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Science, Pseudo-Science and Traditional Knowledge[†]

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Traditional knowledge, for example in taxonomy, agriculture, medicine, natural resource management, and conservation, is valuable both as a resource and as part of the cultural lore. However, it tends to be neglected by modern science, and some scientists regard it as at odds with modern science. How does it differ from astrology, creationism, and various kinds of 'nature medicine' that often come in open conflict with science? And how do both of these two groups of endeavors differ from science? ICSU, the International Council for Science (until 1998: International Council of Scientific Unions), has raised these questions in connection with two documents that resulted from The World Conference of Science that was arranged in Budapest, Hungary, from 26 June to 1 July 1999: *Declaration on Science and the Use of Scientific Knowledge*, and *Science Agenda – Framework for Action.* These two documents define a strategy that shall insure that science responds better to society's needs and aspirations in the twenty-first century, and they both emphasize the importance of preserving and showing respect for traditional knowledge.

The *Declaration* states, in § 26:

> That traditional and local knowledge systems as dynamic expressions of perceiving and understanding the world, can make and historically have made, a valuable contribution to science and technology, and that there is a need to preserve, protect, research and promote this cultural heritage and empirical knowledge.

This principle is further elaborated in the *Framework for Action*, notably in Section 3.4, 'Modern Science and Other Systems of Knowledge'. Here it is declared, in § 87:

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Governments should support cooperation between holders of traditional knowledge and scientists to explore the relationships between different knowledge systems and to foster interlinkages of mutual benefit.

In September 1999 the General Assembly of ICSU unanimously adopted these two documents. However, the General Assembly saw a need to distinguish what is here called 'traditional knowledge' from various kinds of anti-science and pseudoscience. It requested the Executive Board of ICSU to set up a critical study of this issue. After having discussed the matter at several meetings the Executive Board appointed in September 2000 a small Study Group to report on this issue for the next session of the General Assembly in Rio de Janeiro in September 2002. The group, chaired by Jens Erik Fenstad of Norway, has submitted its report.

Traditional knowledge

The report contains a valuable survey of traditional knowledge. This is characterized as 'a cumulative body of knowledge, know-how, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment.' It is emphasized that traditional knowledge, like modern science, is embedded within specific world views: 'These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices, ritual, spirituality and world view.'

Much attention is given to ethnobotany. Linnaeus used folk taxonomies in his development of biological classification systems. Thus, his use of Latin binomials for plant and animal nomenclature was founded on his studies of traditional Lap knowledge and naming. And ethnobotanists have discovered cases in which the number of plant species recognized by local communities was greater than the number of scientific species recognized in the area. Traditional knowledge helps scientists better understand management of biodiversity, agro-ecology, crop rotation, etc. It has also been utilized in biopros-pecting - often in an ethically highly problematic manner - by pharmaceutical firms that have sought patentable material.

The report also mentions medicine as an area which has been strongly influenced by traditional knowledge. According to WHO, 80 % of the world's people depend on traditional medicine for their primary health care.

Science, pseudoscience and traditional knowledge

How then, is traditional knowledge different from pseudo-science? And how are they both different from science? The report notes two main approaches to the problem of demarcating science from pseudo-science, the first sociological, the second epistemological.

First, from a sociological point of view, a pseudoscience is always in more or less competition with a corresponding science from its very birth, and it is typically not propounded by people with an education in the scientific field it is competing with.

Secondly, from the point of view of epistemology, science has a high degree of systematicity, which is manifested in six aspects of science: how it describes, how it explains, how it establishes knowledge claims, how it aims for completeness, how it expands knowledge and how it represents knowledge. In all of these activities, the striving for systematicity plays a crucial role.

Pseudo-sciences, in contrast, are relatively static. They do seldom actively seek new knowledge, but are mainly concerned with defending their turf against the attacks of scientists. They are also little concerned with systematicity, often their claims are of a probabilistic nature, dealing with tendencies and influences, where systematic statistical testing procedures are called for. However, such tests are rarely found, instead anecdotic evidence prevails.

From an epistemological point of view both traditional knowledge and pseudoscience differ from the highly developed sciences by being less systematic. Sociologically, however, traditional knowledge differs sharply from pseudoscience in not being in competition with science. Typically it has originated quite independently of science. It is neither intended to be in competition with science nor need such competition arise when they interact. On the contrary, traditional knowledge has informed science from its very beginnings and continues to do so today.

So far the Study Group's report. It is short, the whole discussion of how traditional knowledge and pseudoscience differ from one another and from science takes up a little more than two pages. These are complex issues, and in what follows, some further observations will be added to those found in the report.

Further sociological considerations

Is it right that the main difference between traditional knowledge and pseudoscience is sociological and not epistemological? Certainly, pseudoscience is often opposed to science. Creationism is today the most notorious example of this. In some states in USA, notably Arkansas, Mississippi and Tennessee, a coalition of Moral Majority fundamentalists and a group of believers in the literal truth of the Bible have founded the Institute for Creation Research. They call themselves Scientific Creationists and claim that their view, which is attuned to the literal truth of Genesis, is far better supported by evidence than evolutionary theory. Therefore they insist that their view, and not evolutionary theory, should be taught in school. Until the 1960s the three states I mentioned had anti-evolution laws forbidding the teaching of evolution. After these laws have been overturned, the creationists have continued fighting for their view on school-boards and other places where they can influence curriculum and choice of textbooks. Some of the more modest creationists have picked up that scientific theories cannot be conclusively verified but involve an element of belief, like creationism. They have therefore argued that both 'models of origin' should be taught in the classroom. Creationism is hence a clear example of conflict between pseudoscience and science. And a very serious conflict it is, especially for the schoolchildren who are affected by it[1].

However, the pseudo-sciences that get the most attention worldwide do not fall into this pattern of being anti-science. Although there is often a conflict between their adherents and science, this is partly because scientists do not leave them alone, but criticize them for having

[1] Kitcher (1982), contains the best discussion I know of creationism and its problems. Another good discussion, incorporated in a general textbook in the Philosophy of Biology, is Sober (2000) (especially Chapter 2).

the beliefs they have. Thus, for example, astrologers have never contested the astronomical theories of modern science, and they do not regard themselves as in competition with astronomy or other sciences. They are concerned with quite other issues, namely what the stars can tell us about our life and what we ought to do. At most they might stand in competition with some of the social sciences. They get sore when scientists tell them that there is no basis for their beliefs, that there is absolutely no reason to trust their predictions and act upon them. However, they get comforted by the fact that a large number of people go to astrology for advice about major decisions, rather than to science.

An opinion poll in the United States in 1975 showed that 22 % of the adult population believed in astrology. The poll was prompted by a statement by 186 scientists, among them 18 Nobel Prize winners, who expressed their concern that astrology was advancing in USA. The advance has continued since then, there are now in many countries astrologer business consultants who give astrological advise on any aspect of business: hiring, strategy, buying and selling, etc. There is also an International Society of Business Astrologers.

What concerns the scientists who criticize astrology is not that astrology stands in conflict with science or is anti-science. The believers in astrology do not try to thwart the work of scientists, cut their funds or oppose the teaching of science in schools. What the scientists find disturbing is the irrationality of those who have such beliefs. This may be a serious problem when astrology is used as a basis for decisions that may affect people negatively, such as in the case of firing people from jobs, or one's decisions concerning family matters, spouses, etc. There was a time when people in power had their court astrologers, but one feels that this is unacceptable in our more enlightened society. In particular, those who criticize astrology may do so out of fear that persons who succumb to such irrational beliefs might easily succumb also to other, more dangerous doctrines.

The problem with most pseudo-sciences, like astrology, is thus not that they are anti-science or compete with science, but their lack of rationality. That is, we are disturbed about their epistemological character, more than about their threatening the established sciences with competition. What, then, is irrational about the pseudosciences and sets them apart from the genuine sciences?

This leads us into a discussion of what rationality consists, particularly the rationality of science. We need not be concerned here about rationality of actions or rationality of values and norms, but will concentrate on the rationality of beliefs.

One extreme view on rationality of belief is that we should believe only that which we have good reasons for regarding as true. This was the view of the Swedish critic of religion, Ingemar Hedenius, 1908-82, who from 1947 to 1973 was professor of practical philosophy in Uppsala. This view may seem sensible. However, depending on what we mean by 'good reasons' it may not be advisable. If we mean that we have good reasons for something only if we have examined it in view of evidence and found it satisfactory, and if we should confine ourselves to such beliefs, we would not survive. Most of the beliefs upon which we act and live our daily lives have never been reflected upon. And even less have they been subjected to critical scrutiny. Our conception of the world is too rich for such an extravagant appraisal. Even if we should stop our hustle and bustle and spend the rest of our lives reflecting on our beliefs we would merely scratch the surface, most of our beliefs would remain forever unexamined.

A better advice would be not to retain any belief that is refuted by experience or good arguments. This was basically the position of Karl Popper (1902-94), who stressed the role of falsification in the development of science. However, astrology survives this test. It is not easy to refute astrology, for three reasons: (1) The predictions of astrology are generally quite vague: 'Today will be a good day to make a new acquaintance'. Or: 'The more change you can instigate this week, the better'. (2) The prediction concerns only a tendency, a likelihood, which cannot be refuted without systematic testing. (3) If, in spite of its vagueness, a prediction should fail, the reason may be that some of your input information is wrong. Thus, for some astrological predictions just a few minutes difference in your birth time may be enough to make another, quite different prediction, more appropriate.

This infalsifiability may, however, be just what is wrong with astrology. This was one of Popper's main points when he attempted to demarcate science from pseudoscience (Popper, 1959, especially Chapters VI and VII). According to Popper, science differs from pseudoscience by being falsifiable: the easier it is to see what is needed to falsify a scientific hypothesis, the better.

However, science might not be as falsifiable as Popper presumed. Popper thought that there could be crucial tests, where some particular scientific thesis can be refuted. However, already the French physicist and historian and philosopher of science Pierre Duhem (1861-1916) observed that scientific hypotheses are not tested one by one, but can only be tested in large clusters (Duhem, 1954). An experiment can show that there is something wrong with such a cluster, but we cannot pinpoint which hypothesis in the cluster should be given up. As Quine (1953) has pointed out, "any statement can be held true come what may, if we make drastic enough adjustments elsewhere in the system" (p.43).

Some adjustment is always needed when a scientific theory clashes with experience. The ancient theory of circular planetary movements was saved by the addition of epicycles. When towards the end of the 19th century measurements of the speed of light clashed with the predictions of Newton's mechanics, the theory was saved for a while through the hypothesis of Fitzgerald-Lorentz contraction. Examples can be multiplied. But many of these modifying hypotheses were experienced as *ad hoc*; they had nothing to recommend them except that they saved the phenomena. The search for better theories therefore continued. Kepler's ellipses replaced the complicated set of circles and epicycles, and Einstein's theory of relativity replaced the amended Newtonian mechanics.

Even pseudoscientists are reluctant to hold on to a theory that is in clear conflict with our experience. Like scientists they normally attempt to modify the theory so that it becomes compatible with what we observe. However, they differ from scientists in two ways. First, due to the vagueness of their 'theories' the risk that they should conflict with experience is minimal. Secondly, they are not reluctant to accept hypotheses that seem rather complicated and *ad hoc*. Take creationism as an example. Creationists, at least the more sensible among them, have to accept that there are fossils that seem to confirm evolutionary views. How can the creationists, who hold that all species of animals that ever existed were created in one single act of creation, explain the fossil record? One easy, but clearly *ad hoc*, explanation was widely held during the late part of the 19th century: God created the fossils together with all the animals. For one who believes in a charitable God, this may be hard to swallow. Why should God deceive us by creating this whole fossil record? Again the creationists had answers. One was that God

wanted to test us. A second answer is that the fossils were placed there by the devil. Bertrand Russell pointed out that from a scientific point of view the opinion that the world with all its fossils was created 6000 years ago has no more merit than the view that it was created 5 minutes ago. We may object to the latter view that we certainly can remember things that happened more than five minutes ago. However, to this there is a ready reply, namely that the memory traces were created together with us. From a scientific point of view 6000 years and 5 minutes seem equally arbitrary. The creationist may object that he has evidence from the Bible that creation happened 6000 years ago. However, again we might object that instead of trying to save the creationist hypothesis through all these *ad hoc* explanations of the findings of naturalist, it might be better to interpret the Bible in a less literal way, especially since there seems to be a good deal of textual and theological evidence that the Bible is not intended as a text book in natural history. As Galileo put it: "The Bible tells us how to go to Heaven and not how the heavens go".

Generally, unwillingness to give up one's view seems to me to be the most distinguishing feature of pseudoscience. This comes to expression in two ways: (1) The theories are vague and do not lend themselves to test and possible falsification. Here astrology is a good example; (2) When the theory makes predictions that can be tested, and the predictions go wrong, then one is immediately ready to save one's pet hypotheses by introducing revisions elsewhere, regardless of how *ad hoc* these revisions may seem. That is, the revisions have no other scientific motivation than saving the theory from refutation.

One may find this kind of stubbornness among scientists as well, but stubbornness comes in degrees, and in pseudoscience it is more extreme. The division between science and pseudoscience is hence a matter of degree. Scientists some times have to accept *ad hoc* hypotheses, because there is no better hypothesis on hand. This is, for example, what happened during the last decades of pre-Einsteinian mechanics, which I mentioned above. However, a scientist will not be satisfied with such a situation, but will try actively to find a better response to the difficulties. He or she will greet with pleasure a theory that gives a simpler explanation of the observed phenomena, although it may take some time and effort before the scientist is satisfied that the new theory does its job. What holds the scientist back, must, however, be scientific and methodological considerations, and not other concerns, for exam-

ple the compatibility of a theory with religious beliefs, political convictions, etc., or the wish to protect one's prestige by defending a theory one has put forth earlier. A believer may find a scientific theory unsatisfactory if it clashes with his/her belief and may work hard to find a theory that fits better. However, the decisive consideration in the choice between those theories that are available must be the empirical and methodological considerations that I have mentioned, for example compatibility with the observations and simplicity.

Simplicity is a difficult notion. However, it is needed in science, for example in order to sort *ad hoc* hypotheses from other, more satisfactory hypotheses. To appeal exclusively to falsifiability, the way Popper did, does not suffice. One of the best writers on this subject, Nelson Goodman (1906-1998), refuted in a 2-page, all too little known article on simplicity Popper's principle that when one has a choice between different theories, one should always choose the more falsifiable one. Instead we should go for the simplest theory. Goodman then goes on:

> Formulation of general standards for comparing the simplicity of hypotheses is a difficult and neglected task. Here brevity is no reliable test; for since we can always, by a calculated selection of vocabulary, translate any hypothesis into one of minimal length, the simplicity of the vocabulary must also be appraised. I am inclined to think that the standards of simplicity for hypotheses derive from our classificatory habits as disclosed in our language, and that the relative entrenchment of predicates underlies our judgment of relative simplicity; but spelling this out takes some pains. (Goodman, 1961, p. 151)

Goodman (1955) spelled some of this out in a small book, *Fact, Fiction and Forecast*. However, the problem of simplicity has remained a central, but very difficult issue in the philosophy of science. It is clearly part of what we need in order to get clear about what distinguishes good science from pseudoscience, or as ICSU's Study Group puts it: systematic science from less systematic speculation.

When it comes to traditional knowledge, it is usually not very systematic; often it is merely a collection of fragmentary insights. Its lack of systematicity may be a main reason that we are reluctant to call it 'science', but rather call it 'knowledge'. These insights are usually based on experience with trial and failing through several generations. Examples abound in traditional medicine, but I will give an example from shipbuilding: the small boats used by fishermen. These boats are often remarkably well shaped for smooth and efficient sailing. The Norwegian theologian and pioneer sociologist Eilert Sundt (1817-75)

gave in 1862 a lecture on the type of fishing boats used in Northern Norway. He there remarked:

> A boat constructor may be very skilled, and yet he will never get two boats exactly alike, even if he exerts himself to this end. The variations arising in this way may be called accidental. But even a very small variation usually is noticeable during the navigation, and it is then not accidental that the seamen come to notice that boat which has become improved or more convenient for their purpose, and that they should recommend this to be chosen as the one to imitate. (...) One may believe that each of these boats is perfect in its way, since it has reached perfection by one-sided development in one particular direction. Each kind of improvement has progressed to the point where further developments would entail defects that would more than offset the advantage. (...) And I conceive of the process in the following way: when the idea of new and improved forms had first been aroused, then a long series of prudent experiments, each involving extremely small changes, could lead to the happy result that from the boat constructor's shed there emerged a boat whose like all would desire.

Jon Elster, from whom this example is taken, uses Sundt's reflections as a starting-point for a highly interesting discussion of Darwin-inspired models of technical change (Elster, 1983, p.135-138). What concerns us here is the phenomenon that Sundt described. Boat-building skill is a good example of traditional knowledge, which by ICSU's Study Group was characterized as 'a cumulative body of knowledge, know-how, practices and representations'. Traditional knowledge is usually imbedded in skills and practices. Science typically is more cognitively oriented and attempts to integrate fragmentary observations and practices into a coherent theory. Hydrodynamics gives us a theory for what happens when boats move through water and may throw light on why some boat-shapes function better than others. The traditional boat-shapes tend to fit very well with modern hydrodynamic theory. This theory gives us an explanation of why they function so well. Some of the traditional forms have presented challenges to the theory, and have given rise to new theoretical developments that are needed to explain them.

Traditional knowledge hence goes hand in hand with science. It provides a testing ground for the sciences and also points to areas where something happens that is not yet scientifically well understood. The early meeting between acupuncture and medical science is an example. Scientists therefore do well in being open and receptive when they encounter traditional knowledge. Practitioners of traditional knowledge on their side should have every reason to be interested in

the sciences, which gradually give us more insight into how and why traditional know-how works and also places traditional knowledge into a more comprehensive theoretical framework.

Pseudoscience is different. Admittedly, it tends to be far more systematic than traditional knowledge. Both astrology and creationism, to mention two examples, are quite intricate edifices. This is why they are called 'science', although the prefix 'pseudo' indicates that we are not happy to count them as sciences. What is lacking is not organization and structure, but what we could call the scientific spirit, that is, willingness of their proponents to give up their view in view of recalcitrant experience. Pseudo-scientists typically have certain fixed views which they do everything to protect. They try to formulate them in such a way that they are hard to falsify and they are willing to go to any extreme in introducing *ad hoc* hypotheses to save their cherished views. As a result, their theories become vague or needlessly compli-cated or both.

Although traditional knowledge is often vague, its practitioners are normally willing to do what they can to formulate their views so that they become testable, and if predictions go wrong they are not satisfied with *ad hoc* revisions. Proponents of traditional knowledge therefore distinguish themselves from pseudo-scientists by having the scientific spirit. They can be expected to be ready to cooperate with scientists who come along and who treat them with respect and openness and are willing to listen and learn.

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