Proceedings of the Iowa Academy of Science

Volume 35 | Annual Issue Article 7

1928

Star Count in the Dark Ring Nebula in Cygnus

D. W. Morehouse
State Department of Health

Richard S. Zug
State Department of Health

Recommended Citation
Morehouse, D. W. and Zug, Richard S. (1928) "Star Count in the Dark Ring Nebula in Cygnus," *Proceedings of the Iowa Academy of Science, 35(1),* 55-67.
Available at: https://scholarworks.uni.edu/pias/vol35/iss1/7

STAR COUNT IN THE DARK RING NEBULA IN CYGNUS

D. W. MOREHOUSE AND RICHARD S. ZUG

To our knowledge the first time this "Bird's Nest" marking was considered as a possible ring of absorbing nebulosity was in 1910 when the senior author noticed the object and mentioned the possibility that it might be an actual ring of dark absorbing nebulosity. The ring is conspicuously evident upon every exposure of long enough duration to exhibit such markings. It is located in the "Labrador" section of the North America Nebula, right ascension 20 hours, 52 minutes, declination plus 45 degrees. Its external diameter is about thirty minutes of arc and its internal diameter about twelve minutes of arc.

In 1926 a nine hour exposure with a Brashear photographic doublet (F-5.5) showed the marking very realistically. The idea then suggested itself to examine the object by means of a statistical consideration of the number of stars found in the ring and in the region immediately surrounding it. Accordingly, a six and one-half hour exposure was made on June 2-3, 3-4, 1927, using the eight and one-fourth inch photographic telescope of the Drake Observatory, which has a focal length of 123 inches.

METHOD OF PROCEDURE

In order to have a system of reference for the stars, an enlarged print of the region was made upon which a system of squares was arbitrarily superimposed. (Fig. 4.) This was made from the six and one-half hour plate. The print was purposely made inverted so that it would be easy to compare it with the plate seen through a microscope. The squares were then numbered from west to east, 1 to 26, and lettered from south to north, A to W. As an example the square A-6 contains the star BD plus 44°3628 and the square M-15 contains the star BD plus 44°3640.

The boundaries of the nebula were arbitrarily determined, using the nine hour photograph of June, 1926. As previously stated, this photograph was taken with an F-5.5 lens and consequently exhibits very plainly the outline of the dark ring against the background of faint stars. The area inside the ring was designated as "A," that outside the ring as "C," and the ring itself as "B."

The star images in each lettered row were examined for photographic magnitude. In estimating the magnitudes, a sequence of six Pleiades star images was used as a scale of image density. The six star images in this scale of image density varied in size and intensity and embraced the entire range of star images which could be found on the six and one-half hour plate. They were arbitrarily numbered 0, 1, 2, 3, 4, 5, 6 from the largest to the smallest images. Each star on the six hour plate was then listed under the image density to which it was most similar.

The next step was to determine the actual photographic magnitude corresponding to each of the six classes of image density. This was done by comparing directly a two and one-half hour plate of the nebulous region with another two and one-half hour plate of the selected area, No. 40, using as the magnitudes of the stars in the selected area those kindly furnished by Dr. F. H. Seares of the Mount Wilson Observatory. Stars of each image density were selected, and the images of these same stars on the two and one-half hour images of known stars in selected area No. 40, thus giving the photographic magnitudes of the different classes into which the star images on the six and one-half hour plate had been divided. The stars used in the comparison and the results are given in Table I. The horizontal row at the top gives the image density and the lower row gives the corresponding photographic magnitude. The first column under each image density gives (1) the location on Fig. 4 of the star having that image density and (2) the selected area No. 40 star whose magnitude was assigned to that image density. The second column gives the magnitude of the selected area No. 40 star.

The magnitude corresponding to image density No. 6 could not be determined in this way, since the images of the faintest stars visible on the six and one-half hour plate do not appear on the two and one-half hour plate. As the selected area No. 40 lies immediately east of the nebula field, a part of the former was visible on the edge of the six and one-half hour plate, and could be compared with the latter, although the images on the edge of the plate were not very good. In examining the section of selected area No. 40 found on this plate, the limiting magnitude seemed to be about 17.0, which was accordingly adopted as the magnitude of image density No. 6.

Table I

IMAGE DENSITY	5		4		3		2		1		0	
	R-14 676	16.2	S-13 883	16.3	R-16 418	15.2	S-13 905	13.9	T-11 330	12.2	P-8 560	10.6
	R-16 867	16.1	S-14 678	14.7	0-11 532	15.1	R-16 294	14.5	S-15 944	12.2	P-8 750	11.4
	R-16 382	17.2	R-14 682	15.5	0.10 730	15.0	T-13 962	14.2	R-15 1042	11.6		
	T-13 200.	16.3	R-16 256	15.6	P-5 304	15.2	P-6 381	13.9	P-5 310	12.0		
	T-13 883	16.3	0-10 529	15.3	P-10 394	14.9	P-7 390	13.8				
	P-5 8	16.2	T-12 682	15.5	P-10 304	15.2						
	P-11 306	16.5	U-11 1032	15.2	P-18 962	14.2						
	P-11 510	16.2	T-13 179	15.7								
	P-12 528	16.8	P-12 526	15.8								
			P-13 704	15.3								
	16.4		15.5		15.0		14.0		12.0		11.0	

TABULATION OF DATA

Table II gives the number of stars of each image density found in the regions "C," "B" and "A," the magnitudes of these stars, and the number per unit area.

Table III contains the data used in the construction of Figures 1, 2 and 3.

DISCUSSION OF RESULTS

Figure 1 shows the number of stars per unit area for different magnitudes in the three regions "A," "B" and "C." Curve *B* lies consistently lower than curve *C* from the eleventh magnitude to the

Table II

Image Density	Photog. Magn.	"C" Region Area 0.2319 Sq. Deg.		"B" Region Area 0.1099 Sq. Deg.		Area 0.0214 Sq. Deg.	
		No. Counted	No./Unit Area (0.0088 sq.°)	No. Counted	No./Unit Area (0.0088 sq.°)	No. Counted	No./Unit Area (0.0088 sq.°)
6	17.0	1148.	43.4	379.	30.3	97.	39.5
5	16.5	659.	24.9	259.	20.7	51.	20.8
4	15.5	263.	9.9	69.	5.5	42.	17.1
3	15.0	100.	3.9	32.	2.5	25.	10.2
2	14.0	48.	1.8	12.	1.0	12.	4.9
1	12.0	36.	1.4	2.	.4	3.	1.2
0	11.0	28.	1.1	7.	.6	1.	.4
Total		2282		860		231	

Total number of stars = 3373.

Table III

"C" Region

Phot. Mag.	Number Counted	Log No. Counted	Log. No./Sq. Deg. (Log. A_m)	No./Sq. Deg. A_m	B_m	Log. B_m
17.0	1148	3.0599	3.6946	4950.	9839.	3.9929
16.5	659	2.8189	3.4536	2842.	4889.	3.6892
15.5	263	2.4200	3.0547	1134.	2047.	3.3111
15.0	100	2.0000	2.6347	431.	913.	2.9605
14.0	48	1.6812	2.3159	207.	482.	2.6831
12.0	36	1.5563	2.1910	155.	275.	2.4393
11.0	28	1.4472	2.0819	120.	120.	2.0792

"B" Region

Phot. Mag.	Number Counted	Log No. Counted	Log. No./Sq. Deg. (Log. A_m)	No./Sq. Deg. A_m	B_m	Log. B_m
17.0	379.	2.5786	3.5376	3448.	6914.	3.8397
16.5	259.	2.4133	3.3723	2357.	3466.	3.5398
15.5	69.	1.8388	2.7978	627.	1109.	3.0449
15.0	32.	1.5051	2.4641	291	482.	2.6821
14.0	12.	1.0791	2.0381	109.	191.	2.2810
12.0	2.	0.3010	1.2600	18.	82.	1.9138
11.0	7.	0.8451	1.8041	64.	64.	1.8062

faintest magnitude. The explanation of this phenomenon is difficult unless we concede the presence of an absorbing medium at about the eleventh or twelfth magnitude. In other words it seems clear that a dark nebula is located at this level. If we assume the nebula is at the level of the eleventh magnitude stars, and take as the average parallax of these stars 0.″0022 (Groningen Publ. 29), we get a distance of about 1500 light years. This, however, is only a very rough approximation and may be much in error. If the nebula lies at the level of the twelfth magnitude stars, its distance would

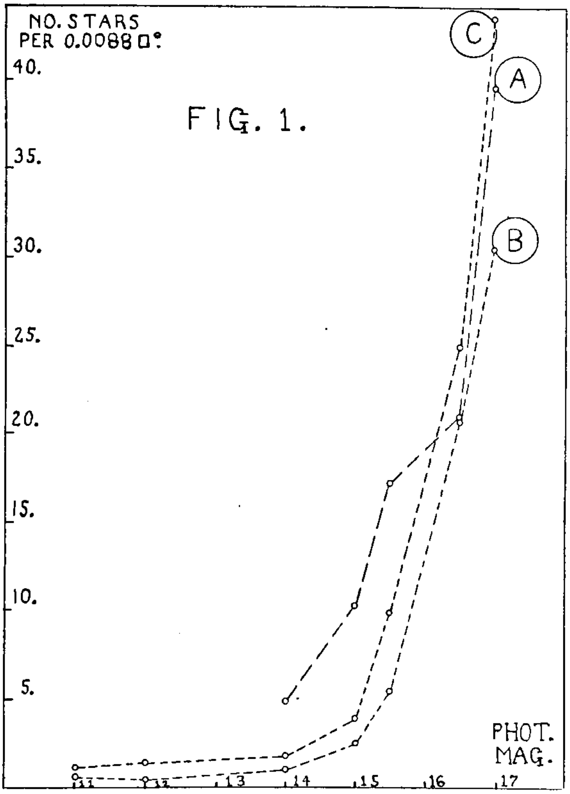

FIG. 1.

NO. STARS PER 0.0088 □°
40.
35.
30.
25.
20.
15.
10.
5.
C
A
B
PHOT. MAG.
11
12
13
14
15
16
17

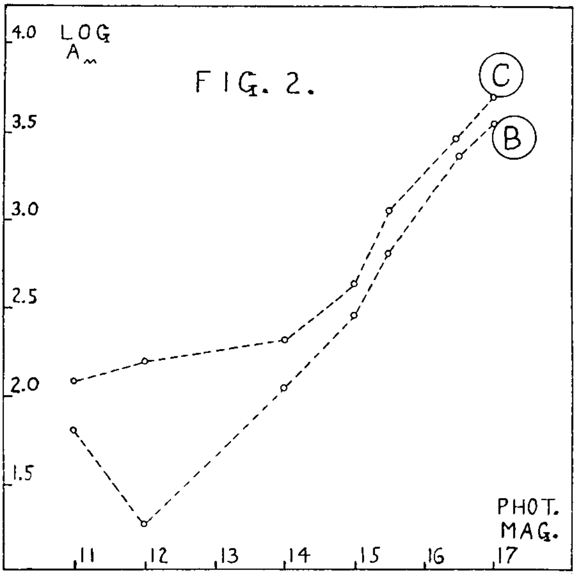

FIG. 2.

LOG A_m
4.0
3.5
3.0
2.5
2.0
1.5
C
B
PHOT. MAG.
11
12
13
14
15
16
17

have to be increased over six times. On the other hand, it may be still nearer, in which case, a star count would be of no avail because of the smallness of the region.

The noticeable increase of stars of 14, 15 and 15.5 magnitudes for the "A" region has not been explained at this writing. For the 16.5 and 17 magnitudes the area shows a decrease in stars over the "C" region, which might be expected if the nebula were the shape of a hollow sphere. The evidence tending to this conclusion is very meager, however. In fact it seems more probable that the shape of the nebula is that of a ring, comparable in form to the ring in Lyra. It is quite possible that the irregularity of the *A* curve is due to the smallness of its area (only 0.021 square degrees).

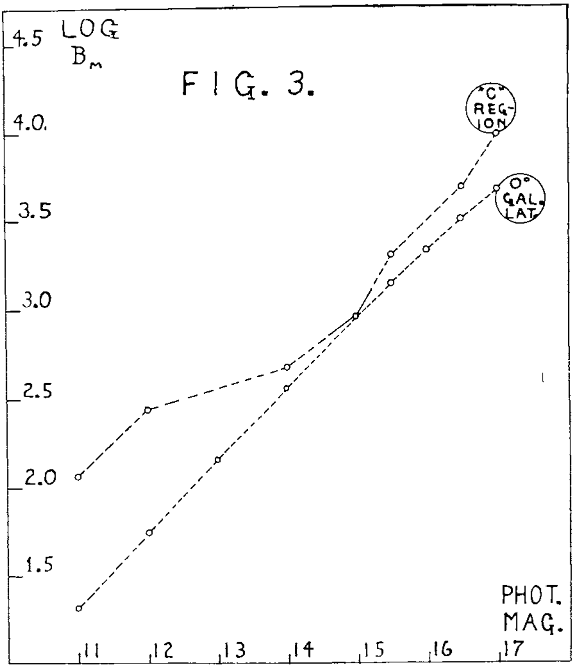
FIG. 3.

Figure 2 is a logarithmic curve of the number of stars per square degree for each different magnitude in the "B" and "C" region. The very striking absence of stars of twelfth magnitude is clearly shown here. Only two stars of the twelfth magnitude were found in the entire "B" region in contrast to an average of 18 for an equal area of the "C" (or normal) region. A constant absorption of about one-third of a magnitude is found for all the stars of magnitude 14, 15, 15.5 and 16.5.

It would naturally be expected that the curve in Fig. 2 of the "C," or normal, region would be a straight line and the observed convexity of it around the magnitudes 14 and 15 leads us to suspect that there is some abnormality connected with the whole star field in this section. In order to investigate this further, a logarithmic curve of the number of stars to a limiting magnitude (B_m) for the "C" region is plotted in Fig. 3 along with the same curve for the Milky Way in general. The data for the second curve are given in Table 4 and are from the results of Seares, Van Rhijn, Joyner and Richmond (Ap. J. Vol. 62).

Table IV

TOTAL NO. OF STARS PER SQ. DEG. TO A LIMITING MAGNITUDE FOR 0° GALACTIC LATITUDE. (MT. WILSON)

PHOT. MAG.	LOG. B_m
17.0	3.68
16.5	3.51
15.5	3.15
15.0	2.96
14.0	2.57
13.0	2.16
12.0	1.75
11.0	1.32
10.0	0.89

We see from Fig. 3 that B_m for the "C" region is over five and one-half times as large for the 11th and 12th magnitude stars as should be the case for a normal region in 0° galactic latitude. It is about one and one-half times the normal B_m for the 15.5, 16.5 and 17 magnitudes, while at the 14 and 15 magnitudes the two curves lie close together.

If the curve of the "C" region is correctly formed, it indicates the presence of two star clouds, the first located at the distance of the 11 and 12 magnitude stars and having a star density about five and one-half times greater than the average for 0° galactic latitude, and the second beginning at the distance of the 15.5 magnitude and continuing as far as the observational methods can penetrate, having a star density of about one and one-half times the average for 0° galactic latitude. The existence of the second cloud is very uncertain, however, in view of the fact that a systematic error in the determination of the photographic magnitudes of the fainter stars could have caused the same appearance of the upper part of the curve as we observe. The excess of stars of the 11 and 12 magnitudes seems to be a real phenomenon.

In any case, in a discussion of the region, it must be remembered that here we have a field which may be influenced by various abnormalities. The close proximity of the North America Nebula may have some effect on the behavior of the star curves. The region is also surrounded on two sides by dense dark clouds of absorbing material. There is evidence that the very dark region immediately north of the "C" region protrudes into the latter in the upper rows, QRS and T of Fig. 4, causing some absorption of light in the 16.5 and 17 magnitude stars.

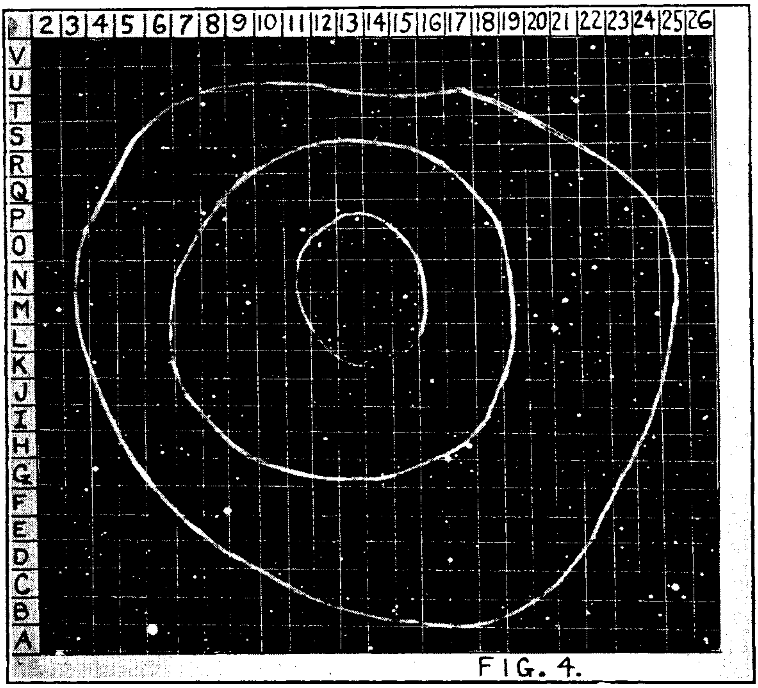

FIG. 4.

In an investigation of the dark regions near the North America Nebula (Astr. Nach. 5334), Dr. Max Wolf finds that a thin cloud of nebulosity exists at the level of the 11.5 magnitude stars. It would seem quite possible that the ring of nebulosity discussed in this present article bears some relation to the cloud observed by Dr. Wolf since the two objects are adjacent to one another and are located at approximately the same distance.

An interesting observation was made of the star BD plus 44°3632. This star was listed in the BD catalogue of 1855 as having a visual magnitude of 9.4. It is not listed in the AG catalog of 1875 although most of the BD stars of this brightness are included in this catalogue. Its photographic magnitude as observed in 1927 was 13.0.

STATUS OF STREAM POLLUTION IN IOWA

A. H. WIETERS

Under the Iowa Stream Pollution Law, adopted in 1923, the State Department of Health is charged with the administration of antipollution measures. The law requires specifically that the State Department shall investigate conditions of alleged pollution and may issue orders for the remedying of such pollution. If the work contemplated under any such order exceeds $5,000 in cost, the State Executive Council must approve such order.

The destruction of fish and other aquatic life and the rendering of a stream unsafe as a source of water supply for domestic consumption are the two bases mentioned in the law, upon which an order may be issued. I presume the reason that the nuisance was not specifically mentioned was because ample authority over nuisances is given the local and state authorities elsewhere in the Code.

Acting under the provisions of this law the Division of Sanitary Engineering has since July 1, 1925, been studying the conditions of pollution of Lime creek, Shell Rock river, and Cedar river. In these studies stress has been laid on the oxygen determinations, namely, dissolved oxygen and biochemical oxygen demand and bacteriological determinations, particularly quantitative determinations of bact. coli. In the later work such determinations as ph. nitrates, chlorides, alkalinity, settleable solids and total solids have been made on some of the wastes.

In addition to the bacteriological and chemical determinations, it has been necessary to make the quantitative determinations of sewage and trade wastes in most instances and in one instance it has been necessary to make stream discharge observations because of the lack of such data.

The oxygen determinations were emphasized because it is believed that these determinations give more reliable information as to the condition of pollution in a stream than any other determination or set of determinations which could be made in the field laboratory, which is the only one available and with the very limited personnel and equipment available for this work. Secondly, trade wastes that are being discharged into the streams that have so far been studied are of such nature that the fish destruction as well as nuisances result from oxygen depletion rather than from any toxic substance discharged into the stream.

It certainly would be very desirable to make more extensive examinations, both on the river samples and on the trade wastes, if funds were available. We have had two instances where it has been necessary to vary this procedure and have had additional chemical determinations. Cyanide from an electro-plating plant, which resulted in the death of 18 dairy cows and thousands of fish, in the one case, and phenol wastes from a gas plant in the other case were the substances in question.

Total bacteriological counts are made largely for interest yet the average results appear to indicate that such results are a fair indication of gross pollution, particularly where domestic sewage is the polluting material.

Quantitative b. coli determinations are the only means, from present knowledge, to determine the maximum stream loading consistent with safe use of the water for drinking and domestic purposes, even after very adequate treatment of the water. Bacterium coli has been adopted as an index for safe loadings of filter plants and therefore where a polluted stream is used as a source of domestic water supply this is a very important determination.

In the work that has so far been done, the need for extensive studies on each stream has been very definitely brought out. So many factors affect the self-purification of streams that from the knowledge now available there is no formula by which one might accurately predict the effect upon a stream of a certain amount of sewage or trade waste.

Municipal sewage is rather constant in its chemical composition and the amount of oxygen-consuming material from a certain population can easily be calculated. Likewise a chemist can easily determine by means of a series of analyses the average composition of a trade waste and this can be converted to a population basis. The stream discharge is easily measured and the quantity of available oxygen can be easily computed from the laboratory and stream flow data. However, in practice the problem is not so simple as there are so many factors affecting the rate of deoxygenation of the stream as well as the rate of reaëration. For instance, temperature of the water in the stream apparently has a marked effect upon the oxygen demand. While the determination of five day B.O.D. when the sample is incubated at 20 deg. C. gives a fairly reliable index of potential oxygen demand, lower temperature of the water in the stream has such a marked effect in deferring biological action that the potential demand is not so soon exerted as under incubating temperatures. Thus the effects of pollution are at the worst considerably farther from the source of pollution in winter than they are in summer. This would prove advantageous in that the polluting material would be more widely diffused and the dilution afforded would be greater were it not for the fact that when the water temperatures are lowest, ice formation is the heaviest and most extensive, thereby cutting off the opportunity for reaëration of the water. All existing formulas for computing reaëration fail when the stream is completely or almost completely frozen. Theriault, Levine and others have conducted some experiments to determine the temperature effect on deoxygenation but these experiments have not yet reached the stage where they are of much value in forecasting the effect of certain wastes on a stream under varying temperature conditions.

Character of wastes also certainly influences the rate of deoxygenation in that the optimum temperature and other stream conditions vary for different wastes.

Therefore it is evident that each stream with a set of conditions peculiar to itself constitutes an individual problem and must be studied as such if any definite conclusion is to be reached.

After the degree of pollution has been determined and the degree of purification needed has been decided upon comes the problem of determining by experiment in the case of many trade wastes a method of treatment that is economically feasible. All trade wastes are not amenable to treatment by the methods now in vogue although most new methods are modifications of the existing methods. The problem is twofold; first, finding a method of treatment which is successful, and second, applying this method so that the costs will not be prohibitive.

The problems confronting the department are not confined to technical consideration alone. There is also the problem of administration. One group of citizens demands that the streams be returned to their original condition of pristine purity. Another group does not deem that the expense to communities and industries of properly treating their wastes is justified by the results thereby obtained.

It is economically unfeasible to meet the demands of the first group and certainly the majority of our people do not agree with the view of the last group. Almost every one will agree that where public health is menaced, such as a case where a city is dependent upon a stream as a source of water supply, treatment of wastes to a degree that the water can be rendered safe must be required regardless of costs. It is also obvious that where a nuisance exists or where fish are killed, steps should be taken to remedy the situation. Progress has been made in correction of stream pollution in Iowa during the past few years.

The Engineering Experiment Station at Ames has devised experimentally a method for successfully treating creamery wastes. While no working plants are as yet in operation it appears to be assured that at least one will be constructed this summer (1928).

This same station is just completing studies on treatment of packing house wastes, which studies will be used as a basis for the design of a complete treatment works for one of the large packing plants in the state. This construction will be completed this year. Several of the gas plants are installing tar and oil removal plants, and in one instance, the wastes are being completely eliminated from a lake.

The National Canners Association and the Iowa Canners Association have agreed to begin investigations for developing a method of treatment of cannery wastes. Experimental work on beet sugar wastes by an Iowa sugar factory has reached a point where the problem of one of the worst pollution conditions in Iowa seems to be nearing solution. Popular sentiment for cleaner streams is becoming aroused to the point where the larger cities in Iowa are beginning to think seriously of their waste problems. Much remains to be done, however.

Iowa has a goodly number of municipal sewage treatment plants. According to our latest records there are two hundred cities and towns in the state that have some kind of sewage treatment plants. These cities and towns have an aggregate population of three hundred and fifty thousand. Many of these plants are not giving satisfactory results, due to faulty design or operation. These figures indicate at once that the treatment plants are for the most part in the small cities and towns, the average population of the towns served with sewage treatment works being 1750.

Of the sixteen first-class cities in the state with an aggregate population of 635,493 only one has a treatment plant and at this place only one-third of the sewage passes through the plant. This condition, however, is now being remedied so that by the end of the year all of the sewage will be treated. Of 305 communities in Iowa having public water supply, with a population aggregating 1,125,000, one hundred-five, with a total population of 775,000, are discharging untreated sewage into the streams of the state.

Of the major industries in the state which produce objectional wastes only one has a waste treatment plant, and this plant is being replaced this year by an entirely new plant, due to unsatisfactory results from the old plant.

Industries and municipalities, however, are coöperating and taking cognizance of their deficiencies in this matter and it appears that Iowa is entering into a new era as far as stream pollution is concerned.

STATE DEPARTMENT OF HEALTH,
DES MOINES.