Revista Mexicana de Astronomía y Astrofísica, **31**, 119-129 (1995)

CALÁN-TOLOLO SURVEY. VI. ONE HUNDRED NEW SOUTHERN QUASARS

J. Maza[1], M. Wischnjewsky[1], R. Antezana[1], and L.E. González[1]

Depto. de Astronomía, Universidad de Chile

Received 1995 April 17; accepted 1995 June 5

RESUMEN

Se presenta la sexta lista de la Exploración Calán-Tololo. Contiene información acerca de 100 nuevos cuasares australes. Los objetos tienen una magnitud B en el intervalo $16 \leq B < 20$, con 81 objetos para los cuales $17.5 \leq B < 19$. Los corrimientos al rojo z son tales que 53 objetos cumplen con $1.8 \leq z < 2.4$, 20 objetos tienen z tal que $2.4 \leq z < 3.4$ y 27 cuasares tienen un z menor que 1.8. Estos cuasares fueron encontrados en Cerro Calán explorando placas de prisma objetivo tomadas en Cerro Tololo usando la cámara Curtis-Schmidt con el prisma ultravioleta delgado y placas IIIaJ. Se presentan cartas de identificación, coordenadas ecuatoriales, una estimación de la magnitud azul, B, y un valor preliminar del corrimiento al rojo. Todos los cuasares de esta lista han sido confirmados espectroscópicamente, información que será publicada posteriormente (Maza 1995).

ABSTRACT

The sixth list of the Calán-Tololo Survey is presented. It contains information for 100 new southern quasars. The objects have a B magnitude in the range $16 \leq B < 20$; for 81 objects $17.5 \leq B < 19$. The redshifts z of these quasars are such that for 53 objects $1.8 \leq z < 2.4$, for 20 objects $2.4 \leq z < 3.4$ and for 27 quasars $z < 1.8$. These quasars were found at Cerro Calán, searching objective prism plates taken at Cerro Tololo using the Curtis-Schmidt telescope, the thin UV prism and IIIaJ plates. Identification charts, equatorial coordinates, an estimated blue magnitude, B, and a preliminary redshift for every object are presented. All quasars in this list have been confirmed using slit spectroscopy. The spectroscopic data shall be presented elsewhere (Maza 1995).

Key words: **QUASARS–GENERAL**

1. INTRODUCTION

The Calán-Tololo Survey (hereinafter CTS) is an objective prism survey conducted at Cerro Calán (Department of Astronomy, Universidad de Chile) in Santiago, using photographic plates obtained at Cerro Tololo Inter-American Observatory (CTIO). We have used the Curtis-Schmidt telescope, IIIaJ plates and the thin UV prism. The CTS is a southern extension to the Tololo Survey (Smith 1975; Smith, Aguirre, & Zemelman 1976) and to the Michigan Survey (MacAlpine, Lewis, & Smith 1977; MacAlpine, Smith, & Lewis 1977a, 1977b; MacAlpine & Lewis 1978; MacAlpine & Williams 1981). The main goal of the CTS is the discovery of new emission line galaxies and quasars. A description of the survey, the procedure and other details can be found in Maza et al. (1988a, 1988b, 1989, 1991, 1992).

List No. 1 of the Calán-Tololo Survey containing 30 new Seyfert 1 galaxies was published in 1989 (Maza et al. 1989). List No. 3 presenting 42 H II galaxies was published in 1991 (Maza et al. 1991). List No. 2 containing data for 40 Seyfert 1 galaxies was published in 1992 (Maza et al. 1992). List No. 4 presenting data for 50 Seyfert 1 galaxies was published in 1994 (Maza et al. 1994). List No. 5 con-

[1] Visiting Astronomer at Cerro Tololo Inter-American Observatory, National Optical Astronomy Observatories, operated by the Association of Universities for Research in Astronomy under contract with the National Science Foundation of the U.S.A.

taining data for 200 quasars was published in 1993 (Maza et al. 1993). The present list contains information for 100 new additional quasars discovered in the Calán-Tololo Survey and fully confirmed by slit spectroscopy at CTIO.

2. OBSERVATIONS

Objective prism photographic plates have been obtained for 266 fields in the southern hemisphere at galactic latitude b such that $|b| \geq 20°$, covering 5150 deg^2. To the original 163 fields of the CTS — see Figure 1 in Maza et al. 1989— additional strips at $\delta = -30°$ (strip F), $\delta = -50°$ (strip G), and $\delta = -55°$ (strip H) have been added in the right ascension interval 19 h $\leq \alpha \leq$ 6 h.

We have used the Curtis-Schmidt telescope at CTIO equipped with the thin UV prism that yields a reciprocal dispersion of 1740 Å mm^{-1} at H$_\beta$, 1340 Å mm^{-1} at Hγ, and 1100 Å mm^{-1} at λ3727 Å (Blanco 1974). We have used Eastman Kodak IIIaJ plates baked in 2% forming gas and exposed to the sky limit (90 min) without trailing. Objects as faint as 19th mag in B are visible at the plate limit. The UV prism spectral resolution at the Curtis-Schmidt plate scale (97″ mm^{-1}) is $\sim$ 30 Å at Hβ and $\sim$ 20 Å at λ3727 Å for a 2″ seeing.

The strong emission lines present in the spectrum of a high redshift quasar —Lymanα, (Lα), most of the time— are resolved on our objective prism spectra. This makes confusion with high redshift starburst galaxies very small. Our method of selecting a quasar candidate relies heavily on the presence of emission lines. The most favorable case is when Lα is near λ4000 Å and the C IV (λ1549 Å) line is at λ5000 Å; that situation corresponds to a quasar with a redshift $z \sim 2.2$. The lines used for candidate selection on the objective prism plates are: Lα ($\sim$ 75% of the time), C IV (λ1549 Å) and Mg II (at λ2798 Å). In a few cases broad absorption lines quasars (BALs) have been found because their spectra look quite conspicuous on the objective prism plates; they look like unusual carbon stars.

3. LIST No. 6

Figure 1 presents identification charts and Table 1 contains the corresponding data for 100 additional quasars found and confirmed in our survey. Quasar candidates are selected from the objective prism plates and they are confirmed using slit spectroscopy at the CTIO 4-m and 1.5-m telescopes. If a candidate turns out to be a known quasar we leave it aside. We are presenting here quasars that, to the best of our knowledge, are new.

Table 1 contains for quasars numbered from 401 to 500 a name, labeled "Object" obtained from a contraction of the letter designating the strip on the sky, the field number in the strip and the candidate number in that field. For example, object A1505 is the fifth candidate selected in area "A15" (fifteenth field in strip "A") (see Fig. 1 in Maza et al. 1989).

Equatorial coordinates (J2000.0) were obtained using the Digitized Sky Survey (DSS), the STSDAS software package and the corresponding tasks, in the IRAF working environment on SUN workstations at Cerro Calán. A preliminary set of coordinates for each candidate was obtained by overlaying a grid on the objective prism plate. Then a 15′ × 15′ image was extracted from the DSS. The object was identified in that image and coordinates were obtained using the plate solution in the header of each image, using the appropriate tasks in the STSDAS software package. The astrometric accuracy of these coordinates is $\leq 1''$.

Table 1 presents a B magnitude estimated from the ESO Quick Blue Chart for every object. The CCD sequence F342–10 from Stobie, Sagar, & Gilmore (1985) was used for our eye estimates. Two of us (MW and RA) made independent estimates, the average of which is presented in Table 1. The agreement between these two data sets is ± 0.50 mag. As quasars in Table 1 could present photometric variability it is necessary to emphasize that the magnitudes quoted correspond to an eyeball estimate made on plates taken at least 15 years ago; those magnitudes do not necessarily correspond to the apparent magnitudes of the quasars in the objective prism plates. These B magnitudes are presented here as a reference.

Column 10 in Table 1 presents preliminary values for the redshifts of the quasars. These figures were obtained at the telescope when the spectroscopic confirmation of the quasars was made. The details of the spectrophotometry shall be presented elsewhere (Maza 1995). The final redshift values will be reported there. The figures given here are just for a general orientation to prospective observers; these redshifts should be accurate to ± 0.02.

Finally Table 1 shows in the last two columns the ESO Quick Blue chart number and the DSS disk number, respectively, where the quasar can be found.

4. STATISTICAL PROPERTIES OF LIST No. 6

In List No. 5 (Maza et al. 1993) a preliminary analysis of the statistical properties of quasars found in the CTS was performed. Figure 2 presents a histogram of the redshifts for these new 100 quasars. In the lower part of Figure 2 four horizontal lines show the redshift interval of visibility in our objective prism spectra for the most prominent emission lines usually present in quasars, as labeled to the right of the horizontal lines.

In the upper part of Figure 2 the redshift range has been divided in four intervals containing 7, 20, 53, and 20 objects, respectively. If we divide in the same way the histogram in Figure 1 of List No. 5 (Maza

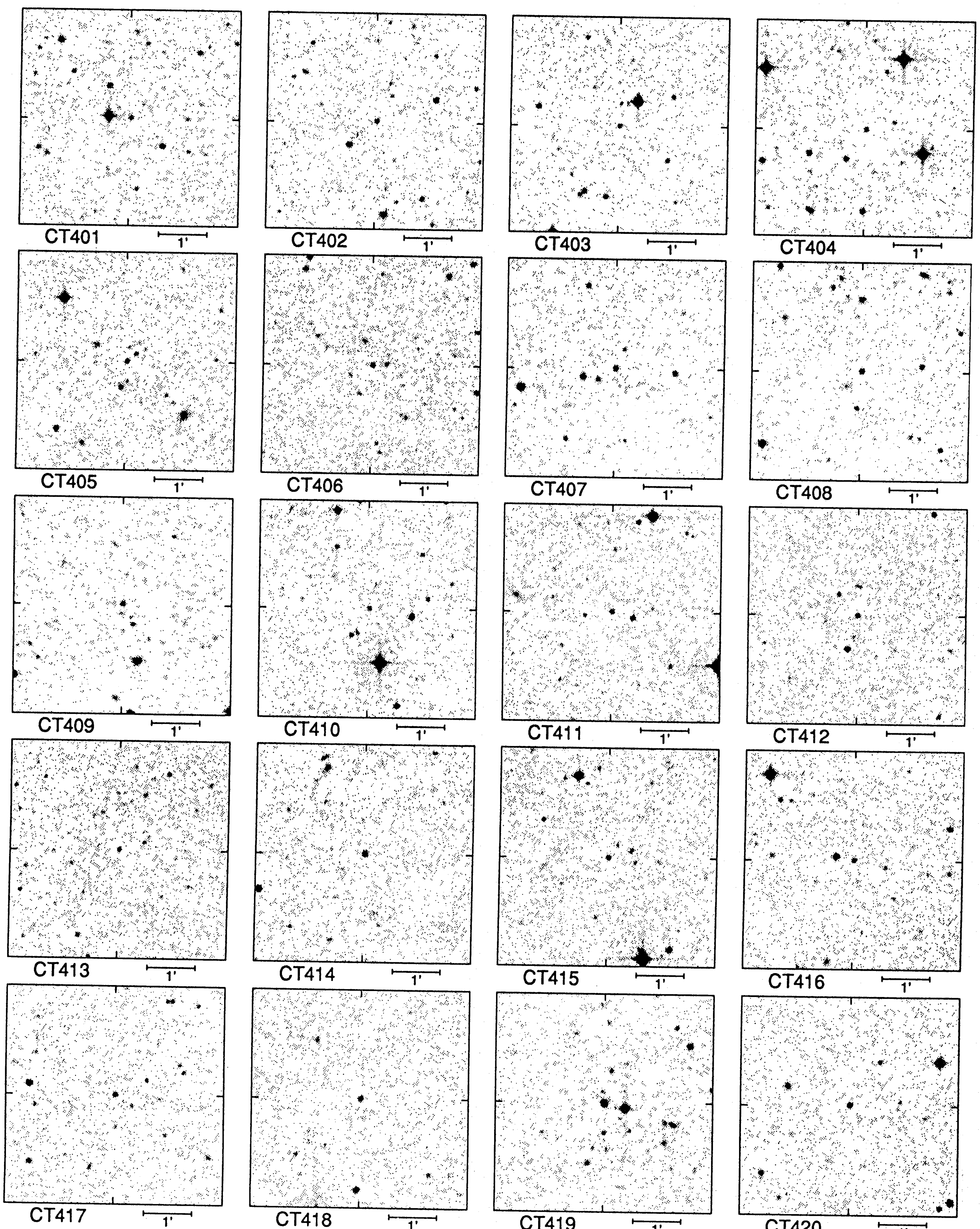

Fig. 1*a*. Objects 401–420. Finding charts for Calán-Tololo quasars from the Digitized Sky Survey (DSS). North is to the top and east to the left. Each chart covers $4' \times 4'$.

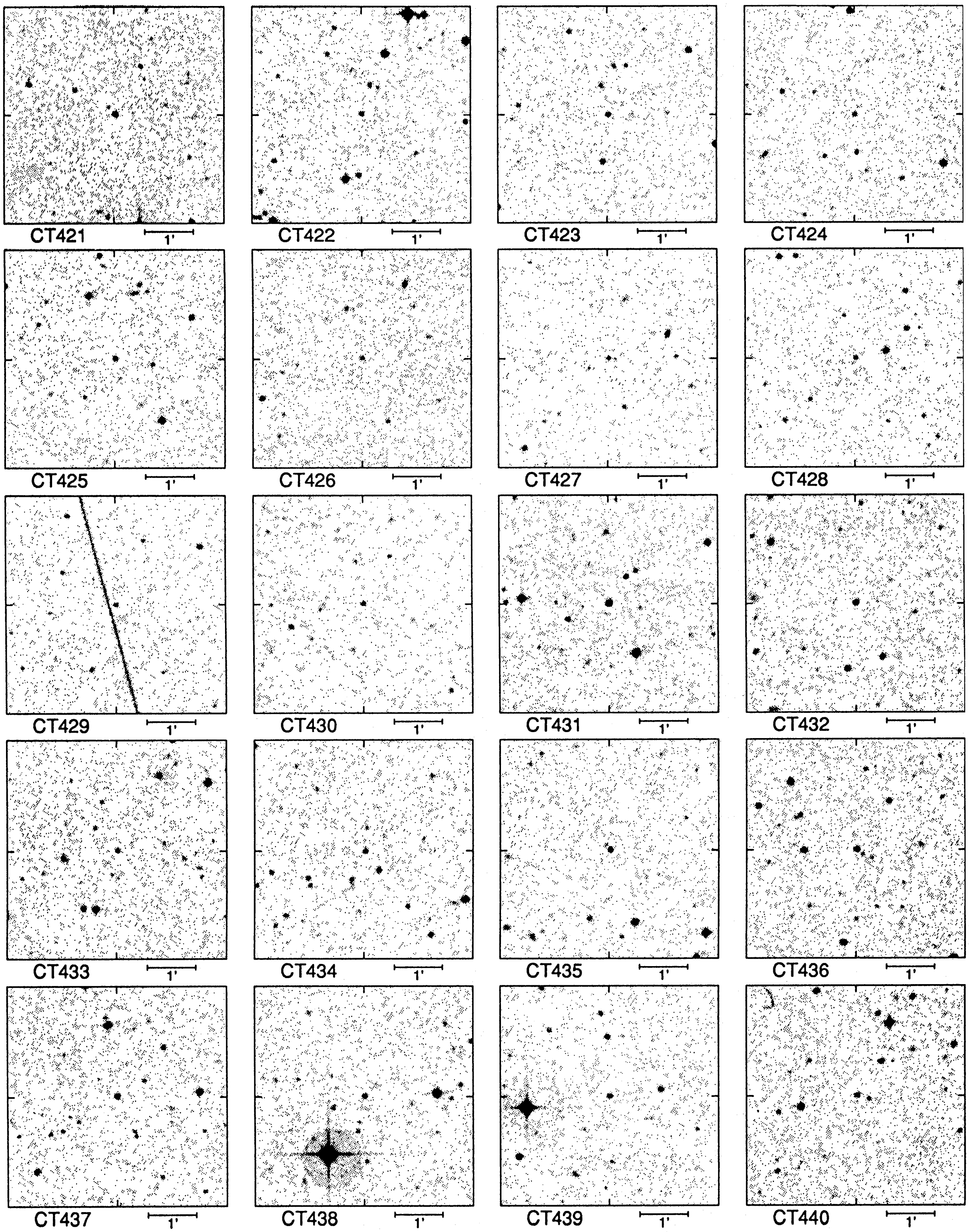

Fig. 1*b*. Same as Figure 1*a* for objects 421–440.

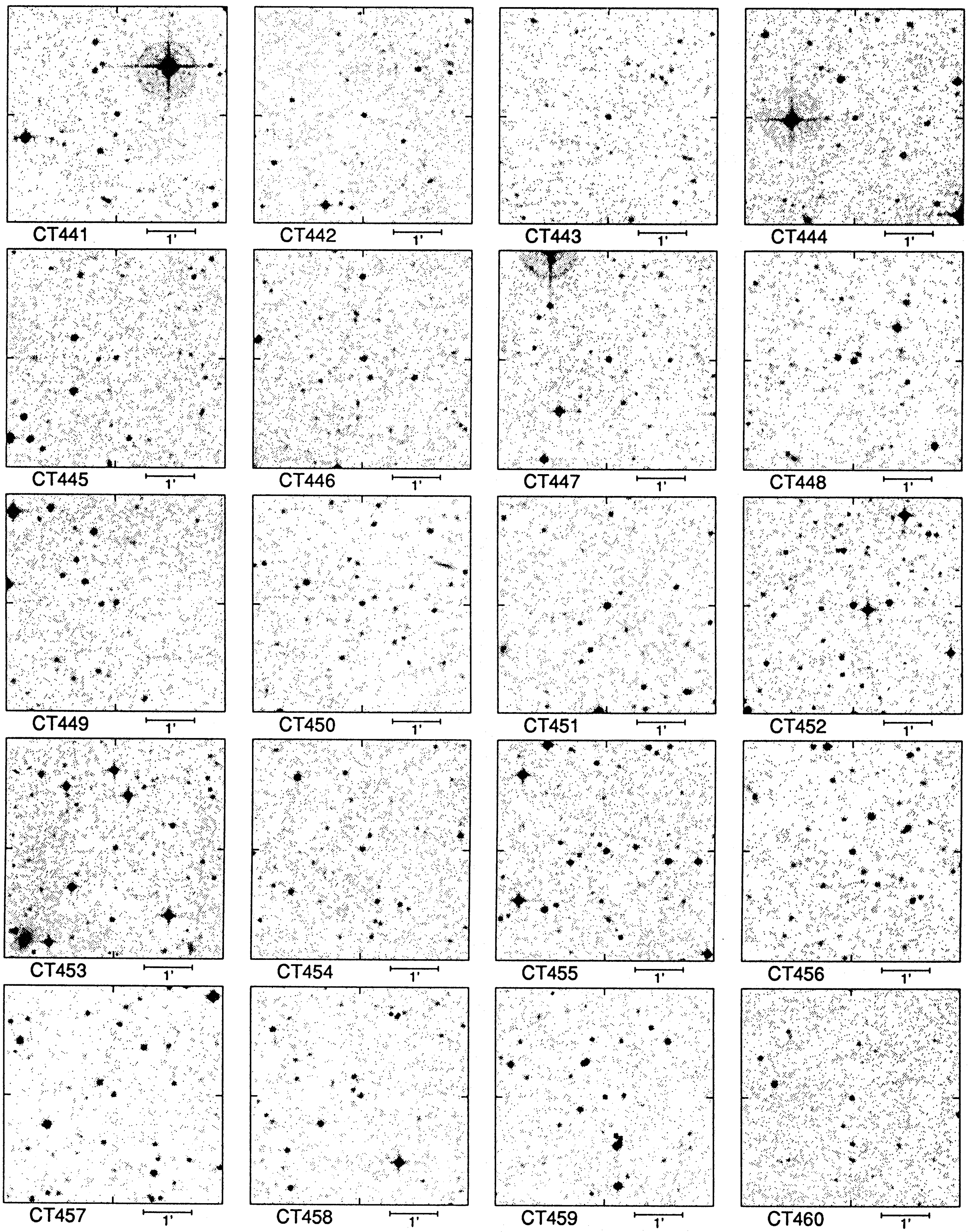

Fig. 1*c*. Same as Figure 1*a* for objects 441–460.

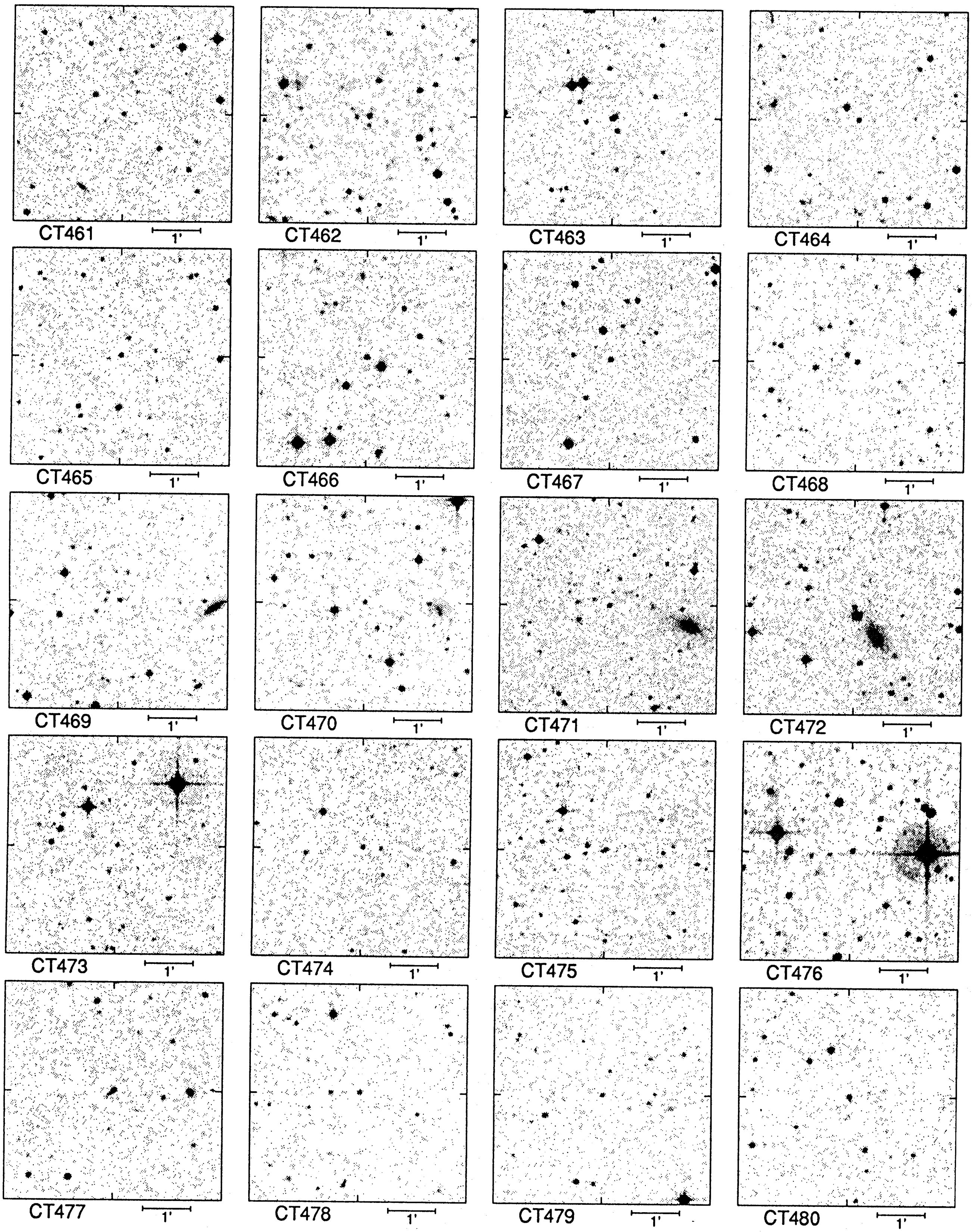

Fig. 1*d*. Same as Figure 1*a* for objects 461–480.

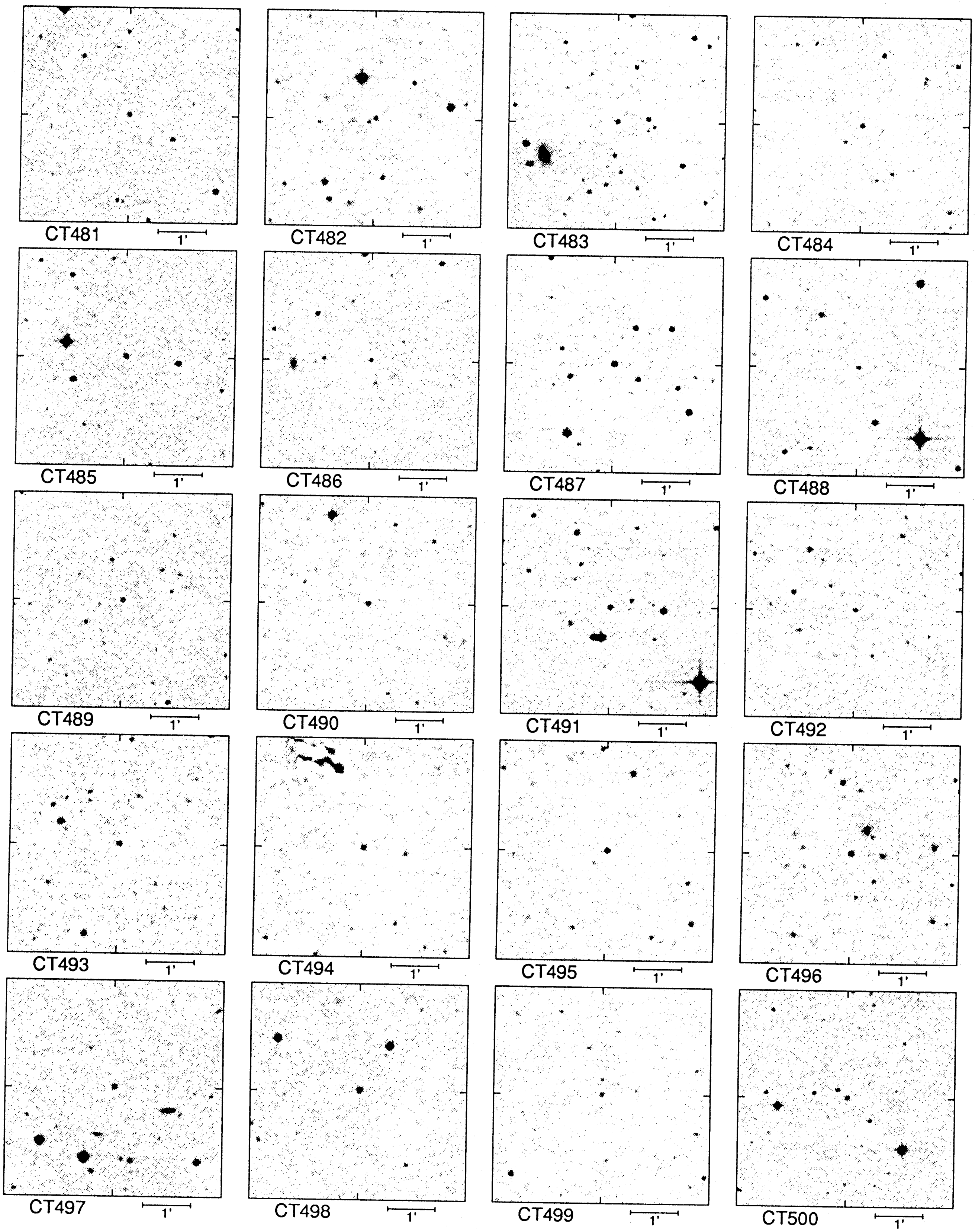

Fig. 1*e*. Same as Figure 1*a* for objects 481–500.

TABLE 1

CALÁN-TOLOLO SURVEY LIST NO. 6: QUASARS

		α (J2000.0) δ					
CT#	Object	h m s	° ′ ″	B	z	ESO	DSS
401	A1505	00 07 19.38	−33 15 17.5	18.6	2.03	349	24
402	C1609	00 09 27.20	−47 03 16.4	18.2	1.99	241	17
403	A1605	00 21 02.99	−35 02 32.3	18.8	2.0	350	24
404	G1706	00 21 14.51	−48 34 31.3	18.1	1.34	194	14
405	A1604	00 22 18.46	−35 16 50.8	18.7	2.0	350	24
406	A1716	00 34 26.84	−37 12 52.4	18.2	3.18	350	20
407	A1715	00 38 28.06	−36 24 26.0	18.1	0.40	351	24
408	G1801	00 41 31.49	−49 36 12.4	17.9	3.24	194	14
409	G1909	01 08 03.77	−50 47 54.0	18.2	2.19	195	14
410	A1821	01 09 28.57	−34 25 26.9	18.2	1.26	352	24
411	A2011	01 34 41.12	−33 14 16.3	18.1	1.28	353	24
412	A2001	01 41 53.71	−33 24 17.0	17.9	2.51	353	24
413	H2205	01 48 18.07	−53 27 02.0	19.1	3.13	152	11
414	C2208	01 58 41.41	−43 25 04.4	17.2	1.29	245	17
415	C2207	01 58 53.55	−45 58 49.4	18.2	2.57	245	17
416	C2210	02 05 51.04	−43 46 19.6	18.2	2.8	245	17
417	A2214	02 08 14.56	−32 37 14.4	17.8	2.26	354	24
418	A2219	02 17 41.76	−37 00 59.9	18.4	2.91	355	24
419	C2416	02 45 54.02	−44 59 39.6	17.6	0.28	247	17
420	C2417	02 52 10.85	−45 56 25.2	18.3	1.61	247	17
421	H2501	02 52 40.12	−55 38 32.0	17.4	2.37	154	11
422	G2501	03 01 27.03	−50 53 52.4	18.2	2.18	199	14
423	H2502	03 04 50.24	−53 19 41.1	18.1	2.27	155	11
424	H2606	03 16 43.86	−56 51 44.6	18.6	3.02	155	11
425	H2609	03 16 50.40	−55 11 09.9	17.9	2.53	155	11
426	H2612	03 17 41.25	−53 11 58.7	19.1	2.33	155	11
427	H2613	03 17 43.26	−53 11 03.4	19.1	2.33	155	11
428	H2623	03 31 29.61	−53 18 19.2	19.6	2.38	155	11
429	H2626	03 33 19.88	−54 16 46.0	18.3	2.05	155	11
430	C2615	03 34 43.28	−44 11 52.4	18.3	2.11	249	17
431	H2703	03 50 59.32	−52 40 34.6	16.8	1.54	156	11
432	H2709	03 56 43.37	−56 43 30.2	17.9	2.33	156	11
433	A2741	04 02 18.77	−32 31 28.0	18.1	1.62	359	25
434	C2902	04 13 16.43	−47 24 18.5	18.4	2.14	201	17
435	A2811	04 14 02.37	−32 45 19.1	18.2	2.04	360	29
436	H2902	04 26 44.43	−52 08 20.2	17.8	2.25	202	14
437	A2907	04 38 37.33	−37 03 41.6	17.0	1.43	361	25
438	G3004	04 42 34.33	−48 21 30.6	18.0	2.63	202	14
439	F2732	04 47 46.52	−31 21 51.6	18.0	2.10	421	29
440	H3105	04 52 21.91	−55 26 08.0	18.3	2.22	158	11
441	H3102	04 53 05.91	−53 27 39.8	18.6	2.34	158	11
442	B2724	04 53 13.70	−41 47 25.5	18.1	2.11	304	21
443	A3024	04 53 59.84	−37 42 45.1	18.1	1.98	304	21
444	H3106	04 55 39.54	−55 57 41.0	18.6	2.35	158	11
445	H3101	04 55 46.58	−52 43 54.1	18.9	2.33	158	11

TABLE 1 (CONTINUED)

CT#	Object	α (J2000.0) h m s	δ ° ′ ″	B	z	ESO	DSS
446	H3110	05 08 24.51	−55 09 10.1	18.1	1.50	158	11
447	F2901	05 20 59.78	−27 37 19.0	17.6	2.20	423	29
448	H3202	05 33 20.58	−54 26 47.9	18.1	2.35	159	11
449	H3404	05 44 29.00	−55 46 15.5	18.4	0.34	159	11
450	H3401	05 45 12.88	−52 41 05.6	18.1	1.31	159	11
451	H3402	05 52 00.50	−53 12 43.5	16.6	1.59	160	11
452	A3302	05 54 45.76	−33 05 17.0	16.7	2.36	364	25
453	A3304	06 06 07.26	−34 47 39.6	18.6	2.28	364	25
454	H3405	06 14 01.49	−55 13 06.3	17.6	1.93	160	11
455	J0111	09 47 45.73	−21 55 47.3	17.4	0.32	566	38
456	M0040	10 06 50.39	−26 05 50.6	18.4	1.88	499	34
457	M0042	10 06 59.32	−27 02 19.4	18.9	2.20	499	34
458	J0317	10 13 42.34	−21 06 20.5	18.0	1.53	567	39
459	M0130	10 23 58.63	−24 28 56.1	18.4	2.28	500	34
460	M0306	10 39 09.51	−23 13 25.7	18.0	3.13	501	34
461	M0280	10 39 13.78	−25 09 29.6	17.8	1.56	501	34
462	M0245	10 43 31.57	−28 40 29.1	17.4	1.49	437	30
463	J0524	11 06 33.48	−18 21 25.0	17.9	2.31	570	39
464	J0610	11 15 24.46	−20 44 18.1	18.3	1.94	570	39
465	J0714	11 44 27.25	−22 14 36.8	18.2	2.27	571	39
466	J0907	12 20 25.92	−20 52 22.9	18.2	0.33	573	39
467	J0904	12 23 10.53	−18 16 43.0	18.1	2.16	573	39
468	J1017	12 31 06.91	−20 07 28.7	17.9	1.34	574	39
469	J1010	12 33 05.86	−20 43 07.6	18.5	1.97	574	39
470	M1225	12 57 33.39	−25 33 26.6	18.6	1.90	507	34
471	J1110	12 58 56.09	−17 50 36.3	18.1	2.06	575	39
472	J1125	12 59 14.02	−19 25 08.7	18.0	1.14	575	39
473	J1139	13 02 36.47	−21 43 50.6	19.1	1.59	575	39
474	J1121	13 09 26.33	−18 24 50.5	18.2	1.07	575	39
475	J1701	14 51 17.80	−21 45 13.1	18.6	1.93	580	39
476	J1706	14 56 49.83	−19 38 52.0	18.7	3.15	581	39
477	G1213	22 45 58.87	−51 33 44.2	18.4	2.29	238	17
478	G1209	22 48 34.11	−50 02 02.9	18.6	1.94	238	17
479	G1212	22 52 15.15	−50 45 12.0	18.6	2.84	239	17
480	G1211	22 52 44.03	−50 21 38.2	17.9	2.90	239	17
481	A1222	22 56 54.81	−35 52 51.9	17.9	2.64	406	28
482	C1426	23 08 47.41	−45 23 03.6	18.2	1.31	291	20
483	C1403	23 09 58.60	−45 02 53.7	18.2	2.08	291	20
484	A1323	23 18 14.53	−34 57 45.3	18.0	1.69	407	28
485	A1303	23 19 57.78	−33 22 10.4	17.8	1.88	407	28
486	A1326	23 20 58.46	−36 59 55.2	18.6	2.0	407	28
487	A1308	23 22 10.83	−34 47 57.2	16.5	0.42	407	28
488	A1305	23 24 20.87	−33 40 13.9	18.5	2.28	407	28
489	C1462	23 25 19.81	−44 49 57.4	18.3	2.0	291	20
490	A1310	23 25 28.57	−35 57 54.0	17.9	0.36	407	28
491	A1317	23 26 06.46	−35 34 50.0	17.2	2.43	407	28
492	C1468	23 29 12.78	−45 45 10.1	18.4	2.41	291	20

TABLE 1 (CONTINUED)

CT#	Object	α (J2000.0) h	m	s	δ °	′	″	B	z	ESO	DSS
493	A1426	23	40	05.34	−36	16	30.9	17.9	2.43	408	28
494	C1508	23	43	13.59	−46	40	02.8	16.4	1.97	292	20
495	C1513	23	43	46.92	−44	07	19.1	16.5	1.90	292	20
496	C1507	23	46	40.59	−46	12	29.9	16.4	1.89	292	20
497	A1415	23	49	58.83	−33	26	48.0	17.7	1.84	408	28
498	C1505	23	50	34.21	−43	25	59.6	16.3	2.9	292	20
499	A1405	23	51	23.84	−36	42	28.9	18.4	1.89	349	24
500	A1402	23	52	11.34	−32	59	07.5	18.1	2.45	349	24

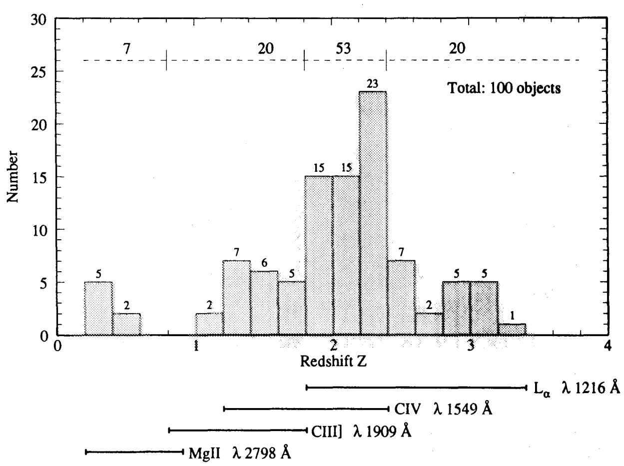

Fig. 2. Histogram of the redshift distribution of Calán-Tololo quasars contained in List No. 6 (present paper). Horizontal lines at the bottom indicate the redshift intervals where the most prominent emission lines in quasars are found on our objective prism spectra.

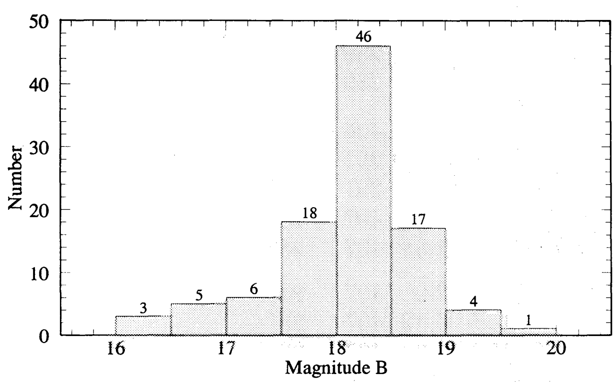

Fig. 3. Histogram of the B magnitude distribution of the Calán-Tololo quasars in List No. 6 (present paper). Thirty two objects have $B < 18$ and twenty two have $B > 18.5$.

et al. 1993) the numbers are 13, 23, 92 and 72 for a total of 200 objects (or 6.5%, 11.5%, 46%, and 36%, respectively). The present list contains a larger percentage of quasars in the redshift interval (0.8, 1.8) than List No. 5 and a smaller proportion of high redshift quasars —those with $2.4 \leq z < 3.4$—. Quasars in the redshift range (0.8, 1.8) are harder to discover in this type of objective prism survey than quasars at $z \sim 2.2$. The reason why we now seem to be more effective detecting low redshift quasars may be associated with our broader experience searching the plates. On the other hand since many of the objects presented here (38 of them) were confirmed using the CTIO 1.5-m telescope it means a discrimination was made against our fainter candidates (which, on the average, are higher redshift objects). The majority of the quasars in this list were discovered at CTIO using the 4-m telescope. In every observing run at CTIO we test a small fraction of the candidates selecting those with the highest probability (we typically try 100 candidates per run out of 300 and we discover 85 new quasars).

Figure 3 presents the histogram of the B magnitudes. A total of 81 quasars have a B mag in the interval (17.5, 19.0). A comparison with Figure 3 in List No. 5 (Maza et al. 1993) reveals this new group of quasars has the same photometric properties as the first two hundred quasars. The median of both groups is $\sim$ 18.25. This new sample has a B histogram too sharply peaked; this could be an artifact of averaging two independent eyeball estimates.

List No. 7 of the CTS, (Maza et al. 1995) will contain another group of 100 additional quasars already confirmed by us. This will bring the total number of CTS quasars to 400 that will merit a global statistical analysis of the properties of the Calán-Tololo Survey.

We thank the Director and personnel of Cerro Tololo for their hospitality. The ID charts were prepared using OZPS, a software developed by P. Ortiz. We are indebted to J. García and P. Ortiz for help with SUN workstations. This work was partially supported by FONDECYT under grants No. 92–1083 and No. 1950573.

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Roberto Antezana, Luis E. González, José Maza, and Marina Wischnjewsky: Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile. (jmaza@das.uchile.cl).