

A Rejection of Nova Orionis 1667, with a Suggestion of a Possible Nova Orionis 1678

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SUMMARY

It has been claimed that Hevelius's catalogued star 48 (Hev) Ori was based on a nova observed in 1667. It has been further argued that a recurrence was witnessed by Bevis around 1745. The historical evidence for both claims is examined and shown to be erroneous. The catalogue position instead was reduced, although incorrectly, from an observation made during the course of a lunar occultation on 1678 March 28. Because of the reliable nature of the observation, the observed object may indeed have been a nova.

Nova Orionis 1667 has aroused mixed feelings among compilers of variable star catalogues. Evidence for the original observation was tenuous, to say the least, but this deficiency had to be weighed against the claims of two later observations of the recurrent nova in the eighteenth and nineteenth centuries. For Lundmark (1) in 1921, the balance tipped to the positive side, and he assigned the nova a probability of 2 (on a scale of 0 to 3). The Gaposchkins agreed in 1938, including the nova in a table of galactic novae, but by 1957 Payne-Gaposchkin had decided to reject it, although apparently not because of any new evidence (2). Weaver had earlier showcased the nova as one of the earliest recorded in the West (3), and although Ashbrook argued strongly in 1963 that the nova was non-existent (4), the *General Catalogue of Variable Stars* continues to retain it as V529 Ori (5).

Evidence for a possible nova 1667 first came to light shortly after J.E.Gore discovered U Ori in 1885 (6). U Ori is about 21 arcmin east of $54\chi^1$ Ori, and in searching older catalogues it was learned that while no star at that position had ever been recorded, Johann Hevelius, in his catalogue in the *Prodromus Astronomiae* (1690), had described a 7^m star midway between $54\chi^1$ and $62\chi^2$ Ori, at a position not far from U Ori (7). Francis Baily, the nineteenth-century editor of Hevelius, had not been able to account for this catalogue entry, designated 48 (Hev) Ori, since there was no star in the heavens at that position, nor was there any observation recorded in Hevelius's massive compendium of observations, the *Machina Coelestis* (1673–79). Baily did however state that the flanking stars, χ^1 and χ^2 Ori, had been observed on 1667 April 18, implying that the missing star was probably observed at the same time (8).

As a candidate for an early observation of U Ori, 48 (Hev) Ori immediately proved unsatisfactory, since there was a difference in longitude of almost a degree. However, the newly uncovered mystery star aroused interest on its

own, and in 1894 D. Packer revealed that a star at the exact position of 48 (Hev) Ori had been observed around 1745 by John Bevis and had been included on the star maps of his *Uranographia* (circa 1750). 'Two independent observations,' concluded Packer, 'affords us a strong probability of the actual existence of such a star' (9). When, immediately thereafter, W. Shackleton announced that he himself had also observed an unrecorded star between χ^1 and χ^2 Ori, the case for nova Ori 1667 was essentially made (10). No further information has been brought to light to the present day.

Considering that the entire documentary evidence for nova 1667 derives from just three astronomical works, it is surprising that these sources have gone unexamined since the first claims for the nova were made. Had they been consulted, it would have been found that the sources do not support the conclusions at all, at least not the conclusion that there was a nova in 1667 which flared up again around 1745. There are extenuating circumstances which probably account for this neglect, since by sheer coincidence two of the sources involved, the Bevis *Uranographia* and the Hevelius *Machina Coelestis*, are among the rarest of all astronomical works, both victims of separate calamities and generally inaccessible to most scholars. The *Machina Coelestis* provides the real key to settling the question of nova 1667, but as we shall see, it raises important new questions in the process. Since the Bevis observation can be disposed of unequivocally, I will deal with it first.

John Bevis was an eighteenth-century British astronomer about whom a great deal of misinformation has been circulated; I have attempted to set the record straight elsewhere (11). However, the two most widely repeated facts about Bevis are quite correct. One is that he made a great number of star observations between 1738 and 1745 at his own observatory just north of London. The second is that he prepared by 1750 a beautiful celestial atlas, the *Uranographia*, a work which was intended to succeed Flamsteed's *Atlas*, but which instead was sabotaged by financial problems, so that only a small number of pre-publication sets survive today.

Not surprisingly, later astronomers have always put these two facts together and assumed that the *Uranographia* was based on Bevis's own observations. That is what Packer did when he found a star between χ^1 and χ^2 Ori on Bevis's maps and concluded that Bevis must have observed it himself. Recently, however, a copy of the Bevis star catalogue has come to light which has necessitated a reappraisal of the *Uranographia* as a record of Bevis's own observations (12). For it turns out that the catalogue and atlas are almost entirely derivative; Bevis may have made thousands of observations, but he used only a handful of these in the *Uranographia*. The rest of the star positions were taken primarily from Flamsteed's two catalogues of 1712 and 1725, with additions from Tycho, Anthelme, and yes, Hevelius. The star on Bevis's map between χ^1 and χ^2 Ori is the 62nd of Bevis's Orion catalogue, and he gives his source as 'He 50', by which is meant the 50th Orion star in Flamsteed's edition of the Hevelius catalogue, as printed in the *Historia Coelestis* (1725). This star is none other than Hevelius's own 48 Ori. Indeed, the coordinates printed by Bevis are exactly the same as those of Hevelius, except that the longitude has been precessed to 1750. In short, Bevis

did *not* observe a star between χ^1 and χ^2 Ori sometime before 1745; the star on his map of Orion was simply taken from Hevelius's own catalogue (13). So much for a recurrent nova.

We now have to consider the purported original observation of 1667. We should first note that Baily (8) was quite right in stating that the unknown star is catalogued by Hevelius in the *Prodromus Astronomiae*. The star's position appears in both the annotated catalogue for epoch 1660 and the briefer catalogue for epoch 1700. Hevelius describes it as 'in Clava intermedia' [the middle star of the club] and places it in his catalogue immediately between χ^1 (in Clava praecedens) and χ^2 (in Clava sequens). His printed coordinates are $\lambda_{1660} = 25^\circ 17' 00'' \text{II}$, $\beta_{1660} = 3^\circ 13' 00'' \text{south}$; $\alpha_{1660} = 84^\circ 58' 12''$, $\delta_{1660} = +20^\circ 12' 23''$ (14).

However Baily was *not* correct in stating that the observations of χ^1 and χ^2 Ori (and thus probably 48 (Hev) Ori) were made on 1667 April 18 and so recorded in the *Machina Coelestis*. This statement has no doubt gone unchecked because most of the copies of volume two of this work, which contains the observations, were destroyed in a fire in 1679, and surviving copies have been hard to locate. Now that we are blessed with a sumptuous facsimile reprint of the *Machina Coelestis*, the Hevelius observations are readily available, and investigation reveals that χ^1 and χ^2 Ori were not observed on 1667 April 18, but rather on 1661 November 23 and December 25. The observations are correctly referenced in the Index to the *Machina Coelestis*, which Baily consulted; apparently he just got the dates mixed up with those of some other observations and failed to catch the error (15). So much for a nova of 1667.

Should we try then to make a case for nova 1661? It would seem as justifiable as nova 1667 used to be, which is to say, the grounds are very weak, but no worse than they were. Fortunately we need not consider this question, for there is one other piece of evidence which alters the entire situation. Baily claimed that there was no recorded observation in the *Machina Coelestis* because no entry appeared in the Index. He was right about the Index but wrong about the observation. The observation *does* exist, and it was printed in the body of the *Machina Coelestis*. It was *not* made in conjunction with the sextant observations of χ^1 and χ^2 Ori in 1661, but was instead made on 1678 March 28, in conjunction with a lunar occultation of χ^1 Ori. It was easy to find because Hevelius devoted most of one page to recording the observation and all of another to one of his typical 'animadversions' discussing it. Viewing with his 12- and 20-foot telescopes (which he never used for positional work), Hevelius observed that χ^1 Ori was occulted by the first quarter Moon at 7^h 31^m, and he recorded its reappearance about 10 arcmin beyond the bright limb at 8^h 28^m. He was then surprised to see another star follow in almost the exact same path, and he observed its first contact at 9^h 16^m and its reappearance at 10^h 29^m (16).

After providing these and other details, Hevelius then asked, what was the second occulted star? It could not have been χ^2 , because χ^2 is not only 10 arcmin farther south, but it is 2° 14' to the east of χ^1 , and as Hevelius puts it, the Moon could hardly cover that distance in 1^h 43^m. He concludes

therefore that he has observed a previously unrecorded star, and from the occultation times and path he calculates a position for 1678 of $25^{\circ}17'11$, $3^{\circ}13'$ south. It is this position which is entered in the subsequent catalogue as 48 (Hev) Ori.

The discovery of this observation changes the whole nature of the problem. Without it, and without the supporting evidence of Bevis, the Hevelius catalogue entry by itself would carry no weight. There are a number of spurious stars in the Hevelius catalogue, as in all of the older catalogues, and while some of these may well have stemmed from observations of real objects, and probably even novae, we are rarely in a position to determine which were valid and which were not, in the absence of other evidence. Even if we had found a pair of sextant observations which yielded 48 (Hev) Ori, we could not be certain that the object existed, since every astronomer of that period was capable of surprisingly sizeable instrument errors (17). But a star observed during a lunar occultation is another matter. However many questions might be raised concerning the initial disappearance, it is highly unlikely that an imagined object would reappear in the right place nearly two hours later. Moreover there is no possibility of instrument error here; no sextant was used, and the clock provided a time differential only. The object must have been real. So we can reopen the question that Hevelius asked: what was that star?

First of all, we need its correct position. It is not surprising, in view of the error-plagued history of 48 (Hev) Ori, to find that Hevelius himself made two mistakes between observation and catalogue. For one thing, he forgot to reduce the position to 1660, the epoch of the catalogue, instead inserting the 1678 coordinates unchanged. And he also used an incorrect position of χ^1 Ori to calculate this position in the first place (18). If we start over and use only Hevelius's statement that the unknown star was 56 arcmin east of χ^1 in longitude and 1.6 arcmin south, we can derive a more correct (if still approximate) position of $\lambda_{1660} = 24^{\circ}54'11$, $\beta_{1660} = 3^{\circ}13'$ south. This puts it 23 arcmin west of the printed catalogue position and thus 23 arcmin west of the positions given in Baily (8), Lundmark (1), and Payne-Gaposchkin (2). The position for epoch 1950, using Hevelius's longitude differential but modern values for χ^1 Ori, is $\alpha_{1950} = 05^{\text{h}}55^{\text{m}}24^{\text{s}}$, $\delta_{1950} = +20^{\circ}15'2''$.

The correct position does not aid significantly in identifying the object. The closest star in any direction brighter than 8^{m} is U Ori, which is still $35'$ west. Had U Ori been the second occulted star observed by Hevelius, the time of occultation would have been over one hour earlier, before χ^1 Ori reappeared. It might be suggested that Hevelius was mistaken about the identity of the first occulted star, χ^1 Ori, but leaving aside the unlikeliness of such an error in a seasoned star observer like Hevelius, the supposition does not help, because there is no pair of stars in the vicinity which are 7^{m} or brighter and 56 arcmin apart in longitude. The thought that we might have here the earliest of all trans-Jovian planetary observations is tantalizing, but in 1678 Uranus was in Pisces and Neptune was even farther west in Capricorn. And none of the minor planets seems to be a promising candidate for an object whose elongation was less than 80° .

We are left with two possibilities: (a) the object was spurious, the reliable nature of the observation notwithstanding, for reasons undetermined, or (b) the object was a nova after all. The nova hypothesis is more attractive, but it cannot be confidently argued without more information. The historical evidence is probably exhausted; no other contemporary observer seems to have noticed the occultation or the nova, and indeed Flamsteed in 1680 observed the quadrangle of 54, 57, 62 and 64 Ori without recording anything singular (19). If further evidence is to be found it must probably come from current studies. Weaver (3) successfully identified D'Agelet's star, nova Sge 1793, in 1951, and the same attempt might be made for nova Ori 1678?, if we may temporarily use that designation. The position Hevelius provided is less certain than that given by D'Agelet, but it is probably accurate to within 2 arcmin in longitude and 30 arcsec in latitude. Recomputation using modern lunar orbital elements might improve that position considerably. And we should keep in mind that Shackleton's claim to have seen an unknown star in the approximate position of Hevelius's star in 1894 might, for all its imprecision, have some scientific worth. At any rate, the rewards for a successful search seem ample enough; if the star in its post-nova state could be recovered, it would be the second oldest galactic nova known with certainty. If corroboration is not forthcoming, nova Ori 1678? must be rejected as inconclusive. But one thing is certain: after 90 fitful years, nova Ori 1667 may have its number permanently retired.

ACKNOWLEDGMENTS

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- (3) Weaver, H.F., 1951. The identification of D'Agelet's nova Sagittae of 1783, *Astrophys. J.*, **113**, 320. He includes nova 1667 with P Cygni and nova 1783 as the oldest galactic novae now known or for which there is hope of rediscovery.
- (4) Ashbrook, J., 1963. Astronomical scrapbook, *Sky and Tel.*, **26**, 80.
- (5) Kukarkin, B. *et al.*, 1970. *General Catalogue of Variable Stars*, Moscow, **2**, 186, 575.
- (6) Gore, J.E., 1886. On the new star in Orion, *Mon. Not. R. astr. Soc.*, **46**, 108.
- (7) Copeland, R., 1886. On a new star in the constellation of Orion, *Mon. Not. R. astr. Soc.*, **46**, 109.
- (8) Baily, F., 1843. The catalogues of Ptolemy, . . . Hevelius, *Mem. R. astr. Soc.*, **13**, 222, 244. 48 (Hev) Ori is Baily's no. 1064. Baily actually labels 62 Ori as χ^4 , and other astronomers have used still different systems. I have converted to modern nomenclature consistently throughout.
- (9) Packer, D.E., 1894. On a remarkable star in Orion, *J. Br. astr. Ass.*, **4**, 96.
- (10) Shackleton, W., 1894. A remarkable star in Orion, *J. Br. astr. Ass.*, **4**, 215. Shackleton was not able to determine the position because of clouds.
- (11) Ashworth, W., 1981. John Bevis and his *Uranographia* (circa 1750), *Proc. Am. phil. Soc.*, forthcoming.

- (12) A copy, apparently unique, of the printed catalogue is in the Library of the American Philosophical Society in Philadelphia, bound with the *Uranographia*. The other eleven known copies contain no contemporary printed matter. The catalogue is discussed in detail in (II) above.
- (13) Ashbrook (4), although not aware of the existence of the Bevis catalogue, shrewdly surmised that Bevis probably borrowed the position of this star.
- (14) Hevelius, J., 1690. *Prodromus Astronomiae*, Gdansk, 228, 296. The catalogue for 1660 is augmented by columns containing positions according to Tycho, Landgrave Hesse-Cassel, Riccioli, Ulugh Begh, and Ptolemy; for the star "in Clava intermedia" these columns are blank. Hevelius did not adopt the practice of using Bayer letters; I have used them (and Flamsteed numbers) for consistency.
- (15) Hevelius, J., 1673–79. *Machina Coelestis*, Gdansk (facs. rpt. Zentralantiquariat der DDR, Leipzig, 1969), 2 (1), 380, 391–2; 2 (2), 390.
- (16) *Ibid.*, 2 (1), 814–5. The occultation is illustrated by an engraving opposite p. 804.
- (17) Although a single recorded pair of sextant observations by itself proves little, other factors, such as the existence of a remnant near that position, can add considerable weight to its validity; see Ashworth, W., 1980. A probable Flamsteed observation of the Cassiopeia A supernova, *J. hist. astr.*, 11, 1.
- (18) Hevelius somehow derived a 1678 longitude for χ^1 Ori of $24^\circ 21' 10''$ II from his 1660 value of $23^\circ 58' 13''$, which implied an annual precession of about 77 arcsec. He knew better.
- (19) Flamsteed, J., 1725. *Historia Coelestis*, 1, 81. Flamsteed's observations were first noticed by Copeland (5).