IRPL-R35

INTERSERVICE RADIO PROPAGATION LABORATORY
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C.
Organized under Joint U.S. Communications Board

Issued
10 April 1946

Comparison of Percentage of Total Time of Occurrence of Second-Multiple Es Reflections and That of fEs in Excess of 3 Mc.

An interesting discrepancy in the long-time trends of sporadic-E ionization seems to exist between data obtained at Watheroo, W. Australia, and those observed at Washington, D.C. This was previously noted in the report "Ionospheric Data," IRPL-F12, in an article "Sporadic-E Variation with Intensity and Latitude of Solar Activity." Observations of fEs made at Washington, D.C. indicate both seasonal and solar-cycle variations which are consistent with the idea that sporadic-E ionization is principally caused by solar radiation, probably corpuscular, emanating from regions near the center of the solar disc. Since solar activity is largely concentrated near solar equatorial regions during minimum periods of solar activity, sporadic-E ionization is a maximum during periods of sunspot minimum, and vice versa, according to this theory.

Values of fEs at Watheroo, W. Australia, [illegible] not scaled. Occurrence of second-multiple reflections from Es were, however, noted, and the percentage of total time during which they occurred was reported to reach a maximum in 1941, - about three years previous to the minimum of solar activity.

Since the data concerned in the establishment of this time trend at Watheroo are not directly comparable with those used for establishing the Washington time trend, it is interesting to investigate both comparisons of fEs as observed at both Washington, D.C., and at Watheroo, W. Australia, and comparisons of fEs and second-multiple reflections from Es at the latter station over the period of time for which data on both are available.

Figs. 11 through 13 present mass plots of fEs observed at Washington, D.C. during the months of December 1944, and April and June 1945. Inspection of the distribution of values shows them to be generally skewed toward the higher frequencies, but with fairly regular graduation throughout. Figs. 14 through 16 present mass plots of fEs observed at Watheroo, W. Australia. In these, the graduation of distribution is far from even, concentration of the distribution occurring near frequencies where band changes are made in the frequency sweep. This indicates marked change in either radiated power or receiver sensitivity in the recorder at these frequencies, or both, with consequent modification of the recorded value of fEs. In such cases, corresponding error exists in the determination of monthly median values of fEs,

(over)

of time percentages [illegible] above a chosen frequency limit, and therefore in trends based upon these quantities.

Daily values, for each hour, of upper-limit second-multiple reflection frequencies for vertical reflections from sporadic-E ionization were not available, but only the percentages of total time of occurrence above 0.5, 5, and 10 Mc. ("Sporadic E-Region Ionization at Watheroo Magnetic Observatory, 1938-1944", Report No. 6 under Contract NXsr-33809, by H. W. Wells, Department of Terrestrial Magnetism, Carnegie Institution of Washington, August 6, 1945). It might be expected that these would bear a nearly constant ratio to those obtained for percentage of time of occurrence of fEs above a designated frequency limit, provided that absorption effects were negligible.

Figs. 1 through 1[illegible] present values of the ratio of the percentage of total time of occurrence of vertical-incidence second-multiple reflections from sporadic-E ionization above 0.5 Mc to the percentage of time of occurrence of fEs above 3 Mc, at each hour of the day, for the months of March through December 1944 during which both of these types of data were available.

It is to be noted that the above ratio is far from constant, for all of these months. Its variation is characterized by relatively high values during night hours, and low values near midday, thus indicating that recorded values of vertical second-multiple reflection limits of frequency are greatly influenced by absorption phenomena, and therefore cannot be expected to manifest trends of the type shown by fEs.

It is particularly noteworthy that the highest night values of this ratio occur during equinox seasons. This is interesting, since sporadic-E ionization is a minimum during these seasons, because it suggests that nighttime absorption, caused by ionization which varies as does sporadic-E ionization, is appreciable. It would thus seem that absorption during periods of ionospheric storminess, probably caused by solar corpuscular emission, according to the theory of sporadic-E ionization mentioned earlier in this report, is very likely a related phenomenon.

If absorption of second-multiple sporadic-E vertical-incidence reflections is, as it seems, dependent upon the amount of sporadic-E ionization present, it is not surprising that a maximum in the percentage of total time of vertical-incidence second-multiple Es reflections should have occurred before that in the percentage of total time of fEs above any selected frequency, - the seeming discrepancy between long-time trends of these quantities noted at the beginning of this report. An optimum condition for high percentage of occurrence of second-multiple vertical-incidence Es reflections should occur when Es is prevalent (i.e., probably nearer sunspot minimum than sunspot maximum), but, before its prevalence is sufficient to cause absorption in amounts diminishing the observation of the second-multiple Es reflections.

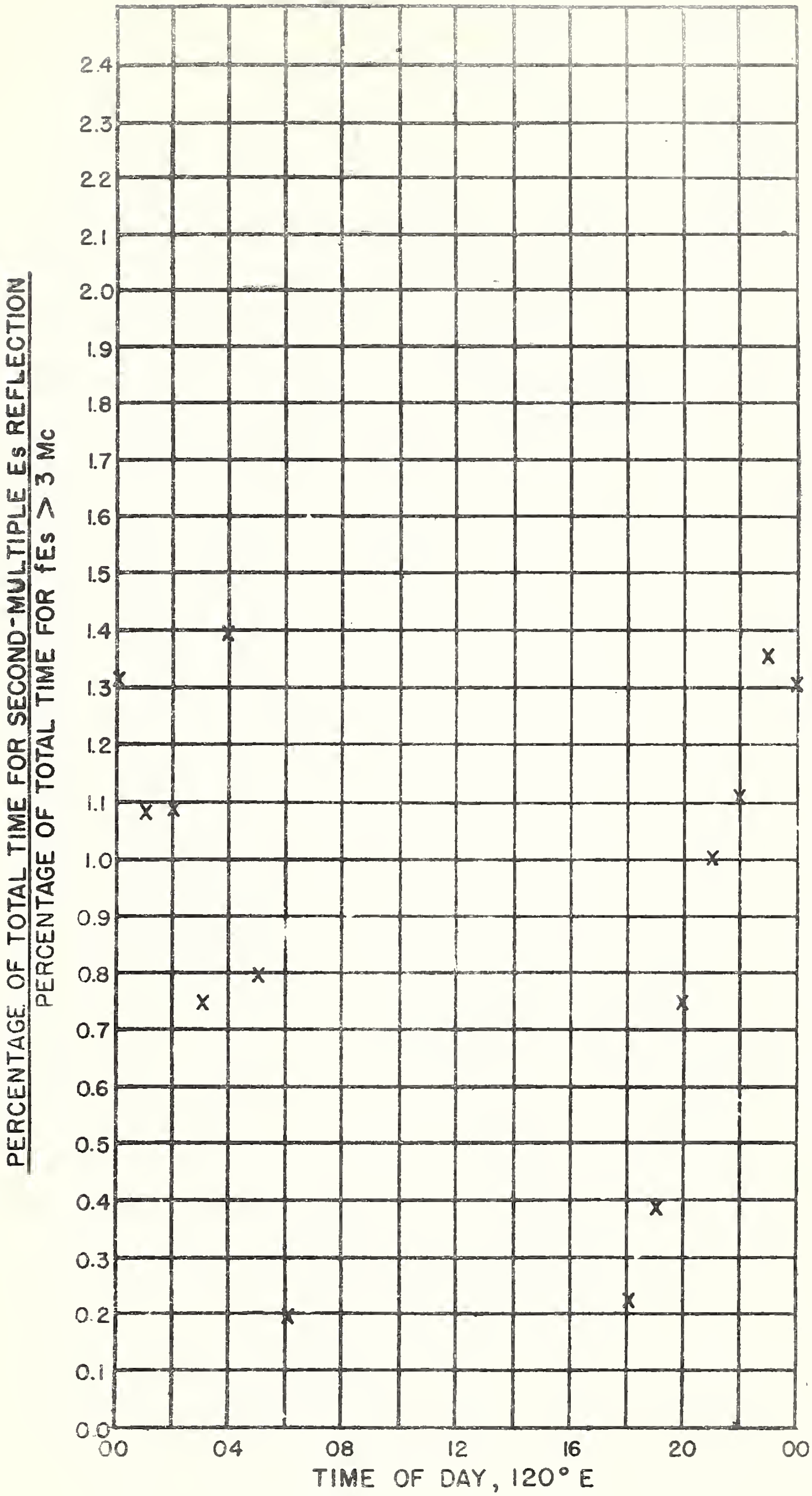

Fig. I. WATHEROO, W. AUSTRALIA
MARCH, 1944

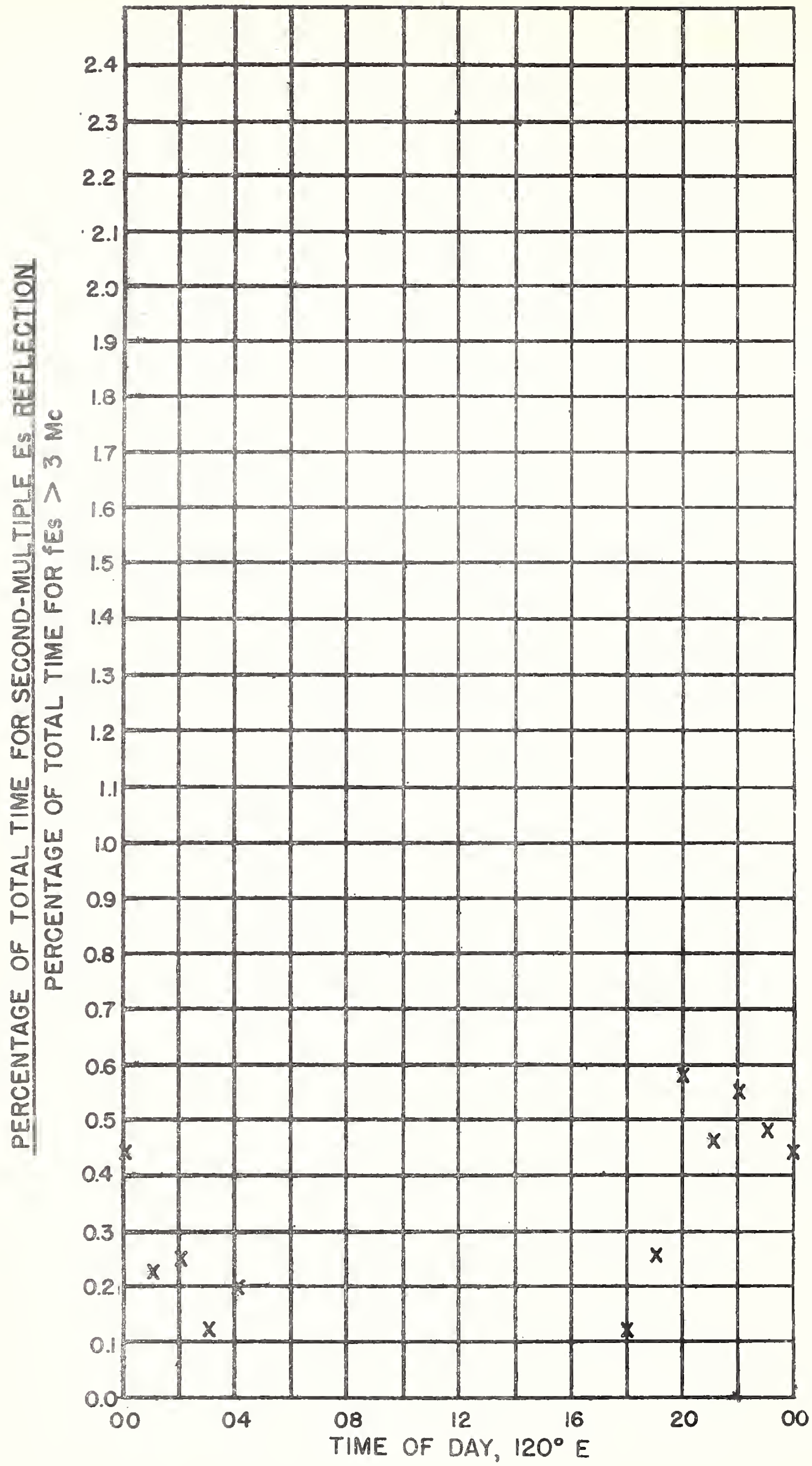

Fig. 2. WATHEROO, W. AUSTRALIA
APRIL, 1944

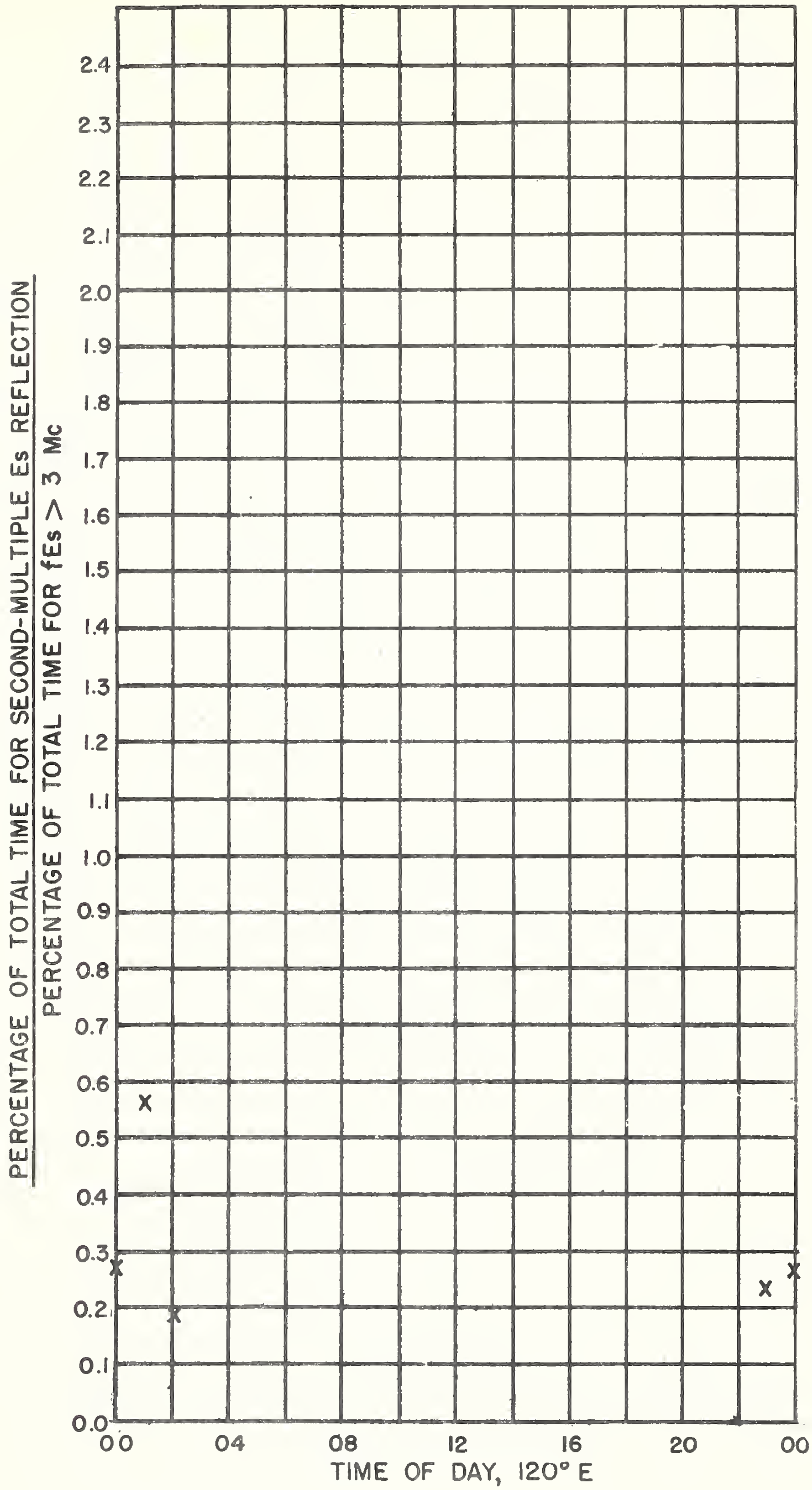

Fig. 3. WATHEROO, W. AUSTRALIA
MAY, 1944

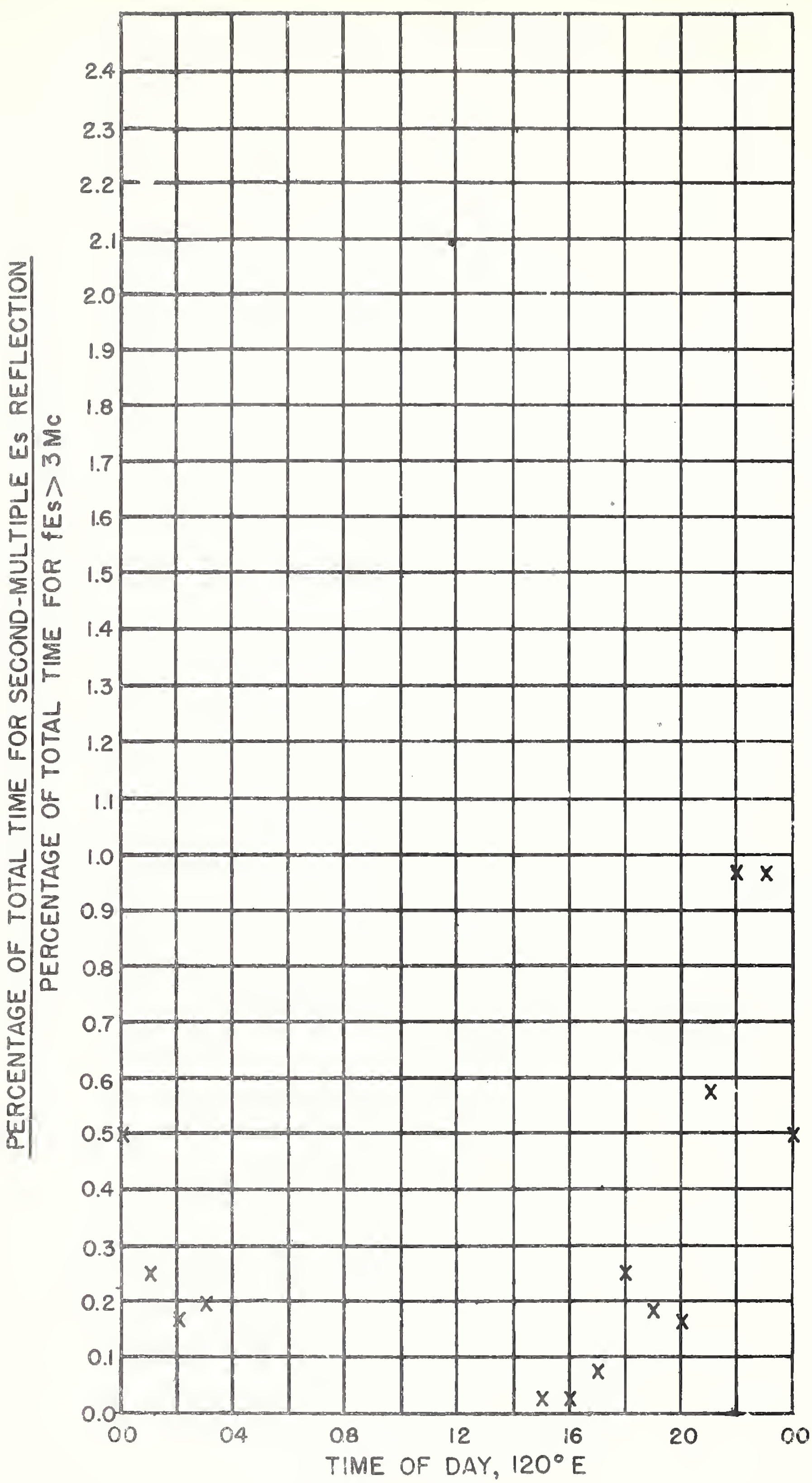

Fig. 4. WATHEROO, W. AUSTRALIA
JUNE, 1944

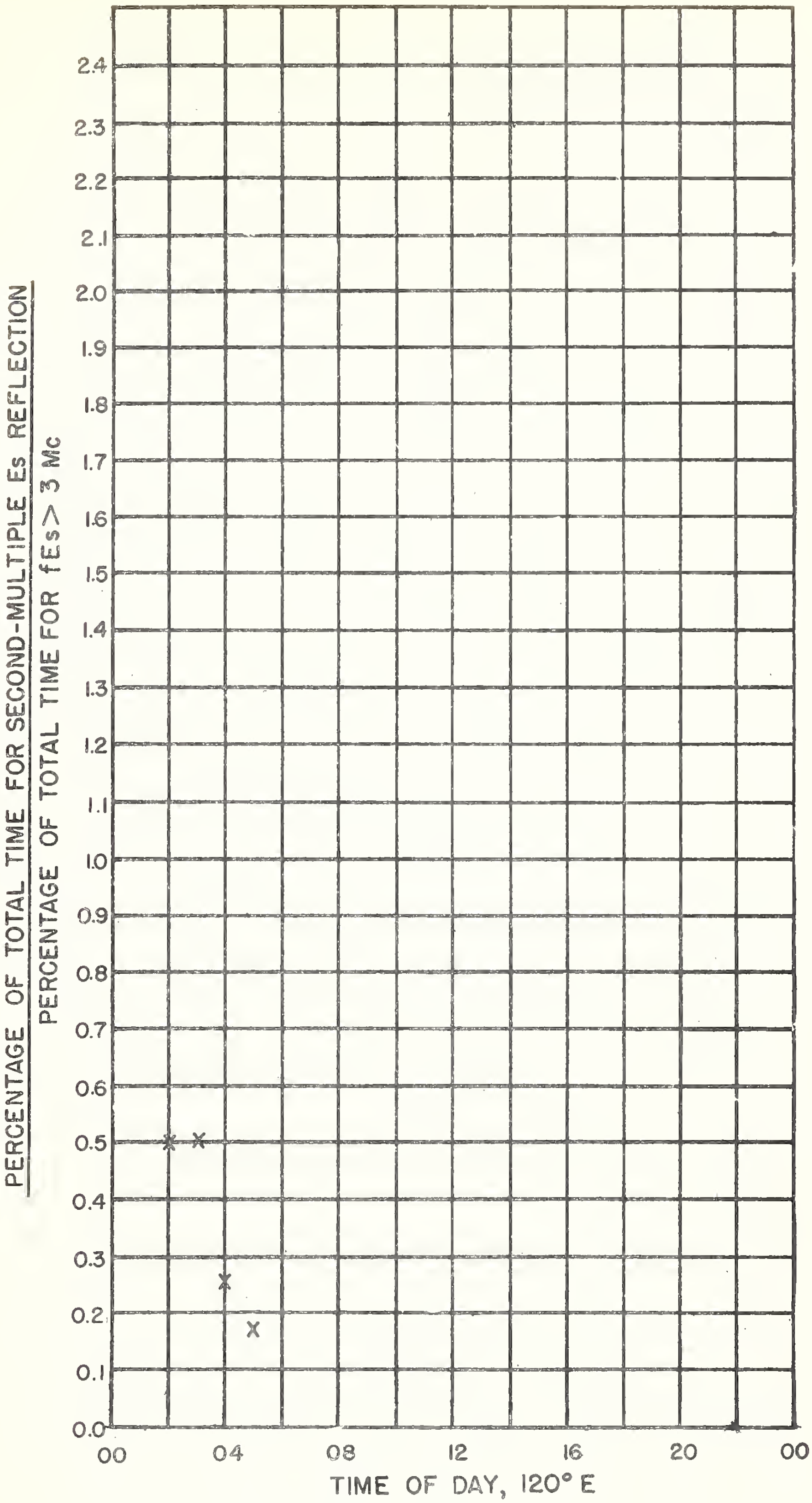

Fig. 5. WATHEROO, W. AUSTRALIA
JULY, 1944

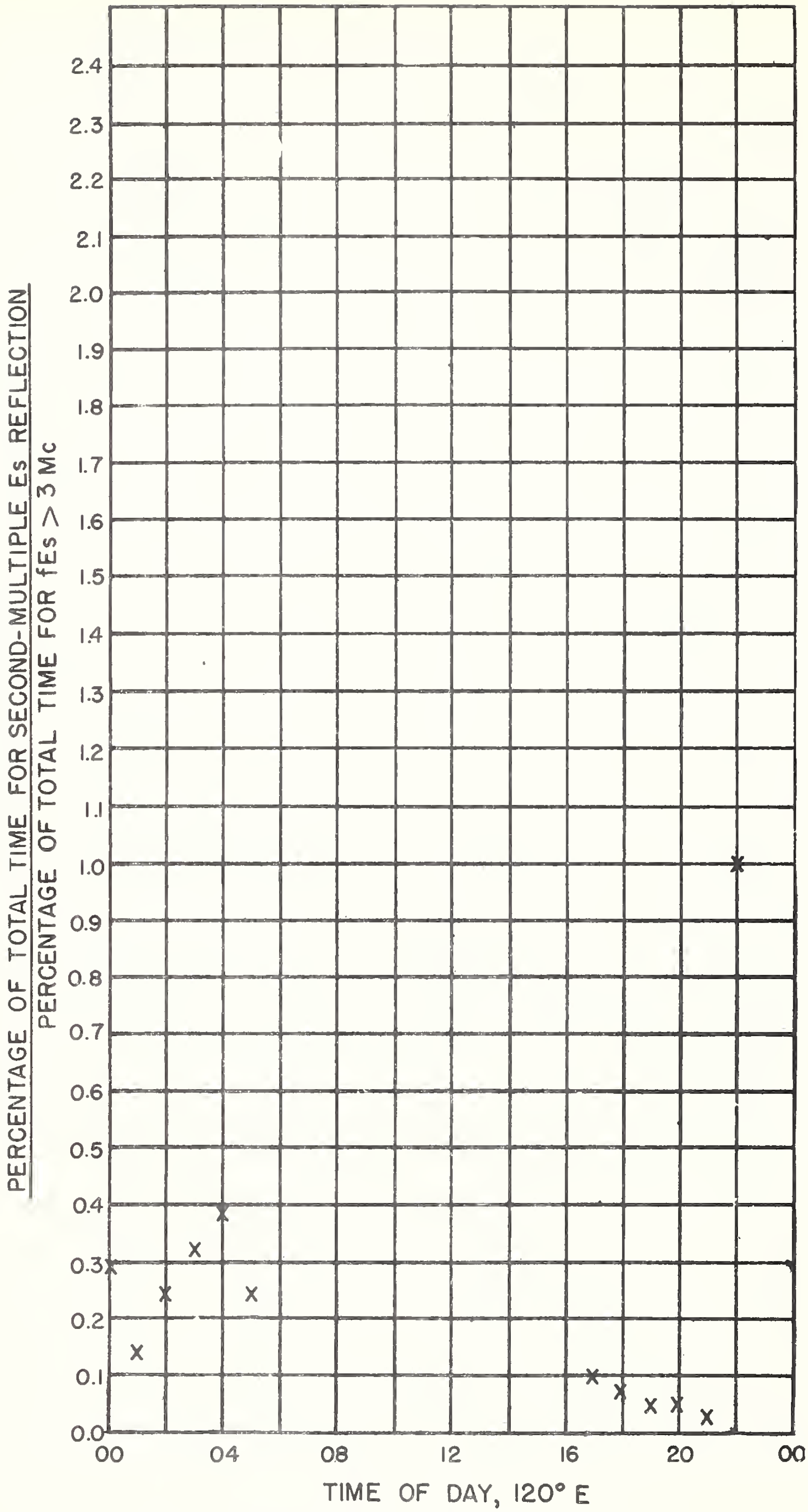

Fig. 6. WATHEROO, W. AUSTRALIA
AUGUST, 1944

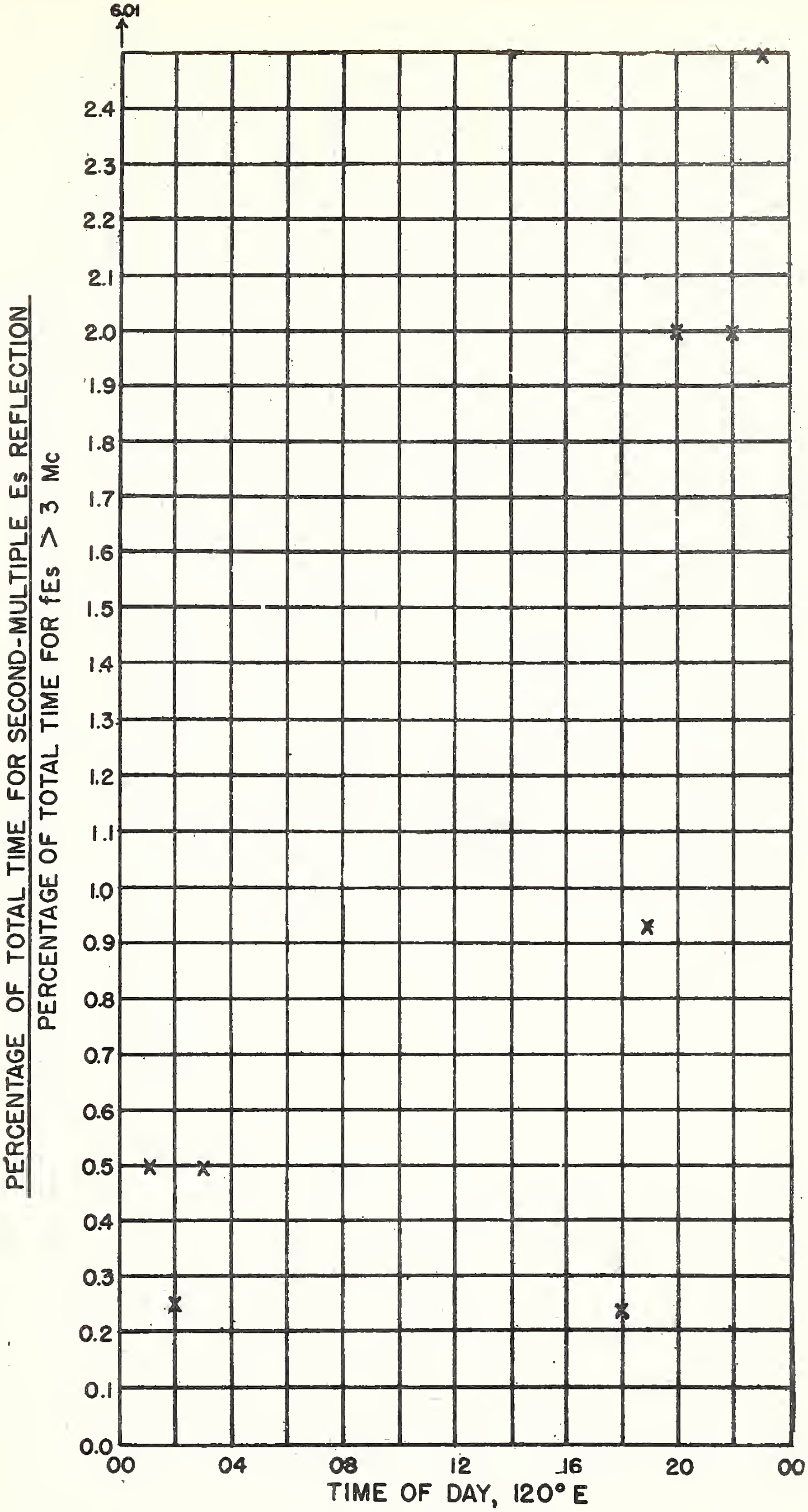

Fig. 7. WATHEROO, W. AUSTRALIA
SEPTEMBER, 1944

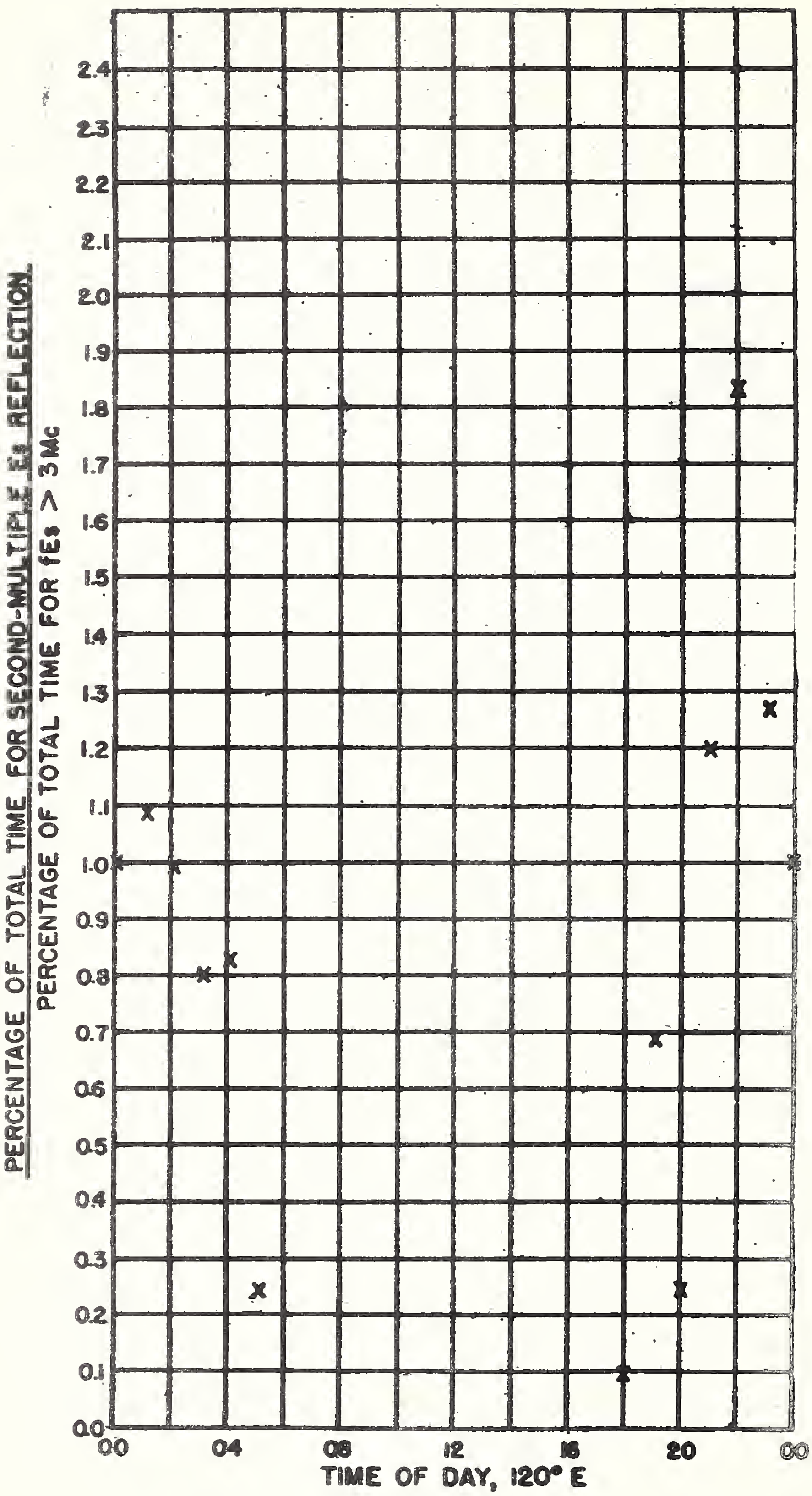

Fig.8. WATHEROO, W. AUSTRALIA
OCTOBER, 1944

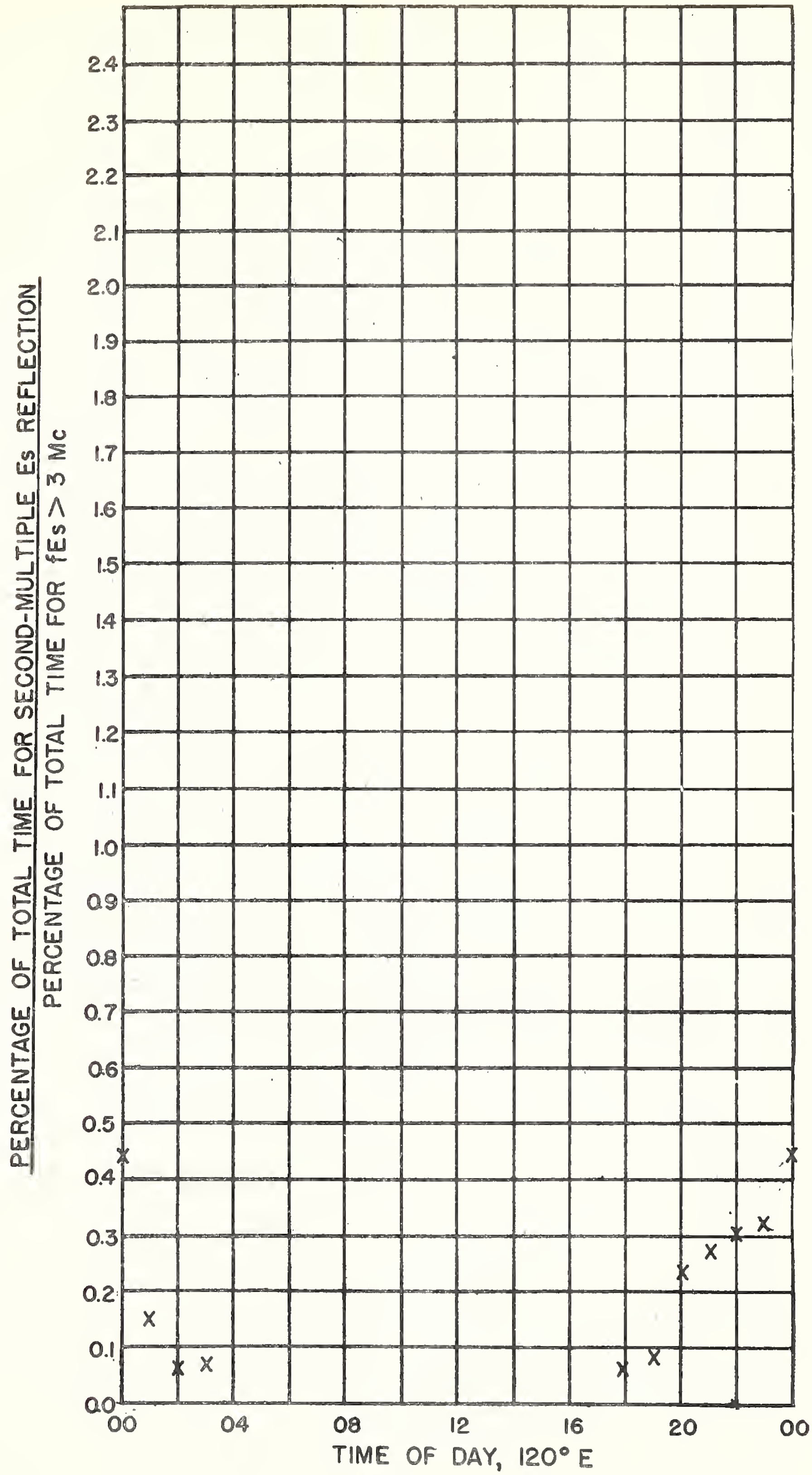

Fig.9. WATHEROO, W. AUSTRALIA
NOVEMBER, 1944

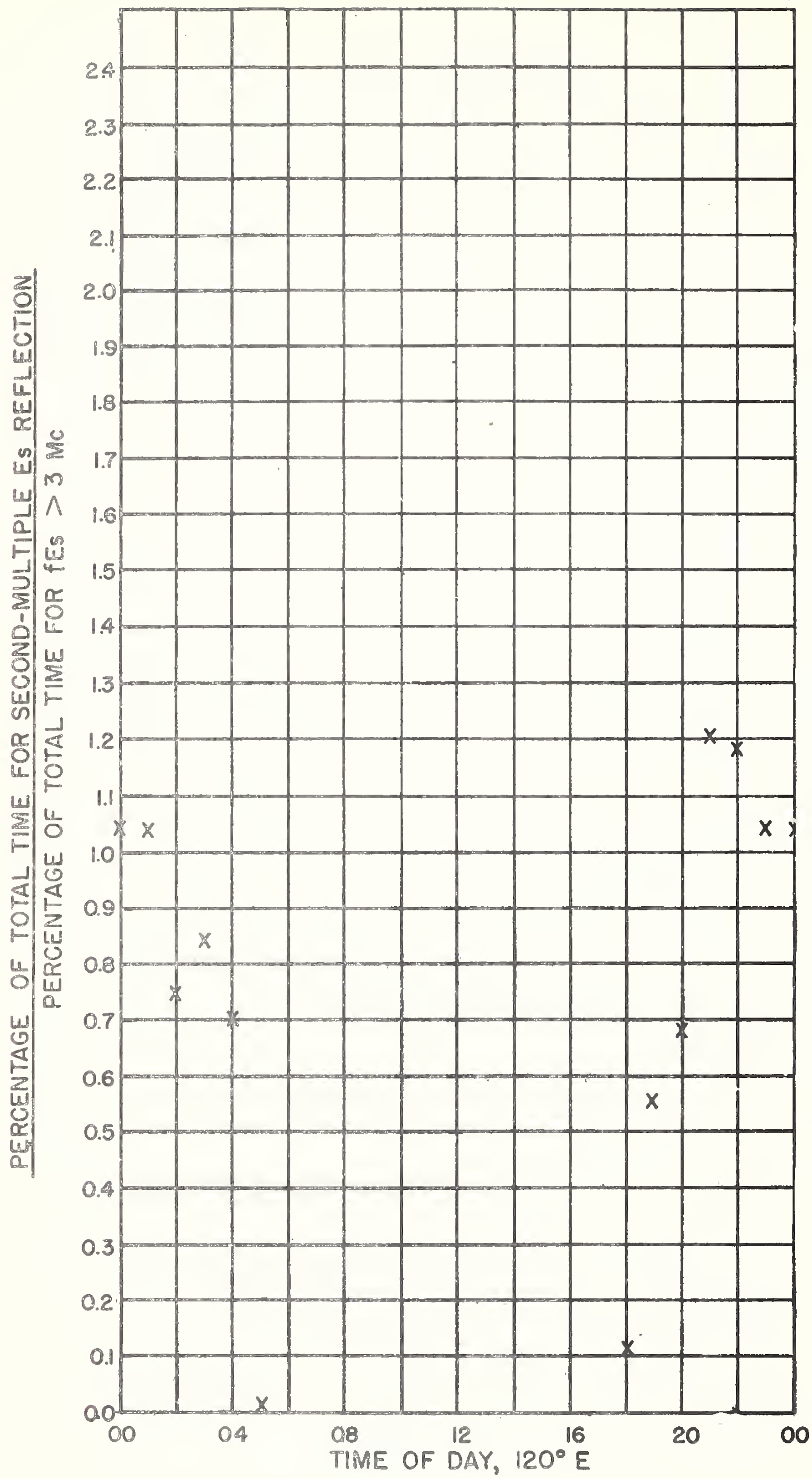

Fig.10. WATHEROO, W. AUSTRALIA
DECEMBER, 1944

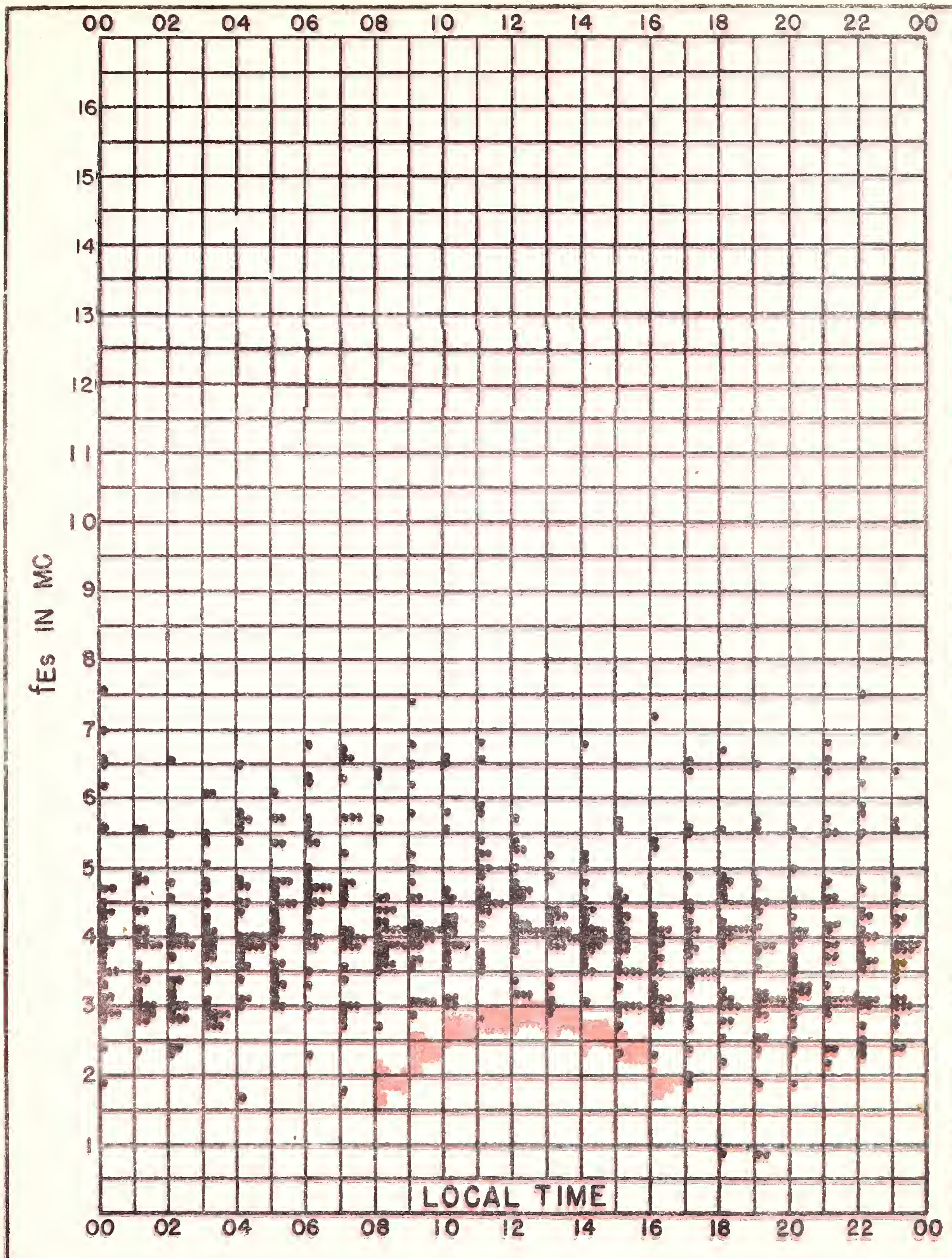

Fig. 11. WASHINGTON, D.C. DECEMBER, 1944

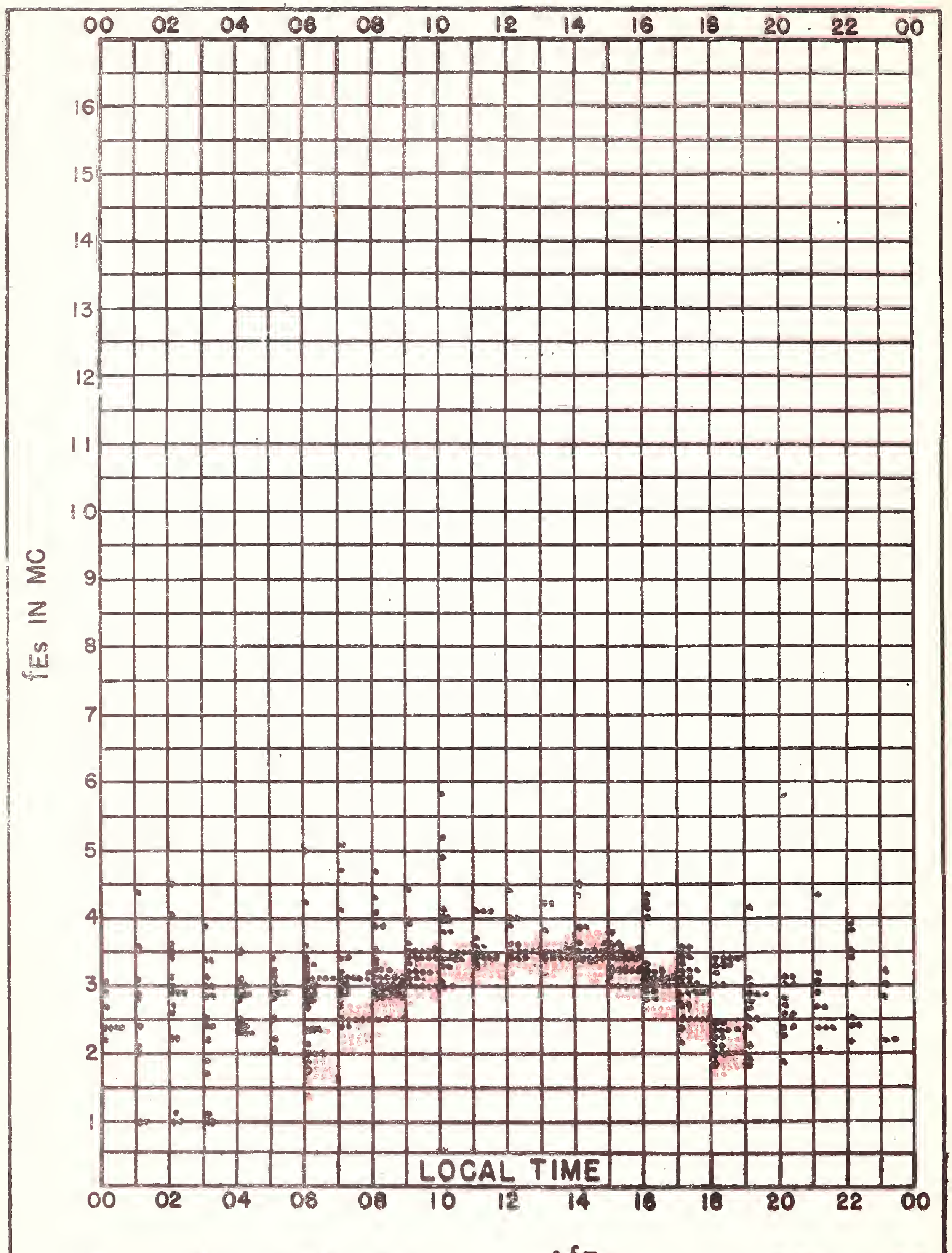

Fig. 12. WASHINGTON, D.C. APRIL, 1945

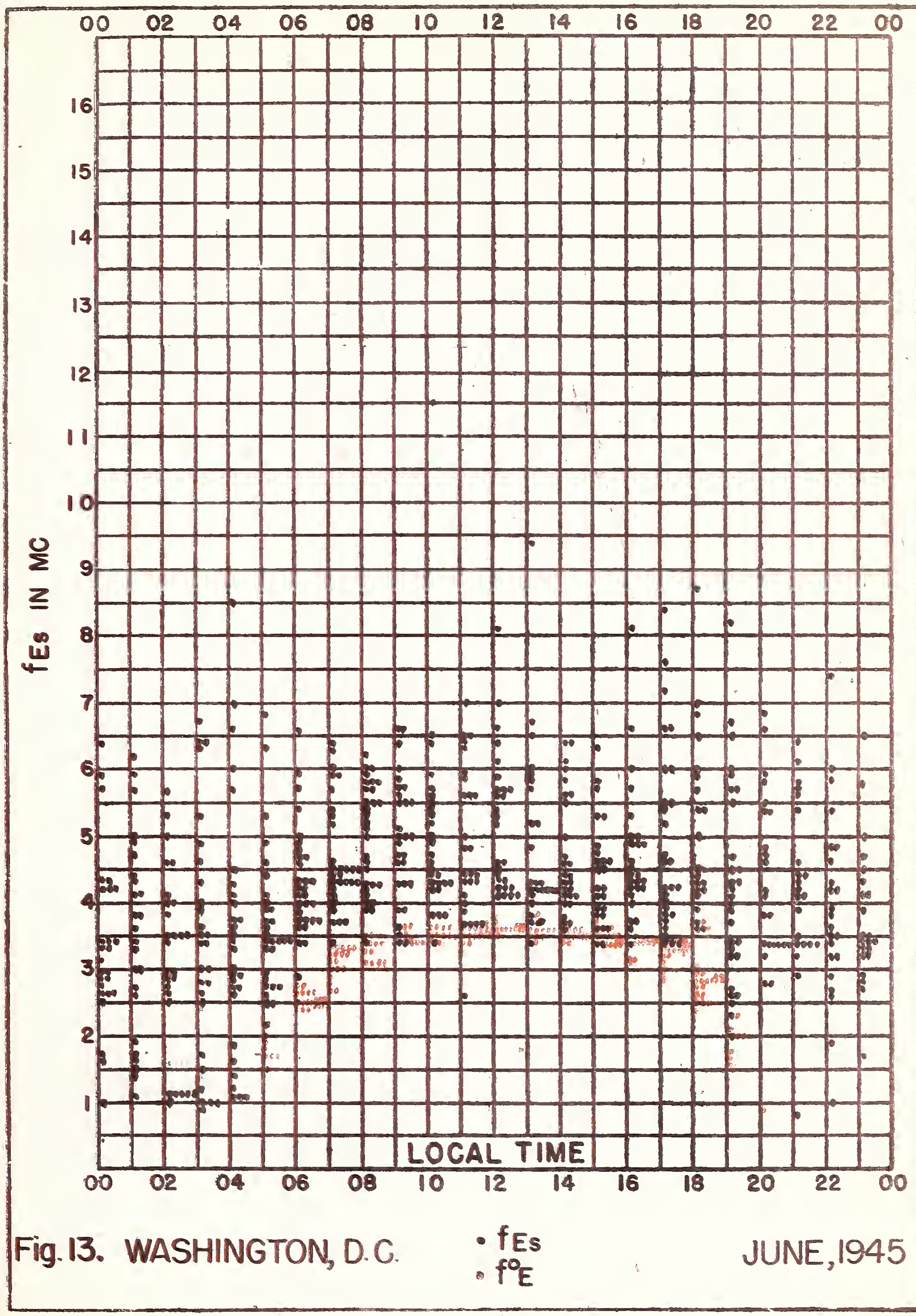

Fig. 13. WASHINGTON, D.C. JUNE, 1945

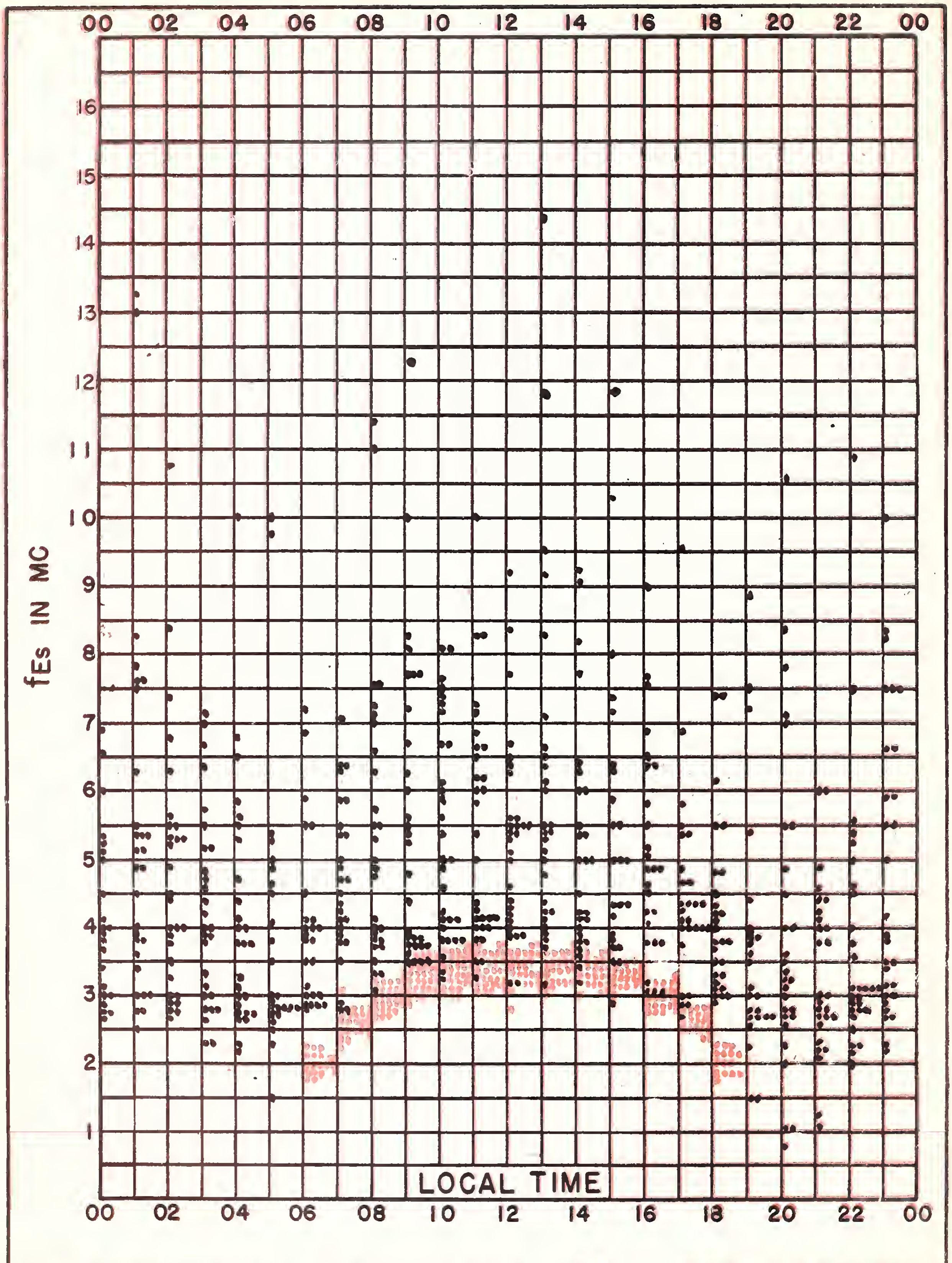

Fig. 14. WATHEROO, W. AUSTRALIA DECEMBER, 1944

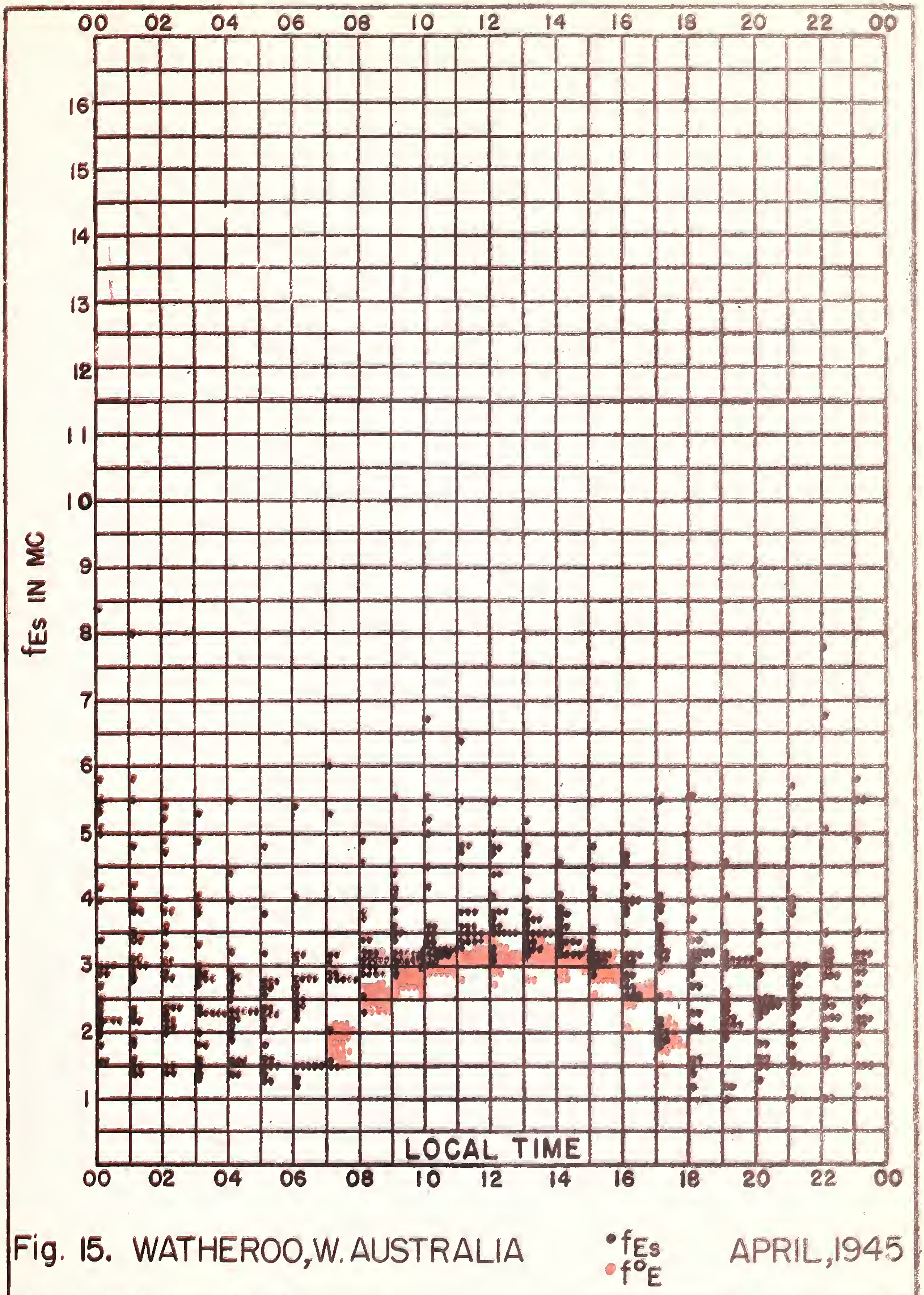

Fig. 15. WATHEROO, W. AUSTRALIA APRIL, 1945

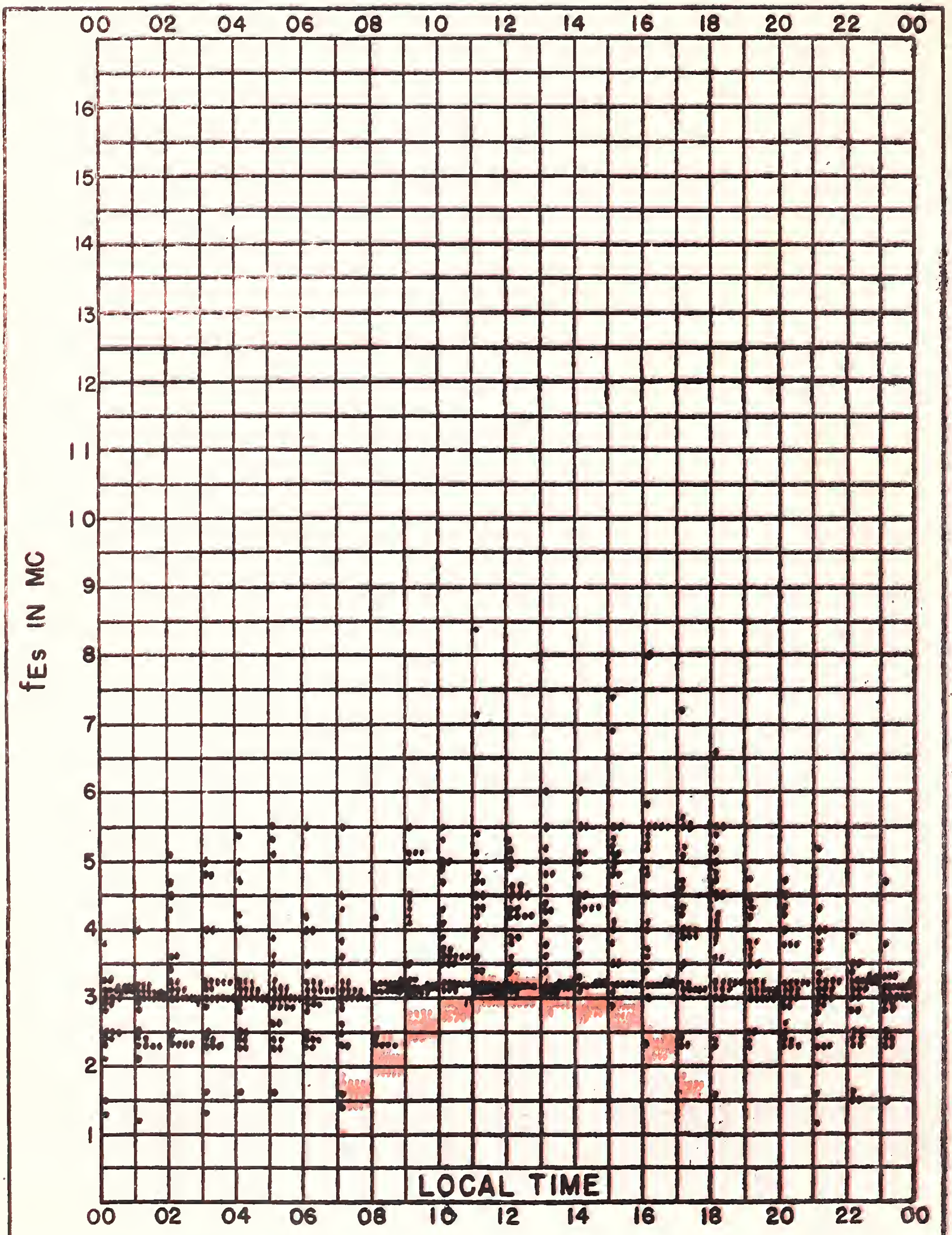

Fig. 16. WATHEROO, W. AUSTRALIA JUNE, 1945