By far the most valuable property of the resin from the standpoint of the critical microscopist is the very high refractive index. When dried on the slide this is between 1.70 and 1.80, a figure far higher than balsam, styrax or other common mounting media. Since fine structure becomes more and more visible the higher the refractive index of the material in which the object is mounted it is obvious that hyrax will show details that are completely invisible in a balsam mount. This property makes the resin particularly valuable in the study of diatoms. In this respect it is almost equal to A. F. S., while its pleasant odor, lack of color and other desirable properties make it more satisfactory for general use. There does not appear to be any chemical reaction with such common stains as have been tested; no fading has been detected thus far.

These experiments are being continued, and while hyrax may not be the best synthetic resin which will eventually be developed it certainly is the most valuable for certain classes of work which has thus far been found. The early batches of the material possessed a definite straw color but by careful chemical manipulation Messrs. L. A. Penn and Paul Ruedrich, who are associated with me in the experiments, have succeeded in producing it practically without color.

G. DALLAS HANNA
CALIFORNIA ACADEMY OF SCIENCES

SPECIAL ARTICLES

ON THE RELATION OF POTASSIUM TO IRON IN THE COMBUSTION OF CIGAR-LEAF TOBACCO[1]

IT has long been recognized that potassium may act as a catalyst in the combustion of cigar-leaf tobacco, and that its efficiency in this respect is largely determined by the form in which it is found in the leaf. These points have never been questioned seriously, but opinions have differed concerning the exact mechanism involved in this form of catalysis.

In our studies on the burning qualities of Pennsylvania cigar-leaf tobacco, we have substantiated the claims of others, namely, that ready combustion is usually, but not always, associated with potassium in organic rather than in inorganic forms of combination. Moreover, we found that if the ash of a cigar was rubbed into the surface of an ash-free cellulose filter-paper, the latter could be made to burn with a glow, instead of a flame, and that the ash from a good burning cigar was more efficient in this respect than the ash from a cigar of inferior burning qualities. This suggested a modification of Garner's method[2] for a study of the effect of individual ash constituents on the combustion of organic materials, apart from those of the cigar-leaf, inasmuch as both insoluble and soluble ash constituents could be used advantageously.

As a result of these experiments it was found that a number of ash constituents and many of the organic compounds of the leaf imparted glowing qualities to the filter-paper. Of these, however, potassium carbonate appeared to be more efficient than any of the compounds studied, although its use usually resulted in the production of a dark ash. It is our opinion that the catalytic action of potassium carbonate on the burning of filter-paper is due to the fact that the potassium ion forms auto-oxidizable compounds with cellulose derivatives, and that the carbonate itself aids in the dispersion of carbon particles, thus increasing the total surface for combustion. That moisture must play a part in the dispersion of carbon was indicated by the fact that a dry mixture of carbon and potassium carbonate did not burn more readily than carbon when used alone. We conclude, therefore, that what holds true for pure cellulose holds true also for leaf tissue. In the latter, however, a greater dispersion of other materials present may likewise take place, materials which may have a catalytic action as well. Among these may be mentioned iron oxides. The presence of a mere trace of these compounds aids in the combustion of dry carbon.

Potassium carbonate, mixed with iron oxides which were obtained by the combustion of organic iron salts, when applied to filter-paper, was found to have a more beneficial effect on the glowing capacity and thoroughness of combustion than when either material was used alone. This observation led us to anticipate a rather close relationship from the standpoint of combustion between potassium and iron as they occur within the leaf. Tests on fermented samples of tobacco failed to show the presence of either the ferric or ferrous iron. A test showing the presence of complex ions of iron, on the other hand, was readily obtained. We have reason to assume, therefore, that the iron must be present in combination with salts of hydroxy acids or related compounds, which normally occur in the leaf. Experiments on the effect of these complex salts on the combustion of filter-paper showed that potassium-iron-citrate, for example,

[1] Published by permission of the director of the Pennsylvania Agricultural Experiment Station as Technical Paper No. 474.

This investigation was conducted in cooperation with Dr. W. W. Garner, of the U. S. Department of Agriculture, Bureau of Plant Industry, Office of Tobacco and Plant Nutrition, and Professor F. D. Gardner, of the department of agronomy of the Pennsylvania State College.

[2] U. S. D. A. Bur. Plant Ind. Bul. 105.

was far more efficient as a catalytic material than ammonium-iron-citrate.

The tests on filter-paper were followed by tests on pure sucrose, used alone or with various other materials, and heated to high temperatures in porcelain dishes. It was found that when sugar, alone, was used, a large increase in volume was obtained, followed by a less rapid loss of water, and fair combustion was apparent until all the water was eliminated. On the other hand, when equal parts of potassium-iron-citrate were used, a less increase in volume was obtained, followed by a slow loss of water. In this instance, however, ready combustion was effected. If the flame was removed before combustion was complete, the mass was found to glow for a long period of time. On complete combustion, a coherent ash remained, containing iron oxides, uniformly distributed and in a very finely divided condition. A somewhat similar result could be obtained by using the ash of a good burning cigar, but not with ammonium-iron-citrate or similar compounds.

The iron remaining behind was found to possess magnetic properties, even when the temperature used exceeded that of a burning cigar. Tests on cigar ash yielded magnetic iron, but only where combustion was incomplete, no test being obtained where carbon was absent. It was thought that the force of attraction between the oxides and certain of the ash constituents was great enough to overcome the magnetic force, because magnetic iron added to an ash failed to respond to a magnetic field. On the other hand, where the iron was not well distributed, enough of the iron oxides became localized in quantities sufficient to overcome the attractive force of the ash particles.

It is suggested, therefore, that good combustion of cigar-leaf tobacco is associated with potassium compounds which give rise to potassium carbonate during combustion, and that the presence of such compounds may serve to intensify the catalytic effects of iron on this process.

D. E. HALEY
OTTO OLSON

PENNSYLVANIA STATE COLLEGE

CARBON DISULFIDE EMULSION FOR THE CONTROL OF A NEMATODE

CARBON DISULFIDE in the un-emulsified state was one of the earlier materials tested in the search for suitable means of controlling the root-knot nematode *Heterodera radicicola* Greef. Several workers[1] reported that the chemical showed some merit for this purpose. Zimmerley and Spencer[2] found it ineffective under greenhouse conditions. Objections to the use of CS_2, such as inflammability, disagreeable and persistent odor, cost and doubtful value as a nemacide, appear to be sufficient explanation for investigators turning to other chemicals and control methods.

We have recently treated nematode-infested soil in a greenhouse with an emulsion of carbon disulfide[3] similar to that developed to control larvae of the Japanese beetle *Popillia japonica* Newman and Asiatic beetle *Anomala orientalis* Waterhouse in lawns. The results of these preliminary tests are encouraging. An emulsion containing approximately 0.7 per cent. *actual* CS_2 has freed infested soil of nematodes under conditions tested.

Applications were made at the rate of one gallon of the diluted emulsion to each cubic foot of soil (greatest depth dimension, eight inches). Soil in pots and in a standard greenhouse bench was included in the experiments, maintaining, of course, adequate check pots and plats. It remains for future investigation to determine: the minimum dosage for a given unit of soil for commercial control; the range of efficiency for such variables as type and condition of soil and the stage and location of the nematode; and finally, from the cost of the treatment, whether or not it has a field of usefulness.

In large commercial greenhouses the soil in the ground or bottom beds is commonly disinfested with steam. The smaller houses are usually not supplied with the necessary heating equipment for steam sterilization. Even in the larger houses it is difficult to treat the benches with steam. Hot water has also been successfully used to control nematodes, but the same factors limiting the use of steam apply to this method and in addition it is more laborious and expensive. It is not feasible for use on bench soil. Carbon disulfide emulsion, if it should eventually fulfil the qualifications of a nemacide, might prove useful in small greenhouses and in treating benches where steam and hot water disinfestation is impractical in large houses. Its cost will limit the use of the emulsion outdoors but it may be valuable for treating seed beds and small areas of ground intended for valuable plants.[4]

P. J. CHAPMAN
M. M. PARKER

VIRGINIA TRUCK EXPERIMENT STATION

[1] E. A. Bessey, Bureau of Plant Industry Bul. 217. 1911. J. A. McClintock, Michigan Tech. Bul. 201. 1915. J. R. Watson, Fla. Bul. 200: 201. 1919. And others.

[2] H. H. Zimmerley and H. Spencer, Virginia Truck Expt. Sta. Bul. 43: 272. 1923.

[3] Supplied by I. P. Thomas and Son Co., Philadelphia, Penna.

[4] The writers call attention to the appearance of a paper by Schaffnit and Weber (*Anz. für Schädlingskunde*, 5: 19) under date of February 15, 1929, in which similar experiments are reported. The present paper was accepted for publication in SCIENCE on February 4, 1929, and is based on work done in the fall of 1928.