Precision With Carbon -- Bio-Organic Chemistry

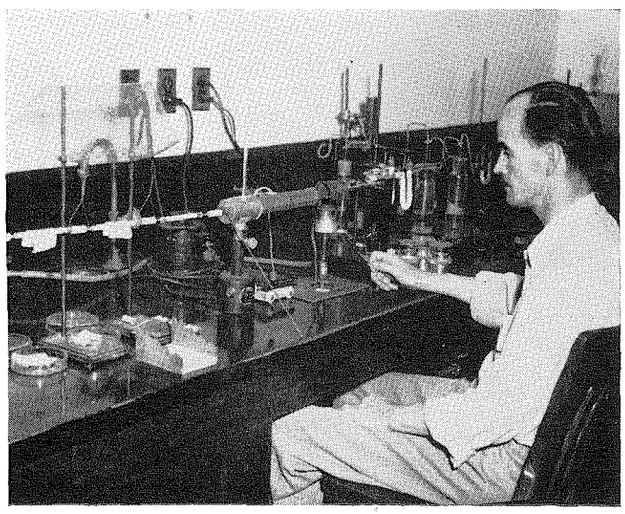
By A. J. HAAGEN-SMIT

ORGANIC Chemistry received its impetus from the study of natural products. The discovery of the constitution and synthesis of urea opened the way for the 300,000 - 400,000 organic compounds now known. While the name "Organic Chemistry" at first indicated the chemistry of the organized world, in later years it became synonymous with the chemistry of carbon.

In the more limited field of Bio-Organic Chemistry we are not concerned with all of the these compounds, which are for the most part synthetics. The number of well characterized compounds known to occur in the living organism is only about 8000 and increases at a rate of less than 100 per year. These figures are astonishingly low when we remember that about a million species of plants and animals have been classified by taxonomists, and that the total number of known seed-bearing plant species alone is estimated at a quarter million and before the war used to increase at the rate of approximately 2000 new species per year.

In any study of biological material the prerequisite for a satisfactory explanation of biochemical phenomena is a knowledge of the variety of compounds taking part in the reaction. The bio-organic chemist has set himself the task of increasing the knowledge of these building stones of the organism. In doing so, he provides the basic requirement for the studies of his fellow worker, the bio-chemist and the physiologist.

Much work remains to be done in this field. A glance through the list of chemically investigated plants shows immediately that only a few species of each family have been investigated and that for many plant families not even one member of the family has found its way into a chemical laboratory. Our chemical knowledge of the investigated species, too, is highly inadequate. Usually, published information consists of mentioning the presence of proteins, amino acids, fats, carbohydrates, rubber, essential oils and alkaloids. As these are all only group names for substances with roughly similar properties, a knowledge of their presence is but of limited use to the biochemist, to the physiologist and frequently to the industrialist.



Since the most numerous compounds found in biological material are compounds containing carbon and hydrogen, the combustion analysis of carbon and hydrogen is highly important to the organic chemist and biologist. Assistant Swinehart is carrying out such a combustion analysis.

While often, as for example in the field of essential oils and alkaloids, the quantities involved are not a special problem, in the case of most physiologically active substances micro-analytical procedures have to be applied to solve the problem. This is also true of the field of flavor substances, which shows in its treatment a certain resemblance to that of the vitamins and hormones. In both cases a physiological assay method is used during the isolation process. For the flavors it is the smell and taste which serve as a guide; for the vitamins and hormones their effects, such as growth, are measured. In both cases the methods used are dictated by the occurrence in extremely low concentrations in the starting material. Even when thousands of pounds of material are worked with, the amounts finally obtained weigh often only a few milligrams. In this way several plant hormones, flavor-substances of pineapple and onions and differentiation factors for certain protozoa were isolated in our laboratory. Together with the U. S. Forestry Service, contributions are being made towards a more complete knowledge of the rosins and essential oils of the genus **Pinus**, and with the Huntington Library a campaign is being carried on to give us a better understanding of the alkaloids in the cacti.

This analytical work is, when possible, followed by synthesis of the compounds and the way is opened for the preparation of a large number of analogues, which might be helpful in explaining the mechanism of biochemical reactions. In the last few years the bio-organic chemist has extended this synthetic work to the incorporation of isotopes of carbon, nitrogen and other elements in these products.

UPPER: Often the quantity of pure chemical compound obtainable from living organisms is very small. Chemical reactions involving such minute quantities of material must be carried out in tiny apparatus in order to minimize losses. Here Dr. Haagen-Smit is shown with some micro chemical laboratory ware. CENTER: Before a chemical compound can be analyzed as a first step in its identification, a sample must be weighed. Dr. Haagen-Smit is shown at one of the micro analytical balances with which it is possible to weigh to the nearest two-millionth of a gram. LOWER: Dr. Gertrud Oppenheimer, research assistant, with several of the micro analytical laboratory burettes. "Patchi" is not an experimental animal.