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FRANCIS BAILY: ANOTHER ASTRONOMER AND ACTUARY

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ABSTRACT

On the occasion of the forthcoming total eclipse of the sun in Devon and Cornwall on 11 August 1999, the name of Baily is likely to receive much publicity because of the accompanying phenomenon of Baily's Beads. The paper explains Baily's Beads and also summarises the very considerable contribution which he made to actuarial science in the early days.

KEYWORDS

Total Eclipse of the Sun; Baily's Beads; Diamond Ring Effect

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In *J.I.A.* Volume **112** Part 2 I wrote a note entitled 'Edmond Halley: Astronomer and Actuary', (coinciding with the then 75-yearly return of Halley's Comet). Topically, because of the forthcoming total eclipse of the sun, visible in Devon and Cornwall on 11 August 1999, it seems appropriate to refer to another astronomer and actuary, namely Francis Baily. Total eclipses of the sun are very rare in any specific area, the last one in the United Kingdom being on 29 June 1927 (apart from one visible in the northernmost part of the Shetland Islands in 1954), and the next is not due until 23 September 2090. The name of Baily is likely to appear prominently in connection with the eclipse in 1999, as his name is associated with Baily's Beads, a phenomenon which occurs during an eclipse of the sun.

Francis Baily was born in Newbury in 1774 and died in 1844, some four years before the Institute was founded. An article by Trevor Sibbett, summarising at length his actuarial activities, appeared in *The Actuary* in October 1994 (Sibbett, 1994). It is sufficient to comment here on his principal contributions to actuarial science. Firstly, while working as a stockbroker in London he published, in 1802, *Tables for the Purchasing and Renewing of Leases, for terms of years certain and for Lives etc.* (Baily, 1802). This was followed, in 1808, by his next publication, *The Doctrine of Interest and Annuities Analytically Investigated and Explained* (Baily, 1808), but perhaps his most important contribution was the 600-page book, entitled *The Doctrine of Life Annuities and Assurances* (Baily, 1810), which he published in 1810, and is the first work which attempted to standardise actuarial notation. After 1810 Baily's interest in actuarial matters seemed to decline, although there are no less than five references to him in *J.I.A.*, and these are all quoted in the index to Volumes 1-40. The reading list on Francis Baily in

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the Faculty and Institute Library Service contains no less than fifteen references to him, together with copies of the above three publications.

In concluding comments on his actuarial activities I quote part of the final paragraph of Trevor Sibbett's article in *The Actuary* (Sibbett, 1994):

> "Francis Baily gathered together the mathematics of actuarial science correcting prevalent errors. He rewrote it in a consistent, relatively succinct and more easily assimilated form, created a firm base for others to work from, and published many monetary functions as well as the basic functions of many life tables for reference for those who needed them. It was a major achievement, which made actuarial science readily accessible to those with an adequate grasp of mathematics."

I also quote part of the first paragraph of Jack Moorhead's article 'Dreams of our Founding Fathers', which appeared in the May 1998 edition of *The Actuary* (Moorhead, 1998):

> "The first actuarial practitioner in North America was Jacob Shoemaker, who in 1809 launched the Pennsylvania Company for Insurances on Lives and Granting Annuities, and indeed was an ornament to his profession. He gave full credit for the help and instruction he obtained from British Actuaries, naming particularly Richard Price, William Morgan and Francis Baily."

It is, however, as an astronomer that Baily attained most fame, being a founder member of the Astronomical Society of London, which later became the Royal Astronomical Society, and he was its President on no less than four occasions. His many and varied contributions to astronomy are recorded elsewhere, notably in a memoir on his death, written by Sir John Herschel, which appeared in *Monthly Notices of the Royal Astronomical Society* (Herschel, 1844).

The astronomical phenomenon by which he is most generally known and which will be referred to extensively on the occasion of the eclipse on 11 August 1999 is Baily's Beads. Although the phenomenon had been recorded by Edmund Halley, another actuary, during the eclipse of 1715, they have been known as Baily's Beads since he observed them at an annular eclipse of the sun, visible in Jedburgh, Scotland in 1836. Determined to see a total eclipse, he then journeyed to Pavia in Italy in 1842, and saw a repetition of the phenomenon of Baily's Beads which were much more prominent, and he described them as 'astonishingly wonderful'. The phenomenon has continued to be associated with his name since he described the eclipse and Baily's Beads in a paper to the Royal Astronomical Society on his return from Italy.

The phenomenon occurs during the seconds before totality and during the seconds after it. The beads are caused because the circumference of the moon is not perfectly circular, but irregular, due to the mountains and valleys on its surface. At the critical time the sun's rays appear through the valleys and are blocked by the mountains, thereby producing blobs of light round the circumference, which are Baily's Beads. They appear only for seconds just before totality, and, as they disappear, it is possible that one prominent valley may remain and an enormous single bead appears. Because of its size and prominence

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it has become known as the Diamond Ring effect. It is described as probably the most dramatic and astonishing feature which appears in an eclipse of the sun. As totality of the eclipse ends the phenomenon occurs in the reverse order, namely the Diamond Ring effect followed by Baily's Beads. During totality one's eyes have adapted to darkness, and so the Diamond Ring effect and Baily's Beads are likely to be seen more clearly at the end of totality rather than at the beginning.

And so, let us hope for good weather in Devon and Cornwall on 11 August 1999, and then, with any luck, Baily's Beads and the Diamond Ring effect may be apparent.

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