

IDENTIFYING NSV OBJECTS IN THE LIST OF INNES VARIABLES

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Summary: Innes (1914) published a list of 111 variables in UOC20. The majority (77%) have now received GCVS names, while the remainder have NSV designations. The identities of many of these NSV entries are still uncertain, and the work done here provides clarification, using the material (finder charts and descriptive notes) published by Innes, together with modern sources.

1. Introduction.

In 1914 R.T.A. Innes published a preliminary list of 111 variables, mostly new, in a field located in Sagittarius, and part of Corona Austrina. He gives approximate positions for 1875, with R.A. given to the nearest second, and declination to nearest 0.1'. Six photographic plates were examined under a blink-microscope. The dates range from 1910 July 29 to 1914 July 25. Magnitudes were estimated for each variable, using a comparison scale constructed by Innes himself, but no comparison stars are published. According to Innes, his limiting magnitude was 17p. Generally no finder charts are given, except for half-tone reproductions of two small-scale plates, by way of two panels (plate VI, opposite page 154). The locations of 36 variables are labelled and shown by arrows. The quality of reproduction is very poor. Apart from a few scattered field stars, the faint field stars around each variable (absolutely essential) simply failed to make the transition from plate to print. The marking of each variable, in spite of this, seemed unambiguous, but this had to be tested. For certain variables Innes provides hints in the text as to their location, by referring to nearby stars. Most, if not all, of Innes' 1914 discoveries are repeated in a 1917 Circular, but there is no improvement in the precision of the coordinates.

2. Recovery of Innes Variables.

Most of the Innes variables have been recovered by later work at Harvard, Leiden and elsewhere. They are of large amplitude, such as the Mira type, and have received proper names. No further attention will be given to them, as my focus is entirely on stars which have, at some stage, carried NSV numbers. The identities of some NSV objects have eluded us right up to the present time. I have decided to provide identifications for **all** NSV objects, even those with proper names.

3. Method.

I took the 1875 coordinates as given by Innes (1914), and applied precise precession corrections, transforming them to equinox J2000. This avoided any rounding errors which may have crept in later compilations or catalogues which referred to B1900, B1950 etc. By comparing my transformed coordinates with the VSX positions, for **all** of the Innes variables, I could ascertain where he gave erroneous or unreliable positions, and also which NSV stars needed particularly close attention. In addition to using the AAVSO's VSX database, I compared Innes' positions with my own on-screen plots stars from 2MASS and UCAC3. The ASAS-3 database often yielded proof of variability, especially for red stars of large amplitude.

Finally, I turned to the half-tone reproductions of Union Observatory plates, referred to in the Introduction. As mentioned before, the reproduction is extremely poor. Each variable has a la-

bel, and an arrow points to the spot, but nothing can be seen. I solved this problem by restoring the missing stars, by making a plot of UCAC3 stars and scaling it precisely to the scale of an enlarged cut-out of Innes' chart. One might ask, was one aware of change due to proper motion over a time span of nearly 100 years? I found that, in practice, p.m. never arose as serious issue. Matching a spatially small plot of UCAC3 stars to a cut-out from the Innes chart was always straightforward. Having restored the faint detail around each NSV star, it became fairly obvious as to the intended target. The arrows had been placed by Innes with commendable accuracy, even when enlarged considerably. Only stars in the immediate vicinity appear on my enlargements, as no good purpose would be served by filling the page with unnecessary detail.

The most obvious, or most likely, candidate is ringed with a circle. All such candidates can be found in UCAC3 or 2MASS. For comparison, a 10'x10' DSS print (B or R) is attached, which provides full detail of the field.

4. General.

Innes' observations were not photometric magnitudes, but rough estimates. In trying to verify his limiting magnitude I looked at a few stars for which Innes assigns a (rough) value.

- Near no. 9 he mentions a following 17^m star. USNO-A2.0 calls it 15.0B.
- North preceding no. 15 there is a 16^m. USNO-A2.0 quotes 15.1B.
- South following no. 56 there is a 16^m. USNO-A2.0 quotes 15.6B.
- About 18" south of no. 64 there is a 16^m. USNO-A2.0 quotes 15.1B.

From this very limited sample Innes' limit of 17 (sic) seems a bit hazy. Stars that are estimated at 16 or 17^m may really be only 15^m.

Meaning of "Short Period". It should be noted that Innes (1917, p300) defines it as follows:

". any period under 100 or 150 days".

5. Notes on Innes variables.

Innes 2. Nearby NSV 10743 = HV 9422, range 16.5-17.8p, was reported by Luyten (1938), at (1900) 18 18 30 -31 35
(1875) 18 16 53 -31 35

This is very similar to Innes 2 = V929 Sgr (M). Positions according to Innes: -
(1875) 18 16 57 -31 35.0 UOC20 (1914) and
(1875) 18 16.9 -31 35 UOC37 (1917)

The true position of V929 Sgr is slightly east of this. No variable, or unusual star, can be found at Luyten's rough position. No finder chart published. Most likely conclusion:

Innes 2 = V929 Sgr = NSV 10743.

Innes 3 = NSV 10783. ASAS-3 lightcurve suggest a SR variable, range 12.0 - 13.5V.

Innes 5 = NSV 10802. Probably the same as ASAS J182705-2903.2 = AUID 000-BHR-621, SR, range 12.0 - 14.0V.

Innes 9 = NSV 10867 = V3418 Sgr = ASAS J182912-3522.5. NSV designation is obsolete.

Innes 21 = NSV 11004. ASAS-3 lightcurve (ASAS J183329-3034.2) suggests SR type, 12.1-12.9V. Also catalogued as star 4-8 by McCuskey and Mehlhorn (1963), spectral type M5.

Innes 32 = NSV 11073. =V4147 Sgr, RRab. Var F8 in 1989AJ.....97..771H.

Innes 42 = NSV 11150. = ASAS J183924-2840.2, range 11.90-13.2V, P ~100d. Possible contamination by star 16" to S.

Innes 52a = NSV 11220. The star I have identified is the faintest member of a triangle, and consistent with Innes, mostly m =17. However, one cannot exclude the possibility 52a is actually one of the other stars in the triangle.

Innes 64 = NSV 11298 = V5543 Sgr = ASAS J184550-3216.5

Innes 79 = NSV_11517 = ASAS J185527-2641.7, Mira, 12.00-13.7V, P~220d. Close companion to east, d=10". Light curve probably compromised.

Innes 82 = NSV 11633 = ASAS J190050-2553.7.

Innes 83 = NSV 11638 = ASAS J190112-2738.9.

Innes 103 =NSV 11851 = ASAS J191616-2718.2. SR, 11.60-12.60V

Innes 108 =NSV 12054 = ASAS J192838-3348.7. SR, 11.95-12.7V

Innes 109 =NSV 12127 = ASAS J193348-3638.8. V=13.81 (0.419). Constant?

TABLE 1 : Identification of Innes Variables with NSV Stars.

<i>Innes</i>		<i>J2000</i>	<i>S</i>	<i>NSV</i>	<i>GCVS</i>	<i>Remark</i>	<i>Plate No.</i>
2	*	18 25 05.48 -31 31 12.3	M		V929 Sgr	NSV 10743 (alt. id.)	1
3	*	18 26 27.31 -33 03 37.6	M	10783		SR?	2
5	*	18 27 05.33 -29 03 15.2	U	10802		SR	3
9	*	18 29 12.38 -35 22 30.7	U	10867	V3418 Sgr	M	4
21	*	18 33 29.31 -30 34 12.2	M	11004		SR	5
32		18 36 23.07 -32 38 28.4	M	11073	V4147 Sgr	RRab	6a,6b
38		18 38 21.42 -36 35 22.9	U	11120	V946 Sgr	M	
39		18 38 17.1 -31 05 53		11123		Id. not possible	7
42	*	18 39 23.95 -28 40 10.1	M	11150			8
52a	*	18 42 50.84 -33 19 36.3	U	11220			9a,9b
59	*	18 45 16.25 -33 33 29.5	U	11277	V1210 Sgr	RRab	10a,10b
62	*	18 45 18.48 -32 11 06.6	U	11286			11a,11b
64		18 45 50.28 -32 16 26.3	M	11298	V5543 Sgr	M	11a,11c
79	*	18 55 27.35 -26 41 44.9	U	11517		M	12a,12b
82	*	19 00 49.48 -25 53 43.5	M	11633			13a,13b
83	*	19 01 11.91 -27 38 51.3	M	11638			14a,14b
103	*	19 16 16.61 -27 18 12.5	M	11851		SR	15
108		19 28 37.65 -33 48 44.3	U	12054		SR	16
109	*	19 33 47.69 -36 38 47.3	U	12127			17

Notes: Asterisk indicates a new/improved position.

S = Source. M = 2MASS; U =UCAC3

6. The Plates. Plates 1 to 17 follow, showing the locations of the variables. Extracts are taken from *Digitized Sky Survey*, in the form of 10'x 10' cutouts, in either blue or red light. Cutouts from the original Innes photocharts also appear, where appropriate, but the scales of the latter are not fixed, as they vary from one field to the next. North is always at the top, east is to the left.

7. References.

Innes, R.T.A. 1914. Union Obs. Circ. 20

Innes, R.T.A. 1917. Union Obs. Circ. 37

Luyten, W.J. 1938. Minn. Publ. 2, No. 6

McCuskey, S.W. and Mehlhorn, R. 1963. Astron. J. 68,319



Plate 1. Innes 2 = V929 Sgr, located between tick marks. Luyten's variable (NSV 10743) is shown with a cross, according to its approximate coordinates.
DSS Blue plate. 10' field. North is up.

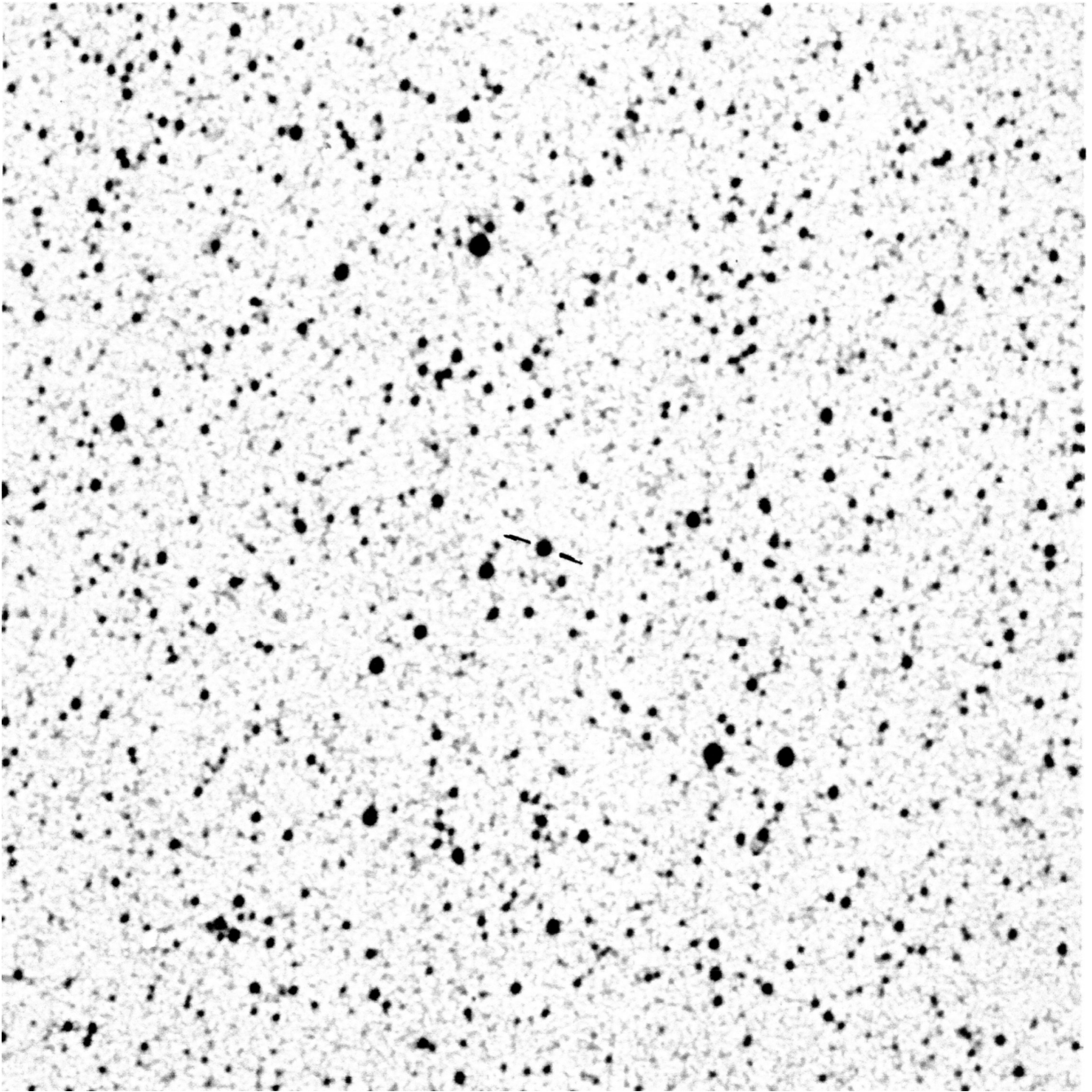


Plate 2. Innes 3 = NSV 10783, between the tick marks.
DSS Blue plate. 10' field. North is up.

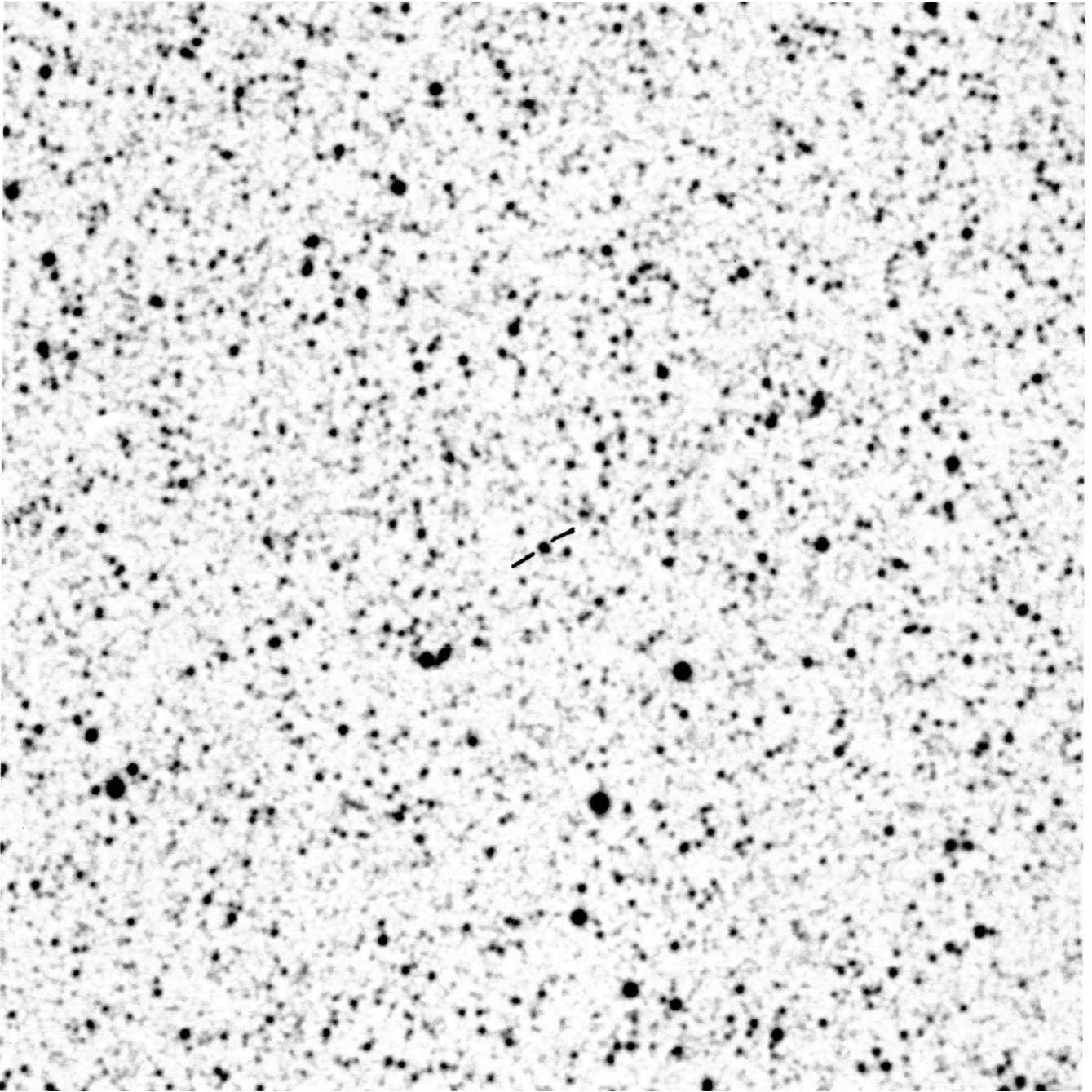


Plate 3. Innes 5 = NSV 10802, between the tick marks.
DSS Blue plate. 10' field.

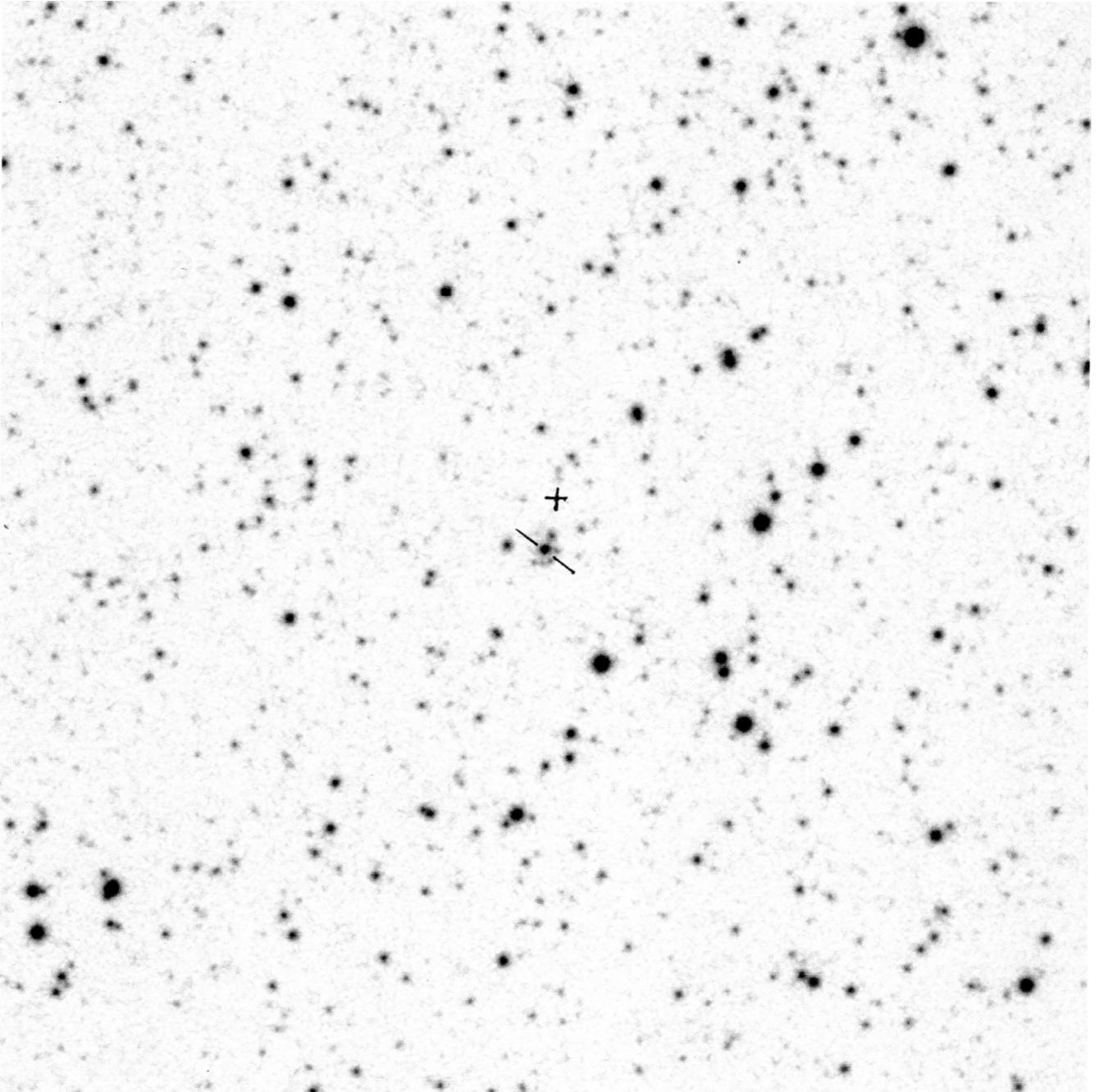


Plate 4. Innes 9 = V3418 Sgr, between the tick marks. Coordinate position for NSV 10867 (Innes) is indicated by a cross.
DSS Red plate. 10' field. North is up.

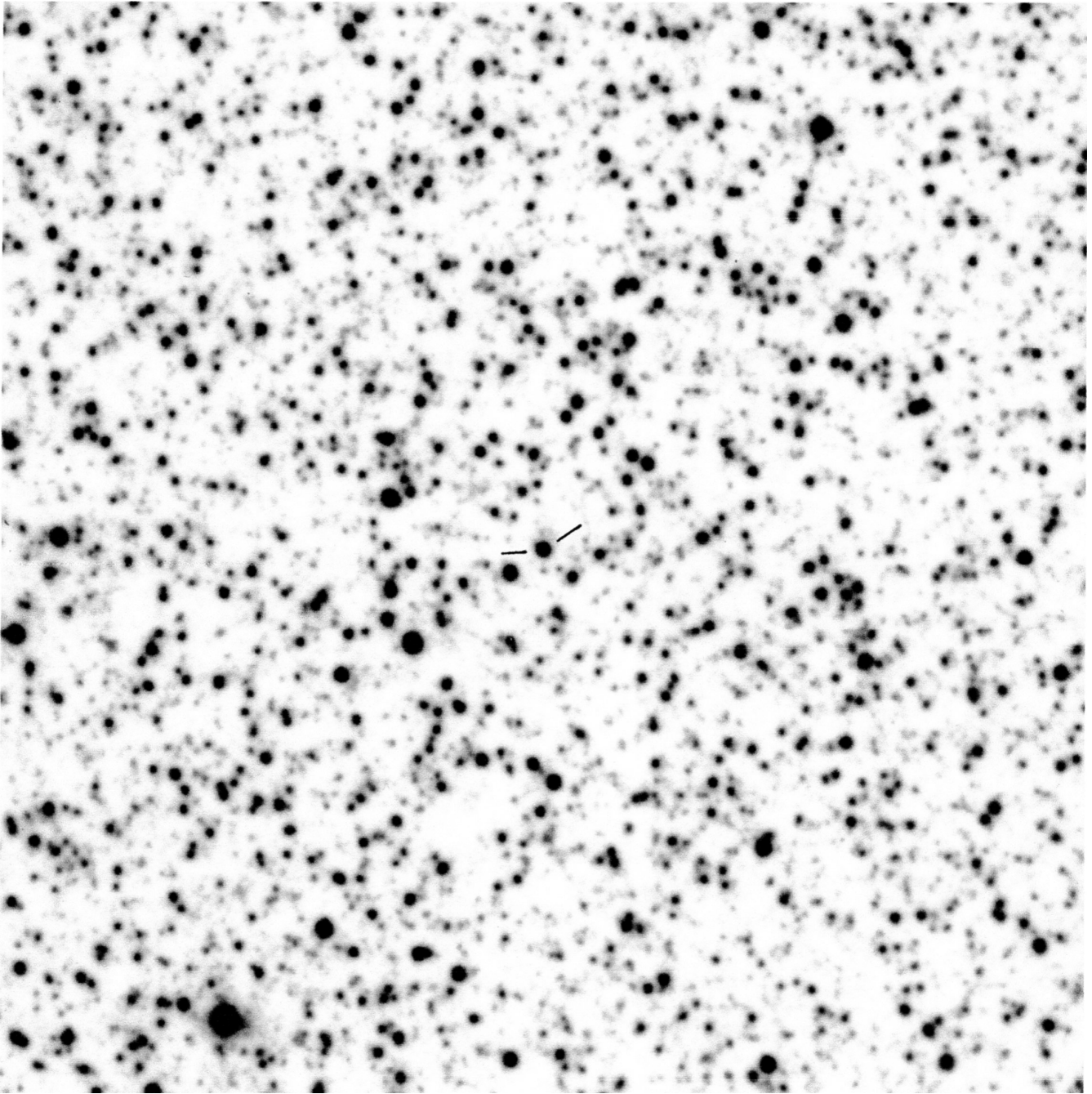


Plate 5. Innes 21 = NSV 11004, between tick marks.
DSS Blue plate . 10' field. North is up.

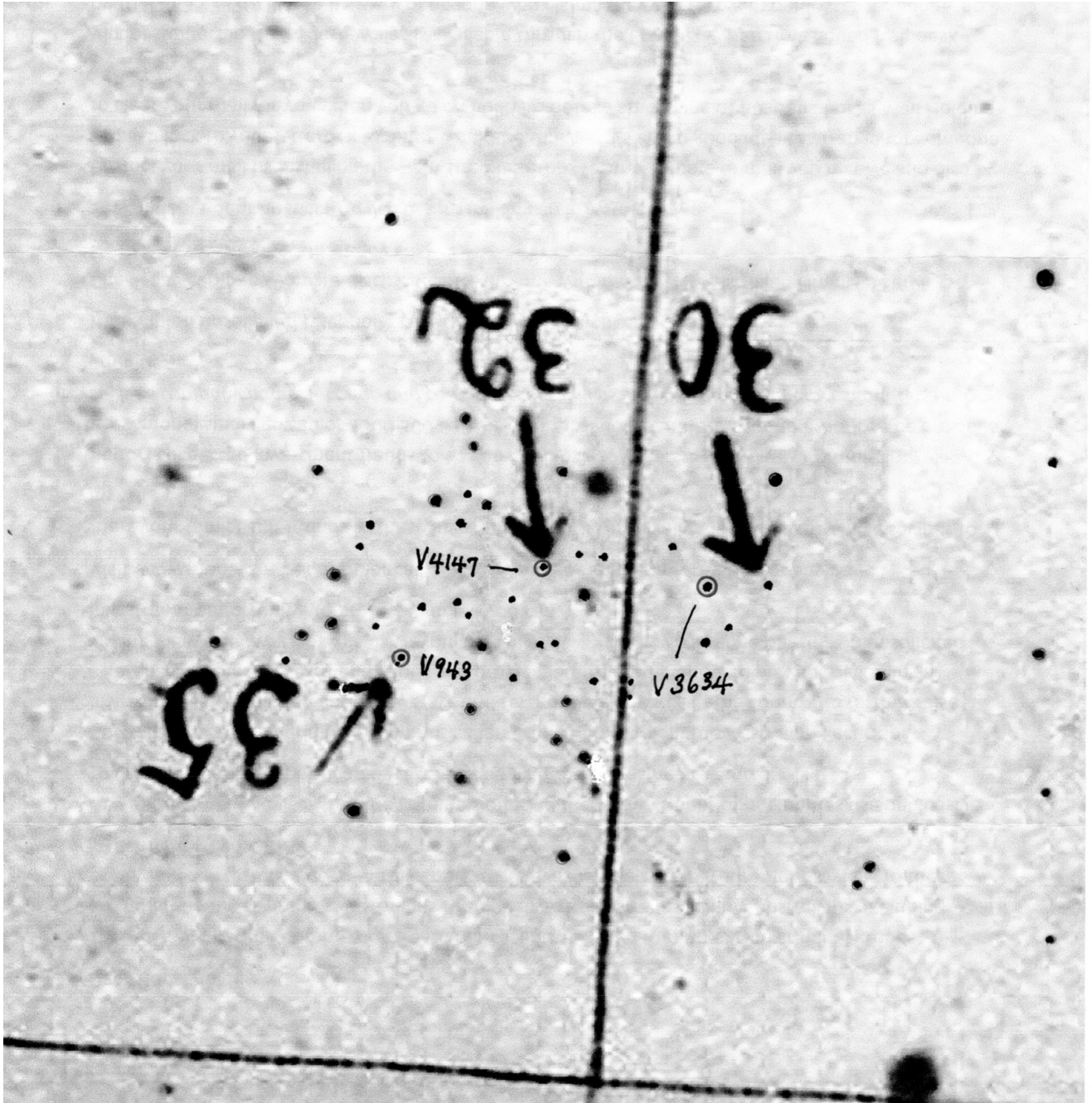


Plate 6a. Innes 30 = V3634 Sgr. Position and magnitudes are consistent with Innes (1914).
 Innes 32 = NSV 11073 = V 4147 Sgr. Innes 35 = V943 Sgr.
 Enlargement of Plate VI of Innes (1914), with faint stars restored.

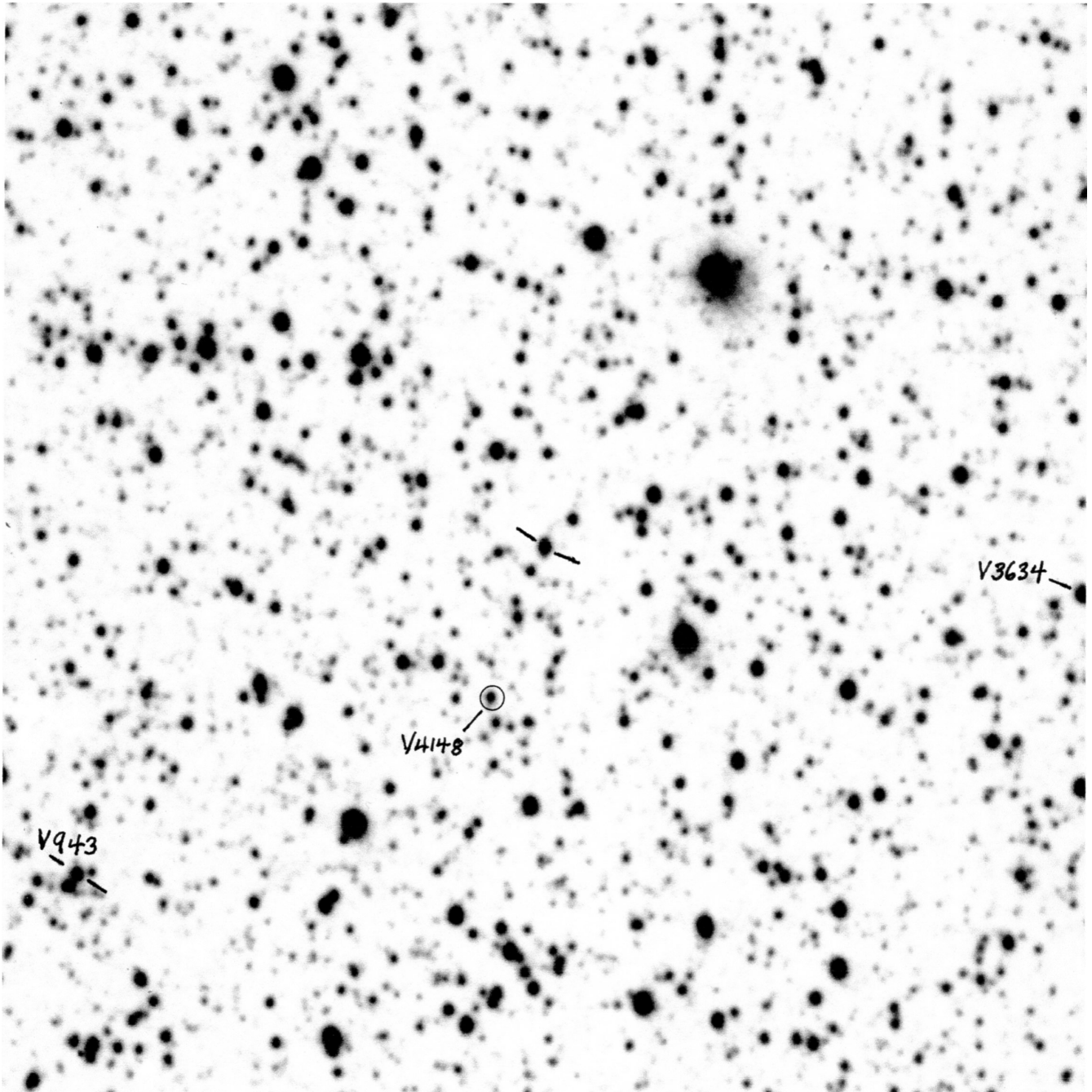


Plate 6b. Innes 32 = NSV 11073 = V4147 Sgr, between tick marks.
DSS Blue plate. 10' field. North is up.

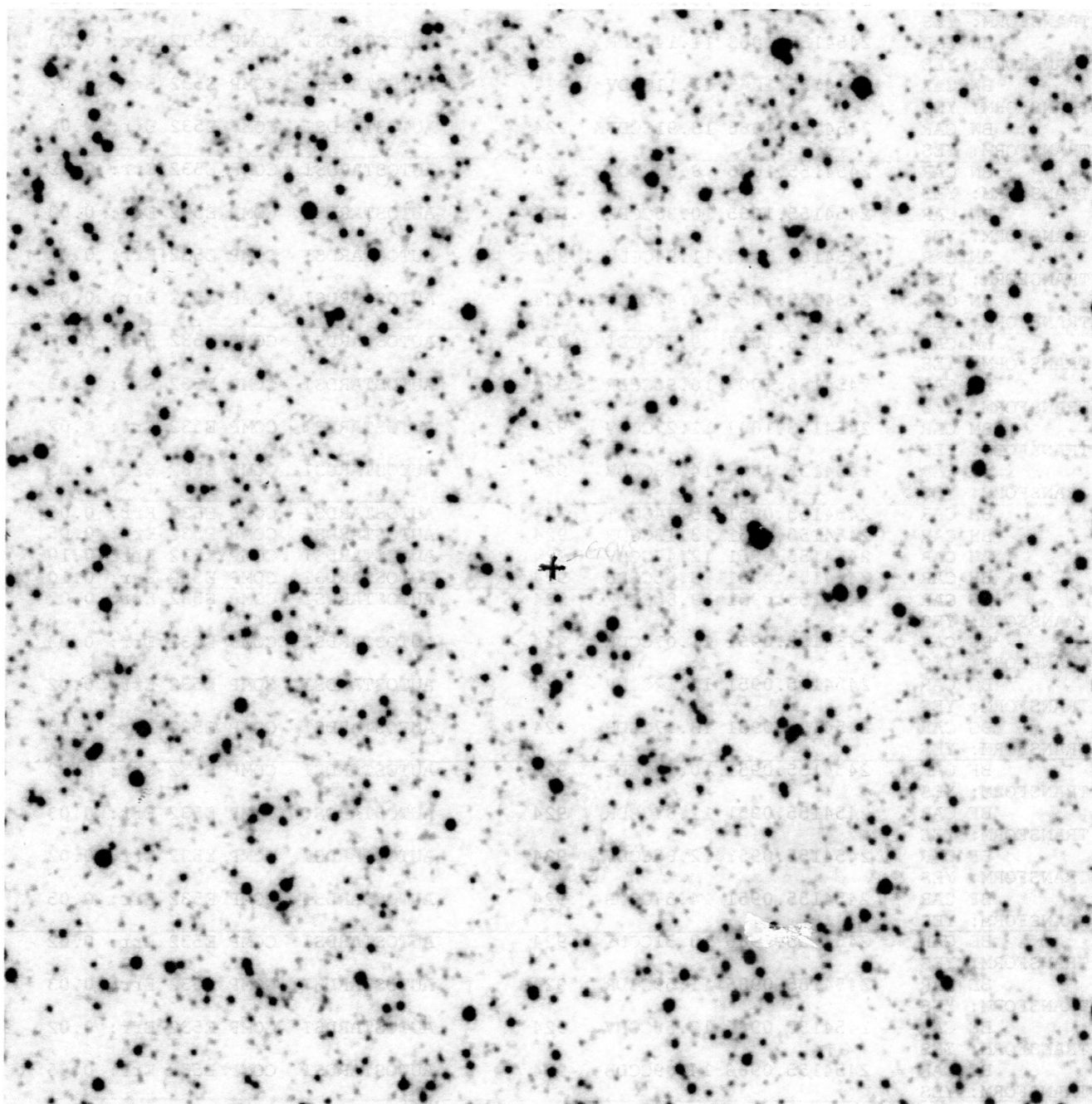


Plate 7. Innes 39 = NSV 11123. Several candidates; identification not possible. Catalogue position is marked.

DSS Blue plate. 10' field. North is up.

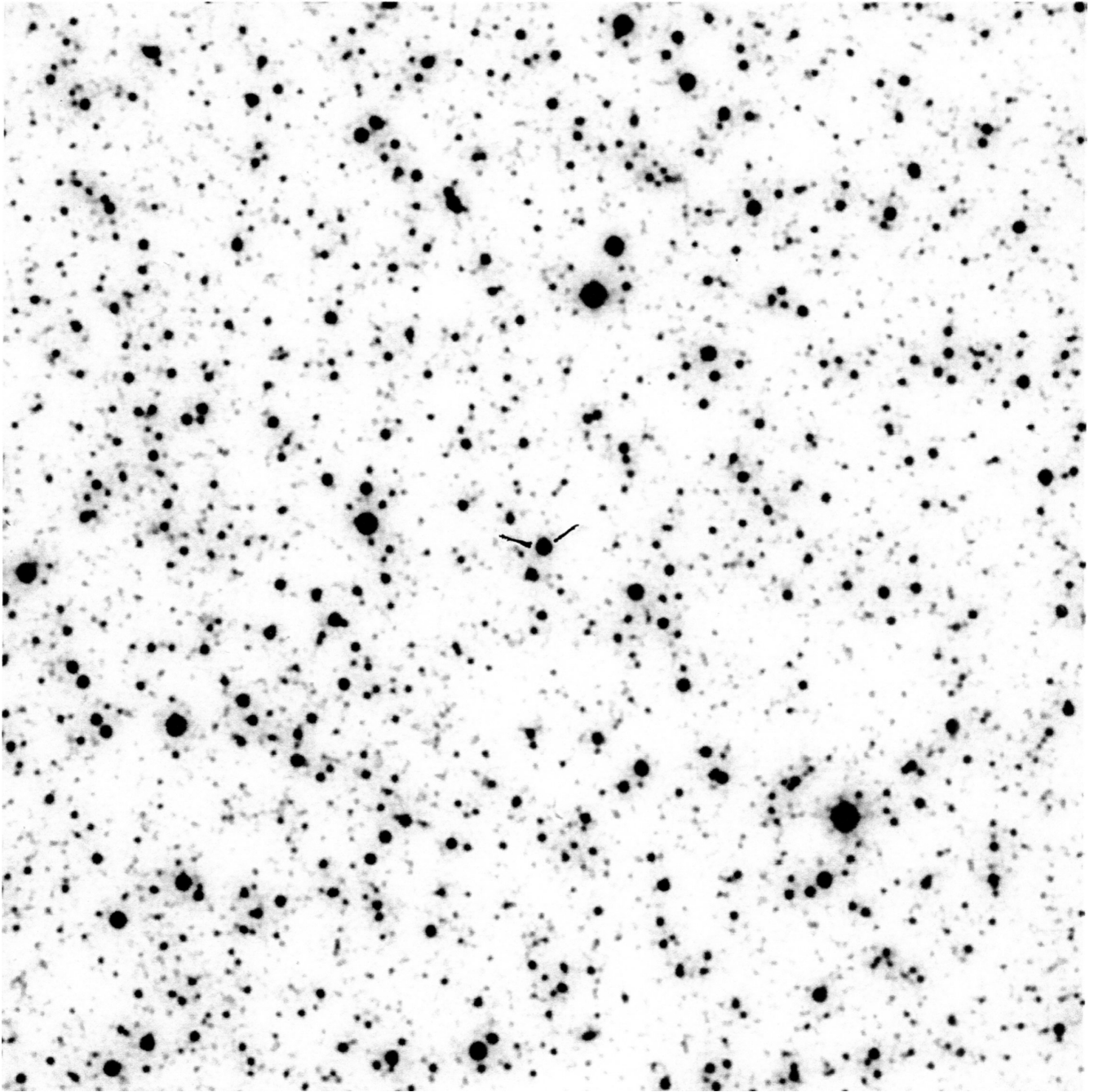


Plate 8. Innes 42 = NSV 11150.
DSS Blue plate. 10' field. North is up.



Plate 9a. Innes 52a = NSV 11220. Assumed id. is immediately below the apex of Innes' arrow. For reference/comparison three stars A, B and C were selected. Photometry (V, B-V) from ASAS-3 and 2MASS respectively is - A: 11.633, 0.42 B: 12.669, 0.40 C: 13.791, 0.84 . Enlargement of Plate VI of Innes (1914), with faint stars restored. North is up.

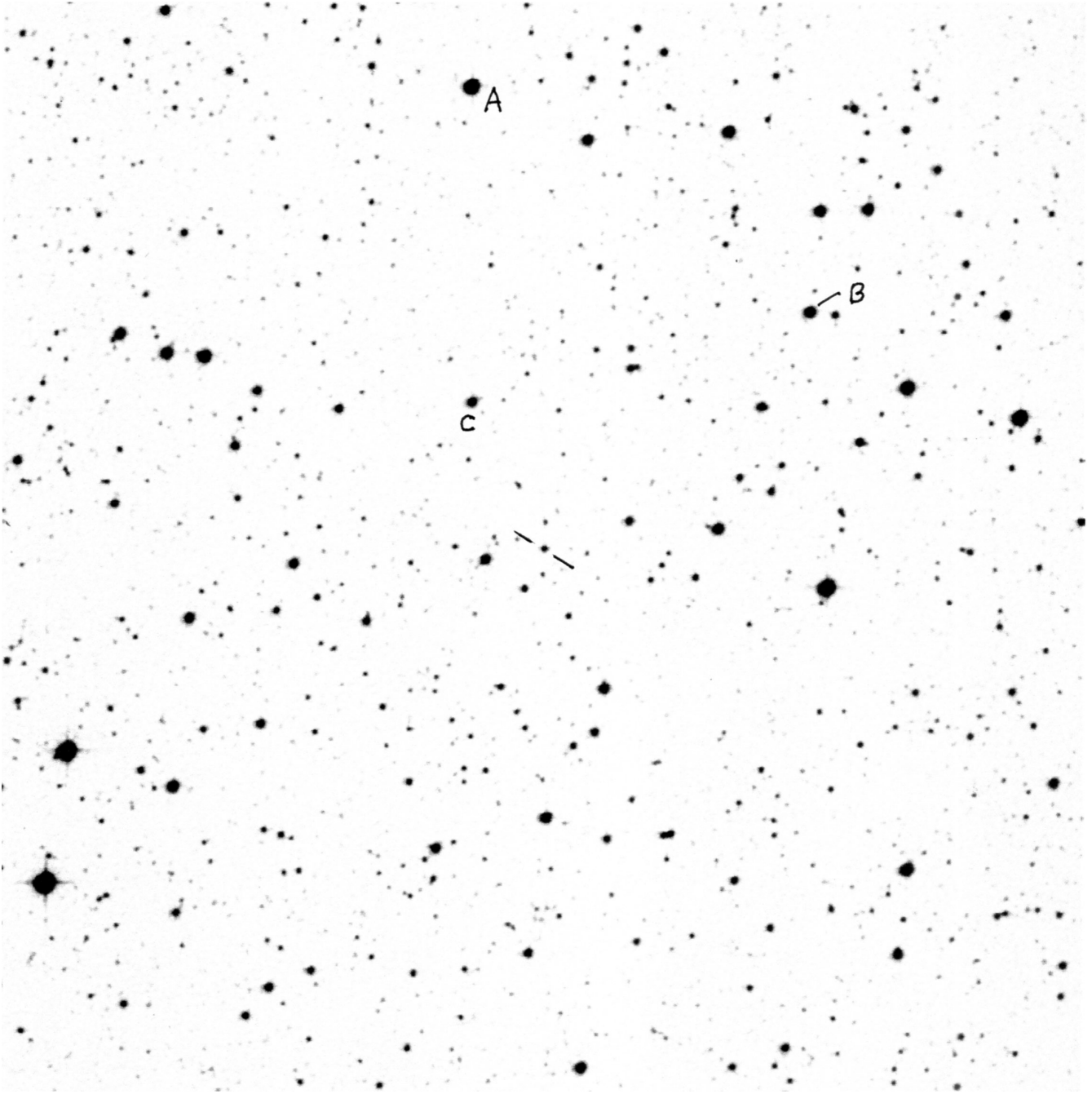


Plate 9b. Innes 52a = NSV 11220. Probable id. is between the tick marks. Innes' arrow points to one faint star in a small triangle, but one cannot completely exclude the other members. Data for the comparison stars A, B and C is given on p13.
DSS Blue plate. 10' field. North is up.

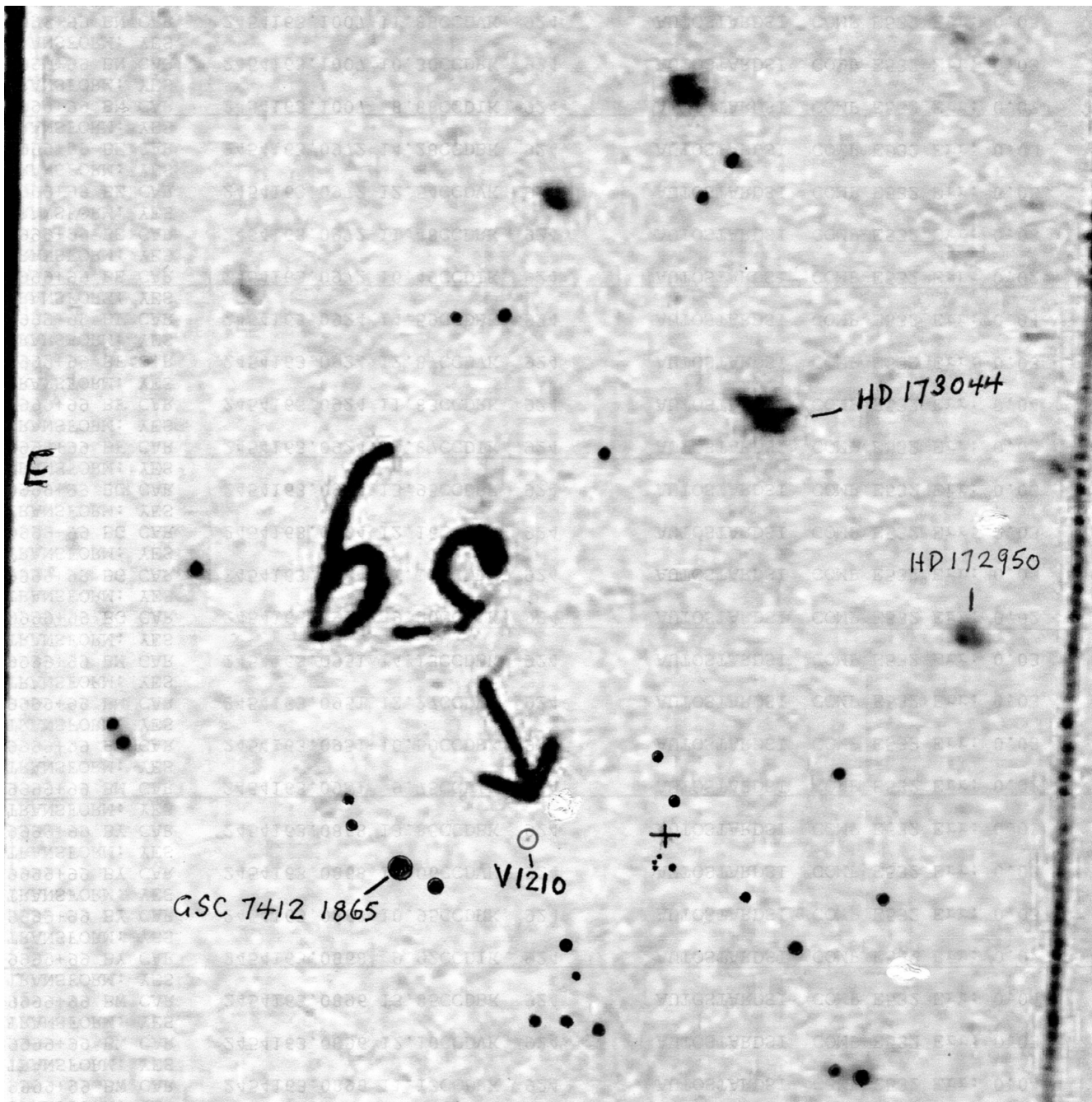


Plate 10a. Innes 59 = NSV 11277 = V1210 Sgr. True position is circled. Innes' coordinates, as shown by cross, are badly out.

Enlargement of Plate VI of Innes (1914), with faint stars restored. North is up.

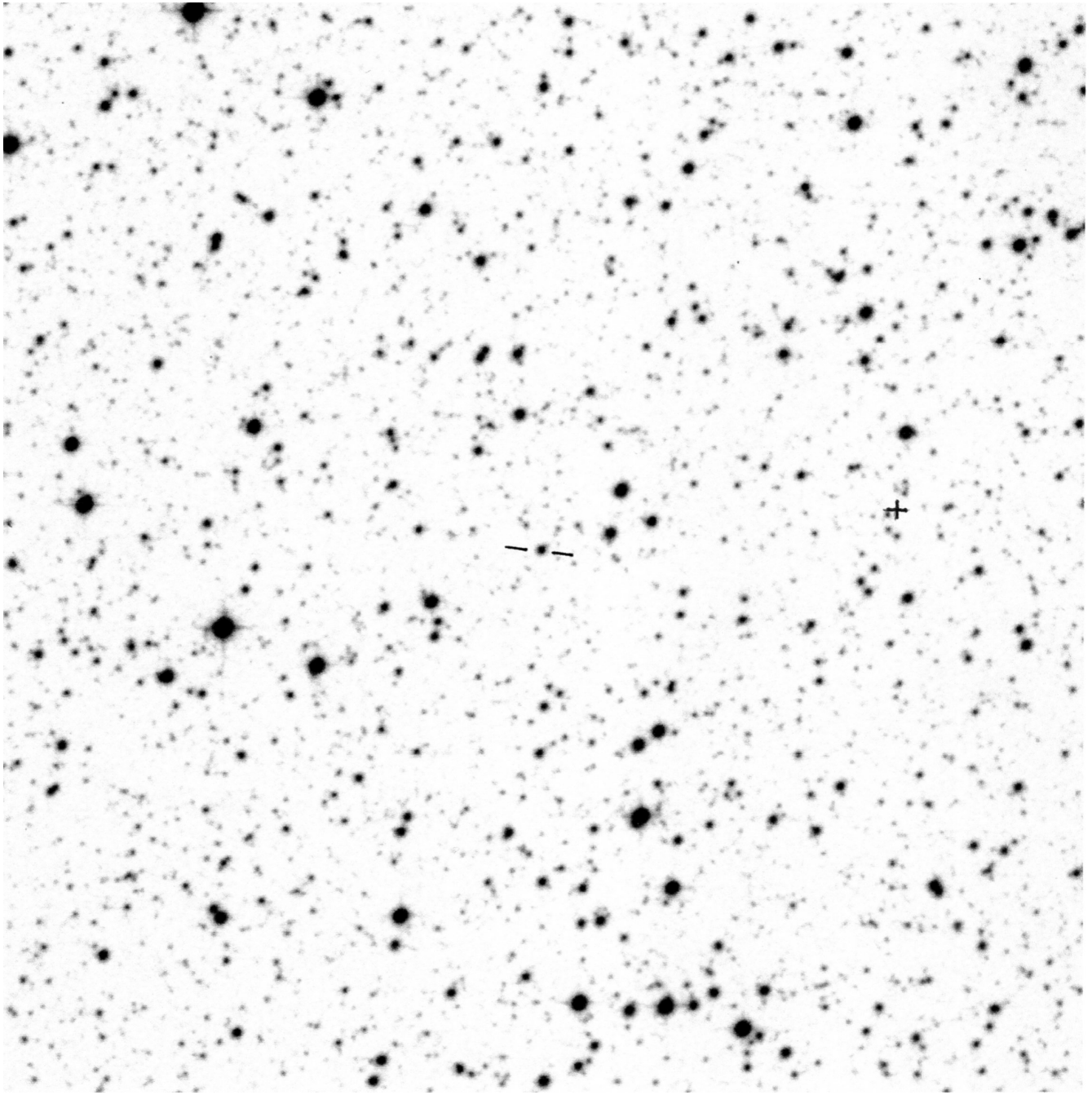


Plate 10b. Innes 59 = NSV 11277 = V1210 Sgr. True position shown by tick marks; Innes' position is marked by a cross.
DSS Red plate. 10' field. North is up.

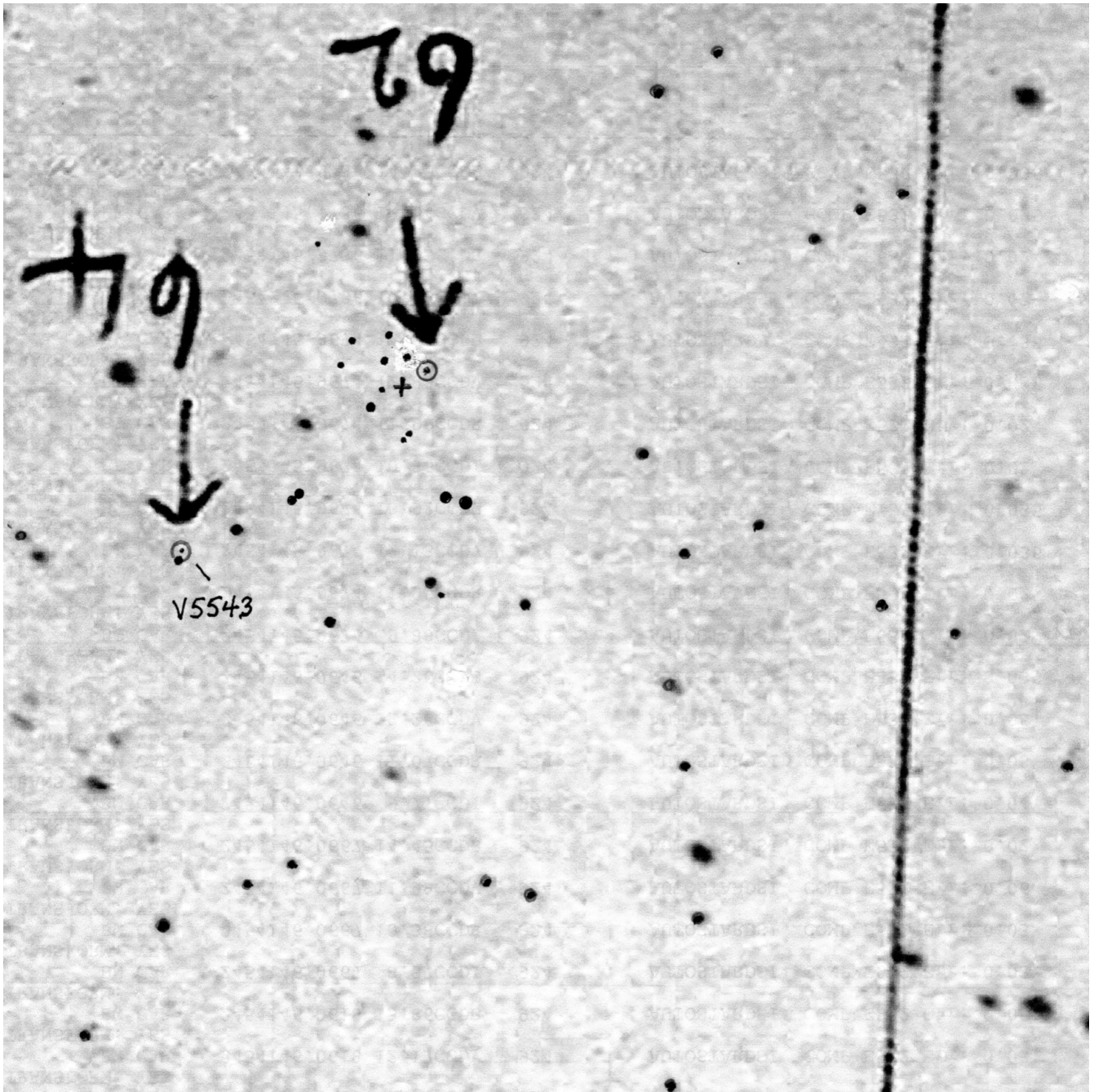


Plate 11a. Innes 62 = NSV 11286. Generally rather faint (Innes 1914). Innes 64 = V5543 Sgr, to which Innes remarks that it is close to a 16mag (end figs. (J2000) 50.78s, 44.3"). Enlargement of Plate VI of Innes, plus restored faint stars.



Plate 11b. Innes 62 = NSV 11286. Faint star between tick marks. Innes' position marked by cross.

DSS Blue plate. 10' field. North is up.

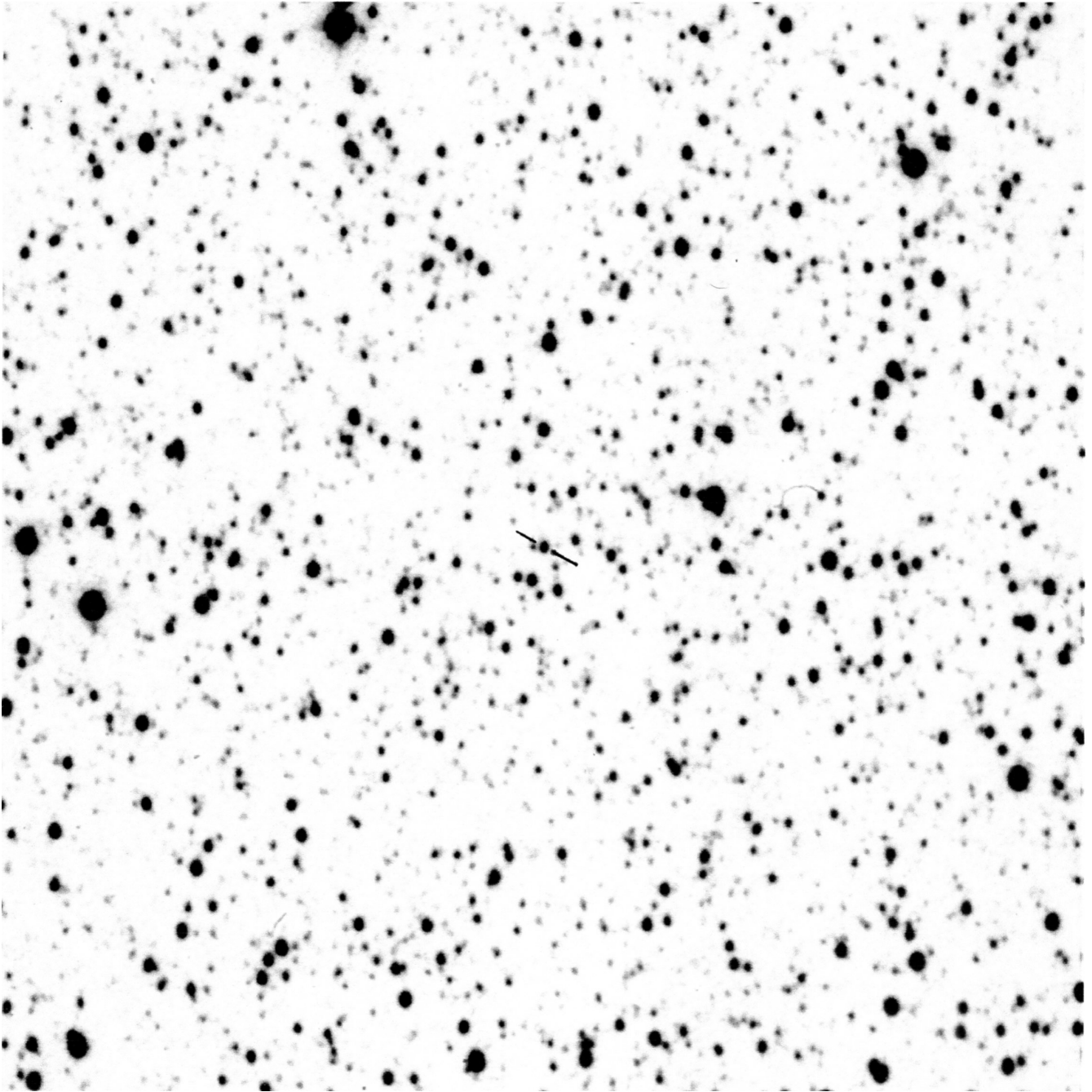


Plate 11c. Innes 64=NSV 11298=V5543 Sgr.
DSS Blue plate. 10' field. North is up.

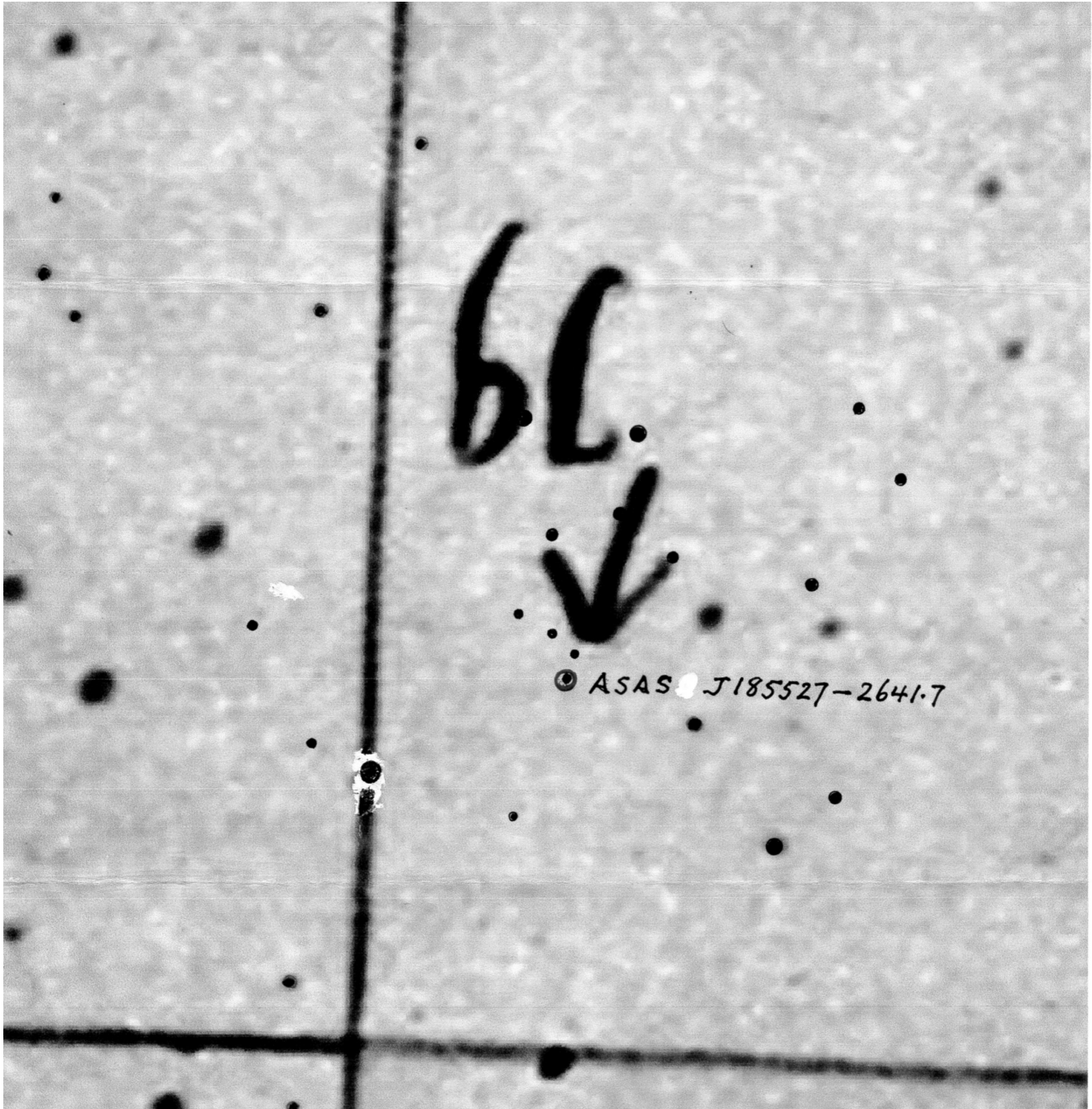


Plate 12a. Innes 79=NSV 11517=ASAS J185527-2641.7, 12.00-13.7V, M., P~220d. Close companion to east, which probably compromises the lightcurve. Innes' position is only 22" south of var. Enlargement of Plate VI of Innes, plus restored stars.

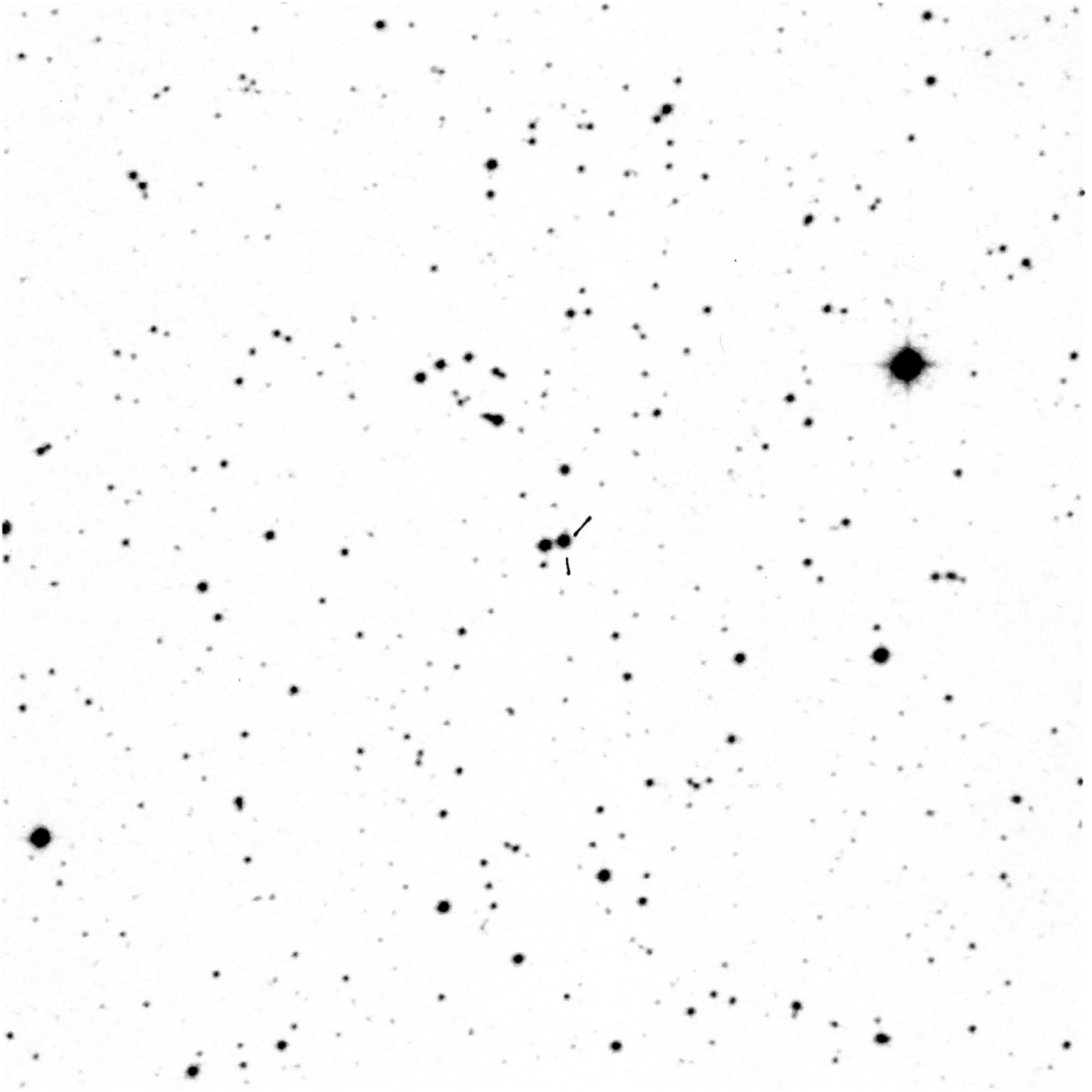


Plate 12b. Innes 79=NSV 11517=ASAS J185527-2641.7.
DSS Red plate. 10' field. North is up.

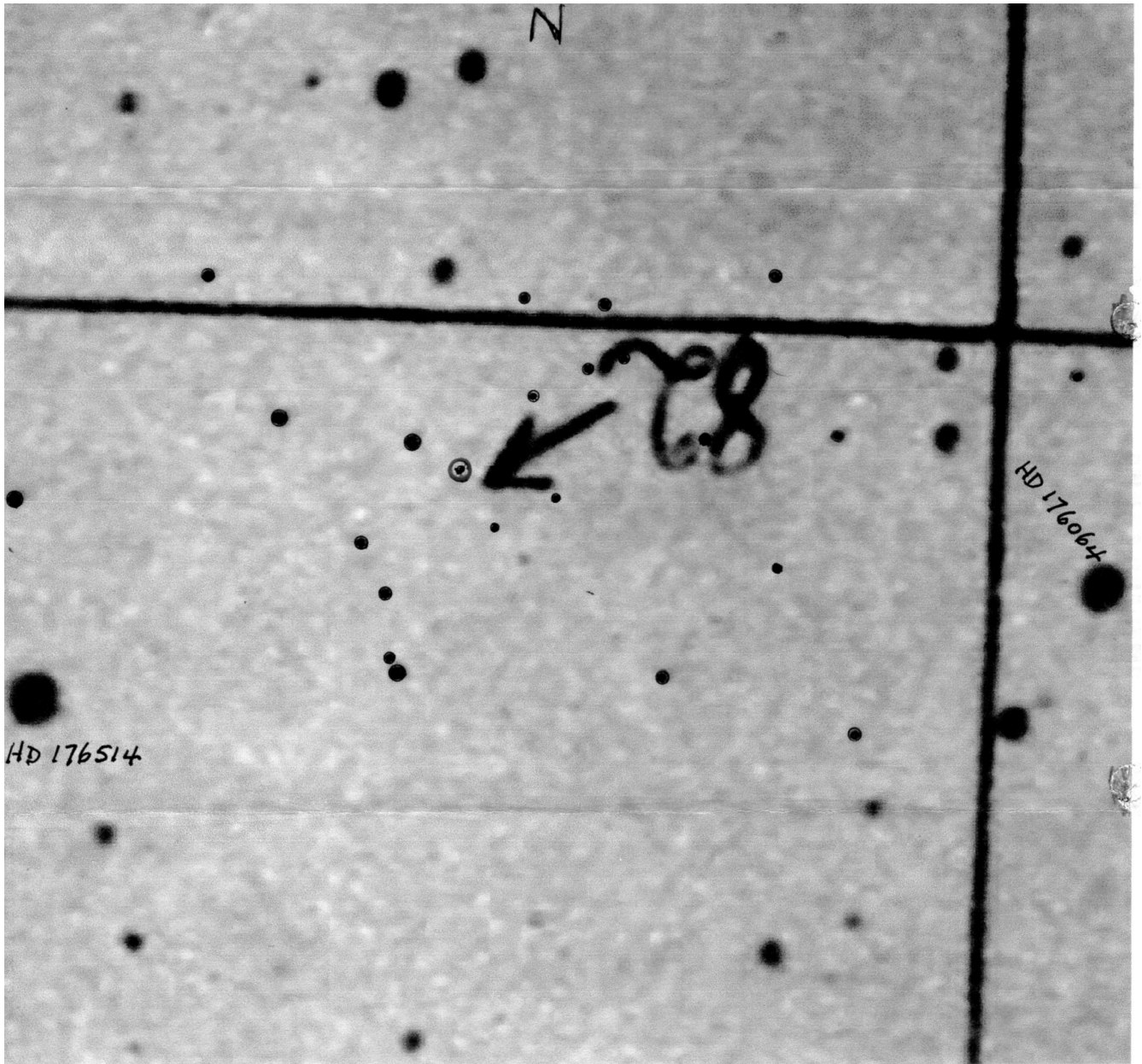


Plate 13a. Innes 82 = NSV 11633.
Enlargement of Plate VI of Innes, plus restored stars.



Plate 13b. Innes 82 = NSV 11633.
DSS Red plate. 10' field. North is up.

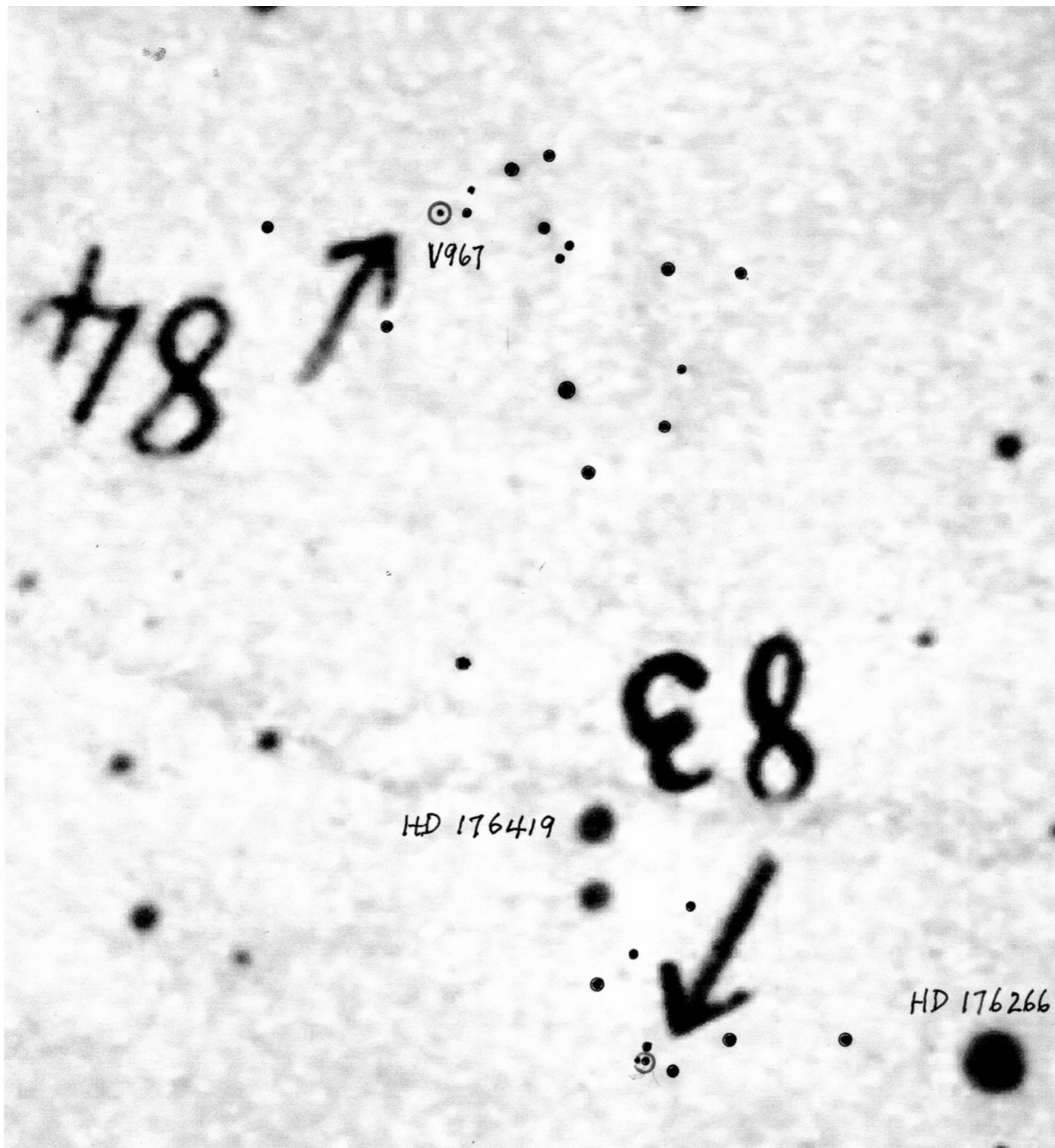


Plate 14a. Innes 83 = NSV 11638. Innes 84 = V967 Sgr.
Enlargement of Plate VI of Innes. Faint stars restored.

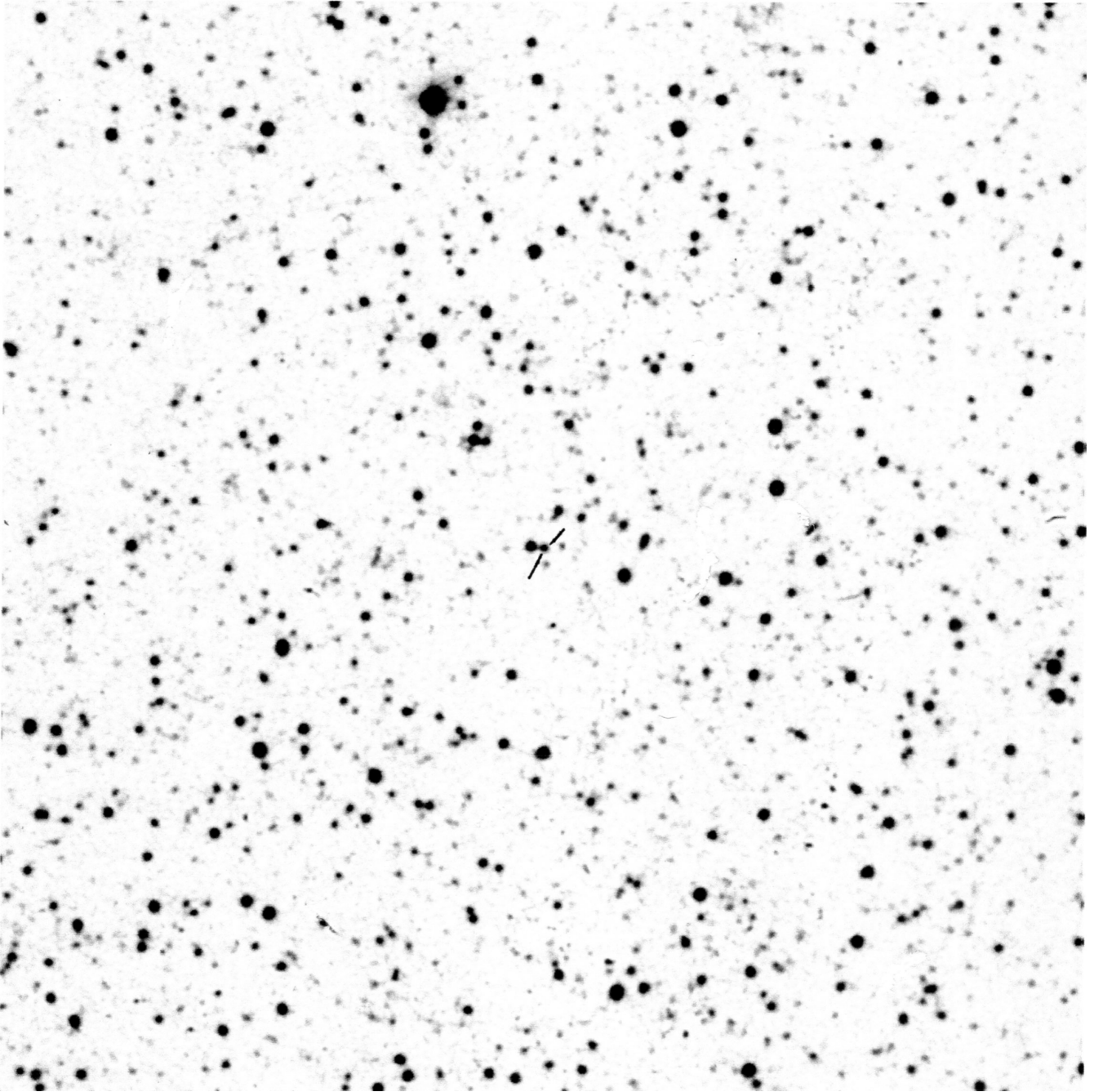


Plate 14b. Innes 83 = NSV 11638. Between tick marks, with close companion to east.
DSS Blue plate. 10' field. North is up.

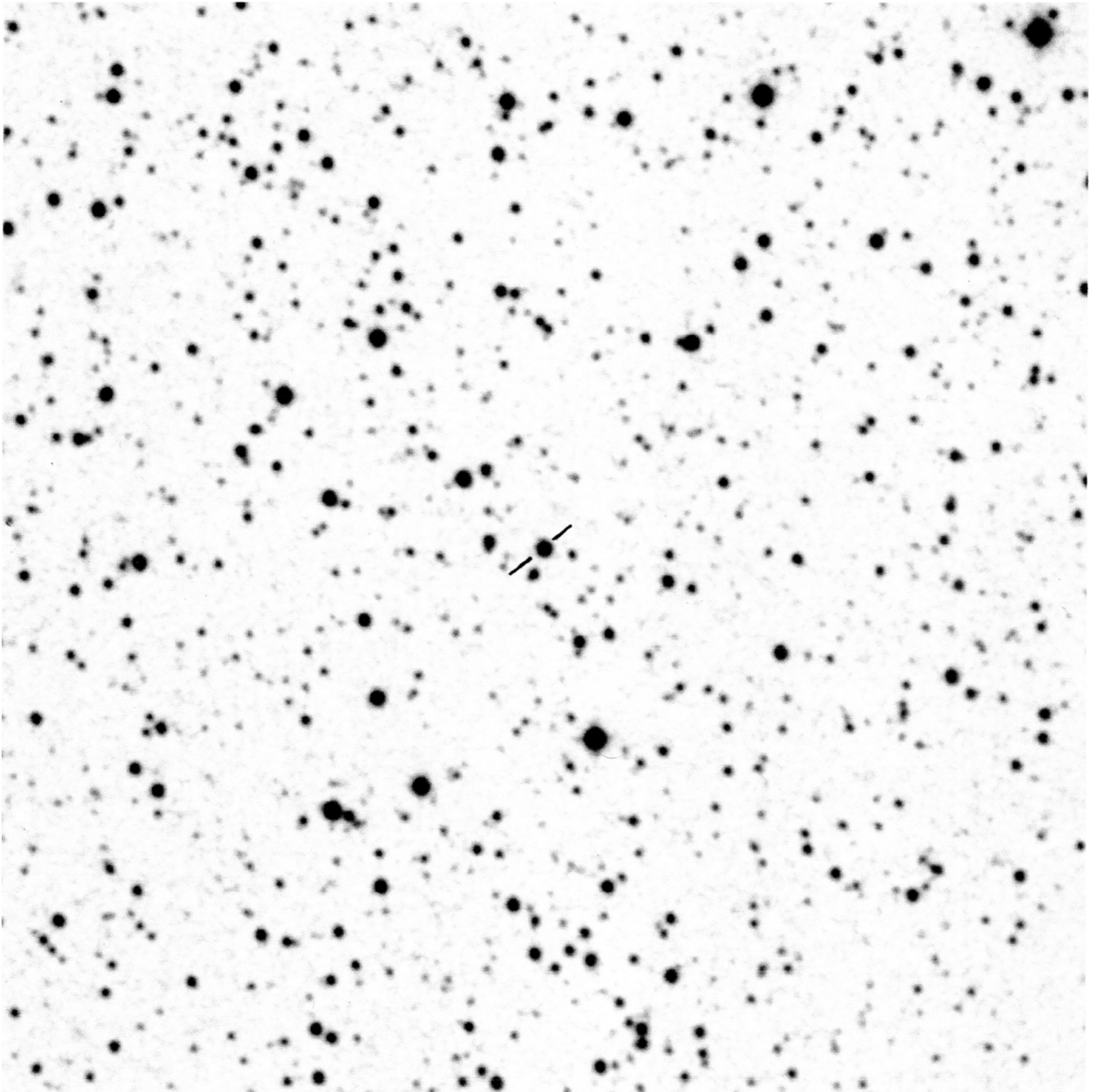


Plate 15. Innes 103 = NSV 11851.
DSS Blue plate. 10' field. North is up.

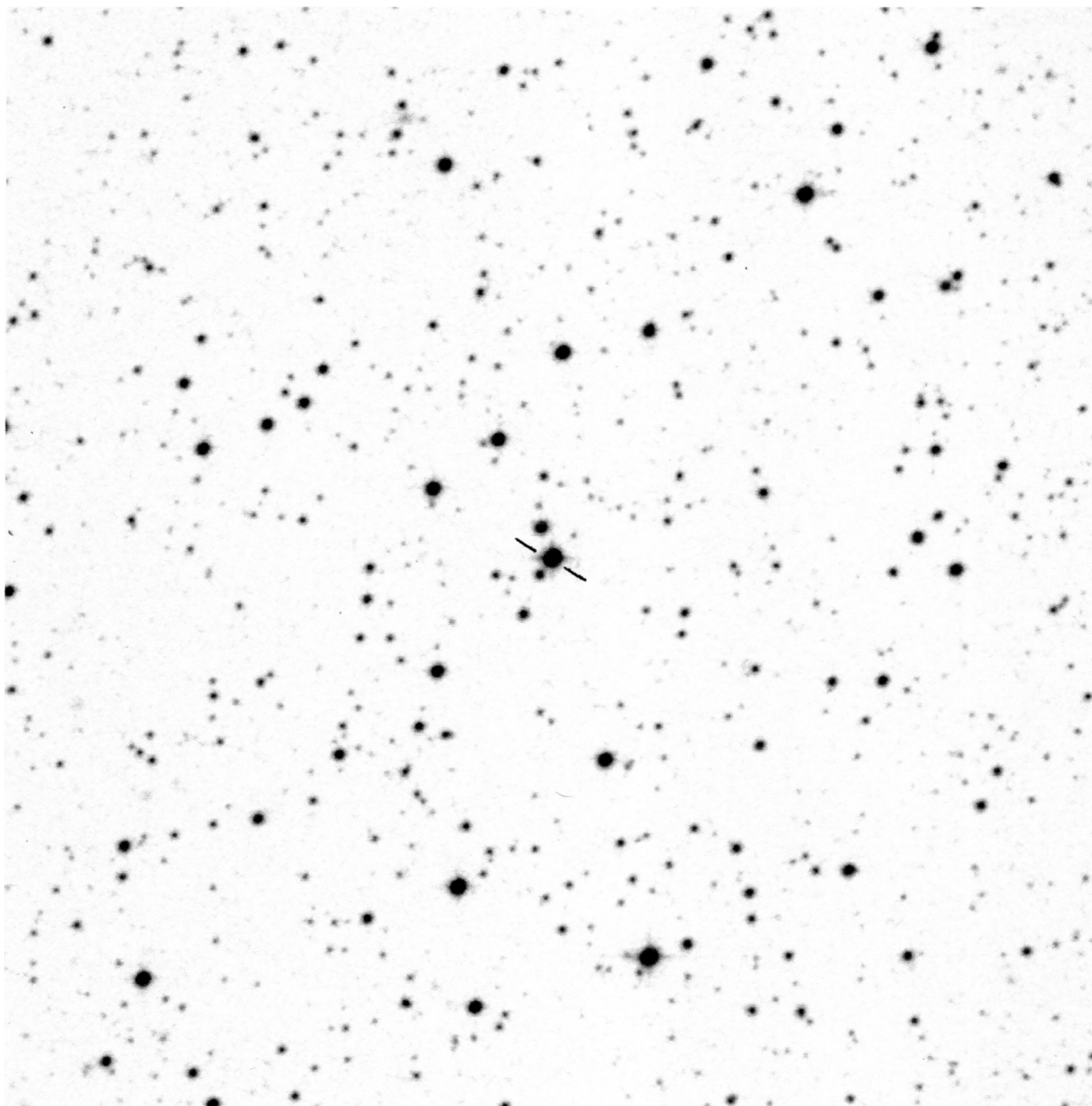


Plate 16. Innes 108 = NSV 12054.
DSS Red plate. 10' field. North is up.

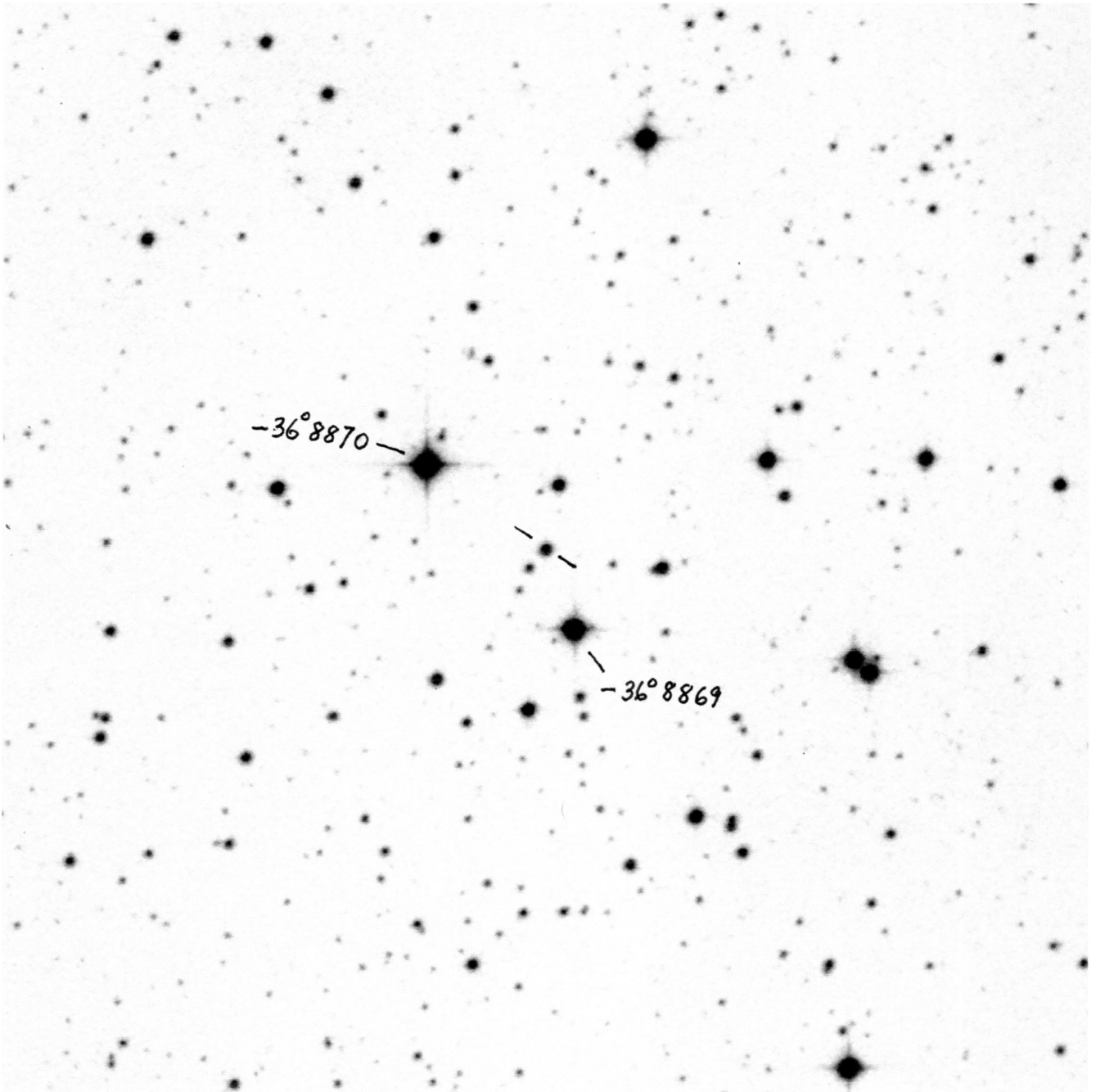


Plate 17. Innes 109 = NSV 12127. Between CPD-36°8869 and 8870. One of a triangle, the others being 15mag (Innes 1914).
DSS Red plate. 10' field. North is up.