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PALYNOLOGY OF THE 75-106 B.C. Hydro CORE HOLE,

HAT CREEK COAL BASIN, BRITISH COLUMBIA

by

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Purpose of Study

I felt that the palynological study of a complete core through this coal field might provide the nucleous for a biostratigraphic zonation of the Hat Creek Basin, as well as possibly helping in the correlation of individual coal seams. I hoped, also, some age conclusions might result.

The opportunity of such a study presented itself with the appearance of the 75-106 B.C.Hydro core hole. This core was sampled and described in detail, in the fall of 1977, by A.R. Cameron and A.R. Sweet of the Geological Survey of Canada, and through their cooperation was made available to me for this study. The following report describes the results of this investigation.

Location and Geology

The Hat Creek Coal Field, located about 240 km northeast of Vancouver contains low grade coal deposits which are among the worldest thickest. These deposits are located in a structural and topographic basin which is some 22 km long and varying from 3 to 5 km in width. These sub-bituminous coals are contained in three major seams with an aggregate thickness of some 280 m. The deposits are grouped into two general areas within the Hat Creek Basin, and will be mined as separate units. These areas are referred to as Number 1 and Number 2 deposits. Core hole 75-106 is located at 54°45'50"N; 121°36'15"W, in the centre of the Number 1 deposit. For a more complete discussion of the regional geology, physical stratigraphy and petrology see Church (1977), Church and others (undated), Kim (1979), and MacKay (1926).

Core and Sampling

Core hole 75-106 penetrated 602 m of sedimentary rocks, including the entire thickness of the Hat Creek Formation. This unit is variously stated to be 425 m (Church, 1977) to 550 m (Kim, 1979) thick. This discrepancy apparently arises because the unit has a variable thickness, but also because there is some disagreement as to where lies the contact with the underlying Coldwater Formation. Nevertheless, core hole 75-106 penetrated the entire Hat Creek Co l Formation with a 50± m penetration into the Coldwater Formation. Three major coal seams were encountered in the core which presumably compare with those described by Church (1977, p. G104). Here he described an upper seam about 160 m thick, a middle seam of 50 m and a lower seam of 70 m thickness. These seams are separated by zones of sandy siltstone, conglomerate, sandstone and a few thin coaly bands.

Although a detailed lithologic description of the entire core has been prepared by Cameron and Sweet, the data has not yet been plotted on a strip log. However, in broad terms, the subdivision presented by Church (1977) was encountered in the core.

In this study 49 samples representing depths ranging rom 26.5 to 605 m. were collected. Data on these samples are tabulated on Table 1. Because original measurements were all in feet, I have retained these figures, but have also given metric equivalents on Table 1. Also shown on this table are the total palynomorphs identified and counted for each sample, as well as the grand total which is 13,365 palynomorphs counted and which were utilized in the accompanying frequency diagrams. Where no figures are given, less than 100 palynomorphs were counted and results are not included in the range chart. Composite samples were collected for the intervals indicated in column 1. For plotting purposes they were averaged and plotted on the range chart using the figure indicated in column 3.

The results of palynomorph counts are given on the accompanying six figures which comprise a total of 18 range charts. In the composite samples which contained both considerable coal and clastics, the two fractions were processed separately, counted separately and plotted independently on the 2 and 3 parts of the range charts. On part 1 the results of combining the two fractions are plotted. The purpose of treating coal and clastics independently was to determine if significant variation in microfloral content existed in the two fractions, and if so, what are the ecological implications. By no means are all the identified taxa itemized on Figure 5 and 6. Only those which occurred with any frequency to be meaningful stratigraphically, or those whose stratigraphic value is that they are present at all, are listed.

All samples were processed using normal palynological techniques with two unsieved slides for frequency counting, plus a series of sieved slides for detailed examination of selected taxa.

Results

Figure 1:1 is the result of arbitrarily categorizing all palynomorphs into one of four groups, i.e. Pineaceae, Cupressaceae-Taxodiaceae, ferns and angiosperms. The major variations seem to be the high abundance of Pineaceae in the upper 300 feet, a rapid decrease in frequency over the next 100 feet, thenceforth a gradual decrease on down the hole. Likewise, the Cupressaceae-Taxodiaceae decrease slightly down the hole. The reduction in the conifers seem to be largely compensated for by an increase in the angiosperms. Figures 1:2 and 1:3 are the same data plotted separately for the coal and clastic fractions. The only significant difference appears to be the slight increase in angiosperms and ferns, with a slight decrease of Taxodiaceae-Cupressaceae in the coal fraction.

Figure 2:1 is a variation on the theme presented in Figure 1:1, with the taxa recategorized to include bisaccate, Taxodiaceae-Cupressaceae, Laevigatosporites (mostly polypodiaceous ferns), Alnus (alder) and "other". Because the first four groupings were dominent I felt it might be meaningful to eliminatethem from further frequency diagrams dealing with other, more sparsly distributed taxa, so that variations would be visible, hence potentially more useful (see figures 5 and 6). Again, the same pattern that appeared in Figure 1:1 repeats itself here. Both the bisaccate and Taxodiaceae-Cupressaceae decrease downhole. Except in the top 300 feet, Alnus is a dominent member of the microflora and tends to increase slightly downhole, apparently at the expense of bisaccate and Taxodiaceae-Cupressaceae. Figures 2:2 and2:3 are similar except that the coal shows a higher proportion of Alnus and a reduced Taxodiaceae-Cupressaceae content.

Figure 3:1 represents the number of Alnus as a percentage of the total count. This is essentially the same data as presented in Figure 2 but shown in a somewhat different format. Alnus is comparatively rare in the top 400 feet but then gradually increases with depth. Figures 3:2 and 3:3 indicate that Alnus is marginally more abundant in the coal fraction.

In addition to counting the Alnus pollen I made a continuous record of the pore frequency; whether the grain contained 3,4,5,6, or more pores. It seemed remotely possible this would have some biostratigraphic significance. The results of this exercise are plotted on Figure 4:1. All that seems indicated is that the pore number can fluctuate widely with no discernable pattern with the exception of the expected fact that most Alnus pollen contains 4 or 5 pores. Figures 4:2 and 4:3 indicate that essentially the same pattern occurs in both the coal and clastic fractions. This at least suggests the variation plotted is not an artifact simply of sampling but is a real structural difference. However, what the significance might be, if any, is not apparent. These differences do not appear consistent and probably are not biostratigraphically useful.

The frequencies of Tsuga (hemlock), Osmunda (a genus of fern) and Baculatisporites (an osmundaceous fern) are indicated on figure 5:1. These are based on a percentage of "other" as indicated on figure 2:1. It is apparent that Osmunda is uncommon in the top 400 feet, an interval which we earlier saw is dominated by the Pineaceae. Below 400 feet Osmunda is present in irregularly variable quantities. Figures 5:2 and 5:3 show that there is basically little difference in the generic frequency of coals and clastics.

Frequency of other selected genera is illustrated on Figure 6:1, with no particular pattern obvious vertically. Again, the clastic and coal fractions (figurds 6:2; 6:3) indicate only marginal differences. and these probably are not significant. One possible exception is Momipites which probably represents Engelhardtia, and this taxa is restricted to the coal. Engelhardtia is a genus within the family Juglandaceae and was a widespread tree in North America throughout the Eocene and Oligocene. It requires summer rainfall, constant high humidity, and a warm climate without much seasonality while winters tend to be dry and warm. This genus would not be out of place in a warm-temperate to sub-tropical coal swamp.

Biostratigraphic Summary

In brief, no immediate vertical subdivsion is possible on the data presented here. An increase in Pineaceae and a decrease in virtually everything else in the upper 400 feet could be the result of major climatic deterioration, or more likely, a change in the local environment which accompanied the termination of deposition in the basin. No definitive answer can be given on the data available. Generally, the taxa and their frequencies appear to be remarkably similar throughout the section. Perhaps other cores would show more useful variation, but on the basis of this single core, I would say that the depositional environment, the climate, and the resulting taxa remained remarkably constant throughout the deposition of the Hat Creek Formation.

On the basis of coal petrology, the highly woody nature of the coal and the marked dominance of Alnus pollen formation of the coal I interpret as having taken place in an alder swamp, although certainly other vegetative types were common. According to Stach, and others (1975, p. 18)"a thickness of 1 m of bituminous coal probably represents accumulation over approximately 6000 to 9000 years." However, the Hat Creek Coal is actually sub-bituminous, so we can assume an accumulation rate of 1 m per 4500 to 7500 years. Using Churchs' (1977, p. G104) figures of an aggregate thickness of 280 m we can rougly estimate the time to accumulate the coal deposits as 1,260,000 to 2,100,000 years. For the sake of argument we can add ± 400,000 years for the depostion of the clastic fraction. Roughly, then, and with a sequence of bland assumptions, this implies that the Hat Creek Coal Formation took 1,660,000 to 2,500,000 years to form. If we accept the age of the formation as Upper Eocene (see discussion below), we find that the Upper Eocene variously considered, according to whose classification we accept, to be 5.5 (Berggren, 1972) to 9.0 (Kulp ,1961) millions of years in length. In any event, the deposition of the Hat Creek Coal Formation apparently required one/half to one/fifth the time interval of the Late Eocene, depending upon what assumptions and what classifications are adopted. It is not surprising, therefore, that biostratigraphic subdivsion was not possible in this formation as the time simply was to short and the environment remained remarably stable (except inthe closing period of basin history). We are fortunate to be able to confidently identify the Upper Eocene without expecting to break it down to stages; unfortunately Tertiary palynology has not been refined to this level as yet.

Age

A palynological age is not completely clear. Glenn Rouse (in Kim, 1979) considers the Hat Creek Formation to be Upper Eocene. B.N. Church (personal communication), from radiometric data, feels that a Late Eocene age is most probable. The data presented here is certainly compatable with these interpretations, but by no means confirms it. Ilex, Tilia, Juglans and Carya certainly indicate a post Middle Paleocene age, while the Gothanipollis appears to be restricted to Eocene and ?Oligocene. Only one specimen of Pistillipollenites was encountered, a taxa common to the Upper Paleocene to Middle Eocene, although rare occurrences are known in the Upper Eocene. In British Columbia this taxa is conspicuous in the Lower and Middle Eocene, hence its near absence is probably significant in suggesting an Upper Eocene age. Diagnostic Neogene forms (such as the Compositae) are totally absent. Consequently, I agree that an Upper Eocene age is probable, although a Lower to Middle Oligocene age can not be totally ruled out on the basis of data accumulated in this study.

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Stach, E., and five others
1975: Stachs textbook of Coal Petrology, Gebrüder Borntraeger Berlin-Stuttgart, 428 p.

	FEET	METRES	FEET	METRES	COUNTED
	87 - 168	26.5 - 51.2	127	38.7	203
	168 - 246	51.2 - 75.0	207	63.1	264
	246 - 324	75.0 - 98.7	285	86.9	318
	324 - 379	98.7 - 115.5	351	106.9	327
CLASTIC	427 - 431	130.1 - 131.4	429	130.7	222
COAL	427 - 431	130.1 - 131.4	429	130.7	305
CLASTIC	482 - 492	146.9 - 150.0	487	148.4	270
COAL	482 - 492	146.9 - 150.0	487	148.4	336
CLASTIC	528 - 534	160.9 - 162.8	531	161.8	313
COAL	528 - 534	160.9 - 162.8	531	161.8	318
CLASTIC	581 - 584	177.1 - 178.0	583	177.7	285
COAL	581 - 584	177.1 - 178.0	583	177.7	342
CLASTIC	623 - 633	189.9 - 192.9	628	191.4	282
COAL	623 - 633	189.9 - 192.9	628	191.4	323
CLASTIC	671 - 681	204.5 - 207.6	676	206.0	221
COAL	671 - 681	204.5 - 207.6	676	206.0	278
	728 - 731	221.9 - 222.8	730	222.5	303
	778 - 789	237.1 - 240.5	783	238.6	454
	825 - 828	251.5 - 252.4	827	252.1	525
	880 - 882	268.2 - 268.8	881	268.5	396
	975 - 985	297.2 - 300.2	980	298.7	357
	1030 - 1035	313.9 - 315.5	1032	314.5	379
	1078 - 1081	328.6 - 329.5	1080	329.2	471
	1132 - 1139	345.0 - 347.2	1136	346.2	446
	1181 - 1184	360.0 - 360.9	1183	360.6	366
	1223 - 1229	372.8 - 374.6	1226	373.7	393
	1239 - 1260	377.6 - 384.0	1249	380.7	—
CLASTIC	1260 - 1279	384.0 - 389.8	1270	387.1	251
COAL	1260 - 1279	384.0 - 389.8	1270	387.1	347
	1279 - 1306	389.8 - 398.1	1292	393.8	108
	1306 - 1333	398.1 - 406.3	1319	402.0	122
CLASTIC	1333 - 1345	406.3 - 410.0	1339	408.1	117
COAL	1333 - 1345	406.3 - 410.0	1339	408.1	121
CLASTIC	1345 - 1349	410.0 - 411.2	1348	410.9	272
COAL	1345 - 1349	410.0 - 411.2	1348	410.9	181
CLASTIC	1349 - 1356	411.2 - 413.3	1352	412.1	272
COAL	1349 - 1356	411.2 - 413.3	1352	412.1	200
	1374 - 1376	418.8 - 419.4	1375	419.1	364
	1432 - 1435	436.5 - 437.4	1434	437.0	454
	1475 - 1478	449.6 - 450.5	1477	450.2	414
	1834 - 1844	559.0 - 562.0	1839	560.5	—
	1844 - 1869	562.0 - 569.7	1856	565.7	—
	1869 - 1891	569.7 - 576.4	1880	573.0	—
	1891 - 1902	576.4 - 579.7	1896	577.9	—
	1902 - 1918	579.7 - 584.6	1910	582.2	402
	1918 - 1939	584.6 - 591.0	1928	587.6	180
	1939 - 1946	591.0 - 593.1	1942	591.9	411
	1946 - 1964	593.1 - 598.6	1955	595.8	—
	1964 - 1985	598.6 - 605.0	1974	601.7	402

49 TOTAL SAMPLES

13,365 PALYNOMORPHS C

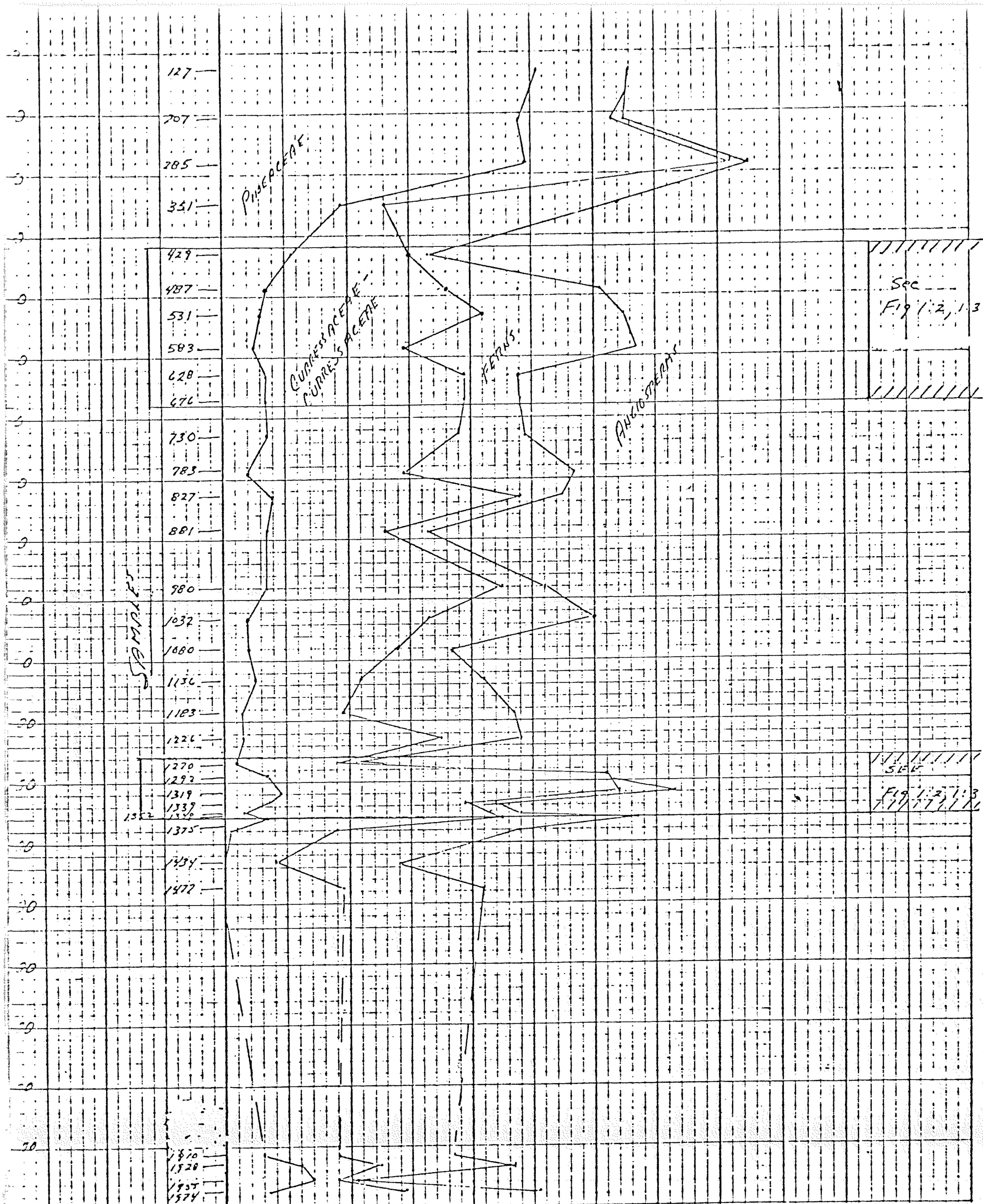


FIG. 1:1 RELATIVE PROPORTIONS: PINEACEAE; TAXODIACEAE - CUPRESSACEAE, FERNS, ANGIOSPERMS


10
20
30
40
50
60
70
80
90
100
PINACEAE
TAXODIACEAE
FERNS
ANGIOSPERMS
27-431
82-493
28-534
581-584
23-633
71-681
260-1279
333-1345
345-1349
349-1356

FIG 1:2

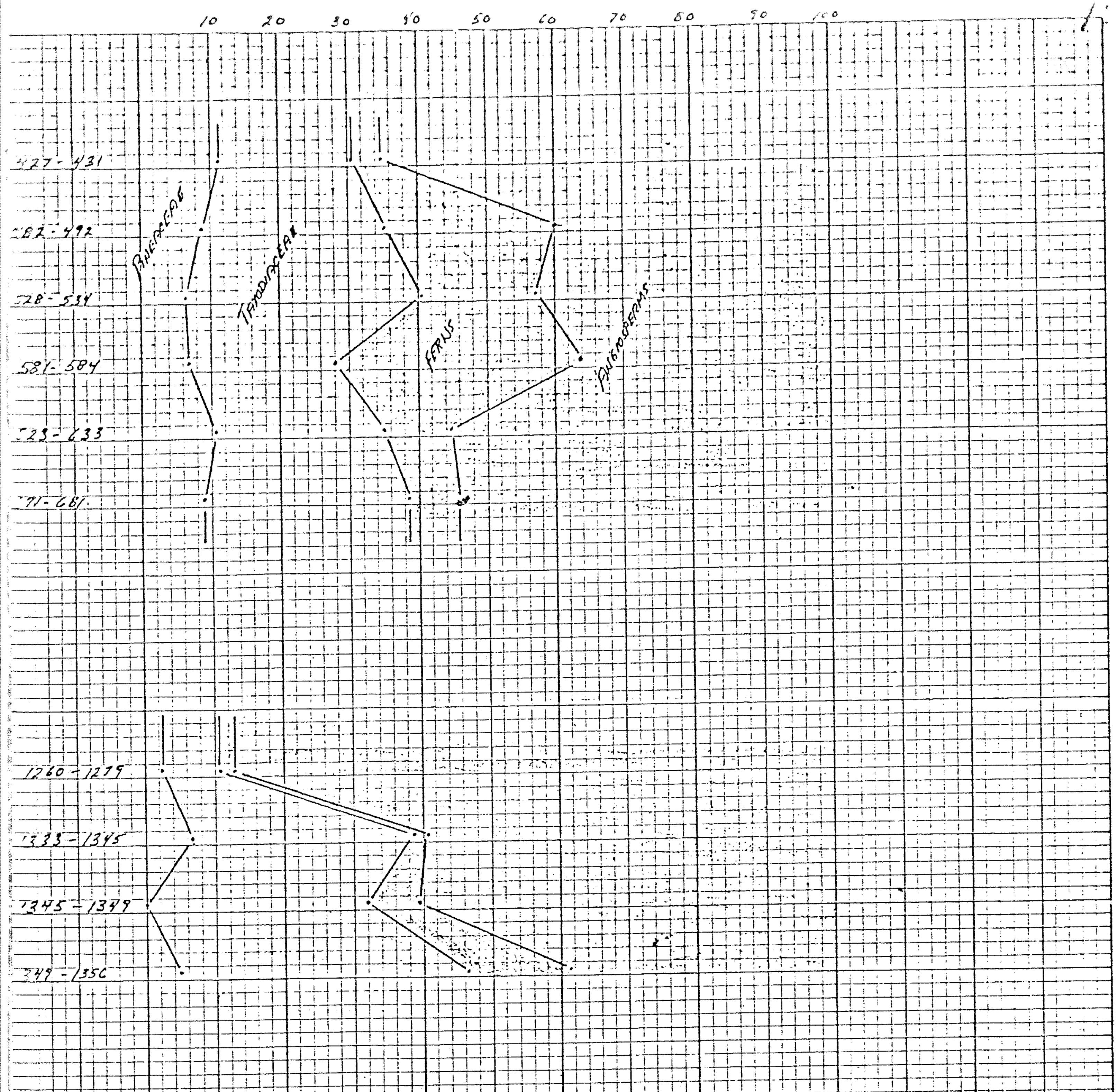

10
20
30
40
50
60
70
80
90
100
FERNS
ANGIOSPERMS
581-584
1260-1279
1333-1345
1345-1349

FIG 1:3

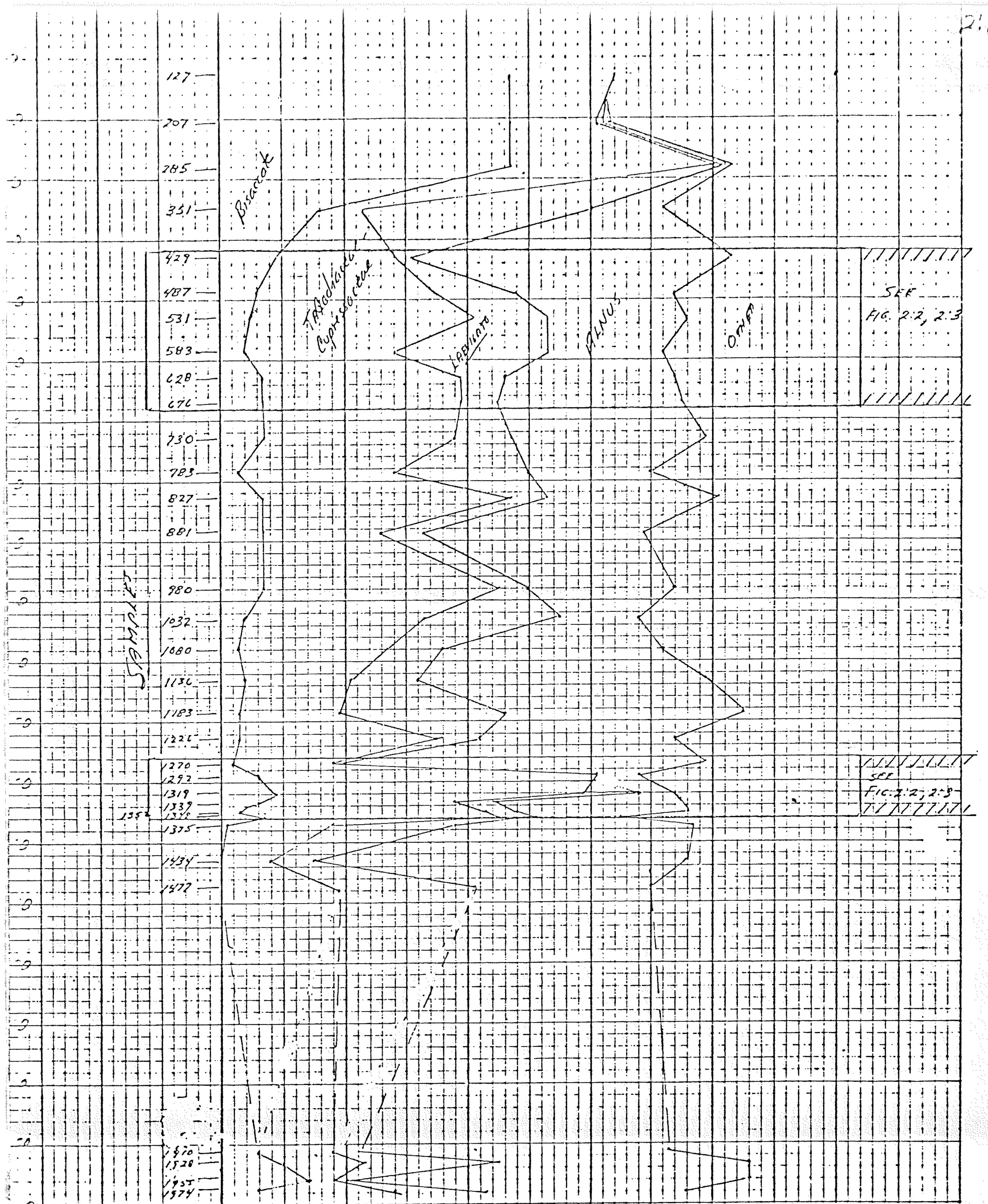


FIG. 2:1 RELATIVE PROPORTIONS: BISACCATE POLLEN, TAXODIACEAE – CUPRESSACEAE; LAEVIGATOSPORITES; ALNUS, OTHER

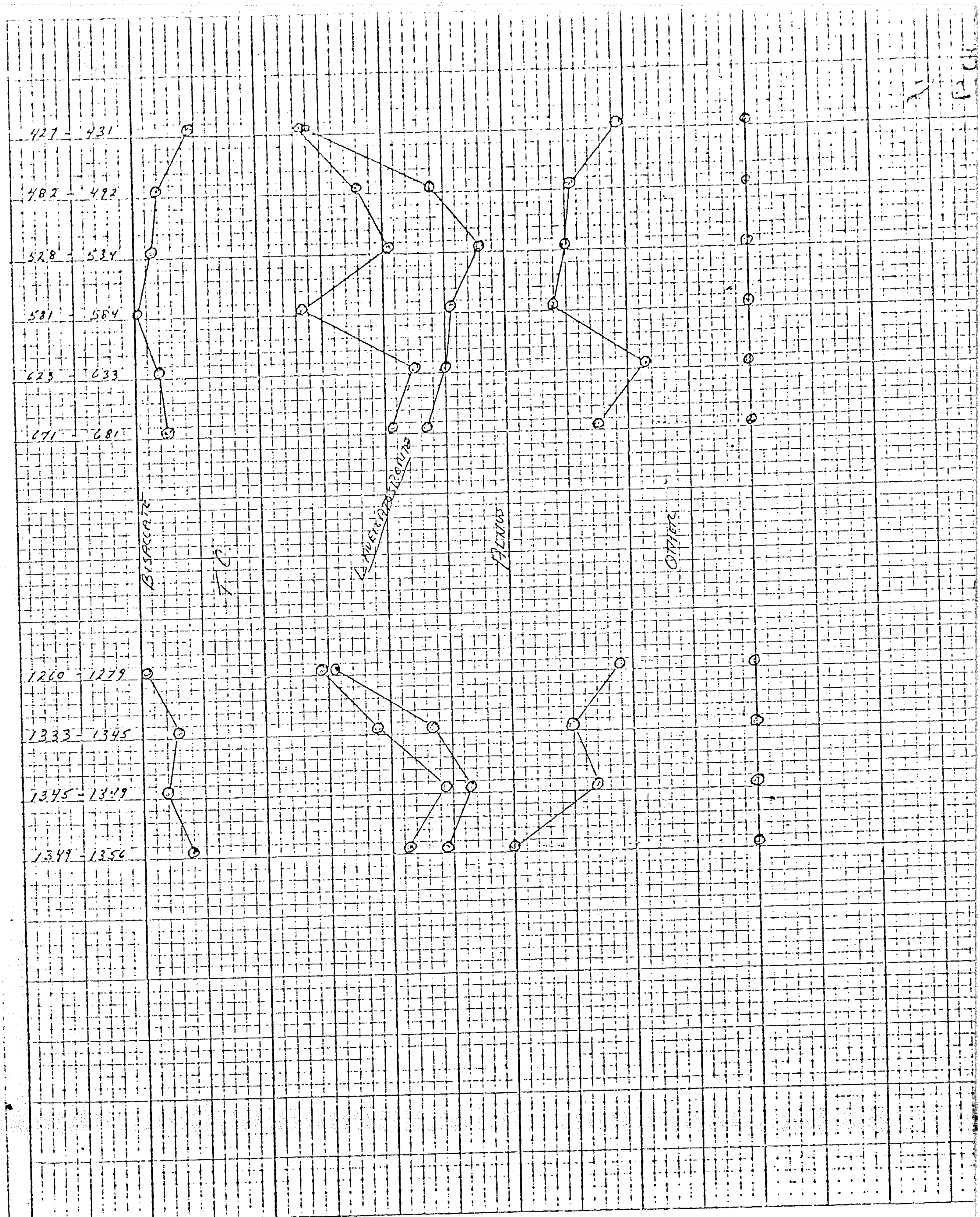
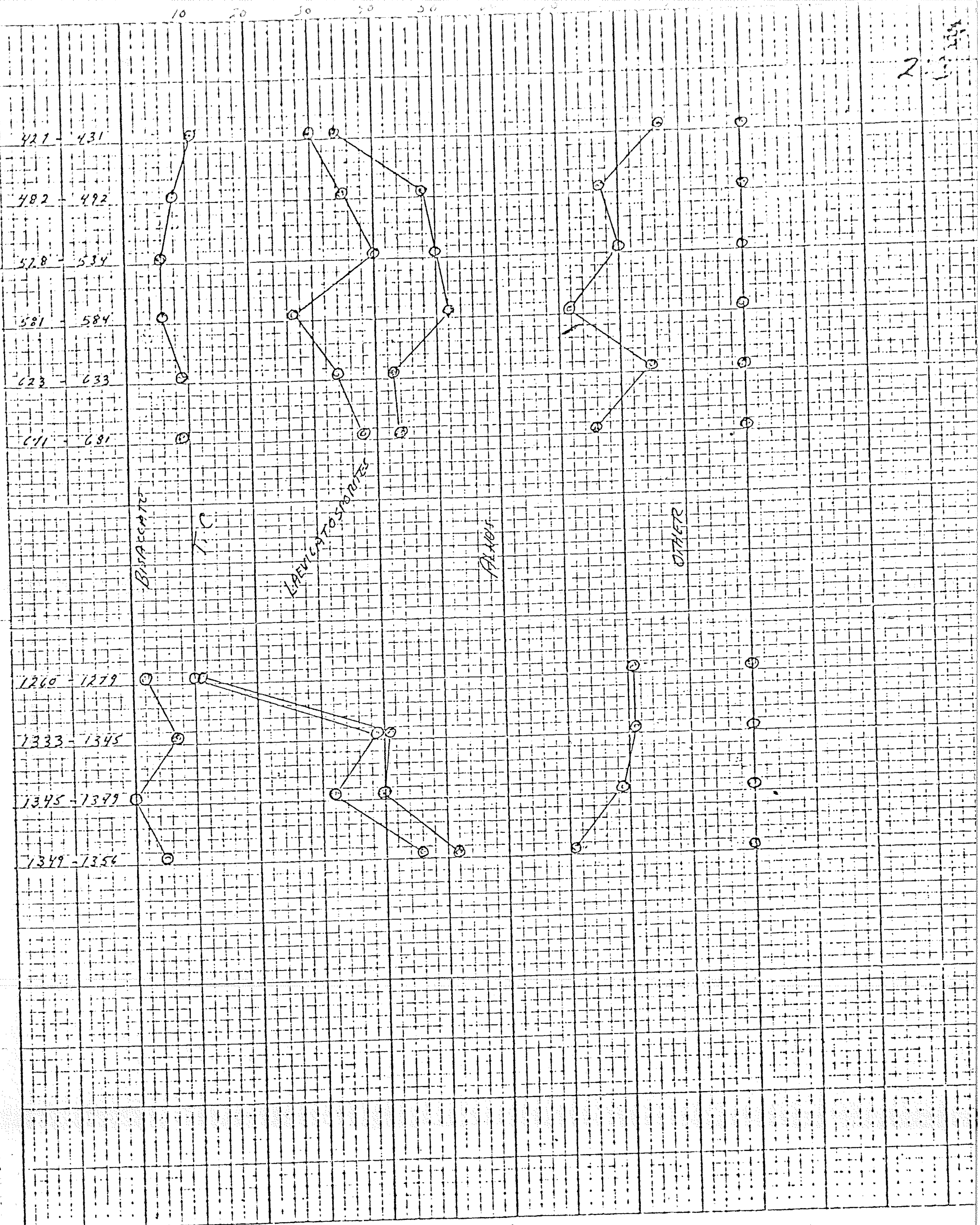

427 - 431
482 - 492
528 - 534
581 - 584
623 - 633
671 - 681
1260 - 1279
1333 - 1345
1345 - 1349
1349 - 1356
ALNUS
OTHER

FIG. 2:2



10
20
421 - 431
482 - 492
528 - 534
581 - 584
623 - 633
671 - 681
BISACCATE
T.C
LAEVIGATOSPORITES
ALNUS
OTHER
1260 - 1279
1333 - 1345
1345 - 1349
1349 - 1356

FIG 2:3

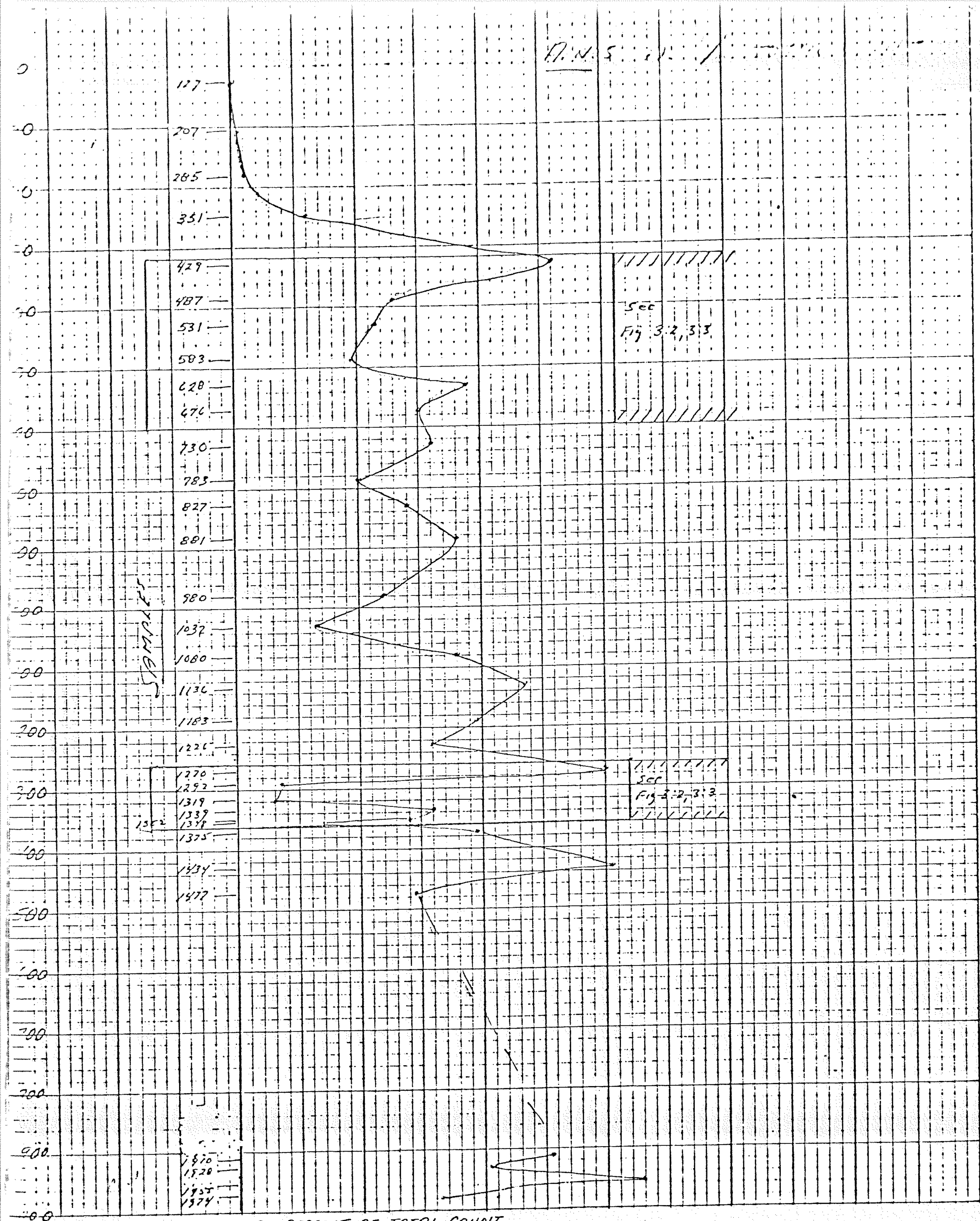
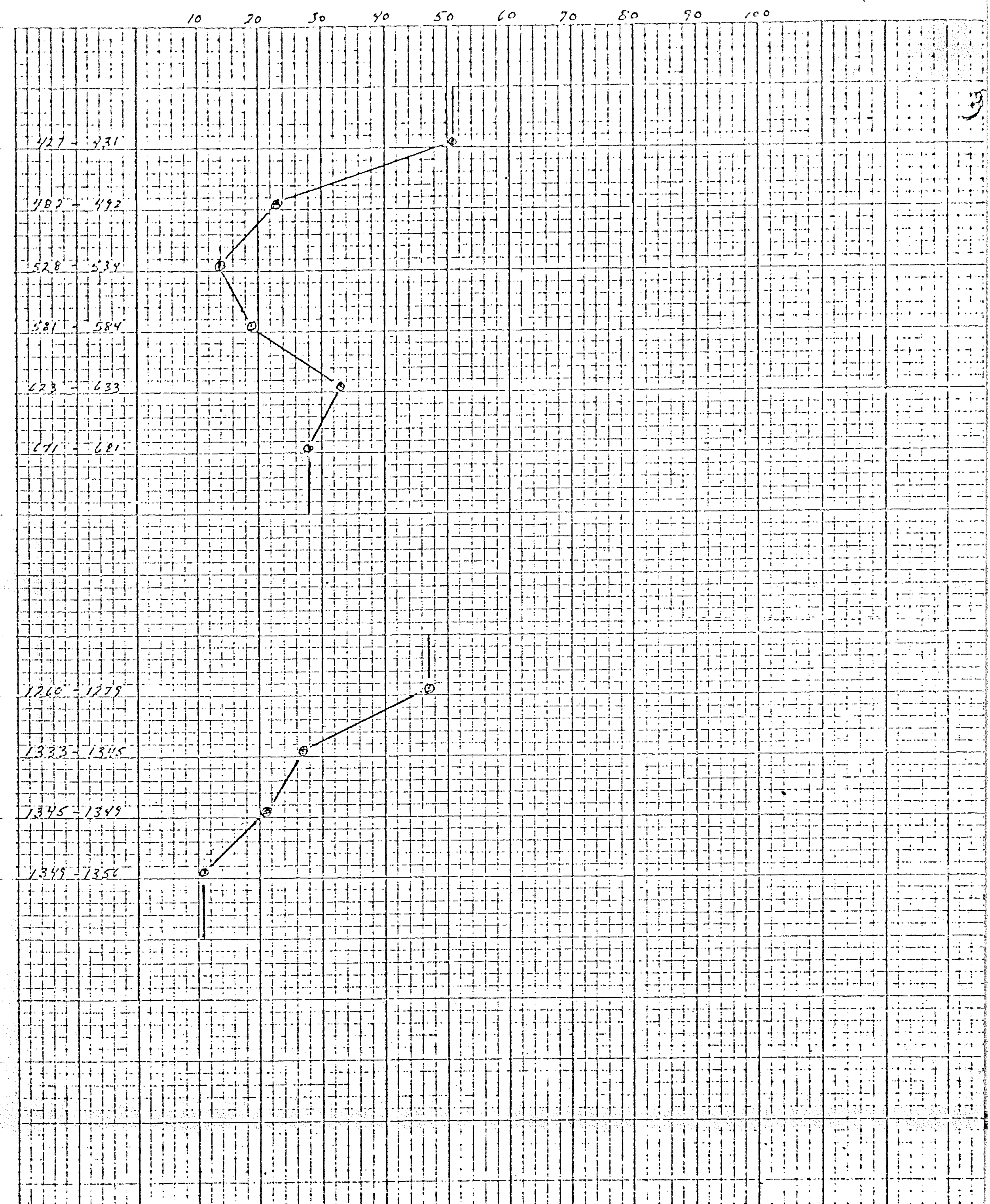
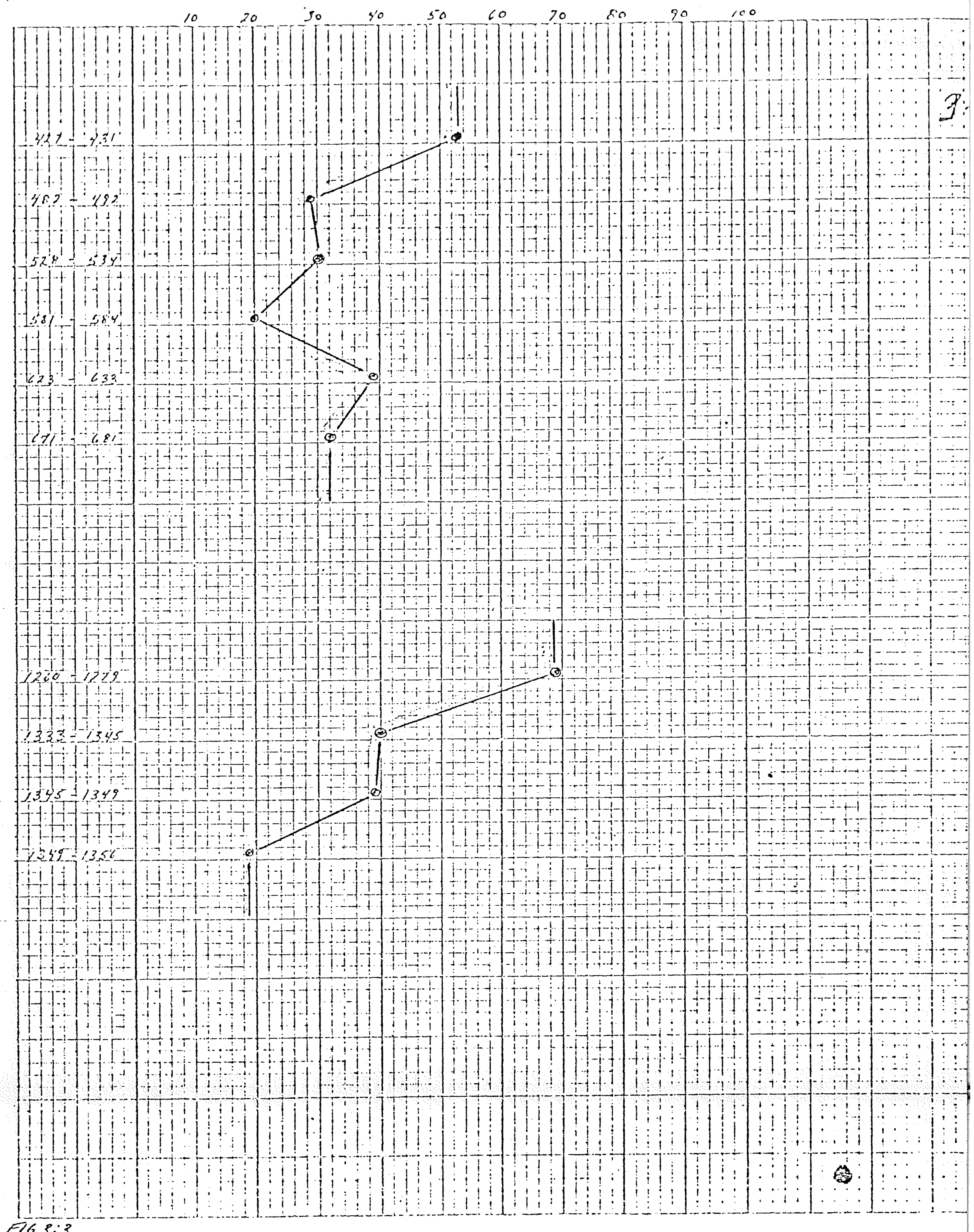


FIG 3:1 ALNUS AS PERCENT OF TOTAL COUNT



10
20
30
40
50
60
70
80
90
100
427 - 431
482 - 492
528 - 534
581 - 584
623 - 633
671 - 681
1260 - 1275
1333 - 1345
1345 - 1349
1349 - 1356

FIG 3:2


10 20 30 40 50 60 70 80 90 100
427 - 431
482 - 492
524 - 534
581 - 584
623 - 633
671 - 681
1270 - 1279
1333 - 1345
1345 - 1349
1349 - 1356
FIG 3:3

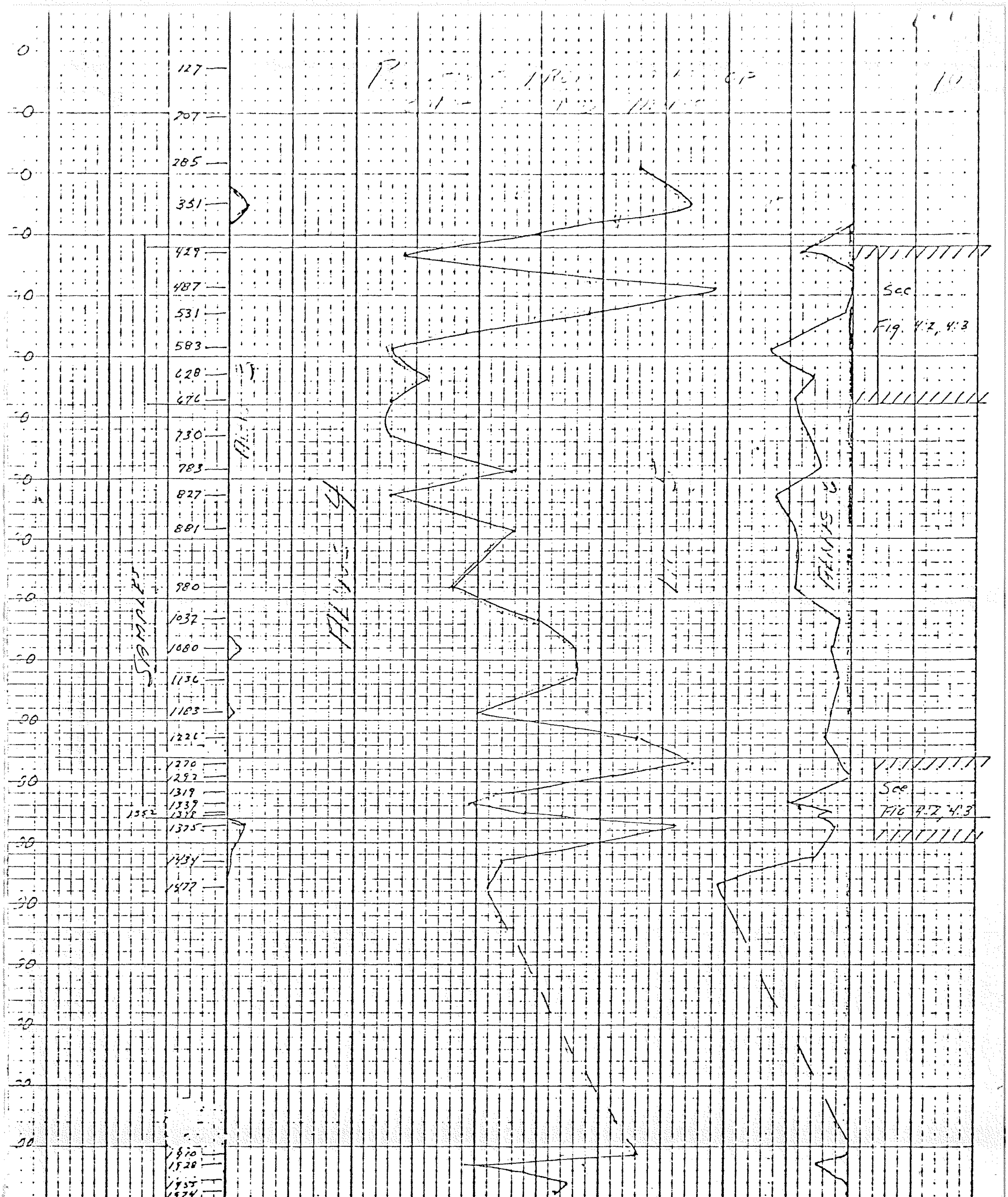


Fig 4:1 Relative Proportion of 3, 4, 5, 6 pored *Alnus* pollen as percentage of total pollen count

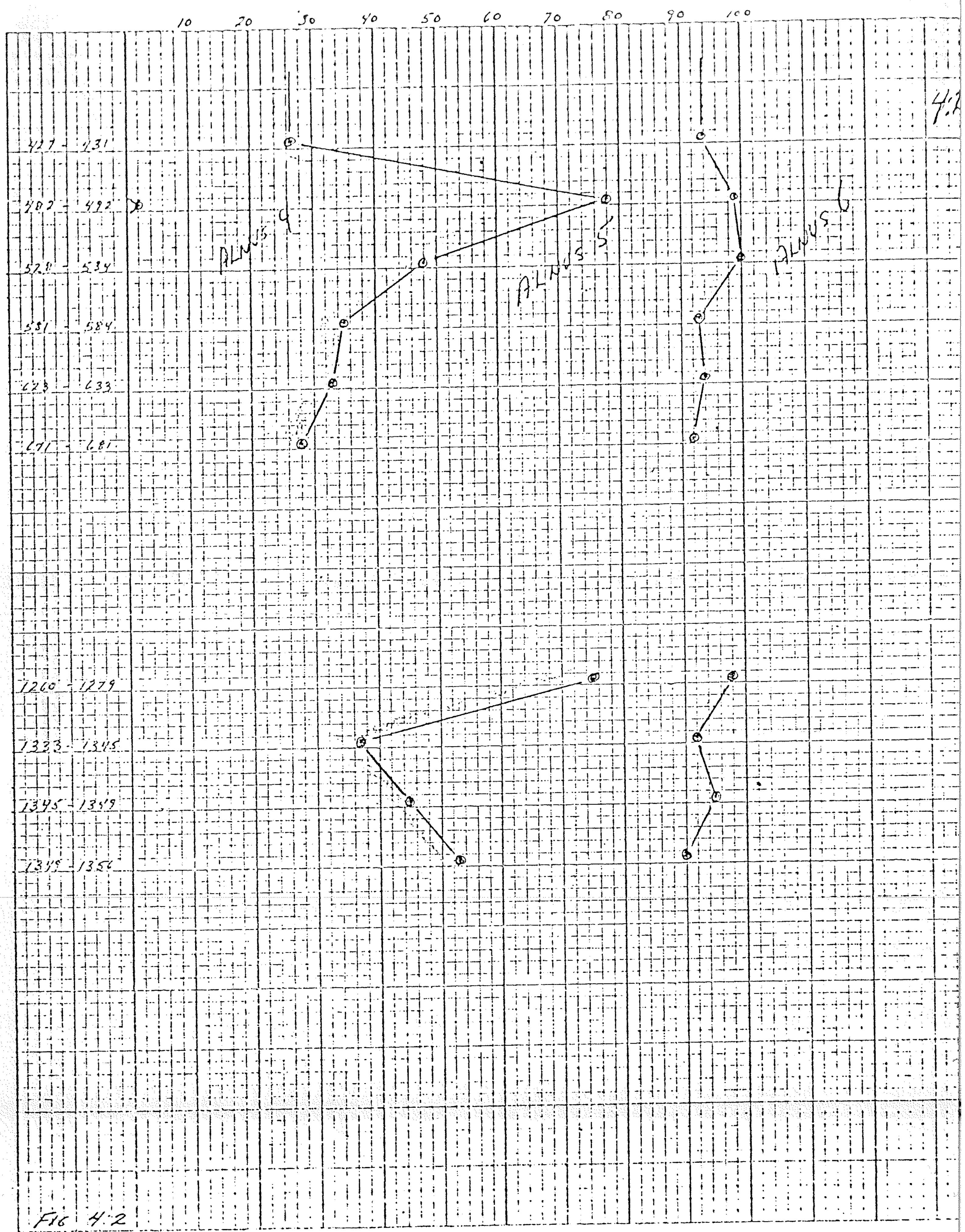

10 20 30 40 50 60 70 80 90 100
427 - 431
487 - 492
528 - 534
581 - 584
623 - 633
671 - 681
1260 - 1279
1333 - 1345
1345 - 1349
1349 - 1356
ALNUS 4
ALNUS 5
ALNUS 6

FIG 4.2

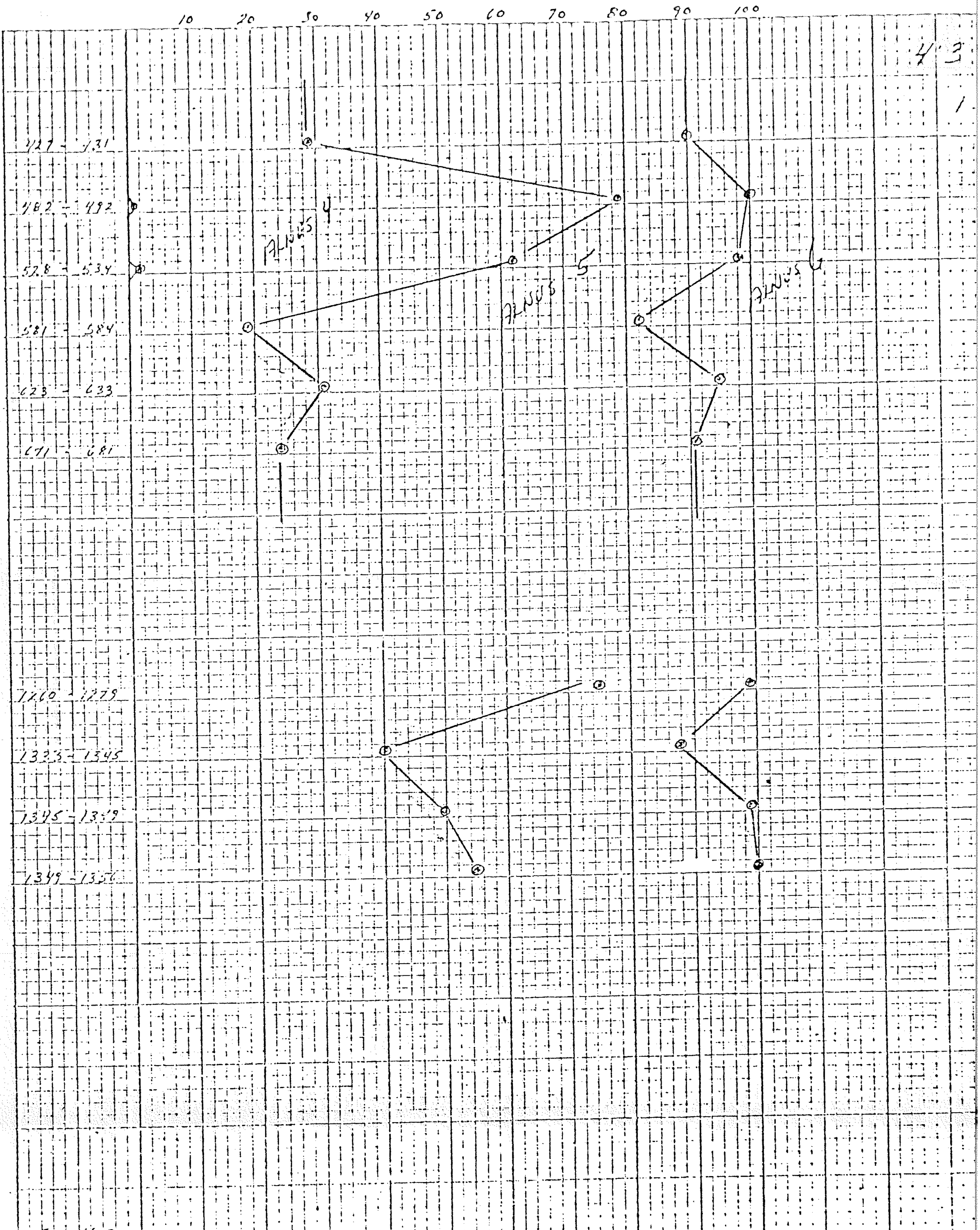

10
20
30
40
50
60
70
80
90
100
4:3
1.
427 - 431
482 - 492
528 - 534
581 - 584
623 - 633
671 - 681
1260 - 1275
1333 - 1345
1345 - 1349
1349 - 1356
ANNUS 4
ANNUS 5
ANNUS 6

FIG. 4:3

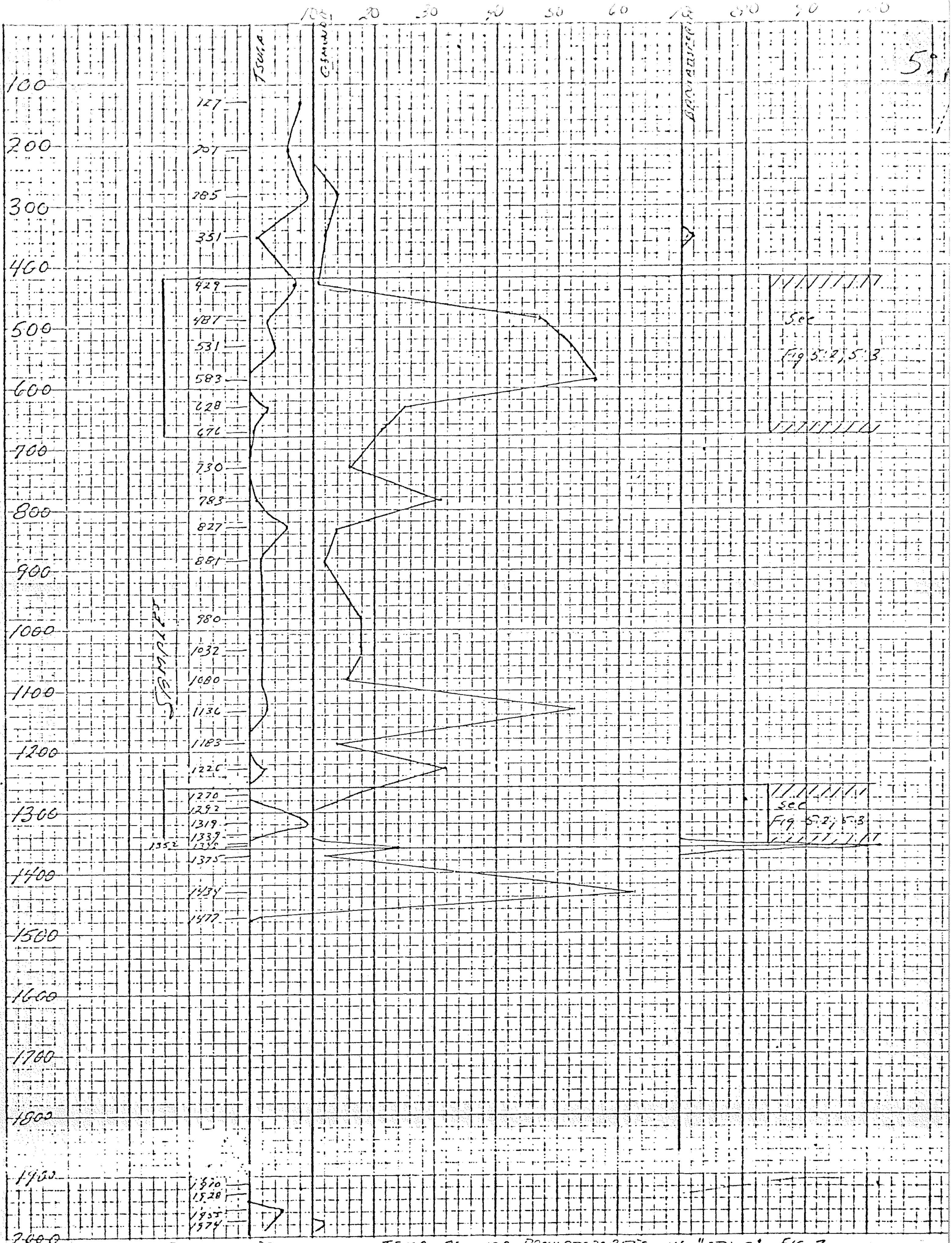


FIG 5:1 RELATIVE PROPORTION OF TSUGA, OSMUNDA, BACULATISPORITES IN "OTHER", FIG. 2

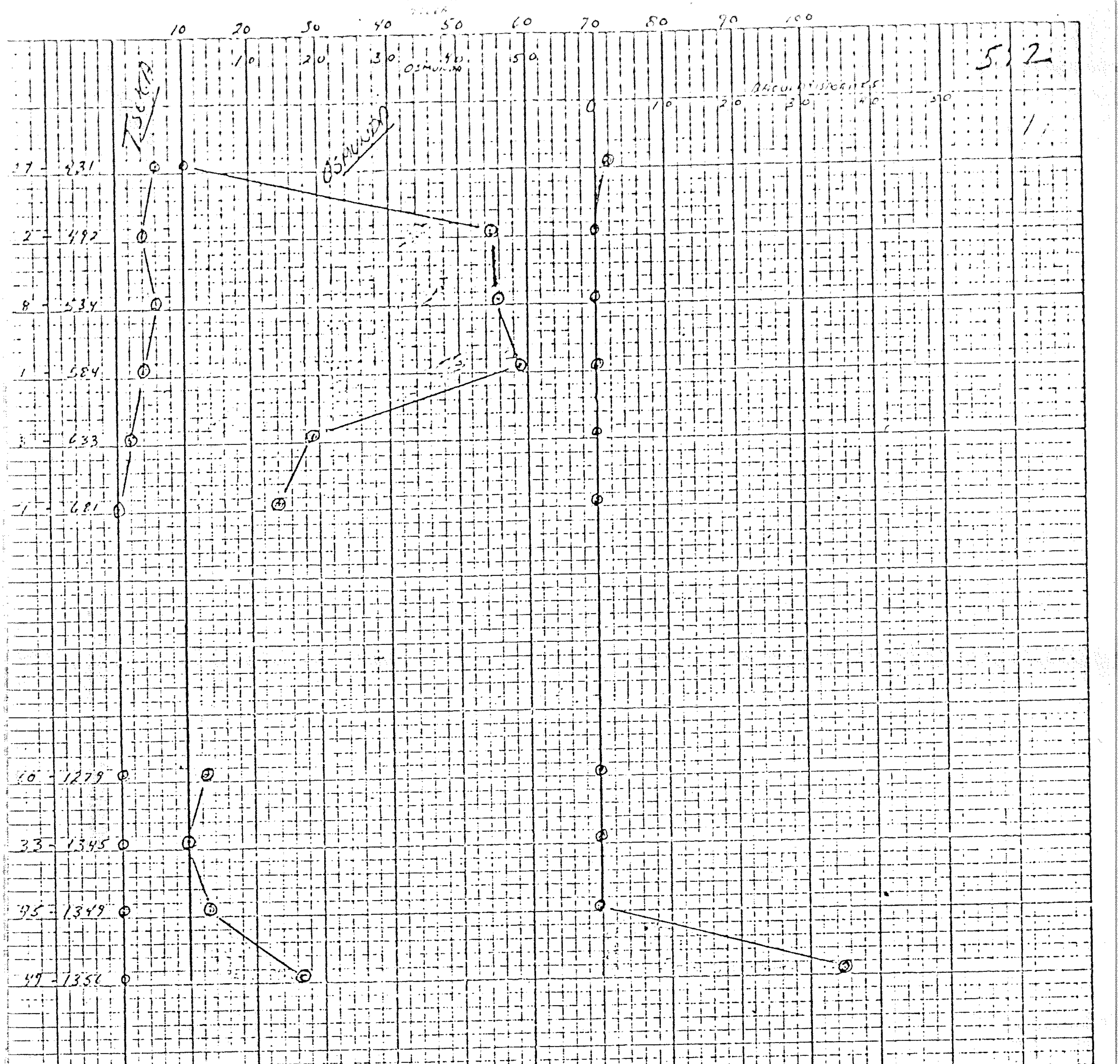
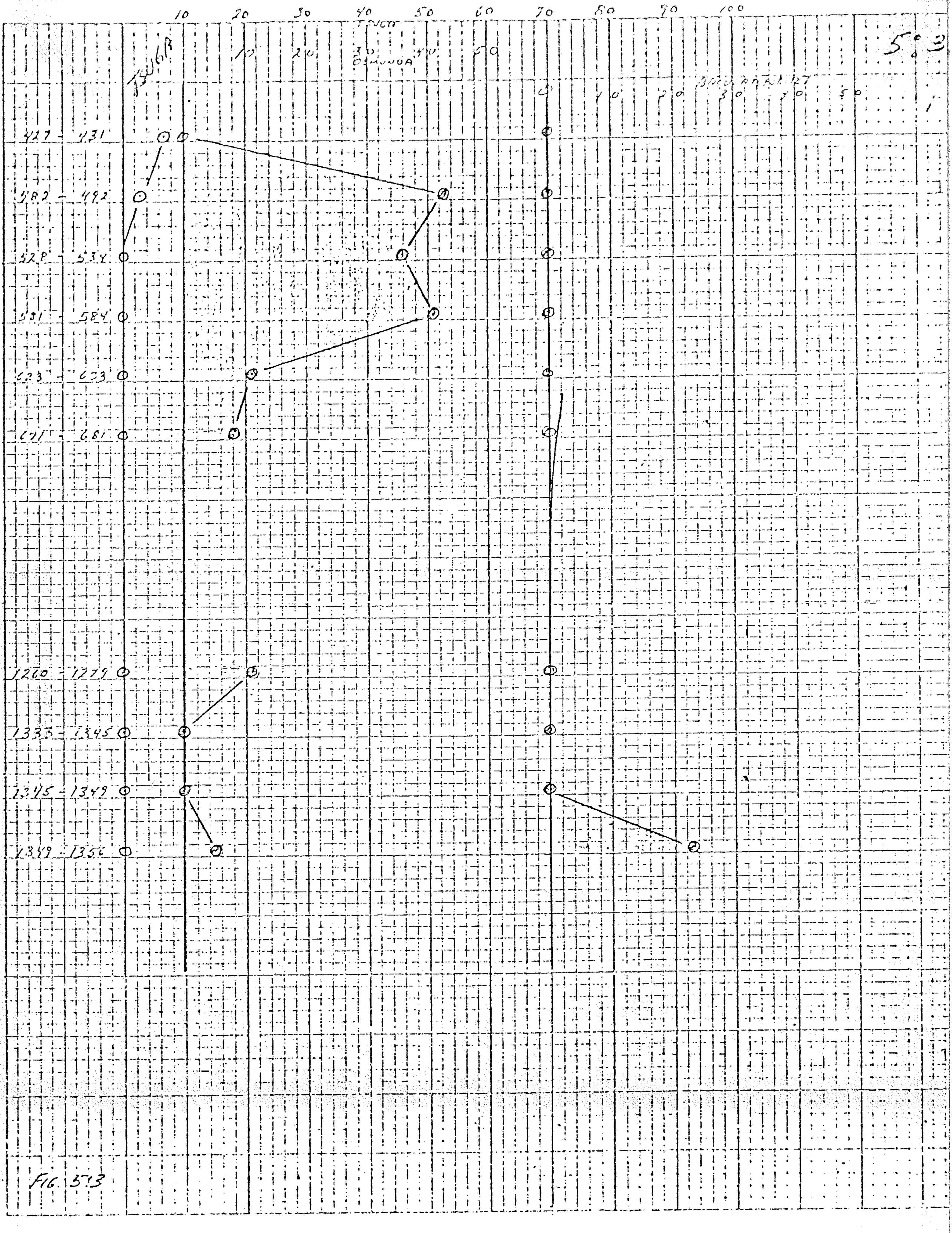

10 20 30 40 50 60 70 80 90 100
TSUGA
OSMUNDA
17 - 231
2 - 492
8 - 534
1 - 584
3 - 633
1 - 681
10 - 1279
33 - 1345
35 - 1349
49 - 1356

FIG. 5.2

5.3



TUBR
TUCH
OSMUNDA
BROADLEAF
427 - 431
482 - 492
528 - 534
581 - 584
633 - 633
671 - 681
1260 - 1279
1333 - 1345
1345 - 1349
1349 - 1356

FIG. 5.3

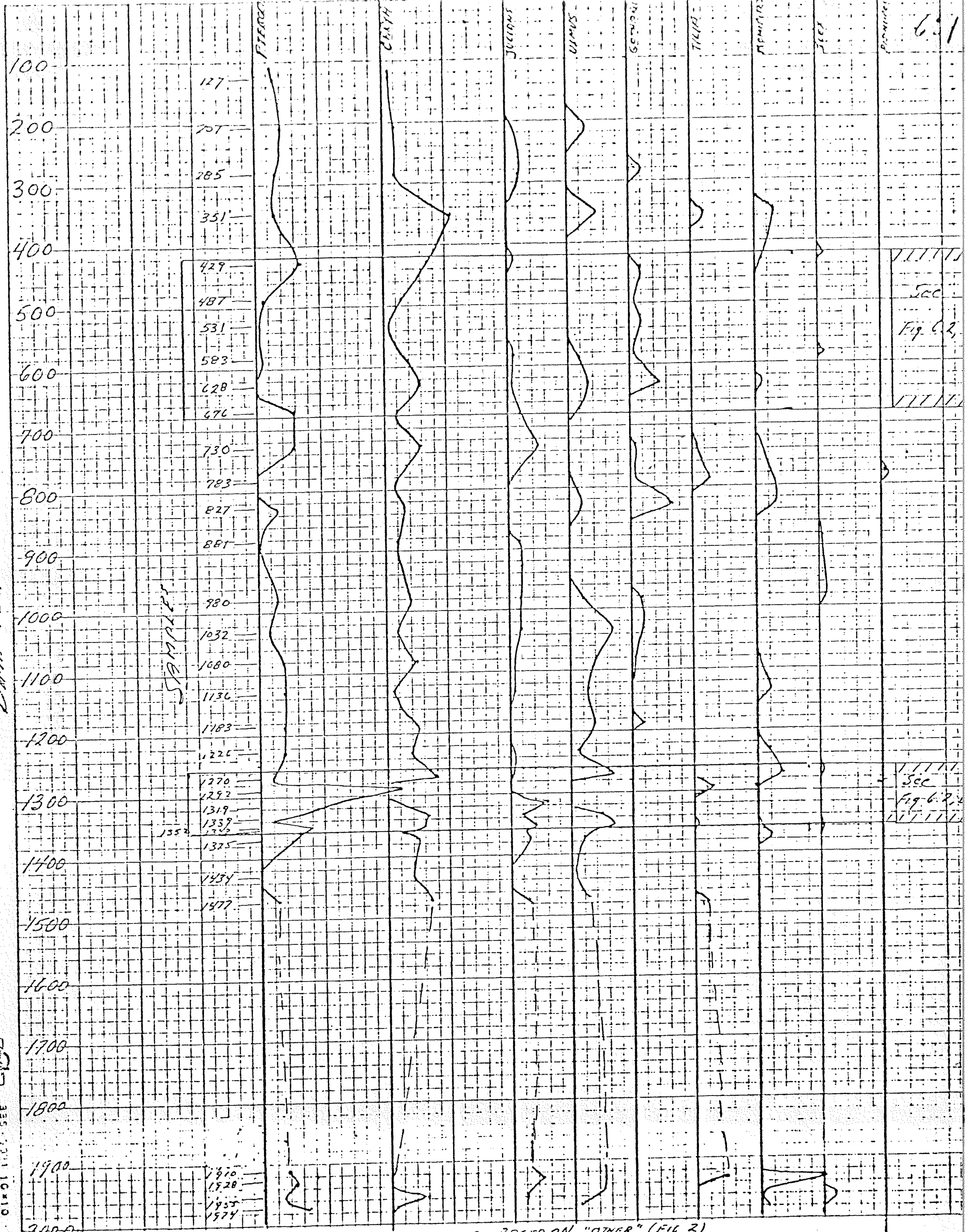
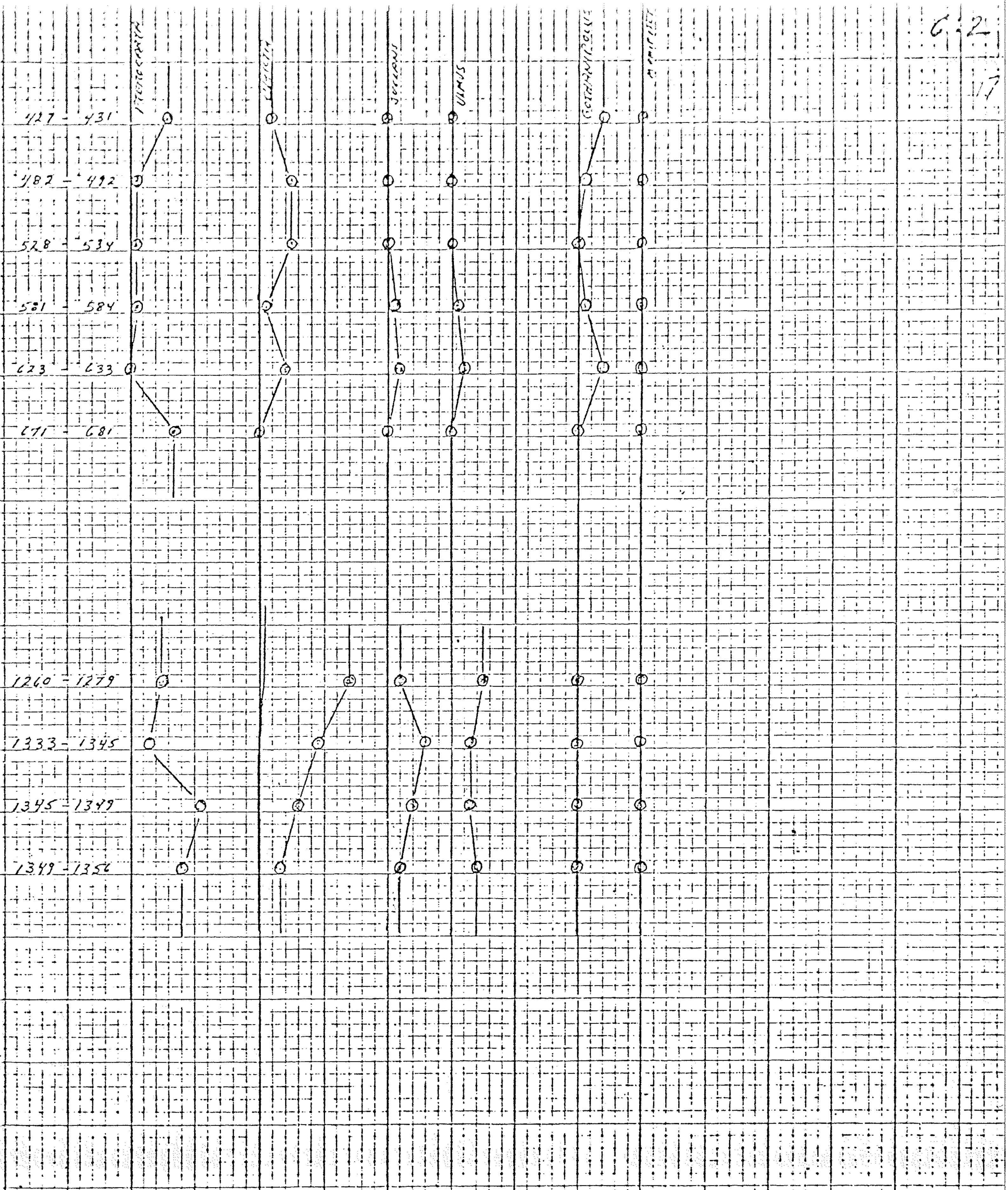


FIG 6:1 RELATIVE PROPORTION OF SELECTED GENERA, BASED ON "OTHER" (FIG 2)



JUGLANS
ULMUS
427 - 431
482 - 492
528 - 534
581 - 584
623 - 633
671 - 681
1260 - 1279
1333 - 1345
1345 - 1349
1349 - 1356

FIG 6-2

CARYA
JUGLANS
ULMUS
427 - 431
482 - 492
528 - 534
581 - 584
623 - 633
671 - 681
1260 - 1279
1333 - 1345
1345 - 1349
1349 - 1356

FIG. 6.3