VARIABLE STARS IN THE GLOBULAR CLUSTER NGC 6712

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ABSTRACT

The variable stars of the disk globular cluster NGC 6712 (Morgan's class V) have been examined on blue-sensitive plates obtained from 1954 to 1963 at the Asiago Observatory Elements and light-curves have been obtained for five RR Lyrae variables, three semiregulars, and one long-period variable Although the cluster has an advanced type, its variable stars do not present peculiarities in period, amplitude, or type. The period distribution of the RR Lyrae *a* star is that of Oosterhoff's group I, with a mean value $P_a = 0^d.548$.

I. INTRODUCTION

NGC 6712 ($\alpha = 18^h50^m.3$, $\delta = -8°47'$; $l^{II} = 25°$, $b^{II} = -4°$; 1950) is a rather loose globular cluster situated in a very dense stellar region. Its concentration class is IX, the integrated magnitude 10, and the diameter about 6'. Morgan (1959) classified NGC 6712 as a disk cluster with moderately strong metallic lines and placed it in class V, intermediate between the metal-poor clusters of the halo (classes I-III) and the strong-line clusters of the nucleus (classes VI–VIII). For its intermediate position the cluster was thought to present some points of interest concerning the C-M diagram and the properties of the variable stars. This communication deals only with the variables, the structure of the color-magnitude diagram having been investigated recently by Sandage and Smith (1962).

The situation of the variable stars in NGC 6712 is rather intriguing because the cluster is seen in projection over an extremely rich field of stars, many of which are variable (Harwood, 1962). It is therefore difficult to separate the variables physically associated with NGC 6712 from those of the field, which are abundant also in the neighborhood of the cluster.

The present investigation has been restricted to fifteen variable stars, all within a distance of 8' from the center of NGC 6712, twelve of which are listed in the second catalogue of H. B. Sawyer (1955) and the others are reported by Harwood. Information is also given on Harwood's variables 141 and 151. Three RR Lyrae *c* stars discovered by Norton near the center of the cluster have not been examined, since in most of the plates their images are fused with those of other stars which are crowded in this region.

II. OBSERVATIONS AND RESULTS

The material used for the study of the variable stars is the following: eighty-five plates obtained from 1954 to 1956 with the 60-cm reflector of Loiano (1 mm = 98"); thirty plates taken at Asiago with the 122-cm telescope (1 mm = 34") from 1957 to 1963; and, for the semiregular and long-period variables, also sixty-five Schmidt photographs (1 mm = 200") covering approximately the same period. Blue-sensitive emulsions (mostly 103a-O) were always employed.

The magnitudes of the variable stars were first determined with reference to a comparison sequence with an arbitrary zero point. Later, the photoelectric *UBV* magnitudes of a sequence of stars were kindly communicated us by A. Sandage, and it was possible to calibrate the zero point to the international photographic system.

Table 1 reports the photographic magnitudes of the RR Lyrae variables and gives also the phases of variables 1, 3, 5, 12, and 13. Magnitudes of the long-period, semiregular, and irregular variables are given in Table 2. The final results are contained in Table 3 and its Notes. Of the fifteen variable stars in the neighborhood of NGC 6712

TABLE 1

Magnitudes of RR Lyrae variables in NGC 6712

PLATE No.	Hel. J.D.	VAR 1 m_{pg}	VAR 1 ph.	VAR 3 m_{pg}	VAR 3 ph.	VAR 5 m_{pg}	VAR 5 ph.	VAR 12 m_{pg}	VAR 12 ph.	VAR 13 m_{pg}	VAR 13 ph.	VAR 4	VAR 6	VAR 11
L	243													
6820	4919.499	16.80	0.189	-	-	16.85	0.217	17.40	.460	-	-	17.65	-	16.9
6831	923.540	16.55	.081	17.35	.653	17.20	.626	17.35	.497	17.00	.231	17.20	17.25	16.85
6834	924.456	17.30	.870	16.40	.050	16.85	.305	-	-	-	-	17.45	-	16.8
6835	924.483	16.60	.923	16.55	.091	17.10	.355	-	-	17.25	.907	17.40	-	16.75
6837	.565	16.50	.083	16.90	.215	17.10	.505	-	-	16.35	.052	17.55	-	-
6841	926.490	17.35	.842	16.60	.150	16.05	.035	17.30	.364	17.20	.473	17.55	17.30	17.3
6842	.515	17.30	.891	16.75	.188	16.30	.081	17.50	.414	17.25	.518	17.45	17.20	17.1
6849	932.530	17.35	.638	17.05	.358	16.15	.110	17.35	.378	16.80	.208	17.65	-	17.4
6850	.554	17.40	.685	17.15	.395	16.35	.154	17.40	.425	17.05	.251	17.70	17.00	17.4
6880	955.394	16.70	.291	17.15	.214	16.20	.032	17.70	.833	17.45	.845	17.20	16.80	17.2
6881	.411	17.10	.324	16.95	.240	16.35	.063	17.50	.887	17.50	.875	17.10	16.20	16.85
6882	.438	17.20	.377	17.05	.281	16.50	.112	16.35	.941	17.10	.922	17.30	16.80	16.75
6884	.518	17.35	.533	17.10	.403	16.75	.259	16.35	.100	16.60	.065	17.25	16.40	17.0
6885	.536	17.25	.568	17.05	.430	16.85	.292	16.50	.136	16.60	.097	17.40	16.80	16.85
6890	957.385	16.60	.179	16.80	.249	17.15	.682	17.65	.813	17.40	.383	17.50	-	16.65
6891	.401	16.70	.210	17.00	.273	17.10	.712	17.65	.845	17.35	.412	17.60	16.60	16.80
6895	.528	17.00	.459	17.25	.467	16.85	.945	16.55	.098	17.30	.637	17.60	17.10	-
6898	958.386	16.40	.134	17.25	.775	16.95	.518	17.60	.804	16.75	.162	17.05	16.40	17.1
6899	.415	16.75	.191	17.30	.819	17.30	.571	17.45	.862	17.15	.214	17.20	16.70	16.8
6907	959.385	16.40	.085	17.25	.298	17.00	.350	17.60	.791	16.70	.938	17.75	17.20	-
6908	.401	16.30	.116	17.25	.332	17.05	.379	17.55	.823	16.35	.966	17.70	16.80	16.9
6909	.418	16.45	.150	17.25	.348	16.95	.410	17.75	.857	16.20	.996	17.75	17.20	17.0
6911	.464	16.80	.239	17.15	.418	17.10	.494	16.65	.948	16.60	.078	17.70	17.20	17.4
6912	.490	16.90	.290	17.20	.458	17.20	.542	16.00	.000	16.70	.124	17.65	17.30	17.1
6913	.513	17.25	.335	17.25	.493	17.15	.584	16.20	.046	-	-	17.80	16.90	-
6914	.528	17.15	.364	17.45?	.516	17.35	.612	16.60	.076	16.90	.192	-	16.50	-

TABLE 1-continued

6936	986.347	17.30	.741	-	-	17.00	.786	-	-	17.40	.857	-	-	16.7
6937	.368	17.35	.782	17.25	.433	17.25	.824	17.50	.459	17.15	.895	17.70	17.40	16.9
6938	.389	17.30	.823	17.15	.465	17.30	.863	17.35	.501	16.75	.932	17.70	17.40	16.85
6939	.410	17.20	.864	17.15	.497	17.20	.901	17.50	.543	16.40	.969	17.80	17.10	17.05
6940	.430	16.95	.903	17.20	.527	17.05	.938	17.45	.583	16.30	.005	17.80	17.40	17.05
6941	.447	16.60	.936	17.20	.553	16.35	.969	17.45	.616	16.30	.035	17.75	17.30	17.15
6945	987.344	17.20	.688	16.80	.921	17.20	.614	17.30	.400	17.35	.629	17.40	17.50	17.5
6946	.371	17.30	.741	16.60	.962	17.10	.663	17.45	.454	17.40	.677	17.45	17.50	17.5
6949	.437	17.30	.870	16.50	.063	17.30	.784	17.60	.585	17.40	.794	17.55	17.50	17.3
6950	5005.350	17.20	.853	17.15	.371	17.25	.629	16.70	.213	17.50	.631	17.65	17.30	16.95
6951	.378	16.80	.908	17.20	.413	17.15	.680	17.25	.269	-	-	17.60	-	16.85
6952	.400	16.05	.951	17.25	.447	17.25	.720	17.50	.313	17.35	.720	17.75	16.20	16.90
6953	.416	16.25	.982	17.35	.471	17.10	.750	-	-	-	-	-	16.30	-
6955	5006.341	17.35	.789	17.00	.881	17.05	.446	-	-	17.20	.392	17.6	-	17.0
6956	.357	17.40	.820	17.00	.906	17.20	.475	17.00	.216	17.25	.421	17.55	17.2?	17.2
6957	.377	17.30	.859	16.90	.936	16.90	.512	17.20	.256	-	-	17.35	-	16.7
6963	5009.336	17.30	.638	17.25	.447	16.70	.937	16.35	.142	17.40	.715	17.35	-	16.9
6964	.353	17.30	.671	17.10	.473	16.35	.968	16.80	.175	17.30	.746	17.35	17.40	16.85
6965	.373	17.35	.710	17.15	.504	16.00	.005	16.90	.215	17.30	.781	17.40	17.30	17.1
7245	5248.522	17.30	.761	16.55	.081	17.05	.497	-	-	-	-	17.40	17.40	-
7246	.540	17.30	.796	16.65	.109	17.15	.530	17.60	.908	-	-	17.55	16.80	17.4
7378	5337.364	16.95	.267	17.25	.519	17.00	.393	-	-	-	-	17.30?	-	-
7379	.390	17.00	.318	17.05	.559	17.10	.441	17.55	.627	17.45	.764	17.50	17.10	17.4
7380	.405	17.15	.347	17.15	.582	17.05	.468	17.50	.657	17.35	.791	17.80	17.10	17.4
7381	.423	17.20	.382	17.15	.609	17.00	.501	17.50	.693	17.45	.823	17.70	17.10	17.5
7382	.444	17.25	.423	17.25	.635	17.00	.540	17.60	.735	17.45	.860	17.70	16.5?	17.5
7383	.460	17.25	.454	17.20	.666	17.05	.569	17.50	.766	-	-	17.80	16.50	16.95
7399	5367.391	17.10	.909	17.15	.295	16.80	.449	17.10	.298	16.50	.085	17.80	17.30	16.70
7409	5370.359	17.30	.705	17.30	.820	17.05	.891	16.85	.201	17.15	.360	-	17.30	17.30
7410	.370	17.40	.742	17.35	.847	17.05	.924	17.10	.237	17.15	.392	17.50	17.20	16.85
7411	.393	17.35	.771	17.40	.871	16.55	.953	17.45	.269	17.40	.420	17.50	17.10	-

TABLE 1-continued

PLATE No.	Hel. J.D.	VAR 1 m_{pg}	VAR 1 ph.	VAR 3 m_{pg}.	VAR 3 ph.	VAR 5 m_{pg}	VAR 5 ph.	VAR 12 m_{pg}	VAR 12 ph.	VAR 13 m_{pg}	VAR 13 ph.	VAR 4	VAR 6	VAR 11
L7413	5371.368	17.30	.676	17.05	.358	17.15	.741	17.15	.208	16.75	.153	17.15	16.80	17.0
7414	.388	17.25	.715	17.15	.388	17.35	.778	17.10	.248	16.85	.187	17.20	16.80	17.1
7416	5372.337	17.25	.568	17.45	.835	17.15	.520	16.50	.135	17.30	.875	17.50	17.10	16.7
7417	.352	17.30	.597	17.50	.858	17.35	.545	-	-	17.45	.902	-	16.80	16.7
7418	.368	17.30	.629	16.95	.882	17.15	.574	-	-	16.65	.930	-	16.80	-
7599	5605.533	16.05	.993	17.25?	.338	16.35	.094	16.90	.952	-	-	17.40	-	16.85
7621	5609.524	17.30	.787	17.15	.422	17.10	.412	17.35	.890	17.35	.426	-	16.60	16.9
7632	5629.468	17.30	.737	17.30	.826	16.15	.980	-	-	17.20	.873	17.15	-	-
7641	5630.540	17.35	.831	17.30	.460	16.50	.946	-	-	-	-	17.80	-	16.9
7650	5633.418	17.30	.451	17.05	.848	16.85	.223	-	-	-	-	-	-	-
7651	.484	17.30	.580	16.60	.948	17.00	.344	-	-	-	-	-	-	16.85
7652	.505	17.30	.621	16.50	.980	17.25	.382	-	-	-	-	-	-	-
7656	5634.462	17.30	.490	17.10	.439	16.40	.137	-	-	-	-	-	-	-
7664	5638.473	17.20	.324	17.30	.554	17.10	.491	17.45	.469	17.40	.878	17.80	17.30	16.9?
7673	5639.485	17.15	.300	16.55	.097	17.10	.347	17.30	.481	17.50	.676	17.45	17.20	16.9
7675	.577	17.3?	.480	16.95	.237	17.10	.516	-	-	-	-	-	-	-
7685	5658.445	17.15	.328	16.30	.001	16.35	.111	16.75	.192	-	-	17.55	17.00	16.9
7691	5660.413	16.70	.172	16.35	.001	17.05	.719	16.45	.106	-	-	17.70	-	16.9
7696	5661.393	16.35	.085	17.35	.495	17.05	.516	-	-	-	-	17.40	16.30	16.95
7700	5662.431	16.20	.113	16.65	.077	17.10	.419	16.60	.120	17.30	.458	17.65	16.40	16.95
7705	5684.384	16.30	.986	17.20	.544	17.15	.671	-	-	-	-	17.60	16.20	17.20
7706	.407	16.40	.031	17.25	.579	17.10	.714	-	-	-	-	17.50	17.00	17.40
7707	5685.367	17.20	.906	16.40	.043	17.20	.474	17.25	.739	-	-	17.30	16.20	17.00
7708	.387	16.30	.945	16.50	.073	17.05	.510	17.60	.779	-	-	17.70	-	16.95
7709	.407	16.00	.984	16.60	.104	17.05	.547	-	-	-	-	17.50	17.20	16.85
7710	.427	15.95	.023	16.70	.134	17.10	.584	-	-	17.10	.329	17.70	-	16.80
7711	5686.379	17.00	.883	17.15	.586	16.95	.329	17.45	.752	16.30	.020	17.25	17.00	16.80
7712	.409	16.40	.941	17.05	.631	17.00	.384	17.70	.811	16.50	.073	16.95	16.30	16.80

TABLE 1-continued

A2985	6018.506	17.30	.517	16.65	.907	17.10	.301	17.40	.338	17.25	.308	16.90	17.00	17.2
2990	6019.525	17.20	.507	17.20	.460	16.55	.169	17.50	.365	16.75	.119	17.80	17.20	17.1
3003	6022.463	16.90	.245	16.60	.939	17.20	.556	17.00	.209	17.15	.341	17.50	17.00	16.6
3010	6023.483	16.80	.246	17.20	.502	17.25	.436	17.00	.247	16.80	.163	17.50	17.20	17.2
3055	6051.425	17.20	.807	16.40	.091	17.25	.659	17.70	.813	17.55	.815	17.70	17.40	16.8
3067	6053.387	17.30	.638	16.65	.082	17.00	.257	17.70	.715	17.10	.302	17.30	17.25	17.5
3071	6070.473	16.20	.007	16.65	.129	16.95	.585	-	-	-	-	-	-	16.6
3097	6080.401	17.20	.396	16.90	.264	17.30	.788	17.50	.445	17.20	.314	17.10	17.20	17.1
3176	6136.254	17.25	.475	17.10	.411	16.80	.198	17.70	.534	17.35	.581	17.40	17.00	17.2
3525	6374.540	17.10	.840	17.45	.673	16.45	.939	17.60	.475	16.55	.086	17.40	16.70	17.1
3529	6391.433	17.45	.832	17.15	.426	16.40	.081	16.40	.074	16.80	.110	17.80	17.20	16.8
3901	6747.550	17.05	.318	17.15	.320	16.25	.039	17.50	.376	16.25	.035	-	-	16.6
3908	6752.549	16.15	.081	-	-	16.70	.205	-	-	17.20	.919	-	16.70	17.1
3915	6761.481	17.20	.525	17.30	.557	17.20	.583	16.30	.084	17.40	.794	17.50	17.40	16.5
3926	6807.396	16.70	.195	17.20	.554	17.30	.770	17.60	.407	17.45	.399	17.70	17.25	17.2
3930	6818.405	17.20	.695	16.95?	.337	16.65	.956	17.60	.304	16.45	.965	17.70	16.4?	17.1
3932	6820.335	17.05	-	-	-	-	-	16.70	.143	17.15	.395	-	-	-
4147	7176.479	16.15	.003	-	-	-	-	-	-	-	-	-	-	-
4531	7516.371	17.25	.802	17.00	.372	17.30	.711	17.50	.529	17.35	.456	17.40	-	17.2
4552	7520.389	17.30	.649	17.30	.497	16.50	.079	17.40	.521	17.30	.597	-		16.8
4575	7529.357	-	-	16.80	.168	17.10	.522	-	-	-	-	-		
5130	7867.406	17.30	.340	17.35	.518	17.10	.352	17.50	.723	17.25	.349	-		
5841	8204.521	17.20	.738	17.00	.435	16.95	.469	17.20	.230	17.10	.502	-		
5842	.538	.20	.760	17.05	.461	17.00	.500	17.30	.264	17.30	.532	-		
5843	8206.502	17.25	.607	17.15	.455	16.20	.101	16.70	.170	16.30	.023	-		
5844	.523	.25	.648	17.30	.487	16.60	.140	16.70	.212	16.30	.060	-		
5846	.571	.30	.742	17.35	.560	16.75	.228	17.10	.308	16.70	.145	-		
5860	8209.510	-	-	-	-	-	-	16.60	.153	17.30	.369	-		
5865	8212.531	-	-	-	-	-	-	16.60	.162	17.30	.738	-		
5872	8225.536	-	-	-	-	-	-	16.10	.028	17.35	.852	-		

TABLE 2

Magnitudes of semiregular, irregular and long-period variables in NGC 6712

N.	Hel.J.D.	VAR 2	VAR 7	VAR 8	VAR 9	VAR 10	VAR 14	VAR 15
	243							
1	4919.50	15.25	15.4	14.6	17.15	16.0	-	16.25
2	923.54	15.0	14.9	14.5	18.5	15.8	16.7	16.25
3	924.50	15.0	14.9	14.45	18	15.8	16.8	16.20
4	926.50	15.2	14.9	14.5	(18	15.7	16.9	16.25
5	932.54	15.65	14.55	14.5	(18	16.2	17.0	16.00
6	955.46	15.6	14.4	13.6	16.9	15.7	17.5	15.70
7	957.44	15.55	14.5	13.7	16.8	15.6	17.5	15.80
8	958.40	15.6	14.5	13.85	17.4	15.7	17.5	15.8
9	959.46	15.7	14.4	13.7	17.8	15.75	17.5	15.75
10	986.39	15.05	15.5	14.8	16.9	16.1	17.6	16.25
11	987.39	15.0	15.6	14.9	17.0	17.95	17.5	16.25
12	5005.39	14.1	17.1	15.5	16.75	-	17.8	16.1
13	006.35	14.1	17.15	15.45	16.95	15.8	17.9	16.1
14	009.35	14.1	17.2	15.4	18.2	15.95	17.8	16.1
15	248.53	14.9	17.8	15.7	(17.7	16.3	17.0	16.25
16	337.40	14.4	13.9	15.2	16.9	16.25	16.95	16.3
17	338.43	14.35	13.9	15.25	17.9	16.25	17.0	-
18	367.39	15.3	14.9	15.6	17.2	16.0	-	15.8
19	370.37	15.4	15.3	15.4	18.3	16.3	17.75	15.9
20	371.38	15.4	15.4	15.3	(18	16.3	17.8	15.85
21	372.35	15.4	15.4	15.35	(18	16.2	17.8	15.95
22	605.53	14.75	(18	15.65	(18	15.7	17.4	15.9
23	609.52	14.35	(18	15.6	(18	16.0	17.9	16.25
24	629.47	14.1	(18	14.4	17.5	15.75	-	16.05
25	630.54	15.05	(18	14.5	17.45	15.8	17.6	16.20
26	633.47	14.05	(18	14.5	(18	15.85	17.8	16.05
27	634.46	14.05	(18	14.3	(18	15.75	-	15.85
28	638.47	14.2	18.5	14.0	(18	15.75	17.6	16.05
29	639.53	14.3	(18	13.95	(18	15.75	17.3	16.05
30	658.45	15.2	18.0	14.0	(18	15.5	17.0	16.15
31	660.41	14.95	18.1	14.3	(18	15.55	17.0	16.05
32	661.39	15.2	18.0	14.0	18.0	15.85	16.7	16.25
33	662.43	15.0	17.7	14.25	17.8	15.8	16.8	16.30
34	684.39	16.4	15.9	14.95	17.2	16.4	15.55	15.80
35	685.53	16.05	15.4	15.0	17.2	16.35	15.5	16.0
36	6018.51	15.5	18.5	14.4	16.9	15.9	17.3	16.2
37	019.53	15.4	18.3	14.5	16.8	16.0	17.4	16.1
38	022.46	15.75	18.5	14.5	17.4	15.9	17.4	16.2
39	051.43	14.35	17.3	-	(19.5	16.3	17.7	15.95
40	053.39	14.35	16.5	15.6	(19	16.3	17.4	16.1
41	070.47	14.25	14.9	-	-	15.8	15.9?	15.6
42	080.40	14.35	14.3	14.8	17.4	15.3	15.9	15.75
43	136.25	15.45	-	14.4	17.7	15.6	16.3	16.00
44	374.54	14.25	18.3	-	-	15.8	17.3	16.2
45	391.43	14.45	18.5	15.2	(18.5	15.55	17.4	16.55
46	747.55	15.15	18.3	15.2	17.9	15.8	16.3	16.3
47	751.48	15.2	(17.5	-	-	-	16.6	-
48	752.55	15.1	18.3	15.6	17.6	15.8	16.8	16.45
49	759.42	15.2	(17.5	-	-	-	16.8	-
50	761.48	15.15	18.3	15.6	17.8	15.8	17.0	16.6
51	762.45	15.35	(17.5	-	-	-	16.9	-
52	776.42	15.45	(17.5	-	-	-	-	-
53	777.40	15.3	(17.5	-	-	-	17.0	-
54	781.46	15.35	(17.5	-	-	-	17.0	-
55	782.37	15.25	(17.5	-	-	-	-	-
56	788.36	15.1	(17.5	-	-	-	17.0	-
57	805.33	15.1	(17.5	-	-	-	17.9	15.9

TABLE 2-continued

N.	Hel.J.D.	VAR 2	VAR 7	VAR 8	VAR 9	VAR 10	VAR 14	VAR 15
	243							
58	6806.34	15.0	17.3	-	-	-	17.7	15.85
59	807.40	15.0	17.3	13.7	18.0	16.3	17.4	15.85
60	834.28	14.7	15.2	-	-	-	-	16.10
61	843.26	14.8	14.6	-	-	-	17.0	16.15
62	844.28	14.7	14.5	-	-	-	17.0	-
63	846.25	14.85	14.5	-	-	-	-	-
64	7103.48	14.85	(17.5	-	-	-	15.4	-
65	112.45	14.8	(17.5	-	-	-	15.25	-
66	120.53	14.9	(17.5	-	-	-	15.25	-
67	129.41	15.1	(17.5	-	-	-	15.9	-
68	130.42	15.4	(17.5	-	-	-	15.95	-
69	133.50	15.4	(17.5	-	-	-	16.2	-
70	135.49	15.6	(17.5	-	-	-	16.45	-
71	139.43	15.6	(17.5	-	-	-	-	-
72	140.44	15.5	(17.5	-	-	-	15.95	-
73	141.46	15.65	(17.5	-	-	-	16.4	-
74	145.48	16.05	(17.5	-	-	-	16.5	-
75	167.43	14.65	-	13.8	-	-	-	16.35
76	176.48	14.25	-	13.7	-	-	-	16.4
77	190.30	14.1	-	14.5	-	-	17.5	16.3
78	468.52	15.1	15.0	-	-	-	-	-
79	494.52	14.8	17.5	14.0	-	-	17.4	-
80	497.52	14.6	17.5	14.2	-	-	17.65	-
81	514.44	14.55	(17.5	13.9	-	-	-	16.1
82	516.37	14.75	18.2	13.7	18.0	15.6	16.9	16.1
83	517.42	14.6	(17.5	13.8	(17.5	15.6	16.8	16.1
84	518.46	14.6	(17.5	-	-	-	16.9	16.1
85	519.43	14.55	(17.5	13.8	-	-	17.0	16.15
86	520.39	14.45	18.2	13.8	18.2	16.0	16.7	16.1
87	521.44	14.5	(17.5	13.8	-	-	16.8	16.15
88	522.44	14.5	(17.5	-	-	-	-	-
89	523.47	14.2	(17.5	13.8	(17.5	-	16.8	16.15
90	524.47	14.2	(17.5	14.3	-	-	17.0	-
91	529.43	14.95	(17.5	-	-	-	-	16.3
92	530.45	15.0	(17.5	-	-	-	16.8	16.35
93	531.35	15.0	(17.5	-	-	-	-	-
94	543.39	15.0	(17.5	14.6	-	-	16.6	-
95	544.38	15.0	(17.5	14.6	-	-	-	-
96	546.34	14.95	(17.5	14.6	-	-	16.6	-
97	547.40	15.0	(17.5	14.9	-	-	-	-
98	549.39	15.0	(17.5	15.0	-	-	16.5	-
99	550.35	15.0	(17.5	-	-	-	16.3	-
100	552.38	14.85	-	15.0	-	-	16.3	-
101	553.38	14.8	(17.5	14.9	-	-	16.6	-
102	558.37	14.9	(17.5	15.1	-	-	17.0	-
103	559.36	15.1	(17.5	15.1	-	-	16.15	-
104	560.41	15.2	(17.5	-	-	-	17.0	-
105	575.34	15.0	17.5	-	-	-	-	-
106	578.33	15.0	17.5	15.4	-	-	-	-
107	582.31	15.4	17.4	15.5	-	-	-	-
108	583.33	15.5	17.3	15.5	-	-	17.4	-
109	867.41	14.8	17.2	-	18.0	-	17.4	16.10
110	204.53	15.35	14.5	-	18.0	-	17.75	16.15
111	206.52	15.05	14.4	-	18.3	-	17.45	16.15
112	209.51	14.8	14.5	-	18.6	-	17.4	16.05
113	212.53	14.65	14.6	-	-	-	17.4	16.0
114	225.54	14.65	15.6	-	17.3	-	17.6	15.85

TABLE 3

VARIABLE STARS IN OR NEAR NGC 6712

Variable	Harwood	x''	y''	M_{pg}	m_{pg}	$\bar{m}_{pg}$	T	P	Remarks	Notes
							243			
1	146	− 63	− 17	16 00	17 40	16 70	6585 415	0ᵈ512040	RR *a*	
2	AP Sct	+ 71	+ 17	14 10	16 10	15 10	5007 4	104 6	SR	1
3		− 28	− 96	16 35	17 45	16 90	5372 445	0 655961	RR *a*	2
4	. .	+181	− 28	16 90	17 80	17 35	(5285 082)	(0 611741)	RR *a*	3
5	154	+ 67	− 74	16 00	17 30	16 65	5009 370	0 545390	RR *a*	
6	. . .	+ 18	− 39	16 20	17 50	16 85	(5285 344)	(0 510849)	RR *a*	4
7	CH Sct	−130	− 17	14 00	18 50	16 25	4956 0	190 6	LP	5
8	149	+ 24	+ 60	13 60	15.70	14 65	4955 5	116 29	SR	6
9		− 1	+290	16 80	~19	. . .			U Gem ?	7
10		− 99	+ 30	15 60	16 40	16 00			Irr	8
11	. . .	−122	−339	16 60	17 50	17 05	. . .	. . . . . .	RR?	9
12	152	+ 31	+ 38	16 10	17 70	16 90	4959 490	0 502776	RR *a*	
13	144	− 94	+ 27	16 20	17 50	16 85	4959 420	0 562653	RR *a*	
14	131	−440	+ 36	15 30	17 90	16 60	5690 5	202 2	SR	10
15	160	+245	− 37	15 60	16 60	16 10			Irr	11
	141	−140	+174	16 8	17 5				E	12
	151	+ 27	+ 49	15 5					Const. *a*	13

NOTES TO TABLE 3

1.—Var 2: Semiregular variable shows fluctuations in brightness as well as in amplitude. The mean light-curve from JD 2434900 to 8200 is reproduced in Fig. 3 The star was nearly constant in brightness from JD 6750 to 6850 The corresponding magnitudes therefore have not been included in the mean light-curve

2.—Var. 3: The observations reported in Table 1 are not satisfied by the period 0 655680 given by Sandage *et al.* (1966).

3.—Var. 4: The elements have been found by Sandage *et al.* (1966). They fit all of the present observations, except one (JD 6023.483, m = 17.50, phase 0 049). The variable probably belongs to the field.

4 —Var. 6: Determination of magnitudes has been difficult for the presence of stars close to the variable. The elements have been found by Sandage *et al.* (1966). They fit the present observations sufficiently well; however, the dispersion of the single points on the mean light-curve is rather large

5.—Var. 7: CH Sct, long-period variable of large amplitude. A period P = 191ᵈ4 satisfies the observations of Table 2 The elements given in Table 3, however, have been derived by a complete discussion with the mean square method of the maxima given by Harwood and those derived by the present observations. The uncertainty in the epoch is $\pm 6^d$; in period, ± 0.3.

6.—Var. 8: The difference between observed and calculated data for maxima given by Harwood suggests a slow periodic variation of the period

7.—Var. 9: A very peculiar variable more frequently at minimum than at maximum; amplitude more than 2.2 mag. Maxima of short duration Mean distance of successive maxima about 11^d, with large irregularities. The star is very probably a foreground U Gem variable.

8 —Var. 10: This star shows irregular fluctuations of brightness of relatively small amplitude The star is likely to be an irregular red variable

9.—Var. 11: The elements have not been found Probably RR Lyrae *c*

10.—Var 14: This variable has been found by Sawyer (1953) and has received No 131 in Harwood's list. The star shows a semiregular fluctuation with a mean period of 202ᵈ2. At times, however, the period changes and the amplitude becomes very small A mean light-curve from JD 4900 to 7200 is reproduced in Fig 3.

11.—Var. 15: Slow irregular fluctuations of relatively small amplitude. Fast variations, however, have been sometimes observed in the course of a night.

12 —Harwood No. 141: Eclipsing binary which undoubtedly belongs to the field and of short period. Minima have been observed at JD 6019 53, 6391.43, 8204.52

13 —Harwood No 151: Does not show appreciable variations in our plates The magnitude is constant, about 15 5 photographic.

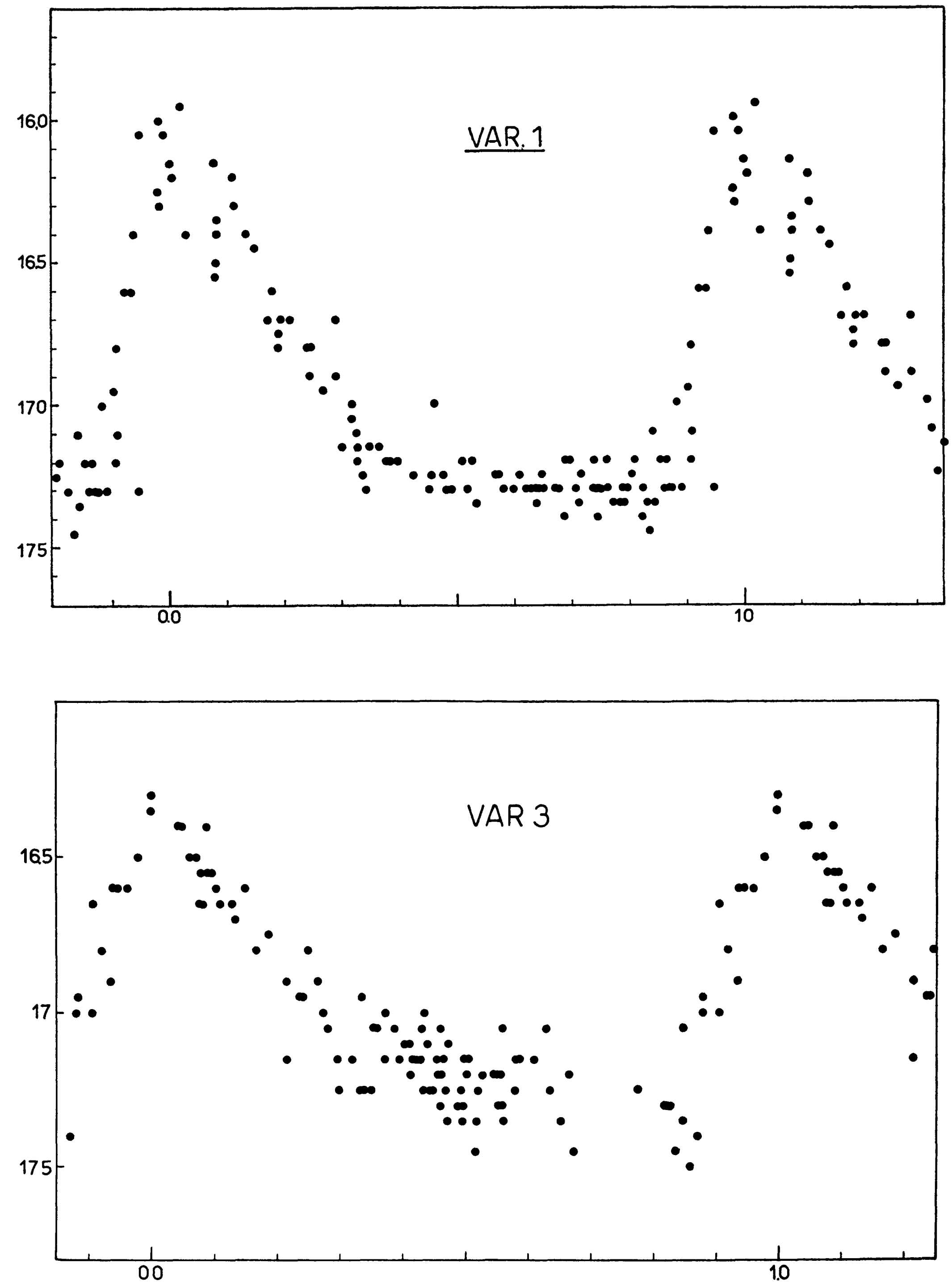

FIG. 1.—Photographic light-curves of the RR Lyrae variables 1, 3, and 5

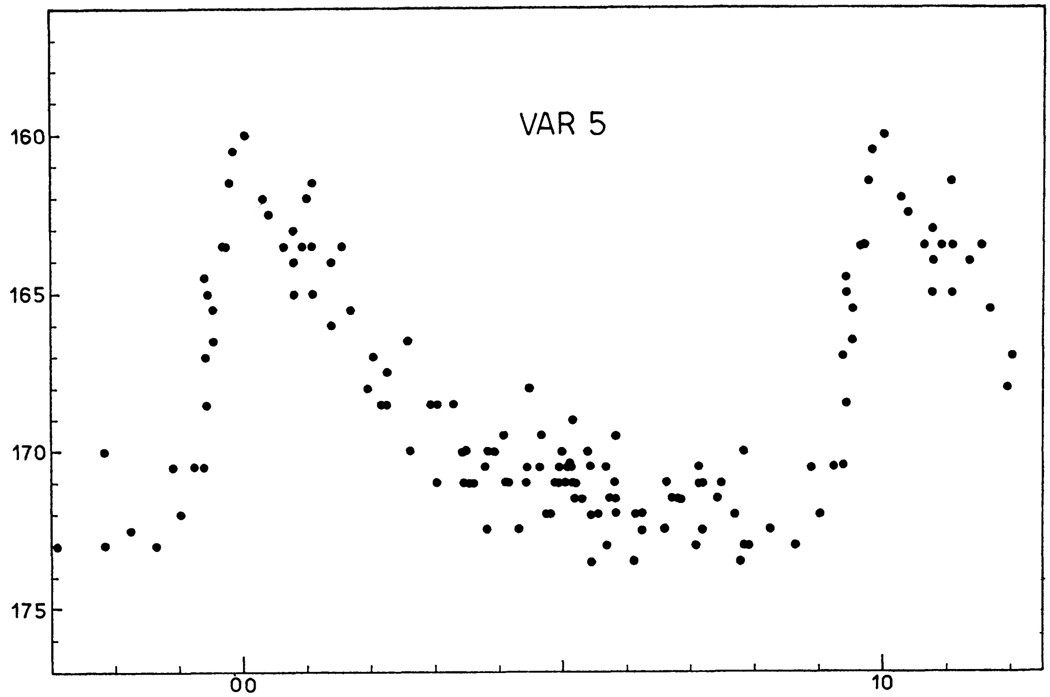

FIG 1—*Continued*

examined here, seven belong to the RR Lyrae type, one is short-period, three are semiregulars, and two are red irregulars, one is probably an U Gem, and one a long-period variable.

Elements have been derived for five of the RR Lyrae variables, all of subtype *a*, for the semiregulars and the long-period variable. Their mean light-curves are reproduced in Figures 1–3. Table 3 also lists in parentheses the elements of the RR Lyrae variables 4 and 6 found by Sandage, Smith, and Norton (1966) (who kindly informed me of their results in advance of publication). The Notes to Table 3 give further information on the characteristics of the variables.

III. DISCUSSION

Excluding Var. 4, which is about 0.5 mag. fainter than the other RR Lyrae in the cluster and therefore is likely not to be a physical member, and Var. 11 of dubious type, NGC 6712 contains nine RR Lyrae variables. Three of them near the center have not been studied here. The other six are RR Lyrae *a* with a mean median photographic magnitude $\bar{m}_{pg} = 16.81$, $\bar{B} - \bar{V} = +0.78$ (Sandage and Smith 1963) and $\bar{V} = 16.12$. The mean amplitude is 1.33 photographic, with very small dispersion.

The period distribution of the RR Lyrae variables puts the cluster in Oosterhoff's group I: variables 1, 5, 6, 12, and 13 have periods from $0^d.51$ to $0^d.56$; No. 3 has a period somewhat larger, $0^d.66$. The mean period $\bar{P}_a = 0^d.548$ practically coincides with that derived by Van Agt and Oosterhoff (1959) as a mean of nine clusters of group I ($0^d.549$).

Three semiregulars, one long-period, and two red irregular variables are listed in Table 3. Two of the semiregulars, Nos. 2 and 8, are in the main body of the cluster, with periods of 105^d and 116^d, which are not exceptional in globular clusters. Their mean apparent magnitudes correspond to those of the 100^d semiregulars seen at the distance of the cluster (Rosino 1951). It is therefore reasonable to conclude that variables 2 and 8 are members of NGC 6712.

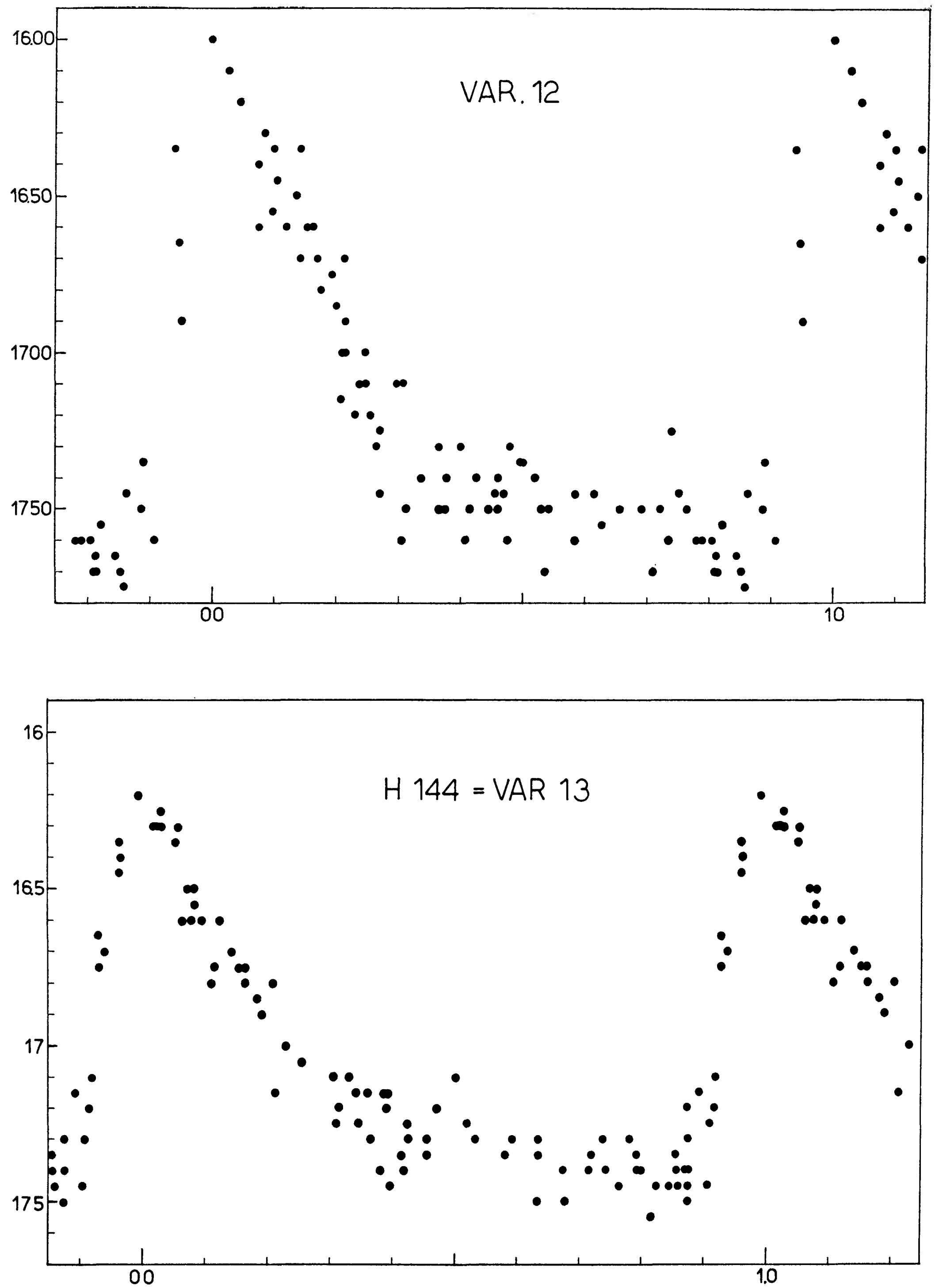

FIG. 2 —Photographic light-curves of the RR Lyrae variables 12 and 13

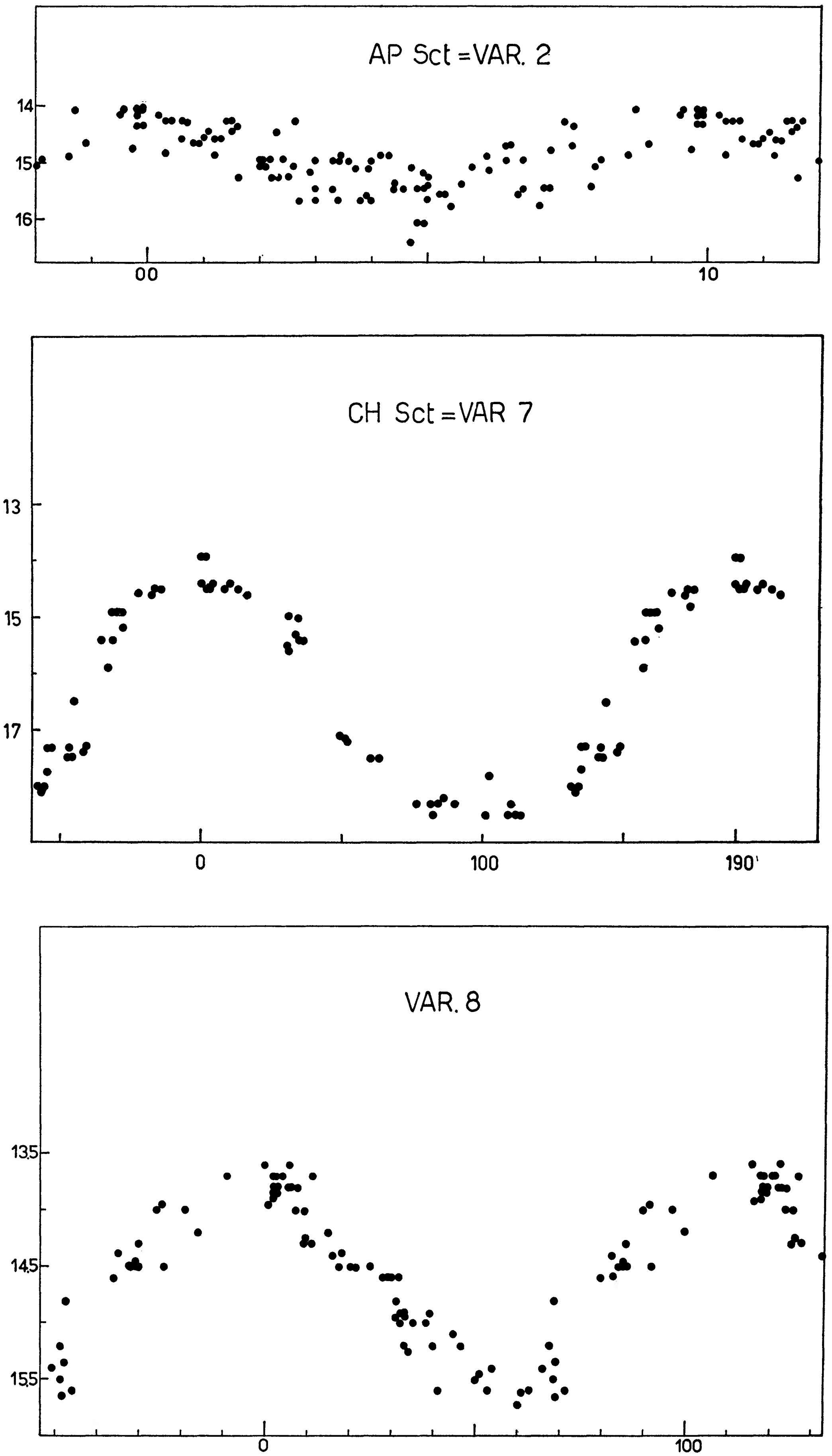

FIG. 3.—Photographic light-curves of the semiregular and long-period variables 2, 7, 8, and 14

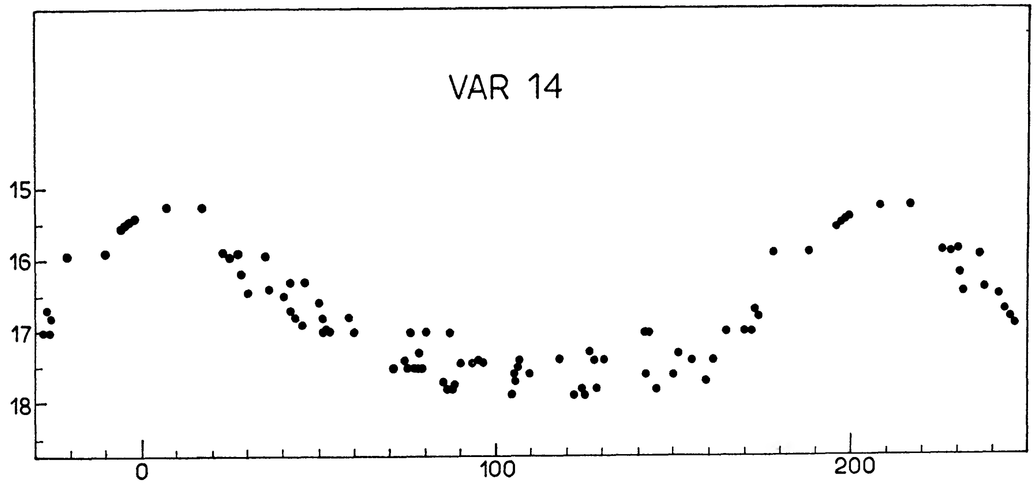

FIG. 3—*Continued*

Much more doubtful is the case of No. 14, a semiregular with $P = 202^d$, and No. 7, a long-period variable with $P = 191^d$. Both are relatively distant from the center in a dense stellar region where variables with $P \sim 200^d$ are frequent. Very likely they are field stars. No definite answer can be given about the membership to the cluster of the two irregular red variables, Nos. 10 and 15.

In conclusion, although of an advanced metal class, NGC 6712 does not present peculiarities from the point of view of its variable stars. Amplitudes, luminosities, and periods are not different from those found in variables of halo clusters of Oosterhoff's group I. Considering the number of RR Lyrae variables associated to the cluster, we can conclude that NGC 6712 has more affinity with the clusters of Morgan classes II–III than with the clusters of high metal content of classes VI–VIII where variables of this type are normally few or absent.

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