states in uranyl salts and tungstates, and also in a number of impurity compounds activated by manganese and chromium.

Uranyl salts, as was to be expected, show no photoconductivity, and the exponential phosphorescence decay curves are in agreement with the idea[1] that the luminescence of these salts is a result of the absorption of energy within the co-ordination group of the uranyl ion.

The tungstates of calcium, magnesium and zinc do not show photoconduction under radiations giving rise to strong fluorescence. This new fact, together with the exponential decay[2], supports the suggestion that the luminescence of these compounds is similar in origin to that of the uranyl salts, and arises from transitions between the excitation states and the ground state of the $WO_4$ ion.

It has recently been shown by one of us[3] that the fluorescence of pure manganous compounds, and of solids activated by manganese, is in many instances due to transitions within the $Mn^{++}$ion. Our measurements on photoconductivity and phosphorescence have now confirmed this view. Pure manganous chloride ($MnCl_2$) is not photoconducting, neither are the compounds cadmium chlorophosphate, cadmium borate, cadmium silicate, or zinc mesodisilicate when activated by manganese. We have also measured the phosphorescence decay curves for these compounds and find them to be exponential. Other examples of non-photoconducting solids we have found are alumina with chromium impurity (ruby), and pure calcium oxide.

As the fluorescence spectra of the uranyl salts, the ruby, and calcium oxide are of the well-resolved type, it would appear that this type of spectrum is in general to be associated with lack of photoconduction.

It is well known that luminescent energy can be stored in certain phosphors at low temperatures; this energy is released on warming the solid. We find that solids showing this effect of 'thermal glow' to any marked extent are photoconducting solids such as willemite and the zinc sulphides. Non-photoconducting solids show little or no thermal glow.

In zinc sulphide phosphors we find also that it is the long period phosphorescence that is enormously delayed by cooling. The medium period decay of the order of milliseconds takes place rather more rapidly when the solid is cooled to 90° K.

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[1] Randall, *Trans. Farad. Soc.*, **35**, 13 (1939).

[2] Strange, *Trans. Farad. Soc.*, **35**, 95 (1939).

[3] Randall, *Proc. Roy. Soc.*, A, **170**, 272 (1939).

## Spectrographic Analysis of Three Arthropods

Two species of insects and one species of chilopod have been analysed by the methods[1] developed in the spectroscopic laboratory of the Experiment Station of the Hawaiian Sugar Planters' Association. These methods give information only on the metallic and semi-metallic elements present in the sample. Although the analyses are essentially qualitative, clear distinctions between the major, minor and trace constituents can be made.

The specimens analysed were selected to cover a wide range of feeding habits. They included sugar cane beetle borers (*Rhabdocnemis obscura* (Boisd.), segregated according to sex); large common centipedes (*Scolopendra subspinipes* Leach); and cypress cockroaches (*Diploptera dytisoides* Serville). The beetle borers are plant feeders, spending all their lives except the adult stage within sugar cane stalks. The centipedes are predators, feeding principally on small insects. The cockroaches are omnivorous scavengers; the particular ones analysed were found in dusty soil under stones and bits of refuse. None of these species is indigenous to Hawaii.

The specimens were washed in boiling distilled water and then ashed in platinum for six hours at 500° C. Two-milligram samples of the ash were used in analysis.

A similarity in metallic constitution was found for the three species, the general composition being:

*Chief constituents*: Phosphorus, silicon, potassium, calcium and magnesium (the chief mineral elements found in plant material).

*Less plentiful constituents*: Iron, manganese, copper and sodium.

*Trace constituents*: Zinc, aluminium, strontium, barium and titanium. (No titanium found in the centipede ash.)

Four additional trace elements were found in the cockroach ash, namely, lead, boron, chromium and nickel. In addition, this ash was strongest in iron, silicon, aluminium, and perhaps calcium and potassium. On the other hand, the centipede ash contained the *least* of the chief soil elements, iron, aluminium and titanium, and of the plant material elements silicon, potassium and perhaps manganese. The beetle borer ash was strongest in barium, and showed a trace of tin. No differences between the composition of male and female borers were noted.

The large number of mineral elements present in the cockroach ash, and the heavier concentration of metals in this sample, suggests a correlation between feeding habits and metallic composition.

Ash analysis results for several other species of insects have been compiled by Uvarov[2].

Thanks are due to Mr. R. H. Van Zwaluwenburg, associate entomologist at the Experiment Station, for suggesting these analyses and for furnishing the specimens.

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## Ionization in the Troposphere

W. KOLHÖRSTER[1] has recently expressed the opinion that G. A. Suckstorff's measurements[2] have proved the existence in the troposphere of additional ionization caused by radioactive substances to be found in the temperature inversion layers. Suckstorff found in the higher layers of the troposphere enormous oscillations of ionization, amounting sometimes to 50 per cent of the measured value. The amplitudes of these oscillations increased with height; thus, Suckstorff formed the opinion that the oscillations were due to radioactive substances of extra-terrestrial origin present in the upper troposphere.