A GNOMONIC STAR ATLAS*

BY REYNOLD K. YOUNG

THE following set of thirteen maps is intended to facilitate the observation of meteors and the plotting of their paths.

When a meteor passes the sky an observer may note its position from one point on its path and its direction or from two points on its path. Most observers prefer the first method. The one point is taken where most convenient, perhaps near a bright star or perhaps part way between two bright stars, and the direction is fixed by mentally producing the meteor track backward or forward to find some mark which would have been in line had the track been sufficiently long. A straight edge held along the path at the instant of observation will greatly assist in this operation. When the position of the meteor has been mentally fixed it should be traced on a star map with an arrow to indicate the direction of flight. Other things to be noted at the moment are, the time, the brightness, the color, the speed, the duration of flight and the character of the train left, if any, or other unusual circumstance.

The observer on studying the observations taken on any one night, among other things, should endeavor to locate points from which several meteors may have proceeded, the so-called radiants. These points are discovered by producing the observed paths backward. This operation is legitimate only on a celestial globe or on a star map so constructed that great circles are projected as straight lines. We know that the meteor is moving about the sun in consequence of the law of gravitation and that we see it in virtue of its encountering the earth on its way.

* A Gnomonic Star Atlas has already been published by R. A. Proctor. Several features of this map are distinctly different from the present Atlas.

Therefore the meteor, the earth and the sun lie in the orbit plane of the meteor. The observer sees the meteor where this plane cuts the celestial sphere and since the plane passes through the centre of the sphere (the earth) the observed path must be a portion of a great circle. It is evident then that the map used must have this property, that great circles in the sky are straight lines on the map; otherwise the produced portion of the meteor path will be in error.

The accompanying charts are constructed on the gnomonic or central projection which gives this desired property. The maps have been made especially for the convenience of meteor observers. It is hoped that the position of the stars as given will be found in general to be correct to within one-tenth of one degree for the epoch 1900. Nothing has been plotted which was deemed unnecessary and which might confuse the maps. All stars down to 5·0 magnitude inclusive have been plotted as well as the brighter variables. The right ascension circles for every hour and the declination circles for every ten degrees have been drawn in. In order to make the reading of positions from the map easier as well as more accurate, the intermediate positions of the right ascension circles for every twenty minutes and of the declination circles for every five degrees have been indicated. This procedure avoids the confusion which might result if all the lines had been drawn in full. The generous overlapping of the charts will prove helpful.

For those who may desire to add the positions of objects or compute the position of the radiants rather than read them off from estimation of their distance from the hour and declination circles, the method of construction of the maps is briefly outlined.

For the circumpolar map, the celestial sphere is imagined cut by a plane which includes a segment of the sphere sixty degrees in diameter. Any point in this segment is projected on the plane by joining it to the centre of the sphere. The north celestial pole may be called the axis of projection. The right ascension circles are straight lines uniformly distributed around the pole and the declination circles remain circles the distance from the pole being given by the formula

$$r = 5{\cdot}89 \cot \delta,$$

where r is the radius of the circle in inches and δ is the declination of the circle under consideration.

For the next six maps, the axis of projection lies at forty-five degrees declination and right ascension successively, zero hours, four hours . . . . twenty hours. If we call the axis of projection of any map the point (0·0) in cartesian co-ordinates, x being the abscissa and y the ordinate, δ the declination of a star and (a) the angle between the hour circle passing through the axis of projection and that one passing through the stars, the following relations hold :—

$$x = 5{\cdot}89\sqrt{2}\ \frac{\tan (a) \cot \delta}{\sec (a) + \cot \delta} \qquad (1)$$

$$y = 5{\cdot}89\ \frac{\sec (a) - \cot \delta}{\sec (a) + \cot \delta} \qquad (2)$$

The equation to the right ascension circles is

$$x = \frac{\tan (a)}{\sqrt{2}}[5{\cdot}89 - y] \qquad (3)$$

and to the declination circles

$$(5{\cdot}89 - y)^2 - (5{\cdot}89 + y)^2 \cot^2 \delta + 2\,x^2 = 0. \qquad (4)$$

The axis of projection for the next set of six maps lies on the equator and at right ascension zero hours, four hours . . . . . as before. With the same notation

$$x = 5{\cdot}89 \tan (a). \qquad (5)$$

$$y = 5{\cdot}89 \sec (a) \tan \delta. \qquad (6)$$

The equation to the right ascension circles is

$$x = 5{\cdot}89 \tan (a), \qquad (6)$$

and to the declination circles

$$y^2 \cot^2 \delta - x^2 = (5{\cdot}89)^2. \qquad (7)$$

The co-ordinates throughout are measured in inches.

The method of computing the position of points on the chart by means of the foregoing equations will now be illustrated by an example.

Let it be required to find the positions of α Arietis from the first chart of the set whose axis of projection lies at 45 degrees declination. By measurement we find $x = 3{\cdot}275$ inches, $y = -2{\cdot}02$ inches.

Substituting these values in equation (3) log tan $(a) = 9{\cdot}7675$. Whence $a = 30^\circ{\cdot}35$ or

$$a = 2 \text{ hours } 1{\cdot}4 \text{ minutes.}$$

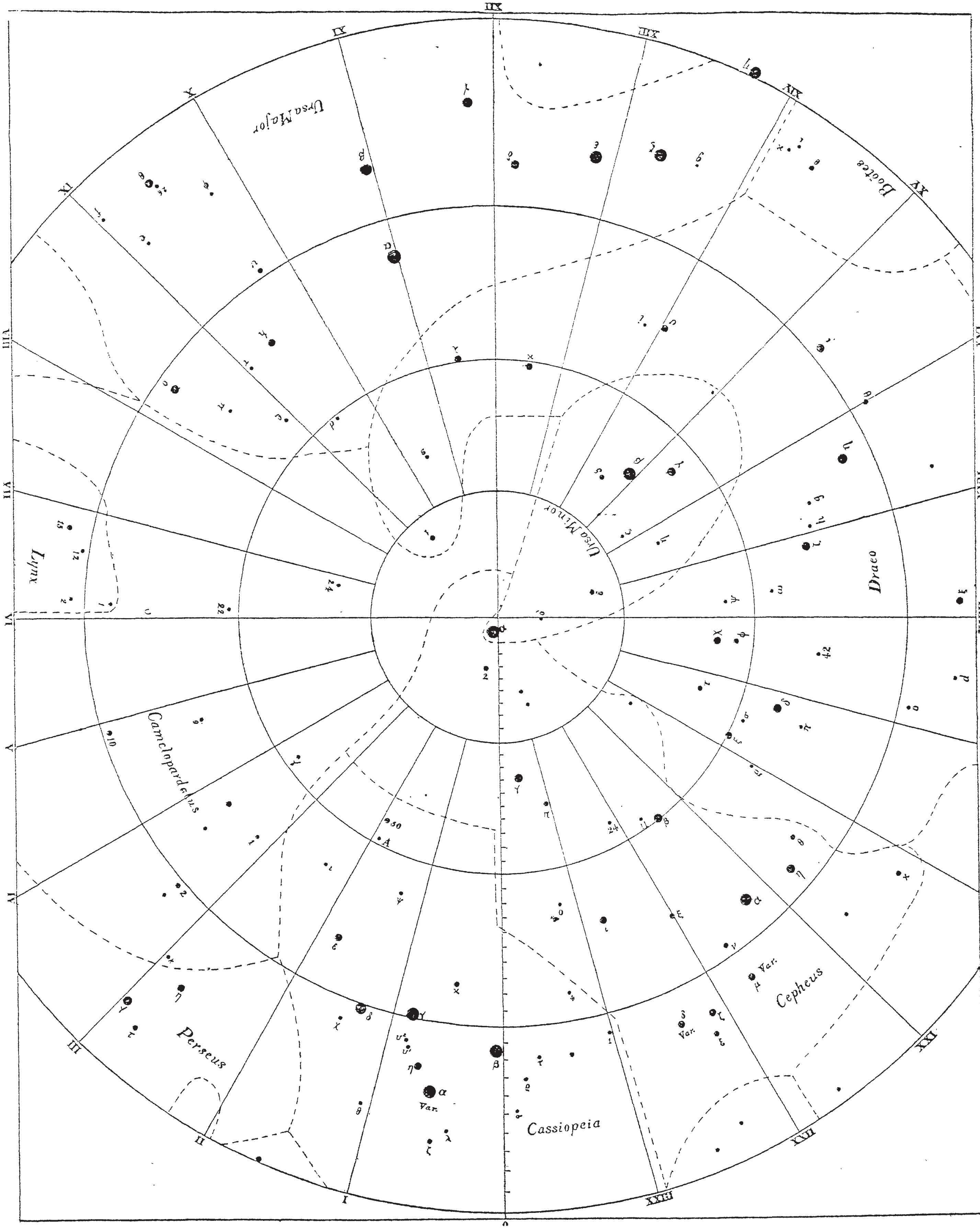
Correct α as catalogued, 2 hours 1·5 minutes.

Either equation (1) or (2) will now serve to determine δ. Substituting in (1) we obtain log cot $\delta = 0{\cdot}2743$, whence $\delta = 22^\circ\ 54'$; δ as catalogued $= 22^\circ\ 59'$.

The numerical co-efficients in the preceeding equations and also the measurements were computed on the basis of the width of the maps being ten inches. Owing to slight variations in the sizes of the maps, due either to errors in the photo-engraving or shrinkage in the paper, this is not the case. The observer must, therefore, measure the width of the chart he is using from outside border to border and multiply the constant 5·89 by whatever fraction of ten inches he finds the width of the map to be.

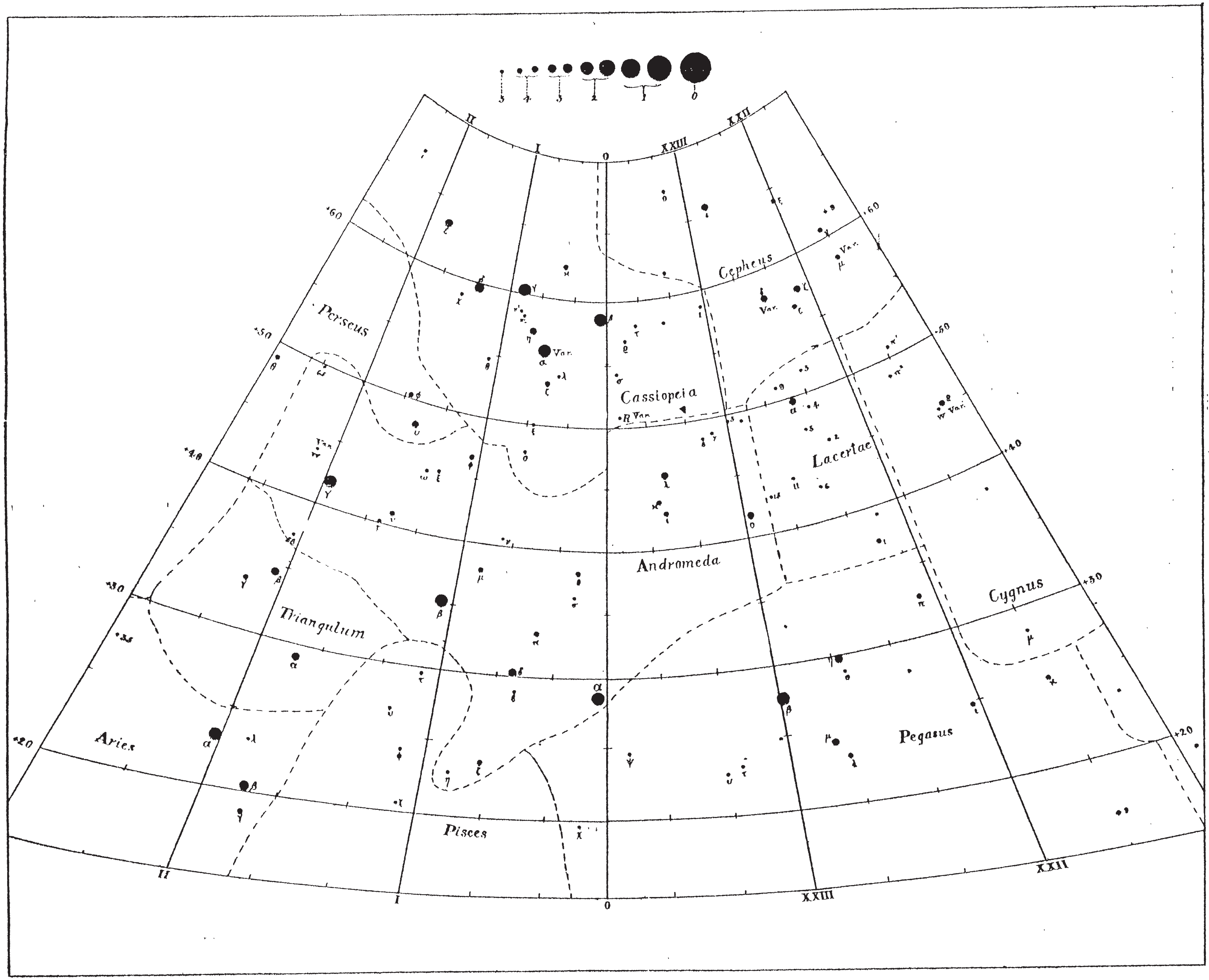
GUIDE TO THE CONSTELLATIONS

GIVING THE MAPS ON WHICH THE CONSTELLATIONS ARE TO BE FOUND

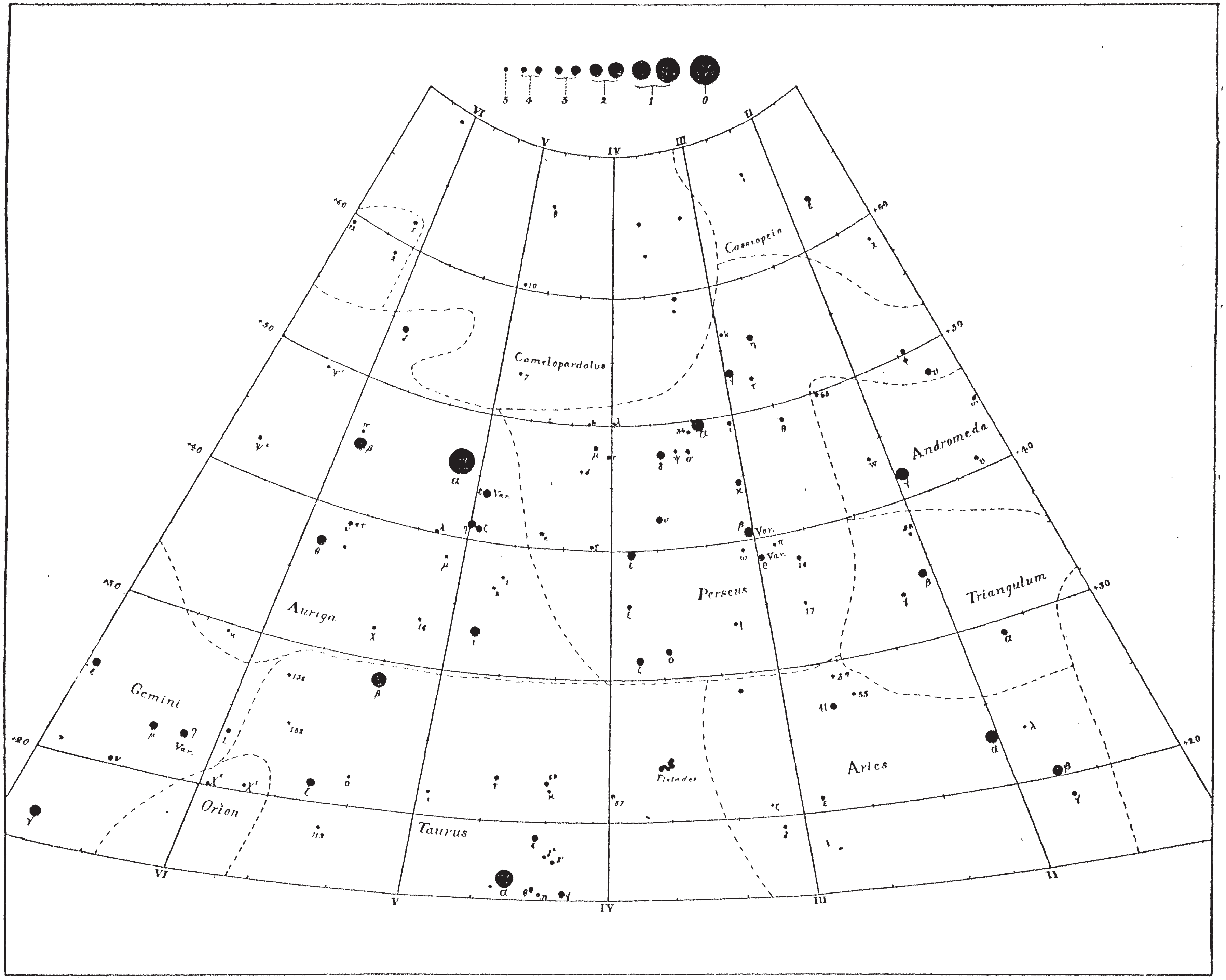


MAP I.—CIRCUMPOLAR

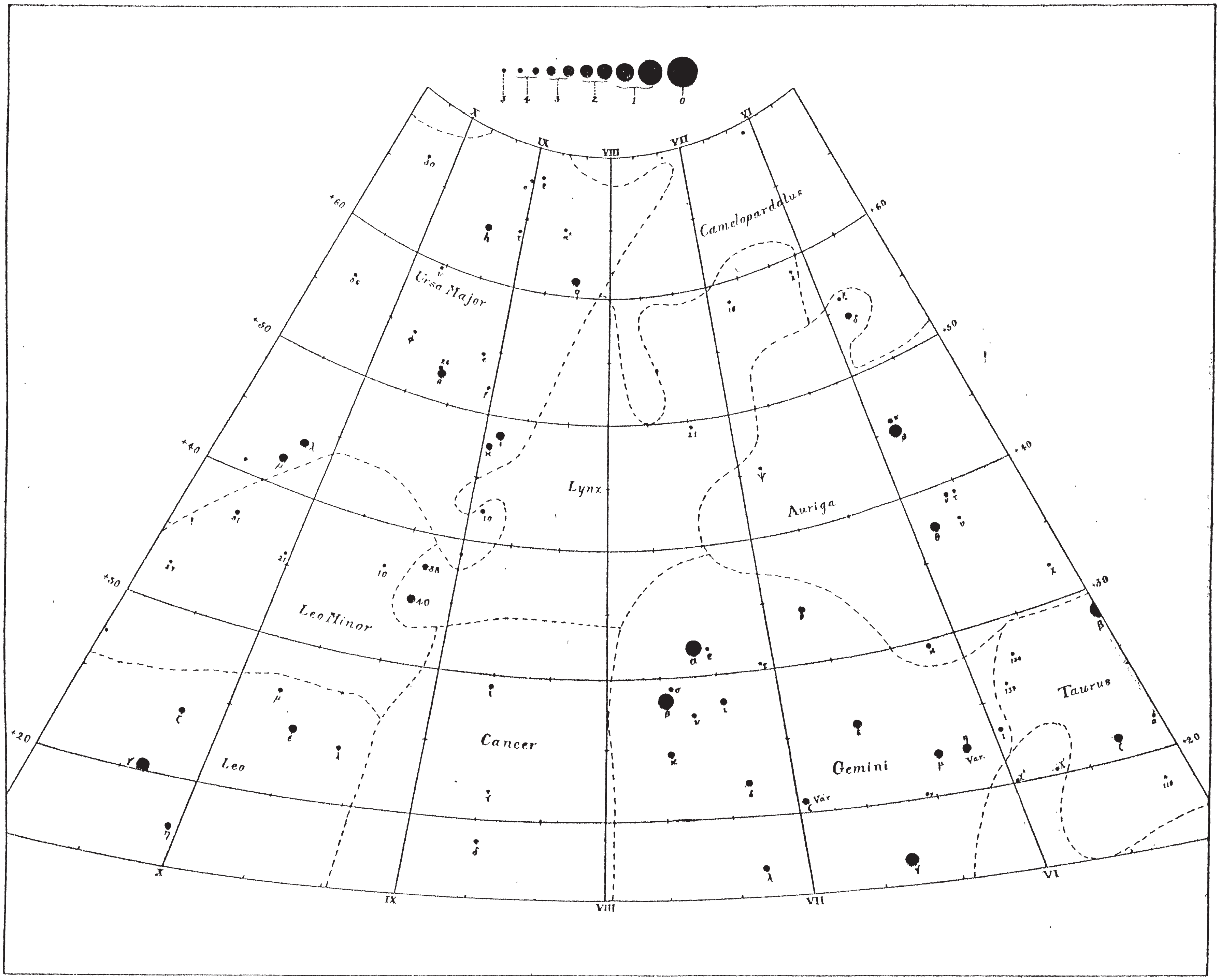
MAP II.—A.R. 0 hours, Decl. + 40°



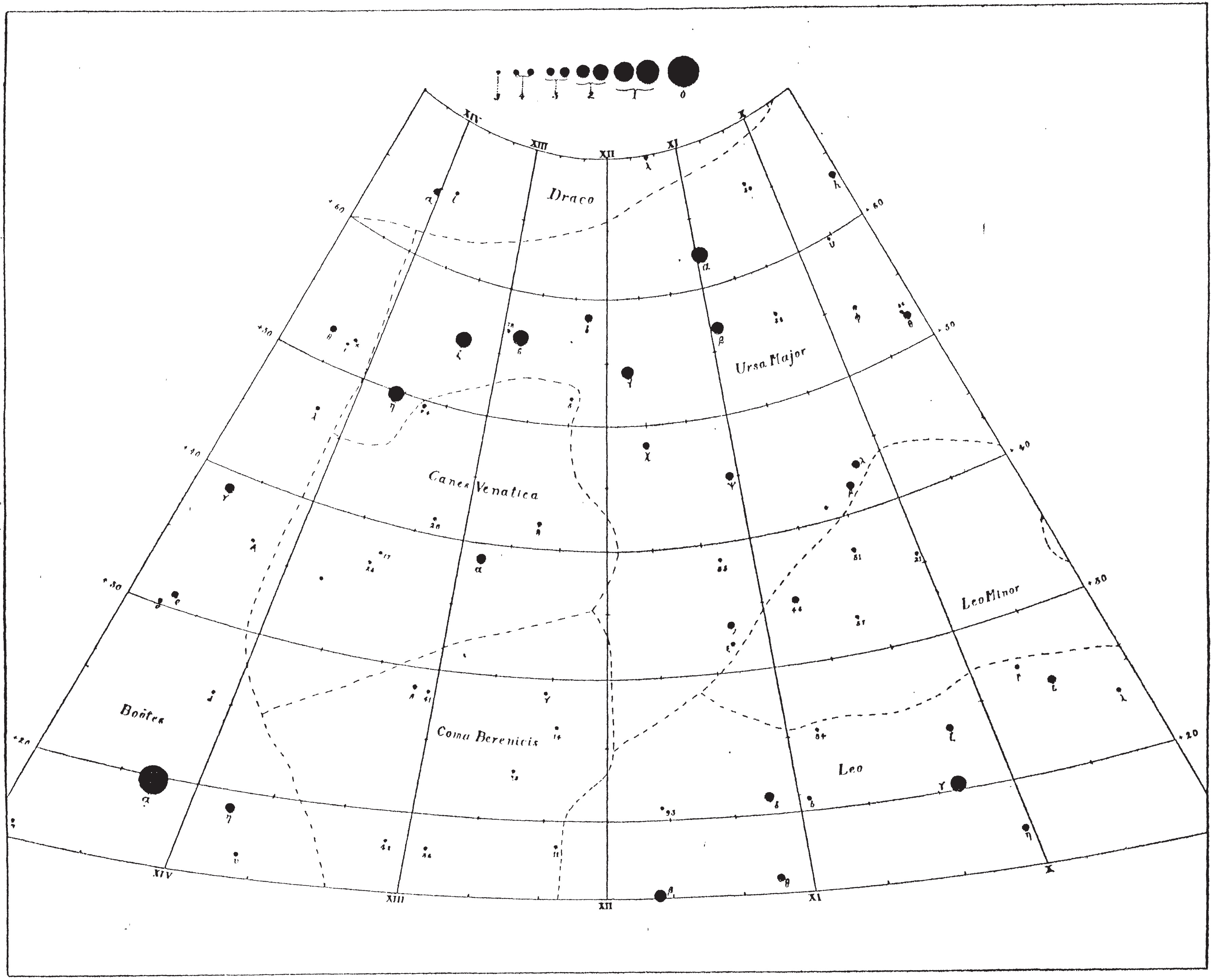
MAP III.—A.R. IV. hours, Decl. + 40°



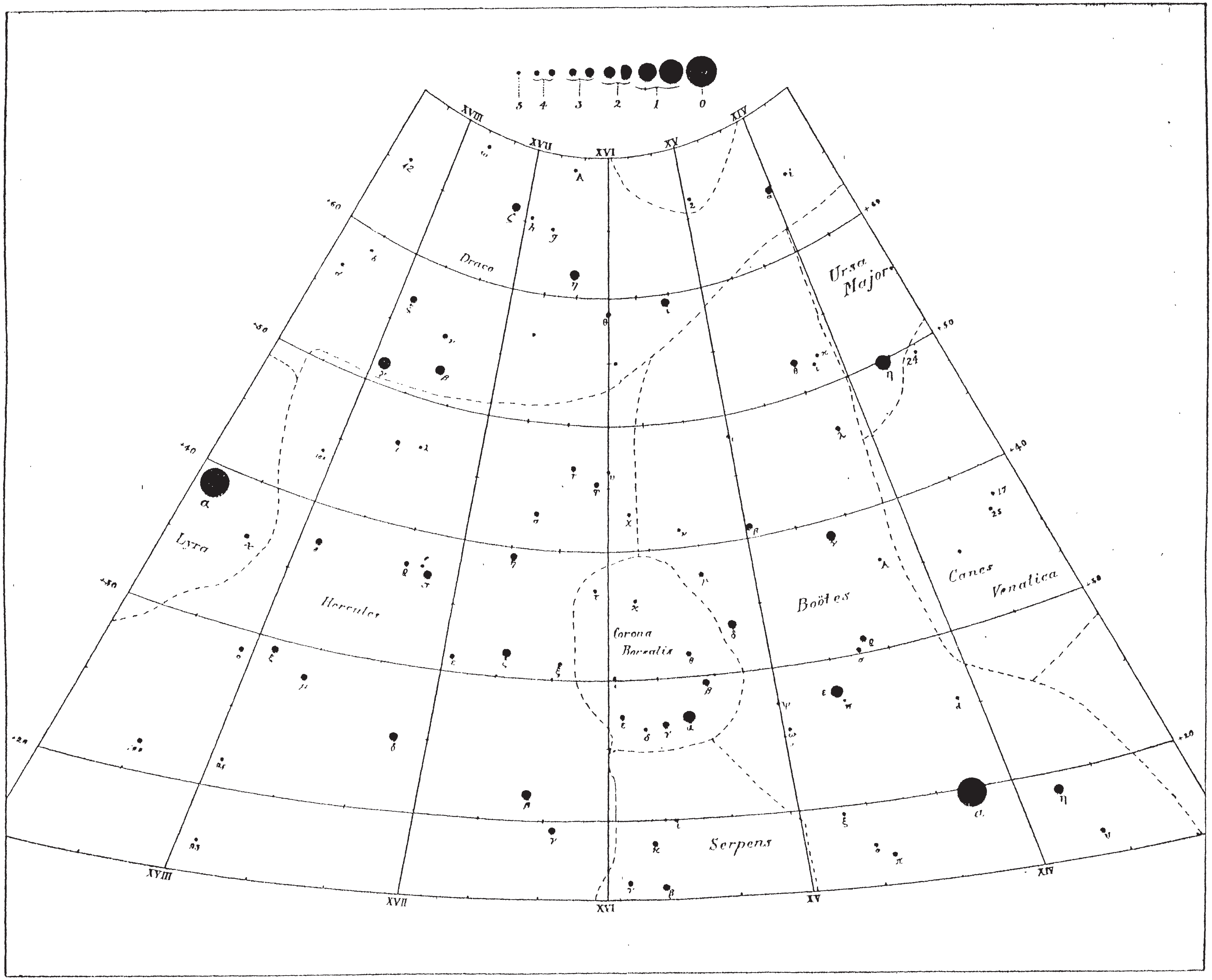
MAP IV.—A.R. VIII. hours, Decl. + 40°

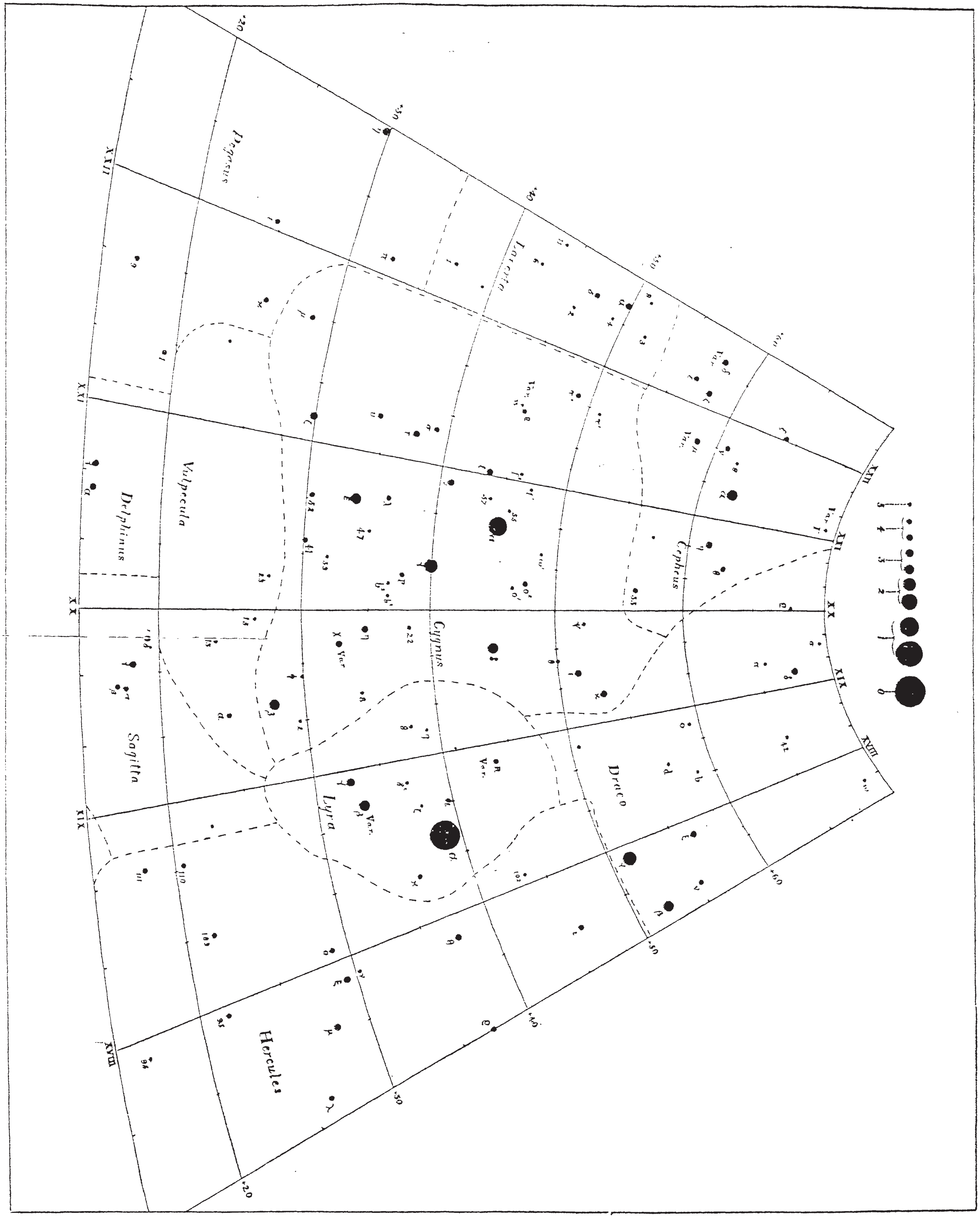


MAP V.—A.R. XII. hours, Decl. + 40°

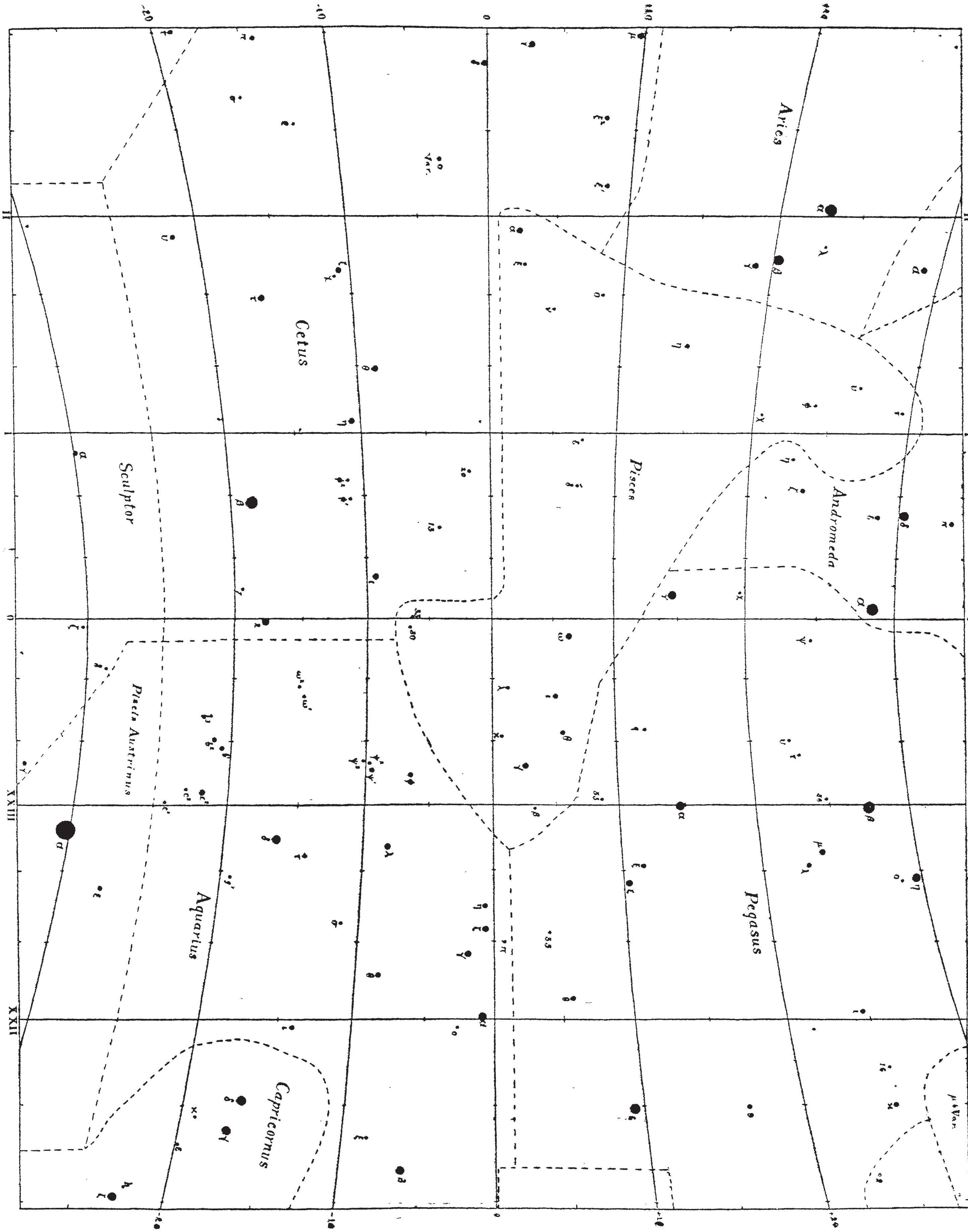


MAP VI.—A.R. XVI. hours, Decl. + 40°

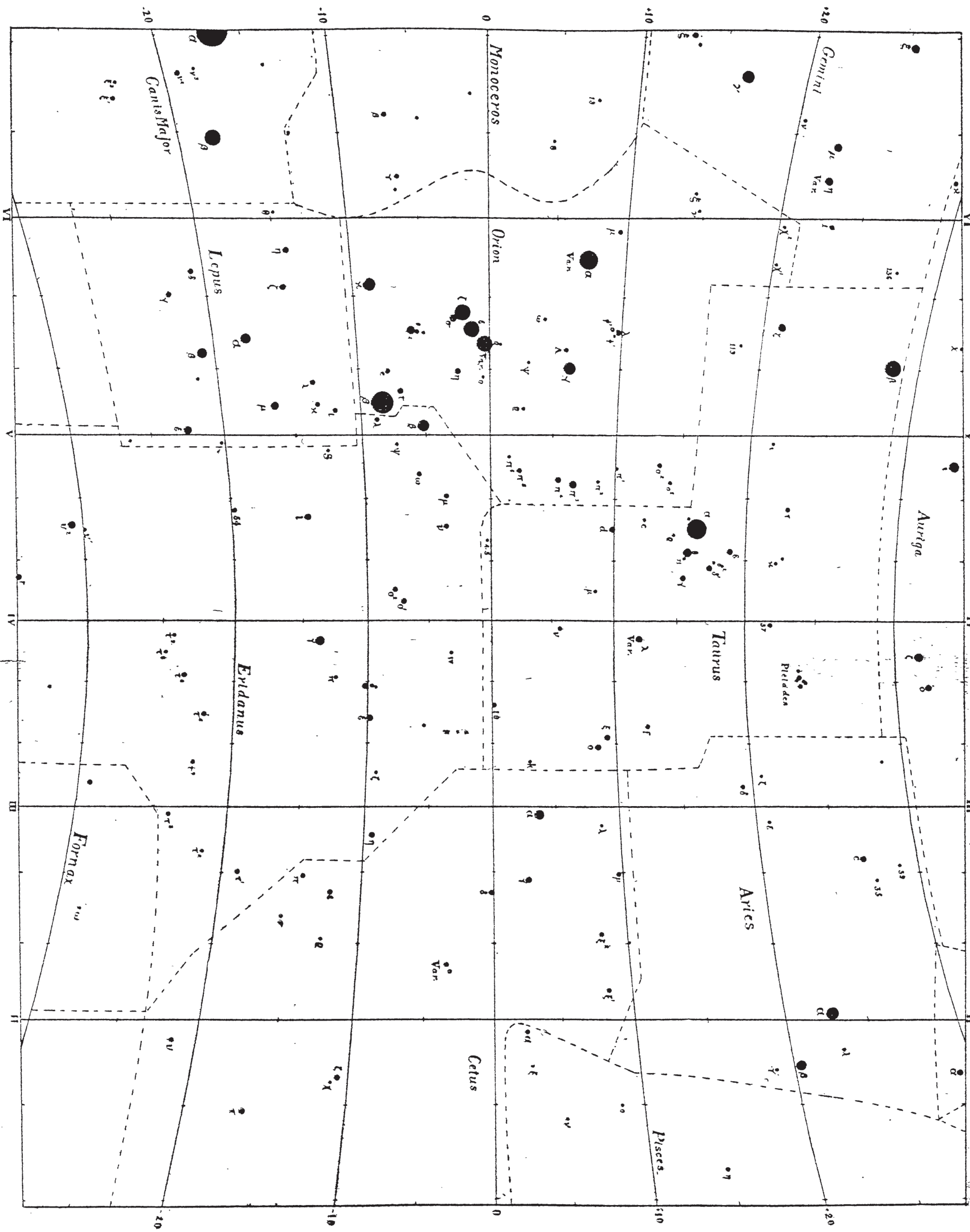




MAP VII.—A.R. XX. hours, Decl. + 40°

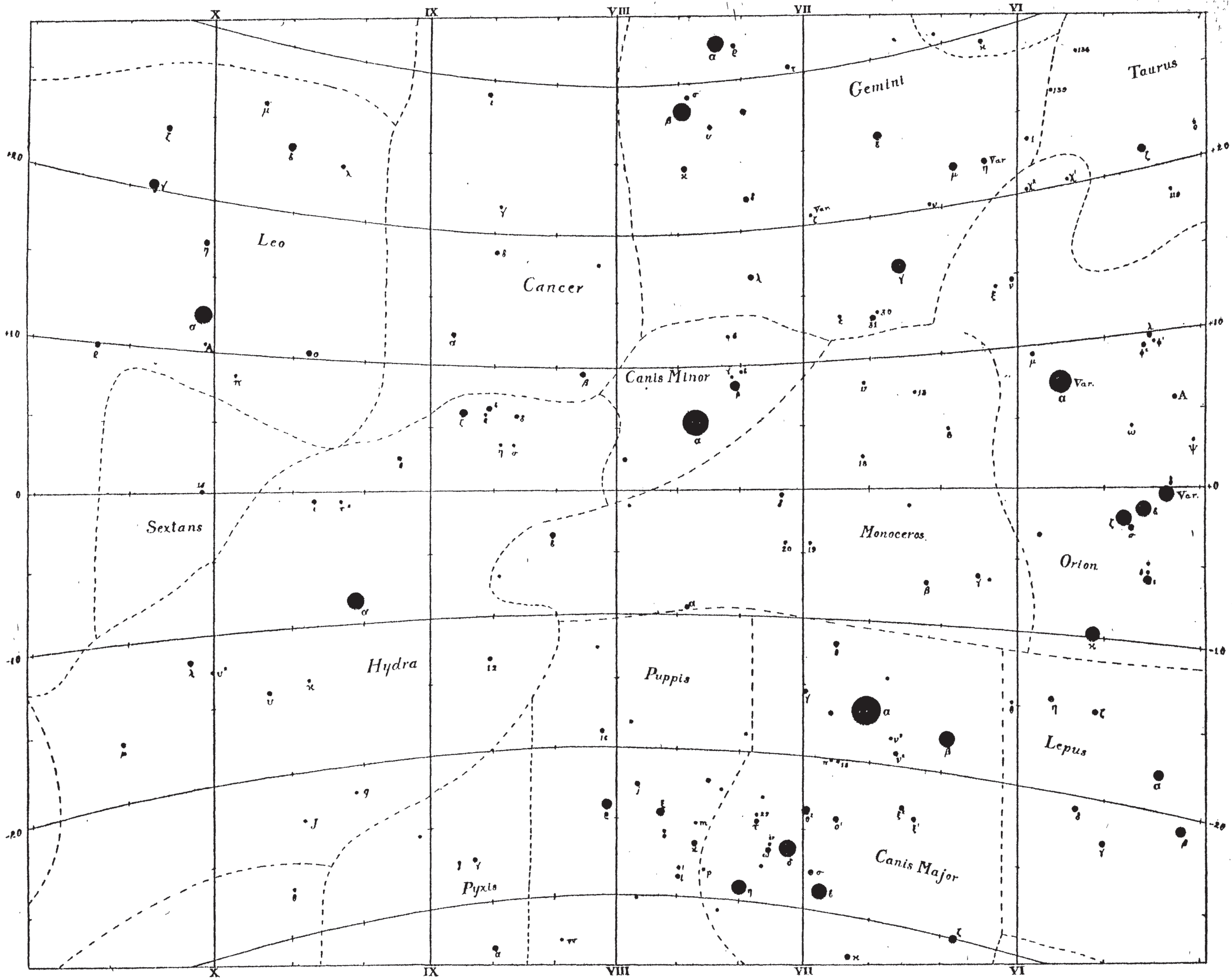


MAP VIII.—A.R. 0 hours, Decl. 0°

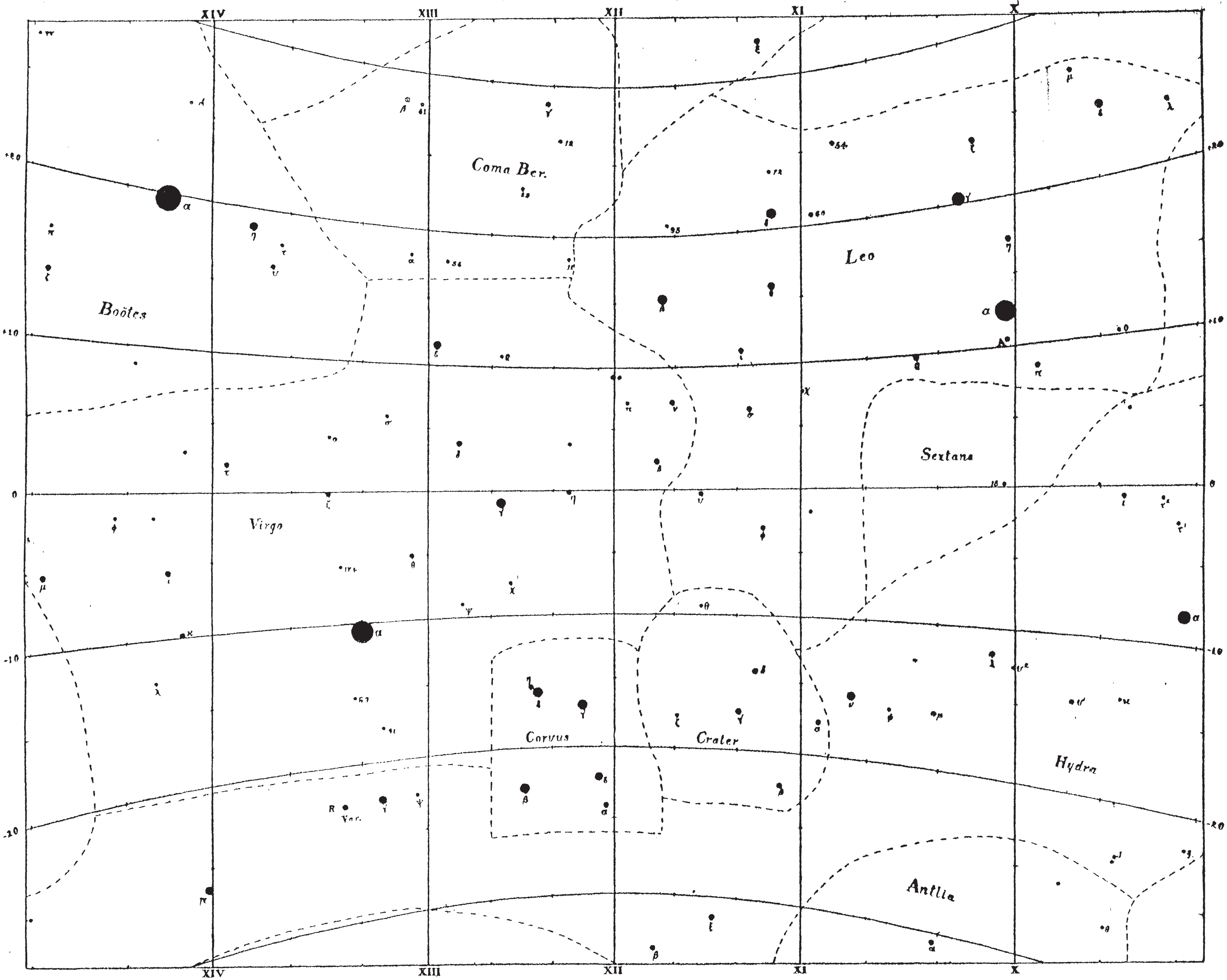


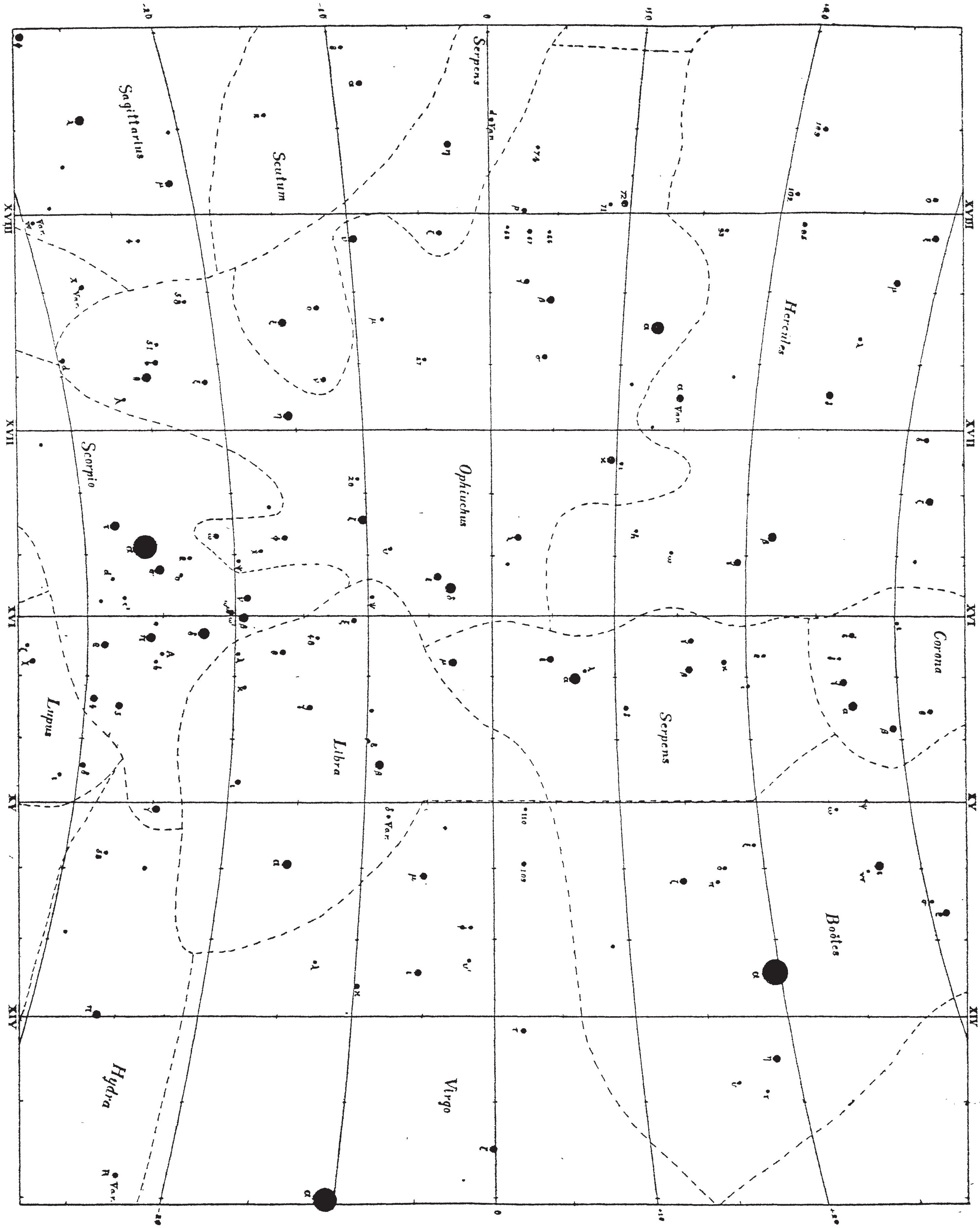
MAP IX.—A.R. IV. hours, Decl. 0°

MAP X.—A.R. VIII hours, Decl. 0°



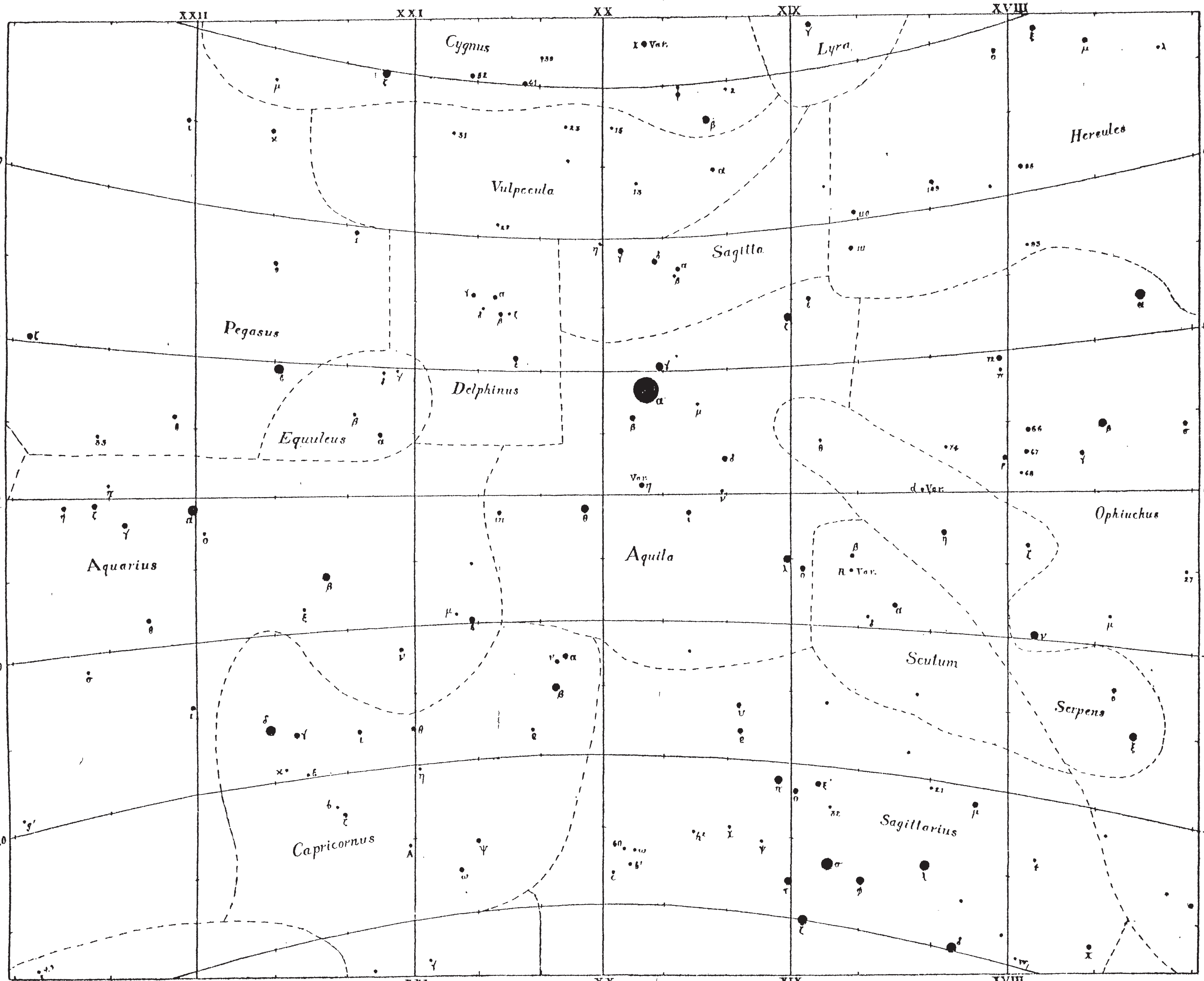
MAP XI.—A.R. XII. hours, Decl. 0°





MAP XII.—A.R. XVI hours, Decl. 0°

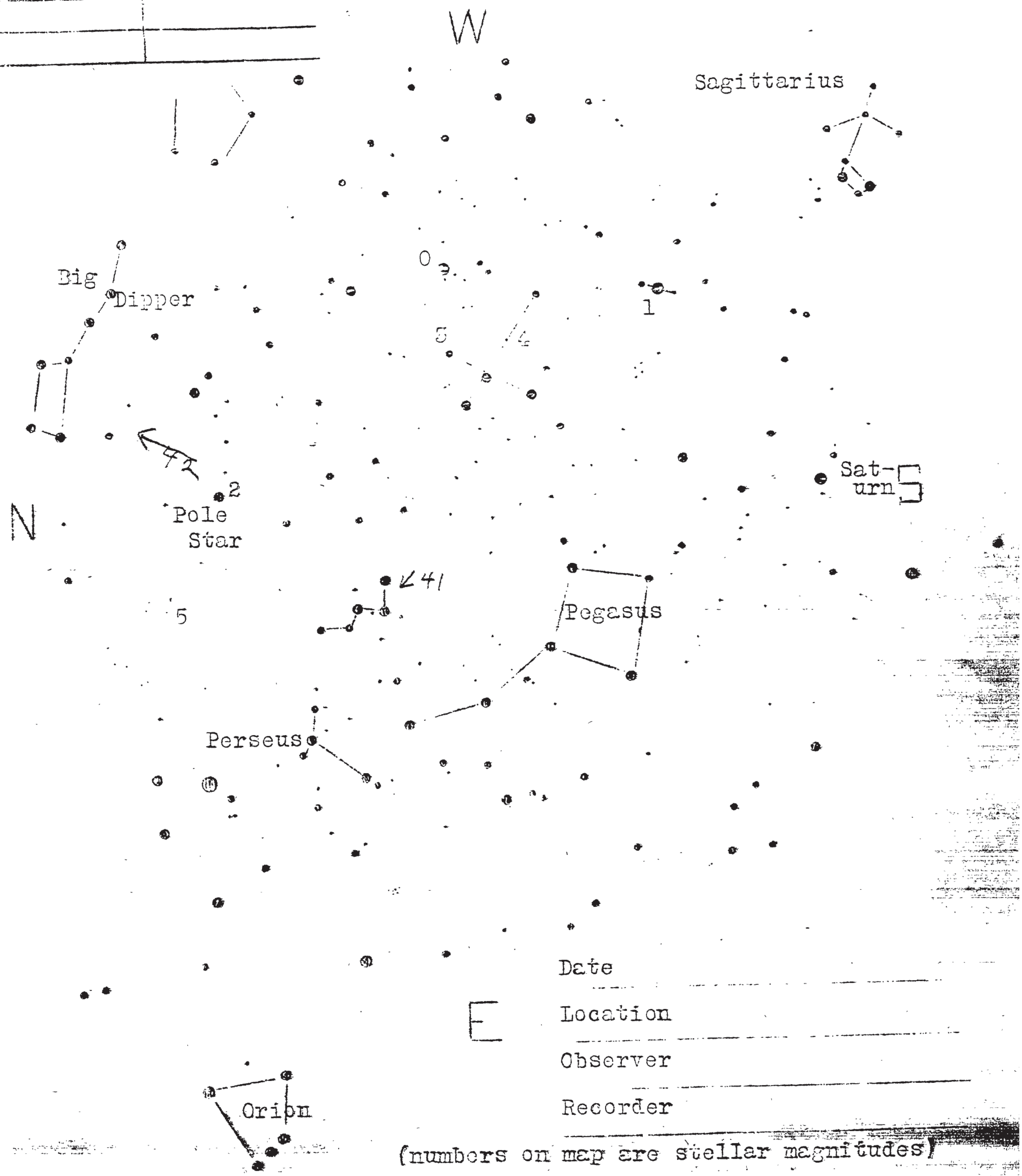
MAP XIII.—A.R. XX hours, Decl. 0°



Observing	
Began	Ended

Perseid Meteor Star Map (1934)

(for use during last half of night)



Date ______________________

Location ______________________

Observer ______________________

Recorder ______________________

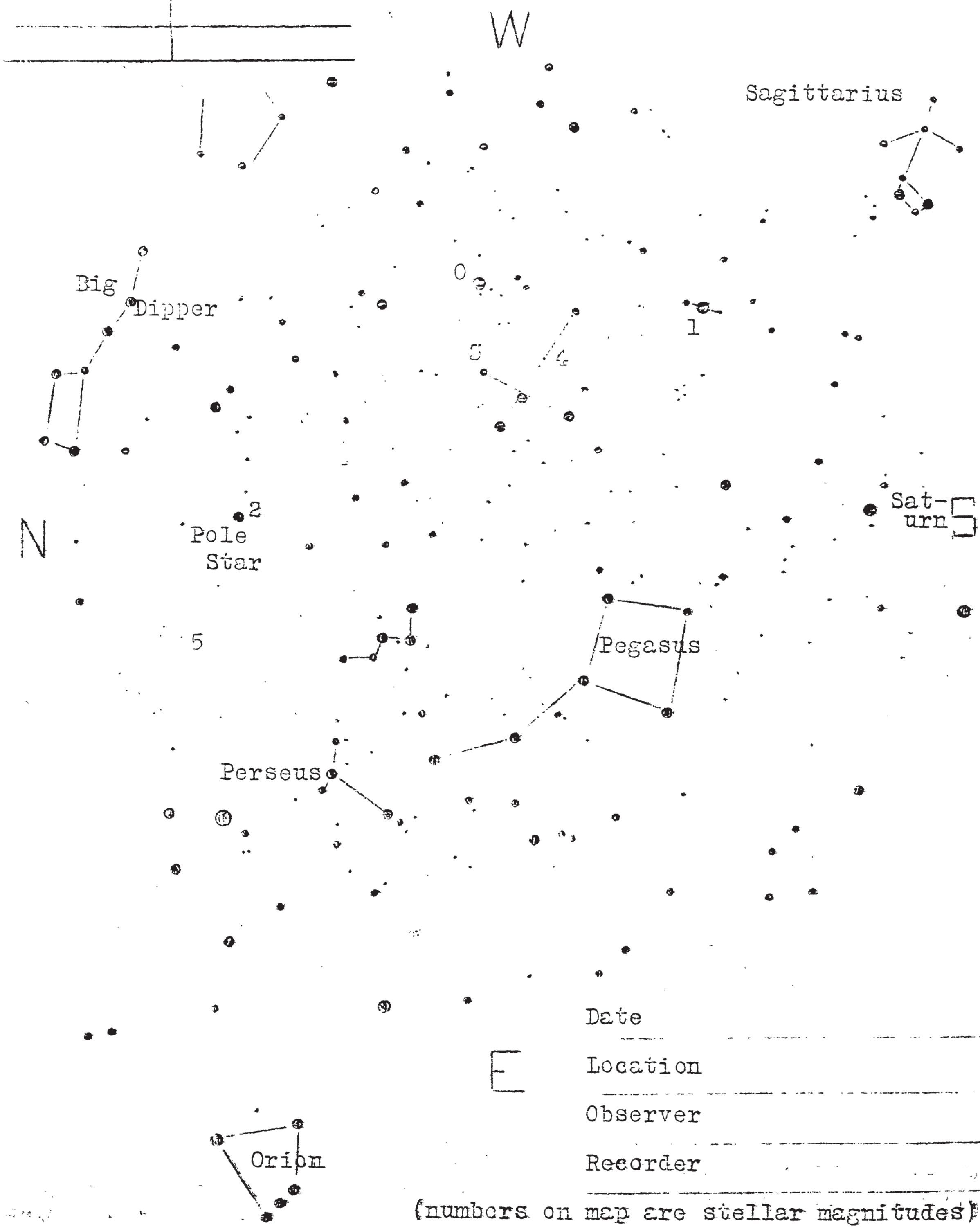
(numbers on map are stellar magnitudes)

Dept. of Astronomy
University of Toronto

Observing Began	Observing Ended

Perseid Meteor Star Map* (1934)

(for use during last half of night)



Date

Location

Observer

Recorder

(numbers on map are stellar magnitudes)

Dept. of Astronomy
University of Toronto