THE ASTROPHYSICAL JOURNAL, 219:803–817, 1978 February 1

ON THE SYSTEMATIC OPTICAL IDENTIFICATION OF THE REMAINING 3C RADIO SOURCES. II. NEW DATA FOR 50 FIELDS

JEROME KRISTIAN, ALLAN SANDAGE, AND BASIL KATEM
Hale Observatories, Carnegie Institution of Washington, California Institute of Technology
Received 1977 May 27; accepted 1977 August 3

ABSTRACT

Data obtained with the Palomar 5 m and 1.2 m telescopes provide proposed candidates or new likely identifications in 14 fields (3C 34, 169.1, 177A, 266, 274.1, 303.1, 325, 327.1, 390, 410, 435.1A, 435.1B, 435.1C, and 437). Previous identifications by others are confirmed, or new data on redshifts, SIT photometry, or optical positions are given for 24 sources (3C 6.1, 13, 20, 43, 61.1, 68.1, 84, 123, 169.1, 173.1, 256, 265, 268.2, 268.4, 274.1, 295, 323.1, 330, 411, 427.1, 434, 437, 438, and 460). Fifteen fields are still empty to the limit of our present material (3C 16, 41, 107, 158, 165, 184, 220.3, 226, 252, 277, 277.2, 322, 368, 415.2, and 470).

Accurate ($\lesssim 1''$) optical positions are listed for a number of field stars near each of 40 sources. Identification charts are given for most fields. A detailed description of each field is given in the Notes to Table 1, including references to work by others and some redshifts and photometry.

Improved optical or radio positions have been used to remove some previous discrepancies. An example is a new measurement of 3C 295 which shows the galaxy to be within 1″ of the radio center of the 5″ double.

Most faint 3CR identifications continue to be galaxies. The only quasar candidates among the 14 new or proposed identifications are 3C 34, 3C 325, and 3C 435.1C.

Subject headings: galaxies: general — quasars — radio sources: general

I. INTRODUCTION

This is the second of a series of papers whose aim is to contribute to the eventual identification of all radio sources in the revised 3C catalog (Edge *et al.* 1959; Bennett 1962). The methods of Paper I (Kristian, Sandage, and Katem 1974, also cited as KSK) are used again here, with new plate material that consists of 15 direct plates taken with the Hale 5 m reflector, six image-tube plates taken with the same instrument, two fields inspected with the integrating TV system of the Hale telescope, and 27 plates taken with the 1.2 m Palomar Schmidt. The results are summarized in Table 1.

Proposed candidates or new likely identifications are given for 14 sources (3C 34, 169.1, 177A, 266, 274.1, 303.1, 325, 327.1, 390, 410, 435.1A, 435.1B, 435.1C, and 437). Previous identifications by others are confirmed, or new data on redshifts, SIT photometry, or optical positions are given, for 24 sources (3C 6.1, 13, 20, 43, 61.1, 68.1, 84, 123, 169.1, 173.1, 256, 265, 268.2, 268.4, 274.1, 295, 323.1, 330, 411, 427.1, 434, 437, 438, and 460). Fifteen fields are still empty to the limit of our present material (3C 16, 41, 107, 158, 165, 184, 220.3, 226, 252, 277, 277.2, 322, 368, 415.2, and 470).

II. THE METHOD

Modern radio positions are now available for most 3CR sources, particularly those at high latitude. We chose the fields for the present search from a catalog of 3C sources that we have maintained for several years. Preference was given to sources with accordant radio positions measured by several independent groups with small internal errors (generally less than 5″). The radio studies used most often are by Macdonald, Kenderdine, and Neville (1968), Mackay (1969), Elsmore and Mackay (1969), Branson *et al.* (1972), and Adgie, Crowther, and Gent (1972, hereafter RRE). More recent high-accuracy data by Pooley and Henbest (1974), Riley and Pooley (1975), and Högbom and Carlsson (1974) from the Westerbork radio telescope were also very useful.

Measurements of stars and galaxies near the radio positions were made on Palomar Schmidt plates with a long-screw, two-coordinate measuring engine, relative to Smithsonian Catalog stars within one degree of the source. Typically, 10 to 20 SAO stars were used in each field. Proper motions of the standard stars were taken into account in most of the fields, although tests showed that the improved accuracy in mean position was only marginal (average differences of only $\sim 0''.3$ in each coordinate of any individual star between reductions with and without proper motion).

Identification charts for the visible objects measured in each field are given in Figures 1–4, and their measured positions are given in Table 2, together with the adopted radio position, which is usually the geometric center if the source is double. The authority for the radio position is given in the "Remarks" column, with the following code: MN I, Macdonald, Kenderdine, and Neville (1968), also cited as MKN; MN II, Mackay (1969); MN III, Elsmore and Mackay (1969); MN IV, Branson *et al.* (1972); RRE, Adgie

TABLE 1

STATUS SUMMARY OF EACH FIELD

Field	Status	b	Type	Best Plate	Comments
3C 6.1	Id by LG (1975)	+17	G ?	48	2″ (1 σ) from center of 26″ radio double
13	Poss. id. by Smith et al.	-23	G, cl?	200R	Radio positions discrepant. id?
16	Still empty	-50	...	48R-PSS	
20	Poss. cl. (Parker et al.)	-11	G, cl?	48R-PSS	Radio double of 50″ separation
34	Possible candidate	-31	?	200 TV system	
41	Still empty	-29	...	48R-200 IT	Also empty in Longair and Gunn
43	Old id	-39	N?	48R-PSS	Id by Sandage, Veron, Wyndham confirmed
61.1	Ambiguous id	+24	G, cl	200	3 min source diameter. Optical cl and BSO
68.1	Candidate	-24	?	200	
84	New position	-13	G	200	Per A = NGC 1275
107	Empty?	-35	...	200	See Paper I. Need confirming plate
123	Id confirmed	-12	G	200	Id by Wyndham: Matthews: Longair
158	Still empty?	0	...	PSSE	
165	Still empty	+ 9	...	PSS	Crowded optical field
169.1	Candidate	+19	Compact	PSSE	Stellar object on one component of 40″ radio double
173.1	Id confirmed	+27	Cl	48:127-04	
177A	Possible new id	+14	G	PSSE	3C 177 is two 4C sources (MKN 1968)
184	Still empty	+30	...	PSS	
220.3	Probably empty	+31	...	PSS	
226	Empty to SS limit	+43	...	PSSE	Wyndham's (1966) candidate 15″ distant
252	Empty to SS limit	+12	...	PSSO, E	
256	Old id. KS chart NG	+69	G	200	Chart in Kristian and Sandage (1970) incorrect
265	Probable id	+75	Gr. of G.	200	Noted in Wyndham (1966)
266	New id?	+64	?	Shallow 200	Wyndham candidate (D here) is 21″ distant
268.2	Id confirmed	+78	G	PSS	Wyndham id within 2″ (1 σ) of center of double
268.4	Old id marginal	+71	Q?, G?	200	BSO is 3.″4 E, 2.″1 N of excellent radio position
274.1	Id?	+83	?	PSSE	Central component of 140 arc sec radio triple
277	Empty? Ft. smudges?	+67	...	PSSO	Two arc min radio double
277.2	Still empty	+78	...	PSS	
295	New optical position	+61	G	200	
303.1	Possible new id	+38	G	48	
322	Empty	+49	...	48	Previous suggested id's (Veron, Wyndham) NG
323.1	Id confirmed	+49	Q	48	Wyndham's candidate OK
325	New id	+44	Q?	200 IT	
327.1	New id if real	+37	G	PSSE	In cluster? At limit of PSSR
330	Suggested id confirmed	+41	G, cl	200 IT	Paper I id OK. Redshift 0.549 (Spinrad et al. 1976)
368	Still empty?	+15	...	200R	Plate flaw at radio position?
390	New id?	+ 6		48	Extremely crowded field
410	Possible id	- 4	?	PSS	
411	Old id confirmed	-15	N in cl	200	Var N galaxy id by Spinrad et al. (1975)
415.2	Still empty	+ 8	...	PSS	
427.1	Id by Smith et al.	+19	G	200 IT	Optical object at center 22″ radio double
434	Id Smith, Spinrad, Smith (1976)	-24	G	200 IT	Plate also in Longair and Gunn
435.1A	New id	+24	G, cl	200 IT	In cluster
435.1B	Possible new id	+24	?	48 IIIaJ	
435.1C	New id	+24	Q	48 IIIaJ	
437	Possible new id	-28	?	200 TV system	Seen on 200 TV at 7″ W and 2″ S radio position
438	Id by LG (1975)	-13	G, cl	200R	
460	Id confirmed	-35	G	200R	Improved radio pos. confirms id of Paper I
470	Still empty	-18	...	PSSE	

NOTES TO TABLE 1: DETAILS OF EACH FIELD

The nature of the identified object, or the character of the remaining empty field, is summarized here for each source as an aid to further photometric and spectroscopic work.

3C 6.1.—Identification (ID) by Longair and Gunn (1975, hereafter LG): faint object, probably a galaxy, ~2″ (1 σ) from weak central component of 26″ radio double (Pooley and Henbest 1974). Five stars in common with Longair and Gunn give position differences (here minus LG) of $\Delta\alpha = +0.''18 \pm 0.''65$, $\Delta\delta = -0.''94 \pm 0.''47$.

3C 13.—Red 200 inch (1.5 m) plate shows a number of faint galaxies within 25″, possibly a distant cluster. A deeper red (Eastman 127-04) plate has been published by Smith, Burbidge, and Spinrad (1976), who suggest one of these as a candidate; but it is 10″ from radio position of Adgie and Gent (1966) in the general direction of the 5C 3 source position angle (Pooley 1969). Hence the position agreement is only marginal and is further confused by radio positions that are discrepant (23″ difference between 5C 3 and the Macdonald *et al.* 1968 positions). The average of the radio positions by Adgie and Gent and by Macdonald *et al.* is shown as a cross; the Smith *et al.* suggestion, by bars.

3C 16.—Empty to routine 48 inch (1.2 m) plate limit except for very weak suggestion of objects at Sky Survey red print limit. Faint galaxy cluster 1.′5 northwest of radio position.

3C 20.—Close pair of faint red galaxies, possibly in a cluster, near center line of 50″ radio double. First noted by Parker *et al.* (1966). The Sky Survey shows another galaxy about the same brightness 20″ NNE, as well as some fainter smudges nearby: may be the bright end of a remote cluster. The radio map in MN *IV* shows the faint galaxy pair plotted 7″ too far west. The pair has optical positions of $00^h40^m20^s.40$, $+51°47'09.''8$ and $00^h40^m20^s.02$, $+51°47'12.''0$. The brighter bluer object to east of pair is at $00^h40^m21^s.27$, $+51°47'10.''0$.

3C 34.—Possible candidate seen on 200 inch Cassegrain SIT slit viewing TV system, on 1976 July 28. Position agreement only marginal: 8″ W of Adgie *et al.* (1972) position; 12″ W, 2″ S of MKN 1968 center for 30″ double. Position disagreement is about twice combined optical and radio errors. Candidate probably appears on Sky Survey red plate at extreme plate limit. On SIT viewer (S-20 response), however, it is much brighter than two faint red stars 25″ SW and 40″ SE that are quite visible on Sky Survey (the SE is mentioned by Wyndham 1965). This suggests that the candidate is either variable or blue. The radio positions of Macdonald *et al.* are plotted.

3C 41.—Empty on our best 48 inch plates and also on 200 inch image-tube plate by LG, all of which have a limit of $V \approx 19.5$. Five stars in common with Longair and Gunn give KSK here minus LG of $\Delta\alpha = -0\overset{s}{.}48 \pm 0\overset{s}{.}47$, and $\Delta\delta = +1''.02 \pm 0''.35$.

3C 43.—Earlier ID by Sandage, Véron, and Wyndham (1965, hereafter SVW), our *D*, is secure on basis of more recent accurate radio positions. Suggested as QSO on basis of optical variability, but inspection of 48 inch plates suggests possible diffuse image. N galaxy? Earlier optical position by Véron (SVW) agrees with ours to better than 2″. An unpublished redshift of $z = 1.459$ by Lynds is reported in a 1977 preprint by D. Stannard and D. S. Neal.

3C 61.1.—Ambiguous. Extended cluster containing BSO (object *L* on our chart). Redshift is $z = 0.184$ for BSO and for several galaxies (Miller *et al.* 1973). The most likely source candidate is brightest galaxy of triple 10″ NW of radio center of MN IV, which is marked by a cross: source size is 3′. Redshift of this candidate not measured by Miller *et al.* Previous discussion by Longair and Gunn (1975) gives positions that are systematically 3″ E and 3″ N of ours, owing perhaps to the high declination of +86°. The ID is not affected by the discrepancy. Although our internal accuracy is only ~1″, our 15 SAO standards do all reproduce to this level and are also consistent in the independent measurements in two position angles of the plate.

3C 68.1—Candidate (*A* on our chart) is on the center line of very unequal (ratio of 9) radio double, 23″ from the strong component which is 0.4 of the distance from the strong to weak component. Noted by Wyndham (1966) (although not his candidate), and by LG, who report observations of Spinrad and of Boksenberg that the spectrum is nonstellar. Image is indistinguishable from stars on red 200 inch plate in routine seeing. The plate is otherwise empty at and between the radio components except for a mere suggestion of a smudge near the strong component. The redshift is $z = 1.238$ (Boksenberg *et al.* 1976).

3C 84.—Per A = NGC 1275. We reexamined the position because of an apparent 2″ (6 σ) difference between the very accurate VLBI position (Cohen 1972; Fanselow 1974) and the nucleus of the galaxy (Matthews, quoted in Wade, Clark, and Hogg 1965). The galaxy has a very sharp nucleus, indistinguishable from a star (< 0″.8 = 500 pc) on short (10^s, 60^s) 200 inch plates. Using Griffin's (1963) positions of nearby stars as secondary standards, we find the nucleus to be 0″.3 ± 0″.6 west of the VLBI position ($03^h16^m29\overset{s}{.}56$, +41°19′51″.74) which presumably refers to the milli-arcsec high-frequency component called 3C 84A(i) by Ryle and Windram (1968). Argue and Kenworthy (1972) have an optical position which is less than 0″.5 from the VLBI position.

3C 107.—In Paper I (positions and chart there) we noted a smudge on the 200 inch *V* plate within a large radio error box. The smudge position is still consistent with an improved (1″.2) RRE position (McEwan *et al.* 1975). Because of the faintness of the object and its somewhat unusual appearance, we believe a confirming plate is required and prefer to classify this as an empty field ($V \gtrsim 21.5$).

3C 123.—A cD galaxy near center line of close (~25″) unequal radio double with structure not along main axis (MN IV; Mitton 1970). Original ID by Wyndham (1966), Matthews (1966), and Longair (1965). A light 200 inch *V* plate in good seeing shows ~4 fainter galaxies ~10″ to east: probably a faint cluster. The cD is within 3″ of the Adgie and Gent (1966) centroid, 5″ of the MN IV center, and 9″ of the Mitton (1970) center. Redshift of $z = 0.637$ by Spinrad (1975), confirmed by KSW.

3C 158.—Empty field? Sky Survey blue is blank. Closest object on Sky Survey red is faint and 5″ (~3 σ) SW of position of Adgie *et al.* (1972). Very low latitude of $b = +0°.2$.

3C 165.—Low latitude ($b = +9°$), crowded field. Radio source is double with separation of 56″. The weaker SE component has a faint ($B \sim 19$) red star ~3″ to NW. Several fainter red objects are along center line of the radio components. Brightest of these, which is extended or is multiple, lies within ~5″ of the radio center.

3C 169.1.—There is a star (*F* on our chart) within < 1″ of one component of a classical 40″ double (Mackay 1969), and the Sky Survey and other Schmidt plates (Fig. 2) are otherwise empty. Deeper plates by Spinrad and Smith (private communication) and unpublished SIT exposure by Kristian and Westphal show a pair of objects 3″.5 apart and 5″–6″ west of the radio center. The brighter of these is the most likely candidate: it is a galaxy with $z = 0.633$ (Spinrad and Smith), $V = 20.9$, $B - V = 0.9$, $V - R = 1.3$ (Kristian and Westphal); its position is $06^h47^m35\overset{s}{.}46 + 45°13'01''.2$ (accuracy ~1″). The fainter of the optical pair ($V = 21.2$, $B - V = 0.4$, $V - R = 1.1$:) looks starlike and is somewhat farther from the radio center ($06^h47^m35\overset{s}{.}32 + 45°13'04''.3$).

3C 173.1.—Galaxy (*A* on our chart) is brightest member of a good group, and is on the center line of a 40″ radio double, 6″ from center (Högbom and Carlsson 1974). Redshift of $z = 0.292$ (Smith, Spinrad, and Smith 1976) gives bright absolute magnitude consistent with radio galaxies in general. Wyndham's (1966) optical position, plotted on map in MKN 1968, is 18″ too far north. Position by Véron (1968) agrees with ours.

3C 177A.—Same as 4C 16.21. Possible ID. Galaxy 8″ E of center of 75″ radio double. 3C 177 is two 4C sources (MKN 1968).

3C 184.—Sky Survey empty. Single radio source.

3C 220.3—Sky Survey empty field. Nearest objects are very red galaxy 18″ S, and 15 mag object 18″ NNE (*B* on our chart) noted by Wyndham (1966), who comments that it looks nonstellar on PSS *red* plate. However, it looks stellar on 48″ *blue* plate by Véron. Source size is less than or equal to 7″ (Elsmore and Mackay 1969). Single radio source.

3C 226.—Sky Survey empty at position of Ghigo and Owen (1973), except for suggestion of faint object 3″ ESE, visible on red plate only. Wyndham's (1966) candidate is 15″ away. Single radio source.

3C 252.—No ID. Best available plates are the Sky Survey, which are empty except for several objects at the limit (most noticeable on the blue plate) near center line of radio source, which is an unequal (ratio of 2) double with 55″ separation.

3C 256.—Error exists in the published chart (Kristian and Sandage 1970: hereafter KS). Object marked there is not the ID (Kristian and Sandage 1976), and chart given in the present paper should replace it. Note that the redshift of 0.378 reported by Smith, Spinrad, and Smith (1976) is for the galaxy incorrectly marked on the KS chart. As far as we know, the redshift of the correct ID had not yet been measured.

3C 265.—Interesting geometry. The radio source is an unequal double (ratio 1.8) with 65″ separation. Between the radio components and along the radio axis is a slightly curved chain of four faint objects, which can be seen in Figure 2. The western pair were first noted by Wyndham (1966), at the limit of the Sky Survey. If we designate the objects as 1 to 4 from west to east, then 1 (the westernmost) is very likely the identification from its position near the radio center and its spectrum, which shows very strong emission lines at a redshift of 0.81 (Spinrad and Smith, private communication; Westphal and Kristian, unpublished). The galaxy is quite blue: SIT photometry by Kristian and Westphal give $V = 20.04$ (9″.7 diameter), $B - V = 0.4$, $V - R = 0.9$. The $V - R$ color is affected by perhaps $0^m.3$–$0^m.4$ by the very strong emission lines ([O II] 3727, [Ne V] 3346 and 3426, and [Ne III] 3869 and 3986) which appear in the *R* passband. There are three interesting faint jets or companions (the seeing is not good enough to resolve them) 2″ to 3″ from the candidate. Two of these lie symmetrically about the candidate galaxy in a NW–SE direction; the third is ENE of the candidate and perhaps more nearly resolved than the other two. From a glance at the SIT photographs, one might guess that they were companion galaxies, but they are rather blue. On the blue SIT frame they are about the same surface brightness as galaxy no. 2, while on the *V* and *R* frames they are only marginally discernible above the noise.

Of the other three objects shown in Figure 2, no. 2 is a red galaxy ($V = 20.00$, $B - V = 1.70$, $V - R = 1.56$), while nos. 3 and 4 have stellar intensity profiles. SIT photometry gives $V = 20.45$, $B - V = 1.1$, and $V - R = 1.0$ for no. 3, and $V \approx 21.5$ for no. 4. The colors of no. 4 are not well determined because it is near a bad spot on the SIT tube, but it is somewhat redder than no. 3. No. 4 is of interest because it lies within 1″ of the center of the stronger radio component.

3C 266.—New ID? Possible object at limit of shallow 200 inch *B* plate, at position of Adgie, Crowther, and Gent (1972). Needs confirmation. The Wyndham (1966) candidate (*D* on our chart) is 21″ away. Single radio source.

3C 268.2.—ID by Wyndham (1966) is within 2″ (1 σ) of center of classical 96″ double (Riley and Pooley 1975). It is a galaxy whose redshift is $z = 0.361$ (Smith, Spinrad, and Smith 1976). $V = 19.26$, $V - R = 1.22$ (measured with a CCD area detector).

3C 268.4.—ID by Wyndham (1966) with QSO, $z = 1.4$ (Schmidt 1968). Our position is 2″ east (twice the combined errors) of the central radio component (Pooley and Henbest 1974), and 1.″5 east of the optical position by Véron (1968). A faint object, probably a galaxy, is 2″ S and 0.″5 E of the QSO (Kristian 1973). The BSO noted by Wyndham is at the edge of a group of faint galaxies, but is probably not connected with them because the cluster has $z \approx 0.3$ (estimated).

3C 274.1.—Faint object 1.″5 S of central component of 140″ triple (Högbom and Carlsson 1974). Visible on mediocre 200 inch red plate, which also has a suggestion of a surrounding cluster. Remarkably, Wyndham (1966) gives the ID, although it must be at the extreme edge of the Sky Survey: it is not visible on our Sky Survey prints. Wyndham's position is 10″ too far north, but that is consistent with his errors. The redshift is $z = 0.422$ (Westphal and Kristian, unpublished).

3C 277.—Empty field, $V \gtrsim 19$. Sky Survey empty to this limit at and between the components of a 2′ unequal double (MKN 1968). There is, however, a sprinkling of objects very near the plate limit, one of which is about 5″ SW of the radio center, which suggest a faint galaxy cluster, but which are much more obvious on the blue than on the red plate. In the absence of better plate material, we prefer to classify this as an empty field to the stated limit. MKN show two objects on their map, which we assume to be *A* on our chart, and the fainter objects just to the south of it. If so, they appear to be plotted ~15″ too far south, and seem to us unlikely to be related to the source.

3C 277.2—Sky Survey empty field. Wyndham (1966) mentions a possible very faint red galaxy near a weak lobe of the source, plotted on the map of Mackay (1969), which we believe may not be real. It is in any case unlikely to be the identification.

3C 295.—Positions were measured on a 48 inch plate, on which the radio galaxy could not be measured directly because its image is blended with those of its companions. A transfer was made to a 200 inch plate by using three galaxies as secondary standards. The resulting uncertainty is estimated to be 1″–2″. The position thus obtained places the brightest galaxy within 1″ of the center of the 5″ double source, using the very accurate radio positions of Pooley and Henbest (1974), and unambiguously specifies it as the radio source. The source is still sometimes referred to as a case of "colliding" or "interacting" galaxies, dating back to its very early discovery. Optically, however, it now appears similar to many other run-of-the-mill radio galaxies in that it is the brightest member of a cluster and has several close companions (as also do many nonradio bright cluster galaxies). Its absolute magnitude and colors are like those of other bright cluster galaxies at similar redshifts. Its main distinction is that it is intrinsically one of the radio-brightest optically identified sources in the sky at $\sim 10^{46}$ ergs s^{-1}, integrated between 10^7 and 10^{11} Hz proper frequency.

3C 303.1.—Galaxy (*B* on our chart) 4″ (~1.5 σ) from position of Wade and Miley (1971). Emission-line redshift of $z = 0.267$ (Spinrad, private communication). Noted by Wyndham (1966), who suggested *A* as the ID; but it is too far away (13″).

3C 322.—Sky Survey empty field. Wyndham's (1966) and Véron's (1966) candidate galaxy (*A* on our chart) is too far away. Nearly equal component radio double.

3C 323.1.—QSO, $z = 0.264$. ID by Wyndham (1966). Our position agrees with that of Véron and Véron (1973) to 0.″6 and with the central radio component of Pooley and Henbest (1974) to < 2″.

3C 325.—New ID. Stellar-appearing object 1.″6 W of radio position on our 200 inch red image-tube plate. Other possible objects ~6″ E of radio position, at plate limit.

3C 327.1.—New ID if real. Galaxy at the limit of Sky Survey red plate. Old ID by Wyndham (1966) and Véron (1966) (*B* on our chart) too far away (15″).

3C 330.—ID in Paper I with a faint galaxy cluster. The southern of the close pair marked in the 200 inch chart of Paper I (Fig. 8) is 1.″5 from the center of this 58″ double, according to the new map by Högbom and Carlsson (1974), which makes the identification unambiguous: it is the brightest cluster member. It has a spectrum rich in emission lines with a redshift of 0.549 (Spinrad *et al.* 1976). The absorption-line redshift of the northern companion galaxy is 0.532, from a rather poor spectrum (KSW; also for photometry), and 0.541 from a spectrum by Spinrad (private communication).

3C 368.—Empty field? Good 200 inch red plate empty, except for a peculiar extended (5″) object at the limit which may be a plate flaw.

3C 390.—New ID? Extremely crowded field, but faint star < 2″ from position of Adgie *et al.* (1972).

3C 410.—The main peak of the map of Högbom and Carlsson (1974) falls midway between the pair of objects marked *H* on our chart. They also show a second weaker radio component 32″ NW of the main peak. A spectrum shows the brighter SE component of the visible pair to be a galactic star. The fainter object, which has not been observed, could be the ID.

3C 411.—ID by Spinrad *et al.* (1975) as variable N galaxy ($z = 0.469$) coincident (< 1″) with nuclear source in classical double. Strong variations on our plates. Object is just visible at the very limit of the blue Sky Survey plate (1953), but easily visible ($\gtrsim$1 mag brighter) on 48 inch blue and UV plates taken by Véron in 1965. The 200 inch red plate in 1973 August shows a fairly hard, but slightly elliptical image ~0.5 mag fainter than Spinrad *et al.* (1975) 120 inch (3.05 m) ($V + R$) plate in 1971 September. This plate also supports the Spinrad *et al.* suggestion of a faint galaxy cluster: very faint galaxies are 4″ west, 3″ south, 5″ north, 11″ northwest, and 13″ southeast of ID.

3C 415.2.—Low-latitude empty field ($b = +8°$). Sky Survey empty at and between components of 33″ double. Nearest objects are 9″ E and 13″ W (star *A*) of center line. Unequal radio double of ratio 2:1.

3C 427.1.—ID by Smith, Burbidge, and Spinrad (1976) on deep 4 m plate: very faint galaxy, not visible on 48 inch IIIa-J, poor 200 inch image-tube *V* plates, or on image-tube plate by Longair and Gunn. Position coincides (< 1″) with center of radio double with 22″ separation. Star 10″ E of ID (star *B*, an early candidate here) has normal colors: $V = 17.83$, $B - V = 0.73$, $U - B = 0.24$ (Sandage, unpublished). Unequal radio double. Ratio ~2:1.

3C 434.—Galaxy < 2″ from center of 12″ double. Smith, Spinrad, and Smith (1976) ID: $z = 0.323$ (Kristian and Westphal, unpublished). $V = 20.84$, $B - V = 1.35$ (Kristian: central 3.″6: multichannel). Plate also in LG. Star *J*, an early candidate, has $V = 18.23$, $B - V = 0.78$, $U - B = 0.10$ (Sandage, unpublished).

3C 435.1A.—New ID. Faint object, probably a galaxy, within 2″ (1 σ) of center of 30″ radio double (Högbom and Carlsson 1974). Visible on 200 inch red image-tube plates, 48 inch IIIa-J: mag ~21. Other faint objects nearby; could be the bright end of a cluster.

3C 435.1B.—Possible ID with faint object (*Q* on our chart) 5″ (1 σ) E and 5″ (2 σ) S of position of Mackay (1969), near limit of 48 inch IIIa-J plate ($V \sim 21$). Mackay suggests a galaxy cluster at the Sky Survey limit, but it does not appear on our copy of the Sky Survey prints or on the deeper IIIa-J plate.

3C 435.1C.—New ID (object *T* on our chart). Position agreement with Mackay (1969) < 1″. Probable QSO from color: visible on Sky Survey blue and 48 inch IIIa-J, not visible on Sky Survey red or 48 inch 098-04. $V \sim 19$–20.

3C 437.—Early candidate, discovered with SIT area photometer by Kristian and Westphal ($V = 22.1$), independently by LG (see their chart). ID less likely on the basis of a later high-resolution map by Longair (1975). The field is otherwise empty to a limit of $V > 22$ from the SIT data. Was a Paper I empty field.

3C 438.—Brightest galaxy of cluster, within ~1″ of center of 17″ double. ID by LG. LG's optical positions are systematically 1.″5 W and 1.″8 N of ours. Our positions are not of the highest quality, but we believe that they are all right at the 1″ level, and that the difference between LG and us is significant. Our position places the galaxy nearer the center of the source. $V = 19.34$, $V - R = 1.5$, $z = 0.29$ (KSW; Spinrad and Smith, private communication). LG estimate mag ~20–21. Our measured magnitude supports

the contention of Smith, Burbidge, and Spinrad (1976) that the estimated magnitudes of LG are systematically too faint. We estimate the difference to be at least 1 mag. The object is visible on the Sky Survey.

3C 460.—ID of Paper I strengthened by improved radio position. Agreement is now 2".2, equal to combined errors. Tentative scanner redshift $z = 0.27 \pm 0.02$ in Paper I confirmed by Kristian and Westphal (unpublished) with digital prism spectrograph. New value is $z = 0.268 \pm 0.001$. The 200 inch plates show a faint point source 4".5 = 30 kpc southwest of galaxy on major axis. For photometry see KSW.

3C 470.—Established as empty field from radio and optical measurements by Riley and Pooley (1975), who measured the positions of star *A* and Wyndham's (1966) candidate (see chart). *A* is 8".5 from the center of a 24" double. Wyndham's (1966) ID (Fig. 4) is 7" away and is an M star (Spinrad, private communication). A chart is included here for convenience (Fig. 4).

et al. or other work by the Royal Radar Establishment group; FM, Fomalont and Moffet (1971).

The internal accuracy of the optical positions relative to the Smithsonian Catalog stars is almost always better than 1", as judged by the difference of our final positions for the standard stars from their catalog places. However, no attempt has been made to correct the values in Table 2 to an absolute grid by comparison with a fundamental frame (such as the FK 4).

For those sources where the optical identification was not measured directly, the position of the radio source was found on the best available plate with respect to the measured objects, using transparent overlays.

III. THE RESULTS

The surveyed fields are listed in Table 1. The result of the optical search is given in column (2), the galactic latitude in column (3), the type of object (if it can be determined from the plates) in column (4), our best plate in column (5), and remarks in column (6). The heart of this paper is the Notes to Table 1, which include a detailed description of each field, references to works by other investigators, redshifts, photometry, etc. Suggested identifications are shown in Figures 1–4, usually enclosed within bars or circles. Lobes of double radio sources are usually indicated by circled crosses.

During the course of this work, parallel investigations have been undertaken by others, most notably H. Spinrad, H. E. Smith, and E. M. Burbidge, and their colleagues at the University of California, and M. Longair, J. E. Gunn, and J. M. Riley, and their colleagues at Cambridge. Their work on some of the sources in Table 1 has already been published, as acknowledged in the Notes; for these our results provide confirmation.

Improved optical or radio positions have been used to remove some previous discrepancies; for example, a new measurement of 3C 295 shows the galaxy to be within 1" of the radio centroid of the 5" double.

The identified sources are mostly galaxies; a few are in obvious clusters or groups, such as 3C 61.1, 173.1, 265, 330, 411, 435.1A, and 438. It is less easy to suggest which of our candidates may be quasars, because the quality of our deep-exposure plates is not, in every instance, good enough to enable us to make a judgment on the sharpness of the image. However, on the basis of image quality or color, we can suggest 3C 34, 3C 325, and 3C 435.1C as possible quasar candidates. The paucity of quasar candidates further supports the conclusion that most optically faint 3C sources are galaxies (Bolton 1969; Kristian 1977).

One purpose of this work has been to provide candidate galaxies that are expected to have large redshifts which, when added to the very distant clusters found in independent optical searches now in progress, should be useful in extending the Hubble diagram (Gunn and Oke 1975; Sandage, Kristian, and Westphal 1976). Both the Lick group and more recently Westphal and Kristian at Palomar have begun the difficult task of determining redshifts for these very faint galaxies. A number of these are given in the Notes to Table 1. Some of the redshifts are indeed very large, and represent a significant advance in extending the Hubble diagram. They include 3C 123 ($z = 0.637$), 3C 265 ($z = 0.811$), 3C 274.1 ($z = 0.422$), 3C 330 ($z = 0.549$ for the radio source, $z = 0.532$ for a second galaxy in the cluster), 3C 434 ($z = 0.323$), and 3C 460 ($z = 0.268$).

The Hubble diagram for brightest cluster galaxies to $z = 0.4$ (with no correction for evolution applied) is starting for the first time to show significant deviations from a straight line (Kristian, Sandage, and Westphal 1978, hereafter KSW). The data for 3CR galaxies at larger redshift show an even stronger effect, although they are probably subject to selection effects and some of them are individually peculiar. The results are strong enough, however, to encourage further work along the present lines, as well as to seek a better understanding of the evolutionary corrections which are necessary before world models can be tested.

We are grateful to John Bedke for his excellent photographic preparation of the finding charts from the original plates and Palomar Sky Survey prints. The uniform density of the final charts is due to his skill in working with quite heterogeneous plate material. It is also a pleasure to thank Felice Woodworth for the tedious work, done with her characteristic patience, tenacity, and skill, of lettering the finding charts.

We are also grateful to the many radio astronomers who have supplied preprints of their work on positions; to Hyron Spinrad, who has kept us informed on all phases of the University of California's (Berkeley–Lick–San Diego) work on identifications and redshifts; and to P. and M. Véron, for a critical reading of the manuscript and several helpful comments.

This work was supported in part by grant MPS 75-16327 from the National Science Foundation.

TABLE 2

POSITIONS OF OBJECTS MARKED IN EACH FIELD

Field	Star	α (1950)	δ (1950)	Remarks
3C 6.1	A	00 13 26.97	+79 00 07.5	Star B of LG
	B	27.10	00 26.4	
	C	28.41	00 33.1	
	D	09.14	+78 59 59.6	
	E	38.68	+79 00 29.8	Star B of LG
	F	12.15	00 45.8	
	G	14.75	00 32.1	
	H	29.66	00 54.4	Star C of LG
	I	44.96	00 47.9	Star F of LG
	J	24.07	+78 59 27.4	Star A of LG
	K	18.81	59 32.0	
	Radio	34.69	+79 00 11.1	MN IV Center
3C 13	C	00 31 28.28	+39 08 19.4	
	D	28.24	08 45.9	
	E	26.68	09 03.4	
	F	25.97	09 27.8	
	G	29.50	08 47.9	
	H	30.45	07 38.9	
	Radio	32.58	07 44	Av. MN I +Adgie
3C 16	A	00 35 11.07	+13 02 33.1	Galaxy
	C	09.29	03 05.5	
	D	07.64	04 11.3	
	E	10.54	03 58.9	
	F	11.79	04 55.7	
	G	14.51	03 21.5	
	H	14.56	01 52.4	
	I	08.80	01 49.7	
	Radio	08.31	03 25.3	RRE position
3C 20	A	00 40 17.59	+51 46 42.9	
	B	16.20	46 36.1	
	C	14.64	46 51.9	
	D	10.31	46 39.1	
	E	12.35	46 53.2	
	F	14.25	47 09.3	
	G	11.58	47 28.9	
	H	17.41	47 36.4	
	I	20.65	47 51.9	
	J	18.32	45 59.7	
	Radio	17.43	47 15.7	MN III (W. comp.)
	Radio	22.43	01.8	MN III (other strong comp.)
	Radio	18.5	11)	Weak central
	Radio	20.2	5)	radio components
3C 34	C	01 07 29.85	+31 32 38.4	
	D	36.41	32 23.0	
	E	37.52	31 47.9	
	F	36.89	30 11.9	
	G	31.61	29 54.0	
	Radio	32.5	31 24	MN I
3C 41	C	01 23 51.50	+32 57 55.5	
	D	57.40	58 23.6	
	G	46.99	57 12.8	
	H	55.83	59 02.3	
	J	59.04	59 06.2	
	K	55.22	57 53.4	
	Radio	54.9	57 37	RRE
3C 43	C	01 27 15.65	+23 23 31.5	
	D	15.06	22 51.3	Radio source
	F	15.84	21 33.0	
	G	19.37	21 03.1	
	H	13.11	21 03.1	
	I	12.74	22 21.5	
	J	08.11	21 55.7	
	K	08.30	20 57.2	
	Radio	15.08	22 52.7	RRE
3C 61.1	A	02 10 31.23	+86 04 53.7	Star D of LG
	B	13.31	05 22.1	Star B of LG
	C	11 18.39	04 42.1	
	D	00.54	06 42.8	Star E of LG
	G	10.31	05 15.4	Star F of LG
	H	12 07.67	06 37.8	
	L	11 10.16	05 22.0	
	M	10 18.35	03 17.8	
	N	43.70	03 40.0	
	Radio	44.45	05 07.4	MN IV
3C 68.1	A	02 29 27.08	+34 10 34.7	LG candidate
	B	28.60	10 56.4	Wynd. candidate
	C	26.63	11 51.3	
	D	21.53	11 54.5	
	E	27.68	09 48.3	Star B of LG
	F	30.82	11 31.6	
	Radio	26.98	10 57.5	MN II
3C 84	Chart and positions in Griffin (1963)			
	Radio	03 16 29.56	+41 19 51.74	Fanselow VLB
3C 107	Chart and positions in Paper I of KSK (1974)			
	Radio	04 09 49.92	-01 07 09.7	Av. of Adgie and Brawne
3C 123	D	04 33 56.66	+29 34 02.7	
	E	59.63	33 58.5	
	F	54.98	33 36.2	
	H	47.88	34 09.7	
	J	53.68	35 15.1	
	K	54.04	34 58.4	
	L	58.22	34 43.1	
	Source	55.16	34 12.6	$\epsilon\alpha = \pm 0^{s}.07$; $\epsilon\delta = \pm 1''.5$
	Radio	55.81	34 08.8	MN IV
3C 158	A	06 18 45.73	+14 33 43.0	
	B	46.47	33 48.4	
	C	46.96	33 25.2	
	D	48.38	33 57.5	
	E	48.61	34 20.7	
	F	48.88	33 51.4	
	G	49.19	34 15.4	
	H	48.75	33 32.9	
	I	48.56	33 11.0	
	K	49.68	34 03.7	
	L	50.35	34 02.2	
	M	50.46	34 04.8	
	N	48.50	34 00.3	
	Radio	50.1	33 41.1	RRE
3C 165	A	06 40 01.91	+23 22 45.8	
	B	03.46	22 34.9	
	C	03.45	22 44.5	
	D	04.66	22 45.6	
	E	05.75	22 31.8	
	F	06.12	21 57.8	
	G	00.84	21 51.4	
	Radio	04.1	22 28	Fomalont a
3C 169.1	A	06 47 42.21	+45 15 10.2	
	B	23.32	14 38.1	
	C	39.23	14 03.3	
	D	38.21	14 13.6	
	E	36.53	13 29.0	
	F	34.63	13 17.7	
	G	28.34	13 15.1	
	H	27.95	12 44.4	
	I	43.32	11 41.8	
	J	30.01	11 24.5	
	K	27.06	11 57.2	
	Radio	35.9	13 03.0	MN II
3C 173.1	A	07 02 47.76	+74 54 16.2	Id
	E	31.17	54 26.5	
	F	32.84	54 45.5	
	I	55.01	52 35.7	
	J	28.04	52 37.0	
	Radio	47.23	54 10.9	Westerbork
3C 177	A	07 21 59.06	+16 07 13.7	
	B	55.33	06 45.1	
	C	55.05	07 48.3	
	D	59.27	07 49.7	
	E	56.92	08 20.7	
	F	22 01.25	07 11.6	
	G	21 52.72	06 57.5	
	Radio	21 58.79	07 38.0	MN I
3C 184	A	07 34 03.21	+70 28 54.5	
	B	09.49	30 53.8	
	C	33 45.34	29 53.2	
	D	52.84	27 57.4	
	E	58.72	32 02.2	
	Radio	59.69	30 04.2	MN III
3C 220.3	A	09 30 49.88	+83 28 36.0	
	B	31 18.19	29 08.6	
	C	31 36.75	28 15.8	
	D	32 07.74	29 25.4	
	E	29 34.68	29 20.2	
	Radio	31 11.26	28 55.2	MN III, Adgie
3C 226	A	09 41 32.28	+09 59 44.4	
	B	31.88	57 51.4	
	C	26.19	58 38.1	
	D	26.80	58 19.5	
	E	42.00	57 15.4	
	F	29.38	10 02 11.0	
	G	31.41	02 56.7	
	Radio	36.15	00 07.3	FM
3C 252	A	11 08 49.43	+35 58 07.2	
	B	32.45	58 50.2	
	C	43.27	55 46.2	
	D	53.80	56 13.7	
	E	33.50	55 50.4	Galaxy
	F	46.54	58 06.7	
	G	40.85	58 44.1	
	Radio	46.1	57 10.2	MN I (a)
3C 256	Optical position listed in Kristian and Sandage (1970, Table 2)			
3C 265	A	11 42 59.58	+31 52 20.7	
	B	52.54	52 23.8	
	C	55.18	51 02.8	
	D	39.87	48 40.3	
	F	43 01.22	49 21.5	
	G	04.57	50 47.2	
	Radio	42 54.67	50 15.6	MN II (B)
3C 266	A	11 43 05.10	+50 01 41.7	
	C	42 58.10	03 22.3	
	D	43 06.74	02 49.5	Wynd. cand. NG.
	E	42 57.32	02 01.2	
	F	43 10.05	02 14.6	
	Radio	43 04.22	02 47.6	RRE
3C 268.2	E	11 58 29.37	+31 49 09.5	
	F	28.85	49 59.1	
	G	26.69	50 29.6	
	H	14.23	50 53.8	
	I	19.30	49 49.8	
	J	37.96	48 11.0	
	Radio	25.03	50 04.5	
3C 268.4	Q	12 06 42.29	+43 56 02.1	
	Radio	41.97	56 00.0	RRE
3C 274.1	B	12 32 54.65	+21 37 24.7	
	D	53.67	39 52.0	
	E	33 05.41	37 40.7	
	F	33 03.04	35 16.5	
	Radio	32 56.87	37 08.7	MN I (Central comp.)
3C 277	A	12 49 27.50	+50 51 14.9	
	B	24.30	51 31.3	
	C	27.54	49 57.4	
	D	10.04	52 58.8	
	E	35.84	49 26.3	
	F	17.00	48 41.2	
	Radio	26.48	50 38.5	MN I Center
3C 277.2	A	12 51 07.54	+15 59 23.3	
	C	02.48	16 01 09.4	
	D	14.26	01 02.9	
	E	10.54	15 55 28.5	
	Radio	03.10	58 39.8	
3C 295	Optical	14 09 33.29	+52 26 13.9	
	Radio	33.43	13.4	Pooley and Henbest
3C 303.1	A	14 43 56.01	+77 19 51.6	
	B	53.12	20 04.6	
	C	53.56	19 28.9	
	D	33.82	19 09.8	
	E	43.90	21 23.7	
	F	44 19.66	20 54.1	
	Radio	43 54.28	20 03.6	C. Wade
3C 322	A	15 33 49.91	+55 46 36.0	Wynd. + Véron id (NG).
	B	48.40	47 51.2	
	C	39.07	47 38.3	
	D	40.24	45 41.5	
	E	41.94	46 38.2	
	F	37.64	46 45.0	
	G	36.47	46 55.1	
	Radio	46.3	46 42.0	MN I
3C 323.1	Optical	15 45 31.19	+21 01 26.9	Wynd. id. OK
	Radio	30.53	01 25.5	Cent. dbl. Pooley + Henbest
3C 325	A	15 49 18.10	+62 50 01.6	
	C	10.13	49 52.9	
	D	06.16	50 48.3	
	E	04.13	50 25.9	
	Radio	14.25	50 20.6	MN II, FM
3C 327.1	A	16 02 15.90	+01 26 25.2	
	B	13.28	26 13.7	Wynd. cand.
	C	12.53	25 08.7	
	D	12.02	25 00.3	
	E	15.94	25 19.1	
	F	11.18	26 27.4	
	G	08.56	25 24.4	
	Radio	12.96	25 58.9	RRE
3C 330	Chart and positions in KSK I			
3C 368	A	18 02 45.16	+11 00 20.4	
	B	43.90	00 52.6	
	C	42.25	01 22.1	
	D	43.49	02 06.7	
	E	42.44	02 18.3	
	F	41.12	01 48.4	
	G	45.90	02 23.8	
	H	44.51	01 17.8	
	Radio	45.74	01 14.8	UT
3C 390	A	18 43 16.95	+09 49 49.3	
	B	16.38	50 21.9	
	C	15.23	50 21.7	
	D	18.55	50 20.8	
	E	17.08	51 25.6	
	F	13.63	51 13.6	
	G	14.33	50 55.9	
	Radio	15.3	50 31.0	RRE
3C 410	A	20 18 06.73	+29 32 09.6	
	B	07.47	32 02.2	
	C	11.54	31 59.3	
	D	10.39	33 34.2	
	E	09.69	33 42.5	
	F	15.04	32 27.2	
	Radio	04.17	32 40.6	RRE
	Radio	04.05	42.4	Westerbork
3C 411	A	20 19 42.60	+09 51 21.1	
	B	43.55	51 56.2	
	C	44.18	52 13.2	
	D	46.77	51 19.1	
	E	45.11	51 01.9	
	F	44.40	50 40.4	
	G	39.28	50 46.8	
	Radio	44.19	51 33.8	Spinrad et al. (1975)
3C 415.2	A	20 31 22.40	+53 35 31.6	
	B	19.72	35 43.2	
	C	26.04	35 45.9	
	D	26.35	34 57.7	
	E	25.17	36 43.8	
	F	18.44	34 38.8	
	Radio	23.3	35 25.6	MN I
3C 427.1	A	21 04 51.15	+76 21 28.3	
	B	47.82	21 06.3	
	C	46.26	20 15.0	
	D	32.46	21 19.5	
	E	32.87	21 43.9	
	Radio	43.17	21 16.2	MN IV A
	Radio	47.08	20 58.6	MN IV B
3C 434	A	21 20 53.50	+15 34 26.4	
	B	53.94	34 33.6	
	C	54.51	34 52.4	
	D	51.25	35 08.5	
	E	52.72	35 00.4	
	F	56.94	35 31.3	
	G	46.41	36 04.7	
	H	56.70	35 49.7	
	Radio	54.40	35 12.3	P + H (1974)
3C 435.1A	A	21 34 11.79	+83 44 35.4	
	B	07.20	44 56.3	
	C	07.40	44 49.0	
	D	33 55.82	45 05.2	
	E	35.62	44 55.7	
	F	34 33.68	43 48.4	
	G	00.90	43 43.0	
	H	04.50	43 35.6	
	I	33 51.86	43 28.5	
	J	45.59	43 17.9	
	Radio	49.48	44 02.7	Westerbork Center
3C 435.1B	Z	21 34 50.96	+84 39 16.9	
	1	34.76	39 00.4	
	L	33 50.94	38 28.4	
	M	41.18	38 52.8	
	O	23.03	39 25.7	
	P	50.15	40 07.4	
	Radio	34 13.5	40 06.5	Mackay (1969)
3C 435.1C	4	21 36 33.77	+84 16 51.3	
	R	17.16	17 28.1	
	S	35 09.60	17 59.6	
	T	51.40	16 46.1	Id
	U	48.98	17 31.0	
	V	29.19	17 43.4	
	W	50.43	16 06.8	
	X	36 03.48	16 07.2	
	Radio	35 51.9	16 46.2	MN II
3C 437	Positions and chart in Paper I KSK (1974)			
3C 438	A	21 53 38.99	+37 45 24.1	
	B	41.83	45 42.1	Star A of LG (1975)
	C	43.75	44 58.9	
	D	44.81	46 05.6	Obj B of LG
	E	46.97	45 35.5	
	F	48.01	45 59.3	Star C of LG
	G	37.24	46 03.1	
	H	45.58	47 33.5	
	Radio	45.50	46 13.6	MN IV Center
	Radio	44.95	46 19.2	MN IV component
	Radio	46.05	46 07.9	MN IV component
3C 460	Positions and chart in Paper I KSK (1974)			
3C 470	Positions and chart in Riley and Pooley (1975)			

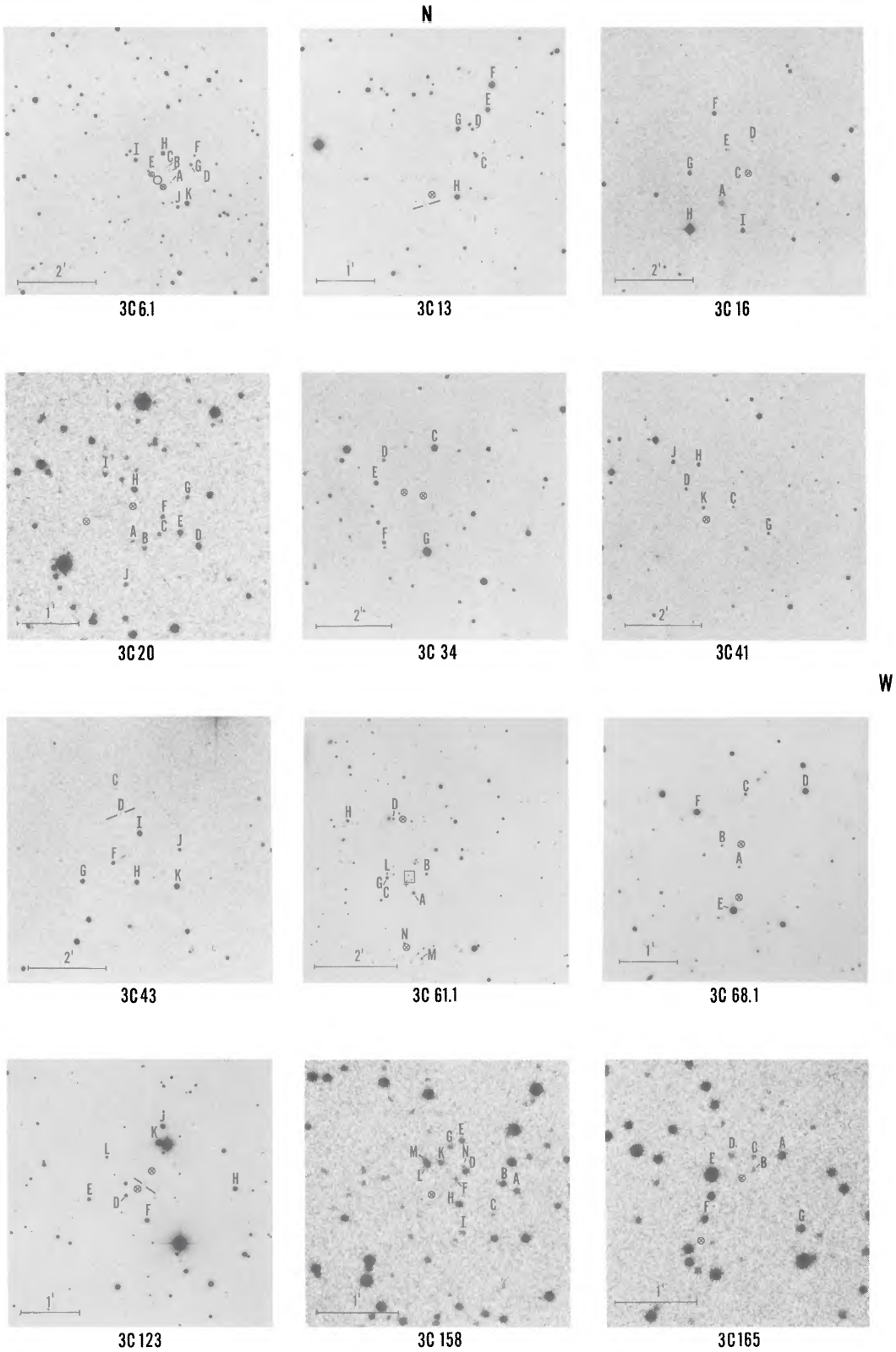

FIG. 1.—Finding charts for 3C 6.1 (48a-O), 3C 13 (200a-E), 3C 16 (48a-O), 3C 20 (48a-O), 3C 34 (48a-O), 3C 41 (48a-O), 3C 43 (48a-O), 3C 61.1 (200, 098), 3C 68.1 (200a-E), 3C 123 (200a-D), 3C 158 (48a-O), 3C 165 (48a-O).

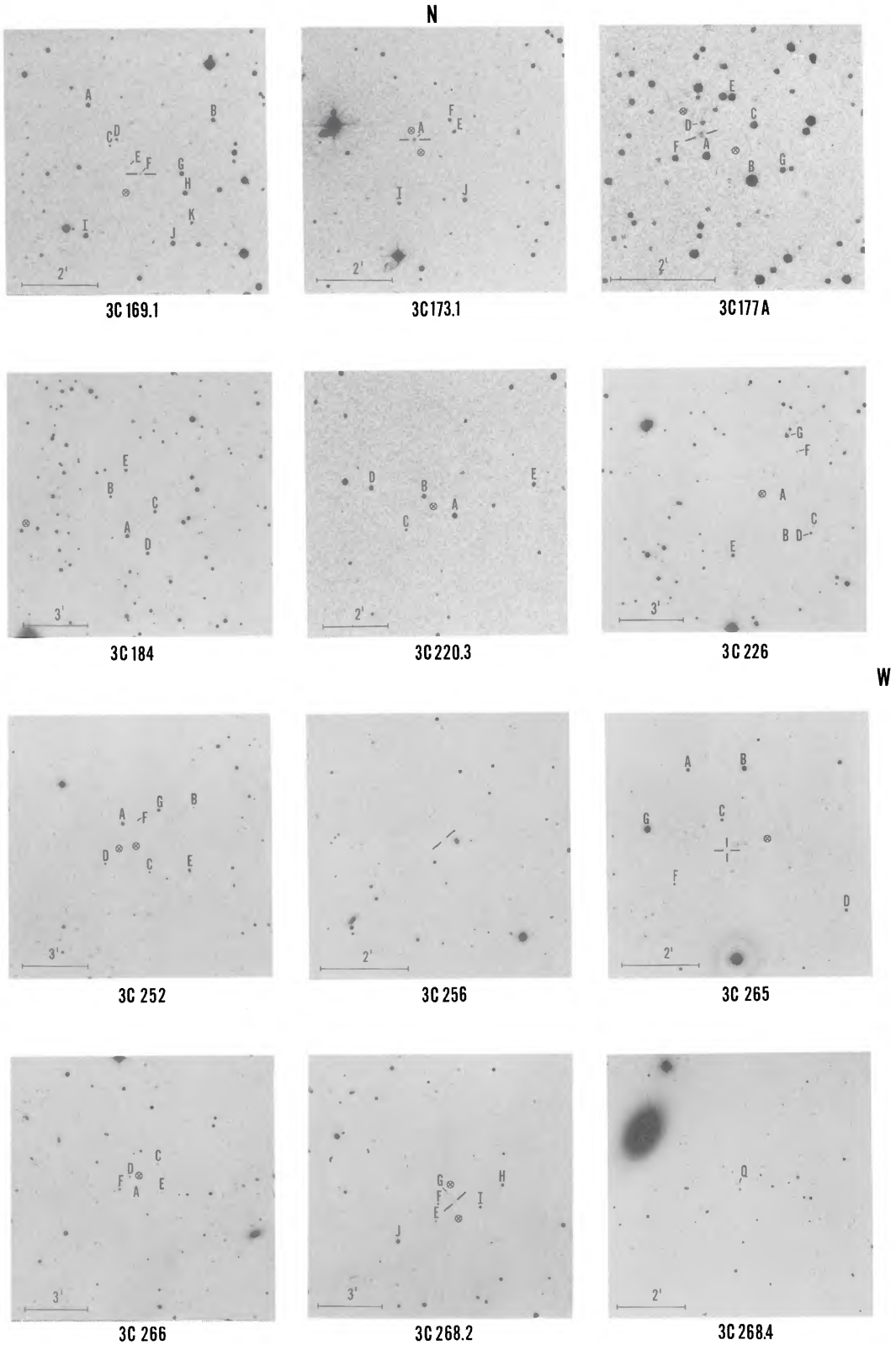

FIG. 2.—Finding charts for 3C 169.1 (48a-O), 3C 173.1 (48a-D), 3C 177A (48a-O), 3C 184 (48 PSSE), 3C 220.3 (48a-O), 3C 226 (48 PSSE), 3C 252 (48 PSSE), 3C 256 (200 IIIa-J), 3C 265 (200a-F), 3C 266 (PSSE), 3C 268.2 (48 PSSE), 3C 268.4 (200a-D).

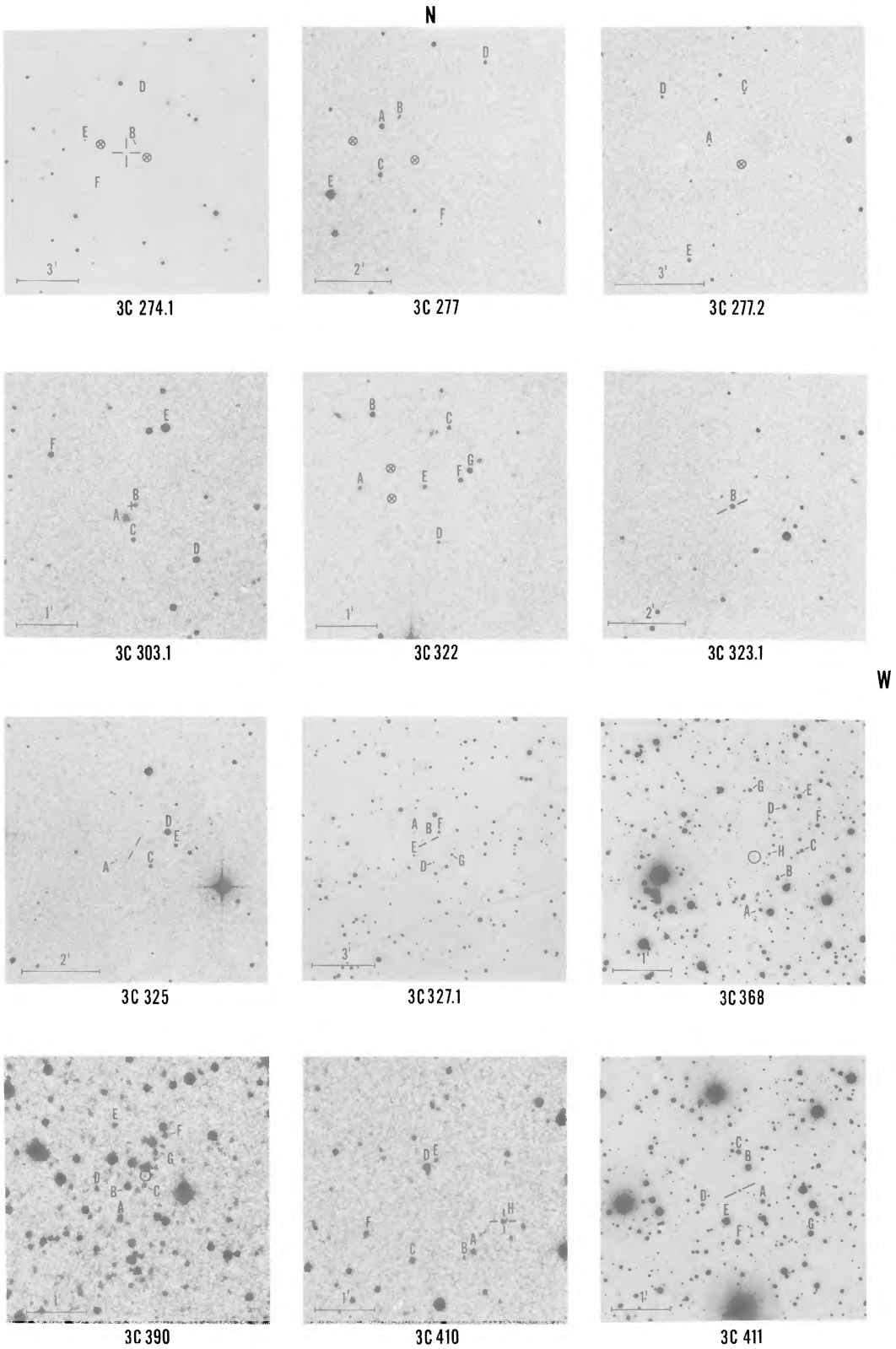

FIG. 3.—Finding charts for 3C 274.1 (200 R, IT), 3C 277 (48a-O), 3C 277.2 (48a-O), 3C 303.1 (48a-D), 3C 322 (48a-D), 3C 323.1 (48a-O), 3C 325 (200 R, IT), 3C 327.1 (48 PSSE), 3C 368 (200a-E), 3C 390 (48a-O), 3C 410 (48a-O), 3C 411 (200a-E).

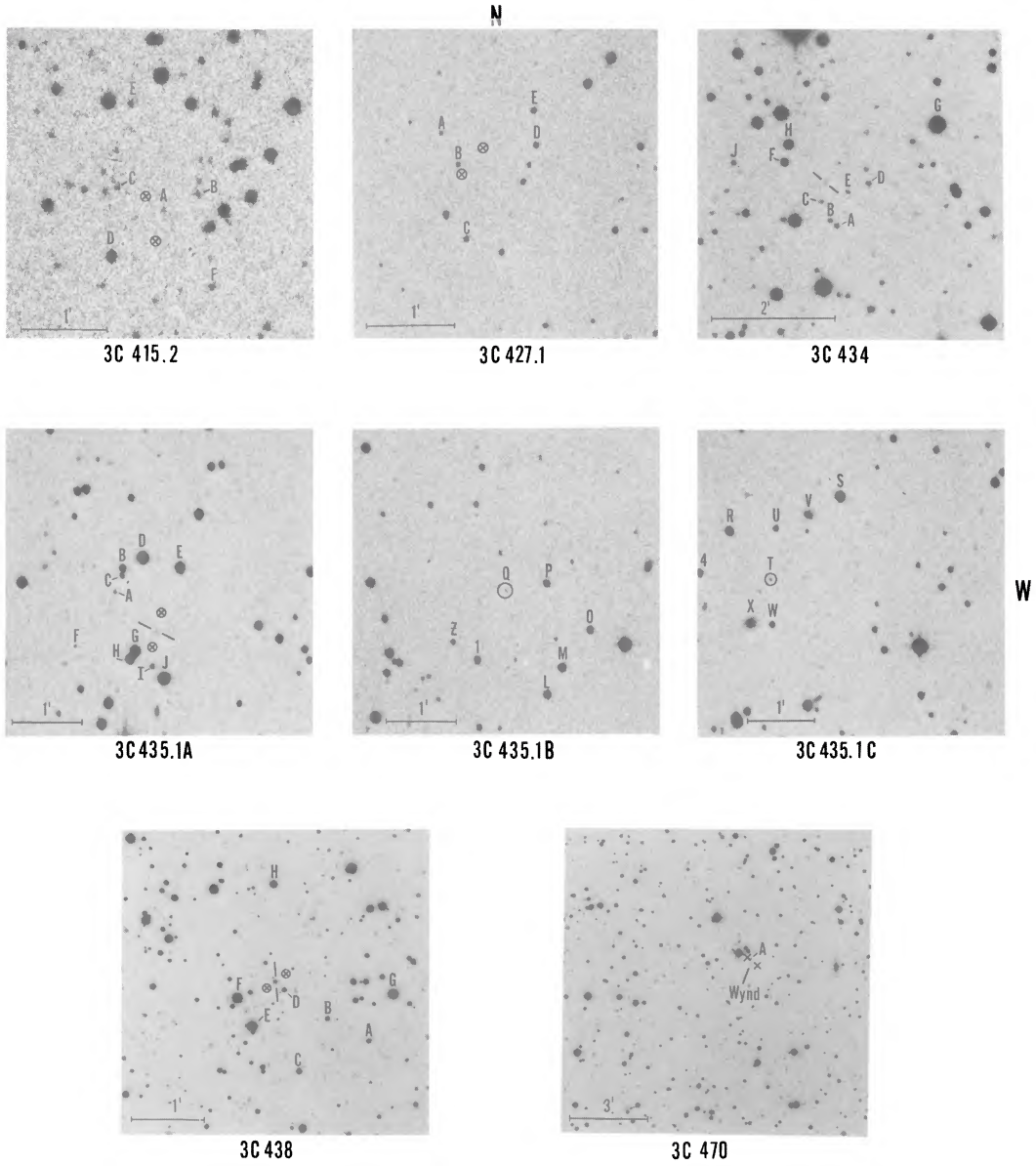

FIG. 4.—Finding charts for 3C 415.2 (48a-O), 3C 427.1 (48 IIIa-J), 3C 434 (200 R, IT), 3C 435.1A (48 IIIa-J), 3C 435.1B (48 IIIa-J), 3C 435.1C (48 IIIa-J), 3C 438 (200a-E), 3C 470 (48 PSSE).

REFERENCES

Adgie, R. L., Crowther, J. H., and Gent, H. 1972, *M.N.R.A.S.*, **159**, 233 (RRE).
Adgie, R. L., and Gent, H. 1966, *Nature*, **209**, 549.
Argue, A. N., and Kenworthy, C. M. 1972, *M.N.R.A.S.*, **160**, 197.
Bennett, A. S. 1962, *Mem. R.A.S.*, **68**, 163.
Boksenberg, A., Carswell, R. F., and Oke, J. B. 1976, *Ap. J. (Letters)*, **206**, L121.
Bolton, J. G. 1969, *A.J.*, **74**, 131.
Branson, N. J. B. A., Elsmore, B., Pooley, G. G., and Ryle, M. 1972, *M.N.R.A.S.*, **156**, 377 (MN IV).
Cohen, M. H. 1972, *Ap. Letters*, **12**, 81.
Edge, D. O., Shakeshaft, J. R., McAdam, W. B., Baldwin, J. E., and Archer, S. 1959, *Mem. R.A.S.*, **68**, 37.
Elsmore, B., and Mackay, C. D. 1969, *M.N.R.A.S.*, **146**, 36 (MN III).
Fanselow, J. L. 1974, private communication.
Fomalont, E. B. 1971, *A.J.*, **76**, 513.
Fomalont, E. B., and Moffet, A. T. 1971, *A.J.*, **76**, 5 (FM).
Ghigo, F. D., and Owen, F. N. 1973, *A.J.*, **78**, 848.
Griffin, R. F. 1963, *A.J.*, **68**, 421.
Gunn, J. E., and Oke, J. B. 1975, *Ap. J.*, **195**, 255.
Högbom, J. A., and Carlsson, I. 1974, *Astr. Ap.*, **34**, 341.
Kristian, J. 1973, *Ap. J. (Letters)*, **179**, L61.
———. 1977, in *IAU Symposium No. 74, Radio Astronomy and Cosmology*, ed. D. L. Jauncey (Dordrecht: Reidel).
Kristian, J., and Sandage, A. 1970, *Ap. J.*, **162**, 391 (KS).
———. 1976, *Ap. J.*, **205**, 308.
Kristian, J., Sandage, A., and Katem, B. 1974, *Ap. J.*, **191**, 43 (Paper I, KSK).
Kristian, J., Sandage, A., and Westphal, J. A. 1978, in preparation (KSW).
Longair, M. S. 1965, *M.N.R.A.S.*, **129**, 419.
———. 1975, *M.N.R.A.S.*, **173**, 309.
Longair, M. S., and Gunn, J. E. 1975, *M.N.R.A.S.*, **170**, 121 (LG).
Macdonald, G. H., Kenderdine, S., and Neville, A. C. 1968, *M.N.R.A.S.*, **138**, 259 (MN I, MKN 1968).
Mackay, C. D. 1969, *M.N.R.A.S.*, **145**, 31 (MN II).
Matthews, T. A. 1966, *A.J.*, **71**, 169.
McEwan, N. J., Browne, I. W. A., and Crowther, J. H. 1975, *Mem. R.A.S.*, **80**, 1.
Miller, J. S., Robinson, L. B., and Wampler, E. J. 1973, *Ap. J. (Letters)*, **179**, L83.
Mitton, S. 1970, *M.N.R.A.S.*, **149**, 101.
Parker, E. A., Elsmore, B., and Shakeshaft, J. R. 1966, *Nature*, **210**, 22.
Pooley, G. G. 1969, *M.N.R.A.S.*, **144**, 101.
Pooley, G. G., and Henbest, S. N. 1974, *M.N.R.A.S.*, **169**, 477.
Riley, J. M., and Pooley, G. G. 1975, *Mem. R.A.S.*, **80**, 105.
Ryle, M., and Windram, M. 1968, *M.N.R.A.S.*, **138**, 1.
Sandage, A., Kristian, J., and Westphal, J. A. 1976, *Ap. J.*, **205**, 688.
Sandage, A., Véron, P., and Wyndham, J. D. 1965, *Ap. J.*, **142**, 1307 (SVW).
Schmidt, M. 1968, *Ap. J.*, **151**, 393.
Smith, H. E., Burbidge, E. M., and Spinrad, H. 1976, *Ap. J.*, **210**, 627.
Smith, H. E., Spinrad, H., and Smith, E. O. 1976, *Pub. A.S.P.*, **88**, 621.
Spinrad, H. 1975, *Ap. J. (Letters)*, **199**, L3.
Spinrad, H., Liebert, J., Smith, H. E., and Hunstead, R. 1976, *Ap. J. (Letters)*, **206**, L79.
Spinrad, H., Smith, H. E., Hunstead, R., and Ryle, M. 1975, *Ap. J.*, **198**, 7.
Véron, P. 1966, *Ap. J.*, **144**, 861.
———. 1968, *Ann. d'Ap.*, **31**, 483.
Véron, M. P., and Véron, P. 1973, *Astr. Ap.*, **28**, 319.
———. 1974, *Astr. Ap. Suppl.*, **18**, 309.
Wade, C. M., Clark, B. G., and Hogg, D. E. 1965, *Ap. J.*, **142**, 406.
Wade, C. M., and Miley, G. K. 1971, *A.J.*, **76**, 101.
Wyndham, J. D. 1965, *A.J.*, **70**, 384.
———. 1966, *Ap. J.*, **144**, 459.

Note added in proof.—The redshift of 0.637 for 3C 123 is spaced primarily on a single bright emission line assumed to be λ3727. Recent infrared scans by Spinrad (private communication) indicate that this line is λ5007 and that the redshift of 3C 123 is 0.218.

BASIL KATEM, JEROME KRISTIAN, and ALLAN SANDAGE: Hale Observatories, 813 Santa Barbara Street, Pasadena, CA 91101