PATROLLING VISUALLY FOR NOVAE

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Abstract

In 1978, "One Man's Nova Patrol" was presented at an AAVSO meeting about the author's then-recently commenced visual nova program. Some progress in visual nova patrolling has occurred in the interim. This paper corrects some errors present in "One Man's Nova Patrol," reviews the general state of visual work, and gives a description of my current binocular program.

1. Sins of the past

Due to a misquote, "One Man's Nova Patrol" (Collins 1978) cited a figure of 50 galactic novae occurring per year of the apparent visual magnitude 7.0 or brighter. The correct citation, based on Bailey (1921), was 25 of magnitude 9.0 or brighter. Estimates by modern workers are more modest. Liller and Mayer (1987) suggest that 14 novae of 11th magnitude or brighter appear per year, inferring 50–100 per year for the entire galaxy. "One Man's Nova Patrol" suggested incorrectly that visual work might soon become the dominant mode of nova discovery. The strength of the photographic effort has notably increased in the intervening years, with many discoveries both of novae and of previously unknown eclipsing binaries and other variable stars.

2. The way things are

"One Man's Nova Patrol" was correct in stating that visual nova discovery was accessible to amateur astronomers. Table 1 lists discoveries of novae brighter than magnitude 8.0 at maximum from 1978 through the end of 1993, excluding known recurrent novae. Modes of discovery, photographic or visual, and discoverers are listed, including contemporaneous independent discoveries. Of 27 novae on the 8th magnitude list, 7 were found visually. Confining ourselves to novae as bright as 7.0, and declination north of -20°, 7 out of 9 were found visually. Three other 7th magnitude novae north of -40° declination were not found visually, but were visible to some active visual northern patrols. The faintest visual find was Nova Vul 1987, between 7.0 and 7.3 and near maximum when found by two visual observers. The brightest was Nova Her 1991, found by Alcock at 5th magnitude. There were no naked-eye nova discoveries during these years; the last such was Nova Cyg 1975. Nova Cyg 1992 and Nova Cyg 1978 alone seem to have eluded photographic discovery, due probably to a winter full moon and proximity to SS Cyg, respectively. As to the group of astronomers now conducting visual patrol, the crew is tiny. Besides the 5 names mentioned in Table 1, I personally know of only 4 others worldwide—none in the southern hemisphere—conducting large enough patrol efforts to have a good chance of making future discoveries. Since my knowledge is likely to be incomplete, I do not list them. I deem these people to be the most faithful of all astronomers.

The typical method for conducting visual patrol entails memorization of small personal asterisms in fields viewed with binoculars (Figure 1). This process proceeds along the Milky Way, 10–20 degrees on each side of the galactic equator. In nova patrol, three different kinds of limiting magnitudes come into play: sighting, patrol, and discovery. The sighting limit is the limit of what can be seen at all without undue strain. For the author, it is usually between 9 and 10, using 10x50 glasses without moon. The patrol limit pertains to what has been memorized—for most workers, this is around 8.0. The discovery limit pertains to discoveries, and from Table 1, this is about 7.0. The one magnitude gap between patrol and discovery limits would be very desirable to reduce in order to increase the discovery rate without a change of instrument. A suggestion for this is given in section 5g.

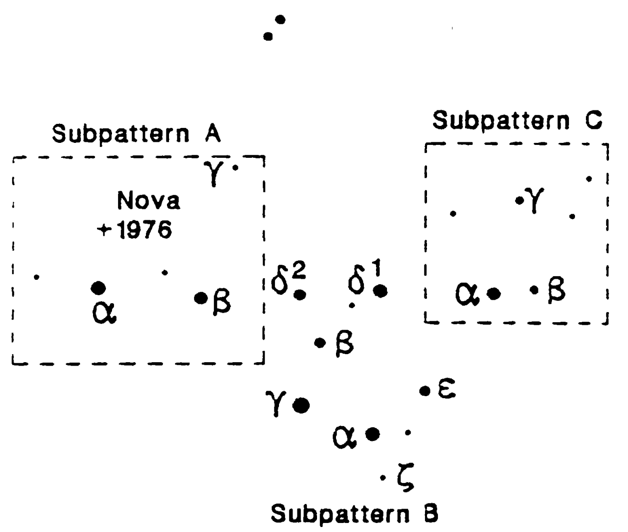
Table 1. List of 8th magnitude novae, 1978–1993

Desig.	*Name*	*Mag.*	*Mode*	*Discoverers (Photographic/Visual)*
2138+43b	Cyg 78 (V1668)	6.3 (7.0)	V	/Morrison, Collins, *et al.*
2016+21	Vul 79 (PU)	8.0	P	Kuwano/
1835-37	CrA 81 (V693)	7.0	P	Honda/
1918+02	Aql 82 (V1370)	6.	P,V	Honda/Beckmann (ind.)
1828-26	Sgr 82 (V4077)	8.0	P	Honda/
1147-66	Mus 83 (GQ)	7.2	P	Liller/
1751-14	Ser 83 (MU)	7.7	P	Wakuda/
1922+27	Vul 84 (PW)	6.4	P	Wakuda/
2022+27	Vul 84 (QU)	5.6 (6.8)	P,V	/Collins, Hess (ind.)
1314-55	Cen 86	7.5	P	Liller/
1428-57	Cen 86	4.6 (5.6)	P	McNaught/
2307+46	And 86 (OS)	6.3 (8.0)	P	Suzuki/
1839+15	Her 87 (V827)	7.5	P	Sugano, Honda/
1753-39	CrA 87 (V394)	7.2	P	Liller/
1900+21	Vul 87 (QV)	7.0	P,V	Sakurai (ind.)/Beckmann, Collins
1841+12	Her 91 (V838)	5.0	P,V	Sugano/Alcock
1807-32	Sgr 91	7.2	P	Camilleri/
0807-34	Pup 91 (V351)	6.4	P	Camilleri/
1803-25	Sgr 92 (V4157)	7.0	P	Liller/
2027+52	Cyg 92 (V1974)	4.3 (7.2)	V	/Collins
1700-43	Sco 92	7.3 (8.2)	P	Camilleri/
1817-28	Sgr 92 (V4169)	7.8	P	Liller/
1817-23	Sgr 92 (V4171)	7.5 (9.2)	P	Camilleri/
1908+01	Aql 93 (V1419)	7.5	P	Yamamoto, Liller/
1806-29	Sgr 93 (V4327)	7.6	P	Sugano, Liller/
1425-50	Lup 93 (HY)	8.0 (8.7)	P	Liller/
2337+56	Cas 93 (V705)	5.2 (6.5)	P,V	Kanatsu/Collins (ind.)

Magnitudes are maximum magnitudes. If the discovery magnitude was known to be different, it is included in parentheses. Visual and photographic magnitudes are mixed freely; photographic magnitudes are often NOT Mp.

3. Why look?

It appears that visual nova patrol is working moderately well for the brighter novae in the northern hemisphere. However, it is highly redundant with the photographic work. Why, in 1994, should we wish to continue visual patrols, when photography can find fainter novae more consistently?



	V	B - V
A α	6.31	-.08
A β	6.88	-.03
B α	5.16	+.98
B β	5.63	-.01
B γ	5.81	+1.55
B δ^1	6.31	-.02
B δ^2	6.67	-.02
B ε	7.16	+.14
C α	6.39	+.02
C β	7.13	+1.14
C γ	7.92	+.57

Figure 1. Brocchi's Cluster (the "Coathanger") in Vulpecula. Experimentally broken down by Collins into 3 subpatterns and ranked by brightness using Greek letter (Bayer) notation. δ^1 and δ^2 in subpattern B are two stars of apparently near-equal brightness. Unlabelled stars are below the patrol limiting magnitude. Photoelectric magnitudes and colors listed to the right of the diagram are taken from Sky Catalogue 2000.0 (Hirshfeld, Sinnott, and Ochsenbein 1991).

At the present state of the art, there are functional advantages to visual patrol:

a. Visual work generally yields a more timely report. As a crude attempt to gauge the timeliness of reporting for recent nova discoveries, I selected 9 novae discovered photographically from 1988 to 1993, and determined the interval between the discovery exposure and the first confirmatory observation, as reported in the AAVSO *Alert Notices*. The average was 2.6 days, while the same for 5 visual first discoveries from 1978 to 1992 was somewhat under 1 day.

b. Visual work succeeds better in broken clouds or moonlight.

c. In locating the brighter novae, visual work probably entails less total labor per sky area covered. Photographic searches, typically going to 10th magnitude and beyond, require multiple guided exposures of at least several minutes. This is followed by film processing and considerable search with blinking or stereopsis techniques. Use of a fisheye lens going only to 8th magnitude, as suggested by McNaught (Liller 1992), should greatly speed this up. However, at present there appear to be no successful fisheye patrols in operation.

d. Visual work is cheaper and requires less infrastructure than photographic. It can be conducted under circumstances that would stop a photographer, who must have access to a variety of less than completely portable equipment.

There are also intangible benefits to visual patrol that are personal to the observer. The experience of visual discovery—actually seeing a break in the eternal firmament—is, quite apart from ego considerations, very remarkable, and surely different from that accompanying a triumph in blinking. The observer, to paraphrase Emerson, is then "glad to the brink of fear." Visual patrol is simple and self-contained, brings the observer into beautiful and long continued contact with the starry heavens, and develops a worthwhile body of knowledge.

Table 2. Collins' patrol coverage by galactic longitude

L	*Full Width (B)*	*Season*	*Comments*
350–20	25	Feb–Oct	Sgr, Oph, Sco: avoid near moon 2–3 per week—spotty.
20–50	25–30	Jan–Nov	Aql, Sct, Oph: 3 per week Contains 100 square degree "faint" region to 9.0, spotty w/o moon.
50–70	25	Jan 20–Dec 30	Vul, Del, Cyg: 3–4 per week.
70–90	30–35	all year	Cyg: 2–3 per week
90–110	15–20	all year	Lac, Cep, Cas: 2–3 per week, spotty.
110–140	10	all year	Cas, Cep: 1–3 per week, spotty.
140–160	5–10	July–Apr	Per: 1–2 per week, very spotty June–Sep.
160–205	—not covered—		
205–260	15–20	Sep–May	CMa, Mon, Pup: 3 per week, spotty before Jan.
260–350	—below horizon—		

4. Collins' patrol

My own nova patrol is conducted with 10x50 binoculars about 15 miles from downtown Phoenix, Arizona. The latitude is 33 degrees north, and the climate is about the best in North America for such work; city lights interfere relatively little, save at the horizons. About 80% of the nights are clear enough for substantial patrol, although extended cloudiness occurs irregularly in the "monsoon" season of July and August. (In the interval 1978–1993, I lived in a different location with significantly less favorable conditions.)

The patrol sweeps the galactic equator, covering the range in galactic longitude 350 (Sgr) to 260 (Pup), with a notable gap from 160 to 205. The patrol limiting magnitude is variable, but near 8.0 in most places. The frequency of coverage averages 3 times per week in the active summer Milky Way areas. (I do not work as hard at this patrol as circumstances would allow). The total sky area covered is roughly 4100 square degrees, which under good conditions is swept at 30–40 square degrees per minute.

Roughly 6600 stars delineated in 970 asterisms comprise the memorization burden. The time budget for a night's work is 1–3 hours sweeping, and 15–30 minutes of suspect checking and record keeping. Figure 2 shows the patrol boundaries; Table 2 details the coverage by region. A significant fraction of 66 AAVSO Selected Areas are covered, but only 19 in their entirety. Working with Selected Areas from the outset of a nova program will minimize this kind of fragmentation.

To gauge the effectiveness of the spatial coverage, a sample of 188 historic novae and probable novae was selected from Duerbeck (1987). These were divided into 3 categories—in, out, and "near out," referring to objects within, without, and without but no more than 5 degrees from a boundary of the patrol region. For each of these categories, a further subcount of those brighter than 8.0 was kept. The results are seen in Table 3. Seventy-seven percent (77%) of all novae fall within the patrol region, but 50% of those outside are near. This interesting result suggests an expansion of the patrol region would be profitable.

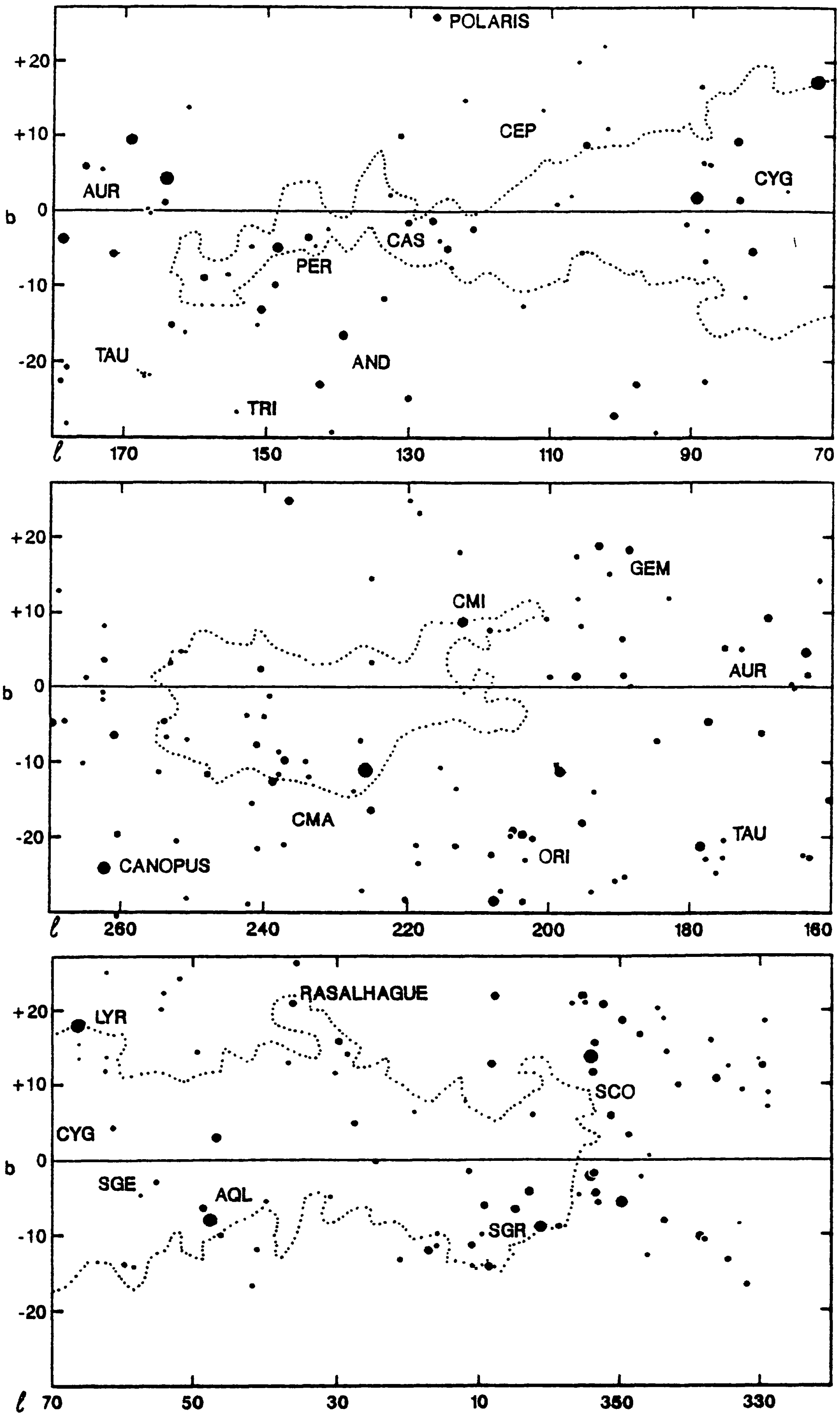


Figure 2. Boundaries of nova patrol area covered by P. L. Collins to about 8.0 visually (with 10x50 binoculars), as of the end of 1993. Most of this patrol region was in place by 1982.

Table 3. Spatial distribution of historical novae relative to Collins' patrol area

	All	*8th Mag.*
Total:	188	90
Inside:	145	68
Outside:	43	22
Near Out:	21	12

"Near Out" are a subset of "Outside"—i.e., novae outside patrol region but within 5 degrees of a boundary. Sample is compendium of Duerbeck (1987) excluding recurrent novae and some questionable objects.

5. Suggestions from my own experience

a. Coverage

Appropriate coverage of your entire patrol region is indispensable. Even "worthless" regions can surprise us, as with Nova Cas 1993. Since you probably won't cover your entire region every single night, record keeping is essential for proper rotation of subregions or Selected Areas.

b. Moon

Visual observers should not neglect moonlit nights. Although some photographic patrols go right through bright time, it is a hindrance. Nova Cygni 1992, happening at the full moon, was apparently not found by any photographer.

c. Sit

Proper physical support, such as a lawn chair, allows fainter stars to be seen in the binoculars and is conducive to critical examination. It is not just a matter of comfort.

d. Rush not

Rushing the patrol loses novae. I actually swept right around Nova Her 1991 at 5th magnitude! It is very easy to think you have swept completely when you haven't.

e. The four seasons

In spring in the northern hemisphere, when searching the summer Milky Way is a predawn activity, time management becomes difficult. You often find that you got out a little too late and dawn is coming a little earlier than you expected. It is a balancing act then between reasonable coverage and reasonable thoroughness. It is helpful to remember that regions like Lyra will be high in the dawn and can be swept well with a certain amount of twilight prevailing, so save these regions for last.

f. Selected Areas

It is very useful to report your patrol monthly to the AAVSO Nova Search Committee. If you do not use the Selected Areas directly, convert your own subregion nomenclature.

g. Enhancement

As discussed in section 2, the typical nova search patrol limit is about one magnitude fainter than the discovery limiting magnitude. This implies that maybe half of the memorization effort and instrumental capability going into the patrol is unused. A technique to reduce this gap to something reasonable (say 0.3 magnitude) would be valuable. This might be more useful for finding additional novae than merely deepening the patrol limit, since no additional demand is made on instrument or sky. Figure 1 shows an experimental approach taken to this end. The original asterism (the celebrated "Coathanger," the site of Nova Vul 1976) was broken down into 3 subpatterns and the stars were ranked by brightness with Greek letters. The enhanced patrol would "walk" the subpattern stars from brightest to faintest. This would count the stars in the asterism in a way that was not sensitive to an uncertain limiting magnitude. It would catch variation among the known members of the asterism as well as newcomers. It could find an interloper hiding in a long chain or complex bright group of stars. A problem with this approach is that the asterisms are viewed under various field orientations and atmospheric conditions, and the relative apparent brightnesses of stars will change. It was thus decided to use an "echelon" approach: stars within a few tenths of a magnitude of each other are given the same Greek letter with ascending subcripts, e.g. γ^1, γ^2, γ^3. The brightness order within a Greek letter echelon is considered subject to change. This approach was tried for about a dozen asterisms over several weeks in 1993, and the effort seemed not unreasonable. It is not yet a part of my regular program, and experiments are continuing.

6. Conclusion

Visual nova patrol is at a significant juncture. Having succeeded well as a prototype activity, it must assume more of the mainline patrol coverage now provided solely by photography if it is to flourish. The yield of visually discoverable novae must be increased to support a larger group of observers. We must deepen the discovery limiting magnitude.

7. Acknowledgements

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