during the exciting conditions of an eclipse, but may also have arisen from the fact that the actual eclipse was shorter than the calculated one.

T. E. Thorpe.

Daylight Meteor, March 18.

This meteor, reported to Nature by Dr. Rorie of Dundee, was also seen by Mr. A. G. Linney at Ackworth, near Pontefract. Careful comparison of their records gave a probable path from just S.E. of Lanark to 30 or 40 miles W. of Mull. Notes received later from the Fort William Low Level Observatory make it probable that the end was nearer there, say just N. of Mull. The former gives an actual path of 180 miles, from a height of 140 to 42 miles; the latter, 140 miles, ending at a height of 40 miles or less. If Dr. Rorie's time is correct, it travelled at a rate of 36 or 28 miles per second, both being rapid. This accounts for the magnificent streak. As this floated across to Dundee in three quarters of an hour, the central part must have in that time travelled 95 or 85 miles at a height of 100 to 90 miles above the earth, and in an E.N.E. direction. Thus its velocity seems to have exceeded 100 miles an hour. The Krakatão dust reached us in the same direction, its greatest height being 30 to 40 miles, and speed 72 miles per hour. A greater speed at greater altitude quite agrees with theoretical probabilities, although the increase seems very great.

J. Edmund Clark.

Roche's Limit.

A letter has been addressed by Mr. D. D. Heath to the Editor of Nature on the statical problem involved in "G. R.'s" approximate method of finding Roche's limit. This letter has been submitted to me, and I have thus been led to look more closely into "G. R.'s" proof, which I adopted in a recent letter to Nature (April 20, 1893, p. 581). Mr. Heath shows that both "G. R." and I have omitted the factor 2 from our result, and I now see besides that a statical solution is insufficient for the problem in question.

The problem may be stated thus:—To find at what distance two equal spheres in contact can revolve in a circular orbit round a third, the centres of the three spheres being in a straight line.

Take the following notation:—The single sphere of density σ and unit radius; the two spheres each of unit density and radii r; c, the distance from the centre of the single sphere to the point of contact of the two; and ω the angular velocity of the system.

The problem may be rendered statical by introducing the conception of centrifugal force estimated from the centre of inertia of the system, which is also the centre of rotation. The distance of the centre of inertia from the point of contact of the two spheres is $c\sigma/(\sigma+2r^3)$.

Then the three equations, only two of which are independent, which express the equilibrium of the spheres are:—

$$\omega^2\left(\frac{c\sigma}{\sigma+2r^3}+r\right)=\frac{\frac{4}{3}\pi\sigma}{(c+r)^2}+\frac{\frac{4}{3}\pi r^3}{(2r)^2},$$

$$\omega^2\left(\frac{c\sigma}{\sigma+2r^3}-r\right)=\frac{\frac{4}{3}\pi\sigma}{(c-r)^2}-\frac{\frac{4}{3}\pi r^3}{(2r)^2},$$

$$\omega^2\left(c-\frac{c\sigma}{\sigma+2r^3}\right)=\frac{4}{3}\pi r^3\left(\frac{1}{(c+r)^2}+\frac{1}{(c-r)^2}\right).$$

Adding the first two of these and dividing by $\frac{2}{3}\pi\sigma$, and then subtracting the second from the first and dividing by $\frac{2}{3}\pi r$, we have

$$\frac{3\omega^2}{\pi}\left(\frac{c}{\sigma+2r^3}\right)=\frac{4(c^2+r^2)}{(c^2-r^2)^2},$$

$$\frac{3\omega^2}{\pi}=1-\frac{8c\sigma}{(c^2-r^2)^2}.$$

Eliminating ω^2 we have

$$c(c^2-r^2)^2-8c^2\sigma=4(c^2+r^2)(\sigma+2r^3),$$

or

$$c^5-2c^4r^2-c^2(12\sigma+8r^3)+cr^4-4r^2(\sigma+2r^3)=0,$$

a quintic for determining c, the approximation to Roche's limit. If the two spheres are infinitely small compared with the single one, this reduces to

$$c^3=12\sigma.$$

Thus the factor 16 (which, as Mr. Heath shows, should have been 8) of "G. R.'s" and of my previous letter must be replaced by 12, when the rotation is taken into account. In the notation used before, we therefore have as the approximation to Roche's limit

$$2{\cdot}29\text{R}\times\left(\frac{\text{D}}{d}\right)^{\frac{1}{3}}.$$

Proceeding further, as I did before, to find when three homogeneous spheres are in contact, so that $\sigma=1$ and $c=2r+1$, we have—

$$22r^5-25r^4-60r^3+14r^2+38+11=0.$$

Unity is a solution of this, so that three equal spheres are in contact—an obviously correct solution.

There is another root with $r=2{\cdot}08$, so that the two spheres are each much larger than the third.

These solutions of course give no approximation to that of the problem to which the latter part of my letter referred.

May 3. G. H. Darwin.

The Use of Ants to Aphides and Coccidæ.

Mr. Cockerell is not quite accurate in saying that I have "adduced the production of honey-dew by aphides as a difficulty in the way of the Darwinian theory" (Nature, vol. xlvii. p. 608). In the passage to which he alludes I have said, that the relationship which in this matter subsists between ants and aphides is one of the very few instances where it can be so much as suggested that the structures or instincts of one species have exclusive reference to the needs of any other species. Therefore, even if this suggestion were not thus opposed to all the analogies of organic nature, "most of us would probably deem it prudent to hold that the secretion must primarily be of some use to the aphis itself, although the matter has not been sufficiently investigated to inform us of what this use is" ("Darwin and after Darwin," p. 292).

But my object in now writing is to corroborate Mr. Cockerell's explanation. For, on looking up my references, I find a letter from the Rev. W. G. Proudfoot, dated March 26, 1891, in which he communicates the following observations:—

"On looking up I noticed that hundreds of large black ants were going up and down the tree, and then I saw the aphides. . . . But what struck me most was that the aphides showered down their excretions independently of the ants' solicitations, while at other times I noticed that an ant would approach an aphis without getting anything, and would then go to another. I was struck with this, because I remembered Mr. Darwin's inability to make the aphides yield their secretion after many experiments. A large number of hornets were flying about the tree, but seemed afraid of the ants; for when they attempted to alight, an ant would at once rush to the spot, and the hornet would get out of its way."

From this it seems probable that, but for the presence of the ants, the aphides would have been devoured by the hornets. It also appears that Darwin's explanation is likewise true, viz. that the aphides are bound to get rid of their excretions in any case, and therefore that "they do not excrete solely for the benefit of the ants."

George J. Romanes.

Christ Church, Oxford, May 6.

Mr. Cockerell's letter (Nature, vol. xlvii. p. 608) suggests the possibility that the following fact bearing on the connection between a coccid and another member of the Aculeate Hymenoptera may be interesting. I have a quantity of *Cotoneaster microphylla* covering a long sunny bank, and this shrub is much infested by a coccid, *Secanium ribis*. The queen wasps (usually early in June, but this year they are beginning now) are attracted in great numbers by the secretion from the coccid and may be taken with a common ring net and destroyed, to the great advantage of my garden. As to the visits of the wasps being of any advantage to the coccid I am somewhat sceptical, though no doubt they are to the wasps—when they are not caught!

Alfred O. Walker.

Nant y Glyn, Colwyn Bay, May 5.