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EDITORIAL

Science and the ascent of man

Man is distinguished from other animals by his imaginative gifts. He makes plans, inventions, new discoveries by putting different talents together; and his discoveries become more subtle and penetrating as he learns to combine his talents in more complex and intimate ways. So the great discoveries of different ages and different cultures, in science, in the arts, express in their progression a richer and more intricate conjunction of human faculties, an ascending trellis of his gifts...

In every age there is a turning point, a new way of seeing and asserting the coherence of the world... Each culture tries to fix its visionary moment, when it was transformed by a new conception either of nature or of man. But in retrospect, what commands our attention as much are the continuities – the thoughts that run or recur from one civilization to another.

— Jacob Bronowski

Books make wonderful gifts; they are rarely discarded, even if unread. Following a conviction, that is becoming increasingly difficult to uphold, that books are amongst the most lasting of presents, I searched many years ago for a gift, in an unprepossessing local bookstore. The intended recipient was a favourite niece, then on the verge of her teens. Carelessly placed on a table intended for books on sale, I stumbled upon Jacob Bronowski's *The Ascent of Man* (British Broadcasting Corporation and Little Brown and Company, USA, 1973), a magnificently illustrated script of the famous BBC TV series. Here was a book I would have loved to possess; but priced as it was it seemed more legitimate to buy it as a gift. Some fifteen years later after my niece, like many others of her generation had left for the United States, I found Bronowski's book lying forlorn, mildly worn and probably untouched by its owner in a forgotten cupboard. Somewhat guiltily I reclaimed it, the smudged, fading inscription on its cover reminding me that I was indeed guilty of petty larceny. As an act of repentance, Bronowski's tale may be worth recalling in these columns, for it is a story in which science and human endeavour are intertwined in a saga that spans the millennia.

Biology rests on the firm Darwinian foundations of shared evolutionary history of living organisms, common ancestry, adaptation and natural selection. All that

has happened since Darwin, has only reinforced the essential unity of biology; today's thrust in comparative genomics highlights the remarkable connections between the genetic blueprints of diverse organisms. In the monotonous and mind numbing sequences of millions upon millions of base pairs of DNA, lie hidden the molecular imprints of a shared history; humbling connections between bacteria, worms, flies and man. But man is decisively different, in that he alone has been able to shape his environment; his survival in inhospitable surroundings determined more by his inventive abilities, rather than the slow and seemingly limited process of biological adaptation by natural selection. Bronowski begins his fascinating story in an area that might indeed be a good candidate as man's original home, 'the valley of the river Omo in Ethiopia near Lake Rudolf', not far from the equator. It is here that an amazing fossil record was discovered in the 1920s, remains of animals and the forerunners of modern man, dating back about two million years. Remarkably, animals appear to have changed little over the years, but the skeletons of our ancestors differ dramatically from our own. Bronowski's interpretation is provocative: 'Human evolution began when the African climate changed to drought: the lakes shrank, the forest thinned out to savannah. And evidently it was fortunate for the forerunner of man that he was not well adapted to these conditions. For the environment exacts a price for the survival of the fittest; it captures them'. Bronowski, a mathematician by training and vocation began his musings on the origins and evolution of man, in 1950, when he was posed the problem of discriminating the teeth of the *Australopithecus* baby skull found south of the equator in Africa, from the teeth of apes. He recalls his sense of excitement: 'I, at over forty, having spent a lifetime in doing abstract mathematics about the shapes of things, suddenly saw my knowledge reach back two million years and shine a searchlight into the history of man'.

In tracing the ascent of man, we must and Bronowski does, separate the long period of biological evolution which stretches over millions of years, from the relatively short span of cultural evolution, which does not stretch beyond ten thousand years; a period for which we have little by way of historical record, beyond about three thousand years. Bronowski prods us gently to ask:

'Why did the cultural changes that have made man the master of the earth begin so recently?' Why, indeed, is the pace of cultural evolution so breathtakingly rapid 'once it takes off', as compared to the slow, hesitant and seemingly random steps of biological evolution? But these are questions which have no real answers as yet; having raised them, Bronowski moves briskly to examine the surging progress of man over the past few millennia. Science is at the heart of Bronowski's story.

In defining the conceptual 'turning points' in the ascent of man Bronowski adopts what a carping critic might call a Eurocentric view; the Mediterranean and the Old and New Testaments form the threads on which his narrative is woven. Bronowski realizes this and says in defence: 'Of course there were great civilizations. Who am I to belittle the civilizations of Egypt, of China, of India, even of Europe in the Middle Ages? And yet by one test they all fail: they limit the freedom of the imagination of the young. They are static, and they are minority cultures. Static, because the son does what the father did, and the father what the grandfather did. And minority because only a tiny fraction of all that talent that mankind produces is actually used; learns to read, learns to write, learns another language and climbs the terribly slow ladder of promotion'. Having defended the setting of his stage, Bronowski embarks on a remarkable tour; one that begins with the 'agricultural revolution' and ends in a contemplative view of the crematoria of Auschwitz. It is a gripping story, told in an engaging manner, in which we see the evolutionary origins of much of modern science and culture. But its beginnings are rooted, as they must be, in that crucial turning point where man recognized the potential of a unique relationship with plants and animals; the transition from the unsettled ways of the nomads to the apparent tranquility of an existence based on agriculture. The domestication of animals provided also one of the first instruments of war, the horse. And in the pages of Bronowski's book I found a description of one of the last 'war games' using horses that remains in existence. This is a game called 'Buz Kashi', a feat of competitive riding played in Afghanistan, a relic of the days of the Mongols. Bronowski's conclusions are prophetic: 'The Buz Kashi is a war game. What makes it electric is the cowboy ethic: riding as an act of war. ...The nomad in his last historic role as warmaker is still an anachronism, and worse, in a world that has discovered in the last twelve thousand years, that civilization is made by settled people'.

The narrative quickens as Bronowski calls attention to the development of architecture, metallurgy and a rapidly increasing 'understanding of the material world'. Straddling the period between the ages is the haunting science of alchemy, a subject Bronowski treats with understanding; after all, alchemy represented the prolonged groping of man to understand the world around him. In presenting the rising tide of human knowledge in the period between the 16th and 19th cen-

turies that Bronowski celebrates 'open and personal discoveries'. The act of Paracelsus, in 1527, when he 'threw into the traditional student bonfire an ancient medical textbook by Avicenna, an Arab follower of Aristotle', is interpreted as a gesture which said: 'Science cannot look back to the past. There never was a Golden Age'. Bronowski pauses at times to take a reflective look; his discussion of sculpture, symmetry and art moves him to quote Michelangelo:

*'When that which is divine in us doth try
To shape a face, both brain and hand unite
To give, from mere model frail and slight
Life to the stone by Art's free energy'.*

It is this unification of the brain and the hand that fascinates Bronowski; it is here that he states his philosophy: 'We have to understand that the world can only be grasped by action not contemplation. The hand is more important than the eye...; and indeed we know as something more than a symbolic accident in the evolution of man that it is the hand that drives the subsequent evolution of the brain'. Bronowski notes approvingly that Benjamin Franklin, in 1778, called man 'a tool making animal'. To Bronowski, of man is the refinement of the hand in action'.

Bronowski moves with felicity through the development of modern science, Galileo, Newton, Darwin, Wallace, Pasteur, Einstein, stories which bear retelling. In reflecting on the development of atomic theory, Bronowski notes that the 'human imagination working communally has produced no monument to equal it, not the pyramids, not the Iliad, not the ballads, not the cathedrals'. In listing the cast of heroes, Bronowski chooses Mendeleev, J. J. Thomson, Rutherford, Bohr, Chadwick and Fermi. But I was struck by the fact that he placed at the head of them all, 'the first founders of the new conceptions', Max Planck and Ludwig Boltzmann; 'to whom more than anyone else we owe the fact that the atom – the world within a world – is as real to us now as our own world'. Boltzmann lived at a time when the ascent of man teetered on a fine intellectual balance'. Boltzmann committed suicide in 1906, little knowing that the 'atomic doctrine' he espoused was going to win. To Bronowski no phrase can 'match the compact and penetrating beauty' of the immortal formula $S = k \ln W$, carved on Boltzmann's gravestone in Vienna.

To end we must return to the beginning and Bronowski: 'Man is not the most majestic of creatures... But he has what no other animal possesses, a jig-saw of faculties which alone, over three thousand million years of life, make him creative. Every animal leaves traces of what it was; man alone leaves traces of what he has created'. We might, following Bronowski, wonder where we are in the ascent of man and where we are going. Unfortunately, the past may not be a good guide to the future.

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