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RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH,
INTENSITY AND FLARE AREA

Elske v. P. Smith

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UNITED STATES AIR FORCE
Bedford, Massachusetts

ABSTRACT

The relationship between several parameters of the H-alpha line at or near maximum is studied. These parameters are line width, central intensity, and flare area. The data were obtained from the I. A. U. Quarterly Bulletin. The correlations between any two of the three characteristics are quite loose, with large amounts of scatter as shown in the appended figures.

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY AND FLARE AREA

Ellison (1949, 1952) found that the H-alpha line-width in flares is correlated with the central intensity. His results were based on a homogeneous sample of data obtained with his spectrohelioscope-spectrograph combinations at Sherborne and Edinburgh. The relationship was linear up to an intensity of about 150 percent of the continuum, but beyond that point the width increased more rapidly with respect to the intensity. In his analysis of the flare of August 5, 1949, Svestka (1951) too found that H-alpha line profiles with large widths tend to have relatively small central intensities. Line widths determined photographically considerably exceeded visual estimates, hence the slope of the relationship between width and intensity depended upon the method of observation. The number of observations used in delineating Ellison's relationship was necessarily limited. For this reason we have used data reported in the IAU Quarterly Bulletin to ascertain whether one may formulate a unique relationship between the H-alpha line-width and central intensity.

Figures 1 a-e are the graphs of the maximum H-alpha width plotted against the central intensity in terms of the neighbouring continuum. Data from each observatory are handled separately to avoid differences due to instrumentation and techniques of reduction. Even with this precaution, the graphs show a large amount of scatter. The correlation is best shown on the plots obtained with data from Herstmonceux and Tashkent. We conclude that though width and intensity both tend to increase together, a strict relationship between the two parameters does not exist. The H-alpha line may be quite intense in some flares while yet having a relatively narrow profile. Similarly many flares have a wide H-alpha line without being very bright. In short, there is considerable variation from flare to flare.

One of the disadvantages in using data from the Quarterly Bulletin lies in the fact that there is no certainty that the data thus reported refer to the time of flare maximum. In a few cases it is possible to study the relationship between intensity and width during the course of the lifetime of a flare. From such studies it is then possible to gauge how much of the scatter in Figures 1 a-e may be attributed to the fact that the observations were not all made at the time of flare maximum. Figures 2 a-d show the relationship of width to intensity for several individual flares. Two of these were observed at Sacramento Peak, while data for the others were taken from papers by Svestka (1961) and by Ellison (1952). Note that both the intensity and

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wavelength scale differ for different flares to accommodate their respective ranges. These graphs indicate a considerable amount of scatter even for individual flares, though the variation from flare to flare is still much larger. The points plotted in Figures 2 a-d include measurements throughout the flare lifetimes; the sample is too small to determine whether the relationship would be improved by including only premaximum and maximum data. Ellison (1952) has shown from his development curves of central intensity and line width that the width decreases more rapidly after maximum than the intensity. The generally smaller widths for the post-maximum points of the September 2, 1960 flare tend to corroborate this conclusion.

That flare area, hence importance, is correlated with the H-alpha central intensity at time of maximum has long been known. Ellison (1952) for instance tabulates the average intensity for each importance classification. Dodson et al (1956) too have shown the relationship graphically on the basis of McMath-Hulbert data. Figures 3 a-e are again based on data reported in the Quarterly Bulletin. The scatter is so large in these graphs that one might almost doubt the reality of a relationship between area and intensity. In fact the mean points, indicated by x's on the graphs, show that the intensity increases only very slightly with increasing area. These mean points represent the mean of the intensity and area over a given area interval. Very few subflares are included in the Quarterly Bulletin, and their exclusion in Figures 3 a-e may well account for the apparent lack of a clear relationship. Miss Dodson's graph did include subflares (area < 2 square degrees) and even plage brightenings; the inclusion of these smaller phenomena greatly affect the appearance of the graph. The significance of subflares in an area-intensity relationship is also apparent from Sacramento Peak data (H. J. Smith 1962).

A similarly large scatter appears in the area-width relationship shown in Figures 4 a-f. This is hardly surprising in view of the loose correlation between area and intensity, and between width and intensity.

We may conclude, therefore, that although flares of large area (and hence great importance) are more likely to have H-alpha profiles with high central intensities and large widths than flares of small areas, nevertheless the three parameters are not closely interrelated.

The data from the Quarterly Bulletins used for this Note were extracted and plotted by Charles Fox, to whom I wish to make grateful acknowledgement. My thanks also go to Mrs. Margaret Smith for preparing the graphs reproduced here.

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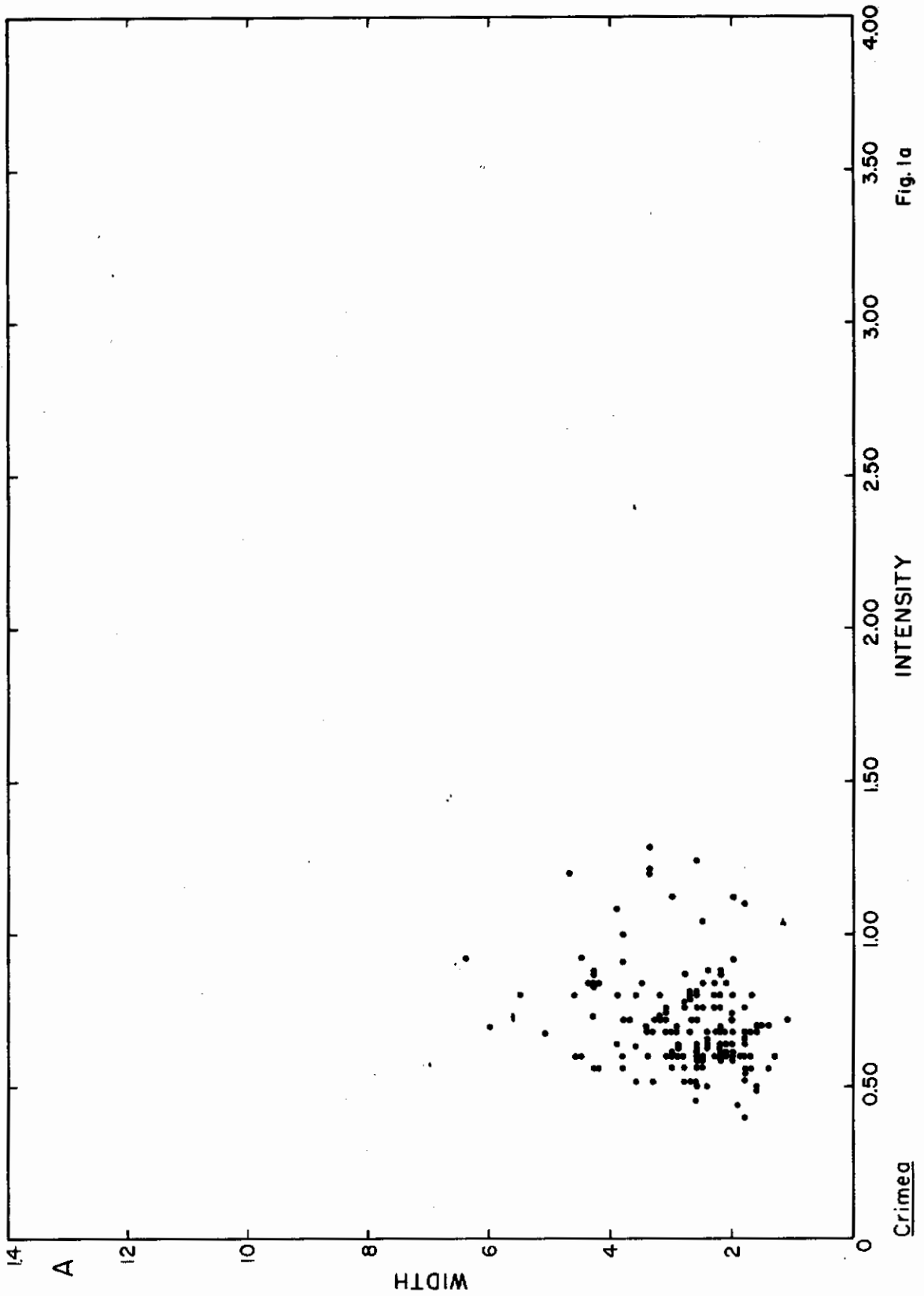


Fig. 1a

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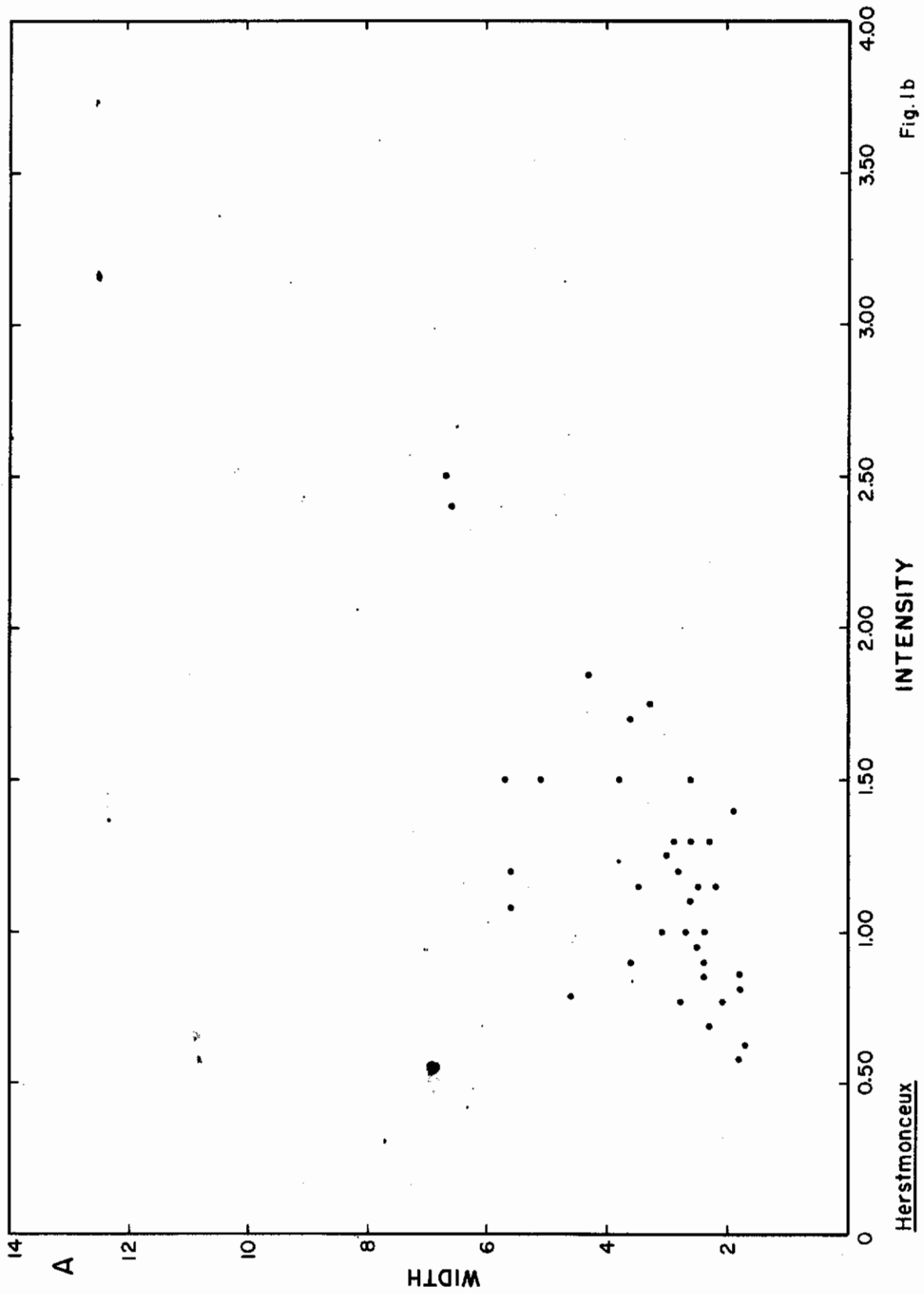


Fig. 1b

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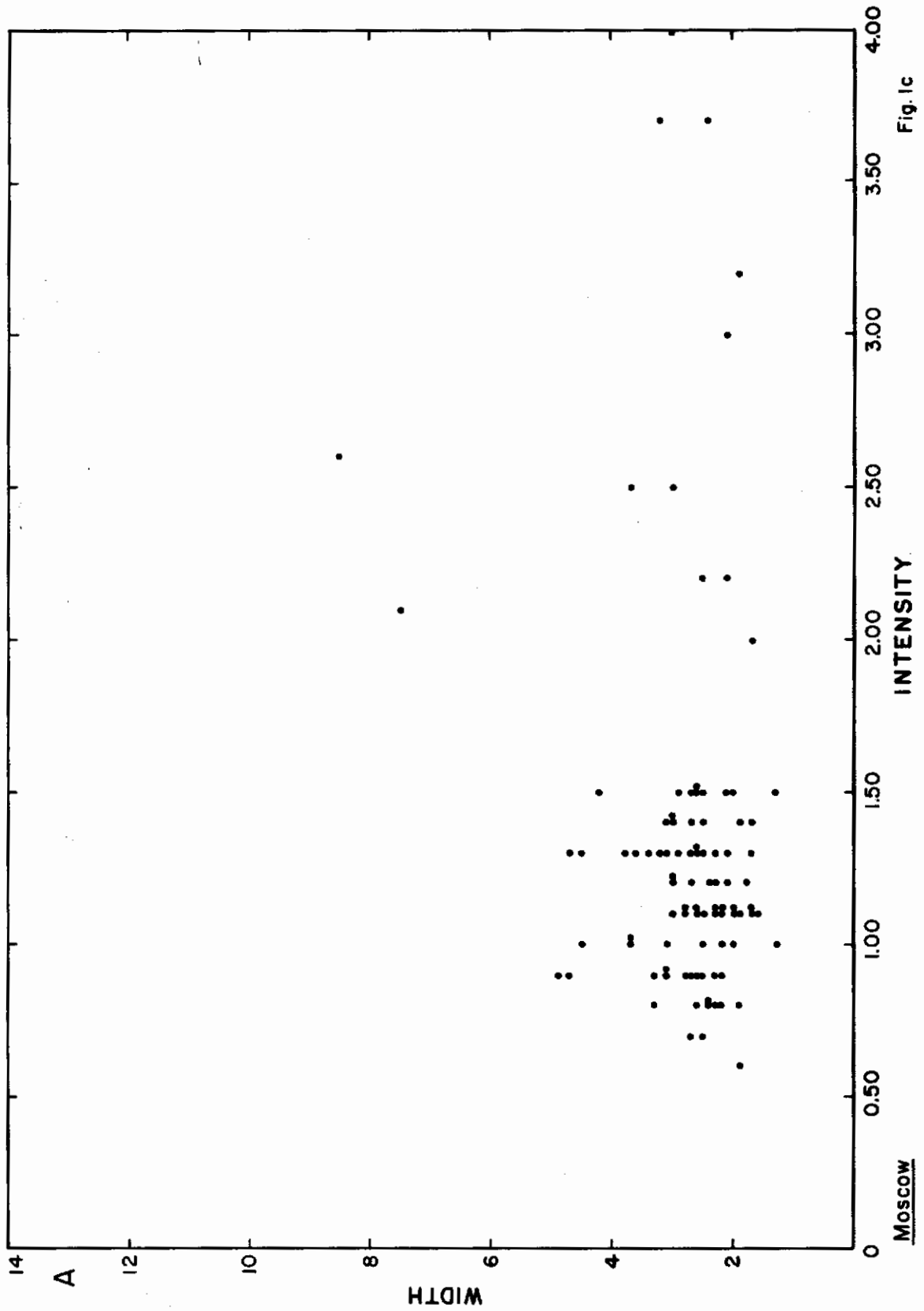
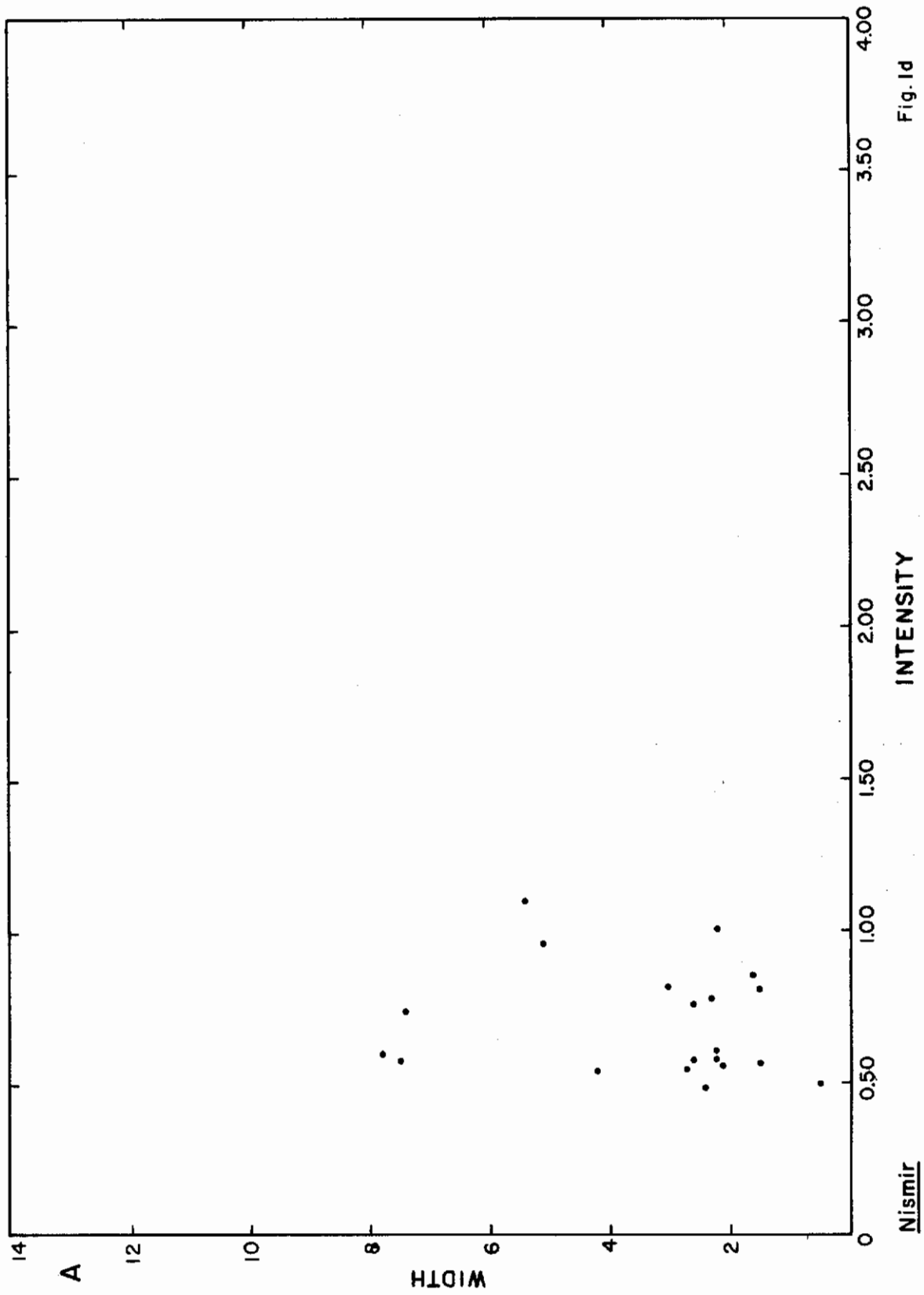
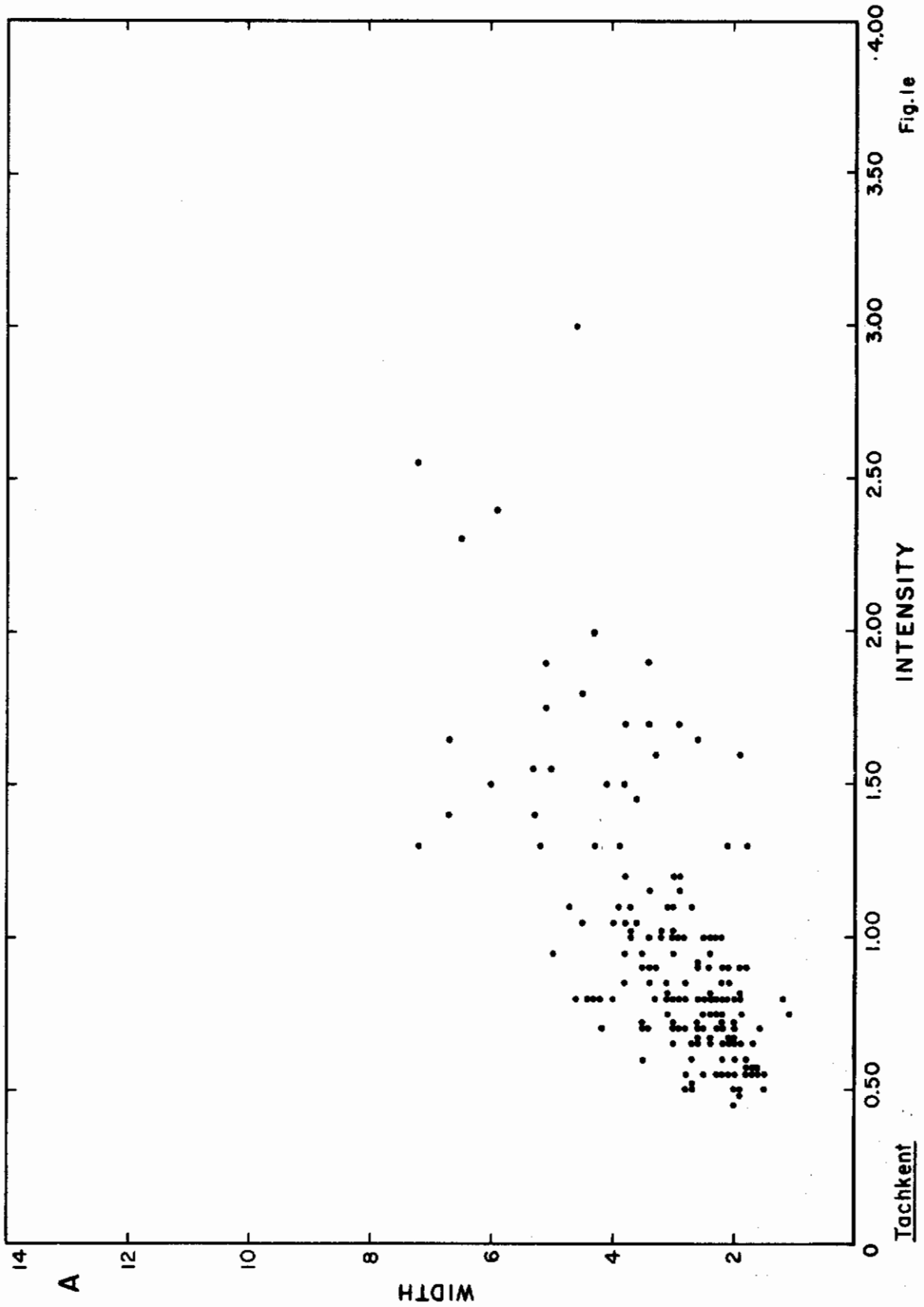


Fig. 1c

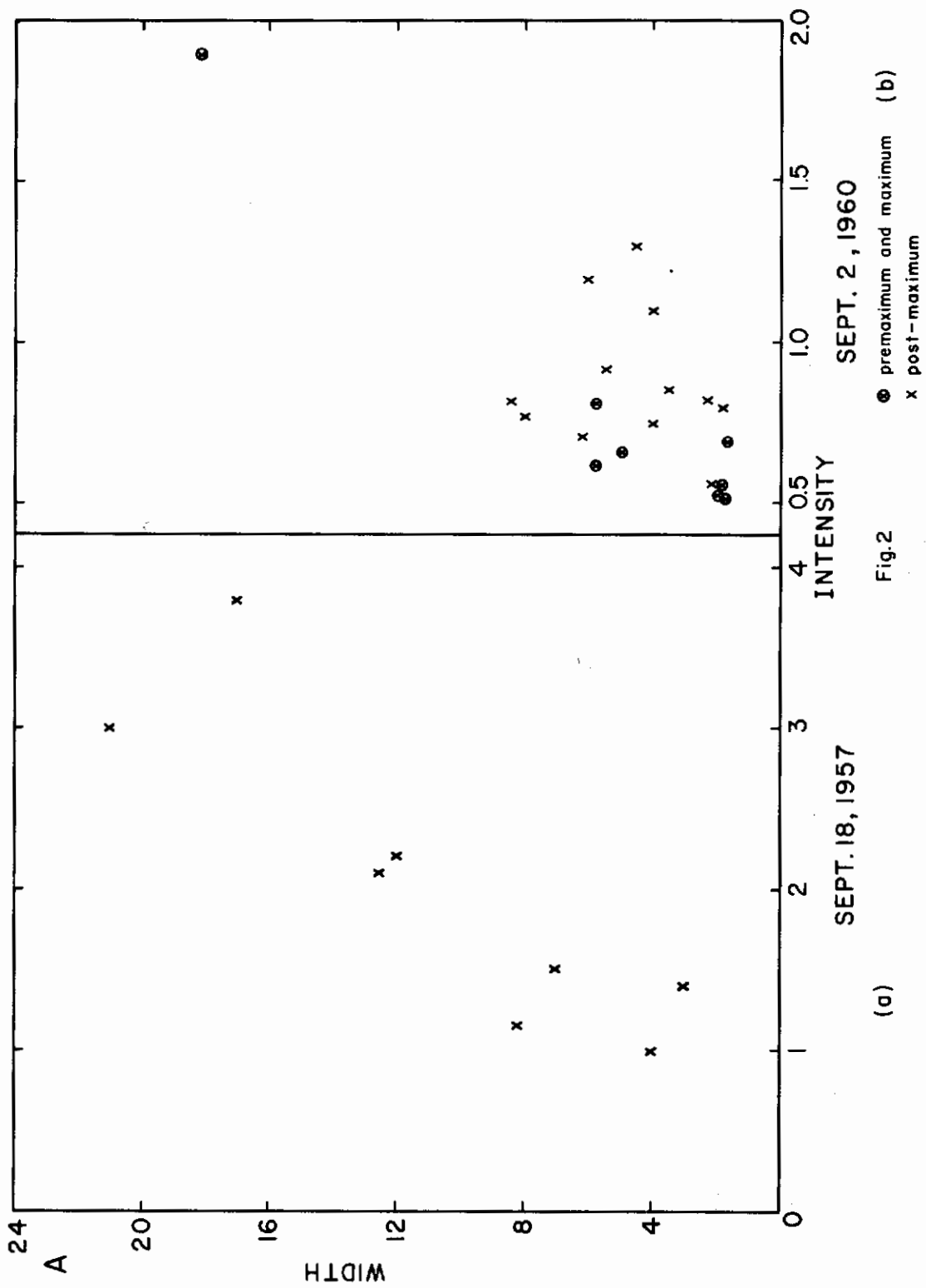
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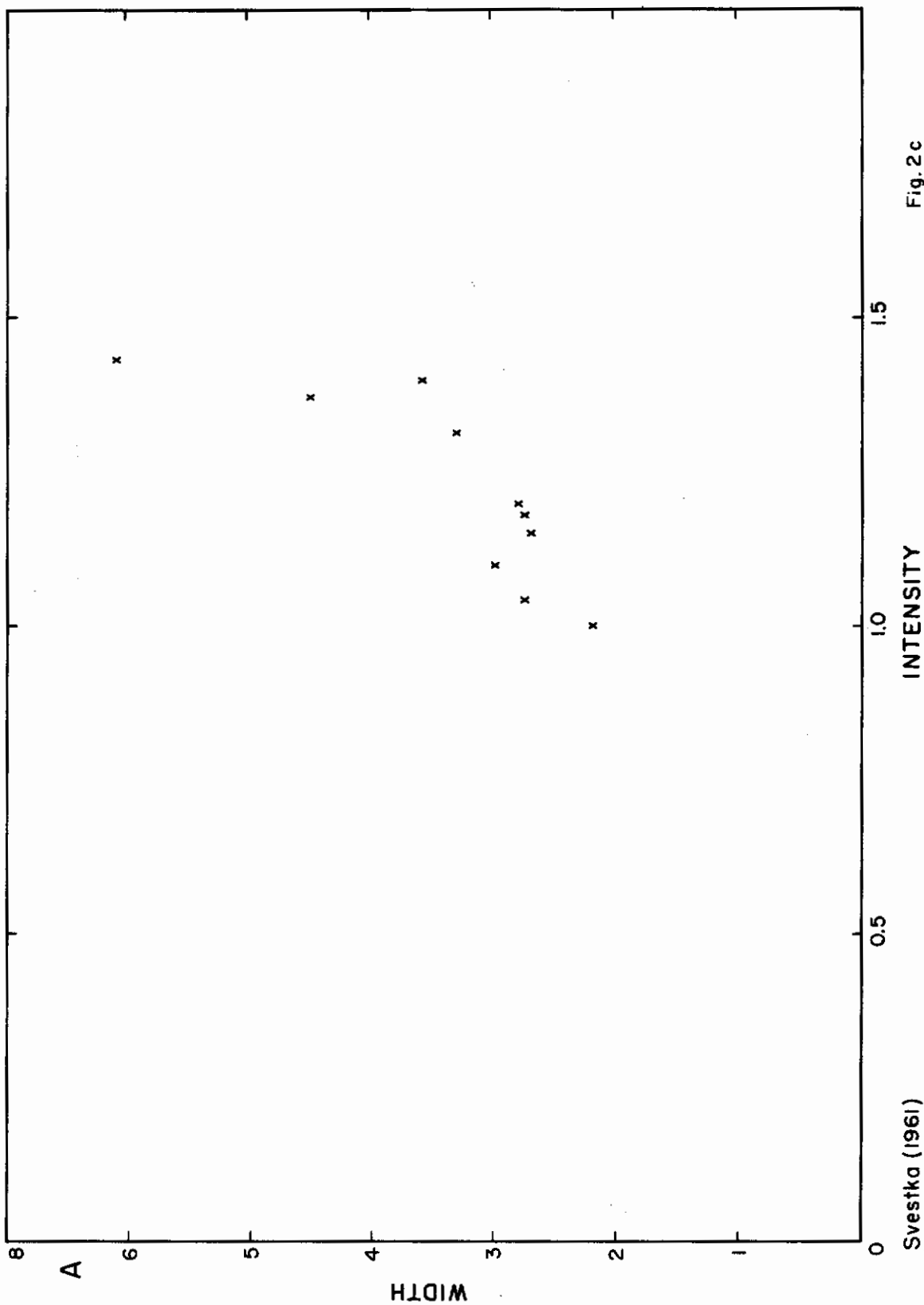
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(a)

Fig. 2

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Svestka (1961)
July 20, 1958

Fig. 2c

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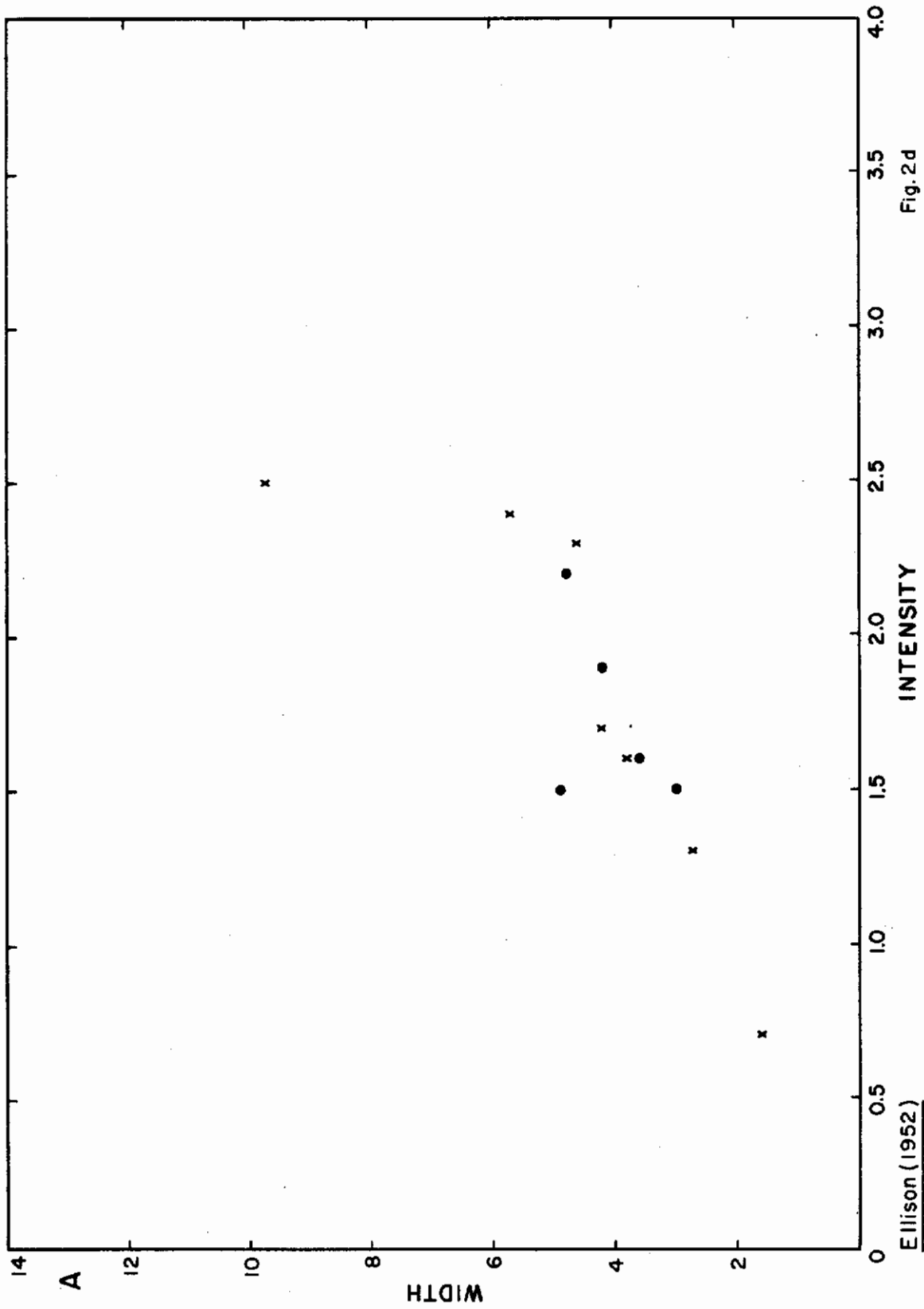


Fig. 2d

Ellison (1952)

x Sept. 15, 1951

• March 24, 1951

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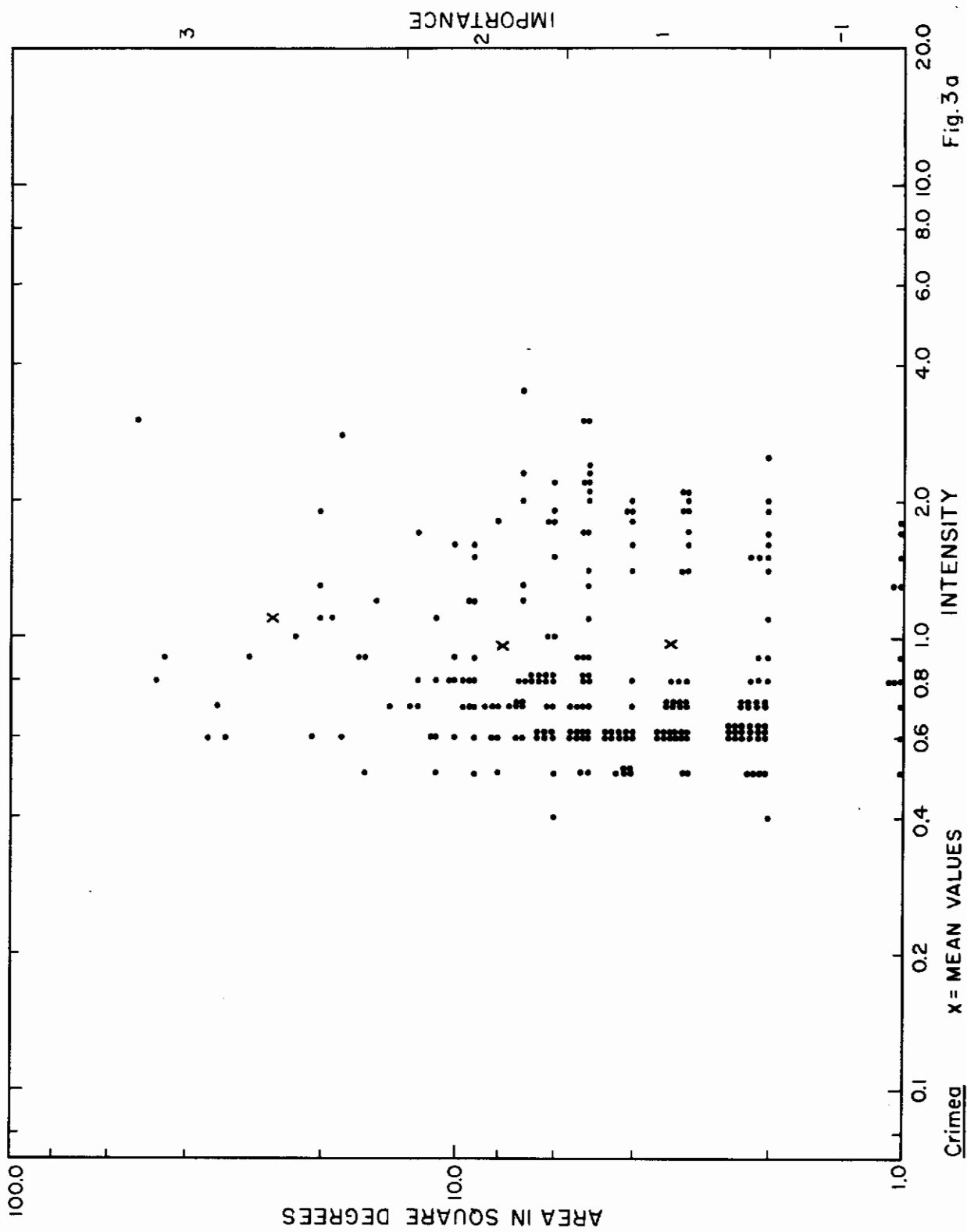


Fig. 3a

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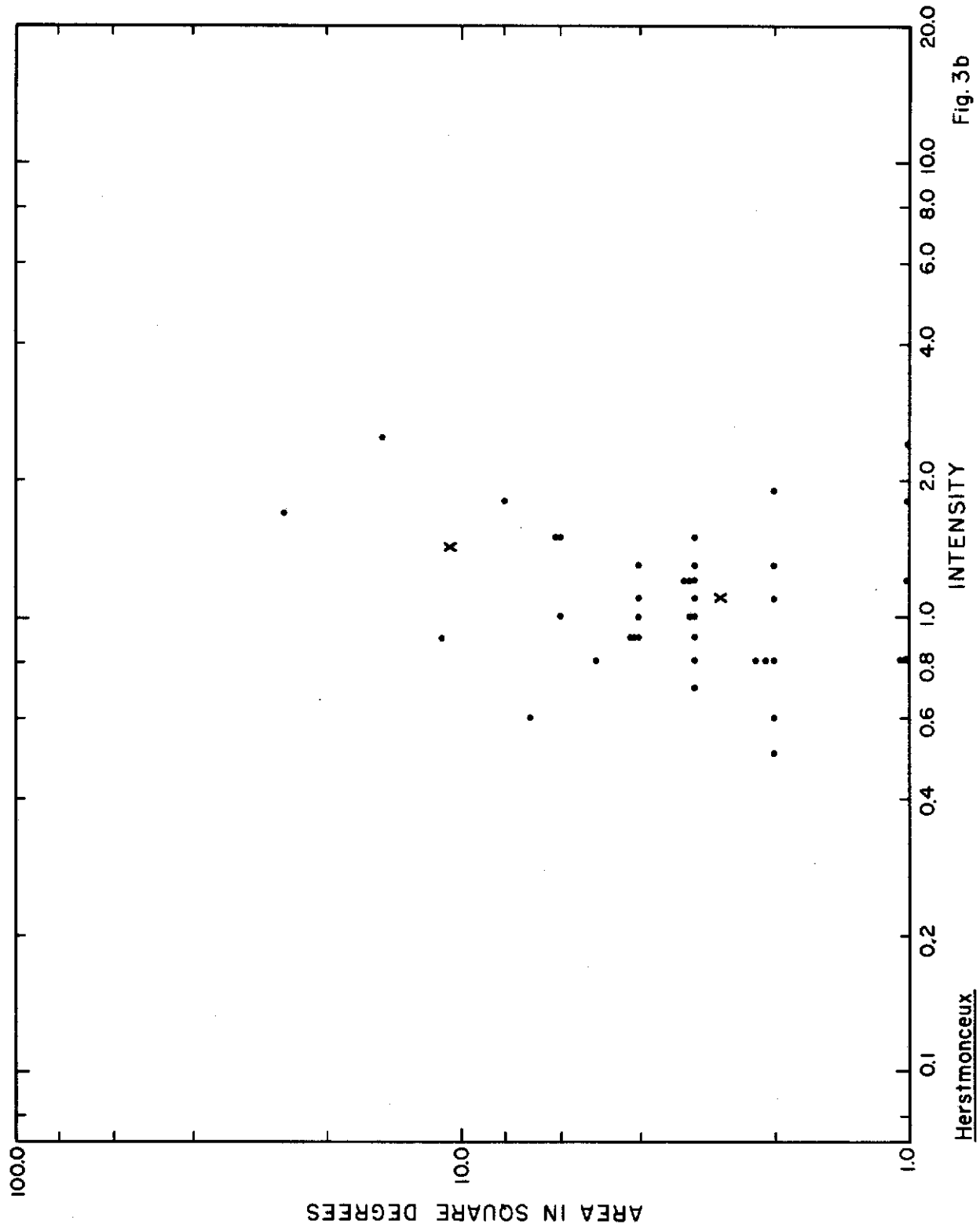
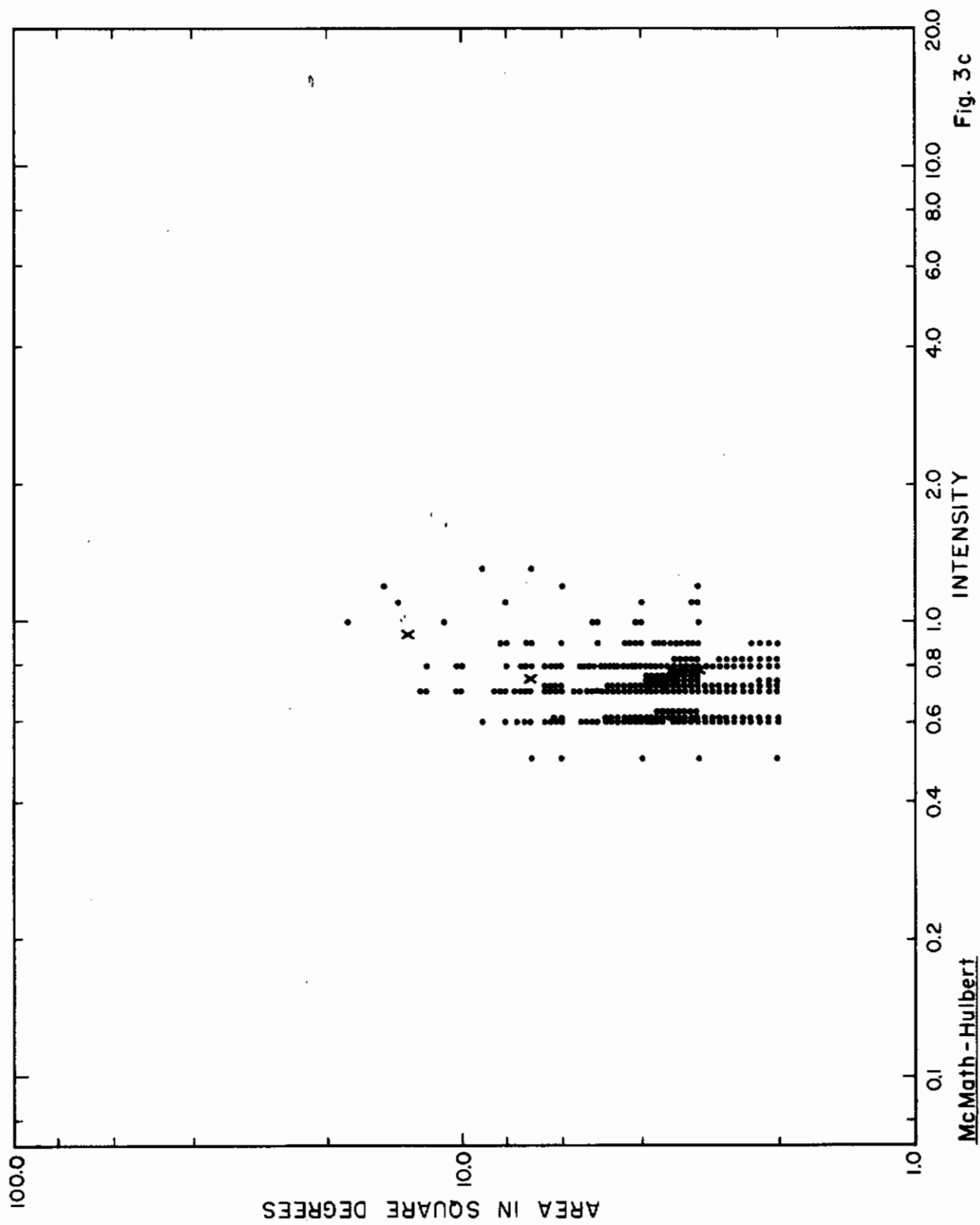


Fig. 3b

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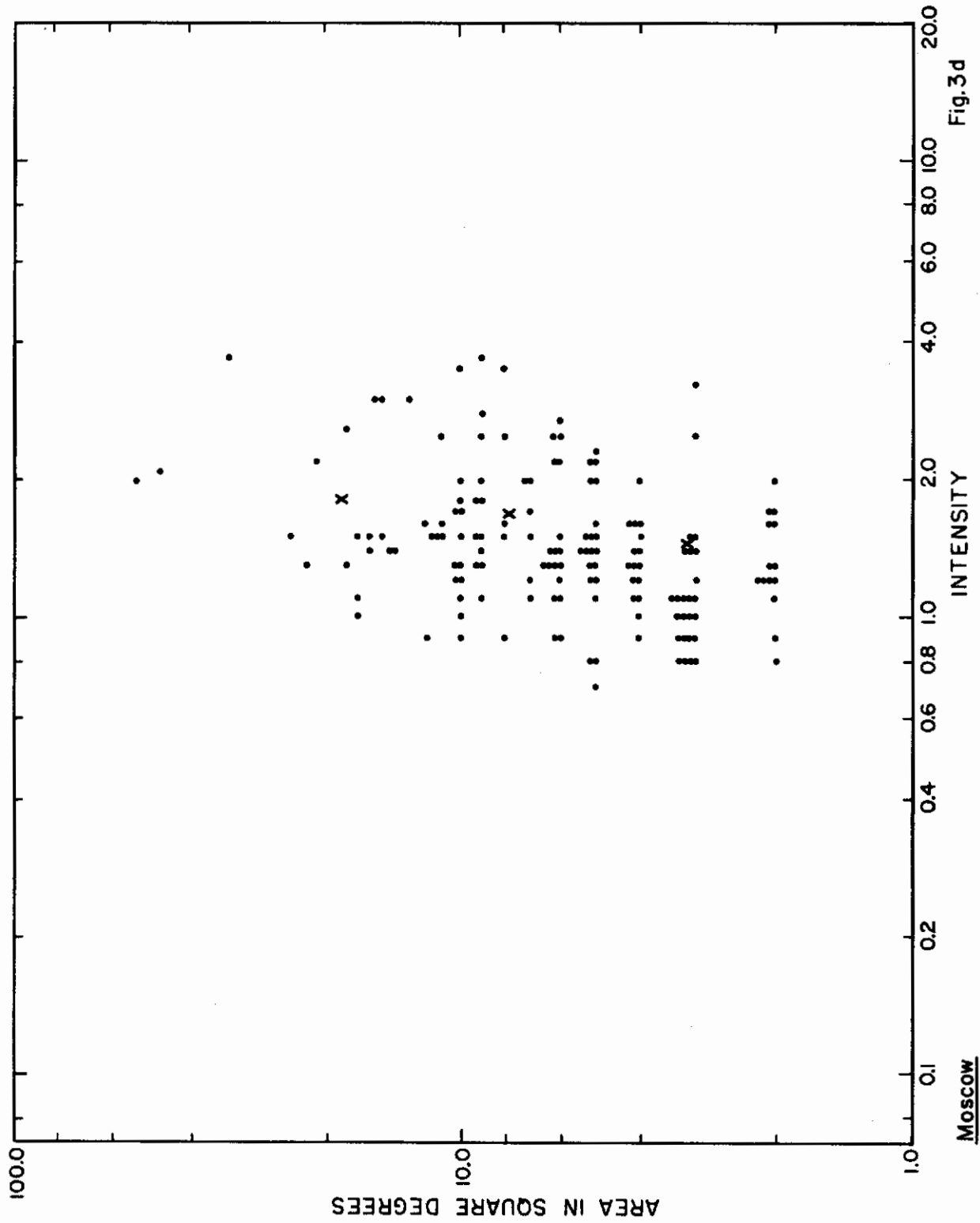


Fig.3d

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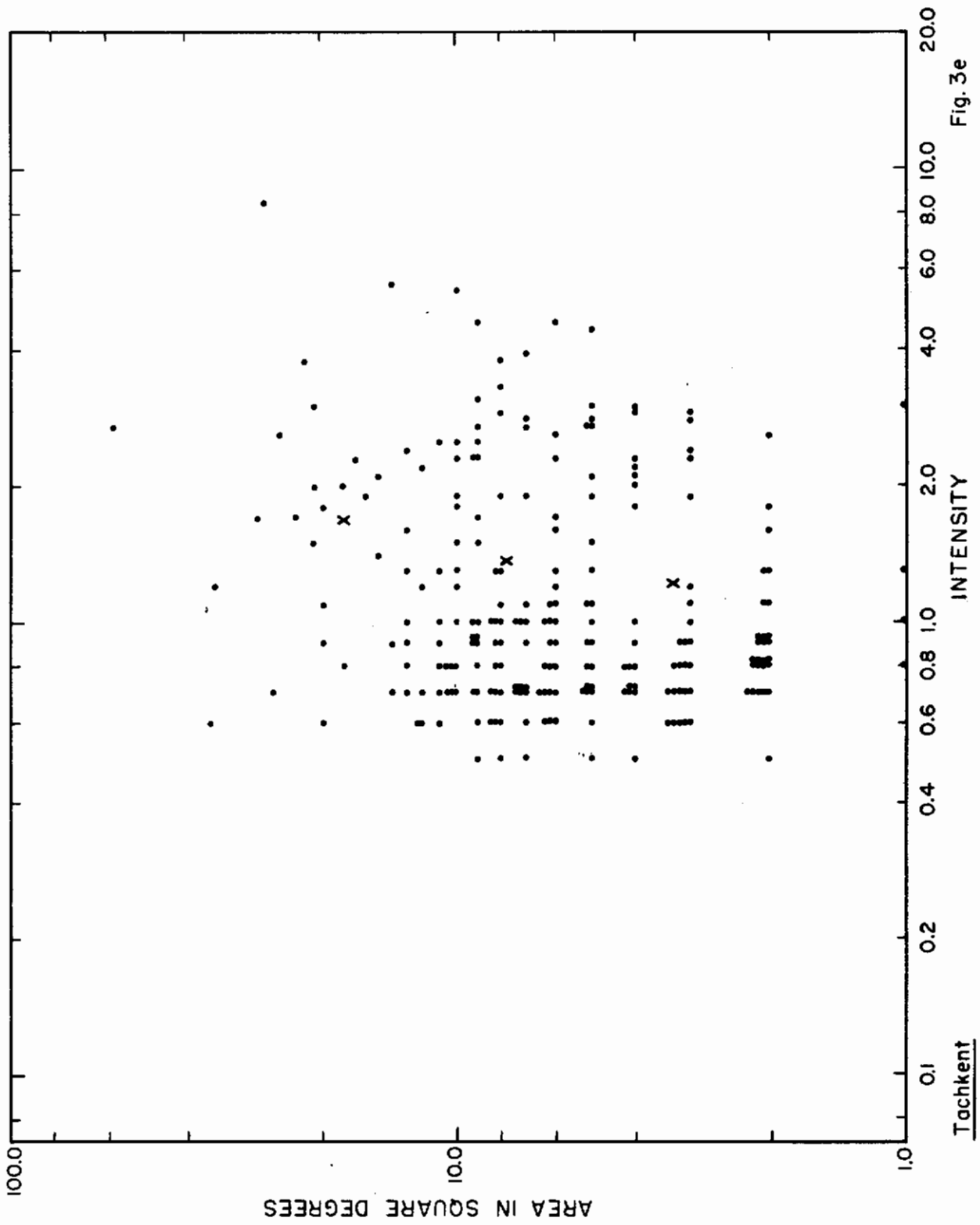


Fig. 3e

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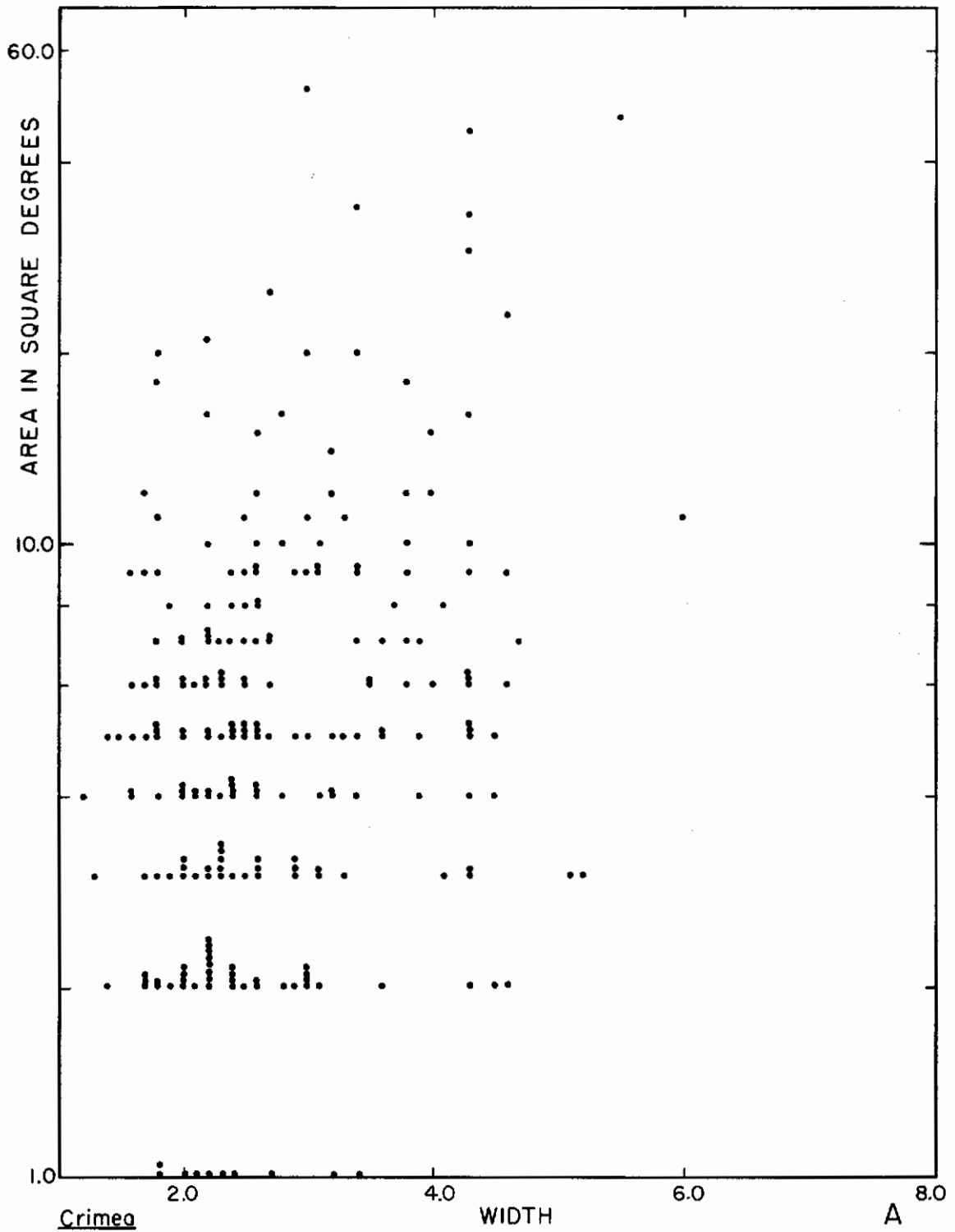
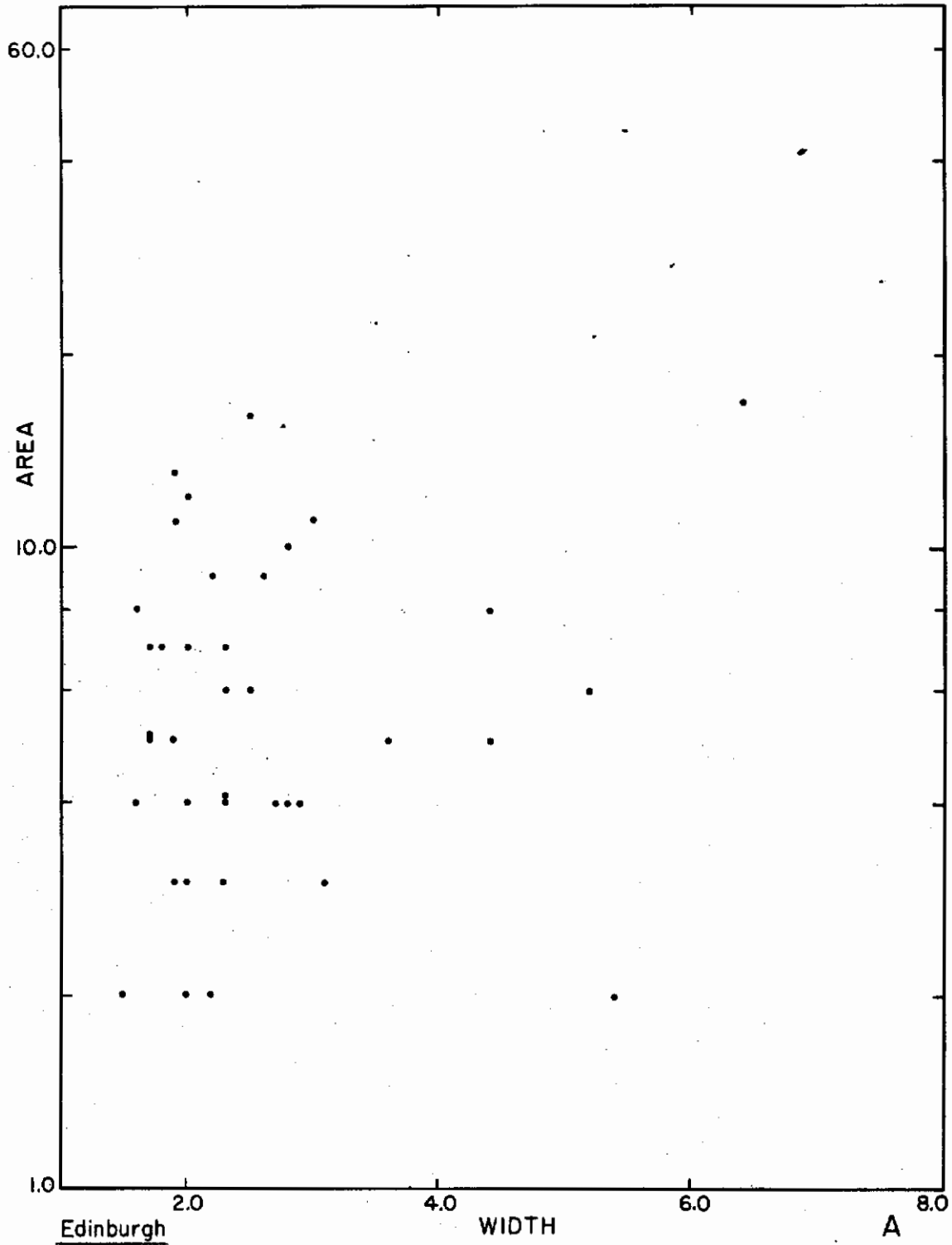


Fig. 4a

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WIDTH
Fig.4b

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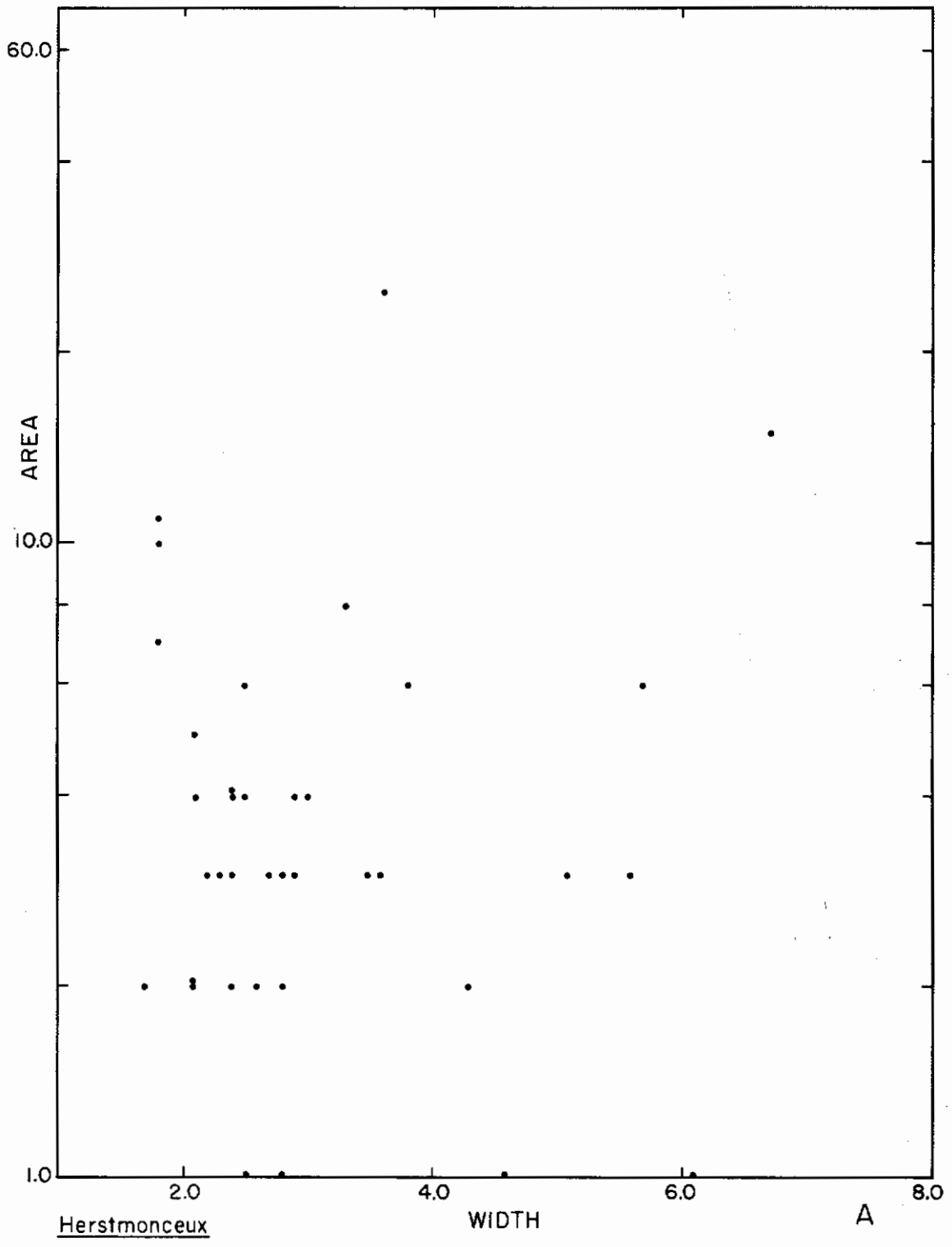


Fig.4c

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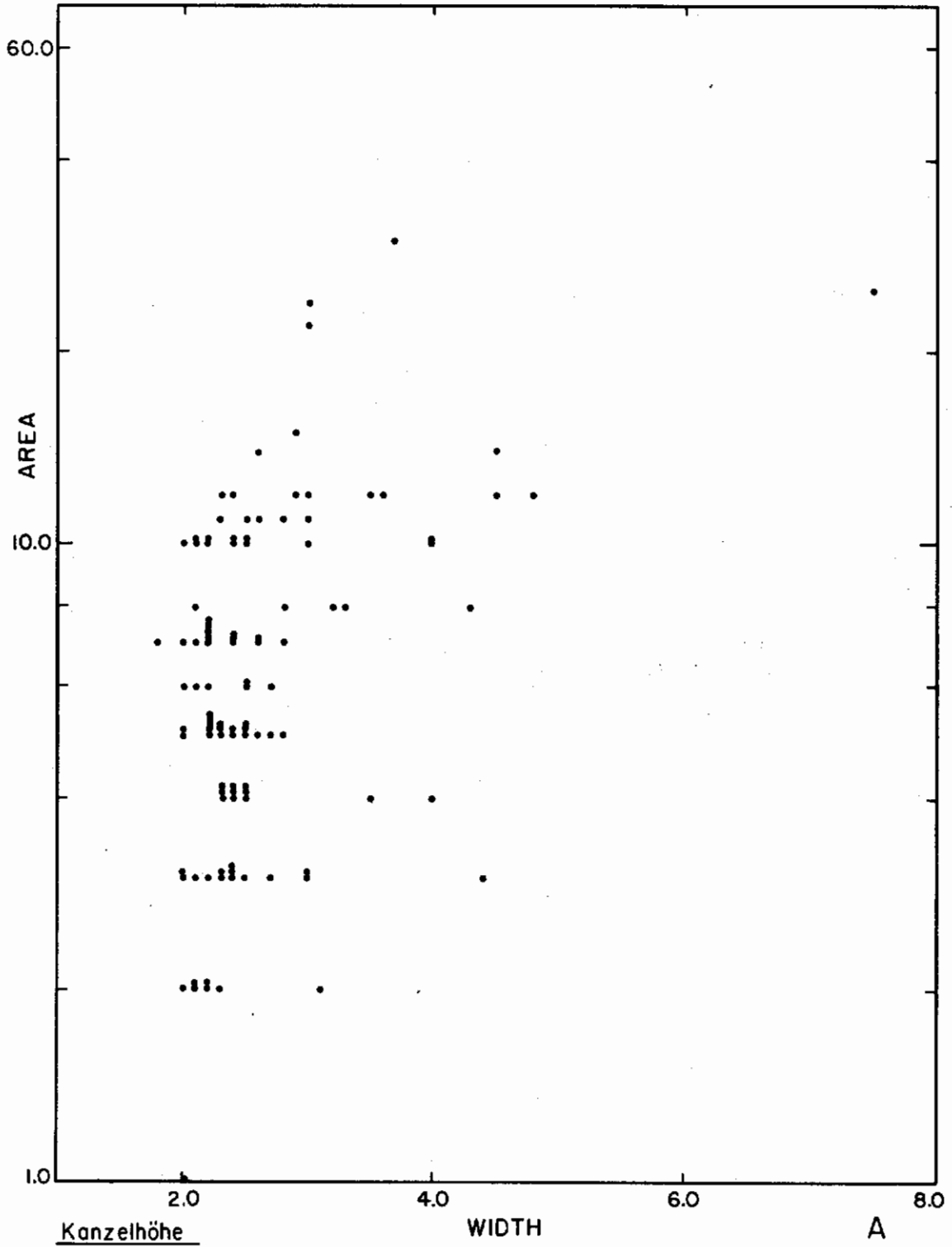


Fig.4d

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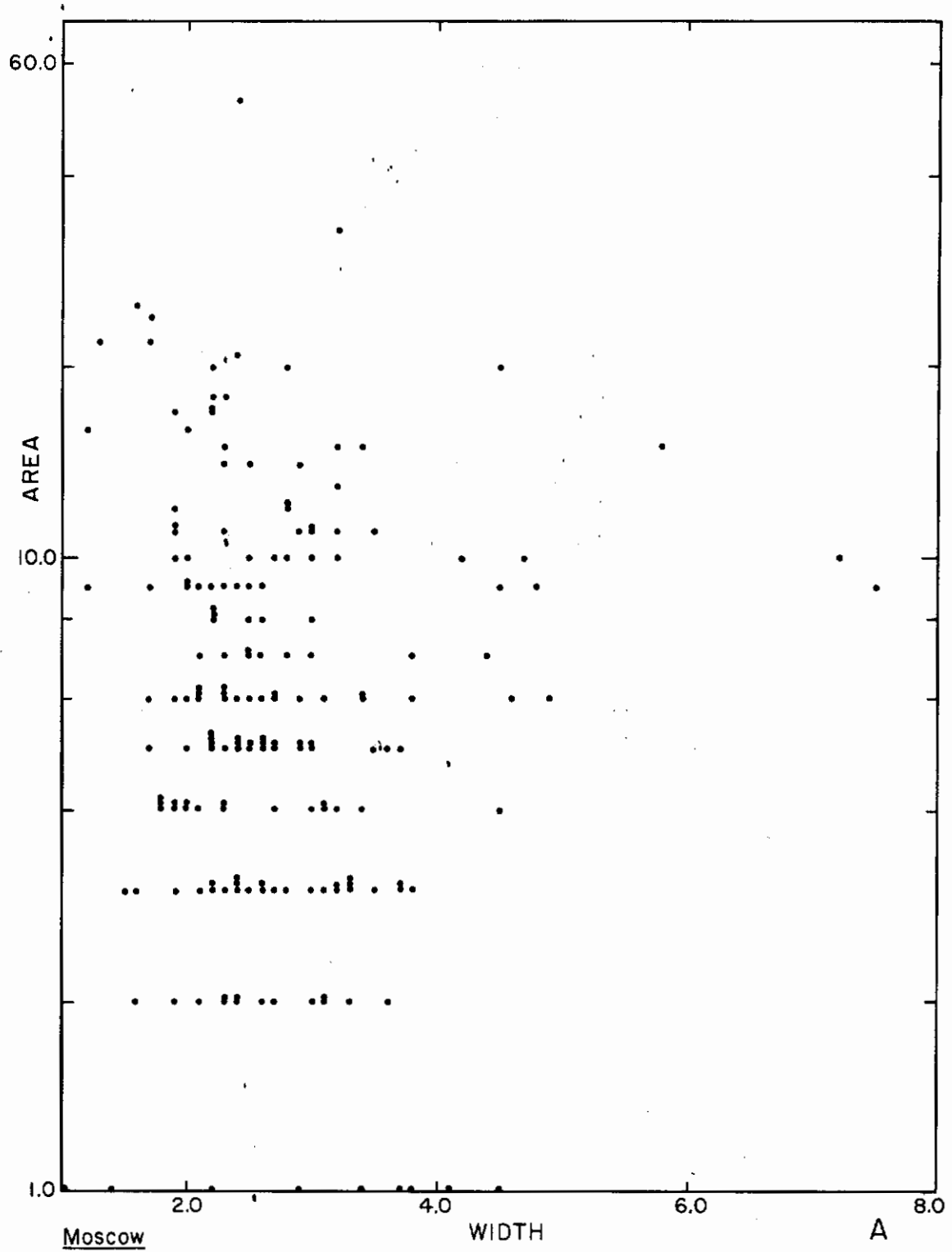


Fig. 4e

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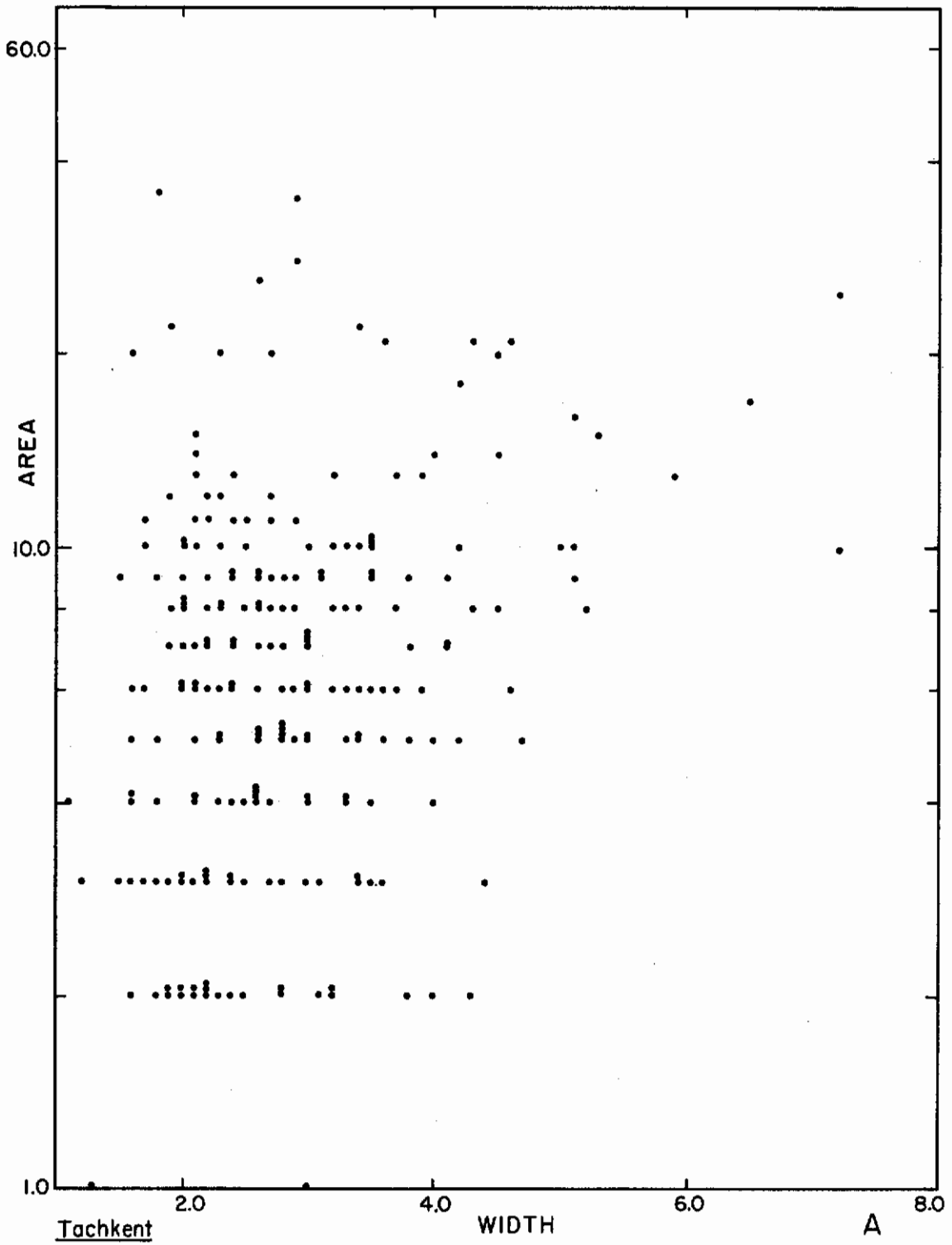


Fig.4f