

the vicinity of Bellingham, State of Washington, U. S. A., having a soil and climate similar to that of the district in Holland just mentioned, and suffering more or less severely from the ravages of *Tylenchus dipsaci* because this nema is not sufficiently held in check by any natural force. We may suppose that in this latter case *dipsaci* has been introduced at Bellingham without the enemies and parasites that hold it in check in the first-mentioned place. The mononchs found in the soil of the Holland district feeding upon *Tylenchus dipsaci* are collected and transported to Bellingham and introduced into the soil. There is good reason to suppose that under the new conditions, finding their food abundant, including the larvæ and young of *Tylenchus dipsaci*, the mononchs will flourish *Tylenchus dipsaci* in check.

If it be asked why injurious nemas are transferred from place to place without their enemies being transferred at the same time, the answer is that nemas injurious to plants are often transferred in the interior parts of plants imported in a living condition, and, as already indicated, the mononchs and other predatory nemas are less common in these situations than they are in the adjacent soil, which latter in the course of commerce often is removed from the roots and not shipped. One need only instance the case of bulbs and similar importations to see how much better chance the injurious parasitic nemas have of being imported than have those nemas which feed upon them. There is also reason to believe that sometimes the parasitic nemas infesting crops are more resistant to untoward conditions, *e. g.*, dryness, than are the predaceous nemas.

We have at the present time arrived at a stage where logically the next step is to try out the introduction of promising species of mononchs. Efforts of this kind will necessarily be somewhat expensive, probably more expensive than the corresponding early efforts to introduce beneficial insects. There can be no doubt, however, that the enormous losses due to plant-infesting nemas fully justify the expenditure of even large sums of money

in an effort to apply this remedy, more particularly because the remedy, when successful, bids fair to be permanent and self-sustaining.

After long-continued and intensive studies I am thoroughly convinced that many of the practises evolved in the transfer of beneficial insects can, with appropriate modification, be applied to the nemas. At the present time the greatest drawback in the case of the nemas is the small number of people who are technically competent to make the necessary biological examinations. It is in this respect principally that their introduction will differ from that of the introduction of useful insects, for the nema problem is essentially a microscopic one. Though the collection of the nemas from the soil differs entirely from the collection of beneficial insects, the methods have already been brought to such a state that there are no insuperable obstacles.

The percentage of mononchs in miscellaneous collections of soil-inhabiting nemas taken from various situations is roughly indicated by the following figures based on the writer's examinations—in each case of from one thousand to several thousand specimens:

1. Miscellaneous collection from very small quantity of soil taken from the roots of 14 species of plants imported from Brazil, 6.5 per cent. mononchs.
2. Sandy soil about the roots of astilbe and peony, Holland, 11.6 per cent. mononchs.
3. Soil from cornfield in New Jersey in autumn, the prevailing genus was *Mononchus*.
4. Sand from Washington filter beds, 96 per cent. mononchs.

N. A. COBB

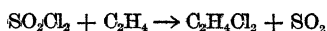
U. S. DEPARTMENT OF AGRICULTURE

#### THE INTERACTION\* OF ETHYLENE AND SULPHURYL CHLORIDE

SOME time ago,<sup>1</sup> while treating sulphuryl chloride ( $\text{SO}_2\text{Cl}_2$ ) with ethylene gas ( $\text{C}_2\text{H}_4$ ) at room temperature, the writer discovered a reaction quite different from any other which has come under his observation. It was noted that when a fairly strong, steady stream

\* First observed on February 28, 1918.

of ethylene is passed into sulphuryl chloride at room temperature no apparent change occurs until the gas has bubbled through for quite a long while. Under certain conditions, however, the colorless liquid suddenly turns greenish-yellow, accompanied by rather a sharp rise in temperature, which during the first two or three hours of the run amounts on the average to approximately  $10^{\circ}$  C. As the temperature rises, the liquid loses its color, soon to be followed by a gradual fall in temperature, which in the course of a few minutes reaches approximately that of the room. When the gas is passed steadily through the liquid, this remarkable cycle returns again and again uniformly and continually in the same order. At the minimum temperature the liquid invariably turns greenish-yellow (about the color of chlorine), which is a sure signal that the temperature will rise. At the maximum temperature, which is usually in the neighborhood of  $35^{\circ}$  to  $40^{\circ}$ , the liquid is colorless. A complete cycle ordinarily requires from 10 to 20 minutes, depending upon conditions, and these cycles may be observed for several hours. In the course of time, however, the cycles become longer and the differences in temperature less pronounced. This is what one would expect. A number of different runs has been made, with the same general results. The accompanying diagram shows very clearly some of the cycles observed when one of the experiments was carried out. An explanation of this interesting phenomenon has not been fully worked out, but the mechanism of the reaction is under investigation. It appears that sulphur dioxide and ethylene chloride (Dutch liquid) are among the products of the reaction. It may be that ethylene and sulphuryl chloride first unite to form an unstable compound which then dissociates into ethylene chloride and sulphur dioxide, or it may be that these products are formed by the interaction of the factors as represented by the following chemical equation:



WILLIAM FOSTER

PRINCETON UNIVERSITY

## THE AMERICAN PHILOSOPHICAL SOCIETY. IV

SATURDAY, APRIL 24

*Afternoon Session—2 o'clock*

WILLIAM B. SCOTT, D.Sc., LL.D., president, in the chair

Presentation of a portrait of the late Edward C. Pickering, LL.D., vice-president of the society, 1909–1917, by Vice-president Hale.

*Animal luminescence and stimulation.* E. NEWTON HARVEY, Ph.D., professor of physiology, Princeton University. (Introduced by Dr. H. H. Donaldson.) The production of light by animals is due to the burning or oxidation of a substance called luciferin in the presence of an enzyme or catalyst called luciferase. It resembles the ordinary artificial methods of illumination by burning in that oxygen is as necessary for animal luminescence as it is for the light of a lamp or tallow candle. It differs in that water is absolutely essential for the light production and no carbon dioxide or heat is produced—at least no carbon dioxide or heat is produced at all comparable to that formed during the burning of such substances as tallow, either in the form of a candle or as food, to supply heat and energy for the body. Light production by animals differs also from light produced by combustion in that the oxidation product of luciferin, oxyluciferin, can be easily reduced to luciferin, which will again oxidize with light production. The reaction is reversible and appears to be of this nature—luciferin + O  $\rightleftharpoons$  oxyluciferin + H<sub>2</sub>O. The difference between luciferin and oxyluciferin lies probably in this, that the luciferin possesses two atoms of hydrogen which is removed to form H<sub>2</sub>O when the luciferin is oxidized. The H<sub>2</sub> must be added to reform luciferin. Whether the reaction goes in one direction or to the other depends, among other things, on the concentration of oxygen and the presence of a reducing agent. In a mixture of luciferin, luciferase, reducing agent and an abundant supply of oxygen, the reaction goes from left to right (with production of light) to an equilibrium. On removal of oxygen the reaction goes in the right to left direction with reformation of luciferin. Thus, while a firefly is flashing, oxyluciferin is produced and between the flashes oxyluciferin is reduced and is now ready to be again oxidized with light production. We may figuratively describe the firefly as a most extraordinary kind of lamp which is able to make its oil from the products of its own combustion. Not only