БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ * BULGARIAN ACADEMY OF SCIENCES
ИЗВЕСТИЯ НА СЕКЦИЯТА ПО АСТРОНОМИЯ
BULLETIN OF THE SECTION OF ASTRONOMY
Том (Vol.) 1

INVESTIGATION ON CLUSTERS AND GROUPS OF CLUSTERS OF GALAXIES

Marin Kalinkov

In the present paper the results of the investigation on clusters and groups of clusters of galaxies, on the basis of Lick's observatory count of galaxies under direction of D. C. Shane, are presented.

The observational material by zones is given in [1—3]. As it is known, Lick's counts of galaxies are based on the plates, obtained with the help of 20″ astrograph (6°×6°). All galaxies up to the limiting photographic magnitude $18^m.2$—$18^m.4$ in squares 10′×10′ are counted. The observations are reduced applying several corrections: off-axis correction, east-west effect, atmospheric extinction, effective exposure time, emulsion factor and personal factor. The uncorrected counts of galaxies per square degree are given in Tables. The corrected counts are used for contour maps — contours of equal surface density (isolines). The contour maps are constructed by running means of four square degrees. The interval between isolines is 10 (i. e., the surface density, in galaxies per square degree, is given through 10 gal./sq. degr.). In the regions, where there is a lack of galaxies, isolines of 5 gal./sq. degr. and 15 gal./sq. degr. are drawn. The local depressions are marked too

Table 1

Zone	Limits by α	Limits by δ	References
I	0^h— 6^h	—20°—+20°	[3]
II	6 —12	—20 —+20	[3]
III	12 —18	—20 —+20	[1]
IV	18 —24	—20 —+20	[3]
V	0 — 6	+20 —+60	[2]
VI	6 —12	—20 —+60	Unpublished; according to [4] the zone is completed.
VII	12 —18	+20 —+60	[3]
VIII	18 —24	+20 —+60	The zone is counted, but not reduced [4].
IX		60°	Also

The Lick observatory count is not complete yet. Table 1 includes the limits of zones and corresponding references.

The data of Lick count have alveady been used already more than once (particularly the Tables) in the investigations of spatial and surface density distribution of galaxies to determine the absorption in the Galaxie too, for example [5—8], and discussion of Neyman [9].

In the present paper clusters and groups of clusters of galaxies only by contour maps have been studied. The catalogue of clusters, which contains at least 4 isolines by contour maps with their morphological description has been compounded. Because I have not available reprint of high quality [1], I was compelled to consider the clusters and the groups of clusters in zone III only, which are given in [10], where the contour maps are composed in detail from 4 quarters of sq. degree. Since the biggest clusters and groups are given in [10], actually in our catalogue 4 clusters of 4 isolines are not taken into account.

The catalogue of all clusters and groups of clusters discussed is given in Table 2, which contains the number, l^{I} and b^{I} of the center of the cluster, or if it is a group, then the coordinates of the center of the biggest subcluster, l^{I}; l_2^{I}, b_1^{I} and b_2^{I} are the galactic coordinates of the points from the limit isolines with the biggest and the smallest galactic longitude and latitude; as limit isolines and the central isolines are given. The last column contains the number of the remarks, which are given after Table 2. When in a group of clusters a subcluster with $\geqq 4$ isolines is observed all the data are given in the Table also. When the isolines of a subcluster are <4, are given coordinates of the subcluster, only if it is the central subcluster in the groups.

The galactic coordinates measured on the contour maps [2, 3] are given with accuracy 0°. 5, and on maps [10] — with accuracy 0°. 1.

Usually the clusters of galaxies are classified as regular and irregular (Abell [11]), or by Zwicky [12, 13] as open, medium compact, compact and very compact. The contour maps of Lick observatory allow to study the distribution of galaxies in the clusters and groups of clusters with the help of the measured areas, surrounded by the isolines.

Let us denote with S_k the area, surrounded by some isoline, where $k=40$, 50, 60... Because all clusters and groups of clusters in Table 2 are located in sufficiently high galactic latitude, then $k \geqq 40$. The areas, surrounded by the isolines formed the series

$$S_k, S_{k+10}, S_{k+20}, \ldots$$

Table 2

Nr	Center l^I	Center b^I	Limits l_1^I	Limits l_2^I	Limits b_1^I	Limits b_2^I	Isolines	Remarks
1	2	3	4	5	6	7	8	9
1	1°.1	+45°.3	0°.4	2°.1	+43°.8	+45°.9	80—130	1
2	9 .0	+87 .0	~315	~ 60	+84 .0	+89 .5	60—140	2
3			7 .5	19 .0	+36 .5	+50 .5	60—110	3
a	11 .0	+47 .5	8 .5	14 .0	+45 .5	+50 .0	70—110	4
4	13 .5	+55 .0	8 .0	17 .5	+53 .5	+57 .0	100—150	5
5			6 .0	22 .5	—42 .0	—52 .0	60—100	
a	18 .0	—45 .0					80—100	6
6	20 .0	+43 .0	25 .0	33 .5	+41 .5	+47 .0	60—110	7
7	24 .0	+34 .5	21 .0	27 .0	+32 .5	+36 .5	50— 90	8
8	27 .5	—47 .5	25 .0	41 .5	—45 .5	—51 .0	40— 70	9
9	53 .0	+35 .0	51 .0	55 .0	+33 .0	+36 .0	60—100	10
10	66 .0	+58 .5	62 .0	69 .5	+57 .5	+60 .5	50— 80	11
11	69 .5	+76 .5	58 .0	84 .0	+75 .5	+78 .0	70—100	12
12	92 .0	—37 .0	87 .0	93 .0	—36 .0	—38 .5	70—100	13
13			94 .5	102 .5	—26 .0	—31 .5	60—100	14
a	95 .5	—29 .0						15
14	95 .5	—21 .0	93 .5	98 .5	—17 .5	—24 .5	40— 70	16
15			66 .5	139 .0	—57 .0	—67 .5	70—120	17
a	97 .0	—64 .0	93 .0	103 .0	—62 .5	—66 .5	90—120	18
b	84 .0	—65 .0	81 .0	87 .0	—64 .0	—66 .0	90—120	19
c	106 .5	—61 .5	102 .5	113 .5	—58 .5	—63 .0	90—120	20
d	132 .0	—63 .5	129 .0	136 .0	—62 .0	—65 .5	80—120	21
16			94 .0	107 .5	—43 .0	—54 .0	60—120	22
a	100 .0	—45 .5	96 .5	101 .5	—43 .5	—48 .5	70—120	23
17	104 .5	—20 .0	103 .0	106 .5	—18 .5	—21 .5	50— 80	24
18			103 .0	110 .5	—23 .0	—29 .5	60—120	25
a	105 .0	—29 .0	106 .0	108 .5	—26 .0	—29 .0	80—120	26
19	115 .0	—20 .5	113 .5	116 .5	—19 .0	—23 .0	50— 80	27
20			81 .5	139 .0	—68 .5	—79 .5	70—160	28
a	118 .0	—76 .5	110 .0	128 .0	—74 .0	—78 .0	90—160	29
b	98 .0	—72 .0	95 .0	107 .5	—69 .5	—76 .5	90—120	30
21	118 .0	—12 .5	116 .0	119 .5	—11 .5	—13 .5	60— 90	31
22			125 .5	134 .0	—35 .5	—40 .5	40— 90	32
a	132 .5	—38 .0						33
23			137 .0	146 .5	—42 .5	—46 .0	50— 90	34
a	139 .0	—43 .5					70— 90	35
24			143 .5	153 .5	—65 .0	—70 .0	60— 90	36
a	148 .0	—66 .5					70— 90	37
25	163 .0	—54 .0	157 .5	169 .5	—52 .0	—57 .5	60— 90	38
26			125 .5	217 .0	+77 .5	+89 .5	60— 90	39
a	173 .5	+84 .5						40
27			171 .5	178 ,0	—34 .0	—36 .5	60—120	41
a	176 .0	—35 .5					70—120	42
28			179 .0	197 .0	+49 .5	+57 .0	60— 90	43
1	192 .5	+54 .0					70— 90	44
29			204 .5	222 .5	+37 .0	+46 .5	60—100	45
a	210 .5	+44 .0					80—100	46
b	206 .5	+42 .5					80—100	
30			197 .5	219 .0	+49 .0	+62 .0	60— 90	47
a	210 .5	+58 .5					70— 90	48
31			232 .5	239 .0	+33 .5	+44 .0	50— 80	49
1	237 .5	+41 .0					60— 80	50
32			237 .0	248 .0	+52 .5	+61 .0	70—100	51
a	242 .5	+57 .0					80—100	52

1	2	3	4	5	6	7	8	9
33	245 .5	+48°.0	240°.0	250°.5	+44°.0	+51°.0	60—100	53
34			247 .3	258 .6	+64 .7	+68 .6	100—200	54
a	252 .8	+67 .0	249 .5	254 .9	+66 .1	+67 .8	140—200	55
b	252 .7	+65 .4	252 .0	254 .4	+64 .9	+65 .9	140—180	56
35	262 .8	+68 .6	259 .9	264 .2	+67 .0	+69 .3	90—130	57
36			271 .1	278 .3	+42 .7	+50 .4	90—280	58
a, b			271 .3	277 .7	+43 .4	+48 .0	110—280	59
a	272 .7	+46 .8	271 .7	274 .1	+45 .8	+47 .7	150—280	60
b	274 .4	+49 .8	273 .5	275 .3	+43 .7	+45 .7	140—250	61
c	274 .9	+48 .8	272 .4	276 .3	+47 .8	+50 .8	110—200	62
37			328 .9	341 .7	+43 .4	+53 .7	80—300	63
a			331 .4	336 .8	+44 .1	+49 .7	140—300	64
a″	334 .9	+46 .9	334 .1	335 .2	+46 .4	+47 .2	270—300	65
b	336 .5	+50 .8	335 .2	337 .5	+49 .3	+51 .7	130—160	66
c	340 .1	+48 .2	339 .0	340 .9	+47 .8	+48 .5	150—180	67
38	337 .4	+41 .4	335 .4	338 .6	+40 .7	+41 .6	50— 80	68
39			337 .1	344 .0	+62 .2	+66 .9	100—240	69
a	340 .7	+64 .3	338 .6	343 .7	+63 .2	+66 .7	110—240	70
40	345 .2	+43 .3	341 .9	346 .7	+42 .1	+44 .9	70—110	71
41			345 .0	351 .9	+57 .4	+59 .9	100—190	72
a	346 .8	+58 .5	345 .7	348 .0	+57 .8	+59 .3	130—190	73
b	349 .9	+58 .9	348 .8	351 .3	+58 .4	+59 .4	130—180	74
42	356 .5	+75 .5	351 .5	10 .5	+73 .5	+78 .0	100—140	75
43	357 .4	+36 .4	356 .4	358 .0	+36 .1	+38 .1	90—120	76
44			354 .1	0 .7	+41 .0	+45 .7	90—260	77
a	359 .3	+43 .0	358 .0	359 .7	+42 .6	+43 .5	190—260	78
b	357 .0	+43 .0	356 .0	357 .8	+42 .2	+43 .2	190—250	79

Remarks to Table 2

1. Single cluster. The isolines 100 — 130 show a spherical symmetry. Zone III.
2. Well isolated compact cluster. Spherical symmetry (excluding isoline 60). The nearest cluster to the North galactic pole. Zone VII.
3. Defined irregular cluster. It consists of 3 clusters, which are surrounded by 1 isoline. Zone VII.
4. The greatest cluster in No. 3. It shows a certain ellipticity.
5. Without the central cluster the isolines have certain symmetry and would be approximated with cardioids. Isoline 140 is located near isoline 130; the area of the latter is very small. No. 4 together with negligible subcluster (100), which most probably is not physically connected with No. 4. The two isolines (80—90) are not taken into account.
6. Most irregular form with several separate and grouped subclusters. Zone IV.
7. Elliptical (without isoline 60) cluster. Zone VII.
8. Comparative regular cluster, as all isolines are convex. Zone VII.
9. Irregular and elongated form. Zone IV.
10. The isolines are lightly pulled out.
11. All isolines only are lightly pulled out. Zone II.
12. Almost elliptical, to a certain degree, reminds of No. 5. Isoline 60 surrounds No. 11, but in a direction extended very far, $\sim 15°$. Zone VII.
13. Isoline 70 has almost a regular form. The position of the center is symmetrical. Zone V.
14. Irregular cluster. Two isolines surrounding two small groups. Zone V.
15. The group is of three isolines only.
16. Isoline 40 is very irregular. Zone V.
17. It is very much pulled out, contains about ten subclusters of a complex structure. Isolines 70 surround two regions with lack of galaxies also. Some of the groups are not physically connected, probably. Zone I.
18. It may be considered as center of No. 15 — isoline 120 encloses the greatest area. It contains small and central groups.
19. This is a simple structure, to a certain degree the isolines are symmetrical.

20. It is in total isoline with 15a. Two isolines remind cardioids.

21. The isolines (without 80) are almost circle, but the central isoline is not in geometric center.

22. Isoline 60 has a very irregular form. Zone I.

23. The actual center of No 16. Isolines 70 and 80 are irregular.

24. The isolines are almost ellipses. Zone V.

25. Two irregular isolines surround two subclusters. Zone V.

26. The central subcluster. Isolines 90—100 are deformed cardioids.

27. The inner isolines are almost circles. Zone V.

28. Very irregular form with 5 separate subclusters. Zone I.

29. The center of No. 20. Isolines 110—160 are almost circles, but the inner isolines are not around the geometric center.

30. Isolines 90—100 are very elongated, but 110—120 less than the former ones.

31. Isolines are lightly elongated in a direction. Zone V.

32. Irregular form. Two isolines surround the central and the smaller subcluster. Zone I.

33. The central subcluster of No. 22. Only three isolines.

34. Isolines 50 and 60 have irregular form and surround two subclusters, the first of which has the isoline 70. Zone I.

35. The central subcluster of No. 23.

36. Two little subclusters in common isolines. Zone I.

37. The central subcluster of No. 24.

38. Very irregular subcluster. Zone I.

39. Irregular form. Isoline 60 surrounds six subclusters and a little region of lack.

40. The central subcluster of No. 26.

41. Elongate cluster. The isoline 60 surrounds a little (1 isoline) and a central subcluster. Zone I.

42. Regular cluster with elongated isolines.

43. Very irregular form. Three separated subclusters. Zone II.

44. The center of No. 28.

45. Irregular form with complex structure — five subclusters, Zone II.

46. The center of No. 29 because it has a bigger plateau form.

47. Irregular form with three small subclusters. Zone II.

48. The center of No. 30.

49. Irregular form with a small and a bigger subcluster. Zone II.

50. The center of No. 31.

51. Elongated form with two small and a medium subcluster. Up to certain degree is symmetric. Zone II.

52. The center of No. 32.

53. Comparatively regular single cluster. Zone II.

54. Two isolines surround three subclusters, one of which is small — two isolines. Irregular form. Definitively double cluster. Zone III.

55. The central cluster of No. 34. The inner four isolines show almost spherical symmetry.

56. Comparatively regular elliptic subcluster. Isoline 180 is not in the geometric center.

57. Single cluster, to a certain degree regular. Zone III.

58. The group of five subclusters. The isoline 100 surrounds a single and a multiple subcluster. The whole group is isolated from other clusters evidently. Zone III.

59. The isolines 110—130 surround four subclusters, two of which are small. Probably this is a physical group and *c* is projected.

60. The center of No. 36. The isoline 140 surrounds *a* and a small subcluster (3 isolines). *a* has very regular form and the isolines are almost ellipses, as isoline 280 is around the geometric center.

61. Very regular elliptic cluster evidently.

62. Single irregular and elongated subcluster.

63. Great group (11 condensations and 2 lacks). Very irregular with complex structure. Zone III.

64. The great group which includes the central subcluster. In all probability this is a physical system. The big subcluster (a') has common isolines 160—220. a' includes subcluster with isolines 220—420. The double subcluster a'' has common isolines 230—260 and is divided into a''_1 (the center) and a''_2.

65. The center of group No. 37.
Comparatively regular form, but isoline 300 is not in the geometric center.
66. Irregular subcluster.
67. Almost elliptic regular subcluster.
68. Regular single elongated cluster. Zone III.
69. Irregular group The isoline 100 surrounds 2 subclusters, one of which is small (only isoline 100). Zone III.
70. The fundamental and central part of No. 39. The irregular and very elongated isolines. 200—240 show almost spherical symmetry.
71. Single cluster with a simple symmetry and elongated isolines. Zone III.
72. Definitively double group with almost equal components. Three isolines surround the two groups. There is a little probability that these groups are not in any physical connection. Zone III.
73. The central cluster of Nr 41. The isolines show almost spherical symmetry.
74. The second cluster. Almost elliptic but the isolines are oriented in two directions.
75. Irregular single form. Zone VII.
76. The isoline 90 has an irregular form. Zone III.
77. Triple cluster. Four isolines surround a small and two almost symmetric and equal clusters in common isolines 130—180. Zone III.
78. The isolines are lightly elongated to b. Probably there is a superposition of the surface density. Regular cluster.
79. Analogous to a, but the centers of two isolines are not in the geometric center.

The central isoline will have the least area. Let us for convenience normalize to 1 the areas. If we denote with S_k* the area of the limit isolines of any cluster, then we shall have

$$(1) \qquad \frac{S_{k*}}{S_{k*}}, \ \frac{S_{k*}+10}{S_{k*}}, \ \frac{S_{k*}+20}{S_{k*}}, \ldots$$

The areas of all isolines of the clusters and groups (Table 2) were measured with the disc linear planimeter Aott, which has relative error 0.1—0.01 per cent for medium areas, depending on their magnitude. But in several cases the central isolines surround very small areas (about 1—3 point of the nonius) then in this case the error is very large and it can reach 50 per cent (if not more). Actually it is of no importance.

The measurements of all clusters and groups of clusters (with $k \geqq 4$ isolines) from Table 2 are given in Table 3, include the numbers of objects and isolines. The tabulated areas for the limit isolines is naturally 1.

Table 3

ι \ No.	1	2	3	3a	4	5	6	7	8	9	10	11	12
40									1.000				
50								1.000	0.408		1.000		
60		1.000	1.000			1.000	1.000	0.432	0.106	1.000	0.454		
70		0.732	0.502	1.000		0.557	0.455	0.270	0.008	0.618	0.119	1.000	1.000
80	1.000	0.551	0.267	0.593		0.259	0.329	0.111		0.360	0.018	0.609	0.644
90	0.496	0.435	0.104	0.360		0.059	0.212	0.019		0.089		0.256	0.223
100	0.265	0.322	0.041	0.197	1.000	0.003	0.107			0.017		0.048	0.036
110	0.136	0.225	0.001	0.004	0.754		0.037						
120	0.057	0.158			0.562								
130	0.004	0.100			0.399								
140		0.047			0.248								
150					0.002								

Table 3 — continued

l \ No.	13	14	15	15a	15b	15c	15d	16	17	18	19	20	20a
40		1.000											
50		0,256							1.000		1.000		
60	1.000	0.100						1.000	0.640	1.000	0.493		
70	0.617	0.022	1.000					0.484	0.382	0.687	0.302	1.000	
80	0.180		0.578				1.000	0.286	0.199	0.361	0.076	0.633	
90	0.059		0.302	1.000	1.000	1.000	0.644	0.180		0.241		0.334	1.000
100	0.016		0.156	0.652	0.371	0.519	0.422	0.105		0.131		0.172	0.646
110			0.086	0.436	0.186	0.318	0.241	0.050		0.051		0.091	0.379
120			0.034	0.222	0.050	0.126	0.026	0.008		0.005		0.054	0.268
130												0.030	0.193
140												0.014	0.087
150												0.005	0.034
160												0.001	0.009

Table 3 — continued

l \ No.	20b	21	22	23	24	25	26	27	28	29	30	31	32
50			1.000	1.000								1.000	
60		1.000	0.658	0.589	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.238	
70		0.686	0.306	0.240	0.302	0.440	0.456	0.564	0.341	0.590	0.336	0.093	1.000
80		0.478	0.082	0.094	0.080	0.111	0.060	0.374	0.103	0.288	0.085	0.017	0.373
90	1.000	0.214	0.051	0.020	0.028	0.032	0.016	0.239	0.023	0.092	0.022		0.155
100	0.408							0.132		0.015			0.016
110	0.242							0.039					
120	0.088							0.005					

Table 3 — continued

l \ No.	33	34	34a	34b	35	36	36(a,b)	36a	36b	36c	37	37a	37a″
60	1.000												
70	0.725												
80	0.461										1.000		
90	0.292				1.000	1.000					0.842		
100	0.117	1.000			0.588	0.795					0.662		
110		0.789			0.327	0.668	1.000			1.000	0.550		
120		0.597			0.057	0.560	0.852			0.801	0.473		
130		0.438			0.009	0.462	0.716			0.617	0.362		
140		0.324	1.000	1.000		0.342	0.519		1.000	0.492	0.284	1.000	
150		0.228	0.734	0.620		0.253	0.401	1.000	0.852	0.309	0.206	0.818	
160		0.159	0.536	0.359		0.191	0.295	0.904	0.684	0.259	0.160	0.700	
170		0.094	0.327	0.185		0.162	0.255	0.815	0.582	0.204	0.131	0.595	
180		0.047	0.194	0.010		0.139	0.222	0.710	0.508	0.165	0.113	0.525	
190		0.022	0.091			0.112	0.189	0.587	0.448	0.103	0.098	0.463	
200		0.005	0.019			0.082	0.159	0.482	0.390	0.006	0.088	0.418	
210						0.067	0.131	0.386	0.333		0.075	0.355	
220						0.055	0.109	0.327	0.269		0.063	0.297	
230						0.045	0.089	0.307	0.182		0.050	0.238	
240						0.032	0.062	0.221	0.118		0.039	0.183	
250						0.022	0.042	0.165	0.067		0.024	0.146	
260						0.011	0.022	0.119			0.023	0.107	
270						0.006	0.012	0.066			0.013	0.064	1.000
280						0.002	0.003	0.016			0.007	0.034	0.594
290											0.002	0.011	0.203
300											0.001	0.001	0.014

l \ No.	37b	37c	38	39	40	41	41a	41b	42	43	44	44a	44b
50			1.000										
60			0.478										
70			0.153		1.000								
80			0.016		0.519								
90					0.256					1.000	1.000		
100				1.000	0.111	1.000			1.000	0.599	0.822		
110				0.734	0.004	0.785			0.610	0.346	0.698		
120				0.573		0.609			0.324	0.010	0.598		
130	1.000			0.444		0.447	1.000	1.000	0.030		0.502		
140	0.568			0.356		0.349	0.768	0.800	0.002		0.418		
150	0.132	1.000		0.285		0.252	0.584	0.536			0.362		
160	0.004	0.576		0.210		0.171	0.427	0.329			0.313		
170		0.260		0.156		0.092	0.270	0.121			0.270		
180		0.106		0.127		0.039	0.140	0.021			0.228		
190				0.091		0.010	0.038				0.188	1.000	1.000
200				0.066							0.159	0.868	0.828
210				0.039							0.126	0.669	0.669
220				0.021							0.087	0.430	0.490
230				0.008							0.066	0.339	0.359
240				0.001							0.038	0.256	0.159
250											0.021	0.181	0.055
260											0.004	0.041	

Certain conclusions about the structure of clusters may be drawn from Table 3. But the values, in which the surface density participates, undoubtedly are more representative.

The normalized area which is included between two neighbouring isolines k^*+l and k^*+l+5 is

(1) $$\frac{S_{k^*}+l}{S_{k^*}}-\frac{S_{k^*}+l+10}{S_{k^*}}.$$

Let us multiply (2) by any mean isolines assuming for this k^*+l+5 Then we have

$$N=\frac{a}{S_{k^*}}(S_{k^*}+l-S_{k^*+l+10})(k^*+l+5),$$

where a is a constant, which depends on the distance to the cluster (in this constant we included the scale of the contour map, also together with the planimeter's constant). Evidently N is the mean number of galaxies in the area, inferred between the neighbour isolines k^*+l and k^*+l+5. Since a may be determined for several clusters only, histograms plotted for N give certain information nevertheless (because a multiplies the ordinates and the form is not changed). Anyhow, (3) gives N only to the limit photographic magnitude. It is clear, the number of the galaxies depends on the distances by means of the luminosity function of galaxies (and for the groups — of the luminosity function of clusters). That is why one must accept by necessity for all clusters $a=1$.

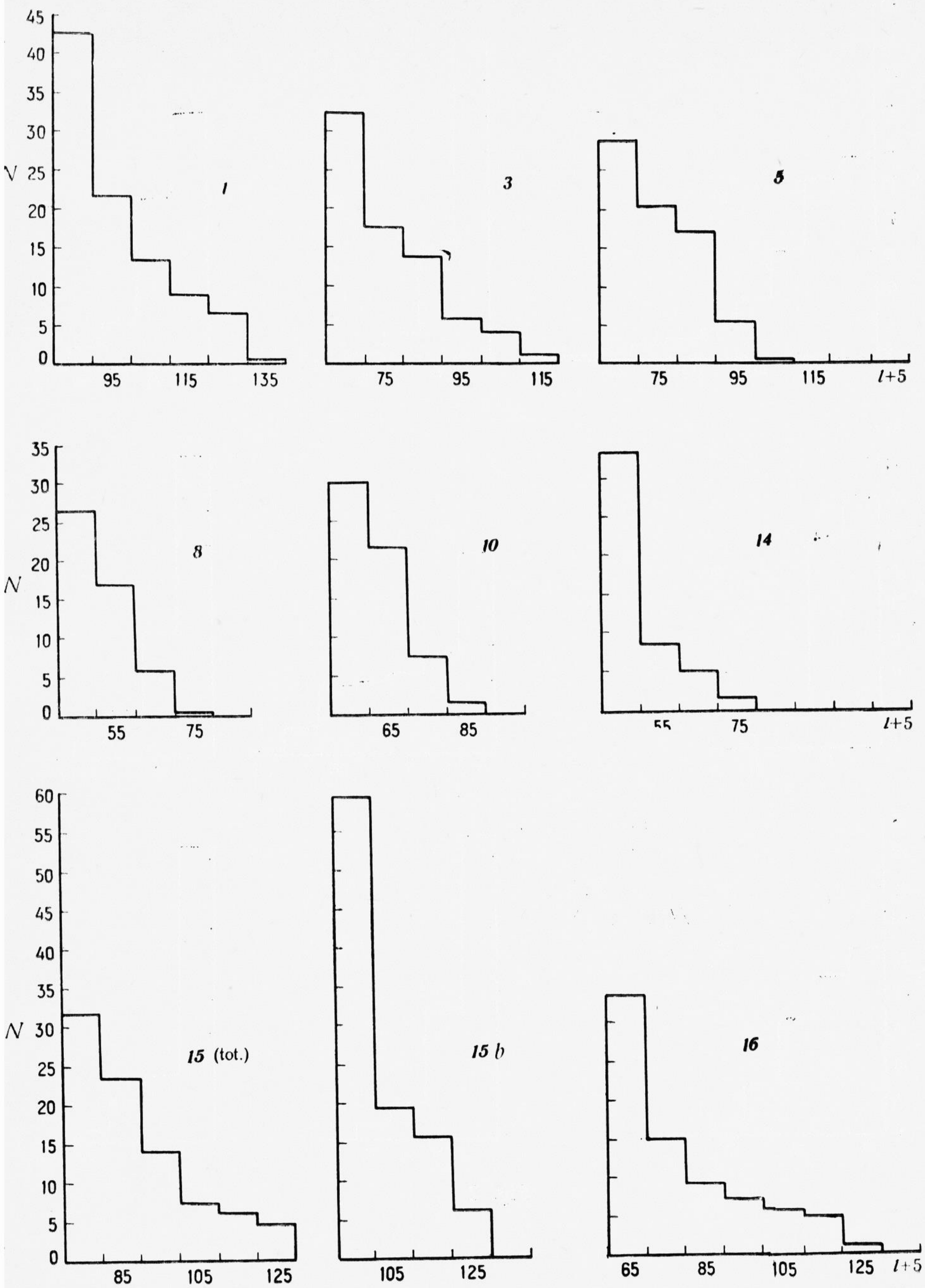

N
1
3
5
8
10
14
15 (tot.)
15 b
16
l+5
45
40
35
30
25
20
15
10
5
0
95
115
135
75
95
115
75
95
115
55
75
65
85
60
55
50
85
105
125
65

Fig. 1

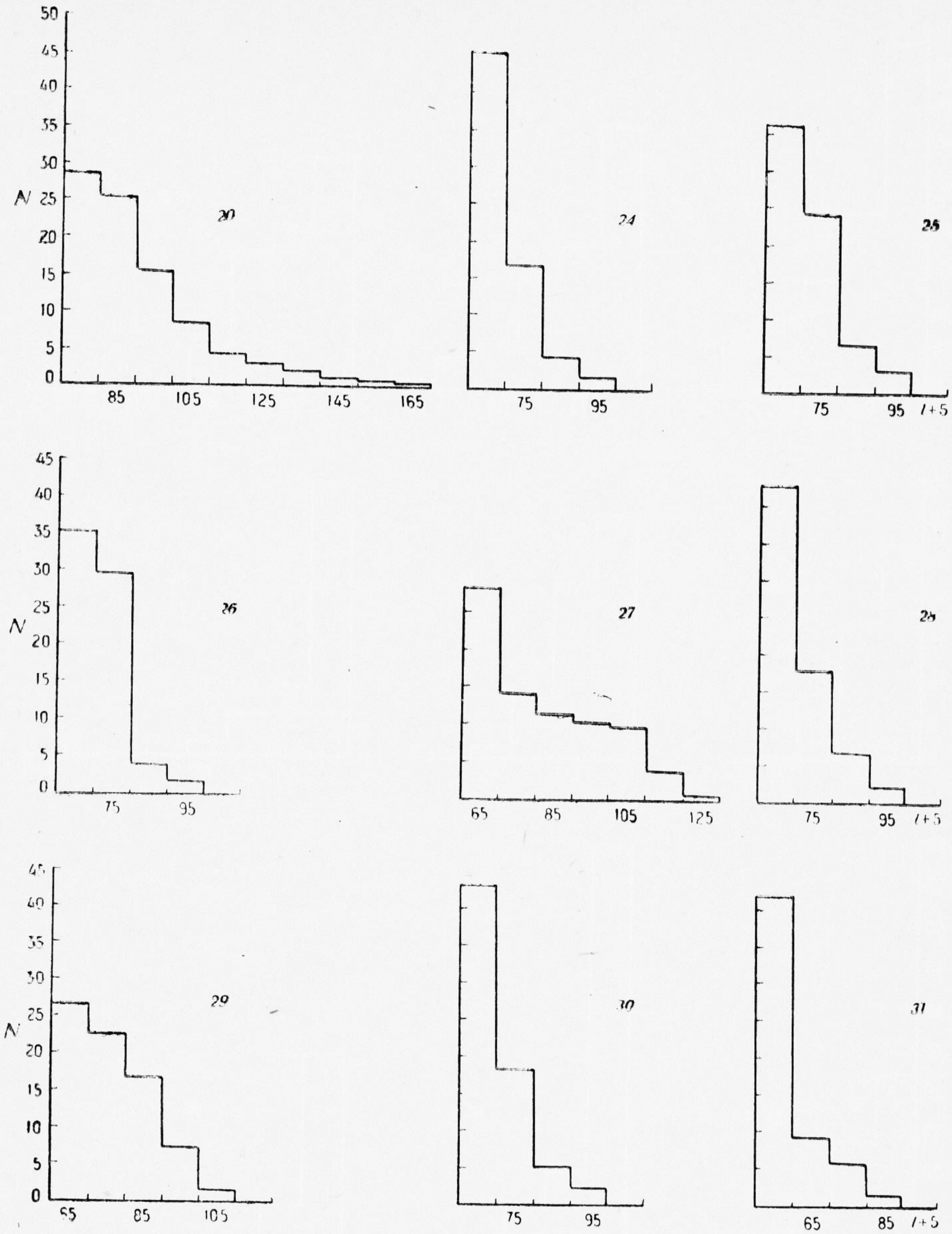

N
0
5
10
15
20
25
30
35
40
45
50
20
24
25
26
27
28
29
30
31
65
75
85
95
105
125
145
165
I+5

Fig. 2

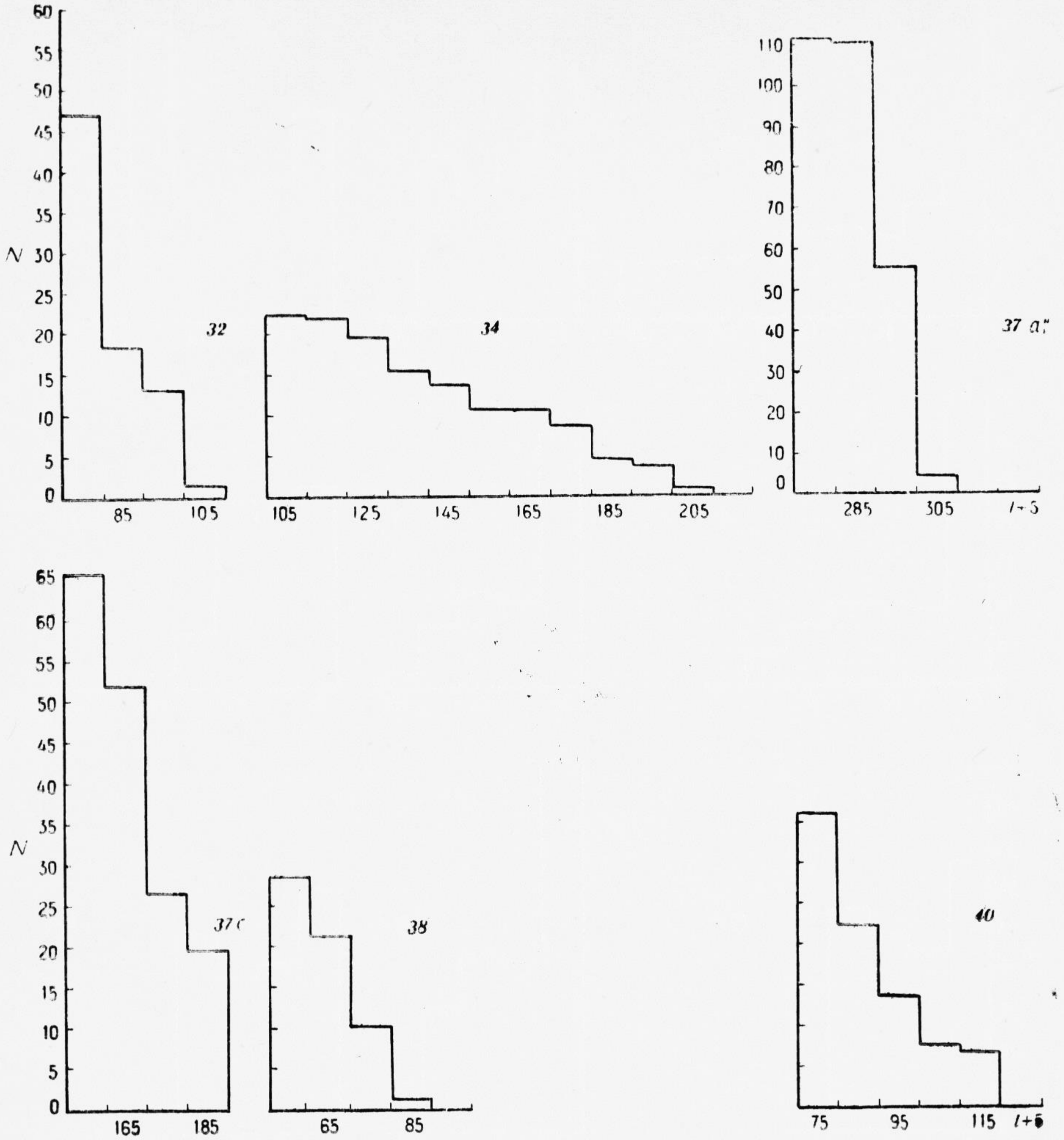

N
32
34
37 a
37 c
38
40
85
105
125
145
165
185
205
285
305
65
75
95
115

Fig. 3

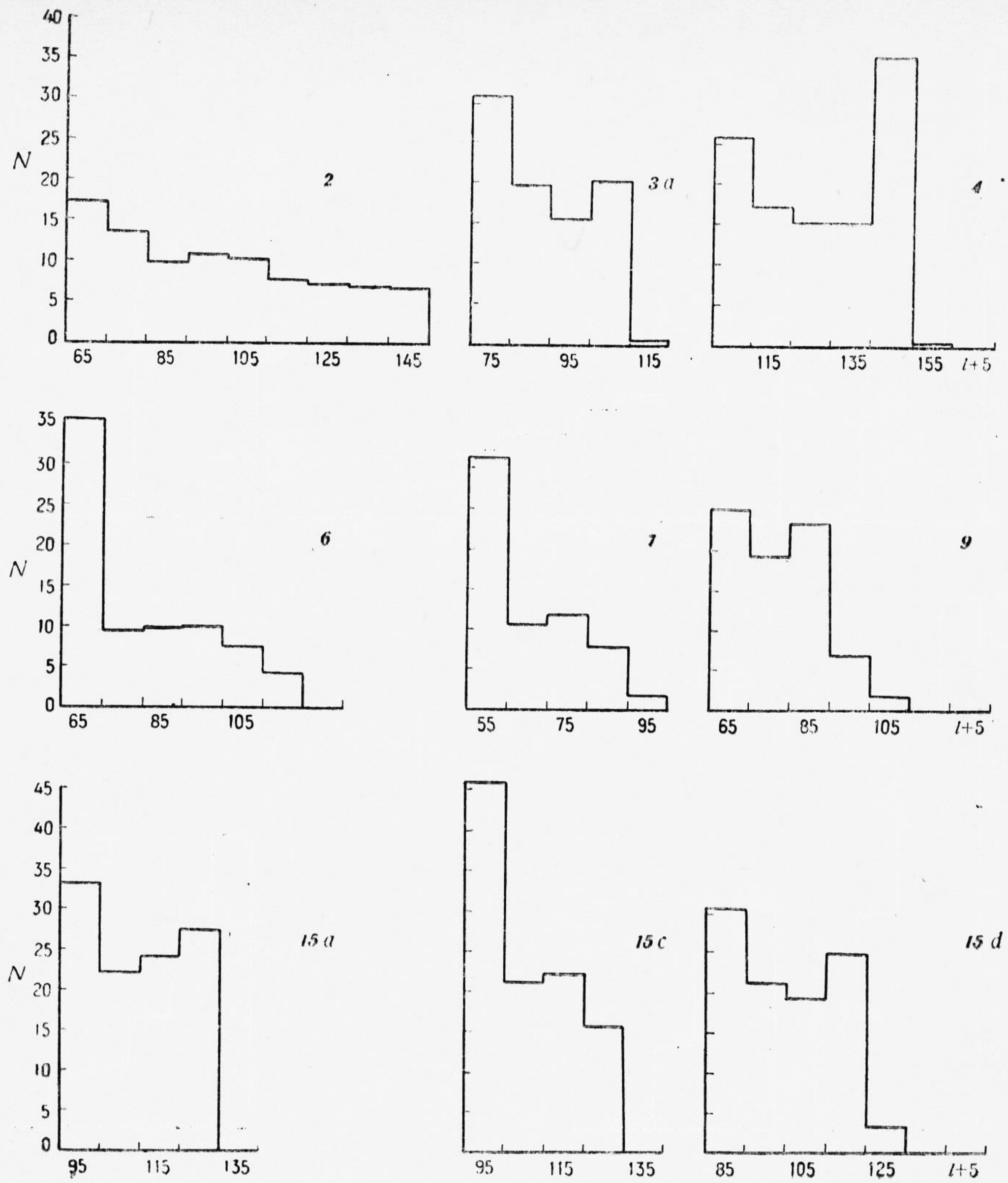


Fig. 4

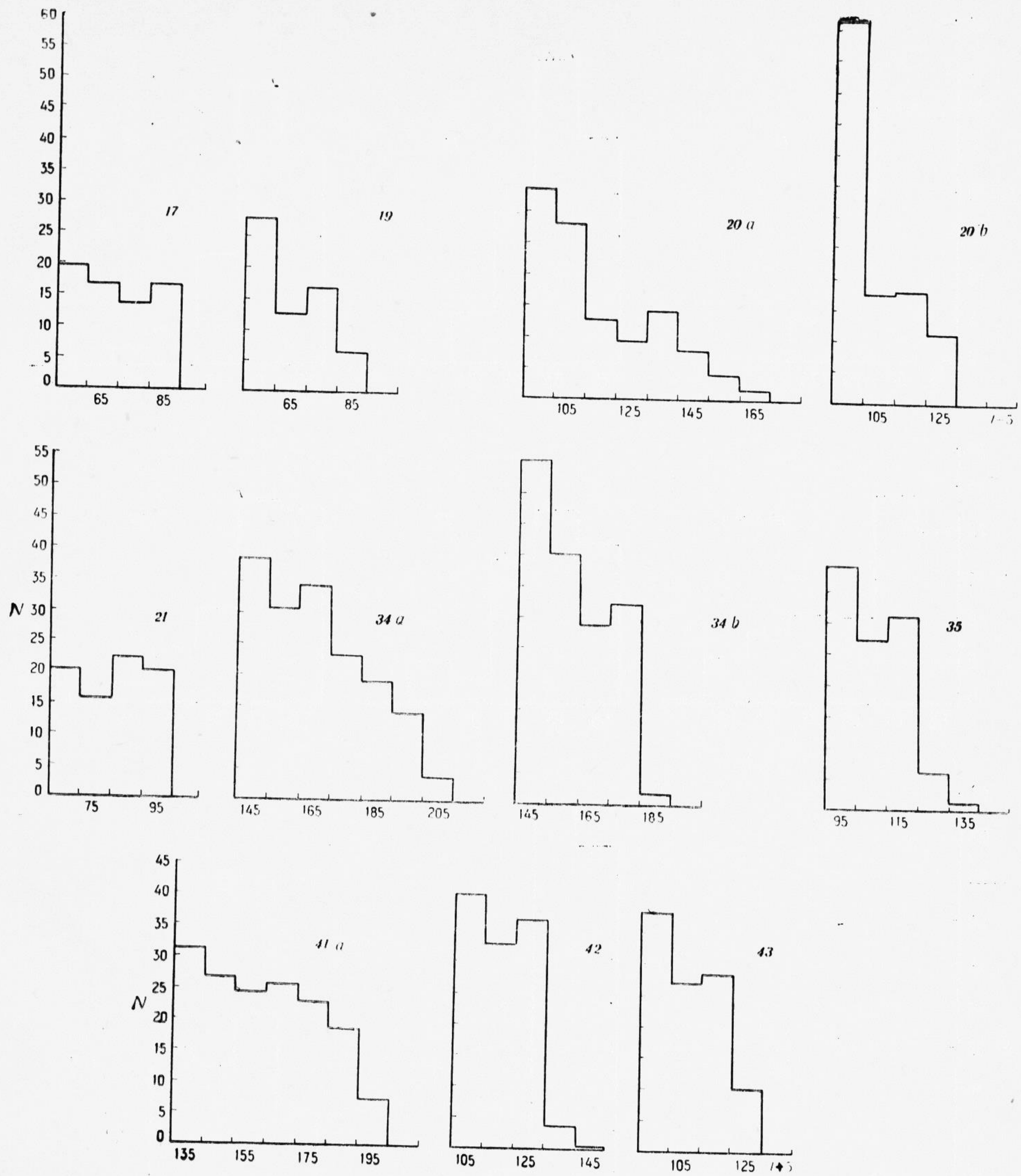


Fig. 5

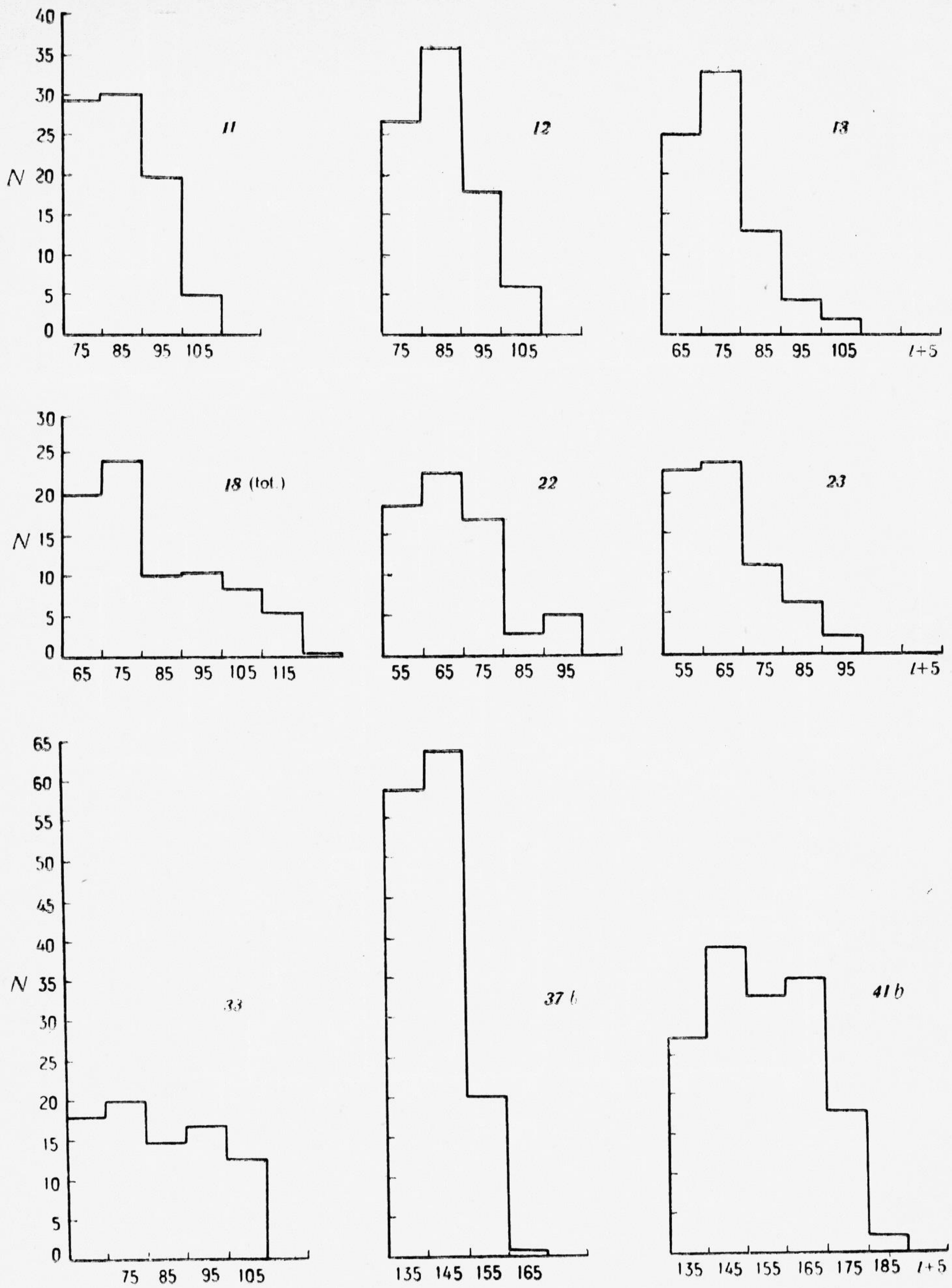


Fig. 6

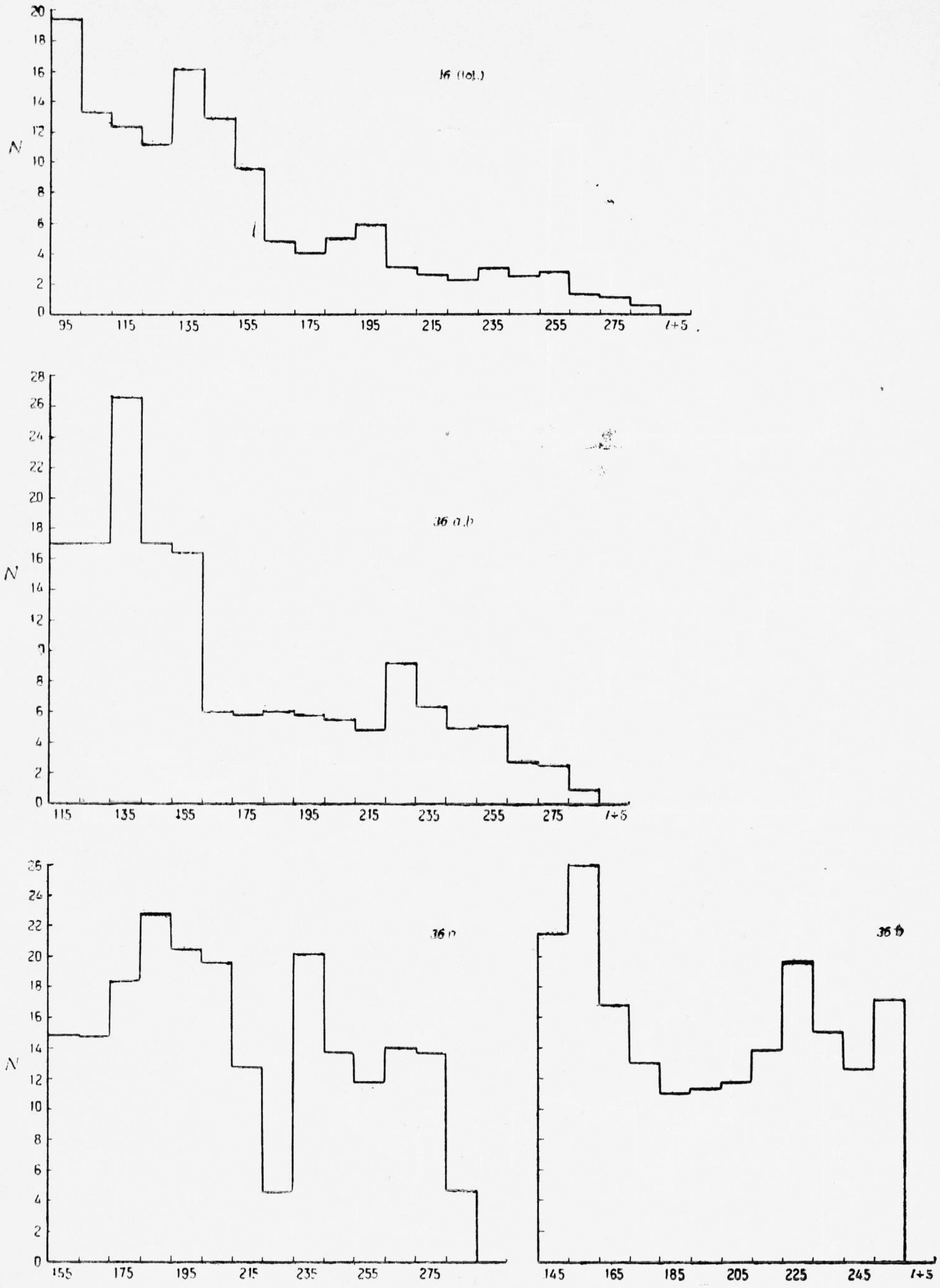


Fig. 7

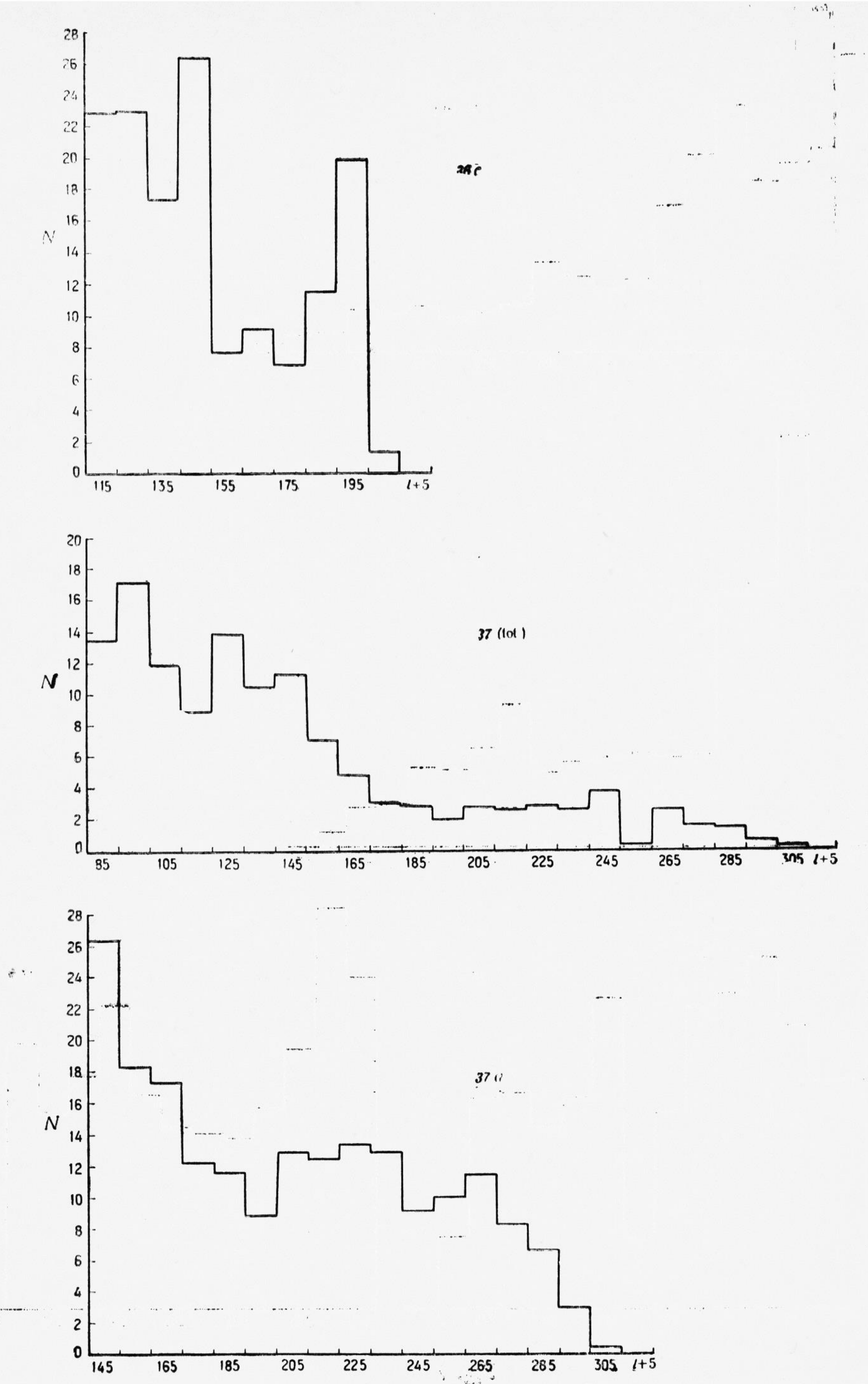

N
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
115 135 155 175 195 l+5
37 (tot)
0 2 4 6 8 10 12 14 16 18 20
85 105 125 145 165 185 205 225 245 265 285 305 l+5
37
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
145 165 185 205 225 245 265 285 305 l+5

Fig. 8

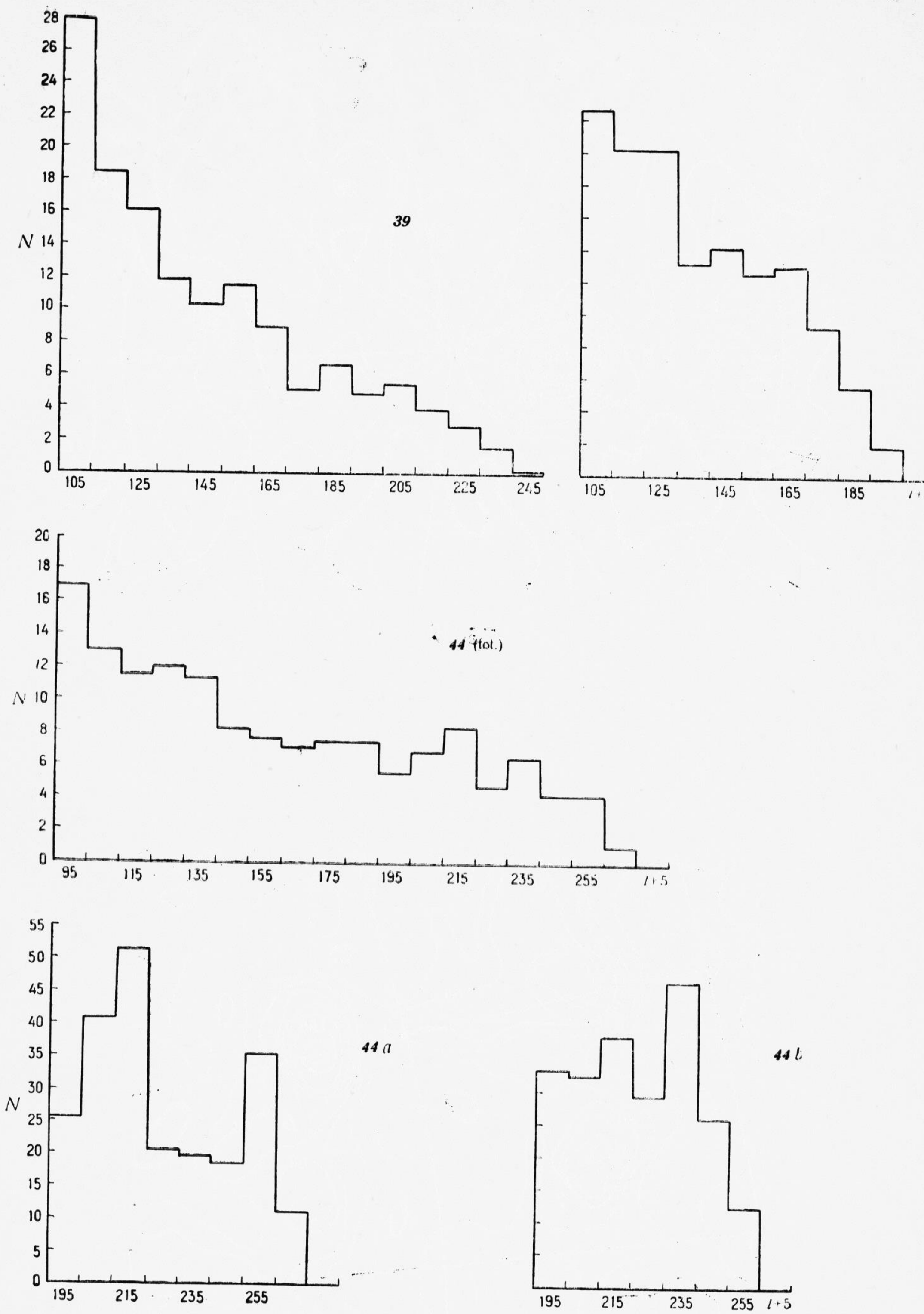


Fig. 9

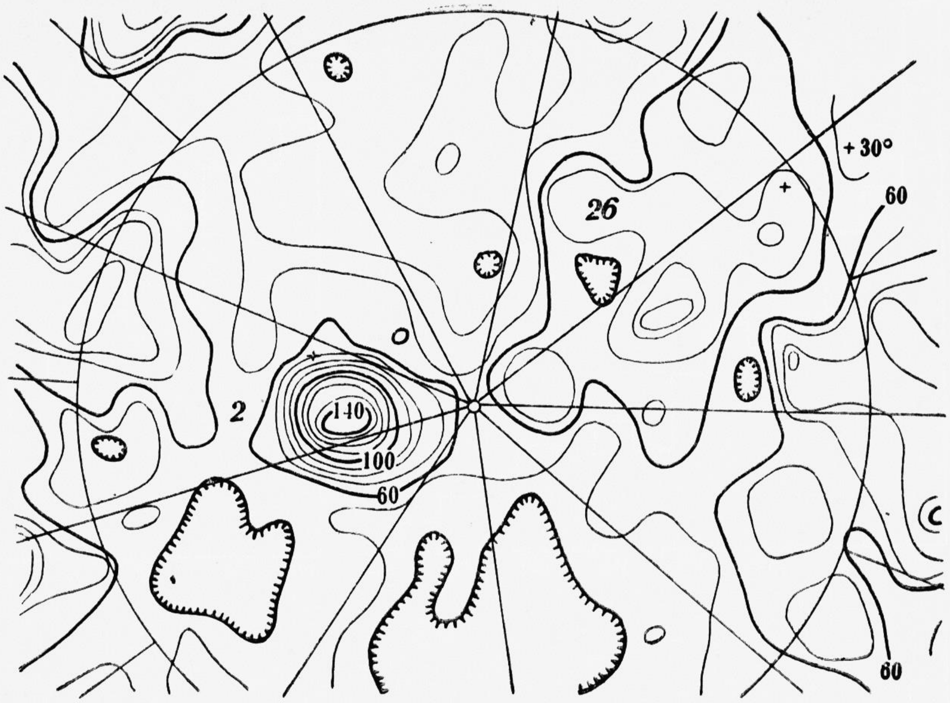


Fig. 10

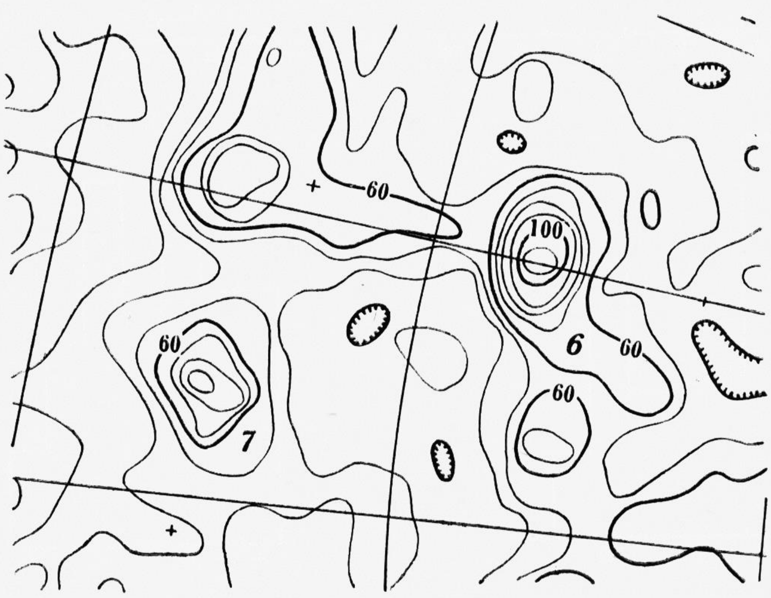


Fig. 11

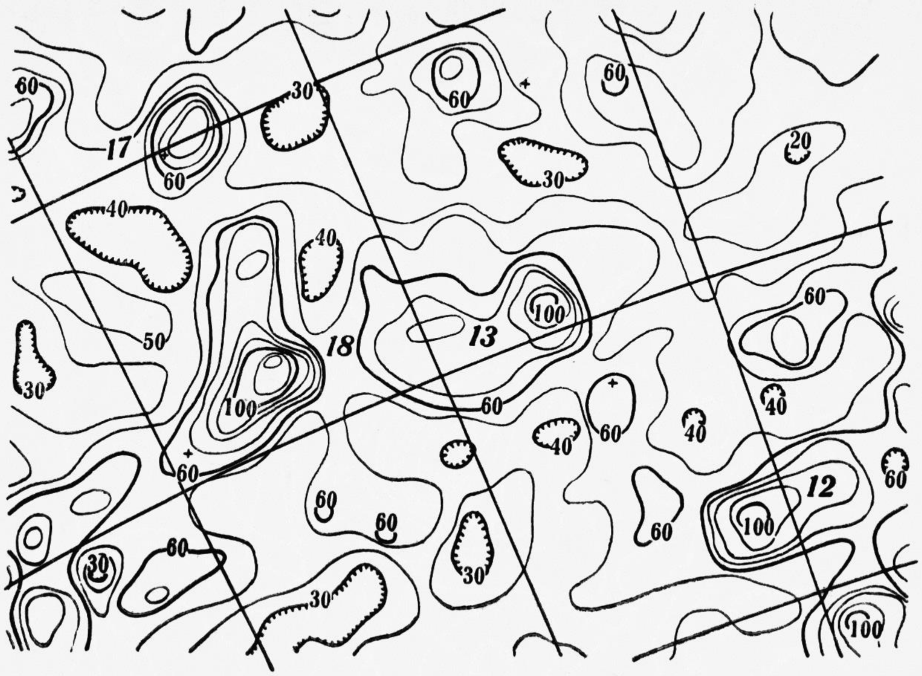


Fig. 12

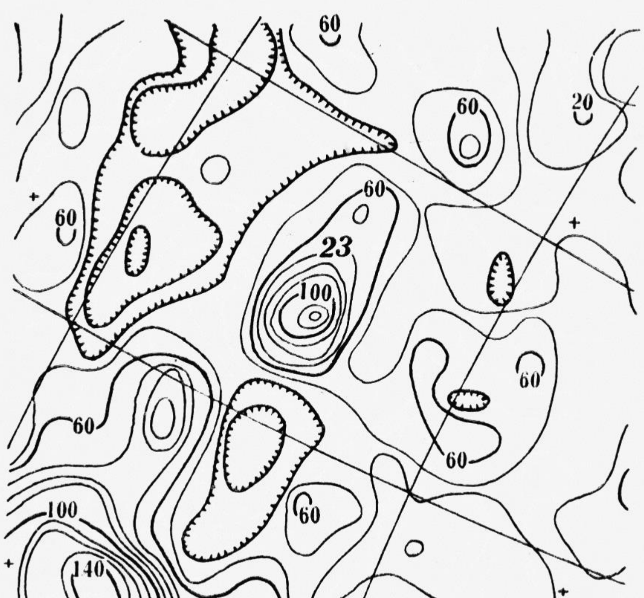


Fig. 13

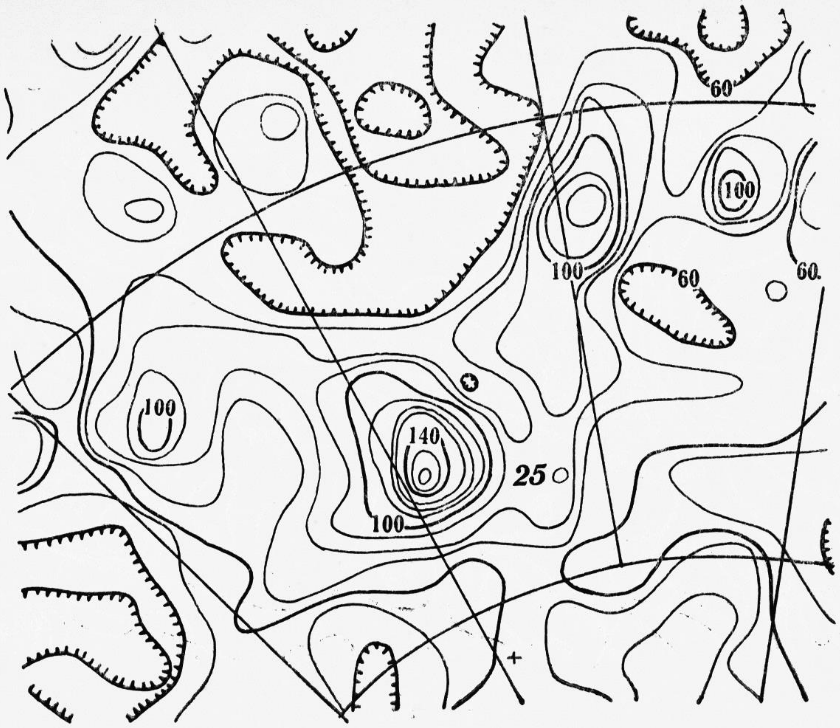


Fig. 14

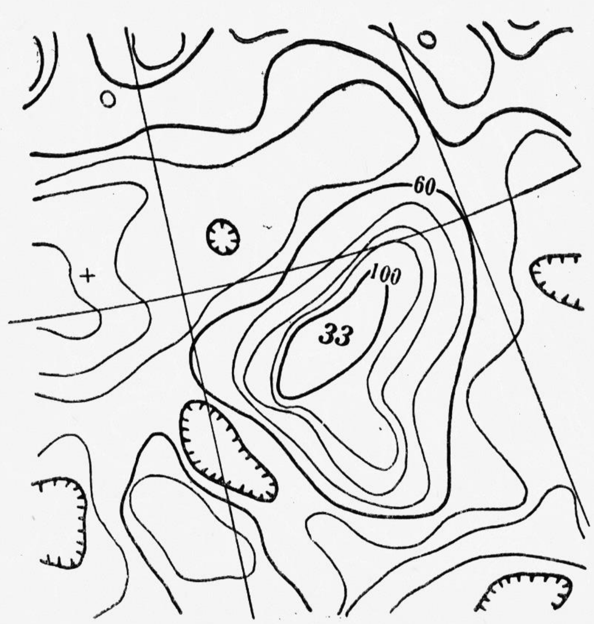


Fig. 15

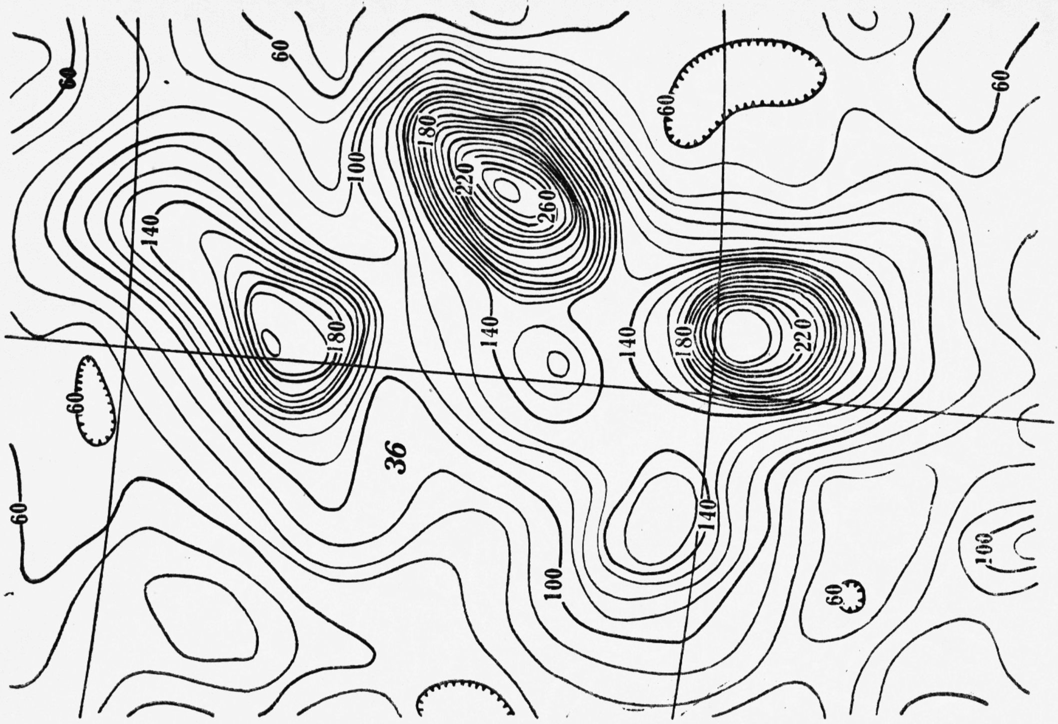


Fig. 17

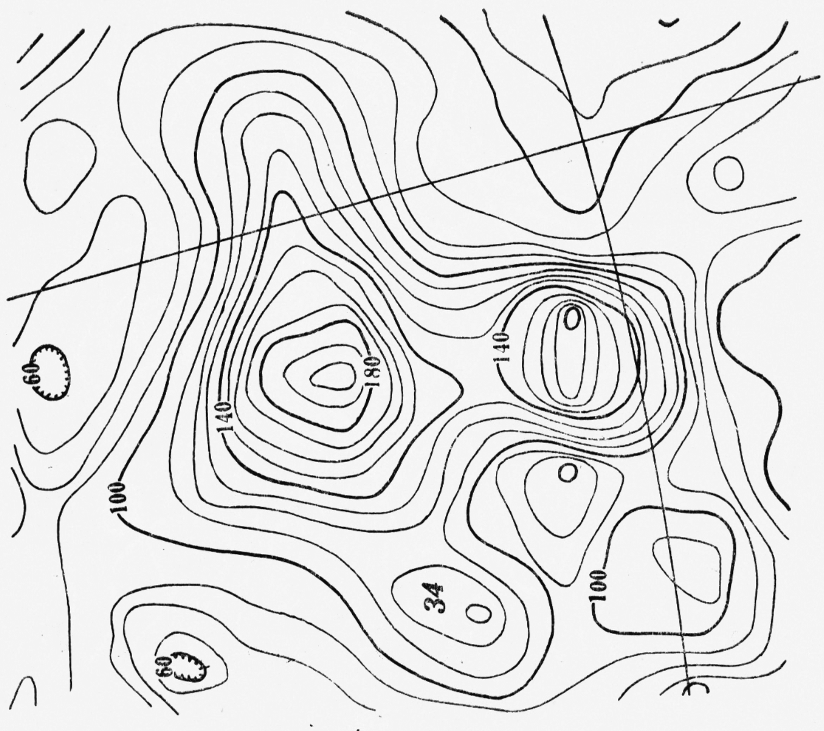
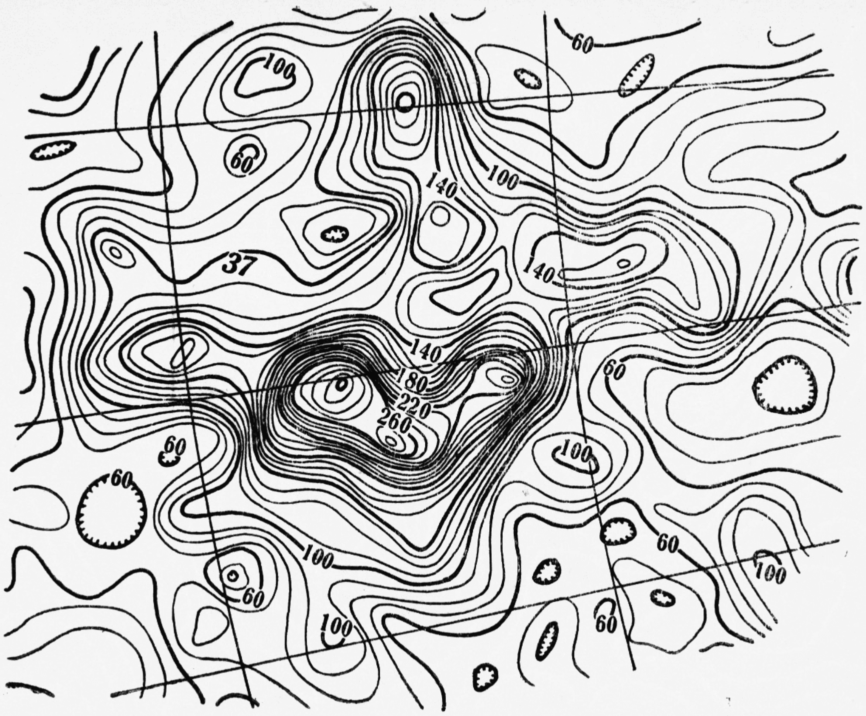
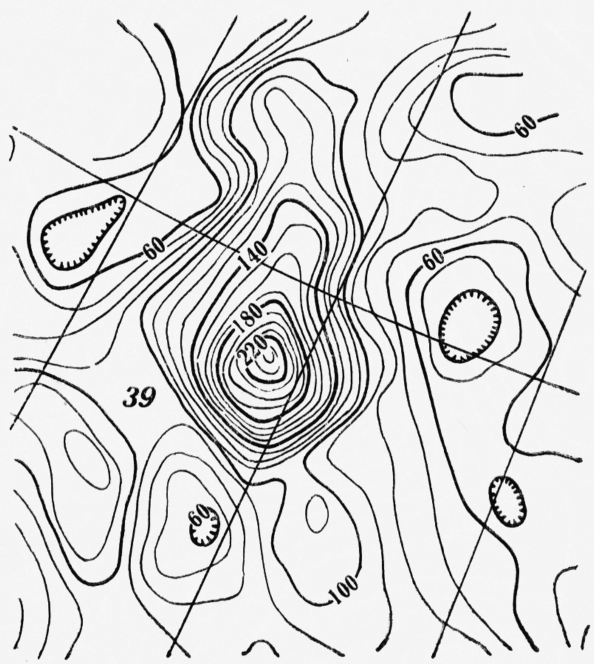


Fig. 16



60
100
60
140
100
37
140
140
180
220
260
60
60
60
100
100
60
100
60
60
100

Fig. 18



60
60
140
60
180
220
39
60
100

Fig. 19

The values of N between two neighbouring isolines are presented as histograms in Fig. 1—9. It is accepted for the central isolines k_{max} that k_{max+10} surrounds area, equal to zero.

The clusters and groups of clusters of galaxies in Fig. 1—9 are classified in 4 classes — A, B, C, D. The histograms show so much variety that

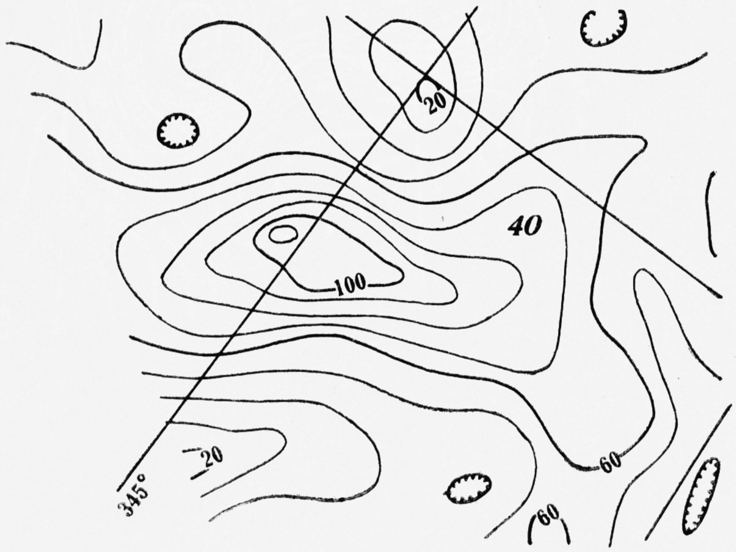


Fig. 20

it is really difficult to be classified. The classification has been made by the following criteria:

A. Regular clusters and groups. The limit stripe contains the largest relative number of galaxies and for the other stripes one observes monotonous diminishing (Figs. 1—3).

B. Comparatively regular, but except maximum in the limits stripe there is another right maximum (Figs. 4—5).

C. There is maximum of N not in the limit stripe, but in the second stripe. Sometimes there is another second maximum. Some histograms are irregular (Figs. 6).

D. The histograms are most irregular (Fig. 7—9).

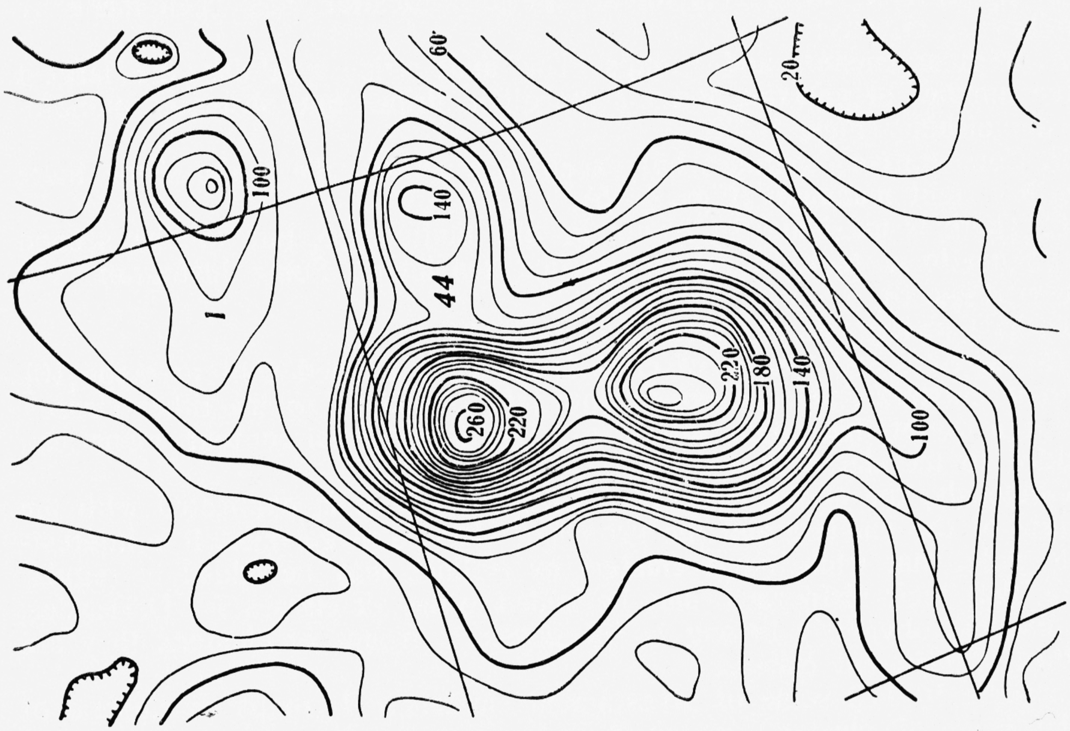
The clusters and groups of class D are from detailed contour maps [10]. But some clusters and subclusters from [10] are added to the other classes. There is a doubt that some objects of class D on usual contour maps can be added to the classes A and C.

Obviously, the above morphological classification is connected with the structure of the clusters and the groups of clusters of galaxies. It is interesting to note, that while some clusters by isolines may be added to regular system, that their histograms may be added to the all classes A—D. Besides, some clusters obviously belong to the physical groups of clusters, they are classified to different classes.

In Figs. 10—22 some of investigated clusters and groups of clusters of galaxies (from all clusters) are given.

+60
100
140
41
180
140
100
60
60

Fig. 22



60
20
100
140
44
1
260
220
220
180
140
100

Fig. 21

The connection between the data obtained (Tables 2—3 and histograms in Figs. 1—9) and the spatial structure of clusters and groups of clusters of galaxies will be examined in another paper.

Acknowledgments

It is a pleasure to acknowledge the large assistance in this investigation of my colleages B. Nenkova, Th. Gaitandjieva, V. Kraichev, and spacial thanks to J. Kostova, all from the Astronomical Section.

REFERENCES

1. Shane C. D. and C. A. Wirtanen, AJ, **59**, 1954, 285.
2. Shane C. D., AJ. **61**, 1956, 292.
3. Shane C. D., C. A. Wirtanen and U. Steinlin, AJ, **64**, 1959, 197.
4. Steinlin U. W., AJ, **67**, 1962, 370.
5. Neyman J., E. Scott and C. D. Shane, AJ, **117**, 1953, 92.
6. Neyman J., E. Scott and C. D. Shane, Proc. Third Berkely Symp. Mathem. Statistics and Probability, Barkeley, **3**, 1956, 75.
7. Агекян Т. А., АЖ, **34**, 1957, 371.
8. Limber P. N., ApJ, **117**, 1953, 134.
9. Neyman J., Problems of Extra-Galactic Research, ed. by G. C. McVittie, N. Y — L., 1962, 294.
10. Shane C. D., Vistas in Astronomy, ed. by A. Beer, Vol. 2, L. — N. Y, 1956, 1574.
11. Abell G. O., Problems of Extra-Galactic Research, ed. by G. C. McVittie, N. Y. —L., 1962, 213.
12. Herzog E., P. Wild and F. Zwicky, Publ. A. S. P., **69**, 1957, 409.
13. Zwicky F., Morphological Astronomy, Berlin, Springer-Verlag, 1952.

ИЗСЛЕДВАНЕ НА КУПОВЕ И ГРУПИ ОТ КУПОВЕ ГАЛАКТИКИ

М. Калинков

(Резюме)

Върху материали от Ликското преброяване на галактиките е изследвана структурата на купове и групи от купове галактики, дадени в каталога (табл. 2). Измерени са с планиметър площите между изолиниите по контурните карти, които, нормирани, са представени в таблица 3. Относителната населеност в куповете и групите от купове галактики е дадена на фиг. 1—9. Всички изследвани купове са класифицирани в 4 групи — A, B, C и D.