HOW TO WRITE
A POPULAR SCIENTIFIC ARTICLE

Most scientific workers desire to spread a knowledge of their subject and to increase their own incomes. Both can be done by writing on science for the general public. If one can sell the article abroad, one can also be an 'invisible export'. In what follows I shall give some hints on how to do it. But let no reader suppose that my method is the only one.

Literary synthesis is like organic chemical synthesis. The method to be adopted depends on the product required, the raw materials, and the apparatus available. As my brain is my apparatus, and different from yours, my methods will also differ from yours.

The first thing to remember is that your task is not easy, and will be impossible if you despise technique. For literature has its technique, like science, and unless you set yourself a fairly high standard you will get nowhere. So don't expect to succeed at your first, or even your second, attempt.

For whom are you writing? This is even more important than the choice of subject. For you will not get an article on the history of eighteenth-century physics into a daily newspaper. *The Times* is unlikely to publish a sympathetic account of Soviet work on mineralogy, nor the *Daily Worker* a highly commendatory report on cotton breeding in the British Sudan. Moreover the length of your article will depend on where it is to be published.

Now for the subject-matter. You may take a particular

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1 *The Times* has since changed its policy. But unfortunately the Sudan is still some way behind Peru, the USA, the USSR, and the West Indies in cotton breeding.
say a bomb explosion, a bird's song, or a cheese. This will enable you to illustrate some scientific principle. But here again take a familiar analogy. Compare the production of hot gas in the bomb to that of steam in a kettle, the changes which occur in the bird each year to those which take place in men once in a lifetime at puberty, the precipitation of casein by calcium salts to the formation of soap suds. If you know enough, you will be able to proceed to your goal in a series of hops rather than a single long jump.

If you try to write an article in this way, you will probably discover your own ignorance, especially of quantitative matters. How completely do a robin's gonads revert to an infantile condition in autumn? How much more calcium is there in milk than in London tap-water? What is the maximum temperature in an exploding bomb? It may take you twelve hours' reading to produce an intellectually honest article of a thousand words. In fact you will have to educate yourself as well as your public.

When you have done your article, give it to a friend, if possible a fairly ignorant one. Or put it away for six months and see if you still understand it yourself. You will probably find that some of the sentences which seemed simple when you wrote them now appear very involved. Here are some hints on combing them out. (Remember, by the way, that I am only giving my personal opinions. Prof. Hogben writes sentences longer than some of my paragraphs, and his books sell very well, as they ought to.) Can you get in a full stop instead of a comma or a semicolon? If so, get it in. It gives your reader a chance to draw his breath. Can you use an active verb instead of a passive verb or a verbal noun? If so, use it. Instead of 'It is often thought that open windows are good for health', or 'There is a widespread opinion that open windows are good for health', try 'Many people think that open windows are good for health'. Or 'Most people', if you think that is the case.

Try to make the order of the phrases in your sentence correspond with the temporal or causal order of the facts with which you deal. Instead of 'Species change because of the survival of the fittest' try 'The fittest members survive in each generation, and so a species changes'. Not that I like the phrase 'a species changes'. It would be better to say 'the average characters of the members of a species, such as weight or hair-length, change'. Of course in the history of scientific discovery an effect is commonly known before its cause. And fairly often a mathematical theorem is known to be probably true before it is formally proved. If you enunciate your theorem before you prove it you are apt to give the impression, as Euclid does, that you are producing rabbits from a hat. Whereas if you lead up to it gently you create less impression of cleverness, but your reader may find your argument much easier to follow.

In a scientific, and still more, a mathematical paper, elegance of presentation, which often means the hat-and-rabbit method, is always great fun, and sometimes desirable. How delightful to produce some wholly unexpected function at the last moment by contour integration, to damn a suggested mechanism by an appeal to Hearnshaw's theorem, or to label a plant which won't breed true as just another case of balanced lethals. By doing so you may help the serious student to short cuts in thinking. But you will merely dazzle the ordinary reader. Go slow, and show him as many steps as you can in your argument or causal chain, even if, in your own thinking, you skip some of them or take them backwards.

When you have written your article it may seem rather gaunt and forbidding, a catalogue of hard facts and abstract arguments. A critic may say it needs padding. I object to padding for padding's sake. It is characteristic of writers who are more interested in their style than their subject-matter, such as Charles Lamb or Robert Lynd, but out of
place in a scientific article. On the other hand you must do what you can to help your reader to link up your article with the rest of his knowledge. You can do this by referring to familiar facts or to familiar literature. I have been severely criticized for 'dragging in' references to Marx in my articles in the Daily Worker, though I think I refer to Engels more frequently. But a number of my readers are familiar with the works of these authors. Engels said certain things about change, as Heraclitus said very similar things before him, and Bergson and Whitehead after him. But for one of my readers who has read Heraclitus, Bergson, or Whitehead, a hundred have read Engels, so I prefer to cite him. If I were lecturing on the same matters to classical scholars I should perhaps cite Heraclitus, even though I think Engels said it better.

In my last book on genetics, there are seven quotations from Dante's Divine Comedy. I have been criticized for 'dragging in' Dante. But I think it worth while to show the continuity of human thought. I don't agree with Dante's theory that mutations are due to divine providence, but I consider it desirable to point out that he had a theory on this subject. I think that popular science can be of real value by emphasizing the unity of human knowledge and endeavour, at their best. This fact is hardly stressed at all in the ordinary teaching of science, and good popular science should correct this fault, both by showing how science is created by technology and creates it, and by showing the relation between scientific and other forms of thought.

A popular scientific article should, where possible, include some news. I try, as a general rule, to include one or two facts which will not be familiar to a student taking a university honours course in the subject in question, unless his teachers keep well up with the periodical literature. As there is often a lag of five years between the publication of a

Discovery and its inclusion in a textbook, this is not very difficult in peacetime. But it is not very easy at present, in view of the number of libraries which have closed down, and the absence of many European and some American periodicals. Of course some care is needed in appraising new work. A very large number of alleged discoveries are not confirmed by subsequent workers. One well-known English popularizer of science has a perfect genius for picking out discoveries of this kind for announcement to the public. If, like myself, the writer is actually engaged in research, and has seen a number of his own bright ideas go west, he is less likely to fall into this particular trap.

In the early stages of popular writing it is well to write out a summary of the article, though I rarely do so myself. Here is a possible skeleton for an article on cheese.

Introduction. A well-known fact, say the shortage of cheese.

Central theme. The process of cheese manufacture.

Why it is important. Cheese as the cheapest food containing large amounts of 'good' protein. Vitamins and calcium in cheese.

Connections with other branches of science. Rennet compared with other enzyme preparations used in industry, for example in confectionery and tanning. Other uses of specific micro-organisms, for example in brewing. Why putrid cheese is safer than putrid meat.

Practical suggestions. How to increase our cheese output. Combating mastitis in cows. Cattle-feed and fertilizers. Should cargo space be devoted to cheese rather than meat? Need for scientific planning of national food supply.

How much of this you can get in depends on the length of your article and your capacity for compression. If you are writing for a highbrow journal you may quote the passages

This has lessened since this article was written.
on cheese from Euripides' *Cyclops*, if for a lowbrow, any of the jokes about the smell of cheese.

That is one way of doing it. But other writers would show cheese as part of the Mysterious Universe. We do not understand protein synthesis, nor the extreme specificity of some enzyme actions. Cheese-making is part of the pre-scientific activities by which we still keep a communion with nature. Cheese is a natural food, and beef is not. And so on. I think this is an anti-scientific attitude. But you can sell that sort of stuff, and get over a certain amount of genuine knowledge while doing so. Everyone must write popular scientific articles in his own way. I have only described one way, and I do not claim that it is the only way, or even the best possible way.

**WHAT 'HOT' MEANS**

One reason why other people find it hard to understand science, and why scientists are apt to lose their tempers with other people, is that scientists either use ordinary words with a special meaning, or invent words of their own which ordinary people do not understand.

I don't think this can be avoided. The history of science shows what has constantly happened. We start with some ordinary word, such as 'hot', whose meaning we think we understand. On the breakfast table are a tablecloth, a knife, and a pot of mustard. The plain man says the knife is cold, the mustard hot, and the cloth neither hot nor cold. A physicist will say that none of them is hotter than the others.

But that does not mean that the plain man is talking nonsense. He certainly gets a feeling of cold from the knife, and a feeling of heat from the mustard if he puts it on his tongue, or rubs it into his skin. The knife and the cloth are at the same temperature, somewhat below that of one's finger. But the knife conducts heat well, so it cools the finger much more than the cloth when one touches it.

The mustard, or to be accurate, one of the chemical compounds in it, excites the same nerve fibres in my tongue as are excited by hot substances, and gives me a sensation of heat. If I rub it into my skin it makes the blood-vessels dilate, and my skin does actually get hotter in a way which a physicist could measure.

Until thermometers were invented and made fairly accurate, it was quite impossible to get any definite answer to the question which of two bodies was hotter, much less to measure temperature or heat. Even now we are apt to trust our senses unduly.