

help here. The main fact is that all swervers project the ball with the seam as nearly as possible in a vertical plane. In the grip the fingers do not touch the seam, although in some cases the thumb does. But evidently there is little purchase on the ball, which is projected with comparatively little spin. If cross wind is not absolutely essential it certainly greatly facilitates the swerve. With some bowlers the swerve is evident from the start; with others it begins to appear only during the latter half of the trajectory. The seam is really a roughened zone on which the air may be supposed to exert a greater frictional force than on the other parts of the ball, especially if the ball be new. With seam vertical and a cross wind blowing, certain definite dynamical effects will follow. One of these will be a tilting of the axis of rotation, a tilting which will, however, take place very slowly when the spin is excessive. This suggests the question, does the seam remain vertical throughout the flight of a swerving ball? The point might be settled by bowling a swerving ball against a blackened surface and finding which part of the ball first came in contact with the surface. That, however, is outside the purpose of the volume.

The questions of swerve and break have much scientific interest, but they cover only a part of the whole; and from a cricketer's point of view much might be said, not only as to the excellence of the pictures, but as to the instruction conveyed by them and by the accompanying letterpress. Mr. Beldam has aimed at getting a succession of positions of each bowler, from the beginning of the final stride before delivery to the follow through after the ball is delivered. In a few cases the series begins even sooner. Where so much is excellent and characteristic it is difficult to choose, but here we have reproduced two pictures which will show to what a high degree of perfection Mr. Beldam has carried his photographic art. The one represents W. Rhodes at the beginning of his final swing, and is chosen partly because of the perfection with which the grip of the ball is indicated. The other is taken from the last quarter of the book, which treats of fielders, and is a remarkably fine picture of J. Tunnicliffe securing a "wide, high up, right-handed catch in the slips." This is one of a series showing Tunnicliffe bringing off difficult catches in most extraordinary attitudes.

Like its predecessor, "Great Batsmen," this volume is a treasure-house of portraits of many of the most conspicuous cricketers of to-day. It is further beautified by a good coloured reproduction of the portrait of F. R. Spofforth painted by H. S. Tuke, A.R.A. C. G. K.

THE POSITION OF AGATHOCLES DURING THE ECLIPSE OF B.C. 310 AUGUST 15.

ON B.C. 310 August 14 Agathocles left Syracuse by sea; at eight o'clock on the following morning he saw a total eclipse of the sun. His exact position is therefore of extreme interest to astronomers. Unfortunately, the course that Agathocles steered is not directly stated. The present paper is an attempt to piece together the various clues contained in the narratives.

We may first briefly glimpse at the way in which Airy handled this question (Phil. Trans., 1853, p. 188). It appears that on August 20, after a six days' voyage, Agathocles landed in Africa at a place that Airy identifies with Alhowareah. Supposing that he went direct, the distance travelled in six days would be 200 miles; if he went round Sicily the distance would be 330 miles. Airy therefore marks off on a map thirty-three miles in a southerly direction and fifty-

five miles in a northerly direction. He labels these positions as the "possible southern position" and "possible northern position," and he states in the text that the northern position is the more probable, partly because the distance is greater, and partly because the provision ships mentioned in the narrative probably came from Gela in the south.

To us, however, it appears totally incredible that Agathocles, after running from a superior enemy for twenty-four hours or thereabouts, should have been within fifty-five miles of his starting point. We will now proceed with our own attempt to reconstruct the situation.

The first point is that Agathocles started early in the morning, and to that extent had the more time in which to get to a distance from Syracuse. This is proved by an expression in the narrative of Diodorus:—"After six days and an equal number of nights, as dawn appeared" (*ἐξ δ' ἡμέρας καὶ τὰς ἴσας νύκτας αὐτῶν πλευσάντων, ὑποφανούσης τῆς ἕως*). We have no wish to strain this expression to imply that he started at the exact instant of dawn on August 14. It clearly, however, implies that Agathocles was at sea for so great a part of August 14 as to render the phrase "six days and an equal number of nights" more exact than "five days and six nights."

Our second point is that Agathocles had a fair wind. We prove this as follows:—The Carthaginian fleet was blockading Syracuse, when some provision ships appeared in the neighbourhood. The Carthaginians went to attack the provision ships; Agathocles escaped from Syracuse; the Carthaginians left the provision ships and pursued Agathocles; the provision ships then entered Syracuse. It must be remembered that warships could be rowed, and that merchant vessels could only sail; and also that so late as the time of Nelson the power of beating to windward practically did not exist. The mere fact that the provision ships entered Syracuse therefore establishes the fact that the wind was favourable, both for the provision ships approaching Syracuse and for Agathocles flying from Syracuse; but other considerations will prove the same point. The Carthaginians, by leaving the provision ships when they had all but seized them (*πλησίον ἤδη τῶν φορηγῶν ὄντες*), clearly had no intention of letting Agathocles escape. Before going to attack the provision ships they probably argued that the occasion would find Agathocles utterly unprepared, and that by the time he had put his men and stores on board they would themselves be back again. Now a stern chase is proverbially a long chase (and, moreover, would have taken them out of sight of Syracuse), and the Carthaginians could not have entertained hopes of getting back in time unless the provision ships lay to windward of them. Even as it was, Agathocles was ready for his opportunity. His men, we are expressly told, had been on board for some days (*πληρώσας ἐξήκοντα ναῦς ἐπετῆρει καιρὸν οὐκ εἰς τὸν ἔκπλουν*), and he got to sea at exactly the right moment, that is to say, when the Carthaginians had all but reached the provision ships.

Agathocles therefore had a fair wind, and to that extent it is the more probable that he was at a considerable distance from Syracuse by the next morning.

Two minor points may here be noticed, though they are not essential to our main case. When the sixth day dawned Agathocles found himself in the vicinity of a Carthaginian fleet, not necessarily the same one. He rowed hard towards shore, and by virtue of a long start arrived first, although the Carthaginians were rapidly gaining on him, being more accustomed to rowing than the Syracusans (Justin). Possibly,

therefore, Agathocles owed his escape on August 14 to the fact that he could sail instead of row. If so, his minimum pace would be seven knots, or otherwise he would have rowed, and the Carthaginians would perhaps have caught him. Again, we are ourselves convinced that Agathocles was expecting the appearance of the provision ships. It may be that he was merely prepared for any favourable opportunity, but there is much to prove that he laid his plans very carefully. He had, for instance, put saddles and bridles on board. He could not take horses with him, but he was prepared to use any he might capture on landing. On a subsequent occasion, thinking that the appearance of owls (as birds of good omen) would encourage his soldiers, he set some free, which he had evidently provided beforehand (Grote).

We have therefore established that by 8 a.m. on August 15 Agathocles had been at sea upwards of twenty-four hours, and that he started with a fair wind. He clearly did not stand out to sea more than was necessary, for to do so would be to abandon part of his start. The last and most important question is, therefore, did Agathocles go north or south?

Our third point is that Agathocles went north. Airy has already noted that the provision ships probably came from Gela, on the south coast of Sicily, since that was the only place still, after the battle of Himera two months previously, friendly to Agathocles (Grote). Airy also notes that even 330 miles is a short voyage for six days, and therefore that the longer course is more probable. Airy also makes a third point. "It is stated by Diodorus that the troops before sailing supposed that they were to make an attack either on Italy or on the Carthaginian part of Sicily; and by Justin, that, while on the voyage, they supposed that they were going on a marauding expedition either to Italy or to Sardinia." The passage in Justin is really stronger than as quoted by Airy; the troops did not realise at the time that it was Africa where they had landed (*tunc primum exposito in Africae litore exercitu consilium suum omnibus aperit*); they appear to have thought that they were in Italy or Sardinia, and consequently they must have passed through the Straits of Messina, and subsequently kept out of sight of land until Africa was reached.

If, as we believe, Agathocles had really planned events exactly as they turned out, he would have ordered his partisans at Gela to send provision ships directly there was a strong south wind, and he probably gave them to understand that he would come to their assistance, and that there would be a naval battle, in which the provision ships might turn the scale. Agathocles must have had bitter enemies in Gela, as he had just perpetrated an atrocious massacre there, and we may assume that his partisans there were bound to him by self-interest only, and had no idea of being sacrificed to the Carthaginians merely that Agathocles might escape.

Enough of his false plans had been allowed to leak out to the Carthaginians for them to suppose that he was coming out of Syracuse to give battle; it was only at the last moment that the Carthaginians, and perhaps also the men of Gela, realised that he was merely bent on escape from Syracuse. Meanwhile he had allowed his men to think that they were bound for Sardinia. Had they steered south his men would have thought that Agathocles was not acting according to a prearranged plan, but from hand to mouth as best he could. If they steered north his men would have felt the confidence engendered by seeing everything going according to the programme. If Agathocles had laid his plans beforehand, he would probably have collected information as to

currents in the Straits of Messina, and would have known that, in the early afternoon of the day preceding new moon, there is a five-knot current running northwards (Mediterranean Pilot). This current may possibly have contributed materially to his escape, for he seems to have been hard pressed (*ἀνεπίστρον σωτηρίας ἔτυχε*). If he went northward, it certainly adds ten miles to the distance he would otherwise have traversed by the time that he saw the eclipse.

P. H. COWELL.

SCIENTIFIC INVESTIGATION IN INDIA.¹

THE Board of Scientific Advice was constituted in the year 1902 by the Government of India as a central authority for the coordination of official scientific inquiry, its object being to ensure that the work of research was distributed to the best advantage, that each investigator employed by Government should confine his researches to the subject with which he was most capable of dealing, and that energy should not be wasted by the useless duplication of work or misdirected by a lack of inter-departmental cooperation. It was, more especially, hoped by the Government that the Board would materially assist it in prosecuting research in those questions of economic or applied science which are of direct practical importance, and thus contribute towards the solution of those problems and matters on which the progressive prosperity of the country, more especially as regards its agricultural and industrial development, so largely depends.

The Board includes the Secretary to the Government in the Department of Revenue and Agriculture, which controls and administers the various scientific and semi-scientific departments, and the heads of those departments, including the Surveyor-General of India, the Director-General of Indian Observatories, the Directors of the Geological and Botanical Surveys of India, the Inspectors-General of Forests, of Agriculture, and of the Civil Veterinary Department.

It advises generally upon the operations of the departments, discusses the programmes of work and investigation of each departmental head, submits annually to Government a general programme of research embodying the proposals of departmental heads in so far as their subjects are to be exclusively dealt with in one department, and its own proposals when two or more departments are to cooperate, and also at the end of the year prepares a review stating briefly the actual results of the work of investigation carried out during the previous year in the scientific departments. The programmes and reviews are communicated through the Secretary of State to the Royal Society, which has selected suitable committees to consider the reports and advise Government chiefly on the scientific problems presented or indicated by the reports.

The necessity for some such arrangement has forced itself upon the Government of India with the rapid extension of scientific investigation during recent years. Private enterprise in such work is practically nil in India, and hence Government has to initiate all scientific investigation that is necessary for the well-being and progress of the Empire. India is at the present stage a country with limited resources, the development of which depends upon the application of modern scientific methods and knowledge to pressing economic problems. The heads of Government can gauge the requirements and initiate departments of inquiry and research, and state for

¹ Report of the Board of Scientific Advice for India for the Year 1904-5