LIGHT CURVES FOR NEW VARIABLE STARS IN CYGNUS, LYRA, AND VULPECULA

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Abstract

Following a brief discussion of the author's methods, information on and light curves for 80 variable stars (73 of which are completely new) are presented, along with finding charts.

1. The search for new variables

The summer part of the Milky Way has been surveyed from photos taken by the author of 33 plate areas as shown in Figure 1. Areas marked with circles are now under evaluation. Fields marked with an X have been thoroughly searched, and the results have been published in the *Information Bulletin on Variable Stars* (IBVS) (Dahlmark 1982, 1986, 1993).

2. Method of discovery

Between 1967 and 1982, twenty-one exposures were taken simultaneously with two cameras connected to the equatorial telescope at the author's private observatory in Montlaux, southern France. A Perkin-Elmer 6.5/30 cm lens with Schott GG filter and Kodak 103aD plates was used for photographic photometry close to the Johnson V system. An Aerostigmat 5.5/30 cm with Kodak 103aO plates without filter was used for photographic photometry close to the Johnson B system. The limiting magnitudes at zenith were V = 15.2 and B = 14.7.

Since 1985, 86 exposures covering nine regions were obtained with a Perkin-Elmer 30 cm camera using Technical Pan film 4415 and Schott 495 filters.

Plates and prints were examined using a blink comparator and six stereocomparators arranged in a circle. Sitting in a turntable chair at the center of the circle enabled the author to examine several plates at the same time, thereby permitting the easy detection of stars with brightness changes of at least 0.3 magnitude.

Data on 80 such stars are shown in Table 1. All magnitude estimates were made with a step scale under the films in a stereomicroscope. The scale is calibrated with the magnitudes obtained from NGC 6823, 6834, 6871, and 6882/5, published in Hoag *et al.* (1961). The magnitudes of about 10 comparison stars located near each new variable were estimated mainly from the 103aD plates and the Schmidt exposures (see example in Figure 2).

Six Schmidt negatives covering the area were enlarged (with negative images to the scale of 1° = 60 mm). A grid of epoch 1950 to determine the coordinates of these new variables was drawn from the positions found in the SAO catalog. For 60 stars, the author's coordinates were compared with those from IRAS. The average deviation in both right ascension and declination is ±13".

Rough B-V color estimates were made for 44 stars. Twenty-four stars have only a lower limit for B-V. Twelve stars are without B-V estimates. The average uncertainty is estimated to be ±0.2, mainly because the B magnitudes are very close to the plate limit.

3. Light curves

This investigation contains the field centered on 19^h46^m +30° within an area of 15° x 20°. Eighty variable stars were found, 73 of which are completely new. The light curves are based on 6720 magnitude estimates.

The profile of the light curves is correct, but the V magnitudes from Technical Pan film may be too bright, especially for red stars.

Most of the variables are Mira type or more or less irregular. Type, epoch and period were deduced from these light curves, and a list was published in IBVS 3855 (Dahlmark 1993), together with finding charts (Figure 3) produced with the Schmidt camera in September 1987. The light curves are presented in Figure 4.

4. Additional stars

IBVS 2157 and 2857 (Dahlmark 1982, 1986) reported on and published finding charts for 98 new variables. For 78 of these, almost nothing is known about their light variations. Fifty of these stars are brighter than magnitude 13 at maximum and 23 are brighter than magnitude 12 at maximum.

Astronomers with at least an 8-inch telescope could perform a very important work in helping to determine the period and epoch for these stars so they can be registered in the *General Catalogue of Variable Stars* (GCVS). The author may be able to make plates from 1967 to 1981 available to serious investigators.

5. Acknowledgements

The author wishes to thank the AAVSO's technical assistants Sara Beck and Grant Foster for their assistance in digitizing and generating the light curves published here.

References

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Dahlmark, L. 1993, *Inform. Bull. Var. Stars*, No. 3855.
Hoag, A. *et al.* 1961, *Publ. U.S. Naval Obs.*, **17**, 1.
Hurst, G., ed., 1990, *The Astronomer*, **26**, No. 311, 237.
Hurst, G., ed., 1991, *The Astronomer*, **28**, No. 332, 182.
Kholopov, P.N. *et al.* 1985, *General Catalogue of Variable Stars*, 4th ed., Moscow.

NOTE ON THE AUTHOR

In 1933, when Lennart Dahlmark was 13 years old, he read an article by Swedish astronomer G. Larsson-Leander describing how nice it was to sit outside on an autumn evening and see the stars wander through the sky. Up to that point, Dahlmark had had no idea that the stars moved, since the city lights of his native Stockholm as well as the brightness of the Scandinavian summer sky hindered stargazing. Excited by what he had learned, Dahlmark sent away for instructions on building a refractor using the lens of an eyeglass. He made the telescope and with it saw the stars in Orion's belt down to magnitude 8.5. (He has since built 10 more instruments.)

Dahlmark wanted to be a professional astronomer, but at the time there were only six permanent jobs in astronomy in Sweden, and competition was, in his words, "stone hard" (Dahlmark 1995). Instead, he taught high school mathematics and physics and practiced astronomy as a hobby. Later on, Dahlmark had the opportunity to assist

Professor Ungve Öhman at Stockholm Observatory with his solar research, observing the sun with a spectroheliograph, photographing solar prominences, and tracking sunspots. He also had the opportunity to accompany Öhman on several expeditions to observe solar eclipses.

While still a young man, Dahlmark came in contact with a well-known, well-to-do Swedish amateur astronomer named Nils Tamm, from whom Dahlmark learned the technique of using a stereocomparator to search for variable stars.

In 1966, a French astronomer friend enticed Dahlmark and his wife to spend their summer holidays in Provence (southern France). There Dahlmark began photographing the summer Milky Way, at first looking for novae, and then concentrating on variable stars. After building a summer home and spending each summer in France for several years, the Dahlmarks settled there permanently upon retirement.

Since that time, Dahlmark spends most of his time gardening, continuing his work in solar astronomy, and searching for variable stars. He has found more than 230 variable stars using blink and stereocomparators of his own construction. In addition, he has written several articles about his discoveries and techniques, including a lengthy article published in the French monthly *l'Astronomie* (Dahlmark 1993).

A stellar example of perseverance, curiosity, and meticulousness, Dahlmark has been a member of the AAVSO since 1982.

—LMA

References

Dahlmark, L. 1993, *l'Astronomie*, **107**, 130.
Dahlmark, L. 1995, private communication.

Illustration 1. Lennart Dahlmark in 1982 with his first blink comparator and seven stereocomparators.

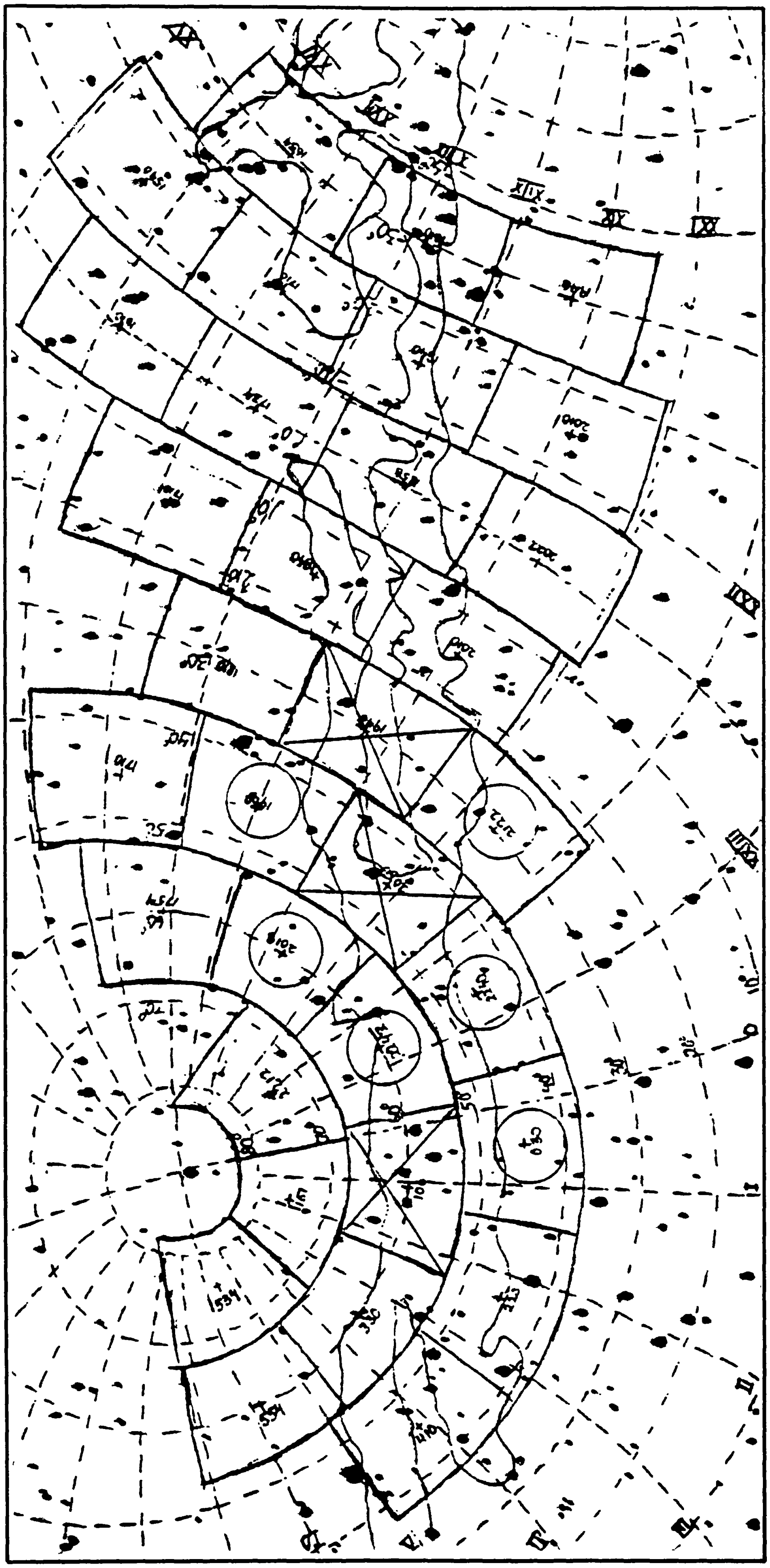


Figure 1. Thirty-three (33) plate areas in the Milky Way. All were photographed from 1967 to 1982; nine areas have also been photographed from 1985 to the present. Areas marked with an X have been thoroughly searched and the results have been published. Areas marked with a circle are currently under scrutiny.

Table 1. Data on 80 variable stars in an area centered on $19^{h}46^{m}+30^{\circ}$.

Star	*R.A. (1950)*	*Decl. (1950)*	m_V *max*	*min*	*B-V*	*Type*	*Epoch 2440000+*	*P (d)*	*Notes*
LD106	$19^{h}01^{m}22^{s}$	+33° 53'.5	11.2	< 15.0	1.7	M	7560	459 c	
LD107	$19^{h}04^{m}15^{s}$	+25° 30'.0	12.5	< 16.0	0.5	M?	6910	338 c	
LD108	$19^{h}05^{m}23^{s}$	+31° 38'.0	12.6	14.4	2.0	SR	6985	308 ?	
LD109	$19^{h}05^{m}38^{s}$	+35° 41'.7	12.0	13.0	1.2	IB	—	—	
LD110	$19^{h}06^{m}02^{s}$	+36° 18'.3	11.9	13.5	1.6	IB	—	—	1
LD111	$19^{h}07^{m}10^{s}$	+32° 48'.3	11.3	12.3	1.5	SR	6990	457	
LD112	$19^{h}08^{m}06^{s}$	+23° 15'.9	13.2	< 15	0 ?		7315	234 c	1
LD113	$19^{h}09^{m}08^{s}$	+24° 39'.4	12.7	16.0	1.2	M	6620	302 c	
LD114	$19^{h}10^{m}35^{s}$	+23° 06'.5	11.8	< 15	—	M	6620	335 c	1
LD115	$19^{h}11^{m}17^{s}$	+26° 53'.6	13.8	< 15.3	—	M	7060	282 c	1
LD116	$19^{h}12^{m}51^{s}$	+36° 55'.8	11.5	14.8	1.5	M	6650	290	1
LD117	$19^{h}19^{m}54^{s}$	+23° 00'.8	12.2	15.2	2.3	M	6945	180 c	
LD118	$19^{h}19^{m}59^{s}$	+26° 16'.7	13.4	< 16.2	—	SR	6740	395	
LD119	$19^{h}20^{m}37^{s}$	+25° 52'.8	12.5	< 15.2	> 0.5	M	7085	292 c	
LD120	$19^{h}21^{m}09^{s}$	+24° 21'.7	10.5	13.2	3.3	M	6740	342 c	2
LD121	$19^{h}21^{m}46^{s}$	+26° 21'.3	13.3	14.7	0.8	IB	—	—	1
LD122	$19^{h}22^{m}28^{s}$	+32° 13'.3	11.7	< 15.2	2	SR	6620	531	3,1
LD123	$19^{h}23^{m}52^{s}$	+26° 32'.3	13.2	< 15.2	1	SR	6930	407	1
LD124	$19^{h}24^{m}12^{s}$	+34° 56'.9	11.6	< 15.2	1.7	M	7280	405	
LD125	$19^{h}25^{m}18^{s}$	+35° 17'.3	11.6	< 15.2	1.6	M	7015	247	4
LD126	$19^{h}25^{m}41^{s}$	+24° 36'.4	11.9	15.2	1.7	M	6945	182 c	1
LD127	$19^{h}28^{m}13^{s}$	+28° 03'.2	12.4	< 15.2	> 2	M	6950	370	2,1
LD128	$19^{h}29^{m}03^{s}$	+23° 24'.0	11.4	15.2	2.4	M	6920	363	
LD129	$19^{h}29^{m}42^{s}$	+28° 44'.0	12.7	14.5	1.3	SR	—	—	
LD130	$19^{h}33^{m}59^{s}$	+34° 09'.2	12.3	15.2	> 2	M	6700	358	1
LD131	$19^{h}37^{m}13^{s}$	+23° 37'.5	11.7	< 15.0	> 1.3	M	7300	292 c	1
LD132	$19^{h}38^{m}13^{s}$	+23° 26'.0	14.0	15.0	—	I	—	—	
LD133	$19^{h}38^{m}58^{s}$	+24° 45'.6	12.1	< 15.2	2.1	M	7300	260	
LD134	$19^{h}40^{m}09^{s}$	+30° 06'.6	12.0	< 15.2	2.0	M	6700	362	11
LD135	$19^{h}41^{m}41^{s}$	+34° 21'.9	10.4	13.0	3.0	SR	6730	560	5,2
LD136	$19^{h}41^{m}55^{s}$	+32° 22'.2	10.2	14.7	4.0	M	6990	562 c	1,2
LD137	$19^{h}44^{m}27^{s}$	+31° 32'.8	11.9	15.0	2.3	M	6700	371 c	
LD138	$19^{h}44^{m}46^{s}$	+28° 01'.1	12.1	< 15.2	> 1.8	M	6890	227	1,6
LD139	$19^{h}45^{m}27^{s}$	+35° 38'.4	12.7	14.6	0.8	SRA?	6680	304 c	1
LD140	$19^{h}47^{m}12^{s}$	+22° 30'.2	13.0	< 15.5	1.3	M	7000	470 c	1
LD141	$19^{h}47^{m}13^{s}$	+29° 24'.0	10.0	12.6	2.7	M	7380	523	2
LD142	$19^{h}47^{m}57^{s}$	+35° 41'.3	11.4	< 15.2	1	M?	6640	452	1
LD143	$19^{h}47^{m}58^{s}$	+22° 25'.0	13.2	< 15.2	> 0.7	M	7280	400	
LD144	$19^{h}48^{m}08^{s}$	+26° 18'.8	13.0	15.0	> 1.5		—	—	1,7
LD145	$19^{h}49^{m}10^{s}$	+26° 02'.9	12.7	< 15.2	—	M?	7160	444	11
LD146	$19^{h}49^{m}33^{s}$	+32° 40'.0	13.0	< 15.1	> 0.9	M	6650	394 c	
LD147	$19^{h}49^{m}58^{s}$	+27° 01'.5	12.0	15.0	1.6	SR	6650	480	8
LD148	$19^{h}51^{m}49^{s}$	+23° 00'.7	13.0	15.0	1.3		6950	200	9
LD149	$19^{h}53^{m}03^{s}$	+22° 23'.3	12.1	< 15.0	> 1.3	M	6945	294	10,11
LD150	$19^{h}53^{m}47^{s}$	+22° 13'.1	11.3	14.5	0.7	SRD?	6885	478 c	1
LD151	$19^{h}54^{m}19^{s}$	+23° 08'.4	12.4	14.2	1.4	SRB	7350	404	
LD152	$19^{h}56^{m}07^{s}$	+31° 46'.7	14.1	< 15.2	> 0.6	M	7400	600	
LD153	$19^{h}56^{m}13^{s}$	+29° 33'.1	12.6	< 15.2	1.5	M	6670	386	1
LD154	$19^{h}57^{m}10^{s}$	+31° 05'.1	11.9	15.1	> 2.8	M	7040	288 c	
LD155	$20^{h}00^{m}29^{s}$	+29° 43'.3	11.8	15.1	> 2	M	7086	585 c	
LD156	$20^{h}01^{m}13^{s}$	+31° 15'.6	12.8	13.7	1.2	I	—	—	
LD157	$20^{h}01^{m}23^{s}$	+29° 46'.6	11.8	13.6	2.0	SR	—	—	

Table 1, cont. Data on 80 variable stars in an area centered on 19^h46^m+30°.

Star	*R.A.* *(1950)*	*Decl.* *(1950)*	m_V *max*	*min*	*B-V*	*Type*	*Epoch* *2440000+*	*P* *(d)*	*Notes*
LD158	$20^h04^m14^s$	+25° 18'.9	12.5	<15.2	1.8	M	7005	204 c	
LD159	$20^h04^m20^s$	+35° 09'.0	12.6	15.1	>1.8	M	7310	460	11,2
LD160	$20^h04^m43^s$	+33° 49'.4	12.5	15.1	>1.4	M	6920	355	12
LD161	$20^h06^m21^s$	+25° 27'.3	13.8	<15.2	—	I	—	—	11
LD162	$20^h07^m44^s$	+31° 49'.9	13.0	<15.2	>1	M	6925	437 c	1
LD163	$20^h07^m56^s$	+25° 29'.2	11.8	15.1	1.6	M	6720	214 c	1
LD164	$20^h08^m51^s$	+22° 43'.0	12.8	15.0	1.5	M	7355	284	1,13
LD165	$20^h10^m30^s$	+24° 27'.8	12.4	<15.2	1.8	M	7050	263 c	
LD166	$20^h13^m34^s$	+25° 17'.7	10.3	<15.2	2.8	M	6660	262 c	1,2
LD167	$20^h13^m57^s$	+24° 04'.4	11.6	<15.2	>1.8	M	6720	452	
LD168	$20^h19^m30^s$	+30° 15'.1	13.0	<15.2	>0.5	SR	6645	403	1
LD169	$20^h19^m31^s$	+29° 05'.1	12.4	15.0	—	SR	6620	420?	
LD170	$20^h19^m57^s$	+22° 13'.8	13.0	14.9	0.7	SRD	6640	148	1
LD171	$20^h24^m03^s$	+27° 59'.7	12.8	<15.0	—		6945	430?	14
LD172	$20^h25^m18^s$	+24° 07'.5	12.0	<16.0	1.8	M	6760	440	15
LD173	$19^h15^m55^s$	+34° 20'.4	12.0	14.8	1.9	M	7375	269 c	
LD174	$19^h19^m40^s$	+24° 37'.4	12.9	<15.8	—	SR	7730	323	1
LD175	$19^h28^m09^s$	+24° 04'.0	14.2	<16.0	—	M	6980	250	
LD176	$19^h46^m35^s$	+31° 58'.6	13.0	15.1	—	M	6650	275	
LD177	$19^h48^m44^s$	+29° 21'.3	12.8	15.2	>1	M	6930	317 c	1
LD178	$19^h50^m23^s$	+30° 42'.4	12.5	14.2	>1.7	M	7050	250	16
LD179	$19^h52^m29^s$	+33° 56'.7	12.5	<15.2	1.4	M	7056	230 c	1
LD180	$19^h54^m17^s$	+35° 22'.2	13.1	<15.0	>0.8	M	6980	382	17
LD181	$19^h55^m31^s$	+30° 35'.0	13.9	<15.2	—	SR	6690	375	1
LD182	$19^h55^m53^s$	+22° 41'.3	13.0	14.7	>1	I	—	—	1
LD183	$19^h56^m24^s$	+35° 35'.1	12.3	14.8	>2	SRB	6619	103	18
LD184	$20^h16^m16^s$	+26° 29'.8	11.8	<15.2	>1.6	M	6715	345 c	
LD185	$20^h16^m33^s$	+28° 25'.7	13.5	15.0	>0.7	M	7715	298 c	

Notes

"c" means that the period is constant between 1967 and 1992.

1. Close faint star (5–30") may influence magnitude estimates at minimum.
2. Possible carbon star.
3. Small light variations, 1967–82.
4. Period changes ±5 days.
5. Period changes between 450 and 560 days.
6. Period changes between 215 and 240 days, average 227 days. LD128 = AI Vul.
7. Light variations only in 1967–70, max. 2440030.
8. Long intervals constant 15.0 at minimum.
9. Period between 195 and 205 days. Fast variations of 0.3 magnitude in one hour.
10. Period increases from 288 to 300 days between 1986 and 1992.
11. Not found on 103aD plates, 1967–82.
12. Period changes from 362 to 355 days between 1970 and 1990.
13. 0.5 magnitude variations in one hour.
14. Nova-like? One one sharp maximum 2446945. No variations 1967–82.
15. Period change ±30 days.
16. Period change between 240 and 290 days.
17. LD180 = V1460 Cyg. Period increases from 367 days (1968) to 382 days (1990).
18. LD183 = V1464 Cyg. The coordinates for V1460 and V1464 in the *General Catalogue of Variable Stars* (GCVS) are inaccurate by 3' and 5', respectively.

LD120 = TAV 1921+24 = CCS 2728 (Hurst 1991); LD135 = TAV 1941+34 (Hurst 1990); LD142 = V1000 Cyg; LD164 = HX Vul (the GCSV coordinates for HX Vul are inaccurate by 10').

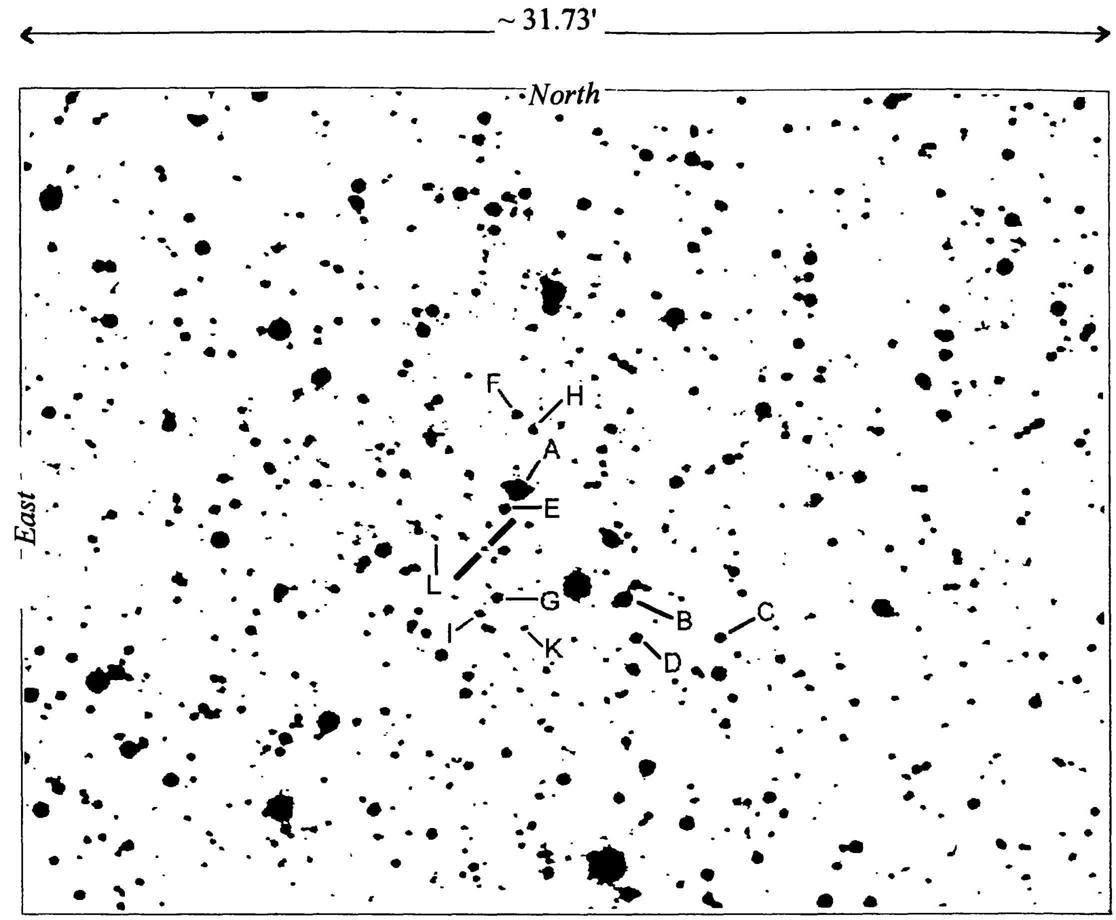


Figure 2. Finding chart for LD148 ($19^h51^m49^s$, 23°00.′7 [1950]; $19^h53^m57^s$, 23°07.′8 [2000]), showing comparison star sequence.

Comparison star magnitudes:

A = 104	G = 135
B = 117	H = 137
C = 123	I = 140
D = 128	K = 145
E = 130	L = 150
F = 131	

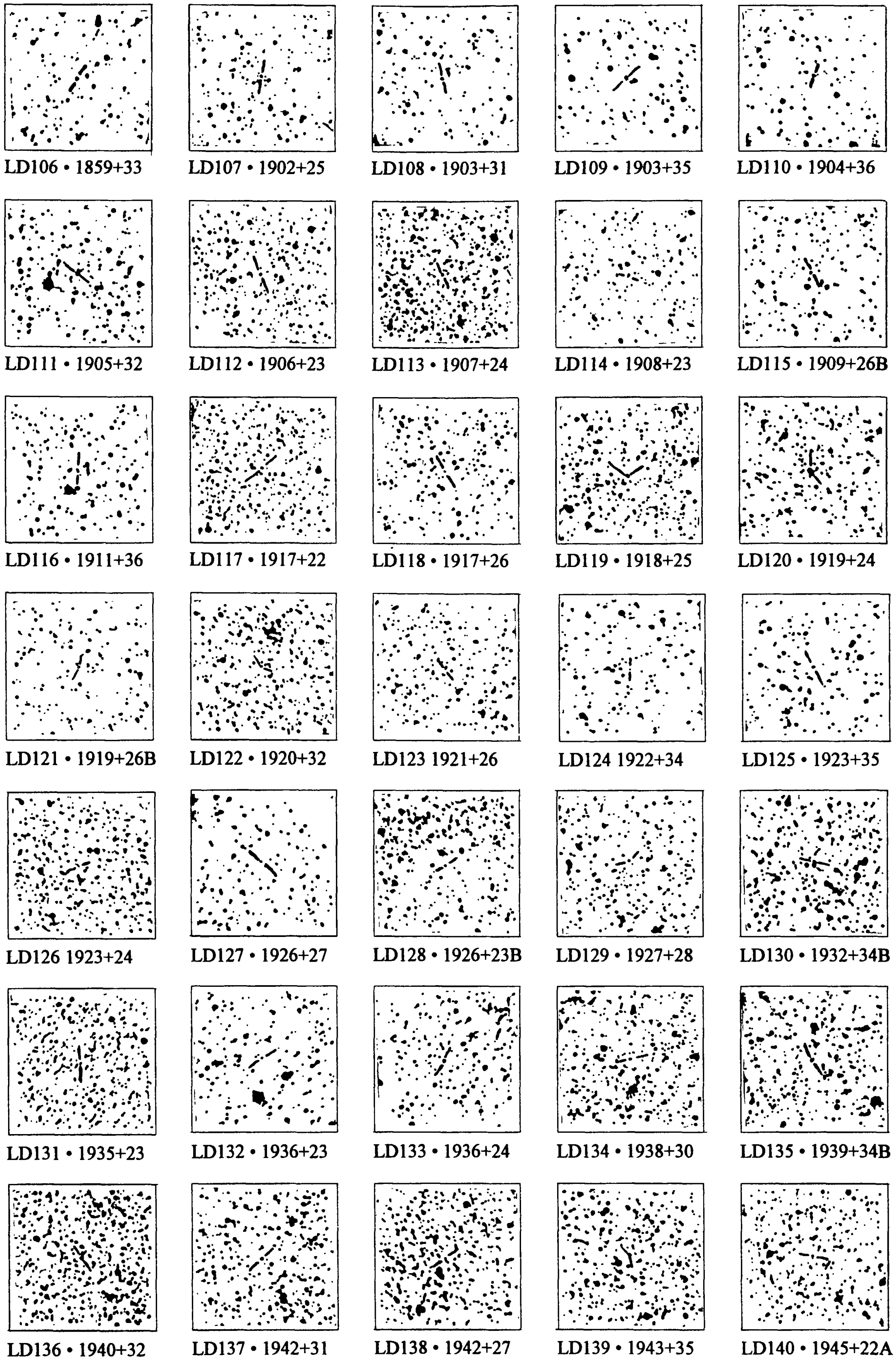
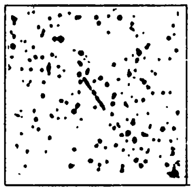
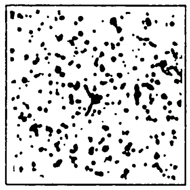
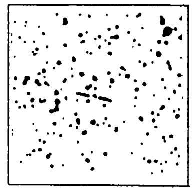
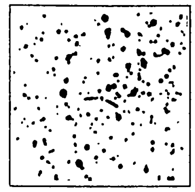


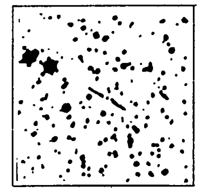
Figure 3. Finding charts for Dahlmark (LD) variables. Each square represents 15' (North is up, East is on the left).

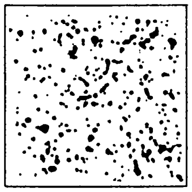

LD141 • 1945+29

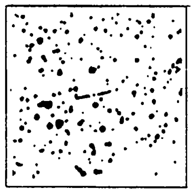

LD142 •1946+35B

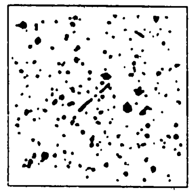

LD143 • 1945+22B

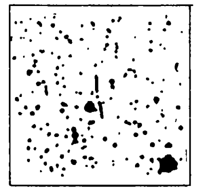

LD144 • 1946+26

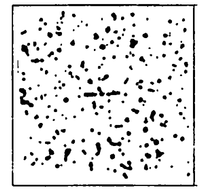

LD145 • 1947+25

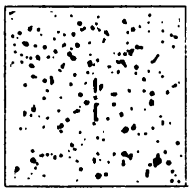

LD146 • 1947+32B

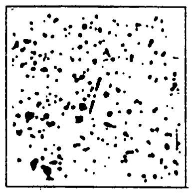

LD147 • 1947+26

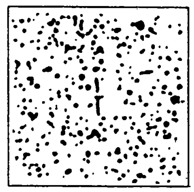

LD148 • 1949+22

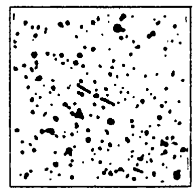

LD149 • 1950+22

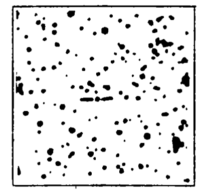

LD150 • 1951+22

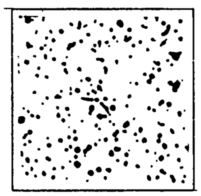

LD151 • 1952+23

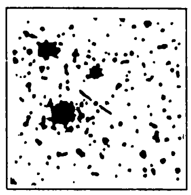

LD152 • 1954+31

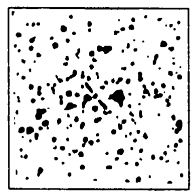

LD153 • 1954+29

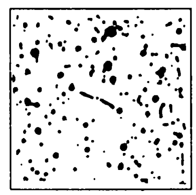

LD154 • 1955+30

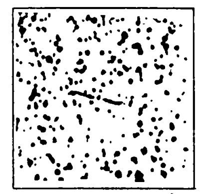

LD155 • 1958+29B

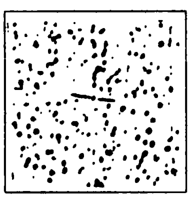

LD156 • 1959+31

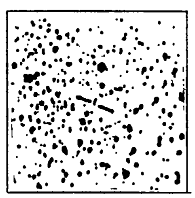

LD157 • 1959+29

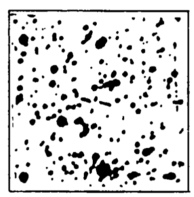

LD158 • 2002+25

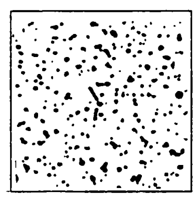

LD159 • 2002+35


LD160 • 2002+33B

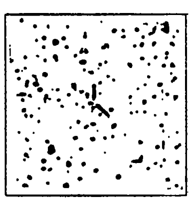

LD161 2004+25

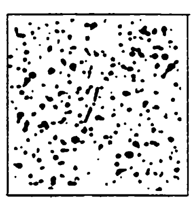

LD162 • 2005+31

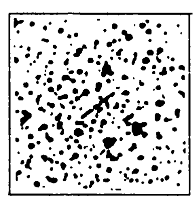

LD163 • 2005+25B

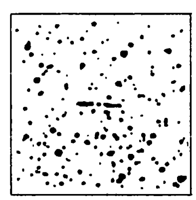

LD164 • 2006+21

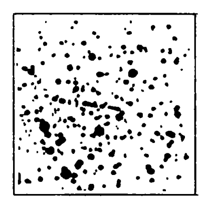

LD165 • 2008+24

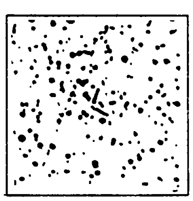

LD166 • 2011+25

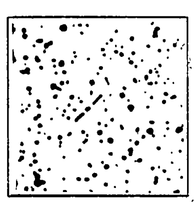

LD167 • 2011+23

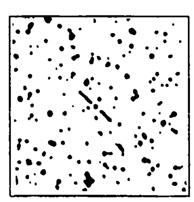

LD168 • 2017+30

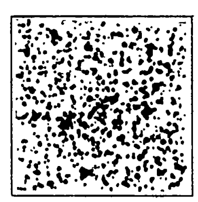

LD169 • 2017+28


LD170 • 2017+22


LD171 • 2022+27B


LD172 • 2023+23


LD173 • 1914+34


LD174 • 1917+24

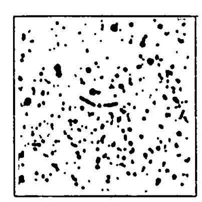
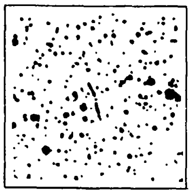
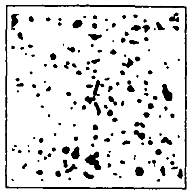
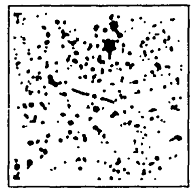
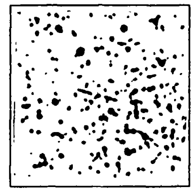

LD175 • 1926+23A

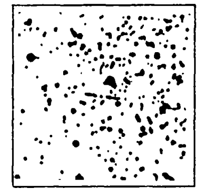
Figure 3, cont. Finding charts for Dahlmark (LD) variables. Each square represents 15' (North is up, East is on the left).

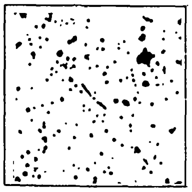

LD176 • 1944+31

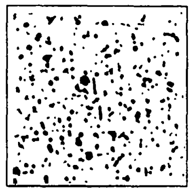

LD177 •1946+29

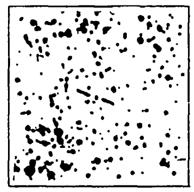

LD178 • 1948+30

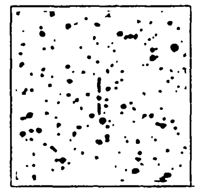

LD179 • 1950+33


LD180 • 1952+35


LD181 • 1953+30


LD182 • 1953+22


LD183 • 1954+35


LD184 • 2014+26

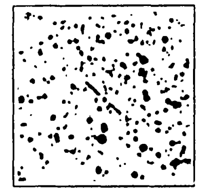

LD185 • 2014+28

Figure 3, cont. Finding charts for Dahlmark (LD) variables. Each square represents 15' (North is up, East is on the left).

Key to Figure 4 (a–t). Light curves (four per page, pages 46–65) for 80 variable stars in Cygnus, Lyra, and Vulpecula listed below, 73 of which were discovered by Lennart Dahlmark.

page	star	desig	page	star	desig	page	star	desig
48 (a)	LD106	1859+33	55 (h)	LD134	1938+30	62 (o)	LD162	2005+31
	LD107	1902+25		LD135	1939+34B		LD163	2005+25B
	LD108	1903+31		LD136	1940+32		LD164	2006+21
	LD109	1903+35		LD137	1942+31		LD165	2008+24
49 (b)	LD110	1904+36	56 (i)	LD138	1942+27	63 (p)	LD166	2011+25
	LD111	1905+32		LD139	1943+35		LD167	2011+23
	LD112	1906+23		LD140	1945+22A		LD168	2017+30
	LD113	1907+24		LD141	1945+29		LD169	2017+28
50 (c)	LD114	1908+23	57 (j)	LD142	1946+35B	64 (q)	LD170	2017+22
	LD115	1909+26B		LD143	1945+22B		LD171	2022+27B
	LD116	1911+36		LD144	1946+26		LD172	2023+23
	LD117	1917+22		LD145	1947+25		LD173	1914+34
51 (d)	LD118	1917+26	58 (k)	LD146	1947+32B	65 (r)	LD174	1917+24
	LD119	1918+25		LD147	1947+26		LD175	1926+23A
	LD120	1919+24		LD148	1949+22		LD176	1944+31
	LD121	1919+26B		LD149	1950+22		LD177	1946+29
52 (e)	LD122	1920+32	59 (l)	LD150	1951+22	66 (s)	LD178	1948+30
	LD123	1921+26		LD151	1952+23		LD179	1950+33
	LD124	1922+34		LD152	1954+31		LD180	1952+35
	LD125	1923+35		LD153	1954+29		LD181	1953+30
53 (f)	LD126	1923+24	60 (m)	LD154	1955+30	67 (t)	LD182	1953+22
	LD127	1926+27		LD155	1958+29B		LD183	1954+35
	LD128	1926+23B		LD156	1959+31		LD184	2014+26
	LD129	1927+28		LD157	1959+29		LD185	2014+28
54 (g)	LD130	1932+34B	61 (n)	LD158	2002+25			
	LD131	1935+23		LD159	2002+35			
	LD132	1936+23		LD160	2002+33B			
	LD133	1936+24		LD161	2004+25			

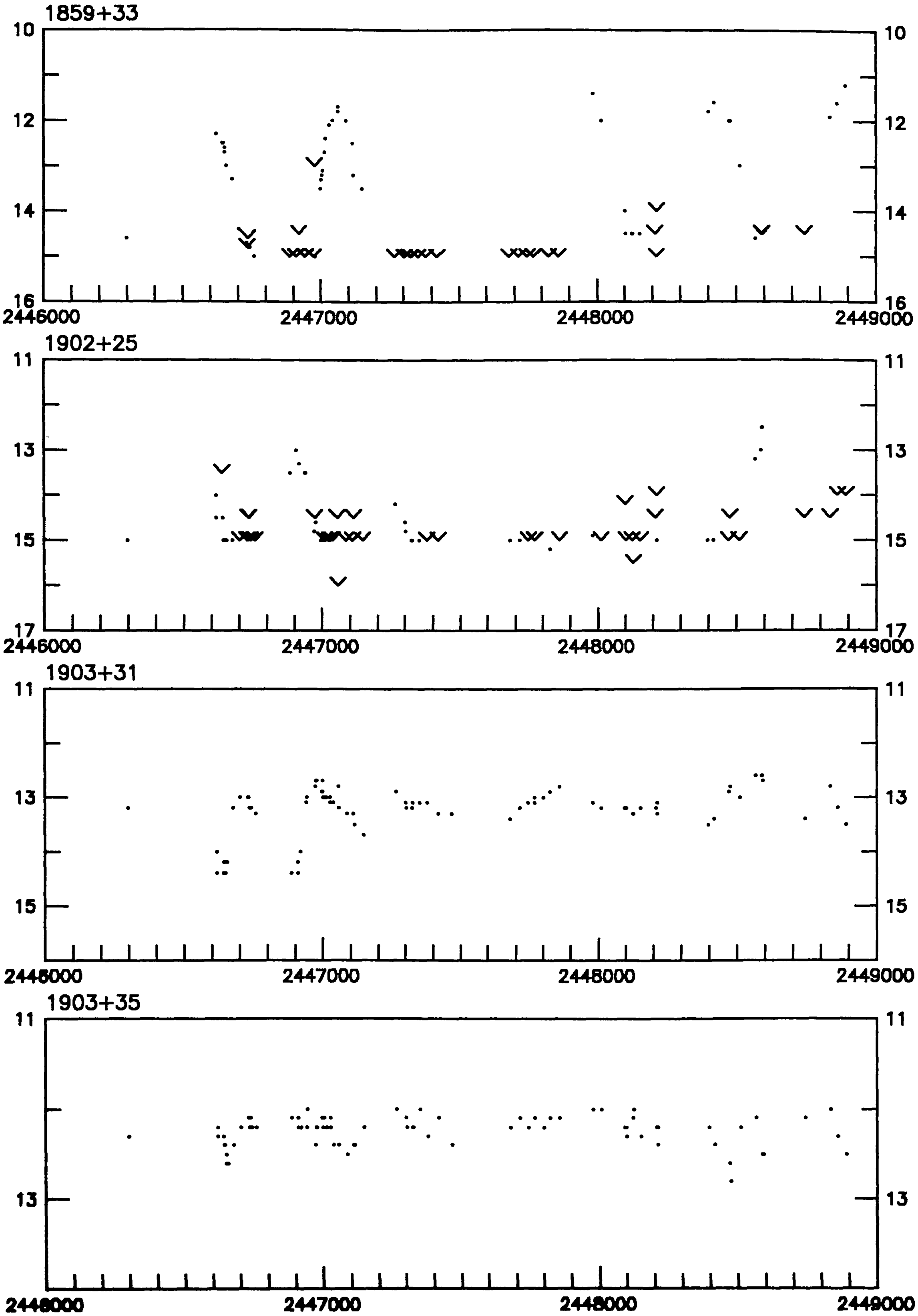


Figure 4 (a). Light curves for LD106–109 (~ JD 2446250–2449000).

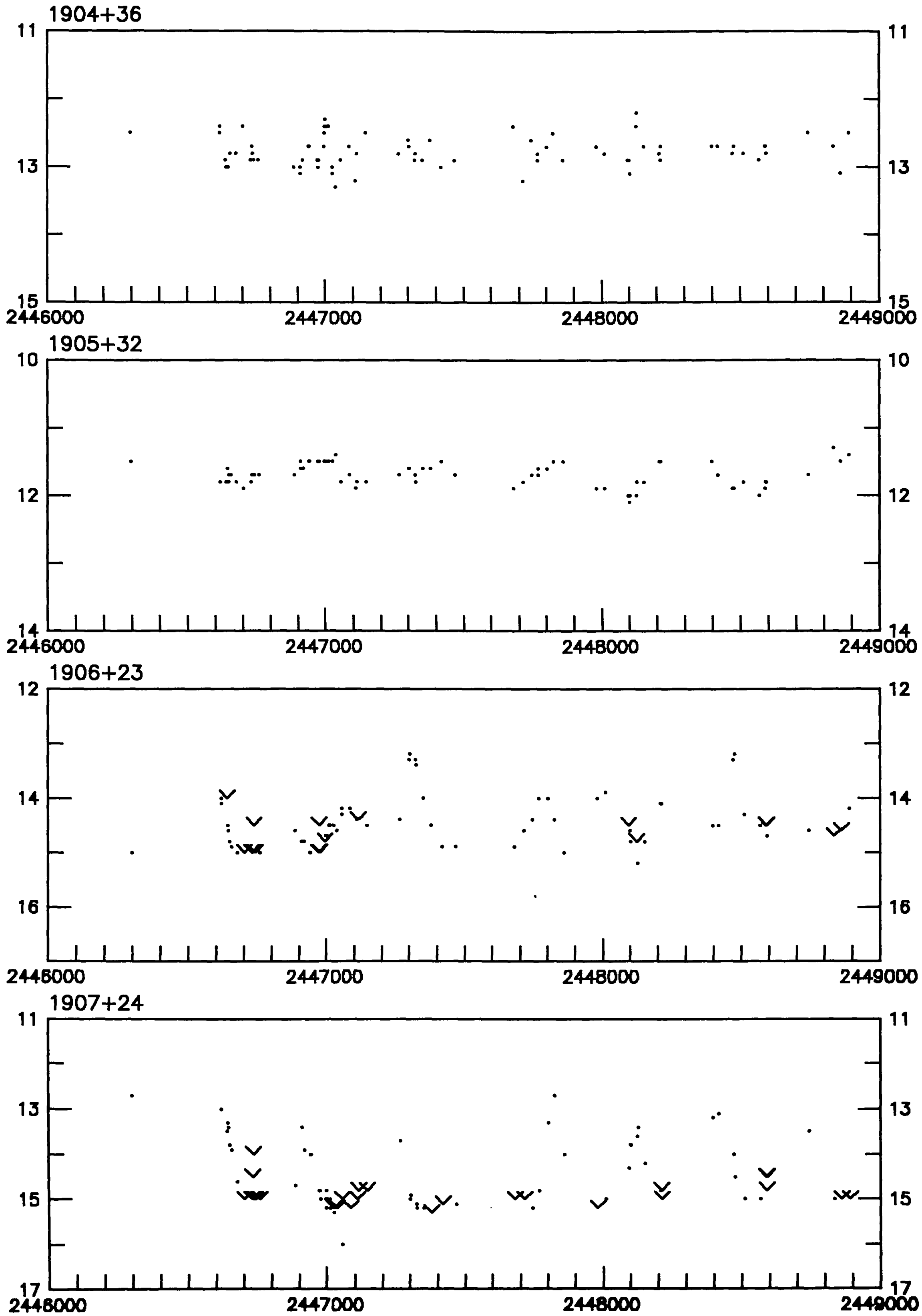


Figure 4 (b). Light curves for LD110–113 (~ JD 2446250–2449000).

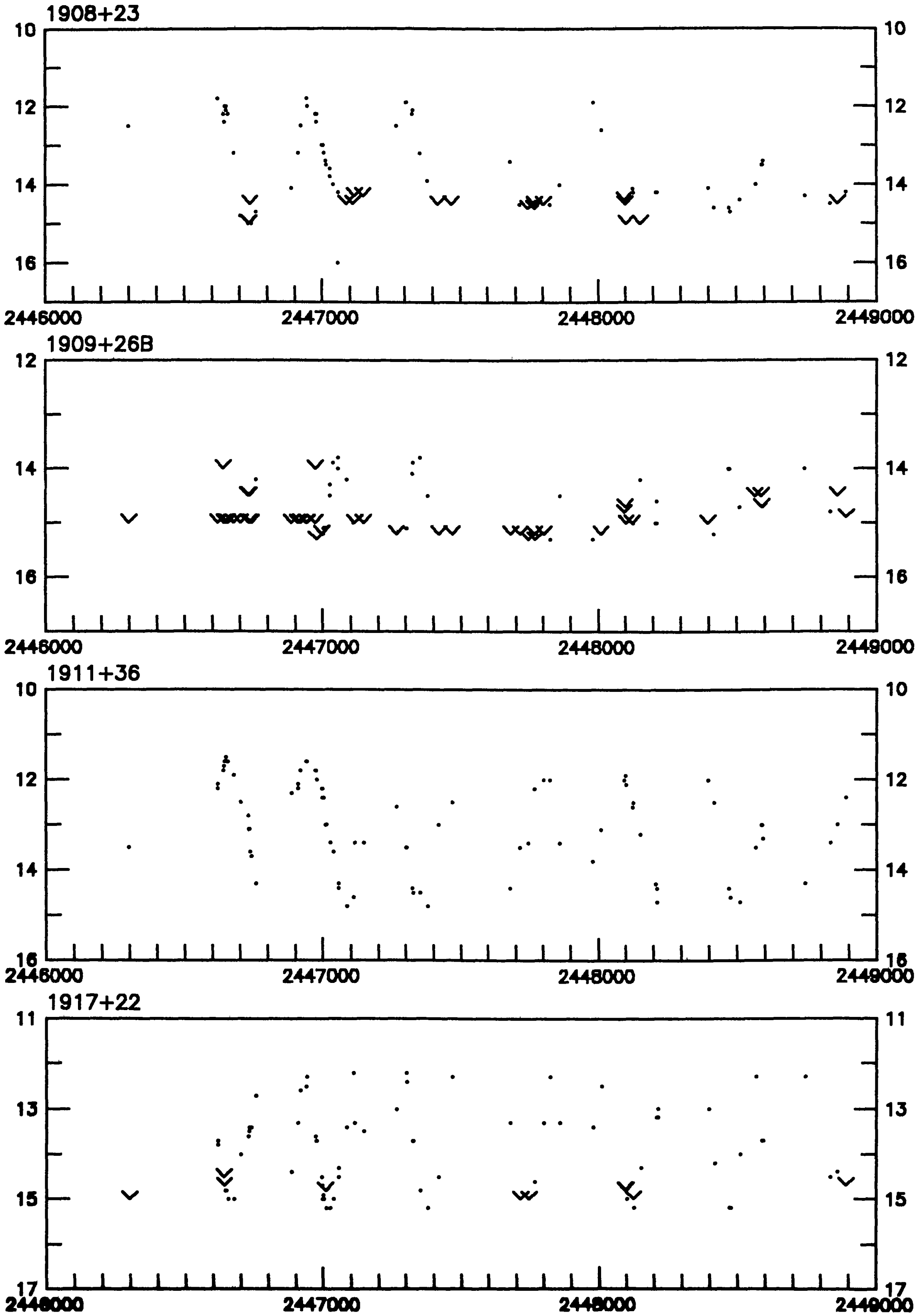


Figure 4 (c). Light curves for LD114–117 (~ JD 2446250–2449000).

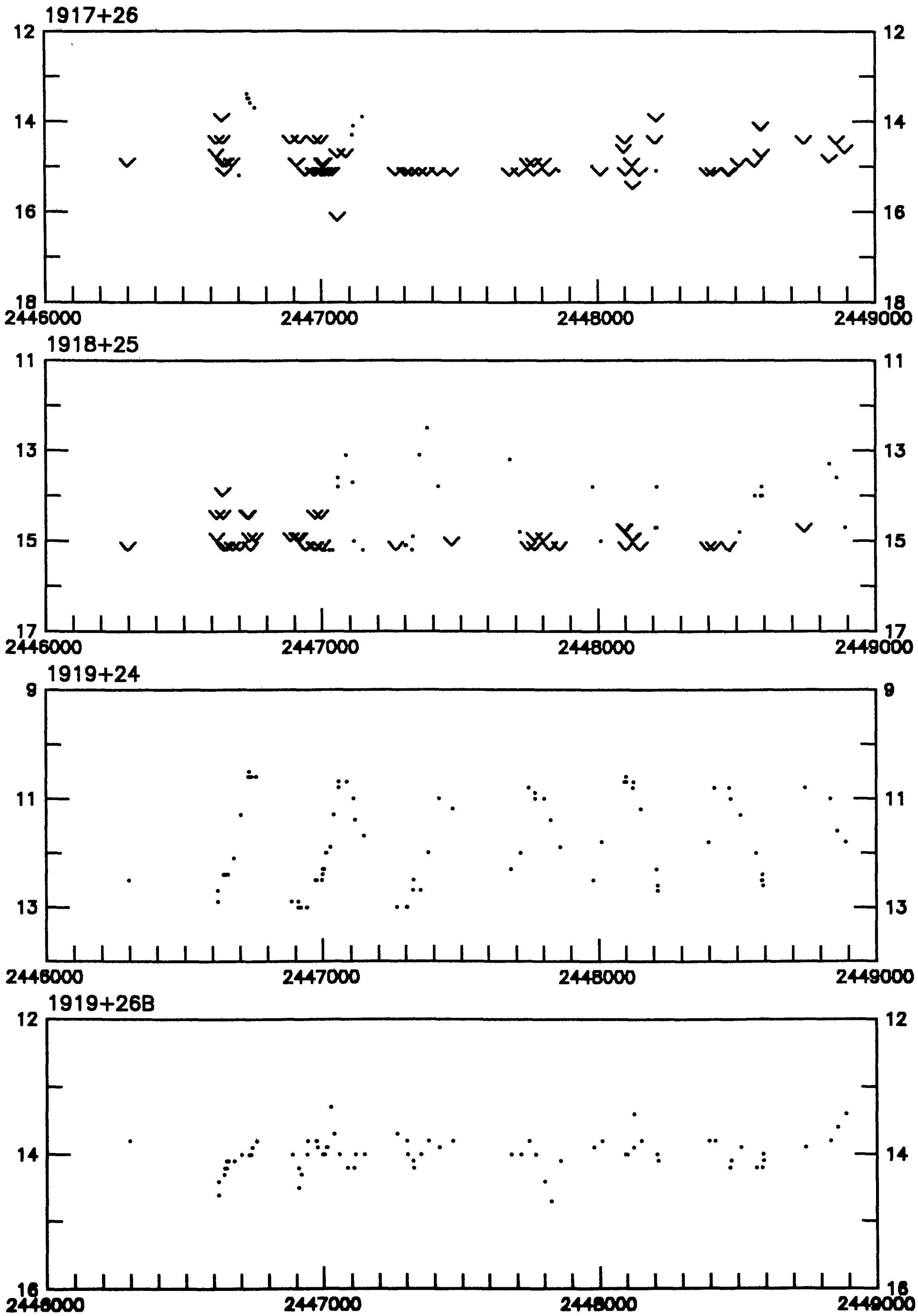


Figure 4 (d). Light curves for LD118–121 (~ JD 2446250–2449000).

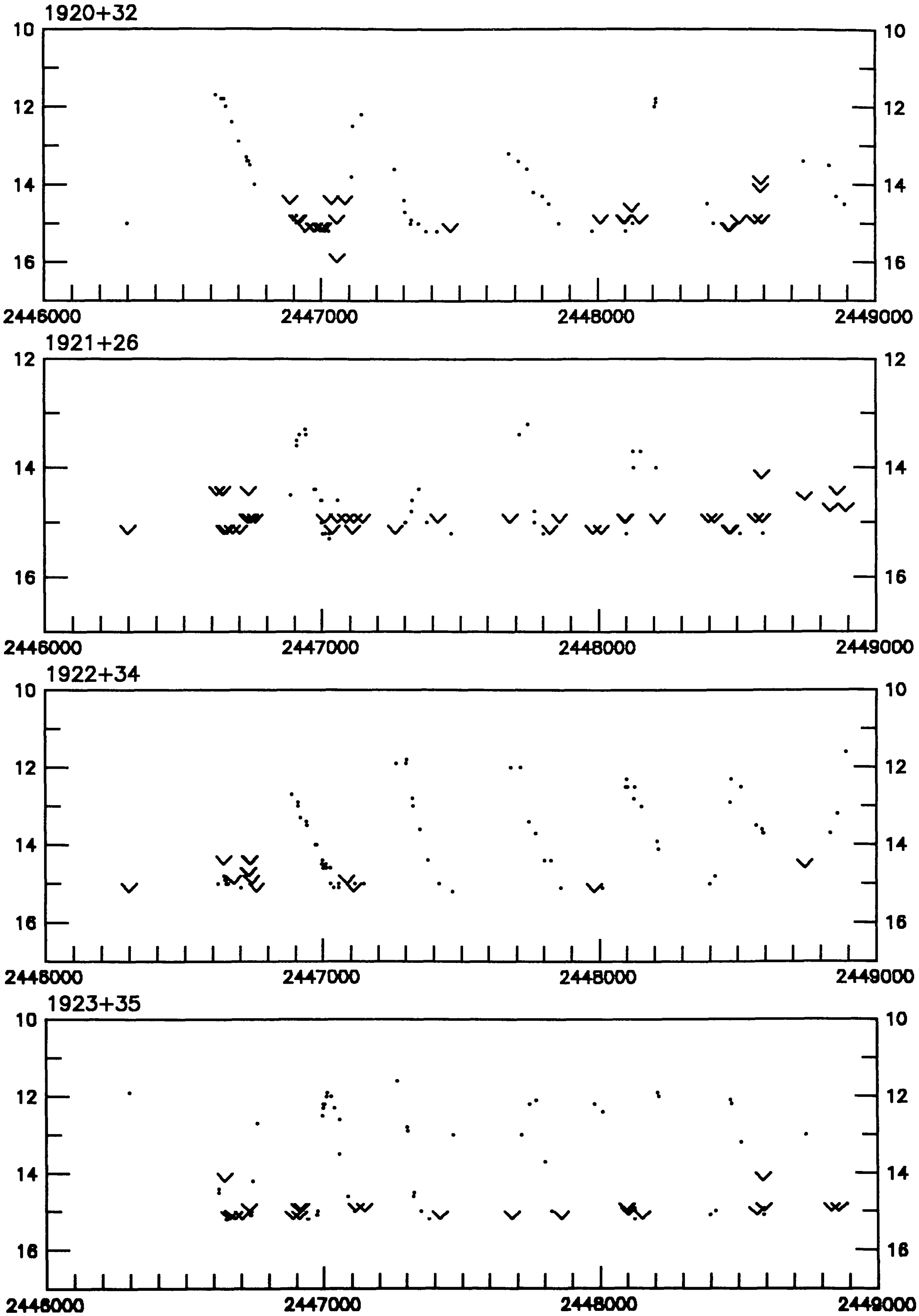


Figure 4 (e). Light curves for LD122–125 (~ JD 2446250–2449000).

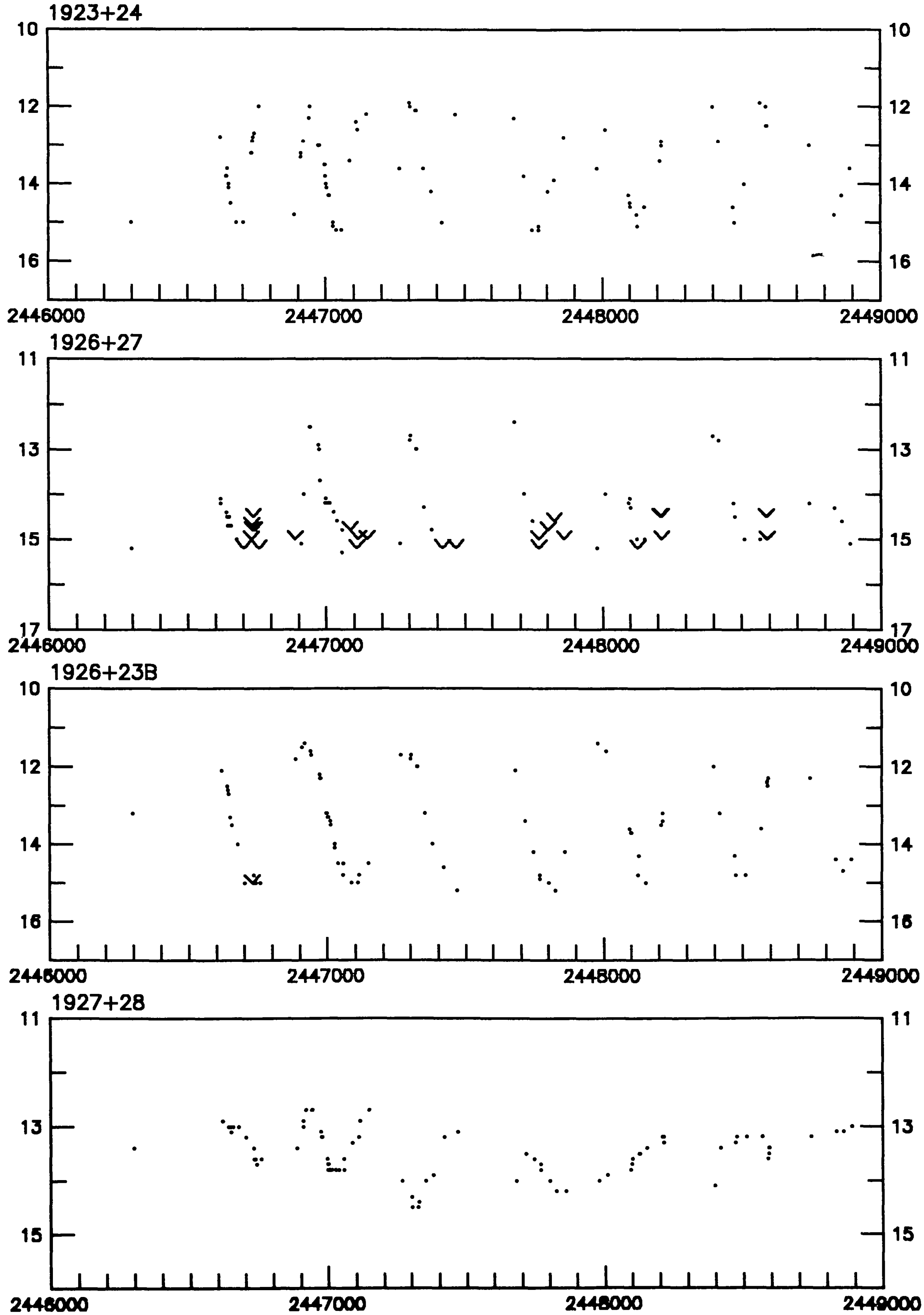


Figure 4 (f). Light curves for LD126–129 (~ JD 2446250–2449000).

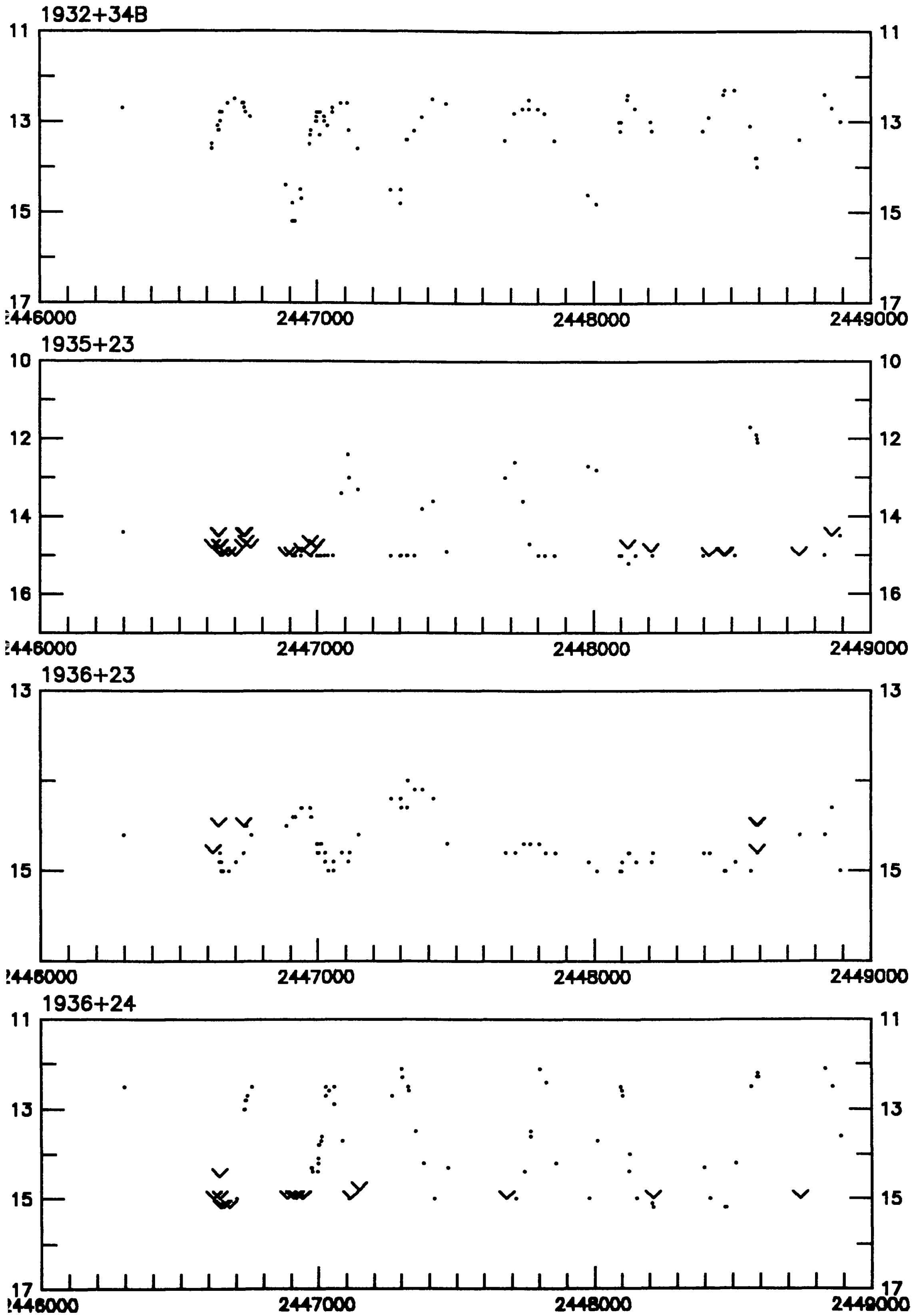


Figure 4 (g). Light curves for LD130–133 (~ JD 2446250–2449000).

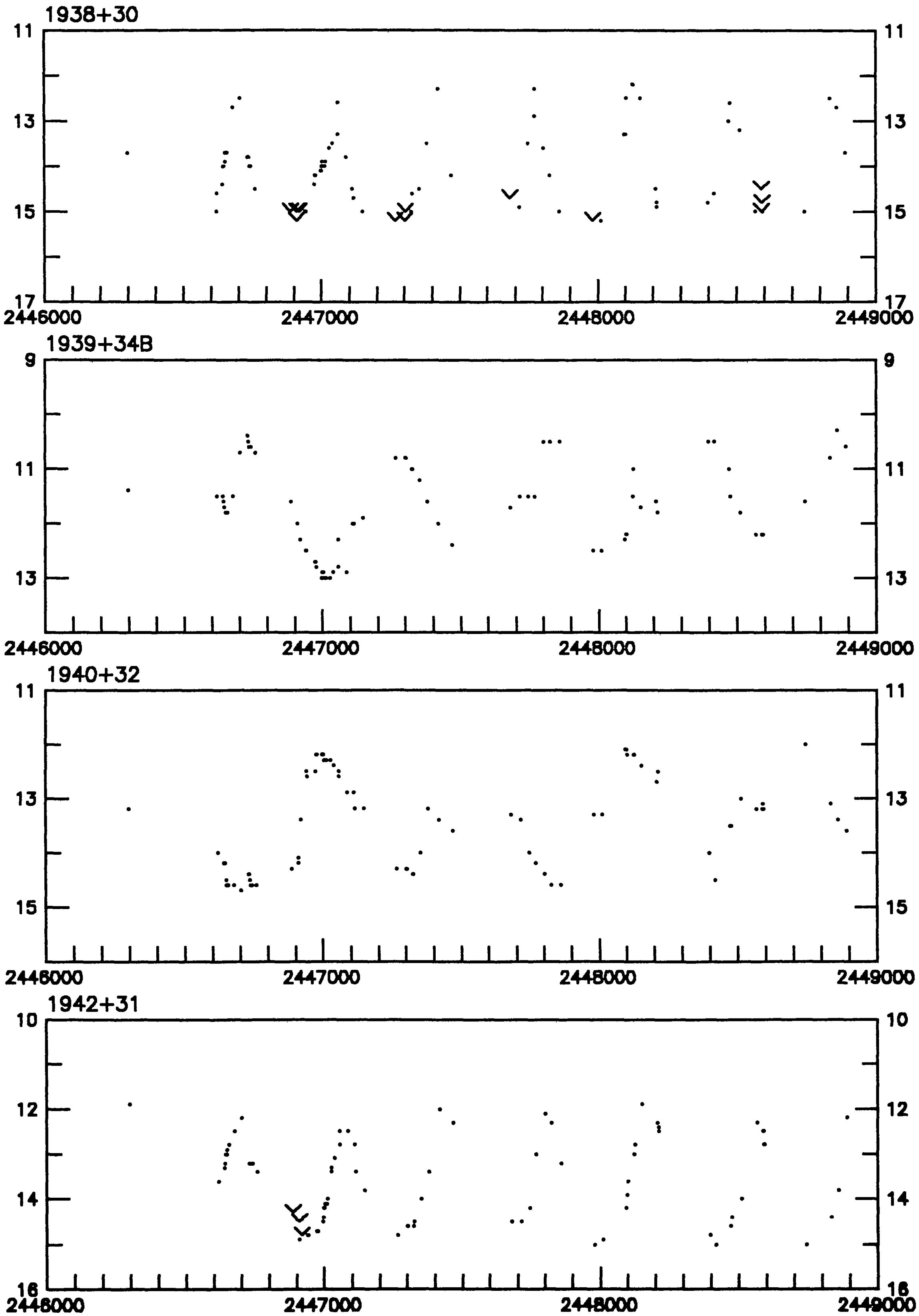


Figure 4 (h). Light curves for LD134–137 (~ JD 2446250–2449000).

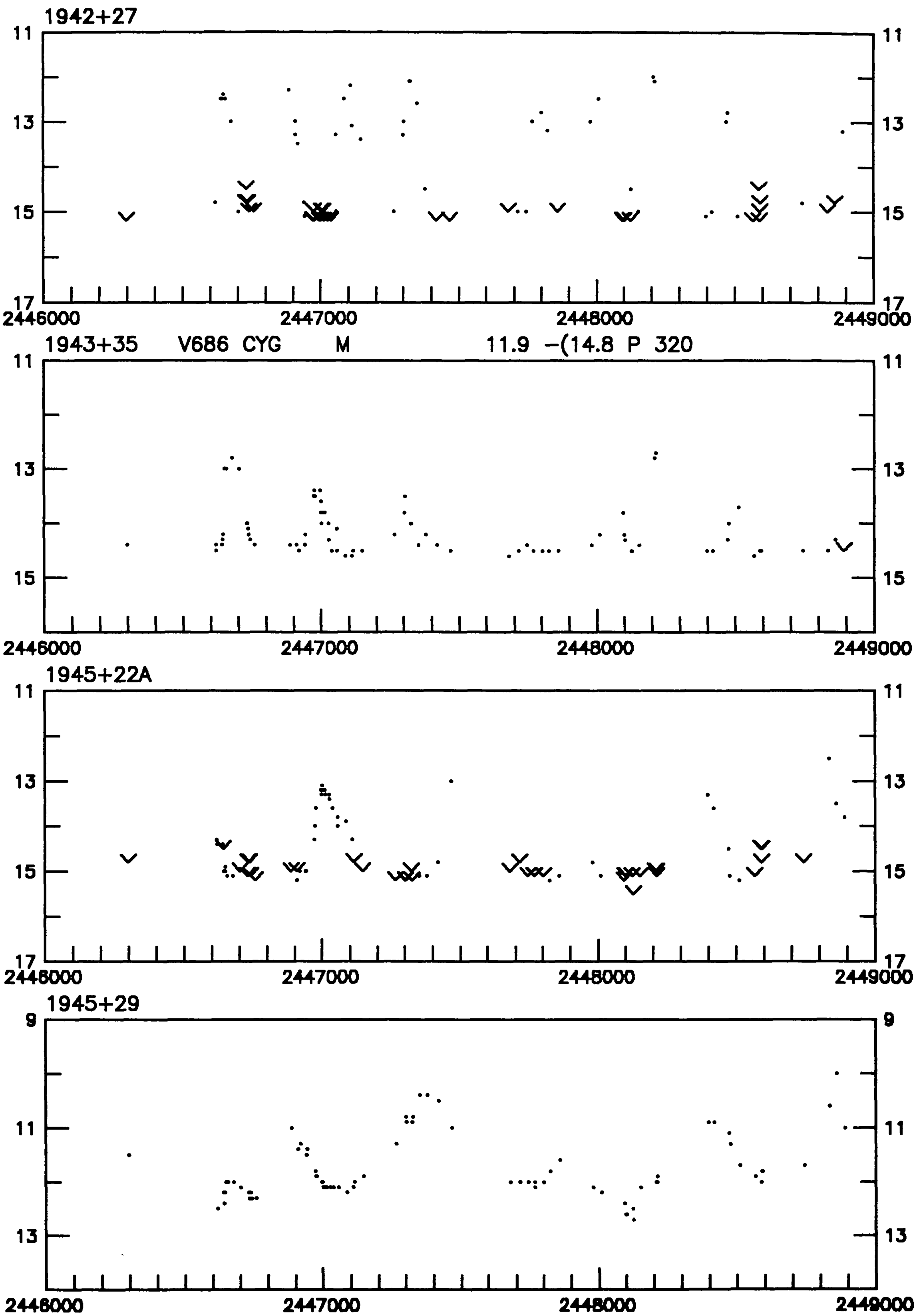


Figure 4 (i). Light curves for LD138–141 (~ JD 2446250–2449000).

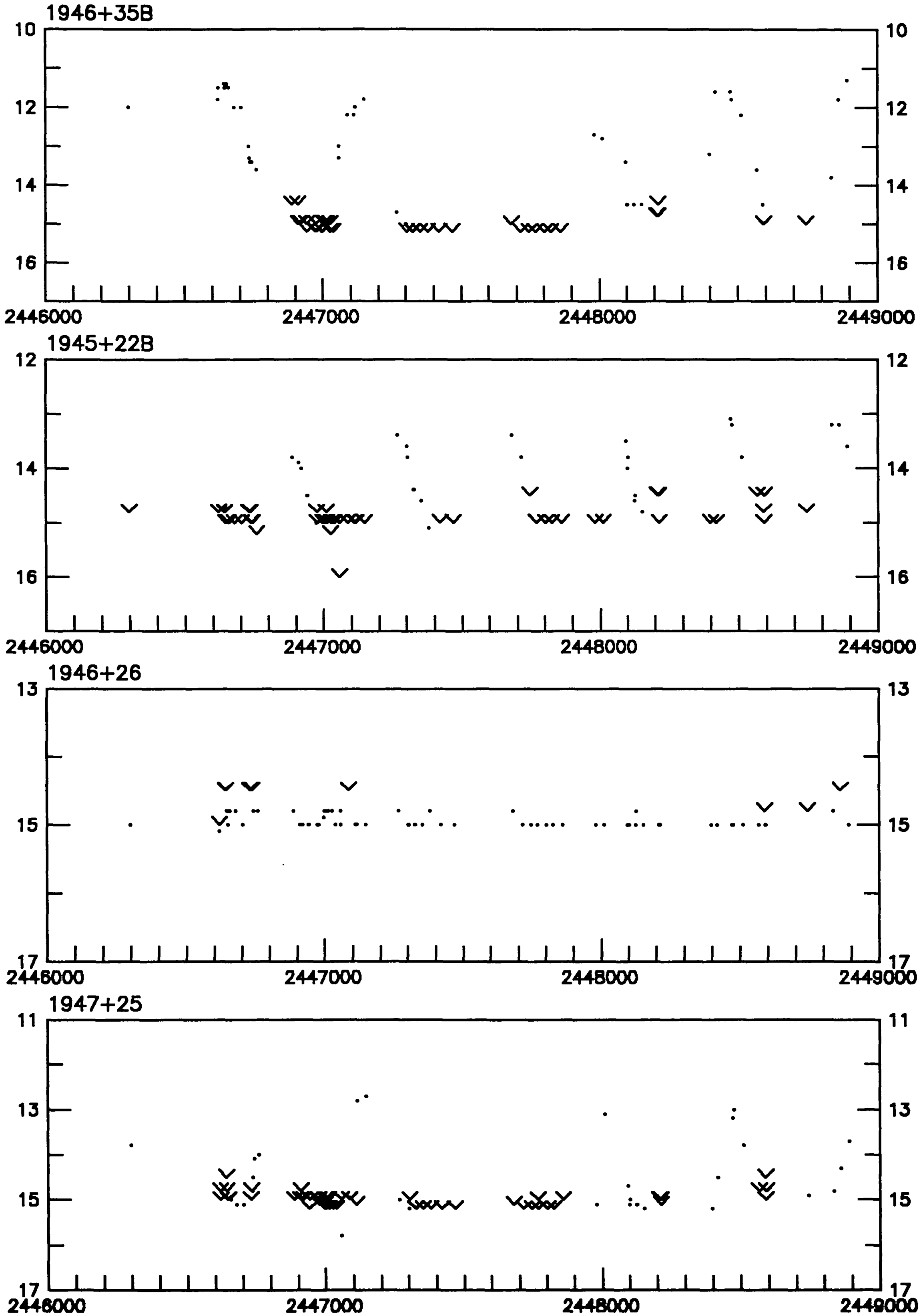


Figure 4 (j). Light curves for LD142–145 (~ JD 2446250–2449000).

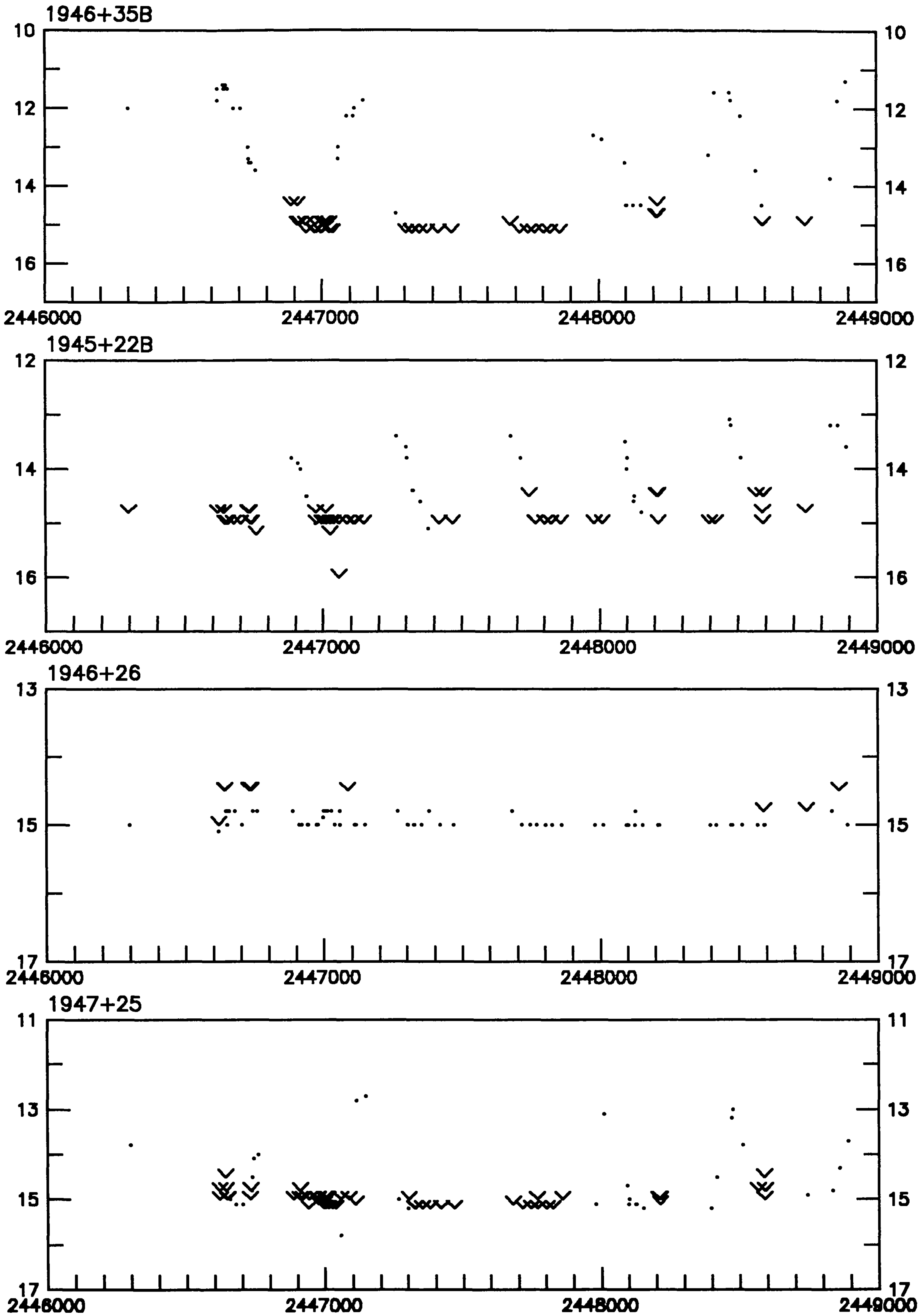


Figure 4 (j). Light curves for LD142–145 (~ JD 2446250–2449000).

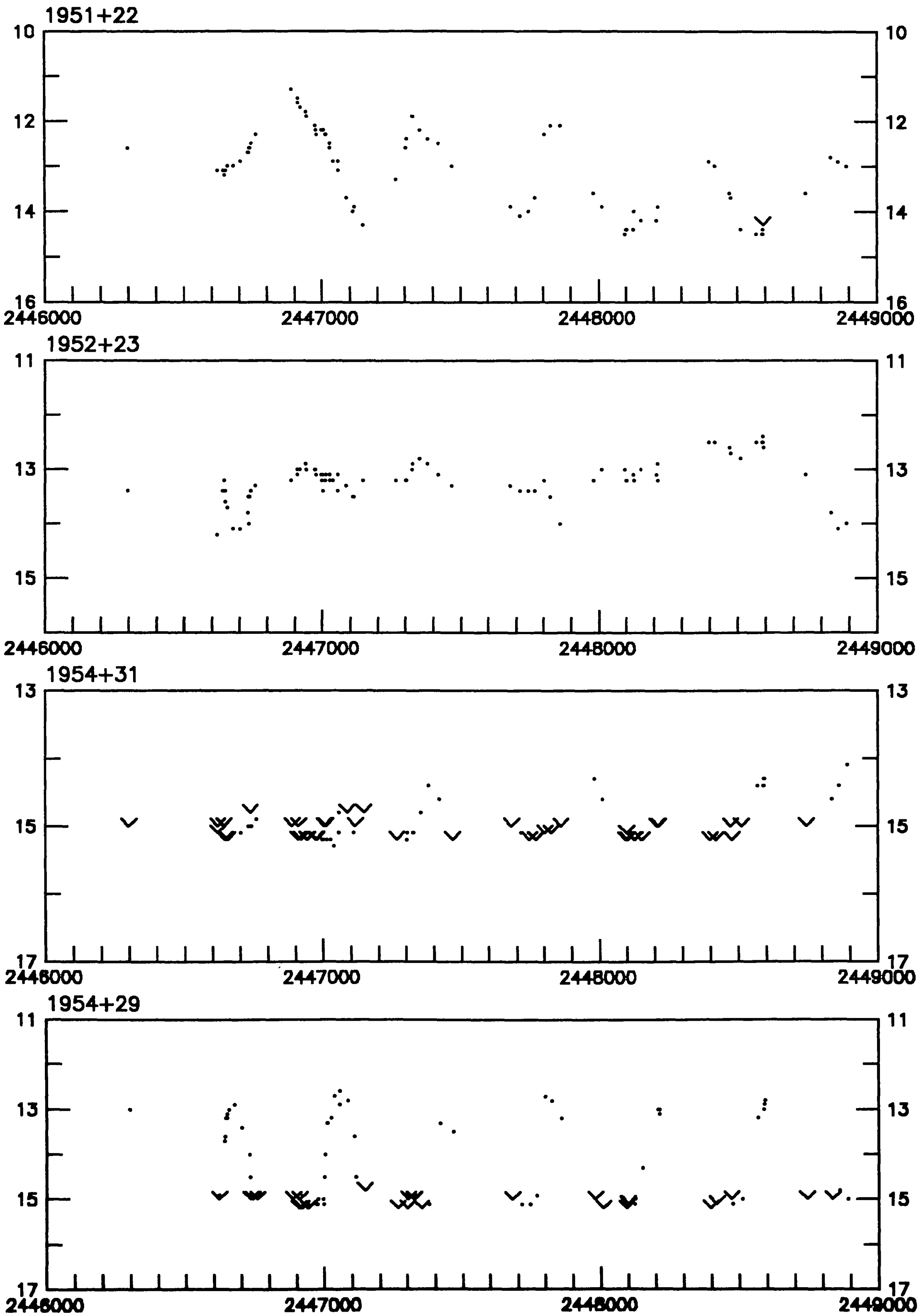


Figure 4 (l). Light curves for LD150–153 (~ JD 2446250–2449000).

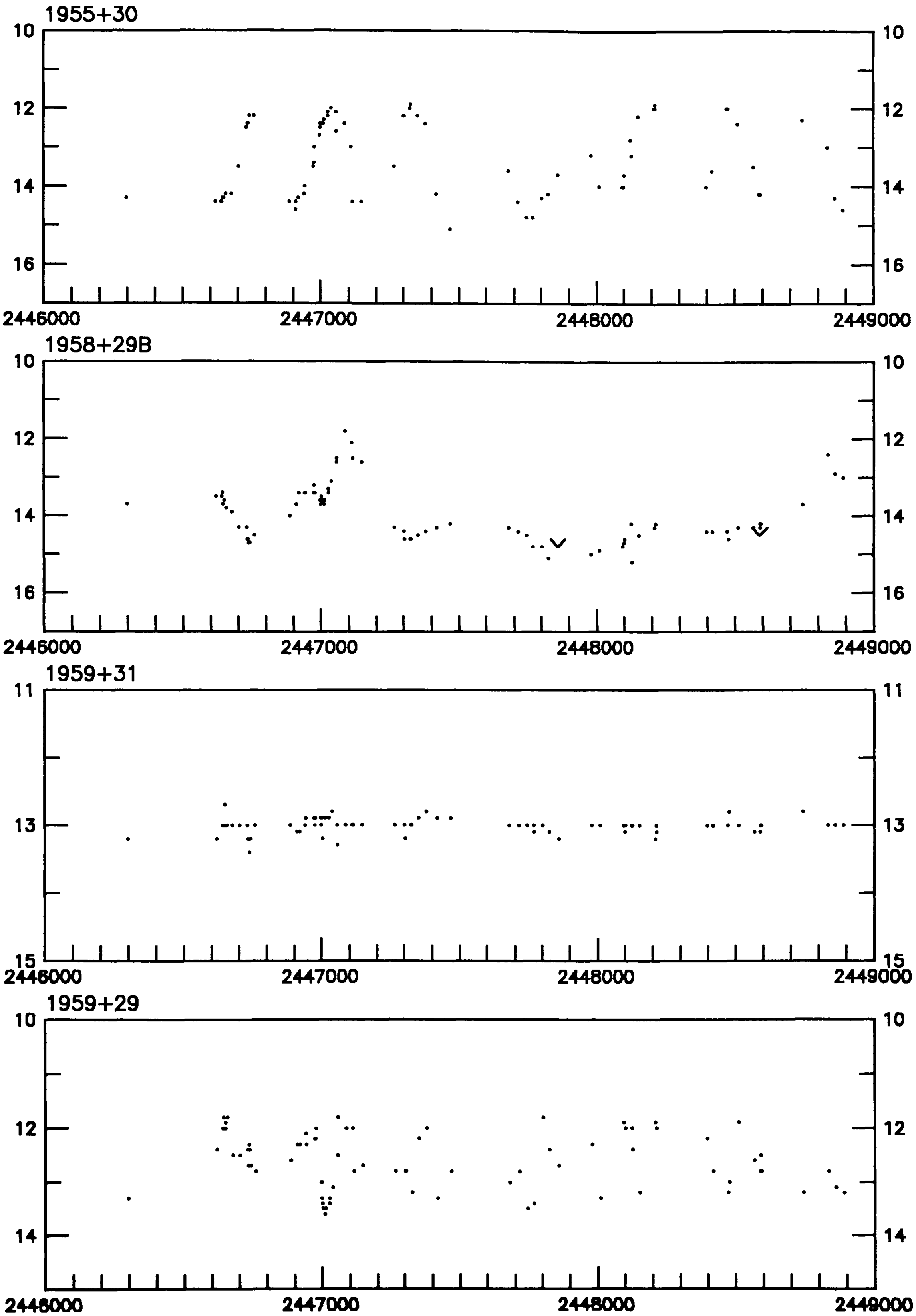


Figure 4 (m). Light curves for LD154–157 (~ JD 2446250–2449000).

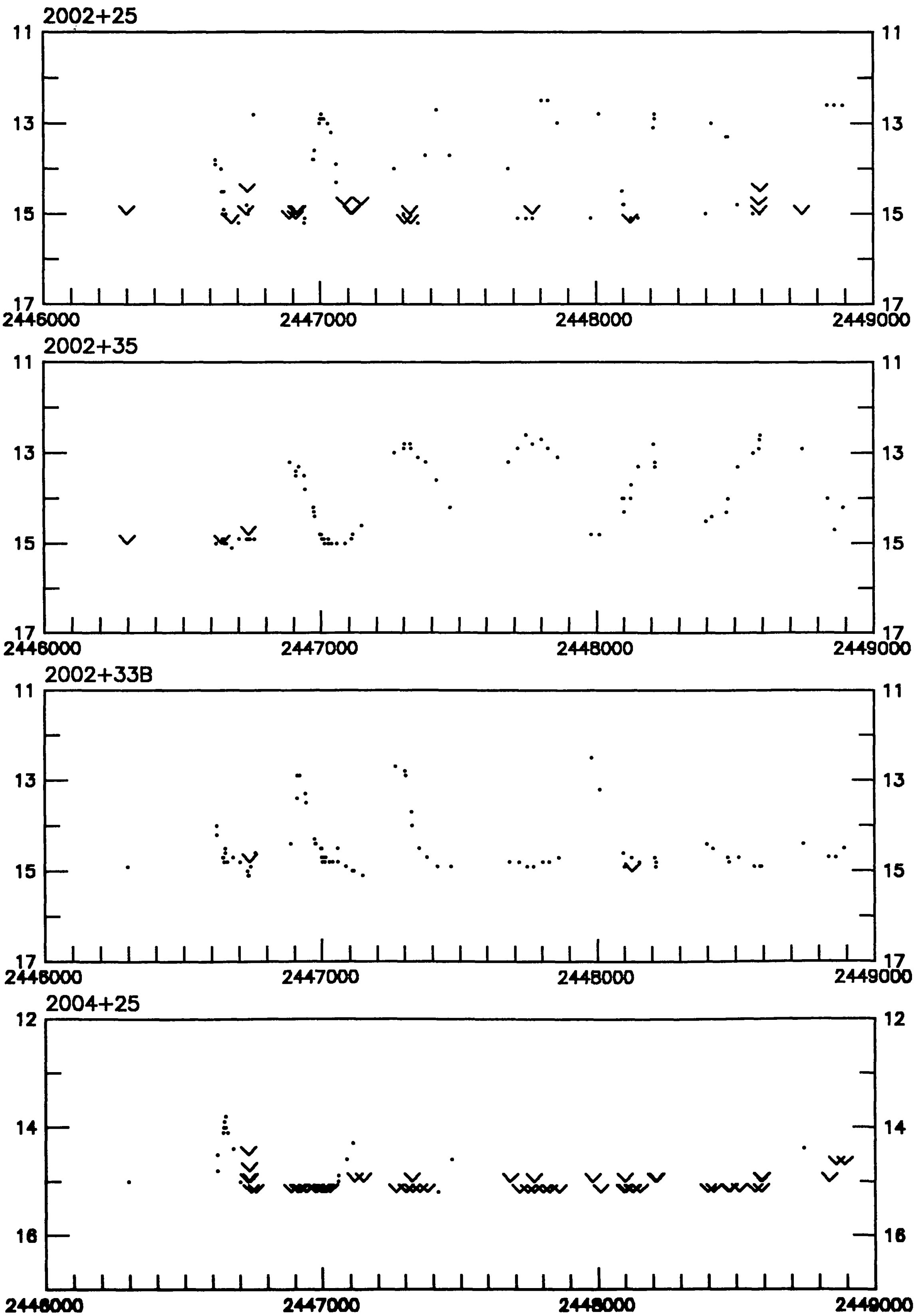


Figure 4 (n). Light curves for LD158–161 (~ JD 2446250–2449000).

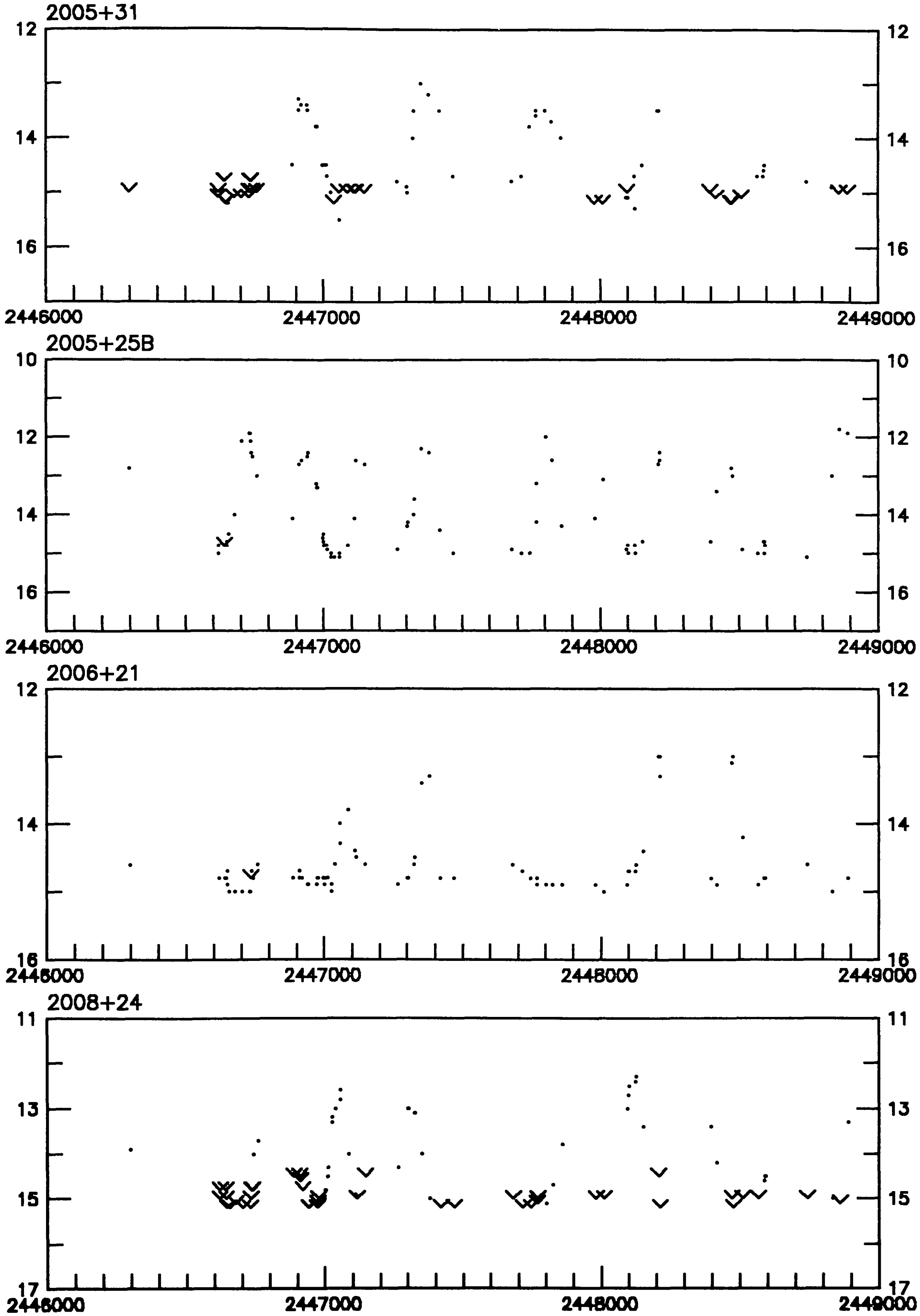


Figure 4 (o). Light curves for LD162–165 (~ JD 2446250–2449000).

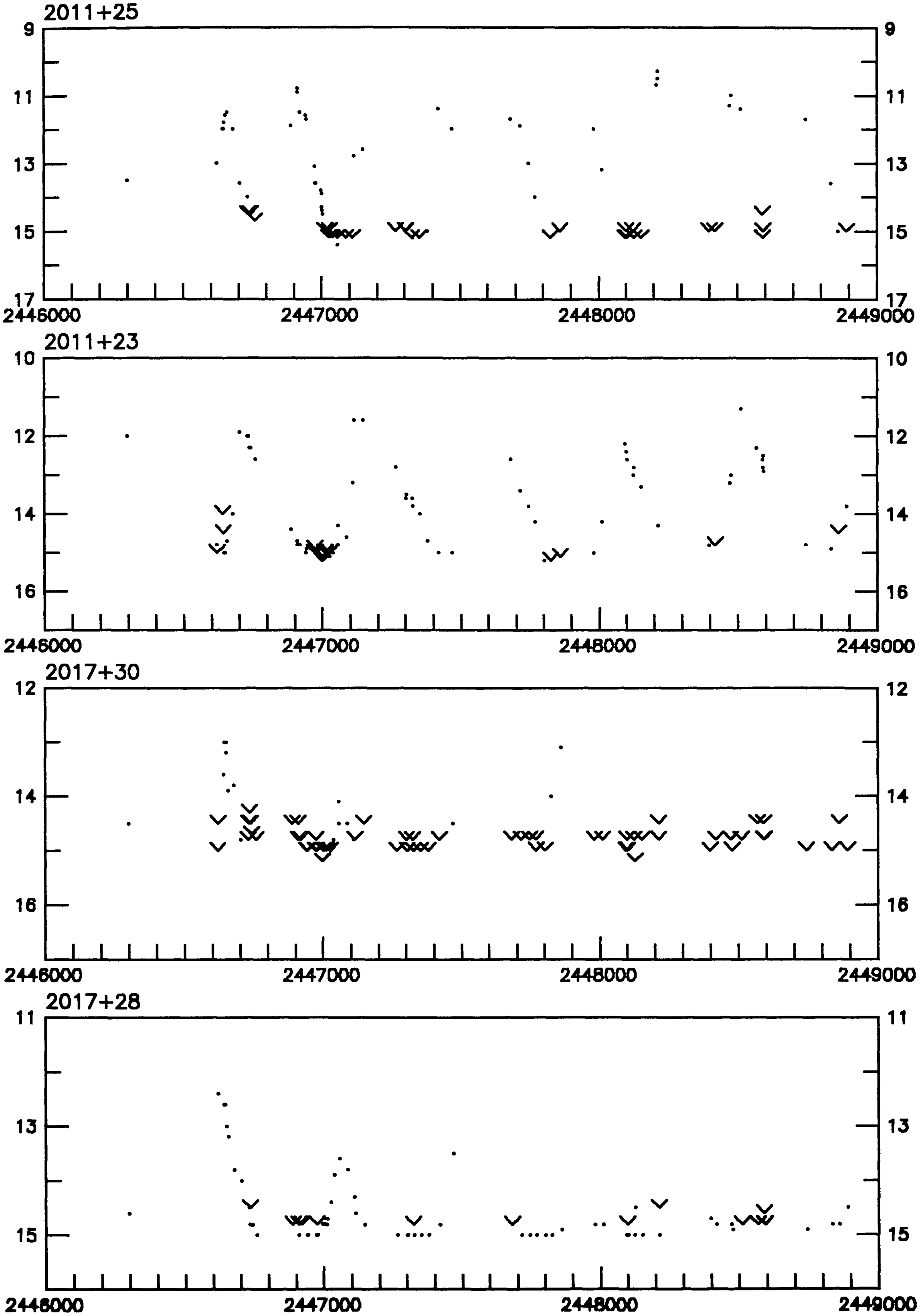


Figure 4 (p). Light curves for LD166–169 (~ JD 2446250–2449000).

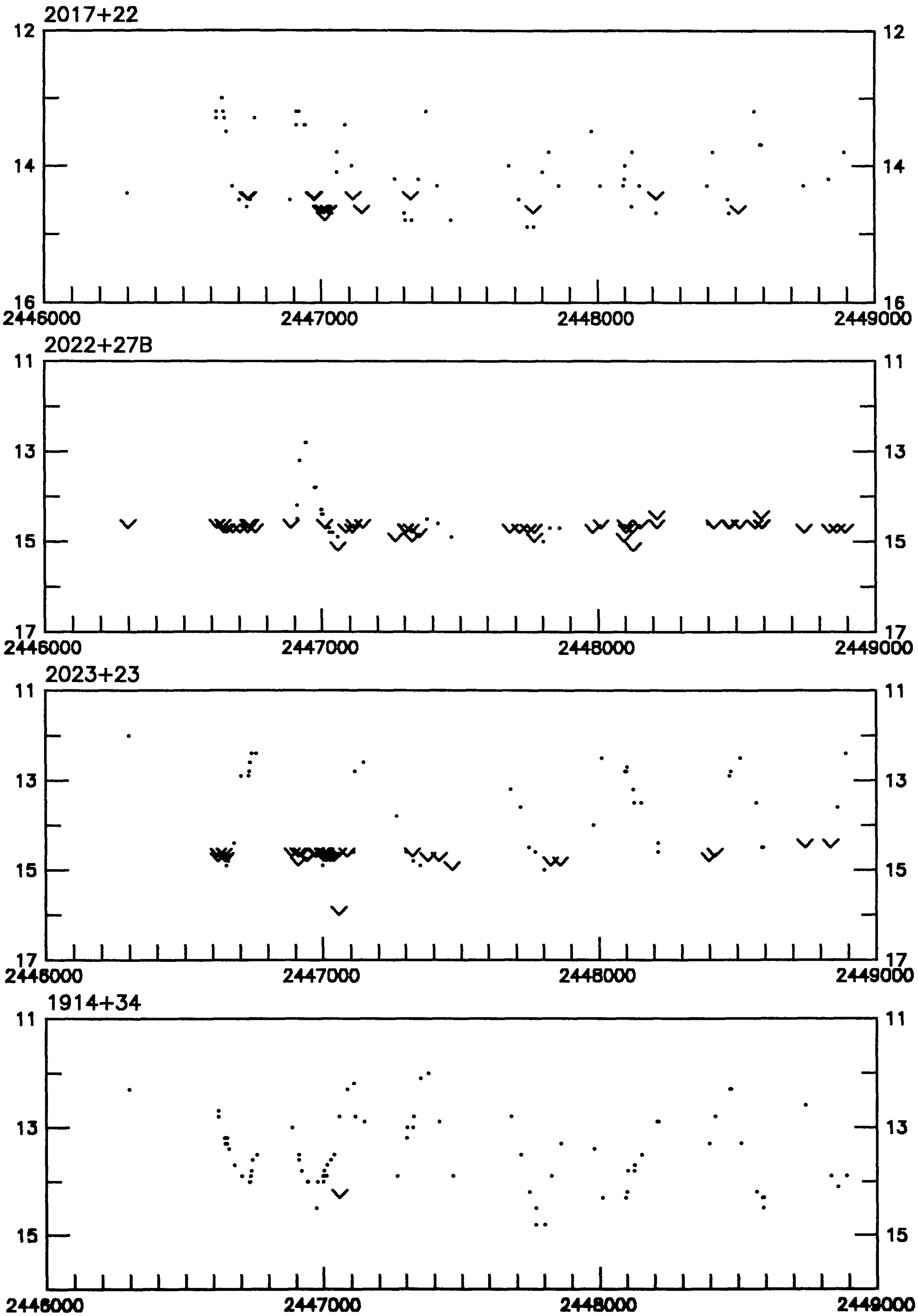


Figure 4 (q). Light curves for LD170–173 (~ JD 2446250–2449000).

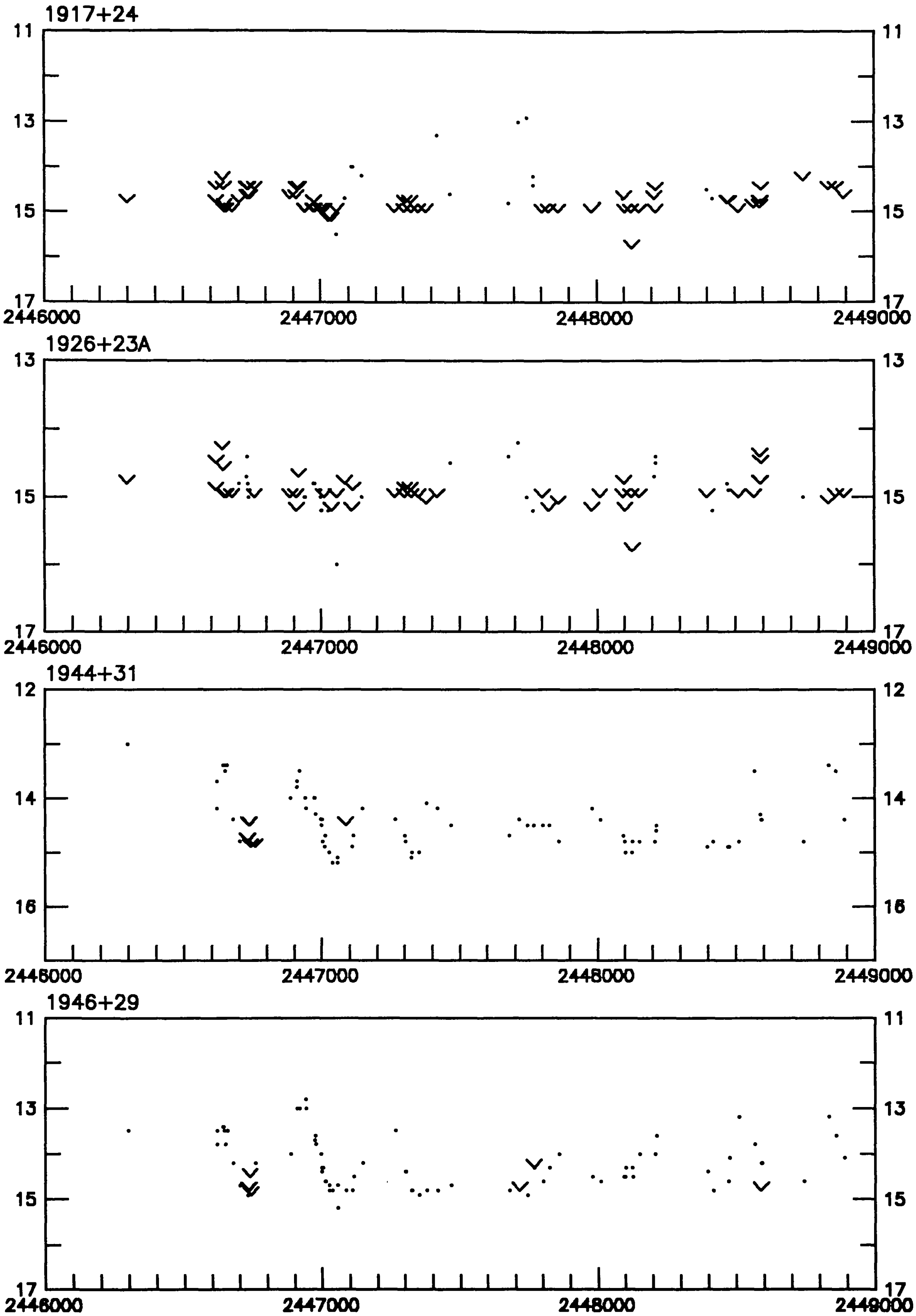


Figure 4 (r). Light curves for LD174–177 (~ JD 2446250–2449000).

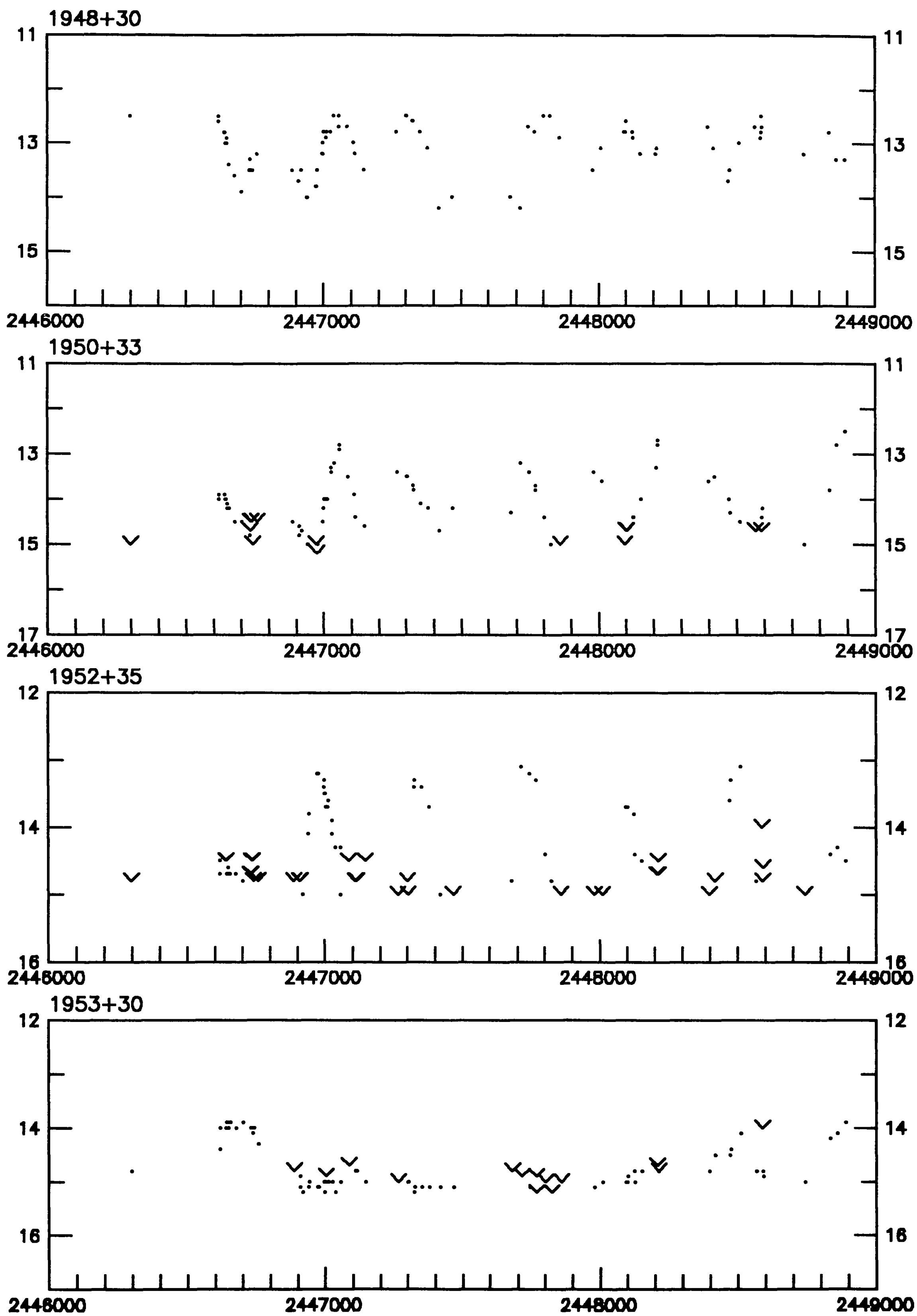


Figure 4 (s). Light curves for LD178–181 (~ JD 2446250–2449000).

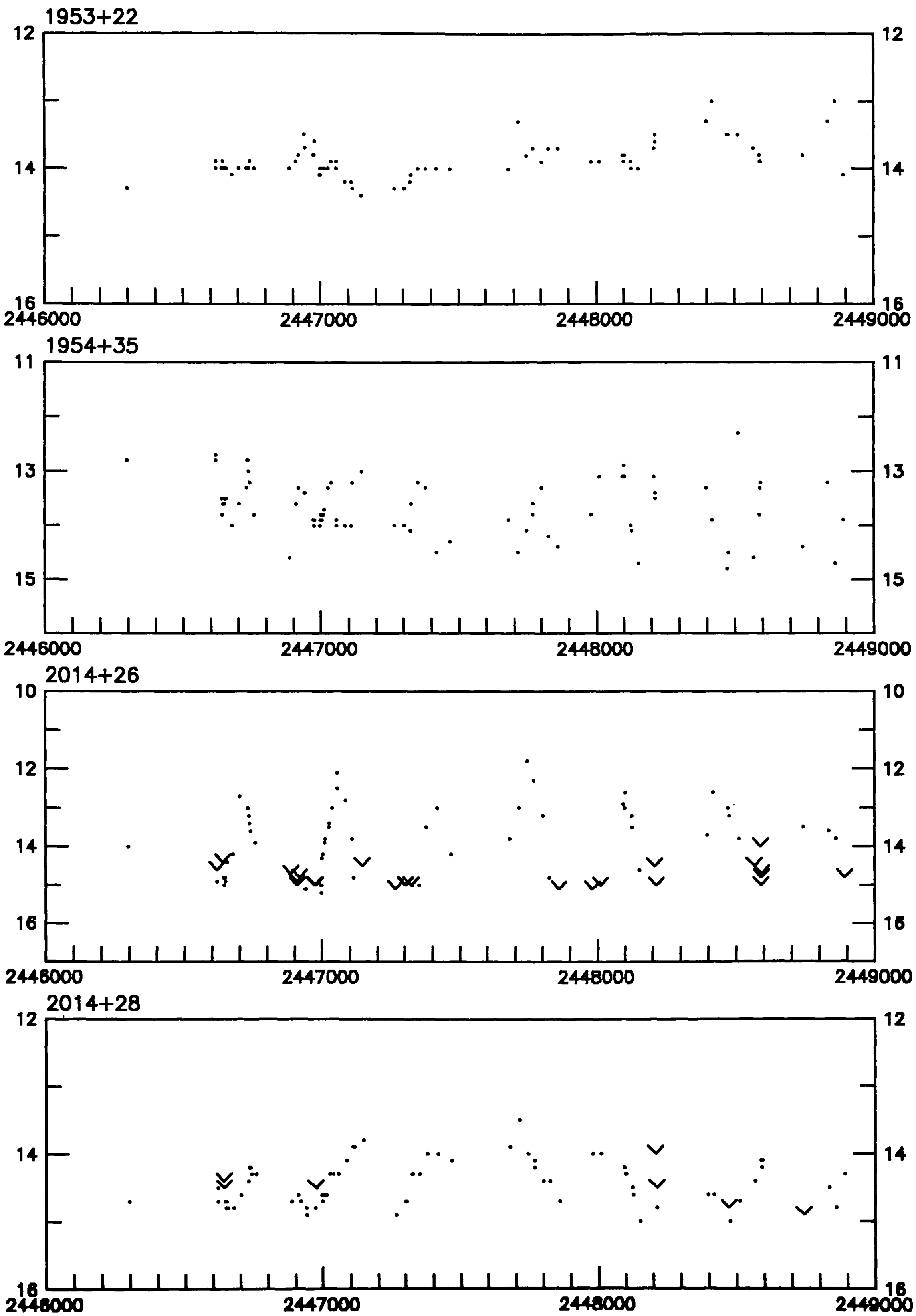


Figure 4 (t). Light curves for LD182–185 (~ JD 2446250–2449000).