ASTRONOMY:
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A SURVEY OF THIRTY-SIX THOUSAND SOUTHERN GALAXIES

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1. The first part of a systematic survey that should eventually include more than half a million galaxies has been completed with the measurement of the distribution and brightness of thirty-six thousand systems in the polar cap, south of declination $-60^\circ$. About seven per cent of the sky is covered.

Because of the great number of faint galaxies that are discernible on long exposure plates made with the large photographic doublets, it is no longer advisable to measure and publish all possible details on each system. But the apparent photographic magnitude is of first importance; it is our most direct indicator of distance, and is the key to information on the space distribution of external systems. It will be determined for every nebula. Exact positions are of less importance, since there is little hope at present of measuring proper motions of such distant objects. For the preliminary discussions of metagalactic structure it suffices to use approximate positions for individual objects, and it will also suffice to measure dimensions and determine classes only in enough selected regions of the sky to get statistically dependable information on the general characteristics of faint galaxies. The more precise relationships of diameter to absolute magnitude and of magnitude and diameter to class can be better studied with objects of the fifteenth magnitude or brighter, and the classification itself can be more definitely elaborated for these same brighter objects. The combined measures of apparent magnitude and approximate positions of faint galaxies will yield information not only on metagalactic structure but also on the important problem of the total absorption of light in Milky Way regions and along the borders of the Galaxy.

2. Eighty-seven long exposure plates taken with the Bruce telescope have been used in the survey of the south polar cap. In establishing magnitude sequences and examining individual objects or special regions, a large number of supplementary long exposure plates have also been used, as well as numerous photographs of other series. Each of the eighty-seven plates has been examined to the limit of detection of nebulous objects. The number of objects falsely identified as external galaxies (perhaps three per cent) is believed to be practically balanced by that of objects that have been overlooked although above the plate limit. The false inclusions and exclusions are more common near plate edges, at the photographic limit of the plates and near the borders of the Milky Way. Less than one per cent of the galaxies of this polar cap have been previously recorded. There are
343 objects brighter than the fifteenth magnitude. They will be studied on small scale plates for the determination of total magnitudes, and on Bruce plates for detailed measurement and for the preparation of somewhat detailed descriptions.

The magnitudes of the individual objects have been twice measured. They are based on stellar sequences established for the most part by the star-count method. The magnitudes are estimated with a mean error of less than two-tenths of a magnitude, but fainter than the seventeenth magnitude the sequences are as yet provisional and the systematic error may approximate half a magnitude. I am indebted to Mrs. Muriel M. Seyfert for her expert assistance in the examination of the plates and in particular for her work in the most laborious part of the survey—the determination of the magnitudes.

3. In publishing the numerical details of the investigation, which will appear as one of the Tercentenary papers from the Harvard Observatory,¹ the distribution of the magnitudes is given for each square degree, as well as for each plate (thirty-five square degrees in area).

In figure 1 the density of galaxies over the whole polar cap is shown. The object of the diagram is to show the general features of the nebular distribution brighter than magnitude 17.5. For the average object on these

![Figure 1](image-url)
plates, this limiting magnitude corresponds to a distance of approximately thirty-five megaparsecs.* A few features of the density diagram are worthy of comment:

a. The long exposure plates actually cover completely only 88 per cent of the polar cap; for the brighter objects, however, additional plates have been used and the coverage is complete.

\* Figure 2

Distribution of galaxies brighter than magnitude 17.5 in the South Polar cap.

b. Both of the Magellanic Clouds fall within the polar cap and the regions they occupy were not surveyed for external galaxies because of the difficulty of distinguishing between nebulosities and star clusters in the Clouds and the external systems seen through them.

c. An exceptionally high density is shown by six nearly contiguous plates that cover an area extending from declination $-80^\circ$ to the edge of the polar cap. In a subsequent communication a special report will be made on this metagalactic cloud which extends northward from the polar cap.
cap about twenty-five degrees and apparently is a higher system comprising some forty or fifty thousand galaxies.

d. The effect of absorption in low galactic latitudes is indicated by the low density in the upper part of the chart. There is in fact a clear indication that the density over the whole of the polar cap (except for the metagalactic cloud referred to above) is considerably below normal for the sky in general. This deficiency may be due in part to details in metagalactic structure; but certainly in the lower latitudes it is almost wholly due to general absorption in the Milky Way.

e. In galactic latitude $-25^\circ$, longitude $300^\circ$, there is an unusually high frequency of bright objects. The region is closely neighboring the galactic window centered at latitude $-16^\circ$, longitude $301^\circ$; plates falling just outside of the south polar cap show in this direction a high frequency of faint galaxies.

4. In figure 2 is shown the relation of the number of galaxies to apparent magnitude. Only 42 of the 87 plates have contributed to the calculation of the means for this frequency curve. The six rich plates have been excluded, as well as all plates in galactic latitudes lower than $25^\circ$, where galactic absorption seriously affects the results. For the area covered by the 42 plates, the number of galaxies per square degree brighter than magnitude 17.5 is 7. Determinations of this quantity for other regions are as follows:

<table>
<thead>
<tr>
<th>Region</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coma-Virgo ($H. A. 88$, No. 1; $H. B. 865$)</td>
<td>21</td>
</tr>
<tr>
<td>Horologium ($H. A. 88$, No. 5), including clusters</td>
<td>49</td>
</tr>
<tr>
<td>Horologium, excluding clusters</td>
<td>43</td>
</tr>
<tr>
<td>Longitude belt $110^\circ$ ($H. A. 105$, Paper No. 10)</td>
<td>28</td>
</tr>
</tbody>
</table>

Hubble's formula, which is based on Mount Wilson surveys, gives 21 galaxies to this magnitude limit. The result above for the Horologium region cannot be considered typical because of complications in that region with a metagalactic cloud.

In figure 2 the straight line indicates the expected frequency on the hypothesis of uniform space density. If the six rich regions are included with the 42 other plates, the pronounced deviation from the straight line relation of log $N$ to apparent magnitude becomes obvious at photographic magnitude 16.5, which probably marks the brightness and implies the distance at which the metagalactic cloud becomes effective in the distribution of galaxies in the south polar cap.

5. To the limit of the present survey there are in the polar cap only a few physical groups of galaxies outside the strip covered by the metagalactic cloud. One falls on a rich plate and is itself populous enough to be treated as a significant cluster. It is located at longitude $276^\circ$, latitude $-31^\circ$, only six degrees from the south celestial pole. So far as shown by
the available photographs it is composed of approximately 200 members, scattered somewhat irregularly over an area of 1.5 square degrees. On the assumption of three-tenths of a magnitude as possible space absorption, its distance is about forty megaparsecs.

*115 million light years.


THE GROWTH OF PLANT EMBRYOS IN VITRO. PRELIMINARY EXPERIMENTS ON THE ROLE OF ACCESSORY SUBSTANCES

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The aseptic culture of plant embryos isolated from the seed dates back to the work of Brown and Morris,¹ Hannig² and Dietrich.³ More recent contributions to our knowledge concerning the culture in vitro of excised embryos have been made by Tukey,⁴ Brunner⁵ and LaRue,⁶ among others. It has been recognized by, for example, Ray⁷ that the embryo culture technique offers a useful tool for biochemical investigations, and it has also been recognized⁸ that it may be used as a practical measure to circumvent the abortion of embryos. It has, however, been found that in general the growth of the excised embryo, even upon a medium containing essential inorganic materials and sugar, is far less than that of normal intact seedlings. This has led to the suggestion⁶ that “accessory growth factors” which are needed in minute amounts, are required by the developing plant as they are by the developing animal organism. The present work, as well as that of Kög1 and Haagen-Smit,⁹ furnish final proof that this is the case; that these accessory substances, although normally furnished by the seed, may be replaced to some extent by pure compounds added in small amounts to the embryo culture medium. These investigations, taken up early in 1936, are concerned particularly with orienting experiments undertaken with an ultimate view toward the elucidation of the nature and mode of action of these accessory growth factors. The embryo culture technique is here to be used as a tool in the “hormonal” analysis of plant development.

Materials and Methods.—Pea seeds of the “Perfection” variety were used for all of the principal experiments. A few of the preliminary experiments were done with the “Alaska” variety. Seeds were sterilized