MEMOIRS-I

57 OF

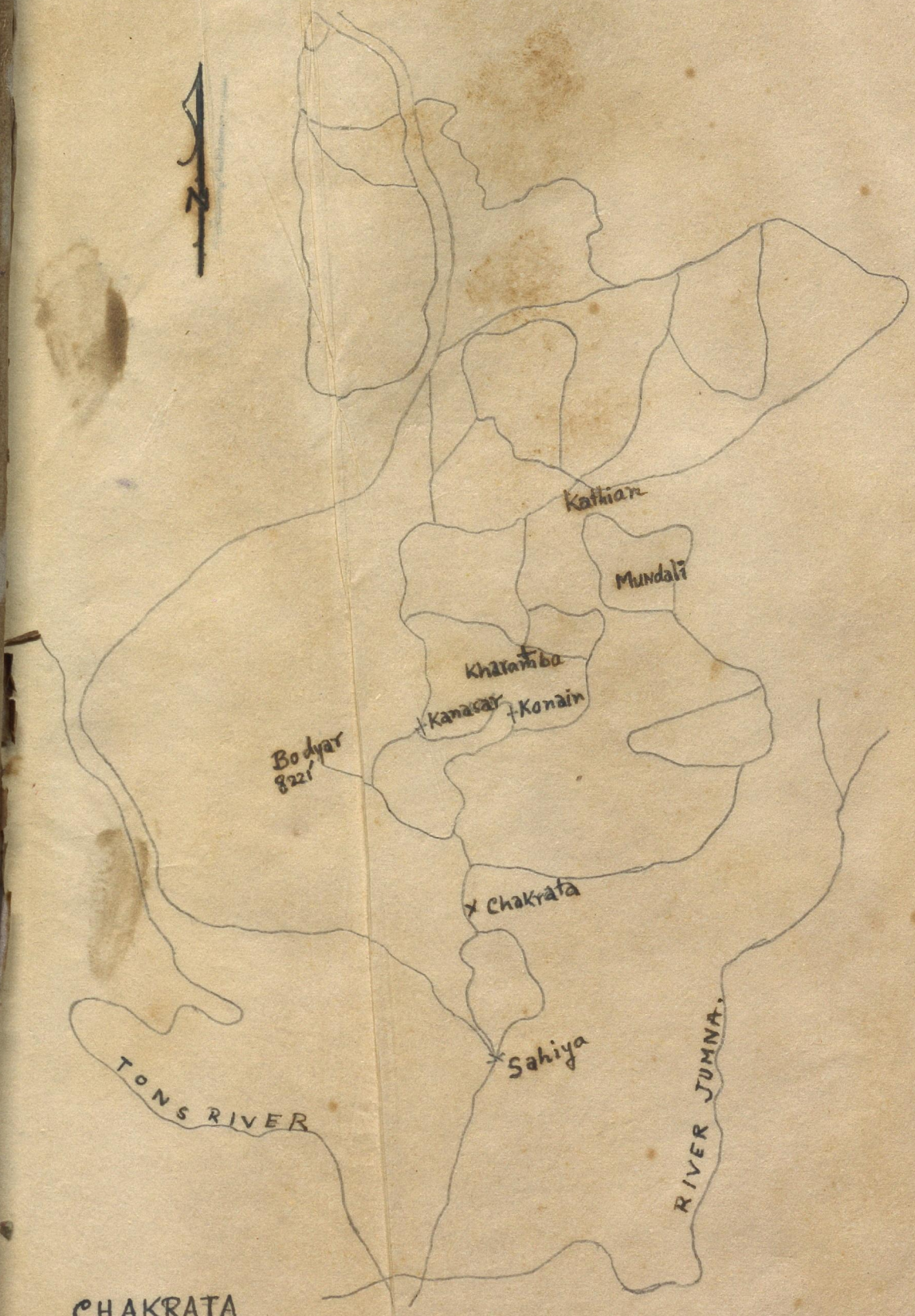
Borlang Award Winner

Mr. S. Debroy, IFS

COMPILED BY:

Bharat Bhushan Dhar

1994 I.F.S.



CHAKRATA
DIVISION
Scale —
1" = 4 miles

Tour Diary.

Dates	Items covered	References
28th May'57	Left New forest for Chakrata in the morning, saw change in vegitation enroute, arrived Chakrata in the evening. Halt.	
29th May.	Introductory lecture on the locality factors of Chakrata divisions.	Silviculture
	Studied botanical specimens on way to lime kiln	Botany
	Visited M.F.P nursery.	Silviculture
30th May'57	Visited the cantonment forest of Quercus incana, studied its working, Studied stacking of fire wood & determination of stacked & solid volume & reduction factor.	Silviculture mensuration
31.5.'57.	Visited the water reservioar at Cokratibba, Constructed a charcoal kiln & studied details of charcoal manufacturing.	Mensuration
1st June'57.	Left Chakrata & reached Mundali, in the way studied vegitational change.	Silviculture
2.6.'57.	Lecture on morphological & phenological characters of some important species.	Silviculture Botany.
	Measurement of heights by various instruments.	Mensuration
3.2.'57.	Survey of preservation plot no 9 Mundali comp 8 & assessment of crop	Survey Mensuration

Date	Items covered	Resp.
4th June '57.	Visit to Kharamba peak and I. G. preservation plot.	Silvi
5th June '57.	March to Kathiatan & back to Mundali Studied Botanical spicies.	Botan
6th June '57.	Sample plot work in Deodar Sample plot no 61, compartment 8 A, on the Cathian road. Determination of top height, basical area, diameter, intensity of thinning.	Silvi & Mensu
7th June '57.	Studied & sketched the plan, section & elevation of the school quarters.	Engin
8th June '57	Visited Mundali compartment 8 B, 8 C, Riknar compartment 14, 15, 16 & 18. Studied Deodar felling & conversion in Riknar compartment 18. Measured height of a Cupressus torulosa	Silvi Utilisa
9th June '57	Alignment of a mule path from the F.R.H., Mundali to a road-crossing about 2 furlongs away.	Survey
10th June '57	Studied increament of Spencer by Pressler's method	Mensu
11th June '57	Botanical excursion.	Botan
12th June '57	Left Mundali for Deoban via Konain. At Konain visited Howard's folly & carried out complete enumeration in 3 different altitudinal zones, from bottom to top.	Silvi
13th June '57	Lecture on soil science & dug pit to study soil profile & carry analysis.	Soil Science

Date.
14th June '57
15th June
16th June
17th June
18th June
19th June
20th June
21st June
22nd June
23rd June
24th "
25th "
26th June
27th June

Date.	Items covered	Reference
4th June '57	Lecture on soil science.	Soil science
5th June	Visit to Dioban compartment no 76, 9a 4, 66, 5a & Sample plot 1 & 2.	Silvi.
th June	Visit to Konain, Study dibbling of Fir etc. Field test in Silviculture, botany & mensu.	—
th June	March to Kanasar & halt.	—
th June	Stem & stump analysis	Mensuration
th June	Computation of datas of stem & stump analysis.	"
th June	Compilation of datas of stem & stump analysis	"
st June	Thinning (preceded by marking at Kanasar 6)	Silviculture
nd June	March to Bodyar & back. Lecture on the ecological types of Chir.	Silviculture
3rd June 4th " 5th "	Topographical survey	Survey
th June	Visit to Kanasar compartment 9, Chir zone. Carried out enumeration and prepared stock map (Kanasar 8)	Silviculture
7th Jun.	Computation of Enumeration datas.	Mensuration

SILVICULTURE

CHAKRATA FOREST DIVISION.

Locality factors.

1) Name & situation.

Chakrata forest division is situated in the Pargana Jaunsar - Bawar of D. Dun civil district.

2) Configuration of the ground :-

Mountainous varying from about 16°30 to about 10905 in chachpur block

The 2 main lines of drainage are the tons and the Jamuna rivers. All gradations and aspects occurs, but most of the area is steep to very steep & precipitous ground is very common. As a rule the steepest ground occurs on the more southernly aspect, but there are many exceptions to this

3) The strata are mostly designated by local names and starting from the oldest are as follows :-

i) Crystallin rocks :- Represented by gniss in the Pabar valley and gniss and granite in parts of Murach.

ii) Jaunsar series (Oldham's Chakrata series) consisting generally of grey slate and quartzites underlaid by a band of limestone, which is again underlaid by a great series of purple quartzites & slate, marked by the

by the prevallance of red mottled be
These rocks are considered to be of Si
age and occur between Chakrata & Ka
and in parts of the Dhanras Tiuni, D
ghar, Dharaghar, Riknar, Kurang & Ka
blocks.

iii) The Deopan series.

Consisting of a great thickness of gr
shales and considered to be of Carbonif
age. This occupies a very large area of the
central and Northern half of the division
the greater part of the forest is situat
on it.

iv) The Mundali series.- Consisting mostly
the conglomerates with a slaty matrix the
which pebbles of quartzite, slate or lim
stone are scattered; or of limestone con
merates in a limestone matrix and con
ed to be of probably Permean age. T
occurs in the Mundali & Kalsi blocks.

v) The Bulwar series - consisting of fine
glassy quartzite with interbedded schiest,
of the beds containing granules of blue quart
The series may be of post eocene or m
age. This occurs chiefly in the Dharmig
and Khunighar blocks.

vi) The Nahan series (lower Siwaliks) Cons
of alternating beds of fine grained, us
grey firm sand stone, of clays usually
red in colour and almost always

some shade of red & or purple, which weathers in a nodular manner. The beds are probably of middle tertiary age, and a small part of the Kalsi block is on them.

4) Climate :- Naturally with such varying hts. a great differences in climate must occur, in fact the variation is from subtropical to Alpine, but the above discription applied to by far the greater part of the area, while the climate of Kalsi and the low lying valleys, such as the Tons at Tunni & Thadiar is that characteristic of the submontane districts.

5) Rainfall :- The following is the average rainfall at various places in the divisions from 1929 to 1939 with the average annual

Dakpathar	Chakrata,	Deoban,	Kathian,	Tunni Samson
71·68"	66·54"	60·26"	57·80"	33·35" 43·64"

CANTONMENT FOREST.
CHAKRAT.

The Chakrata cantonment comprises of areas classified as follows.

1) The station area containing practically all the bungalows, parade grounds of the Chakrata & Kailana stations. There is a considerable amount of bush growth along road side. In the neighbourhood of buildings. Part of the bush growth is natural but a great deal has been planted almost entirely with conifers, chiefly Deodars to improve the station.

The station area is further classified under the military lands manual into 3 types of land as under;

a) Land which is at present required or reserved for specific military purposes.

b) Land which is not so required or reserved at present but which is retained in the cantonment for the effective discharge of the duties of the govt of India in respect of army administration.

c) Land vested in the cantonment authority

2) An area of 3391 acres outside the station area including the forest area and south western grassy slopes of the present W. plan.

3) The 3 cantonment vegitable gardens viz., Kailana, Khadera & Patiadhar. Areas of diff. working circles are as under

ii) fuel supply w.c.

1829 acres

ii) Protection w.c.

1562 acres

iii) Station area w.c.

491 acres.

The Forest.

Quercus incana forms the principle sp
the forest. It has mixed in varyin
tions with Rhododendron arborium, Pi
ovalifolia and other unimportant mi
nour species.

Over a large part of the forest
main crop of young trees to be a fa
uniform one with a crop diameter
exceeding 8", and often less than
It seems probable that these you
crops originated soon after protec
started in 1880 and that they a
10 to 50 years old. There are fair
of older trees in places, trees of 8
& 12" to 16" diam classes occurring in
patches or scattered amongst mai
crop while larger old trees are fo
scattered through out in varyin
tions being generally more numer
near the nullas and in the lower p
of the compartment.

chilmary block in the East is not so well stocked as the west and the age classes are more mixed and the forest distinctly more of a selection type

Generally speaking, it is still true that the younger of age classes between 6"- 10" diam are greatly in excess and that trees between 10" & 16" diam are deficient. while there are still fair no old trees between 16" to 24" diam.

Fa a forest worked under selection group system, the regeneration is deficient. This is chiefly due to the large area covered by a dense crop 16" to 10" in diam, where regeneration is ~~not~~ cannot appear and is not reqd. Although ~~felling~~ selection fellings have been carried out for the last 15 or 16 yrs. on improvement felling for a long period before this, they have consisted mainly in removing the large old trees standing over ~~to~~ regeneration and comparatively few gaps suitable for ~~specific~~ fresh regeneration have been made

Considerable nos of conifers exist as a result of artificial introduction. The commonest is Deodar, then Kail. Some Chir is also found at the lower limits of the forests.

~~Summary of prescriptions.~~

Summary of Prescriptions.

Working circle	Heading	Prescriptions.
Fuel supply	Principle species	
	Bamj	
	Blocks & compartments.	all compartment are numbered series each block separately.
	Felling series	2 Felling series formed.
	choice of species	Bamj oak to be favoured.
	Silvi system	group selection
	Exploitable diam	16". For the duration of this W.P. a growing diam of 20"
	Rotation.	100 yrs assume to produce 16" diam
	Felling cycle	15 yrs.
	Calculation of the yield	By Mantal's formulae for the whole working stock down to 4" diameter in each series
	yield prescribed	prescribed by wt. Chakrata felling series 15600 mds. Kailana series 3260 (mds = 100 Lbs)
	method of executing the fellings.	Prescriptions objects of felling, broad principle governing marking as explained.
	thinnings.	need for thinnings emphasised
	sequence of felling	orders are just suggested.
	S. S. O.	To be done after the main felling usual operations indicated. Part not mention.
	artificial regeneration.	not necessary, none prescribed. replacement of casualties in existing plantations left to executive staff
	Coniferous plantations.	To be worked with Oak. No separate prescriptions necessary yet. No conifer over 16" in diameter to be felled except for urgent thinning. Cautions given against too heavy thinnings.
	miscellaneous regulations.	Whole W.C. to be strictly protected grazing & grass cutting & fire protected.

Headings	Prescriptions.
Blocks & compts.	The area of grassy slopes of the last plan divided into compartments
Method of treatment.	Usually no work prescribed except protection of tree growth. Dead trees to be felled. For areas with dense patches of tree growth, separate cultural prescriptions given.
Artificial regeneration.	Suggested for blanks in given areas
grazing.	whole W.C. to be open to grazing and grass cutting except a few comts. controll rest with the cantonment authorities but D.F.O. can intervain if in his opinion grazing becomes excessive.
Fire protection.	Whole W.C. to be fire protected.
Blocks & compts.	15 compts made.
method of treatment.	To be managed entirely to improve & maintain the asthetic amenities of the station. One compartment to be gone over every year beginning from 1. Marking rules indicated.

While proceading towards the "Lurli" bloc
we saw that the ridges of the cantonmen
area have been planted up with mainly co
ferous and also some broad leaf species, wh
chiefly are as follows

Conifers:- 1) Cidrus deodara
2) Abis pindrow
3) Cupressus torulosa
4) Cupressus kashmeriana
5) Cryptomeria species
6) Thuja species
7) Picla smigthiana
etc.

Broad leaf species
1) Aesculous indica.

These are managed under state ow
From here we saw a 50' wide fire lin
running along the contour and running
about half way from the top. It separ
the (major) protected forests above it fro
the private forests which are recently
being taken over by the govt.

The fire line is regularly cleane
controll-burnt in early February & May
to reduce the fire hazard.

Except the fire line there are no
protection measures against fire like fir
tower e.t.e. as the area is not very grea
everything is in visible range from the to
the ridges. The forest coups are also
subjected to controll burning during Feb

Next we reached the Lurli block, compartment 4 to study the fuel working circle

The main principle of this w.c. being to maximum volume production, it would be ideal to apply coppice a coppice with standard system to these forests (Banj oak) for best results. But due to the reasons as described below, it is not applied here.

1) Correct statics for Oak are not available and it has been found out that the M.A.I curve for Oak culminates at 60 yrs which produces a size of not more than 16" diameter. (Practically the diameter is below 10" always) It has also been found that for fuel above 4" diameter is good enough, but for charcoal manufacturing, which is the practice here, this diameter measurement is not economic enough. Fo this purpose 16" diameter is most suitable. This is why a 100 yrs rotation is prefered here to a smaller rotation like 60 yrs. The diameter corresponding to 90 yrs age is about 12·1".

2) Aesthetic reasons also prevent the applications of ~~large~~ scale coppice system, as this practice makes ~~the~~ places bare for some period which also goes against sight protections.

3) The table of the trees crop contains 50 yrs and over aged trees. Though part of the crop may be suitable for coppicing, but the part of the crop which lies in the future yr. coups may not be suitable for coppicing.

Same is ~~in~~ the case with mature stems scattered over the entire forest area and in order to get revenue from these stems, it imperative ~~to~~ that the entire area has go through rapidly before these trees dec

Considering all the above points gr selection system was adopted here whic has worked very well for the last 31 yea

The ide is to safeguard the yield of ction / size trees ~~by~~ to perpitualy by ~~remo~~ prescribing removal of the trees only to extent of the recruitment ~~from~~ the pre-sel to selection class. For this Smythe's s guarding formulae is applied.

$$x = \frac{f}{t}(1 - Z_2) \times 2,$$

where ~~x = total no of trees~~ trans ~~ition~~

x = total transition from pre sel class to the selection class in the felling cy

t = time of transition from pre sel to

f = felling cycle

Z = mortality factor (percentage in passage from 2 to 1.

~~Based~~ In case of Oak $t = 40$ yrs. f $Z = 40\%$, and hence $x = \frac{15}{40} \times \cdot 6 \times 2 =$

Based on this the annual yield % of selection size stems to be removed

$$y = \{x / I + x/2\} \times 100 \pm a = 50\% \text{ rough}$$

where a = forester's safety factors.

Hence $\frac{1}{2}$ the exploitable trees are removed (

M.F.P. NURSERY. (F.R.I.)

Chakrata

It was started in 1952, for providing seedlings ~~for~~ of medicinal plants for large scale production. But its has since been converted into a research station to carry out experiments on the germination of seeds, methods of transplantation etc. of native & exhotic species of medicinal plants. It is financed by the C.S.I.R. and is managed by F.R.I.

Altitude :- 7000' to about 7300'.

Aspect :- North-east aspect

Rainfall :- 66" is the annual rainfall.

The beds are along the contours on terraces In the drier months watering is done by tops.

Following are the plants which are being tried for germination & yield datas.

① Mentha piperiata.

This was procured from Kashmere, propogation is done by runners. Active principle is menthol which is about 55% of the pipperment oil. It is used as a ~~m~~ anticaptic and for confectionary. It should be free of weeds for good quality oil.

② a) Artemisia brevifolia

This was also collected from Kashmere

b) Artemisia meritima — from Pakistan

c) Artemisia cina — from Russia.

The plant flowers but does not seed. It grows well in higher altitude with low rainfall. Active principle is Santogen. It flowers in early November & gives fruit in December. Seeds very small (2000 seeds / gm) Spring sewing in percolation beds.

... as, broad-leaf species like Maple, Prunus

Chrysanthemum cinerariafolium

Active principle comes out of the flowers is pyrathenin. It's a contact as insecticide. Flowers are collected when the disc florates open from $\frac{1}{4}$ th to $\frac{3}{4}$ th. 2000 seeds per gms. Sowing is done in the Springs in percolation beds. Transplanted by split root stalk.

Atropha belladonna

Seeds from France

Atropha acuminata - from Indicus

The difference between the species lies between the flowers, the former purple and the latter being dirty yellow colour. Active principles are Hyoscianine & ap atropin, hyscine. They are extracted from the roots and leaves. Sowing is done in the Spring & harvesting is done in May when in flower. Sowing depends on period of transplantation. Harvested 6" above ground and as new shoots come out it is generally harvested again in the same season. Seeds are collected in August

Podophyllum hexandrum :-

Active principles are Podophyllotoxin, Picropodophyllin, Quercetin. Seeds do not germinate and hence cuttings are used. Fruits are edible. ~~The~~ used as purgative.

Chenopodium ambrosioides.

Seeds obtained from East Indies. ~~Ascar~~ Ascaridol is the active principle. Used for removing intestinal worms & in veterinary practice. Seeds are very minute takes

days to germinate. Oil obtained from unripe fruits. transplanting is done in July & August.

Aconitum heterophyllum (non poisonous)

Aticin is the active principle which in poisonous ones it is aconitine. ·4% comes out of the rhizome. used as a febrifuge. It is propogated by the rhizome.

Digitalis lanata
Digitalis purpuria.

Active principle is Digitalin. used in heart disorders. Biinial (biennial plant). Sowing is done in April & May in percolation beds. transplanting is done towards the end of monsoon.

Ephedra gerardiana Active principle is Ephedrine, used in Asthma. A xerophytic plant growing above 7000'. Ephidrine content is more in male plants than in female plants. Harvested before frost season sets in.

[illegible] species like Maple, Prunus

Chakrata to Mundali.

The trac from Chakrata to Mundali is hilly and presents all the aspects, though the main direction of the path runs North & North East. It not only presents the various aspects but also passes through a varying altitude between 7000' to 9500'

Aspect & altitude play an important part on the distribution & composition of vegitation. Soil factors, of course, are also important to some extent.

The southern aspects are generally barren because of being hotter (and subjected to insolation) & gradient being steep. Easterly & Westerly aspects, though receiving an equal amount of insolation differ in their temperature condition. In the East the ~~air temperature~~ angle of incidence is greatest in the morning, before there is ~~temperature~~ is fully warmed up & perhaps the dew is still on the vegitation a has only recently gone, & tissues frozen during the night may be rapidly thawed out with distructive effects. In the West the Sun shines the brightest after the air has already been heated up & all dew, dried off, and hence frost damage is minimum. South East & South west ~~as~~ aspects will fall between these extremes.

Northern aspects are cooler than the southern ones and there is about 1000' difference in altitudinal distribution of species. In the northern aspect the vegitation changes with altitude. Deodar mixed with Banj oak was seen near Chakrata. Spruce & Fir mixed with Mana Oak (Quercus dilatata) were seen on still higher altitude near Deoban peak.

In Deodar zones, in moist depressions & nullas, broad-leaf species like Maple, Prunus

Wall-nut etc was predominent. On dry & hotter aspects, kail was flourishing & still drier slopes had only shrubby growths.

4.6.'57

I. G's preservation plot.

Virgin deodar forest :—

This plot of mixed deodar & Spruce forest in which no felling have taken place is to be preserved permanently in accordance with the suggestions contained in paragraph 13 of the note on an inspection tour ~~by~~ of the Chakrata division of U.P. by the G. S. Hart (I.G, forest, Govt. of India) on 25.7.1913.

Previously it was a mixed forest of Spruce & deodar, but nowa, the overwood consists of deodar & fir chiefly and sometimes of spruce. Under this profuse fir regeneration is coming up. If left to itself, the plot will tend to be more ~~xero~~ mero-phytic

Species	4"-8'	8"-12"	12"-16"	16"-20"	20"-24"	24"-28" and over
Deodar	-	-	1	1	2	52
Spruce	-	-	-	-	-	
Fir	2	7	8	6	6	5

Morphology & Phenology.

1) Cedrus deodara :-

Seeds - about 250 per oz, with elongated wings (size of seed with wing 1" to 1½"). Dispersal is by wind, but because of its considerable wt it is limited to a distance of only 100' to 120' around the tree. Of course, this dimensions varies with the flow of wind considerably. Cones start opening up in Sept & Oct. Seeds, therefore, are to be collected by the end of October. Each cone will give about 40 to 50 seeds.

Bark. Greyish to reddish brown in colour with vertical and elongated fissures. It has a thinner bark than Kail.

Branches :- The branches & branchlets are horizontal or slightly dipping down, the tip being invariably dipping downwards. The branches are more or less whorled, but this feature is less marked in the case of Deodar than in the case of Kail.

Crown :- Immature deodar has a conical crown & the same is the case with a vigorously growing tree. But mature deodar has ~~flat topped~~ cylindrical flat topped crown.

Leaves. Short acicular glaucous & green, mostly in dense fascicles on tip of abbreviated branches.

Cone :- Male catkins are ovoid 1" or so in length, small pendulous & light yellow in colour. Female cones are erect, ovoid, 4" to 5" long in mature stages 3" to 4" at base. Scales are fan shaped & closely compacted. When the scales have fallen off a persistant central axis remains on the stem

Reproduction. —— Male catkins appear towards the tips of branches in the month of ~~AA~~ May to June and increase in size till Sept

when they ripen and after that there is
shading of pollen. Deodar is both monoecious as
as diocious. The diocious is the more common one
monoecious, the female cones are higher ones,
for cross pollination. The female cones also
grow towards the tips & glow July & Aug &
upto Sept, when it is 1½" or so & bluish green in
In Sept, Oct, cones open slightly and pollinati
takes place. Then the growth is arrested duri
winter months; it starts growing vigorously a
in March.

The female cone is ovoid is shape &
dually turns brown with drying up of the
scals & they open up by the end of Oct next
dispersal starts. Some of the lower ovaries
not get fertilised and remain attached. Abo
16 months elapse between appearance of the
and the dispersal of seed.

Regeneration. Seedlings start appearing af
the melting of snow & masses of them ar
destroyed due to draught. It can tolerat
shade in early stages & during middle age
becomes as a moderate light demander.

Reproduction & survival of seedlings a
not uniform & a good flush of seedling app
only once in a few years owing to,-

1) A good seed year occurs only once in 5 ye

2) An abundance of seelings will coincid
with years of heavy snowfall followed by a
good rain, so that moisture conditions are
for survival.

Generally deodar is worked in a rotati
of 150 to 160 years.

Picea smithiana (Spruce)

Seed:- Seed light & plentifull, (a typical characteristic of a pioneer sp) easy dispersal. About 1800 to 2000 seed to a cone.

Bark Light scaly bark, ash in colour. Main Branches are horizontal, pendulous & the branchlets are pendulous giving it a bottlebrush shape.

Crown Conical, tends to be broad based specially in open localities due to excessive branching

Leaves (needles) — 1" to 1½" long, quadrangular in section. Leaves may last 6 to 7 years & they start growing in Spring.

Cone :- Both ♀ & ♂ cones appear in March & April. The female cone is erect first but later hangs down. The male ~~catkin~~ pollen is shed in the 2nd month of May.

Reproduction. After pollination & fertilization the ♀ cone increases in size attaining a maximum size in July, and ripening at the end Oct. From 30 years ~~and~~ onwards of its age it produces viable seed and a bumper seed year is occurs every third year.

Regeneration. — A moderate light demander in the early stages only, but there after, it needs a lot of light. It is subjected to suppression by weeds and so controll grazing is definitely very beneficial. Lopping in middle to adult stages is injurious. It is also subjected insulator. The adult trees are susceptable to the attack Tramatis pini

Pinus roxburghii (Chir).

Seed. Seeds are long with membraneous wings, about 300 seeds per ounce, & each cone produ-

40 to 45 seeds. Femal cones open out in
a May for dispersal of seeds. The seeds
born on ~~seeds~~ scales with a marked ho

Bark. is dark grey in colour in y
and middle aged trees & exfoliates
vertical plates separated by deep ve
fissures. It is very thick specially
middle aged and old aged trees (
amongst the conifers). It is very
hardy. In the older trees, the fissu
becomes shallow and the entire bar
gradually smoothens out with a red
yellow colour.

The flakes are as long as 2
length & 4" in width.

Crown. - Candelabra shape & tap
needles are at the end of branches an
Branches & branchlets curves upwards
are rarely horizontal

Leaves. 3 per bundle, triangula
section. Old leaves are shed in May
and the new ones appear which ar
to yellowish green. Though the trees
evergreen & semievergreen at places,
may be deciduous as well. The le
may last for a year or two. These are
for packing fruits etc.

cies is monoecious, male
cones appearing on different branches of th
tree. ♂ flowers appear in January.
long & it ripens between February &

The period of ripening depends to some extent on the altitude, it appears. In general it ripens earlier in lower altitudes and later in higher. abt

Female cones appear in January. They may be solitary or in clusters of 2 or 3 4 at the apexes of the new shoots. It begins to grow & pollination takes ~~place~~ place in Feb. & April. After pollination it increases in size till Oct. & the colour changes from green to light brown. The growth remains dormant till next Jan. & depending on the altitude in February fresh growth starts. The cone attains full growth at about July. In the meanwhile in January another new cone will come up & by Oct next the older cone will become brown; the scales harden up and no further growth is indicated till next April. 24 months, therefore elapses between the appearance of the cone and shedding of seed Formerly seed was collected in Jan & February but it has been found that seeds collected in December are also as good.

Reproduction & regeneration. Lot of good seed is obtained every year & a bumber seed year occurs every 3rd a 4th year. Regeneration is not difficult if in early stages fire controll & ~~the~~ grazing controll can be effected and adaquate canopy manipulation can be carried out. As their seeds are audible, most of it is taken away by birds & man.

Coniferous.

amily :- Taxaceae

Taxus genera :- It has a characteristic distichous dark flat green leaves, Bark thin reddish brown. Its distribution is in the Himalayas, Khasia & Naga hills & Burma. Occurs above 6000', but in Chakrata it does so over 8000 ft as an associate of high level fir & Spruce forest. The wood is tough & elastic. Leaves have an alcoloid which is poisonous but the content varies from place to place and at some places it is heavily lopped for fodder.

Family :- Pinaceae

Abies spectabilis & densa :- Occurs in Western Himalayas at high altitudes. It is locally known as West Himalayan high level silver fir (11000' to 14000'). These trees are always stunted. They reaches very great heights & girths. Ht of 206' & girth of 26' are recorded. It is always found as an associate of Picia smithiana, but sometimes it also occurs in pure patches or mixed with species like Oak, Acer etc, Aesculus, Pinus etc. Altitudinal limits are 7000' to 11000'.

Abis pindrow :- The wood is soft and useful for matches & paper pulp. It is very easily attacked by a fungus called Tramatis pini. The disease manifests in the formation of brown wood as is in spruce. It has a narrow crown and consequently forms a dense crop indicating a nature of shade tolerance of the specie. The needles are lifted & with two silver lines. It does not occur generally East of Kumaon.

~~Family~~ Picea smithiana :-

A large evergreen tree the North & North-western Himalayas. Heights over 200' & girth over 19' are common. Its distribution is from 7000' to 11000' & it occurs from Afganistan to Kumaon. The needles are quadrangular in section. It is a pioneer species in high altitude forests (7000' to 11000'). The wood is suitable for matchs industry and in making paper pulp ~~industry~~. It is used for shingles, tea boxes & plankings. During war time a large quantity of this wood was used in aircraft manufacturing as a substitute for Sitka spruce. But the local species being ~~knoty~~ more knoughty is not used much presently.

Cedrus deodara

It occurs only in Western Himalayas commonly between 6000' & 8500'. Snow appears to an important factor in its distribution. It attains a large size (hit upto 240' & girth upto 36' are recorded. The trees belonging to the temple g are generally larger. It generally does not on the East of ~~Manali~~ Alaknanda. Its no associates are Picea smithiana & Pinus wallichiana. It is a very gregarious species other associates are Oaks, cherries, chestnuts maples and other broad leaf species of temp forests. Extraction is in the form of saw timber (sleepers), wood often burnt for insence and stumps are found alive long after

have been fitted. The destructive distillation gives tar oil, while steam distillation gives an essential ~~oil~~ oil. A very durable coniferous timber used in making beams, plankings doors etc.

Pinus (a) wallichiana - leaves in fascicles of 5 & less than 5.
(b) merkusii (Burma) 2
(c) gerardiana (i) . . . . . 3 stiff leaves
(ii) . . . . . 3 soft & longer.

Larix griffithiana - Found in 1 in each genera of India, whereas Larix europea & leptolepis are exotics. It closely resembles cedar in branch & leaf arrangement

In cedrus cones are evergreen & the cones break up on the branches. In Larix leaves are deciduous and cones hang on to the branches for a long time.

Distinction.

1) leaves evergreen :-

a) Cones may be pendulous woody & persistant

i) leaves are acicular & in bundles - Pinus

ii) leaves not acicular & not in bundles - Picea

2)

i) Cones erect.

breaking on the branches leaving a central axis

i) leaves distichous - Abies

ii) leaves in tufts on the tip of arrested branches - Deodar.

2) leaves - deciduous :-

Larix.

Family :- Taxodiaceae :-

Cryptomeria japanica

It is a good & strong wood in Ja
and was introduced in India in Darjeeling st
districts abundantly. But being a very fast
species in India its wood was found to be
no use except for a few purposes like bas
separator mechanical pulp and it is now
used as a substitute for Oregon pine in ship
ding industry.

Family :- Cupressus

Cupressus torulosa :- Cones deep & with woody
A large tree with bark splitting off in large sh
It can stand a large variation of climate. It
occ occurs from Chamba (H. P.) eight up to Nepa
(6000' to 9000'). It's very commonly found on li
ston rocks. The timber is excellent & durable, a
good pencil wood.

Fagales.

1) Betulaceae Betula { alnoides (lower altitude)
utilis (high altitude)

2) Fagaceae quercus { lucana
dilatata
semicarpifolia
castanopsis

3) Coilaceae Corilus corina.

Juglandales. Family – Juglandaceae

Juglance regia, used as to extract butter.

Acers Family Sapindaceae

Acer { oblongum
leasum (5 lobed leaf margin
Pictum (5 lobed leaf ...
acuminatum (5 lobed with acute

Details of Mr. Naquavi's working plan (53-67).

Deodar working circle:

Special object of management is to restock the severely burnt areas & complete regeneration in P.B, areas of the previous plan, artificially or naturally. For enumeration, 3 types of P.B, areas are known.

i) Finally felled area.
ii) Areas where seeding felling, takes place.
iii) Unworked areas.

In (1) & (2) areas total enumeration is carried out. In P.B. (unallotted) areas, 25% stratified random sampling is to be carried out.

Silvicultural system:- Irregular shelterwood group system.

Regeneration period:- 40 years.

Rotation age — 160 years.

Reduction factor

Quality	Deodar	Kail.
I	1·7	1·7
II	1·0	1·3
III	·5	1·0

General quality of deodar:- II
.. .. .. kail — III.

Exploitation period of P.B.:-

$$\frac{160 \times \text{Reduced area of P.B.}}{\text{Reduced area of W.C.}} = 45 \text{ years.}$$

Yield:- calculated from the formula

$y = \frac{V + i/2}{P}$, where y = yield of P.P.
V = volume of overwood
i = increment in period P.

$= 1\%$

Now V = 3683847 cft.

In 45 years increament, therefore, will be:

$$\frac{3683847 \times 100}{23}$$

∴ Total volume = V + 2

= 4531131 c.ft.

∴ Annual yield = $\frac{4531131}{45}$ c.ft.

= 100692 c.ft.

Special features of W.C.

An area of 256 acres are to be planted every year to remove the annual yield of these 256 acres, 156 acres in P.B, & the rest is in P.B. unalloted, concentrated on burnt patches.

In P.B, areas (i + ii), silviculturally available deodar (20" & over) & Kail (16" & over) can be felled to get the yield.

Method of marking.

1) First locate groups of regenerations & carry out seeding felling where ever need.

2) Remove the over-wood standing over groups of established regeneration.

3) To open up the patches, felling along the pr is to be carried out to a width of two o i.e., 100' in the case of deodar.

4) Successive secondary felling should be continued untill the patches coalesce to g & the whole area is gone over & the ve lating nature of the canopy is maintained.

5) In the advance growth carry out so tending operations.

Mehod of tending

i) No felling in (a) areas ~~and~~

ii) Only dead & dying trees are felled in (a) areas

iii) Advance growth of deodar & kail seedlings 1' & over to be retained as the part of the future crop. Vigorously growing deodar (4"-6" dbh) & kail upto 12" d.bh. should be retained to count towards.

If seeding felling & thinning do not meet the yield, only then 2 to 3* crown width gaps can be created by the removal of only mature stems to induce fresh regeneration.

Four inch maps are to be prepared to show the following:—

a) Gaps of unestablished advanced growth.
b) Artificial gaps to induce regeneration.
c) Natural gaps required to be regenerated.
d) Groups retained as future crop.

Subsidiary silvicultural operations. (S.S.O.)

a) Removal of marked but unfelled trees & other inferior species (mixture of broad leaf sps. to be favoured)

b) Slash removal to be effected by burning in heaves. This should follow main felling & should be definitely over by November.

c) Removal of thic humus layer. Slash burning should be followed by hoeing up of the humus layer, mixing it up with the burnt ash and the exposure of the mineral soil

d) Shrub cutting

Thinning in P.B. 1) Light crown:- It should be carried out in a belt of two crown width round the patches of advance growth & in the zone of advance growth itself. This will synchronise with the felling areas.

2) In shade demanding species there will be crown thinning & in light demanding species, there will be ordinary thinning

Forest Nursery, Mundali.

Nursery work is not done in India to the extent in most temperate countries, and only in a few localities, can the standard be said to be the high one.

Deodar is now being raised largely by artificial method in high altitudes (6000'-9000'). The following factors should be considered to establish a forest nursery:-

1) Site. The nursery should be situated as centrally for the area to be planted as is available. A fairly high well drained soil is desirable. In the hills a moderate slope should be selected to have a good drainage; a northerly aspect is always preferable in the W. Himalayas except at higher elevations. But in E. Himalays this exposure is too wet & cold above 4000' & so West or S.W. aspects are to be preferred. Newly cleared forest area is best suitable, no overhead shade being left except in some hot, dry localities where it is helpful; some degree of shade on the South is however usually advantageous. Nurseries should never be sited on natural blanks in the forest, which invariably have some something against them.

2) Layout of beds:-

In the hills the beds have to be laid out along the terraces, which must be wide enough to allow at least one full width bed & a path all around it ie., 10ft. The beds are best laid out with their lengths from E to W as this position is most convenient for shading young plants from frost & Sun.

The more common used width of a bed is 6' & the standard width of deodar bed is 3' only. The length of the bed varies from 6' to 40'

the former being the most suitable for deodar

Irrigation is done by water, distributed by from a reservoir by siphoning.

For deodar $1\frac{1}{2}$ year's old seedlings are u for transplanting. Seeds are sown in winter, o before snowfall. They remain covered with sno uptill Feb. March. In March snow melts & se germinate. Next year when they become $1\frac{1}{2}$ y old, the transplants are taken out & pl in forest sites in pits 18" deep having a s cing of 10'×10'.

In the case of Fir $3\frac{1}{2}$ year old seedl give best results, because the species is ve slow growing in the beginning. In case of Sp both transplanting & dibbling of seeds in the sery beds are done.

Plantation

Mundali block
comp. 8c & 7c.

area - 250 acres.
year - 1949-50.

Species tried:-

1) Maples 2) Willow 3) Bird cherry
4) Wall-nut. 5) Acer species

Spacing:- 6'×6' In pits 1'×1'×$1\frac{1}{2}$'.

Transplants.

Transplants were obtained from the fore (near the mother trees) every year, there is a of casualties (1000-2000). Hence replacement f failure is done every year.

Weedings:- Two weedins every year in p tation. Percentage of Acer is almost nill, th of Wall nut is 95% (average height $3\frac{1}{2}$', 1955).

Fencing. Four strand 2 ply 12 gauge wire-fencing is used. Posts are 10' apart. is about Rs 40/- per C.W.T.

Site preparation. Pits are $1\frac{1}{2}$'×1', spaced 10'×1 soil is worked in May weathered & then filled in early June. Cost pit production - (4)- per pit planting — /1/- for plant, tenc

to Riknar compartment no 13U.

Aspect :- South to South West.

area :- 193 acres, 189 deodar, 4 blank.

Soil. A good deep clayey loam but there are precipitations slopes where it is shallow.

Elevation - 7250' to 9135'

Gradient :- Very steep to precipitous, but but at the top when it is moderate

growing stock :- Deodar - Predominates throughout the area. In cooler aspects it is mixed with Spruce, Fir & Quercus dilatata. The overwood has been completely removed, practically no natural regeneration. Plantings & sowings done in 1942 to 44 have almost failed. Qua

Quality. Deodar - II density - 5

Past history. 1951 - Transplanting 700 deodar seedlings over 8 acres. Two weedings were done.

1952. Transplanting - 450 deodar seedlings over ½ acre. Weeding done in Aug, '52.

1953. Transplanting 500 deodar seedlings over ½ acres in July, weeding was done in Aug. '53

Riknar comp no 14.

According to Monroe's working plan 41-55

The area is under deodar working circle in P. B unallotted.

Altitude :- 9500' to 9800', area - 254 acres

87 acres - deodar & 167 Fir & Spruce.

Soil. A good deep loam & clayey.

Gradient :- Slop to precipitous

Aspect. North, North-East (Spruce & Fir) & South & S. East (deodar).

Deodar is irregular, age class - 30 - 60 yrs.

quality - II to I, at times - III (bulk II)

density - '7

Past history :- Worked very regularly under selec
system. In 1902, 1904, 630 trees were remo
under selection felling from comp 13, 14 & 15.
From 1917-18 to 1920-21, 220 diodar tr
were removed under selection fellings.
improvement fellings 126 diodar, 1 kail
106 Fir & 20 Spruce were felled, 189 Spr
& 174 Fir to promote diodar regenerati
Cultural operation.- These were carrie
in 1933. In 1928 it was closed to graz
opened again in 1933. Subsequently thi
was done.

Rikmar Compartment no 15.

Area - 308 acres. diodar - 251 acres, Bi
Spruce & Fir - 23 acres, Oak - 23 acres, Th
workable - 11 acres.

Soil. A good deep loam except on pre
pitous slopes of which there is a good de

Elevation. - 6150' to 9666'.

Gradient :- Step to precipitous

Aspect - North-East, East, South East
generally.

Growing stock :- To the top the wo
is a mixture of Fir, Spruce & Kharsu
Over the rest of the area, diodar is pr
minent mixed with Spruce. Kharsu co
in at the higher levels & Fir in cooler
places. The area is well stocked & the
is almost entirely in pole stage with
scattered diodar-over-wood composed of
mature & over mature trees. Age averag
30 to 60 years.

Quality - II, sometimes I & at the

III

Density — ·7.

Past history. From 1928, it has been allotted to P. Bu. From 1903 to 1921, selection felling was done. Thinning & cleaning were done over 251 acres, in 1941. Cultural operations were done over 240 acres. ~~In~~ 1921-'22 ~~& 70 acres~~.

Area closed to grazing in 1928 & opened 1933.

Riknar compartment 18

Area :- 279 acres, of which 217 deodar, 12 scattered deodar.

Soil. A good deep loam generally, but poor and shallow on spurs.

Elevation. 6263' — 9575'.

Gradient. — very steep to precipitous, very precipitous in upper parts.

Aspect. — West, South East, South, South west.

Growing stock. In the top above the path C. torulosa of poor quality usually predominates on precipitous ground. Elsewhere, deodar predominates, mixed with kail & Banj oak in lower regions. The area is well-stocked with deodar poles of 45 to 60 years age class, mostly with some in 60 to 90 years class.

Quality :- Deodar - II, but generally III of Spence.

Density. — ·7.

Past history :- Fellings from 1904 to 1906 deodar & C. torulosa — 406 were felled in comps. 18, 19 & 20, under unregulated fellings. In 1905-1906 to 1919-1921 — 460 deodars were removed, in selection fellings. Dead & dying deodars were felled in 1943.

Cultural operations done over the whole area in 1921-22. It was closed to grazing in 1928 & again opened in 1933. An accidental fire by lightening, burnt 7 acres on 12.4.44.

Increament boring.

.6.57.

Konain 10a (Howard's folly).

Deodar working circle.

Aspect - N, N.W, NE.

Altitude 5900' - 9300'

Originally a fir & Spruce forest. 80 acres have been clearfelled by Howard in 1918 - 1920 & planted up with Deodar. This succeeded in the lower reaches & in the higher altitude got replaced by broad leaf species, & few that could survive are stunted & unhealthy. Its known as Howard's folly even though this area supports quality I & quality II deodar at the lower reaches, but at the top they are dying. In the clearfelled areas first stage of succession is that of broad leaf species. Then fir succeeds & ultimately give rise to Fir & Spruce forests.

Deodar plantation,

Konian 6b.

This area was clear felled in 1925 except seed
mature trees which are retained due to irregular
of crop.

Deodar is raised in nursery by sowing seeds in beds 6
Choice of good seeds are taken from mature
trees. In each bed 4 chatak of seed is require
Sowing is done in the end of November. Seeds ger
minate by March & April. In June & July
rain starts transplanting & pricking in done (spac
3"×6") After one years from 1st July to 1st Augu
it is transplanted in forest sight in pits 2'×1'
spacing given = 10'×10' & made along contou

Cultural operations.

Weeding - 1st year - one weeding Oct
2nd year - 2 weeding - July-Aug &
september - october.

Cost :-

preparation of bed - 14/- per bed, when
area is large & when area in small it is
about 6/ to 8/-

Seed collection :- As 14/- to As 16/- per acre
pits - Rs 4/- to Rs 6/- per hundred pits
Rs 8/- in very hard ground.

survival % :- 50.

In 5 years the maximum growth is
3 to 3½'.

6.57. Konain 126.

Deodar working circle.

P.B unallotted or P.b last.

Plantation is done here only to fillup the patchy blanks here & there, although these areas are not normally worked.

Aspect – Normally West. (Hence kail is preferred).

Soil is worked in circular patterns – 9" hoed in patches 10' x 14', staggered.

Cost One anna per pit.

Seed ~~Rs~~ Rs 1/8/- per seer.

Beds 8 – 10 seeds are sown per bed. Seeds are very light, about 300 per ounce, sown in December. Germination takes place in March.

Weedings:–

1st weeding is done in June (rain).

2nd weeding is done in Spt. (winter)

Cost – 2/- first weeding

1/- 2nd ..

Success of germination of kail here was found out to be only about 7%, which, however, in some patches ranges upto 12%.

15. 6. '57

Compartment 4.

(Fir & Spruce overlapping W. C)

Nursery :- Total area — 100 acres
Planted — 25 acres.

Seed is brought from Nainital

Beds are raised type (6") 6'×4'.

1 chattak of seed is put per b

Seed sown in November, germin takes place in April. Next July pr is done at spacing 6"×3", 2nd pr is carried out (9"×6"). afterwards.

Transplanting is done at the 4 year in pits $1\frac{1}{2} \times 1\frac{1}{2}'$ at 20'×20' sp

Although plantation during th rains is surer, winter planting is recommended when there is no dir of soil moisture after the melting snow. Growing conditions will be favourable for longer periods.

Deodar plantation, Konain

Aspect.— W. cooler & is hence more su for deodar. Pits are 2'×2'×2' at a spacem of 10'×10'. Ball plants (4 yr. old) from nurs beds are used. In refractory areas as t larger transplants are preferable to su so that they may survive against drou

15.6.57.

Deoban compartment 7b.

Area - Spruce & Fir 31 acres.
Oak 73 "
Total 104 acres.

The area is under Chakrata fuel working circle.

Soil - A good deep clayey loam, often clayey, shallow in places.

Altitude :- 8540' - 9500'.

Aspect :- N.E, E, S.E.

Gradient :- moderate

Growing stock - mixed crop & $H C_3$ 8(a) 8(b).

/

Preservation plot no 23.

Elevation 9300'

Slope - 32°

Top heights :-

Fir 60' - 22" diameter
Spruce - 65' - 15·5" ...
Oak 57' - 15" ..

6.57.

Thinning.

A thinning is carried out in a crop to lessen the continued struggle for existance & betterment existed among the individuals of the community, which weakens not only those which gives way to the it but also those which comes out victorious. A forester, therefore, has to intervene in the process & by thinning a chance is given to the best trees which have got a better chance of survival & removing the dead & dying trees which in future are supposed to be defeated in lifes struggle.

Openions vary as to the effect of thinning on top height of a crop - but the general tendency now, is to attribute top height to the site quality, & diameter increament to thinning and other tending operations.

Recent informations on the subject as given by Baking who experimented with Teak in Indonesia is that thinning has got some influence on the top height of a crop. Anyway, the influence of thinning is the greatest on the lateral growth & less in the hight.

Points to be observed in thinning:-

a) Whether the crop is of light demanders or a shade bearing species.

c) Whether the crop is regular or irregular

Irregularity may due to (i) the admixture of different age groups or (ii) admixture of different species or a combination of both.

And for each of the above cases thinning is guided by different principles.

Case I Whether the species is a light demander a shade-bearer, on this depends the type thinning to be applied. There are two broad of thinning.—

a) Ordinary thinning:—

In this case we starting lifting the canopy ~~lifting~~ starting from the lower crown classes to the dominent ones. This type is generally applicable to the light demanding species which get sufficient light by the removal of the suppressed stems. Such species are teak in plains & Chir in the hills.

b) Crown thinning:—

Here lower crown classes & the moribund are not removed at first & removal starts from the top to the bottom of the crop. The retention of suppressed stems provides sufficient shade for regeneration & better development of the shade bearer & protect site factors. Sps suitable are deodar which is a shade bearer, more at the early stage. Fir & spruce are also both shade-bearers, fir being more so in this respect.

Whether the crop is regular or irregular.

When the crop is regular there are various methods on which the grade & intensity of the is prescribed:—

When a yield table is available prescription is given on the basis of—

a) Volume:— The volume of the crop after marking is calculated for the unmarked trees & compared with the volume given for the of crop in the yield table. If it is less, the no of trees to be removed is reduced. But is very cumbersome the calculate the volume of crop specially in a hilly country

c) Basal area. - Basal area of the crop after marking is calculated & compared with the yield table basal area. This is also very cumbersome & laborious.

c) Average diameter:- Present trend is to prescribe thinning on the nature of the N-D curve. No of stems is found out by the method of spacing. [In general we do calculate rectangular spacing, though the spacing in nature is triangular type. This is why a conversion factor is to be used. The c.f. for converting rectangular spacing into triangular spacing is Cos 30° which is equal to $2/\sqrt{3} = 1.2$.]

But since low quality specis take a longer time than the heigher quality ones to attain the same diameter, therefore N-D curve does not, strictly speaking, give any clear picture & therefore it is better to take N-A (no against Age), but in practice it is also difficult to know the actual age of the crop.

d) By comparing the density of the crop with the density for grades of thinning, generally given in yield tables or from multiple yield tables.

THUMB RULE

When there is no yield tables available, foresters are guided by some thumb rules in thinning for particular specis.

e.g. Sal – 1½ times diam. expressed in feet.

Deodar – a) Howard's - 12 times the diameter
b) Glover — 4 " " girth.
upto a height of 60'.

The spacement should be ½ of the total height & then it slowly falls to 2/5th of, crown width being all the time ½ the height of the tree.

For crown thinning, no hard & fast rule
All the yield table checks described above
applied to the ordinary thinning but
this can also be equally applied to
thinning, provided that the suppressed
are not taken into accounts, which
the no of stems. There are only 2 grades
crown thinning — light & heavy
done only by ocular estimation.

Other principles in thinning

i) Thin to the best stem — best stem
be for site quality shape of bole, economic
importance of the species & vigour of growth

ii) Thin lightly, frequently. It is better
thin lightly but frequently than to thin he

iii) In a forked stem of species like K
either remove both a certain both.

When the crop is very irregular, we
divide the plot into smaller units (dep
on the mixture of species or the age gradat
& prescriptions for 1 group should not
carried out into another which has not the
composition or the same age gradations

In a mixture the first thing to not
that which species is to be favoured (
by its economic importance). But when
are equally important, shade bearers
to be favoured. In case of a mixture
Deodar & Kail as is in Kanasar 6, Deo
is to be favoured as it is a shade
as well as a more economically important

than Kail. But there may be exceptions for the dead & dying trees. Top broken deodar can easily be retained, but a top broken can in no case be retained as it is attached by tematos fibril.

Age of commencement of thinning:-

Below pole stage the long tending operation is to be carried out which may be named as mechanical thinning but strictly speaking it is not a thinning at all & only a spacing out measure.

Thinning starts only with the attainment of the pole stage when the trees begin to express its dominance.

Spacement of Deodar.

1) 4' high deodars spaced to 6'
2) 8" diam. ... ... 8'

Thinning cycle - 5-10 yrs. If a crop is not thinned for 2 or 3 cycles, it should not be thinned to the same degree at a time but the degree should be attained gradually.

6.57. Ecological types of Deodar.

In an undisturbed forest (in its primary stage of succession) the entire reflex of habitat factors can be expressed in terms of the ground flora & more so when the forest has reached its climatic climax.

Based on Mohans types (1939)

1) Unstable deodar :- Found below the belt of deodar. The quality is poor and the tendency is to form compact group scattered from one another. Occupies an ecotone between Deodar & lower level subtropical conifer. Regeneration is generally inadequate by & difficult to obtain. It is characterised by ground flora found in the lower deodar zone & upper chir zone. (e.g Berberis, myrcine, cotoneaster etc).

2) Pure deodar. Stable climax type, characterised by little weed growth (Viola, Ainslia, Valleriana, fragaria, indigofera, desmodium etc). Weed growth generally low, humous thin, this is the principle belt of deodar and the crop responds ideally to shelterwood system. Regeneration is not a problem here (eg. Bihals of Kulu)

3) Cedrus - Blue pine type :-

Occupies warmer aspects & sites where original deodar forest has been subjected to heavy fellings. The tendency in this type is for kail to colonise the blanks rather than deodar. But under adequate shade provided through an irregular canopy or through any of the shelterwood system, natural regeneration may be obtained.

4) Cedrus – hardwood type:–

Mixture of broadleafed species wi
deodar tends to sweeten the humous co
ting conditions suitable for natural
regeneration. Wherever there are vaca
in the Oak forest, deodar invades such
specially in the moister localities. This
one of the reasons which led to the
practice to encourage deodar in Oak
est by girdling Oak & supplimented
plantations.

5) Cedrus – Picea, Abis type:–
(High level deodar type)

It is the tension belt of or the ec
between high level conifer forest & t
true deodar belt. Conditions are norm
too moist for deodar regeneration. Hum
is thick. Usual weeds are :–

Strobilanthes, Impaticns, Iris
Dipsicus etc. Regneration conditions a
difficult & favourable conditions are
be created by –

1) Closure to grazing
2) Burning
3) Exposure of mineral soil
4) Drastic canopy manipulation.

CHIR (Pinus roxburghii).

P B, working.

Conversion to quasi-uniformity of irregular crop resulted due to past unregulated fellings and selection fellings. Since chir responds well to uniform system, attempt has been made to convert the crop ~~ultimately~~ to uniform quasiformity to convert the crop ultimately to uniform system. At the beginning, the conversion area was almost $\frac{1}{4}$th of the total area & growth statics indicated that for ~~the~~ area & growth statics indicated that for chir would have attained the size of 120 years, chir would have attained the size of 26" diameter (quality I) & 20" (for quality III), i.e., suitable for rotation. Hence 40 years, are then required to convert the balance 3/4th of the forest.

Regeneration on converted coupe would normally have average 15 years, but here the period is 30-40 years. Besides there, there are areas with several patchy regeneration over which overwood still stands if the conversion is to be retained to 90 years, there areas which came over to felling especially towards the end of the conversion period, would have been lost because of the suppressed regeneration and some of the matured stems might have deteriorated. In case we hasten the conversion period up, the regeneration coupe at the end of this abrupt conversion period might be still immature to yield revenue & not fit for felling. Therefore optimum period is adopted for conversion to synchronise with the age of the P. B last to make it

suitable for final felling. Taking all t
into account, 80 years were fixed for c
sion period. When current working pl
came into being, if there were only
years left. But due to unent during
plantation period, a considerable portion
of converted area has been destroyed
Necessitating a slowing down the progre
of conversion, the conversion period w
extended from 80 to 100 years, which
means from the start of the working pl
A period of 48 years is required to
cover the unconverted coupe.

Method of conversion working.

It semulates uniform system in chir t
begin with cognisance is taken of 2 fa

1) chir is a pronounced light demand

2) With adequate attention, regenerati
is fairly easy to establish, generally
entirely by natural means or sometimes
aided by dibbling.

Sequence of Operations.

The more shade bearing a species is, th
more staggered should be in time the
regeneration felling, to keep pace with
the progress of regeneration. But in th
case of a light demander, regeneration
felling opens up the canopy drastically

Seeding felling.

6 to 10 trees are to be retained per acre (10 on hotter aspects & 6 ~~or~~ or fewer on cooler aspects).

Retention of mother trees:-

The mother trees retained should be free from twist as far as possible, as it is a hereditary character. The crown should be spheroidal.

After having done the seeding felling, one has to create conditions congenial for establishment of regeneration. It occurs in zones rather close to habitation (low altitude), and therefore it will be obviously influenced by biotic factors like fire, grazing etc. In the seeding stage, both are injurious for regeneration & retards the establishment

Method of Establishment:-

a) Pre-seedling stage:- In this stage grazing should be permitted and shrub cutting should be done under controlled conditions, so that weed growth is kept low, and also to expose the ~~su~~ mineral soil to act as a good seed bed. Prior to a good seed year a light controll burning should be ~~done~~ carried out.

Just after the seeds are fallen,

a) controll burning should be stopped

b) Grazing is also to be stopped till the recruitment comes in.

b) Recruitment stage.

Controlled shrub-cutting only is
be introduced, but no grazing shoul
be permitted till the seedlings are ab
3' in height. If the regeneration
dense, certain amount of mechanica
thinning is indicated & when the se
lings are 4' hight they should be
out - 6'. [1½ times the height in early sta

When the seedlings are 2'-3' high
simultaneously controll burning shoul
be started (managed from the up hill sid
so that the burning is always under cont
For this first of all, fire tracers are
be cleared & the entire compartment
vided into some sections. Also all th
debries are to be cleared along wi
dry needles and cones. Controll burn
is generally carried out just after
fall & before the sprout of new leav
i.e., ~~at the latest~~ last week of Februa
at the latest. Precautions are to b
taken against the rolling cones, from
rolling into other sections.

This type of controll burning redu
fire hazard & at the same time ma
the seedlings more & more fire har
it also activates the cambial growth

UTILISATION

7.

Wire skidding.

On our way to Kharamba peak, we witnessed a gravity wire skidding operation, by the help of which converted logs & slupers were being sent down from a hill top to the valley below.

This method was first devised by Mr. Alexander Coroleff of Canada. The operation chiefly consists of sending down loads fixed to a load carrier which skidds down along a stretched steel wire between a higher & a lower station. The main parts are as follows.

1) Track wire A wire of high tensile strength (S.W.G. 628, diameter - 0.15 & breaking strength - over 2 tons)

2) Tightining arrangement :- The rope is lightened by winch which can be easily ~~handled~~ operated by hand.

3) Load carrier. It is usually a wooden block with a whole & a slot on the side.

4) The rope has an old motor tyre tied to it near the lower station which takes the impact on it and relieves the load off the wire.

The span of such wire skidding should not exceed 1500' & the angle of slope should not be more than 35°.

Deodar felling in P.B. area.

Riknar compartment 18.

Deodar & other trees of exploitable size are felled here mannually by using axe only. Some trees are first lopped before felling & such trees are marked (L) ~~and tied with a rope for~~ Some trees are tied with rope to direct the fall.

Rates of felling & conversion are given below as

1) Felling.

Diameter class	Rate.
8"-12"	Rs 3/- per tree
12"-16"	Rs 8/- . . .
16"-20"	Rs 12/- . . .
20"-24"	Rs 1/8/- . . .
24"-28"	Rs 2/4/- . . .
28" & above	Rs 3/8/- . . .

Average earning of a man from felling Rs 3/- per day. For trees above 16" diameter a team of 2 persons work per tree, otherwise i.e., below 16" diameter 1 man is sufficient.

2) Lopping — Rs 1/- per tree irrespective of size.

3) Sawing — Logs are made by saws of various sizes. 10' long size logs are made from deodar stem & 12' long logs from Spruce & Kail generally. Size, of course, varies with special demand.

Rations are supplied at a standard rate to the labourers, which amounts to an extra cost of Rs 15/- per slupee. (The labourers include all working for felling, conversion & extraction upto floating station.

Size of extraction.

Deodar — 10'x10"x5'

Spruce, Kail & Fir — 12'x10"x5"

miscellaneous size sections.

10'x5", 8"x5", 7"x5", 5'x5"
6"x4", 10"x3", 8"x3", 4'x4".

Outturn per tree class (sawn timber):-

	No.	Size.	
1) 8"–12" class.	1	10′ × 7" × 5"	
	2	10′ × 5" × 5"	
	Round bullies etc.		
	Total – 7 c.ft. (approx		
2) 12"–16" class	2	10′ × 8" × 5" – 1st la	
	1	10′ × 10" × 5" –	2nd l
	1	10′ × 7" × 5" –	
	1	10′ × 5" × 5" –	3rd la
	1 – Scantlin		
	Total – 13 to 14 c.ft (a		
3) 16′–20′ class	2	10′ × 10" × 5" – 1st la (even 12′ can be available	
	2	10′ × 8" × 5" – 2nd la	
	etc.		
	Total – 24 c.ft. (approx)		
4) 20"–24" class	4	10′ × 10" × 5" – 1st la	
	3	10′ × 10" × 5" – 2nd la	
	etc.		
	Total – 40 to 45 c.ft. (appr		
5) 24"–28" class	6	10′ × 10" × 5" – 1st la	
	4	10′ × 10" × 5" – 2nd.	
	etc.		
	Total 70 c.ft.		

6) 28" & over class. — total 100 c.ft. & over.

Transport is done manually from the felling site to the intermediate depot, situated 2 furlongs apart. Rate of transportation of 1 c.ft. is Rs/4/-.

Cost. –

1) Transportation cost upto rope way – Rs 1/4/- per sleeper.

2) From rope way to wet slide – Rs 1/2/- per sleeper

3) Cost of transportation by wet slid – Rs 1/4/-

4) Upto launcing depo the cost of transport is about Rs 1/2/- per sleeper.

Over & above this about Rs 1/8/- per sleeper is spent to transport the timber to Dak-pathar boom. Cost of rafting there is Rs 1/- per sleeper.

Approximately the cost of transport of a sleeper from felling sight to the boom sight is about Rs 7/6/- without the charge of royalty. Market price for 1 c.ft. of diodar is Rs 6/- to Rs 6/8/-

Out turn of the compartment = 28000 sleepers per year. – 100000 c.ft. approximately.

SOIL-SCIENCE.

6.57
&
6.57.

Soil

Soil is refered to that portion of the Earths chrust which changes & disintigrated owing to various natural phenomena. It is generally has some characteristics of parent rocks from which it had been weathered. Soil is enriched by the decaying of organic matters, also it contains many micro-organisms.

It is a very complex substance in which are poised various minerals, plant & animal elements. It's best to look upon the soil complex as a living entity, in which minerals, plants, & micro-organisms are held in a dilicate balance. These constituents together with climatic factors act and intract such that, the resultant effect is manifested in the form of soil fertility. If any of these factors changes, than the soil fertility will, in its turn, also change. No doubt, the parent rock has a very great bearing on the type of soil produced, but the soil forming processes are also equally important if not more. It's possible for the same type of rock under extreme conditions to produce different types of soil, under different soil forming processes.

Weathering of rocks - This takes place in 2 ways

1) Physical method
2) Chemical method

a) Hydration, b) Hydrolysis c) Oxidation, d) Action of H_2CO_3
e) Release of acid from humus

As a result of these above reactions different types of soils are formed.

<u>Soil profile</u> - A vertical section of soil layers showing different colours owing to difference in their compositions. The section thus exhibited from top to the bottom right upto parent rocks is called a soil profile.

A soil profile may be said to consists of horizons or layers

1) Top most layer (undecomposed organic matter) A_{00}

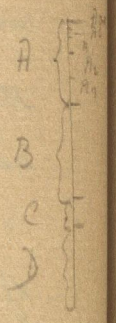
2) A_0 + (decomposed organic matter a humus)

3) Layers from which materials are leached which is known also a eluvial layer. (A_1, A_2)

4) ~~Sub~~ Layers where minerals are deposited the layers above, also known as illuvial layer

5) Sub soil layer (or ~~parent material~~ partly weathered parent material)

6) Parent rock.



Climatic

i) Cool moist climate (temperate)

ii) Moist tropical climate.

iii) Arid climate.

iv) Semi-arid climate.

13.6.57.

In each of the above climatic zones, different types of soil are found, which are as follows

a) Temperate climate – podsols:-

A temperate climate is characterised by a low temperature and a low rainfall. Decomposition of plants is very slow & A-horizon becomes acidic. acids are mostly organic which forms some co also. These acids & salts combine with sesqui in a ~~p~~ manner which is not yet ~~p~~ fu understood. The bases are thus leached dow B-horizon where they get deposited, thus in the surface layer, the ~~sur~~ percentage of SiO_2 increa & it gives the A_2 layer an ash-grey colour.

which in Russian is called a podzol. This whole process is known as Podsolisation. A lesser degree of podsolisation forms a brown forest soil.

Tropical climate. - Laterisation.

Due to heavy rainfall, water moves downwards, since temperature is also very high, the leaves & twigs etc. are quickly decomposed & they release, on decomposition, bases which react alkaline to litmus. The rate of liberation of R_2O_3 & SiO_2 is very rapid, but SiO_2 is leached down to B-horizon & R_2O_3 accumulates in A-horizon, giving it a deep brown colour, which under acute laterisation forms nodules. whereas in B-horizon a greater percentage of SiO_2 is observed. This whole process is known as laterisation; & the reddish brown upper soil layer (hardens when exposed to air) is called laterite.

Arid - 1) saline soil (due to excessive evaporation NaCl at the top)
2) Alkaline soil.

Semi arid - 1) Black cotton soil
2) Alluvial soil. It is an immature soil formed by transportation.

6.57. A pit was dug (6'×4'×6') to study the soil profile. and to study the nature & property of the different soil layers (thickness, Texture, colour, pH consistency &c), A monolith of podsolic formation was also taken, for detailed experiment.

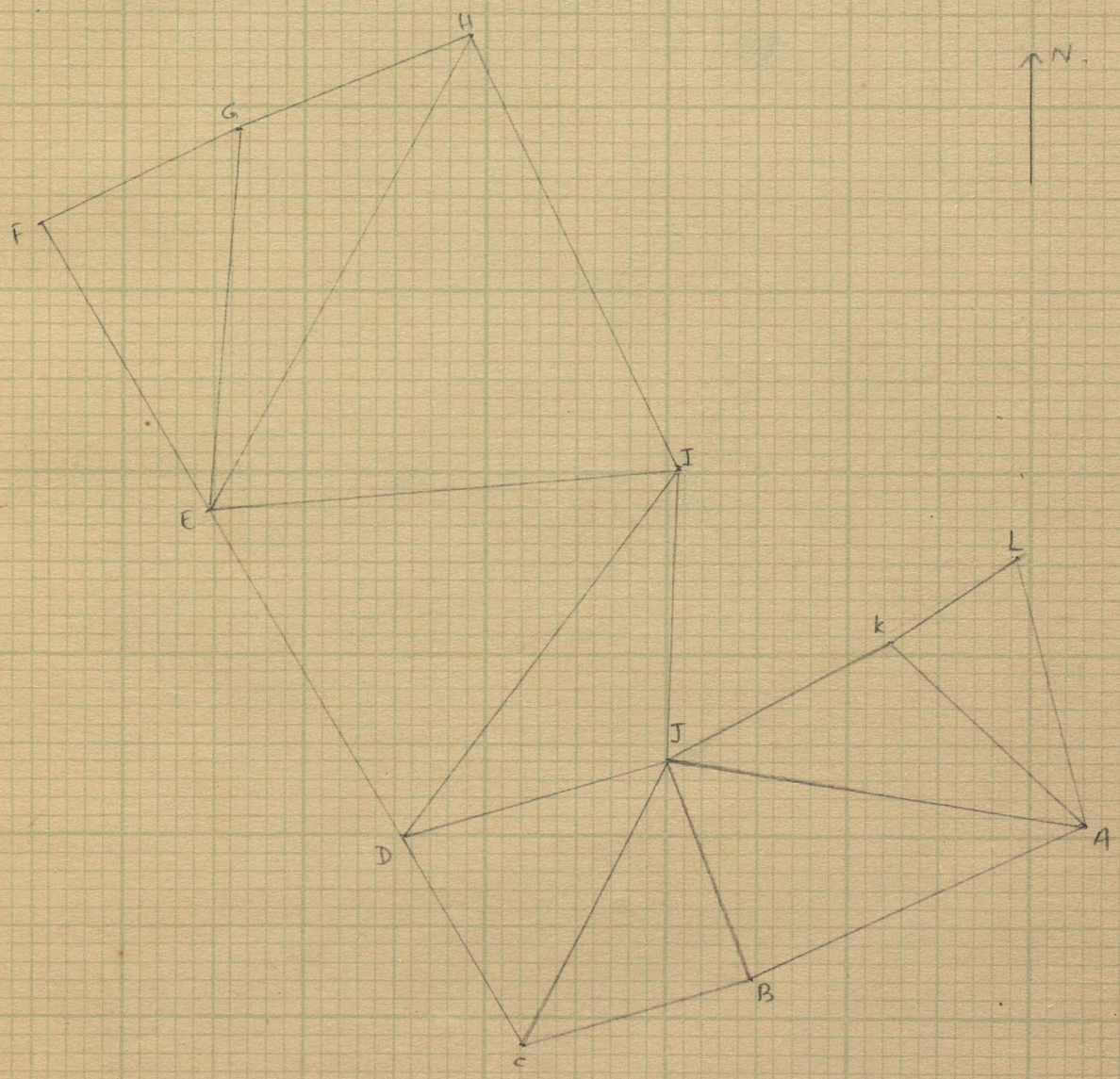
SURVEY &

MATH x

Roy.

'57.

Alignment Of Mule Path.



Total Area = :79 acres.

Deb Roy.

= 88 97.

ALIGNMENT OF MULE PATH.

'57.



Total area 1·3 acres.

Deb Roy

= 85 47'.

'57.

ALIGNMENT OF MULE PATH.

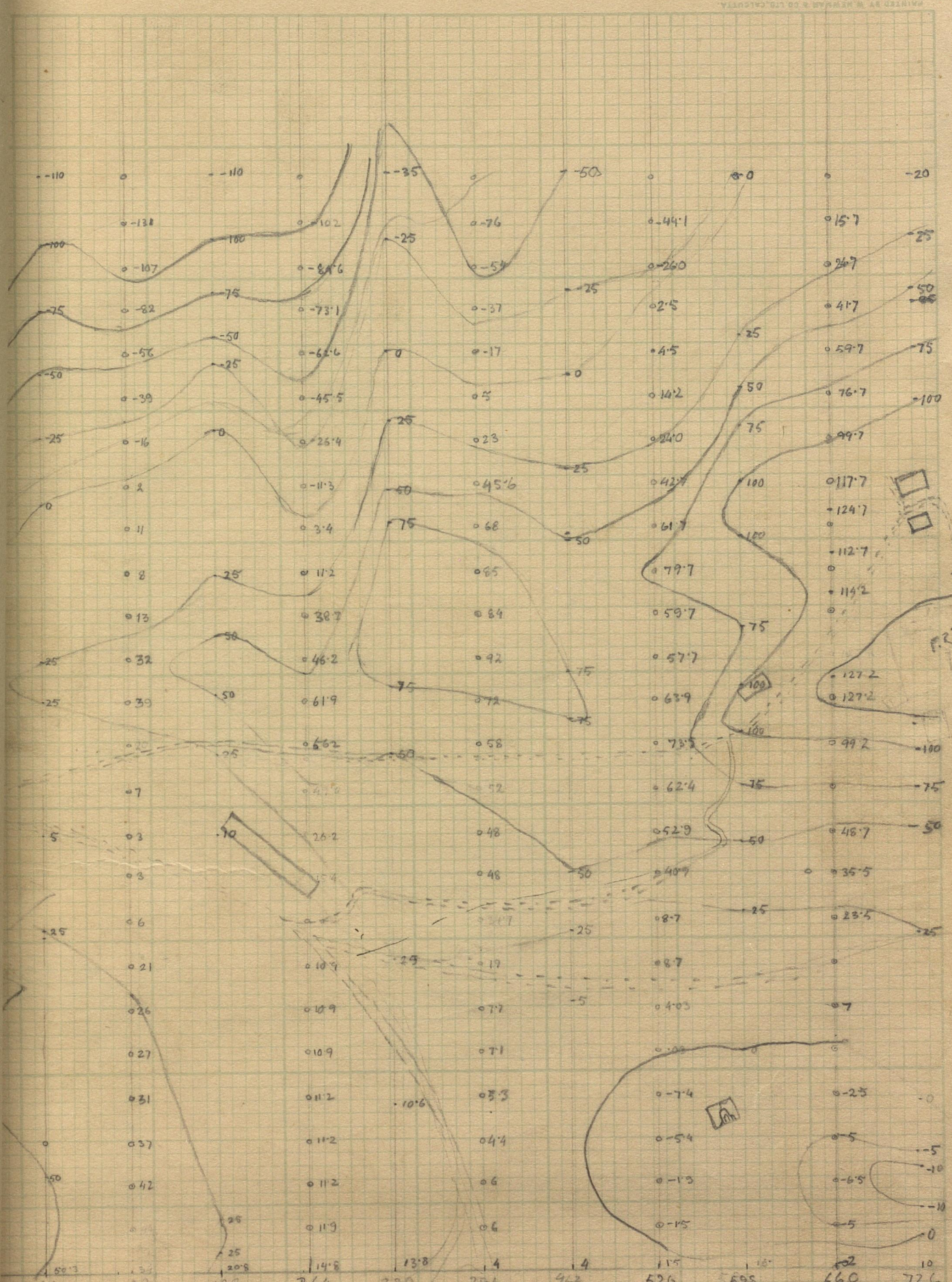
erical no.	sloping distance in ft.	F. B.	B. B.	Gradient	Angle of Elevation	Angle of depression	Horizontal distance	Rise	Fall.
1.	110′	143°30′	323°30′	1 in 70	—	0-50′	110′		1·5994
2.	81′6″	136°30′	316°30′	1 in 15	—	3°40′	81°32′		2·5562.
3.	103′6″	220°	40°	1 in 15	—	3°50′	102′6″		5·0328
4.	210′	176°	356°	1 in 16	3°30′		209·4′	12·0205	
5.	133′	141°	321°	1 in 8	7°10′		132′	16·9317	
6.	51′	37°	217°	1 in 6	9°		50·37′	8·9779	
7.	81′	127°15′	307°15′	1 in 10	6°		80·56′	8·4669	
8.	47′	197°	17°	1 in 5	12°45′		45·81′	10·3729	
9.	48′6″	56°	236°	1 in 4	13°45′		47·06′	11·6404	
10.	74′	44°30′	224°30′	1 in 6	9°25′		72·11′	12·1041	
11.	57′	138°15′	318°15′	1 in 4	13°40′		56·31′	13·4674	
12.	54′	52°	232°	1 in 5	12°36′		52·89	11·8877	
13.	44′8	112°30′	292°30′	1 in 5	11°20′		43·2′	8·7457.	
14.	57′	114°30′	294°30′	1 in 10	—	6°	56·69′		5·8582
15.	70′6′	103°30′	283°30′	level	0-15′		70	·3073	
16.	65′	82	262°	1 in 10	6°		64·65′	6·7944	
17.	76′	100°30′	280°30′	1 in 7	8°		75·25′	10·5769	
18.	35′8″	108°30′	288°30′	1 in 8	7°25′		35′	4·5823	
19.	41′3″	105°	285°	1 in 18	3°10′		41·01′	2·4352	
20.	64′	116°30′	296°30′	level	0-30′		64′	·5587	
21.	123′8″	136°30′	316°30′	1 in 4	6°15′		123′	13·4635	
22.	79′	119°	299°	level	—	0-10′	79′	·2299	
						Total	154′	15·24.	

Total height = 154 - 15·24 ft
= 139′.

∴ height of the crossing = (8408 + 139) ft
= 8547′.



Scale - 16" = 1 Mile.


66
132
198
264
330
396
462
526
598
660
726



MENSURATION

Sample Plot Form No. 8.

RECORD OF DIAMETER MEASUREMENTS.

Sample Plot No. 61 CHAKRATA Division. U. P.

Species.	Height at which measurement is taken.	Diameters at right angles in inches and decimals, and condition recorded in the year [D1=Predominant, D2=Codominant, d=dominated, s=suppressed]. 19 .	19 . Average	19 . Tree no	Diam	19 . Average & crown class	19 . Tree No	Diam	19 . Average & crown class	Trees removed and their condition. Year.	Diameters at right angles.
Deodar	4'-6"	12·7" / 13·0	12·85"	16	9·8" / 10·7"	10·25" D1	193	14·7 / 15·6	15·2		
"	"	11·8" / 11·7"	11·2"	17	15·6" / 16·5"	16·05" D1	194	11·2 / 11·8	11·5		
"	"	16·4" / 15·7"	16·1"	18	10·7" / 11"	10·85" D1	199	14·4 / 14·7	14·55		
"	"	11·0" / 11·9"	11·4"	21	12·1" / 12·5"	12·3" D1	200	14·4 / 15·8	15·1		
"	"	9·7" / 10·0"	9·85"	23	17·3" / 17"	17·15" D1	208	13·7 / 14·6	14·2		
"	"	12·3" / 12·1"	12·2"	26	12·7" / 11·4"	12·05" D1	216	14·6 / 16·2	15·4 D1		
"	"	10·1" / 9·9"	10·0"	27	13·6" / 14"	13·8" D1	220	12·6 / 13·4	13·0 D2		
"	"	12·8" / 12·4"	12·6"	29	10" / 10·5"	10·25" D1	221	11·2 / 10·8	11·0 d		
"	"	12·4 / 13·0"	12·7"	136	11·1" / 11·1"	11·1"	223	9·8 / 9·9	9·8 d		
"	"	12·8" / 15·9"	14·3"	139	12·0" / 13·4"	13·1"	227	20·1 / 20·5	20·3 D1		
"	"	15·1 / 15·3	15·2"	144	8·6" / 9·1"	8·8"	230	14·8 / 14·5	14·6 D1		
"	"	10·6 / 11·2	19·9	145	12·0 / 13·9	13·3	234	11·2 / 12	11·6 D1		
"	"	17·4 / 16·8	17·1"	149	9·2 / 11·3	10·2	236	14·1 / 14·9	14·5 D1		
		17 / 17·9	17·45"	151	11·9 / 12·3	12·1	243	12·9 / 13·4	13·2		
		12·2 / 12·8"	12·5"	155	17·2 / 19·2	18·1	247	10·4 / 11·1	10·8		
		13·9 / 15·1"	14·5"	160	16·5 / 16·7	16·6	248	16·1 / 17·0	16·8		
		12" / 12·8"	12·4"	165	13·0 / 19·5	13·8	252	12·4 / 13·7	13·1		
		14·6" / 15"	14·8"	166	14·7 / 15·0	14·8	253	11·0 / 11·4	11·2		
		11·9 / 11·9	11·9	168	11·9 / 11·9	11·9	257	10·5 / 10·	10·2 d		
		9·0 / 8·9	8·95"	171	11·4 / 12·7	14·6	258	12·1 / 14	13·0 D2		
		13·3" / 13·5"	13·4	173	14·4 / 14·9	14·6	260	8·1 / 9·	8·6		
		10·3 / 10·6	10·45"	174	12·2 / 12·3	12·2	268	12·6 / 14	13·3 D2		
"	"	11·6" / 12"	11·8" D1	175	13·0 / 13·5	13·25	264	18·0 / 20·4	19·2 D1		
"	"	11·4" / 11·6"	11·5" D2	177	15·9 / 15·3	14·6	266	13·1 / 12·9	13·0 D2		
"	"	16·4" / 16·4"	16·4" D1	183	8·7 / 9·1	8·8	271	11·1 / 11·8	11·4 D1		
"	"	15·2" / 16·2"	15·1" D1	185	9·9 / 10·4	10·2	273	15·3 / 15·5	15·4		
"	"	14·6" / 15·5"	15·05" D1	196	13·5 / 14·2	13·8	281	12·6 / 13·1	12·8		
		15·4" / 15·7"	15·6" D1	197	11·1 / 11·5	11·3	283	12·7 / 13·6	13·1		
"	"	16·3 / 17·3	16·8 D1	190	9·3 / 10·0	9·6	284	15·2 / 16·4	15·8		
"	"	13·5 / 14	13·75 D1	192	12·1 / 12·5	12·3	288	15·9 / 17·2	16·5		

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Indent No. Dis/53—M/11-39- 8-4-53.

F. R. I. 24.

RECORD OF DIAMETER MEASUREMENTS.

Sample Plot No. Division.

Tree No.	Species.	Height at which measurement is taken.	Diameters at right angles in inches and decimals, and condition recorded in the year [D1=Predominant, D2=Codominant, d=dominated, s=suppressed]. Diams at ⊥ 19 s.	Average dm. & Crown class. 19	Tree no. 19	Diams at ⊥ 19	average dm. & Crown class 19	Tree nos. 19	diams at ⊥ 19	average dm. & Crown class 19	Trees remove their condi Year.
292	cedrus deodara	4'-6"	19·2 / 19·5	19·3 D1	401	11·8 / 12·6	12·2	485	12·6 / 13·8	13·2	
297			14·7 / 15	14·8 D2	402	16·7 / 15·4	16·0	488	16·0 / 18·2	17·1	
306			13·6 / 14·5	14·1 d	404	17·2 / 16·7	16·9	492	14·8 / 15·2	15·0	
310			12·1 / 12·5	12·3	410	10·6 / 11	10·8 d	493	7·2 / 7·2	7·2 s	
316			14·1 / 14·7	14·4	412	15 / 16·1	15·5	496	11·7 / 11·8	11·7	
317			11·0 / 11·5	11·2	415	12·2 / 12·3	12·25	501	14·1 / 13·5	13·8 D2	
321			17·3 / 19·4	18·3	416	14·5 / 14·3	14·4	502	12·7 / 12·2	12·45 D2	
304			9·1 / 9	9·0 d	420	13·0 / 13·1	13·05	503	12·2 / 12·4	12·3	
336			11·3 / 11·1	11·2	427	13·2 / 14	13·6	509	14·3 / 14·9	14·6	
337			9·6 / 9·8	9·7	425	8·0 / 8·6	8·3	521	16·9 / 16·5	16·7	
341			15·3 / 16·3	15·8	426	13·6 / 13·5	13·55	524	13·6 / 13·3	13·45	
342			10·3 / 11·2	10·7	427	7·2 / 7·8	7·5 s	525	13·1 / 14·2	13·6	
343			10·6 / 11·0	10·8	429	10·0 / 11·1	10·5	35	15·5 / 15·6	15·55 D1	
347			12·9 / 12·9	12·9	43[illegible]	15·3 / 15·2	15·25				
350			11·5 / 11·8	11·6	433	11·2 / 11·1	11·15				
353			10·5 / 10·5	10·5	434	11·9 / 12·0	11·9				
357			11·5 / 11·9	11·7	438	14·6 / 14·9	14·4				
364			17 / 17·2	17·15	440	17·3 / 18·9	18·1				
365			16·3 / 15·8	16·05	441	9·9 / 10·4	10·1				
369			7·0 / 7·4	7·2 s	447	16·5 / 18·7	17·6				
371			12·3 / 12·1	12·2	448	14·3 / 14·2	14·2				
377			15·4 / 16·2	15·8	454	9·3 / 9·4	9·3				
379			18·5 / 18·7	18·6	455	11·9 / 11	11·4				
381			11·8 / 13·1	12·4	456	14·4 / 13·9	14·2				
385			7 / 7·8	7·4 s	463	16 / 15·6	15·8				
388			11·8 / 11·1	11·4	469	16·5 / 16·9	16·7				
391			17·9 / 18·3	18·1	471	19·6 / 20·3	19·9				
393			11·5 / 11·7	11·65	476	10·6 / 11·4	11·0				
397			9·9 / 11·3	10·6	482	14·4 / 14·0	14·2				
398			12·3 / 12·5	14·45	483	12·2 / 12·4	12·3				

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F. R. I. 22.

~~Exptl.~~/Sample Plot form 2.

Description of Exptl./Sample Plot No. 61 CHAKRATA **Division.** W. P

Species. Cedrus deodara

Object of experiment. To find the growth statics, corresponding to various grades of thinnings

Area in acres. ×0·79 acres.

Situation. In Mundali block compartment 8 B, at a distance of about ½ mile from F.R.H, Mundali on Mundali - Kathian road.

Height above mean sea level.

Climate—

a. Mean annual rainfall. 60" – 70"

b. General. Heavy snowfall in winter, Summer is also quite cool.

Rock, soil and humus. Slates, shales & phyllite found in abundant, a thick layer of undecomposed humous is found on the upper surface of the clay loam soil

Aspect and slope. North west. slopes – Moderate to very steep.

Type of forest. Pure Deodar forest, champion's group II C(b).

Age of crop at first measurement. Not known.

Date of formation. " "

Interval of measurement. 5 years.

Interval of thinnings. 5 years.

Method of demarcation. A cut branch 1'×1' is dug all along the periferri of the Sample plot & some wooden posts bout 6" in diamter & 5' long (2' underground) are fixed at the corners. buffer zone of width equal to 1 tree length is maintained all around.

Method of numbering and marking trees. Trees are serially numbered, ~~thro~~ above a cross mark, put 4·6" from the ground on the uphill side or in the same direction. The nos are given by a white paint.

16. Condition of plot when formed— Pure Quercus incana (Bang Oak)

a Overwood. The trees were girdled and under with Cedrus deodar.

b. Underwood. —

c. Weed growth. —

d. Regeneration of principal species. —

17. Details of work carried out at first formation. Not known.

18. Details of treatment to be applied. —

19 Remarks.

GIPD—165 FRI & Coll DD—13-2-28—500.

Division.	Sample Plot No.	Sample Tree No.	Crown Class.	Age.	Diameter at 4½ ft.	Total height.	Length of shoot of last.....years.	FORM FACTORS.				SOLID VOLUME.				Bark thickness at 4½ ft.	Bark percentage of total volume.	Length of stem timber.	Crown length.	Crown width.	Form quotient.		Percentage of Sap-wood in stem timber.	
								Timber.		Smallwood.		Timber.		Smallwood.							Crown length. / Total height.	Over bark.	Under bark.		
								Stem.	Branch.	Stem.	Branch.	Stem.	Branch.	Stem.	Branch.									
				Years.	Ins. and dec.	Ft.	Ft. & dec.	To three places of decimals.				Cubic feet to two places of decimals.				Ins. and dec.		Ft.	Ft.	Ft.	To three places of decimals.			

D/20/53 (Part III—11 11-53—11150

Experimental Plot Form No. 1.

SITUATION MAP.

Experimental Plot No. Division.

Scale—One inch = mile

Indicator Plot No.

1. Species _____
2. Situation _____
3. Date of formation _____
4. By whom laid out _____
5. Overhead cover _____
6. Remarks _____

Increment.	Date and initials.	Number planted.	Number surviving.	Survival %.	Height.			Standard error of the mean.	[Difference between means.	Standard error of the difference.
					Mean.	Minimum.	Maximum.			

NOTE.—1. If detailed analysis is required for more than one treatment the space to the right should be divided horizontally into the corresponding number of parts.

2. Measuremetns should be given all either in inches or in feet, the symbol being written against the first entry.

3. Each treatment should be given a separate series of numbers from unity.

4. The following abbreviations and symbols are used to describe condition :—

o. vacant space from start.

x. disappeared.

n. normal.

v. vigorous.

w. weak.

m. sickly (moribund).

c. new shoot from base (coppice).

b. top broken or browsed.

f. forked.

II, III. with 2, 3 shoots from base.

ll. leafless.

Species.	Date and Initials.

History of Sample Plot No. Division.

Particulars.

DDun—2,650—28-4-52—GIPS

Sample Plot Form No. 6.

RECORD OF PERIODIC MEASUREMENTS OF SAMPLE PLOTS.

Sample Plot No. **Division.**

Crop.	Species.	Main Crop.														Intermediate yield from thinnings.										Total crop.		Increment of final crop.			
		Number of trees per acre after thinning.	Height.		Form factors.			Diameters.			Basal area per acre after thinning.	Volume per acre				Number of trees per acre.	Average height.	Diameters.			Basal area per acre.	Volume per acre.				Basal area.	Stem Timber.	Periodic.		Periodic mean.	
			Top.	Crop.	Stem Timber.	Smallwood.		Minimum.	Maximum.	Average.		Stem Timber.	Smallwood.		Total.			Minimum.	Maximum.	Average.		Stem. Timber.	Smallwood.		Total.			Basal area.	Stem Timber.	Basal area.	Stem Timber.
						Stem.	Total.						Stem.	Branch.									Stem.	Branch.						
s.			Feet.					Inches and dec.			Sq. ft. & dec.	Solid cub. ft.					Feet.	Inches and dec.			Sq. ft. and dec.	Solid cub. ft.				Sq. ft. and dec.	Solid cub. ft.	Sq. ft. & dec.	Solid cub. ft.	Sq. ft. & dec.	Solid cub. ft.
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34

RIC/55—8-10-55—2,470.

Stump analysis

Object :-

1) To determine the progress of diameter increament on the average stump throughout the life of the trees analysed or over any desired period.

2) To correlate the rate of diameter increament with the action of external influences affecting all the ~~differing from tree to tree~~ trees.

3) To correlate the rate of diameter increament with the action of external influences differing from tree to tree.

4) As compared with the other methods of collecting these datas, stump analysis has the following advantages :-

a) Data can be collected from the stump of any felled tree as long as the wood remains sound.

b) Data can be collected at any time with a minimum of manual labo labour.

c) Usually the data can be multiplied to any desired extent with no objection other than the time taken in measuring.

d) The field work is simple & easily learnt.

e) Each tree provides data for the whole period of its life.

The method is accordingly particularly applicable to the following investigations :-

a) Rapid collection of diameter increament data in current or recently worked coupes.

b) Investigations in which special reasons exist rendering it advisable to have a large

no. of data, particularly if they are requ
pon all parts of an extensive forest area

c) Investigations in areas in which th
are objections to the wastage of timber inv
in special fellings for the collection of da
or in cutting stems at other than the low
possible level. This will often happen whe
exceptionally large trees are in questi

Stem analysis.

Objects:- 1) To determine the average rate of diameter, height and volume increament with action of external influences such as defoliation or lopping throughout the life of the trees analysed

Advantages:-

a) The data are collected from trees carefully selected which still standing as most suitable for the purpose in view, and so are most suitable.

~~b) The data collected~~

2) To correlate the average rate of diameter height and volume increament with the action of external influences such a defoliation or lopping.

Advantages:-

a) The datas are collected from trees carefully selected which still standing as most suitable for the purpose in view, & so are most reliable

b) The data collected are complete in all respects for the tree analysed tho so that no data from other trees or tables are required.

c) The data collected are more reliable than those obtained by any method based only on measurements on the lower parts of the bole, since the measurements taken higher up serves as a check on the lower ones.

d) As the section analysed can be chained and examined at leisure, more accurate counting and measurements are possible.

e) The height increament data provided

a valuable check on those for diameter increament, for determining whether the trees analysed can be accepted as typical for the purpose in view.

Corrections to be applied to volume growth figures :—

If 'D' is the average of d.b.h. measurements d_1, d_2, d_3 etc and 'σ' the standard deviation, the basal area of the tree of average basal area is $\frac{\pi}{4} \frac{\Sigma(D \pm \sigma)^2}{n}$,

$$\text{which is} = \frac{\pi}{4} \frac{nD^2 + n\sigma^2 \pm \Sigma 2D\sigma}{n}$$

$$= \frac{\pi}{4} (D^2 + \sigma^2)$$

The volume of the mean tree of average diameter is $\pi/4\, D^2$.

The ratio of the basal area & hence the volumes of two mean trees by the two methods is therefore $\frac{D^2+\sigma^2}{D^2}$, or the relative % error is $\sigma^2/D^2 \times 100$.

— x —

No of quadrat	Size	Aspect	Overwood: Species	No of stem/acre	Range of diameter	Average diameter	Top height	Top Dia	Under wood: Species	No of stems	size class	Ground flora: Species	frequency	Remarks
I	1ch x 1ch.	North east	Cedrus deodara	10	30"-40"	35"	132'	3'-4'	Quercus dilatata	56	0"-12"	herbs.		
			Picea smithiana	3	12"-18"	15"		18"	Acer pictum	12	0"-4"	Dinelia aptera	a	
									Acer cesium	6	4"-8"	Vallisina wallichii	a	
									Cedrus deodara	12	0"-4"	Sarcococa saligna	f	
									Picea. smithiana	6	8"-12"	fragoria indica	f	
II	"	"	Cedrus deodara	14	30"-45"	36"	145'	3'4"	Quercus dilatata	42	0"-8"	Jasminum humile	f	
									Cedrus deodara	42	8"-8"	Daphne canabina	+	
									Salix tetrasperma	6	0"-4"	Elcholtzia polystycha	+	
III	"	"	Cedrus deodara	15	30"-38"	35"	115'	3'2"	Quercus dilatata	84	0"-12"	Boenninghausiana albiflora	+	
									Cedrus deodara	6	0"-8"			
									Ilex dipirana	6	0'-8"			
									Corylus colurna	6	8"-8'	Ferns.	f	
									Prunus padus	6	0"-4"	Senitio alba	+	
IV	"	"	Cedrus deodara	12	33"-39"	37"	118'	3'3"	Quercus dilatata	73	0"-12"	Polygonum verticilatum	+	
									Acer pictum	6	0"-4"	Vibunum nepalensis	f	
									Salix tetrasperma	6	0"-6"	Desmodium gyrony.	0	
									Corylus colurna	6	0"-8"	Strobilanthus auriculata	0	
									Prunus padus	12	0"-4"	Asparagus	0	
									Cedrus deodara	36	0"-8"	Barbaris lycium	0	
V	"	Northern	Cedrus deodara	2	20"-22"	21"		22"	Quercus dilatata	11 / 6 / 2 } 19	0"-4" / 4"-8" / 4"-12"	Galium oporini	0	
			Picca smithiana	10	16"-36'6"	20"	127'	36'6"	"			Salvia glutinosa	0	
									Picea smithiana	5 / 6 / 2 } 13	0"-4" / 4"-8" / 8"-12"	Aquileziapubiflora	0	
									Abis pindrow	3 / 15 } 18	0"-4" / 4"-8"	Euphorbia villosa	0	
									Acer pictum	9 / 3 / 1 } 13	0"-4" / 4"-8" / 8"-12"	Shrubes.		
									Symplocos cretizoides	1	0"-4"	Lonicera aungastifolia	f	
									Cornus macrophylla	1	0"-4"	Indigofera pulchella	f	
									Cedrus deodara	2 / 5 } 7	4"-8" / 8"-12"	Rosa moschata	f	
VI	"	South-East	Cedrus deodara	7	16" & over	26"	128		Cedrus deodara	2	0"-12"	Vibernum foetens	f	
									Quercus dilatata	8	4"-8"	Syplocos rugosus	f	
									Acer pictum	1	4"-8"	Deutzia corymbosa	f	
									Picea smithiana	2	4"-12"	Lonicera quinquilocularis	f	
									Corylus colurna	1	4"-8"			
									Prunus padus	2	4"-8"			
VII	"	North-East	Cedrus deodara	5	16"-24"	20"	132'	24'	Cedrus deodara	3	8"-12"			
									Abis pindrow	1	8"-12"			
									Quercus dilatata	4	4"-12"			
VIII	"	"	Cedrus deodara	7	16" & over	34"	123'		Acer cesium	1	4"-8"			
									Quercus dilatata	3	4"-8"			
									Prunus padus	1	4"-8"			
IX	"	South-East.	Cedrus deodara	9	16" & over	23"	115'		Cedrus deodara	5	4"-12"			
									Quercus dilatata	11	4"-8"			
									Prunus padus	4	0"-4"			
									Abis pindrow	3	8"-12"			
									Corylus colurna	1	4"-8"			

Table I

D.B.H (O.B) in inches	D.B.H. (U.B) in inches	Twice bark thickness in inches	Increament for 5 years	
			radial	to Diam.
5·9	5·2	0·7	*0·53	1·06
9·1	8·1	1·0	0·46	0·92
13·5	12·4	1·1	0·22	0·44
17·5	16·25	1·25	0·15	0·30
20·65	19·45	1·2	0·15	0·30
26·45	25·25	1·2	0·165	0·33.

D.B.H. (U.B) in inches	Diameter increament %			Volume increament		
	By Pressler's formula	By compound interest for.	Average	By Pressler's method	By schneider's formula	Average
5·2	4·5	4·5	4·5	8·9	8·2	8·5
8·9	2·18	2·07	2·13	4·34	4·36	4·35
12·4	0·71	0·77	0·74	1·44	1·43	1·43
16·25	0·364	0·33	0·35	0·74	0·75	0·54
19·45	0·29	0·30	0·30	0·57	0·58	0·57
25·25	0·243	0·243	0·243	0·48	0·48	0·48

Increament boring.

1) Object :- To determine the percentage of diameter & volume increament put on by trees for a definite period.

2) To determine the time taken by the tree to pass from one diameter class to another.

3) To determine the current annual increament of trees of given diameter.

4) Assessment of rotation.

Procedure :- Trees growing under average conditions were grouped under different diameter classes (4" diam. classes).

Borings were taken at D.B.H, the distance being measured from the up hill side.

Two borings were taken one at each end of the average diameter.

All borings were taken at right angles to the surface of the tree and upto a depth of about 2 inches.

Width of the first five annual rings was determined & average taken.

The diameter under bark was also measured.

A tree having an average diameter of 4·2" was felled flush to the ground and the annual rings counted to determine the age of the tree.

Computation. The age of the other diam. classes was computed from a age-diameter graph.

Diameter increament percent.

a) By Bruessler's formula —

$$p = \frac{D_2 - D_1}{D_2 + D_1} \times \frac{200}{n},$$

where n = no of rings in the last inch of the rad
D_2 = present diameter & D_1 = initial diameter (5 y

b) Compound interest formula.

$$\frac{D_2}{D_1} = (1.0 \cdot p)^n$$

Volume increament.

a) By Schneider's formula.

$V_1 = \frac{400}{nD}$, where n = no of rings in the
inch of radius & D = aver
(taken D.B.H. under bark)

b) By the formula

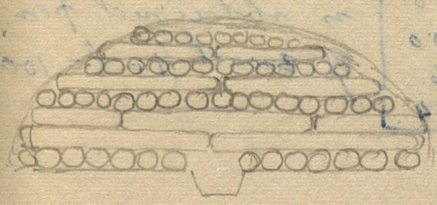
$$\frac{D_2^2 - D_1^2}{D_2^2 + D_1^2} \times \frac{200}{n}.$$

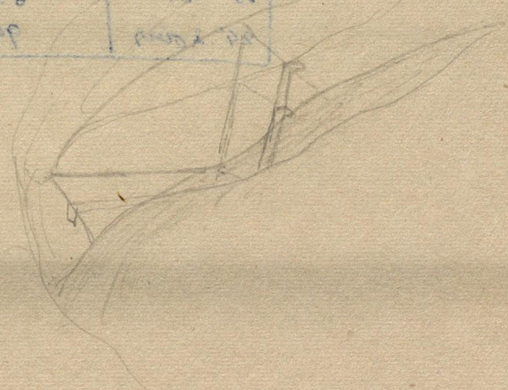
Charcoal manufacturing.

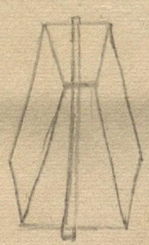
7.

All Quercus species yield good quality charcoal. The best quality of charcoal is obtained from Quercus semicarpifolia. But because it grows at a very high altitudes which cause a difficulty in transportation, so most of the charcoal is obtained from Quercus incana which grows at lower altitudes. One md. of Coal (82·28 lbs) is obtained from 5 mds (md = 100 lbs) of fuel.

Charcoal kiln. — Usually the charcoal kiln is prepared in depressions (ravines) in leeward side. A channal at the bottom (1' deep + 15" wide). is made all along the length of the kiln. A kiln has got a usually length of 16 in the shape of a box cutting. This channal opens into a flue & that provides a clear passage for the air through the kiln. The kiln is made in a box cutting with 12' wide inner side & 14' wide at the front side. The kiln is made 6' high. 6' long billets are placed longitudinally &







horizontally in alternate layers. The firing of the kiln is done through the channal. The mouth of the channal is also closed 2 days afterwards and the flue is also closed after some time. The

whole process is completed within.

Dm. class	Total wood in cft.
4"–8"	5 cft.
8"–12"	12 "
12"–16"	27 "
16"–20	50
20"–24"	90 "
24" & over	75-135 " & over.

Conversion factor between charcoal & wood

Fuel

1 md (100 Lb)

1 solid cft. of Oak = ·7 md
1 " " " Kokat = ·4 "
1 " " " Chir = ·45 "
1 " " " deodar = ·45

1 cft. of stacked wood = ·5 solid volum

or multiplying factor = 2.

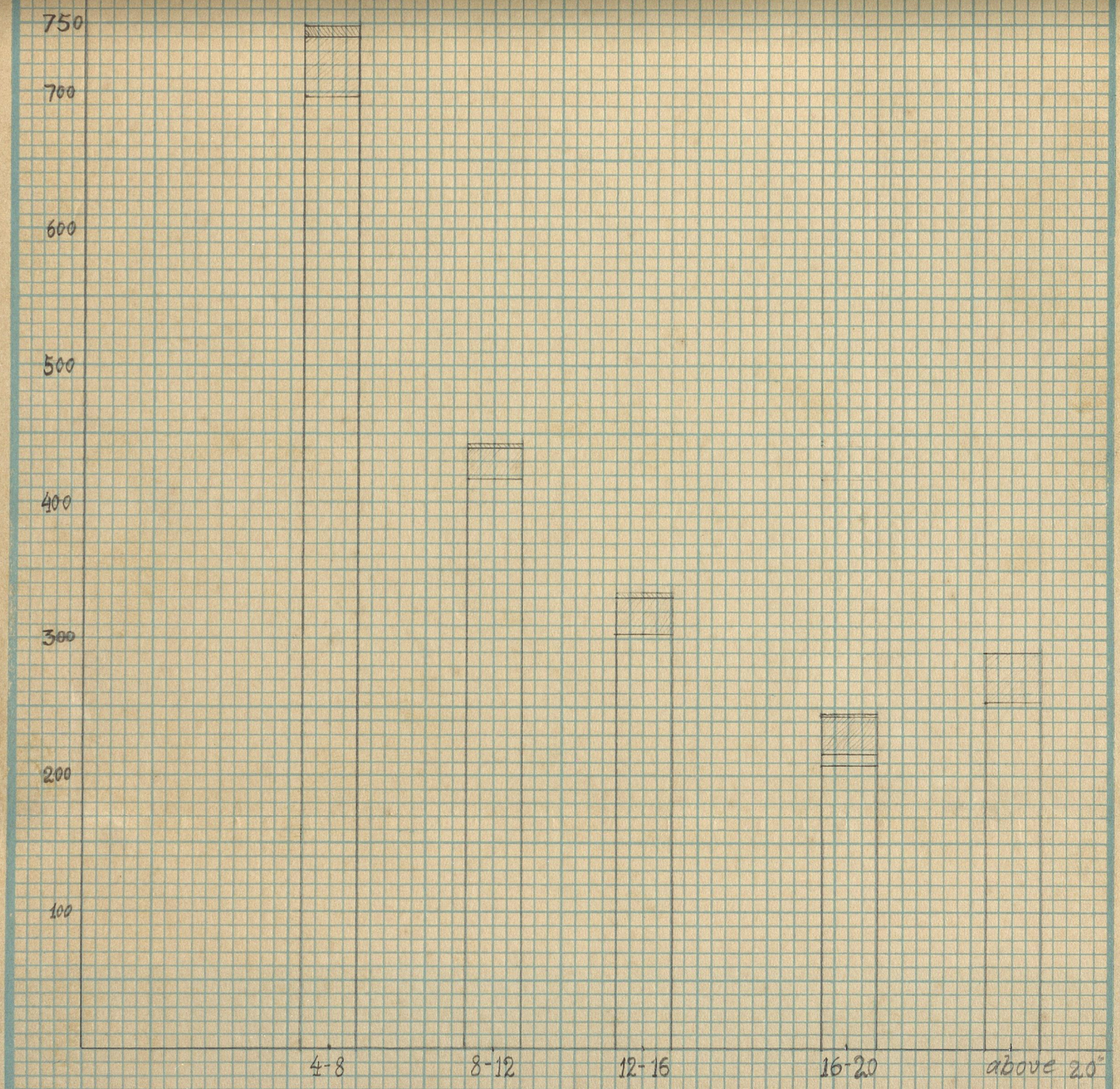
Outturn of diameter in maunds.

Dm Class	Oak	Kokat
4"– 8"	3·5	2·0
8"– 12"	8·4	4·8
12"– 16"	18·9	10·8
16"– 20"	35·0	20·0
20"– 24"	63	36
24" & over	94·5	54.

One md of charcoal is obtained from 5 cft of wood (1 md = 100 Lbs

Serial no	stump height	stump height	average radius at stump ht. U.B. in inches
1	3"	19·6"	9·8
2.	12"	39·75"	19·87
3.	14"	26·1"	13·05
4.	1'10"	26·6"	13·3
5.	4"	26·2"	13·1
6.	5"	21·9"	10·95
7.	9"	21·95"	10·97
8.	9·5"	26·8"	13·4
9.	6"	31·8"	15·9
10.	1'9"	28"	14
11.	12"	28·8	14·4
12.	14"	23·9	11·95
Average	10·9"		

Dev Roy.



Diameter classes:—

Dev Roy.

Serial no	stump height	[illegible] stump height	average R-adius at stump ht. U.B. in inches
1	3"	19·6"	9·8
2.	12"	39·75"	19·87
3.	14"	26·1"	13·05
4.	1'10"	26·6"	13·3
5.	4"	26·2"	13·1
6.	5"	21·9"	10·95
7.	9"	21·95"	10·97
8.	9·5"	26·8"	13·4
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10.	1'9"	28"	14
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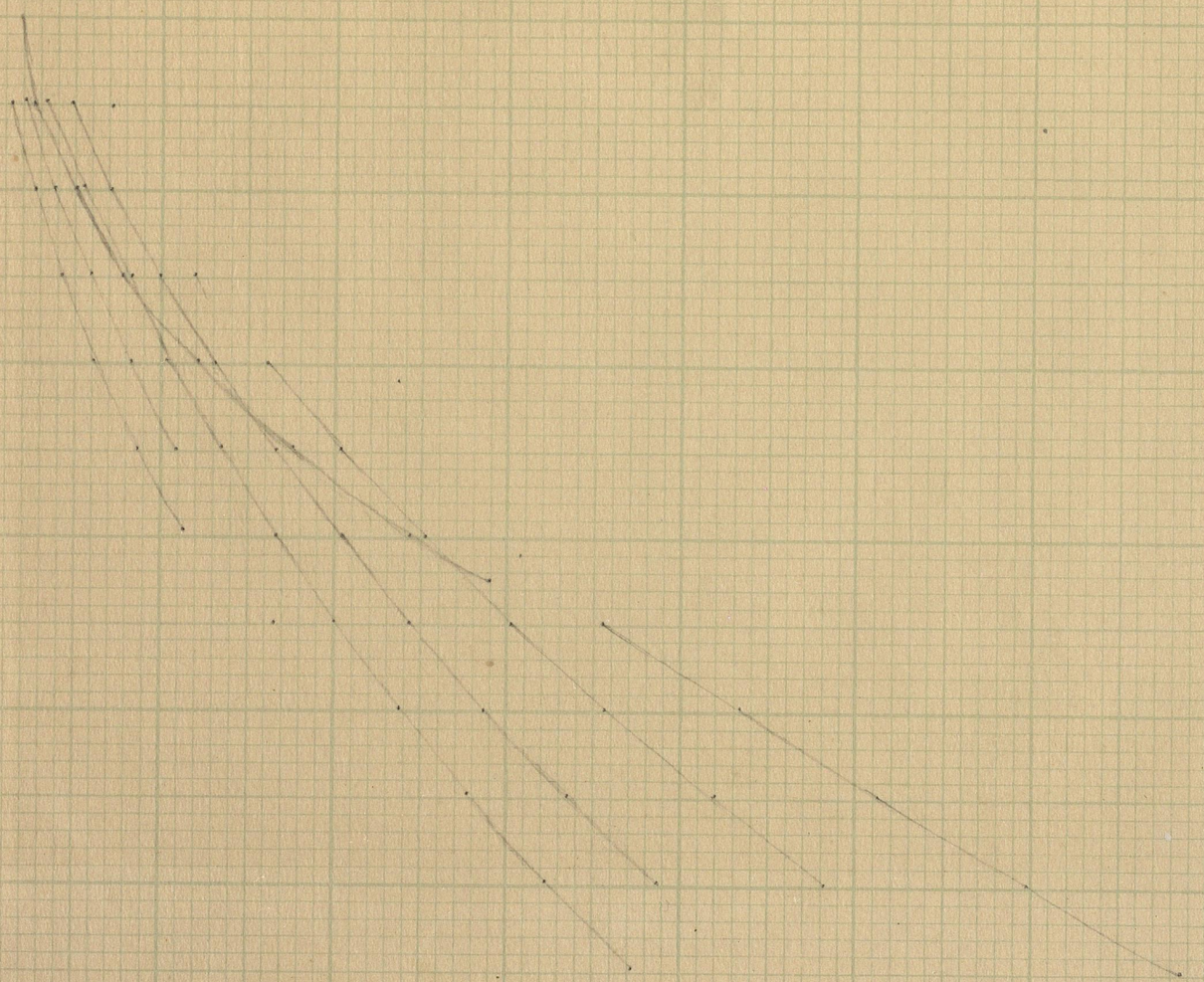
12.	14"	23·9	11·95
Average	10·9"		



Deb Roy.

Serial no	Stump height	[illegible] stump height	average R-adius at stump ht. U.B. in inches
1	3"	19·6"	9·8
2.	12"	39·75"	19·87
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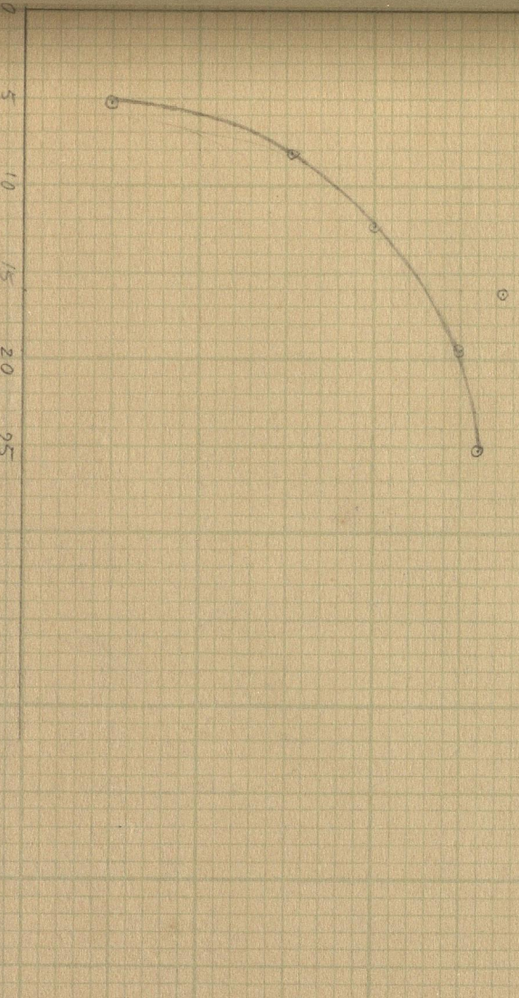
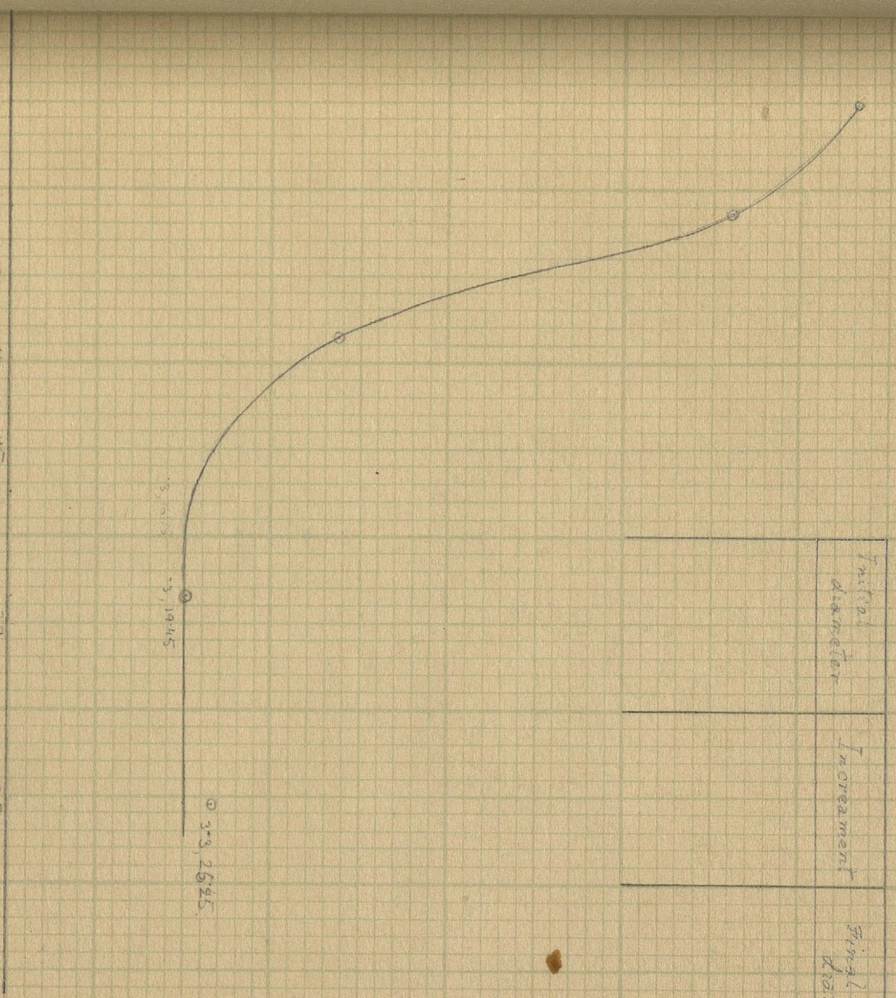
7.	9"	21·95"	10·97
8.	9·5"	26·8"	13·4
9.	6"	31·8"	15·9
10.	1'9"	28"	14
11.	12"	28·8	14·4
12.	14"	23·9	11·95
Average	10·9"		



Arb Roy.

Serial no	Stump height	[illegible] stump height	average radius at stump ht. u.b. in inches
1	3"	19·6"	7·8
2.	12"	39·75"	19·87
3.	14"	26·1"	13·05
4.	1'10"	26·6"	13·3
5.	4"	26·2"	13·1
6.	5"	21·9"	10·95
7.	9"	21·95"	10·97
8.	9·5"	26·8"	13·4
9.	6"	31·8"	15·9
10.	1'9"	28"	14
11.	12"	28·8	14·4
12.	14"	23·9	11·95
Average	10·9"		





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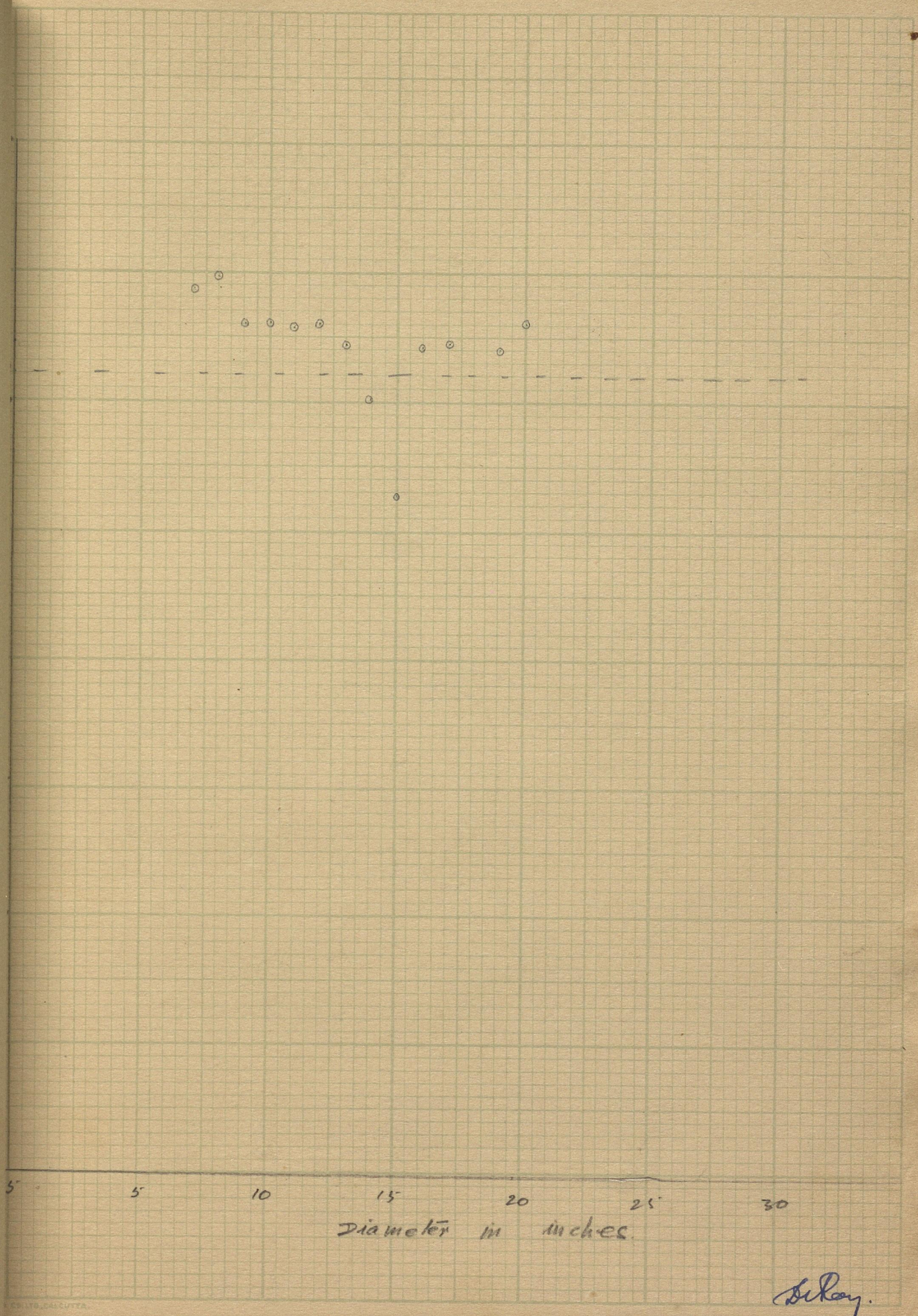

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Serial no	Stump height	Stump height	Average radius at stump ht. U.S. in inches
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9.	6"	31·8"	15·9
10.	1'9"	28"	14
11.	12"	28·8	14·4
12.	14"	23·9	11·95
Average	10'9"		

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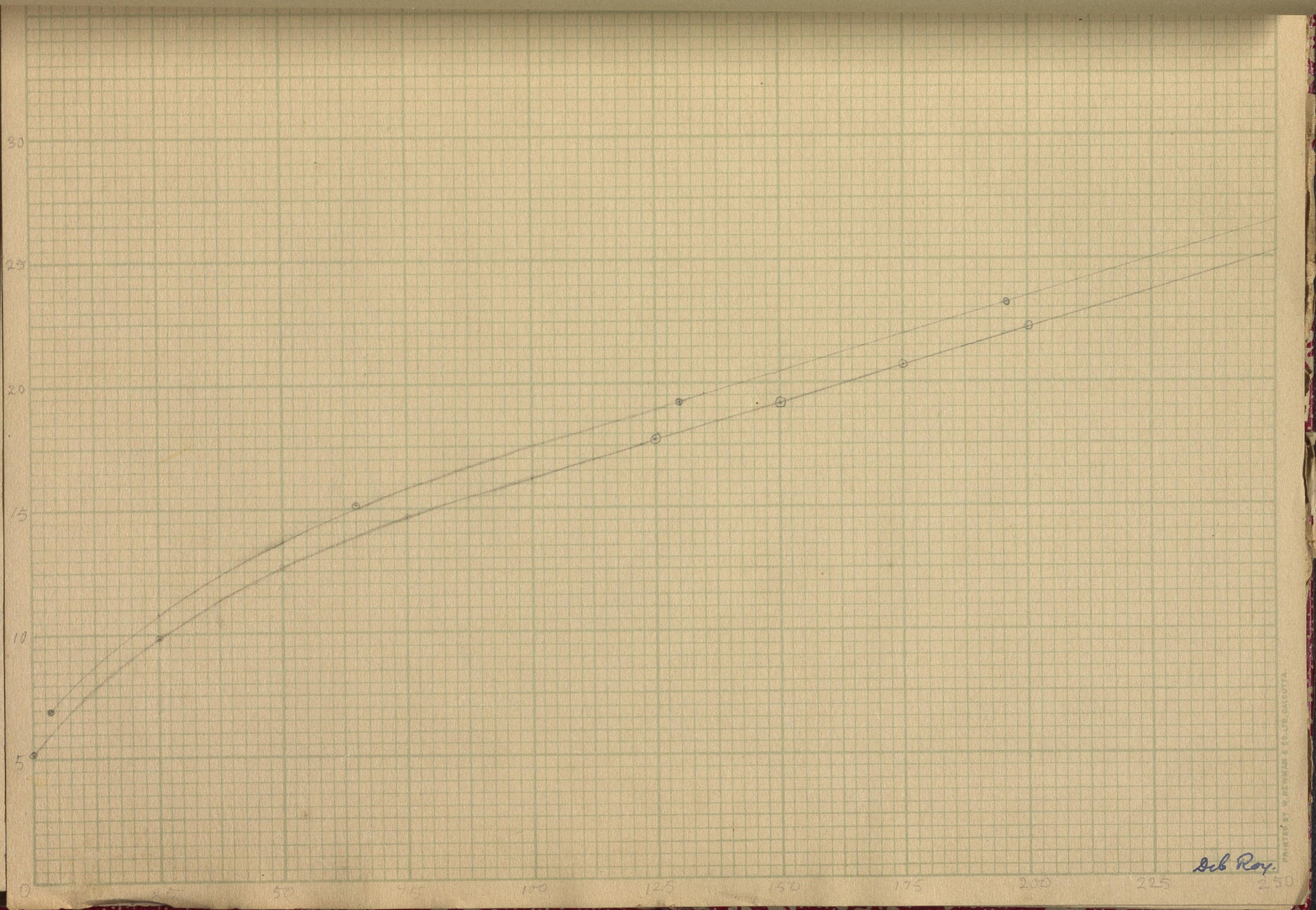
Average	10·9"		



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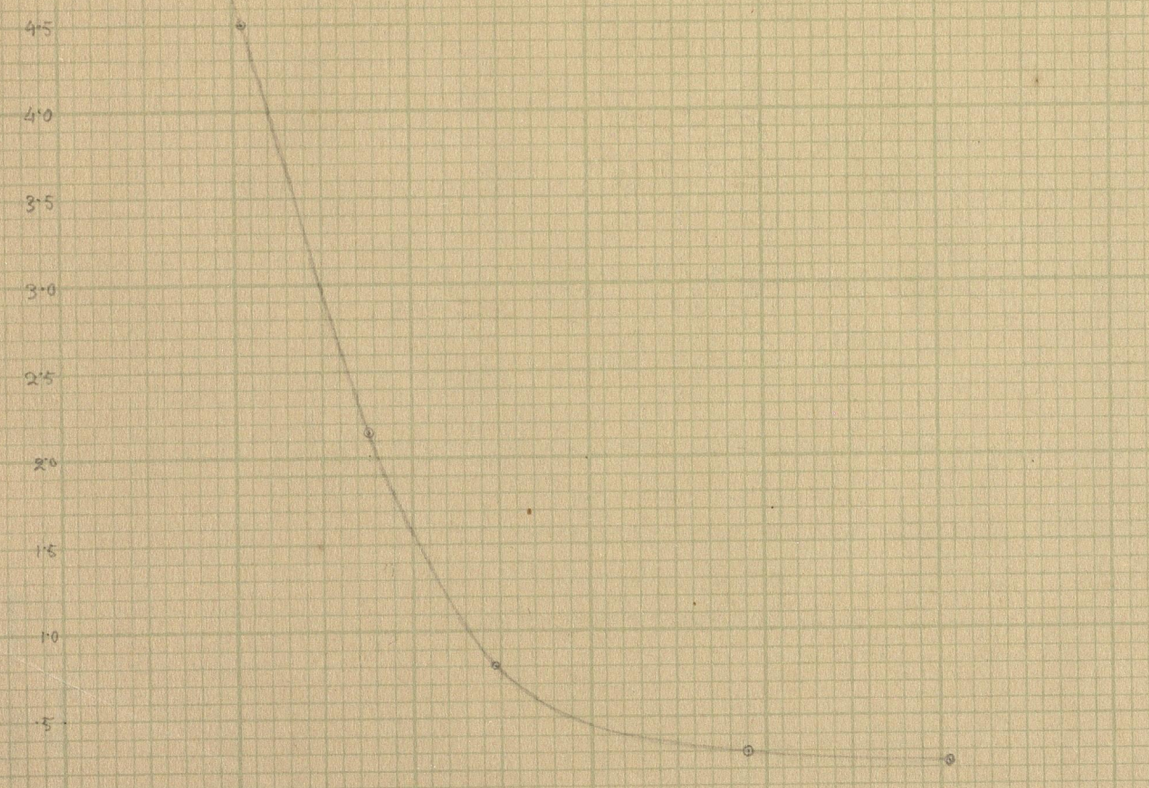
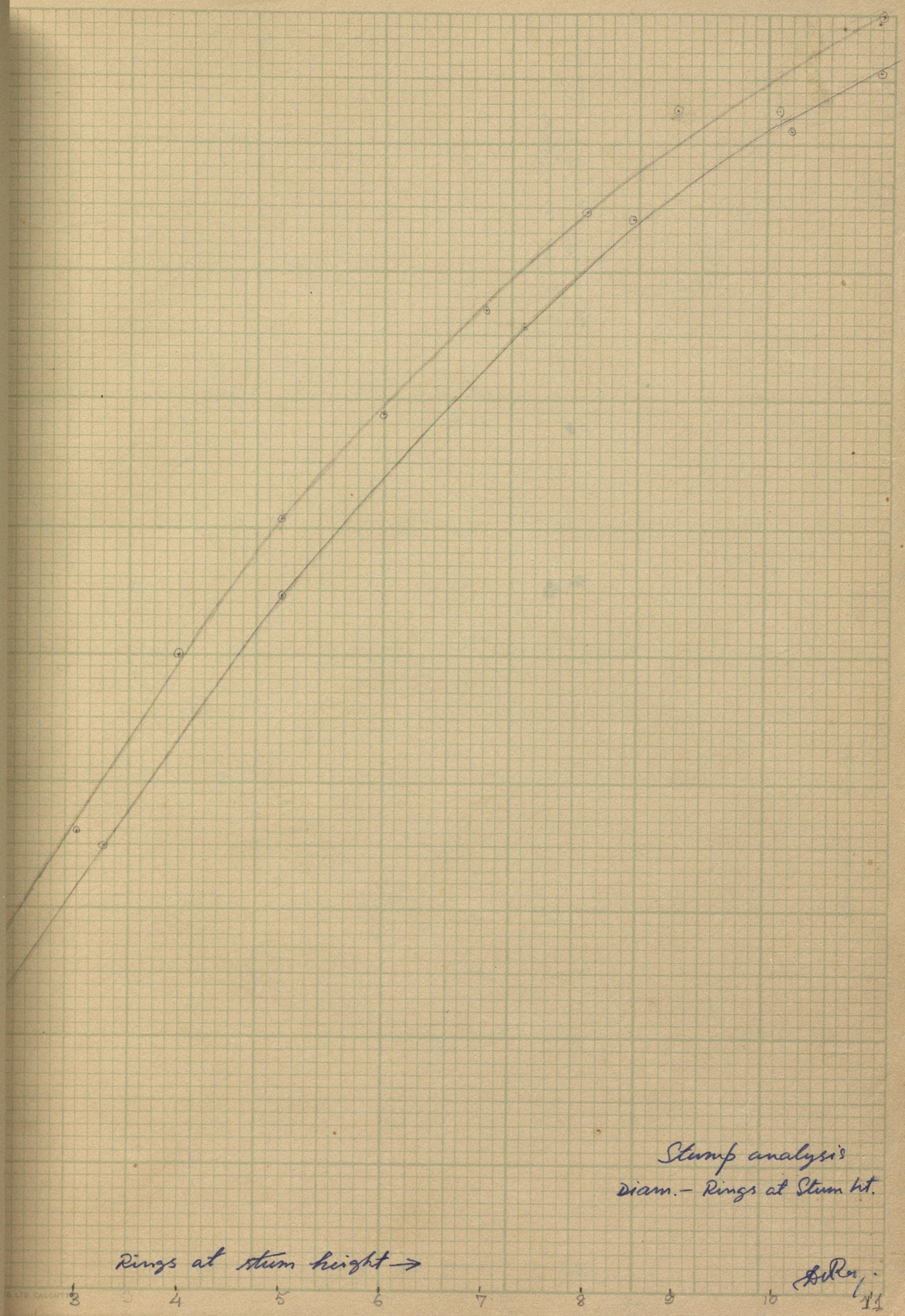
12.	14"	23·9	11·95
Average	10·9"		



Deb Roy



Stump analysis
Diam. – Rings at Stum ht.

Serial no	Stump height	Stump height	Average R. adius at stump ht. U.S. in inches
1	3"	19·6"	9·8
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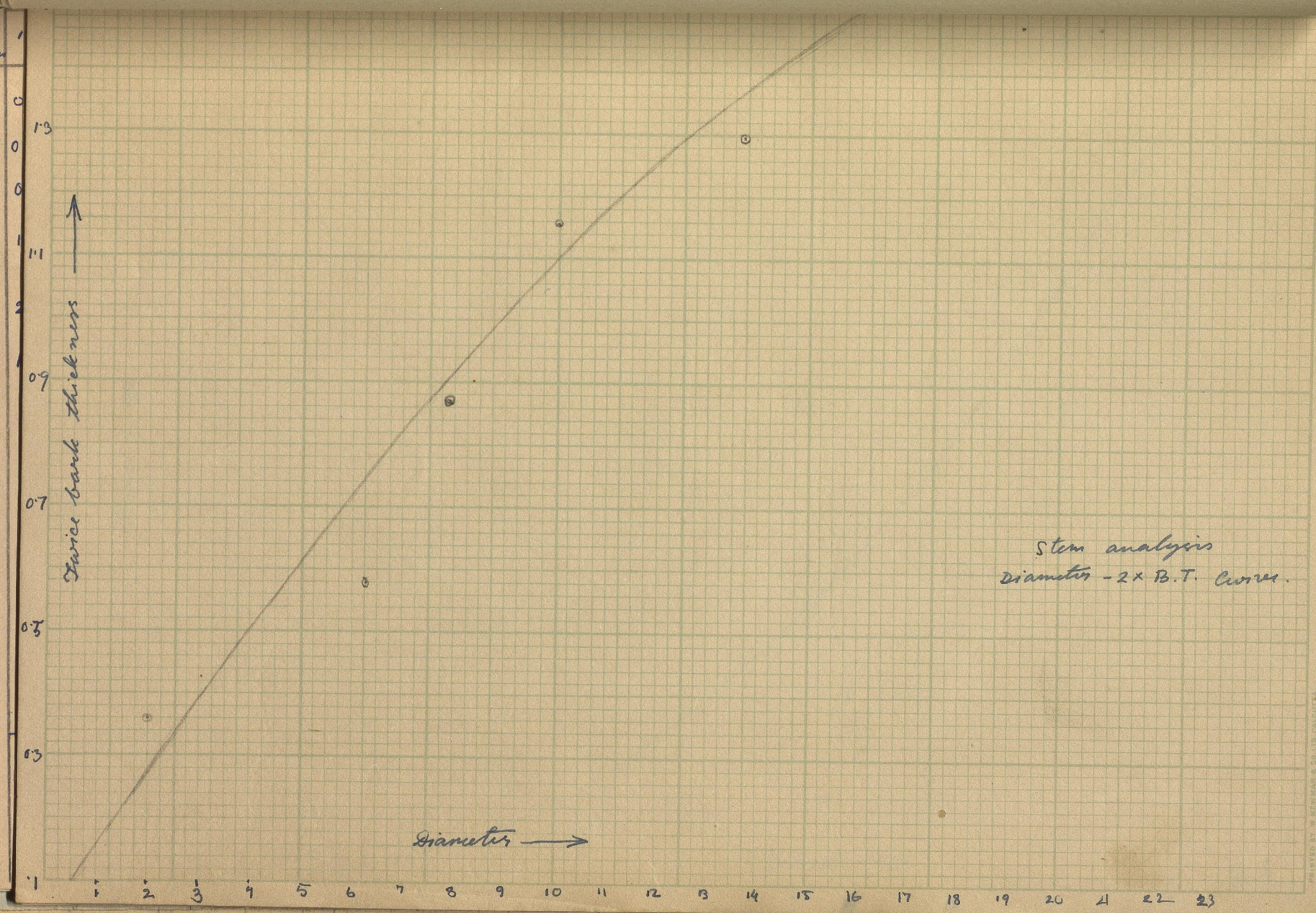
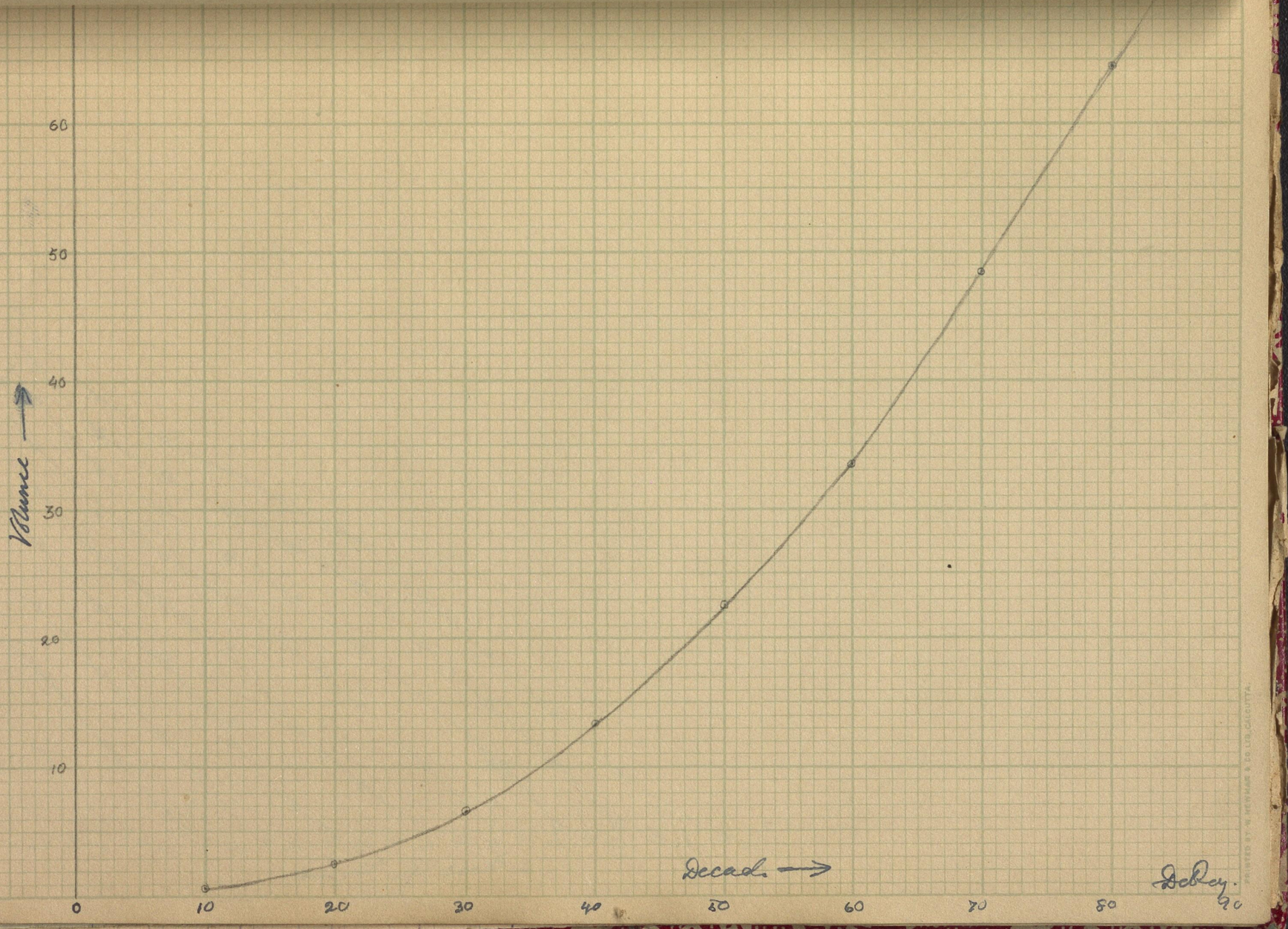
11.	12"	28·8	14·4
12.	14"	23·9	11·95
Average	10'9"		

Serial no	stump height	stump height	average R-adius at stump ht. U.B. in inches
1	3"	19·6"	9·8
2.	12"	39·75"	19·87
3.	14"	26·1"	13·05
4.	1'10"	26·6"	13·3
5.	4"	26·2"	13·1
6.	5"	21·9"	10·95
7.	9"	21·95"	10·97
8.	9·5"	26·8"	13·4
9.	6"	31·8"	15·9
10.	1'9"	28"	14
11.	12"	28·8	14·4
12.	14"	23·9	11·95
Average	10·9"		

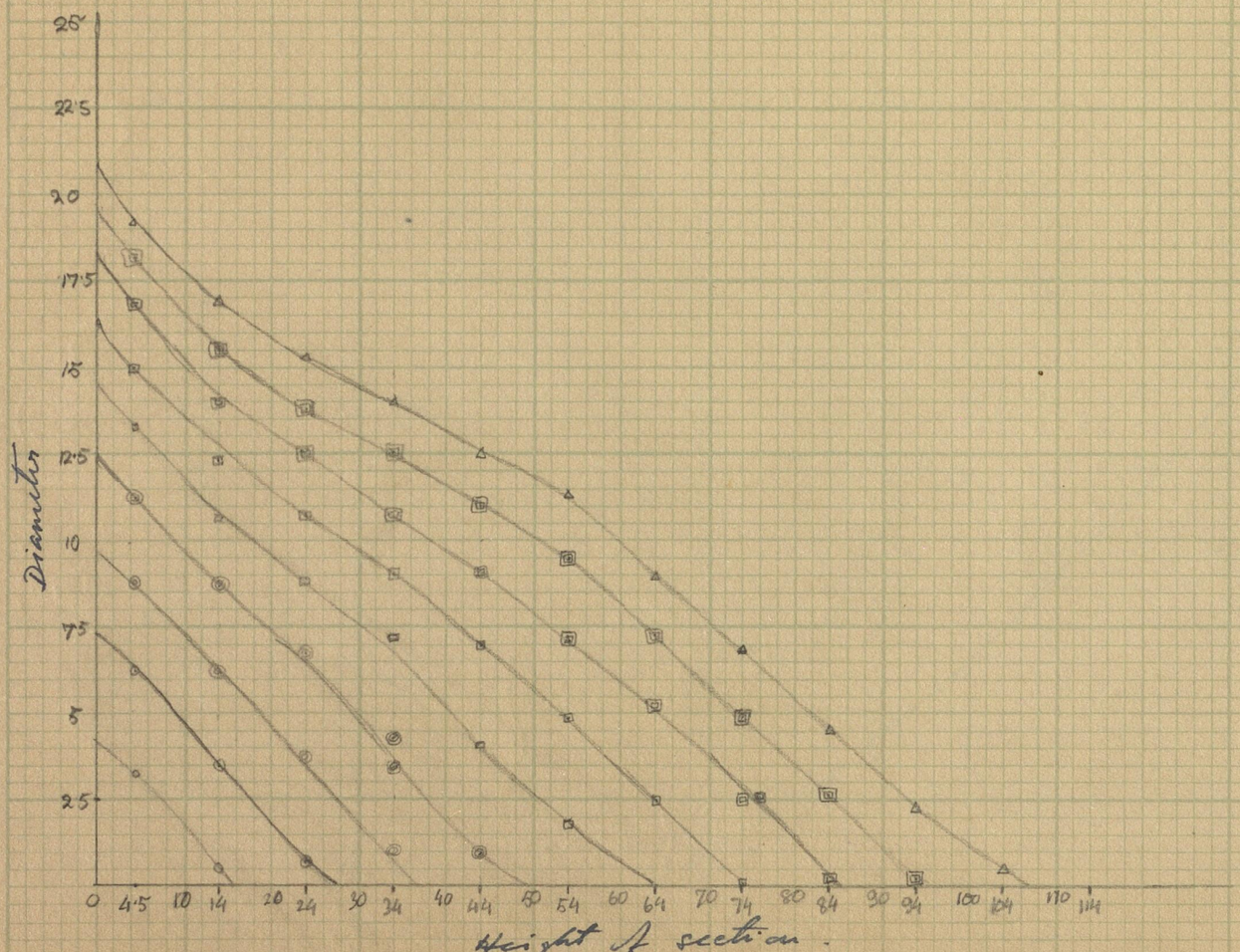


Serial no	Stump height	Diameter at stump height U.B. in inches	
1	3"	19·6"	7·8
2.	12"	39·75"	19·87
3.	14"	26·1"	13·05
4.	1'10"	26·6"	13·3
5.	4"	26·2"	13·1
6.	5"	21·9"	10·95
7.	9"	21·95"	10·97
8.	9·5"	26·8"	13·4
9.	6"	31·8"	15·9
10.	1'9"	28"	14
11.	12"	28·8	14·4
12.	14"	23·9	11·95
Average	10·9"		

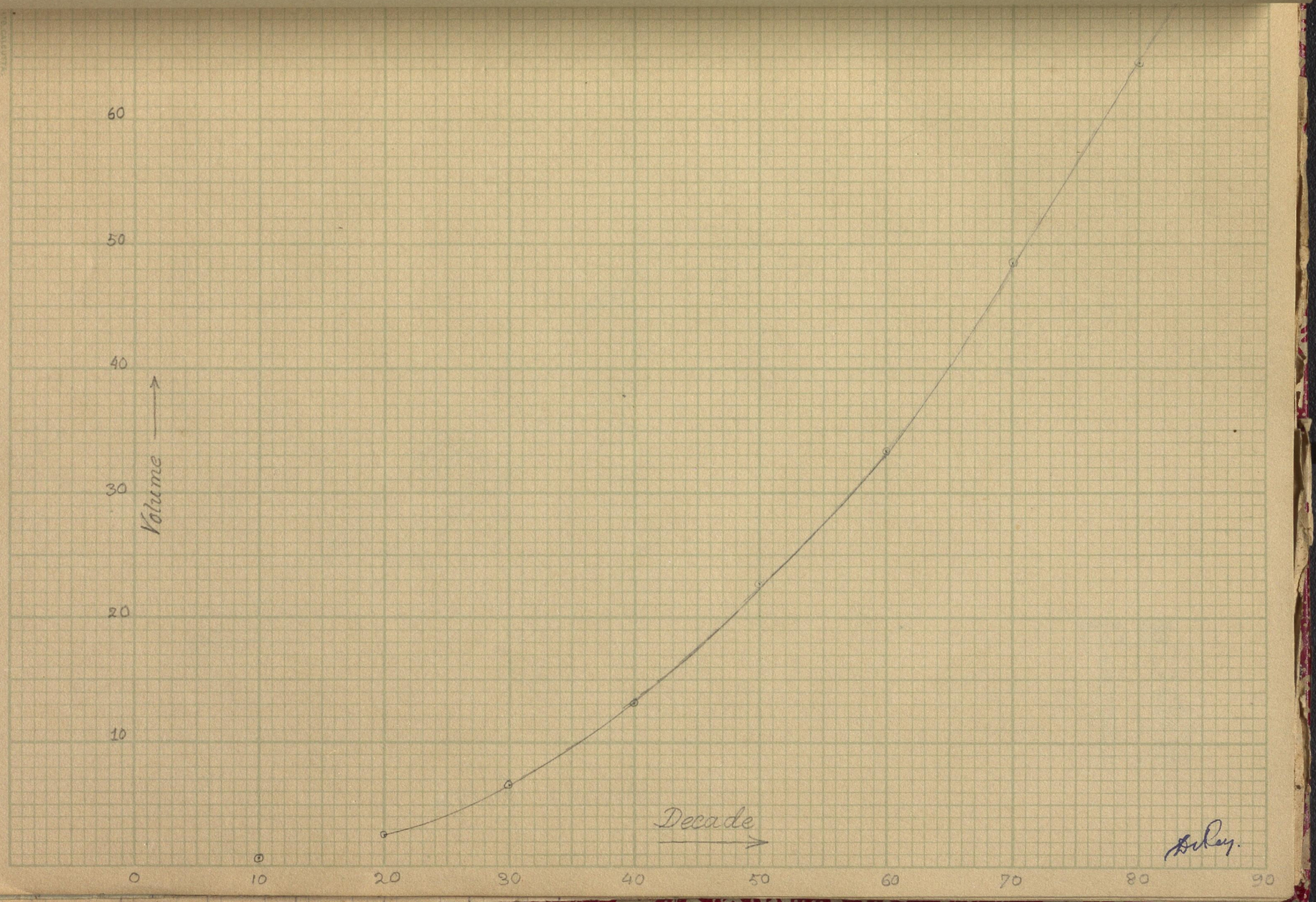


Serial no	Stump height	Girth at stump height	Average radius at stump ht. u.b. in inches	
1	3"	19·6"	7·8	C
2.	12"	39·75"	19·87	0
3.	14"	26·1"	13·05	0
4.	1'10"	26·6"	13·3	1
5.	4"	26·2"	13·1	2
6.	5"	21·9"	10·95	1
7.	9"	21·95"	10·97	
8.	9·5"	26·8"	13·4	
9.	6"	31·8"	15·9	
10.	1'9"	28"	14	
11.	12"	25·8	14·4	
12.	14"	23·9	11·95	
Average	10·9"			

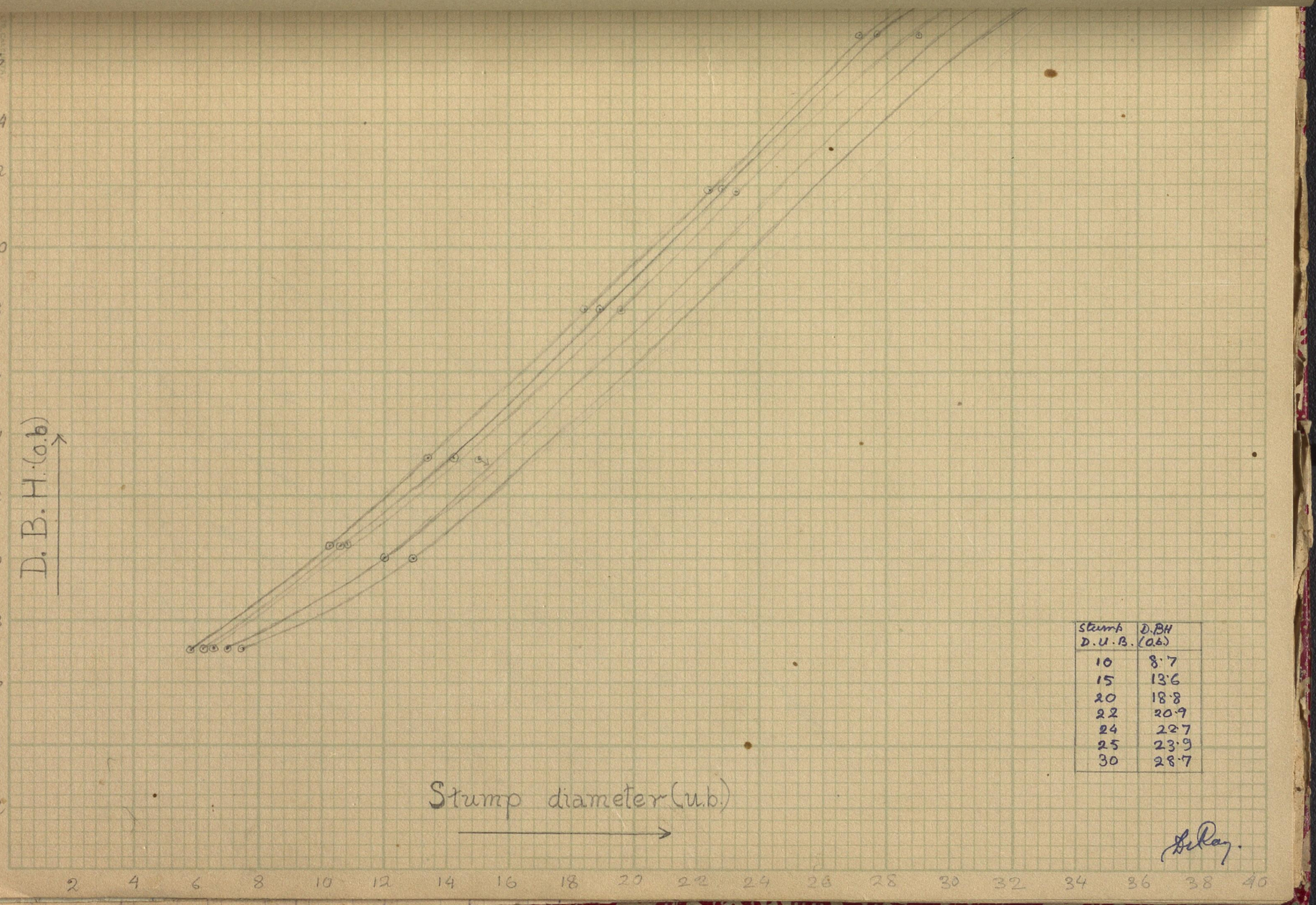
Diameter-height section.



Stem no	Height	Stump height	Girth at stump ht. U.B. in inches	
1	3"	19·6"	7·8	0
2.	12"	39·75"	19·87	0
3.	14"	26·1"	13·05	0
4.	1'10"	26·6"	13·3	1
5.	4"	26·2"	13·1	2
6.	5"	21·9"	10·95	1
7.	9"	21·95"	10·97	
8.	9·5"	26·8"	13·4	
9.	6"	31·8"	15·9	
10.	1'9"	28"	14	
11.	12"	28·8	14·4	
12.	14"	23·9	11·95	
Average	10·9"			



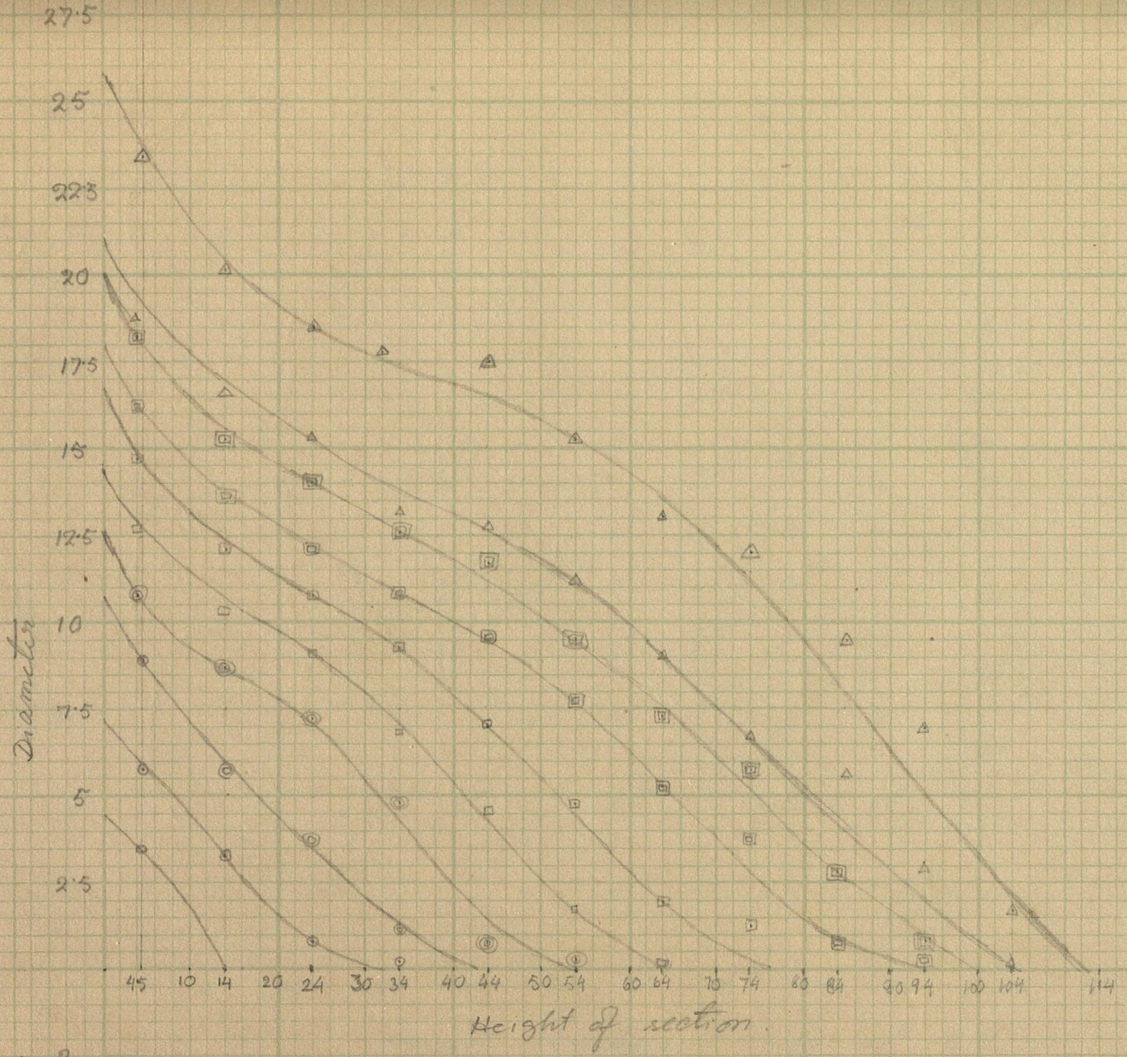
Serial no	Height	Stump height	Radius at stump ht. U.B. in inches	
1	3"	19·6"	7·8	0
2.	12"	39·75"	19·87	0
3.	14"	26·1"	13·05	0
4.	1'10"	26·6"	13·3	1
5.	4"	26·2"	13·1	2
6.	5"	21·9"	10·95	4
7.	9"	21·95"	10·97	
8.	9·5"	26·8"	13·4	
9.	6"	31·8"	15·9	
10.	1'9"	28"	14	
11.	12"	28·8	14·4	
12.	14"	23·9	11·95	
Average	10·9"			



Stump D.U.B.	D.BH (o.b)
10	8·7
15	13·6
20	18·8
22	20·9
24	22·7
25	23·9
30	28·7

Serial no	Stump height	stump height	[illegible] adiris at stump ht. U.B. in inches	
1	3"	19·6"	9·8	0
2.	12"	39·75"	19·87	0
3.	14"	26·1"	13·05	0
4.	1'10"	26·6"	13·3	1
5.	4"	26·2"	13·1	2
6.	5"	21·9"	10·95	1
7.	9"	21·95"	10·97	
8.	9·5"	26·8"	13·4	
9.	6"	31·8"	15·9	
10.	1'9"	28"	14	
11.	12"	28·8	14·4	
12.	14"	23·9	11·95	
Average	10·9"			

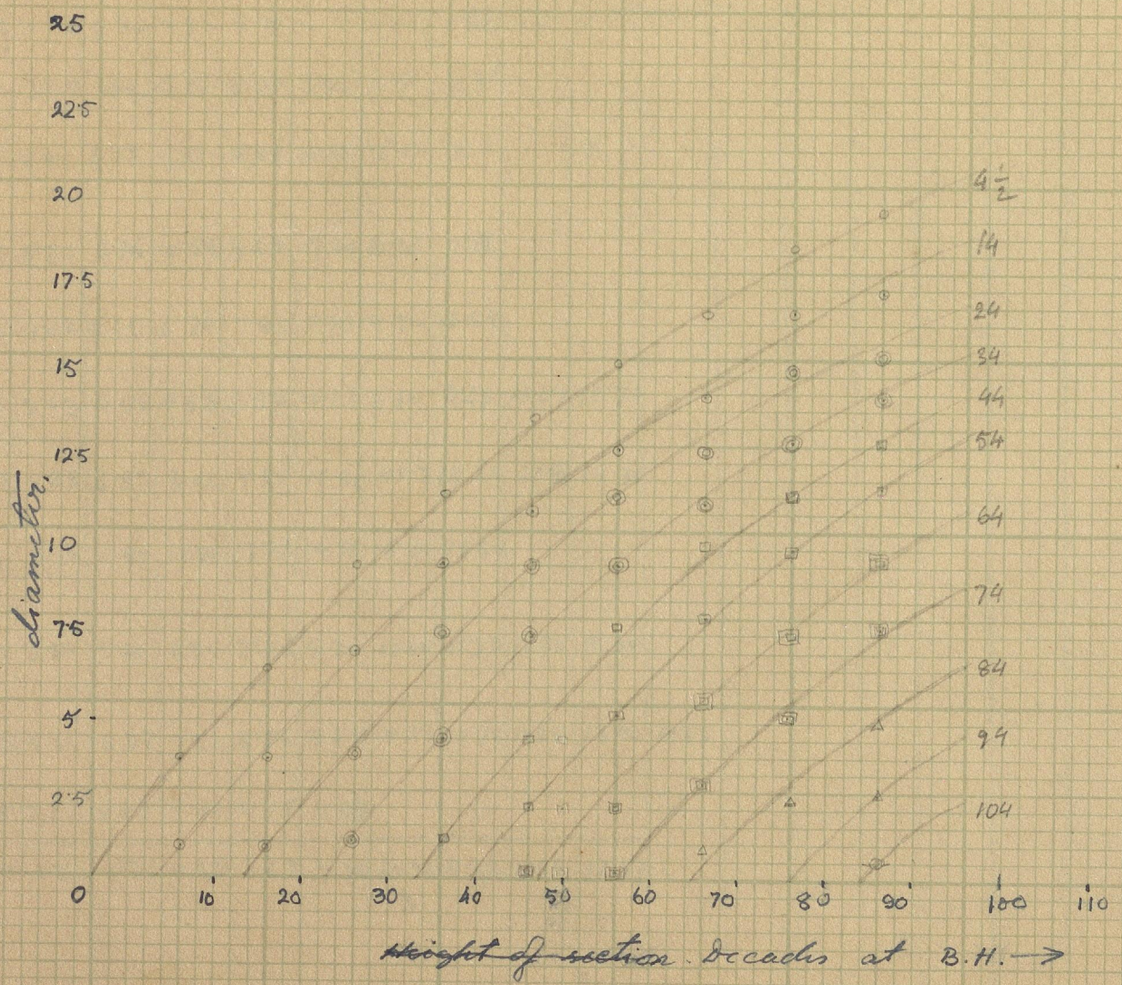
section curve.



DeRoy.

Serial no	Stump height	Diameter at stump height U.B. in inches	Average radius at stump ht. U.B. in inches	
1	3"	19·6"	7·8	0
2	12"	39·75"	19·87	0
3.	14"	26·1"	13·05	0
4.	1'10"	26·6"	13·3	1
5.	4"	26·2"	13·1	2
6.	5"	21·9"	10·95	1
7.	9"	21·95"	10·97	
8.	9·5"	26·8"	13·4	
9.	6"	31·8"	15·9	
10.	1'9"	28"	14	
11.	12"	28·8	14·4	
12.	14"	23·9	11·95	
Average	10·9"			

curve.



Serial no	stump height	[illegible] stump height	average K-adius at stump ht. U.B. in inches	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	length. inches.	[illegible] eings
1	3"	19·6"	9·8	0·79	1·55	2·36	3·71	4·76	5·79	6·84	7·94	8·71	9·17	9·71									
2.	12"	39·75"	19·87	0·95	2·30	3·72	5·70	7·05	8·35	9·95	11·22	12·37	13·70	14·77	16·27	17·7	19·12						
3.	14"	26·1"	13·05	0·99	1·76	3·07	4·40	6·78	8·26	9·66	11·80	12·85											
4.	1'10"	26·6"	13·3	1·02	3·00	5·05	6·77	8·25	9·45	10·62	12·07	13·1											
5.	4"	26·2"	13·1	2·25	3·90	5·30	6·74	7·54	8·49	9·40	10·30	11·42											
6.	5"	21·9"	10·95	1·49	2·76	4·09	5·25	6·34	7·45	8·70	9·70	10·55											
7.	9"	21·95"	10·97	1·26	2·25	3·43	4·56	5·58	6·50	7·28	8·14	9·23	10·09	10·70									
8.	9·5"	26·8"	13·4	1·23	3·23	5·23	6·87	8·02	9·35	10·51	11·17	12·20	12·96	13·30									
9.	6"	31·8"	15·9	1·86	6·14	9·50	11·45	12·64	13·72	14·50	15·10	15·64											
10.	1'9"	28"	14	1·22	2·20	3·50	5·20	6·90	7·95	9·30	10·40	11·30	12·20	13·30									
11.	12"	28·8	14·4	1·98	3·98	5·50	6·87	7·82	8·56	9·47	10·13	10·76	11·85	13·40	14·68								
12.	14"	23·9	11·95	1·79	4·15	7·17	8·69	9·80	11·15	11·89													
Average	10·9"			1·39	3·09	4·83	6·35	7·62	8·67	9·84	10·72	11·66	11·66	12·57									

Constant of Stem form

$$y = \frac{x}{a + bx}$$

	x	Constant. $x + y$

Tree No	Height years [illegible]													
	1 $0\frac{1}{2}$	2a	3a	4a	5a	6a	7a	8a	9a	10a	10½	11½	12½	13½
1	·7746	2·8301	7·2430	13·7760	22·7330	34·2957	48·1180	64·5113	80·7781					
2.	·6333	2·4883	6·6529	13·0468	22·4967	34·5318	48·5452	64·8890	82·6752					
3.	·6019	2·4663	7·3	14·4668	23·0032	34·7730	48·4386	65·4723	78·7900					
4.	·6144	2·4955	6·8103	14·0682	24·5756	30·8415	51·1827	65·3536	77·1027					
5.	·5266	2·4157	6·9011	13·3415	22·6279	34·0389	48·0340	64·2902	79·4158					
6.	·6018	2·6750	6·8440	13·5095	22·1048	34·7773	48·4831	64·8834	83·8799					

Tree No.	Height of section (feet)													
	4½	14	24	34	44	54	64	74	84	94	104	114	124	134
Diam.	3·34	7′ cone												
Basal area	0·0612	2·0 ·0218	Total volume ·6019 cft.											
Volume	·5508	·0511.												
Diam	5·93	3·50	1·25	5′ cone ·5										
B. area	·19	0·0669	·0085	·0014	Total volume ·24663									
Volume	1·71	·669	·085	·025										
					3′ cone									
Diam.	9·06	6·5	3·97	1·20	·3′7									
B. area	·4517	·2304	·0863	·0079	·0007	Total volume = 7·3								
Volume	4·0653	2·304	·863	·079	·0007									

... & comp.

Time	Height of section (feet)													
	4½	14	24	34	44	54	64	74	84	94	104	114	124	134

4½	14	24	34	44	54	64	74	84	94	104	114	124	134	
D.U.B.	D.U.B.	D.U.B.	D.U.B.											

4 E	14	24	34	44	54	64	74	84	94	104	114	124	134	
D.U.B	D.U.B	D U B	D.U.B											

Section No.	Ht of Section	Ht to section	Rings on section	Diameters O.B.	Diameters U.B.	Twice bark thickness	Average radius (U.B.)	Ht of Section.	Radius at successive decade marks. 130	120	110	100	90	80	70	60	50	40	30	20	10
8	74	63	35	~~·80~~ ~~7·8~~ 7·9	~~7·0~~ ~~7·1~~ 7·05	·0 ·85	3·5	10					2·8	1·85	·65	–	–	–	–	–	–
													2·7	1·75	·55	–	–	–	–	–	–
													5·5	3·6	1·20	–	–	–	–	–	
9	84	76	22	~~4·45~~ ~~4·60~~ 4·5	~~3·7~~ ~~4·9~~ 3·85	~~·0~~ ·65	1·9	10					1·45	·55	–	–	–	–	–	–	–
													1·2	·45	–	–	–	–	–	–	–
													2·65	1·0	–	–	–	–	–	–	–
10	91	85	13.	~~2·05~~ ~~1·8~~ 1·97	~~1·6~~ ~~1·80~~ 1·7	~~·27~~ ·27	·85	14					·58	–	–	–	–	–	–	–	–
													·30	–	–	–	–	–	–	–	–
													·9	–	–	–	–	–	–	–	–

Additional measurements

1) Total ht of the tree – 98'
2) Total age of the tree – 107 branch
3) Height of first green ~~branch~~ 23'6"
4) Ht to full crown
Average clear bole – 27'
Crown width – 25'
5) Ht to 8" diamtr (O.B.) – 77'
6) Dia. U.B. at 8" O.B. – 6·2, 6·2
7) Ht to 2" O.B. – 91'2"
8) Diam. U.B at 2" O.B dia 1·6"/1·8"=1·7"
9) Length of small stem wood 14'2"
10) Height for B. Ht. to half way 46'9"
Dia. O.B. – 14·0/12·5 = 13·3
Dia. U.B. 12·0/12·6 = 11·8".

Serial no of Section	Ht of Section	Age on section	Rings on section	Diameters O.B.	Diameters U.B.	Basic Thickness	Average radius	Length of Section	Radius at successive decades reckoned from 120	110	100	90	80	70	60	50	40	30	20	10	Additional measurements
1	4½	0	98	23·5	21·0	2·1	4·9	9				10·05	9·55	8·75	8·09	6·69	5·5	4·45	3·15	1·9	
				20·35	18·6							9·25	8·75	8·0	7·4	6·65	5·75	4·85	3·8	2·1	
				21·7	19·8							19·30	18·30	16·95	15·45	13·3	11·25	9·30	6·95	4·0	
2.	14	12	86	20·2	18·5	1·65	9·02	10				8·0	1·4	6·6	5·69	4·8	4·1	2·65	1·15	—	
				14·2	17·6							9·4	8·7	7·75	6·7	5·85	4·85	3·7	1·75	—	
				19·7	18·05							17·4	16·1	14·35	12·35	10·65	8·95	6·35	2·90	—	
3	24	15	88	19·4	17·85	1·65	8·3	10				8·35	7·75	6·75	5·8	5·0	3·85	2·3	1·05	—	
				17·1	15·5							7·15	6·55	5·8	5·1	4·6	3·45	1·95	1·0	—	
				18·25	16·6							15·50	14·3	12·95	10·9	9·6	7·30	4·29	2·05	—	
4	34	19	79	17·2	15·5	1·60	7·5	10				6·89	5·9	5·2	4·55	3·69	2·55	1·5	0·15	—	
				16·0	14·5							7·5	6·6	5·65	4·8	3·85	2·55	1·15	0·15	—	
				16·6	15·0							14·35	12·5	10·85	9·35	7·5	5·1	2·69	0·3		
5	44	33	65	15·1	13·4	1·55	6·6	10				6·25	5·9	4·2	3·05	2·0	·9	—	—	—	
				14·6	13·2							6·6	5·45	4·4	3·4	2·25	1·2	—	—	—	
				14·85	13·3							12·89	10·95	8·6	6·45	4·25	2·1	—	—	—	
6	54							10				4·6	3·75	2·75	1·9	·89	—	—	—	—	
												5·45	4·1	3·3	2·35	1·05	—	—	—	—	
												9·75	7·85	6·05	4·25	1·90	—	—	—	—	
7	64							10				4·3	3·27	2·09	·9						
												4·05	2·7	1·69	·5						
												8·95	5·95	3·90	1·0						

Computation for Bark thickness. Stem analysis

Division — Chakrata

Block & compart. kanasar

Species :—

Quality

Crown class :—

D. 2X bark thickness

I.B.

Height of section. Feet.

Tree no.	4½	14	24	34	44	54	64	74	84 Age div.	94 Age div.	104 Age div.	114 Age div.	124 Age div.	134 Age div.

Height of Section (Feet)

Tree no	4½	14	24	34	44	54	64	74	84	94	104	114	124	134
	Diab	Diab	Diab											
1.	1·95													
2.	2·95													
3.	3·0													
4.	2·7													
5.	4·75													
6.	4·7	·95												
Average	3·34													
1	3·75	1·75	–	–										
2	5·30	×	1·50	–										
3	6·95	2·90	2·05	0·30										
4	3·75	2·7	–	–										
5	8·0	5·43	–	–										
6	7·55	3·90	2·15											
Total	35·60	16·68	5·70	0·30										
Average	~~3·34~~ 5·93	3·34	·95	·05										

Decade – I

Decade II

Sec no	Height of Section (feet)													
	4½	14	24	34	44	54	64	74	84	94	104	114	124	134
	Dub	D. Ub												
40th	8·75 15	6·00	5·50	2·80	~~0·00~~									
	9·90 10	7·10	×	3·20	~~0·0~~									
	11·25 25	8·95	7·30	5·10	2·10									
	9·25 25	7·80	7·25	5·65	0									
	13·4 4	12·05	8·45	5·95	2·85									
	13·10 10	9·7	7·80	5·95	~~×~~	·20								
Total														
Average														
50th.	10·40	7·60	7·25	4·90	2·75	—	—							
	10·55	8·85	8·70	5·40	3·50	1·80	—							
	13·30	10·65	9·6	7·50	4·25	1·40	—							
	11·05	9·05	~~D·65~~	6·30	5·95	—	—							
	16·80	15·03	11·55	9·15	7·60	4·25	×							
	15·20	11·45	9·30	8·30	×	3·45	1·00							
Total														
Average														

4th decade

5th decade

Species

Division

Block and Compartment

0"-6"		6"-12"		12"-18"		18"-24"		24"-36"		36"-48"		48"-60"		60"-72"	
Age	Height	Age	Height	Age	Height	Age	Height	Age	Height	Age	Height	Age	Height	Age	Height
1	6"	2	12"	3	18"	6	24"	9	36"	14	48"				
2	6"	3	12"	4	18"	6	24"	10	36"	13	48"	16	60"	17	72"
1	6"	3	12"	6	18"			9	36"	11	48"	14	60"	18	72"
				5	14"	10	21·5"								
4	6"	4	12"	5	18"			9	36"	11	48"	14	60"	17	72"
2	6"	5	12"	6	18"	4	24"	10	36"	12	48"	14	60"	17	72"
4	6"	2	12"	4	18"			5	36"	6	48"	7	54"		
1	6"	1	12"	2	18"	3	24"	6	36"	8	48"	8	60"	19	72"
1	6"	2	12"	4	18"			8	36"	10	48"	14	60"	16	72"
2	6"	3	12"									12	54"		
												13	60"		
Total Number															
Average	2"	6"	12·8	12"	4·3	17·5	5·8	23·3	8·2	36"	10·6	48"	12·4	58·6	17·3	72

	4½	14	24	34	44	54	64	74
	D.U.B.	D.U.B.	D.U.B.	D.U.B.	D.U.B	D.U.B	D.U.B	D.U.B.
1	6·85	3·90	2·40	—				
2	9·10	4·10	×	0·70				
3	9·30	6·35	4·25	2·65	Decad 3			
4	7·35	4·80	×	—				
5	10·73	9·21	4·45	0·70				
6.	11·00	7·00	4·80	3·15				
Totals	54·33	35·36	15·90	7·20				
Av.	9·06	5·89	3·97	1·20				

Height of Section (feet)

Time No.	4½ D.U.P.	1H D.U.P.	2H	3H	4H	5H	6H	7H	8H	9H	10H	11H	12H	13H
							Decade 6th.							
6th decade	12·00	9·35	9·00	7·40	5·40	3·15	0·90	—	—					
	11·80	10·35	9·90	8·20	6·05	×	×	0·75	—					
	15·45	12·35	10·90	9·35	6·45	4·25	1·00	—	—					
	13·65	11·15	×	8·40	7·90	×	4·05	2·00	—					
	18·40	16·65	14·10	12·05	10·90	7·90	×	3·70	0·40					
	17·05	13·40	10·90	10·30	×	5·90	3·40	1·20	—					
Total														
Average														
7th	13·45	10·95	10·40	9·10	8·10	6·10	4·20	1·60	—	—				
	13·30	11·55	11·00	9·70	8·25	6·90	6·75	3·50	×	—				
	16·95	14·35	12·55	10·55	8·60	6·05	3·70	1·20	—	—				
	15·15	12·75	×	11·00	9·75	9·35	5·75	4·30	—	—				
	19·95	17·85	15·65	13·40	12·90	10·25	×	6·25	2·50	1·70				
	18·35	14·96	12·15	11·70	×	8·20	5·90	3·70	1·65	—				
Average	16·19	13·72	12·35	10·96	9·52	7·81	5·26	3·42	·91	·28				
Total														

6th decade

7th decade

Height of Section (Feet)

Tree no	4½	14	24	34	44	54	64	74	84	94	104	114	124	134
	Dia	Dia												
8th	14·75	12·55	11·90	10·85	10·00	8·60	6·90	4·60	2·40	—	—			
	14·30	13·00	12·20	10·90	9·85	8·85	8·20	6·20	X	2·05	—			
	18·30	18·10	14·30	12·50	10·75	7·85	5·85	3·60	1·00	—	—			
	17·80	15·15	14·55	13·35	12·70	10·40	7·70	6·15	4·35	—	—			
	21·20	19·10	17·25	15·50	14·70	12·00	X	9·15	5·40	3·15	—			
	19·80	16·35	13·80	13·30	X	10·40	8·20	5·80	3·65	—	—			
	17·69	15·37	14·00		11·64	9·68	7·40	5·91	3·30	0·86				
9th	21·10	17·95	15·05	15·7	—	12·85	10·60	8·4	6·1	2·95 +2·5′				
	15·90	13·85	13·1	12·1	11·3	10·00	8·55	6·95	5·75	1·25	70 -1·5′			
	19·30	17·40	15·50	14·35	12·85	9·75	8·35	5·5	2·65	·90 -3′				
	16·00	14·00	13·20	12·10	1110	10·20	8·95	7·90	X	4·20	1·55			
	22·55	20·25	18·55	16·80	1620	14·20	X	11·0	8·10	5·50				
	18·1	16·40	16·0	13·3	12·70	10·95	9·55	3·9	5·55	2·70 +1·5′				
			—											

8th decade.

Line No.	Distance of section (feet)													
	4½	14	24	34	44	54	64	74	84	94	104	114	124	134
	D.U.b	D.U.b.												
10th	—													
	—													
	—													
	—													
	23·20	21·35	19·85	18·05	17·50	16·00	×	12·95	10·10	7·55	3·45	·30 -1·5	10th decade	
	23·80	19·90	17·20	×	×	14·80	13·25	11·45	9·05 +2·5	5·80+2·50				

| | | |

Species

Division

Block and Compartment

0 - 6"		6" - 12"	12" - 18"	18" - 36"	36" - 48"	48" - 60"	60" - 72"
Age	ht.						