in diseased Pedipalps either as the *d*- or *l*-form, more probably the latter. It results from the decomposition of proteins in the host, and has been detected in vertebrates as a rare urinary sediment associated with acute yellow atropy of the liver, phosphorus poisoning and yellow fever.

F. A. BANNISTER.

Mineral Department,
British Museum (Natural History).

The Lachish Letters and the Use of Iron Inks in Antiquity

THE documents found early in 1935 on the ancient biblical site of Lachish, and now known as the Lachish Letters, were brought to London on the return of the expedition. During the summer of 1935, at the request of Mr. L. J. Starkey, I submitted them to a chemical examination. At the same time I made a more general investigation of the subject of early inks.

A survey of the literature indicated a consensus of opinion that iron displaced carbon inks at some time during the Middle Ages. I found, however, that the ink used in these letters contained both carbon and iron.

The problem is complicated by the presence of ferric iron in the body and on the surface of the sherds, and it was necessary to develop a special technique for testing the microscopic particles detached from various positions within and outside the lettering. It was observed that the better preserved writing was richer in iron, and the more eroded characters were primarily carbon.

A further search of the literature gave evidence of the early knowledge of iron inks. An examination was therefore made of the material available in the British Museum, and it was found that most of the writing on vellum of the early Christian period was in iron free from carbon. The earliest of these was the second century leaf from a Codex, concerning which Kenyon[1] says: "The earliest extant examples (of vellum) are probably two leaves, one in the British Museum containing part of Demosthenes' De Falsa Legatione (B.M. Additional MS. 34,473 i) . . ." A minute fragment of this taken from a broken edge of a paragraphing line, after subdivision into portions of about 0·02 mm. in size, was tested under the microscope. This gave the reactions for iron, the ink being entirely soluble and leaving no residue of carbon. Of the third and fourth century vellum documents or fragments, three out of twelve were carbon. Among the nine of iron type is the Codex Sinaiticus, which is a good example of this carbon-free brown iron ink.

Iron inks are decomposed with time to brown ferric oxide and hydroxides, which in the case of these early vellum manuscripts, appear as an almost transparent gel, combined perhaps as a complex with the vellum.

It can scarcely be doubted that the writers of antiquity insisted upon an ink of good appearance, comparable when fresh with a carbon ink, and as in these examples carbon is absent, the iron must have been in combination with a gall or tannin extract.

The ancient world was well acquainted with iron inks and with the various combinations which could be made with carbon, copperas, oak galls and gum; and it was with such an iron and carbon mixture that the Lachish Letters were written.

A complete account of the work will be found in "The Lachish Letters. I. The Wellcome Archæological Research Expedition to the Near East", which is now in the Press.

ALKIN LEWIS.

Chemical Department,
King's College,
London, W.C.2.

[1] "Books and Readers in Greece and Rome", **42**, 92 (1932).

Effect of Meteoric Shower on the Ionization of the Upper Atmosphere

OBSERVATIONS on the ionization of the upper atmosphere during a meteoric shower have as yet been very few in number and have all been confined to the Kennelly-Heaviside or *E* region. So far as we are aware, only two observations, one carried out in the United States[1] and the other in India[2], comprised direct measurements of the ion content of this region during the Leonid showers. Both gave strong evidence that ionization of this region increases enormously during such showers.

It seems natural to inquire if meteoric showers have any effect on other regions besides the *E* region of the ionosphere. Measurements with this object in view were carried out at Calcutta on five consecutive nights during the Leonid shower in November 1936. The dates of observations were centred around the night of maximum shower, November 14–15. The critical penetration frequency method was employed for the purpose; the range of frequencies used was 1–15 Mc./sec. Observations were made at intervals of one hour between 22.00 and 05.30 hours. The observed results are plotted in Figs. 1 and 2.

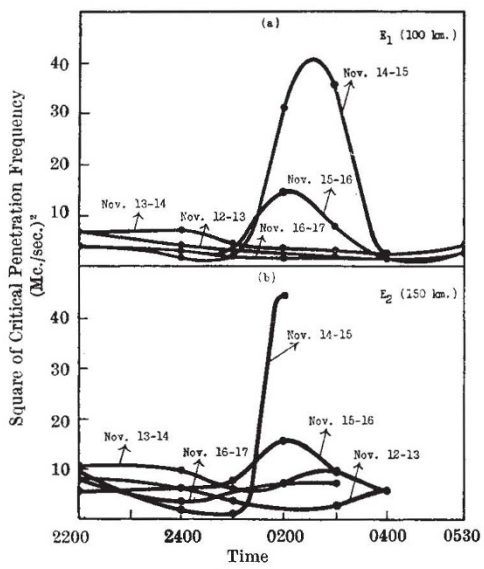

Fig. 1.

Fig. 1 (*a*), E_1 region. There is sharp increase of ionization between 01.00 and 04.00 hours, which is the period of maximum intensity of the shower in the nights of November 14–15 and 15–16.

Fig. 1 (*b*), E_2 region. Similar increase as in the case of E_1. The drop in the curve for November 14–15 could not be observed, presumably because the ionization fell below that of the E_1 region.