

J. D. Bernal. *The sage of science*. By Andrew Brown. Pp. 576. Oxford: Oxford University Press, 2007. Price (paperback) GBP 12.99. ISBN 978-0-19-920565-3

I first heard the name Sage one morning in Oxford in the winter of 1962, having just arrived from New Zealand. Dorothy Hodgkin, in a delighted state, literally skipped out of her room saying 'Sage is coming!' Cakes were bought and when he arrived we were all subjected to his questions, comments and advice. His friendly interested manner removed any serious nerves and it was immediately obvious that he really had a thorough grasp of what we were trying to do.

I found this biography of J. D. Bernal by Andrew Brown a serious and extraordinarily good read, indeed I could hardly put it down. There is much in it that is new, the writing flows well, the organization of the diverse and complex material is deeply researched and handled impressively and for me, though not I suspect for all, the detail is often fascinating. One gets a vivid impression of Bernal's immense intellect and his scientific abilities, his moral and social attitudes, his critical role in crystallography's growth and his extraordinarily eventful life.

The book was first published in 2005 and has been widely reviewed, generally very favourably but it is nonetheless worthwhile to have comment on the book in *Acta Crystallographica* since Bernal was a fundamental and immensely creative figure in X-ray crystallography. Brown has used Bernal's diaries, which he kept all through his life, with great advantage. Their accuracy and detail are an indication of how Bernal thought, and demonstrate Bernal's descriptive abilities that served him powerfully in his research and thinking, and communicate forcefully his total engagement with life. Throughout the book, Brown uses quotations frequently and well; those relating to Bernal's genius and his personal characteristics I found particularly appropriate.

A biography of Bernal presents unusual problems. He did so much. It succeeds in showing how Bernal's astonishing scientific gifts and his intellectual power gave him outstanding capacities for just knowing (he was wonderful on the *Brains Trust*), for research and for military advice, reminding one of the Renaissance scientists. Most importantly, the book captures Bernal's character: we see the man's complexity, his deep sympathy for individuals – typified by his friendships, and his empathy for children. We see his extraordinary intellect which gave him the capacity to think with breathtaking scope, to absorb information prodigiously and to cope creatively with detail, and, hugely important, his peerless ability to concentrate, penetrate and connect information. An anecdote from Barbara Low who worked with Dorothy Hodgkin in the war on penicillin illustrates his grasp – and perhaps the use of those diaries. Bernal came about every 6 months to review progress on this important and secret crystallographic project, on arrival he would, without prompting, outline where the research was 6 months or so ago, then what they had planned to do and then ask what had happened. Finally, there was Bernal's simple goodness, and as Crick emphasizes, his approachability, generosity, almost innocence, in dealing with people, something that I saw for myself. His generosity set a wonderful example; he gave his time, his ideas and of course his affections (there are complexities here). Brown reveals the pains Bernal went to resolve differences in opinion and gives accounts of his abhorrence of public unpleasantness in argument. This idealism (he believed absolutely that science should do good) and humanity were intrinsic and, to my mind, they were admirable. His ideals were motives for, and connected to, his political beliefs and to the relevance of science

in planning peaceful, fairer and more productive societies. To balance the picture however, in his domestic life Bernal's theoretical approach verged on the unreal, never buying clothes and using his car without apparent awareness of regulations or safety.

Brown gives a most useful description of the state of the contemporary general scientific and technological level that set the stage for Bernal's own research and made it so consequential. Thus, when Bernal started research into physics and chemistry, the Braggs were bringing the structural dimension into contemporary research in such centres as the Royal Institution in London, and the Universities of Leeds and Manchester. This activity was growing which meant that Bernal's ideas and discoveries often became foundations for its later explosive expansion. Bernal chose to concentrate on the analysis of single crystals, an approach that quickly made major impacts in metallurgy, mineralogy, chemistry and in biochemistry and medicine. In addition, his and Fowler's original ideas and research on water, while not crystallographic, laid the foundations for understanding its physical and chemical properties, its role in biology and indeed in the origin of life.

Bernal's role in developing crystallographic analysis is seen through his genius for extracting structural information from crystals by combining optics, fluorescence, unit-cell geometry and the general distribution of intensities. The book highlights how this approach to the sterol crystals gave the chemists a massive push in the right direction. Bernal was also capable of being an effective and gifted experimentalist, he could manipulate minute and difficult crystals such as graphite with great skill and then solve their structures. He contributed to crystallographic practice through the rotation camera that he developed and that was produced very successfully on a commercial basis. The camera, and his transparent charts (Bernal charts) for indexing of X-ray reflections on oscillation rotation photographs, enabled any laboratory to undertake serious research and was one factor in the success of the single-crystal X-ray technique. I can speak for their value, I used them myself.

When Bernal moved back to Cambridge from the Royal Institution, he built up a laboratory of the widest interests to which people all over the world began to send crystals and problems and which attracted some of the best chemists and physicists around – Dorothy Crowfoot, Isadore Fankuchen and Max Perutz just to mention three. The interest in biology and medical relevance quickly became a feature of the lab's culture and anticipated the current activities of structural biology. The studies on sterols brought new directions to chemical thinking. The diffraction and biophysical experiments with Fankuchen on viruses which characterized essential features such as their size, shape and structural properties were seminal and a prelude to the spectacular determinations of virus structures that occurred more than 40 years later. The growth of crystallography soon led to scientific meetings. At these, Bernal was in his element, on occasion commenting on almost every presentation. Consistent with his views on science and society, he was a leading figure in reviewing the field, in setting up the X-ray Analysis Group in Britain and, after the war, the International Union of Crystallography.

The book puts Bernal's contributions to the war effort in perspective. Though much less known than those he made to crystallography and structural science, they matched, perhaps more than matched, these. His activities in the war began through the Cambridge Scientists Anti-War Group that caught his idealism. The Group investigated how best to protect the population, especially the urban poor, from bombing. The clarity and content of this report led to him and Zuckerman being invited to help with government's civil defence planning. His qualities soon attracted attention and he was brought into many aspects of the war effort. In 1943, he was

summoned by Mountbatten from North Africa to advise on the Normandy landings. Brown describes the extraordinary lengths Bernal went to get information on the beaches, to collate it and to translate it into military requirements. He was involved in almost everything: the locations of the underwater defences, the accurate charting of the coast (using every available map), the collection and analysis of photographs from every source, acquiring samples of the sand and mud on the proposed beaches to analyse their load-bearing properties, and the rigorous photographic mapping of the potential landing sites and their defences. There is a relevant anecdote from Dorothy Hodgkin about a dinner in London she had with Bernal and others. One guest recounted during the meal that his family had for many years gone to Normandy for their summer holidays. Bernal asked casually were there photographs. There were, many. When this individual left, Bernal excused himself, went home with the guest and borrowed all his holiday photos. Another approach that will appeal to crystallographers is Bernal's using precisely timed and positioned aerial photos to record wave patterns at different tide levels on the Normandy beaches. These he used to determine the gradients on the beaches. Dorothy Hodgkin adds a detail, she told me that Bernal was also able to find the locations and depths of underwater devices from these photos – an exemplary use of diffraction.

The book also explores the tensions in Bernal and Zuckerman's relations, the complexities it seems were on Zuckerman's side. It is obvious that Bernal was clearly deeply involved in planning many of the D-Day operations, something that Zuckerman raised doubts about. Researching Bernal's activities in these, Brown has brought to our attention an unsung hero, Logan Scott-Bowden, whose dangerous and demanding trips to the beaches during the planning stages provided vital information about their composition and defences. This information went directly to Bernal and it is good to know that the information went to someone who knew how to use it. Brown also provides convincing evidence that Bernal did indeed visit the Normandy beaches on D-Day + 1, something Zuckerman strenuously denied. That such a trip was unnecessary and that Bernal was really too valuable to take such risks is true but Bernal's passion to see the outcome of his planning is exactly Bernal.

When the war broke out, Bernal was negotiating for X-ray equipment following a grant from the Rockefeller Foundation. Bernal arranged with the Foundation to have the equipment and his cholesterol project with Harry Carlisle sent to Dorothy Hodgkin in Oxford. This was a very generous and good decision, illustrating incidentally the critical role of the Rockefeller Foundation in maintaining, even preserving, structural research into biological systems in Britain during and after the war. When the war was over, Bernal got no recognition in Britain for his colossal and crucial efforts. This does seem miserable, especially when the Americans awarded him the Congressional Medal of Freedom. He returned to academic life and to the huge job of re-establishing his laboratory – but he assumed many, far too many, other responsibilities, many concerned with trying to establish sensible relations between East and West. Brown describes his travel and lecturing schedule, it was astonishing. These distractions explain at least in part Bernal's failure to score any more big scientific goals, in spite of the admirable scientific strategy he had for his Birkbeck laboratory. There were groups pursuing protein structure, water, silicates, theory, X-ray production, a wonderful nucleus for discovery. In biology, however, which Bernal saw as hugely important, the great discoveries were made elsewhere, mostly in the MRC unit in Cambridge. Here Max Perutz assembled a collection of people in, by comparison with Bernal, a seemingly haphazard way. Many of these were in a sense *via* Bernal. One

important name, Vernon Ingram, illustrates the scope of Bernal's influence, he was a Polish refugee and prepared the crucial mercury derivative of haemoglobin.

Brown detects in Bernal an understandable awareness at the way the triumphs he stimulated were not in the end his. It seems to me that the very different histories of the two laboratories where Bernal had most influence, the MRC Unit in Cambridge and Birkbeck, raise interesting questions about research environments. Was the difference caused by the difference in their research talent, was it the nature of university life with all its distractions and less certain funding and the contrast of the consistent concentration on research in Cambridge, was it Bernal's frequent absence, was it London compared to the provinces, was it the appalling state of the Birkbeck building, or was it that science at its most original is not easily steered? The explanation probably is a mix of these factors. There is no doubt however that Bernal had all the gifts needed to see that some of the great discoveries happened at Birkbeck.

Bernal's political ideas and his humane beliefs were part of his persona. Brown traces his capacity for convictions from his religious upbringing, idealism and Irish nationalism, and this makes sense. These transformed at Cambridge into ideas of personal freedoms, socialism and communism. Before the war, there was a good deal of respectability in these views but as the oppressive and brutal character of Stalin's regime emerged, particularly after the war, Brown shows how Bernal's consistent support for the Soviet Union and its policies caused surprise and considerable hostility. This is illustrated by his defence of Lysenko's naive anti-genetic policies in agriculture that, with Stalin's support, had destroyed Soviet genetics and killed some of its leaders. Looking back, Bernal's support of Lysenko and his failure to criticize Soviet repressive and military actions seem inexplicable in a man of such perception and humanity. But this was the time of cold war tensions in which capitalism and communism were seen to be in profound competition. Bernal's loyalty was with socialism and better societies. One supposes that he swallowed his criticisms to help protect socialism's geo-political future. Certainly Dorothy Hodgkin was also sympathetic to socialist ideals and therefore to the Soviet Union and communist society. She said that Bernal thought that public criticism never helped in these matters, it led only to the loss of any leverage that one might have had.

It should be remembered that Bernal's application of science to the allied military machine in World War II helped it to succeed but he was fully aware of the horrors implicit in what he was doing. This commitment contradicted his dedication to peace and hatred of war. He knew about how to make weapons more effective and he knew the dreadful consequences for people on the receiving end of his advice. But he judged this was essential to defeating the greater horrors of defeat by the militarists in Nazi Germany and Japan. He also knew about nuclear weapons and even advised the government on the consequences of their use. In this context, one should note how Bernal felt about his war work:

'The only time I could get my ideas translated into action in the real world was in the service of war. And though it was a war which I felt then and still feel had to be won, its destructive character clouded and spoiled for me the real pleasure of being an effective human being.' [World Without War, 1961.]

One can also ask perhaps whether Bernal's compromise with his pacifist principles in the war had some parallels with his stubborn support of the Soviet Union which he thought would preserve socialism, central to his political convictions. The problem here is that he failed to predict the moral and economic failure of the Soviet

system that followed its wretched internal policies and practices; here perhaps his idealism was too strong for independent judgement. The pity of it is that Bernal became regarded by others as politically naïve and even irrational, this, one fears, has left an unfortunate memory in which some of his best qualities are forgotten.

In conclusion, however, this biography gives Bernal the stature of genius, who did immense scientific good, a view firmly confirmed by the opinion of other outstanding scientists, notably Linus Pauling, and reminding us just how much this remarkable man started and just how much he inspired others.

Why, man, he doth bestride the narrow world

Like a Colossus, and we petty men

Walk under his huge legs and peep about

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