments chiefly because of the quality of its wood, which was exceedingly exaggerated through the imports and value of bird's-eye maple wood. Dr. Mayr [4] first mentioned important reasons for planting and the advantages of this tree species in comparison to the indigenous great maple or sycamore; namely, the sugar contents of the sap and the greater shade-bearing capacity of the same tree.

[1] "Die Arbeitspläne für Anbauversuche und für die Untersuchung des waldbaulichen Verhaltens ausländischer Holzarten." Danckelmann und Mundt, "Jahrbuch der preuszischen Forst- und Jagdgesetzgebung," 14 Bd., 1882, pp. 13, 27.

[2] The planting of this tree has been practically given up.—EDITOR.

[3] "Feststellung der Anbauwürdigkeit ausländischer Waldbäume," Berlin, 1880.

[4] "Die Waldungen von Nord-Amerika," München, 1890.

The experiments in Germany are not of a very extended nature. Prussia had, according to Schwappach,[1] in the year 1901 only 0·2 hectares, or 0·49 acres, planted with this tree. In Bavaria the planting trials are limited to a few places with a few trees. It thrives everywhere where the indigenous great maple grows, similar methods of raising and testing being suitable. Its enemies are (1) mice (peeling of the cortex at the foot of the stem), (2) deer, (3) the fungus *Nectria cinnabarina*, (4) frost to a lesser extent. Nowhere in Europe has the sugar maple produced the especially expected bird's-eye maple wood. The reason for the occurrence of this valuable misgrowth, which the great and Norway maple also produce, is still unknown. Whether this abnormity can be made by the continual pruning of the branches on the stem similar to pollarding, as practised in France, must be seen by experimenting.

4. *Betula lenta*, L., Red Birch, Black Birch, Cherry Birch.

With this tree species, according to Schwappach,[2] 20·20 acres had been planted up to 1901 ;

[1] "Ergebnisse der Anbauversuche mit fremdländischen Holzarten in Preuszen." "Zeitschrift für Forst- und Jagdwesen," 1901.

[2] *L.c.*, 1901, p. 151.

in Bavaria there are only a few single specimens. Dr. Fernow,[1] of the United States, says that this birch is only a small tree which scarcely deserves planting, whereas

5. *Betula lutea*, Michx., Yellow Birch,

is the tree which yields the valuable wood of the yellow to reddish colour. Experiments with this have not been made in Europe.

6. *Betula papyrifera*, Marsh, Canoe Birch, White Birch.

Only in Austria, according to Cieslar,[2] have experiments with this birch been made in order to prove the usefulness of this species in high mountains.

7. *Carya alba*, Nutt, White Hickory, Shellbark Hickory.

With this, the most important of the Carya species, 167·70 acres had been planted, according to Schwappach[3] (*l.c.*), in 1884, and in 1901 only 101·67 acres left; an unsatisfactory result, taking into account the new plantations, which were doubtless made during this period.

[1] "Zeitschrift für Forst- und Jagdwesen," 1901, p. 616.

[2] "Zentralblatt für das gesamte Forstwesen," 1901.

[3] Das holz der empf. exot. Laubholzarten, "Forstwissenschaftliches Zentralblatt," 1884.

Raising and transplanting are very much hindered by the very deep and very tender tap-root. During the first ten years it is of slow growth, and is usually overgrown by other indigenous species planted with it.

The wood of trees grown in Germany has proved just as valuable as that in America. According to Prof. Dr. H. Mayr,[1] it has a specific gravity of 75, and, from a note from Nuremberg, excellent qualities as waggon wood. The trees at present growing in Germany have produced seeds which showed poor or no germinative power at all.

8. *Carya porcina*, Nutt, Hickory, Pignut Hickory.

Of this tree species, which is inferior to the *alba* in the value of the wood, there were in 1890 in Prussia 19·62 acres, and in 1890 only 7·54 acres left, hence also a considerable reduction of the trial plantation areas. Whether this species was planted with the *alba* under natural conditions, namely, in groups about one-tenth of an acre in extent, is not to be seen from the monograph.

Wood from trees grown in Germany shows,

[1] Sargent, "Report on the Forests of North America," Washington, 1884.

according to Mayr (*l.c.*), a specific gravity of 83, and so it is equal to any in America, which, according to Sargent, has a specific gravity of 83 to 86.

9. *Carya amara*, Nutt, Bitternut.

Of this, which is less valuable in every direction than the former, there were in 1890 in Prussia 45 acres, and in 1900 only 29·89 acres left. Although easy to raise, the valueless wood produced excludes it from further trial plantations.

10. *Carya tomentosa*, Nutt, Hickory, Mocker Nut.

Of this tree species there were in 1901 in Prussia still 19·35 acres planted up. It has been as successful as was expected.

11. *Carya sulcata*, Nutt, Big Shellbark Hickory.

In 1890, in Prussia, 24 acres were planted, and of these only 0·98 acres were left in 1901. Further planting was given up.

12. *Castanea americana*, Raf., American Chestnut.

Taking into account the smaller amount of warmth required, compared to the indigenous variety, this tree was tried recently in South

Germany (see Professor Mayr).[1] The plantations are too young to show very much at present.

13. *Catalpa speciosa*, Warder, Western Catalpa, Hardy Catalpa.

The planting trials are of small extent, and have only been really successful in situations with long, warm summers.

14. *Fraxinus americana*, L., American White Ash.

Introduced in the middle of the eighteenth century, extended plantations (Dessau[2]) of grown trees of this species exist. Also recently the American ash is often planted instead of the indigenous ash in Germany. Schwappach mentions a plantation area in the aggregate of 67·62 acres in the year 1901. With the exception of one unimportant advantage, that of a little greater frosthardiness (in the late spring), this ash does not possess either in the wood or in rate of growth any quality that would justify planting it in preference to the indigenous ash. It is stated at Dessau[3] that the wood of the

[1] "Ergebnisse der Anbauversuche mit amerikanischen etc. Holzarten." "Fw. Zentralbl.," 1898.

[2] Danckelmann, "Fraxinus americana," "Z. f. F. u. J.," 1881, p. 118. [3] Schwappach, *l.c.*, 1896, p. 337.

white ash attains a higher price than that of home-grown trees.

15. *Juglans nigra*, L., Black Walnut.

The planting of this tree, according to the data of Schwappach, has been reduced considerably in Prussia from 84·03 acres in 1890 to 31·85 acres in the aggregate in 1900. This reduction in the trial planting areas seems in the first place due to unsuitable sowing, which caused a late germination of the seed. A limitation of the planting areas of this tree to the climatic warmest situations in Germany is not necessary, as it has been planted with care (naturally not in the open) at an elevation of 1,700 feet in Southern Germany. It is sufficient if it has good soil and warm situation where the oak still thrives. From the numerous failures the conclusion must not be drawn that it is difficult to raise the tree, or that unfavourable results with timber produced in Germany are to be made. On the contrary, timber from trees grown in Germany has the same specific gravity, according to Nordlinger[1] and Mayr,[2] and the same beautifully coloured heartwood, as that in America. Only the very

[1] "Das Vorkommen ausländischer Holzarten in Württemberg," "A. F. u. J.," 1882, p. 174.

[2] "Das Holz der empfohlenen exot. Laubholzarten," "F. Zentralblatt," 1884, p. 136.

best American timber—that of Indiana, Kentucky, and Tennessee—is superior.

16. *Juglans cinerea*, L., Butter Nut.

In consequence of the small value of the timber of this tree, it has scarcely been planted in Germany.

Only Austria[1] and Livonia[2] mention this tree as a plantable and plantworthy one, as the tree will still grow in climatic situations where the black walnut already gives out.

17. *Liriodendron tulipiferum*, Tulip Tree, Yellow Poplar.

Although this species is to be found as a grown tree all over Germany in the warmer situations, and although the wood is well known as being soft, easily worked, and durable (according to Mayr especially suitable for water-pipes), it has not received any attention forestally there; only in France[3] has the tree found a place in sylvan plantations. Vonhausen[4] had in 1881,

[1] Cieslar, *l.c.*, pp. 101, 150, 196.

[2] "Forstliche ausstellung zu Riga, 1899," and Mayr, "Naturwiss. u. forstl. Studien im nordw. Ruszland," 1900.

[3] "Le Tulipier," by P. Mouillefert. "Revue des Eaux et Forêts," 1897.

[4] "Einbürgerung fremder Holzarten," "A. F. u. J. Z.," 1881, p. 297.

and Cieslar [1] in the year 1901, drawn attention to this species as a forest tree.

The clear-cutting system, for the most part at present predominating, gives naturally no possibility for this tree, and also many other exotics, of growing up.

18. *Platanus occidentalis*, L., Western Plane, Buttonwood, Sycamore, Plane Tree.

Although this tree is very extensively used both in Germany and Austria for ornamental purposes, it is not cultivated anywhere on strict forestal lines, notwithstanding the fact that the wood possesses a pre-eminently beautiful structure with its medullary rays.

19. *Populus canadensis*, Mönch., syn. *Populus monilifera*, Ait., Canadian Poplar Cottonwood, Canadian Poplar, and *Populus balsamifera*, L., Balsam Poplar, Balm of Gilead, Balsam Poplar.

In cultivating these various species of poplars the chief idea in Germany seems recently to have been the production of the greatest possible quantity of wood. The wood itself is very soft, and of no use except as backing for furniture and

[1] Cieslar, "Über Anbauversuche mit fremdländischer Holzarten in Österreich," "Zentralblatt f. d. gesamte Forstwesen," 1901, p. 208.

the manufacture of paper. The young growing trees are peculiarly liable to injury and, indeed, destruction by the larvæ of the *Cossus ligniperda*. It is only in the Rhine Valley[1] that we find a large area of poplar coppice. The growth of these poplars, more particularly isolated trees in avenues, is really astonishing and, according to Kisling,[2] nineteen trees of this species fifty-two years old and raised at Koslin, averaged some $3\frac{1}{2}$ f.m.[3] of timber each. In the lowlands of the Rhine and Main, Walther found the price to be 22 marks per f.m., and I found one could get 30 marks per f.m. at Forchheim.

20. *Prunus serotina*, Ehrh., Late-blossoming Cherry, Black Cherry.

This tree, also, has been known a long time in Europe, and has enjoyed great favour for decorative purposes. The wood produced from it shows the same red heart as that of the American cherry-tree. Generally speaking, it does not yield any valuable timber planted in parks, so that no comparison can be made as to the respective usefulness of the German and American serotina

[1] Walther, "Die kanadische Pappel in der Main-Rhein-Ebene," "A. F. u. J." 1895, p. 67.

[2] "Anbau der kanadischen Pappel," "A. F. u. J.," 1898, p. 251.

[3] = 39·1—a cubic foot, literally one festmetre, one solid cubic metre.

wood. It is some twenty years since attempts at growing it under forest conditions were commenced. According to Schwappach's calculations, only 1·7 hectares[1] have been planted. The following, at any rate, proves its rapidity in growth, for, as Booth[2] says, it attained in the course of twenty-two years a height of 14 metres with a diameter of 60 centimetres just above the ground.

21. *Quercus alba*, L., White Oak.

This tree which, from the botanical, sylvicultural, and timber-producing points of view, is a very near relation of both the indigenous oaks has, nevertheless, not been planted anywhere on a large forestal scale, although as an ornamental tree for autumn time it far excels any other kind of oak.

22. *Quercus macrocarpa*, Michx., Large Fruited Oak, Bur Oak, Overcup Oak.

Here again, as regards this oak, which so far has given no proof of superiority over the native species, nothing in the way of trial planting has been attempted in Germany outside the park

[1] 1 hectare = 2.47 acres.

[2] "Die weitere Behandlung der Versuche mit ausländischen Holzarten," "Zeitschrift für Forst- und Jagdwesen," 1892, p. 339.

palings, and it is only in Austria[1] that we hear of such experiments.

23. *Quercus palustris*, du Roi, Bog Oak, Needle Oak, Pin Oak.

This rapid-growing oak with its beautiful trunk has been grown as a forest tree in certain small areas in the Rhine province, Württemberg, and Hungary, and it is on record that the pin oak has attained, in 48 years a height of 21·3 metres and 44 centimetres in diameter, compared to the pedunculate oak with a height of 16·9 metres and diameter of 36 centimetres. The trunk and contents of the pin oak was 1·04 f.m., and of the pedunculate oak only 0·49 f.m.

As regards the technical qualities of the wood, it was found to be inferior to the pedunculate oak, but the tanning properties of its bark are quite equal to it.

24. *Quercus rubra*, L., Red Oak.

No American oak has acquired such importance or been so widely distributed as the red oak both in park and forest, where it is planted both in high and copse forest.[2] In Prussia, in the year 1900, there were some 41·56 hectares. The rapid

[1] Cieslar, *l.c.*, pp. 101, 150, 196.

[2] Weise, "Das Vorkommen fremdländischer Holzarten in Deutschland," "Z. f. F. u. Jw.," 1882, pp. 81, 145.

growth of this oak is really very astonishing Danckelmann [1] tell us that some full-grown trees reached in the course of 50 to 55 years quite, and occasionally more than, 24 metres in height and 50 centimetres in diameter. Eberts [2] tells us the same thing about the Government District of Aachen, and Lorey [3] from Württemberg. Dr. Eichhorn [4] makes out that up to its fiftieth year the red oak produces a greater quantity of wood than the home oak but from that period decreases, and Hartig [5] gives us the same information about trees one hundred years old. The investigations made by Mayr [6] show that wood grown in Germany possesses a specific gravity in the sap-wood of 64, heart 67. German oak, given the same breadth of rings, has a specific gravity of 67 or 70. Nördlinger [7] estimates a special gravity of only 60 for timber having rings of one millimetre in breadth. The contents of tannin in

[1] "Anbauversuche mit ausländischen Holzarten in den preuszischen Staatsforsten," "Z. f. F. u. Jw.," 1884, p. 370.

[2] "Verhalten einiger fremdländischer Holzarten im Regierungsbezirke Aachen," "Z. f. F. u. Jw.," 1892, p. 267.

[3] Lorey, *l.c.* see previous pages.

[4] "Untersuchungen über das Holz der Roteiche," "Forstl.-naturw. Z.," 1895.

[5] "Ergebnisse der Anbauversuche in Bayern," "Forstl.-naturw. Z.," 1892.

[6] *L.c.*, 1884, p. 129.

[7] Literarischer Bericht über "Les chênes de l'Amerique septentrionale en Belgique," "A. F. u. Jz.," 1888, p. 95.

the bark is only 1·07 per cent. As regards the commercial value of the wood, American opinion is unfavourable to the red, and favourable to the white oak, and we have only Macoun [1] to refer to, who talks about using red-oak wood for staves. The same reports come from Austria. [2]

25. *Robinia pseudoacacia*, L., Acacia, Locust, False Acacia, Robinia.

No broad-leaved tree coming from America has been so widely distributed as the one known as Robinia. The extent of all these Robinia plantations is not known. Alsace [3] reports more than 30 hectares of copse forest (Niederwald), Hungary [4] 70,000 hectares of high and copse forest.

We find everywhere that in warm climates the wood matures with wonderful rapidity. If Illes [5] is to be believed, the quantity of 50 years' old wood amounted, in Hungary, to 250 f.m. per

[1] "Forest Wealth of Canada," 1900, p. 27.

[2] "Ös. F. u. Jz.," 1899, p. 291. Die Anbauwürdigkeit der Roteiche von Oberförster Spanily.

[3] Halbbauer, Edelkastanie und Akazie als Waldbäume im Oberelsass, "A. F. u. J.," 1896, p. 249.

[4] Lorey, "Die Waldungen Ungarns," "A. F. u. J.," 1889, p. 104 und v. Alten, "Das Forstliche auf der Pariser Weltausstellung," "Z. f. F. und Jw.," 1901, p. 68.

[5] Die Akazie in Ungarn, "Öst. Fz.," 1891, p. 321.

joch (yoke),[1] which means an increase of 15 f.m. per year and hectare; the average height of the trees being 27 metres, average diameter 26 centimetres. Here we have the culmination of the increment at 20 years, and if we go on the basis of the poorest quality, the full increment came to 3·6 f.m. per year and hectare. From what Eberts[2] says the robinia yielded 760 f.m. under 50 years' rotation. Under coppice the rotation is fixed at from 15 to 20 years, and in high forest at from 50 to 60 years.

Acacia wood enjoys the best reputation everywhere, and in point of durability, hardness and resistance is not far short of oak itself. It is liable to be broken by the wind and it suffers from early frost. Hares, *Coccus cacti*,[3] *Lecanium robiniarum* also diminish its growth.

26. *Ulmus americana*, L., American Elm, White Elm.

This is known all over the world as a tree for parks, but has only just been taken up for forest culture. It is, however, strongly recommended on account of its rapid growth.

[1] Joch = about one acre.

[2] Der Akazienniederwald, "A. F. u. J.," 1899, p. 168.

[3] Prof. Sajo, "Die Akazienschildlaus," "Forstl.-naturw. Z.," 1896, p. 81.

B. East American Conifers.

27. *Abies balsamea*, Miller, Balsam Fir.

This fir, which shows itself everywhere as an ornamental tree, never comes up to the height standard required for forestal purposes in Germany, namely, 20 metres and more. For this reason no attempts have been made to cultivate it, especially as in point of the quality of wood and adaptability for forest planting it is in no way superior to the indigenous species.

In Austria it is tested with a view to its growth in cold, mountainous altitudes.

28. *Juniperus virginiana*, L., Virginian Juniper, Pencil Wood, Red Juniper, Red Cedar.

A warm climate (such as that required for the sweet chestnut) is a first necessity to the proper growth of this tree. Under these circumstances the attempts at cultivation which have been made in Germany would appear to be of no value. The oldest Faber plantations at Stein, near Nuremberg, are merely a proof of this. The remunerative cultivation of pencil wood can only be thought of in climates warmer than the warmest in German territory, such as Hungary, Dalmatia, the South of France, &c.

29. *Chamæcyparis sphæroidea*, Spach., Spherical Cypress, Swamp Cypress, White Cypress.

This tree is to be found in parks. Its immunity to frost made Mayr consider this species to be well worth trying in the forest at a height of 540 metres above sea-level. Experiments in growing it are so far, however, of a very isolated character.

30. *Picea alba*, Link, White Pine, White Spruce.

This spruce, which is in great favour as an ornamental tree, is in no way superior to the indigenous spruce as a forest tree. Experiments are only being made with it in the Austrian Alps.

31. *Pinus banksiana*, Lamb, Banks Pine, Jack Pine, Scrub Pine.

It was Mayr [1] who first called attention to the super-excellent sylvicultural qualities of this species of timber tree, the result being that its cultivation was begun on a large scale all over Germany, Russia, Austria, and even in America itself. In Prussia alone in the year 1900, that is, 10 years after Mayr's book appeared, 12 hectares were under cultivation, and the area is not less outside Prussia. One single firm (Hein, of Halstenbeck) sold in quite a few years some 5,000,000 Banksia plants. As a preparatory tree

[1] "Die Waldungen von Nord-Amerika," München, 1890.

for the afforestation of all waste lands in damp, swampy places, as well as in arid, poor, sandy, and gravelly soil it is the best yet discovered, but as timber, although it is equal to the native pines as regards alburnum and heart wood, this has no decisive influence, in point of value, on the question of cultivation. It is a great mistake to form without any reason a comparative estimate between the timber of the Banksian and Weymouth pines on the basis of the relation of the Banksian pine wood to ordinary pine.

32. *Pinus rigida*, Mill, Pitch Pine.

A great deal of attention has been paid to this species of pine, especially in Prussia. According to Schwappach some 146·5 hectares had been planted there up to 1900. A very poor opinion was formed of the results of the majority of these experiments made both in and out of Prussia. On poor, sandy soil this pine is just as good as the native species, but in marshy places where it succeeds better, it succumbs far sooner than the common pine to other dangers such as damage from wild animals, snow fall, &c.

The timber, to judge from American experience, does not differ from the Banksian pine; this rigida pine is, on the other hand, very suitable for producing resin, and this fact alone is sufficient to justify its continued forest cultivation. The

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capacity of this pine to produce stool shoots, which has been so much exaggerated (especially in magazine articles), would seem to have but slight forestal importance for Germany, and then only under the warmest climatic conditions.

33. *Pinus strobus*, L., Weymouth Pine, White Pine.

This pine is the only conifer which one hundred years ago became naturalised in the forests of Germany and the surrounding states. Its rapidity of growth, immunity from frost, and other sylvicultural qualities which distinguish it from the common pine have assured it a place in the forest, especially as the extraordinarily favourable opinions from America as to its wood had directed the attention of foresters previously to this tree. This very Weymouth pine shows what a mistake it is to apply the opinion of a foreign country respecting its forest products straight away to the valuation of the same timber in one's own land in competition with other kinds of timber. In the United States of East America this pine was practically the one and only conifer existing amidst an ocean of broad-leaved trees which was capable of providing a strong, soft wood suitable for building purposes, and hence the opinion of the Americans as to its being an excellent first-class wood for

commercial objects; but when it was transplanted to Germany it came into conflict with three soft and strong coniferous timbers of the highest class, namely, pine, fir, and spruce. The opinion as to its wood here is, of course, quite different. As regards size and growing capacity it excels the indigenous pine, and, as a matter of fact, is better at first than both spruce and fir, but as time advances it is surpassed by the two kinds of wood just mentioned. The shape of the trunk is more favourable than in the case of the common pine, but according to Professor Endres,[1] is less favourable than that of spruce and fir. As regards the timber-producing quality of the wood, it must be said that this pine wood is much lighter as regards weight than all the rest of European conifers, and is easier for working up. The heart of this tree is as hard as that of the pine, and far harder than that of the fir and spruce, because the heart or core, like all trees, only develops even in the case of these firs after a number of years, so that a comparison of the wood of young Weymouth pines to that of older pines and firs is not admissible. The resinous contents are far in excess of all native firs, spruce, and pines. This is the collective judgment about Weymouth pine, taken from the very comprehensive mass of

[1] Wachstum und Ertrag der Weymouthskiefer. "A. F. u. J.," 1890, p. 206.

literature published on the subject, and if a comparison be made with the above in the shape of the few statements from the Americans (Fernow, Spalding, Graves, Macoun, Dawson, Gifford, Sargent), the result will be that the Weymouth pine is not one whit behind as regards the show it makes in Europe than what the Americans tell us in regard to the output and sylvicultural qualities of the wood. In all this it must not be forgotten that Weymouth pines a hundred years old are not met with every day. These have, as a rule, sprung up here and there, and cannot, therefore, possess the same fine grain as is shown in the American trees which boast of more than a hundred years grown in a thick forest.

34. *Taxodium distichum*, Rich., Bald Cypress, Bog Cypress, Deciduous Cypress.

This beautiful ornamental tree flourishes only in places where mild winters prevail, such as Southern and North-western Europe, Holland, Belgium, and neighbouring territories, not forgetting Great Britain.

35. *Thuja occidentalis*, L., *Arbor Vitae*, White Cedar.

We have no account of any forestal experiments with this species, but it may be said that it is to be found all over outside woods, and the tree itself is known to be very hardy.

36. *Tsuga canadensis*, Carr., Hemlock.

Experimental raising of this tree has only been carried out on a small scale in Bavaria. One would think that the rapid growth, durability of the wood, and the tanning properties of the bark would have brought this tree into greater prominence. Even in America this species of wood was altogether neglected (while Weymouth pine was to be got), except for the bark torn from the trunk for tanning purposes.

C. West American Broad-leaved Trees.

37. *Fraxinus oregana*, Nutt (*Fraxinus oregona*, Mayr), Oregon Ash.

The experiments with this are quite isolated, and it has only been cultivated with success by Mayr.

D. West American Conifers.

38. *Abies amabalis*, Forb., Purple Fir Amabalis Fir.
39. *Abies concolor*, Gord., American Silver Fir, White Fir.
40. *Abies grandis*, Lindl., Great Coast Fir, Great Silver Fir.
41. *Abies nobilis*, Lindl., Pacific, Noble, Fir, Red Fir.

Experiments with these four firs have been

carried out chiefly in North Germany, and there only on a very small scale, say, according to Schwappach, hardly 2½ hectares in all.

42. *Chamæcyparis lawsoniana*, Parl., Lawson's Cypress, Port Oxford Cedar.

The ornamental planting of parks first drew attention some fifty years since to this particular kind of wood. It belonged to those West American species which came pretty well through the exceptionally cold winter which prevailed in Mid-Europe in 1879–1880, and it was only at a later period that Sargent and Mayr called attention to the splendid qualities of the timber (light, very durable, and scented).

If we may judge from an experience of twenty years, the wood grown in Germany is quite equal in excellence to the American variety. Formation of heart wood appears in the tenth year, and the wood possesses the same strong, pungent odour as the American kind. Strong poles which had fallen victim to the worst enemy of this cypress, namely, the root fungus, *Agaricus melleus*, were utilised for palings without removing the bark, as is often done in America. Another fungoid disease has proved fatal to many different plantations in Germany, that is, the one which attacks branches and terminal shoots, known as the bark fungus, *Pestalozzia*

funerea, the characteristics of which are a white resinous drop, a decaying belt of bark with an intumescence node overlaying it. The official statistics putting the experiments in Prussia at 12·7 hectares by no means represent all the attempts at cultivation in Prussia, much less Germany.

43. *Chamæcyparis nutkænsis*, Spach., Nutka Cypress, Yellow Cypress, Yellow Cedar.

This cypress, which constitutes the best wood in the north of West America as far as Alaska, has not been officially recommended for planting in Germany, because of the unfavourable results of a few garden specimens. The majority of the experiments which were carried out by Mayr show that this tree is almost on a par with the Lawson cypress as regards its excellent properties and the dangers to which it is liable. In exposed areas, however, it is much more sensitive than the Lawson cypress.

44. *Picea engelmanni*, Engelmann's Spruce.
45. *Picea pungens*, Engelm., Blue Spruce.
46. *Picea sitkænsis*, Mayr (Sichensis Trautw. et Mayr), Sitka Spruce, Tideland Spruce, Menzies Spruce.

As there is no prospect that these three spruces will produce a better wood than the native article

other reasons were put forward for its cultivation as, for instance, in the case of *Pungens* and *Sitkænsis*, its needle-like equipment which serves as a protection against damage by the denizens of the forest. Then, again, along with these motives for cultivation, which are quite incontestable from the sylvicultural economic point of view, its advantages as regards rapid growth, resistance to frost, &c., have been dwelt upon, and, in fact, there was an idea that in these spruces a class of timber had been obtained which could be raised in mountainous regions beyond the limits of our own spruce. In Prussia about 63 hectares of Sitka spruce have been planted with very successful results, it having been introduced into most localities of the warmer forest zone. *Pungens* is considered very hardy against frost, and is, moreover, much appreciated as an ornamental tree.

47. *Pinus jeffreyi*, Engelm., Jeffrey's Pine, Black Pine.
48. *Pinus ponderosa*, Lawson, Yellow Pine, Bull Pine.
49. *Pinus scopulorum*, Lemon.

These three species, which in their botanical characteristics are closely related but yet sufficiently distinct from each other to be such, are

cultivated only on a small scale in Germany. The *Pinus jeffreyi* with white bloom covered yearling shoots, buds without resin and light, reddish brown scales with dark tips. Leaves of a whitish green shade, in robust specimens turned somewhat towards the shoot, and about 23 centimetres in length. The *Pinus ponderosa*, with cylindrical buds terminating abruptly in a short tip, close joining scales rather brown with whitish tips, young shoots of a brilliant browny green, and no bloom. The needles stand at right angles from the shoot, colour dark green and of the same length as the preceding species, *Pinus scopulorum*. Shoots slightly bloom covered, needles shorter than in 47 and 48. Buds brown with whitish scale edges.

Experiments are much fewer than formerly chiefly because of the susceptibility of the seedlings to the *Lophodermium pinastri* (Leaf-shedding fungus). Schwappach, in his report, says, besides, that the plants which at first developed pretty well, for some inexplicable reason gradually withered and died later on. The timber is equal to that of the indigenous product (the name "ponderosa" is merely to show that the wood is heavier than the Weymouth pine), so that its production is unnecessary, even if it does attain (after several hundred years) gigantic sizes in West America.

50. *Pseudotsuga douglasii*, Carr, Coast Douglasia, Douglas Spruce, Douglas Fir, Red Fir, Oregon Fir.
51. *Pseudotsuga glauca*, Mayr, Colorado Douglasia, Colorado Douglas Fir.
52. *Pseudotsuga macrocarpa*, Mayr, Big Cone Douglas Fir, Big Cone Red Fir.

Of these three species of *Pseudotsugas*, the *douglasii* and *glauca* are the most extensively cultivated. The *Pseudotsuga macrocarpa* has so far proved useless on account of its great susceptibility to frost (Mayr). Of the two first mentioned the Coast Douglasia has been more generally adopted and it is to this species alone that all statistics apply which are published in Great Britain and Germany about its growing properties and excellent timber. All particulars on this subject confirm the dictum expressed by Mayr, that the maritime districts of the North Sea and the Atlantic from Mid-Europe must be considered as the stronghold of the Douglas fir. The nearest approach to this is found in the moist atmospheric conditions prevailing on the Northern and Eastern slopes of certain localities of secondary mountain chains (Bavarian Forest, Fichtel Mountains).

Schwappach gives, *l.c.*, page 264, the following

particulars about the height which the Douglas fir attains, viz. :—

Age (years)	Average height in metres.	Extreme height in metres.
5	0·5	1·0
10	3·5	7·0
15	8·5	12·0
20	13·5	15·0
25	16·0	18·0

It is very unfortunate that for the purpose of verifying all statements about soil, climate, and locality we have no statistics to go upon. Dr. Nisbet [1] speaks of an area in Scotland widely planted on good soil (at intervals of 6 ft.), which, in the course of forty years reached an average height of 23 metres and an average diameter of, at a man's height, 70 centimetres. This would come to 340 f.m. per hectare which is not more than what our native spruce and fir could produce on the most fertile soil. We have no statistics as to results from Germany. The particulars which Schwappach gives us as to the increased growth in certain districts gives us no idea of the general output. All the same it would appear as if the Douglas fir, grown in the most favourable localities in Europe, would do just as well as in its own home. In its home Mayr (see *l.c.*) gave 4,100 f.m. as the solid output of timber for

[1] "Our Forests and Woodlands," 1900, p. 208.

a period of eighty years on the best sandy loam soil, in the climatic stronghold of the Douglas fir (that is, the coast of the State of Washington). Macoun [1] (*l.c.* p. 134) mentions several places which have turned out 3,000 f.m. per hectare in which trunks of less than 0·6 metres and over 1·6 metres diameter were not used, which means that the trees were undoubtedly, several hundred years old. The earliest comparative investigations with reference to the wood grown in Germany were undertaken by Mayr, who, in 1884, compared the oldest example (at that time) in Germany, raised on the estate of John Booth, Kleinflottbeck, to the American wood. The German wood had the same reddish heart as the American, and displayed, with the increasing annual width of ring, an increasing specific gravity which was confirmed fifteen years later by other investigators (Cieslar, Hartig). Mayr occupied himself simply about the weight which he, as a disciple of Hartig, assumed at that time to be the very alpha and omega in point of quality of the wood. After his investigations Mayr came to the conclusion that the timber of the Douglas fir, even from the poorest quality (that is, weight) is better than fir and pine timber and as regards its best qualities (weight) is quite equal to larch.

[1] "Report of the Canadian Forestry Association in 1901," p. 10.

The information that we get from England [1] confirms the fact of the red colour of the heart of the timber grown there. In that country it is worth 35 M. per f.m. and that only for young and rather knotty timber. In the course of twenty years it has been shown that thorough forest cultivation has resulted in about 200 cubic metres per hectare being produced. The bark is, moreover, according to Semler [2] noticable for its tanning properties (13 per cent.). The experiments made in Prussia in 1900, according to the official statistics, comprised an area of 146 hectares, and the area not officially mentioned cannot be much less, as in most cases the Douglas fir was not planted by itself, but as a mixture with other kinds. Amongst its most inveterate enemies in may be mentioned weevils and roebuck.

53. *Sequoia gigantea*, Decaisne, syn. Wellingtonia, Giant Sequoia, Bigtree.

Attempts at raising this genus of tree have been made not only in France,[3] Austria, and England,[4] but also in Germany. In Württemberg

[1] Simpson, "The New Forestry," 1900, p. 101.

[2] Tropische und nordamerikanische Waldwirtschaft und Holzkunde, 1888.

[3] "Les Sequoias von Bourotte." "Revue des Eaux et Forêts, 1887," p. 489.

[4] Simpson, *l.c.*, 104.

in the year 1863 seedlings were planted in various parts of the country and the report on the subject says that in the temperate lowlands these plants were frost-bitten in the very severe winter of 1879–80, but escaped the danger in the higher altitudes. The plains or lowlands are not on clear, still, and frosty nights, any warmer than higher sites, and, as a matter of fact, are colder than the more exposed positions, as naturally the coldest air finds its way to the lowest point. The Sequoiæ grown under home conditions are now about 27·7 metres in height with a diameter of 95 centimetres one metre above the ground. A high degree of moisture coupled with mild winters such as we get on the North Sea Coast and in the higher parts of the West German Central mountain districts are the primary conditions of success in the cultivation of this timber.

54. *Thuja gigantea*, Nutt, Giant Arbor vitæ, Red Cedar.

Experiments on a pretty extensive scale were made with this species of timber throughout Germany and Austria, and for some fifteen years they were very well maintained. Hindrances to their development occurred in the shape of unusually severe late frosts in March and April (see Mayr in his sessional report to the German Dendrological Society in 1901), and also the

fungoid disease already alluded to in connection with the *Chamæcyparis lawsonsiana* caused by *Pestalozzia funerea.* In many localities trees of twenty years' growth were entirely destroyed.

55. *Tsuga mertensiana*, Carr, Western Tsuga, Western Hemlock, Fir, Western Hemlock.

This *Tsuga*, first recommended by Mayr on account of the better (more cylindrical and fuller length) shape of its trunk and quicker development as compared with the Canadensis variety, has only been tried in a small way. The chief risk it runs is from early frost until the plant reaches a height of 2 metres, after which it is hardy.

PART III

Sylvicultural Characteristics and Treatment of the Various American Species of Trees.

THE solution of the question as to how foreign trees stand in regard to heat and light, the different chemical and physical composition of the soil, technical treatment of seed, planting and raising, is just as important for the cultivation of the foreigner in Europe as for its cultivation in its own home in America. For the proper utilisation of European experiences in America it should be noted that:

1. In the European reports concerning the attempts at raising them, unfortunately very little information (and that only superficial) is given on the subject of the causes of non-growth or total disappearance.

It must be admitted that it is sometimes a very difficult matter to get such information, and in many cases it is even now quite impossible.

Then, too, it is not everybody's business to acknowledge openly to faults committed and recognised in the treatment of some particular species, and the consequence is that statements as to failure find speedier and more permament publicity than those referring to successful achievements. The cause of poor growth is, for instance, very often attributed to frost without any reference as to late frost, early frost, winter frost, needle shedding due to frost, or unfavourable temperature during the period of vegetation being in fault, so that other experimenters have not got the chance of adopting suitable sylvicultural measures, or to give an opinion as to the adaptability of the timber being grown.

2. The knowledge of the sylvicultural qualities was acquired in Germany chiefly in exposed areas, consequently under the most unfavourable conditions as regards growth. In areas of this kind there is a combination of dangers acting against the plant (such as heat, cold, drought, animals, weeds, and men), so that it is impossible to spot the particular cause or combination of plants or animals to which the exotic tree is exposed.

3. In most cases the exotics were given unfavourable soil, on the assumption that their pretensions must be more modest in order to possess a justification for their cultivation. For

instance, in this country they are very often planted in highly cultivated gardens, where they enjoy the benefit of enclosures already provided.

4. In cases where these were not grown pure planting of the foreign specie singly amongst the native trees already there was often adopted for promoting their growth, the result of which was that the exotics were overgrown and forgotten.

5. It is not very clearly discernible from the reports that any number of failures in Germany must be traced not to the climate, soil, or method of treating the wood, but simply and solely to the depredations of wild animals in German forests. On the other hand, it appears very plainly from the experiments that American spruces, firs, larches, oaks, elms, maples, and ashes were subject to the same physiological sylvicultural laws as their corresponding European arboreal kindred; that all these American timbers can be grown in Europe under identical precautionary measures as those adopted for the home-grown species, that they can be subjected to the same methods of treatment as the indigenous trees, and that their output is equal to that of the corresponding native kinds of timber in point of durability, shape, and excellent quality.

It follows naturally from all this that also the

American representatives of the said species of trees in America can be treated sylviculturally in precisely the same way as their European relatives have been handled and mishandled for more than one hundred years past. Only such differences will arise according as different people may make different demands on the wood. For this reason a comparison of the sylvicultural characteristics of the same species of trees existing simultaneously in Europe and America has been as far as possible avoided. If the American readers of these pages should consider this a fault, I can only refer them to the statistics contained in the forestry publications, especially German, on the subject in which they will find all necessary information as to the treatment of spruce, firs, pines, larches, oaks, &c. Let it not be objected that other conditions prevail in America. Both soil and climate which are the basis for the best development of fir pine and larch are absolutely identical over all the Northern Hemisphere. The only difference is the position occupied by the timber in the internal economics of the inhabitants of Europe, America, and Asia. Pines do not, however, follow this general rule, as they do not constitute a uniform species of tree, but are simply a collection of various kinds. The following survey of the sylvicultural peculiarities of the different kinds of

American timber trees cultivated in Europe is drawn principally from two sources:

1. From observation of the trees in their own home.

2. From observation of the trees in their new home, chiefly Germany.

As regards the first point, the studies made in the home of the American varieties of timber, are all of the most recent date, previous investigations being principally of a systematic botanical and geographical character, with but little reference to the physiological peculiarities. The first complete work dealing principally with the sylvicultural peculiarities of the trees is the production of a German forester, Professor Dr. H. Mayr, who visited America on behalf of the Bavarian Government, and subsequently proceeded on his own account to Japan and India on a search for various kinds of profitable timber.trees, and to establish natural laws for growing the same. The Americans themselves, on the occasion of an inquiry into their supply of timber and the commercial value of the different species, brought a considerable amount of uselful forest data to light, among the number being Professor Charles Sargent, Professor F. Fernow, Charles Mohr, Dr. John Gifford, Henry Graves, Pinchot, and a Canadian,, Macoun.

Secondly, a great many observations were

made during the five years which I spent in this work in Germany, Austria, and France, and data also gathered from the scientific papers of Prof. Dr. Mayr; and, finally, from the very comprehensive reports on the results of planting experiments in the State forests of Germany and Austria and the private woods of Great Britain. In order to spare as much detail as possible on the subject as to the amount of warmth which must be allowed to a given species of timber during its period of vegetation in order to enable it to begin and complete its growth in proper time, the following way, which was originated by Mayr, has been chosen. As all classes of timber trees are connected with a certain climatic zone, such trees may, inversely, be used for fixing the climate, and the territorial distribution of a particular species may be looked upon as a climatic zone. Within this zone not only can the typical species be grown, but also all other kinds of trees found with it. Now, as the classes of trees such as Abies, Picea, Larix, Quercus, Fagus, Betula, &c., belong to the same climatic zone all over the Northern Hemisphere, it is quite enough, for delimitating the climatic zone of any kind of timber, to mention the typical species within whose territory it is being or can be grown. The fact that some particular kind of timber can be raised outside

the boundaries of its territorial distribution has been used as an argument against the correctness and adaptability of Mayr's zone formation, the fact being altogether forgotten that every species of wood can also be grown some little distance beyond its territorial home:

1. If it is kept at a distance from the other species of timber which would otherwise naturally outgrow it.

2. If the fructification and maturity of seed is not required. English Elm (*Ulmus campestris*) is an example of this.

3. If the same climatic conditions are afforded it beyond its territorial distribution which it enjoys within such limits, to which must be added that by our ability to choose sites, soil, and the method and degree of protection, &c., we are in a position to modify the conditions of temperature in a positive or negative direction. The best data, therefore, as regards the climatic demands of any particular species, and the starting-point for the further study of its sylvicultural management, are to be found in the zone of vegetation in which it grows and can be raised. It is only in localities where seed and plants cost almost nothing and where trained foresters are absent that the dictum of ignorant growers may be followed, which, to speak the truth,

often possesses a very practical value, namely, that you may sow and plant all kinds of seeds and plants wherever you like and chance with what results.

As regards statistics on the subject of resistance to frost, all these may be averaged, because, for instance, hardiness against a late frost not only depends on the beginning of growing period of the tree, but also on the occurrence of a frosty night. In a given year, for example, in which frost appeared early in May the same species of trees are liable to and suffer from frost, which develop their buds at the beginning of May, while in another year the late frost only appears in June, and those species are liable to and suffer from frost whose vegetation begins early in June, whereas those which began growing a month earlier have proved less susceptible. Much the same applies to the effect of the lowest temperatures on trees, as the localities in which these occur are liable to variations so that the idea of establishing a zone of cultivation on the basis of the lowest temperature of winter, as has been suggested quite recently, is not sound.

1. *Acer dasycarpum.*

This very rapid growing tree which is said

to attain a height of 30 metres[1] possesses no interest from a forestal point of view.

2. *Acer negundo.*

The same may be said of this tree.

3. *Acer saccharinum.*

This species can be successfully raised in all places where other maples grow. With the exception of tolerating a little more shade the sugar maple is so closely allied to the European great and Norway maple that all that is known sylviculturally about the latter may be equally applied to the sugar maple.

4. *Betula lenta.*
5. *Betula lutea.*

Of these two varieties, the former, *Betula lenta*, is really only a small growing tree, as distinguished from the latter, a forest tree. *Betula lutea*, too, is like all other birches as regards its resistance to frost, but in colder forest regions it is substituted by *Betula papyrifera.* In other respects it is very much like the European birches, with the exception of its timber which is of greater value, and it stands more shade,

[1] From "Rod and Gun in Canada." Out of the forestry section of the magazine, Nov., 1901, p. 18.

and it does not possess the latter's whiplike branch formation.

6. *Betula papyrifera*

resembles in all respects the European birches.

7. *Carya alba.*

This, the most important of all hickorys, requires the climate of the silver fir, and wherever the latter can be grown, even if without the seeds maturing, the cultivation of this *Carya* is feasible. In such localities it is quite proof against frost, but in its youth and up to its tenth year is very slow in growth, so that, on this account, it is only suitable for cultivation in clumps among rapid growing broad-leaved trees. Sowing is recommended, as planting the long-rooted hickory is a difficult matter. The great reproductive power from the stool which it displays, according to Mayr, renders it particularly suitable for coppice cultivation in which connection it will supply most valuable small wood. On the best soil it is suitable too for growing as high forest, 100-foot trees being found in various parts of Germany.

8. *Carya porcina*

resembles the preceding, except that it can be grown on pine soil of second quality as well.

9. *Carya amara.*

Apart from its advantage as a rapid growing tree, this hickory possesses no other valuable quality. The same may be said of

10. *Carya tomentosa.*

11. *Carya sulcata*

can only be grown on the best soil, where the sweet chestnut also reaches maturity.

12. *Castanea americana.*

Treatment is the same as in the case of the European chestnut. Attempts that have been made to grow it outside its territorial and climatic zone have not shown better results than with its European relative.

13. *Catalpa speciosa.*

This valuable species of wood seems only to thrive where the nuts of the sweet chestnut come to maturity. The chief risks it runs are late and winter frost. It should be raised in clumps under a light screen of tall timber among broad-leaved trees.

14. *Fraxinus americana.*

Climate, soil, and treatment just the same as with European ash.

15. *Juglans nigra.*

Wherever the sweet chestnut thrives this tree also flourishes, preferably on the best soils. Even within the domain of the oak, black walnut can be raised on good soil in warm situations. Smaller clumps in partial clearings or groups of trees are recommended, but planting it pure has not proved to be of any good. On the other hand, in the special zone of the sweet chestnut mixed planting among the other broad-leaved timber trees is quite admissible on account of the speedy growth of the walnut. It is advisable to keep the nuts during the winter, so that when they germinate in the spring they can be planted in the same place. This is also done with the *Carya* nuts.

The transplanting of seedlings of two or more years' growth is much easier in the case of Walnut than Hickory. With a view to giving it plenty of light it is necessary that the crown be entirely exposed, but the stem enclosed by Ashes, Oaks, Maples, Beeches, and so on, for the purpose of growing a trunk free from branches. It is only high forest with a rotation

of eighty to one hundred years that is now being considered.

16. *Juglans cinerea.*

This displays a similar attitude to the foregoing species, but shows a power of standing a somewhat colder climate. The poor value of its timber prohibits its cultivation in places where the black walnut can be raised.

17. *Liriodendron tulipifera.*

This tree can be grown very easily within the limit assigned to the sweet chestnut and on the warmer sites in the Oak zone—that is, under the lateral protection of other broad-leaved trees and on soils varying from good to best. This tree loves the light and rapidly builds up a straight stem and produces a considerable quantity of timber in a short period of time. The seed usually germinates very well.

Transplantation is easy, and this tree may be recommended for planting small areas or in clumps in the broad-leaved woods.

18. *Platanus occidentalis.*

The plane is recommended for planting river banks liable now and again to inundation in the warmer regions of the broad-leaved woodland,

where it may be utilised in copse or as a standard.

19. *Populus canadensis* and *balsamifera.*

These free, rapid-growing kinds of deciduous trees will do in moderately good, but fresh soil. It is cultivated by means of cuttings or raised from seeds, in which case it is important to note that the seed loses its germinating power a few days after maturity. Even root shoots can be used as planting material. Recommended to be planted pure on river banks.

20. *Prunus serotina.*

Wherever the sweet chestnut or oaks grow this cherry-tree also thrives. It is a rapid-growing, deciduous tree which can be grown on medium and good soils (from pine soils third quality upwards). Cultivation in groups amongst broad-leaved trees, and it is useful for underplanting of light-loving species, filling up of holes due to snow, &c., in young pine plantations.

21. *Quercus alba.*

The white oak can apparently be raised wherever the indigenous oak grows, with which it also shares precisely the same method of treatment.

22. *Quercus macrocarpa.*

This, which, next to the *Quercus alba*, is the most important American oak, shows also no difference in its sylvicultural qualities. In Germany it is of as little importance as the *alba*.

23. *Quercus palustris.*

This oak is more modest in its demands upon the soil than indigenous oaks, grows more rapidly than the latter, but is inferior, as already mentioned, in the quality of its timber. The treatment is the same as that of European oaks, but whether it possesses the same advantages as the red oak has yet to be proved.

24. *Quercus rubra.*

Thrives wherever oaks are to be found, is very quick in growth, easily transplanted, and can be utilised on indifferent soils (pine soils of No. 3 quality). Its slight shade-bearing quality makes it suitable for underplanting pines, and its rapidity of growth allows it to be employed later on for filling up any gaps in all broad-leaved, also pine, cypress, and thuja plantations, and it is equally suitable in copse, where, however, its reproductive capacity is smaller than in the case of the white oak.

25. *Robinia pseudoacacia.*

The sylvicultural qualities of this tree, together with its adaptability, have been so thoroughly described in journals dealing with forestry that there is hardly anything now to be said. This species of timber tree can be grown both as high forest and in coppice, and even on the poorest soils, given the same climate as the sweet chestnut and warm oak localities. It is especially useful for the afforestation of waste lands. The *Robinia* may be recommended for mixing with the pines on the fourth quality soil and upwards, and it is also useful for underplanting pines. In copse forest, where it suffers at times from storms, new growth is made by root shoots, which appear in great abundance where its roots are cut by making trenches. The property which its roots possess of assimilating nitrogen from the air gives it the character of a valuable soil-improving species of tree, which should be more widely distributed in high forest than appears to be the case at present.

26. *Ulmus americana.*

Apart from its greater rapidity of growth, this elm shows no difference in its sylvicultural peculiarities from the European mountain, Scotch or witch elm, *Ulmus montana.*

27. *Abies balsamea.*

Sylvicultural development and treatment are pretty much the same as in the case of the European fir. It seems to be more suitable for Northern Europe than the Central European species, and more closely resembles the Siberian fir, both in its botanical and forestal aspects.

28. *Chamæcyparis sphæroidea.*

A fairly rapid-growing half-shade bearing kind of tree, which is worth growing in the domain of the sweet chestnut on moist and on fresh soil in the oak region—that is, on fairly good land in groups among the broad-leaved timber tree. The few experiments made with it have demonstrated its frost-hardiness. Where oak disappears and spruce and beech predominate, of course it can only be planted on an area with a south aspect.

29. *Juniperus virginiana.*

Although this fairly rapid growing tree makes little demand either on soil or climate, it nevertheless requires a considerable amount of warmth to enable it to attain technically useful dimensions. All experiments made so far prove that useful sizes can only be produced in the natural distributive region of the sweet chestnut where the tree may be raised in groups or in

pine plantations on really good soils. Its cultivation is simple and easy. The thinning should be light, removing all crooked or poor material at the right time. In Germany this juniper cannot be classed as a commercial tree.

30. *Picea alba.*

Displays the same attitude towards the European spruce as the balsam fir does to the Central European variety. In America it may be cultivated and raised on the same principles which govern European foresters in regard to their spruces. It has no forestal value in Germany.

31. *Pinus banksiana.*

The attempts at growing this tree, to which Mayr's investigations made in its native localities gave rise, have fully answered all expectations. This very rapidly growing species of timber is absolutely frost hardy, so that it will exist under the extremest conditions of temperatures (exposed areas, waste lands, &c.). It is superior to all other kinds of trees (even to the rest of the pines) on the poorest, driest, sandy, and gravelly soils, and in swampy districts is more useful than the European marsh pine. Its high value for the afforestation of waste lands, the formation of protective or "fore" forest, for fixing the soil

of sand dunes, the growing of wind and fire screens, in planting with and under indigenous pines on the worst class of land, becomes every day more and more apparent and explains the enormous sale of plants in Europe, notwithstanding the incredible dearness of the seed (at present 59s. 3½d. per pound). A change will come about in a very short time as the Banksian pine begins to yield seed from its sixth year, and thenceforward almost every year, fully-formed seeds which, from my investigations, possess sufficient powers of germination. Boden [1] also has published his researches on this subject. From the observations I made which related to examples planted more than 15 years in the forest, consequently the oldest in Germany (the seeds of this pine having been collected by Professor Dr. H. Mayr during his first visit to North America in 1885), the following results were obtained :—

1 litre of the largest cones weighed, fresh, 552·15 grammes.
1 litre of the smallest cones weighed, fresh, 570·70 grammes.
The average was therefore 561·42.

[1] Samen von Pinus rigida und P. Banksiana. "Z. für F. u. Jw.," 1898, p. 17.

The largest cones weighed, air dried, 407·10 grammes.

The smallest cones weighed, air dried, 441·72 grammes.

Showing an average of 424·41 grammes.

When the cones were opened their bulk increased from 1 litre to 2½ litres.

1 litre of the largest open cones weighed 127·60 grammes.

1 litre of the smallest open cones weighed 123·55 grammes.

Average, 125·57 grammes.

The number of the largest closed cones was 55 per litre, and 140 of the smallest; of the largest opened cones 17, and the smallest open ones 38, thus averaging 97 for the closed and 27 for the open. As regards the largest cones all, barring two, opened at an average temperature of over 25 degrees Celsius, and of the smallest 35 remained shut. As this temperature is very common in the open air, and even with great care the cones can be heated to as much as 45 degrees, it may be assumed that ordinary atmospherical conditions will suffice to bring all the *banksiana* cones to their opening point to at any rate within 5 per cent., as happens in the case of the Grafrath trees, partly first of all in October, and partly in March and April. As the

empty cones remain to a great extent on the tree and close up again in damp weather, this is the reason of the quite unnatural representation that the cones of the *Pinus banksiana* only first open when fire spreads through the forests ("Rod and Gun in Canada," Forestal Section, 1902, page 17, relating to *Pinus banksiana*).

10 of the largest cones weighed, fresh, 94·80 grammes.

10 of the smallest cones weighed, fresh, 35·22 grammes.

Consequently one medium cone weighed 6·5 grammes.

The specific gravity of the largest cones, fresh, was 106·5 grammes.

The specific gravity of the smallest cones, fresh, was 190·1 grammes.

Average, 107·8 grammes.

If water equal to 100 grammes.

In length the largest cone was 6 centimetres, the medium size 4 centimetres, and the smallest 2 centimetres. 1 litre of the largest cones yielded 809 grains, weighing, after cleaning, 2·45 grammes. 1 litre of the smallest cones yielded 600 grains, which weighed 1·01 grammes. Consequently for 1 kilogramme of seed an average of 71,320 cones is required, which occupy a space of 735·26 litres. 1 kilogramme of seed contains between 300,000 and 500,000

grains. The seed of the largest cones gave a germinating capacity of 43 per cent., the smallest 39 per cent., thus constituting an average of 41 per cent. The young *banksiana* plants are not affected by the needle-shedding fungus; damage from forest animals heals easily, and they grow with upward tending branches after the manner of spruce, so that they do not encroach on other underplanted timber trees, and costly branch prunings can be dispensed with. The oldest plants in Grafrath show that the Banksian pines, by reason of their shorter needles (which from the fifteenth year is even shorter than in the case of the native pines) is quite insensitive to snowfall. In view of these extraordinary sylvicultural qualities its value as a timber takes only second place. It would appear that, as the result of imperfectly understood American publications, errors have crept in which may remain a long time unrecognised. Mayr has, on the other hand, demonstrated that the timber of the *Pinus banksiana* is quite equal to that of European pines. It was found that 22 metres was the greatest height development in the United States, and, according to the latest reports from Canada,[1] the *banksiana* attains the same height in that country as the American red pine, *Pinus*

[1] From "Rod and Gun in Canada," 1902, p. 17, *Pinus banksiana.*

resinosa, namely, of 35 metres and more. As the climatic conditions of the greater part of Germany resemble each other more closely than those of the United States where the *banksiana* is found outside its natural home, that is, in warmer latitudes, the prospects for the height development of this species of pine in Germany are far more favourable than have been hitherto imagined.

32. *Pinus rigida.*

This three-needle sheathed pine is, generally speaking, a rapid-growing, light-loving variety of tree which, however, requires a warmer climate (coast districts and the inland climate for oak and sweet chestnut). Although, as a rule, its demands with regard to quality of soil are quite modest, it does not come up to indigenous pines, not to speak of the *banksiana*, on the very poorest lands. Its long stiff needles expose it to being weighed down by snow, and in its younger stages of growth it suffers very severely from injury by snow. It is so liable to damage from forest animals that it is hardly possible to raise it without some kind of protection. The damaged parts heal up rapidly, as it possesses the peculiarity of being able to develop its dormant buds, hence its reputed reproductive capacity from the stool after being cut down

at an early age. This peculiarity has been the source of quite a mass of literature,[1] and has been far too greatly exaggerated as regards its sylvicultural value. It would seem that the reproductive power diminishes rapidly *pari passu* with the lessening of warmth during the growing season. A favourable subject for this particular kind of investigation was found in the experimental forest gardens of Professor Mayr, at Grafrath, near Munich. In those gardens there were numerous instances of *Pinus rigida* being partly broken and partly bent by snow, so that it was deemed better to cut all flush with the ground, and the investigations carried out three years afterwards proved that only 3·8 per cent. of the trees produced shoots from the stem stumps, and one half of these had at the time of investigation a great number of shoots already dying, so that, speaking of the whole number of trees for the three years, barely 2 per cent. of them yielded shoots possessing any vitality. No doubt the cold situation, 570 metres above sea-level, on a forest area in which the *rigida* had been used as a nurse, was something to blame for the unfavourable result with these pines.

[1] Sprengel, "Widerstandsfähigkeit der Pinus rigida gegen Feuer," "A. F. u. J.," 1896, p. 175. Ditmar, "Ausschlagsfähigkeit der P. rigida," 1889, p. 75, "A. F. u. J.," Dr. Laspeyres, "Ausschlagsfähigkeit der P. rigida," 1889, p. 65, "Z. f. F. u. Jw."

For all these reasons the value of this timber is of small account, at any rate in Germany, even if, indeed, it possesses any at all. Its cultivation inland can only be justified by the expectation that the tree may, later on, be grown for resin-tapping.

33. *Pinus strobus.*

It is quite impossible, in this place, to do justice to the enormously comprehensive literature on this subject by mere quotations from the authors and reference to their observations. In the following lines the idea is simply to give a collective sketch of the sylvicultural peculiarities of this highly interesting and valuable species of timber tree. It is just the fundamental difference it displays as against the indigenous two-needle sheathed pines that has assured it a position among the forest trees worth planting. Moreover, the other remaining species belonging to the *strobus* division share, according to Mayr's reports, the same sylvicultural peculiarities. This is more especially the case as regards the European *strobus*, the Greek Weymouth pine, *Pinus peuce*, which possesses only one disadvantage as against the American variety, that it was discovered 200 years later. The Weymouth pine is a rapid-growing, half-shade bearing kind of tree, finding its home in

localities where the area of distribution of oak predominates. Starting from that point, it seeks the warmest localities with fresh to moist soil. In the colder zones it gives the preference to the ordinary forest soils for oak and beech, and even on the pine soils of Class I., II., and III. On pine soils under Class III. it is of no use whatever. Being absolutely frost-hardy, it is, consequently, suitable for the afforestation of damp localities on river banks and for preparatory cultivation in frost-visited localities, where it acts as a nurse for other tender pine species.

It has proved its value in filling up spaces in conifer plantations, for underplanting among common pines on soils of Class I. to III.; for planting out in groups of small extent, for the underplanting of light-demanding broad-leaved trees and between ashes, among which it at first equals but afterwards surpasses in growth. Among the dangers which threaten this pine may be mentioned blister rust, to the investigation and suppression of which Prof. Dr. V. Tubeuf has devoted the greatest attention. This fungus attacks young plants from about their fourth year of existence, up to which time the *strobus* does not appear to have any fungoid enemies, as it does not fall a prey to the dangerous *Lophodermium pinastri*. On the other hand, the Weymouth pine is attacked up to

the pole stage of growth by the *Agaricus melleus*, a root parasite which often perforates the plants to a most serious extent, and it is only by the planting of a rapid growing species of broad-leaved tree, such as alder, ash, and red oak with it that such danger can be averted. The cotton louse, *Chermes strobi*, has a special tendency to fall upon the Weymouth pine in its twentieth year, lessening its height growth and destroying weak plants. It is more particularly exposed to the ravages of forest animals, nibbling of the sprigs and gnawing the bark (especially by deer), so that a certain German forester to whom deer-stalking, &c., is everything, proposed in all seriousness to do away with the Weymouth pine on account of these ravages. As regards its timber, the Weymouth pine is, in its early years, much tougher than that of the common pines, and succumbs much less frequently to snow-pressure and breakage. Investigations on the subject of the sylvicultural peculiarities of the Weymouth pine, just alluded to, have been more especially carried out, apart from the other authors named, by Dr. Wappes,[1] Prof. Dr. Kunze,[2] Dr. Lorey, Burkmayer, Brill, Spalding,[3]

[1] Zur Kenntnis und Würdigung der Weymouthskiefer, "A. F. u. J.," 1897, pp. 8, 51, 365.

[2] Beiträge zur Kenntnis des forstlichen Verhaltens der Weymouthskiefer. Tharandter Jahrbuch, 1900, p. 159.

[3] "The White Pine," 1895.

Walther and Danckelmann. Plantations in Germany which can now be felled have shown (*see* Dr. Wappes) that the Weymouth pine can easily be reproduced from self-sown seed—that is under the light protection of the older trees. Most attention is being given everywhere to the artificial reproduction by the planting of from four- to six-year-old trees raised in seed-beds. It is used under the numerous and varied conditions already mentioned, but, in general, it may be here remarked that the Weymouth pine, during the first ten years of its life, does not always keep pace with the native timber trees, and is therefore liable to be overgrown, if mixed singly among broad-leaved trees, but less so among conifers. In such cases small groups are to be recommended, so that at any rate two or three individuals in the group may reach felling maturity. Under such circumstances the Weymouth pine appears at its best in cleanness of trunk, straightness and height. Pure plantings of Weymouth pines should not exceed an area of 1 hectare, so as to prevent the extension of its enemies, and also because in such pure plantations this pine has greater difficulty in shedding branches than when mixed with coniferous, and especially broad-leaved trees.

34. *Taxodium distichum.*

In the localities already mentioned in the last section this species of timber tree may be cultivated, at the same time it must be noted that the more moist the situation given to it, the warmer must be the climate in the vicinity of the plantation. In localities like this quite pure plantations may be laid out, but the colder the general climate in such a place is the more necessary it becomes to avoid moisture of soil.

35. *Thuja occidentalis.*

Resistance to frost, toleration of shade, and splendid quality of timber recommend this hitherto quite neglected species of tree for planting singly in oak localities between these or else Weymouth pines, for the underplanting of oaks, pines, larches, and particularly on the fresher kinds of soil; and as a protective timber in frost-exposed situations along with the Banksian pine. Even if under such conditions it may be only a small tree, its material is, nevertheless, more valuable than that of an indigenous species of the same dimensions.

36. *Tsuga canadensis.*

A rapid growing, shade-bearing kind of tree, particularly adapted for planting in groups be-

tween broad-leaved trees and for mixing singly with the Weymouth pine. Between the home pines it may find a place in small groups on soils of Classes I., II., and III. Among firs and spruces only large groups or pure plantations are suggested. Sylvicultural characteristics, quality of timber, and tanning material justify a wide use of this tree.

37. *Fraxinus oregona.*

Experimental cultivation with this species is advisable in localities similar to those in which the native ash is grown.

38. *Abies amabilis.*
39. *Abies concolor.*
40. *Abies grandis.*
41. *Abies nobilis.*

Trials with these firs possess a natural justification only outside the natural territorial limits of the home fir, but in similar climatic locations, conditions of soil and raising are the same as the native species requires.

42. *Chamæcyparis lawsoniana.*

This, generally speaking, frost-hardy, fairly rapid growing tree, which may be reckoned among the shade-bearing species, yields useful

timber at quite an early age. Investigations made by me on some state property acquired in the forest district of Freising [1] gave in three samples 68 per cent., 70 per cent., and 73 per cent.—that is, an average germinating capacity of 70·3 per cent. One litre of seed weighs 0·25 kilo and contains 500,000 grains, so that 1 kilo contains two millions. The warmer the climate the greater must be the increase of atmospheric moisture in the case of this tree, at least equal to that which characterises oak locations. In situations with humid air (such as on the sea-coast and the north and east slopes of medium mountain ranges, narrow valleys) a moderately fresh soil will suffice for it. Under all other conditions the demeanour of the Lawsoniana is unfavourable, and it succumbs to its enemies, to which, on so-called warm slopes, the branch disease (according to Mayr, killing of the chlorophyl due to low winter temperatures) belongs. Natural reproduction always is carried on subject to lateral or slight upper protection, so that it should be planted in groups between broad-leaved trees or common pines and Weymouth pines, but not between firs and spruces, in case it should be of equal age with its environ-

[1] Near Munich. Begun some twenty years ago by Forstrat Bierdimpfel, they are being extended by Forstmeister Striegel.

FIG. 2. Thirty-year Oaks underplanted with *Chamæcyparis lawsoniana* for fifteen years in the Experimental Forest Gardens of Grafrath.

Facing page 95.

ment. It would appear to be better to give the Weymouth and other pines and said species of timber, especially the oaks, a start in order to bring in the cypress when the oak is to be thinned for the first time (*see* Fig. 2). On pine soils of Class I. and II. it thrives with certainty, but on poorer soils its raising is doubtful. The longer time the seedling takes in growing the greater is the danger from snow pressure, as is the case with all cypresses, on account of the greater extension and density of the foliage. It is likely that the rapid growth of the Lawson cypress in Great Britain, which is its climatic home, accounts for the fact that it does not suffer in spite of the heavier load of snow. Where the sweet chestnut or oak can be grown the climate should correspond as regards warmth, but in colder situations there is a drawback to the planting of the cypress, &c., by the way in which the plant divides into several shafts just above the ground. A small planting distance—that is, a plant to 1 square yard—is always advisable for cleaning the boles. The laying out of pure plantations is a doubtful procedure, as they will hardly escape if *Agaricus melleus* or *Pestalozzia funerea* once take root. The many risks, those from wild animals amongst others, have greatly diminished the disposition to grow this species in Germany.

43. *Chamæcyparis nutkænsis.*

The foregoing remarks apply to this in every respect. As appears from the demeanour of the tree in the experimental gardens of Grafrath, the Nutka cypress suffers even more than the Lawson variety from *Pestalozzia funerea*, which causes the decay of the bark on the young shoots, so that the overlying shoot (top or side shoot) dies off, due to the swelling of its base through its thickening in size during the growing season following the destruction of the bark.

44. *Picea engelmanni.*
45. *Picea pungens.*

Engelmann's spruce does not appear to possess any advantage over the European variety, and where it is indigenous it can be treated in exactly the same way as the latter.

The prickly spruce starts fresh growth somewhat earlier than the European one, and suffers less than the latter under certain circumstances—as, for instance, if late frosts set in pretty early. Whether this circumstance, as well as its prickly needle-like leaf formation, suffice as a protection against animals to justify its cultivation at the expense of the European spruce may remain a moot point.

46. *Picea sitkænsis.*

As regards this spruce, its prickly foliage is less of a guidance for its cultivation than what has already been said about West American firs in their useful application in connection with spruce.

47. *Pinus jeffreyi.*
48. *Pinus ponderosa.*
49. *Pinus scopulorum.*

These three moderately rapid growing, light-loving species require fairly good soil, somewhat fresh in the case of the Jeffreyi tree. One- and two-year-old trees are very much endangered by the needle-shedding fungus.

The buds of the grown plants are gnawed by the squirrel and the bark by mice. From reports received from North Germany they have, for some inexplicable reason, gone largely to decay before reaching the age in which their greatest peril, snow pressure, threatens them. Nothing, therefore, can be said about the further employment of these three species outside their native domain.

50. *Pseudotsuga douglasii*, Coast douglasia.
51. *Pseudotsuga glauca*, Colorado douglasia.
52. *Pseudotsuga macrocarpa.*

This last kind of tree can be left out of

further investigations. The Coast douglasia is a rapid-growing, shade-tolerating species which combines the peculiarities of both fir and spruce, while its root system adapts itself readily, according to Mayr, with the given conditions of the soil. On the other hand, it is not a kind of tree adaptable for poorer pine soils than Classes II. to III. In its early years it is susceptible to early frosts on account of its late after-growth (September), but as regards late frost it stands, in its demeanour, between fir and spruce. In the severe temperature of winter it suffers from browning of the needle, needle-shedding, and killing of chlorophyl. It is, consequently, suitable in moist atmospherical situations such as have been already mentioned in connection with the *Chamæcyparis lawsoniana*. Warm, open plains, with their contrasts in temperature, should be avoided. Pure plantations can be made on cold areas, when these slope to the south-east or east, or north and north-west, up to an altitude in which the fir appears pure. In low-lying places some slight protection by copse or the stool shoots of broad-leaved and coniferous trees is desirable. The Coast douglasia develops best in groups amongst broad-leaved coniferous trees introduced before or after their reproduction. It is also adapted for filling up bare patches where it is planted singly. Close planting, that is one plant

per square yard, is suggested. With the exception of the larch no other kind of timber has, more than this one, such special need for protection against the rubbing action of the roebuck. As regards *Agaricus melleus*, it is less susceptible than the indigenous spruce.

The Colorado douglasia displays a remarkable difference in demeanour which, perhaps, gives it a greater value as an ornamental tree, and, in many cases, even as a forest tree. It has, as a rule, blueish white needles, and its long, regular, spheroidical development of stem and branches, raise it, in point of beauty, to the level of a silver spruce. Its absolute immunity to premature frosts and the severest temperatures of winter place it, in this respect, above the Coast douglasia, with which last, however, it displays the same susceptibility to late frosts. Then, again, there is the slow growth, in consequence of which it can barely keep pace with indigenous firs and spruce. It is, consequently, not adapted for the filling up of open plantations; but, on the other hand, it is more suitable than the Coast douglasia for making pure plantations in sloping localities, in which southern aspects may also be given to it (very instructive examples on this point are to be found in the Experimental Forest Gardens of Grafrath. See also illustration 3). It is advisable to provide such pure plantations with an admixture

of larch, because larch probably continues to lead throughout its whole life. If all the sylvicultural peculiarities of both species are examined, which, so far, cannot be kept separate and which explains the confusion that has arisen in the biological description of the Douglas fir, the rapid growth of the Coast douglasia may be contrasted with the greater safety and certainty of growth of the Colorado douglasia.

53. *Sequoia gigantea.*

Less warmth and much more atmospherical moisture is the first vital condition for this rapid-growing, light-loving timber species, hence the reason why it thrives better in an island climate than on continents, better inside than outside the forest, better on the hill than the plain. In such situations the extreme temperatures of winter, which form generally the greatest menace to its existence, are not so intense, of which the admirable results with the sequoia in Great Britain, Switzerland, Württemberg, and the experimental gardens at Grafrath, 570 metres above sea-level, gives ample proof. It is quite worthy of further trials despite the failures, which may be partly traced to planting it in places unsuited to its development.

FIG. 3. Douglas Fir, twenty years old and twelve metres high, in the Experimental Forest Gardens of Grafrath.

Facing page 100.

54. *Thuja gigantea.*

This arbor vitæ shares the same sylvicultural peculiarities as the Lawson cypress, and may be cultivated under identical conditions, bearing, however, in mind that it suffers more than the Lawson cypress from the ravages of the *Pestalozzi funerea.* The suppression of this fungus by means of continually new forming shoots is more difficult it its case, and the future alone can show whether this fungus may not render the cultivation of this species of timber tree altogether impossible.

55. *Tsuga mertensiana.*

This very rapid growing somewhat shade-tolerating tree, with the slender drooping tips of its branches, is exposed to danger from early frosts up to the tenth year of its existence, and from that period onward it seems to be as hardy as the Canadian tsuga, to which it is superior in rapidity of growth. This variety of tree may, therefore, be employed in the same localities as have already been suggested for the Canadian plant. With these may be added two kinds of timber trees which, hitherto, have only been treated in the experimental gardens of Grafrath, namely, the

56. *Pinus murrayana*, Balfour,

which has been recommended by Mayr for laying out pure plantations in the high-lying moors. A slight experiment carried out in a small cold position adjacent to a moor has shown this species to be rapid in growth and immune against frost. As these pines, which are related to the Banksian variety, grow to a height of 30 metres on soil adjacent to moors in America, it is recommended that further trials with it might be made.

57. *Pinus resinosa*, Ait.

This American red pine belongs to the regions of Eastern North America, and plays there a similar part to that of the red or common pine in Europe. There is no reason for Europeans to cultivate it, and no reason why Americans should seek for another method of treating the red pine than that which its sister in Europe enjoys.

Retrospect.

If we survey the collective sylvicultural peculiarities of American trees, the first thing to be noted is the immunity to frost of the East American varieties, with which may be ranked those from the Rockies, while those from the Pacific coast, with its moist atmosphere, appear

to be the most sensitive. It is, also, noteworthy that the West American trees are, on an average, more rapid in growth than their East American kindred, and attain higher and stouter dimensions than the latter. As regards the cultivation of the West American kinds in East America only the coast territories and wooded mountain valleys were taken into consideration, while in West America the East American species of trees thrive in the same way as the European. The planting of European varieties in East America is only likely to promise success in the British section—that is, in Canada—but this would be quite superfluous, as the closely related varieties in those parts already fulfil their purpose.

For the afforestation of bare tracts of land it is only the East American species that can be considered. According to Professor Mayr's estimate, the prairie should be suitable for forest cultivation as far as 90° W. lat., but afforestation with the usual far-reaching methods of planting on extensive areas, which is unnatural, is not, however, to be recommended. Let large areas be planted with groups of trees in order to continue afforestation round each until the extended groups close up together. This is also the method which helps forward the natural distribution of any species of wood.

If we, then, glance over the American varieties of trees in relation to their value for the German and, incidentally, European forests the most valuable acquisitions, both as regards forest planting and value for sylvicultural purposes are, the Robinia, Weymouth pine, both the Douglasias and the Banks pine. With these come next hickory and walnut; cypresses are hardly likely to become of a greater general value. Such species as are closely related to European firs, pines, ashes, oaks, &c., may turn out useful for sylvicultural reasons in those parts of Europe in which these species of tree are not to be found, but in those localities where these kinds of timber already exist the kindred exotics appear to be superfluous.

Out of all the general natural laws and methods of raising trees as partly published by Prof. Mayr, and partly given in his lectures on sylviculture, both with the cultivation of the native as well as the foreign varieties, the following data are selected with his sanction :—

1. The raising of different kinds of trees is best carried out in small gardens sheltered by the high forest. Where it is desired to sow on open land slight protection should be given.

2. Sowing with indigenous kinds can be done later than in the case of foreign trees, for which autumn or spring sowing in April is advisable.

As a rule one should avoid giving the exotics a special treatment; for instance, covering them in winter, as this usually turns out unfavourably. It is only in the case of very late sowing that a winter shelter becomes necessary, at least in the first year, and this must not be too thick, and should be gradually removed as spring approaches.

3. The quality of the seed must only be judged by its percentage of germinative power. Of two quantities of seeds quite equal in this respect, the cheaper one should be used, not those advertised by the dealer on account of their specially good origin (coming from unknown northern territories of distribution, straight-growing trunks, &c.), as this recommendation simply results in making it more costly.

In every grain of seed lies the type of the plant in its normal state, as regards frost-hardiness, power of growth, straightness of trunk, and so on, and it is only the new situation (soil and climate) plus the raising, which decide whether, and in what way, the tree grows.

4. The first attempts at growing an indigenous tree outside its natural stronghold (take, say, the larch all over Europe, north of the Alps) or even a foreign wood, must always be carried out under such conditions (climatic zone, protection, soil, &c.) as will give the greatest guarantee of their development. It is only after we become ac-

quainted with the results of all these experiments that others can take place, which in some particular respects (say, different soil, climate, or method of raising) the experiment is different, so that in the case of some failure the exact cause of it can be given there and then. The mere accumulation of unfavourable conditions in one experiment, such as bad soil, cold situation, open location, depredations of forest animals, or the rivalry of weeds and copse wood does not yield in the case of failures any useful starting point for further experiments.

5. The farther any variety of tree, be it indigenous or foreign, is transplanted away from its native home to a colder climate the better the soil and the more abundant the light that must be given to it.

6. The farther some variety of tree is transferred away from its climatic home to a warmer region the greater claims has it on moister soils. It will stand longer and stronger effects of light, which, again, facilitates its being raised under slight shade.

7. On poorer soils all kinds of trees are in greater need of light, so that their raising under shade becomes more difficult.

8. As a protective growth, broad-leaved, light-loving trees should be used wherever possible, such as birches, poplars, willows, alders, and

oaks. Shelter by conifers is always more unfavourable than that of the above trees, with the exception of the Strobus species ; with these may be ranked two- and three-needle-sheathed pines Spruces and firs, along with beeches, are the least suitable as protective plants.

9. The notion that anywhere in the world, whether above, or north of, our vegetative boundaries, species of timber may grow or be planted may be dismissed as unnatural.

10. It is only in the case of trees which grow quicker, or at least as quickly, as their neighbours that individual mixing is admissible. In other cases planting in groups is preferable, so that perpetual supervision and continued felling in the experimental areas may not be required.

11. No foreign firs, spruce, oaks, ashes, &c., can furnish in the distributive domain of their closely related indigenous species any better product than the latter. The same conditions under which the native tree produces good or bad wood will also make its foreign kindred good or bad.

12. On the other hand, in the case of all climatically admissible "foreign trees," the species of which (genus in the pine section) are not represented in the home forests, experimental plantations should be undertaken.

13. In order to arrive at climatic conditions of

a country and to fix its zone of vegetation, not only particular species of timber but also agricultural plants may be used. For instance, in this way the cultivation of the vine, rice, mulberry, almond, &c., corresponds climatically to the natural growing territory of the sweet chestnut; the cultivation of tobacco and maize corresponds to the hottest territory of the oak in which the sweet chestnut grows partly wild and is partly raised. The cultivation of hops and wheat corresponds to the cold territory of the oaks and beeches. The cultivation of wheat and rye corresponds to the warmest spruce zone, that is, firs, spruce, or beech, whereas rye alone or pasture land areas characterise the colder domain of the spruce and larch.

14. The pine, *Pinus sylvestris*, is no use for judging the climate of any particular species, and is to be found between the zone of evergreen, sub-tropical, broad-leaved trees as far as the confines of the Alpine or Polar forest regions.

In conclusion, I may refer to a symptom I have met with all over Europe, and which is more convincing than any number of words, namely, that plants thrive best, both indigenous and foreign species of trees, where the planter devotes himself impartially, lovingly, and patiently to the raising of his charges.