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No. 4.

THE FORESTS OF MANCHURIA.

by Norman Shaw, M.A.

University of Oxford.

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Editor's Note.

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by Norman Shaw, M.A.



Author of "Chinese Forest Trees and Timber Supply", "The Soya Bean of Manchuria" and "Manchurian Tussock Silk".

A general account of the forest vegetation and timber resources of Manchuria.

Oxford, 1936.

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INTRODUCTION.

We are glad to have the opportunity of giving circulation to this independent account of the forest vegetation and timber resources of a little known territory by one who has long resided in it and is conversant with its languages. It should be understood that the Institute has had no opportunity of making a special study of the region described such as would enable it to share with the author responsibility for the information given, and its function has been limited to scrutiny of the botanical nomenclature employed; but many foresters and students of world timber resources will be interested to have this picture of hitherto unfamiliar conditions.

J. N. OLIPHANT.

THE FORESTS OF MANCHURIA.

Norman Shaw, M.A.

The Manchurian forests have been studied by the Russians and Japanese, who have produced quite an appreciable pamphlet literature about them, but very little has been written on the subject in English. In view of the dwindling resources of timber throughout the world, interest is now being awakened in remote sources of supply and as, in addition, Manchuria has been attracting attention from the political point of view, a short account of the forests and timber supply of the region seems to be worth undertaking.

GEOGRAPHY AND CLIMATE.

The "Lytton Report" states that the area of Manchuria is as large as that of France and Germany taken together, being estimated at about 380,000 square miles. Its three provinces are Fengtien in the South, having an area of 70,000 square miles, Kirin in the East, with 100,000 square miles, and Heilungkiang (Amur) in the North, with over 200,000 square miles. Manchuria is continental in its characteristics. There are two mountain ranges, the Changpai in the south-east and the Hsingan in the north-west. The former is split up into many side ranges of considerable height (Changpai Peak is said to exceed 8,000 feet) while the Hsingan, which forms the barrier between Mongolia and Manchuria on its western side, thence bending north-eastwards and again to the south-west and meeting the Changpai series at the junction of the Sungari and Amur, has more the nature of a plateau, with few mountains exceeding 3,000 feet in height. It is formed of old sedimentary or igneous rock, which weathers and forms sand dunes in many places. In the Changpaishan there is much lava and basalt formation, and the Peak itself is the crater of an extinct volcano.

Between these two ranges lies the great Manchurian plain, of which the northern part belongs to the basins of the Sungari, having its source in the Changpai crater lake, and its great affluent the Nonni, which rises in the Hsingan. The southern part of the great plain belongs to the basin of the Liao river, flowing south from the Mongolian plateau, and has no bearing on the forest question, for it is quite timberless. The Amur, forming the frontier with Siberia, has had up till now little importance in the timber trade, but its affluent the Ussuri, bounding the province of Primorsk, of which the chief port is Vladivostock, is used for rafting, and the Tumen, dividing Manchuria from Korea at the north-eastern point of

the latter country, is also a rafting river; the Yalu, forming the Korean frontier on the East, is the best-developed timber river of all.

As Manchuria extends between lat. $38^{\circ}43'$ and $53^{\circ}30'$ north, and long. $117^{\circ}50'$ and $135^{\circ}20'$ east, it is seen to lie practically within the same zones as the northern latitudes of Great Britain, but being less affected by ocean currents and greatly influenced by the proximity of the Gobi desert, its climate is continental, and it suffers extremes of heat and cold: in the long and severe winter (in extreme North Manchuria only July and August are usually free from frost) every river is frozen hard for many months, while the heavy rainfall of the monsoon season causes almost annual floods on one river or another.

FLORA.

The flora of Manchuria is on the whole palearctic: putting aside the Liao basin, which has the semi-arid conditions of North China, and the desert-like steppes of the Mongolian border, the forest regions contain several areas, and the flora is diversified. Generally speaking, the vegetation resembles that of British Columbia, and is analogous to that of the Siberian forest meadow country: the further north one goes the more alpine are the conditions. In the Hsingan range Larch and Birch are the prevailing trees; in Kirin province - the Sungari valley - is what may be called the Manchurian flora proper, with the Korean Pine as the leading tree. The Hsingan, which forms the border-range fringing the lower terrace of the great Central Asian plateau towards the plains, is the line of division between two floristic regions; its western slopes have scant vegetation in the form of Alpine pastures, the only trees present being the Siberian Willow and thorn scrub. But as soon as the descent is made on the eastern slopes in Manchuria the warmer climate brings a new flora, and trees grow freely even on the plains: the mountains are covered with great forests, both coniferous and broad-leaved, the last pure at the base of the hills and mixed with conifers above, while conifers prevail on the upper slopes. The Yalu river basin, which receives the full force of the south-west monsoon, differs in some respects from the Sungari basin, resembling somewhat the forest regions of Central China, though the tropical element is absent. Fuller descriptions of the tree flora will be found below.

FOREST AREA.

The forest area, in the absence of any cadastral survey,

has naturally been only estimated, and such estimates vary from thirty to forty per cent of the total area of the country, i.e. somewhere between 120,000 and 150,000 square miles, though Mr. A. de C. Sowerby, author of "A Naturalist in Manchuria", adopts the more conservative estimate of 100,000 square miles. Japanese authorities give the area of standing trees, presumably omitting swampy land, lakes and rivers, and cultivated land in the forests, as roughly 90,000,000 acres.

FOREST TREES.

Following is a list of the principal trees of marketable quality - a small share of the three hundred species known:-

CONIFERS.

Pinus koraiensis Sieb & Zucc. (P. mandshurica Rupr.). This is called the Red Pine, and is five-leaved: the Russians call it Cedar. It extends from Korea into the Bureya mountains and into Primorsk, grows to a height of 80 feet, from trees of which size deals 56 feet long can be cut, has a straight and strong grain, and is much used in house and junk construction, though said to be inferior to Douglas Fir. Its cones, 6" long, contain edible seeds, used for confectionery. The seeds are also eaten by birds and mammals - bears, wild pig, squirrels, chipmunks and mice, jays, nutcrackers, cross-bills, etc. (Sowerby).

LARCH: Larix kaempferi Sarg. (L. leptolepis Murr.) occurs only in the higher ranges, and is the chief component of the forests in the Hsingan and on the lower but not on the middle Amur. Here it does not exceed 60 feet in height, but on the Sungari and Yalu it grows as high as 130 feet. Near Changpai peak are large forests composed entirely of Larch, which thrives in the damp volcanic soil. In the Sungari basin it is found only in the depths of the forests. Being the hardest coniferous wood, it is also the easiest to work, and is used for the exposed parts of buildings, for sleepers (life 12 years) and for telegraph poles, as well as in boat-building. Owing to its damp-resisting quality it is preferred to Douglas Fir by the Chinese for the last purpose.

SILVER FIR: Abies veitchii Lindl., grows with Pine and Spruce on the Sungari and Yalu. It grows to 100 feet, and its wood is elastic and pliable and therefore suitable for window frames, shingles and sieves, as well as for junk building. It has also come into use for the manufacture of coarse paper and has a high oil content.

Other Silver Firs are A. holophylla Maxim. and A. nephrolepis Maxim. which grow mixed with broad-leaved trees, and A. sibirica Ledeb. or Pitch Fir which occurs only in coniferous forests. The wood of these is of poor quality.

SPRUCE: Picea polita Carr. grows mixed with Red Pine, and has the same distribution and dimensions. The wood is white, soft and very easy to work, but has a shorter life than that of the Korean Pine; it is used for beams, telegraph poles, and the window frames of Japanese houses, as well as for match boxes and paper making.

Picea jezoensis var. hondoensis (Mayr.) Rehder, is a larger tree than P. polita, but less widespread; it is called the Fish Scale Pine by the Chinese, from the character of its bark, and is used by them in house and furniture construction.

YEW: Taxus cuspidata Sieb. & Zucc. grows from the Southern Ussuri to the Yalu. Height 40 feet, diameter 1 foot. The wood is hard but elastic, red in colour, and used for making utensils, coffins, furniture, chopsticks and for engraving; it is almost as useful as boxwood for this last purpose. The coffins of the wealthy, and pillars of large mansions and temples are made from this wood. The heart-wood of old trees is often decayed.

Taxus rigida Sieb. & Zucc. This tree is rather scarce, but is much appreciated for making fine furniture in Japan, though little used in Manchuria. It is very hard and durable in water.

Taxus baccata L. occurs in North Manchuria.

There are other conifers of less importance such as Pinus densiflora Sieb. & Zucc., which grows to 100 feet, has only two needles, and yields a strong and durable wood used for bridge building and for fuel; P. sylvestris L., which grows in thin woods on the shady steppe, but is rare elsewhere; P. tabulaeformis Carr. (P. funebris Komar.). P. mukdenensis is a local tree of Mukden and identified by Dr. Ohga, the Japanese botanist, who, incidentally, found 500 species of plants in the park of the Emperors' tomb near that city.

BROAD-LEAVED SPECIES.

The proportion of this class is said to be sixty per cent to forty per cent of conifers, and the following six trees

constitute seventy per cent of the broad-leaved trees:- Oak, Birch, Lime, Ash, Elm and Willow.

OAK: There are several kinds of Oak in Manchuria, where the tree has a wide distribution: it is first met with at Albazin, on the Amur, as a shrub, and does not assume larger proportions until the Bureya Mountains and the southern slopes of the Hsingan are reached.

Quercus mongolica Fisch. grows in quantity, with Black Birch, up to 3,000 feet: on the mountain steppes it is a shrub. On the middle Amur it is one of the most frequent forest trees, growing with Bird Cherry and Ash on level tracts, and with other broad-leaved trees on mountain tops. In the Sungari forests it reaches 40 feet in height. Here it is used for making sleighs and cart-shafts and for fuel.

Quercus crispula Bl. the Oak of the Yalu, reaches 80 feet in height, and grows everywhere, as does Q. dentata Thunb. These trees, better developed in the somewhat milder climate, are highly valued for their wood, which is hard and resistant to decay but, unless steam-dried, liable to warp and split. When so treated these woods are used in machinery and shipbuilding; for beer casks, axles, sleepers, oars; and very largely for fuel, providing the best charcoal. The trees prefer sunlight and dryness. Their bark is valued as a drug by the Chinese, and from dead trees a highly appreciated fungus - Peziza auriculata - is eagerly sought after for Chinese feasts.

Q. mongolica Fisch. (small-leaved), Q. dentata Thunb., Q. aliena Bl. and Q. acutissima Carruthers (Q. serrata Sieb. & Zucc. not Thunb.) are, as dwarf trees, the staple food of the wild (tussore) silkworm of South Manchuria, where sericulture is a valuable and growing industry. Oaks easily regenerate after fires, which are frequent in Manchurian forests, and this characteristic renders them valuable to the forest industry.

ASH: Fraxinus sieboldiana Bl., grows to 100 feet on the Yalu, but only to 60 feet in the Sungari region: it prefers northern aspects in valleys and damp places. Although the grain is not close, the wood is hard and heavy, as well as elastic, and is capable of bearing enormous strains. It is extensively used by both Japanese and Chinese, the latter employing it for furniture and scales, carts and clogs, as well as for gunstocks, and the railways finding it useful for sleepers. As it is easy to cut and work, and bears transportation well, owing to the fact that it does not split readily, it is a favourite timber in industry.

LIME: Tilia mandshurica Rupr. & Maxim is a small tree of North Manchuria. Tilia cordata Mill. and Tilia amurensis Rupr. grow in all three provinces. T. cordata is the Lime of the Altai and the Urals; on the middle Amur it is found with Oak and Maple, and on the Sungari in mixed forests of Red Pine, Spruce, Elm and Maple. In the North it does not exceed 40 feet in height, and 2 feet in diameter, and on the Sungari it attains 60 feet and $3\frac{1}{2}$ feet; but it is at its best on the Yalu, where it grows to 80 feet. The wood is white and soft, handsome and easily worked, and, in thin planks, suitable for fine work in interior buildings; it is also used for making curved utensils, furniture, pencils and matches, as well as in the paper industry. The bark is employed by the natives for making ropes and sandals, and even for cloth. Where the forest has been cut the dead Lime grows a fungus named ma ku.

BIRCH: There are several species of this common tree, which grows throughout Manchuria, though scarce in the South. In the extensive swamp lands of Northern Kirin and Eastern Heilungkiang conifers, Oak and Walnut are replaced by Birch. It grows along the whole course of the Amur: while great forests of it are found on the Siberian steppes, and woods along the ranges north of Mongolia and Turkestan. It grows pure on dry soil, such as the Hsingan plateau mountains, and is often associated with Larch: it also forms pure woods where Oak has been felled. The following species occur:- Betula alba var. vulgaris Rgl., the White Birch: another name - possibly for a variety - is given by a Russian botanist, viz:- B. platyphylla Suk. This is the most common form. Betula davurica Pall., the Black Birch, occurs in the Hsingan in woods of which Larch is the foundation, or pure where Larch woods have been destroyed by fire.

Betula costata Trautv., grows from the Bureya mountains to the Ussuri, and Betula ermani Cham. and other stunted species are found on the Lower Amur. Betula utilis D. Don (B. bhojpathra var. typica Rgl.) is the valuable birch of the Yalu basin: its heartwood is very hard and close-grained so that among the Chinese it has earned the name of the "axe-breaker", and it is used largely for cart-axles and wheelbarrows, and where great tensile strength is required. Birch wood is suitable for the floors of railway trucks and of stone-carts, as the sudden fall upon it of heavy material does not cause it to split and splinter as would deal under similar treatment. It is difficult to work and in the remoter districts is used only for fuel, though its calorific value is not sufficient to make it useful for charcoal. Betula chinensis Maxim. is also listed, but is used solely for fuel.

MAPLE: On the north-west side of the Hsingan Acer ginnala Maxim. grows in broad-leaved woods, but does not exceed 20 feet in

height, and is used solely for fuel. Down the Amur is Acer cissifolium K.Koch., growing everywhere, especially in dry localities, and attaining 40 feet. This wood is used to make furniture, as it is hard and close of grain. It is also, on account of its strength, used for the under-structure of sheds and for cart frames, as well as for fuel. The most useful Maple is however Acer pictum var. parviflorum Schneid. (A. mono Maxim.) which attains 50 feet in height and 2 feet in diameter, and grows further south. It yields an elastic and close-grained wood, useful for furniture, floor boards, pipes, chopsticks, mirror frames, etc. It is one of the most costly woods on the market. The tree occurs in mixed forests everywhere on the Sungari except in the pure Larch woods.

WALNUT: In North Manchuria Juglans mandshurica Maxim. is found between the Bureya Mountains and the Kumara River, growing in both mixed and pure broad-leaved forests. It is 60 feet in height, bare of branches for 30 feet, and has a straight trunk. The wood is very hard. Juglans stenocarpa Maxim. is similar to the last, but restricted to hilly tracts and does not occur on the banks of the Amur. Woeikoff, the Russian botanist, states that in post-tertiary times, the Walnut migrated as far north as Yakutsk, but when the climate became drier and the lakes dried up, was driven south to North Korea; the advent of anti-cyclones in a later period explaining its recurrence, together with the Maple, in the Dahurian floral area. One of the most valuable trees of the Sungari and Yalu basins is Juglans sieboldiana Maxim. which, in the former region, grows in valleys with Maple and Poplar, but on the Yalu is found both on hillsides and in valleys. The wood, light brown both in sapwood and heart, is elastic, does not warp, and is easy to stain, and is therefore valued for first class furniture and woodwork; trays, clogs and gunstocks are also made of it. Unfortunately the demand for it has caused it to become scarce.

ELM: Ulmus campestris var. vulgaris Planch., and var. laevis Planch. are the chief trees of the Yalu broad-leaved forests, growing in valley bottoms. The timber, however, contrary to general rule, is liable to split owing to the wood becoming frozen in the bitter winters, and is therefore seldom cut into boards. This tree goes nearly as far as the mouth of the Amur. The wood is used for bowls, trays and other turnery, axe handles, pulleys and cart bodies. It can be steamed and made into the provision boxes used by the natives. Ulmus montana Stokes, the Wych Elm, grows 40 feet high - half the height of U. campestris - and is abundant from the Bureya mountains to the course of the Amur. On the northern slopes of the Hsingan, where the rocks crumble owing to the alternations of daily heat and nightly cold, both extreme, Ulmus japonica Sarg., and U. macrocarpa Hance, exist

with Junipers, Rhododendrons, Ribes, and Rhamnus: with the exception of U. macrocarpa, which is found in small quantities in mid and South Manchuria and North Korea, none of these grow elsewhere. The river valleys of the forest and steppe region of Barga (N.W. Manchuria) are characterized by Ulmus pumila L. (the Elm of North China) growing along river beds with Poplars, Willows and Alders. This Elm is rarely met with in grass, and where it occurs on the steppes is probably a secondary phenomenon due to the intervention of man. No other Elm in the world, in the opinion of M. Woiehoff, gives such clean growth: and he recommends U. pumila as cover for other plants, as artificial woods formed of it perish rapidly, do not require fertile soil, and are immune from insects and fungous diseases.

A curious feature of Chinese forest economy is that the powdered bark of Elms is boiled and used as cement for tiles and stone; the soaked roots provide material for coarse paper, and the leaves and fruit are used to feed domestic animals by this people who waste nothing except their forests.

POPLAR: The Poplar is a very common tree in Manchuria; and Populus suaveolens Fisch. follows the whole course of the Amur, where it is 40 feet high. In the Sungari and Yalu basins however it attains 80 to 100 feet by 5 feet diameter, being the largest of the broad-leaved trees. The wood is not of high quality, and is used for building only by the poorer classes, but the South Manchuria Railway has used large boards to construct coaches. Poplar, formerly neglected, has of recent years come increasingly into use for match making, and in the paper pulp industry: the species thus used appears to be Populus alba L. Populus tremula L. the Aspen, is common in the river valleys and mountain steppes of Barga, and is identical with the Aspen of the Altai and Siberia: it grows in thinly stocked Larch woods with White Birch. In the Upper Nonni Valley occur P. suaveolens var. gracilis Skwrtsoff, and var. hinganensis Skw., the latter being a special type related to P. pilosa Rehder, of Mongolia. It is not certain whether P. tremula var. dauidiana Schneider, which is common in all mountains of North China, and at its finest on the 4,500 foot line, grows in Manchuria.

WILLOW: The Willow is the commonest tree in Manchuria, but of little use commercially: the most important use to which it is put is for making the large twig baskets used for carting wild silk cocoons, and in the basket industry generally. On the Amur nine species of Willow exist, and the wood is used for making canoes, as framework for the roofs of poorer huts, for ropes, and

in the form of chips for kindling fires. The leading species are Salix caprea L., and S. gracilistyla Miq. (S. thunbergiana Bl.). On the mountain steppe of Barga, S. brachypoda Trautv. grows with stunted Oaks among the grass. But the most interesting Willow is that of the Nonni valley, Salix bracteosa Turcz. (Chosenia macrolepis Nakai) which is found scattered from Korea throughout Manchuria and the Transbaikal even as far as Kamchatka. Its quick growth and narrow crown make it desirable for use in cities and gardens, and in industrial plantations. There are many forms hybridized with common species of Willows, and especially with S. rorida Lacs. and S. viminalis var. gmelini Anders. In the wilder parts of Manchuria Willow ashes are used for making coarse gun-powder; only among a primitive people could such a use survive, and the practice is dying out.

ALDER: This tree, valuable for its great durability under water, is used for piles. Its distribution is northern: the White Alder (said to be Alnus incana Moench) flourishes along the Amur as far as Sakhalin, and reaches 69° N. latitude in Siberia. A. hirsuta var. sibirica Schneid. (A. sibirica Fisch.) is confined to damp valleys in Barga on the North, and in the Nonni valley, where it occurs with Willows, Birch and Poplars. There is also a species named A. hirsuta Turcz. but this determination seems to be vague.

The above completes the list of common trees; there are others interesting on account of their special character, such as Phellodendron amurense Rupr., the Amur Cork Tree, 70 feet high, with a thick bark the interior of which is yellowish in colour and prized as a drug and dyeing agent. The wood also has a yellow tinge, is very hard, and valued for furniture and house decoration. Phellodendron is distributed along the middle Amur, going as far as 50°10'N. lat., but also grows on the Yalu, where it is highly valued. Maaackia amurensis var. buengeri Schneid., like the last, does not grow in pure woods, but mixed with other broad-leaved trees; it flourishes especially on the Amur and Ussuri. The wood is yellowish-brown and coarse and is used in building and for farm tools and axe handles, but it is inferior for making charcoal. The tree is 80 feet high at its maximum, but usually smaller.

Acanthopanax septemlobus (Thunb.) Koidz. (A. ricinifolius Seem.) grows scattered but not in groups, particularly on the Yalu. The wood is of medium hardness, has a fine grain and gloss, and is sometimes used in Japan as imitation zelkova (a popular furniture wood in Japan). Spear handles, tools, trays, etc. are made from it, and the bottom boards of the Yalu junks. The railways

have furnished coaches with this wood, but it has become scarce from over-exploitation, and boards 55 feet in length are no longer obtainable, as they were twenty years ago.

Among less important trees are Syringa robusta Nakai, which grows on rocky slopes and along stream beds in South Eastern Manchuria, as well as in Korea and North China; Syringa amurensis var. mandshurica Maxim., S. japonica Decne., and S. amurensis var. genuina Maxim., which reaches 45 feet and has a wide distribution from Korea to Siberia; Chaenomeles sinensis Koehne (Cydonia sinensis Thouin, Pyrus sinensis Poir.) used for engraving on boards and book frames; and Hazel, Crab Apple and Alder, all of which are common.

DESCRIPTION OF FOREST REGIONS.

I. The Yalu Basin.

The river Yalu, which forms the south-eastern frontier of Manchuria, and debouches below the port of Antung, has a length of 340 miles from its source in the Changpai crater lake. It is a turbulent river, and rafting needs great skill in the upper reaches, where rapids are frequent. The forest area is reached 100 miles above Antung - the lower reaches having been long since denuded - and continues on the western bank for 200 miles, having an area of 1,800 square miles. Its chief tributary is the Hun, which has numerous affluents, of which the lower have been deforested; but the upper courses of these streams are still rich in dense primeval forest, with an area approaching 1,700 square miles. Cutting began in 1823, when the Emperor Tao Kuang required large pillars for his palace; and later on, when this region was a No-Man's Land, the trade was appropriated by bandits; but it was not until 1871, when the great Viceroy Li Hung Chang asserted control over the bandit armies, that regular trade in timber began. The coming of the Russians stimulated trade, and from 1901 to 1903 a million logs (fu) of 8 foot length were rafted down for building purposes. In 1908, after the Japanese victory, the Yalu Timber Company was formed under joint Chinese and Japanese control, and forest exploitation assumed large proportions, many saw-mills arising at Antung. The banks of the Yalu were formerly covered with mixed forest, chiefly of broad-leaved trees - Oak, Ash, Elm, Walnut and Birch (the Bhojpattra Birch which is highly valued, is now almost extinct). Further away from the banks conifers - Red Pine, Spruce, Larch, and a little Yew - increase

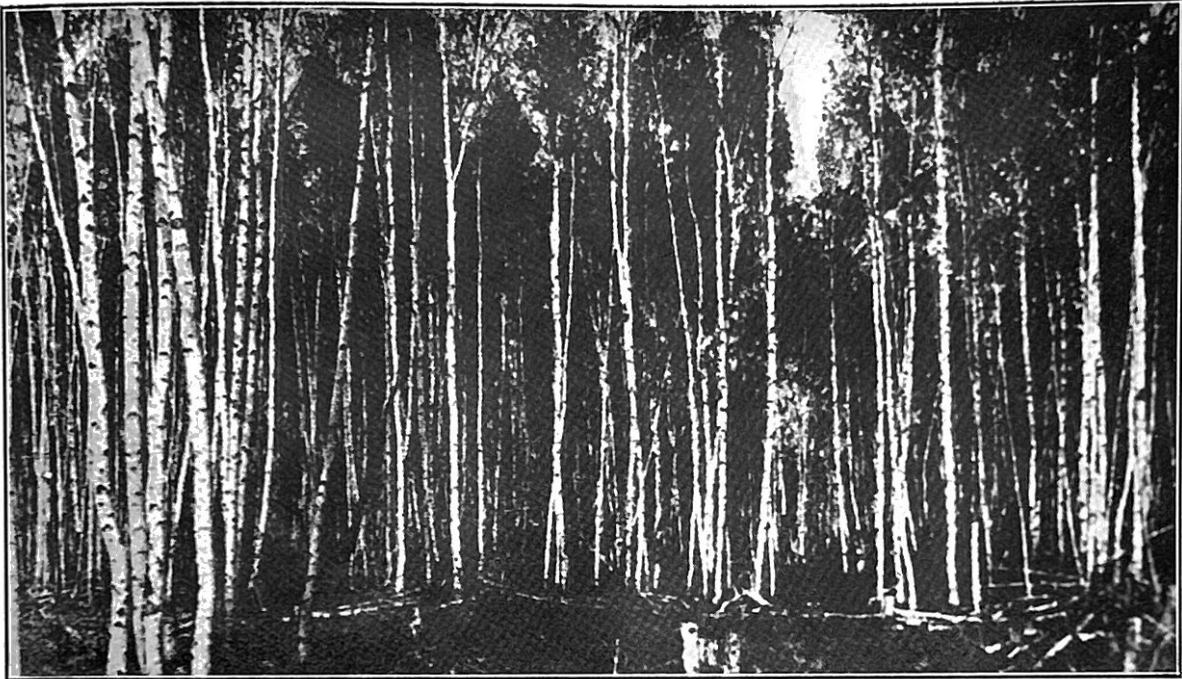
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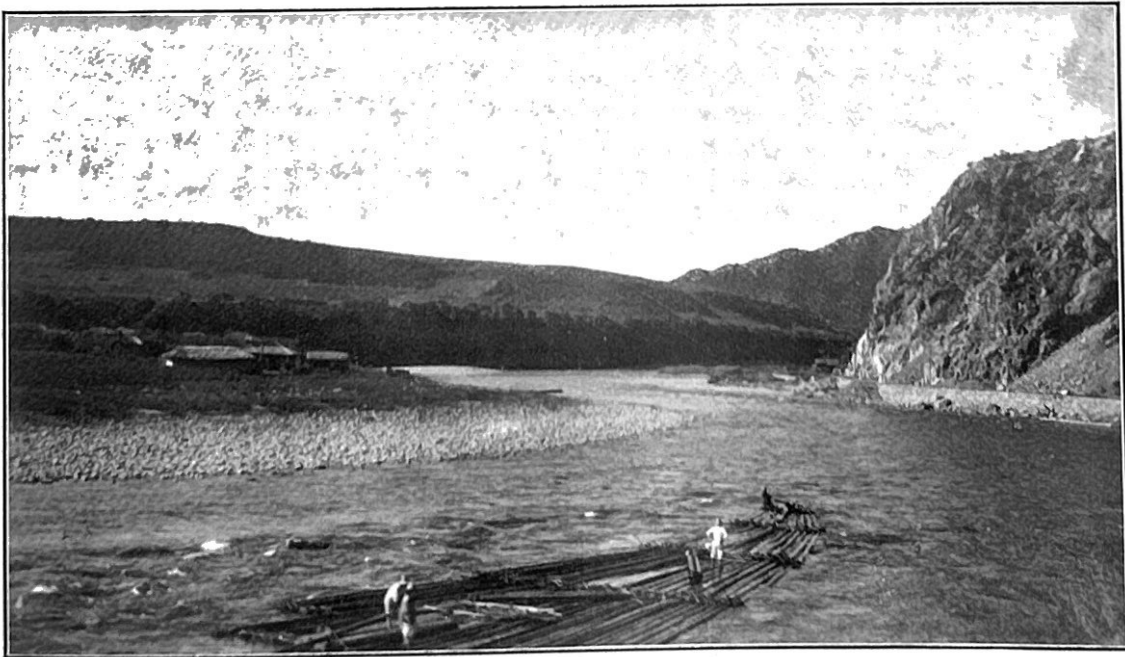
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HSINGAN BIRCH FOREST



RAFT ON RIVER TUMEN: JAPANESE TYPE

Photos: The Author

as the mountains rise, other species being restricted to the valleys. In mixed forests Oak, Lime and Birch are associated with Pine and Spruce; and in the still inaccessible virgin forests conifers form two-thirds of the tree cover, which is extremely dense. James, who, with Younghusband, travelled to the "Long White Mountain" in 1885, describes the almost impenetrable character of the forest in the swampy regions, but also notes the open glades of meadow land covered with flowers.

The capacity of timber content in this area has been estimated at from 3,623 to 4,700 million cubic feet, and the annual production is $21\frac{1}{2}$ million, of which coniferous wood yields 20 million, Picea jezoensis var. hondoensis leading with 6 million. The trees are felled by hand, and trimmed and rough squared in the forest, after which they are drawn by horses to streams and floated down to the riverside where they are formed into rafts.

II. Upper Sungari Basin.

This region is north of that last described, and begins where the Sungari emerges from the same lake crater as the Yalu. The river, which has a length of 1,500 miles to its junction with the Amur, runs north-west to the provincial capital of Kirin, where it enters the plains, thereafter flowing past Harbin to the Amur near Habarovsk. The Upper Sungari basin, having an area of 6,000 square miles, is divided into two sections, the first being surrounded by mountains on all sides. These are the Mutanling (range) on the north, the Ying-o, rising to 6,000 feet, on the east, the Changpai to the south, and the Laolungkang (watershed of the Yalu) and Na-erh-hung to the west. There are, in this upper basin of the Sungari, two main branches of the river: the Erh-tao (meaning second branch) to the north and the Tou-tao (first branch) to the south; they are separated by the plateau of Pinganling, from which many lesser streams flow to the main branches, the volume of which is further increased by other tributaries from the border ranges. After the junction of the Erh-tao and Tou-tao the Sungari is 200 yards broad, and it soon plunges, at Taweltzu, through a magnificent gorge, quite impassable in the rainy season of late summer.

The forests of this enclosed area cover 4,800 square miles and are estimated to contain 6,760 million cubic feet of standing timber. There has been very extensive cutting during the past years and in the more accessible parts the hills have been almost denuded, not only by timbermen but also by peasant

immigrants who have burnt out the hillsides to clear the land for farming. Two towns have sprung up, Antu in Kirin and Fusung in Fengtien, mushroom growths of a pioneering population, where some semblance of authority seeks to replace lawlessness, and which serve, under the iron hand of the Japanese, as centres for the suppression of the all-prevalent banditry. West of Antu the side streams were long ago worked for alluvial gold in the gneiss and mica schist formations: the hills were swept bare by fires, and are now stony and grass covered, resembling the hills of China proper. But on the summits Red Pine, Silver Fir and Hondo Spruce grow to immense size in pure coniferous forests, preserved by their inaccessibility. North of Antu is an uninhabited region of pure woods of Larch, the only tree that can flourish in the impermeable lava soil. From Antu to Fusung there is a rough road some 80 miles in length; and here are virgin forests of giant conifers, Oak, Elm and Walnut, with secondary growth of Poplar, Maple and Birch, Hazel, Alder, Crab-Apple, Elder and wild vines; the only signs of habitation being the log cabins of hunters and ginseng collectors. Continuing south-west from Fusung is a dreary succession of gloomy swamp forests of broad-leaved trees, great Oaks being conspicuous: the dense thickets forming the undergrowth are the home of deer and wild boar. Later Larch — the highest tree — again occupies the summits, but as Changpaishan is approached there are open meadows of exquisite colouration, rivalling, as Youngusband says, Kashmir.

The headwaters of the Tou-tao river contain the best forests of Manchuria, with the true Manchurian flora, broad-leaved trees forming one-third of the timber: here are to be found giant Phellodendron. Turning west there is much pure coniferous forest; the north-west corner of this area has been described by a Scottish missionary, one of the rare white men to penetrate it from the plains. He says that the different varieties of trees are usually disposed in groups; one passes through miles of Oak woods, then Elms and Walnut in another group, and later, on crossing a hill top, a vast sea of Pine breaks on the eye, majestic trees 150 feet high. Further on again, the road is cut through a dark Larch wood with tall bare stems. Willow and Poplar are rare: they tend to follow the settlements and to spring up round the new towns. Further north is an area long under settlement, much of it taken up by farms and much reduced to sterile waste by fires. Conifers have been largely cut away, but the broad-leaved forests contain Poplar, Elm and Maackia — large trees 70 feet high. Fuel and charcoal are now almost the only produce of the forests.

In the section below Taweitzu the Sungari becomes a broad rapidly flowing river, whose volume is augmented by many

tributaries entering from the border range on the east. Westwards there is only one large affluent, the Huifa, which was descended from its upper waters in 1913 by Mr. Sowerby. Even at that time he found a large number of settlers pushing their way into the forest, which could only be entered by old clearings or on the spaces made by devastating fires. In the forests were Pine, Spruce, Oak and Walnut of enormous size, many as much as 8 feet in diameter, Silver Fir 150 feet high; a secondary growth of Maple, Poplar, Birch, Hazel (Corylus heterophylla Fisch.) etc.; and a jungle of shrubs, creepers, lilacs and wild vines (Vitis amurensis Rupr.), practically impenetrable. Denudation of these hills has since proceeded far eastwards, even beyond the Sungari, where in 1913 there was still primeval forest - wild country controlled by a powerful bandit chieftain. The principal easterly affluent is the Lafa river, rising on the north-west slopes of the Changkuangtsai-ling, a range several hundred miles long. On the east is the Laoyeh-ling, and these hills still contain much forest: the area being estimated at 1,200 square miles with timber resources of 1,970 million cubic feet. Until 1928 rafts were brought down the Lafa to its junction with the Sungari, but the completion of a railway line from Kirin to the new town of Tunhua in that year has diverted the trade to rail transport, and the ultimate effect will be to speed up timber operations. At first, however, timber exploitation was reduced owing to the heavy burden of taxation imposed by the Manchurian authorities, and from 1931 by the political troubles, coupled with very great activity of bandit gangs. The railway has now been extended to meet the Korean line near the north-east coast of Korea, and it may be presumed that increased activity in lumbering has ensued. The market of Kirin is close at hand, and constitutes the centre for supply of the great plain of Central Manchuria: tens of thousands of split logs are sold by weight for firewood - and this in a country rich in coal! An abundance of sleepers is also supplied, and large quantities of poles, while the finer woods, Oak and Maple, are used in the furniture trade. The real forest belt has now receded to the remoter ridges of the ranges, and cutting proceeds at a slower pace owing to the difficulty experienced in getting the logs to the streams. The soil of the ranges above-mentioned is granitic, and the trees are of much the same character as in the headwaters district, though Red Pine becomes scarcer northwards.

III. Hurka or Mutan River Basin.

The third district is that watered by the Hurka or Mutan River, which, rising in the eastern slopes of the Changkuangtsai and Mutan mountains, flows north-east to join the Sungari at

Sansing, on its lower course below Harbin. Only the upper waters of the Hurka are included in the region, which occupies an area 120 miles by 60, containing some 2,600 square miles of forested land. Timber resources are said to amount to 3,500 million cubic feet. After some 300 miles, the Hurka reaches Ninguta, centuries ago the centre of a powerful state and possibly overthrown by seismic disturbance, for there is much volcanic soil in the district. The lower course of the river here has been thickly settled by Chinese immigrants for over 60 years, and the foothills and plains have been denuded of timber, but in the surrounding mountain summits there is still much primeval forest. A lake of considerable size, the Chingpo, lies on the river above Ninguta, and a waterfall at its egress prevents rafting of logs; beyond this they are brought in only for the supply of local needs from the hills to the east and west. Roads, however, do not exist: there are only cart tracks available in winter. Thus the forests lying to the eastward remain untouched, and are magnificent mixed woods, two-thirds Red Pine and Spruce, with Ash, Maple, Elm, Poplar and fewer Oak and Lime. Towards Korea begins a belt of Yew, which timber is greatly prized in the trade. This forest is also claimed as the richest in Manchuria. On the Mutan-ling, where the rocks are of gneiss and mica schist formation, virgin forests also survive, but immigrants are creeping up the valleys, where the humus renders farming easy and profitable, and fires are beginning to waste the forest wealth, though little cutting for timber is carried on. Silver Fir and swamp-land Larch cover much of the hills in this section, and the Maackia is first found. Turning to the west of the Hurka, the soil becomes infertile, being of basaltic formation: in this district of Omu the spurs of the Changkuangtsai-ling are intricate and rocky, and only primitive footpaths used by charcoal-burners and hunters exist; and a vast trackless belt of forest begins, not yet penetrated by man except on its fringes, which extends for several hundred miles westwards with a width in some places of 150 miles. It is only in the Tunhua depression that lumbering is active, but doubtless ways will be found by the Japanese by which this untapped wealth will be exploited in the course of time.

IV. The Tumen River Basin.

The strategic railway already referred to crosses the Hurka-Tumen watershed - the Haerpaling - at its lowest point, and enters the basin of the Tumen, an eastward flowing river with many tributaries falling into it from the Yalu, Sungari and Hurka watersheds. This river, which flows into the Sea of Japan, is the boundary of Korea along its lower course, and the territory on

its lower waters is densely populated by ever increasing swarms of Koreans. Cultivation is very intense, and the neighbouring hills have been completely denuded to satisfy requirements for fuel and building material, with the result that the rivers have been silted up, and disastrous floods are of almost annual occurrence. However, inaccessibility still preserves the forests of the remoter mountains. The trees bear much the same character as in the regions previously described, but in the north-western corner the Bhojpattra Birch grows with Walnut and Elm, and Pinus densiflora, named the "Oil Pine", occurs on granitic soil. Towards the Russian frontier deforestation has prevailed, but in the central portion of the region, where the humidity from the Japan Sea brings warmth in the summer and fills the rivers, there are valuable broad-leaved forests, containing much Walnut. The forest area of the Tumen basin is 3,200 square miles, and Japanese experts, who have traversed the ground completely, estimate its resources at 4,200 million square feet. The average annual export is 10 million cubic feet, but is likely to increase.

V. The Ussuri Area.

Northwards from the Hurka basin at Ninguta, and passing over the Chinese Eastern Railway zone, the Ussuri river is reached, which forms the frontier with Russia. This river rises in the large lake of Hinka and is navigable by steamers for most of its course; hence its immediate neighbourhood has been stripped of wood, though the opposite hills on the Russian side are magnificently forested. Many Koreans, as well as Chinese, have settled in the valley, and one finds the usual tale of forest destruction by fire: in addition, steam-launches go some distance up the side streams, and as all steam vessels in these parts use wood as fuel, the consumption is very large. In some places the high mountains have no springs of water, and only scrub oak is able to grow, but on the whole this is a very richly forested region in its remote, unexplored parts, as steep hills unfitted for transport and a sparse population maintain its inviolability. The forest area is estimated at 14,000 square miles, but no computation appears to have been made of its resources. Splendid Oak forests are a feature of the region, which however contains most of the usual trees of the Sungari, the Korean Pine being still prominent.

VI. Eastern Section of the Chinese Eastern Railway.

This section is not geographical, but economic, being the

centre of the most highly exploited portion of Manchuria. The Russian built railway (which has just passed into the hands of Manchukuo by purchase) opened up the region south-east of Harbin, running to the Russian frontier near Vladivostock, and for over 200 miles of its course the forests have now been worked since 1904. This zone contains twenty "concessions", with 300 miles of light railway, some of which penetrates for 40 miles into the hills. Geographically it is situated partly on the western slopes of the Changkuangtsai-ling, and partly on the lower waters of the Hurka, and covers 9,000 square miles of territory, much of which has however been already cut over. The tree growth does not differ much from that of the Upper Sungari. Pine, Spruce and Silver Fir are shipped to Vladivostock and Harbin, while Walnut, Oak and Elm, and to a lesser extent Maple, are cut for fuel to supply the needs of the railways, steamers and large towns of the plains. Several saw-mills exist, and are kept busily at work, but since the 1931 crisis, the operations of bandits and the political situation have interfered with lumbering. However, now that the Chinese Eastern Railway has been handed over to the Manchukuo government, safer conditions will be established. The proximity of Harbin has made these forests accessible to sportsmen, and much big game - the splendidly furred Manchurian tiger, grizzly and black bear, Wapiti, pig and smaller game - were sought after in more peaceful times. Timber resources are computed at nearly 9,000 million cubic feet.

VII. Lalin River Area.

South-west of the last region is that of the Lalin River, which drains the Lao-yeh-ling North of Kirin City. This tract has an area of 2,400 square miles and a capacity of 3,000 million cubic feet, but is rapidly filling up with population owing to its nearness to the plains.

VIII. The Lower Sungari Area.

In this area all trees near the river have long since been felled, but on the headwaters of the rivers in the district, beginning 125 miles from Harbin, there are still considerable forests, whence wood is rafted to the Sungari sawmills. The usual trees are found, Birch, Ash, and Phellodendron being the most valuable. Two hundred miles from Harbin the city of Sansing is reached, where the Hurka enters the Sungari. The neighbourhood of Sansing is completely deforested, but, sixty miles up-stream, logs are brought down from the western slopes of the

Ussuri watershed mountains, a wild range, trackless and little penetrated. The forested area of the Lower Sungari on the Kirin side - the river forms the boundary of Heilungkiang province - is variously estimated at between 4,300 and 5,700 square miles.

IX. The Little Hsingan.

This range branches off from the Great Hsingan in 52° N. Lat., and runs south-east for 500 miles to the junction of the Amur and Sungari; it also forms the watershed between the Amur and the Nonni, principal affluent of the Sungari in North Manchuria. The range averages 150 miles in breadth, and this vast area remains almost unexplored, although the advent of new railways into its western foothills is opening up the lowlands to settlement. The forest area is estimated at 38,000 square miles, and guesses at the resources vary from fourteen to thirty-five thousand million cubic feet! Where the hills approach the Amur and Sungari they have been bared by settlers and lumbermen; steamers and junks conveying the logs to the riverine towns. In the valleys facing south, Oak, Elm and Birch flourish, and there are open meadows now converted to pasture. Ascending the Amur there are impressive pine-clad gorges with park-like glades dotted with White Birch: lumbering is limited by the distance from which timber can be profitably hauled to the river in winter by the primitive methods in use, and the mountain heights remain untouched. Most of the timber is used for fuel by the river steamers, and piled in stacks at the ports of call. Larch comprises 70 per cent of the forest stock, the balance being composed of Birch (Black and White), Oak and Poplar.

X. The Great Hsingan.

The eastern slopes of this border range were, centuries ago, wooded as far south as Jehol, where remains of the Imperial hunting forest still exist. But, with the coming of the Mongols, the Hsingan no longer formed a frontier for the Tungus peoples, pre-eminently a forest folk; and in the thirteenth century Chinghis Khan's nomadic and pastoral hordes overwhelmed the plains, the Tungus retreating into the forests. South of the River Tao there are now no vestiges of forest remaining. The Hsingan forest area is estimated at anything between 54,000 and 70,000 square miles, and its resources at 56,000 million cubic feet. In the north-west of the region, on the western side of the range, is the district of Barga, traversed in its southern part by the Chinese Eastern Railway, which joins the Siberian line

at Manchuli. This area - that of Hailar - has been more extensively studied by Russian botanists than any other part of Manchuria. (Only 0.1 per cent of Manchuria has been investigated in detail; 32.9 tentatively, and 67 per cent not at all.) Barga is divided into steppe and alpine zones. In the former, where the influence of the Gobi desert is felt, the strong solar heat encourages fires, which prevent the regeneration of trees, and the soil is very thin. The trees consist of Scrub Oak, Poplar, Sallow, Alder and Aspens in the valleys, and Pinus sylvestris L. on the sandy dunes; there are also the herbs of various floras - Manchurian, Korean, Siberian and Mongolian. Southwards the foothill slopes are composed of loam and loess, with alkaline deposits towards the Dalainor level. The Alpine zone in the north remains unexplored except where the foothills approach the Argun and Amur, into which many tributary streams flow. Pinus pumila L. has been noted here, and other Alpine plants may be expected.

On the Hsingan Larix gmelini Pilger (L. dahurica Turcz.) constitutes 70 per cent of the stand, White and Black Birch and Aspen forming the bulk of the remainder. On the northern steeps, among crumbling rocky soil, are many species of special type - Juniperus dahuricus L. and J. communis L., Ulmus japonica Sarg., and U. macrocarpa Hance, with Rhododendron and vines for undergrowth. On these northern slopes the frost is perpetual, and the soil, being continuously moist, is favourable to tree growth, even though the annual rainfall does not exceed 12 inches.

In only two regions of the Great Hsingan has there been any exploitation of timber. Along the upper Amur, Russian steamers began to ply from Habarovsk in the early nineties, making connection with Siberia via the Shilka river. These steamers burned wood fuel and also carried it downstream for the use of the townships. The forests have thus been cut along the river for some dozen miles back. Of late, however, disturbed political conditions have stopped this trade: few steamers ply, and practically no rafts have come down since the closing of the frontier by the Soviet Government, and doubtless some regeneration is occurring. The other lumbering area is on the western Chinese Eastern Railway line, which here crosses the Hsingan between Tsitsihar and Hailar. There are 8 concessions covering 8,000 square miles, in which timber has been worked for over 30 years, and, as a result, forests have been cleared for 25 miles on each side of the railway. Beyond this limit, the hills are well covered with trees - Larch, Pine and Birch - and even where the hills have been cleared secondary growth is already re-appearing. Hazel is prominent in this region, and in peaceful times 15,000 tons of hazel nuts were exported yearly to Harbin: a great abundance of berries of all kinds is also collected for export.

With these two exceptions, and some small clearings on the road from the main Nonni river to Aigun on the Amur where it traverses low passes, the great plateau of the Hsingan remains unexplored primeval forest, mainly of Larch: Pine does not occur on the Hsingan heights north of the Chinese Eastern Railway. The rare inhabitants of the forest tract are Tungus - nomads who have only recently become owners of reindeer - and a few Chinese bandits who cannot be pursued into the wilds.

SUMMARY OF REGIONAL STATISTICS.

The following table shows estimates of the total areas and capacities of the Manchurian forests:

	Area in sq. miles.		Capacity in million c.f.	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
I. YALU & HUN BASINS	- 3,756	3,890	3,078	3,623
II. UPPER SUNGARI	- 3,732	5,700	7,425	8,740
III. HURKA BASIN	- 2,476	3,431	3,576	4,210
IV. TUMEN BASIN	- 3,089	3,302	3,570	4,204
V. SANSING REGION (including Ussuri area)	- 14,592	20,989	22,217	26,153
VI. CHINESE E.R. EAST	- 9,184	10,516	7,631	8,983
VII. LALIN BASIN	- 872	2,514	2,553	3,005
VIII. LITTLE HSINGAN	- 22,584	39,670	29,730	35,000
IX. GREAT HSINGAN	- 52,000	73,537	47,572	56,000
	<u>112,285</u>	<u>163,549</u>	<u>127,352</u>	<u>149,918</u>

The minimum figures for square mileage are those compiled by Russian statisticians, who are more conservative in their estimates than the Japanese. The latter, with that meticulous attention to detail for which they are notable, have even supplied figures for the number of trees in the forests, though they have to admit defeat in the case of the Hsingan, for which no figures are supplied. The tree statistics show a proportionate distribution of 63 per cent of conifers and 37 per cent of broad-leaved species.

LUMBERING.

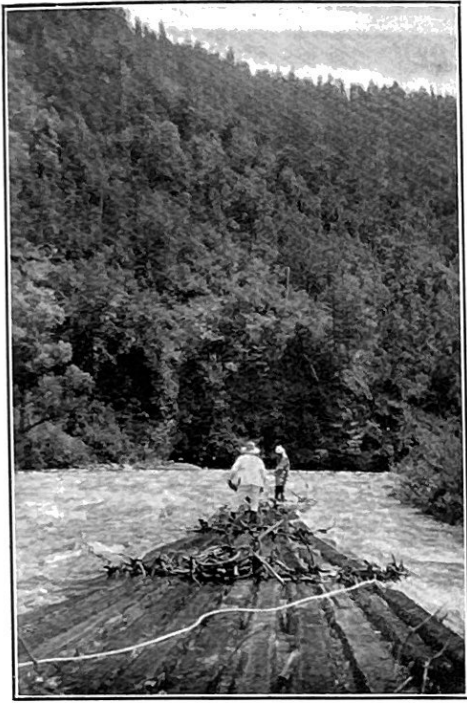
Scientific lumbering is carried on only in the Yalu, Tumen and Chinese Eastern Railway areas: elsewhere extraction work has until recently been carried on by Chinese contractors. Gangs of men under a headman proceed after the summer rains are over to the forests, where logging is done entirely by hand, the

timber being dragged by horses or oxen to the nearest stream and thence floated down to a river junction. There the logs are made up into rafts, on which the raftsmen live as they float them to the market. There is great waste in the operations of these primitive woodmen: many trees of lesser size are burnt at the bottom and left for the winds to blow down, tops are burnt with brushwood, and holes are made in the butts of the logs whereby they can be tied together for rafting, with the result that the butt ends are rendered unfit for any use but fuel. Valuable hardwoods - Walnut, Oak etc., are used as firewood at Kirin and elsewhere. In certain limited areas, however, lumbering is scientifically carried on: on the Yalu light railways, shelter docks and up-to-date sawmills have been in existence for many years, and the Tumen area is now being modernized. The concessions on both the eastern and western sections of the Chinese Eastern Railway have already been referred to, and the Japanese are extending scientific lumbering to new regions. Production statistics are uncertain, but some years ago the consumption of the Chinese Eastern Railway alone was stated to be $43\frac{1}{4}$ million cubic feet. This figure must have decreased considerably later, with the diminution in cutting due to unsafe conditions and high taxation, and as a result of the increased use of coal. Ten million cubic feet come from the Upper Sungari, and the output of the Tumen is also 10 million, while that of the Yalu now averages a little over 20 million cubic feet.

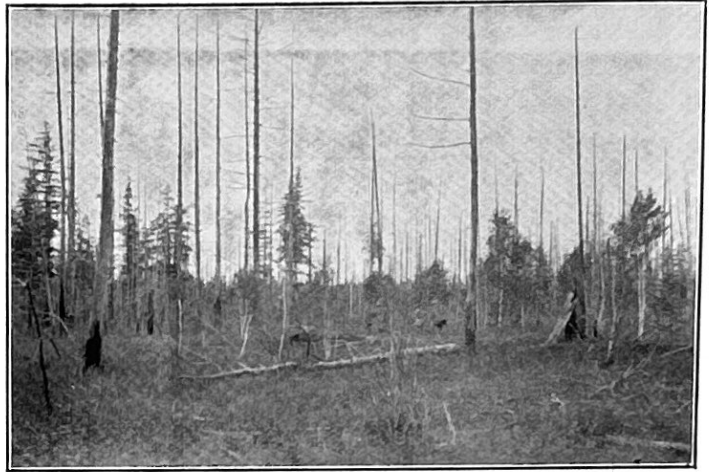
RAFTING.

Chinese rafts on the Sungari are formed of a series of units, each consisting of 15 logs, trimmed and rough squared in the forest: each of the 20 to 40 units is some 22 feet in length. Such a raft requires from 8 to 16 men to steer it. The Japanese rafts on the Yalu are connected together more loosely, and are 9 logs wide at the front, broadening out at the back so that they are in the shape of a long narrow triangle (see illustration). The first section is loosely joined to the rest and can be manipulated by a tiller for steering through rapids. Being built in articulated sections these rafts require only a couple of men to steer them, whereas the Chinese type has heavy cross timbers laid across the main raft to bind it together in a rigid square, and requires much more labour.

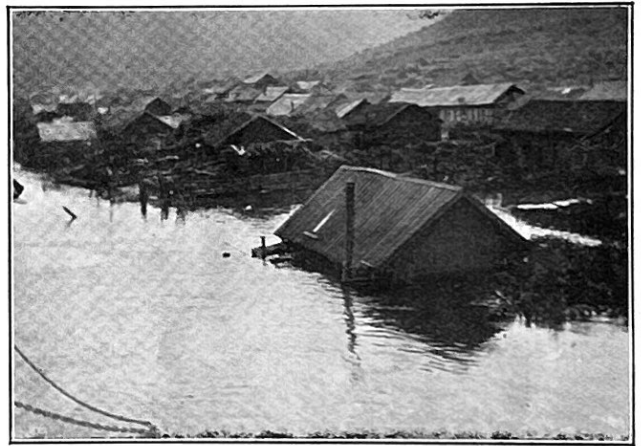
As already indicated, the forest area of Manchuria has been largely reduced, especially during the last 80 years, by the spread of agriculture: millions of settlers have migrated from China and ruthlessly destroyed all tree growth, especially on the east of Fengtien province. The result has been catastrophic floods, occurring almost annually and causing vast loss; the most



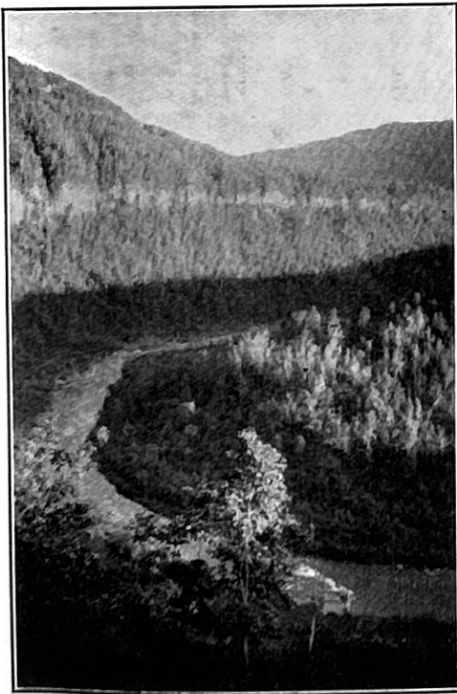
RAFT SHOOTING RAPIDS AT THE
UPPER YALU RIVER



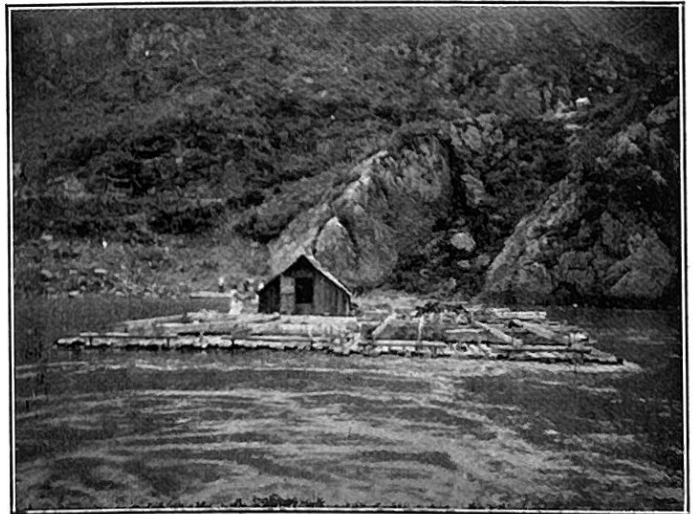
FIRE HAVOC



SUNGARI FLOODS, 1928



HEADWATERS OF THE YALU RIVER



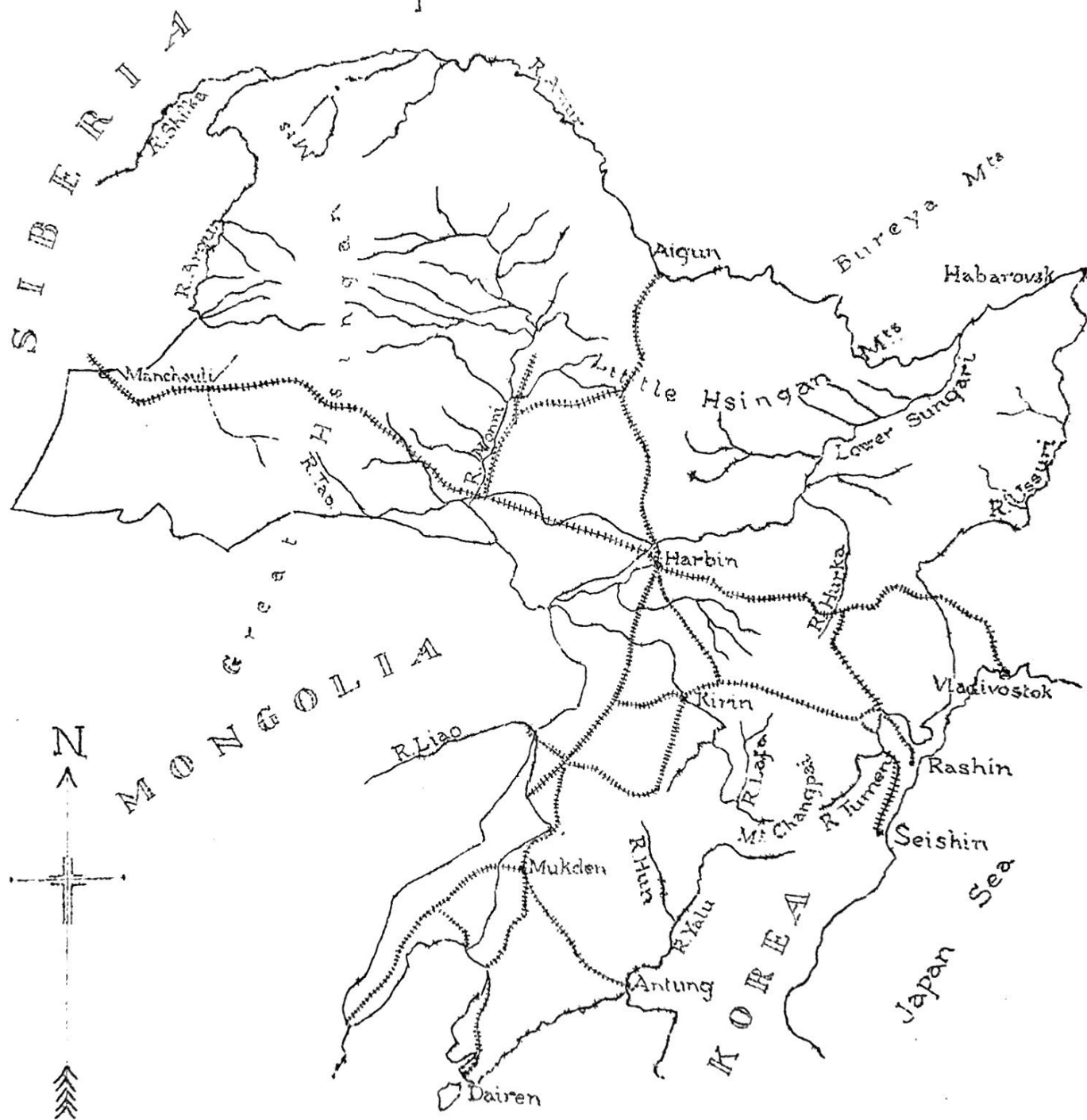
CHINESE RAFT ON THE UPPER YALU RIVER

recent being the universal inundation of 1934, when Harbin itself was in danger. In the forests the axe is accountable for only 10 per cent of the destruction, the remainder being due to fires carelessly or deliberately caused. Centuries ago central and western Manchuria were forested but the forests were destroyed by fire. Steppe formation has replaced them, changing the climate and giving rise to floods such as those which have silted up the Liao river and made it almost unnavigable. No reafforestation has ever been attempted by the Chinese, but the Japanese authorities have taken it in hand near Dairen and on the Korean bank of the Yalu, where the hills clothed with young woods contrast vividly with the western bank, formerly densely forested but now completely bare. The Japanese will doubtless now extend afforestation throughout the country. To them the timber supply of Manchuria is of prime importance, for Japan, which consumes 2 billion cubic feet of timber annually, at present has to import 30 per cent. of that amount, and the drain on her resources is serious, prejudicing her international balance of payments. The forest resources of Manchuria are ample for Japan's requirements, and the opening of the new Kirin-Tunhua-Korea railway has provided a cheap route for export of timber. At the same time the construction of a new line from the Tumen to the eastern section of the Chinese Eastern Railway (now the Manchukuo State Railway), though primarily strategic, has opened up the lower Hurka district for timber export. Manchuria, which has hitherto imported much Douglas Fir for building requirements, will now find it possible to increase her exports of wood to North China and other markets; this trade has for many years been considerable, but under scientific management will increase, and the bestowal of greater care on the economical development and preservation of forest resources, accompanied by increased use of Manchurian coal, to replace valuable hardwoods hitherto wastefully burnt as fuel, will certainly be a feature of Japanese economic policy in Manchuria.

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Sketch map of Manchuria



----- Railways

100 50 0 100 200 300 400 Miles

