as well as the other causes of dispersion in the median magnitudes, such as optical doubling, the Eberhard effect on magnitudes in crowded places, and the errors in measured median magnitudes and calculated periods. Less scattering than we now find is hardly to be expected, even when much more extensive and precise photometry is carried through. Furthermore, it is also quite possible that some Cepheids with identical periods actually have measurably different candlepowers. We have, as yet, no theory that demands exact relationships between period and luminosity, and we have some evidence that the classical Cepheids may not be all of one kind.

* At the distance of the Large Cloud, 1′ is equivalent to approximately 25 light years. The total diameter is 18,000 light years. For the main body of the Cloud the linear diameter is about 10,000 light years, which is probably less than one-quarter of the diameter of the comparable central part of our own galactic system. Consistent with this dimensional difference, the luminosity of the Large Cloud is less than one-tenth of that of the galactic system, and the Cloud's mass and star population may be but a hundredth.

[1] These PROCEEDINGS, **37**, 133–138 (1951); *Harvard Reprint* 345 (1951).

[2] These PROCEEDINGS, **26**, 541–548 (1940); *Harvard Reprint* 207 (1940).

[3] These PROCEEDINGS, **34**, 173–179 (1948); *Harvard Reprint* 306 (1948).

[4] *Ast. J.*, **55**, 249–251 (1951); *Harvard Reprint Series* II-36 (1951).

MAGELLANIC CLOUDS. IV. ON THE PERIOD FREQUENCY ANOMALIES

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1. One of the most striking facts that has turned up in our studies of the Magellanic Clouds is the preferential concentration of longer period Cepheids into the denser parts of the Small Cloud, while fainter variables, with unusually short periods for classical Cepheids, are dominant in the variable star population of the sparse outer areas. The correlation of average period length with distance from the center of the Small Cloud has been definitely established,[1] but the evidence has not been clear for the Large Cloud. We have now increased the number of its measured variables from 144, published before 1948, to 320, and have made a thorough examination of the period distribution in six regions. (Two-thirds of all the variables in these regions are classical Cepheids.) A new examination of the period frequency anomaly is, therefore, possible. We base it on new data for 204 classical Cepheids, for which the periods of 110 are yet to be published.[2]

Results for the six selected regions are summarized in the following tabulation:

REGION	LOCATION	NUMBER OF VARIABLES	MEDIAN PERIOD	DISTANCE FROM GEOMETRIC CENTER	DISTANCE FROM CENTER OF AXIS
A	N 1856	35	$6^{d}.88$	$1^{\circ}.5$	$1^{\circ}.2$
B	Axis	81	4.46	1.3	0.3
C	30 Doradus	18	6.24	1.6	1.6
D	Intermediate	28	4.34	2.9	2.9
E	N 1783	19	3.65	3.3	4.3
F	N 1866 ·	23	3.19	2.9	4.2
A + B	Axis fields	116	4.79		
E + F	Outer fields	42	3.26		

The location of the six fields is shown in the photograph of the preceding paper.

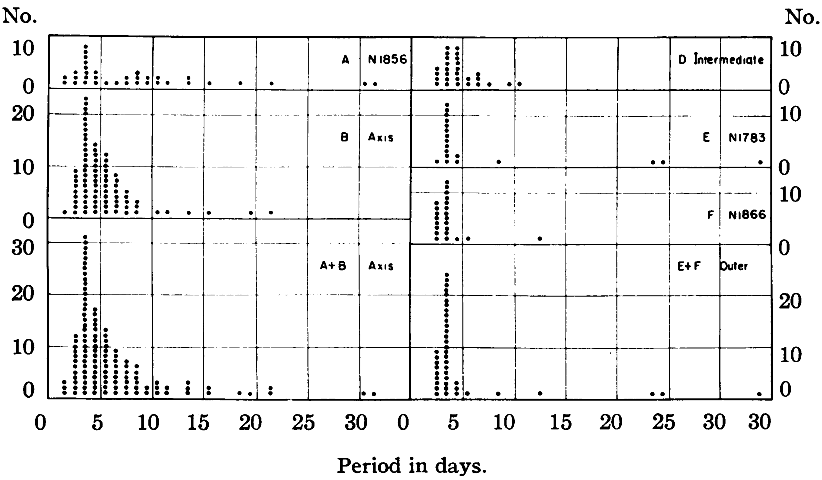

FIGURE 1

Frequency of periods for classical Cepheids in five fields of Large Cloud.

2. The effect clearly shown for the Small Cloud is strongly indicated by the numbers in column 4 of the table. The actual difference between the star-composed "bar" of the Cloud, which we call Axis, and the outer regions is probably greater than shown, since some of the short period variables in our survey of the Axis fields may not be located in the dense regions, but rather are projected on the Axis from the outer parts of the Cloud. Also, we should note that in the most obscured fields (e.g., the east end of the Axis) the faintest variables, which will usually have the shortest periods, would be most easily dimmed out of the reach of our surveys. We believe, however, that this selective effect can by no means erase the observed tendency for the longer periods to appear preferentially in the dense Axis region. The low value of the median for field B makes the anomaly less

convincing here than in the Small Cloud. In field B there are 14 irreguar variables mostly of the type found commonly in the Orion Nebula, and 15 variables of unknown type; most of these are relatively bright and the unrevealed Cepheids among them would move the median toward longer periods.

In figure 1 the distribution of periods is shown for each field separately, and also for the combinations of the Axis pair and the two outer fields.

A preferential nuclear location of long period classical Cepheids in our Galaxy similar to that in the Magellanic Clouds is complicated by the fact that the galactic nucleus is exceedingly rich also in the cluster-type Cepheids which are absent from the Magellanic Clouds.

3. In figure 2 a new comparison is made of the distributions of Cepheid

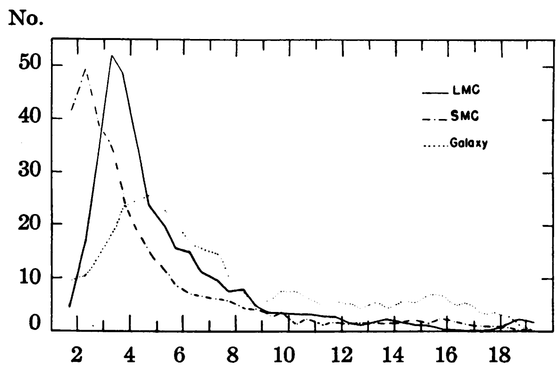

FIGURE 2

The frequency of the periods of classical Cepheids in three galaxies.

periods in both Magellanic Clouds and in the galactic system. The data have been adjusted to equal numbers of stars and have been smoothed in order to bring out pictorially the second important anomaly in the properties of Cepheids in the Clouds—namely, the striking difference in frequency distribution of periods between the galactic system and the Small Cloud, with the Large Cloud intermediate. Only three of the 196* periods of classical Cepheids in the six completely examined fields of the Large Cloud are less than two days. In the Small Cloud 135 periods out of 536 are less than two days. In the galactic system, with data from the Russian Catalogue of 1948, and the 1949 and 1950 Supplements,[3] the score is 20 out of

* The eight stars with periods greater than 20 days are omitted from the figure and computation.

433. The percentages are 1.5, 25.2 and 4.6. The data for the Clouds will change little with increase of numbers, and the ratio of 1 to 17, therefore, stands out as a most remarkable and suggestive phenomenon.

4. That the period frequency anomaly is associated with the stage of development in these similar irregular galaxies is a fair supposition. The Small Cloud, on this hypothesis, is more "advanced" than the Large. It is intermediate in some of its evolutionary characteristics between the dust-and-gas rich Large Cloud and the dust-free Sculptor Cluster, which is a dwarf open-structure spheroidal galaxy very rich in variables of the cluster-type.[4] The Sculptor Cluster has few classical Cepheids and few highly luminous stars; the Small Magellanic Cloud has many of both, but the Large Cloud is much richer in such supergiants.

The scores of Cepheids with periods around 1.5 days in the Small Cloud may be that system's version of cluster-type variation; and this observation leads to the suggestion that the chemistry and the behavior of the Cepheids of a galaxy or globular cluster are related to its mass and stage of development.

[1] These PROCEEDINGS, **28**, 200–204 (1942); *Harvard Reprint* 241 (1941) and *Harv. Obs. Bull.* 916 (1942).

[2] *Harv. Obs. Bull.* 921 (1952), in press.

[3] Kukarkin, B. V., and P. P. Parenago, *The General Catalogue of Variable Stars*, Moscow (1948), *First Supplement to the General Catalogue of Variable Stars*, Moscow (1949), and *Second Supplement to the General Catalogue of Variable Stars*, Moscow (1950).

[4] Shapley, H., *Comparison of the Magellanic Clouds with the Galactic System*, Mich. Pub., **10**, 79–84 (1951); *Harvard Reprint Series* II–37 (1951).

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*BREAKAGE OF CHROMOSOMES BY OXYGEN**

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The general physiological effects of oxygen on tissues and whole organisms, such as non-nuclear effects, death and other phenomena, are well known. Cleveland[1] has mentioned that oxygen will partially or completely destroy the chromosomes and nuclear membrane of the gametophyte of the flagellate *Trichonympha*, which lives in a roach. This paper, however, is concerned only with a very specific effect of oxygen on the cell, the breakage of the chromosomes and production of chromosomal aberrations identical with those induced by radiation.

Treatment of Tradescantia flower buds and dry pollen grains with oxygen produces chromosomal aberrations which can be observed in the