appearance. They are so similar, indeed, that it is very doubtful whether they would have been recognized, even as varieties, if cytological examination had not shown them to differ in respect to their chromosomes, and if they had not been bred in the laboratory to test their compatibility. Here is an apparently clear case of incipient species formation. It seems practically certain that these two varieties, or species, have had a common origin, and that their individuality at the present time is due mainly to their incompatibility. Either of them would, in our opinion, pass for a mutant race of the other; and it is not difficult to imagine that they might have become differentiated from one another in some such way as that outlined above; i.e., by mutations that brought about incompatibility. With the incompatibility once established they are now free to diverge more and more until they become clearly differentiated from one another.

4. To recapitulate: The evidence from two cases of incompatibility between mutants in laboratory cultures, together with evidence from what appear to be mutant forms and incompatible varieties in nature, tends to remove one of the most serious objections to the mutation hypothesis, and lays emphasis upon the possible evolutionary importance of mutations involving incompatibility.

1 In each case the two respective mutants appeared in pedigreed laboratory cultures, leaving no doubt about their being typical ‘mutants.’

2 For additional data on the mutants in D. virilis see Metz, C. W., Genetics, Princeton, 1916, 1 (591–607); for data on those in D. melanogaster see Morgan and Bridges, Washington, Carnegie Inst., Pub., No. 237, 1916.

3 Morgan and Bridges, op. cit. 1.


5 Sturtevant, A. H., Amer. Nat., Lancaster, Pa., 49, 1915 (190–192). Other cases of a similar sort could be added; this one is used because it is taken directly from a Drosophila.


ABSORPTION EFFECTS IN THE SPIRAL NEBULAE

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A study of the negatives of spiral nebulae obtained with the Crossley Reflector has shown that the phenomenon of dark lanes caused by occulting or absorbing matter is much more frequent than had previously been supposed. A paper of considerable length on this subject, in which the evidence is supplied chiefly by half-tone illustrations of seventy-seven spirals, will be published soon by the Lick Observatory. An abstract of that paper follows.
A first division of the evidence is supplied by those spirals which are seen edgewise, or nearly so, and show indubitable evidence of an absorbing lane (cf. fig. 1 for three typical examples of this class). Twenty-nine such objects have been photographed, and the published descriptions of nine additional edgewise spirals, not yet photographed, clearly indicate that they also should be included.

That thirty-eight of the larger edgewise spirals should show clear evidence of bands of obstructing matter must be regarded as establishing that this phenomenon is a very common one, and is probably the rule rather than the exception.

A second division of the evidence is afforded by that large group of spiral nebulae whose principal planes make a slight but appreciable angle with our line of sight. Any actual irregularities due solely to

\[ \text{FIG. 1} \]

asymmetry of form in the spiral nebulae should, taking a sufficiently large number of cases, show asymmetrical effects oriented at random with regard to the position of the major axis of the projected (elliptical) images. This, however, is not the case. In the relatively frequent cases where the greatly elongated spirals show any lack of symmetry, such asymmetry is almost invariably with reference to the major axis of the ellipse. This asymmetry manifests itself frequently in 'lanes' prominent on one side of the major axis and faint or invisible on the other, in a fan-shaped nuclear portion, in an apparent displacement of the nebular material on one side of the major axis, or in various combinations of these effects. Fifteen elongated nebulae show prominent dark lanes on one side of the major axis. Contributory evidence is afforded by thirty-one spirals in which the nebular matter is markedly
fainter on one side of the major axis of the projected ellipse, or in which it appears to extend farther from the apparent center on one side of the major axis. A fan-shaped nuclear portion is prominent in thirteen elongated nebulae. Figure 2 shows a typical example of this group.

It is not impossible that these effects may be due to the same general cause which produces analogous effects in our own Galaxy, though there is manifestly a good deal of assumption in postulating the same character of occulting material in the vicinity of objects so different in spectrum, in space distribution, and in space velocity, as the spirals and, for example, the great diffuse nebulosities. It will be of interest, however, to mention some probable intra-galactic manifestations of occulting material.

a. Many diffuse nebulosities show a marked falling off in the number of faint stars in their immediate vicinity. Very faintly luminous or non-luminous matter in the peripheral regions of these nebulae seems to offer the only possible explanation.

b. The 'Coal Sacks' and other starless regions in or near the Milky Way seem to be best explained as due to the interposition of great expanses of occulting material between these areas and our own position in space.

c. Professor Barnard has described many small starless regions, which he believes to be 'dark nebulae,' and a number of these are available for study on negatives taken with the Crossley Reflector. It is impossible to believe that these are actual 'holes' in the Milky Way. As Campbell has pointed out, the age of these must be of the order of hundreds of millions of years, and the random motions of the stars would long since have obliterated the clear-cut edges, if not the entire phenomenon, if they ever had the character of 'holes.'

d. Similar dark patches are seen projected on the luminous background of many of the giant diffuse nebulosities. It is impossible to conceive that these clear-cut spots are 'holes' extending through a mass of nebular matter for distances measured in light years.
e. About twenty-five spectroscopic binaries are known in which the 
H and K lines of calcium do not partake at all of the periodic shift 
shown by the other spectral lines, or give a markedly smaller range of 
radial velocities. This phenomenon is well explained by the interpo-
tion of a cloud of invisible calcium vapor between us and the binary. 
All but one of these stars are located in or near the Milky Way, and 
several are in or near dark rifts of the Milky Way.

f. There exists a sidereal arrangement for which no adequate explana-
tion has yet been found—the peculiar grouping of the spiral nebulae 
about the galactic poles, and the entire absence of these bodies in the 
Milky Way structure. It has been suggested that occulting matter in 
the peripheral regions of our Galaxy cuts off from our view all spirals 
lying in or near our galactic plane, and presumably far outside of our 
stellar system.

g. There is strong evidence that much absorbing material exists in 
the outer strata of planetary nebulae.

In the case of the edgewise and nearly edgewise spirals, the evidence 
for occulting material seems unquestionable. Vacant spaces dividing 
these objects into two similar and parallel nebular forms would appear 
to be mechanically inconceivable. For nebulae whose planes make 
larger angles with the line of sight, the alternative hypothesis that these 
appearances are mere open lanes encounters several difficulties. Such 
lanes should show most clearly at the ends of the major axes of the 
elongated nebulae, for there the foreshortening effect due to the inclina-
tion of the nebular planes would be least. But the photographs leave no 
doubt that these dark lanes are invariably parallel to the major axis, and 
are most apparent near the ends of the minor axis.

A possible phase effect might be proposed as an explanation of the 
differences of intensity on opposite sides of the major axis. But such a 
theory demands that the light of the spirals be due to reflection. Against 
this theory may be urged:

a. All attempts to detect evidences of polarization in the spiral nebulae 
have given negative results.

b. The reflection hypothesis demands that the light of the outer por-
tions of the nebulae should come ultimately from a central nucleus, or 
star, or aggregation of stars of sufficient brightness to illuminate the 
outer portions, and that these outer portions should in general be fainter 
than we find them. Many nebulae have no such central condensations, 
and in others the nucleus is so faint as to be entirely inadequate. Many 
others show patches of nebular matter in the outer regions of the nebulae 
which are as bright as or brighter than the central part,—an im-
probable result on the reflection hypothesis.
If we could observe our own Galaxy from a sufficient distance, it would probably have many resemblances to a spiral nebula (compare Easton's work on the Milky Way as a spiral). The evidence adduced that rings or whorls of occulting matter are of very frequent occurrence in the spirals is a point of great weight in connection with the evidences of similar matter in our Galaxy. In particular, the results may be regarded as bearing very directly on the only hypothesis which seems to explain the peculiar grouping of the spirals: that the invisibility of spiral nebulae in our Galaxy and their scarcity in the regions contiguous to our Galaxy are due to the presence of occulting matter in the outer confines of our stellar system.

THE SYNERGETIC ACTION OF ELECTROLYTES

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Numerous cases are reported in which a mixture of toxic salts is less harmful than either salt used by itself. This has been called antagonism since one salt antagonises the action of the other. Theoretically the opposite action may exist, in which one salt increases the toxicity of the other. I suggest that this be called synergy. Very few cases of this are reported and in some instances there is difficulty in deciding whether they really belong in this category because we lack data to show what the result would be if each salt acted independently of the other. Such data can be secured only by studying the effect of each salt separately and at various concentrations.

Studies of this sort have been made by me during the past summer at Woods Hole. The marine alga, *Laminaria Agardhii* Kjellm., furnished the experimental material. The behaviour of this plant with reference to antagonistic salts has been studied by Osterhout who employed the method of electrical conductivity for this purpose. This method was used by me in his investigations. As the details of the procedure are the same as in the experiments of Osterhout it is unnecessary to describe them here.

The salts used were the purest obtainable and the distilled water was not toxic to delicate test objects.

As I was primarily interested in the effects of anions the action of a series of sodium salts was investigated. These included the chloride, iodide, bromide, nitrate, acetate, sulphocyanide, sulfate, citrate, and