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A SEARCH FOR COOL CARBON STARS. I. CASSIOPEIA REGION

By

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Abstract

We have made a search for cool carbon stars using the 4° prism spectra of the Kiso 105 cm Schmidt telescope. The surveyed area is in the Cassiopeia region along the galactic plane (l= 115° to 130°, b=−5° to +5°). We present a list of 210 cool carbon stars detected in this work, in which 98 stars are newly discovered. Simple statistics and characteristics of this sample are briefly discussed in connection with their distribution in space and magnitude.

1. Introduction

Blanco (1965) indicated that there is a striking difference in the distribution of carbon stars from M giants along the galactic plane; carbon stars are relatively richer in the arms and the outer regions of the Galaxy. Blanco and McCarthy (1983) showed that the C/M (carbon to M stars) ratios are respectively 2.2, 4.7, and 19.2 for the LMC, the peripheral and the central regions of the SMC, while it is about 0.01 in the solar neighborhood. Recently, Aaronson et al. (1984), Margon et al. (1984), Azzopardi et al. (1985a, 1985b), Mould et al. (1985) surveyed and investigated faint carbon stars located in the bulge and halo of the Galaxy and in dwarf spheroidal galaxies of the Local Group. In these circumstances, it has been very important to search faint carbon stars in the study of structure and chemical composition of the Galaxy, Magellanic Clouds, and nearby galaxies.

Carbon stars, especially cool ones, exhibit conspicuous absorption bands of C_2 and CN molecules in the visible and infrared wavelength ranges. The objective prism attached to the Schmidt telescope is one of the best instruments for the detection and the spectral classification of faint carbon stars. Infrared spectral surveys using Kodak IN emulsion have been extensively made since a pioneering work of Nassau and Velghe (1964). Stephenson (1973) compiled those surveys into a general catalogue of cool carbon stars of the Galaxy, which collects 3,219 stars distributed over the whole sky. This catalogue is thought to be complete down to about 11, 10, and 10 mag in the photographic, red, and infrared regions, respectively. Stephenson (1985) published a supplementary list of 105 new carbon stars in the Galaxy.

Meanwhile, several investigators (e.g., Kurtanidze and West 1980; Fuenmayor 1981; Ichikawa 1981) have detected galactic carbon stars of fainter magnitudes using the Schmidt or widefield telescopes. Most of these deep surveys cover small selected areas in the sky due to elaborating survey work. Maehara (1985) classified about 60 cool carbon stars into the C system in the Cassiopeia 180 square-degrees region with the 105 cm Schmidt telescope, and obtained the space number density of 100 stars kps^{-3}. A combination of thick prism and 103 aF emulsion is favorable for the spectral classification, but a deeper survey is possible with IN emulsion because of larger fluxes of cool carbon stars in the infrared wavelength region.

Although more than 3,000 carbon stars are known in the Galaxy, accurate data on the distribution, spectral subclass, brightness, and variability are still uncertain. Actually, many carbon stars listed in Stephenson's (1973) catalogue have not been given their accurate positions for the convenience of follow-up observations. In this paper, we present accurate positions and charts of 210 cool carbon stars detected in the 180 square-degrees area of the Cassiopeia region.

2. Observation and Detection

We made spectroscopic observations with the 4° prism of the Kiso 105 cm Schmidt telescope. A combination of hypersensitized Kodak IN emulsion and the Schott RG695 (or RG645) filter covers the wavelength range of $\lambda\lambda$6900–8800 Å (or $\lambda\lambda$6400–8800 Å). In this range, there are three strong CN molecular bands whose heads are located at $\lambda\lambda$7945, 8125, 8320 Å. Representative spectra obtained are shown in figure 1, where the atmospheric A band also forms a conspicuous feature in the spectra.

The rugged features of carbon stars are highly remarkable among smooth features of earlier stars than K-type. Furthermore, they are different in the ruggedness from those of M- or S-type stars. This is the same system as Nassau and Velghe (1964), and the detectability of this search is higher due to a larger aperture and a larger plate scale of the Kiso Schmidt telescope. However, it must be noted that spectral features in this wavelength region are almost insensitive to the C subclass (figure 1). We usually took more than two 4° prism plates with different apex directions in order to compare spectral features and to improve the detectability.

We also took direct (V band) plates for the determination of the celestial position and brightness. All

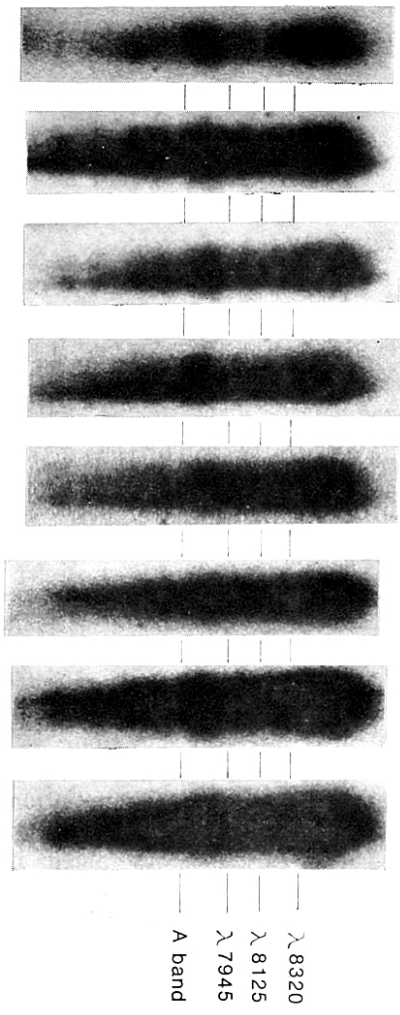


Fig. 1. *Representative spectral features of coll carbon stars. The number following "S" is the Stephenson's (1973) number of the stars.*

Table 1. *Plates used in this work*

Field (1)	Plate No. (2)	Apex direction (3)	Emulsion (4)	Filter (5)	Exposure (min.) (6)	Observation date (7)
A0082: 0^h00^m $+65°$	K1702	South	IN+	RG695	119.7	1978/10/01
	K1752	South	IN+	RG695	50.0	1978/10/21
	K3369	North	IN+	RG695	60.0	1981/10/03
	K1931	Direct	IIaD	GG495	15.0	1978/12/25
A0083: 0^h40^m $+65°$	K1709	South	IN+	RG695	120.0	1978/10/02
	K4451	West	IN+	RG695	60.0	1984/10/25
	K1932	Direct	IIaD	GG495	15.0	1978/12/25
A0084: 1^h20^m $+65°$	K3029	East	IN+	RG695	60.0	1980/11/26
	K4452	West	IN+	RG695	60.0	1984/10/25
	K1933	Direct	IIaD	GG495	15.0	1978/12/25
A0118: 0^h00^m $+60°$	K0925	North	IN+	None	60.0	1977/10/17
	K1255	North	IN+	RG645	89.9	1977/12/13
	K0906	Direct	IIaD	GG495	27.1	1977/10/11
	K1852	Direct	IIaD	GG495	40.0	1978/11/21
A0119: 0^h36^m $+60°$	K0914	West	IN+	RG645	59.9	1977/10/14
	K0926	West	IN+	None	60.0	1977/10/17
	K1909	North	IN+	RG695	59.9	1978/12/18
	K1853	Direct	IIaD	GG495	29.7	1978/11/21
A0120: 1^h12^m $+60°$	K3824	South	IN	RG695	60.1	1982/10/26
	K4450	South	IN+	RG695	60.0	1984/10/25
	K1943	Direct	IIaD	GG495	15.0	1978/12/26
A0121: 1^h48^m $+60°$	K1256	North	IN+	RG645	90.0	1977/12/13
	K2328	North	IN+	RG695	53.0	1979/10/16
	K3027	East	IN+	RG695	60.0	1980/11/26
	K1930	Direct	IIaD	GG495	15.0	1978/12/25

the plates used in this work are listed in table 1. Column 1 gives the field number and its central position. Columns 2 and 3 respectively denote the plate number and the apex direction of the 4° prism. The plus sign in column 4 denotes hypersensitized emulsion by silver nitrate solution. These plates cover the sky area of 180 square degrees in the Cassiopeia region (l=115° to 130°, b=−5° to +5°), which is the same as Maehara (1985). The area is shown in figure 2, plotted with carbon stars detected in this search.

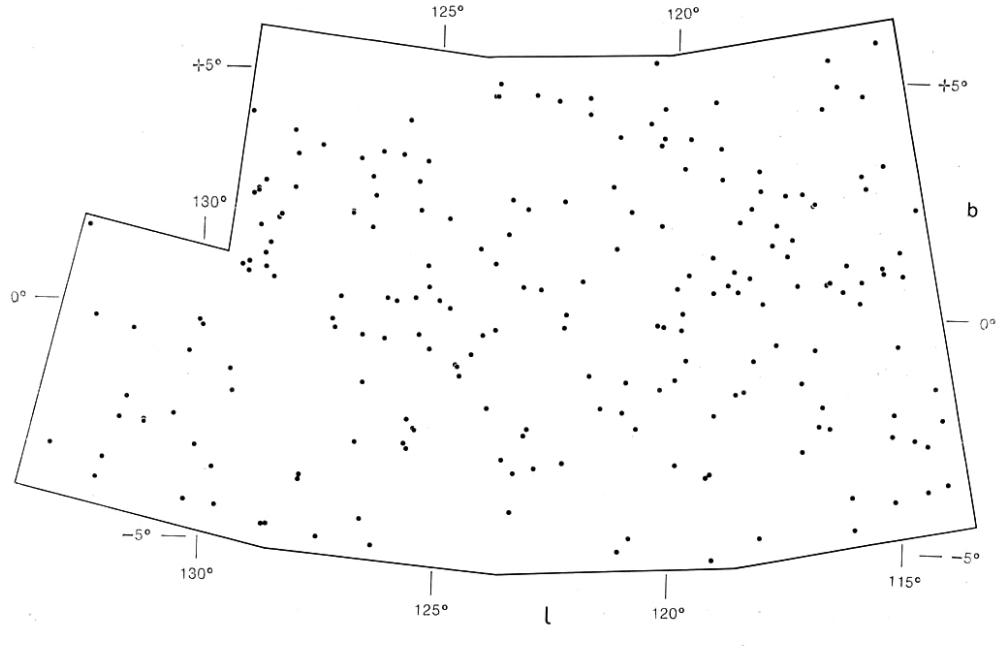


Fig. 2. *Distribution of carbon stars detected. The coordinate is given in the galactic one.*

Table 2. *List of carbon stars detected in this work*

	R.A.(1950) (1)	DEC.(1950) (2)	L (3)	B (4)	V (5)	REMARKS
1	$23^h33^m32^s.2$	$+67°24'27''$	$115°.83$	$+5°.86$	15.6:	
2	23 34 35.3	+ 63 44 58	114.88	+ 2.33	14.7:	
3	23 38 41.4	+ 64 49 54	115.61	+ 3.24	14.0	
4	23 39 14.7	+ 66 21 48	116.08	+ 4.70	14.7	NK
5	23 39 15.2	+ 59 57 47	114.37	- 1.47	14.5:	
6	23 39 23.7	+ 59 16 26	114.20	- 2.14	15.6	
7	23 39 29.0	+ 62 56 56	115.19	+ 1.41	14.6	
8	23 40 03.5	+ 64 27 25	115.12	+ 0.91	16.5	
9	23 40 58.1	+ 57 55 47	114.05	- 3.49	11.5	S3200
10	23 42 47.2	+ 58 48 06	114.50	- 2.70	13.6	S3201
11	23 43 08.6	+ 64 24 49	115.96	+ 2.72	14.5	
12	23 43 13.2	+ 64 43 13	116.05	+ 3.01	16.3	
13	23 43 19.8	+ 62 36 13	115.53	+ 0.96	14.8	NK
14	23 43 20.3	+ 62 42 57	115.56	+ 1.07	14.8	NK
15	23 43 51.7	+ 61 01 30	115.19	- 0.59	15.7	
16	23 44 06.2	+ 66 42 12	116.63	+ 4.91	16.6	
17	23 44 21.8	+ 57 52 03	114.47	- 3.66	14.0	
18	23 44 37.0	+ 58 59 18	114.78	- 2.58	15.3	
19	23 44 48.6	+ 67 16 36	116.84	+ 5.45	15.6	
20	23 47 01.1	+ 59 37 32	115.23	- 2.04	14.2	
21	23 47 46.8	+ 62 31 10	116.00	+ 0.75	14.2	NK
22	23 48 06.1	+ 59 10 52	115.26	- 2.50	15.4	
23	23 48 17.2	+ 66 17 37	116.94	+ 4.41	15.2	
24	23 48 44.1	+ 62 06 22	116.02	+ 0.32	15.3:	
25	23 49 47.4	+ 62 56 35	116.33	+ 1.11	15.7	
26	23 49 49.2	+ 57 48 55	115.16	- 3.88	11.7	S3206
27	23 51 16.1	+ 62 26 51	116.38	+ 0.59	13.4	S3208
28	23 53 24.7	+ 62 39 22	116.67	+ 0.74	14.0	
29	23 53 28.5	+ 64 21 18	117.03	+ 2.40	15.1	
30	23 54 00.7	+ 64 19 09	117.08	+ 2.35	13.8	
31	23 54 07.6	+ 62 37 17	116.74	+ 0.69	14.9	
32	23 55 34.1	+ 64 36 04	117.31	+ 2.59	14.7	
33	23 56 07.9	+ 58 04 30	116.04	- 3.81	11.9	S3209,NK
34	23 56 56.6	+ 57 23 40	116.01	- 4.50	10.5	S3211
35	23 58 03.5	+ 59 36 26	116.59	- 2.36	13.0	S3212
36	23 58 19.4	+ 61 18 15	116.95	- 0.70	12.7	S3213
37	23 58 42.0	+ 60 04 38	116.76	- 1.91	6.5	S3214
38	23 58 56.0	+ 64 38 26	117.67	+ 2.56	16.0	
39	23 58 57.6	+ 63 41 01	117.49	+ 1.62	13.8	
40	23 59 29.0	+ 62 42 18	117.36	+ 0.65	14.3	NK
41	23 59 42.5	+ 59 41 27	116.81	- 2.32	11.5	S3215
42	00 00 22.6	+ 63 20 46	117.58	+ 1.26	15.1	
43	00 01 31.3	+ 64 02 10	117.83	+ 1.91	11.7	S3217
44	00 01 35.4	+ 60 38 41	117.22	- 1.42	11.9	S3218
45	00 02 53.0	+ 63 38 11	117.91	+ 1.49	15.5	
46	00 03 07.9	+ 65 14 15	118.22	+ 3.06	15.9	
47	00 03 09.2	+ 59 13 07	117.16	- 2.86	15.4	
48	00 03 36.6	+ 64 49 02	118.19	+ 2.64	15.7	
49	00 04 57.2	+ 64 26 40	118.27	+ 2.25	13.2	
50	00 04 59.2	+ 61 31 47	117.78	- 0.62	14.0	I1

The detection was visually made on prism plates using the Nikon binocular microscope. The detectability of faint carbon stars varies slightly from field to field, because we use plates of unequal condition on exposure time, seeing, and sensitivity gain by hypersensitization. We may possibly miss some carbon stars due to the overlapping of spectra with neighboring stars, or pick out wrong stars (e.g., S-type ones) due to their confusing spectral features. In most cases, however, we could check the identification by comparing objective prism plates.

3. Measurement

We measured V-band plates using the XY measuring machine of the Kiso Observatory. This instrument is so sophisticated that it gives us the density weighted centroid of a star image and the integrated density value of the image (Soyano et al. 1986). The coordinate on the plate is converted into the celestial position with the standard coordinate method. The accuracy of the celestial position thus obtained is $\pm 0.5''$ except for images near the corner of the plate.

The integrated density value of each image was adopted as a measure of its brightness. We picked out brightness standard stars down to ~ 12 mag from Blanco et al. (1968) over the whole area, and a photoelectric observation of faint stars ($V \lesssim 16.4$) of the open cluster NGC129 (Arp et al. 1959). The accuracy of V magnitude thus obtained is better than ± 0.2 mag for stars of $V \lesssim 11$, and it is degraded to be ± 0.5 mag at $V \sim 17$ mag.

Table 2. (*continued*)

	R.A.(1950) (1)	DEC.(1950) (2)	L (3)	B (4)	V (5)	REMARKS
51	00h06m20.3	+ 62°26'15"	118.°09	+ 0.°24	10.6	S3,I2
52	00 08 29.7	+ 64 12 45	118.61	+ 1.96	14.0	
53	00 08 55.8	+ 63 01 50	118.38	+ 0.78	15.6	
54	00 09 24.9	+ 61 16 09	118.26	- 0.97	15.0	I3
55	00 10 18.3	+ 66 48 01	119.19	+ 4.49	17.5:	
56	00 10 18.7	+ 65 49 24	119.05	+ 3.52	16.1	
57	00 10 36.1	+ 62 45 21	118.62	+ 0.48	15.3	I5,NK
58	00 10 42.6	+ 63 10 51	118.70	+ 0.90	9.4	S4,I6
59	00 10 44.8	+ 65 10 30	119.00	+ 2.87	16.0	
60	00 11 50.2	+ 60 38 51	118.46	- 1.63	14.6	I4
61	00 12 04.5	+ 57 31 33	118.04	- 4.72	13.0	S6
62	00 12 19.9	+ 62 55 30	118.84	+ 0.62	14.4	I8
63	00 13 12.2	+ 60 36 49	118.62	- 1.68	12.3	S8
64	00 14 34.5	+ 63 32 44	119.18	+ 1.20	11.6	S9,I11
65	00 15 08.0	+ 62 47 28	119.14	+ 0.44	15.7	
66	00 16 18.7	+ 66 05 35	119.69	+ 3.70	13.0	NK
67	00 17 21.6	+ 60 12 26	119.08	- 2.15	13.0	I9
68	00 18 08.5	+ 65 28 17	119.80	+ 3.06	16.5	
69	00 19 01.9	+ 58 58 18	119.14	- 3.40	12.5	S12,I10
70	00 19 15.1	+ 63 13 01	119.66	+ 0.81	15.3	
71	00 19 42.9	+ 58 54 56	119.22	- 3.47	10.2	S13,I12
72	00 19 54.2	+ 57 10 00	119.05	- 5.21	13.9:	
73	00 21 06.8	+ 66 47 28	120.25	+ 4.34	16.3	
74	00 21 09.8	+ 62 24 27	119.78	- 0.02	15.5	I13
75	00 21 21.2	+ 61 25 36	119.70	- 1.00	15.0	
76	00 21 39.6	+ 62 04 27	119.80	- 0.36	15.8	
77	00 21 50.2	+ 66 09 30	120.25	+ 3.70	15.1	NK
78	00 21 53.2	+ 62 57 34	119.92	+ 0.52	14.6	
79	00 22 21.4	+ 67 45 19	120.47	+ 5.29	13.7	
80	00 22 28.6	+ 66 00 32	120.30	+ 3.55	15.4	NK
81	00 23 36.5	+ 61 01 29	119.93	- 1.42	14.7	
82	00 23 48.1	+ 64 17 31	120.27	+ 1.83	15.4	
83	00 24 30.7	+ 66 29 37	120.56	+ 4.01	16.8	
84	00 24 39.8	+ 59 13 59	119.89	- 3.22	16.5	I14
85	00 24 56.4	+ 62 09 34	120.19	- 0.31	14.6	
86	00 26 00.2	+ 62 12 02	120.32	- 0.28	12.8	I17
87	00 26 19.9	+ 60 53 43	120.24	- 1.63	11.7	S17
88	00 29 35.8	+ 64 38 33	120.92	+ 2.12	16.4	
89	00 30 48.4	+ 60 02 23	120.73	- 2.48	14.6	
90	00 31 11.4	+ 66 15 08	121.20	+ 3.71	15.4	NK
91	00 32 11.1	+ 61 02 32	120.97	- 1.49	12.2	S20,I20
92	00 32 46.8	+ 63 52 37	121.22	+ 1.33	13.6	I22
93	00 32 47.9	+ 57 43 55	120.83	- 4.80	12.1	S22,I19
94	00 32 54.5	+ 65 11 05	121.31	+ 2.64	16.1	NK
95	00 33 01.6	+ 60 20 45	121.02	- 2.19	13.6	I21
96	00 34 40.7	+ 57 27 08	121.07	- 5.09	13,8	
97	00 36 45.7	+ 60 29 40	121.49	- 2.07	13.1	S25,I23
98	00 37 12.1	+ 67 05 48	121.85	+ 4.52	14.4	
99	00 37 13.5	+ 66 44 38	121.84	+ 4.17	13.9	NK
100	00 38 30.5	+ 61 11 57	121.74	- 1.38	13.8	

We have detected 210 cool carbon stars in the present sky area, and a list of all the detected carbon stars is given in table 2. The first two columns denote the equatorial coordinates at the equinox of 1950. The third and the forth columns give the galactic coordinates, and the next column denotes the V magnitude derived from the direct plates listed in table 1. The identification of individual carbon stars with previous catalogues and papers is given in the last column, where the abbreviation of the catalogue is given at the end of the table.

In this search, 62, 40, and 28 carbon stars are respectively identified with those in the catalogues of Stephenson (1973), Nikolashvili and Kurtanidze (1985), and Ichikawa (1981). There are 98 newly discovered carbon stars in the table. The catalogue of Nikolashvili and Kurtanidze (1985) is a preliminary one whose position accuracy is sometimes down to several arcminutes. Ichikawa (1981) investigated the distribution of late-type stars in the sky area of 38.5 square-degrees, and obtained the accurate position and brightness of 34 carbon stars. We compare the results of 28 common stars between this work and Ichikawa (1981) in order to examine the accuracies of the position and the brightness. The celestial position coincides as good as 3 arcseconds on the average, and the systematic and random errors of the V magnitude are estimated to be 0.4 and 0.2 mag, respectively.

Finding charts of all the stars listed in table 2 are given in figure 2 for the convenience of follow-up observations. The field is about $10' \times 10'$, and north

Table 2. (*continued*)

	R.A.(1950) (1)	DEC.(1950) (2)	L (3)	B (4)	V (5)	REMARKS
101	$00^h39^m30^s.4$	$+63°12'03''$	121°.93	+ 0°.62	14.4	I24,NK
102	00 42 34.8	+ 62 30 16	122.26	- 0.09	14.3	I26,NK
103	00 42 46.0	+ 64 53 20	122.34	+ 2.30	12.9	NK
104	00 42 53.0	+ 62 13 29	122.29	- 0.37	15.9	
105	00 43 22.1	+ 59 21 17	122.28	- 3.24	12.2	S28,I27
106	00 44 07.1	+ 67 02 04	122.52	+ 4.44	13.9	
107	00 47 21.5	+ 63 00 58	122.81	+ 0.42	12.9	S31,I28
108	00 48 07.0	+ 59 13 57	122.89	- 3.37	13.9	
109	00 48 53.8	+ 67 08 34	122.99	+ 4.54	12.2	S33
110	00 49 26.0	+ 60 03 22	123.05	- 2.54	12.3	S34,I30
111	00 49 56.9	+ 59 55 27	123.12	- 2.68	11.9	S35,I31
112	00 50 08.7	+ 64 42 55	123.12	+ 2.12	15.2	NK
113	00 50 34.3	+ 63 04 13	123.18	+ 0.47	10.9	S36,I32
114	00 51 33.9	+ 59 07 07	123.33	- 3.48	13.4	I33
115	00 51 55.0	+ 58 17 34	123.38	- 4.31	8.8	S38
116	00 53 12.9	+ 64 54 52	123.45	+ 2.32	12.3	S41
117	00 53 32.3	+ 59 23 32	123.58	- 3.20	15.7	NK
118	00 53 49.0	+ 64 10 48	123.52	+ 1.58	13.3	S42
119	00 55 31.2	+ 62 08 28	123.76	- 0.45	15.9	
120	00 56 01.7	+ 63 32 39	123.78	+ 0.95	11.0	S43
121	00 56 20.6	+ 60 28 11	123.91	- 2.12	14.3	S44,I34
122	00 56 50.9	+ 67 21 10	123.76	+ 4.76	13.0	S45
123	00 57 17.5	+ 67 04 25	123.81	+ 4.49	14.8	NK
124	00 57 41.2	+ 67 04 32	123.85	+ 4.49	12.7	S49
125	00 57 42.2	+ 62 00 03	124.02	- 0.58	14.1	
126	00 59 00.9	+ 63 49 33	124.10	+ 1.25	15.2	
127	00 59 37.0	+ 61 35 37	124.26	- 0.98	11.0	S52
128	01 01 29.5	+ 61 06 41	124.51	- 1.45	11.8	S53
129	01 02 01.5	+ 61 18 54	124.56	- 1.25	13.1	
130	01 02 17.7	+ 61 19 37	124.59	- 1.23	13.6	
131	01 03 59.0	+ 62 32 31	124.73	- 0.01	14.7	NK
132	01 05 30.3	+ 64 24 46	124.78	+ 1.87	12.2	S54
133	01 05 58.9	+ 62 40 21	124.95	+ 0.14	14.3	NK
134	01 07 04.6	+ 61 38 22	125.15	- 0.89	15.1	
135	01 08 14.0	+ 62 57 36	125.18	+ 0.44	14.7	
136	01 08 25.9	+ 59 53 44	125.44	- 2.61	13.0	
137	01 08 31.8	+ 59 55 43	125.45	- 2.58	15.8	
138	01 08 44.5	+ 63 23 53	125.21	+ 0.88	14.7	NK
139	01 09 19.4	+ 61 55 16	125.39	- 0.58	14.7	
140	01 09 33.4	+ 59 28 56	125.61	- 3.01	13.0	
141	01 09 49.9	+ 60 06 16	125.60	- 2.39	12.8	S57
142	01 10 00.5	+ 59 35 17	125.66	- 2.90	11.8	S58
143	01 10 30.6	+ 62 41 45	125.46	+ 0.20	13.5	S59
144	01 10 54.0	+ 65 35 47	125.26	+ 3.09	11.3	S60
145	01 11 16.8	+ 64 32 02	125.39	+ 2.04	15.1	
146	01 12 15.8	+ 65 08 27	125.44	+ 2.65	16.0	NK
147	01 13 27.9	+ 57 22 14	126.31	- 5.07	12.8:	
148	01 13 51.6	+ 62 34 45	125.86	+ 0.12	15.5	
149	01 15 16.5	+ 61 46 31	126.10	- 0.67	15.1	
150	01 15 26.5	+ 66 24 40	125.65	+ 3.95	13.7	NK

is up and east to the left. The faintest stars appearing in the charts are from 17 to 18 mag. Partial sky area is given for several carbon stars located near the edge of the plate.

4. Discussion

In the present search the mean number density of carbon stars is about 1.2 stars degree^{-2}, and it is 3.7 times larger than that of Maehara (1985). This is one of the widest-field deep surveys which have been made along the galactic plane (cf. Alksne and Ikaunieks 1981). Therefore, it collects many distant carbon stars in the direction of the Perseus arm. Concerning the limiting magnitude of the survey, there are some ambiguities in the observation conditions and in the variability of individual stars. The former effect seems to come from the variation in seeing, and hypersensitization gain of IN emulsion.

The number distribution against the V magnitude is illustrated in figure 4, where the cumulative number log $N(\leqq V)$ is plotted in 0.2 magnitude bin. The present distribution is less steep than that of the equal-density without extinction. This may partly come from the increasing interstellar extinction with the distance, and from the increasing height(z) perpendicular to the plane with the distance. According to Alksne and Ikaunieks (1981), the scale height of carbon stars in the z direction ranges from 50 to 600 pc. It is supposed from the figure that the completeness of this survey is around 13 mag in the V band. The mean number density around $b=\pm1°$

Table 2. (*continued*)

	R.A.(1950) (1)	DEC.(1950) (2)	L (3)	B (4)	V (5)	REMARKS
151	$01^h15^m37^s.2$	$+62^\circ37'15''$	$126^\circ.06$	$+0^\circ.18$	12.0	S64
152	01 15 43.6	+ 57 53 46	126.56	- 4.52	12.2	S65
153	01 16 02.0	+ 65 40 28	125.78	+ 3.22	16.3	
154	01 18 09.9	+ 60 47 02	126.55	- 1.62	14.0	
155	01 18 09.9	+ 59 30 09	126.70	- 2.89	14.2	
156	01 19 26.8	+ 61 47 33	126.59	- 0.60	15.5	
157	01 20 13.2	+ 65 40 42	126.21	+ 3.27	14.9	NK
158	01 20 17.7	+ 64 03 41	126.41	+ 1.67	15.3	
159	01 20 25.4	+ 64 44 20	126.35	+ 2.34	14.4	NK
160	01 21 37.2	+ 65 07 24	126.42	+ 2.74	13.9	
161	01 22 07.6	+ 57 23 43	127.47	- 4.92	12.3	S66
162	01 24 15.3	+ 62 31 28	127.05	+ 0.20	13.8	
163	01 24 21.2	+ 64 18 10	126.82	+ 1.96	14.1	
164	01 24 24.2	+ 61 51 07	127.16	- 0.46	14.0	
165	01 24 27.0	+ 64 18 16	126.83	+ 1.97	13.5	
166	01 24 29.4	+ 65 27 53	126.68	+ 3.12	12.6	NK
167	01 25 16.4	+ 62 01 06	127.24	- 0.28	12.9	S67
168	01 26 27.0	+ 58 38 09	127.87	- 3.61	10.9	S69
169	01 26 32.9	+ 58 31 51	127.89	- 3.71	12.4	
170	01 30 17.7	+ 57 29 44	128.54	- 4.66	9.0	S70
171	01 31 00.8	+ 57 28 07	128.64	- 4.67	11.7	S71
172	01 32 47.2	+ 65 36 37	127.51	+ 3.39	14.7	NK
173	01 36 35.5	+ 64 36 40	128.08	+ 2.48	12.6	NK
174	01 37 07.6	+ 62 39 31	128.49	+ 0.57	13.4	NK
175	01 37 21.3	+ 65 18 51	128.03	+ 3.19	12.2	NK
176	01 38 04.1	+ 64 00 08	128.35	+ 1.91	13.3	
177	01 38 26.3	+ 63 54 36	128.40	+ 1.83	12.8	NK
178	01 38 49.9	+ 57 40 25	129.64	- 4.28	12.9	S74
179	01 38 52.4	+ 62 50 05	128.66	+ 0.78	11.7	S73
180	01 38 57.3	+ 65 47 08	128.10	+ 3.68	13.6	NK
181	01 39 07.3	+ 63 21 25	128.58	+ 1.30	11.6	S75
182	01 39 31.2	+ 63 07 00	128.68	+ 1.07	14.1	NK
183	01 39 56.1	+ 60 06 57	129.31	- 1.86	12.9	
184	01 40 37.4	+ 58 26 01	129.73	- 3.49	12.0	S78
185	01 41 12.1	+ 60 34 50	129.37	- 1.37	15.2	S79
186	01 41 34.6	+ 63 40 00	128.79	+ 1.66	15.1	NK
187	01 41 56.7	+ 62 40 08	129.03	+ 0.69	12.9	S80
188	01 42 04.5	+ 62 52 03	129.01	+ 0.89	12.7	S81
189	01 42 33.7	+ 64 37 49	128.70	+ 2.62	13.1:	NK
190	01 43 09.0	+ 62 46 22	129.15	+ 0.82	15.2	NK
191	01 43 28.9	+ 64 23 06	128.85	+ 2.40	14.7:	
192	01 43 30.6	+ 64 24 06	128.85	+ 2.42	13.6:	
193	01 43 55.0	+ 57 38 09	130.32	- 4.18	13.5	
194	01 44 07.9	+ 58 48 23	130.10	- 3.03	13.5	S83
195	01 44 20.7	+ 64 17 53	128.96	+ 2.34	14.6:	
196	01 47 37.6	+ 61 19 30	129.97	- 0.48	16.5	
197	01 48 18.0	+ 61 25 12	130.03	- 0.37	14.2	NK
198	01 48 19.5	+ 65 57 50	129.00	+ 4.06	15.4:	
199	01 48 42.9	+ 59 21 07	130.55	- 2.37	12.5	
200	01 48 49.3	+ 60 43 12	130.25	- 1.04	14.4	
201	$01^h53^m10^s.5$	$+59^\circ00'55''$	$131^\circ.19$	$-2^\circ.56$	9.0	S87
202	01 53 17.4	+ 59 04 05	131.19	- 2.51	11.5	S88
203	01 57 03.0	+ 59 25 38	131.56	- 2.04	14.0	
204	01 57 20.1	+ 59 00 38	131.71	- 2.43	12.3	S89
205	01 58 00.5	+ 58 03 47	132.04	- 3.32	9.7	S90
206	01 58 15.8	+ 57 35 51	132.20	- 3.76	10.9	S91
207	01 59 05.9	+ 60 51 45	131.43	- 0.59	12.9	NK
208	02 06 09.3	+ 60 53 30	132.25	- 0.32	15.9	NK
209	02 06 45.0	+ 58 00 19	133.17	- 3.05	14.5:	
210	02 12 32.7	+ 62 39 31	132.43	+ 1.59	14.2:	

Abbreviation in Remarks
S: Stephenson (1973)
I: Ichikawa (1981)
NK: Nikolashvili and Kurtanidze (1985)

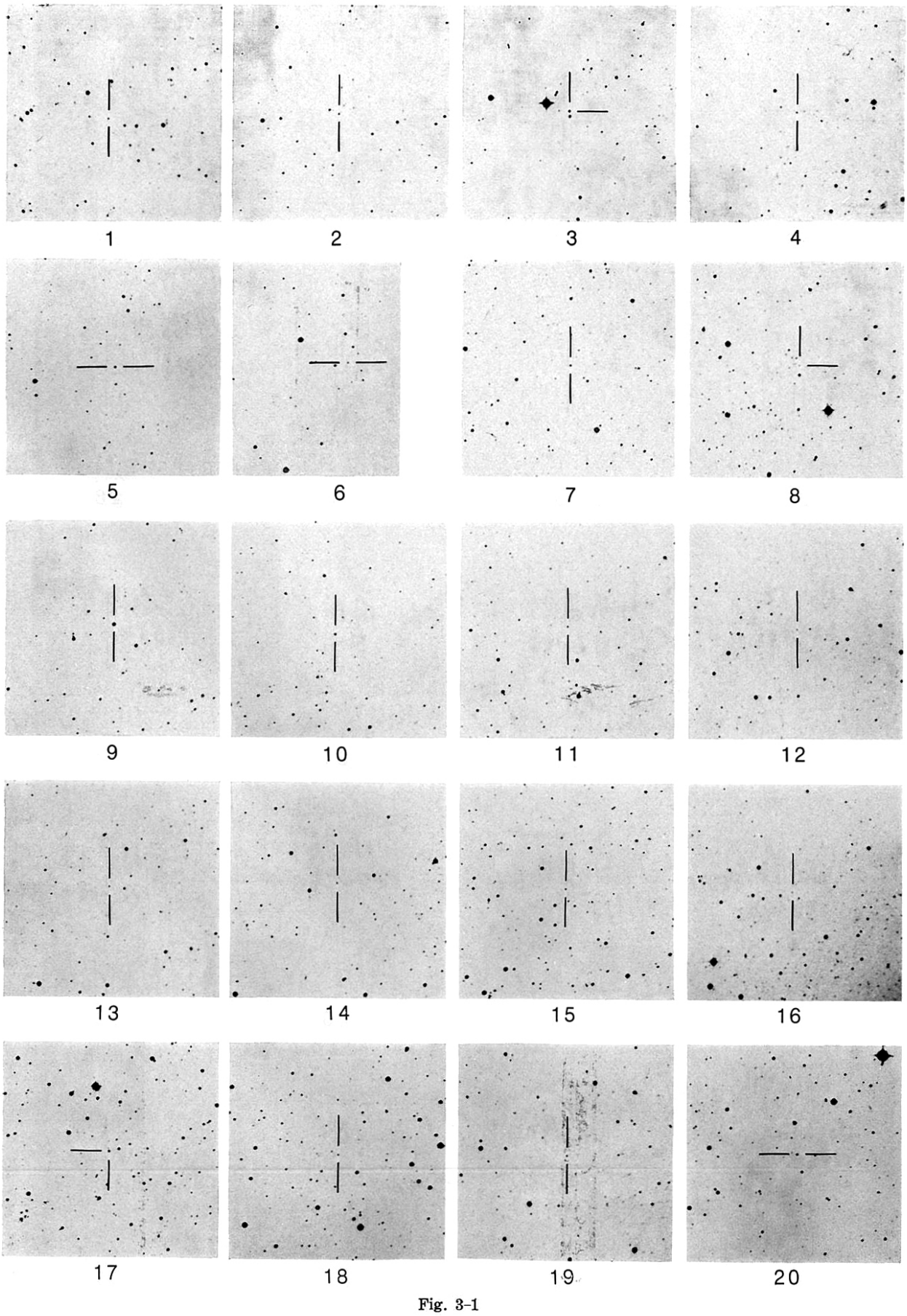
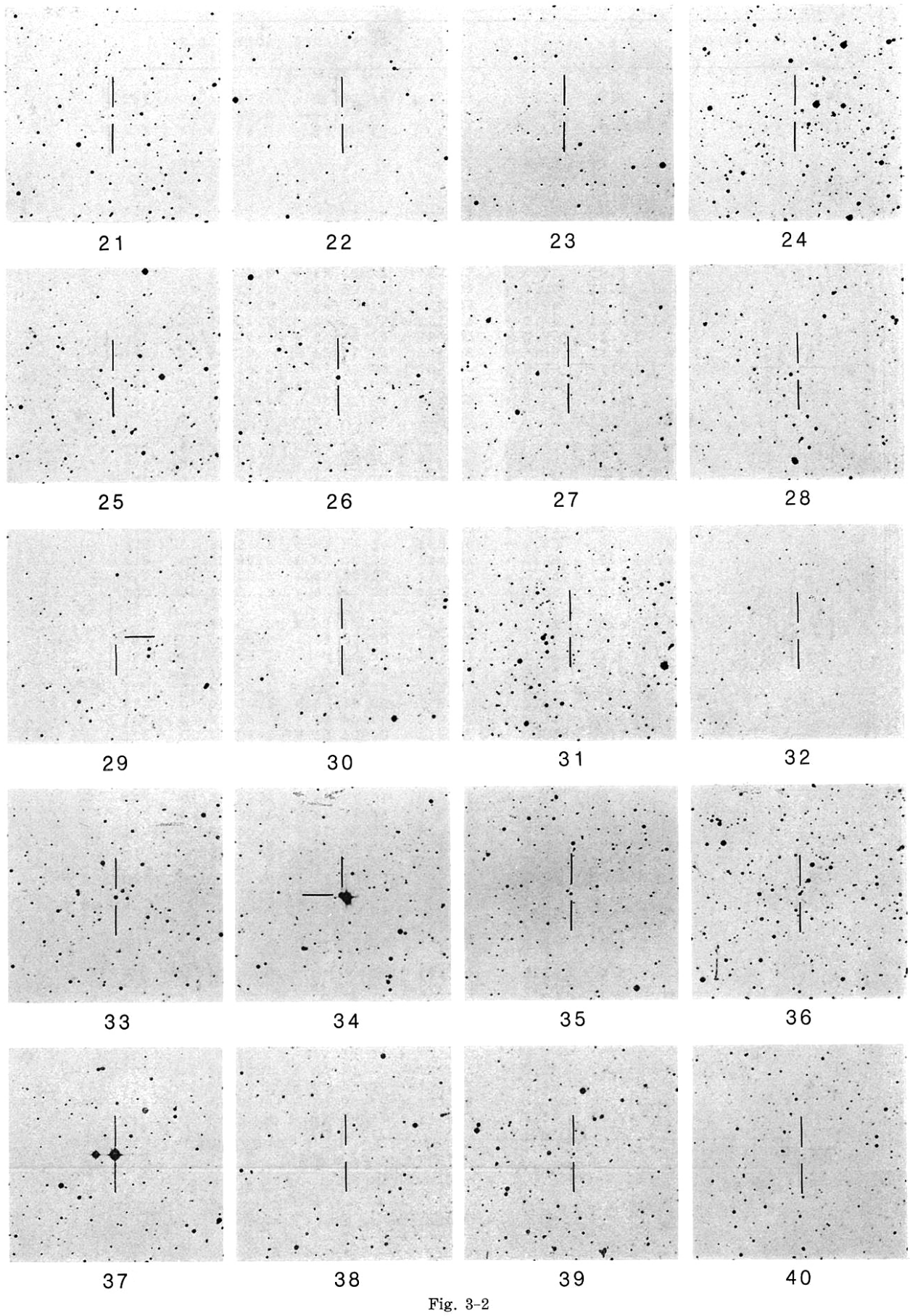


Fig. 3-1



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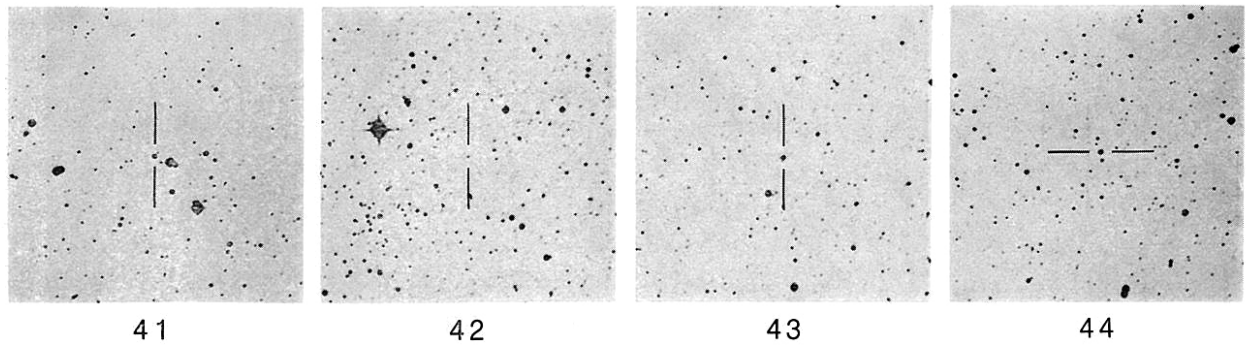
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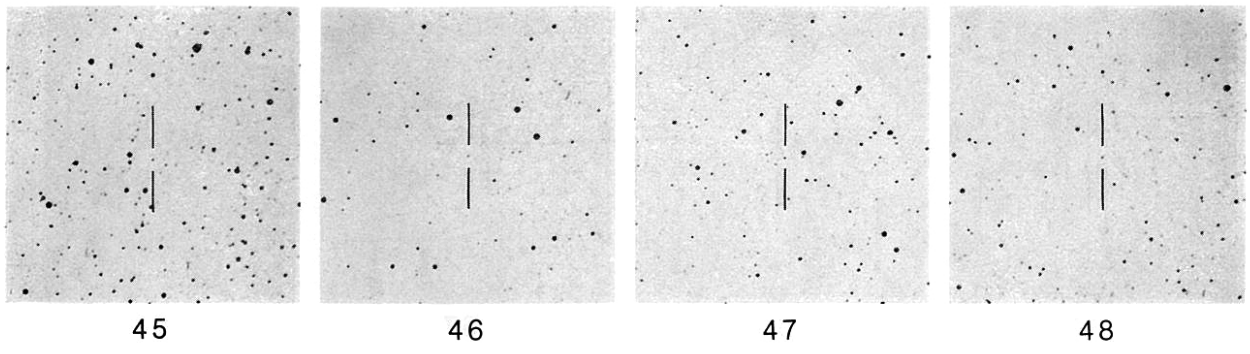
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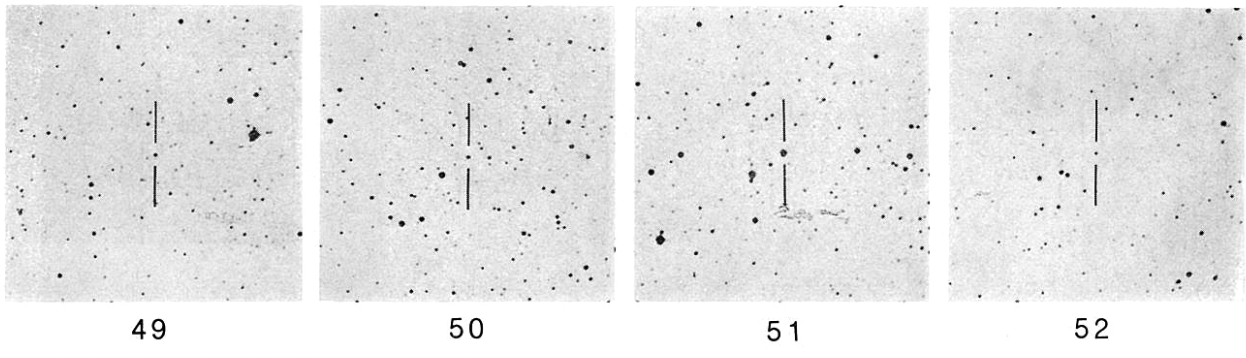
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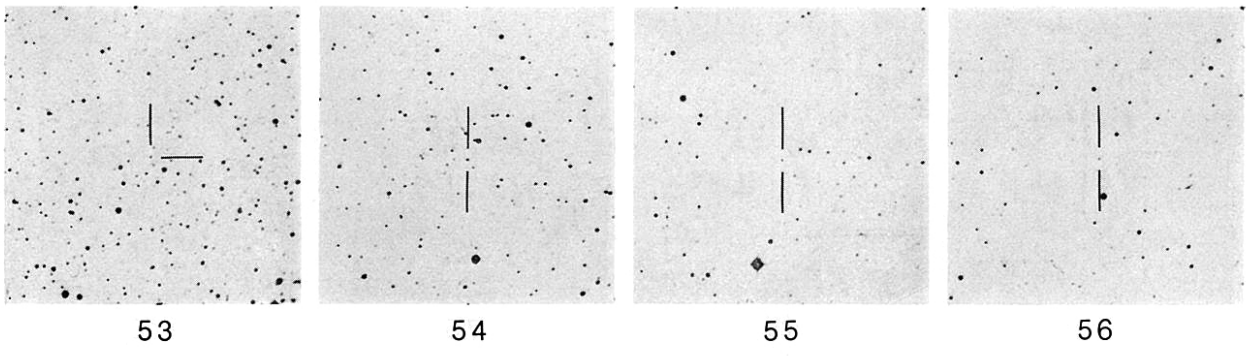
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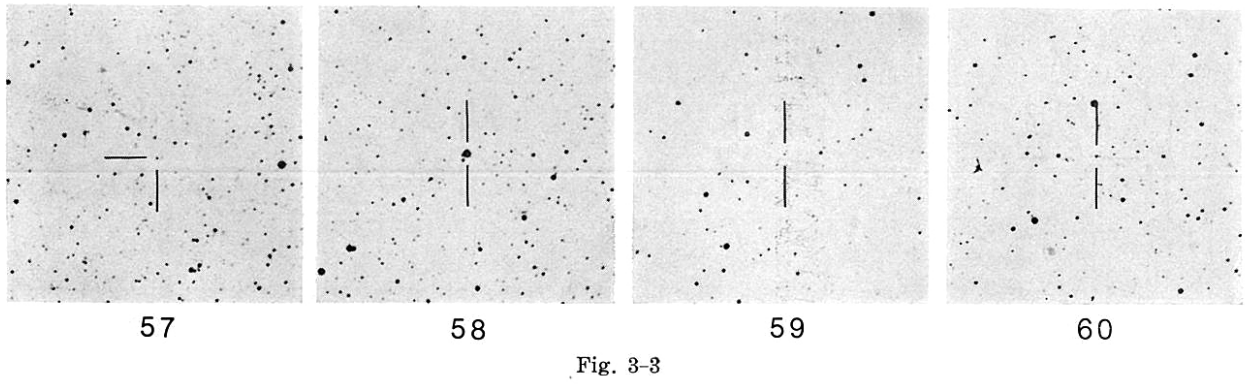
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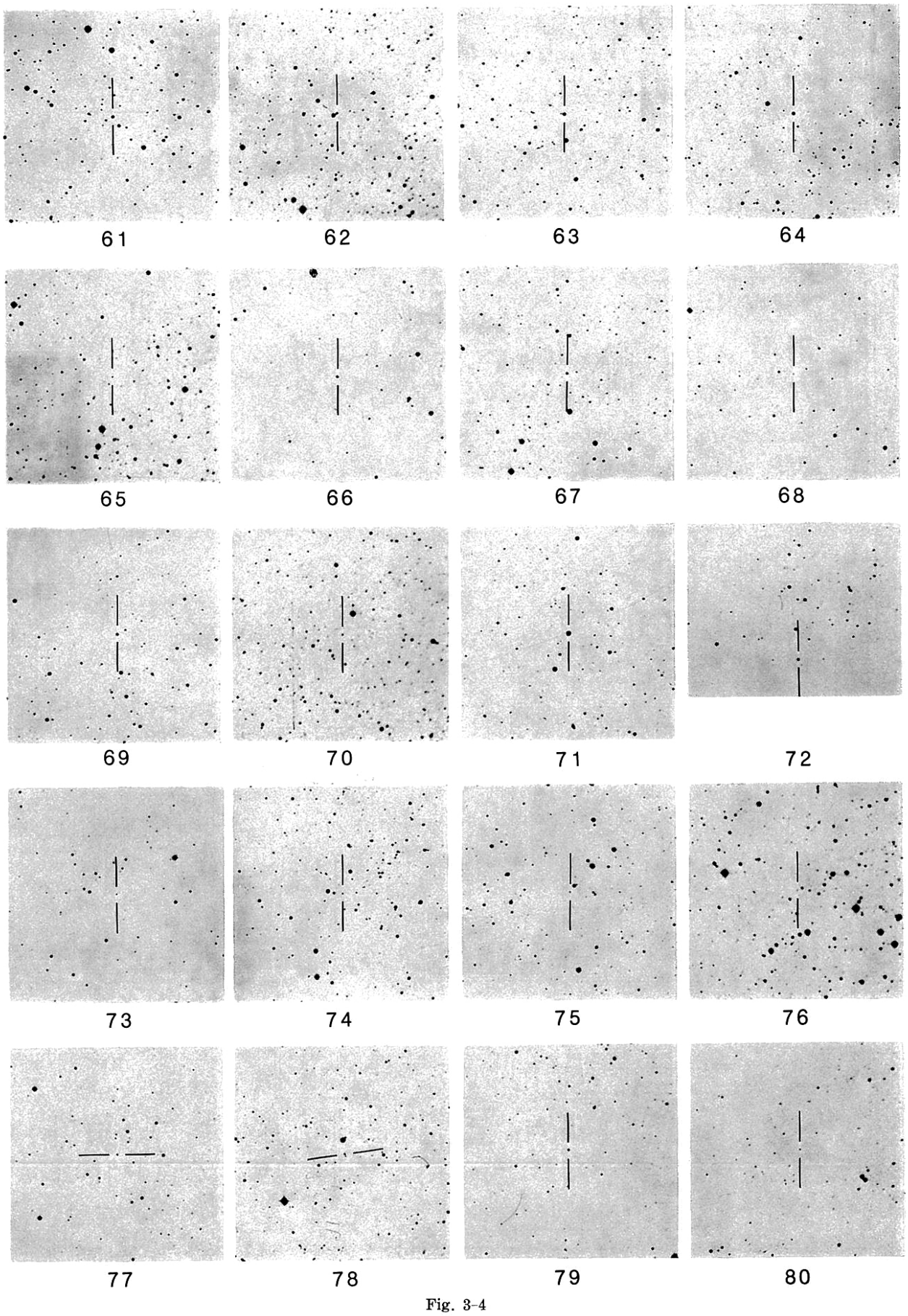

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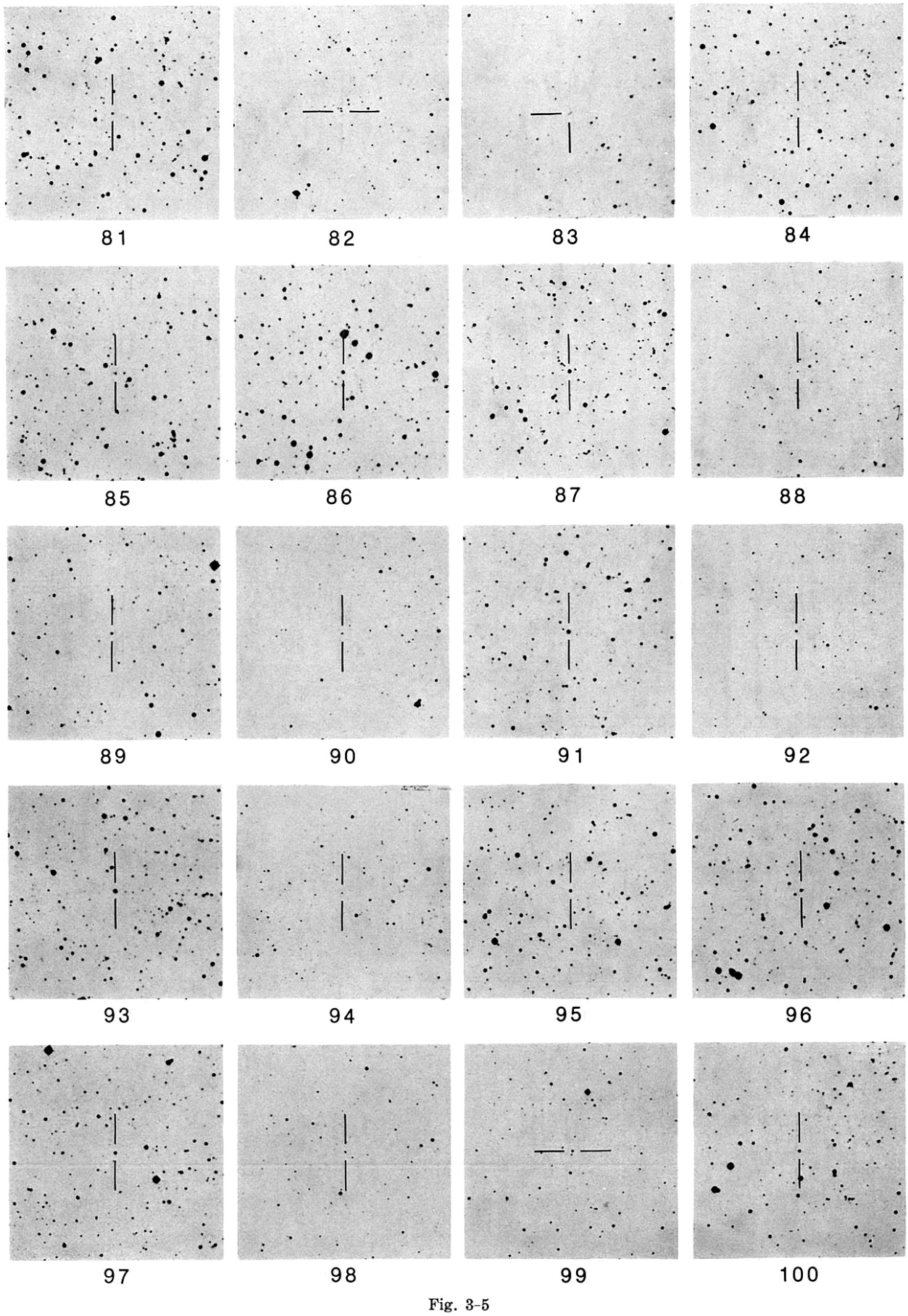

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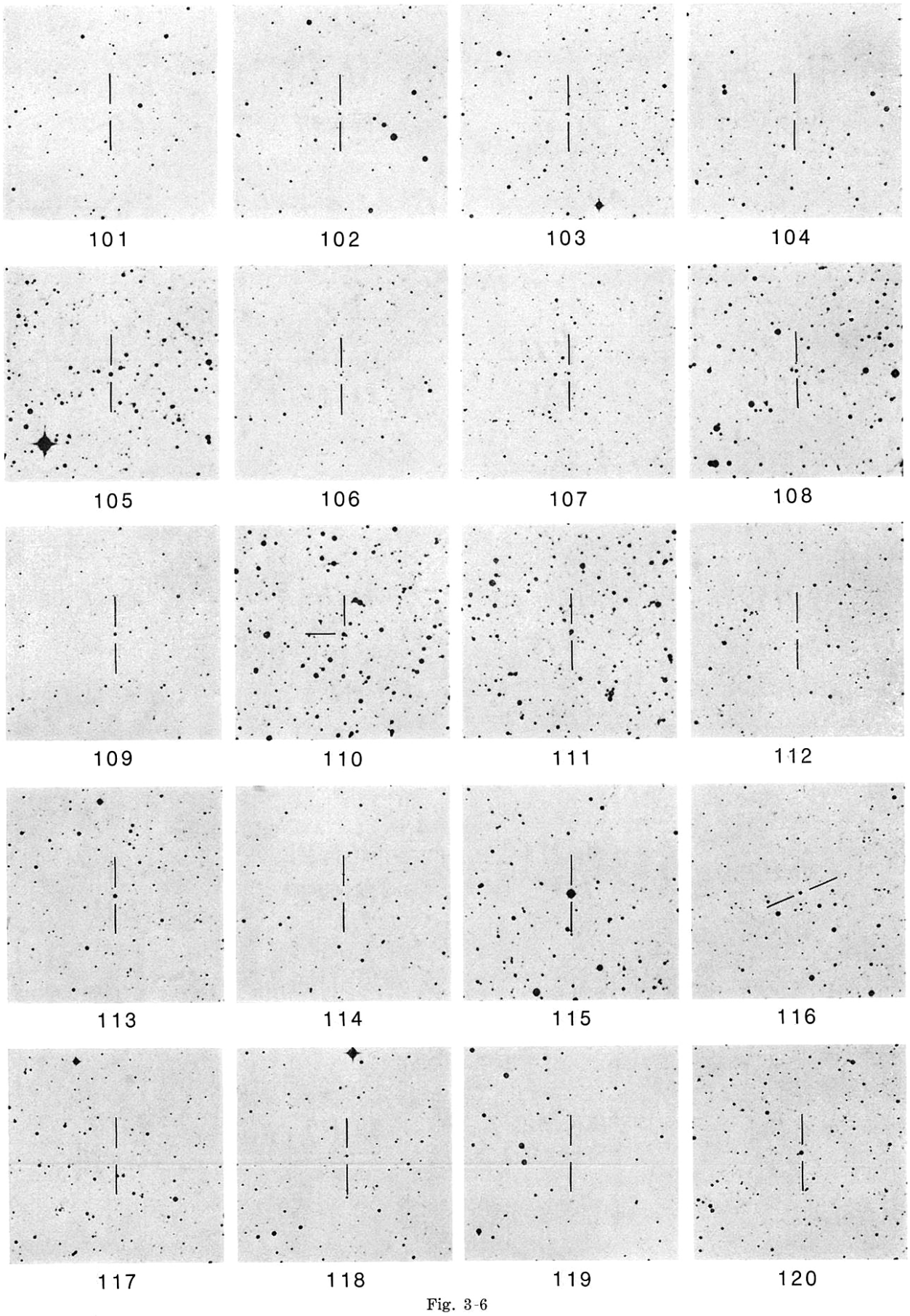
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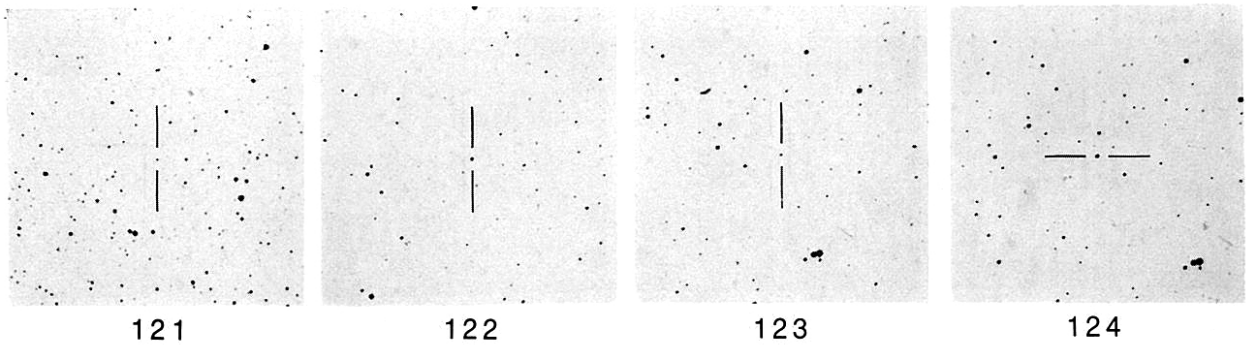
Fig. 3-6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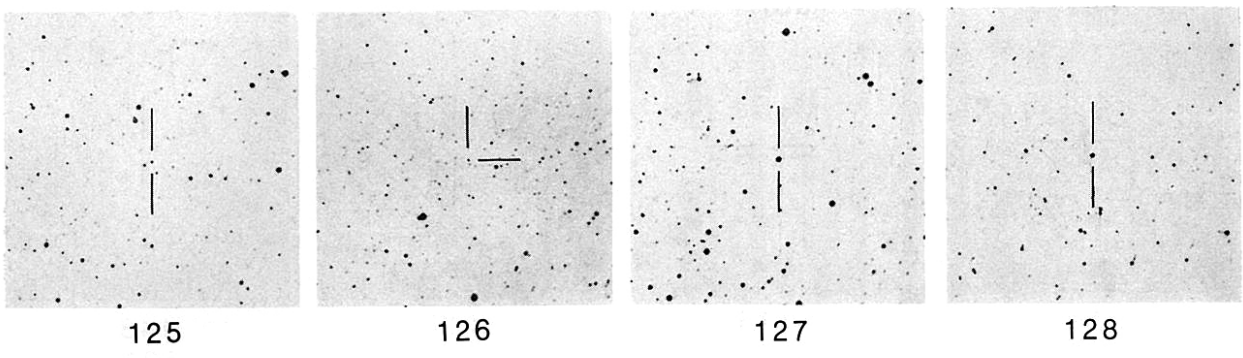
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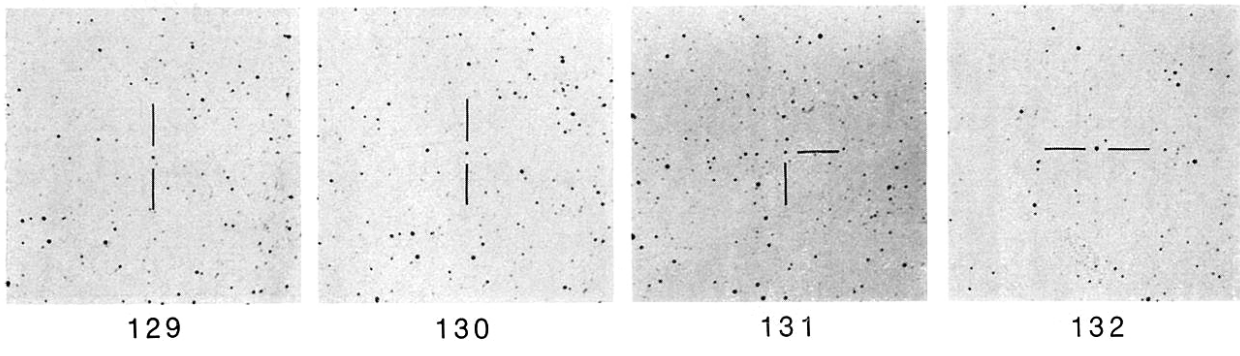
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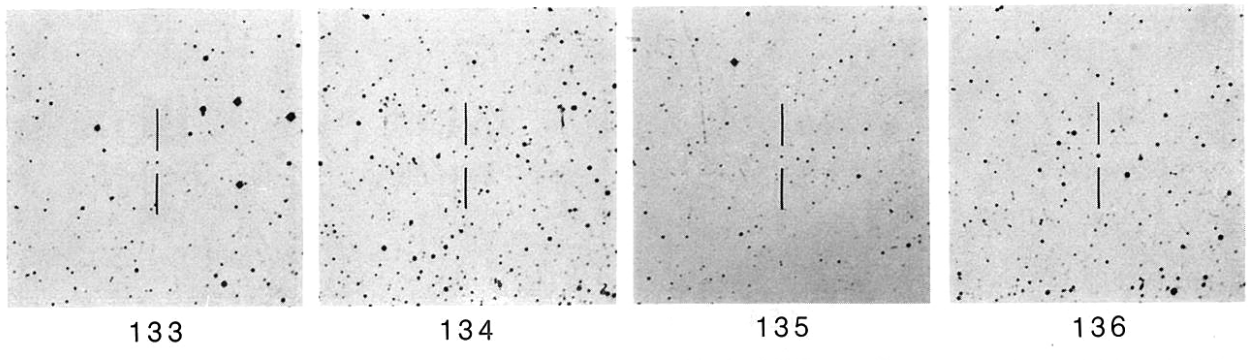
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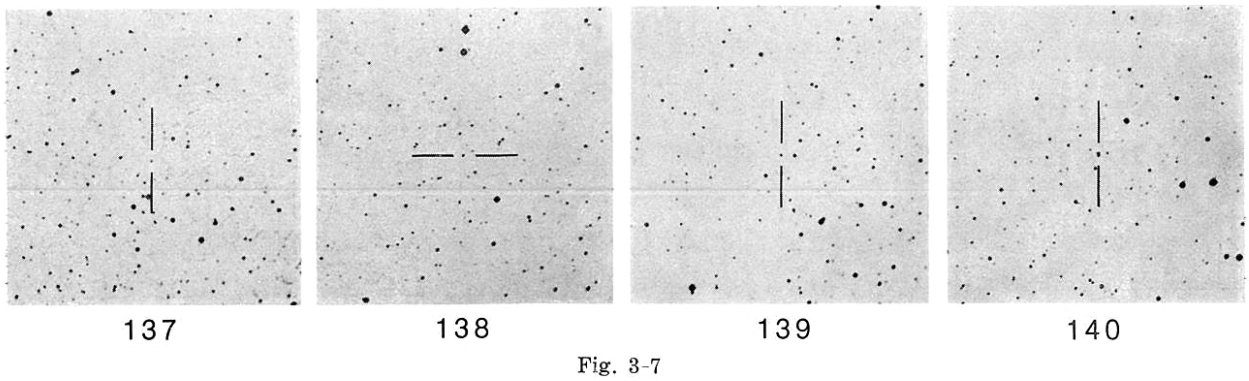
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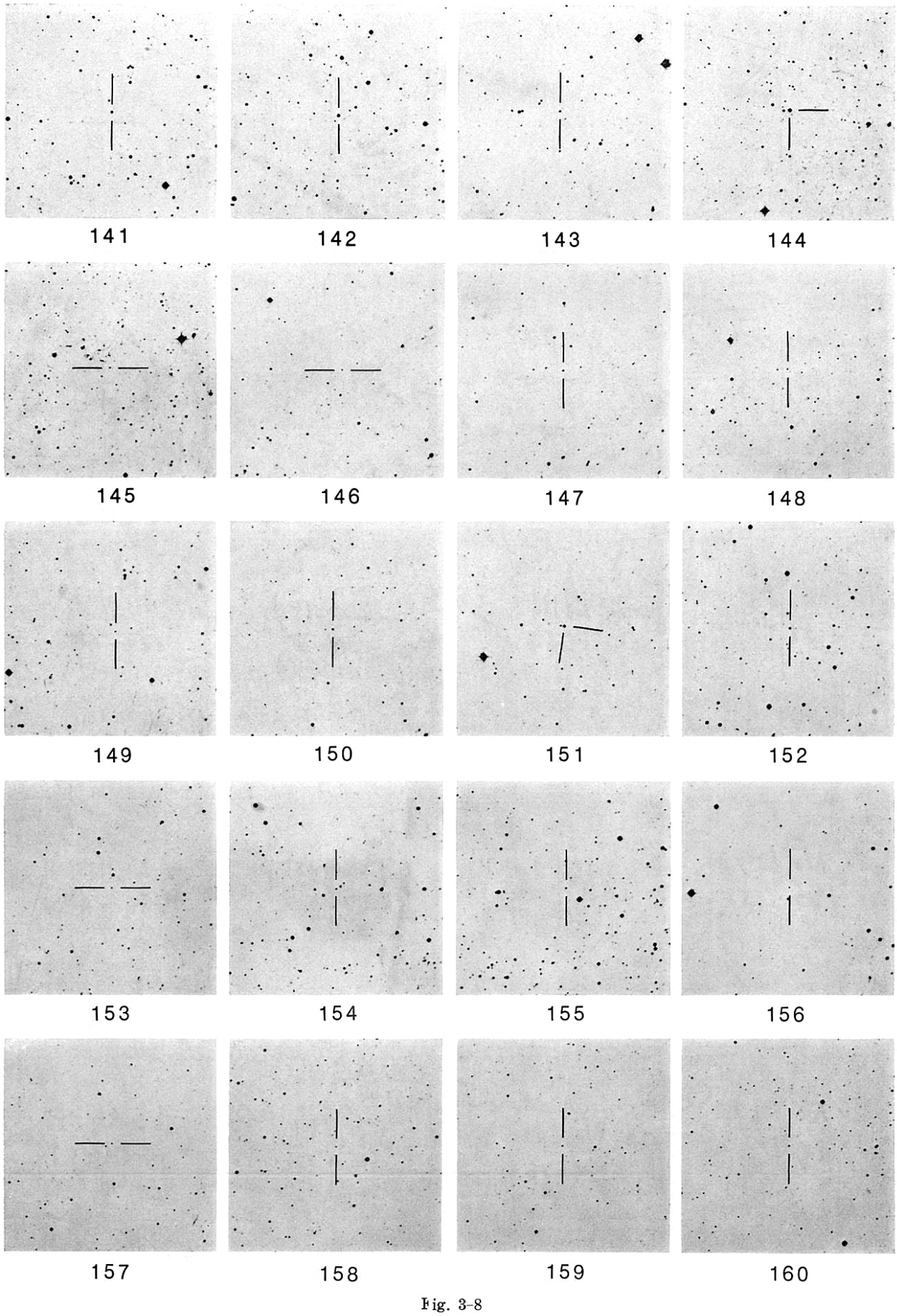
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Fig. 3-8

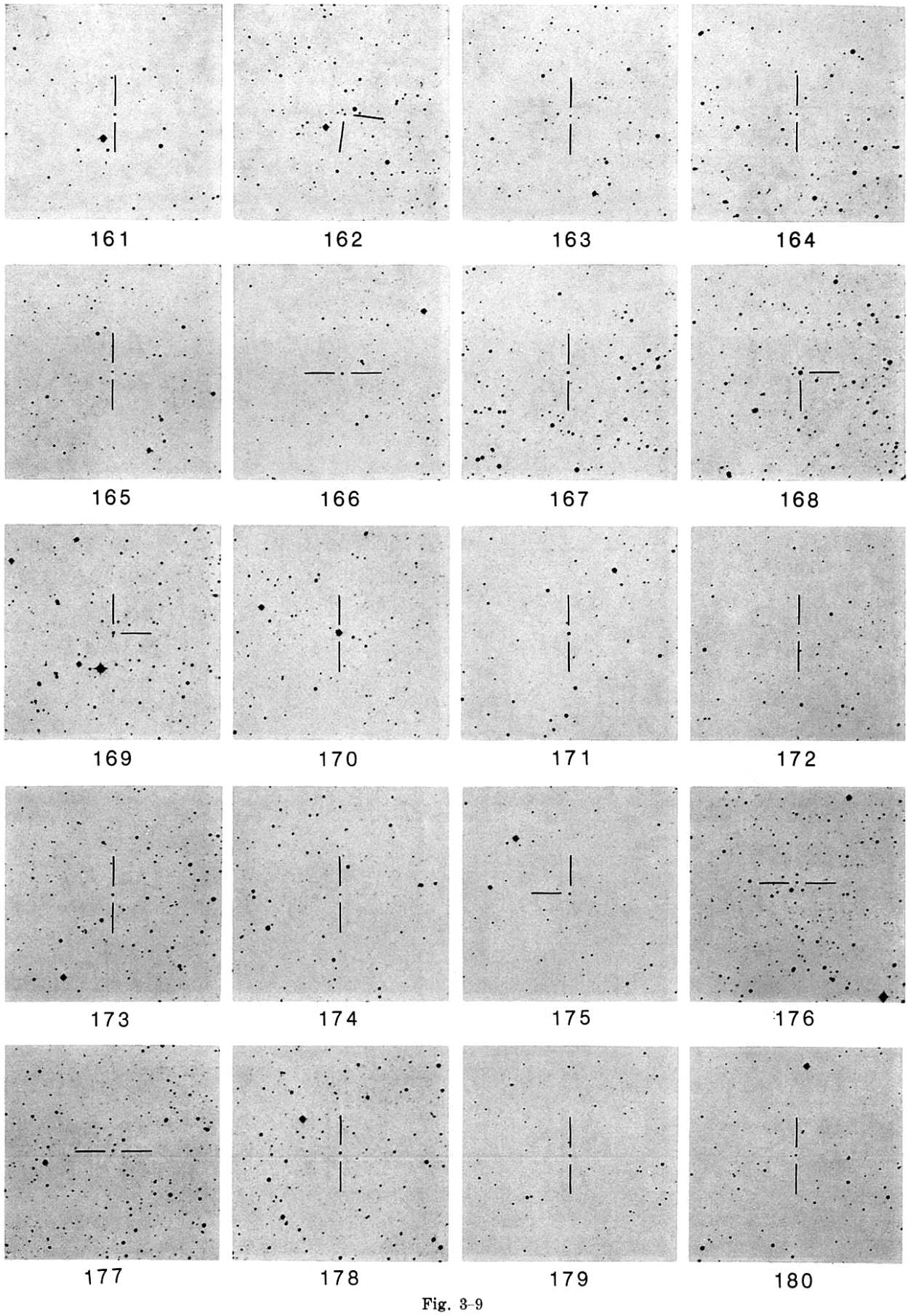
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Fig. 3–9

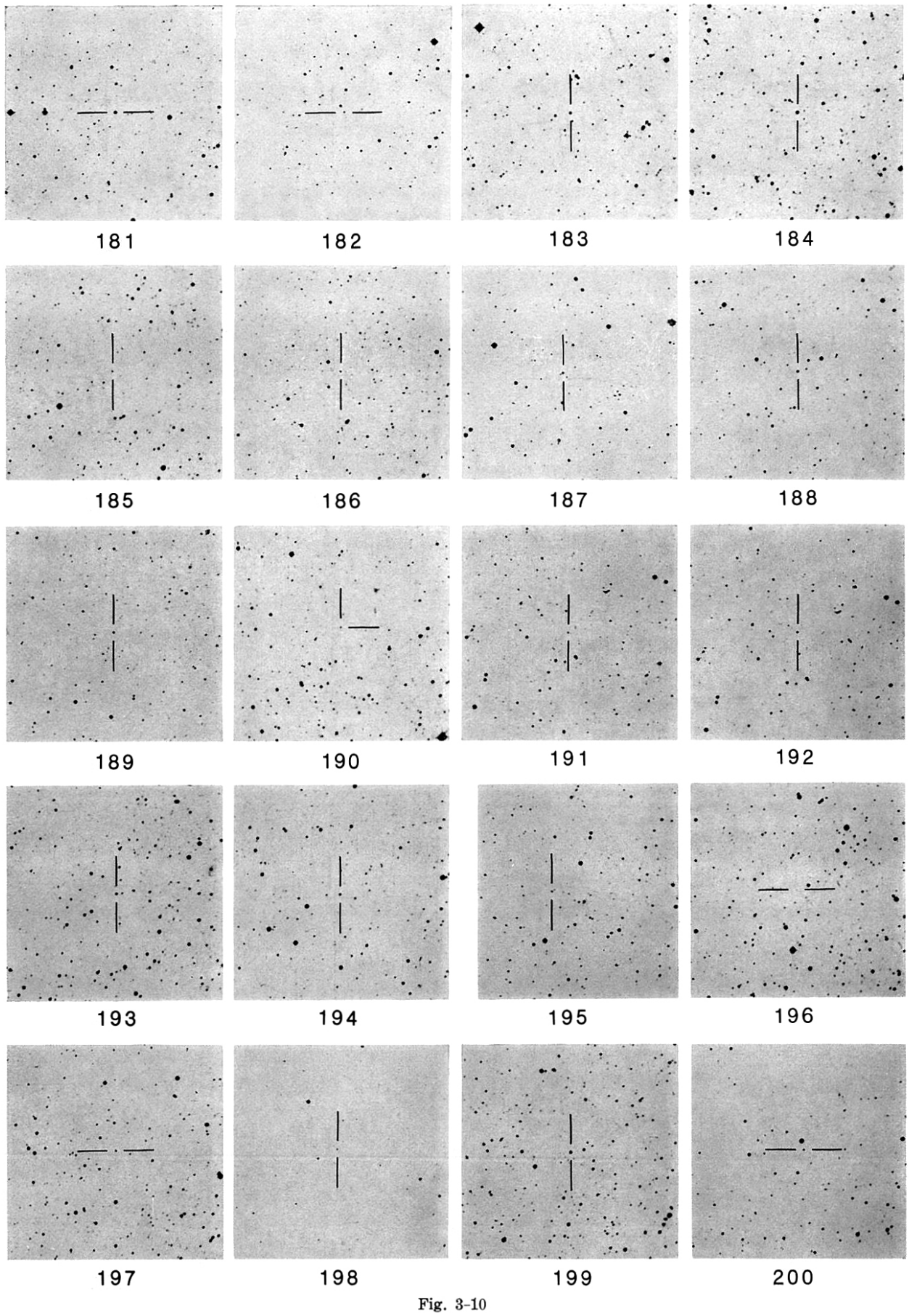
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Fig. 3-10

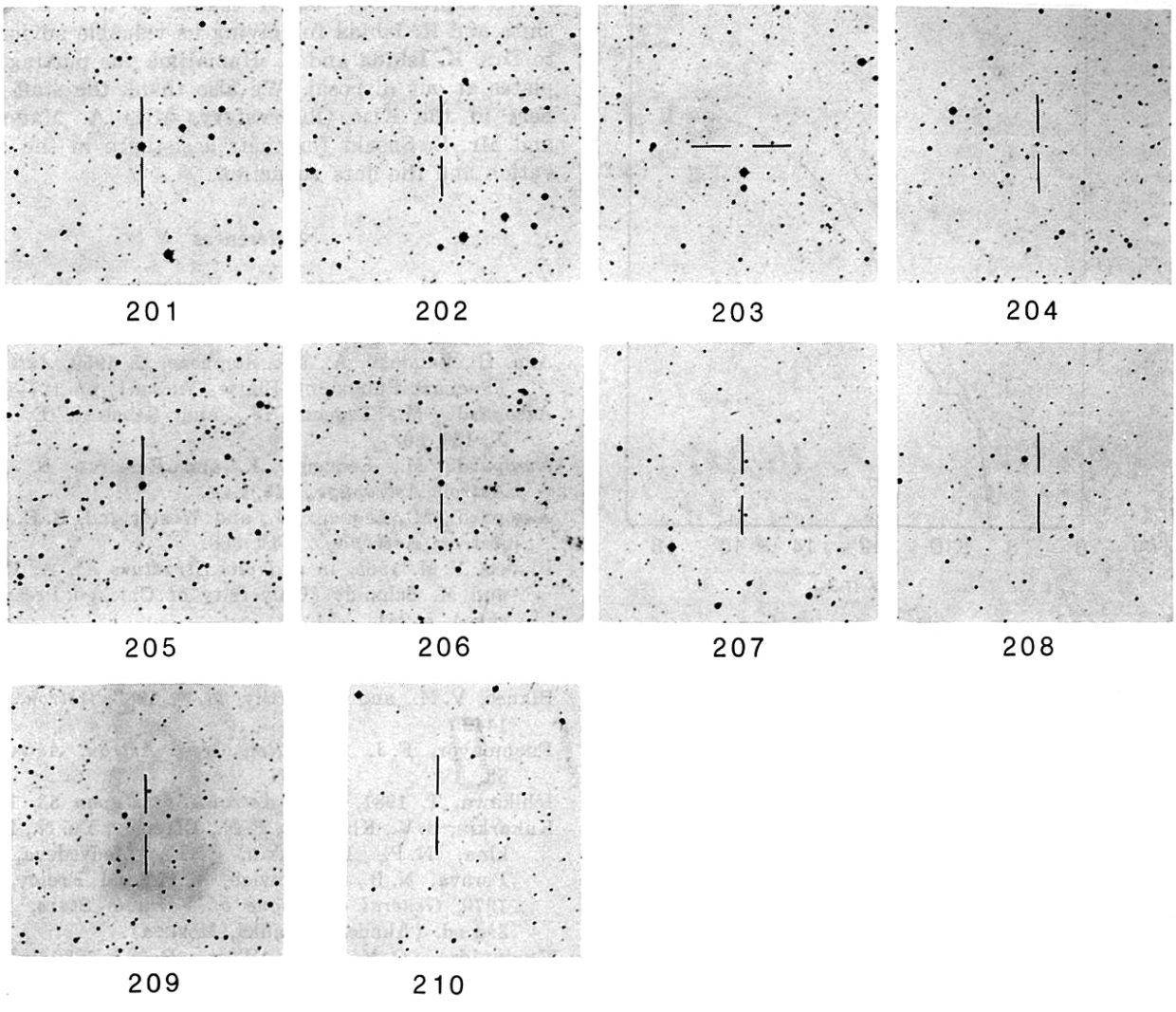

Fig. 3–11

Fig. 3. *Charts of the carbon stars detected in this work. The field is about 10′×10′, and north is up and east to the left.*

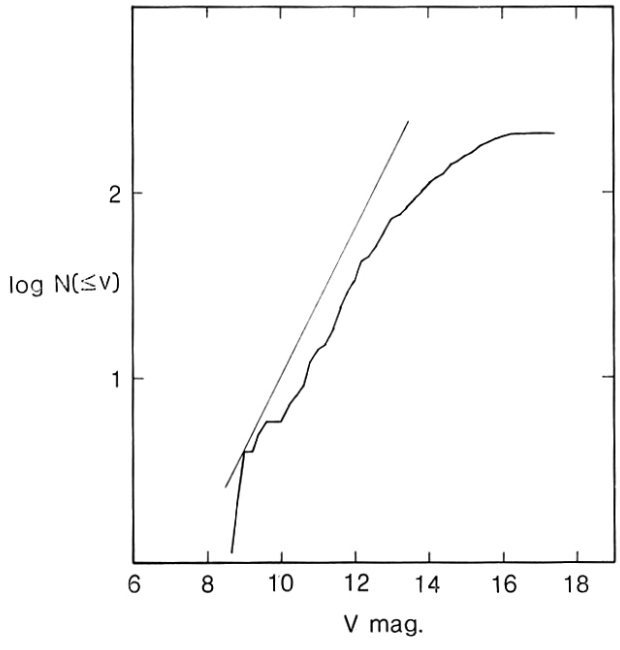

Fig. 4. *Logarithmic cumulative number of the carbon stars versus V magnitude. The thin line denotes the number of the equal-density distribution.*

is twice as much as that of $b=\pm 5°$ in this sample (figure 2).

Concerning the variability of the carbon stars, we consult the general catalogue by Kukarkin et al. (1970). Thirteen variable stars are identified in this sample; 4 Mira, 5 semiregular, and 4 irregular variables. The brightness variation of them is about 2 mag on the average, ranging from 0.6 to 4.3 mag. As a whole, there are so many variables in cool carbon stars, and the variability is possibly a main cause of missing carbon stars listed in previous catalogues. Actually, we miss several carbon stars (Nos. 3203, 15, 48, and 51) in the Stephenson catologue, and several stars found by Ichikawa (1981).

We detect a number of close pairs of carbon stars in this search. There are 8 pairs with the separation of $<6'$, including 2 extremely close pairs (Nos. 163/165 and 191/192) of similar brightnesses. We estimate the expected number of pair carbon stars according to the Scalo et al. (1981) method. As a result, the actual number of pairs with a separation of $\leq 2.3'$ is distinctly more than that of the expected number, and it becomes almost the same for distant pairs. Some of these pairs might be physical ones, although there has been a controversy on the occurrence of close pairs of carbon stars (e.g., Westerlund 1964, Scalo et al. 1981).

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