great strength of these bands in the Cygnus source identify it as a very late-type star. These features and the prominent night-sky features are identified in Figure 2.

These spectra demonstrate the value of an image-tube spectrograph system for obtaining low-dispersion spectra of faint sources with telescopes of moderate size. Observations can be carried out in regions of the spectrum in which photographic plates are relatively slow. Preliminary reductions indicate that radial velocities can be determined with accuracies comparable to those obtained from usual photographic processes.

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OPTICAL IDENTIFICATION OF NEW QUASI-STELLAR RADIO SOURCES

Continuing the program of identification and measurement of quasi-stellar radio sources (QSS) (Sandage and Wyndham 1965; Véron 1965*a*, *b*), we present here the identifications of twenty-one new QSS's, photoelectric data for twenty-three QSS's (eighteen of which are among the new identifications), and optical positions with an accuracy of about 1″ in both coordinates for all known QSS's whose positions are not already published (Griffin 1963; Véron 1965 *a*, *b*). The method of identification is based on published and unpublished radio positions of high accuracy determined at the Owens Valley Radio Observatory. In addition, unpublished positions by Toth, Wade, and Heeschen (1965) and by Wade, Clark, and Hogg (1965) at NRAO, and by Adgie (1964, 1965) at the Royal Radar Establishment, Malvern, were used to identify several[1] of the sources before accurate California Institute of Technology (C.I.T.) positions were available. The identifications for 3C 249.1 and 3C 280.1 were first suggested by Longair (1965).

The new identifications, together with the photometry, are given in Table 1. Table 2 lists the optical positions of previously known QSS's for which no positions have been published. Table 3 gives photoelectric data for previously identified QSS's which have no photometry. The excellent agreement of the radio and optical positions assures that most, if not all, of the sources in Table 1 are properly identified. The abnormal colors

[1] 3C 2, 3C 119, 3C 204, 3C 215, 3C 263, 3C 268.2, and 3C 277.1.

TABLE 1

DATA FOR 21 NEW QUASI-STELLAR RADIO SOURCES

Object	Radio Positions			Optical Positions		Photometry			
	α(1950.0)	δ(1950.0)	Ref.*	α(1950.0)	δ(1950.0)	V	$B-V$	$U-B$	Date (1965)
3C 2.	$00^h03^m48^s.9 \pm 0^s.3$	$-00°21'07'' \pm 10''$	1	$00^h03^m48^s.70$	$-00°21'06''.6$				
43	01 27 15.2±0.5	23 22 43 ±11	1, 2	01 27 15.18	23 22 52.0				
119	04 29 07.9±0 4	41 32 01 ±10	1	04 29 07.84	41 32 08.7				
138.	05 18 16.5±0.3	16 35 30 ±10	1	05 18 16.51	16 35 26.2	18.84	0.53	−0.16	Mar. 26–27
181.	07 25 20.3±0.3	14 43 54 ±10	1	07 25 20.36	14 43 47.2	18.92	0.43	−1.02	Mar. 26–27
186.	07 40 56.6±0.4	38 00 25 ±10	1	07 40 56.67	38 00 31.9	17 60	0.45	−0.71	Jan. 9–10
191.	08 02 04.0±0.3	10 24 08 ±10	1	08 02 03 78	10 23 58.1	18.4	0.25	−0.84	Jan. 9–10
204.	08 33 18.6±0.5	65 24 06 ±10	1	08 33 18.23	65 24 05.9	18.21	0.55	−0.99	Mar. 26–27
207	08 38 02.4±0.3	13 23 01 ±10	1	08 38 01.73	13 23 05 4	18.15	0.43	−0.42	Mar. 26–27
215	09 03 44.1±0.4	16 58 10 ±10	1	09 03 44.15	16 58 15 7	18.27	0.21	−0.66	Jan. 9–10
247	10 56 09.8±0.5	43 17 25 ±10	1	10 56 08.93	43 17 35 4	18.82	0.52	−0.25	Mar. 28–29
249.1.	11 00 30.5±2.2	77 15 05 ±10	1	11 00 30.56	77 15 08.1	15 72	−0.02	−0.77	Mar. 26–27
261.	11 32 17.2±0.5	30 21 51 ±10	1	11 32 16.31	30 22 01.0	18.24	0.24	−0.56	Mar. 26–27
263	11 37 10.5±0.7	66 04 26 ±10	1	11 37 09.38	66 04 25.9	16.32	0.18	−0.56	Mar. 28–29
268.2.	11 58 22.5±0.6	31 50 08 ±10	1	11 58 26.61	31 50 29.8	18.31	0.42	−0.20	Mar. 28–29
270.1	12 18 04.6±0.5	33 59 44 ±10	1	12 18 04.00	33 59 50.0	18.61	0.19	−0.61	Mar. 26–27
275.1	12 41 28.0±0.3	16 39 23 ±10	1	12 41 27.68	16 39 18.7	19.00	0.23	−0.43	Jan. 9–10
277.1	12 50 15.9±0.5	56 50 27 ±10	1	12 50 15.31	56 50 37 0	17.93	−0.17	−0.78	Mar. 28–29
280.1.	12 58 14.4±1.0	40 25 12 ±10	1, 3	12 58 14.15	40 25 15 4	13 44	−0.13	−0.70	Mar. 26–27
281.	13 05 23.0±0.3	06 58 06 ±10	1	13 05 22.52	06 58 16.4	17.02	0.13	−0.59	Mar. 26–27
336.	16 22 32.9±0.4	23 52 21 ±10	1	16 22 32.45	23 52 00.7	17 47	0.44	−0.79	Mar. 28–29

* References for the radio positions:
1. Fomalont, E. B., Wyndham, J. D., and Bartlett, J. F. 1965 (in preparation). Errors quoted are preliminary.
2. Read, R. B. 1963, *Ap. J.*, **138**, 1 (δ only).
3. Clark, M. E. 1964, *M.N.*, **127**, 405 (α only).

and star-like images on the Palomar Sky Survey prints confirm that the sources are all QSS's rather than normal radio galaxies.

Finding charts for nineteen of the twenty-one objects are shown in Figure 1 as taken from the Sky Survey prints for all except 3C 119, which is reproduced from a 200-inch plate. North is at the top, west to the right. Several objects of special interest deserve individual comment.

3C 2: This object is either at the plate limit or is invisible on the blue Palomar Sky Survey plate taken on September 27–28, 1954. It is definitely present on the red Survey plate, appearing about 0.3^m above the plate limit. If these particular plates attain the

TABLE 2

NEW OPTICAL POSITIONS OF QSS'S

Object	α(1950 0)	δ(1950 0)	References*
3C 9	$00^h17^m49^s.83$	$+15°24'16''.5$	1
47.	01 33 40 30	+20 42 16 0	3
208	08 50 22 79	+14 03 58 3	4
216	09 06 17 26	+43 05 59 0	1
245	10 40 06 11	+12 19 15 1	1, 2
279	12 53 35 94	−05 31 08 0	4
334	16 18 07 40	+17 43 30 5	5, 7
MSH 13-011	13 35 31 34	−06 11 57 4	4

* References:
1 Ryle, M , and Sandage, A. 1964, *Ap J.*, **139,** 419
2 Hazard, C., Mackey, M B , and Nicholson, W 1964, *Nature*, **202,** 227
3 Schmidt, M , and Matthews, T A 1964, *Ap J* , **139,** 781
4 Sandage, A , and Wyndham, J. D. 1965, *Ap J* , **141,** 328
5 Wyndham, J. D. 1965, *A J* , **70,** 384
6 Adgie, R. L 1964, *Nature*, **204,** 1028
7 Bolton, J G 1965, private communication

TABLE 3

PHOTOELECTRIC DATA NOT PREVIOUSLY PUBLISHED

Object	V	$B-V$	$U-B$	Date (1965)	References*
3C 254	17 98	0 15	−0 49	Jan. 9–10	6
279	17 75	26	− 56	Mar. 26–27	4
298	16 79	33	− 70	Jan. 9–10	6
334	16 41	12	− 79	Mar 28–29	5, 7
MSH 13-011	17 68	0 14	−0 66	Mar. 28–29	4

* The references to the identifications are given in n * of Table 2.

limiting magnitudes of the average Sky Survey plates (Minkowski and Abell 1963), 3C 2 was at $B \geq 21.1^m$, $R = 19.7^m$, with a color of $B - V = 1.4\sqrt{1.6} = 0.9^m$ on this date.

Plates taken on November 25–26 and November 27–28, 1964, with the 200-inch and 48-inch Schmidt telescopes showed that the QSS had become brighter by at least $\Delta B = 1.5^m$, appearing as a very blue object at $B \simeq 19.5^m$. On twelve blue plates taken of the region by Gehrels with the 48-inch between September and October, 1960, the object is clearly visible, but near the plate limit. Magnitude estimates, very kindly made by van Houten, suggest slight variations around a mean magnitude of $B \simeq 20.5^m$. A red plate taken by Luyten on September 26–27, 1962, shows the object near the red

plate limit. A blue plate taken by Berger on August 20–21, 1963, and a blue plate taken by Véron in November, 1964, show 3C 2 to be at about $B = 19.5^m$. The abnormal blue brightening must, therefore, have taken place between September 27–28, 1954, and August 20–21, 1963. Moreover, if we can trust the red color from the 1954 Survey plates, the object changed color, becoming bluer during the outburst. Figure 2, reproduced from the 200-inch plates of 1964, shows 3C 2.

3C 43: This radio source was independently identified by Matthews (1964) and by Parker (1964). It became fainter by about $\Delta B = 0.9^m$ between the date of the Sky Survey plate (September 25–26, 1954) and our Schmidt plates of January 6–7, 1965. The estimated magnitudes are $B \simeq 19.6^m$ on the 1954 blue Survey plates and $B \simeq 20.5^m$ in January, 1965. A reject Survey plate on November 27–28, 1951, shows 3C 43 to be about $B = 20.0^m$—intermediate between the 1954 and 1965 intensities.

Intensity variations have been observed (Sandage 1964) in five other QSS's (3C 48, $\Delta B = 0.30^m$, observed for 16 nights over 4 years; 3C 273, $\Delta B = 0.25^m$, on 20 nights over 13 months; 3C 47, $\Delta B = 0.20^m$, on 2 nights over 9 months; 3C 196, $\Delta B = 0.27^m$ on 6 nights over 11 months; and 3C 216, $\Delta B = 0.27^m$ on 2 nights over 5 months), but none has reached the amplitudes of 3C 2 and 3C 43. Only 3C 2 has shown an apparent change of color—an observation which must be considered as uncertain because the image is close to the plate limit.

3C 119: This object, at galactic latitude $b^{II} = -4°$, has a large ultraviolet excess as shown by an ultraviolet and a yellow plate taken with the 200-inch, but it is about 2″ SW. of a bright star, making it impossible to get photoelectric data. The excellent agreement between the radio and optical positions leaves no doubt on the identification.

3C 138: This object is at a low galactic latitude of $b^{II} = -11°$. If we assume the reddening is $E(B - V) = 0.30^m$, the colors become $(B - V)_0 = 0.23^m$, $(U - B)_0 = -0.38^m$, and it is in the region characteristic of QSS's in the $U - B$, $B - V$ diagram. Independently identified by Bolton (1965) and by Matthews (1965). Source 0518 + 16.

3C 191: Independently identified by Bolton (1965). Source 0802 + 10.

3C 249.1: First suggested by Longair (1965). With $V = 15.72$, this is the second brightest QSS after 3C 273.

3C 268.2: At the limit of the QSS region of the $U - B$, $B - V$ diagram. The colors are those of an extreme subdwarf! The radio and optical positions disagree in declination.

3C 275.1: A suggested identification with the peculiar galaxy NGC 4651 by Davies and Longair (1964). Precise radio positions by Toth *et al.* (1965), and by Fomalont, Wyndham, and Bartlett (1965), show the galaxy is not the source, despite its peculiar jet and counterjet. The blue object marked in Figure 3 is the correct identification.

3C 277.1: The photoelectric data are not conclusive in showing this to be a QSS. The $B - V$ is very blue compared with known QSS's. It may be a blue star with near-main-sequence colors.

3C 280.1: First suggested by Longair (1965). Same remarks on the colors as for 3C 277.1.

Finally, we should point out that new, accurate C.I.T. positions of 3C 228, together with an optical position, show that the identification proposed by Sandage (Sandage and Wyndham 1965) is wrong. The C.I.T. position (1950.0) of $9^h47^m28^s.3 \pm 0^s.6$, $+ 14°34'06'' \pm 11''$ differs too much from the previously suggested optical object at $9^h47^m25^s.38$, $+ 14°34'40''.0$. There is nothing on the Sky Survey prints at the radio position. The optical object is probably an interloper similar to the four objects with strong ultraviolet excess near the positions of 3C 194, 3C 205, 3C 225, and 3C 280, and the many blue stellar objects discussed elsewhere (Sandage and Véron 1965).

Two of us (A. S. and P. V.) are very grateful to the NRAO observers and to Adgie for sending us their accurate radio positions before publication. Our thanks also go to

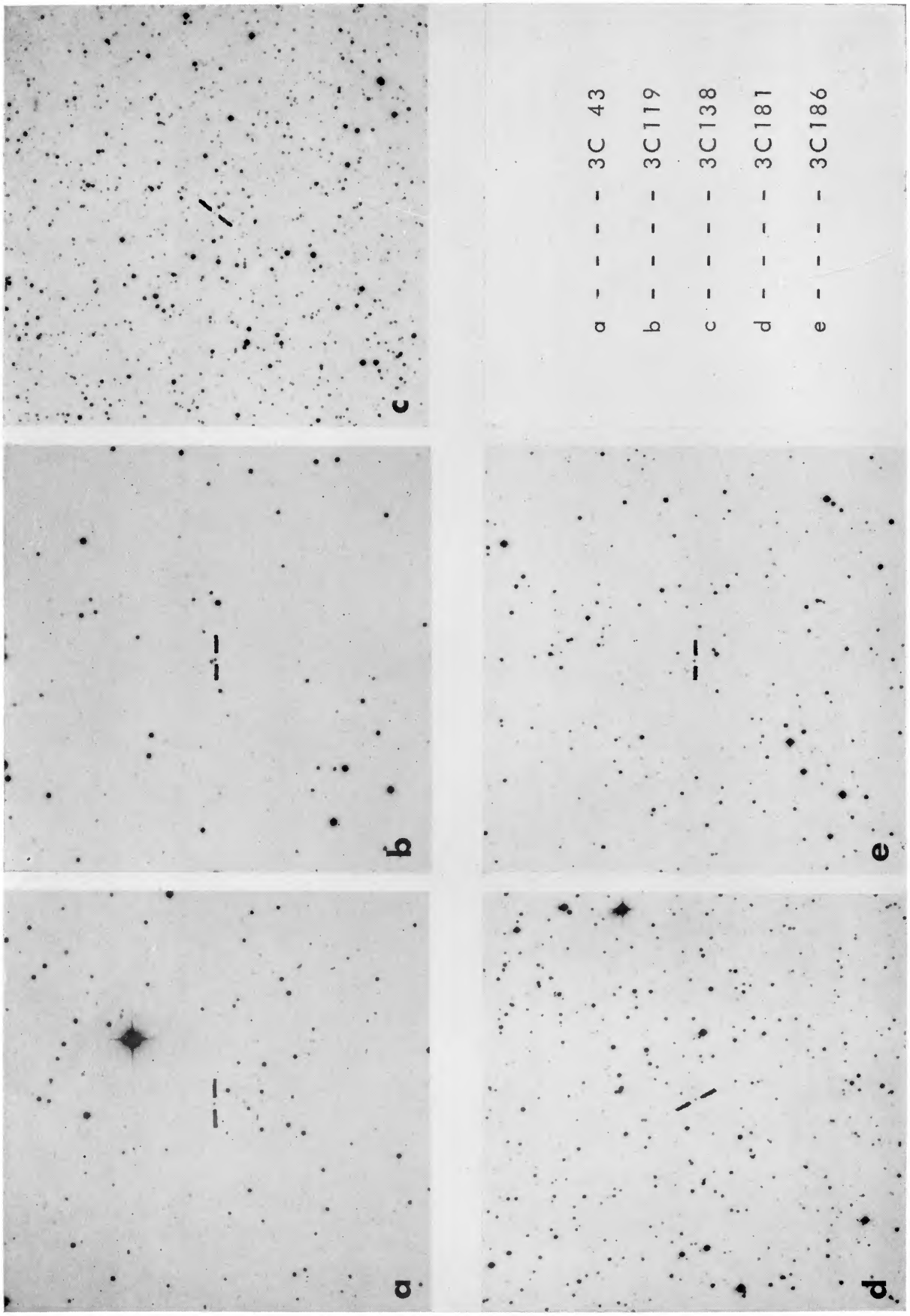

FIG. 1.—Identification charts for 19 of the new QSS's, reproduced from the 48-inch Schmidt Sky Survey charts, except for 3C 119, which is from a 200-inch plate

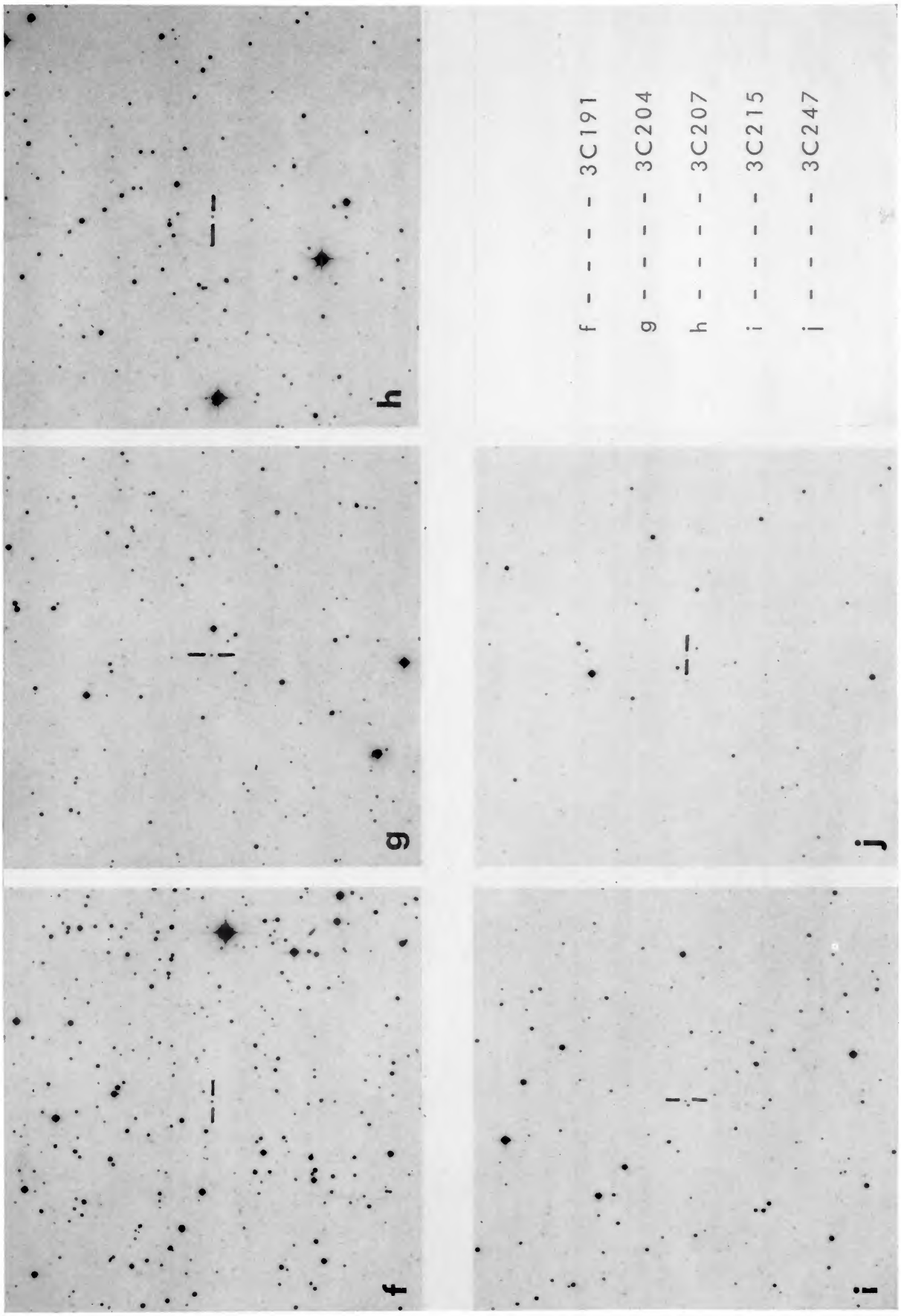

FIG. 1.—*Continued*

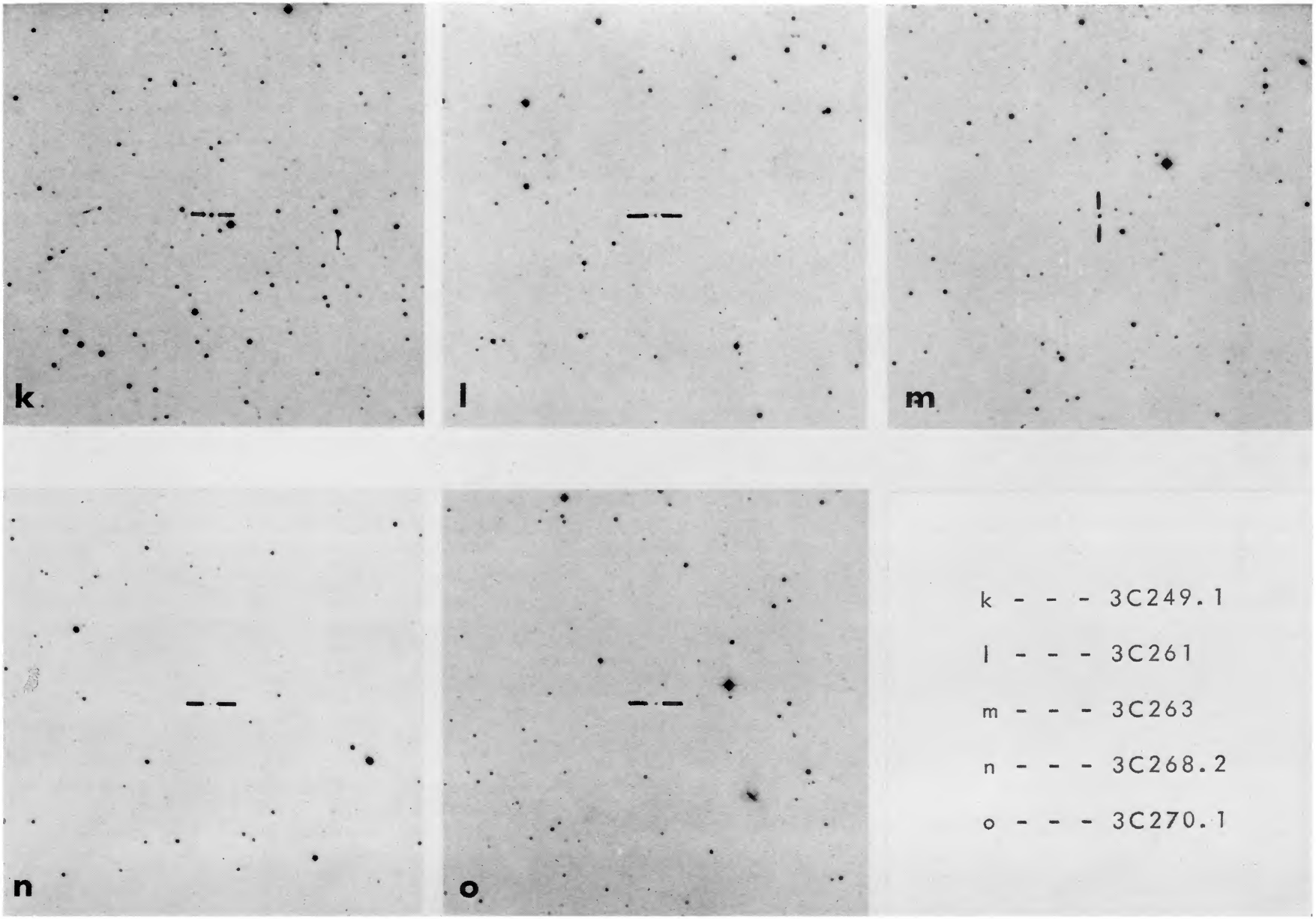

FIG. 1.—*Continued*

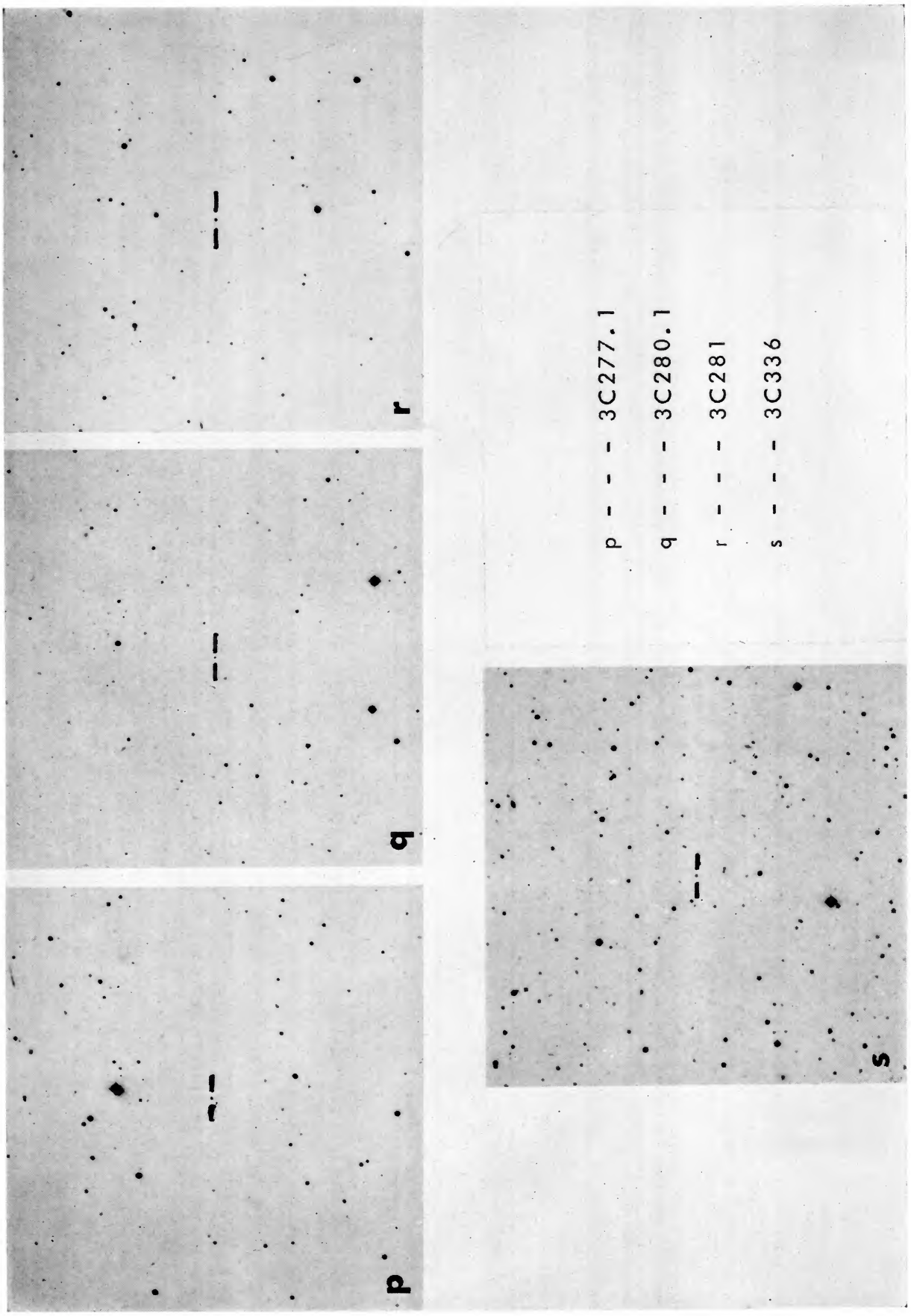

FIG. 1.—*Continued*

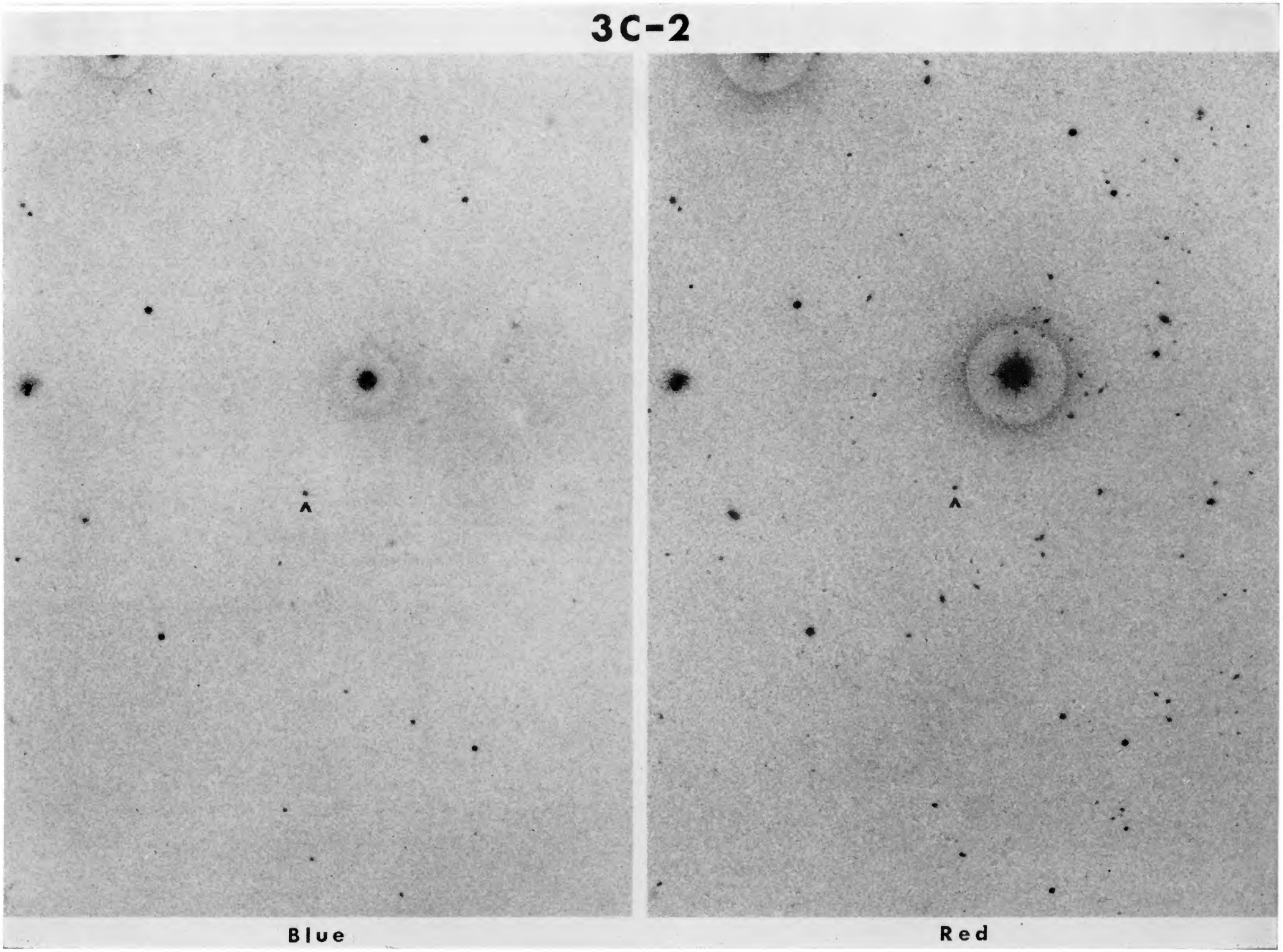

FIG. 2.—3C 2 reproduced from 200-inch plates taken on November 25–26, 1964, on 103a-O and 103a-E + RG1 plates

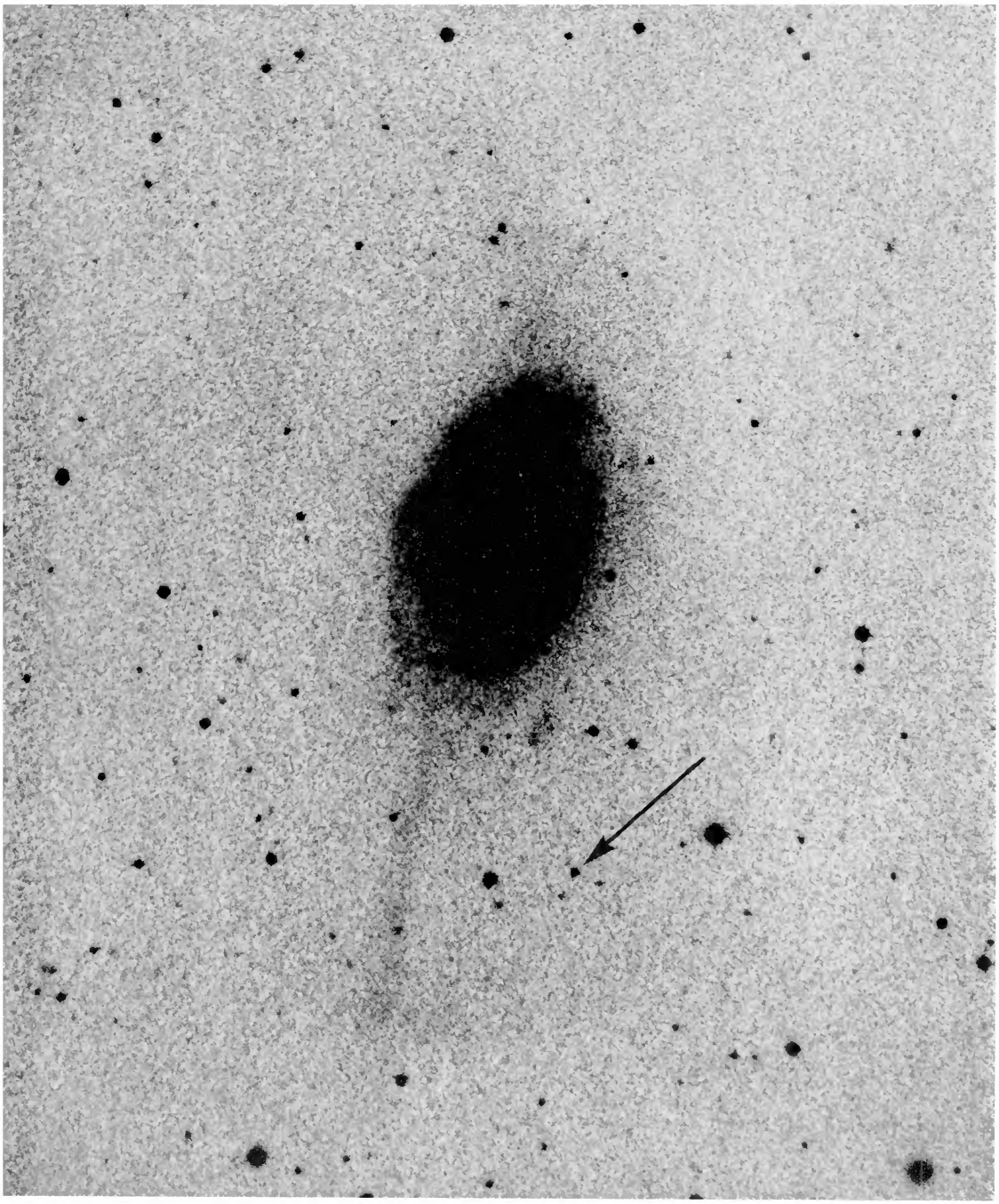

FIG. 3.—Field of 3C 275.1 showing the QSS and the peculiar galaxy NGC 4651. The reproduction is from three 48-inch Schmidt blue plates combined by W. C. Miller by multiple printing to show the jet, counter-jet, and elliptical halo of this superposed foreground galaxy. The two shorter exposure prints of the galaxy are shown to illustrate the nuclear regions of the spiral.

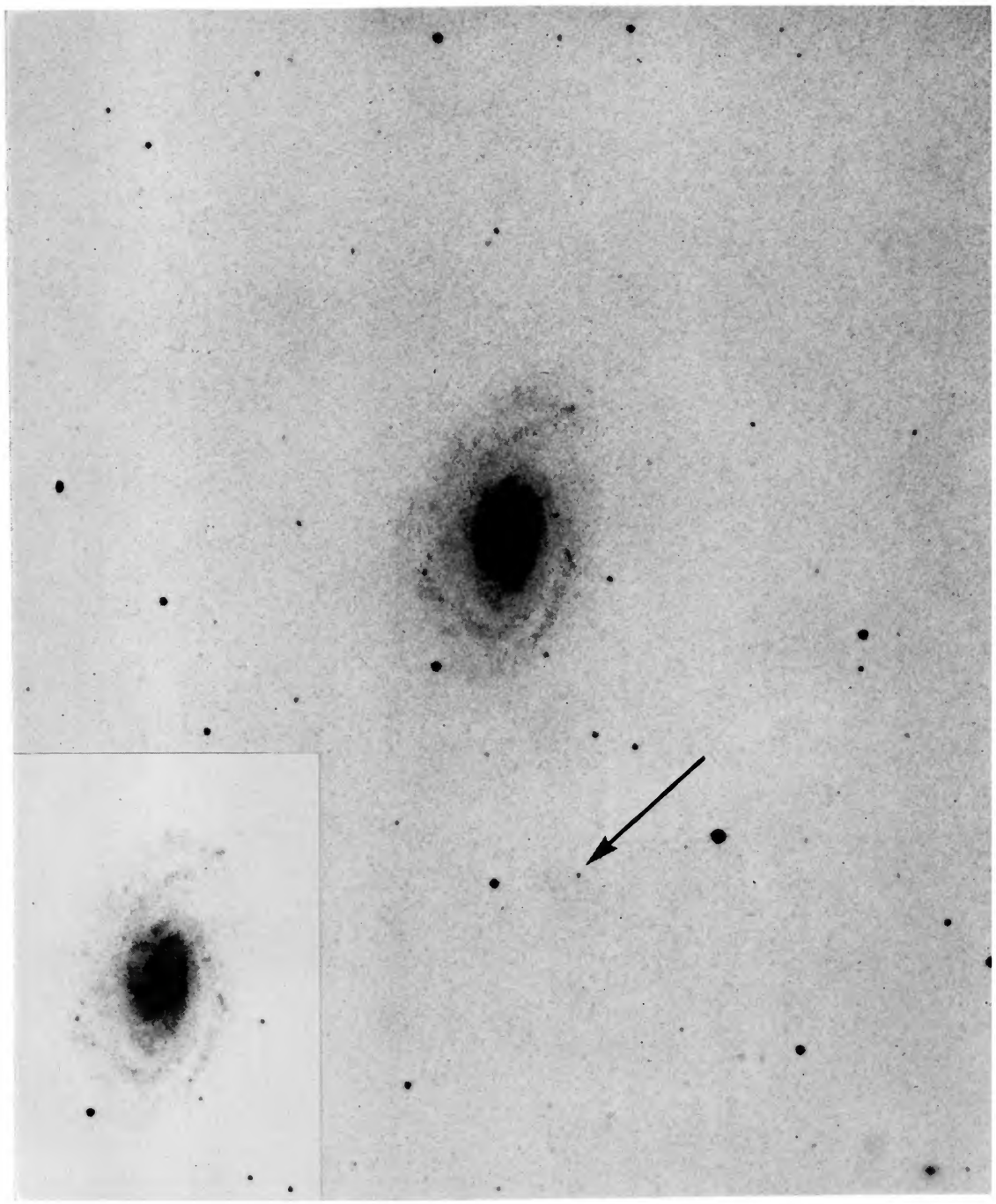

FIG. 3.—*Continued*

van Houten for estimating the magnitudes of 3C 2 on 48-inch Schmidt plates now stored in Leiden.

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