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TABLES

ZONE	ALTITUDE (M)
Lowland	Sea level - 450
Montane	450 - 900
Subalpine	900 - 1,400
Alpine	>1,400

TABLE 1. Altitudinal Zonation (according to Wardle, 1963)

ALTITUDE FT	(M)	WARDLE'S FLORISTIC ZONES	MORRIS'[1] TEMP. ZONES °C	TAYLOR POHLEN ZONES	THORNTHWAITE[2] ZONES	MILLER[3] ACCL. ZONES °C	
				Alpine	1		
6000	(1828)	Alpine					
5000	(1524)		3.8		15		
			5.0		16	10	TIMBERLINE (43°LATS.)
4000	(1219)	Subalpine		Subalpine	32		
3000	(914)						
2000	(609)	Montane			63		
1000	(304)						
		Lowland			763		
0							

TABLE 2. Concepts of Altitudinal Zonation, as compared with those expressed by Taylor and Pohlen (1962).

(1) Refers to mean annual air temperature °C determined at these altitudes.

(2) Thornthwaite's temperature efficiency index $i = \frac{T-32}{4}$

(3) Accumulated temperature for the three warmest months calculated from a threshhold temperature of 43°F.

SOIL NAME	GROUP	TEXTURE	PARENT MATERIAL	VEGETATION	ALTI. RANGE (ft)
Carrick	(1) Y.B.E.	Fine Sandy	Solifluct Schist	Poa colensoi F.N.Z.	3000 - 4500
Kaikoura	Y.B.E.	Loam	Greywacke	Snow tussock Alpine herbs	up to 6000
Kirkliston	Y.B.E.	Sandy loam	Greywacke	Carpet grass	3000 - 5000
Hohonu	(2) Pod Y.B.E.	Sandy loam	Granite	Carpet grass	3000 - 5500
McKerrow	Pod Y.B.E.	Silt loam	Schist		3000 - 5000
Moonlight	Y.B.E.	Sandy loam	Schist	Red tussock	1000 - 5500
Obelisk	Y.B.E.	Sandy loam	Schist	Snow tussock	4200 - 5400
Puketeraki	Y.B.E.	Silt loam	Greywacke	Snow tussock	3500 - 5500
Resolution	Pod Y.B.E.	Sandy loam	Gneiss		3000 - 5000
Spenser	Y.B.E.	Sandy loam	Greywacke	Carpet grass	3500 - 6500

TABLE 3. Characteristics and Altitudinal Range of some Mountain Soil Sets

(1) Yellow-brown earths (2) Podzolised yellow-brown earths

SOIL	HORIZON	MECHANICAL ANALYSIS %				BULK DENSITY g/cm^3	TOTAL POROSITY %	MACRO POROSITY %
		2 - 0.2 mm	0.2 - .02 mm	.02 - .002 mm	<.002 mm			
Kaikoura steepland(1)	A	11 - 44	27 - 44	18 - 27	11 - 22	.62 - .78	69 - 74	26 - 30
	B	11 - 42	29 - 36	18 - 30	11 - 24	.87 - .97	62 - 66	18 - 22
Subalpine(2)	A	13	38	27	22	.58	75	29
	B	11	35	30	24	.76	70	24
Alpine(3)	A	44	27	18	11	.78	69	30
	B	42	29	18	11	.97	62	18

TABLE 4a. Physical Analyses taken from a Range of Mountain Soils.

(1) McDonald, 1960.

(2) Molloy, 1964.

(3) Molloy, 1964.

SOIL	HORIZON	MOISTURE CONSTANTS Field Capacity % by Vol.	Wilting Point % by Vol.	Available Moisture % by Vol.
Kaikoura[1]	A	21 - 40	9 - 17	12 - 23
	B	27 - 36	13 - 16	14 - 20
Sublapine[2]	A	32	14	18
	B	36	16	20
Alpine[3]	A	21	9	12
	B	27	14	13
Alpine[4] (Yellow brown earth)	A	77	42	35
	B	66	33	33

TABLE 4b. Moisture Storage Capacity from a Range of Mountain Soils.

(1) McDonald, 1960.
(2) Molloy, 1964.
(3) Molloy, 1964.
(4) Archer, 1971.

LANDFORM ASSOCIATION OR FORMATION		CORRELATION WAIMAKARIRI	WESTLAND
SPEIGHT	GEOL. SURVEY MAP	GAGE 1958	GAGE & SUGGATE 1958
Pukaki	Tekapo	Poulter	Kumara -3
Maryburn	Mt John	Blackwater	Kumara -2

TABLE 5. Chronology of late Otiran Glaciation.

MORAINE SET	AGE	DESCRIPTION	CORRELATION WAIMAK.	CAMERON VALLEY
Dun Fiunary	1930-1750 AD	Largely unvegetated	CAHILL[1]	ARROWSMITH[2]
Jacks Stream	1300 BP	Partially vegetated		
Ferintosh	2000-4000 BP	Vegetated partly breached by stream	WHITE?[1]	MARQUEE[2]
Birch Hill	9000 BP	Vegetated breached and eroded by stream	CROW?[1]	WILD MAN[2] I & II

TABLE 6. Aranuian and late Otiran Moraine Sets

(1) Burrows unpublished

(2) Burrows (1973)

PERENNIAL SNOW AND ICE	SOUTH AND EAST ASPECTS	NORTH AND WEST ASPECTS
(Hectare)	(Hectare)	(Hectare)
120	2713	1417

TABLE 7. Summary of the Areas related to Aspect in the Twin Stream Catchment.

ALTITUDE (M)	ASPECT	MEAN ANNUAL TEMPERATURE ^{o}C	THORNTHWAITE T - E INDEX	ZONE
1400	E.S.E.	3.6	12.53	
1250	South	4.4	13.29	Alpine
1250	North	6.0	18.87	
				Subalpine
1200	East	6.3	21.12	
850	E.S.E	8.1	27.89	Montane

TABLE 8. The Relationship between Thornthwaite's T - E Index and Mean Annual Temperature ^{o}C and the Altitudinal Zones in the Twin Stream Catchment.

DATE 1968-1969	1200m (S) °C	1200m (N) °C	DIFF. °C	(± S.E.)
June	3.8	8.2	4.4	1.61
September	1.7	7.3	5.5	1.90
December	8.1	11.2	3.1	1.92
March	6.5	10.7	4.2	1.84
Mean	5.0	9.3	4.3	1.82

TABLE 9. Mean Diurnal Temperature Range (°C) during the Soltices of 1968 and the Equinoxes of 1968 and 1969 on the North and South Aspects.

DATE 1970-1971	FIELD STATION 850 (M)	PYRAMID BASIN 1480 (M)	DIFF.
	mm	mm	mm
December	64.5	116.8	52.3
January	40.4	85.8	45.4
February	32.3	52.3	20.0
March	35.3	41.9	6.6
April	50.0	192.0	142.0
May	134.6	200.7	66.1
Total	357.1	689.5	
Mean	59.52	114.92	55.4 Ratio 1.93

TABLE 10. Altitudinal Comparison of Monthly Rainfall between Field Station (850 m) and Pyramid Basin (1480 m) in 1970 - 1971.

SNOW COURSE (m)	PERIOD	NO. OF DAYS	TOTAL WATER EQUIVALENTS (cm)	RATE PER DAY
	1969			
1,371	15 June - 3 July	19	4.80	.252
1,524	15 June - 5 Sept.	83	17.30	.207
1,645	15 June - 5 Sept.	83	22.60	.207
	1970			
1,371	30 June - 6 Oct.	99	19.50	.197
1,524	30 June - 6 Oct.	99	36.80	.372
1,645	30 June - 6 Oct.	99	43.30	.437
	1971			
1,371	7 July - 1 Aug.	26	3.30	.125
1,524	1 June - 14 Oct.	136	33.00	.242
1,645	1 June - 14 Oct.	136	43.60	.320

TABLE 11. Net Accumulation of Snowpack, 1969 - 1971, in Pyramid Basin Snow Courses

(Altitudinal Range: 1,371m - 1,645 m)

SNOW COURSE (m)	PERIOD	NO. OF DAYS	TOTAL WATER EQUIVALENTS (cm)	RATE PER DAY
	1969			
1,524	6 Sept. - 3 Oct.	28	17.30	.616
1,645	6 Sept. - 3 Oct.	28	11.90	.425
	1970			
1,524	7 Oct. - 24 Oct.	18	23.80	1.320
1,645	7 Oct. - 24 Oct.	18	11.51	.640
	1971			
1,524	15 Oct. - 4 Nov.	19	33.00	1.730
1,645	15 Oct. - 4 Nov.	19	30.00	1.570

TABLE 12. Net Ablation of Snowpack, 1969 - 1971, in Pyramid Basin Snow Courses

(Altitudinal Range: 1,524m - 1,645m)

ALT.	ASPECT	CYCLES (%)	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL %
							percent		of	month					
850	E.S.E.	Ice days[1]				-	-	-	3	-	-	-	-		1
		Frost free[2]	100	100	100	87	45	46	42	55	56	74	96	100	75
		Frost altern.[3]				13	55	53	55	45	44	26	4		24
1460	E.S.E.	Ice days							13	19					3
		Frost free	100	96	100	66	29	30	26	35	44	52	93	97	64
		Frost altern.		4		34	71	70	61	45	56	48	7	3	33
1550	S.E.	Ice days	4			NO	10	37	61	22			NO		15
		Frost free	90	96	71		16						DATA		24
		Frost altern.	6	2	29	DATA	74	63	39	71	100	100	20		60

TABLE 13. Freeze-thaw cycles ranging in altitude (850 m - 1,550 m) - 1968-1972.

(Temperatures recorded above snow surface from thermograph probes)

(1) Ice Days — Temp. °C — 0°C and below during 24 hr period.

(2) Frost free — Temp. °C — Above freezing during 24 hr period.

(3) Frost alternate — Temp. °C — Alternate, freezing and above during 24 hr period.

1968/ 1970	NORTH %	N.E. %	EAST %	S.E. %	SOUTH %	S.W. %	WEST %	N.W. %
JAN	9	8	15.	6	NIL	12	19	24
FEB	6	5	10	10	"	15	21	33
MAR	4	10	5	7	"	10	23	41
APR	2	4	5	4	"	10	35	42
MAY	4	9	5	5	"	7	22	46
JUNE	5	4	1	7	"	10	25	48
JULY	15	8	7	5	"	15	15	35
AUG	10	7	7	5	"	7	20	35
SEP	6	10	7	4	"	20	13	37
OCT	4	10	13	11	"	13	15	34
NOV	7	6	7	5	"	18	15	40
DEC	8	4	20	5	"	15	18	32

TABLE 14. Percent of Wind Direction, 1968 - 1970, from Field Station (850 m). (Height of Instrument 2 m above ground.)

DEPTH (cm)	SEP.-OCT.-NOV. SPRING (°C)	DEC.-JAN.-FEB. SUMMER (°C)	MAR.-APR.-MAY AUTUMN (°C)	JUN.-JUL.-AUG. WINTER (°C)	MEAN (°C)
ALTITUDE: 850m	ASPECT: S.E.	ELDEFULVIC SOILS			
-30	7.0	13.8	9.3	1.1	7.8
ALTITUDE: 1250m	ASPECT: S.	ELDEFULVIC-ELEFULVIC SOIL			
- 5	2.1	9.6	3.7	-2.3	3.2
-10	1.8	9.3	4.1	-2.0	3.3
ALTITUDE: 1250m	ASPECT: N.	CLINI-ELDEFULVIC SOIL			
- 5	4.3	9.6	8.0	0.8	5.6
-10	4.0	10.3	6.0	0.5	5.2
ALTITUDE: 1480m	ASPECT: E.S.E.	ELEFULVIC SOIL			
- 5	1.6	11.0	4.0	-1.6	3.8
-10	0.1	9.3	3.4	-2.0	2.7
ALTITUDE: 1550m	ASPECT: S.E.	FULVI-ELEGELIC SOIL			
- 5	-3.0	6.6	2.0	-3.5	0.52
-10	-2.6	4.5	2.5	-2.6	1.7

TABLE 15. Seasonal Variation of Mean Soil Temperature (°C), 5cm depth, throughout a Number of Soils. (Altitude: 850m - 1550m) (Data compiled over a 4 year period - 1968-1972)

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
nperature	°F	58.2	57.8	53.8	46.3	40.9	37.3	34.5	38.7	41.5	46.5	50.5	53.7	46.6
	°C	14.4	14.0	12.0	7.8	4.4	2.8	1.5	3.5	5.0	7.8	10.0	12.0	8.1
infall	in	3.6	4.7	6.8	6.8	3.8	3.4	5.8	7.9	6.0	7.9	7.5	6.1	74.80
	mm	91.4	119.3	172.7	172.7	96.5	86.3	147.3	200.6	152.4	200.6	190.5	154.9	1785
Heat Index		5.04	4.92	3.81	2.02	0.98	0.44	0.14	0.63	1.08	2.06	2.98	3.79	27.89=I
ADJ P-E	mm	1.0	1.0	0.9	0.6	0.4	0.2	0.1	0.3	0.4	0.6	0.7	0.9	
J PE	mm	98	82	73	42	25	11	6	21	30	53	65	90	
orage Change	mm	-7	+7	0	0	0	0	0	0	0	0	0	0	
orage	mm	95	102	102	102	102	102	102	102	102	102	102	102	
tual vaporation	mm	98	82	73	42	25	11	6	21	30	53	65	90	599
ter deficit	mm	0	0	0	0	0	0	0	0	0	0	0	0	
rplus water	mm	0	37	99	131	71	75	141	180	122	148	125	90	1219
n off	mm	56	46	73	102	86	106	124	152	137	142	134	112	

P.E. mm = 599 Humidity Index = $\frac{1219}{599}$ 100%

idity Index mm = 0 Moisture Index = 100% Summer conc. of thermal efficiency = 45%

TABLE 16. Water Budget of the Cass Soil at 850m (after Thornthwaite). Data compiled during the period 1967 - 1970.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Precipitation																
P (mm)	442	124	97	64	24	119	171	88	118	32	103	371	114	27	261	2155
Evaporation[(1)]																
(mm)	71	114	109	122	117	90	62	55	-	-	11	24	27	157	149	1107

TABLE 17. Monthly Precipitation and Evaporation. Lower Field Station (850 m) October 1968 - December 1969 (Archer & Collett, 1971).

(1) Evaporation recorded from a raised pan evaporimeter.

ALTITUDE (M)	1470	1470	1470	1560
ASPECT	E.S.E.	NORTH	NORTH	S.E.
Ht above GD	1m	1m	GD surface	GD surface
PRECIP/PE	1.8	0.6	1.4	3.1

TABLE 18. Ratio of Precipitation and Potential Evapotranspiration, during January - February, 1971.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Precipitation	(mm)	162	140	266	75	203	120	253	304	200	442	124	96	2385
Saturation Def.	(mm)	3.73	4.59	4.20	2.41	2.90	1.59	0.97	2.05	2.80	2.80	3.70	3.27	35.99
Water Need	(mm)	87.60	98.40	84.00	48.00	58.00	31.80	19.40	41.00	56.00	56.00	74.00	65.40	
Hum. Coeff.		1.84	1.42	3.16	1.55	3.50	3.77	13.04	7.40	3.57	7.89	1.67	1.46	50.27
Rain Need	(mm)	75	43	182	28	146	89	234	264	144	386	50	31	
Water Stored	(mm)	75	100	100	100	100	100	100	100	100	100	100	100	
Leaching Rainfall	(mm)	75	43	182	28	146	89	234	264	144	386	50	31	1672
Available H_2O		162	140	266	75	203	120	253	304	200	442	124	96	

TABLE 19. Humidity Coefficients calculated for 850 m Altitude Zone on the S.E. Aspect.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Precipitation	(mm)	162	140	266	75	203	120	253	304	200	442	124	96	2385
Saturation Def.	(mm)	3.73	4.59	3.26	2.12	1.84	1.56	0.75	1.32	1.13	1.91	2.78	2.25	27.24
Water Need	(mm)	74.60	90.60	65.20	42.40	36.80	31.20	15.00	26.40	22.60	38.20	55.60	45.00	
Hum. Coeff.		2.17	1.55	4.08	1.77	5.52	3.85	16.87	11.52	8.85	11.57	2.23	2.13	72.1
Rain Need	(mm)	87.40	49.40	200.80	32.60	166.20	88.80	238.00	277.60	177.40	403.80	68.40	51.00	
Water Stored	(mm)	87.40	100	100	100	100	100	100	100	100	100	100	100	
Leaching Rainfall	(mm)	87.40	49.40	200.80	32.60	166.20	88.80	238.00	277.60	177.40	403.80	68.40	51.00	1841.4
Available H_2O		162	140	266	75	203	120	253	304	200	442	124	96	

TABLE 20. Humidity Coefficients calculated for the 1,200 m Altitude Zone on the North Aspect

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Precipitation	(mm)	162	140	266	75	203	120	253	304	200	442	124	96	2385
Saturation Def.	(mm)	3.60	4.54	3.06	1.44	1.55	1.22	0.20	0.51	0.52	0.79	2.83	1.53	21.79
Water Need	(mm)	72.00	90.80	61.20	28.80	31.00	24.40	4.00	10.20	10.40	15.80	56.60	30.60	
Hum. Coeff.		2.25	1.54	4.40	2.60	6.50	4.90	63.20	29.80	19.20	27.90	2.19	3.20	167.68
Rain Need	(mm)	90.00	49.20	204.80	72.40	172.00	95.60	249.00	293.80	189.60	426.20	67.40	65.40	
Water Stored	(mm)	90.00	100	100	100	100	100	100	100	100	100	100	100	
Leaching Rainfall	(mm)	90.00	49.20	204.80	72.40	172.00	95.60	249.00	293.80	189.60	426.20	67.40	65.40	1975.40
Available H_2O	(mm)	162	140	266	75	203	120	253	304	200	442	124	96	

TABLE 21. Humidity Coefficients calculated for the 1,200 m Altitude Zone on the South Aspect

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
recipitation	(mm)	242	210	396	110	302	180	373	454	300	662	244	136	3609
aturation Def.	(mm)	2.82	4.16	1.92	0.47	0.20	0.20	0.10	0.10	0.25	0.45	1.75	1.50	13.8
ater Need	(mm)	56.40	83.20	38.40	9.40	4.00	4.00	2.00	2.00	5.00	9.00	35.00	30.00	
um. Coeff.		4.29	2.52	10.31	11.70	75.50	45.00	186.50	227.00	60.00	73.50	6.97	4.50	707.7
ain Need	(mm)	181.00	126.80	357.60	100.60	298.00	176.00	371.00	452.00	295.00	653.00	209.00	106.00	
ater Stored	(mm)	181	100	100	100	100	100	100	100	100	100	100	100	
eaching Rainfall	(mm)	181.00	126.80	357.60	100.60	298.00	176.00	371.00	452.00	295.00	653.00	209.00	106.00	3326
vailable H_2O		242	210	396	110	302	180	373	454	300	662	244	136	

TABLE 22. Humidity Coefficients calculated for the 1,550 m Altitude Zone on the S.E. Aspect

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	$\bar{X}$	
T°C	13.3	14.4	14.4	7.8	7.8	2.2	-0.6	3.3	5.6	6.1	9.4	11.1	7.9	
Hum. Coeff.	1.84	1.42	3.16	1.55	3.50	3.77	13.04	7.4	3.57	7.89	1.67	1.46		
A (provisory)	0.58	0.60	0.67	0.22	0.25	0.03	0.00	0.06	0.14	0.17	0.34	0.42		
h/12	1.28	1.17	1.05	0.91	0.86	0.81	0.76	0.86	0.99	1.13	1.20	1.30		
A	0.74	0.70	0.70	0.20	0.21	0.02	0.00	0.05	0.14	0.19	0.40	0.54	0.34	G.I.

TABLE 23. Calculation of Growth Index (S.E. Aspect, 850 m site)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	$\bar{X}$	
T°C	10.7	12.3	12.3	5.3	4.8	0.78	0.00	0.00	1.0	2.5	6.4	10.3	5.5	
Hum. Coeff.	2.17	1.55	4.08	1.77	5.52	3.85	16.87	11.52	8.85	11.57	2.23	2.13		
A (provisory)	0.41	0.48	0.51	0.11	0.09	0.00	0.00	0.00	0.01	0.03	0.18	0.41		
h/12	1.28	1.17	1.05	0.91	0.86	0.81	0.76	0.86	0.99	1.13	1.20	1.30		
A	0.52	0.56	0.53	0.10	0.07	0.00	0.00	0.00	0.01	0.0.3	0.21	0.52	0.22	G.I.

TABLE 24. Calculation of Growth Index (North Aspect, 1,200 m site)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	$\bar{X}$	
T°C	10.3	11.6	11.5	4.4	4.5	-0.56	-2.0	-0.44	0.00	1.50	5.9	8.4	4.6	
Hum. Coeff.	2.25	1.56	4.4	2.6	6.5	4.9	63.2	29.8	19.2	27.9	.2.19	3.2		
A (provisory)	0.38	0.45	0.49	0.10	0.09	0.00	0.00	0.00	0.00	0.02	0.13	0.30		
h/12	1.28	1.17	1.05	0.91	0.84	0.81	0.76	0.86	0.99	1.13	1.20	1.30		
A	0.48	0.52	0.51	0.09	0.07	0.00	0.00	0.00	0.00	0.02	0.15	0.39	0.18	G.I.

TABLE 25. Calculation of Growth Index (South Aspect, 1,200 m Site)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	$\bar{X}$	
T°C	8.9	10.2	10.1	3.0	3.1	-2.0	-3.4	-2.0	-1.4	0.00	4.5	7.0	3.1	
Hum. Coeff.	4.29	2.52	10.31	11.7	75.5	45.0	186.5	227.0	60.0	73.5	6.97	4.5		
A (provisory)	0.30	0.38	0.39	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.09	0.21		
h/12	1.28	1.17	1.05	0.91	0.84	0.81	0.76	0.86	0.99	1.13	1.20	1.30		
A	0.38	0.44	0.40	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.10	0.27	0.14	G.I.

TABLE 26. Calculation of Growth Index (S.E. Aspect, 1,550 m Site)

CAT. I	CAT. II	CAT. III	CAT. IV			CAT. V		CAT. VI
BASAL FORM	MAIN ENERGY STATUS	CLASS	ILLUVIAL HORIZONS	PANS AND MOTTLES	GLEY	ORGANIC MATTER RANGE %	ENLEACHING	PARENT MATERIAL
.) SKELIFORM	ELESKELOUS	ELEGELIC		Few - distinct	Weak - Moderate	7 - 34	Very strong - Moderate	Weak comminuted chlorite schist and greywacke solifluct
		ELELITHIC		Nil		0 - 5	Very strong	Weak comminuted schist and greywacke
		ELECLINIC		Nil	Nil - Weak	7 - 20	Moderate - Strong	Weak comminuted schist and greywacke
		ELELUVIC		Nil	Weak	0 - 5	Moderate - Strong	Weak comminuted glacio-fluvial outwash
?) ORGANIFORM	ELEORGANOUS	ELEPLATIC		Few - distinct	Weak - Moderate	16 - 20	Moderate - Strong	Weak comminuted schist and greywacke
3) FULVIFORM	ELEFULVOUS	ELEFULVIC	Clay, iron	Nil - Few	Nil - Moderate	4 - 15	Strong - Very strong	Weak argillised schist and greywacke
	ELDEFULVOUS	ELDEFULVIC	Clay, iron	Nil - Many	Nil - Moderate	4 - 15	Strong - Very strong	Weak argillised schist and greywacke

TABLE 27. Technical Classification of the Main Basal Groups of Soils

CLASS	INTERGRADE	PARENT MATERIAL	PHYSIOGRAPHY	DRAINAGE	HORIZON	BASE STATUS OF A HORI.%	ORGANIC MATTER	O.M.%	GLEY,MOTTLES ETC	ILLU-VIATION	REGIME
Elegelic	Lodi-	Greywacke,schist, solifluct	Solifluction lobe	Impeded	Well developed O, shallow incipient B	2 - 4	Platy humicol, humiskel	20	Diffused gley few distinct mottles	Weak	Flushing, strong organic
	Pulvi-	-do-	-do- ,frost hummocks	Well drained	Well developed humic A,incipient B	4 - 8	Lithiskel, humiskel	20	Weak gley	Weak	-do-
Eleclinic		Greywacke,schist, solifluct,moraine	Moraine,outwash fans	Excess drain	Raw mineral soil	4 -12	Lithiskel	0-5	Nil	Weak	Flushing
	Humi-	-do-	-do-	Well drained	Shallow O, well developed humic A if B incipient	3 -10	Humiskel lithiskel complex	5-20	Nil	Weak	Flushing, strong organic
Elelithic		Ridge detritus, unstable colluvium	Ridge crest eroded steepland	Excess drain	Raw mineral soil	1 - 3	Lithiskel	0-5	Nil	Weak	Wasting
Eleluvic		Glacio-fluvial outwash	Basins or depressions in terrain	Imperfect poorly drained	Thin A forming on fresh fine textured sediment,possible buried incipient B	4 -12	Humiskel lithiskel	0-5	Weak-moderate gley,mottling	Weak	Flushing, mixing of fresh sediment
Eleplatic		Outwash	Basins	Poorly drained	O,overlying C_1 of silt,sand	30	Humicol, humiskel	15	Humic gley	Weak	Flushing, mixing
	Luvi-eleplatic	-do-	-do-	-do-	-do-	0 -15	Humiskel platy humicol	15	Strong-mod. gley,mottling	Weak	Topogenous bog
Elefulvic		Greywacke,schist colluvium,moraine	Steepland,toe of slopes	Well drained	A,B,C	5 - 7	Humicol lithiskel complex	15	Nil	Clay, iron	Leaching, strong org.
	Madenti-	-do-	Depressions, toe of slopes	High seasonal water-table	A,B,C	7 -17	-do-	5	Humic gley mottling	-do-	Gleying, strong org.
	Clini-	-do-	Steepland	Excess surface drainage	A,B,C	4 -10	-do-	5-15	Nil	Weak	Wasting
	Enleached phase	-do-	-do- to undulating terrain	Well drained	O,A,B,C	4 -13	Ligno-parenchymal humiskel	5-15	Moderate-strong mottling	Clay, iron	Strongly enleached
Eldefulvic		-do-	-do-	-do-	A,B,C	5 -11	Humicol lithiskel complex, mullicol	5-15	Weak mottling	Clay, iron	Leaching strong org.
	Clini-	-do-	Steepland	Excess surface drainage	A,B,C	5 -11	Humicol lithiskel complex	5-15	Nil	Weak	Wasting
	Madenti-podi-	-do-	-do- to undulating terrain	High seasonal water-table	A,B,C	6 -13	Ligno-parenchymal humiskel	5-15	Moderate-strong mottling	Clay, iron	Gleying strong org.

TABLE 28. Technical Classification of Category III with Intergrades

HORI.	DEPTH (cm)	ORG.C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	BS %	pH
					M.e/100gm							
O_1	0-5	-	-	-	-	-	-	-	-	-	-	-
O_2	5-14	17.50	0.75	23	0.17	0.13	0.16	0.11	21.02	0.57	2.7	3.95
Og	14-31	8.79	0.50	17	0.05	0.10	0.07	0.06	14.66	0.28	1.9	4.05
(u)O	31-34	-	-	-	-	-	-	-	-	-	-	-
(u)G	34-41	-	-	-	-	-	-	-	-	-	-	-
(u)B	41-51	3.61	0.25	14	0.08	0.12	0.07	0.09	17.48	0.34	1.9	4.50

HORI.	DEPTH (cm)	Ca-P	Alfe-P	Occ-P	Total Inorg. P	Org. P	Total P	Allophane
		Phosphorus Fraction p.p.m.						
O_1	0-5	-	-	-	-	-	-	-
O_2	5-14	trace	59	313	372	1003	1375	Weak
Og	14-31	-	3	513	516	684	1200	Moderate
(u)O	31-34	-	-	-	-	-	-	-
(u)G	34-41	-	-	-	-	-	-	-
(u)B	41-51	10	95	197	302	618	910	Strong

TABLE 29. Chemical Analysis - Lodi-elegelic Soil

ALTITUDE: 1,500 - 1,800 m
ASPECT: South
SLOPE: Undulating

MEAN TEMPERATURE - AIR : 1 - 2°C
- SOIL: 0 - 1°C
PRECIPITATION: 3,000 - 3,500 mm

Hg/Hl : 0.97

HORI.	DEPTH (cm)	CLAY < .002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
O_1	0-5	-	-	-	-	---
O_2	5-14	6	46	40	8	Silt loam
Og	14-31	9	44	40	7	Silt loam
(u)O	31-34	-	-	-	-	---
(u)G	34-41	-	-	-	-	---
(u)B	41-51	7	50	36	7	Silt loam

TABLE 30. Physical Analysis (% Fine Earth) - Lodi-Elegelic Soil

HORI.	DEPTH (cm)	Org.C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	BS %	pH
					M.e/100gm							
A_1	0- 8	11.8	0.51	23.0	0.24	0.14	0.33	0.54	14.97	1.25	8.5	4.20
(u)A	8-25	4.07	0.25	16.3	0.08	0.09	0.09	0.09	11.47	0.35	3.1	4.35
(u)B	25-28	1.61	0.12	13.4	0.04	0.08	0.05	0.06	11.99	0.23	1.9	4.35

HORI.	DEPTH (cm)	Ca-P	Alfe-P	Occ-P	Total Inorg. P	Org. P	Total P	Allophane
		Phosphorus Fraction p.p.m.						
A_1	0- 8	77	193	23	293	587	860	---
(u)A	8-25	-	120	150	270	280	550	Moderate
(u)B	25-28	-	80	163	243	132	375	Moderate

TABLE 31. Chemical Analysis - Fulvi-elegelic Soil

ALTITUDE: 1,500 - 1,800 m
ASPECT: South
SLOPE: Undulating

MEAN TEMPERATURE - AIR : 1 - 2°C
SOIL: 0 - 1°C
PRECIPITATION: 3,000 - 3,500 mm

Hg/Hl : 0.75 - 0.90

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
A_1	0-8	-	-	-	-	---
(u)A	8-25	1	21	65	13	Loamy sand
(u)B	25-28	1	16	74	9	Sand

TABLE 32. Physical Analysis (% fine earth) - Fulvi-Elegelic Soil

HORI.	DEPTH (cm)	Org. C %	N %	Ca % Total elements	Mg % Total elements	Fe_2O_3 % Total elements	pH	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org. P	Total P	P-Ret. P	Allophane
								Phosphorus Fractions p.p.m.							
A	0-1	-	-	-	-	-	-	-	-	-	-	-	-	-	---
C	1-6	0.30	0.01	0.35	0.42	10.44	5.6	600	110	325	1034	165	1200	0.00	Weak

TABLE 33. Chemical Analysis - Eleclinic Soil.

ALTITUDE: 1,800 - 1,900 m

ASPECT: East

SLOPE: 20°

MEAN TEMPERATURE: 1 - 2°C

SOIL TEMPERATURE: 0 - 1°C

PRECIPITATION: 3,000 - 3,500 mm

Hg/Hl : 0.78 - 0.90

HORI.	DEPTH (cm)	ORG. C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca % Total	Mg % Total	Fe_2O_3 % Total	BS %	pH
					M.e/100gm										
O	0-12	11.79	0.82	14.4	-	-	-	-	-	-	0.11	0.25	-	-	4.30
A	12-25	3.57	0.23	16.0	0.67	0.22	0.09	1.04	29.52	2.83	0.08	0.27	11.44	9.6	4.05

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg.-P	Org-P	Total-P	P-Ret. %	Allophane
		Phosphorus Fractions p.p.m.							
O	0-12	32	81	413	526	924	1450	2	Weak
A	12-25	3	92	125	220	455	675	2	Moderate

TABLE 34. Chemical Analysis - Humi-Eleclinic Soil

ALTITUDE: 1,500 - 1,800 m SLOPE: 30° PRECIPITATION: 3,000 - 3,500 mm

ASPECT: East MEAN TEMPERATURE - AIR: 0 - 3°C Hg/Hl : 0.76 - 0.97

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
O	0-12	3	12	81	4	Sand
A	12-25	10	7	79	4	Sandy loam

TABLE 35. Physical Analysis (%Fine Earth) - Humi-Eleclinic Soil

HORI.	DEPTH (cm)	Org.C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	BS %	pH
					M.e/100gm							
A/C	0-10	1.43	0.08	17.9	0.03	0.10	0.03	0.08	6.60	0.24	3.6	4.70

HORI.	DEPTH (cm)	Ca-P	Alfe-P	Occ-P	Total Inorg. P	Org. P	Total P	Allophane
		Phosphorus Fraction p.p.m.						
A/C	0-10	8	126	88	222	355	575	----

TABLE 36. Chemical Analysis - Elelithic Soil

ALTI.: 1,500 m . ASPECT: N.E. SLOPE: 0°-5° MEAN TEMP.: 3°C PRECIP.: 3,000-3,500 mm

Hg/Hl: 0.78

HORIZON	DEPTH (cm)	CLAY $<$.002mm	SILT .002-.02mm	FINE SAND .02-.2 mm	COARSE SAND .2-2 mm	TEXTURAL CLASS
A/C	0-10	0	6	91	3	SAND

TABLE 37. Physical Analysis(%Fine earth)

HORI.	DEPTH (cm)	Org. C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca	Mg	Fe_2O_3	Al_2O_3	SiO_2	BS %	pH
					M.e/100gm						% Total Elements						
A	0-5	2.50	0.21	11.9	0.12	0.11	0.12	0.41	12.24	0.76	0.18	0.32	9.24	14.07	47.0	6.2	4.40
A	20-25	1.21	0.10	12.1	0.01	0.09	0.04	0.11	11.46	0.25	0.23	0.33	10.21	12.24	51.0	2.2	4.50
GC	20-100	1.65	0.14	11.8	0.03	0.10	0.05	0.18	14.46	0.36	0.20	0.19	7.12	12.24	51.0	2.5	4.40
uB	100-120	1.86	0.13	14.3	0.04	0.10	0.05	0.19	15.14	0.38	0.16	0.19	10.52	20.86	47.9	2.5	4.40

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret %	Allophane
		Phosphorus Fractions p.p.m.							
A	0-5	60	105	475	640	360	990	30.0	Weak
A	20-25	50	150	262	462	213	675	29.5	Strong
GC	20-100	10	53	118	181	492	675	44.5	Strong
uB	100-120	15	110	188	313	437	750	59.5	Strong

TABLE 38. Chemical Analysis - Eleluvic Soil

ALTITUDE: 1,700 - 1,800 m SLOPE: 5° PRECIPITATION: 3,500 mm

ASPECT: South MEAN TEMPERATURE - AIR: 1°C Hg/Hl: 0.78—0·90

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
A	0-20	3	26	55	16	Loamy Sand
A	20-25	3	11	76	10	Sand
GC	25-100	8	19	72	2	Loamy Sand
uB	100-120	4	11	78	7	Sand

TABLE 39. Physical Analysis (% Fine Earth) - Eleluvic Soil

HORI.	DEPTH (cm)	Org. C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca	Mg	Fe_2O_3	Al_2O_3	SiO_3	BS %	pH
					M.e/100gm						% Total Elements						
O_1	0-3	16.4	0.90	18.2	0.22	0.15	0.24	0.38	24.43	0.99	0.12	0.19	3.56	17.79	28.73	4.1	4.15
C_2	7-10	5.25	0.41	12.8	0.14	0.14	0.19	0.20	20.10	0.67	0.15	0.30	4.29	27.14	40.47	3.3	4.20
O_3	10-12	5.95	0.46	12.9	-	-	-	-	-	-	0.14	0.28	4.43	26.69	40.47	-	4.95
C_3	12-17	5.00	0.41	12.2	-	-	-	-	-	-	0.14	0.28	4.43	28.50	40.47	-	
O_4	17-19	6.05	0.44	13.7	-	-	-	-	-	-	0.14	0.19	3.43	21.71	41.53	-	

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret. %
		Phosphorus Fractions p.p.m.						
O_1	0-3	-	80	153	233	932	1165	54.5
C_2	7-10	-	70	253	308	692	1000	

N O D A T A F O R L O W E R H O R I Z O N S

TABLE 40. Chemical Analysis - Plati-eleluvic Soil

ALTITUDE: 1,500 - 1,600 m SLOPE: Flat PRECIPITATION: 3,500 mm

ASPECT: South MEAN TEMPERATURE - AIR: 1°C Hg/Hl: 0.78 - 0.97

HORI.	DEPTH (cm)	CLAY < .002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
O_1	0-3	12	58	29	1	Silt Loam
C_2	7-10	8	28	60	6	Loamy Sand

TABLE 41. Physical Analysis (% Fine Earth) - Plati-Eleluvic Soil

ALTITUDE: 1,200 - 1,800 m | SLOPE: 25° | PRECIPITATION: 3,500 m

ASPECT: N.E. | MEAN TEMPERATURE - AIR: 2 - 3°C | Hg/Hl: 0.72 - 0.9(

HORI.	DEPTH (cm)	CLAY < .002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
O	0-15	10	11	73	6	Sandy loam
G	15-30	4	11	62	22	Sand

TABLE 42. Physical Analysis (% Fine Earth) - Eleplatic (Eutric Phase) Soil

HORI.	DEPTH (cm)	Org.C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	BS %	pH
					M.e/100gm							
O	0-15	8.20	0.50	16.4	0.27	0.18	0.92	5.76	19.61	7.13	36.4	4.85
G	15-30	2.57	0.17	15.1	0.15	0.14	0.32	2.86	13.34	3.53	26.5	4.85
uO	30-35	-	-	-	-	-	-	-	-	-	-	-
uG	35-54	-	-	-	0.11	0.13	0.24	1.61	9.24	2.09	22.5	5.00

HORI.	DEPTH (cm)	Ca-P	Alfe-P	Occ-P	Total Inorg. P	Org. P	Total P	Allophane
		Phosphorus Fraction p.p.m.						
O	0-15	-	-	-	-	-	-	---
G	15-30	230	120	115	465	450	915	Weak
uO	30-35	-	-	-	-	-	-	---
uG	35-54	-	-	-	-	-	-	---

TABLE 43. Chemical Analysis - Eleplatic (Eutric Phase) Soil

HORI.	DEPTH (cm)	Org. C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca	Mg	Fe_2O_3	Al_2O_3	SiO_2	BS %	pH
					M.e/100gm						% Total Elements						
A	0-15	6.29	0.45	13.97	0.33	0.16	0.52	0.66	14.52	1.67	0.09	0.06	4.06	18.14	43.6	7.4	4.05
B_1	15-22	5.57	0.37	15.05	0.10	0.11	0.11	0.14	6.81	0.46	0.12	0.08	5.26	19.50	52.6	3.8	4.60
B_2	22-37	3.29	0.19	17.31	0.04	0.07	0.03	0.11	8.42	0.25	0.11	0.11	11.98	13.60	47.0	2.5	4.60
C_1	37+	2.75	0.15	18.33	-	-	-	-	-	-	0.13	0.22	10.29	12.69	47.0	-	-

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret %	Allophane
		Phosphorus Fractions p.p.m.							
A	0-15	25	45	125	195	765	1000	43.0	Weak
B_1	15-22	13	37	275	325	450	775	57.5	Moderate
B_2	22-37	-	30	50	80	445	525	70.0	Strong
C_1	37+	-	17	38	55	545	600	67.5	Strong

TABLE 44. Chemical Analysis - Elefulvic Soil

ALTITUDE: 1,400 - 1,700 m SLOPE: 25° PRECIPITATION: 3,500 mm

ASPECT: E.S.E. MEAN TEMPERATURE - AIR: 3.5 - 4.0°C Hg/Hl: 0.75-0.76

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
O	0-15	8	25	63	4	Loamy Sand
B_1	15-22	7	29	68	6	Loamy Sand

TABLE 45. Physical Analysis (% Fine Earth) - Elefulvic Soil

HORI.	DEPTH (cm)	Org. C %	N %	C/N	Ca	Mg	Fe_2O_3	SiO_2	Al_2O_3	pH
					% Total Elements					
O	0-4	6.79	0.44	15.2	0.09	0.09	3.57	46.0	2.29	4.14
A	4-11	3.93	0.26	14.8	0.12	0.09	7.81	45.0	9.00	4.35
B	11-31	2.86	0.18	15.8	0.12	0.10	10.61	47.0	14.98	4.55

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret %	Allophane
		Phosphorus Fractions p.p.m.							
O	0-4	-	110	163	273	727	1000	46.0	Weak
A	4-11	-	72	25	97	578	675	66.5	Moderate
B	11-31	-	31	75	106	519	675	69.5	Strong

TABLE 46. Chemical Analysis - Elefulvic Soil (Strongly enleached Phase)

ALTITUDE: 1,500 - 1,600 m | SLOPE: 5° | PRECIPITATION: 3,500 mm

ASPECT: South | MEAN TEMPERATURE - AIR: 1 - 3°C | Hg/Hl: 0.78

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
A	4-11	8	37	42	13	Silt Loam
B	11-31	5	14	69	12	Sandy Loam

TABLE 47. Physical Analysis (% Fine Earth) - Elefulvic Soil (Strongly enleached phase)

HORI.	DEPTH (cm)	Org C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca	Mg	Fe_2O_3	BS %	pH
					M.e/100gm						% Total Elements				
A	0-10	3.93	0.25	15.7	0.36	0.16	0.25	0.69	11.56	1.46	0.91	0.24	11.15	12.6	4.70
uA/B	10-20	1.29	0.07	18.4	0.03	0.10	0.06	0.06	7.22	0.25	0.93	0.26	12.07	3.5	4.60
uB/C	20-35	-	-	-	-	-	-	-	-	-	0.88	0.28	11.29	-	4.69

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	Allophane
		Phosphorus Fractions p.p.m.						
A	0-10	0	96	95	191	484	675	Strong
uA/B	10-20	0	72	238	310	490	800	Strong
uB/C	20-35	-	-	-	-	-	-	---

TABLE 48. Chemical Analysis - Clini-Elefulvic Soil

ALTITUDE: 1,400 - 1,700 m
ASPECT: North
SLOPE: 30°
MEAN TEMPERATURE - AIR: 3.5°C
PRECIPITATION: 3,000 mm
Hg/Hl: 0.75

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
A	0-10	6	10	60	24	Sand
uA/B	10-20	7	12	55	26	Sand
uB/C	20-35	7	4	71	18	Sand

TABLE 49. Physical Analysis (% Fine Earth)- Clini-Elefulvic Soil

HORI.	DEPTH (cm)	Org C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca	Mg	Fe_2O_3	BS %	pH
					M.e/100gm						% Total Elements				
A	0-4	14.00	0.72	19.5	0.04	0.13	0.05	0.11	15.00	0.33	-	-	-	2.2	4.50
G	4-39	2.15	0.17	12.6	0.04	0.12	0.05	0.11	15.92	0.32	0.20	0.30	10.39	2.0	4.55
B	39-64	1.86	0.15	12.4	0.05	0.11	0.05	0.11	13.26	0.32	0.15	0.12	5.03	2.4	4.55

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret %	Allophane
		Phosphorus Fractions p.p.m.							
A	0-4	-	73	100	173	1027	1300	44.0	Moderate
G	4-39	-	85	60	145	415	560	56.5	Strong
B	39-64	-	60	297	357	503	860	56.5	Strong

TABLE 50. Chemical Analysis - Madenti-Elefulvic Soil

ALTITUDE: 1,600 - 1,700 m SLOPE: 0° PRECIPITATION: 3,500 mm

ASPECT: South MEAN TEMPERATURE - AIR: 1°C Hg/Hl: 0.75 - 0.80

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
A	0-4	-	-	-	-	---
G	4-39	11	60	19	10	Silt Loam
B	39-64	13	9	74	4	Sand

TABLE 51. Physical Analysis (%Fine Earth) - Madenti - Elefulvic Soil

HORI.	DEPTH (cm)	Org. C %	N %	C/N	Ca	Mg	Fe_2O_3	SiO_2	Al_2O_3	pH
					% Total Elements					
O	0-6	-	-	-	-	-	-	-	-	-
A	6-16	5.14	0.28	18.16	0.87	0.11	6.83	46.2	5.00	4.00
B_1	16-31	3.43	0.20	17.15	0.92	0.17	11.67	45.0	10.88	4.35
B_2	31-91	1.86	0.10	17.71	0.12	0.20	10.81	52.6	19.50	4.60
B_3	91-101	1.29	0.06	19.84	0.13	0.22	9.58	49.9	9.07	4.70

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret %	Allophane
		Phosphorus Fractions p.p.m.							
O	0-6	-	-	-	-	-	-	-	---
A	6-16	-	13	88	101	524	625	49.0	Weak
B_1	16-31	-	20	50	70	455	525	92.0	Moderate
B_2	31-91	-	2	110	112	348	460	58.5	Strong
B_3	91-101	-	30	123	153	282	435	50.5	Strong

TABLE 52. Chemical Analysis - Eldefulvic Soil (Strongly enleached phase)

ALTITUDE: 1,402 m | SLOPE: 25° | PRECIPITATION: 3,500 m

ASPECT: S.E. | MEAN TEMPERATURE - AIR: 4°C | Hg/Hl: 0.60 - 0.65

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
O	0-6	-	-	-	-	---
A	6-16	13	30	29	23	Silt Loam
B_1	16-31	-	-	-	-	---
B_2	31-91	19	43	29	9	Silt Loam
B_3	91-101	15	34	40	11	Silt Loam

TABLE 53. Physical Analysis (% Fine Earth) - Eldefulvic Soil (Strongly enleached phase)

HORI.	DEPTH (cm)	Org. C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca	Mg	Fe_2O_3	Al_2O_3	SiO_2	BS %	pH
					M.e/100gm						% Total Elements						
A	8-15	5.21	0.25	20.0	0.30	0.13	0.46	0.61	12.72	1.50	0.12	0.15	8.49	13.30	44.5	11.8	4.40
uA_1	15-19	2.93	0.15	19.0	-	-	-	-	-	-	0.18	0.28	11.69	18.56	46.2	-	-
uA_3	19-41	1.86	0.07	25.0	0.07	0.10	0.08	0.09	8.66	0.34	0.13	0.32	12.41	18.14	46.6	3.9	4.90
uB	41-71	1.64	0.06	25.0	0.10	0.11	0.09	0.10	9.04	0.40	0.11	0.34	13.18	19.50	47.4	4.4	5.00

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret %	Allophane
		Phosphorus Fractions p.p.m.							
A	8-15	7	128	325	460	465	925	40.0	Moderate
uA_1	15-19	30	240	88	358	392	750	54.0	Strong
uA_3	19-41	4	91	388	483	492	975	58.0	---
uB	41-71	18	92	325	435	490	925	77.5	Strong

TABLE 54. Chemical Analysis - Clini-eldefulvic

ALTITUDE: 1,250 m | SLOPE: 25 - 30° | PRECIPITATION: 3,500 mm
ASPECT: North | MEAN TEMPERATURE - AIR: 5.5 - 6.0°C | Hg/Hl: 0.50

HORI.	DEPTH (cm)	CLAY .002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
A	8-15	13	35	48	4	Silt Loam
uA_1	15-19	-	-	-	-	---
uA_3	19-41	3	20	42	35	Loamy Sand
uB	41-71	5	15	58	22	Loamy Sand

TABLE 55. Physical Analysis (% Fine Earth) - Clini-eldefulvic

HORI.	DEPTH (cm)	Org. C %	N %	C/N	K^+	Na^+	Mg^{++}	Ca^{++}	C.E.C.	T.E.B.	Ca	Mg	Fe_2O_3	Al_2O_3	SiO_2	BS %	pH
					M.e/100gm						% Total Elements						
A	0-20	5.71	0.34	16.89	0.42	0.12	0.69	0.74	14.26	1.97	0.06	0.05	2.26	2.88	45.0	13.8	4.50
G	20-32	3.43	0.21	16.10	0.20	0.12	0.22	0.29	14.14	0.83	0.03	0.04	2.14	2.88	48.0	5.9	4.24
B_1	32-38	4.93	0.24	20.54	0.08	0.10	0.08	0.15	15.34	0.41	0.04	0.05	10.32	12.92	46.6	2.7	4.45
B_2	38-58	4.43	0.19	22.71	0.05	0.12	0.05	0.16	16.32	0.38	0.08	0.11	15.35	10.89	43.6	2.3	4.60
				N O	D A T A		F O R		L O W E R		H O R I Z O N S						

HORI.	DEPTH (cm)	Ca-P	Al,Fe-P	Occ-P	Total Inorg-P	Org-P	Total-P	P-Ret %	Allophane
		Phosphorus Fractions p.p.m.							
A	0-20	7	43	135	185	550	735	23.5	Nil
G	20-32	-	25	200	225	275	500	28.0	Weak
B_1	32-38	10	35	215	260	405	665	66.5	Weak
B_2	38-58	-	20	500	320	450	974	90.0	Strong
		N O	D A T A	F O R	L O W E R	H O R I Z O N S			

TABLE 56. Chemical Analysis - Madenti-Podi-Eldefulvic Soil

ALTITUDE: 1,097 m SLOPE: 30° PRECIPITATION: 3,000 mm

ASPECT: S.E. MEAN TEMPERATURE - AIR: 4.5°C Hg/Hl: 0.55 - 0.60

HORI.	DEPTH (cm)	CLAY <.002mm	SILT .002-0.02mm	FINE SAND 0.02-0.2mm	COARSE SAND 0.2-2.0mm	TEXTURAL CLASS
A	0-20	10	34	50	6	Silt Loam
G	20-32	12	36	46	6	Silt Loam
B_1	32-38	17	34	44	5	Silt Loam
B_2	38-58	22	21	53	4	Sandy Loam

TABLE 57. Physical Analysis (% Fine Earth) - Madenti-Podi-Eldefulvic Soil

REF. NO.	SOIL CLASS	ALTITUDE (m)	A/B RATIO
TW2	Podi-Madenti-Eldefulvic	1,097	0.80
TW3	Podi-Madenti-Eldefulvic	1,286	1.25
PB1	Clini-Eldefulvic	1,330	0.35
TW8	Eldefulvic (strongly enleached phase)	1,450	0.65
TW9	Eldefulvic (strongly enleached phase)	1,402	0.25
TW11	Eldefulvic (strongly enleached phase)	1,460	0.35
PB4	Elefulvic	1,475	0.60
PB5	Elefulvic	1,478	0.75
TW10	Elefulvic (strongly enleached phase)	1,606	1.00
TW14	Elefulvic (strongly enleached phase)	1,676	0.85
PB6	Elefulvic	1,828	1.50
TW18	Lodi-Elegelic	1,834	5.80
TW19	Lodi-Elegelic	1,859	3.60
TW22	Eleluvic	1,850	2.50

TABLE 58. Development of A and B Horizons

PROF. REF.	SOIL CLASS	DEPTH (cm)	Ca-P kg/ha/cm	Ca-P p.p.m.	Al,Fe-P kg/ha/cm	Al,Fe-P p.p.m.	Occ-P kg/ha/cm	Occ-P p.p.m.	Org-P kg/ha/cm	Org-P p.p.m.	Total-P kg/ha/cm	Total-P p.p.m.
MB18	Humi-Eleclinic	0-12	19	32	51	81	272	413	584	924	927	1450
		12-25	2	3	76	92	104	125	376	455	558	675
	Profile		21		127		376		960		1485	
MB5	Clini-Elefulvic	0-10	-	-	59	96	59	95	300	484	418	675
		10-20	-	-	82	72	273	238	563	490	918	800
	Profile		-	-	141		332		863		1336	
MB6	Madenti-Elefulvic	0-10	-	-	61	85	171	238	414	577	646	900
		10-18	-	-	18	30	159	263	230	382	407	675
		18-38	-	-	18	10	581	323	524	292	1123	625
		38-53	-	-	74	70	14	13	629	592	717	675
	Profile		-		171		925		1797		2893	
MB10	Clini-Eldefulvic	8-15	4	7	67	128	172	325	246	465	489	925
		15-19	8	30	66	240	24	88	108	392	206	750
		19-41	8	4	178	91	664	388	966	492	1816	975
		41-71	46	18	237	92	840	325	1266	490	2389	925
	Profile		66		548		1700		2586		4900	
MB14	Clini-Eldefulvic	0-20	46	30	316	210	172	115	954	635	1488	990
		20-70	65	16	325	79	1220	325	1660	405	3270	825
	Profile		111		641		1392		2614		4758	

TABLE 59. Phosphorus Fractions of the Soils forming the Alto-Sequence in Mary Basin

PROF. REF.	SOIL CLASS	DEPTH (cm)	Ca-P kg/ha/ cm	Ca-P p.p.m.	Al,Fe-P kg/ha/ cm	Al,Fe-P p.p.m.	Occ-P kg/ha/ cm	Occ-P p.p.m.	Org-P kg/ha/ cm	Org-P p.p.m.	Total-P kg/ha/ cm	Total-P p.p.m.
TW24	Eleclinic	0-5	415	600	76	110	226	325	115	165	832	1200
	Profile		415		76		226		115		832	
TW22	Eleluvic	0-5	13	60	23	105	81	360	106	475	223	990
		5-25	69	50	208	150	364	262	296	213	937	675
		25-100	50	10	267	52	596	118	2487	492	3400	675
		100-140	49	15	367	110	620	188	1444	437	2480	750
	Profile		181		865		1661		4334		7040	
TW16	Madenti-Elefulvic	0-4	-		14	73	20	100	201	1027	235	1300
		4-19	-		88	85	62	60	433	415	580	560
		19-39	-		163	60	810	297	826	303	1790	660
	Profile		-		265		892		1460		2624	
TW14	Elefulvic (enleached)	0-7	-		570	110	85	163	377	727	1032	1000
		7-15	-		424	72	147	25	340	578	911	675
		15-22	-		169	31	412	72	283	519	864	675
		22-30	-		54	10	616	113	219	402	889	525
	Profile		-		1217		1260		1219		3696	
TW2	Madenti-Podi-Eldefulvic	5-20	7	7	44	43	138	135	562	550	744	735
		20-32	-		20	25	161	200	222	275	403	500
		32-38	5	10	7	35	103	215	194	405	304	665
		38-58	-		34	20	848	500	761	450	1651	974
	Profile		12		105		1250		1739		3102	

TABLE 60. Phosphorus Fractions of the Soils forming the Alto-Sequence in the Twin Basin

MICA	CHLORITE	FELDSPAR	QUARTZ
17.6	9.5	33.5	39.2

TABLE 61. Mineralogy of the silt fraction (percent) (5 μm - 50 μm)

SOIL AND REF. NO.	HORI.	1°CHLORITE	MICA	VERMIC	1°CHLORITE	MICA VERMIC	PEDOGENIC CHLORITE	FELDSPAR	MICA
Madenti-Elefulvic TW2	A	1	2		1		1	1	3
	B	1	2		1	1	1	1	1
Clini-Eldefulvic MB10	A	1	1			2	1	1	2
	uA	1	2		2	1	2	1	2
	B	1			2		1	1	1
Clini-Eldefulvic PB1	A	1	1		2				1
	B	1	1		4		1		1
Elefulvic PB5	A	1	3		1	2	1		1
	B	1	1		1	1	1		1
Eldefulvic (strongly enleached) TW9	A	1	1		1	2	1		1
	B		1		1		1		1

Note:

0 = 0%
1 = 0 - 20%
2 = 20 - 40%
3 = 40 - 60%
4 = 60 - 80%
5 = 80 - 100%

TABLE 62. Mineralogy of the Clay Fraction (0.2 µm - 2 µm)

SOIL	HORI.	B.D. g/m^3	AVAIL.H_2O (g/g soil) (F.C.)	F.C.%H_2O (pF 2.52)	W.P.%H_2O (pF 4.2)	AVAIL.H_2O F.C.-W.P.	AVAIL.H_2O (g/g soil) (F.C.-W.P.)
Clini-Eldefulvic	A	.800	.425	53.2	32.5	20.7	.170
	B	.919	.419	45.6	16.0	29.6	.272
Eldefulvic	O	.758	.579	76.5	25.5	51.0	.386
Elefulvic	A	.850	.475	55.8	23.0	32.8	.177
	B	.791	.516	65.3	13.0	52.3	.413
Lodi-Elegelic	O	.775	.596	77.0	40.0	37.0	.286
Fulvi-Elegelic	O/A	.800	.490	60.0	29.5	40.5	.324

TABLE 63. Moisture Storage Values

g/g - refers to moisture retained on a volume basis

F.C. and W.P. - refers to the percentage of moisture in the soil at field capacity, and wilting point.

DATE	PRECIP. mm	P.E. mm	LOSS mm	GAIN mm	AVAIL.H_2O (pF 2.52) mm	
JAN. 6-15	68.10	5.10		63.00	49.00	(63.0 surplus)
JAN. 16-21	17.40	13.70		3.70		(3.7 surplus)
FEB. 2-20	1.50	9.49	8.99		40.00	(No surplus)

TABLE 64A. Available Moisture, Fulvi-Elegelic Soil from January - February 1971 (10cm Soil Depth)

DATE	PRECIP. mm	P.E. mm	LOSS mm	GAIN mm	AVAIL.H_2O (pF 2.52 mm	
NOV. 25-30	19.60	8.97		10.63	48.00	(10.63 surplus)
DEC. 1-15	92.10	5.27		86.81	48.00	(86.81 surplus)
DEC. 16-21	7.80	8.80	1.00		47.00	(No surplus)
JAN. 6-15	68.10	7.39		60.71	48.00	(59.71 surplus)
JAN. 16-21	17.40	29.10	11.70		36.30	(No surplus)
FEB. 2-20	1.50	15.27	13.77		22.53	(No surplus)

TABLE 64B. Available Moisture, Elefulvic Soil from November 1970 - February 1971 (10 cm Soil Depth)

DATE	PRECIP. mm	P.E. mm	LOSS mm	GAIN mm	AVAIL.H_2O (pF 2.52) mm	
JAN. 6-15	68.10	12.40		55.70	43.00	(55.7 surplus)
JAN. 16-21	17.40	36.20	16.80		26.20	(No surplus)
FEB. 2-20	1.50	29.70	28.20		0	(Deficit)

TABLE 64C. Available Moisture, Clini-Elefulvic Soil from January - February 1971 (10 cm Soil Depth)

SAMPLE NO.:	3	35
	SNOW p.p.m. LITRE	MELTWATER p.p.m. LITRE
Solids	0.28	-
pH	4.8	5.2
Cl	3.10	0.14
K	0.91	0.11
Na	0.28	0.40
Mg	0.17	0.10
Ca	0.66	0.19
P	0.42	0.10

TABLE 65. Results of Mineral Analysis (from 2 Samples) of Snow and Meltwater - Twin Basin - January 1971.

PERIODICITY SOIL FORMING PROCESS	SEDIMENTATION FLUSHING			EROSION/DEPOSITION COLLUVIATION
SOIL GROUP	Y.B.E.	-	POD. Y.B.E.	Y.B.E.
MOISTURE REGIME	HYDROUS			HYGROUS
GEOMORPHIC REGIME	GLACIAL			PERIGLACIAL

TABLE 66. Contrast between Régimes influencing the Hydrous and Hygrous Soils

SPECIES	K1		K2		K3
	uO*	A_1*	1uO*	3uO*	uO*
	1	2	3	4	5
	33cm	9cm	36cm	84cm	56cm
	%	%	%	%	%
Podocarpus totara type	-	1	-	-	-
P. spicatus	-	-	-	3	+
P. ferrugineus	-	-	-	+	-
Podocarpus	2	1	4	-	2
D. cupressinum	-	1	1	tr	tr
Phyllocladus	84	94	30	68	32
Nothofagus fusca type	1	1	1	2	6
N. menziesii	2	-	tr	4	2
Dracophyllum	1	-	2	tr	3
Gramineae	5	1	34	19	24

TABLE 67. Percent Pollen Count taken from Horizons of the Periodic Sequence (1971)

*Refers to horizons at the depths stated below the various ground surfaces. E.G. uO,33 cm below K1 surface. (See Figure 44)

SPECIES	% Count
Podocarpus spicatus	1
P. totara type	8
Podocarpus	2
Dacrydium cupressinum	tr
Phyllocladus	61
Pinus	+
Nothofagus fusca type	tr
N. menziesii	8
Coprosma	2
Plagianthus type	+
Tetrad (not *Dracophyllum*)	+
Gramineae	14
Cyperaceae	tr
Gaimardia	tr
Hypolaena	tr
Compositae	2
Caryophyllaceae	+
Gentiana	tr
Lycopodium australianum type	1
Lycopodium	4
Cyathea colensoi type	tr
Monolete	3
Trees and Shrubs	84
Herbs	16

TABLE 68. Percent Pollen Count taken from Surface Sample (Soil)

NEW ZEALAND SYSTEM CLASS	INTERGRADE	KUBIENA'S SYSTEM	7TH APPROXIMATION ORDER	SUB-ORDER	GREAT SOIL GROUP
.elithic		Alpine, hamada, rawmark	Entisol	Psamments	Cryopsamments)
.eclinic		Snow basin, rutmark	"	Aquents	Cryaquents)Psammaquents
	Humi-eleclinic	Protoranker, moder ranker, dystrophic ranker	"	"	"
.egelic	Lodi-elegelic	Dystrophic peat ranker	Histosol	Folist	Boro-folist
	Fulvi-elegelic	Moder ranker	Entisol	Aquents	Cryoaquents
.eluvic	Plati-eleluvic	Moder gley, dystrophic anmoor, mull-gley (semi-terrestrial)	"	"	"
.eplatic (eutri)		Hanging anmoor, basin anmoor	Histosol	Fibrist	Boro-fibrist
.efulvic		Alpine, braunerde	Inceptisol	Umbrept	?
	Madenti-	Moder gley soil, podsolic-gley	"	Aquept	Haplaquepts
	Clini-	Difficult to correlate	"	Ochrepts	Dystrochrepts
.efulvic (strongly en-leached phase) and podic intergrades		Degraded braunerde, alpine sod podsol Alpine humus soil (Jenny)	Spodosols	Orthod	Lithic cryorthod

TABLE 69. Comparative Classification of Alpine Soils

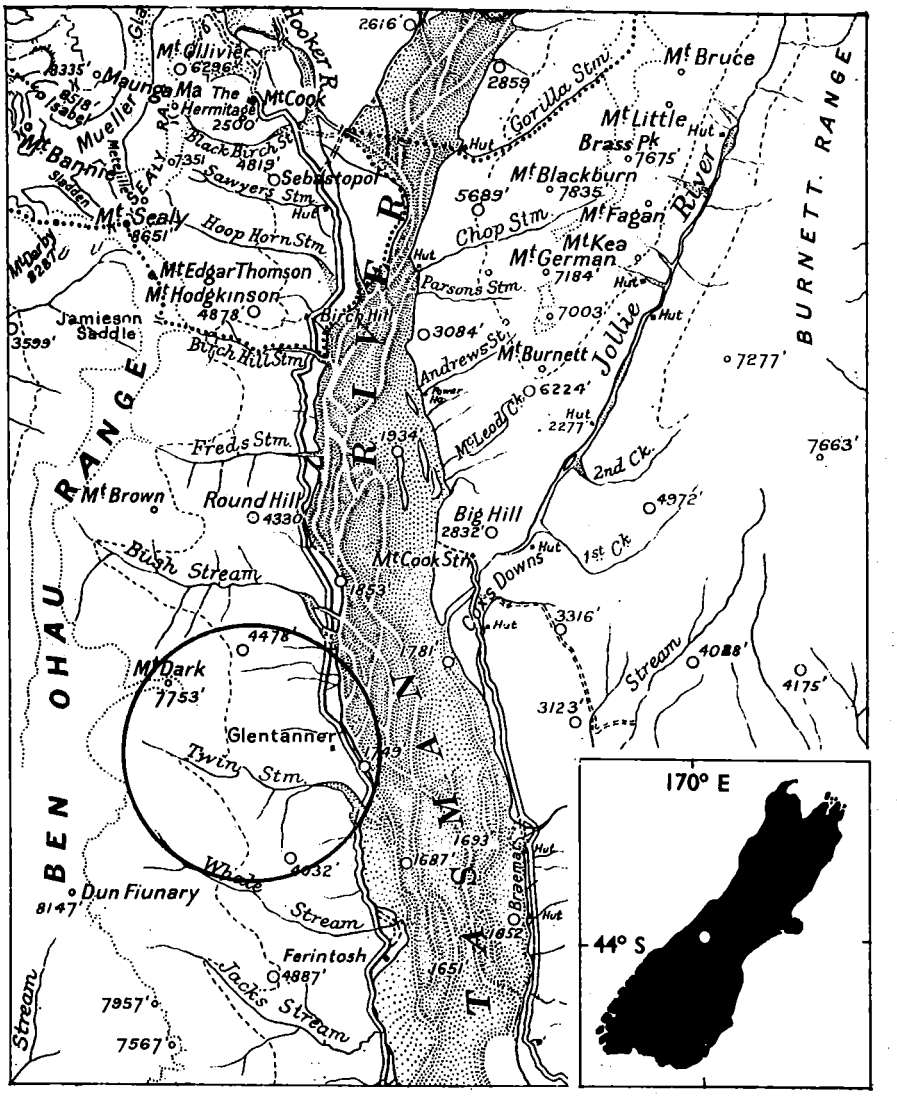


FIGURE 1. Location of the Study Area.

Legend:

53H	Cass Hill Soil
55bH	Puketeraki Hill Soil
55b	Puketeraki Soil
57	Kaikoura Soil
65	Lewis Steepland Soil
100	Alpine Soils

FIGURE 2. Soils of the Ben Ohau Range outlined in black. Taken from the soil map, sheet 8, scale 1:253,440. Compiled by Soil Bureau Staff, 1968.

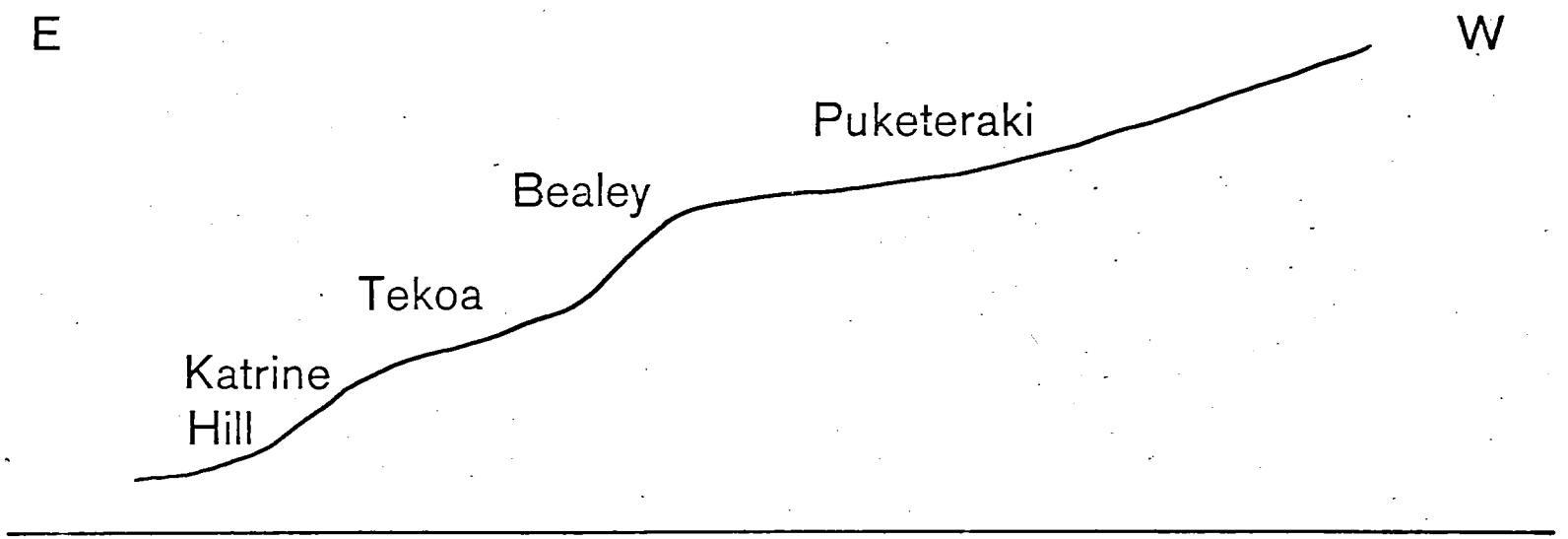


FIGURE 3. Toposequence of soils through the North-East part of the Ben Ohau Range.

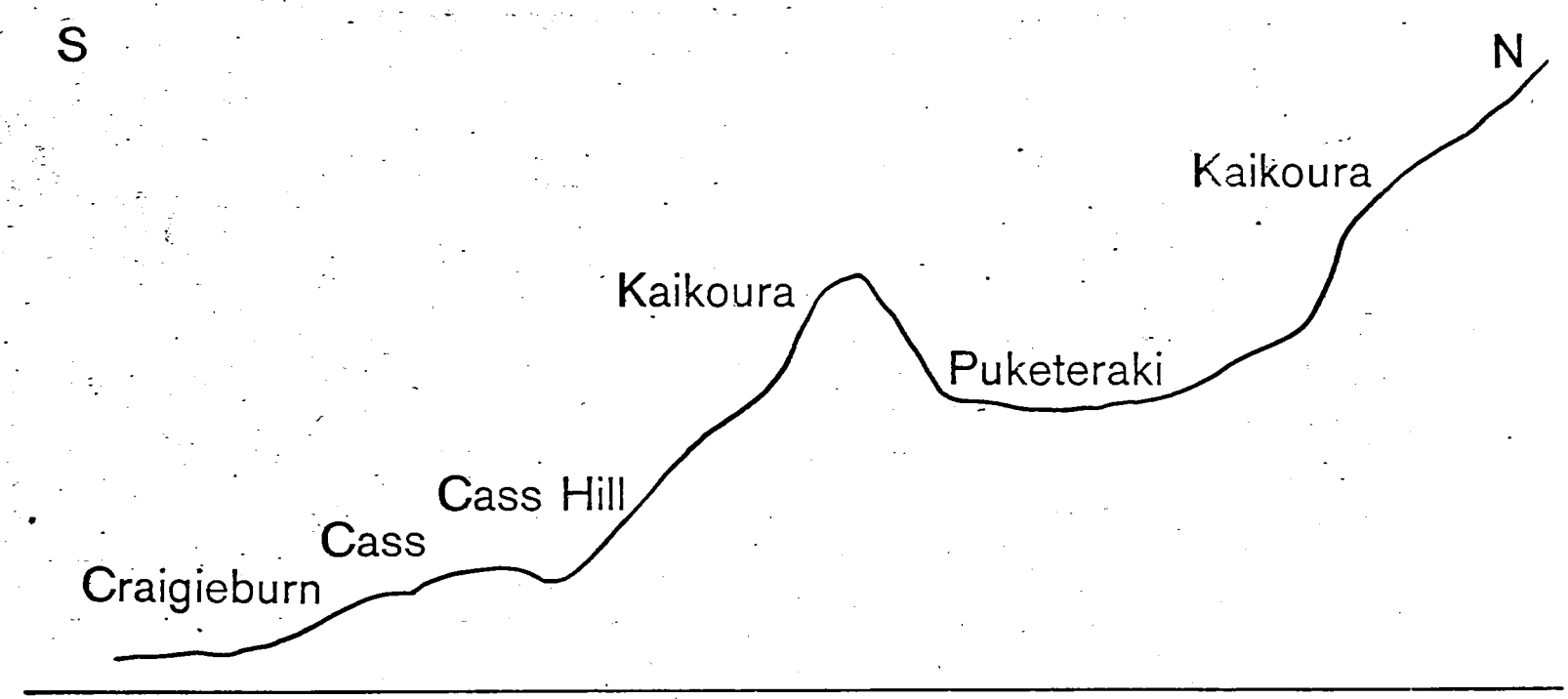
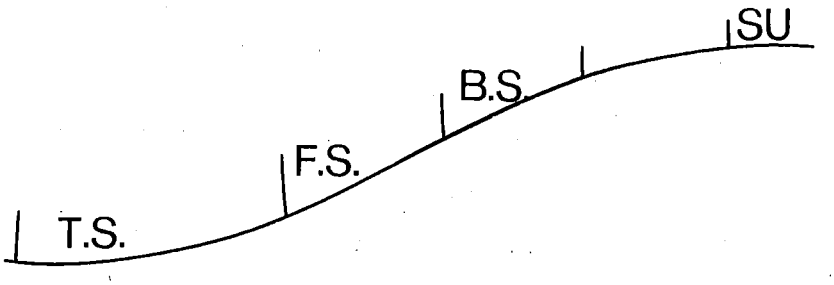


FIGURE 4. Extended legend to the soil map (from a survey by Soil Bureau Staff, 1973), unpublished.



T.S. Toe Slope
F.S. Foot Slope
B.S. Back Slope
SU Summit

FIGURE 5. Cross Section through slope of low relief (after Ruhe, 1969).

1. Summit
2. Seepage Slope
3. Convex
4. Fall Face
5. Mid Slope
6. Colluvial Foot Slope
7. Toe Slope

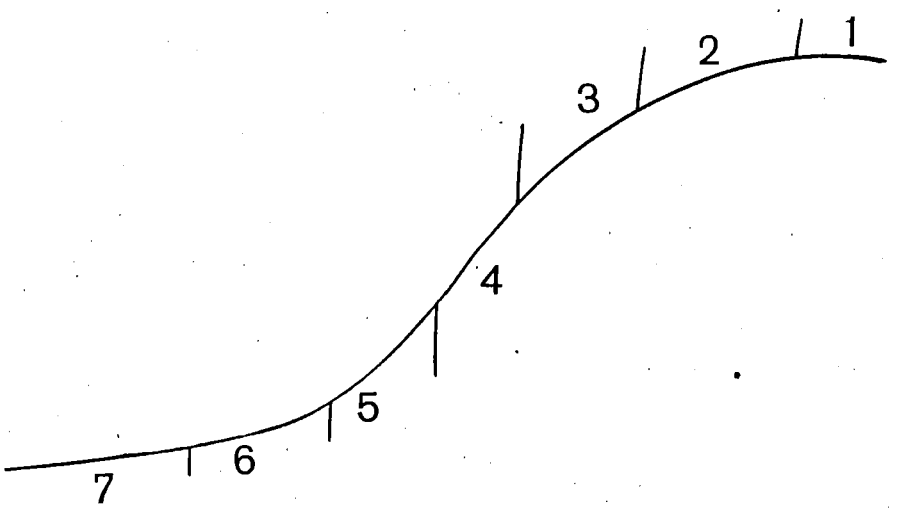


FIGURE 6. Cross Section through slope (after Dalrymple et al, 1968).

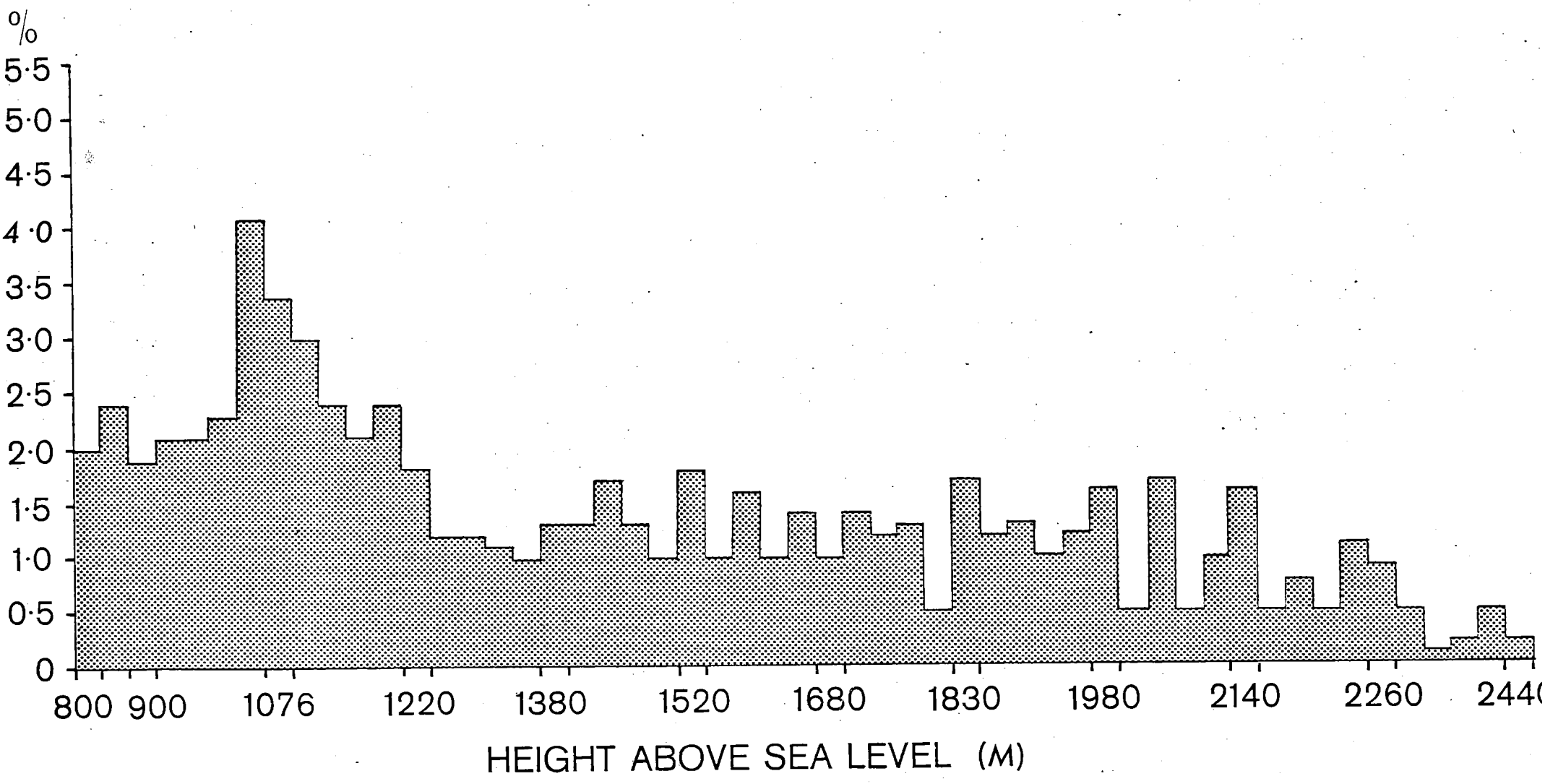
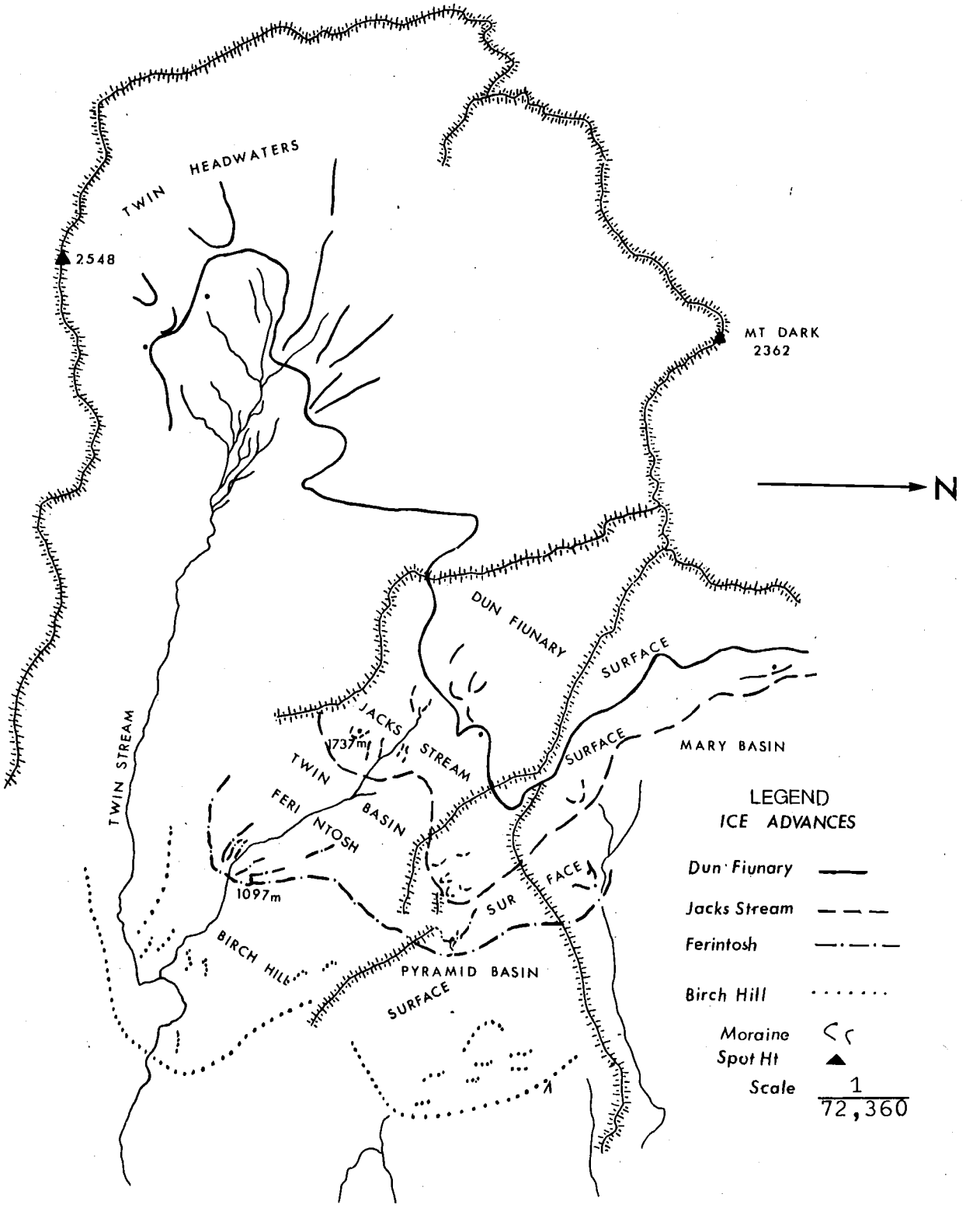


FIGURE 7. Altimetric frequency graph which records the Altitudinal Range of the Twin Stream Catchment. (Compiled from mean contour height from a 1 cm^2 grid.)

FIGURE 8 GEOMORPHOLOGICAL MAP



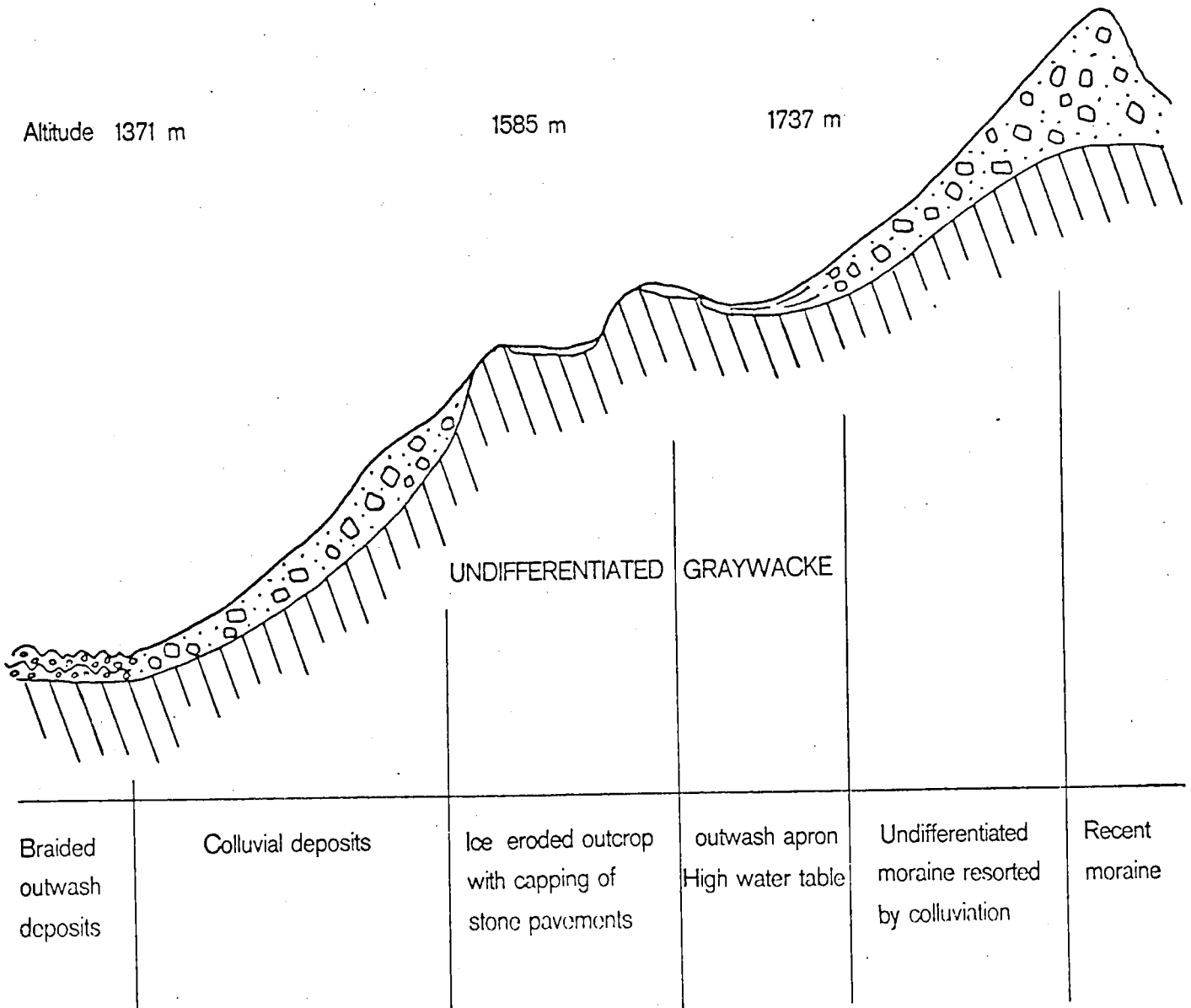


FIGURE 9. N.E.-S.W. Transect through the South Side of the Upper Part of the Twin Stream Headwaters (not to scale).

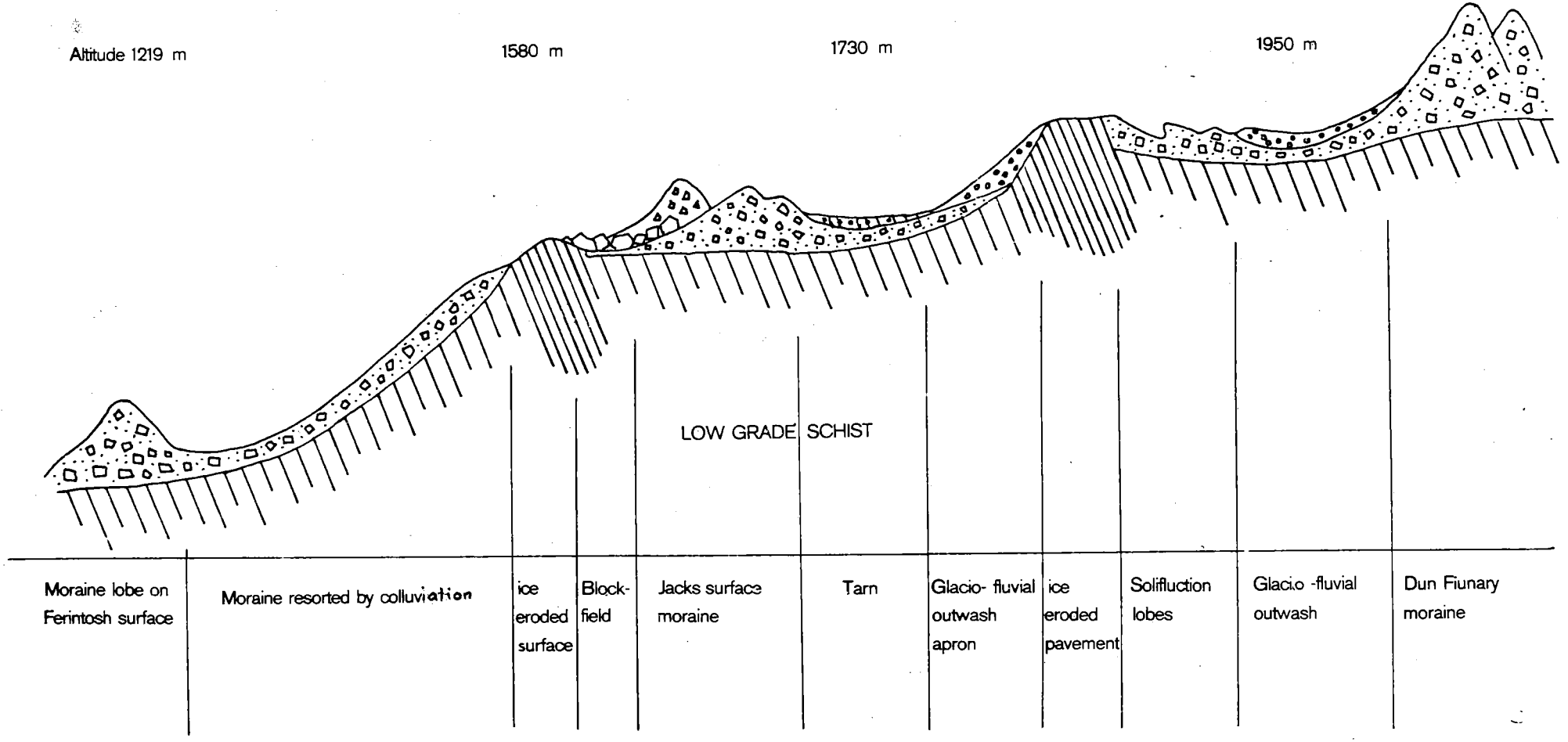


FIGURE 10. N.N.E. - S.S.W. Transect through the Twin Basin (not to scale).

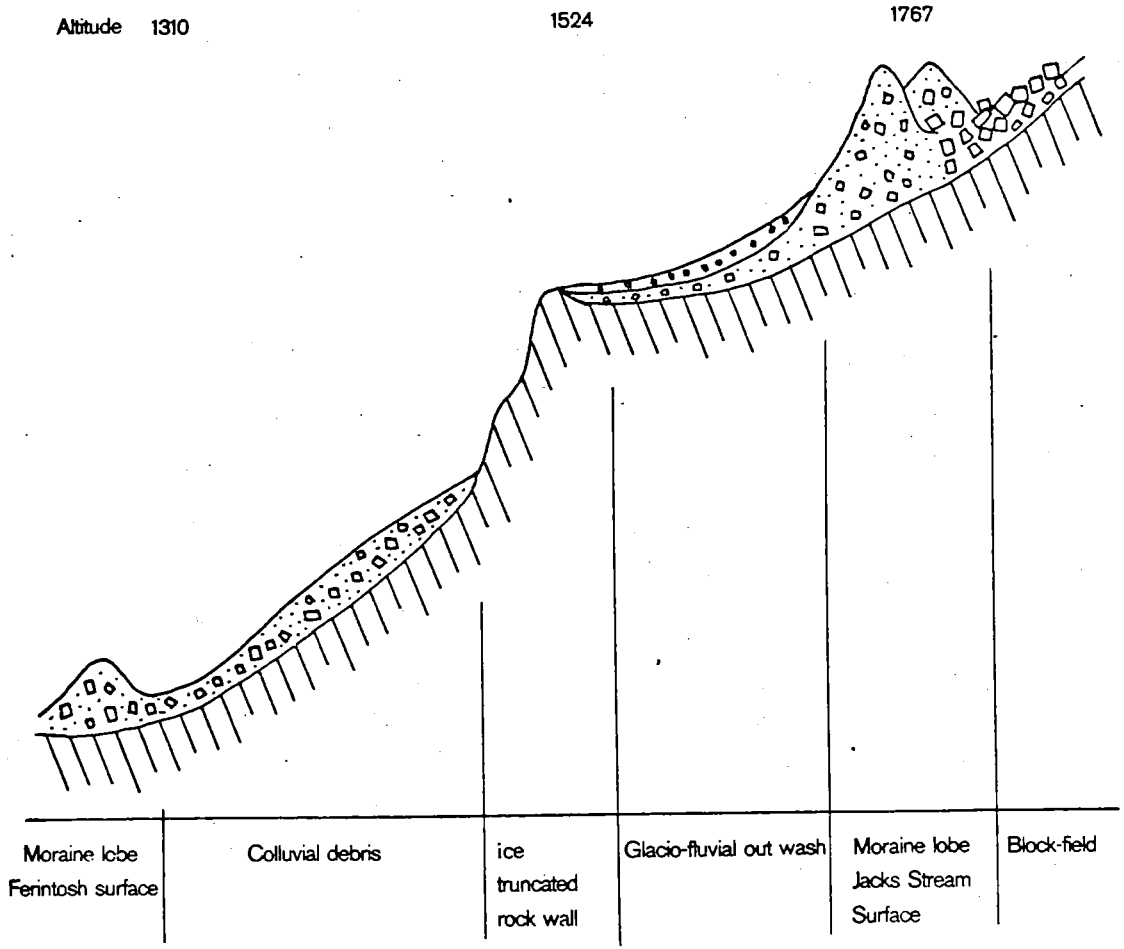


FIGURE 11. N.N.E. - S.S.W. Transect through the Mary Basin (not to scale)

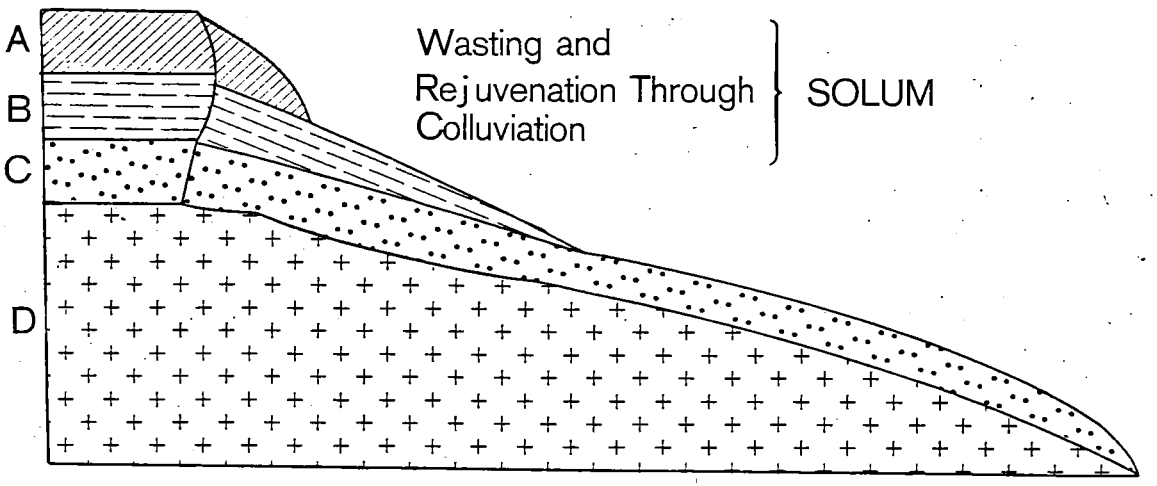


FIGURE 12. Cross Section through colluvial deposits showing the diverse origin of material ranging from top soil, A, subsoil, B, and parent material, C and D.

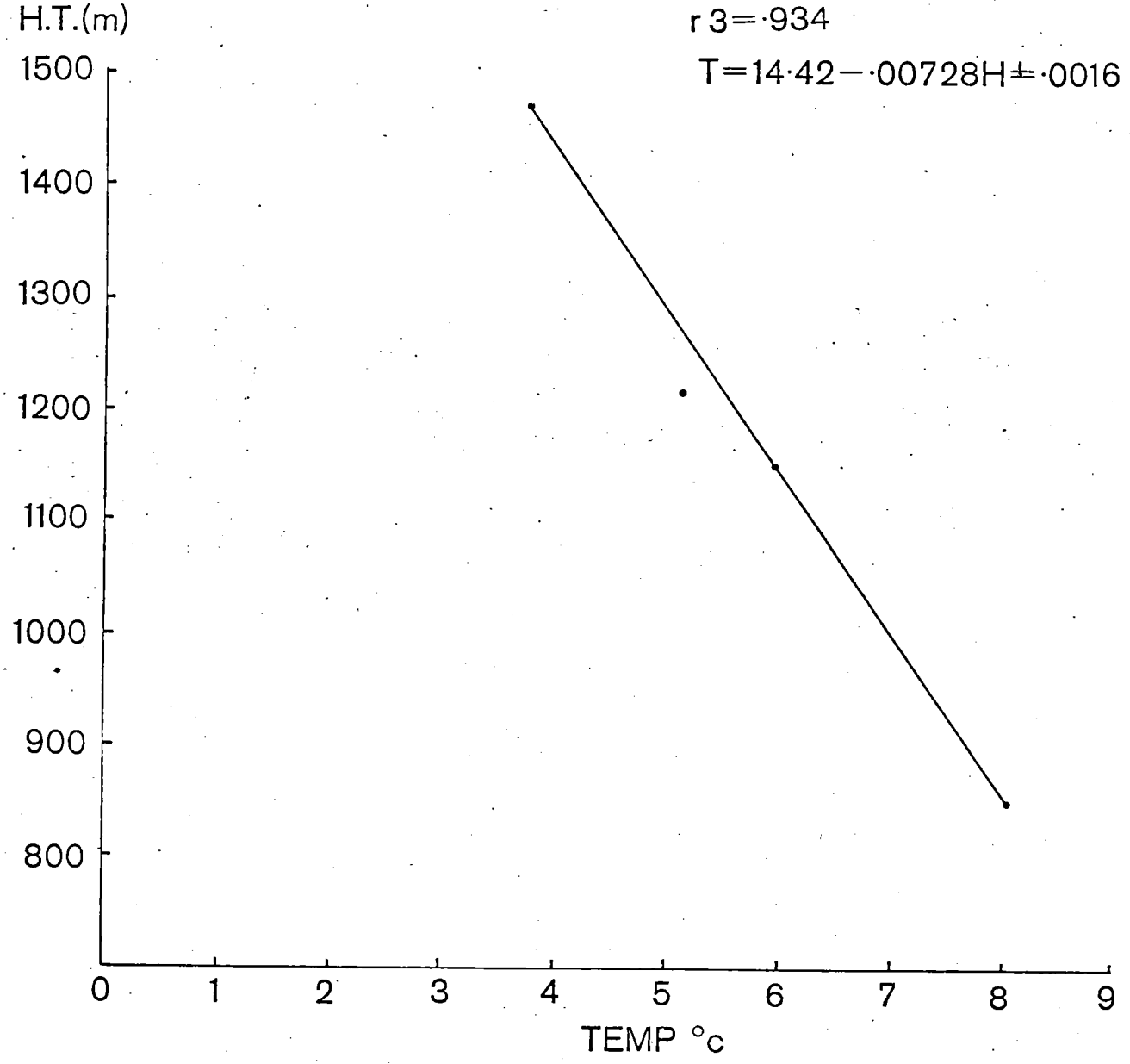


FIGURE 13. Linear Regression showing the relationship between altitude and $\bar{x}$ annual temperatures. (Temperature taken over period 1968-1972)

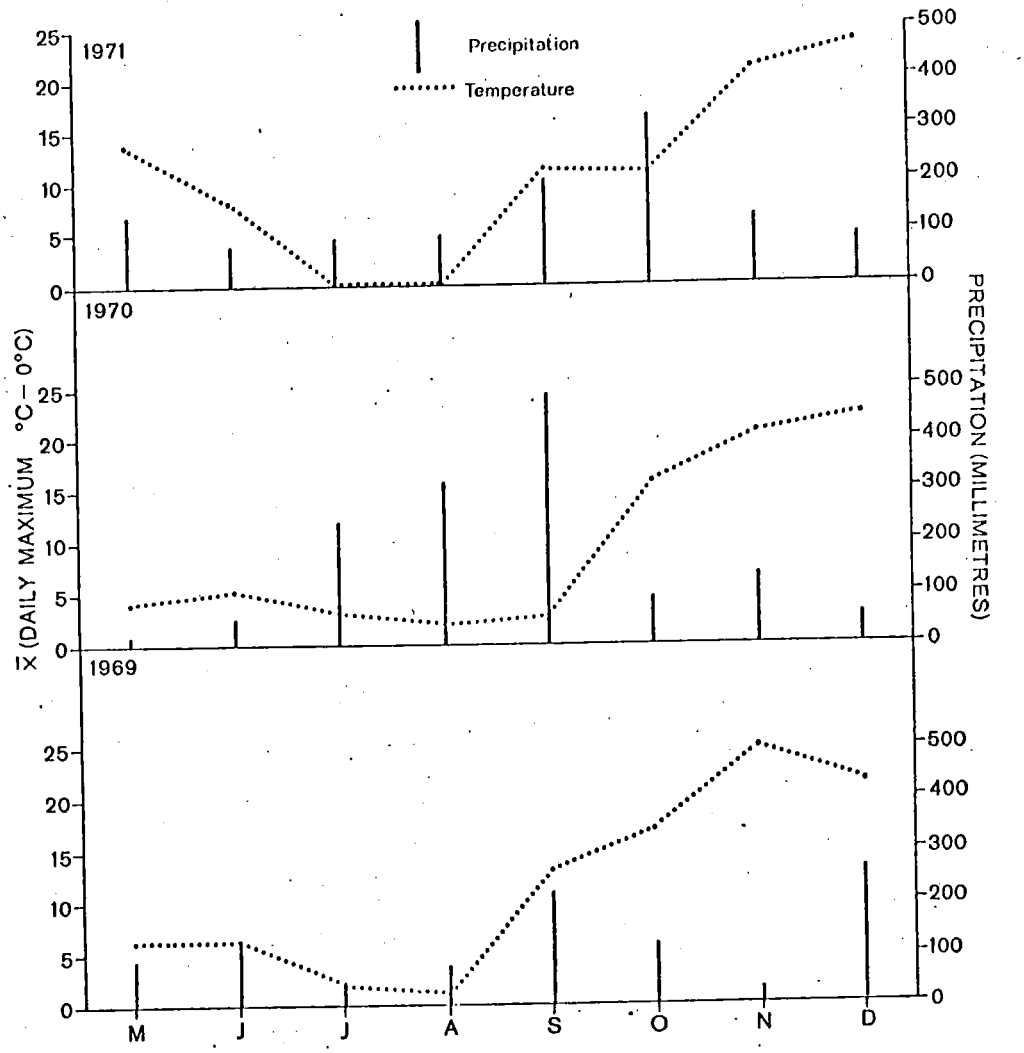


FIGURE 14. Mean daily temperature above freezing in relation to precipitation. (Temperature taken over snow period 1969-1971)

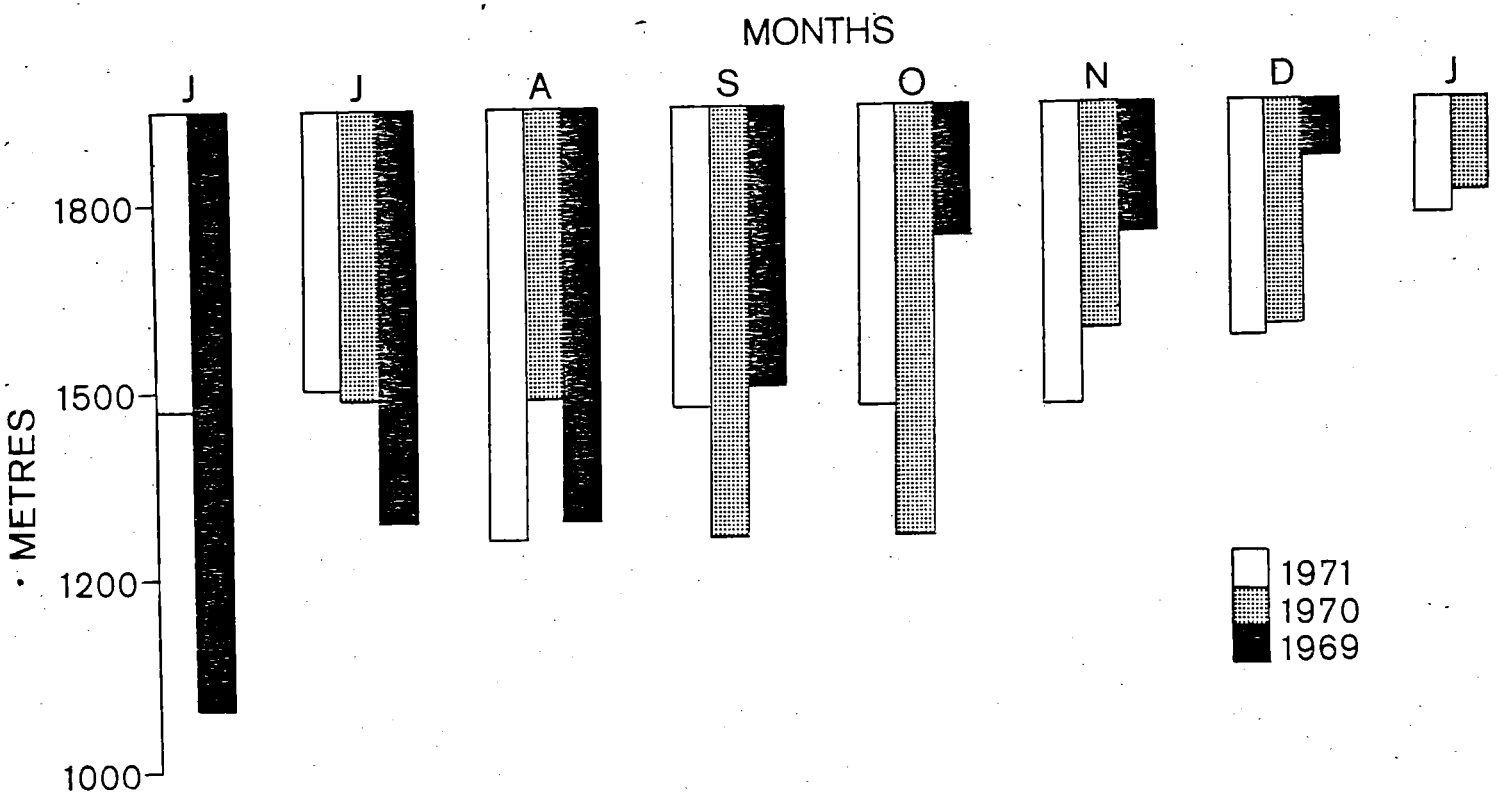


FIGURE 15. Altitudinal Distribution of Snow in the Twin Stream Catchment during three year period, 1969-1971.

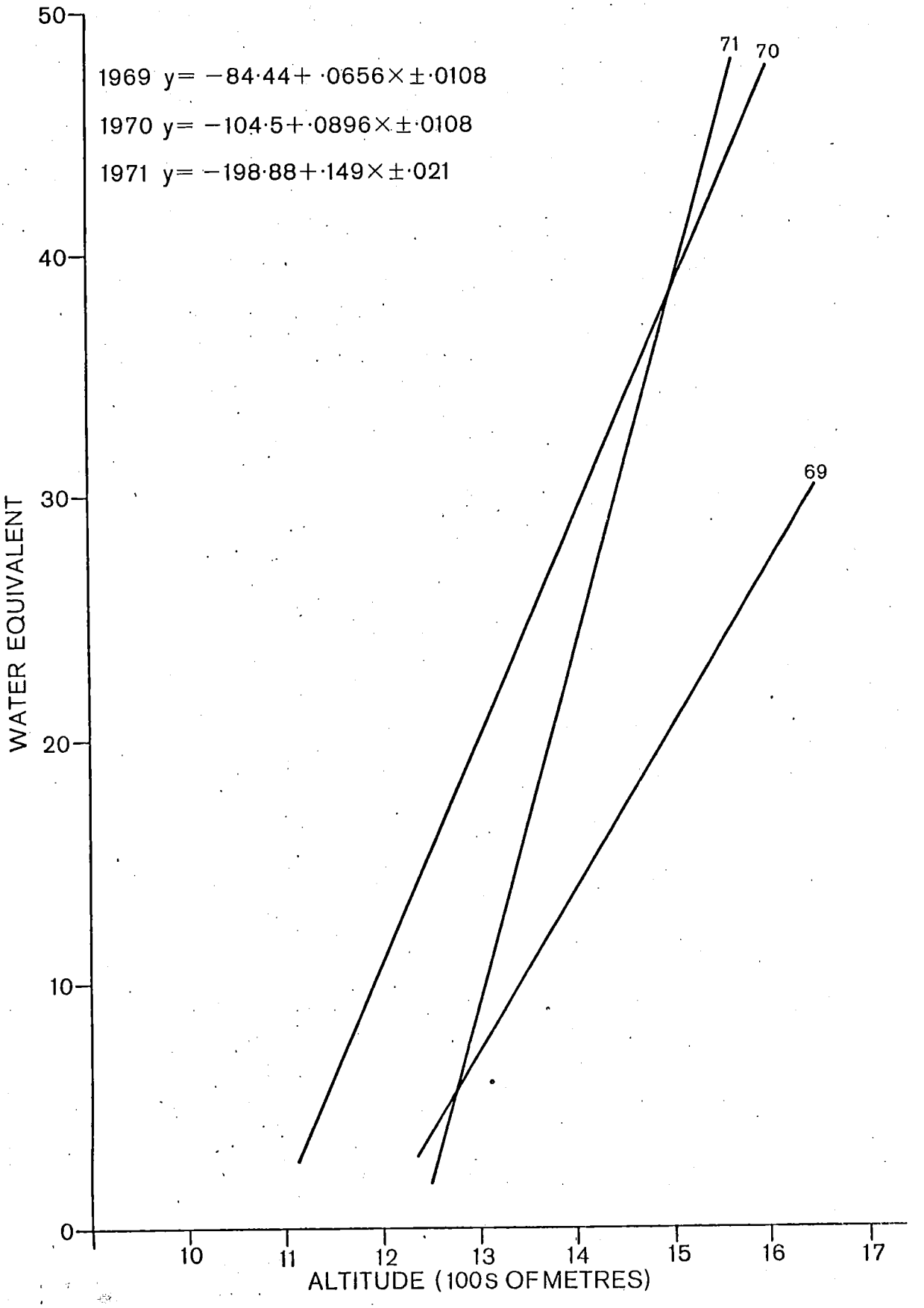


FIGURE 16. Water Equivalent of Snow (cm) in relation to altitude, from 1969-1971 - Twin Stream Catchment

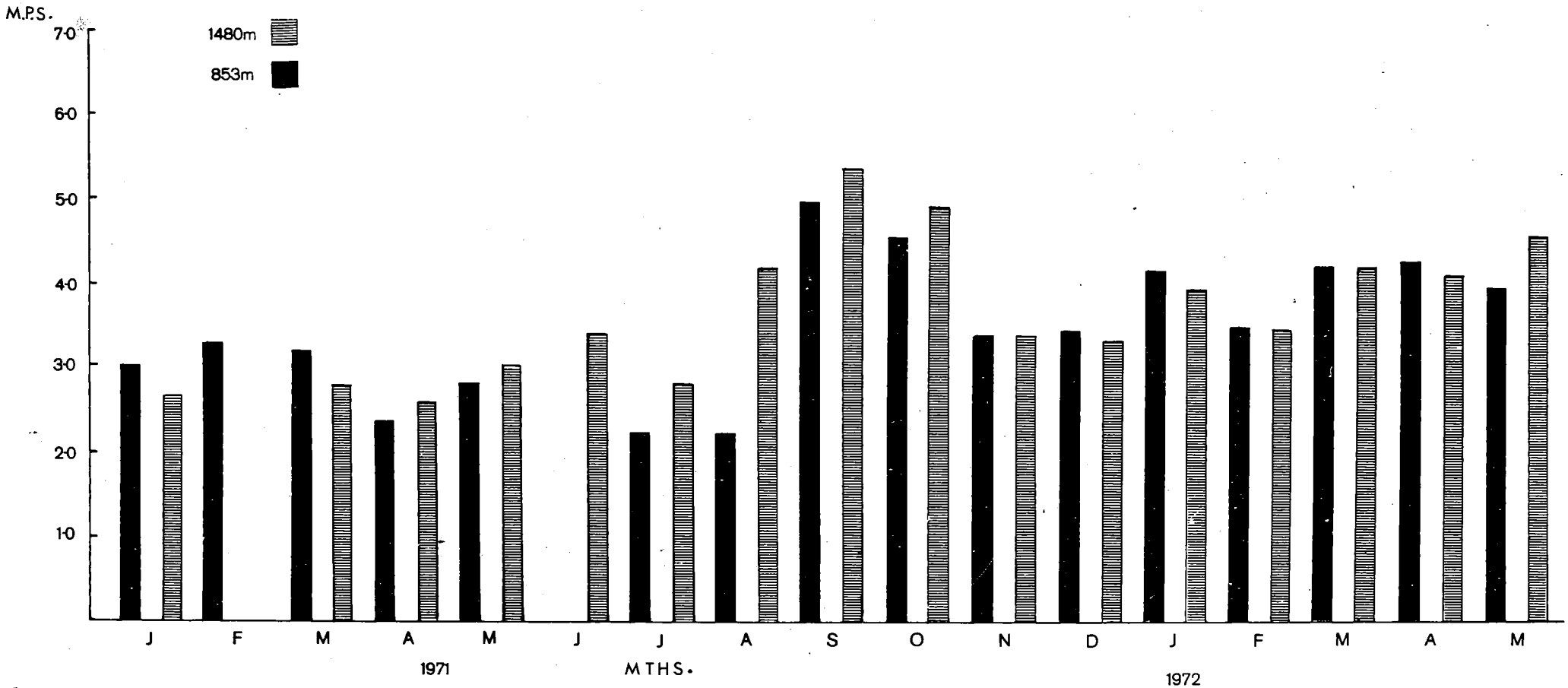


FIGURE 17. Average Wind Speed (mean hourly values in metres per second) between the Lower Field Station, 853m, and the Upper Field Station, 1,480m.

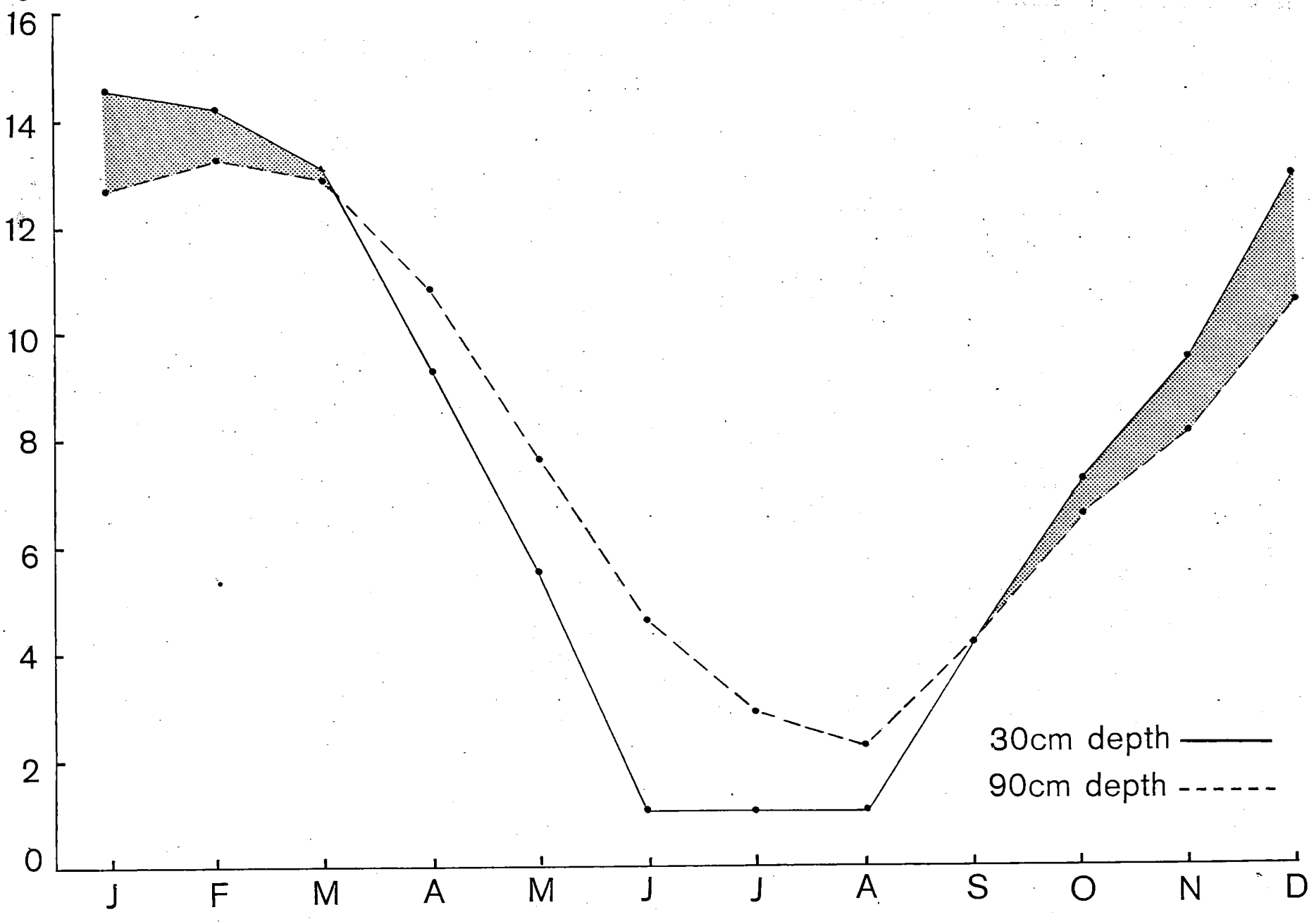


FIGURE 18. Soil Temperature (°C) taken from 30cm and 90cm depths at 850m altitude January - December, 1968-1972.

(Note: Hatched area at base of each diagram refers to duration of snow cover.)

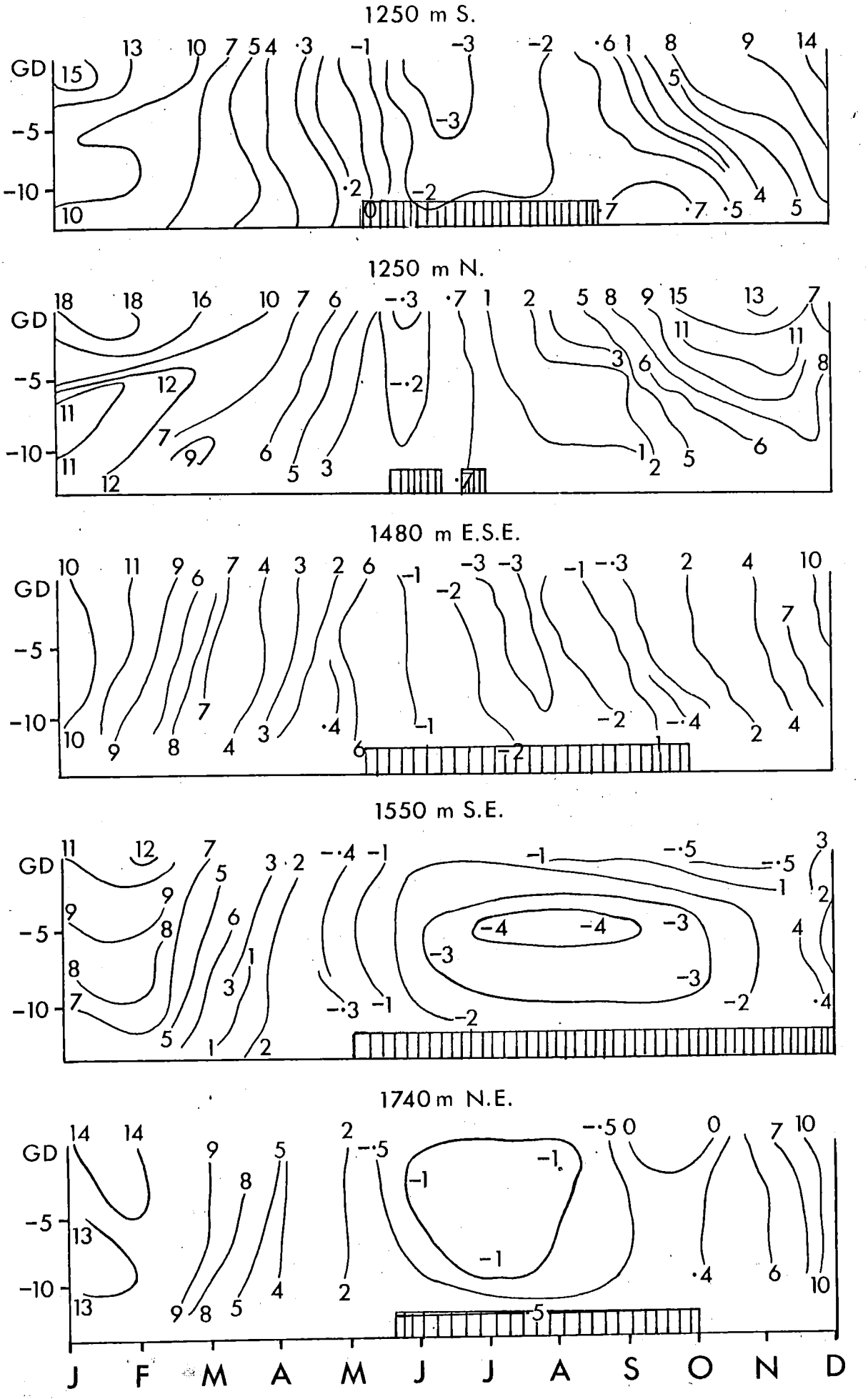
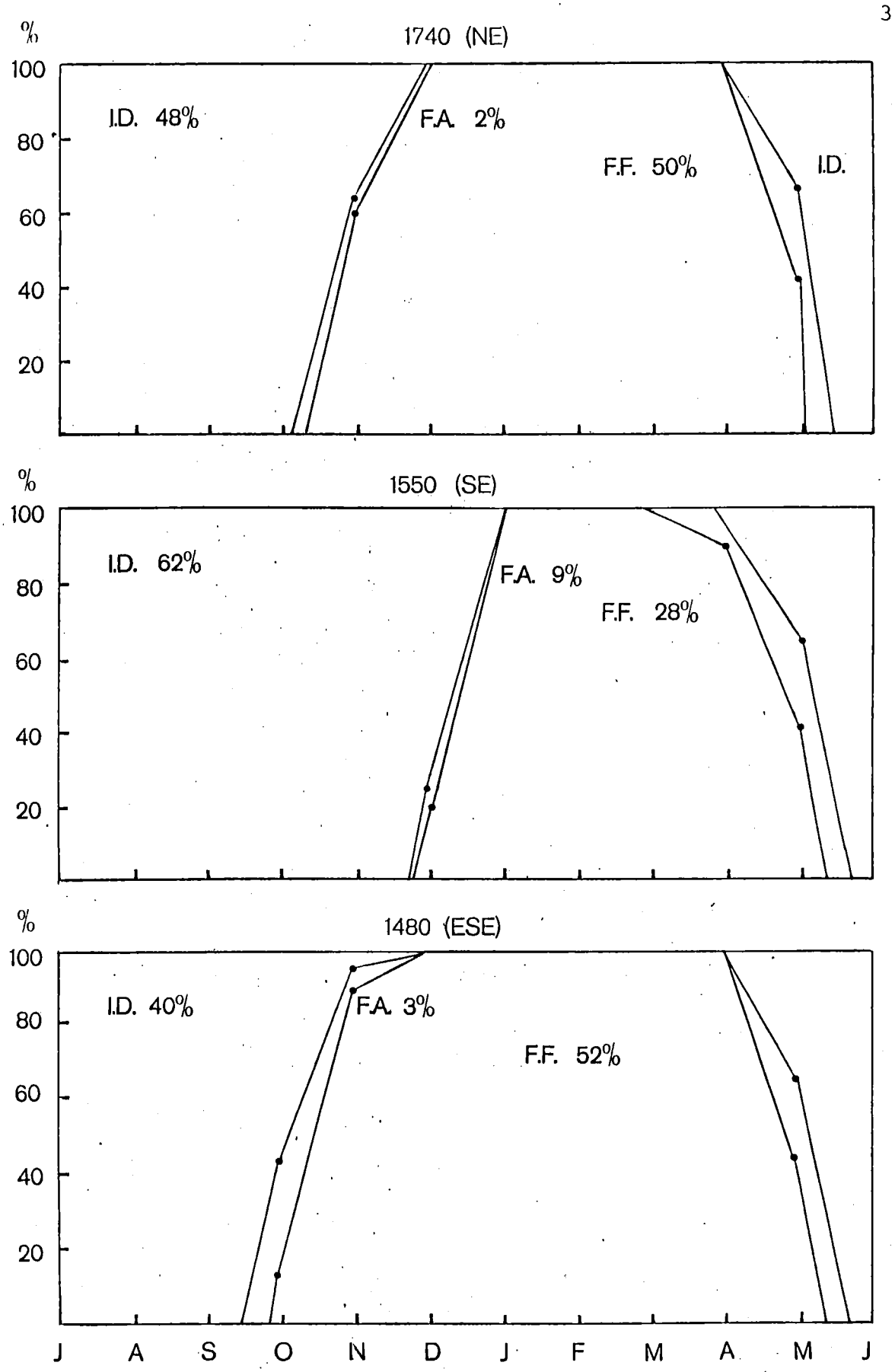


FIGURE 19. Isotherms of Mean Monthly Temperature (°C) of soil profiles ranging in depth from ground to -10 cm - January - December 1968 - 1972.



I.D. = Ice Days

F.A. = Frost Alternate

F.F. = Frost Free

FIGURE 20. Freeze-thaw cycles compiled for soil temperatures at 5 cm depths - 1970 - 1972.

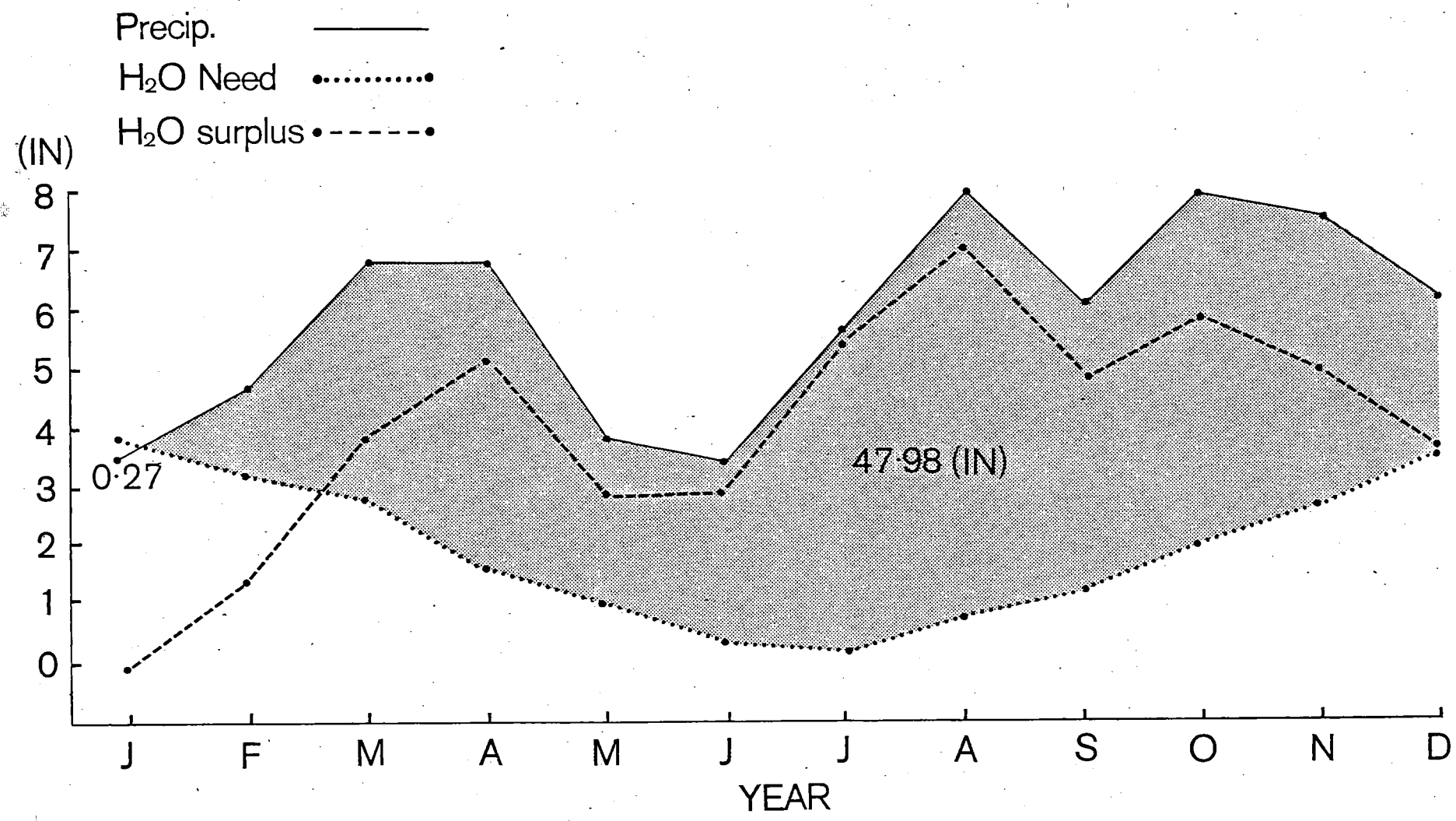


FIGURE 21. Thornwaite's rational classification for the mid-altitude sector (1,000 m) of Twin Stream Catchment - 1968-1972.

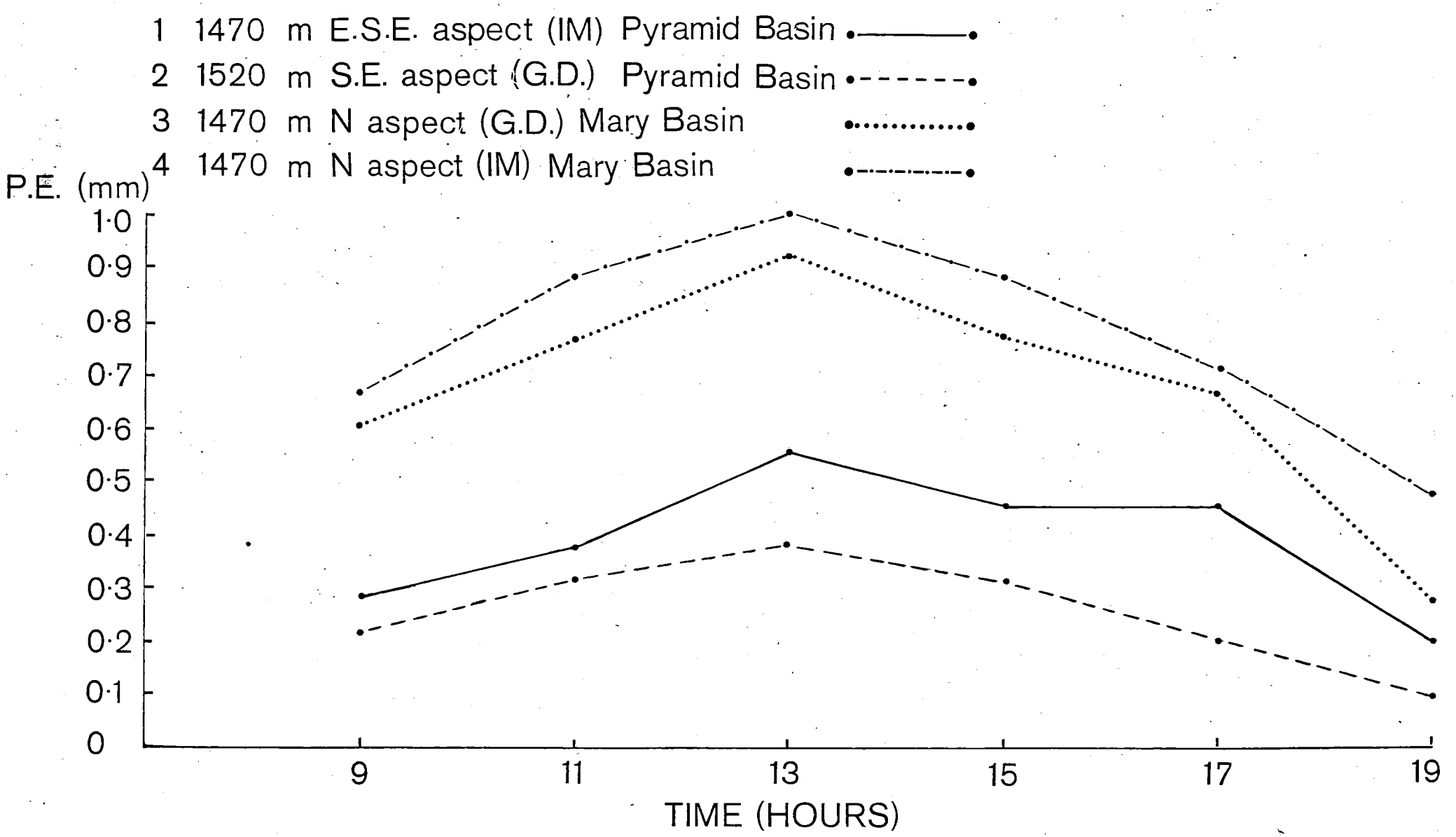


FIGURE 22. Potential evapotranspiration on various aspects at 1 m height and ground surface over a 24 hrs period - January 1971.

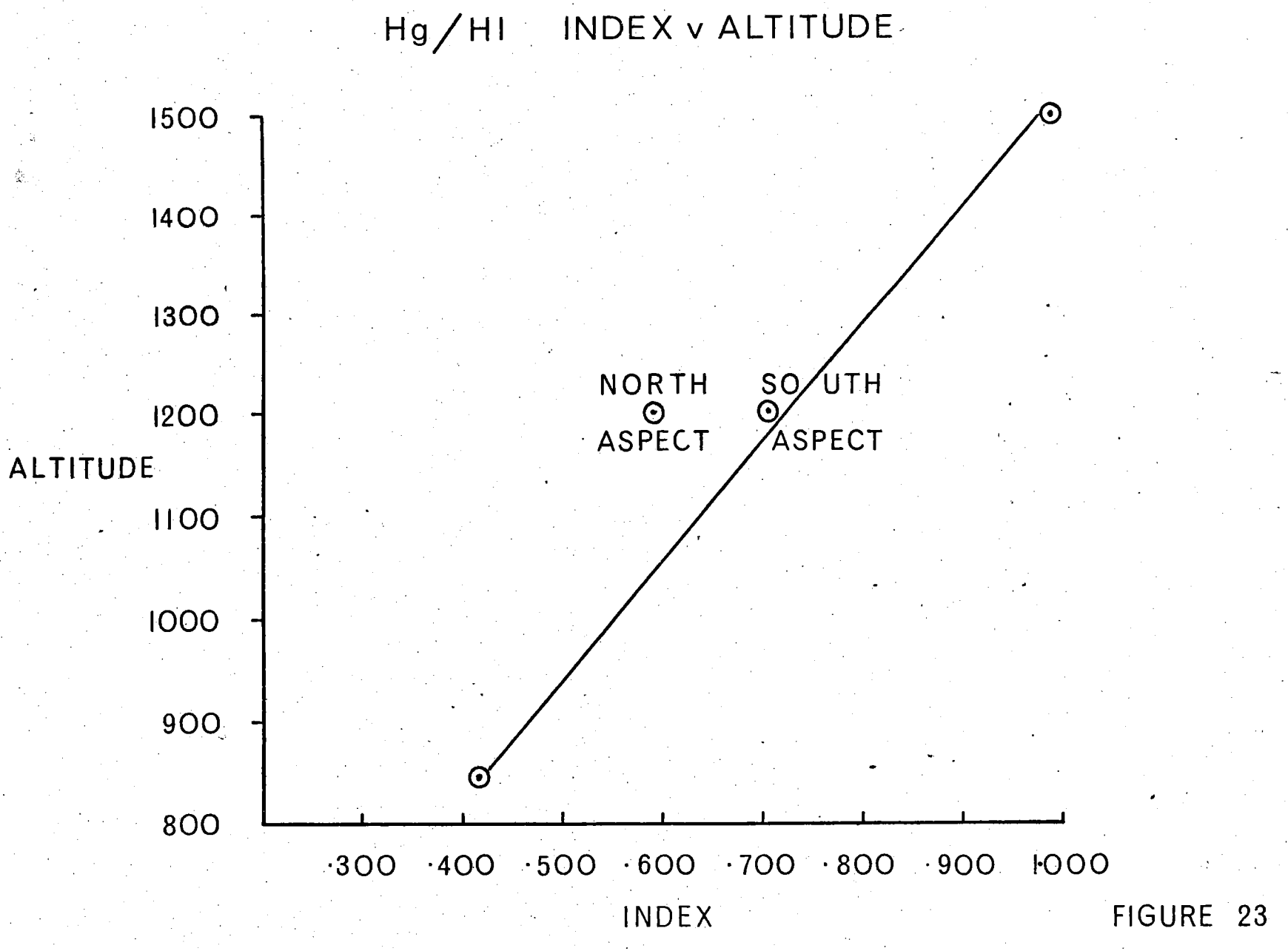

Hg/HI INDEX v ALTITUDE
1500
1400
1300
1200
1100
1000
900
800
ALTITUDE
NORTH ASPECT
SOUTH ASPECT
·300 ·400 ·500 ·600 ·700 ·800 ·900 1·000
INDEX

FIGURE 23

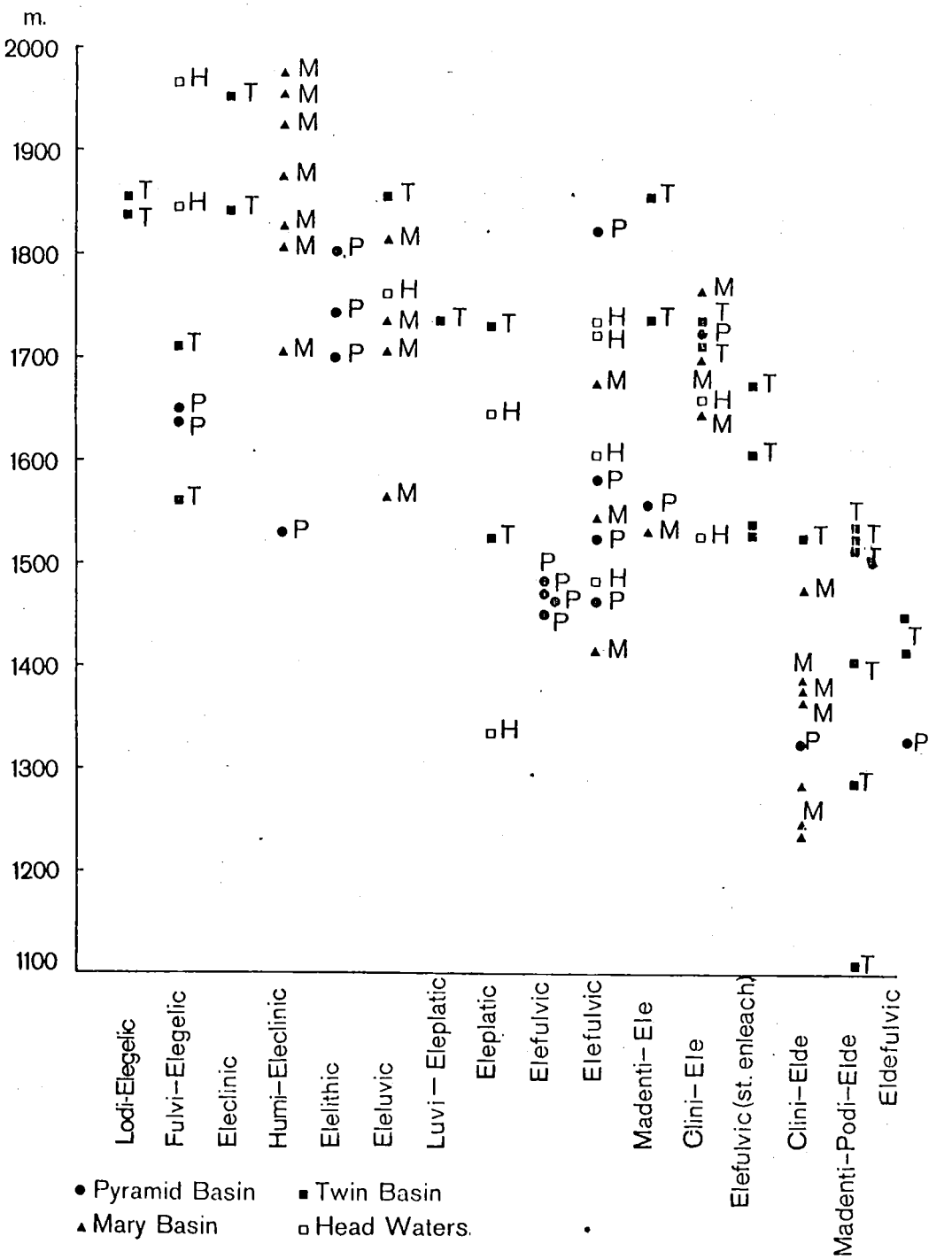


FIGURE 24. Altitudinal Distribution of the soils throughout the study area.

FIGURE 25 ALTO-SEQUENCE OF SOILS IN THE TWIN BASIN

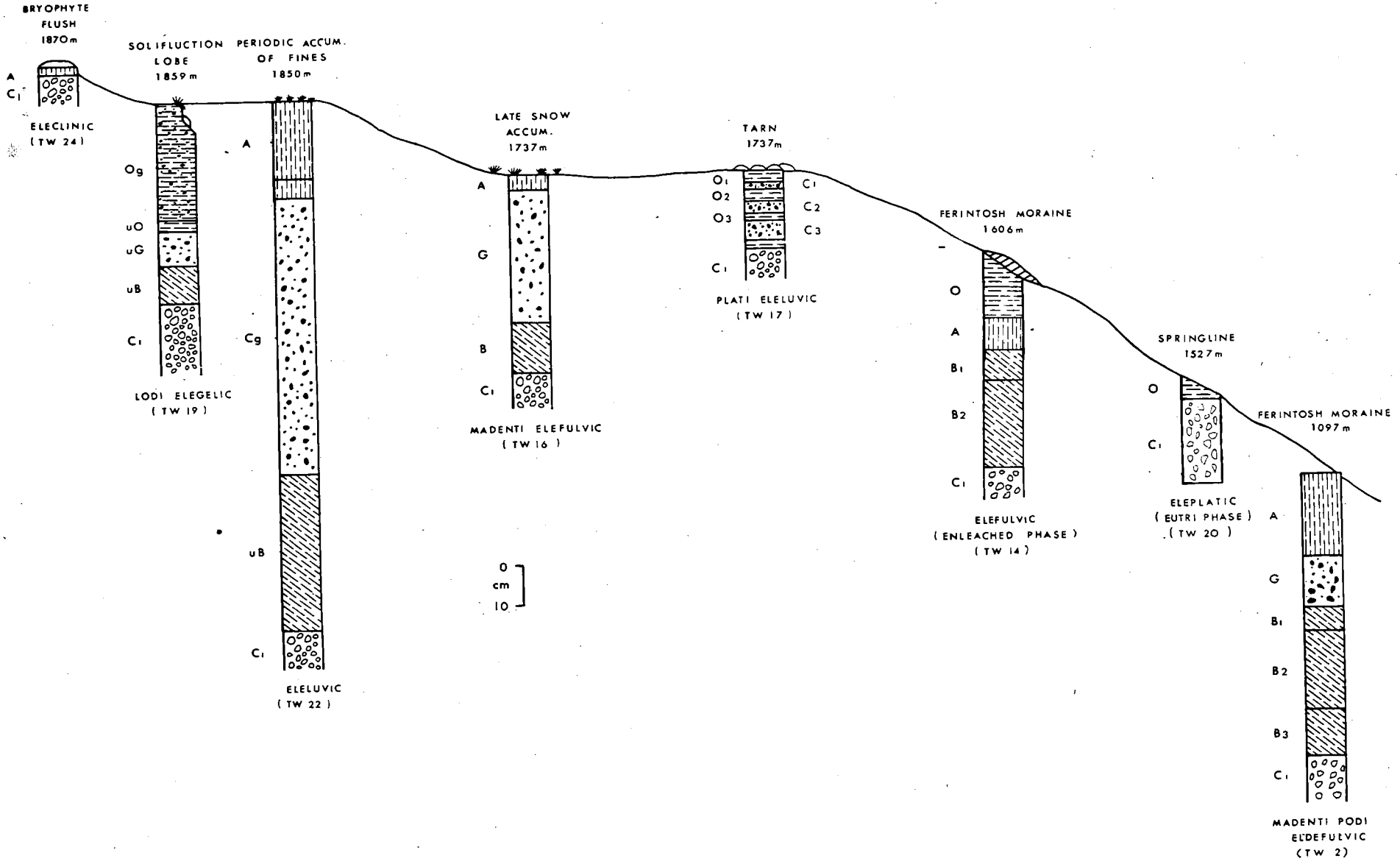


FIGURE 26 ALTO-SEQUENCE OF SOILS IN THE TWIN STREAM HEADWATERS

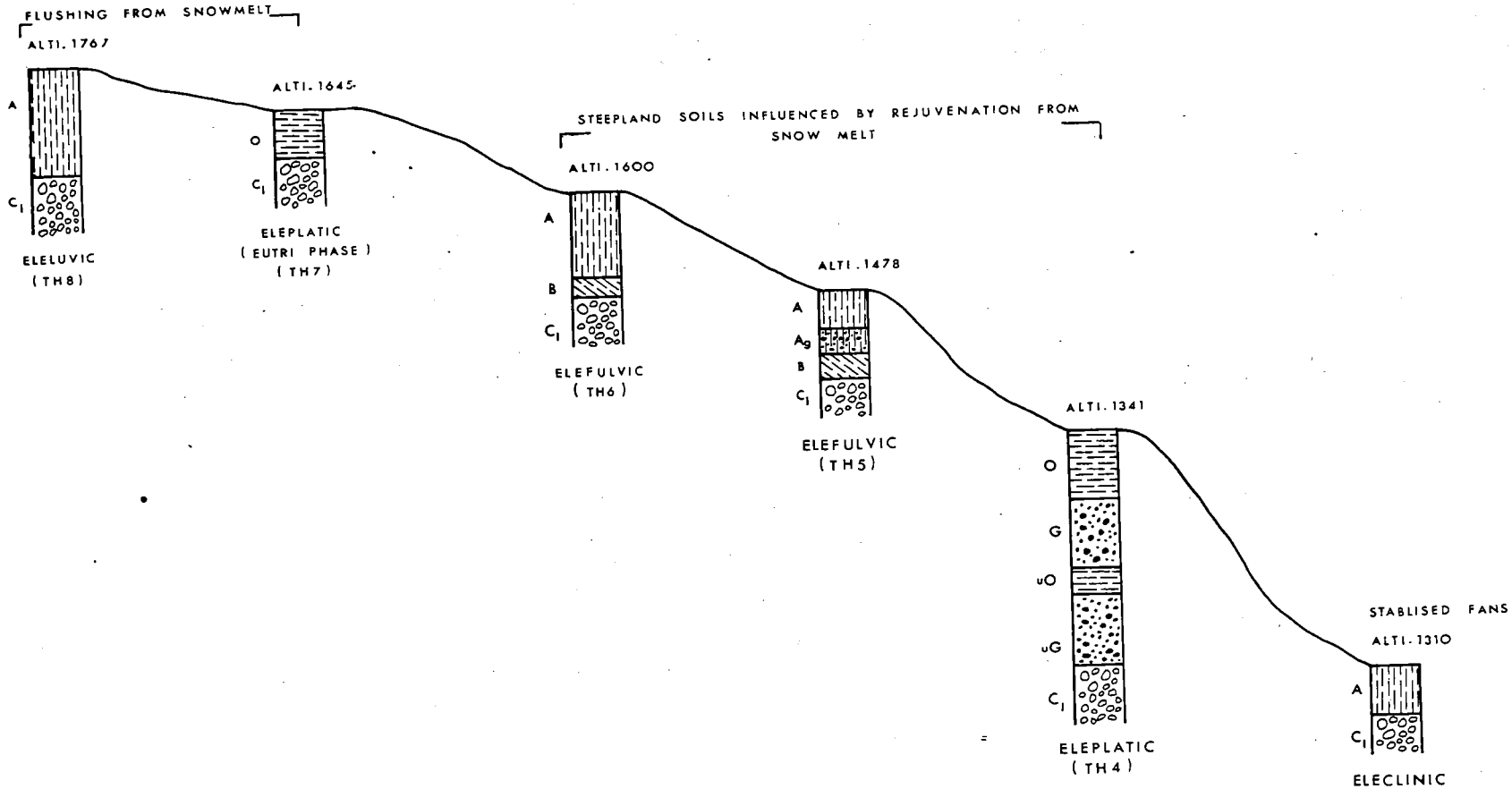
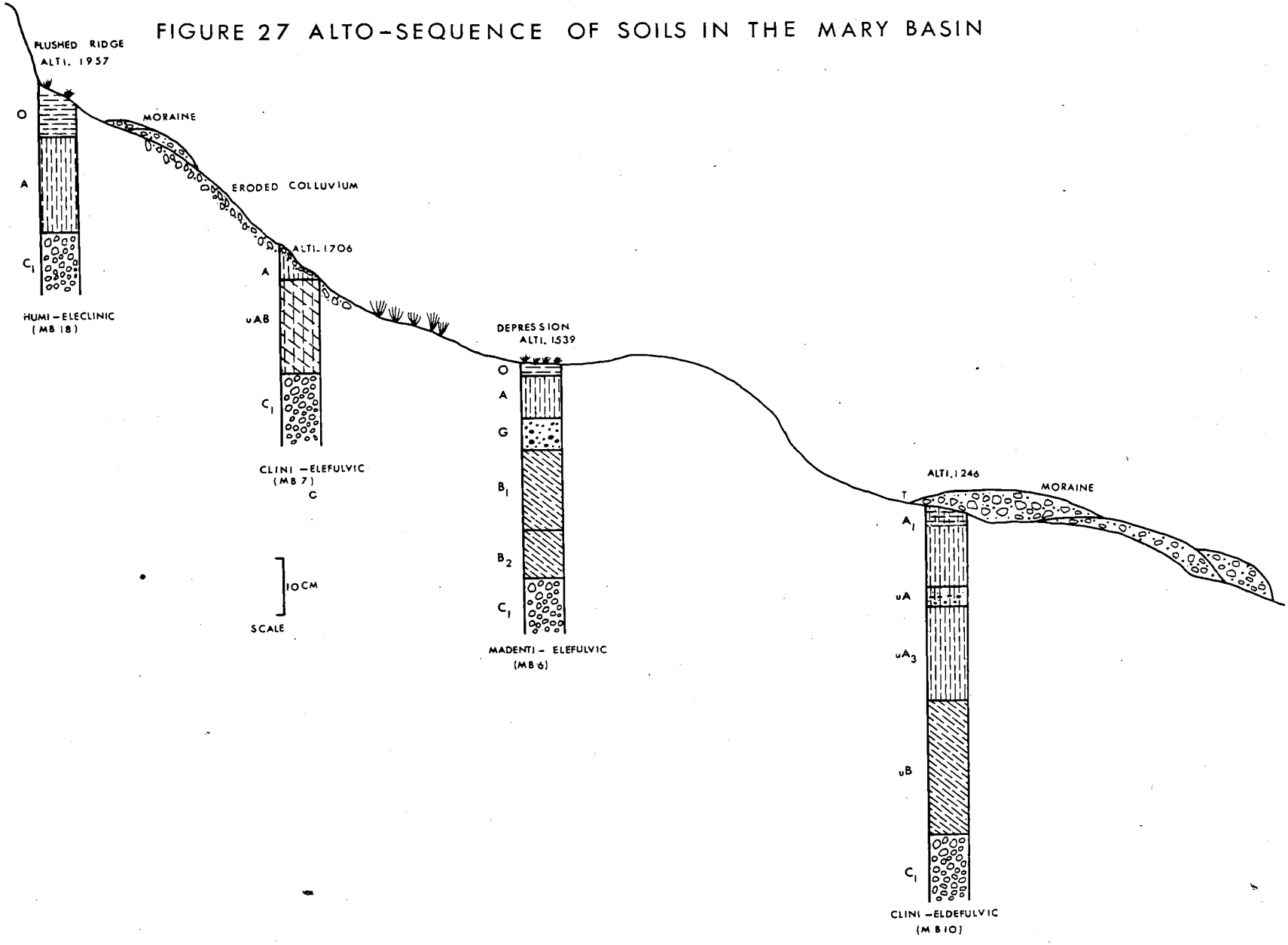


FIGURE 27 ALTO-SEQUENCE OF SOILS IN THE MARY BASIN



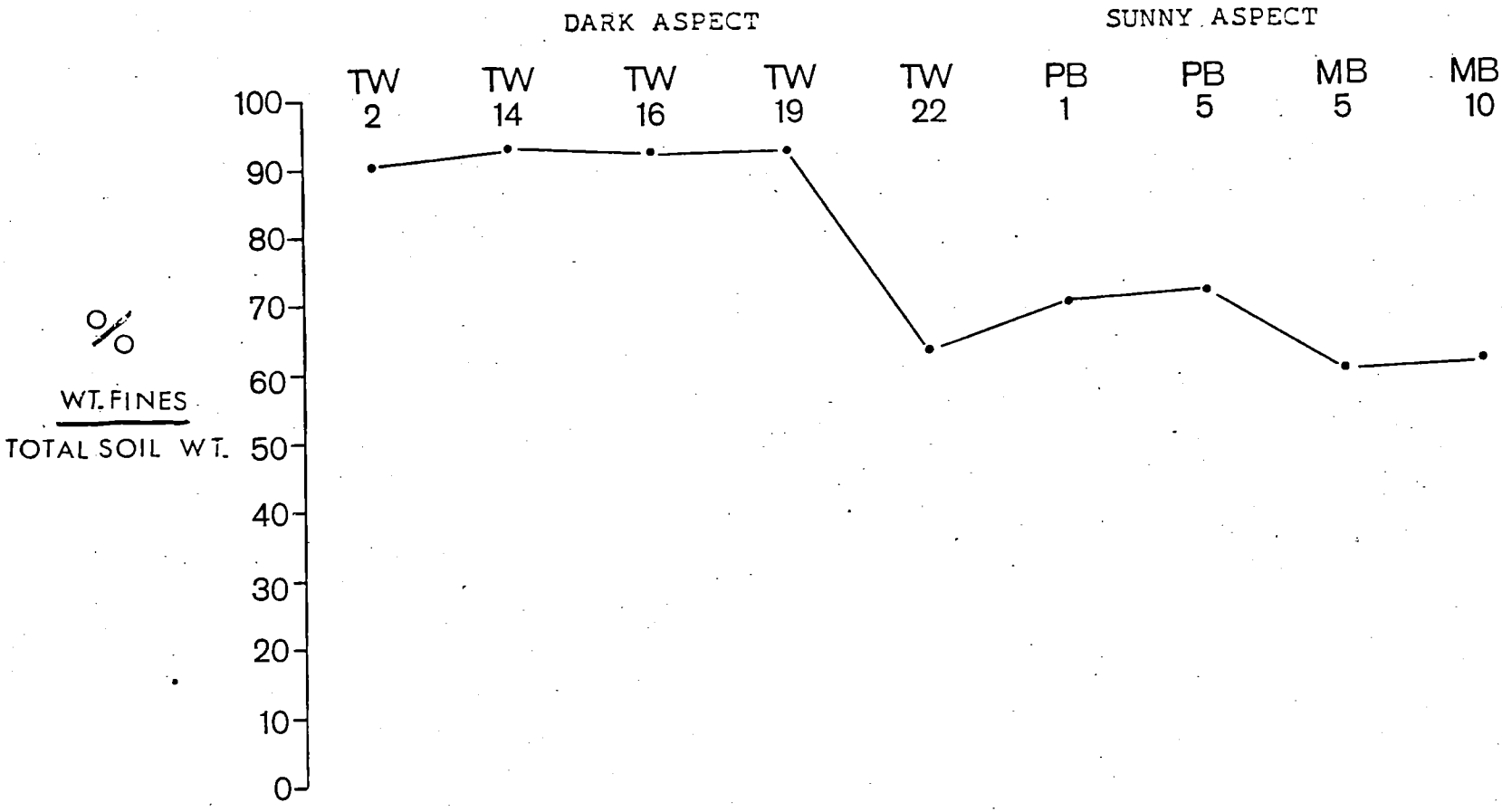


FIGURE 28. Proportion of Volume Weight (fine earth) to Total Bulk Density of the Fine Fraction < 2 mm of a Range of Soils.

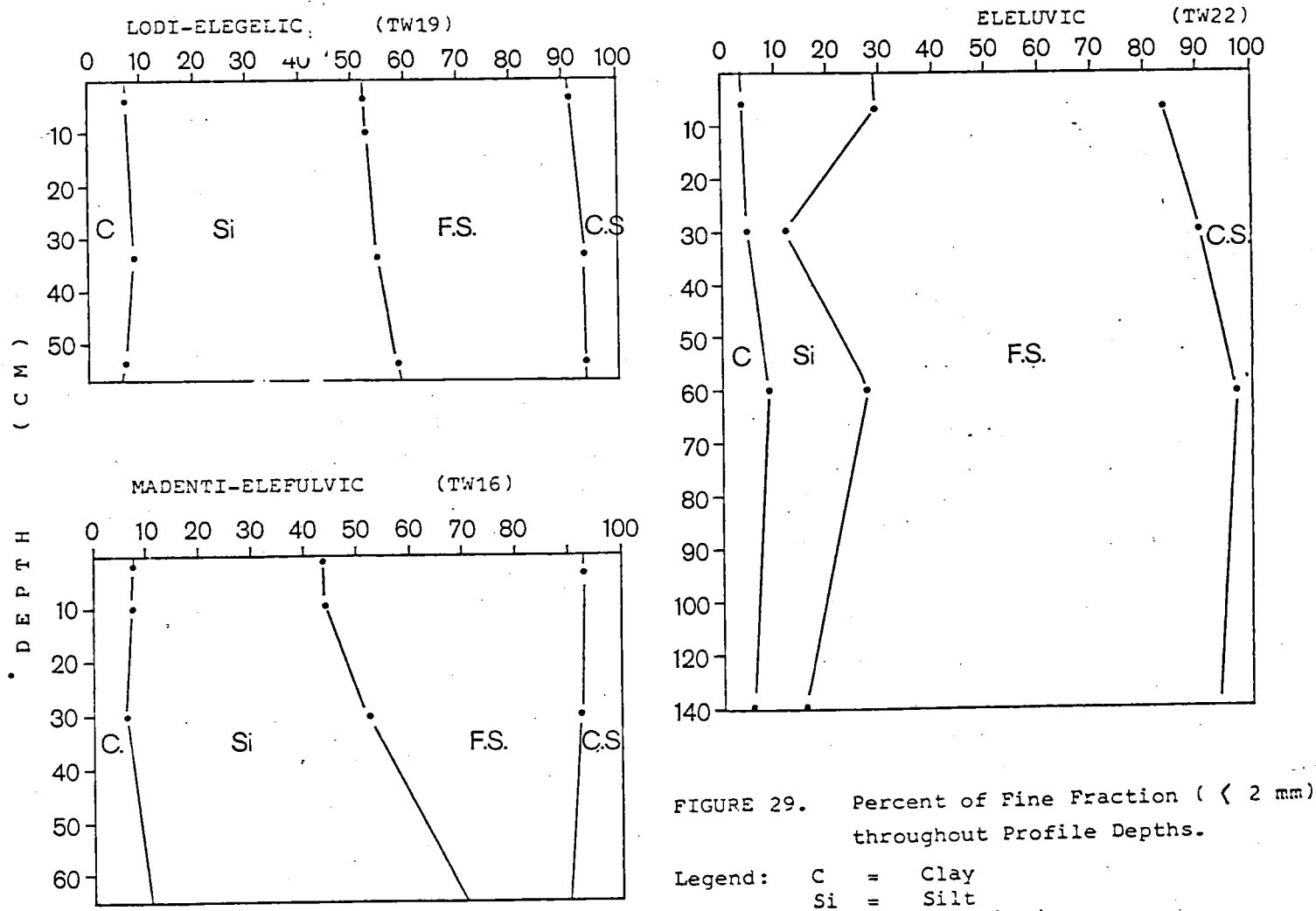


FIGURE 29. Percent of Fine Fraction (< 2 mm) throughout Profile Depths.

Legend:
C = Clay
Si = Silt
F.S.= Fine Sand
C.S.= Coarse Sand

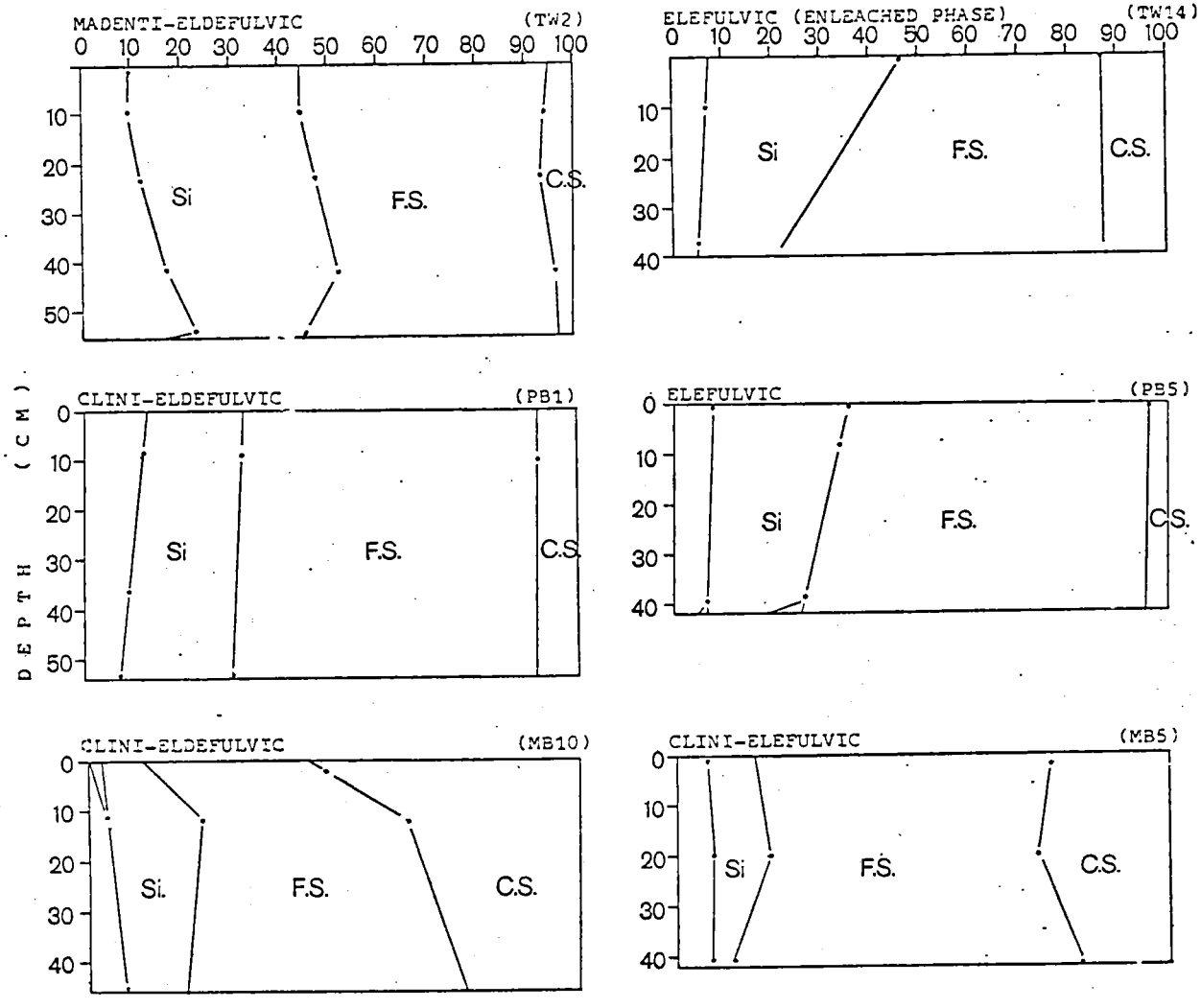


FIGURE 29. Percent of Fine Fraction ($\leq$2mm) throughout Profile Depths.

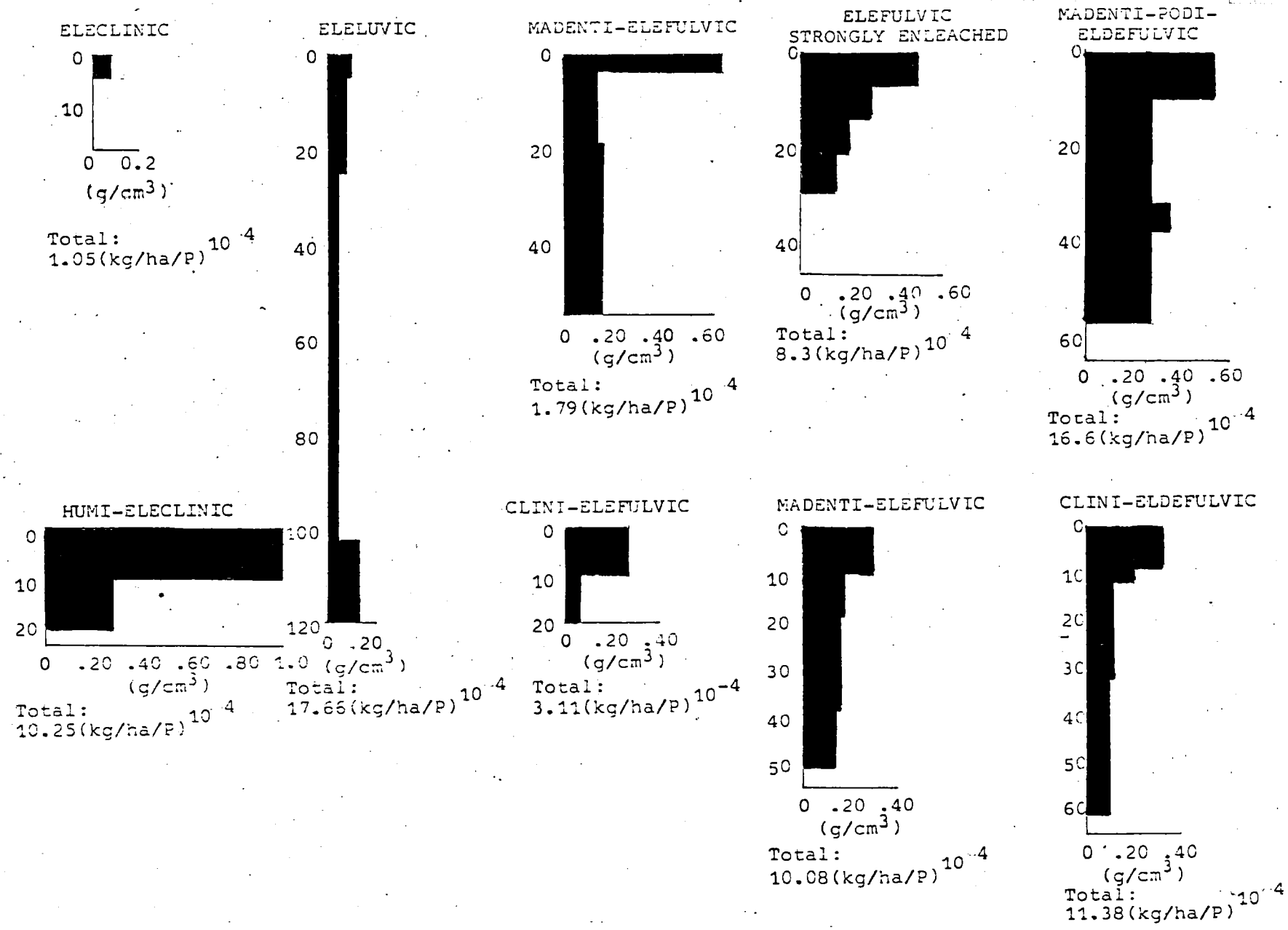


FIGURE 30. Carbon contained in the soils of the Twin and Mary Basins - Alto-Sequences.

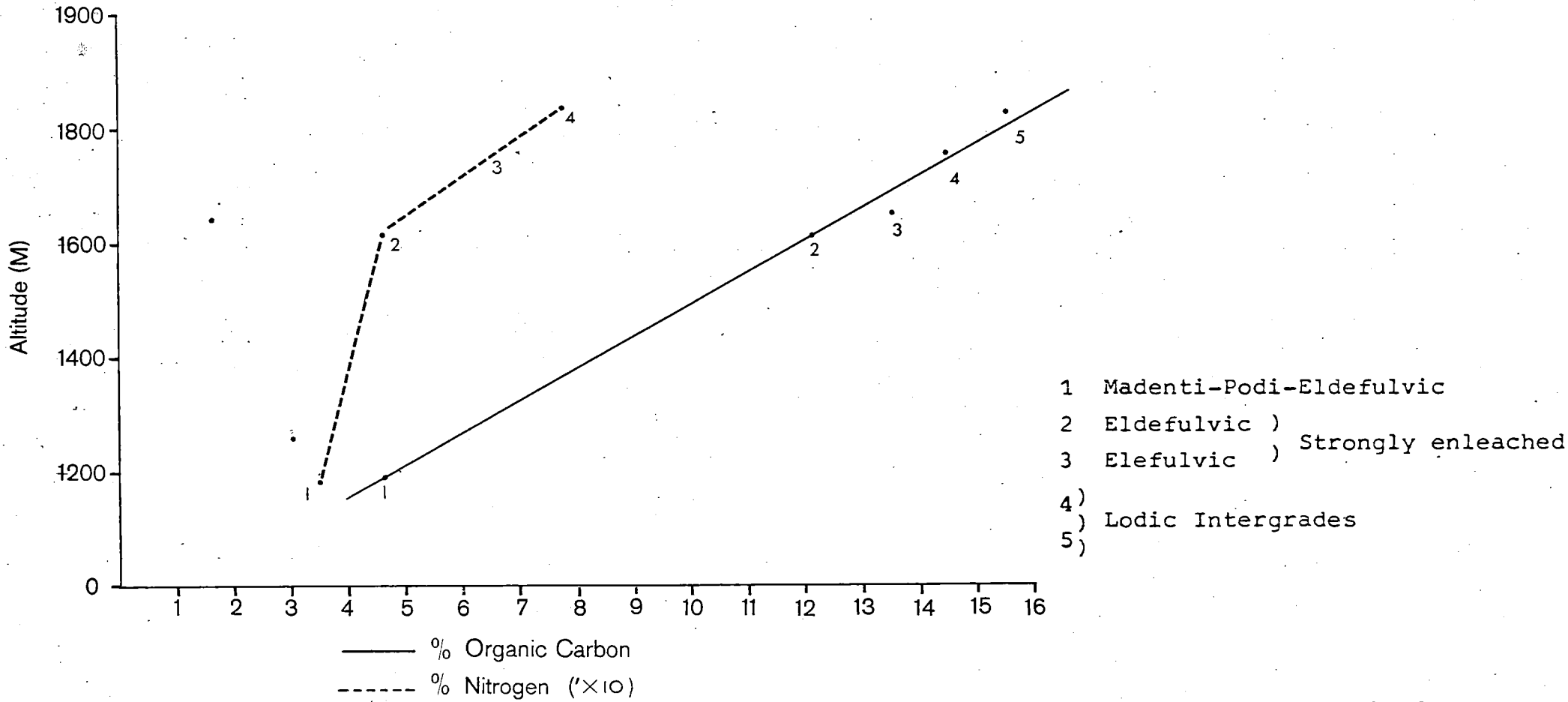


FIGURE 31. Relationship of nitrogen and organic carbon in top 0 - 5 cm of soil with altitude on the South aspect.

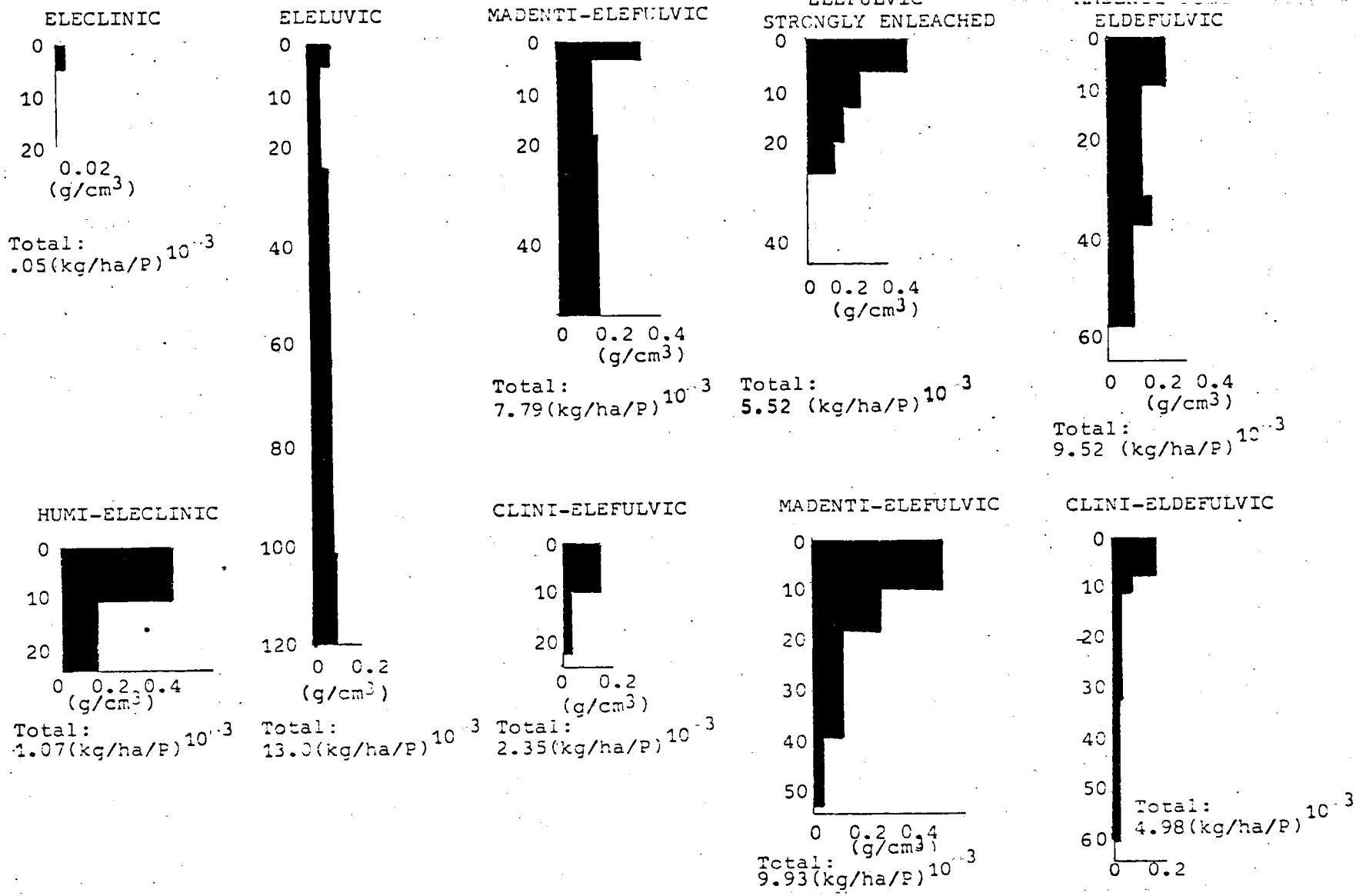


FIGURE 32. Total Nitrogen of the Soils in the Mary and Twin Basins.

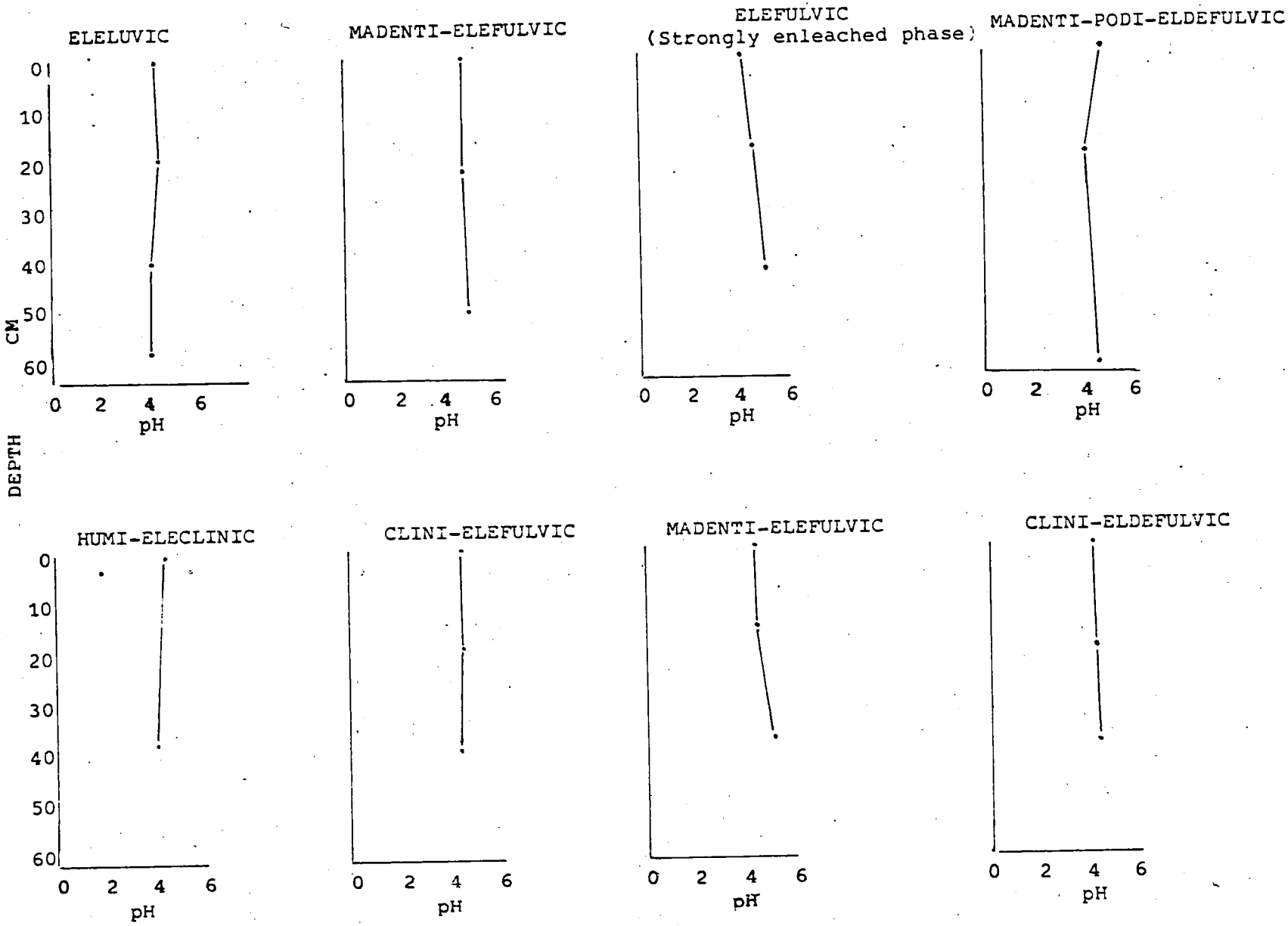


FIGURE 33. pH of Soils from the Mary and Twin Basins.

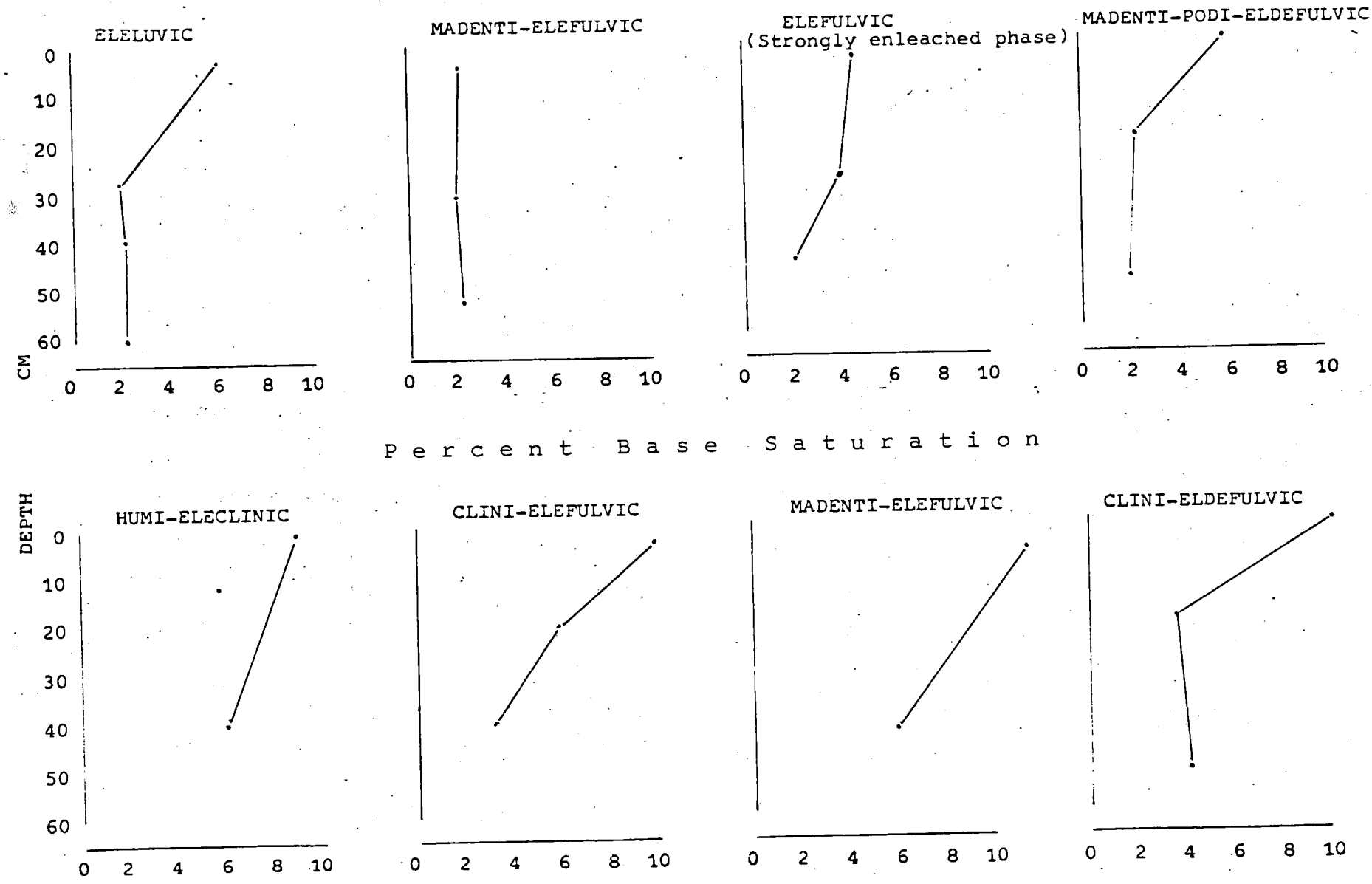


FIGURE 34. Percent Base Saturation of soils from the Mary and Twin Basins.

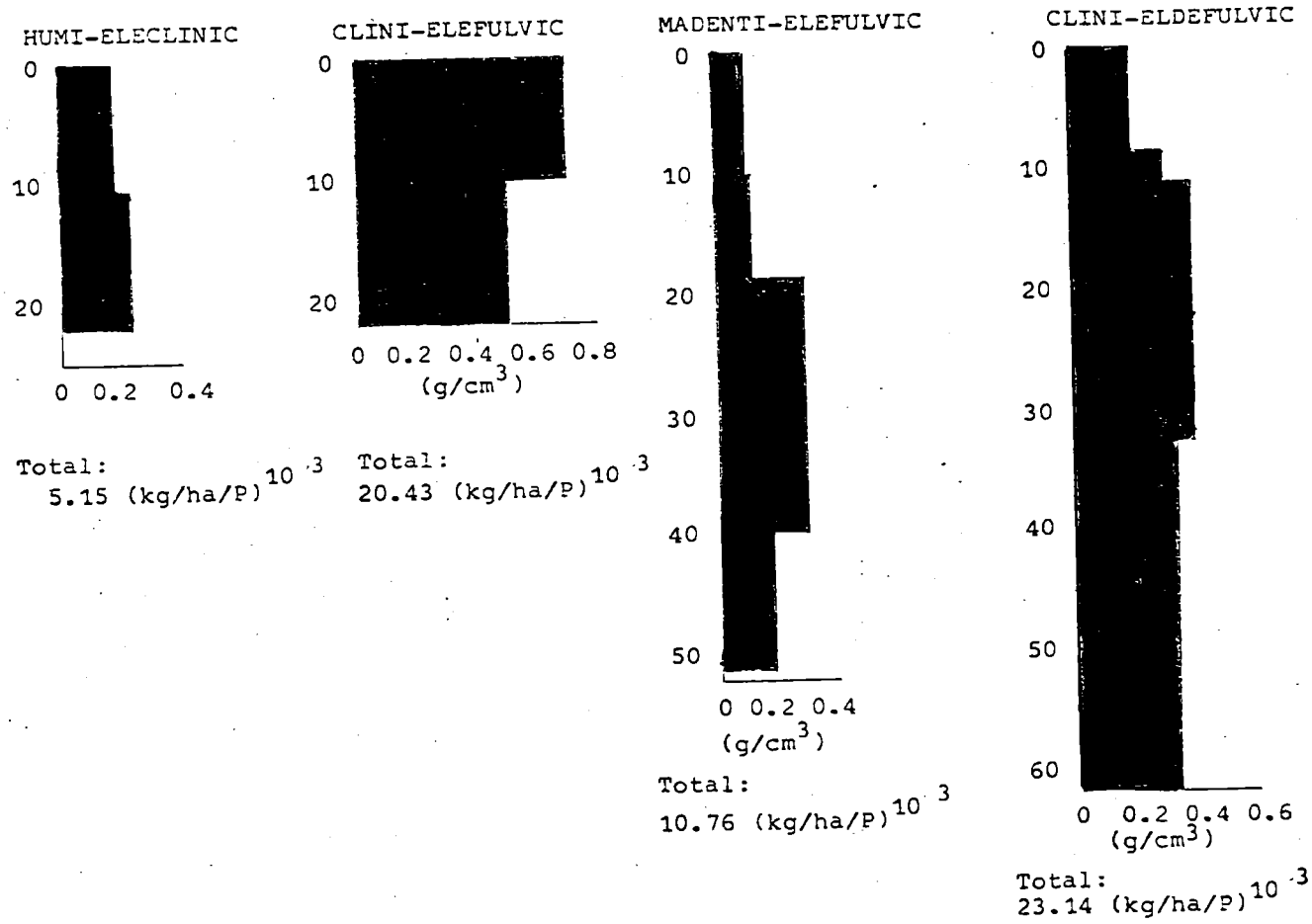


FIGURE 35a. Calcium and Magnesium Total Elements (g/cm^3) contained in the Soils of the Mary Basin Alto-Sequence.

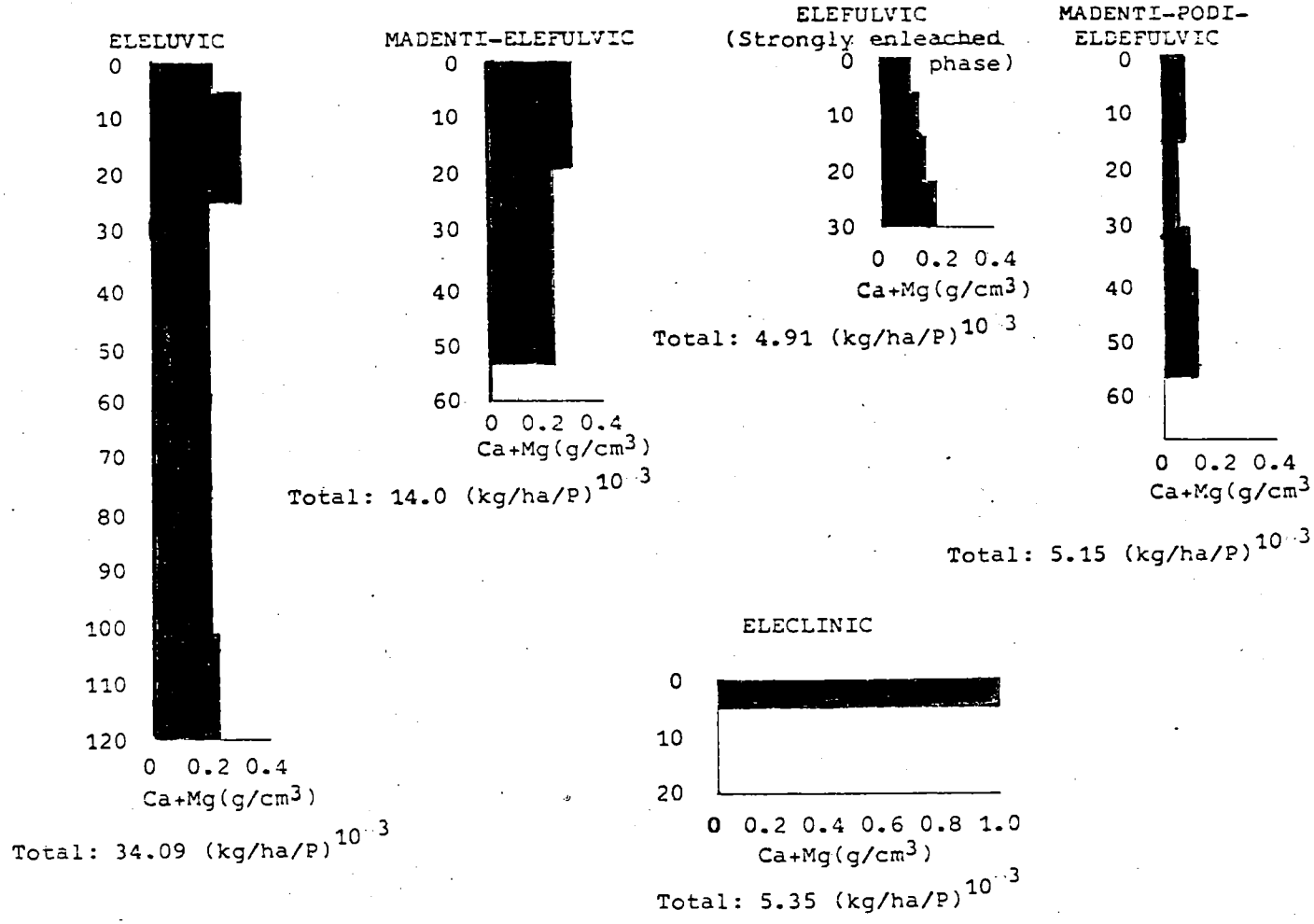


FIGURE 35b. Calcium and Magnesium Total Elements (g/cm^3) contained in the Soils of the Twin Stream Basin Alto-Sequence.

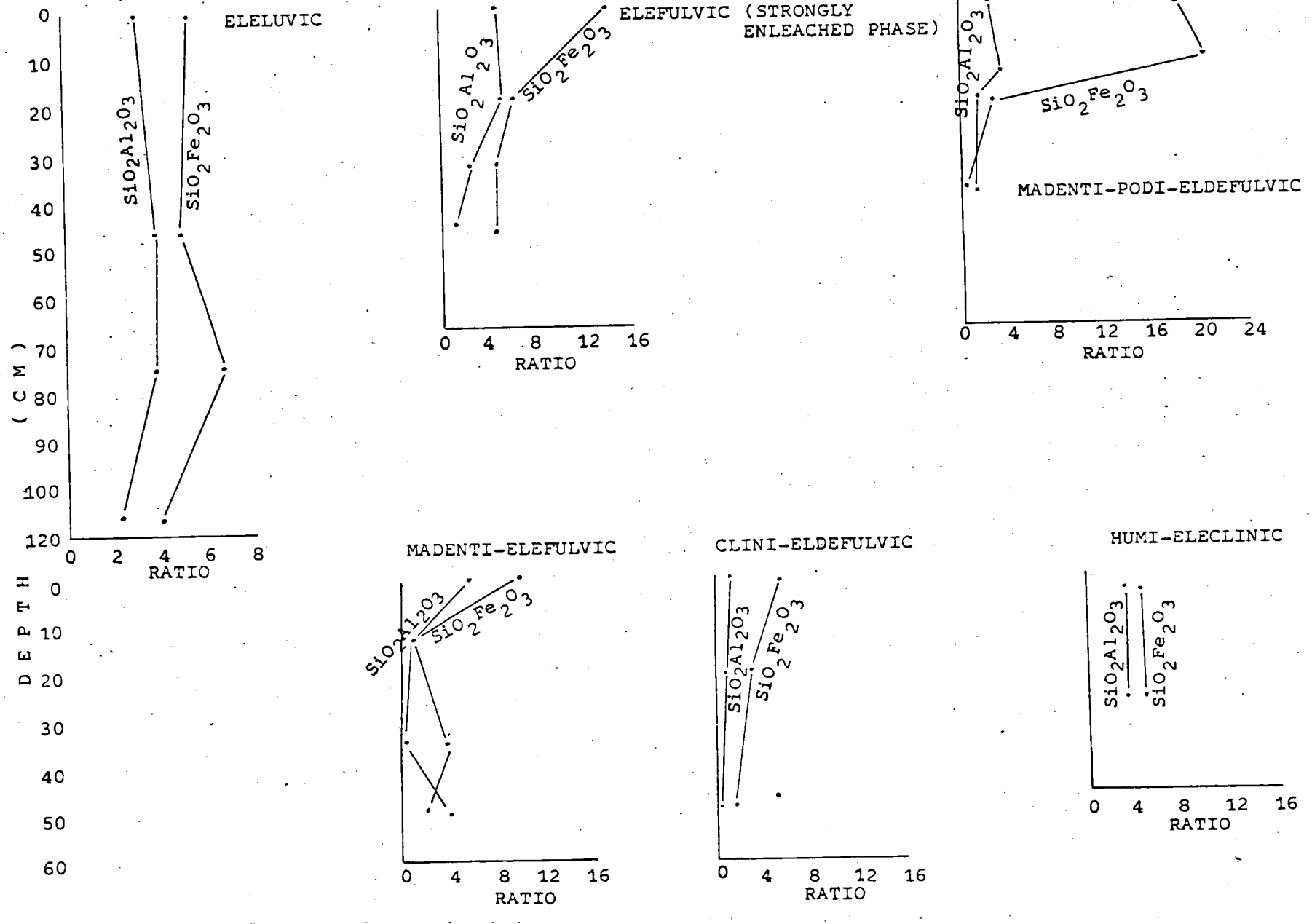


FIGURE 36. Sesquioxide Ratio of Soils in Mary and Twin Basins.

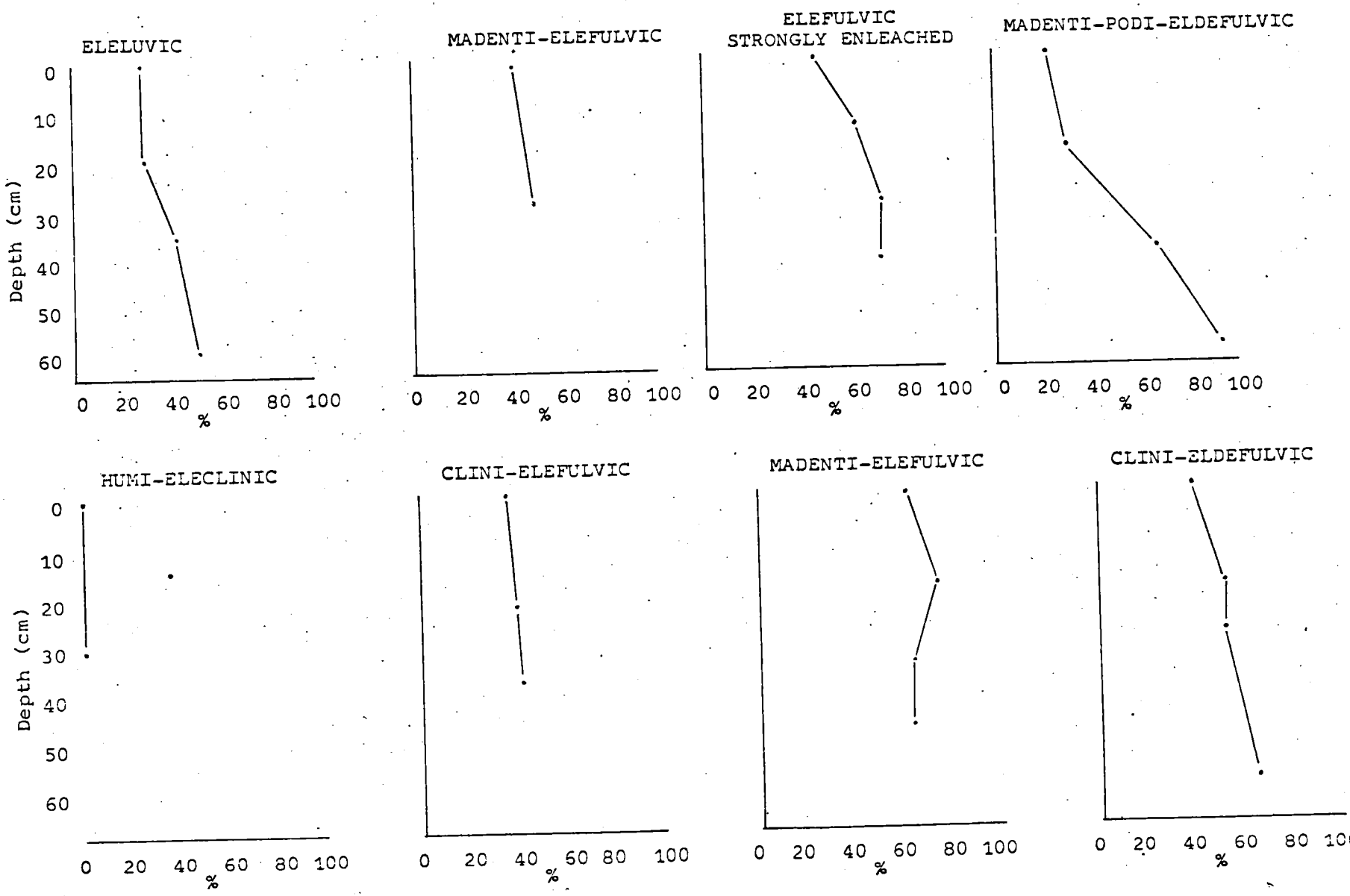


FIGURE 37. PHOSPHATE RETENTION

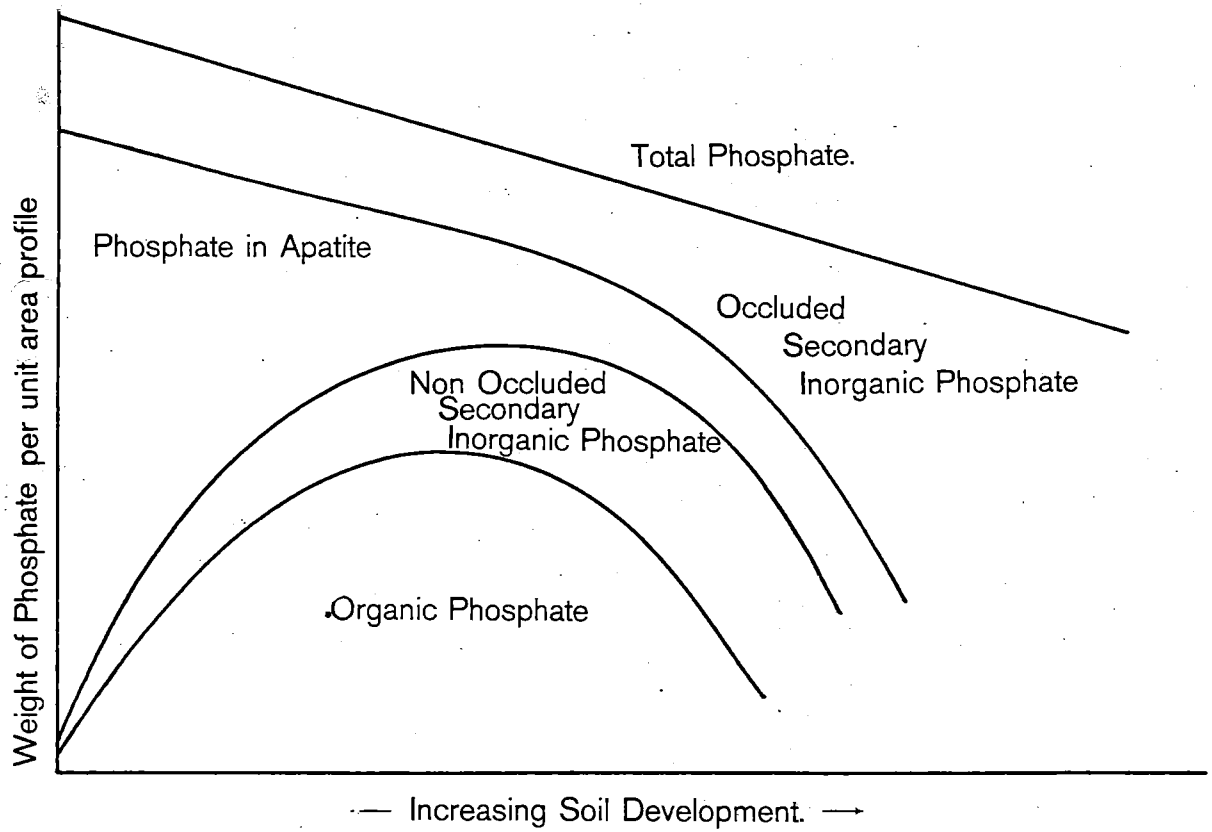


FIGURE 38. Changes in the magnitude of phosphate fractions during pedogenesis (after Williams and Walker, 1969).

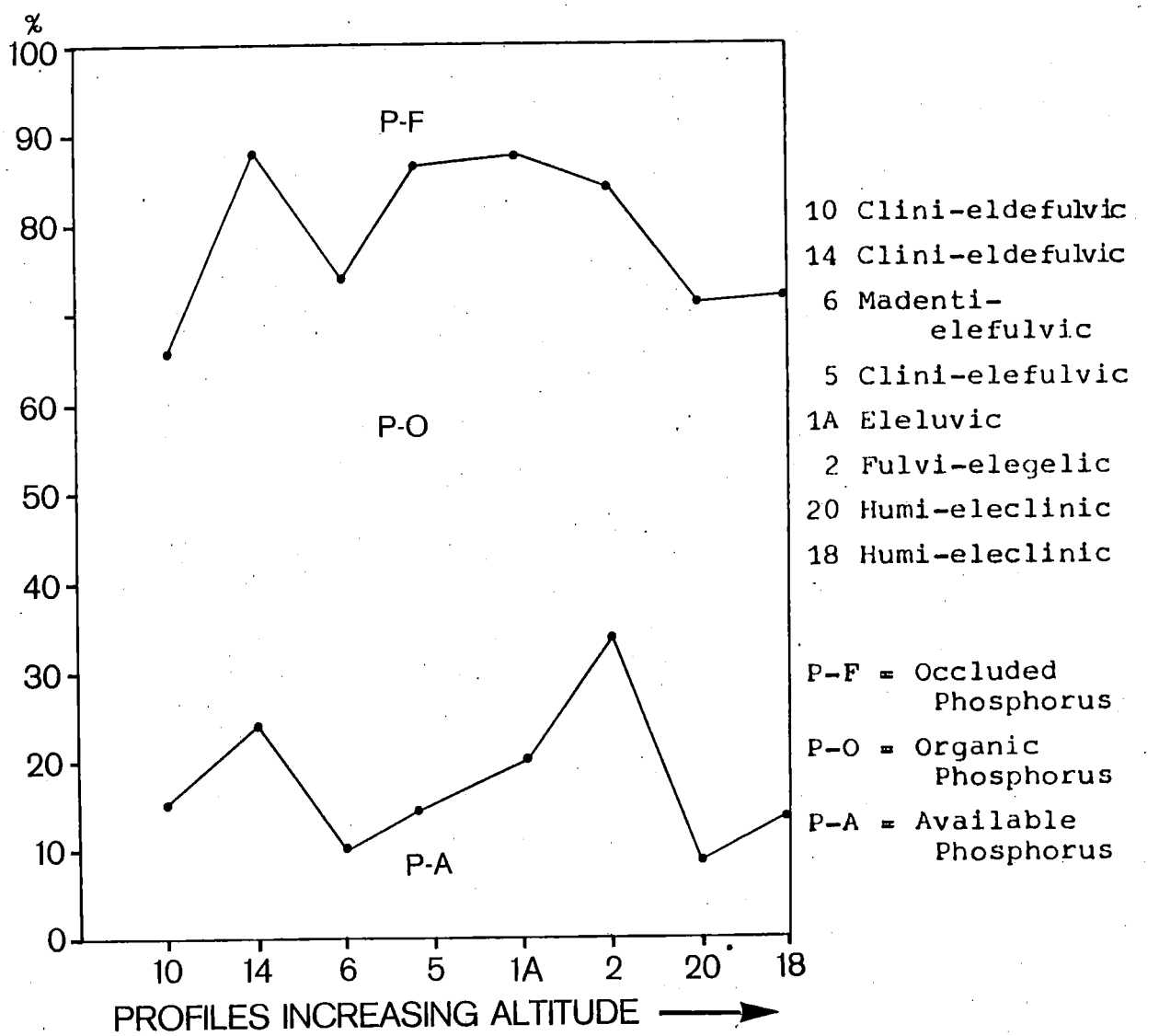
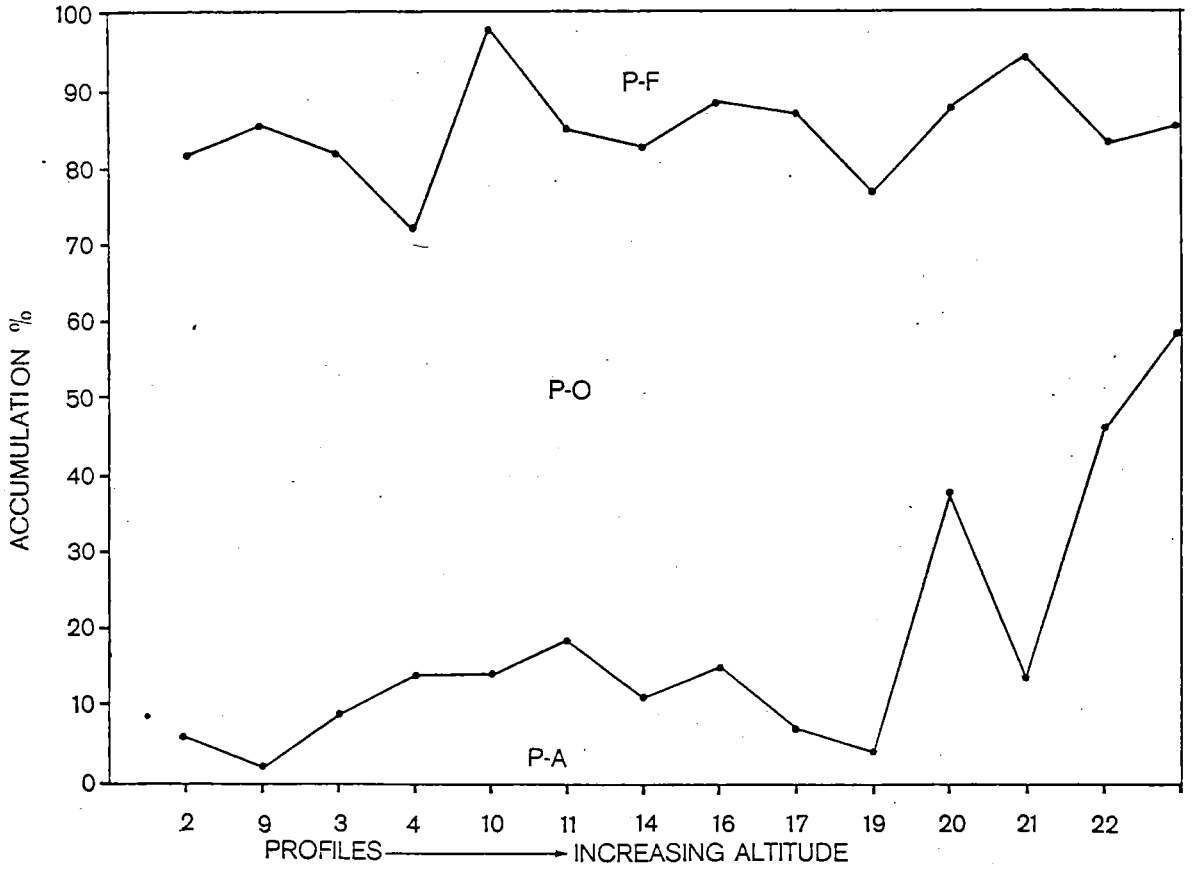


FIGURE 39. Phosphorus fractions in the A horizon of the Mary Basin soils.



P-F= Occluded Phorphorus.

P-O= Organic Phosphorus.

P-A= Available Phosphorus.

2, 3, 4 Madenti-podi-eldefulvic
9, 11 Eldefulvic (strongly enleached phase)
10, 14, 16 Elefulvic
17 Luvi-eleplatic
19 Lodi-elegelic
20 Eleplatic
21 Fulvi-elegelic
22 Eleluvic
24 Eleclinic

FIGURE 40. Phosphorus fractions in the A horizons of some hydrous soils in the Twin Basin.

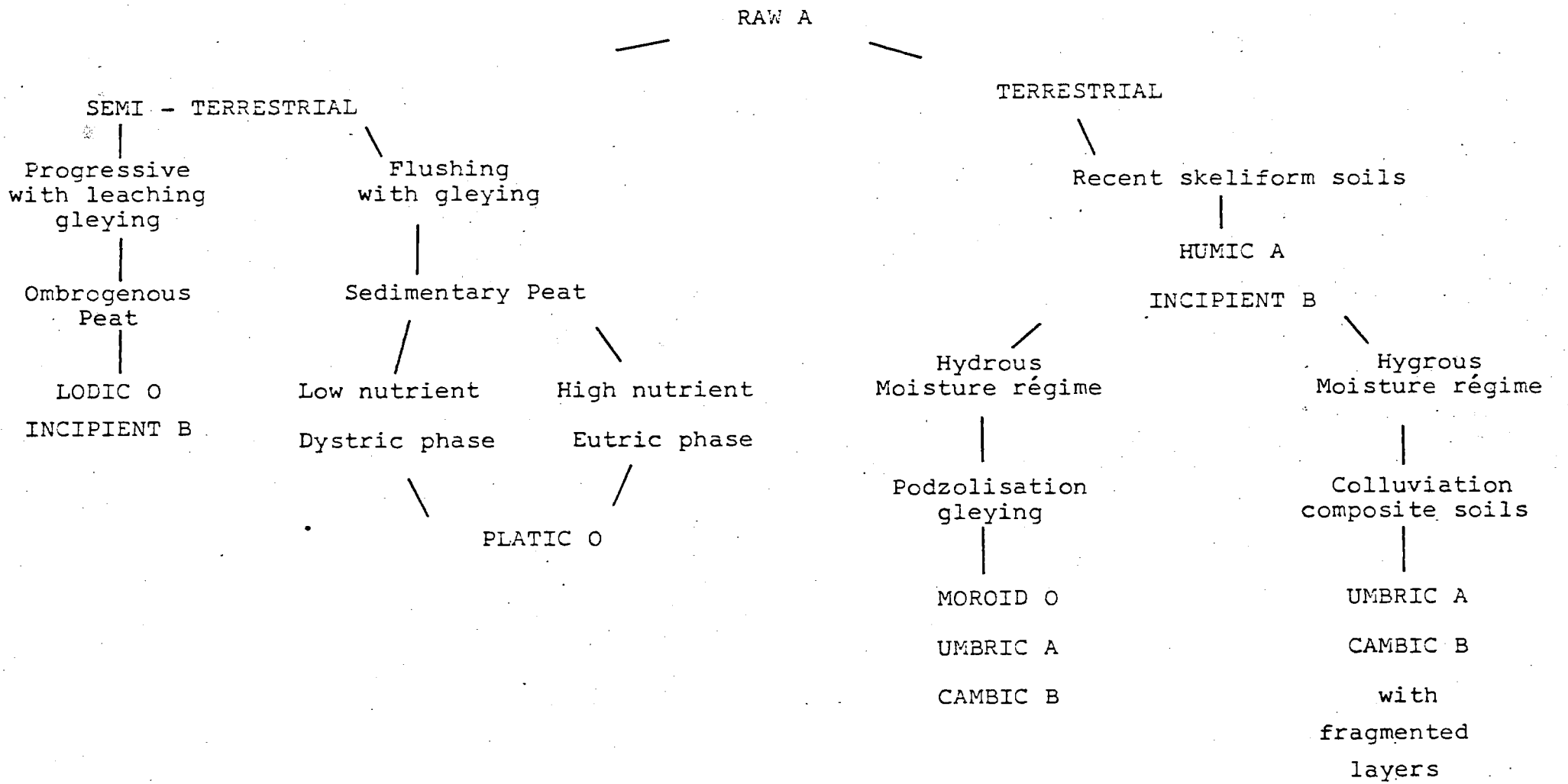
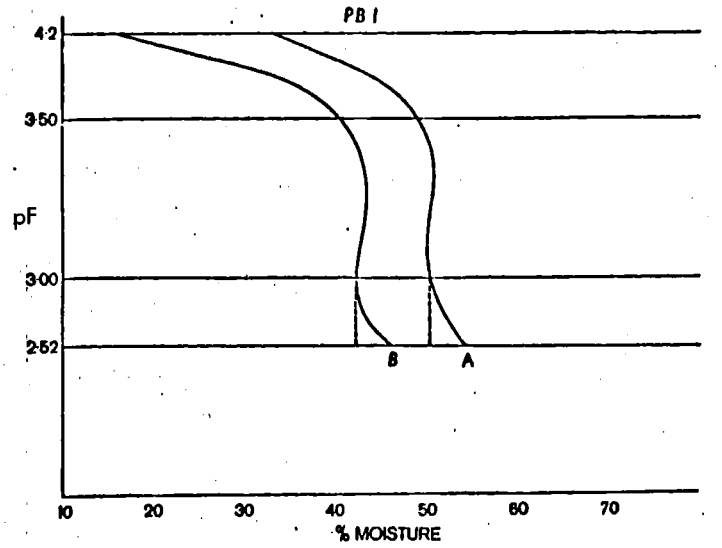
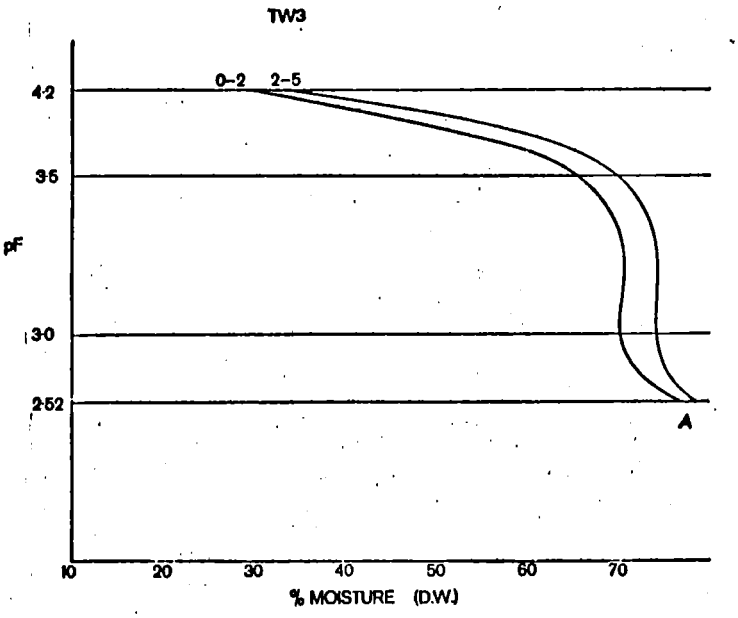


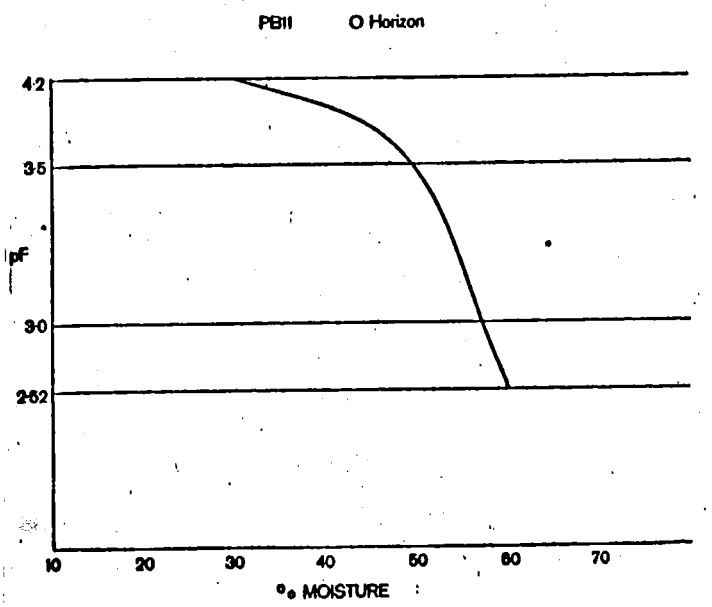
FIGURE 41. Diagnostic Horizons in Relation to Soil forming Processes.



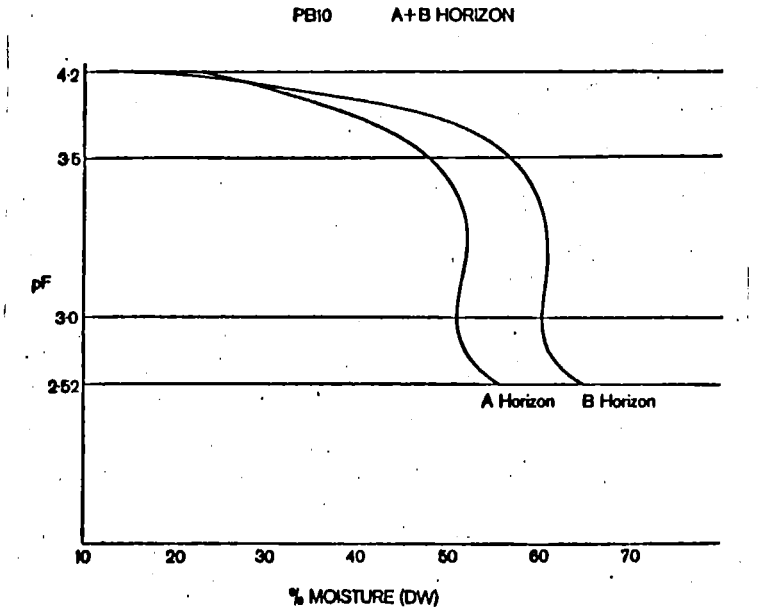
A : Clini-eldefulvic



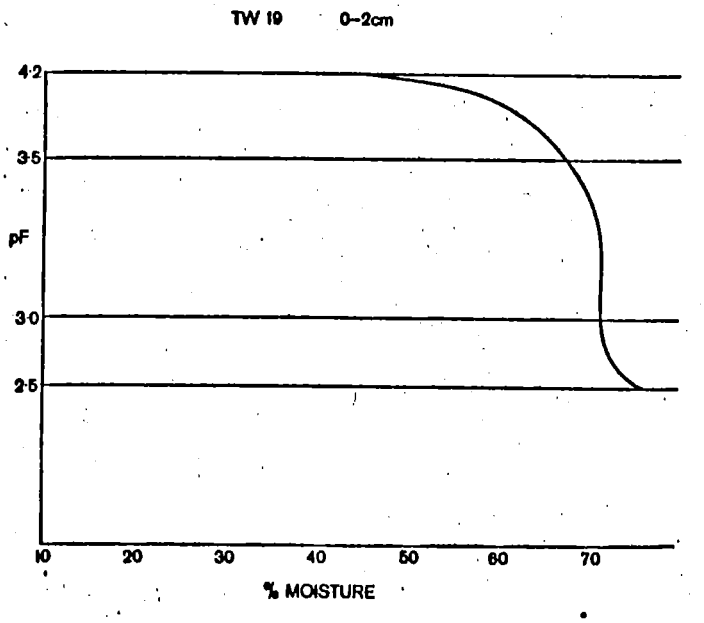
B : Madenti-eldefulvic



C : Madenti-elefulvic



D : Elefulvic



E : Lodi-elegelic

FIGURE 42. Moisture Retention Curves.

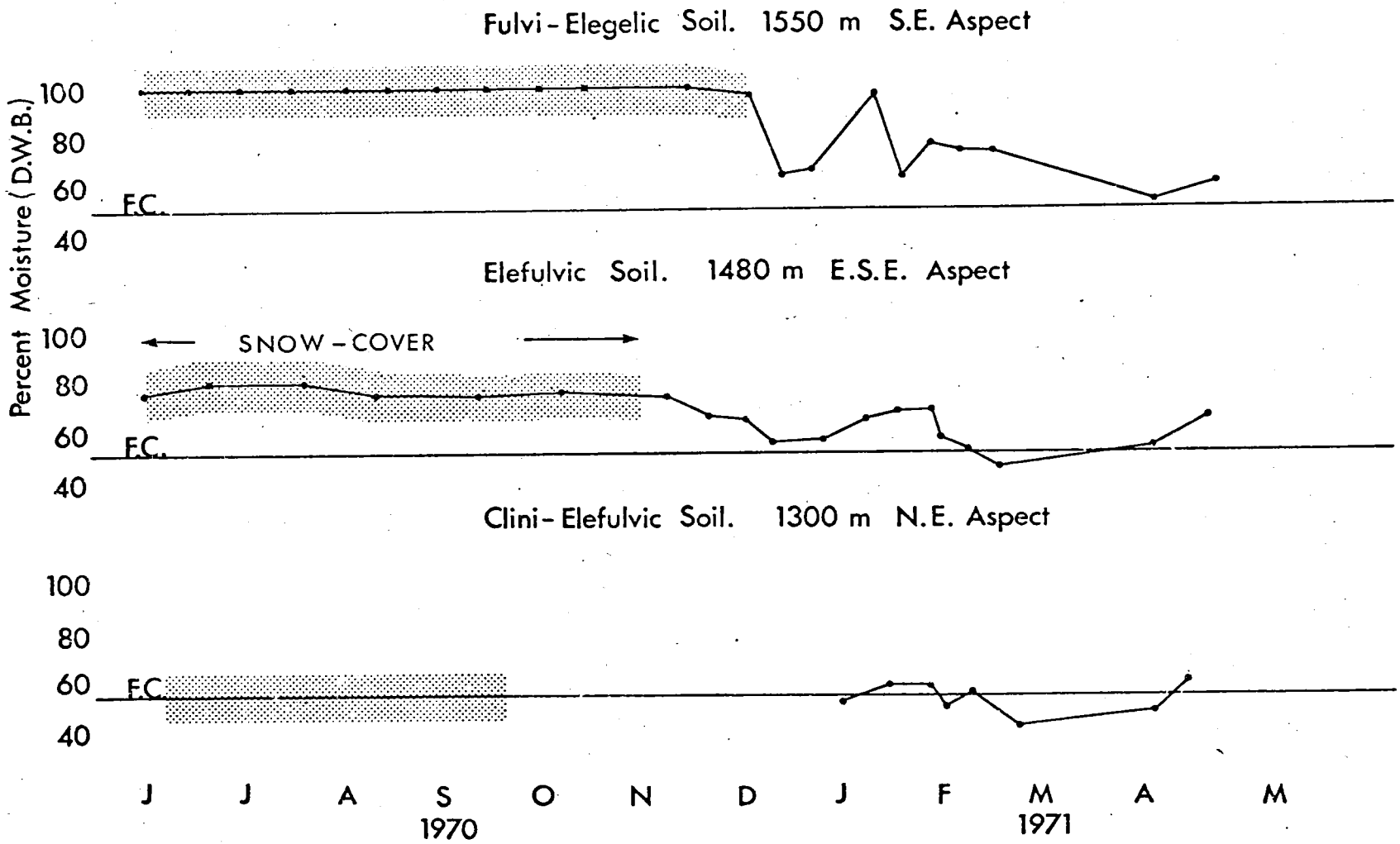


FIGURE 43. Soil Moisture Status (determined gravimetrically) during 1970 and the summer and autumn of 1971 of a range of soils.

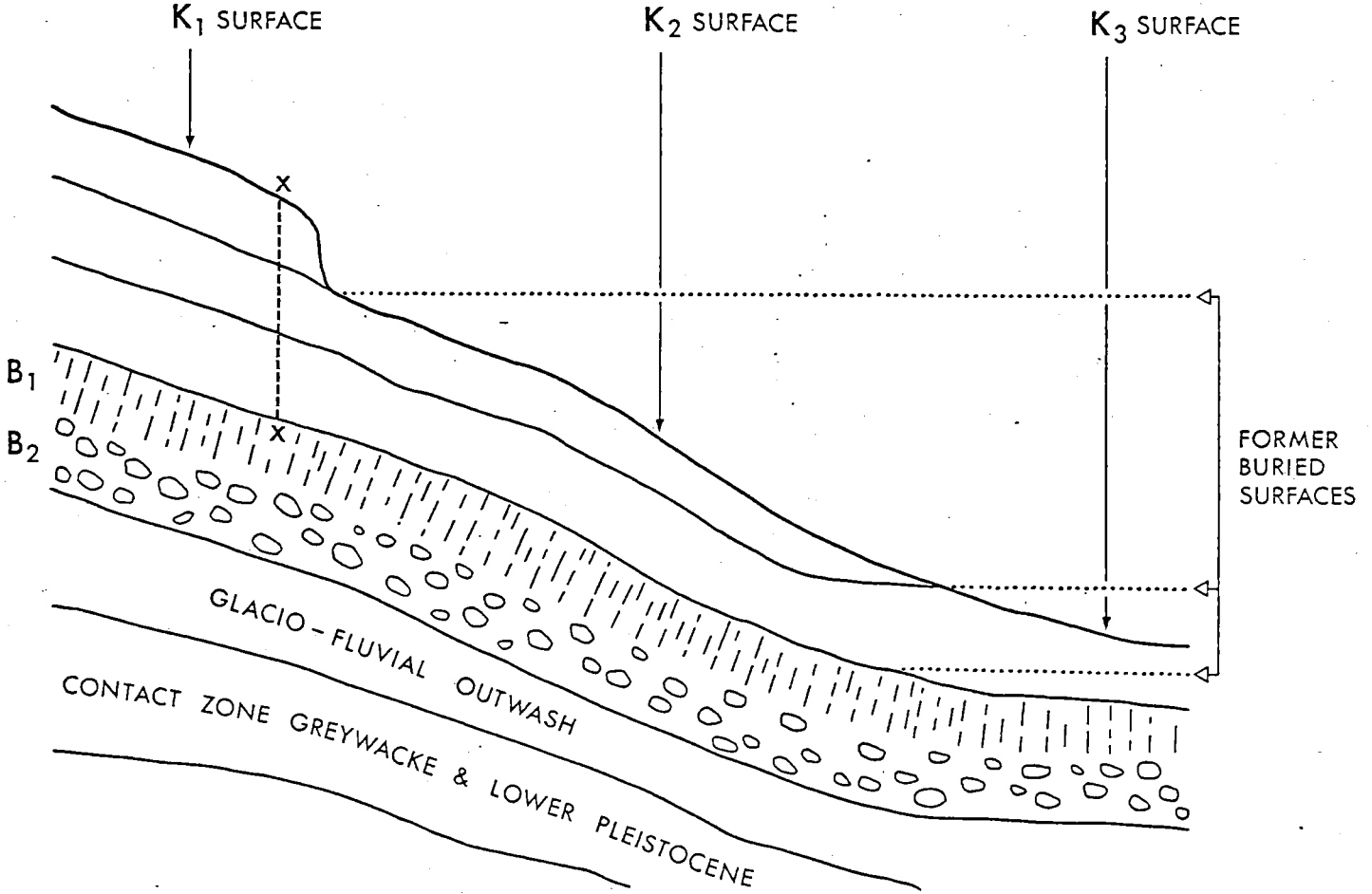


FIGURE 44. Cross section through a periodic soil sequence of three different aged ground surfaces (vertical line X, see Plate 34, soil profile).

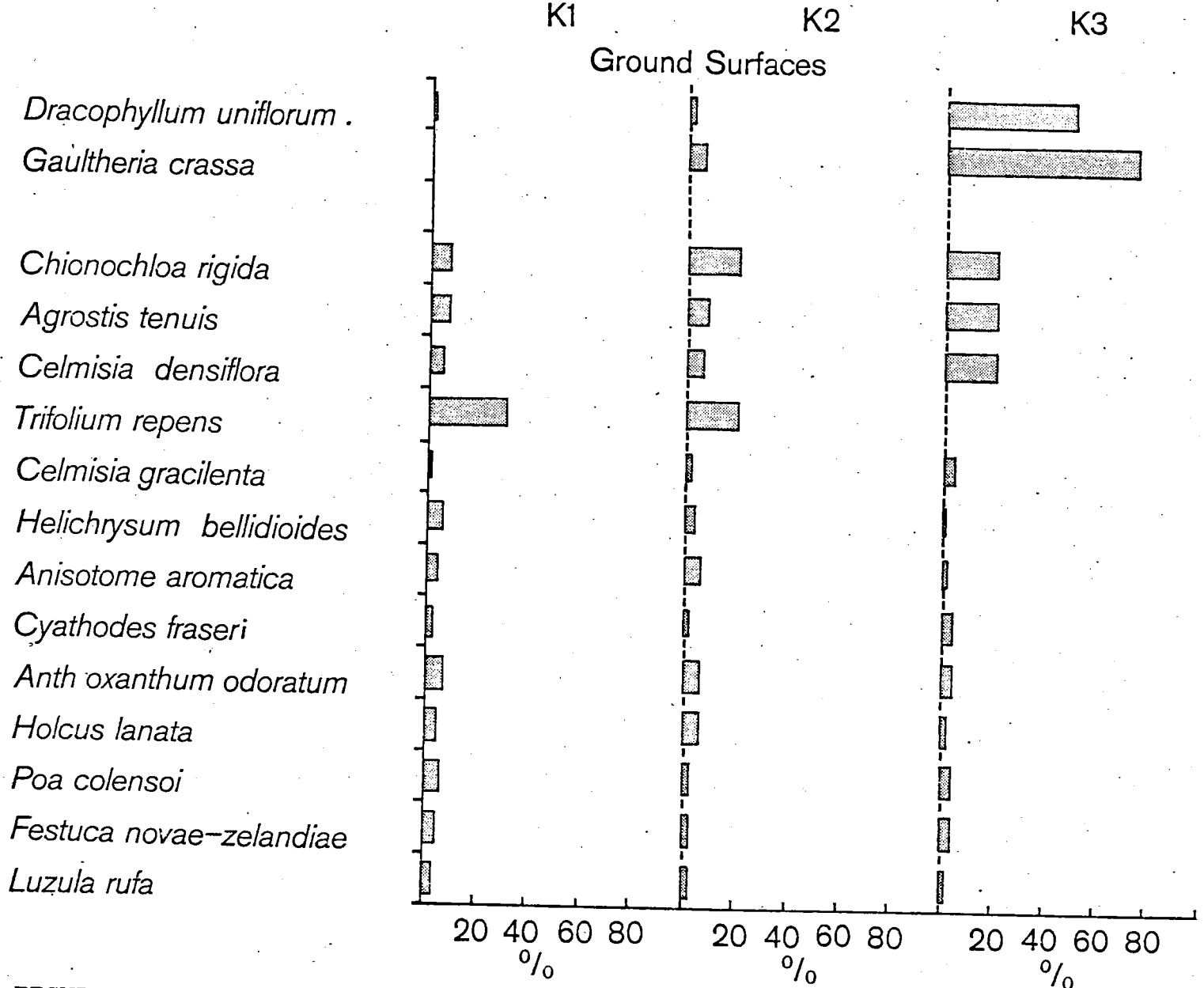


FIGURE 45. Plant Communities in relation to the ground surfaces.

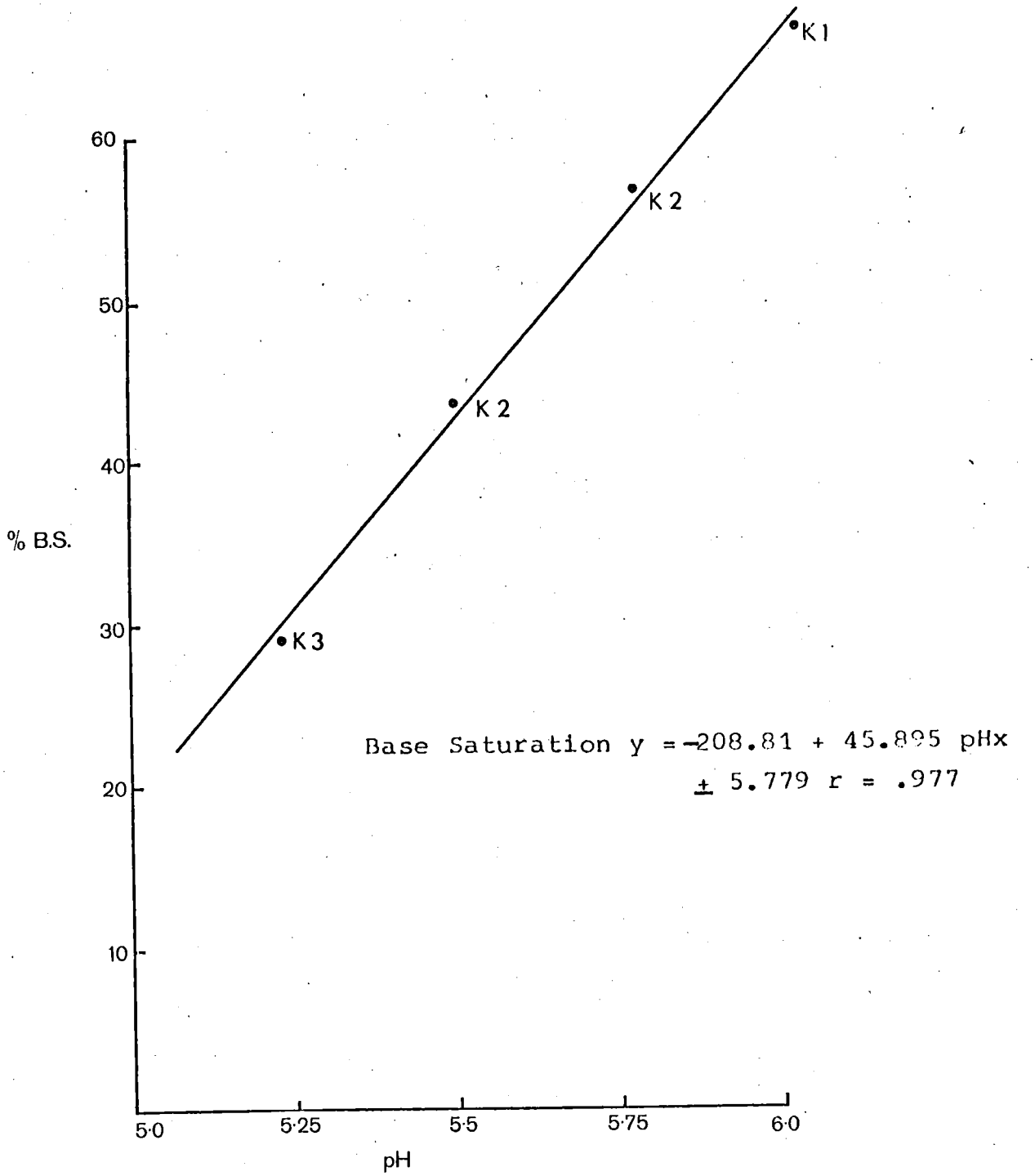


FIGURE 46. Ground surfaces in relation to pH and base saturation.

1 : Celmisia hectori
Celmisia haastii
with Agrostis subulata

2 : Chionochloa oreophila

3 : Chionochloa macra
with Celmisia lyallii

4 : Dracophyllum pronum

Scale : 1cm = 10m

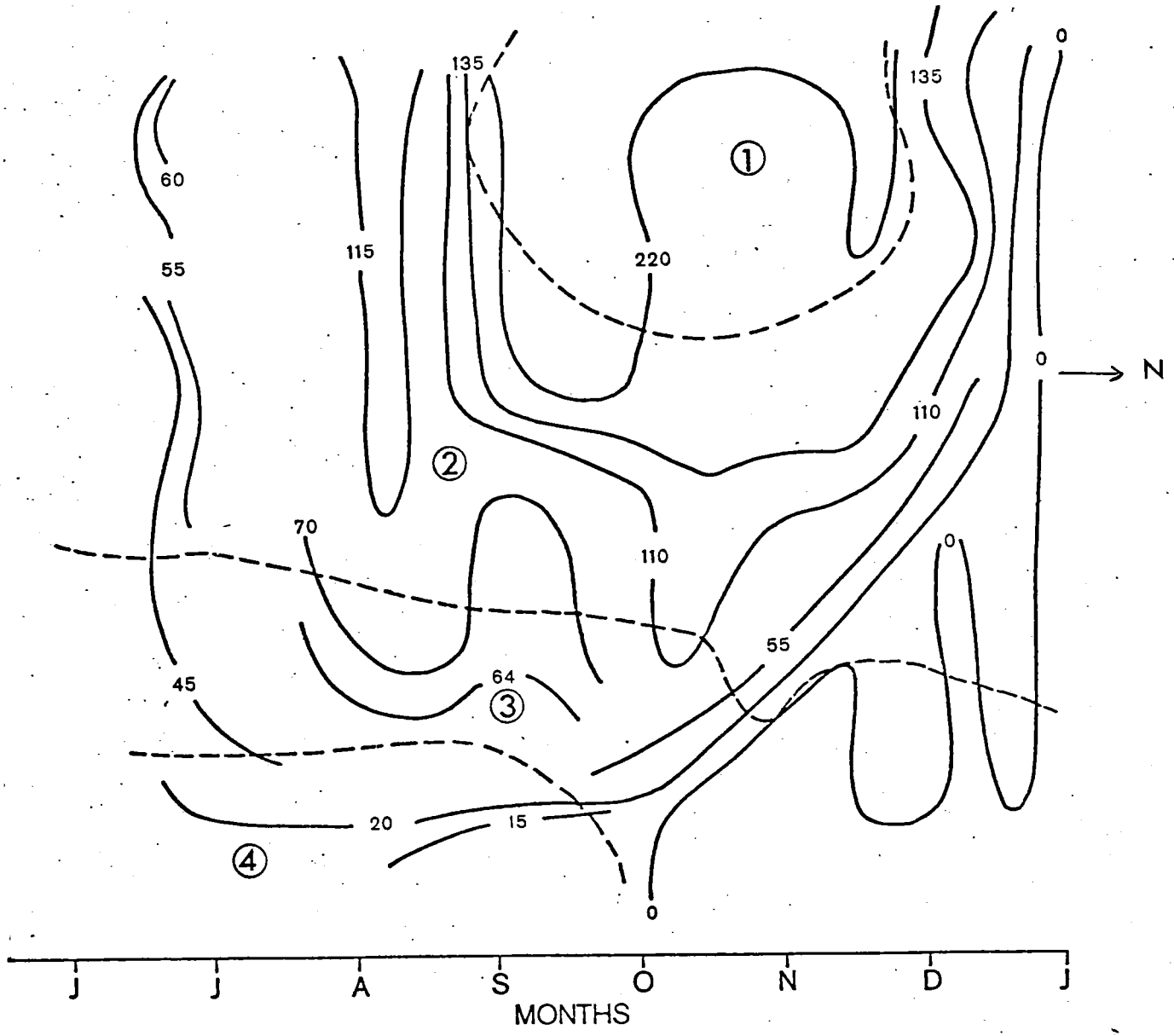


FIGURE 47. Isopacks denoting snow depth (cm) and the distribution of plant communities. June 1970 - January 1971 - Pyramid Basin.

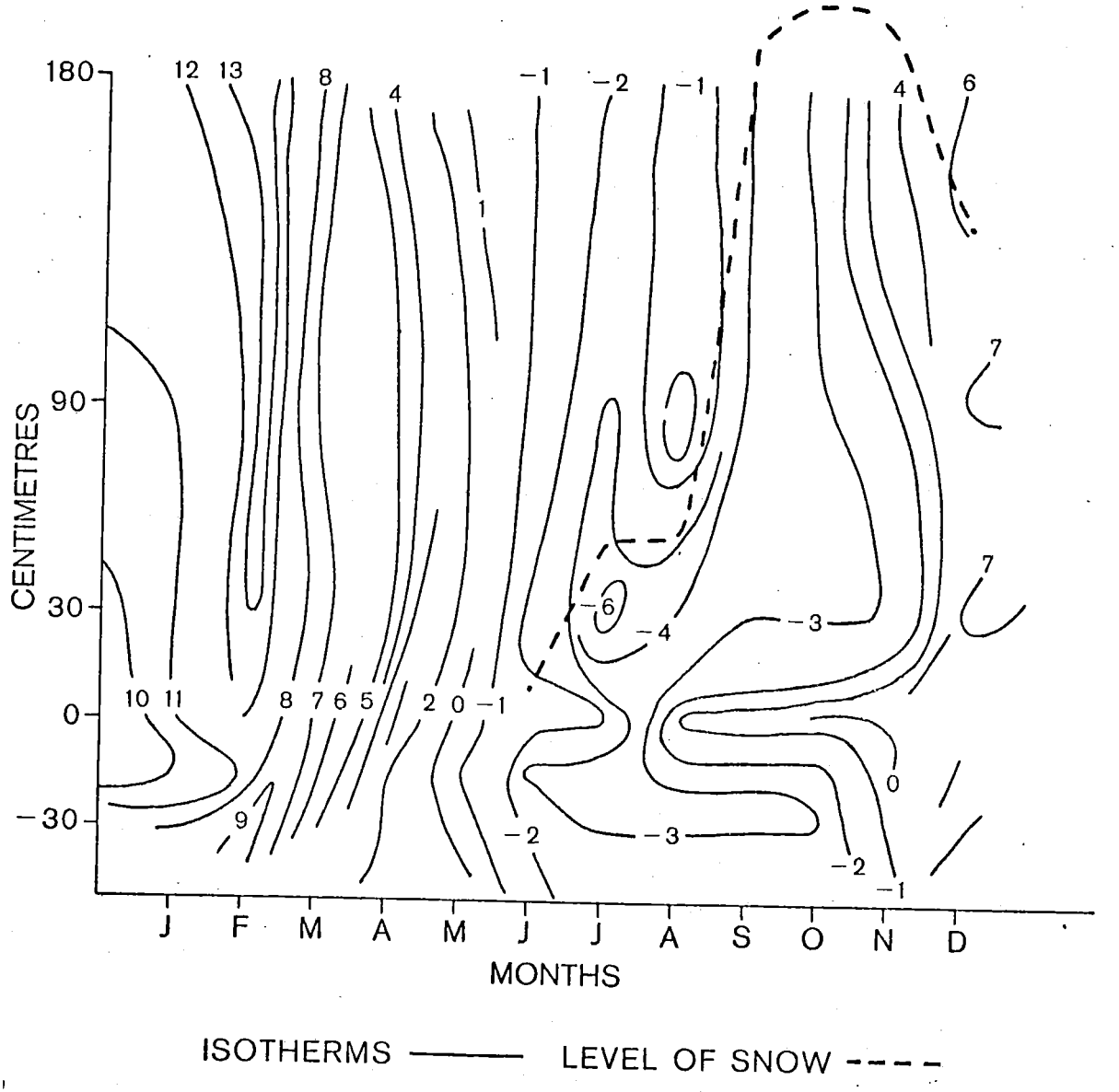


FIGURE 48. Vertical temperature (°C) through the snowpack and below ground surface from 180 cm to -30cm. Hatched line records the depth of snow during different months. January.- December, 1971 - Pyramid Basin.

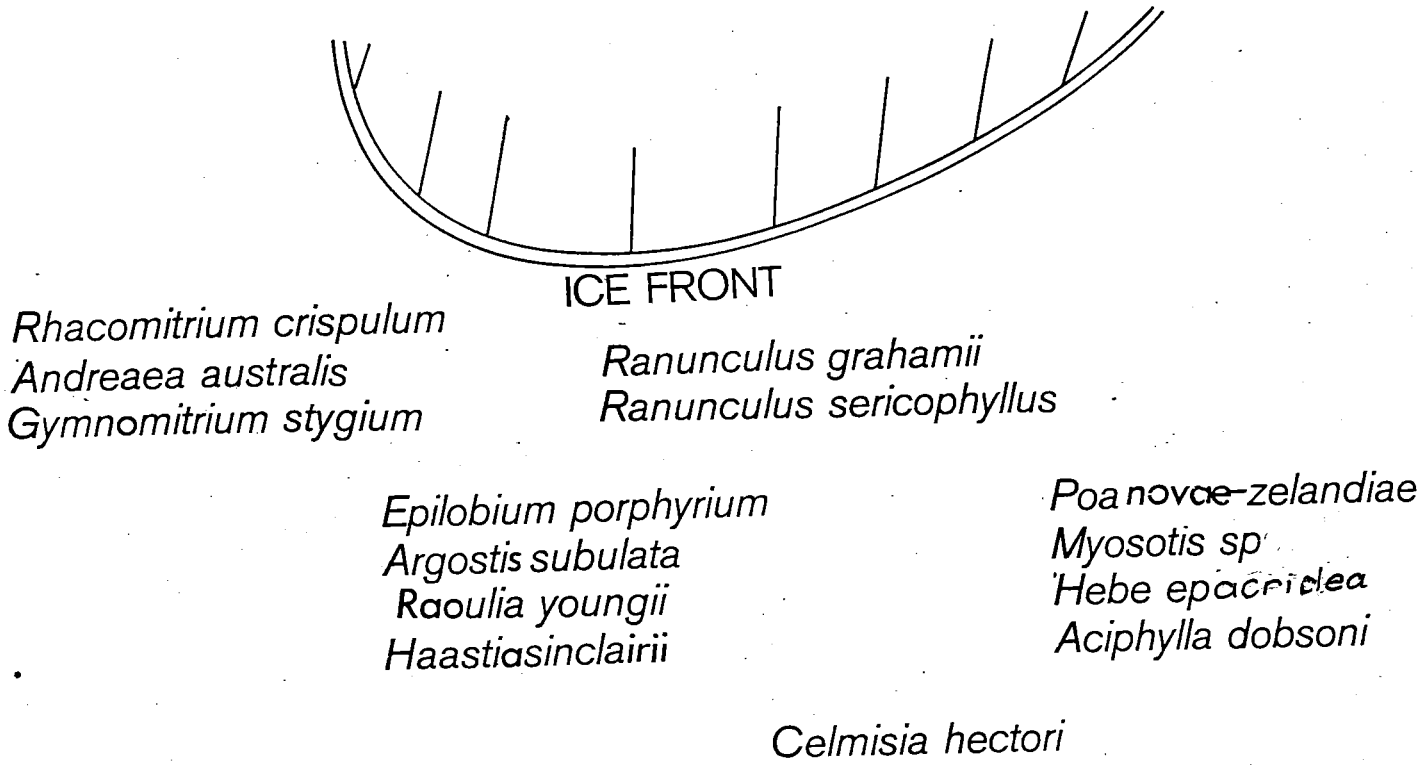
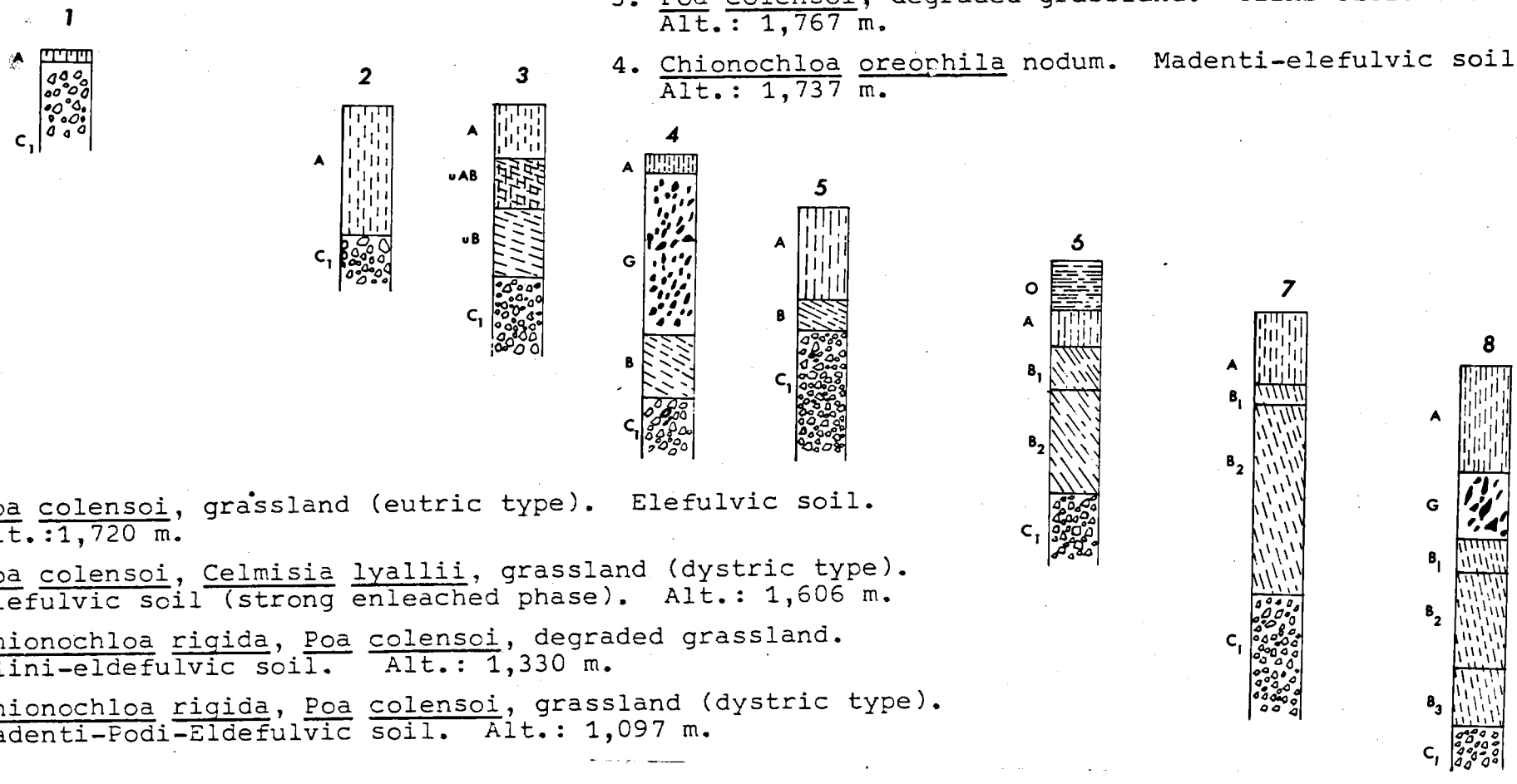


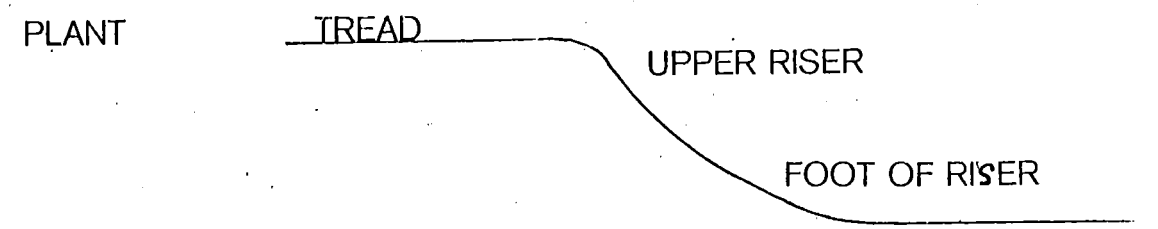
FIGURE 49. Pioneer communities of isolated plants colonising new ground on the Dun Fiunary surface adjacent to a small glacier.

1. Celmisia hectori nodum. Eleclinic soil. Alt.: 1,800 m.
2. Marsippospermum gracile, Celmisia haastii nodum. Eleluvic soil. Alt.: 1,767 m.
3. Poa colensoi, degraded grassland. Clini-elefulvic soil. Alt.: 1,767 m.
4. Chionochloa oreophila nodum. Madenti-elefulvic soil. Alt.: 1,737 m.



5. Poa colensoi, grassland (eutric type). Elefulvic soil. Alt.:1,720 m.
6. Poa colensoi, Celmisia lyallii, grassland (dystric type). Elefulvic soil (strong enleached phase). Alt.: 1,606 m.
7. Chionochloa rigida, Poa colensoi, degraded grassland. Clini-eldefulvic soil. Alt.: 1,330 m.
8. Chionochloa rigida, Poa colensoi, grassland (dystric type). Madenti-Podi-Eldefulvic soil. Alt.: 1,097 m.

FIGURE 50. Alto-Sequence of Associations of plant noda and soil types.



PLANT	TREAD	UPPER RISER	FOOT OF RISER
Drapetes lyallii	4		
Anisotome imbricata	3		4
Brachycome sinclairii	1		
Calthaobtusa			2
Celmisia angustifolia	2		
Celmisia haastii		5	3
Celmisia hectori			4
Celmisia laricifolia	2		
Celmisia sessiliflora	4		6
Cotula pectinata	1		
Ourisia caespitosa			1
Phyllachne colensoi	4		
Pygmea pulvinaris	1		
Ranunculus gracilipes		2	
Raoulia grandiflora	2		
Agrostis subulata	2		
Carex pyrenaica var- cephalotes		2	
Chionochloa oreophila		5	
Luzula pumila	3		2
Marsippospermum gracile	2	6	
Poa colensoi	2		
		3	2

FIGURE 51. Zonation of plants in relation to a solifluction lobe. (Numbers refer to a visual rating of the Domin Scale, Appendix VII.)

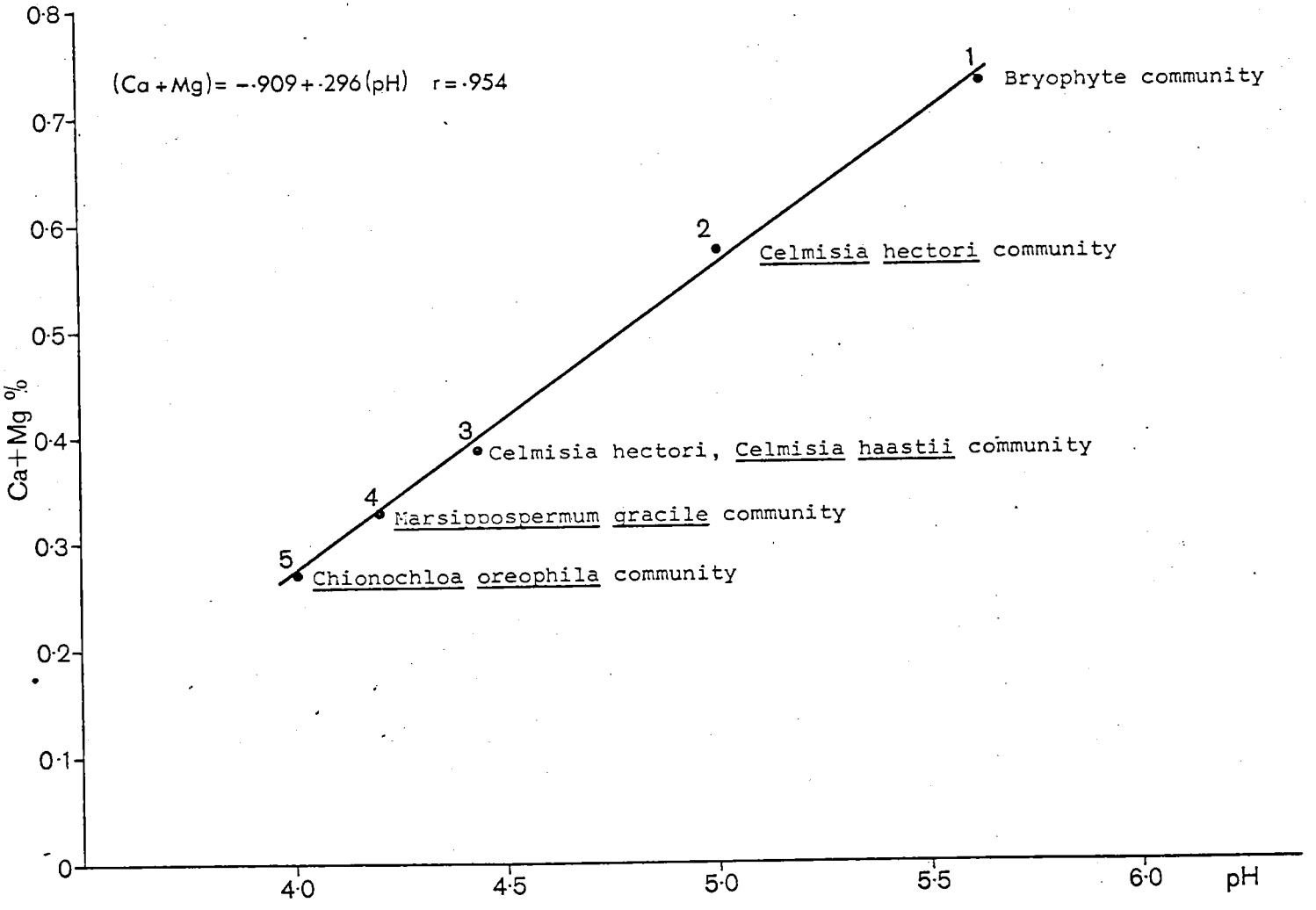


FIGURE 52. The Relationship of Calcium and Magnesium and pH to developing plant communities.

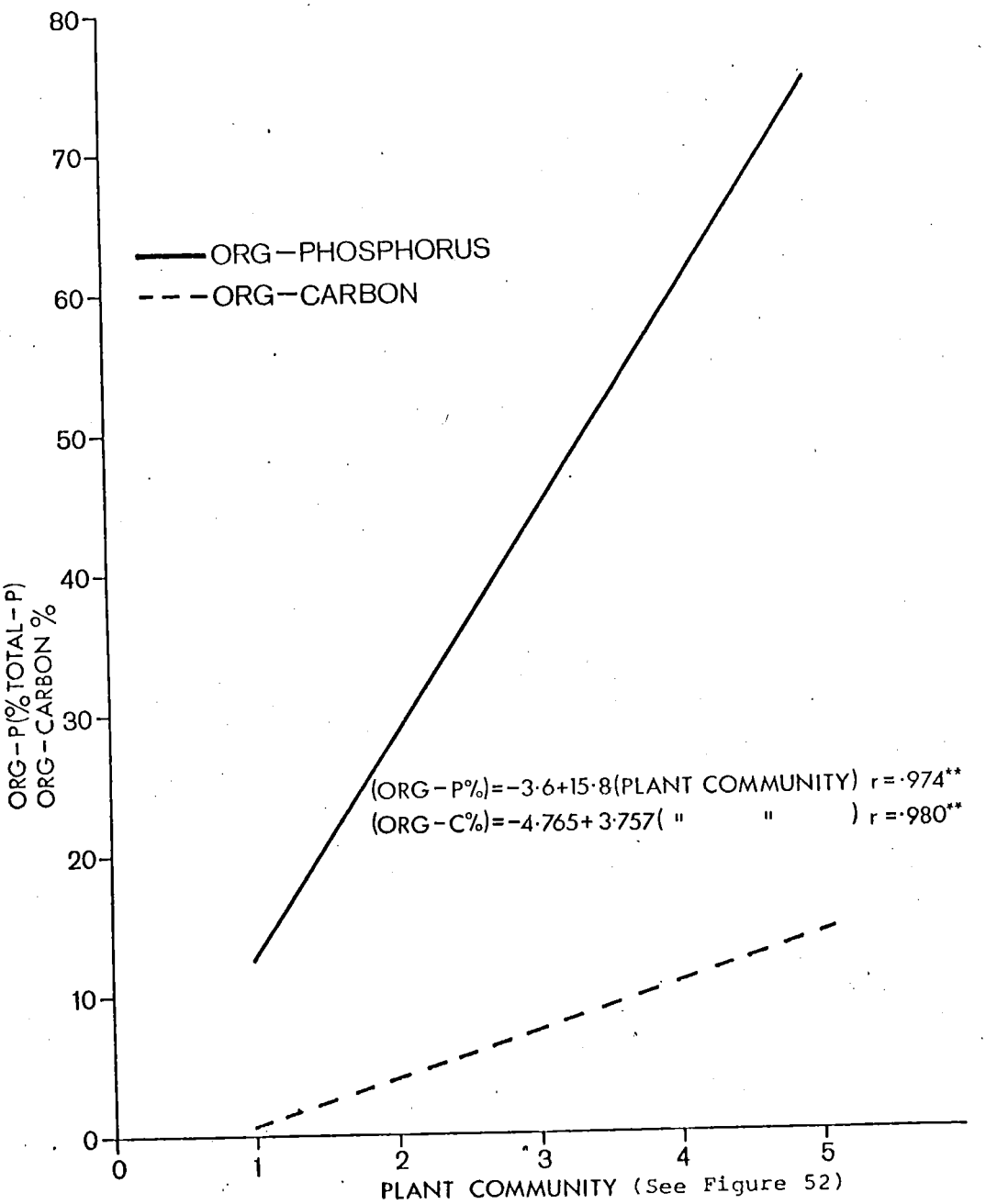


FIGURE 53. The relationship of organic phosphorus and organic carbon to developing plant communities.

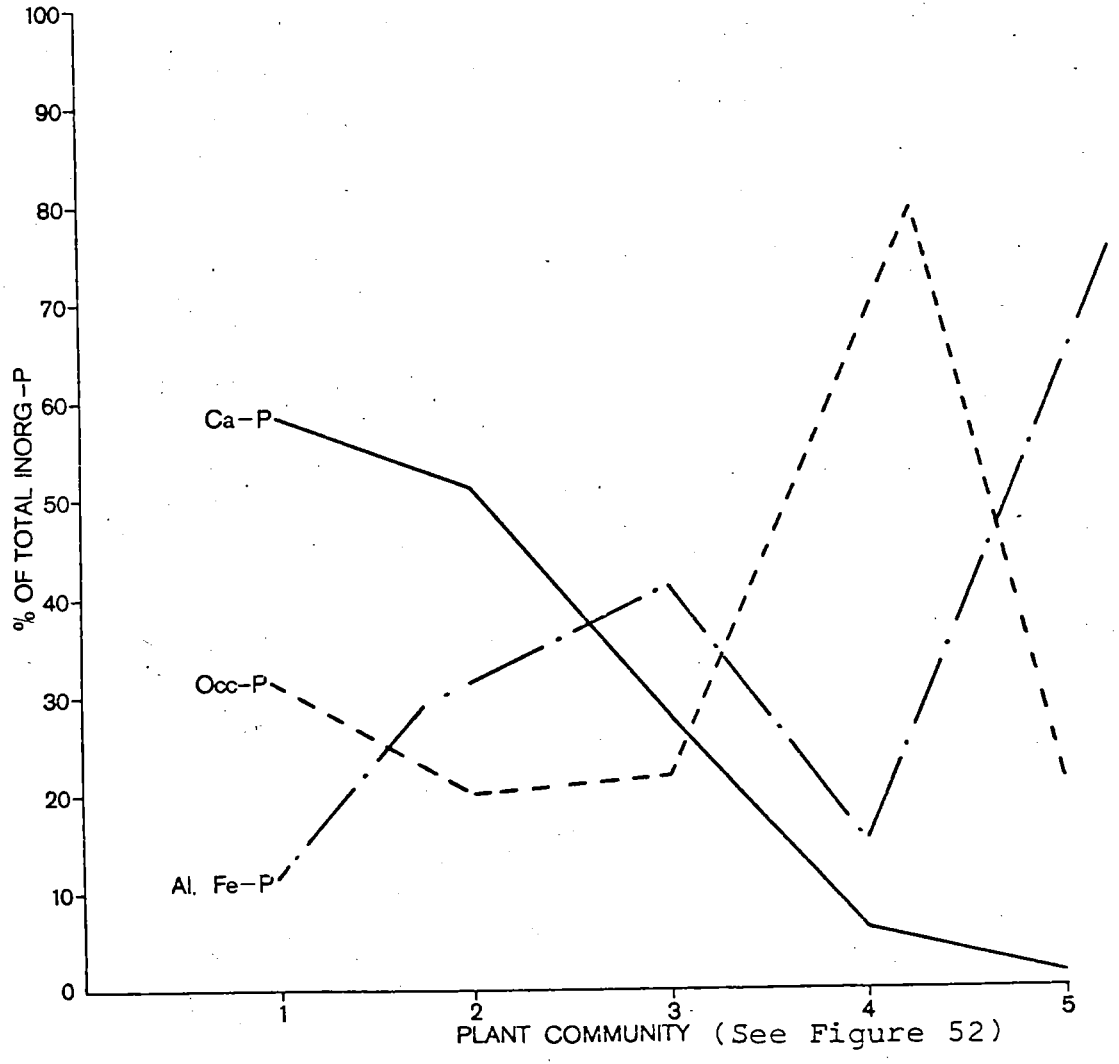


FIGURE 54. Plant Communities in relation to various forms of phosphorus fractions.

PLATE 1. Localities in the Twin Stream Catchment.

Legend: F.S. - Field Station

X - Instrument Sites

— - Snow Course

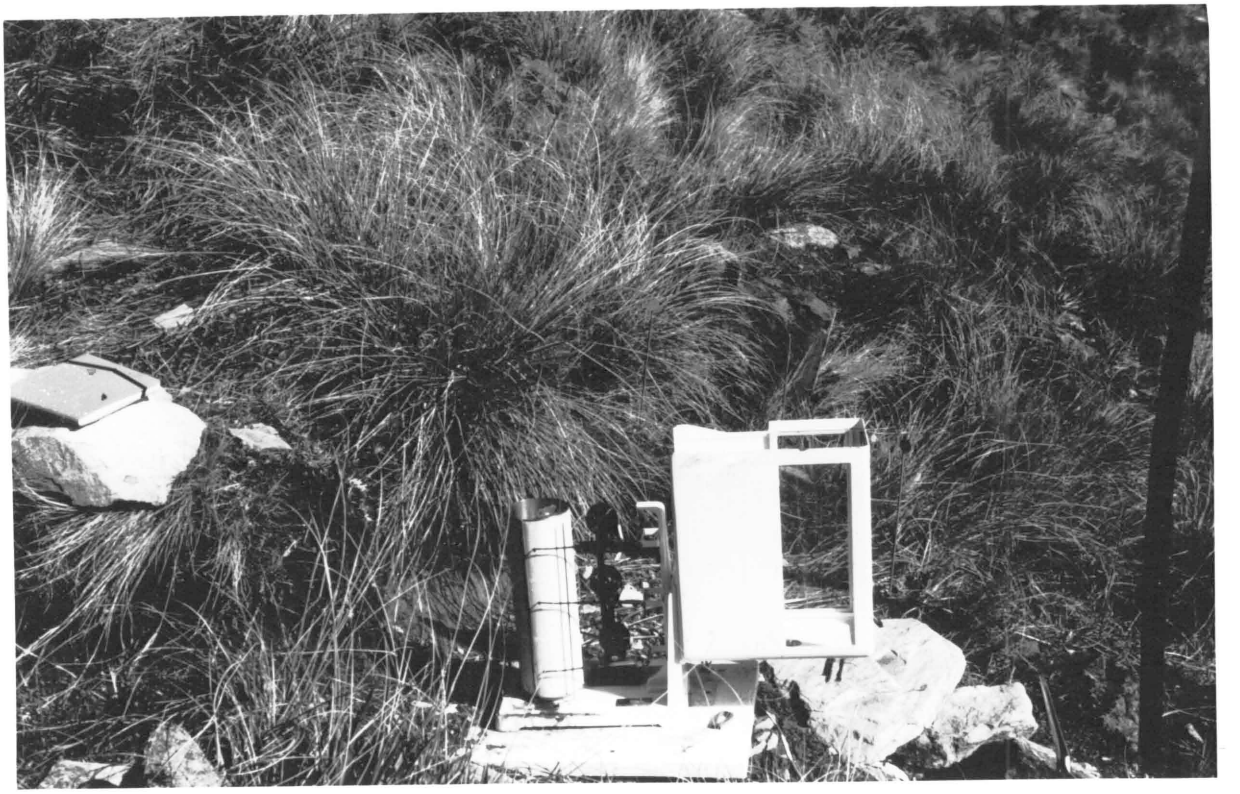


PLATE 2. Lambrecht 3-Pen Thermograph.

PLATE 3. Location of Instruments in Pyramid Basin (1,737 m).

PLATE 4. Panoramic view of Twin Stream Catchment from East Bank of the Tasman River.

PLATE 5. Birch Hill Moraine Lobes in Mid-Distance.

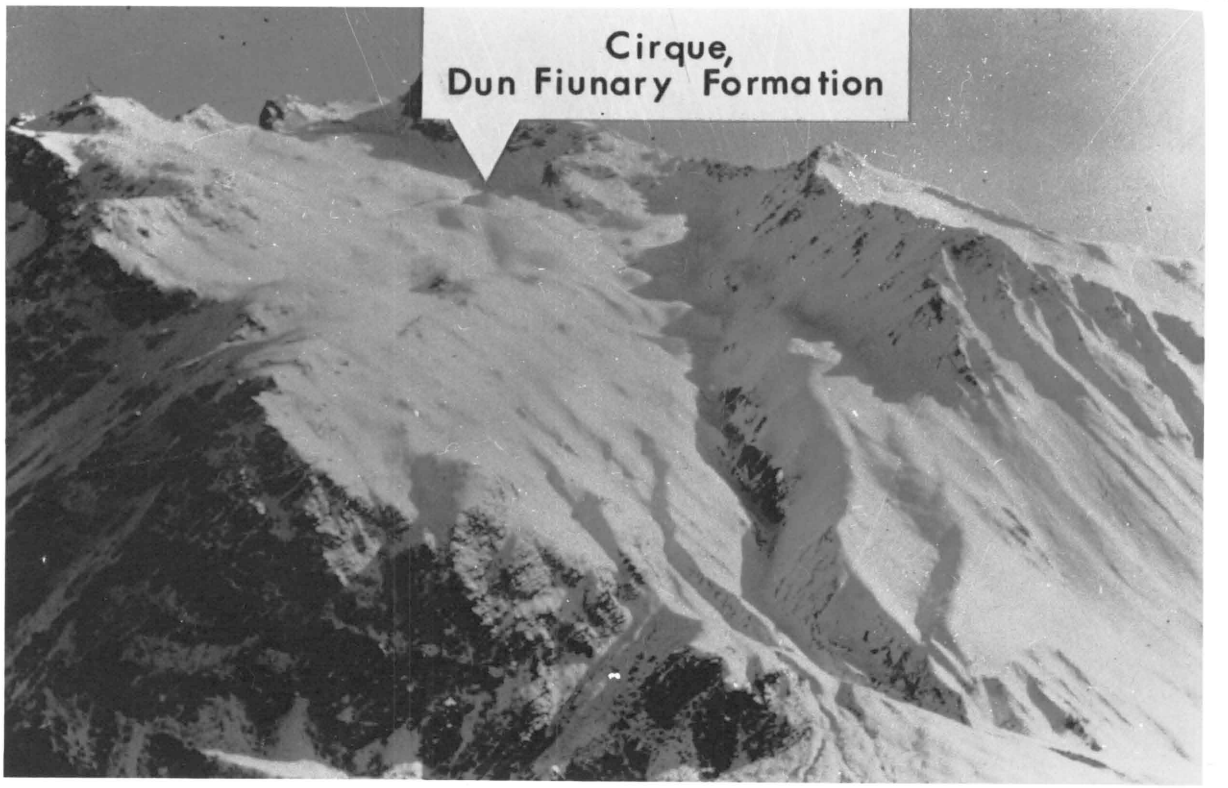


PLATE 6. Twin Basin with the Upper Dun Fiunary Surface. The older Ferintosh Surface (lower part of basin) has been breached by Stream.

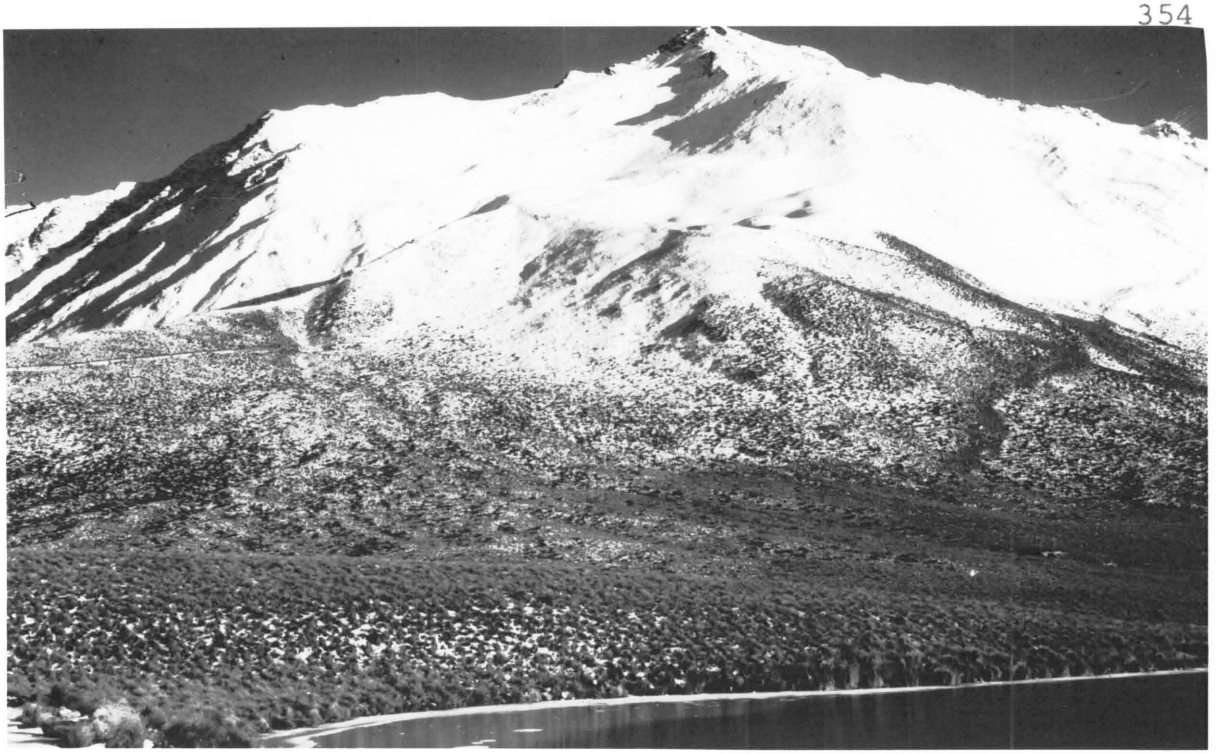


PLATE 7. Looking westwards up into Pyramid Basin. The Massive Morainic Deposits (mid-centre of Plate) belong to the Ferintosh Surface.

PLATE 8. Looking North-East down the Ferintosh Surface of Mary Basin.

PLATE 9. Upper Part of Pyramid Basin clear of Snow.
Light Snow (left of Plate) lies in Twin Basin.

PLATE 10. Looking North-West on the Upper Part of Mary Basin.

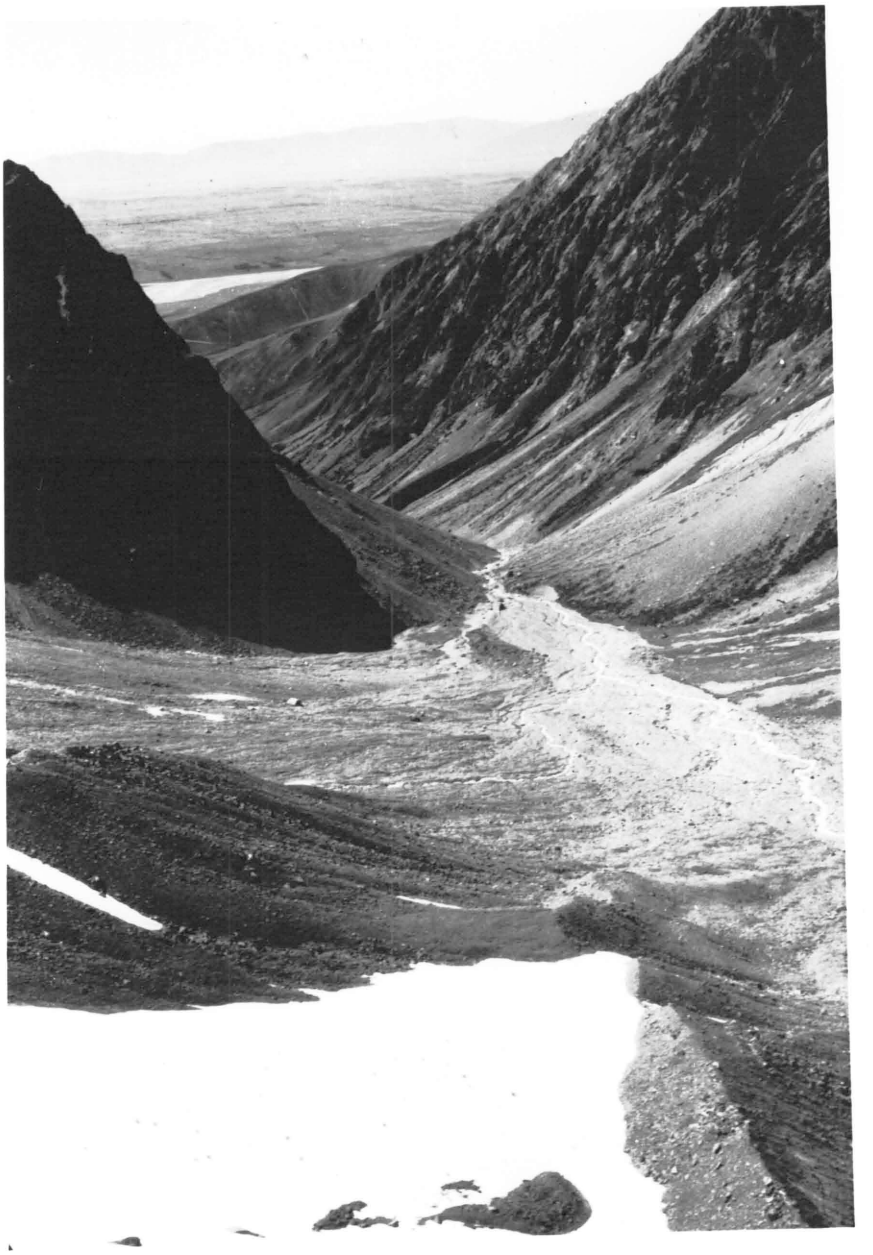
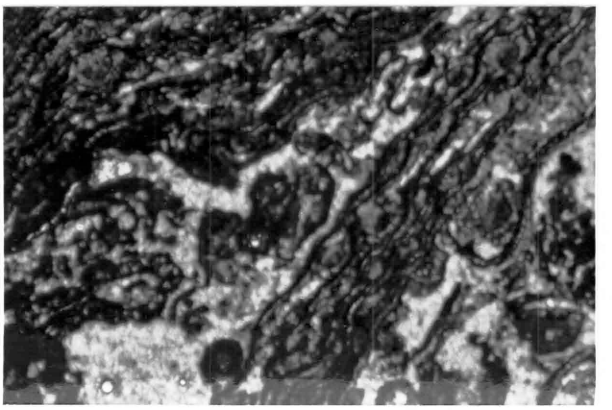
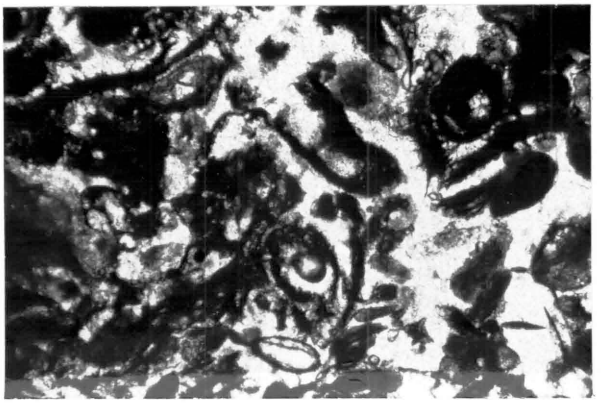


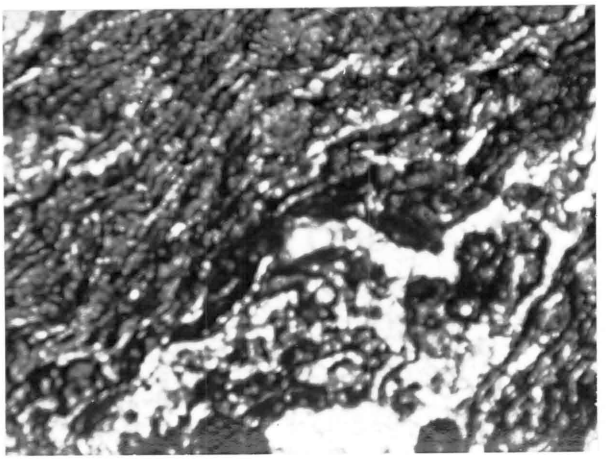
PLATE 11. Looking East down Twin Stream Headwaters.



A

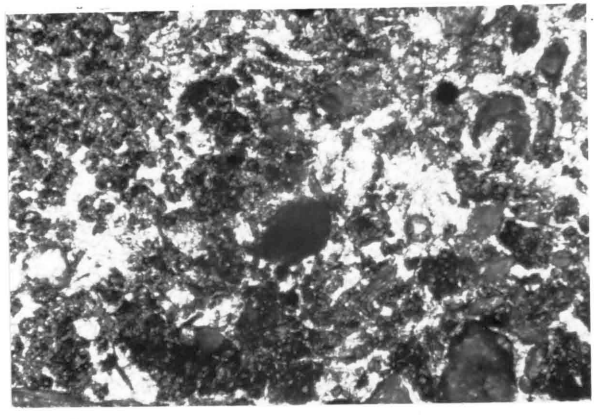


B

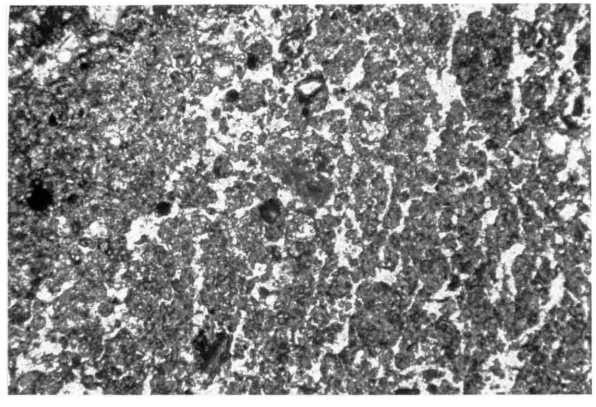


C

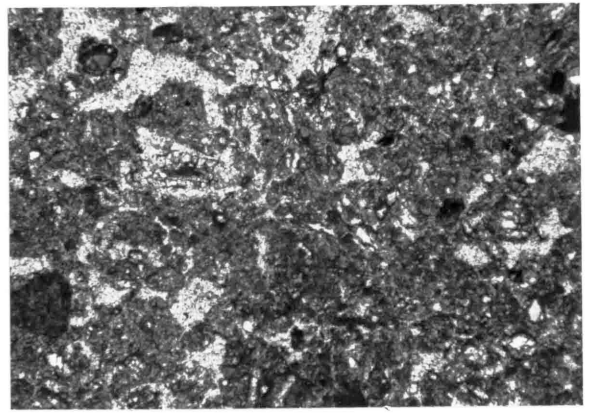
PLATE 12. Thin sections of organic material, A, B and C.



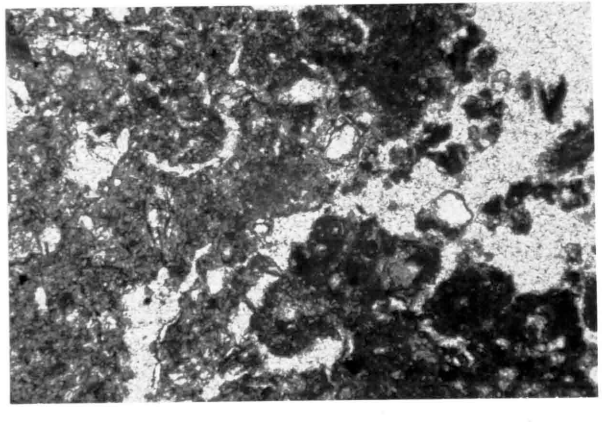
A



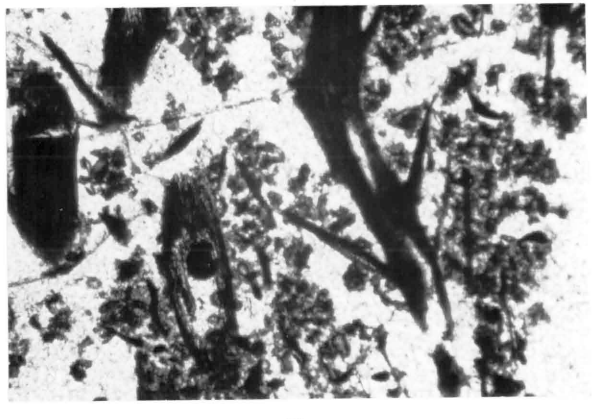
B



C



D



E

PLATE 13. Thin sections of organic material, A, B, C, D and E.

PLATE 14a. Stone banked Terrace on which the Elegelic Soils have developed.

PLATE 14. Lodi-Elegelic Soil - Organic Soil developing upon a turf-bank, solifluction lobe.

PLATE 15. Fulvi-Elegelic Soil - Soil has developed upon stabilized solifluct.

PLATE 16. Eleclinic Soil - Initiation of Soil on unweathered detritus close to the perennial snowline.

PLATE 17. Humi-Eleclinic Soil - Organic material accumulated on a rock pavement.

PLATE 18. Humi-Eleclinic Soil - This Humic Soil is developed in a strong rejuvenating régime on steepland terrain.

PLATE 19. Elelithic Soil - Skeletal Soil developed on an exposed ridge in a strong wasting régime.

PLATE 20. Eleluvic Soil - Over a metre of fine textured material at the toe of a glacio-fluvial fan.

PLATE 21. Plati-Eleluvic Soil - Thin organic soils developed on lake bed sediment.

PLATE 22. Eleplatic Soil (Eutric Phase) - Gleyed soils developed along a springline.

PLATE 23. Elefulvic Soil - Steepland soil developed in a mid-slope location.

PLATE 24. Elefulvic Soil (Strongly Enleached Phase) - Steepland soil under a high moisture régime.

PLATE 25. Clini-Elefulvic Soil - Steepland soil developed on a warm aspect.

PLATE 26. Madenti-Elefulvic Soil - Developed in a depression on glacio-fluvial outwash.

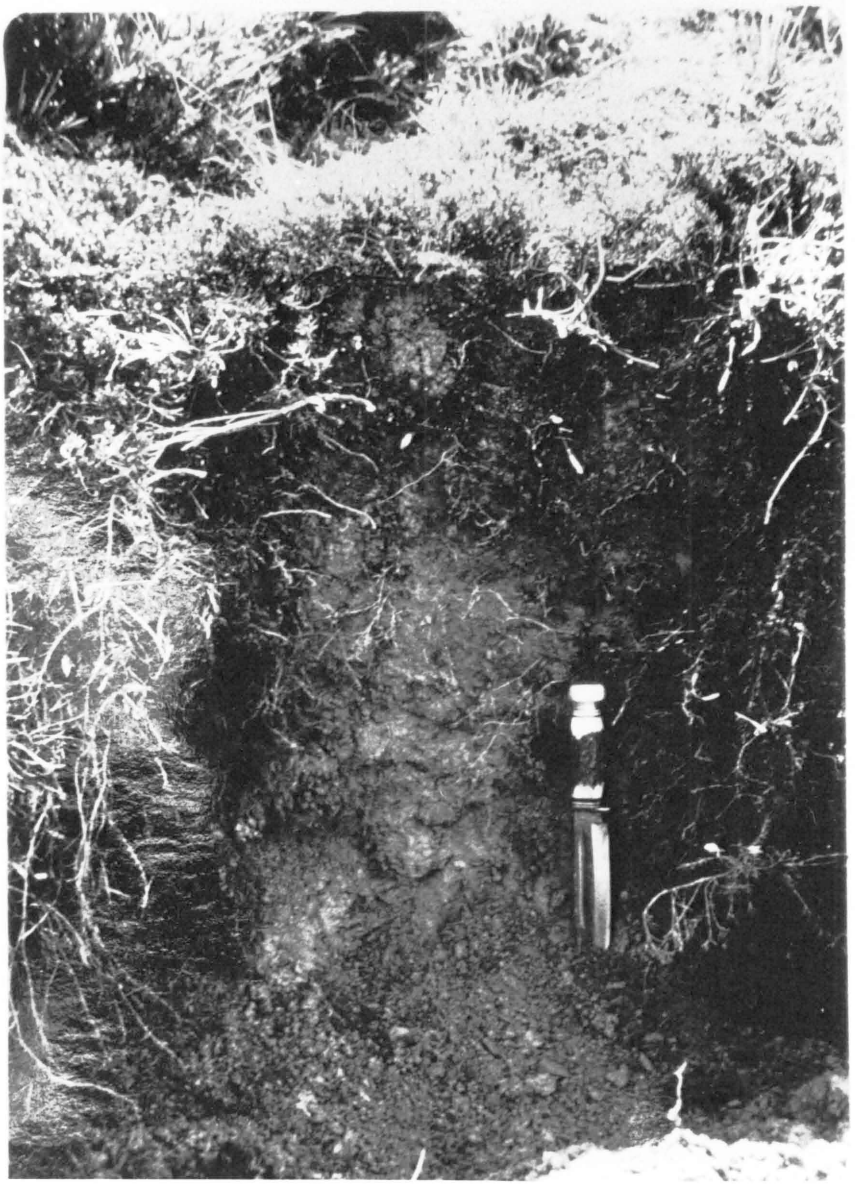


PLATE 27. Eldefulvic Soil (Strongly Enleached Phase) - Steepland soil developed in a high moisture régime.

PLATE 28. Clini-Eldefulvic Soil - Composite soil developed on colluvium.

PLATE 29. Clini-Eldefulvic Soil - Thin soil developed on a morainic ridge.

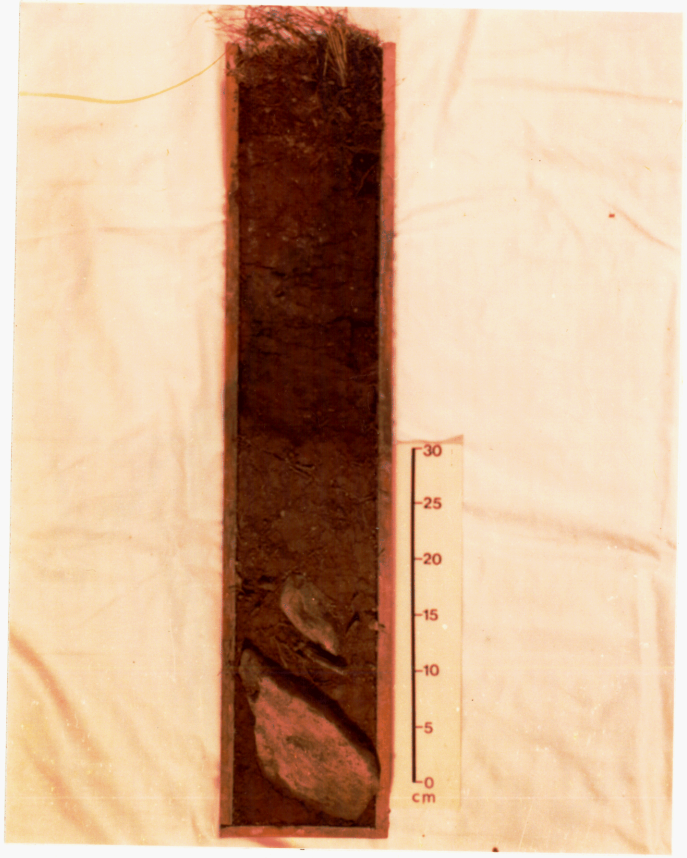


PLATE 30. Monolith of the Lodi-Elegelic Soil.

PLATE 31. Monolith of the Fulvi-Elegelic Soil.

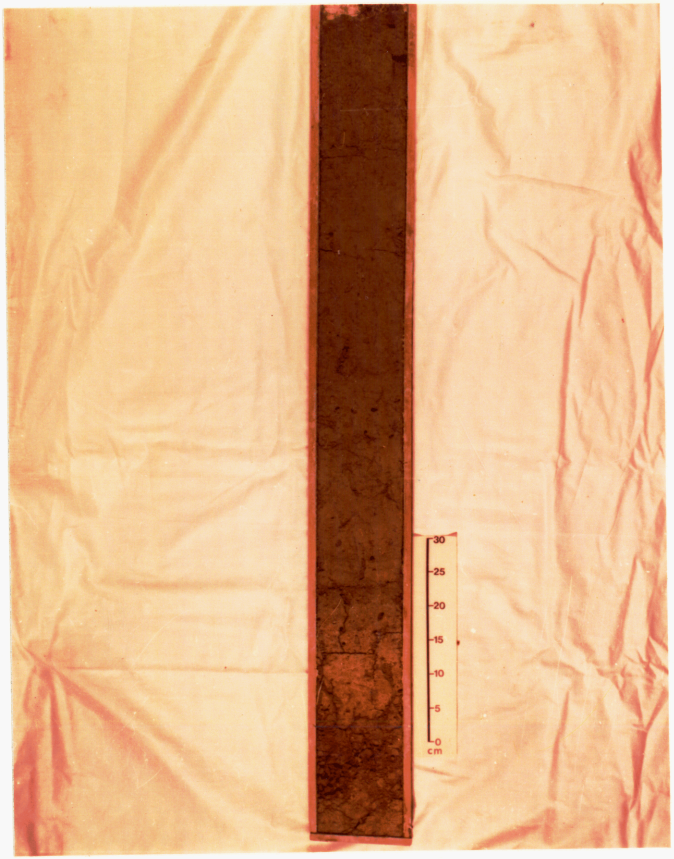


PLATE 32. Monolith of the Eleluvic Soil.

PLATE 33. Monolith of the Madenti-Elefulvic Soil.

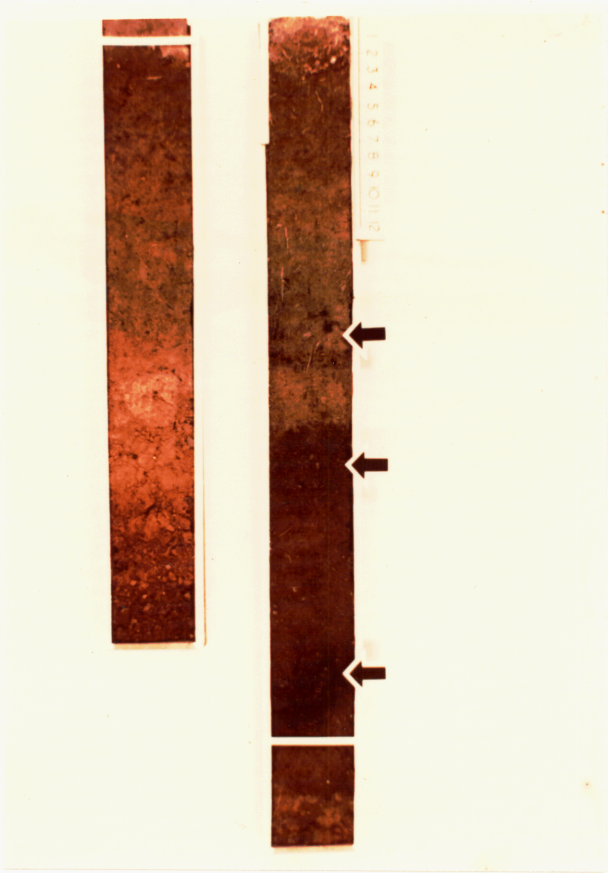


PLATE 34. Periodic Soil indicating three former surfaces (Arrows indicate buried ground surfaces).

PLATE 35. Eutrophic Grasslands with dominant *Poa colensoi*, *Notodanthonia setifolia* and sub-dominant *Celmisia lyallii*.

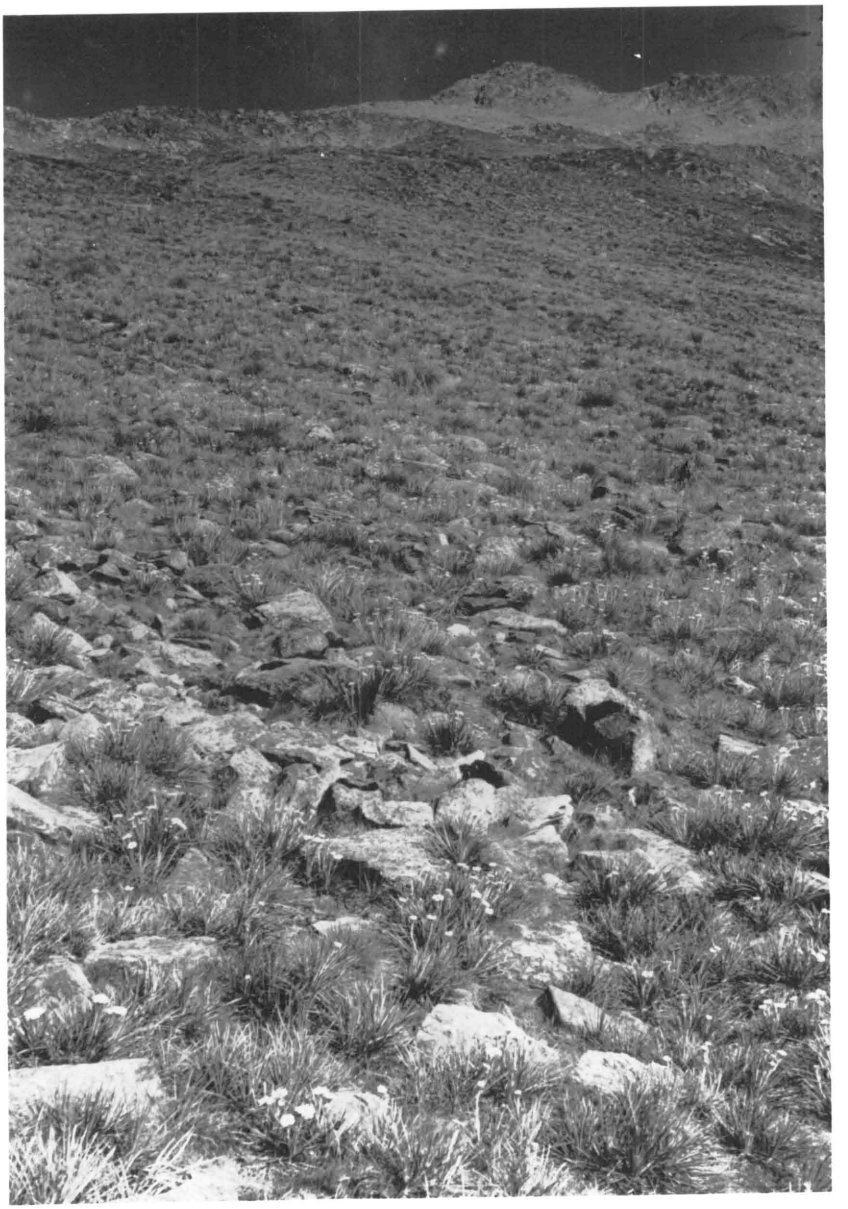


PLATE 36. Dystrophic Grasslands with dominant Celmisia lyallii and a few isolated tussocks of Chionochloa macra.

PLATE 37. Degraded Grasslands with dominant *Chionochloa rigida*.

PLATE 38. Chionochloa oreophila nodum on the site of a former tarn which has previously been filled by glacio-fluvial sediments.

PLATE 39. *Marsippospermum gracile*, *Celmisia haastii* nodum developed on a site of former frost hummocks.

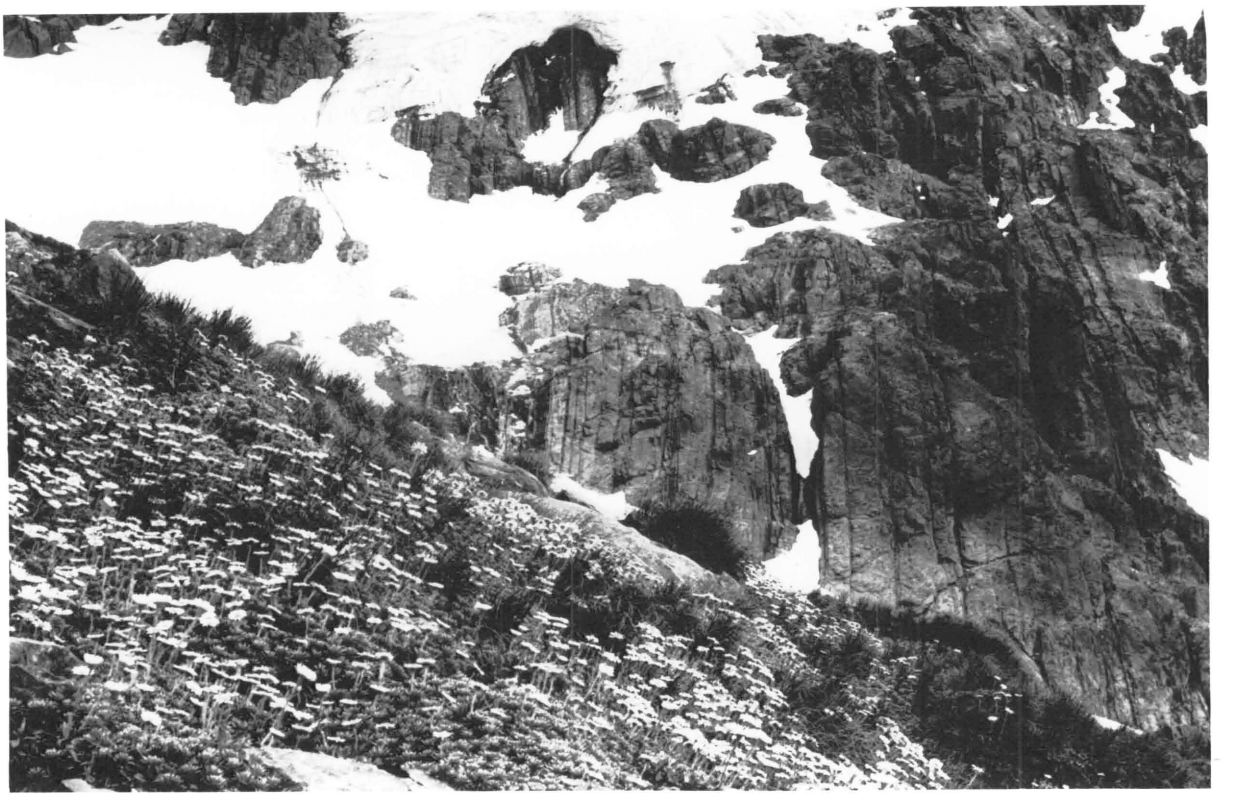


PLATE 40. *Celmisia hectori* nodum developed on solifluction detritus in the headwaters of Twin Stream.

PLATE 41. Anmoor peat forming organic material (designated by line).

PLATE 42. Alternating bands (designated by lines) of peaty organic material, with a mat formed by Oreobolus spp. on the surface.

PLATE 43. Chionochloa oreophila and Celmisia haastii formed on an organic complex consisting of humicol with lithiskel material.

PLATE 44. Chionochloa macra and Chionochloa rigida forming an organic material of humiskel and lithiskel.

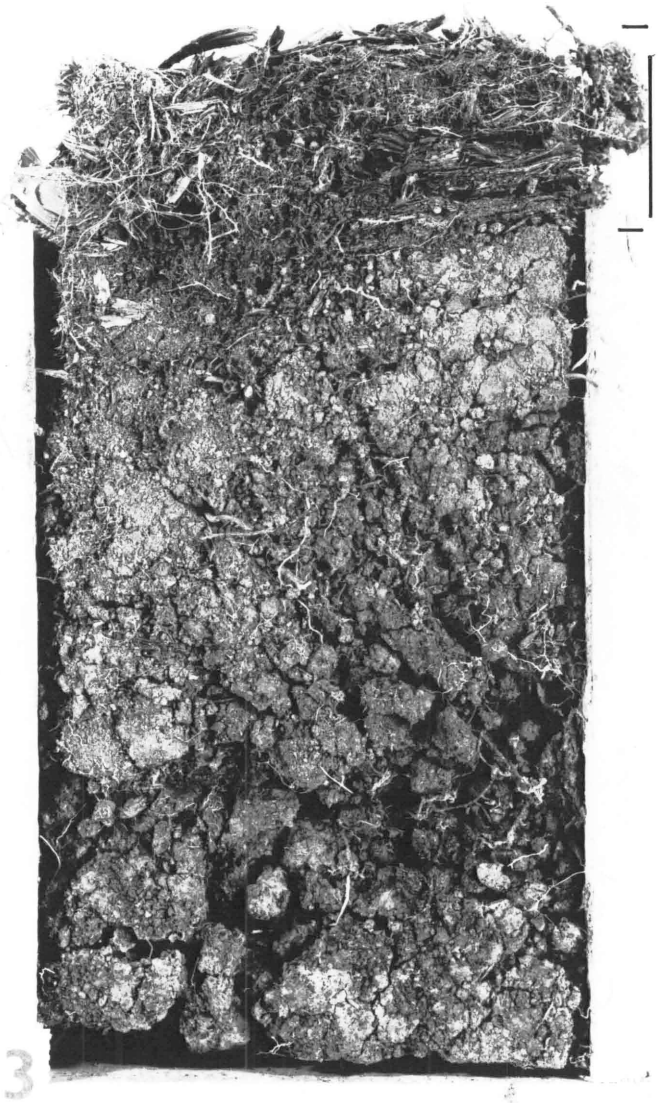


PLATE 45. Celmisia lyallii forming raw humus (designated by line) in the dystrophic grasslands.

PLATE 46. Humicol-mullicol complex with some lithiskel (mull-like-moder) typical of the more stable soils in the degraded grasslands.

PLATE 47. Solifluction terraces on the Upper Jacks Stream Surfaces in Twin Basin.

APPENDICES

I. SLOPE ANALYSIS

II. DRAINAGE

III. CHEMICAL ANALYSIS

IV. TABLE FOR COMPILATION OF HUMOGENIC, HUMOLYTIC INDEX

V. SOIL PROFILE DESCRIPTION

VI. LOCATION AND ALTITUDE (M) OF SOIL PROFILE DESCRIPTION

VII. PLANT COMMUNITIES AND DOMIN SCALE

APPENDIX I

SLOPE ANALYSIS

NAME		SLOPE
1. Flat	:	-
2. Flat to gently undulating	:	-
3. Easy rolling	:	Slopes under 5^{o}
4. Rolling	:	Slopes under 12^{o}
5. Moderately steep	:	Slopes under 23^{o} may slope between 12^{o} and 23^{o}
6. Moderately steep to steep	:	Most slopes under 30^{o}, may slope between 18^{o} - 20^{o}
7. Steep	:	Slopes between 30^{o} - 38^{o}
8. Very steep	:	Slopes of 40^{o} - 45^{o}
9. Precipitous	:	45^{o} (rockwalls, etc.)

APPENDIX II

DRAINAGE

Drainage classes were also adapted from Taylor and Pohlen, with some slight modification to class concept. These classes referred to soil drainage classes according to the rate from which water is removed from the soil. They can be summarised as follows:

0. Very poorly drained : Frequent ponding, peaty surface, layers gleying.

1. Poorly drained : Similar to above but with more fluctuation in the water tables.

2. Imperfectly drained : Slow removal of water. Active flushing from seepage. Some form of perennial gleying.

3. Moderately well drained : Differs from above in that there is a distinct seasonal wetting and drying cycle. Gleying will therefore be a temporary seasonal feature.

4. Well drained : Rapid removal of water from soil.

5. Somewhat excessively drained : Rapid removal of water, characteristic of coarse textured soils.

6. Excessively drained : Very rapid removal, associated with very shallow coarse textured soils.

APPENDIX III

CHEMICAL ANALYSES

All analyses were made, except where stated, on air dried samples 2 mm in diameter.

1. pH was determined using a glass electrode with a 1.25 soil distilled water mixture. This was allowed to stand for 24 hours before readings were taken.

2. Organic carbon - The chromic acid method based on spontaneous heating by dilution with H_2SO4 (Walkley and Black method), see Jackson, 1960, page 219.

3. Total nitrogen was determined by semi-micro Kyeldahl method using selenium dioxide as a catalyst.

4. Cation exchange capacity - Leaching was carried out using ammonium acetate and washing with ethanol. The ammonia was then distilled in Kyeldahl and titrated against 0.1 NHCl (See Metson, 1956, page 105).

5. Exchangeable cations - The leachate of 1 N NH4 acetate from the previous CEC determination was added to strontium chloride to give a concentration of 200 ppm Sr^{2+} ions. Ca^{++}, Na^{+} K^{+} were determined by flame photometry and Mg^{++} by atomic adsorption.

6. Total exchangeable bases (T.E.B.) - This was determined by summation of the exchangeable elements (Metson, 1956, p.105).

7. Base saturation - This was calculated using the formula % Base Saturation = $\frac{TEB}{CEC} \times 100$.

8. Total calcium, magnesium, potassium and iron - These were determined by incineration of the soil at 500°C followed by the addition of a 12.5% lanthanum chloride solution before determination in an atomic absorption spectrophotometer.

9. Total aluminium and silicon - Aluminium was separated from other ions by NH_4OH separation, followed by NaOH separation. The quantity of aluminium was determined colorimetrically (Jackson, 1960, page 297). Silicon was fused with Na_2CO_3, dehydrated with $HClO_4$. Metallic cations were washed clear with 6N HCl. A solution was then made with NaOH which was determined colorimetrically by the molybdosilicic yellow colour method (Jackson, 1960, page 294).

10. Phosphorous fractionation can be expressed by the equation Pt = P - inorg + P- org + P-occluded.

Where P = Total P extracted with Na_2CO_3 fusion (Muir, 1952, with modification by Jackson, 1958).

P-inorg = Inorganic phosphorous fractionated into acid extractable Ca-P, Al and Fe bound P, (non-occluded) (Williams et al, 1967, with modifications by Fife, unpublished).

P-org = Organic phosphorus extracted by the "ignition" method of Saunders and Williams (1955) as modified by Walker and Adams (1959).

P-occluded = inorganic phosphorus insoluable in 1H $H_2 20_4$ after ignition. This is obtained by subtracting P-inorg + P-org from Pt.

The concepts and significance of phosphorus fractionation are discussed by Walker (1965) and Williams and Walker (1969).

11. Phosphorous retention - 1 gm of air dried soil was dispersed in sodium dihydrogen phosphate. The phosphorous retained in the suspension was determined by the vanadate - molybdate method.

APPENDIX IV

TABLES FOR COMPILATION OF HUMOGENIC AND HUMOLYTIC INDICES, AFTER PAPADAKIS, 1961

T		H																	
F	C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0
32.	0.	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
33.8	1.	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.01	.01	.01	.01	.01	.01
35.0	2.	.00	.00	.00	.00	.01	.01	.01	.01	.01	.01	.02	.02	.02	.02	.02	.02	.02	.02
36.5	2.5	.00	.00	.00	.00	.01	.01	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03	.03	.03
37.4	3.	.00	.00	.00	.00	.01	.02	.03	.03	.03	.03	.04	.04	.04	.04	.04	.04	.04	.04
38.3	3.5	.00	.00	.01	.01	.02	.03	.04	.04	.04	.04	.05	.05	.05	.05	.05	.05	.05	.05
39.2	4.	.00	.00	.01	.02	.03	.04	.05	.05	.05	.06	.06	.06	.07	.07	.07	.07	.07	.07
40.1	4.5	.00	.00	.01	.02	.03	.05	.06	.06	.06	.07	.07	.08	.09	.09	.09	.09	.09	.09
41.	5.	.00	.00	.01	.03	.04	.06	.08	.08	.08	.09	.09	.10	.11	.11	.11	.11	.11	.11
41.9	5.5	.00	.01	.02	.03	.05	.07	.09	.09	.10	.11	.11	.12	.13	.13	.13	.13	.13	.13
42.8	6.	.00	.01	.02	.04	.06	.08	.10	.11	.12	.13	.13	.14	.15	.15	.15	.15	.16	.16
43.7	6.5	.00	.01	.02	.04	.07	.09	.11	.13	.14	.15	.15	.16	.17	.17	.17	.17	.18	.18
44.6	7.	.00	.01	.03	.05	.08	.11	.13	.15	.16	.17	.17	.18	.19	.20	.20	.20	.21	.21
45.5	7.5	.00	.01	.03	.06	.09	.12	.14	.17	.18	.19	.19	.20	.21	.22	.23	.23	.24	.24
46.4	8.	.00	.01	.04	.07	.11	.14	.16	.18	.20	.21	.22	.23	.24	.25	.26	.26	.27	.27
47.3	8.5	.00	.01	.04	.07	.12	.15	.18	.20	.22	.23	.24	.25	.27	.28	.28	.29	.30	.30
48.2	9.	.00	.01	.04	.08	.14	.17	.20	.22	.24	.25	.27	.28	.30	.31	.31	.32	.33	.33
49.1	9.5	.00	.01	.05	.09	.15	.18	.22	.24	.26	.27	.29	.31	.33	.34	.34	.35	.36	.36
50.	10.	.00	.01	.05	.10	.16	.20	.24	.27	.29	.30	.32	.34	.36	.37	.37	.38	.38	.39
50.9	10.5	.00	.01	.05	.11	.17	.21	.25	.29	.31	.32	.34	.36	.39	.40	.40	.41	.41	.42
51.8	11.	.00	.02	.06	.12	.18	.23	.27	.31	.33	.35	.37	.39	.42	.43	.43	.44	.44	.45
52.7	11.5	.00	.02	.07	.13	.19	.24	.29	.33	.35	.38	.39	.42	.45	.46	.46	.47	.47	.48
53.6	12.	.00	.02	.07	.14	.20	.26	.31	.35	.38	.40	.42	.45	.47	.48	.49	.50	.51	.51
54.5	12.5	.00	.02	.07	.15	.21	.27	.32	.37	.40	.43	.44	.47	.49	.51	.52	.53	.54	.54
55.4	13.	.00	.02	.08	.16	.22	.29	.34	.39	.42	.45	.47	.50	.52	.54	.55	.56	.57	.57
56.3	13.5	.00	.02	.09	.17	.24	.31	.36	.41	.44	.47	.49	.52	.55	.57	.58	.59	.60	.60
57.2	14.	.00	.02	.09	.17	.25	.32	.38	.43	.47	.50	.52	.55	.58	.60	.61	.62	.63	.64
58.1	14.5	.00	.02	.09	.18	.26	.33	.39	.45	.49	.52	.54	.58	.60	.63	.64	.65	.66	.66
59.	15.	.00	.03	.09	.19	.27	.35	.41	.47	.51	.55	.57	.61	.63	.66	.67	.68	.69	.69
59.9	15.5	.00	.03	.10	.20	.28	.36	.43	.49	.53	.57	.59	.64	.66	.69	.70	.71	.72	.72
60.8	16.	.00	.03	.10	.20	.30	.38	.45	.51	.55	.59	.61	.66	.69	.71	.72	.73	.74	.75
61.7	16.5	.00	.03	.10	.20	.31	.39	.46	.52	.57	.61	.64	.68	.71	.74	.75	.76	.77	.78
62.6	17.	.00	.03	.11	.21	.31	.40	.47	.53	.59	.63	.66	.70	.74	.76	.77	.78	.80	.80
63.5	17.5	.00	.03	.12	.21	.32	.41	.48	.55	.61	.65	.68	.72	.76	.78	.80	.81	.82	.84
64.4	18.	.00	.03	.12	.22	.33	.43	.50	.56	.62	.66	.70	.74	.78	.80	.82	.83	.85	.86
65.3	18.5	.00	.03	.12	.22	.34	.43	.51	.57	.63	.68	.72	.76	.80	.82	.84	.85	.88	.89
66.2	19.	.00	.03	.12	.23	.35	.44	.52	.59	.65	.70	.73	.78	.82	.84	.86	.88	.90	.91
67.1	19.5	.00	.03	.12	.23	.35	.45	.53	.60	.67	.73	.75	.80	.84	.86	.88	.90	.92	.94
68.	20.	.00	.03	.12	.24	.36	.46	.55	.62	.68	.73	.76	.82	.86	.88	.90	.92	.94	.96
68.9	20.5	.00	.03	.12	.24	.36	.46	.56	.63	.69	.74	.77	.83	.88	.90	.92	.94	.96	.98
69.8	21.	.00	.04	.12	.24	.37	.47	.56	.64	.70	.75	.79	.85	.89	.92	.94	.96	.98	1.00
70.7	21.5	.00	.04	.13	.25	.37	.48	.57	.65	.71	.76	.81	.86	.90	.94	.96	.98	1.00	1.02
71.6	22.	.00	.04	.13	.25	.37	.48	.58	.66	.72	.77	.82	.88	.91	.95	.97	.99	1.02	1.03
72.5	22.5	.00	.04	.13	.25	.37	.48	.58	.66	.73	.78	.82	.89	.93	.96	.99	1.01	1.04	1.05
73.4	23.	.00	.04	.13	.25	.38	.48	.58	.66	.74	.79	.83	.90	.94	.98	1.00	1.03	1.06	1.07
74.3	23.5	.00	.04	.13	.25	.38	.49	.59	.67	.75	.79	.84	.91	.95	.98	1.02	1.04	1.08	1.09
75.2	24.	.00	.04	.13	.25	.38	.49	.59	.67	.75	.80	.84	.92	.96	1.00	1.03	1.05	1.09	1.10
76.1	24.5	.00	.04	.13	.25	.38	.49	.59	.67	.75	.80	.84	.92	.97	1.01	1.04	1.06	1.10	1.12
77.	25.	.00	.04	.13	.25	.37	.49	.59	.67	.75	.80	.85	.93	.98	1.02	1.05	1.07	1.11	1.13
77.9	25.5	.00	.04	.13	.25	.37	.49	.59	.67	.75	.81	.86	.94	.99	1.02	1.06	1.09	1.12	1.14
78.8	26.	.00	.04	.13	.25	.37	.49	.59	.67	.75	.81	.86	.94	.99	1.03	1.06	1.09	1.13	1.15
80.6	27.	.00	.04	.13	.25	.37	.48	.58	.67	.74	.81	.85	.94	1.00	1.04	1.07	1.10	1.14	1.17
82.4	28.	.00	.03	.12	.24	.36	.47	.57	.66	.73	.80	.85	.93	1.00	1.05	1.08	1.11	1.16	1.19
84.2	29.	.00	.03	.12	.23	.35	.46	.56	.65	.72	.79	.84	.93	.99	1.05	1.08	1.11	1.17	1.20
86.	30.	.00	.03	.11	.22	.33	.44	.54	.63	.71	.77	.83	.92	.99	1.04	1.08	1.12	1.18	1.21
87.8	31.	.00	.03	.11	.22	.32	.43	.52	.61	.69	.75	.81	.91	.98	1.03	1.07	1.12	1.19	1.22
89.6	32.	.00	.03	.10	.21	.31	.41	.50	.59	.67	.73	.79	.90	.96	1.02	1.07	1.11	1.18	1.23
91.4	33.	.00	.03	.10	.20	.30	.39	.48	.57	.65	.71	.77	.88	.94	1.01	1.06	1.10	1.17	1.23
93.2	34.	.00	.03	.09	.19	.28	.37	.46	.55	.62	.69	.74	.85	.92	.99	1.04	1.09	1.16	1.22
95.	35.	.00	.03	.09	.18	.27	.35	.44	.52	.60	.65	.72	.82	.90	.96	1.02	1.06	1.15	1.21
96.8	36.	.00	.02	.08	.16	.25	.33	.42	.49	.57	.63	.69	.79	.87	.93	.99	1.04	1.13	1.20

TABLE 1. A (growth index) in function of T (temperature) and H (humidity coefficient for h = 12 (day of 12 hours).

C	e^{ct}	C	e^{ct}	C	e^{ct}	C	e^{ct}
16.5	.1	5.5	2.1	15.	8.	24.5	29.9
11.5	.2	6.	2.3	15.5	8.6	25.	32.
9.	.3	6.5	2.5	16.	9.2	25.5	34.3
7.	.4	7.	2.6	16.5	9.8	26.	36.8
5.	.5	7.5	2.8	17.	10.6	26.5	39.4
3.5	.6	8.	3.0	17.5	11.3	27.	42.2
2.5	.7	8.5	3.2	18.	12.1	27.5	45.2
1.5	.8	9.	3.5	18.5	13.	28.	48.5
1.	.9	9.5	3.7	19.	14.	28.5	52.
0.	1.	10.	4.	19.5	15.	29.	55.7
1.	1.1	10.5	4.3	20.	16.	29.5	59.7
1.5	1.2	11.	4.6	20.5	17.1	30.	64.
2.	1.3	11.5	4.9	21.	18.4	20.5	68.6
2.5	1.4	12.	5.3	21.5	19.7	31.	73.5
3.	1.5	12.5	5.7	22.	21.1	31.5	78.8
3.5	1.6	13.	6.1	22.5	22.6	32.	84.4
4.	1.7	13.5	6.5	23.	24.3	32.5	90.5
4.5	1.9	14.	7.	23.5	26.	33.	97.
5.	2.0	14.5	7.5	24.	27.9	33.5	103.9

TABLE 2. Table for computing the humolytic index (H1). Values of e^{ct} (for calculating H1)

APPENDIX V

SOIL PROFILE DESCRIPTIONS

1. Elegelic soils

i) Lodi-elegelic soils

Horizon	Depth (cm)	
O_1	0 - 5	Undecomposed root mat, with abundant fine to small fibrous roots.
O_2	5 - 14	Black (5yr 2/1) peaty loam; very friable, greasy, amorphous, partially decomposed organic material with abundant fine to small fibrous roots; distinct boundary.
Og	14 - 31	Dark brown (10yr 4/3); peaty loam; very friable; weakly developed fine crumb structure; spot gley; abundant fine to small roots; wavy distinct boundary.
(u)O	31 - 34	Black (5yr 2/1); peat loam; very friable, greasy, amorphous, partially decomposed organic material with abundant fine to small fibrous roots; distinct boundary.
(u)G	34 - 41	Light grey (5y 7/1); silt loam; very friable; weakly developed fine crumb structure; diffused gley; frequent small fibrous roots; diffuse boundary.
uB	41 - 51	Light olive brown (2.5yr 5/6); stony silt loam; friable; slightly sticky; moderately developed fine to medium crumb structure; few fragments of small roots.
C_1	51+	Unweathered solifluct of angular schist fragmented by physical processes.

ii) Fulvi-elegelic soils

Horizon	Depth (cm)	
A_1	0 - 8	(5y 5/2) Olive loamy sand, friable, weakly developed, fine crumb structure, abundant roots, distinct boundary.
uA	8 - 25	5y 5/3 Olive, stony loam sand, very friable; weakly developed fine crumb structure; abundant fibrous and semi-woody roots; diffused boundary.
uB	25 - 28	5yr 5/8, yellowish red; stony silt loam, friable, weakly developed fine crumb structure; dispersed iron, with few fine mottles 2.5y 5/6 (red); few fine roots indistinct boundary.
C_1	28 - 48	Solifluct fragments of angular greywacke.

2. Eleclinic soils

Horizon	Depth (cm)	
A	1	Moder from roots and partially decomposed organic material.
C_1	5	Partially sorted glaciofluvial outwash with over 70% fine material and particles of organic debris.
C_2	10+	Coarse sub-angular glacio-fluvial outwash.

i) Humi-eleclinic soils

Horizon	Depth (cm)	
O	0 - 12	Dark grey brown; (10 yr 4/2) peaty loam
A	12 - 25	Dark yellow brown (10yr 4/4) fine sandy loam; friable; weakly developed fine crumb structure; abundant medium to small woody and fibrous roots; indistinct boundary.

i) Humi-eleclinic soils (contd)

Horizon	Depth (cm)	
C	25^{+}	Angular to sub-angular rock fragments of schist and greywacke.

3. Elelithic soils

Horizon	Depth (cm)	
A	0 - 2	Brown (7.5yr 3.2) stony sandy loam; very friable structureless; abundant coarse woody fragments of roots and plant debris, diffused boundary.
C	2 - 10	Solifluct fragments of angular schist.

4. Eleluvic soils

Horizon	Depth (cm)	
A_1	0 - 25	Greyish brown 2.5y 5/2 sand; friable, weakly developed fine crumb structure; many few small fibrous roots, indistinct boundary.
GC	25 - 100	Pale olive (5y 6/3) sand; very friable; weakly developed fine crumb structure; diffused gley with reddish brown (5y 4/4) mottles; very few oxidised root fragments; distinct boundary.
uB	100 - 120	Yellowish brown (10yr 5/6) sand very friable, slightly sticky weakly developed fine crumb; few stones; partially decomposed root fragments; indistinct boundary.
uC_1	120+	Unsorted glacio-fulvial outwash.

i) Plati-eleluvic soils

Horizon	Depth (cm)	
O_1	0 - 3	A closely compact mat of Oreobolus roots.
C_1	3 - 4	Yellowish brown 10 yr 5/4 loamy sand; very friable; structureless; abundant fine fibrous roots; distinct boundary.

i) Plati-eleluvic soils (contd.)

Horizon	Depth (cm)	
O_2	4 - 7	Very dark brown (10yr 2/2); friable; greasy amorphous peaty loam with some small fibrous roots; distinct boundary.
C_2	7 - 10	Yellowish brown (10 yr 5/4); very friable; structureless many small fibrous roots; distinct boundary.
O_3	10 - 12	Very dark brown (10 yr 2/2); friable amorphous peaty loam with some small fibrous roots; distinct boundary.
C_3	12 - 17	Yellowish brown (10 yr 5/4); loamy sand, very friable; structureless many small roots.
O_4	17 - 19	Very dark brown (10 yr 2/2); friable; amorphous greasy peaty loam; few small fibrous roots; distinct boundary.
C	19+	Water-table overlying outwash gravels.

5. Eleplatic soils

i) Eleplatic (eutric phase)

Horizon	Depth (cm)	
O	0 - 15	Mat of hygrophytic plant roots with an alternate layer of partially decomposed organic material; distinct boundary.
G	15 - 30	Light grey to grey (5y 6/1) sand; friable; weakly developed finecrumb structure, partially decayed organic matter, abundant fibrous and fleshy roots; distinct boundary.
uO	30 - 35	Dark reddish brown (5 yr 3/2); friable, greasy; partially decomposed peaty material with

i) Eleplatic (eutric phase) (contd.)

Horizon	Depth (cm)	
		recogniseable fragments of un-decayed Celmisia leaves and stems; distinct boundary.
uG	35 - 54	Grey (5y 5/1); gritty silt loam; friable; weakly developed fine crumb structure; many dark red (3.5 yr 3/6) mottles; few fragments of roots; indistinct boundary.
C_1	54+	Colluvial gravels.

6. Elefulvic soils

Horizon	Depth (cm)	
A	0 - 15	Dark yellowish brown (10 yr 4/4) loamy sand; friable; weakly developed; fine crumb structure; few angular to sub-angular stones; abundant fibrous and woody roots indistinct boundary.
B_1	15 - 22	Yellowish brown (10 yr 5/6) stony loamy sand; friable; weak to moderately developed fine crumb structure; frequent small fibrous roots diffuse boundary.
B_2	22 - 37	Yellowish brown (10 yr 5/8) stony sand; friable; moderately developed crumb structure; few fine root fragments; indistinct boundary.
C_1	37+	Fragmented schist from undifferentiated moraine, with some colluvial debris.

i) Elefulvic (strongly enleached phase)

Horizon	Depth (cm)	
O_1	0 - 2	Undecomposed litter of Celmisia lyallii.
O_2	2 - 4	Partially decomposed acid humus, (moder silicate).

i) Elefulvic (strongly enleached phase) (contd.)

Horizon	Depth (cm)	
A	4 - 11	Dark grey, 10 yr 4/1; silt loam very friable weakly developed crumb structure, abundant small fibrous roots; distinct boundary.
B_1	11 - 16	Yellowish-brown 10 yr 5/6; silt loam; friable, weakly developed fine crumb structure, few angular stones; many fine fibrous roots indistinct boundary.
B_2	16 - 31	Brownish yellow, 10 yr 6/6; stony silt loam; friable, weakly developed fine crumb structure, clay coating on stones, several distinct brown mottles, 7.5 yr 5/6, few root fragments, diffuse boundary.
C_1	31+	Angular unweathered fragments of solifluct.

ii) Clini-elefulvic soils

Horizon	Depth (cm)	
A	0 - 10	Dark greyish brown (10 yr 4/2); gritty sandy loam very friable; moderately developed fine crumb structure; abundant fine fibrous roots, a diffused boundary.
uA/B	10 - 20	Yellowish brown (10 yr 5/4); stony sandy loam; very friable; weakly developed fine crumb structure, few small fibrous roots, indistinct boundary.
uB/C	20 - 35	Yellowish brown (10 yr 5/4) stony sand; very friable; weakly developed fine crumb structure; fragments of small fibrous roots indistinct boundary.

iii) Madenti-elefulvic soils

Horizon	Depth (cm)	
A	0 - 4	Very dark brown (10 yr 2/2). Very friable partially decomposed peaty material.
G	4 - 39	Light grey to grey (5y 6/1); silt loam very friable, weakly developed fine crumb structure; spot gley with a few faint reddish brown (5yr 4/4) mottles; few fragments of fibrous roots; diffuse boundary.
B	39 - 64	Brown to dark brown (7.5 yr 4/4); stony sand, very friable; weakly developed fine crumb structure; many fine dark olive (5 yr 4/4); mottles; clay coating on sub-angular stones; frequent fragments of roots; indistinct boundary.
C_1	64+	Angular outwash gravels.

7. Eldefulvic soils

i) Eldefulvic (strongly enleached phase)

Horizon	Depth (cm)	
O_1	0 - 3	Dark reddish brown (5 yr 2/2), litter fragments of Celmisia lyallii and Dracophyllum.
O_2	3 - 6	Brown to dark brown (10 yr 4/3); very friable partially decomposed organic material; distinct boundary.
A	6 - 16	Dark greyish brown (10 yr 4/2), silt loam; friable, weak to moderately developed fine crumb structure; few stones; many small fibrous roots; diffuse boundary.
B_1	16 - 31	Yellowish-brown (10 yr 5/8); silt loam; friable; moderately developed medium crumb structure; few small root fragments, diffuse boundary.

i) Eldefulvic (strongly enleached phase) (contd.)

Horizon	Depth (cm)	
B_2	31 - 91	Brownish-yellow (10 yr 6/8); silt loam, friable, moderately developed fine to medium blocky structure; light yellowish-brown (2.5 y 6/4) spot gley; with a few fine yellowish red (5 yr 5/8) mottles; few angular stones with clay coating; few fine root fragments, indistinct boundary.
B_3	91 -101	Brown (7.5 yr 3/2), gritty stony sandy loam; very friable and structureless.
C_1	101+	Angular schist from colluvial and solifluct material.

ii) Clini-eldefulvic soils

Horizon	Depth (cm)	
A_1	0 - 15	Dark grey (10 yr 4/1) silt loam friable moderately developed medium nut structure; few unweathered gravels, abundant fine fibrous roots; indistinct boundary.
uA_1	15 - 19	Dark yellow brown (10 yr 4/4); stony silt loam, friable, moderately developed fine nut structure, abundant fine fibrous roots.
uA_3	19 - 41	Yellow brown (10 yr 5/4); gritty loamy sand, very friable, moderately developed fine crumb structure; fragments of charcoal with a few small pores; few fine root fragments; diffuse boundary.
uB	41 - 71	Brownish yellow (10 yr 6/6); stony loamy sand; very friable; weakly developed fine crumb structure;

ii) Clini-eldefulvic soils (contd.)

Horizon	Depth (cm)	
		light grey (5 yr 7/1), spot gley, with a few moderate red (2.5 y 4/6) mottles some pores, few fragments of fibrous roots, indistinct boundary.
C_1	71+	Schist and argillite fragments.

iii) Madenti-podi-eldefulvic soils

Horizon	Depth (cm)	
A	0 - 20	Dark grey (10 yr 4/1); silt loam, very friable; slightly sticky; weakly developed fine crumb structure; abundant fine fibrous roots; with some small woody roots; indistinct boundary.
G	20 - 32	Grey (N6/); silt loam, very friable, slightly sticky; diffuse gley; few fine yellowish red (5 yr 5/8), mottles; few small fragments of roots; distinct boundary.
B_1	32 - 38	Yellowish red (5 yr 4/8) silt loam; very friable; moderately developed fine to medium crumb structure; abundant small fibrous roots; indistinct boundary.
B_2	38 - 58	Yellowish red (5 yr 5/8); stony sandy loam, friable; weakly developed fine crumb structure; few roots; indistinct boundary.
B_3	58 - 70	Strong brown (7.5 yr 5/6); loamy sand; very friable, sticky, weakly developed fine crumb structure roots are rare; diffuse boundary.
C_1	70+	Angular fragmented colluvial debris of schist and greywacke.

APPENDIX VI

LOCATION AND ALTITUDE (M) OF SOIL PROFILE REFERENCES

TWIN BASIN		(M)		(M)
Eleclinic	TW24	(1844)	TW25	(1950)
Lodi-elegelic	TW18	(1834)	TW19	(1859)
Fulvi-elegelic	TW 5	(1560)	TW21	(1709)
Eleluvic	TW22	(1850)		
Eleplatic	TW20	(1737)		
Luvi-eleplatic	TW17	(1737)		
Madenti-elefulvic	TW15	(1853)	TW16	(1737)
Clini-elefulvic	TW12	(1737)	TW13	(1706)
Elefulvic (strongly enleached phase)	TW10 TW16	(1606) (1524)	TW14 TW 7	(1676) (1524)
Eldefulvic (strongly enleached phase)	TW 9 TW11	(1402) (1460)	TW 8	(1450)
Madenti-podi-eldefulvic	TW 2 TW 4	(1097) (1417)	TW 3	(1286)

TWIN STREAM HEADWATERS		(M)		(M)
Fulvi-elegelic	TH 3	(1966)	TH11	(1844)
Eleluvic	TH 8	(1767)		
Eleplatic (eutric phase)	TH 4	(1341)	TH 7	(1645)
Elefulvic (weakly enleached phase)	TH 5 TH 9	(1478) (1737)	TH 6 TH10	(1600) (1722)
Clini-elefulvic	TH 1	(1529)	TH 2	(1658)

PYRAMID BASIN		(M)		(M)
Fulvi-elegelic	PB12	(1645)	PB13	(1645)
Humi-eleclinic	PB 8	(1524)		
Madenti-elefulvic	PB11	(1554)		
Elefulvic (weakly enleached phase)	PB 6	(1828)	PB 9	(1524)
	PB14	(1585)	PB 3	(1453)
	PB 4	(1475)	PB15	(1463)
	PB 5	(1478)	PB10	(1470)
Clini-elefulvic	PB 7	(1722)		
Clini-eldefulvic	PB 1	(1330)		
Eldefulvic	PB 2	(1335)		

MARY BASIN		(M)		(M)
Fulvi-elegelic	MB 2	(1706)	MB 3	(1813)
	MB 4	(1820)		
Eleluvic	MB 1	(1706)	MB22	(1813)
	MB23	(1737)	MB24	(1560)
Madenti-elefulvic	MB 6	(1539)		
Elefulvic (eutric phase)	MB 9	(1545)	MB16	(1402)
	MB17	(1676)		
Clini-elefulvic	MB 5	(1767)	MB 7	(1706)
	MB 8	(1645)		
Clini-eldefulvic	MB10	(1246)	MB11	(1246)
	MB12	(1280)	MB13	(1478)
	MB14	(1371)	MB15	(1371)
	MB25	(1371)		
Humi-eleclinic	MB18	(1975)	MB19	(1920)
	MB20	(1966)	MB21	(1874)

APPENDIX VII

PLANT COMMUNITIES (DOMIN SCALE)

System used to enumerate species in various stands (relève) was the ten-point Domin Scale which measured their cover and abundance:

1. One or two individuals
2. Sparsely distributed
3. Frequent but low cover ($<$ 1/20)
4. Cover 1/20 - 1/5
5. Cover 1/5 - 1/4
6. Cover 1/4 - 1/3
7. Cover 1/3 - 1/2
8. Cover 1/2 - 3/4
9. Cover 3/4 - 9/10
10. Cover complete or almost so.

(See McVean and Ratcliffe (1952), page 6.)

PLANTS LISTED ON PERIODIC SOIL SEQUENCE

Plot (10 x 10m^2)	K_3 (1)	K_3 (2)	K_2 (3)	K_1 (4)
SHRUBS				
Carmichaelia monroi		+		
Cassinia vauvilliersii		1		
Coprosma cheesemanii	1	1	+	
C. petriei				
Coriaria plumosa		4	4	
Cyathodes colensoi	2		+	
C. fraseri	2	1	+	1
Discaria toumatou	+	1	+	
Dracophyllum uniflorum	7	+	+	+
Drapetes dieffenbachii	1			
Gaultheria crassa	8	6	2	
G. depressa	2	1		+
Hebe buchananii				+
H. odora		+	1	
Myrsine nummularia	2			
Pimelea oreophila	1	+		
GRASSES				
Aira caryophyllea	2			
Agropyron scabrum	1		2	1
Agrostis petriei			1	1
A. tenuis	5	5	4	4
Anthoxanthum odoratum	2	2	3	3
Chionochloa rigida	5	9	5	4
Festuca novae-zelandiae	2	1	1	2
F. var. rubra commutata			+	

Plot (10 x 10m^2)	K_3 (1)	K_3 (2)	K_2 (3)	K_1 (4)
GRASSES (contd.)				
Hierochloe brunonis	+			
Holcus lanatus	1	+	3	2
Notodanthonia buchananii	+	1	1	
N. setifolia	1		+	2
Poa caespitosa		+		1
P. colensoi	2	3	1	3
P. kirkii		+		
FORBS				
Acaena hirsutula				2
A. saccaticupola		+	1	
Achillea millefolium		+		
Aciphylla aurea		+		
Anisotome aromatica	+	3	3	2
Blechnum penna-marina	2			
Brachycome sinclairii	+			
Caltha novae-zelandiae	+			
Celmisia angustifolia	2		+	1
C. coriacea	+			
C. densiflora	5	3	3	3
C. gracilenta	2	1	1	+
C. lyallii	+			
C. petiolata	2	2	1	
Cerastium arvense			2	2
Cotula pectinata	+			
Craspedia uniflora		2		
Dicranoloma robustum	+			

Plot (10 x 10m^2)	K_3 (1)	K_3 (2)	K_2 (3)	K_1 (4)
FORBS (contd.)				
Gentiana corymbifera	+	+		
Geranium microphyllum	+	+		
Geum parviflorum	+	1	1	2
Hieracium pilosella	1	1		
H. praealtum				
Helichrysum bellidioides	+	1	2	3
Hypochaeris glabra	1			
H. radicata		1	1	2
Linum catharcticum	+	+	3	
Lolulia linnaeoides		1		
Lycopodium fastigiatum		+		
Microseris scapigera	1	2	3	
Prasophyllum colensoi		2		
Pratia angulata				
Raoulia glabra	1			
Ranunculus gracilipes	+	1		
R. lappaceus	+	1	1	
R. lyallii		2		
Rumex acetosella				1
Schizeilema haastii		1	3	3
Senecio haastii	1			
Trifolium repens		2	5	7
Viola cunninghamii		+		
Wahlenbergia albomarginata	1	2		2

Plot (10 x 10m^2)	K_3 (1)	K_3 (2)	K_2 (3)	K_1 (4)
BRYOPHYTES				
Dicranoloma robustum	+			
Hypnum cupressiform	+			
Polytrichum juniperinum	+			+
Rhacomitrium langunosum	+			

DEGRADED GRASSLANDS NODUM

PLOT NO.	MB7a	MB8a	MB14a	MB8	MB7	MB14
PLOT AREA : (m^2)	4	4	4	4	4	4
ALTITUDE : (m)	1219	1340	1300	1767	1706	1371
ASPECT :	NNW	NNW	NNW	NNE	NE	NNE
SLOPE : (°)	27	25	30	25	38	35
BARE GROUND : (%)	25	20	30	40	35	25
SPECIES LIST						
Coprosma cheesemanii		2				
C. pseudocuneata	1					
Cyathodes colensoi	5		4			2
C. fraseri	4		1			2
Drapetes dieffenbachii		1				
Dracophyllum uniflorum	2		4			2
Gaultheria crassa	3					
G. depressa	2					
Hebe odora		3				
H. subalpina		4				
Pentachondra pumila	1					
Pernettya nana			3			
Pimelea oreophila						2
Aciphylla aurea	4		6			4
A. similis			1			
Brachycome sinclairii						3
Celmisia angustifolia		1				
C. coriacea		4	3			
C. densiflora		1				
C. gracilenta	1					
C. lyallii	3		5	8	7	3
Cotula pectinata				2	2	
Epilobium alsinoides				1	1	
Geranium microphylla			1			
Helichrysum bilidoides			2			
Hieracium pilosella	1					
H. prealtum.			1			
Hypochaeris radicata	3					3
Phormium cookianum			1			
Raoulia subsericea	3		1			
Rumex acetosella				1	1	
Scleranthus uniflorus			1			
Chionochloa rigida	6	6	8			7
Festuca novae-zelandiae	2		2			
Poa colensoi	2		1	6	5	5
P. kirkii					1	

DYSTROPHIC GRASSLANDS NODUM

PLOT NO.	PB15A	TW2	TW3	TW4	TW5	TW6	TW7	TW9	TW10	TW11	TW12	MB6	MB10	MB16
PLOT AREA : (m^2)	4	4	4	4	4	4	4	4	4	4	4	4	4	4
ALTITUDE : (m)	1243	1097	1268	1417	1560	1524	1530	1402	1606	1524	1737	1539	1246	1402
ASPECT :	SE	SE	SE	SE	SE	E	NE	SE	SW	ESE	NE	NE	SE	NE
SLOPE : (°)	38	38	20	40	5	36	35	35	5	40	40	5	25	38
BARE GROUND : (%)	Nil	Nil	Nil	Nil	Nil	5	10	5	Nil	10	15	Nil	10	Nil
SPECIES LIST														
Coprosma pseudocuneata		3												
Dracophyllum kirkii	1						1							
D. pronum			6	1		5			3	2	3	2		
D. uniflorum	5	5	5					4				2	4	5
D. uniflorum x pronum	4							4						
Drapetes dieffenbachii											2			
Gaultheria crassa		4												
G. depressa	3													
Hebe buchananii												1		
H. lycopodioides	2		1			2						2		
H. odora	3	3	1											5
Myrsine nummularia		2												
Olearia nummularifolia														
Pentachondra pumila	1													
Pimelea oreophila	1	2												
Aciphylla aurea	2													
Aciphylla scott-thompsonii		2											4	
A. similis			3	2		5		4	4	5	3	3		
Anisotome flexuosa		3									3			3
Astelia nivicola			1	1										
Brachycome sinclairii											2	2		
Celmisia angustifolia														5
C. coriacea														
C. densiflora	1													
C. laricifolia					5									
C. lyallii	3		7	8	8	8	8	7	8	8	7	8		3
Cotula pectinata				1								2		
Craspedia uniflora		2												
Epilobium alsinoides, ssp.atrip.				2								2		
Geum parviflorum														1
Hieracium prealtum		3												
Hypochaeris radicata	3													
Lobelia linneoides	1			1										
Plantago uniflora	1													2
Phormium cookianum													3	
Raoulia grandiflora											2			
Rumex acetosella												2		
Viola cunninghamii		2												
Agrostis petriei	1										2	2		
A. subulata												2		
Chionochloa crassiuscula										3				
C. oreophila						1								
C. rigida	6	8	7	11								5	8	
C. macra						2		4						
Deyeuxia avenoides	1													
Erythranthera pumila	2													
Festuca matthewsii												4		
Koeleria cheesemanii				3										
Notodanthonia setifolia										3		4		
Poa colensoi	2	6	5	6	6	5	5	3	5	3	5	7		5
Trisetum youngii				2										
Luzula crinita x petriana				3						1				
L. rufa											1			
L. traversii				1										
Oreobolus pectinatus														
Uncinia divaricata				2										
U. fuscovaginata				2								1		
Lycopodium australasica												2		
L. fastigiatum		2	3								2	3		
L. scariosum	3													
Cladonia spps.	1													
Polytrichum juniperinum			1	1		2								
Stricta crocata			1	1										
Rhacomitrium languinosum				1										
Cetraria islandica	1													

EUTROPHIC GRASSLAND NODUM

PLOT NO.	TH1A	TH1	TH2	TH5	TH6	TH9	TH10	TH3	MB23
PLOT AREA : (m^2)	4	4	4	4	4	4	4	4	4
ALTITUDE : (m)	1341	1539	1658	1473	1586	1580	1722	1966	1737
ASPECT :	NE	NE	NE	NE	NE	NE	E	NE	NE
SLOPE : (°)	5	35	40	38	30	40	38	38	35
BARE GROUND : (%)	6	5	10	5	NIL	5	NIL	NIL	NIL
Coprosma pseudocuneata				1					
C. pumila		5							
Dracophyllum pronum				5					
Drapetes dieffenbachii			1						
Gaultheria depressa								2	
Pimelea oreophila	2				1				
P. prostrata		5							
Aceana caesiaglauca	2								
A. hirsutula			2						
Aciphylla aurea									2
A. similis		1		2					
Anisotome flexuosa		3	2	3		3	3	3	
Brachycome sinclairii	3	3			1		2	2	
Celmisia angustifolia			2						
C. lyallii	5	8	5	8	4	6			8
C. sessiliflora								5	
C. walkeri								1	
Cotula pectinata		2	2		2	1	2		
Epilobium alsinoides, ssp.atrip.				3	3	3			
Euphrasia zelandica					2				
Geum parviflorum									
Lobelia linneoides				2	1				
Phyllachne colensoi								2	
Pygmaea pulvinaris								1	
Ranunculus gracilipes		2						2	
Raoulia grandiflora							2	3	
Rumex acetosella		2	2		2				
Schizeilema haastii	2								
Senecio scorzoneroides				2					
Viola cunninghamii		2	1		1	1			
Wahlenbergia albo-marginata	2								
Agrostis subulata	1				1		1		
Chionochloa crassiuscula				3					
C. oreophila								1	
Festuca matthewsii	7								
Koeleria cheesemanii	2				1				
Notodanthonia setifolia					6				3
Poa colensoi	4	7	7	6	7	6	7	7	6
Carex wakatipu			4		2	1			
Luzula crinita var. petriana							1		
L. traversii	2								
Schoenus pauciflorus				1					
Uncinia fuscovaginata					1				
U. sinclairii						1			
Blechnum penna-marina	2	1							
Lycopodium fastigiatum	3	2		3					
Stricta crocata			1						

UNCLASSIFIED RUPICOLOUS NODA

PLOT NO.	TW1	MB13	PB6A	PB13A
PLOT AREA : (m^2)	10	4	1	1
ALTITUDE : (m)	1090	1478	1337	1400
ASPECT :	SW	NNE	E	E
HABITAT :	SHINGLE	SCHIST BLUFF	STONE PAVEMENT	STONE PAVEMENT
BARE GROUND : (%)	NIL	20	10	15
SPECIES LIST				
Coprosma pseudocuneata				
Dracophyllum pronum	2		6	
D. uniflorum	5	4		
Drapetes dieffenbachii			2	1
Gaultheria crassa	2			
Hebe buchananii		1		
H. ciliolata				
H. epacridea				
H. odora		3		
Olearia nummularifolia		3		
Podocarpus nivalis	5			
Senecio cassinioides	3	3		
Aciphylla aurea		3		
Anisotome flexuosa			4	3
Brachycome sinclairii			2	
Celmisia coriacea		2		
C. densiflora		2		
C. lyallii	2	5	3	
Colobanthus acicularis				2
Fostera sedifolia				
Leucogenes grandiceps				
Ourisia caespitosa				
Phyllachne colensoi			1	
Pygmea pulvinaris			1	2
Ranunculus lyallii	1			
Raoulia grandiflora			1	1
Agrostis imbecilla			2	
A. subulata				2
Erythranthera pumila			2	
Poa colensoi				3
Luzula pumila				2
Hymenophyllum villosum		1		
Hypolepis millefolium		1		
Polystichum cystostegia		2		
Grimmia spps.		1		1
Neuropogon spps.				2
Parmelia spps.		1		
Polytrichum juniperinum				2
Rhacomitrium languinosum		1		
Rhizocarpon spps.		2		
Thamnolia spps.		2	2	

CHIONOCHLOA OREOPHILA NODUM

PLOT NO.	TW16	TW17C	TH8	PB11A	PB11B	MB19	MB20	MB22
PLOT AREA : (m^2)	4	4	4	6	4	4	4	4
ALTITUDE : (m)	1859	1767	1767	1554	1554	1800	1870	1813
ASPECT :	E	SE	NE	E	E	NE	NE	NE
SLOPE : (°)	5	FLAT	FLAT	25	3	15	25	FLAT
BARE GROUND : (%)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
SPECIES LIST								
Coprosma pumila				2				
Drapetes lyallii				2		2	2	
Gaultheria depressa				1				
Anistome imbricata				3	2	3		
Celmisia angustifolia				1			1	
C. haastii	3	3	4	3	4	5	2	3
C. laricifolia				1				
C. lyallii				1				
C. sessiliflora		2	2					
Epilobium alsinoides spp. atrip				2				
Euphrasia zelandica				2		2		
Fostera sedifolia				2	1			
Phyllachne colensoi				3			2	2
Plantago langiera				1				
Raoulia grandiflora				1			1	
Agrostis imbecilla				1				
Chionochloa macra				2	3		1	
C. oreophila	9	9	4	7	8	6	8	8
Hierochloe brunonis					1			
Poa colensoi	2		7	4	7		2	
Carex acicularis			2					
C. enysii			2					
C. lachenalii			2					
C. pyrenaica var. cephalotes	3	2			4			
Marsippospermum gracile	2	3	3	1		3		
Uncinia divaricata					1		4	
Polytrichum commune			2					
P. juniperinum				1	1	3	3	
Psilopilum australe			1					

CELMISIA HECTORI NODUM

PLOT NO.		PB7A	PB7B	MB4
PLOT AREA	: (m^2)	1	1	1
ALTITUDE	: (m)	1737	1750	1800
ASPECT	:	ENE	ENE	E
SLOPE	: (o)	5	10	5
BARE GROUND	: (%)	10	5	NIL
SPECIES LIST				
Celmisia haastii				1
C. hectori		6	8	8
C. sessiliflora		1		2
Epilobium porphyrium			1	
Agrostis subulata			1	
Polytrichum juniperinum			1	1

CELMISIA HAASTII, MARSIPPOSPERMUM GRACILE NODUM

PLOT NO.	TW18	TW2B	TH11	MB2A	MB2	MB3
PLOT AREA : (m^2)	4	2	4	4	4	4
ALTITUDE : (m)	1828	1810	1844	1615	1767	1798
ASPECT :	S	SE	E	SE	SE	E
SLOPE : (°)	5	FLAT (STEP)	5	30	5	32
BARE GROUND : (%)	NIL	10	10	NIL	NIL	NIL
SPECIES LIST						
Drapetes lyallii						4
Arisotome imbricata	2		4			
Celmisia angustifolia	2					
C. haastii	4	5	7	7	2	5
C. hectori	3		7			
C. lyallii				2		
C. sessiliflora	3		2			
Epilobium porphyrium						
Fostera sedifolia			1			
Geranium microphylla			1			
Ourisia caespitosa				1		
Phyllachne colensoi	2		1	1		
Pygmea pulvinaris	2					
Agrostis subulata						
Chionochloa oreophila	2	4				
Poa colensoi	2			7	1	5
Carex pyrenaica var. cephalotes		2				
Luzula pumila	2		1			
Marsippospermum gracile	5	4	3	1	8	3
Lycopodium fastigiatum					2	
Polytrichum commune					1	
P. juniperinum		3		2		

DRYOPHYTE, HYDROPHYTE NODUM

PLOT NO.	TH4A	TH7	TW20	TW17A	TW17B	TW24
PLOT AREA : (m^2)	4	4	4	4	4	4
ALTITUDE : (m)	1341	1645	1737	1767	1767	1920
ASPECT :	10	30	30	FLAT	FLAT	FLAT
BARE GROUND : (%)	NIL	NIL	NIL	5	NIL	40
SPECIES LIST						
Drapetes lyallii		2				
Hebe epacridea				1		
Pentachondra pumila					2	
Abrotonella caespitosa	6					
Aceana saccaticupula		3				
Aciphylla dobsonii				1		
Anisotome imbricata			3			
Caltha obtusa		1			3	
Celmisia haastii					3	
C. sessiliflora					3	
Colobanthus apetalus var. alpina	6					
Gnaphalium luteus		2				
Neopaxia australasica				3	3	
Gurisia caespitosa			2			
Plantago uniflora					2	
Ranunculus gracilipes			1			
Raoulia youngii				3		1
Stackhousia minima					2	
Agrostis imbecilla					1	
Poa colensoi					1	
Carex lachenalii			1			
C. pyrenaica var. cephalotes					2	
Luzula pumila					2	
Marsippospermum gracile					1	
Oreobolus pectinatus		3			5	
Schoenus pauciflorus		2		3		
Scirpus aucklandicus		4				
Andreaea acccumminata				2		
A. australis			1	2		3
Bartramia papillata	3					
Blindia robusta				2		
Brachythecium paradoxum					1	
B. salebrosum					1	
Breutelia affinis				1		
Calliergon sarmentosum				1		
Conostomum australe				1		
Drepanocladus uncinatus			1			
Gymnomitrium stygium						5
Marchantia berteroana			3			
Philonotis australis	6	6	6			
Polytrichum commune			3		1	
Rhacomitrium crispulum						1
Tortula rubra			1			