"wrong way Corrigan" of the solar system. But, while Lyttleton even showed how the whole thing could have happened, and also that perhaps it happened not so very long ago, astronomically speaking, it is one of those things we may never be able to prove or disprove.

It is an interesting speculation, and, in fact, at the University of Minnesota, I have regularly discussed this in class since 1937. One might even speculate further, and, as a sort of joke, suggest that if Pluto were once a moon of Neptune it might well have come through Neptune's atmosphere, which contains a lot of methane—and got covered with soot. This is not only appropriate for the god of the underworld but might explain why Pluto gives so little light. From its mass—which is not too certainly determined—we guess that Pluto should be nearly as large as the earth but, from its feeble light, it seems only a little larger than the moon. Of course, there are still many difficulties, the most outstanding perhaps being the large mass of Pluto. Most satellites are something like 10,000 times less massive than their primary (at most). Our moon is only 81.5 times smaller in mass than the earth, but if Pluto has been a satellite of Neptune, its mass is only 20 times smaller than that of its primary.

But all these are wild speculations and I am sure that they must have occurred to hundreds of others. Only scientists, in general, do not rush into print, dusting off old theories and presenting them as new.

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Recombination in Bacteria

I should like to add my comments to those of J. Lederberg [*Science* **122**, 920 (1955)] on the recent news report [*Science* **122**, 278 (1955)] concerning recombination in the colon bacillus. In microorganisms, recombination of hereditary characters involves precisely that and nothing more. Until the mechanism of meiosis has been adequately defined, either by cytological procedures or by chromosome maps, and the existence of a standard meiotic apparatus has been established, it is not possible to determine how recombination has been achieved.

Recombination of hereditary characteristics in microorganisms may be the result of at least six different mechanisms: (i) crossing-over at meiosis, (ii) gene conversion, (iii) transduction, (iv) transformation, (v) misassortment of autonomous extrachromosomal hereditary particles, and (vi) mutation induced by substrate. The last named is particularly important when the recombinants are isolated from a selective medium, as in genetical analysis of the colon bacillus. A seventh possible mechanism of recombination is mitotic crossing-over, but its demonstration depends on assumptions concerning genic stability that have recently undergone drastic revision.

Current explanations of recombination in the colon bacillus *assume* (i) a normal standard meiotic mechanism and (ii) a single mechanism of recombination, namely, meiotic crossing-over; deviations from the anticipated results are explained in terms of abnormalities of the assumed mechanism. In the absence of tetrad analysis, it seems necessary to withhold judgment in view of the possibility that other recombinatorial mechanisms may be involved.

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Urea Complexes of Lithium Chloride

The pharmaceutical importance of the urea addition complexes of calcium chloride and calcium iodide was first investigated by Greenbaum (*1*). A systematic study of the urea addition complexes of the alkaline earth halides has recently been extended by Pande and Bhatnagar (*2*). By use of the monovariation method (*3*), complexes of the general formula,

$$BaX_2 \cdot n\mathrm{CO(NH_2)_2}$$

where X is chloride, bromide, or iodide and n is equal to ½, 1, 2, and 4 were found. Because of the similarity between the reactions of lithium salts and the corresponding alkaline earth compounds, the complexes with urea should also be of a similar nature. This was indeed found to be the case.

The complexes between urea and lithium chloride in solution were determined using the monovariation method applied to two physicochemical properties of the system, the relative viscosity and the index of refraction. A total of 23 solutions were prepared, each containing 5.10 ml of 1.967M LiCl solution and 0 to 21.00 ml of a 2.00M urea solution. Each mixture was then diluted to a total of 100 ml.

The relative viscosity of each solution was measured using an Ostwald viscometer in a water bath at 25 ± 0.02°C. The index of refraction of each solution was measured with an Abbe refractometer at the same temperature.

The results of the viscosity measurements of each solution are shown in Fig. 1. The index of refraction curve is not shown but was of a similar appearance. From the curve, a maximum point of viscosity indicates a complex between urea and the lithium chloride in solution. It can be seen that there are three maxima in the curve, corresponding to complexes having the following compositions $\mathrm{LiCl \cdot CO(NH_2)_2}$, $\mathrm{LiCl \cdot 2CO(NH_2)_2}$, and $\mathrm{LiCl \cdot 3CO(NH_2)_2}$. A complex having the composition $\mathrm{2LiCl \cdot CO(NH_2)_2}$, was not found, as was the case with the barium halides.

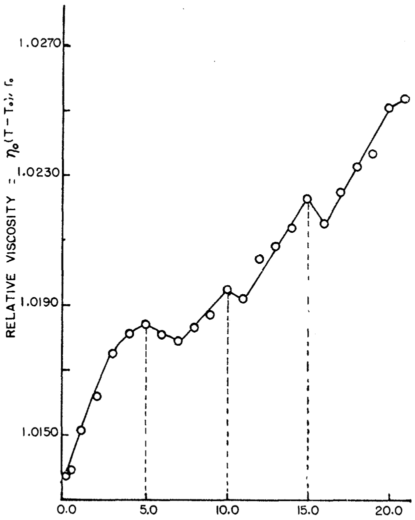

Fig. 1. Viscosity of the urea-lithium chloride system.

The nature of the bonding in these complexes is not known but is presumably an ion-dipole attraction between the metal ion and the nitrogen atoms of the urea molecule. As a consequence, the complexes are relatively unstable. In the cases where the calcium halide complexes have been isolated in the crystalline state (*1, 4*), it was found that they were hygroscopic and easily soluble in water but insoluble in organic solvents.

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