8h. 4′ 57″ p.m., and Achernar at its eastern elongation at 8h. 49′ 40″ p.m. and the difference of their readings was 76° 10′ 34″. To find their azimuths A and B.

Tan. $\frac{1}{2}$ (A—B) = Tan. $\frac{1}{2}$ (A+B) Tan. $\frac{1}{2}$ (D+E) Tan. $\frac{1}{2}$ (D—E)

Log. Tan. $\frac{1}{2}$ (A—B) = Log. Tan. $\frac{1}{2}$ (A+B) + Log. Tan. $\frac{1}{2}$ (D+E) + Log. Tan. $\frac{1}{2}$ (D—E)

= Log. Tan. (38° 5′ 17″) + Log. Tan. (63° 19′ 10″) + Log. Tan. (5° 29′ 35″)

= 9·8941851 + 10·2987972 + 8·9830243

= 9·1760066

Tan. $\frac{1}{2}$ (A—B) = 8° 31′ 45″

$\frac{1}{2}$ (A+B) = 38° 5′ 17″ as observed

$\frac{1}{2}$ (A—B) = 8° 31′ 45″ as above.

Therefore by adding and subtracting these equations we get—

A = 46° 37′ 2″ and B = 29° 33′ 32″

OBSERVATIONS ON MR. R. M. JOHNSTON'S VITAL STATISTICS.

By A. B. Biggs.

[*Read November* 17, 1884.]

It would be presumptuous in me to discuss in detail the interesting and ably-compiled Vital Statistics issued by Mr. Johnston for the year 1883. There is one branch of the subject, however, to which my attention was drawn by a sub-leader in the *Mercury* of 10th September, upon which, as it comes somewhat within my own line of study, I think I may, without impertinence, make a few observations. I quote from the article referred to :—" The course of investigation has led to the discovery that there is a coincidence between the minimum and maximum *sun-spot periods* and the death-rates, and again, with the *position of the planet Jupiter* in his orbit. The *maximum* sun-spot period appears to be when Jupiter is between aphelion and perihelion ; and this corresponds with the *lowest* death-rate, that is, when the depression in the diagram is greatest. On the other hand, the *minimum* sun-spot period appears to be when Jupiter is at perihelion, and this corresponds with the *highest* point of the diagram of the death-rate, etc." This appears to me to fairly represent the conclusion at which Mr. Johnston has arrived, and which his diagram, so far as it goes, appears to show. Now, the point that immediately struck me on reading this was, that the fluctuations of the death-rate

curve might correspond with and be dependent upon *either* the sun-spot periodicity *or* the position of Jupiter in his orbit. But we are not at liberty to couple the two phenomena of Jupiter and sun-spots, inasmuch as the periods, although very nearly equal, are not quite so. The accepted average sun-spot period is 11·11 years, whilst the period of Jupiter is 11·86. There is, therefore, a difference of three-quarters of a year. It follows then, that, starting from an epoch of coincidence, the sun-spot period will gain three-quarters of a year on every revolution of Jupiter, passing all through Jupiter's period in about 166 years. In half that time then, or 83 years, the sun-spot maximum, from being coincident with Jupiter's *perihelion*, will come to coincide with his *aphelion*. It must, therefore, be evident that the sun-spot period has no relation to Jupiter's movements. I am aware that some eminent authorities have favoured the notion that the periods are connected, but it could only have been on the assumption of a different sun-spot period from that which more extended observation has established.

The sun-spot maximum and Jupiter's perihelion are now approaching coincidence, which will probably occur at Jupiter's next perihelion in 1892. Their present near coincidence may very likely have suggested the idea of their being mutually concerned in affecting our death-rate.

There seems to be a disposition in many quarters to attribute some special influence to the planetary positions, especially their perihelia. Jupiter, in particular, being the nearest of the giant planets, as well as by far the largest, would, on both accounts, have immensely more influence than all the others put together; that is, on the supposition that any influence at all could be exercised by any of them on account of orbital position. The idea implies, of course, not a *direct* influence upon the earth itself, but an *indirect* one, exerted through the planet's influence primarily upon the sun. Now, notwithstanding Jupiter's vast bulk, relatively to the other planets, his mass is less than one-thousandth part of that of the sun, and his mean distance 480 millions of miles. At this vast distance it is difficult to conceive of any particular influence that he could exert upon the sun under any circumstances. His relative distances at perihelion and aphelion are as 10 to 11 (very nearly), surely not sufficient difference for the sun to trouble himself about.

Now, why should so much importance be attached to the *perihelion* position, as if it were some critical point, perfectly distinct from every other part of the orbit? The planet is approaching it from the time it leaves its aphelion, and as gradually recedes from it until it reaches aphelion again.

If any influence could be supposed to be exerted by Jupiter

upon our affairs, one would think it were more reasonable to look for something direct, as, for instance, when he is in opposition to the sun. He is then, of course, much nearer the earth than when in conjunction, very nearly in the proportion of 10 to 15, or as 1 to $1\frac{1}{2}$. This occurs at intervals of slightly over 13 months. On such a supposition, then, we should have some marked disturbance occurring about a month later every year. But, is it so? I leave this for statisticians to answer.

For my part, I may say that it would require most conclusive argument, backed up by a considerable amount of statistical evidence, to convince me that Jupiter can have any influence upon us whatever, either direct or indirect; that is, of course, apart from the question of gravitational perturbation, an astronomical nicety that does not at present concern us. The question of physical changes in the sun (as the increase or diminution of sun-spots, by whatever cause produced) affecting the conditions of life in our planet, stands, I think, on quite another footing. As the great *heart* of the system, any physical commotion there might well be supposed to affect, more or less, the whole planetary family. That there *is* some connection between such solar disturbances and the electrical condition of our globe seems to be well established. I think it, therefore, not unreasonable to expect that our mortality curve should be affected from this cause.

Unfortunately, our statistics do not extend sufficiently far back to either establish or disprove that any relationship exists between *them* and either sun-spots or Jupiter's position. Moreover, I think that a careful examination of those we have tends rather to discountenance the notion that any such relationship exists.

In the following tables I take the mortality maxima and minima from Mr. Johnston's columns, and the sun-spot periods from Professor Newcombe.

DATES OF JUPITER'S PERIH.	DATES OF JUPITER'S APH.	YEARS OF SUN-SPOT. MAXA.	YEARS OF SUN-SPOT. MINA.	YEARS OF DEATH-RATE. MAX.	YEARS OF DEATH-RATE. MINA.
1797·71	1791·78	1793 ?	1810	1848	1845
1809·58	1803·64	1804	1823	1866	1851
1821·44	1815·51	1816	1833	1873 to 1875	1860
1833·30	1827·37	1829	1844		1862
1845·16	1839·23	1837	1856		1869
1857·03	1851·09	1848	1867		1879
1868·89	1862·96	1860	(1878)		
1880·75	1874·82	1870	1889 ?		
1892·61	1886·68	1882			
		1893 ?			

Table showing the approximate coincidences of death-rate *maxima or minima, with Jupiter's perihelion or aphelion positions, and with epochs of sun-spot maxima or minima :

DEATH-RATE YEARS OF MINIMA.	JUPITER'S PERHN OR APHN.	SUN-SPOT MAXA OR MINA.
1845, England only	P. 1845·2	Min. 1844
1851, Eng'd with Sweden	A. 1851·1	—between—
1860, „ „ „	—between—	M. 1860
1862, Europe with Tas.	A. 1862·96	—between—
1869, „ „ Australia	P. 1868·9	M. 1870
1879-81 „ „ „	P. 1880·75	—between—
MAXIMA.		
1848, England only	—between—	M. 1848
1866, Europe & Australia	„	Min. 1867
1873-5, General.	A. 1874·8	—between—

The above tables show, with regard to *Jupiter's positions*, 3 perihelia and 2 aphelia to death-rate min.; also, 1 aphelion to death-rate max. Sun-spots, 2 max. and 1 min., to death-rate min.; also, 1 max. and 1 min. to death-rate max. Nothing very conclusive about this, anyway.

To sum up the foregoing observations, I may say, firstly, that, theoretically, it is highly improbable that Jupiter can have any influence upon us whatever, and that statistics, so far as they go, fail to show that he has.

Secondly, that it is, theoretically, more probable that physical changes in the sun, such as variation in spottedness, should have some such influence, but that solar observations and vital statistics have not run together long enough to establish the fact of any connection between them.

It is interesting to note that Mr. Johnston's death-rate curves all show an upward tendency during the past year or two, corresponding in time with a period of abnormal telluric disturbance, and also with abnormal atmospheric conditions, as shown by our recent *sunset glows*. Considering the intimate relationship that exists between the air we breathe, and our very existence, is it too much to suppose that the circumstance referred to may have something to do with the present upward tendency of our death-rate curves ?

In connection with this enquiry it is much to be regretted that our vital statistics do not reach farther back. However, the question opened up by Mr. Johnston is of sufficient interest to merit special consideration in the future, although the phe-

*Abbreviations—"M.," maximum ; "Min.," minimum ; "P." perihelion; "A.," aphelion.

nomena in question, unlike the sanitary arrangements which are supposed to engage the attention of our municipal authorities, are absolutely beyond our control.

A REJOINDER TO MR. A. B. BIGGS'S CRITICISM ON OBSERVATIONS MADE IN RESPECT OF THE "OBSERVED PERIODICITY OF THE DEATH RATE." Etc.

By R. M. Johnston, F.L.S., Etc.

[*Read November* 17, 1884.]

I am glad to see that so able a critic as Mr. Biggs has taken up the important subject of the "Death rate in its observed coincident relation to super-terrestrial phenomena," which was recently introduced by me in a paper read before this Society; although, at the same time, it is to be regretted that he has based his remarks upon a brief abstract from a newspaper rather than upon the paper itself, for it has greatly misled him as regards the nature and scope of my argument.

It appears to me to be very clear that Mr. Biggs' difficulty is caused chiefly by erroneously assuming that the relations commented upon are *simple* instead of *complex*, and that belief in a more or less striking observed *coincidence* seems to be regarded by him as synonymous with a like belief in a corresponding *mutual inter-dependence* between the matters which have been observed to coincide.

Now there is a very wide difference between the conception or conviction of a known agreement or *coincidence* and the conception of an underlying casual relation. We can fairly conceive and admit of identity of movement or action between several phenomena for a limited space of time without prejudice, even when we assume that such coincidence is not uninterrupted for a longer period, or that it may be due (1) to mutual inter-dependence alone; (2) to causes unknown acting independently; (3) to causes unknown acting together; (4) to certain causes known and unknown, or imperfectly known, acting in combination.