CHAPTER VI

RESULTS OF BORON ESTIMATION

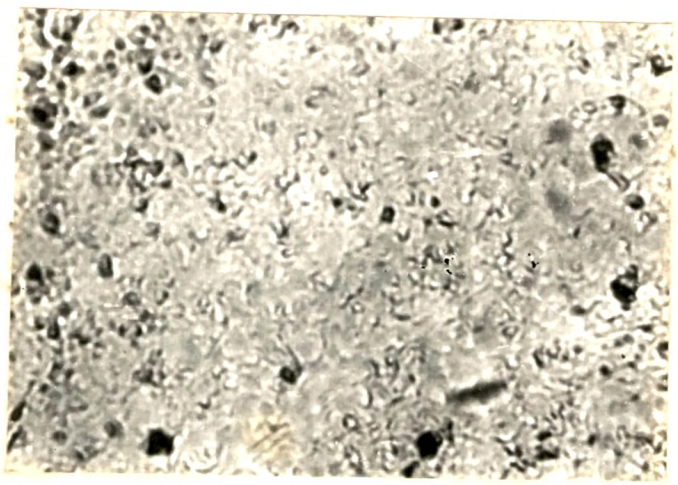
The results of boron estimation of sixty nine samples, prepared from the same twenty medicinal plants, referred earlier, are presented in this chapter.

6.1. DISTRIBUTION OF ALPHA-PARTICLE TRACKS IN CN DATECTORS:

The alpha-particle tracks revealed after etching the CN pieces are similar to those shown in plate vi. The distribution of tracks are found to be uniform.

6.2. EXPERIMENTAL DATA:

Boron contents of the plant samples are presented in table 6.1. In the first column of the table, the scientific names of the plants are given. The parts studied in each case are given in the next column. The corresponding track densities, as observed, and the boron contents, as estimated, are shown in the third and fourth columns respectively. Boron content of the standard Orchard leaves used is (33±3) ppm. The values of boron contents of the various parts of the plants(samples) are found to vary from 3.3 ppm in the stem of *E.neriifolia*



ALPHA PARTICLE TRACKS

TABLE 6.1

Boron contents of various parts of the plants.

Sl. No.	Names of the plants	Parts studied	Track density $x10^4/cm^2$	Boron content ppm
1.	Acorus Calamus, Linn	1.Leaves	2.821	8.6±0.3
		2.Root	1.870	5.7±0.2
2.	Adhatoda Vasica,Nees	1. Plant	6.068	18.5±0.4
		2. Root	5.182	15.8±0.4
		3. Flower	3.284	13.8±0.4
3.	Alstonia Scholaris,R.Br.	1. Leaves	3.287	10.0±0.3
		2. Bark	6.954	21.2±0.5
		3. Root	8.331	25.4±0.6
4.	Asparagus racemosus, Willd.	1. Plant	1.706	5.2±0.2
		2. Root	5.970	18.2±0.4
5.	Azadirachta indica,Linn.	1. Leaves	4.164	12.7±0.3
		2. Bark	2.394	7.3±0.2
		3. Root-brak	3.182	9.7±0.3
		4. Fruit	1.378	4.2±0.2
6.	Butea monosperma(Lam) Taub.	1. Leaves	3.542	10.8±0.3
		2. Bark	2.460	7.5±0.2
		3. Root	3.083	9.4±0.3
		4. Flower	2.657	8.1±0.2
		5. Seed	2.821	8.6±0.2

Table 6.1. contd.

Sl. No.	Names of the plants	Parts studied	Track density $x10^4/cm^2$	Boron content ppm
7.	Caesalpinia crista Lam.	1. Leaves	5.884	17.9±0.9
		2. Bark	5.432	16.6±0.8
		3. Root	3.952	12.1±0.8
		4. Seed	3.214	9.8±0.7
8.	Calotropis gigantea R.Br.	1. Leaves	7.042	21.9±0.5
		2. Root	8.823	26.9±0.5
		3. Flower	3.900	11.9±0.3
9.	Datura metal, Linn.	1. Plant	2.197	6.7±0.3
		2. Root	3.510	10.7±0.4
		3. Seed	3.349	10.2 ±0.3
10.	Euphorbia neriifolia, Linn.	1. Leaves	2.066	6.3 ±0.2
		2. Stem	1.082	3.3 ±0.1
		3. Root	4.723	14.4 ±0.4
11.	Mallotus Phillipinensis, Muell, Arg.	1. Leaves	3.975	12.1 ±0.3
		2. Bark	2.896	8.8 ±0.4
		3. Root	2.122	6.5 ±0.2
		4. Fruit	3.739	11.4 ±0.3
12.	Moringa Oleifora, Lam.	1. Leaves	3.136	9.6 ±0.2
		2. Bark	4.395	13.4 ±0.3
		3. Root	5.838	17.8 ±0.4
		4. Flower	3.149	9.6 ±0.3
		5. Fruit	3.739	7.4 ±0.2

Table 6.1. contd.

Sl. No.	Names of the plants	Parts studied	Track density $x10^4/cm^2$	Boron content ppm
13.	*Pongamia glabra*, Vent.	1. Leaves	4.428	13.5±0.4
		2. Bark	2.099	6.4±0.2
		3. Root	5.412	16.5±0.5
14.	*Ricinus communis* Linn.	1. Leaves	8.440	25.7±0.5
		2. Root	16.940	51.6±1.1
		3. Flowers	6.756	20.6±0.5
		4. Seed	6.273	19.1±0.4
15.	*Saraca indica* Linn.	1. Leaves	5.990	18.4±0.4
		2. Bark	9.479	28.9±0.7
		3. Root	4.526	13.8±0.4
16.	*Tamarindus indica*, Linn.	1. Leaves	4.690	14.3±0.3
		2. Bark	7.970	24.3±0.5
		3. Root	5.314	16.2±0.4
17.	*Terminellia arjuna* W & A.	1. Leaves	8.561	26.1±0.6
		2. Bark	3.018	9.2±0.3
		3. Root	9.381	28.6±0.6
18.	*Thevetia neriifolia*, Juss	1. Leaves	4.658	14.2±0.4
		2. Bark	3.969	12.1±0.3
		3. Flower	3.969	12.1±0.3
		4. Kernel	4.723	14.4±0.4
		5. Root	5.445	16.6±0.4

Table 6.1. Contd.

Sl. No.	Names of the plants	Parts studied	Track density $x10^4/cm^2$	Boron content ppm
19.	Vitex negundo. Linn.	1. Leaves	7.642	23.3±1.1
		2. Bark	15.449	47.1±1.4
		3. Root	16.990	51.8±1.6
		4. Flower	8.857	27.0±1.1
20.	Vitis quadrangularis.	1. Leaves	5.182	15.8±0.5
	Wall.	2. Stem	4.395	13.4±0.3
		3. Root	3.346	10.2±0.3

to 51.8 ppm in the root of V.negundo. In plants, the average boron content is shown to be about 50 ppm.[1-2] Earlier works[3-6] on boron estimation by using PTA method have found boron concentrations in plants in various ranges such as 10.9 ppm to 19.2 ppm, 17.7 ppm to 42.8 ppm, 57.5 ppm to 135 ppm. Thus the values of boron contents estimated here, lie within the range.

6.3. GRAPHICAL REPRESENTATIONS OF DATA:

(a) The data, shown in table 6.1, are represented by the bar diagrams of figure 6.1, A variation in boron contents among different samples is seen in most cases.

(b) The frequency as well as proportional distributions of the data are shown by the histograms in figure 6.2. The mode

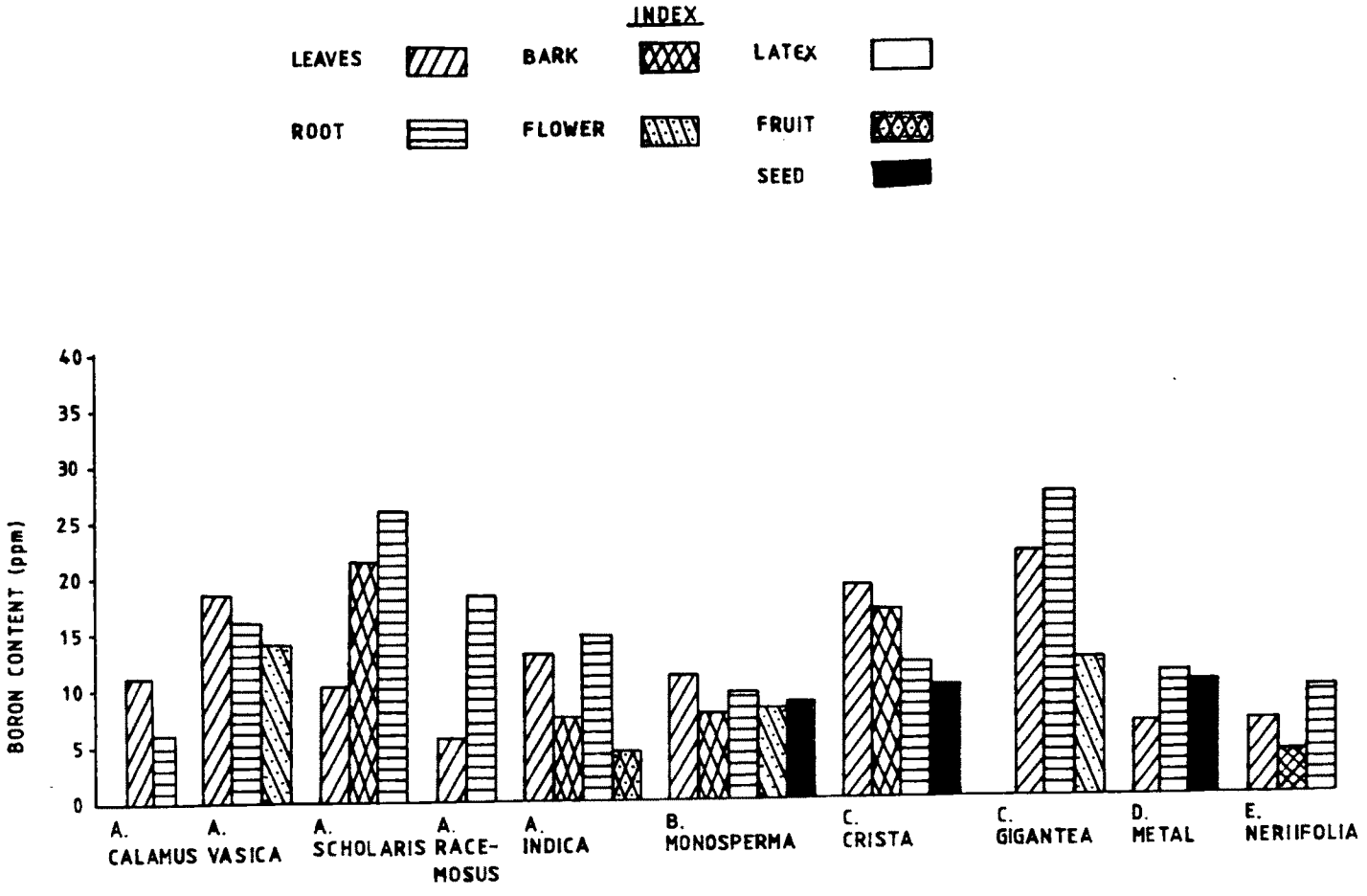


FIG. 6·1A BAR DIAGRAMS SHOWING BORON CONTENTS OF PLANT SAMPLES.

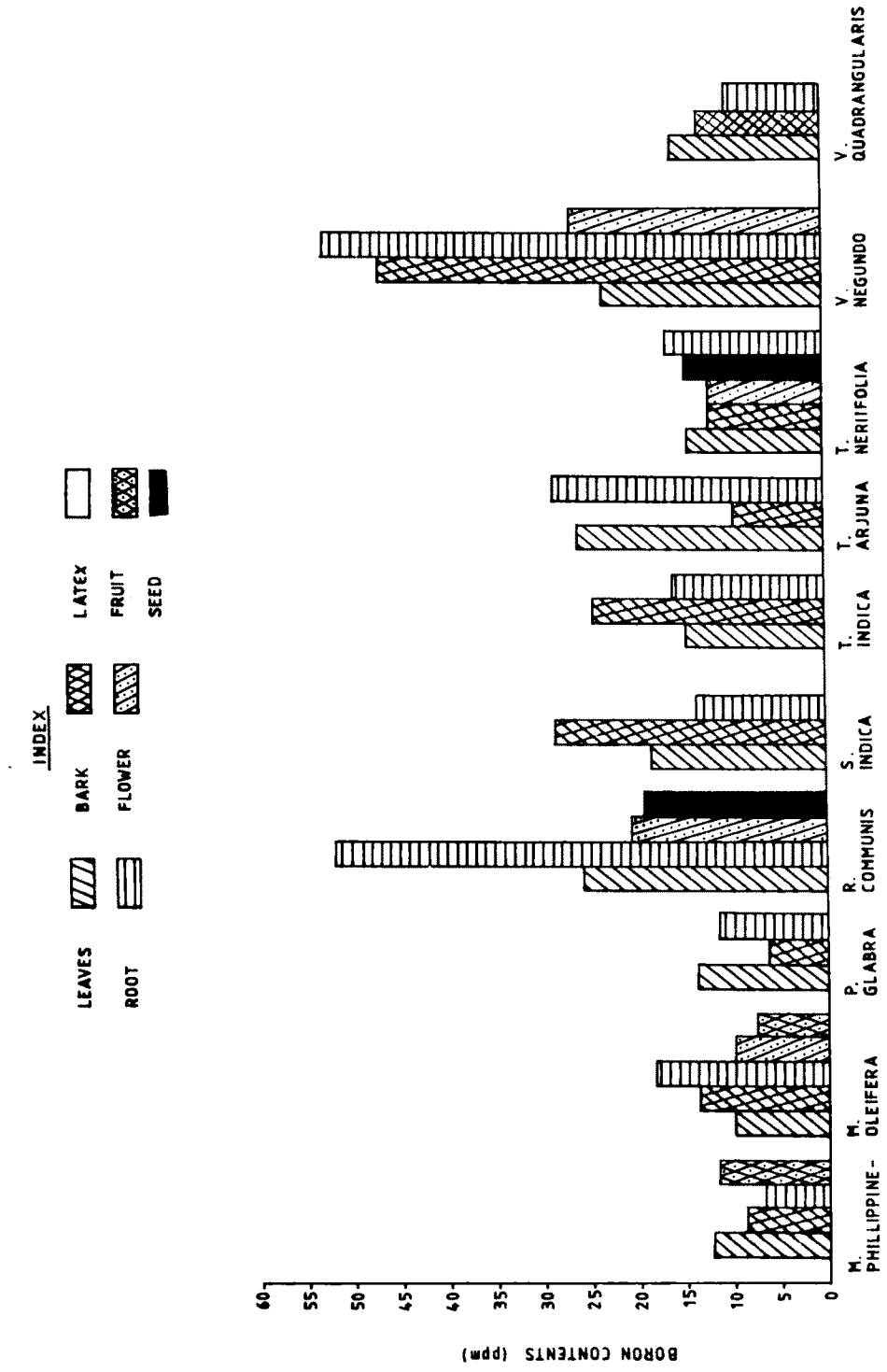


FIG. 6·1 B BAR DIAGRAMS SHOWING BORON CONTENTS OF PLANT SAMPLES.

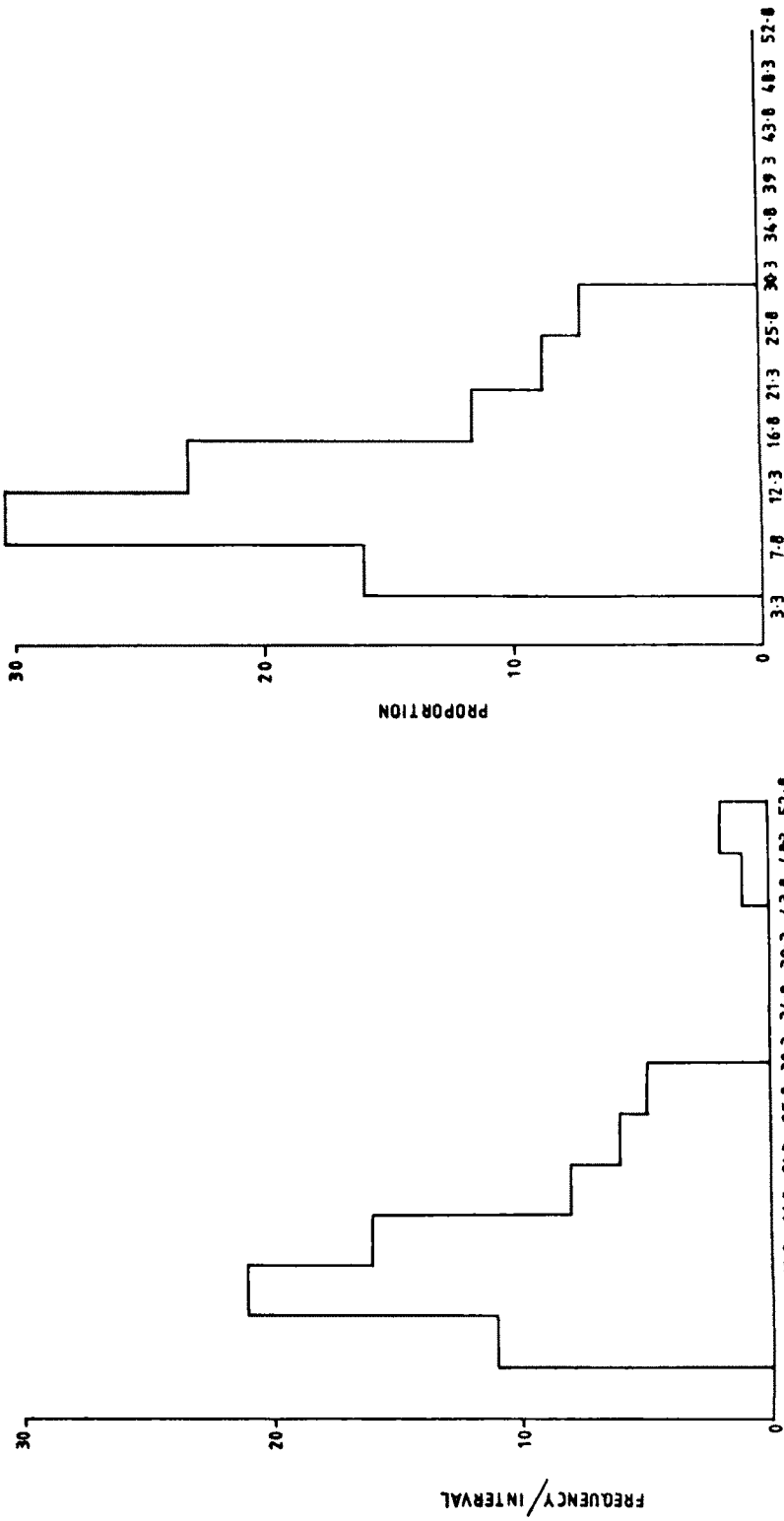


FIG. 6·2 FREQUENCY DISTRIBUTION OF THE BORON CONTENTS IN PLANT SAMPLES.

of the distribution is from 7.8 ppm to 12.3 ppm, between which 30% of the data lies. The data normally ends at about 29 ppm. There are three comparatively higher values of boron contents - 47.1 ppm, 51.6 ppm and 51.8 ppm in the bark of V.negundo, roots of R. communis and V. negundo respectively.

(c) The average boron contents of various parts, viz, leaves, barks etc, are shown by the bar diagrams of figure 6.3. Here it is seen that the boron content is comparatively higher in roots than in other parts. This may be due to the two high values in roots, mentioned in the preceeding paragraph. When these two values are excluded (shown by the shaded portion) the average boron content of the roots becomes almost equal to those in the leaves, bark and flower. The boron content of the seed and fruits (taken together) is low as compared to those of the other parts.

(d) Separate frequency distributions for leaves, bark etc. are shown in the histograms of figure 6.4. 40% of the boron contents in roots is found to lie between 13.8 ppm and 18.3 ppm. The boron contents of most parts lie within 8.3 ppm to 13.3 ppm (leaves-30%, flower 43%, fruit & seed 50% of the total), while those of bark lie within 3.3 ppm to 8.3 ppm (29% of the total).

6.4. BORON CONTENTS OF SOIL:

Boron contents of the soil samples are given in table 6.2. The values vary from 13.4 ppm to 25.8 ppm with an average

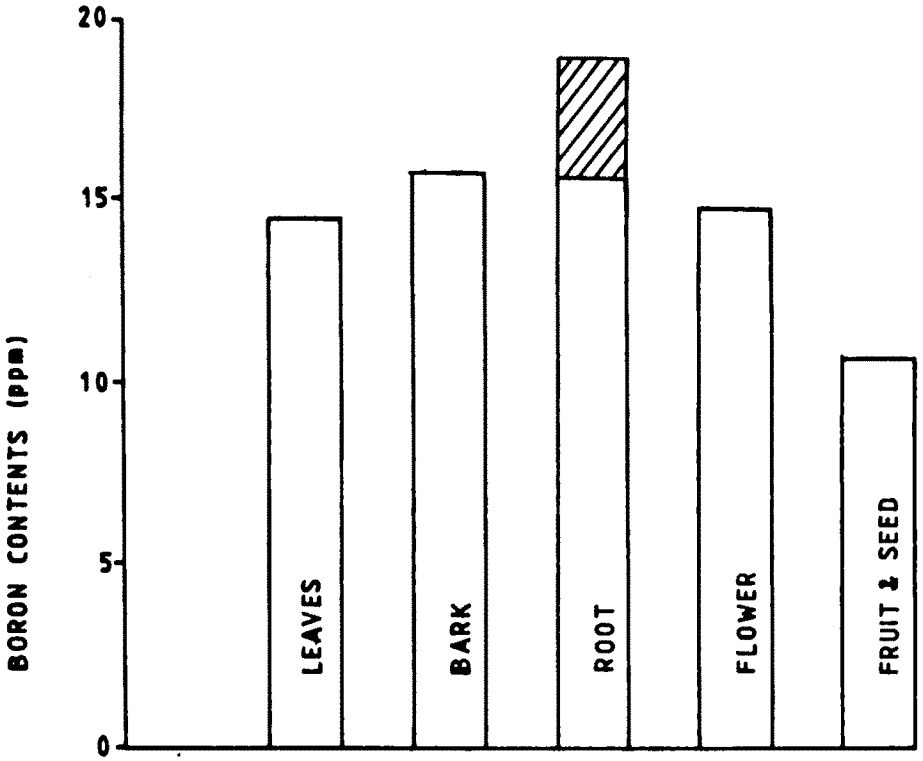


FIG. 6.3 AVERAGE BORON CONTENTS OF VARIOUS PARTS OF THE PLANT SAMPLES.

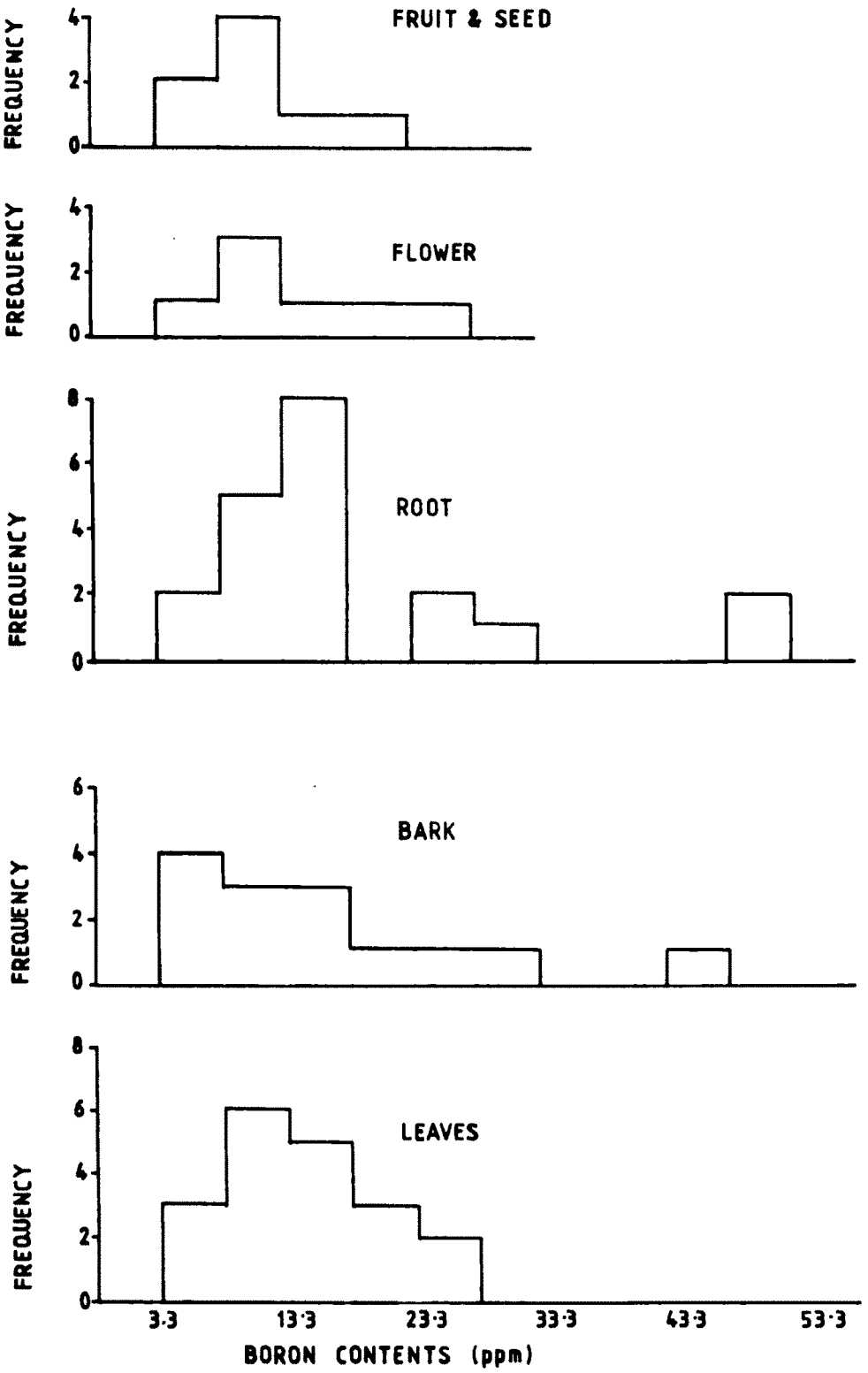


FIG. 6.4 FREQUENCY DISTRIBUTIONS OF DIFFERENT PARTS OF PLANTS.

of 20.1 ppm. The average boron content of the plant samples is 15.6 ppm, while they vary from 3.3 ppm to 51.8 ppm in the samples taken. As quoted by Gulati et al[4] the concentration of boron in soils varies from 2-100 ppm, with an average of 10 ppm. The results presented in the table lie within this range.

TABLE 6.2

Boron contents of soil samples

Sl.No.	Soil samples	Track densities $x10^4 cm^2$	Boron contents ppm
1.	No. 1	8.462	25.8±0.6
2.	No. 2	4.395	13.4±0.4
3.	No. 3	6.953	21.2±0.5

6.5. RESULTS OF T-TEST FOR SIGNIFICANCE OF VARIATION OF BORON CONTENTS IN DIFFERENT PARTS OF THE PLANTS:

The significance of difference of boron contents in various parts of the plants are tested statistically (t-test-appendix II). The results are discussed below.

(i) The leaves, and the rhizome of A.calamus plant have contents of boron, the difference in the amounts of which

is statistically significant (t = 6.101 for d.f. 95). The medicinally used part of the plant is the rhizome.

(ii) The differences between boron contents of the leaves and root, and flower and root are insignificant (t_{l-r}=1.564 and t_{fl-r}= 1.146 for d.f. 52 and 50 respectively) and that between the leaves and flower is significant (t= 3.588 for d.f. 52) in A. vasica plant. The medicinal properties of these parts are similar.

(iii) In A. scholaris, the boron contents in various parts differ significantly among one another (t_{l-b}=8.300, t_{l-r}=9.461 and t_{b-r}= 2.638 for d.f.s 70, 64 and 50 respectively). The bark and root possess the same medicinal properties.

(iv) The difference between boron contents of the leaves and root of A. racemosus plant is significant (t = 12.292 for d.f. 52). The root has a few more medicinal properties in addition to those found in leaves of this plant.

(v) The boron contents of the various parts of A. indica plant differ significantly from one another. The medicinal properties of the root-bark and fruit are similar and so also of leaves and root.

(vi) The various parts (except seeds) of B. Monosperma plant possess almost similar medicinal properties. But, the boron

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The t-values given are calculated ones, which are compared with the table value of t = 1.960 at 5% level of confidence Also l,b,r, fl, fr, s stands for leaves, bark, root, flower, fruit & seed respectively and d.f. for degrees of freedom.

content in seeds is significantly different only from that in the leaves (t = 3.415 for d.f. 105); while the parts of the plant with identical medicinal properties are found to have boron contents of significant differences (t_{l-b}= 4.872 for d.f. 115, t_{l-f} = 3.380 for d.f. 109, t_{b-r} = 2.349 for d.f.121).

(vii) The bark and leaves of the plant C.crista have the same medicinal properties; the boron contents of these two parts also are not significantly different (t = 0.881 for d.f. 69). The root also possesses similar medicinal properties, but its boron content is significantly different from that of the leaves (t = 3.208 for d.f. 64).

(viii) In C. gigantea also, the boron contents of various parts are significantly different from one another (t_{l-r}=2.12 for d.f. 42, t_{r-f}= 6.988 for d.f. 51, t_{l-f}= 4.733 for d.f. 49). The medicinal properties possessed by the leaves are almost opposite to those possessed by the root and flowers and the properties of root and flowers are almost similar.

(ix) The leaves and roots of D. metal plant possess common medicinal properties but their boron contents are significantly different (t = 4.760 for d.f. 65). The seed has a few more properties in it in addition to those found in these two parts; but its boron content is significantly different only from that in leaves (t_{s-l}= 3.216 for d.f. 78 and t_{s-r}=0.406 for d.f. 63).

(x) Boron contents of all parts of the E.neriifolia plant

are found to have significant differences (t_{l-b}= 7.788 for d.f. 136, t_{l-r}= 9.612 for d.f. 97 and t_{b-r}= 15.696 for d.f. 105). The medicinal properties of these parts are similar.

(xi) The leaves and fruits of M. philipinensis plant have medicinal properties of opposite actions (laxative and constipative). But their boron contents are not significantly different (t = 1.005 for d.f. 59). There are significant differences among boron contents of other combinations of the parts (t_{l-b}= 4.929 for d.f. 47, t_{l-r}= 10.081 for d.f. 64, t_{b-r}= 3.277 for d.f. 51, t_{b-fr}= 2.919 for d.f. 46, t_{r-fr}=7.043 for d.f. 63).

(xii) Except in leaves-flower combination, the boron contents in various parts differ significantly from one another in M.oleifera plant (t_{l-f}= 0.048 for d.f. 96, t_{l-b}= 2.914 for d.f. 66, t_{l-r}= 6.914 for d.f. 67, t_{b-r}= 3.517 for d.f. 45, t_{b-f}= 4.195 for d.f. 74 and t_{r-f}= 11.466 for d.f. 75). The medicinal properties in various parts of the plant are diverse with parallel actions.

(xiii) In P. glabra plant, leaves and root have no significantly different values of boron contents (t = 1.579 for d.f. 55), but the boron content of bark differs significantly from those of leaves and root (t_{l-b}=9.127 for d.f. 91, t_{b-r}= 7.775 for d.f. 86). The leaves and bark possess common medicinal properties.

(xiv) In R. communis plant, the boron contents are significantly different from one another in various parts (t_{l-r}=7.011 for d.f.32,

t_{l-s}= 2.833 for d.f. 51, t_{r-f}= 9.057 for d.f. 30, t_{r-s}=17.608 for d.f. 39) except in the combinations flower-leaves and flower-seed (t_{f-l} = 1.758 for d.f. 42, t_{f-s} = 0.684 for d.f. 49). Some of the various parts have similar medicinal properties.

(xv) In S. indica plant, the boron contents in various parts are significantly different from one another (t_{l-b}= 3.620 for d.f. 38, t_{l-r} = 2.310 for d.f. 51, t_{b-r}= 5.153 for d.f. 41). Here also the bark and root possess the same medicinal properties.

(xvi) In T. indica plant, the bark has significantly different boron content from both leaves and root (t_{b-l}= 4.925 for d.f. 55, t_{b-r}= 4.238 for d.f. 46), The later two have no significant difference in this respect (t_{l-r}= 1.601 for d.f.57). The medicinal properties of bark and root are same, and are different from those of the leaves.

(xvii) Barks of T. arjuna tree contain significantly different content of boron from its leaves and root (t_{b-l}=9.176 for d.f. 47, t_{b-r}= 11.783 for d.f. 48), while the later two have insignificantly different boron contents in them (t_{l-r}=1.038 for d.f. 37). However, the bark and root of this plant possess the same medicinal properties.

(xviii) Bark and root of the T. neriifolia plant, with the same medicinal properties, contain boron contents of significant difference (t = 5.178 for d.f. 55). Although the medicinal

properties of the seeds are different from those of the other parts, yet its boron content does not differ significantly from theirs (t_{s-l}= 0.142 for d.f. 57, t_{s-b}= 1.897 for d.f. 58, t_{s-f} = 1.668 for d.f. 58, t_{s-r}=1.608 for d.f. 55).

(xix) In V. negundo plant the medicinal properties of various parts are same in some respects. Significant variations of boron contents are found to contain in cases of leaves with bark, leaves with root, bark with flower and flower with root (t_{l-b}= 6.078 for d.f. 64, t_{l-r}= 5.675 for d.f. 58, t_{b-f}=4.898 for d.f. 67 and t_{f-r} = 4.822 for d.f. 61).

(xx) Leaves and root of the plant V. quadrangularis, with same medicinal properties have significant difference in boron contents in them (t = 7.301 , for d.f. 76). The stem with a number of medicinal properties differs significantly in boron content from the root, but does not do so when compared with the leaves. t = 2.743 < 1.667 for d.f. 21 + 76)

In the previous chapter significance in some respects in the modes of variation of uranium contents among the various parts of the plants was observed. This was considered to be an indication of some possible relation of medicinal properties with uranium contents of plants.

But the present analysis does not show any regularity in the manner of variations of boron contents so that it may be related to some of the medicinal properties. However the boron contents of the various groups of samples with a

particular medicinal property have been calculated and the results are discussed in the next section.

6.6. BORON CONTENTS OF VARIOUS GROUPS OF SAMPLES WITH IDENTICAL MEDICINAL PROPERTIES:

The mean boron contents of the various groups of samples having a particular medicinal property are presented in table 6.3. In this table the results show that the values of boron contents increase from 10.4 ppm (in the conception preventing group) to 20.3 ppm (in the caustic group).

These data are shown by the bar diagrams in Figure 6.5. The differences among the boron contents of the various groups of samples are not much prominant like uranium.

The t-test (appendix iv) results show that the differences among boron contents of most of the groups of table 6.3 are not significant. Only the few combinations of groups, as shown in table 6.4, have significant differences from one another. No other combination of the groups has been found to have significant difference in boron content. Moreover, the differences are sometimes significant for some groups with identical properties (e.g. stomachic-antidysenteric & antidiarrhoeics, abortifacient-conception preventing etc.) and sometimes also for some groups with medicinal properties of opposite actions (e.g. caustic-emollient).

Thus these variations are not regular in contrast to the observations in the case of uranium. Hence it is difficult to

draw any inference regarding any possible relationship between the boron contents and medicinal properties of plants.

TABLE 6.8

Boron contents of various groups of samples with a particular medicinal property.

Sl. No.	Groups of samples with medicinal properties	No. of samples	Mean Boron content ppm.	Sample S.D. ppm.
1.	Conception preventing	4	10.40±0.30	±0.60
2.	Aphrodisiac	13	12.35±1.86	±6.72
3.	Expectorant	16	12.89±1.59	±6.35
4.	Stomachic	19	12.90±1.60	±6.97
5.	Emollient	18	13.01±1.51	±6.40
6.	Antitubercular	9	14.03±2.18	±6.71
7.	Emetic	13	14.18±1.91	±6.83
8.	Anthelmintic	30	14.43±1.21	±6.61
9.	Resolvent	22	14.55±1.44	±6.73
10.	Laxative	10	14.65±1.75	±5.53
11.	Useful in ulcers	15	14.96±1.72	±6.68
12.	Antiseptic	18	14.99±1.78	±7.54
13.	Antiarthritic	16	15.12±1.12	±4.44
14.	Astringent	25	15.84±1.40	±7.02
15.	Febrifuge	30	16.08±1.33	±7.30
16.	Antispasmodic	19	16.40±1.52	±6.61
17.	Anodyne	15	16.41±1.51	±5.87

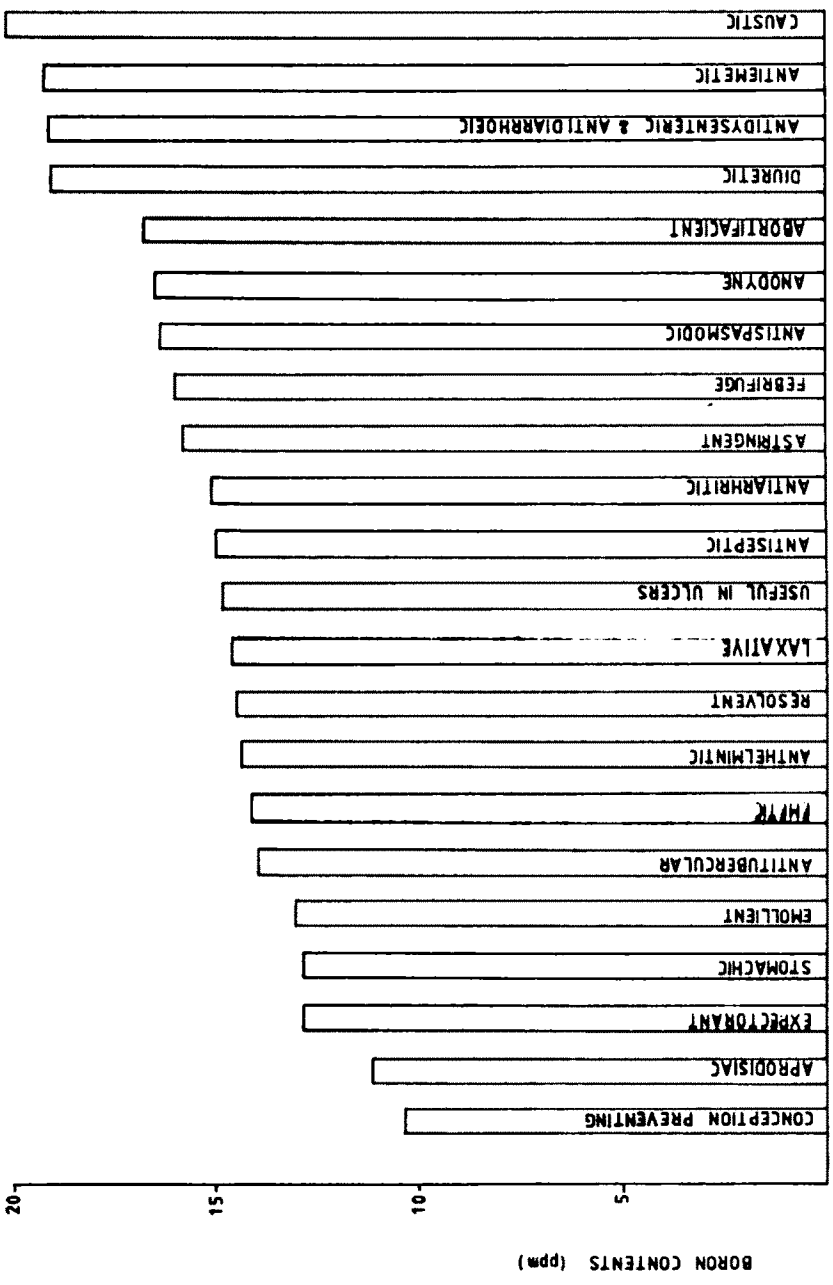

FIG. 6.5 BAR DIAGRAMS SHOWING BORON CONTENTS OF VARIOUS GROUPS OF SAMPLES WITH A PARTICULAR MEDICINAL PROPERTY.

Table 6.3 contd.

Sl. No.	Groups of samples with medicinal properties	No. of samples	Mean Boron content ppm.	Sample S.D. ppm.
18.	Abortifacient	4	16.78±1.59	±3.18
19.	Diuretic	17	19.04±3.32	±14.02
20.	Antidysenteric & Antidiarrhoiec	14	19.22±1.88	±7.05
21.	Antiemetic	7	19.26±5.45	±4.02
22.	Caustic	7	20.27±1.91	±5.06

TABLE 6.4

Results of t-text for significance of difference among some combinations of groups of samples with a particular medicinal property.

Sl.No.	Combinations of groups of samples with propery		Degrees of freedom	Calculated t-value	Table value of t for the given d.f. at 25% level of confidence
1.	Caustic-	conception preventing.	9	3.515	2.262
		- Aphrodisiac	18	2.589	2.101
		- Expectorant	21	2.599	2.080
		-Stomachic	24	2.460	2.064
		- Emollient	23	2.582	2.069
		- Anthelmintic	35	2.132	1.960
		- Antiarthritic	21	2.342	2.080
2.	Antidy- senteric & Anti- diarih- oeics	Conception prevending	16	2.357	2.120
		Aphrodisiac	25	2.490	2.060
		Expectorant	28	2.499	2.048
		Stomachic	31	2.483	1.960
		Emollient	30	2.521	1.960
		Anthelmintic	42	2.141	1.960
3.	Aborti- facient	Conception preventing.	6	3.415	2.447

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