SCIENCE AND CIVILIZATION

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IN the valley of the Nile there once dwelt a people with a very advanced civilization. The Egyptians had been at peace for at least 1,000 years and their lives had been spent under comfortable circumstances—a minimum of labor sufficed to procure the necessities of existence. They were profoundly religious. Much of their time and thought was devoted to a preparation for life with Osiris beyond the mountans in the west. Superficially at least the passage of 6,000 years has not materially improved the lot of man. While it is true that we have more effective means of communication and can travel from place to place more quickly, yet these things do not necessarily add to the sum total of human happiness. In fact, some observers see in these apparent improvements the seeds of past and future wars. Furthermore, it is highly probable that the average Egyptian earned his living more easily and had more leisure for thought and self-improvement than the average man in the present Western civilization. Equally probable is it that thoughts of the future life played a far greater role in the lives of the Egyptians than amongst ourselves.

What Progress?

The question then arises, has mankind made any real progress in the last 6,000 years, or have we been effectively marking time? If we have made any progress, what differentiates our civilization from the Egyptian? To the writer, and, after all, each person must answer such questions for himself, the present Western civilization is chiefly differentiated from and is an improvement on the earlier Egyptian in our greater knowledge of the processes of Nature and of our more intelligent interest and curiosity in such matters. If this view is correct, and it is at least partly so, it is clear that acquirement of scientific knowledge is a criterion of progress and a justification for our existence. It will, therefore, be a matter of some interest to see at what times in the past man first became interested in the problems of Nature and his success at various stages in attacking these problems.

The First Period and Aristotle

Aristotle, the famous Greek philosopher, was born about 384 B.C. In him and his writings we have the first accurate realization of the importance of an ordered knowledge of all things, be they politics or astronomy or man himself. And that, in its essence, is science itself. And yet, prior to Aristotle, there had been true men on the earth for at least 50,000 years. Of what did these early men think? Were they interested in the natural phenomena which occurred about them? The answer to such questions must be pure inferences for covering the period 5000 B.C.—50,000 B.C. we have no written records, only an occasional bone or skull and a few drawings to give a clue as to the nature and life of this prehistoric man. Of the very earliest man—the so-called paleolithic and neolithic man—it is probably safe to infer that his thoughts were devoted to the practical questions of preserving life in himself and his family. It is probable that such natural phenomena as the rising and setting of the sun, the roar of thunder and the flash of lightning, the appearance of the stars in their seasons, he took for granted much as the lower animals still do. As, however, families began to grow into tribes, there probably developed a great fear and respect for the Old Man, or chief of the tribe. And even when he was dead, there was fear in the savage breasts lest he might return to punish them for some misdemeanor. And so gradually we may suppose the idea developed that behind all the natural phenomena of daily life there was some Being, divine or malignant, who, like the Old Man of the tribe, was rewarding or punishing his people. A desire to propitiate this Being and provide him with a home or temple, with servants or priests would be natural succeeding steps to these primitive ideas.

Oriental Temples

Whether by some such process of thought or in some other manner is not known, but certain it is that about 6000 B.C. temples made their appearance. Many of these temples had their axes so oriented that the first rays of the sun on the Summer solstice would shine down and illuminate the image at the end of the aisle. The earliest temples appeared in Mesopotamia under the Sumerians and in Egypt. Stonehenge was probably of much later date (2000 B.C.). Connected with these temples were servants or priests of the god, and it is amongst these priests that we find the first real interest in natural phenomena. Partly for religious purposes and partly for its practical value to a nation of farmers and shepherds, the priests began to study the stars. In Egypt the twelve signs of the Zodiac were assigned, and from the path of the sun through these constellations a calendar was formed which enabled the priests to predict the flooding of the Nile. The day was divided into 24 hours of 60 minutes each, and the present decimal and the more convenient, though now never used, duodecimal scales of counting or notation were devised. In the hands of the priests was the care of the writing. If not actually invented by them, the cuneiform system of the Sumerians and hieroglyphics of the Egyptians were wonderfully developed by the priests. From these writings we have some record of the life of these times.

Priests as Scientists

The debt that science owes to these priests is very great. At a time when there was no interest in Nature the priests themselves studied and fostered an interest in natural phenomena. And yet the arrangement was by no means ideal. For the priests depended for their living on fostering the superstitious beliefs of their people. Eventually then the learning and researches of the priests were perverted to these ignoble ends, and true science as such languished. However, about this time the kings, such as Nabonidus, monarch of the second Babylonian empire, and famous as a historical student, and some of their subjects who had independent means, became interested in learning. Herodotus, the first historian whose writings are preserved, traveled extensively in order that he might describe events more accurately. So that while an ordered knowledge of all things or science languished officially, here and there were to be found men who kept up the tradition of learning.

First Philosophers

And thus we come to Aristotle. As was earlier indicated, Aristotle was born about 384 B.C.; he was the son of a medical man and was early trained with the purpose of following his father's profession. At the age of 18, however, he went to Athens and there studied under Plato for some twenty years. Following this, he was a tutor to Alexander the Great and traveled extensively for twelve years. Eventually at the age of 50 Aristotle founded a Lyceum at Athens, where he gave lectures and wrote his famous works on Politics and Physics. The importance of Aristotle for science was briefly this: He realized, in contradistinction to his Greek contemporaries and predecessors, that there were other methods of acquiring knowledge outside of mere opinion or debate in the market place. Science, Aristotle defined as organized knowledge which treats of some selected subject. The mode of attack is to secure as much information about the subject as possible and then to determine the causes of or to explain in terms of something simpler the observed phenomena. The Aristotelian principles were applied after his death most completely at Alexandria. Here, under Ptolemy, the Museum was founded, and a brilliant galaxy of men, including Euclid, Eratosthenes, who measured the diameter of the earth to within fifty miles, Archimedes and others gathered and carried out brilliant and important work.

The Mediaeval Period and Roger Bacon

With the death of Aristotle is closed an epoch in the history of man and the development of his mind, an epoch remarkable for its length—some 50,000 years—and for the fact that science is placed on the firm foundation of observed fact. The subsequent developments must be briefly sketched and are indeed, in one sense, of less importance. For the important things are the awakening of interest and the formulation of the correct principles of attack, and these were well begun by the time of Aristotle.

During the Mediaeval period science and civilization seemed to be, and probably were, largely at a standstill. The barbarian invasion and conquest of the Roman Empire, while bulking large in our eyes, was but an incident in the history of man. For the ideas which had their origin in the earlier period of history were still preserved in the minds of the few, and in time became the common property of the many. As soon as the Germanic peoples as a whole had become educated up to the knowledge of their vanquished enemies, then once again there was a ferment of new ideas, and a wonderful period in the history of Europe began.

Some two hundred years before the Renaissance, however, there lived a humble Franciscan monk who defined in the most precise manner the principles of the scientific mind. To him, more than to any other, we owe the wonderful scientific results of the last 300 years. Roger Bacon was born about 1210, studied at Oxford and Paris, and returned to the monastery at Oxford. On account of his writings against dogma and authority he spent much of his life under suspicion and frequently in imprisonment. To Roger Bacon belongs the title, sometimes given to his better known namesake, Francis Bacon, Lord Verulam, of the "Father of Experimental Philosophy." For it was he who taught us to disregard opinion, even the opinion of Aristotle, and to put our beliefs and theories to the acid test of experiment.

What, then, is the distinction between the teachings of Aristotle and Bacon? While Aristotle had realized and stated the importance of a systematic study of natural phenomena, he was so concerned to discover the causes that he neglected to ascertain exactly how Nature behaved. He advanced a great many theories, some valuable, some foolish, but in each case he neglected to test by experiment whether these theories were correct. It is Roger Bacon's great achievement that he pointed out that the first object of science was to determine how Nature behaved, either by observation or experiment, and that the second object was by a process of inductive reasoning, checked by experiment, to determine the causes of the observed phenomena. That, in short, is the scientific method of today.

The Modern Period

The important and varied scientific investigations which characterize the most recent period in the history of man cannot be mentioned, let alone described in this brief article. Each of them is, however, an exemplification of the principles of experimental science as stated by Bacon. In proof of this may be mentioned the work of three typical men of the period.

Galileo (1565-1624) performed the first crucial experiment. Aristotle had taught, and his followers believed, that when two weights fell to the ground, the heavier one fell faster. Galileo put this idea to an experimental test, and from the Leaning Tower of Pisa he dropped simultaneously two unequal weights. To the amazement and horror of his learned contemporaries the heavy and light weight reached the ground simultaneously. This experiment, truly Baconian in its conception and performance, was the first of the blows which eventually overthrew those Aristotelian beliefs which were false. At the same time the experiment was the foundation of the science of dynamics.

To Newton (1642-1727) we owe the first comprehensive theory of the universe—that theory which is contained within the law of gravitation. Now the essential characteristic of Newton's wonderful piece of induction was not so much that he thought that the inverse square law would explain the motion of the heavenly bodies. Aristotle himself might possibly have guessed as much. The important thing was that Newton was not content with his theory until he had put it to experimental verification. The most important of these tests was to determine whether the attraction of the earth for the moon predicted by theory was the same as that observed. Until he had convinced himself that this test and others like it were completely satisfied, Newton did not regard his theory of any value, nor was he willing to publish it.

Another great generalization in science is that which we owe to Einstein. His achievement is briefly this: From a group of mutually contradictory experimental facts Einstein has formed a unique and complete theory which in its simplest form tells us the behavior of matter irrespective of the motion of the observer. In its more complete form Einstein's theory treats gravitation within infinitesimal regions of space and time as equivalent to acceleration. Now note that, following the Baconian principles, Einstein, like Newton and other eminent scientists, has worked out certain verifiable tests for his theory. Beautiful and complete though it may be in itself, neither Einstein nor any other scientist is satisfied with the theory unless these tests are met. An important Canadian expedition, with Drs. Chant and Young, to verify or disprove one of Einstein's predictions will probably just have returned from the eclipse in Australia as this article appears.

Conclusion

In the introductory paragraph the thesis was advanced that the progress of civilization is a function of the development of science. On these grounds a brief study has been made of the development of scientific principles and methods from the earliest times down to the present day. It has been shown that the true scientific method was that first enunciated by Roger Bacon, which requires that Nature be studied by experiment first to determine the mode of operation, and second by induction, with experimental tests, to explain or learn the causes of the observed phenomena. In conclusion, it should be pointed out that if science is as important a test of the progress of humanity as on the face it appears to be, then clearly it is a common duty to advance the study of science in every possible way. In no way can this be more successfully done than by each individual taking an interest and studying and reading all he can about the developments of science. For the standard of scientific achievement of a generation is not measured by the genius of a few research workers, but by the average knowledge of all men.

The Hills

Now men there be that love the plain,
  With yellow cornland dressed,
And others love the sleepy vales
  Where lazy cattle rest;
But some men love the ancient hills,
  And these have chosen best.

For in the hills a man may go
  Forever as he list,
And see a net of distant worlds
  Where streams and valleys twist
A league below, and seem to hold
  The whole earth in his fist.

Or if he tread the dales beneath,
  A new delight is his,
For every crest's a kingdom-edge
  Whose conqueror he is,
And every fell the frontier
  Of unguessed emperies.

And when the clouds are on the land,
  In shelter he may lie,
And watch adown the misty glens
  The rain go marching by,
Along the silent flanks of fells
  Whose heads are in the sky.

And in the hills are crystal tarns
  As deep as maiden's eyes,
About whose edge at middle-noon
  The heavy sunshine lies,
And deep therein the troll-folk dwell
  Can make men wondrous wise.

The gorse of Spring is like a host
  Of warriors in gold,
And Summer heather like a cloak
  Of purple on the wold,
While Autumn's russet bracken is
  Monk's livery of old.

Our lord, the sun, knows every land
  But most he loves the fells;
At morning break his earliest torch
  Upon their summit dwells;
At eve he lingers there to catch
  The sound of vesper bells.

The men who dwell among the hills
  Have eyes both strong and kind,
For as they go about their works
  In Heaven's sun and wind,
The spirt of the stablished hills
  Gives them the steadfast mind.

—W. N. Hodgson.

A Little Nun

Within the cloistered convent garden, where
  Her light steps always paced the self-same round,
  Each day some new small loveliness she found—
An opened bud, a frond of maiden hair,
A humming bird's wee, blossom-hidden lair,
  A dragon fly, like spun Venetian glass,
  A web of gossamer that starred the grass,
Or thistledew, by stray winds wafted there.

And, when her tinkling, silver beads she told,
  Bird songs and drowsy humming of the bees
  Were tangled in her murmured litanies,
Until her "Ave Marias" seemed to hold
  The fragrant, immemorial wonder of
  All Nature's evidences of God's love.

—Charlotte Becker.

Years ago, when Canada was simply a huge territory sprawling between the oceans, with nothing to bind it together or give this mighty Dominion real cohesion, people who were regarded as ripe for the asylum used to say that one day a great steel road would run across it from end to end and give it what it needed most, an artery, but they were laughed at. Then the C.P.R. came along and, disregarding mountains and rivers and hundred-mile-long chains of lakes and every conceivable engineering difficulty, gave Canada their mighty steel road on which the whole economic life of the Dominion depends. It is one of the greatest engineering feats in the world, a thing before which a man should stand bareheaded.—Lord Northcliffe.

(BY RICHARD L. POCOCK)

ZZZ — slap — zzzz — slap — zzzzzz—slap. "Ha! you little divil, gotcha that time, didn't I? Gotcha that time, you bet I did, you little psalm-singing little——"

"Here, Tom, what on earth's coming off over there? For the love of Mike, stop the unseemly language. What's biting you, anyway?"

"Biting me, what's biting me, did you say, Dick? Why this little blankety blank skeeter was trying to bite me, but I just slapped him for a knockout, and he's not going to bite me or anybody else any more. Now, what do you know about that, Dick, a skeeter in November, and right here in the Old Shack, and there ain't supposed to be any skeeters on the Island, at least, that's what the boosting advertisements say. Well, there's a specimen anyhow, a full-grown specimen of the mosquito vulgaris or common or garden skeeter, captured in the middle of November on Vancouver Island, or I'm a Dutchman."

They're No Joke

"Well, well, Tom," old Dick laughed, "you're blossoming out into quite a humorist, and a man that can see anything funny in skeeters is sure some humorist. Never could see anything funny in them myself; in fact, I've known them to be quite a serious matter several times before now, but not on Vancouver Island; at any rate, in this part of it, Tom, and that's a fact. Those fellows that advertise "no mosquitoes" aren't so far from the truth after all, you know, Tom. Sure you might once in a while come across an odd one or two if you were hunting them for museum specimens or something of that sort, Tom, but if you wanted to get more than a few specimens you'd have to hunt them, at least, in these parts, instead of their hunting you, same as they do in some places I've been in. But a skeeter at this time of the year and right here in our Old Shack, Tom, is rather out of the way, one must admit; but even then in a way it's a good advertisement for our climate. There ain't so many parts of Canada where you'd be getting such mild and sunny weather in the middle of the month of November as we've been getting, and I guess your skeeter must have got wind somehow of the climatic advantages in this part of the world and came around to sample our Indian Summer. Maybe it's a good thing you squashed him, Tom, or he might have brought his friends and relatives along to form a colony, and, much as we appreciate Winter strawberries, December roses and all that sort of thing, Winter skeeters aren't quite so desirable, and that's a fact."

"Yes, boys, we're mighty lucky to live in a country where there aren't any mosquitoes, speaking generally. Why I remember when I first came to the Coast, one of the things that made me think I'd like to stop was that I'd got away from a country where there were skeeters, not to mention other sorts of flies and beastly little pests. What the Almighty put them on earth for has always been a puzzle to me as well as a whole lot of other fellows; in fact, I know lots of men who are ready to swear that it was some of old Nick's work for a fact.

It Didn't Take

"Talking of flies, I'll never forget one or two experiences I've had with them. You see, Tom, the old-timers will tell you that a man gets inoculated to skeeter poison after a while and they don't bother him, but me, I never stayed in a skeeter country long enough for that desired result to be attained. Maybe it's my sweet disposition that always made me such a mark for 'em. I guess some of the old sour doughs' hides are too tough for a skeeter to penetrate anyway and that's why they don't seem to bother 'em so much, but they sure did give me hail Columbia, and that's a fact. The first Spring I ever put in in British Columbia I thought I'd never be able to stick the black flies. They follow the snow, you know, that is, when the snow begins to melt off the lower levels, the black flies come to life in myriads, and, as the snowline goes higher up, the flies are higher up, too, but there's just as many down below, all the same, so it seemed to me. I was doing assessment work on a claim and my old partner told me of several dodges for fighting them. Building smudges was one. I used to build smudges outside the cabin door and sit in the smoke till I was blind and half suffocated, but the flies seemed to like it. Then there was bacon grease. Smear your face with bacon grease, he said, and the flies won't bother you. My giddy aunt! Smoke and bacon grease were their two favorite foods, taken with a nip out of my face as a standby on the bill of fare.

"But the black flies and the no-see-ems (you know the no-see-ems, Tom); they were just little pets compared with the mosquitoes. I remember making a prospecting trip up a mountain where they were just as thick as they well could be. If you sat down for a wind on the trail they'd pitch on the front of your legs where the overalls were tight and they could stick their little bills through a pair of overalls just as quick as a needle. Why, any time you brought your hand down with a slap on your knee you'd kill at least half a dozen every time, and that's gospel truth without any exaggeration, and you talk about having skeeters here, Tom!

A Pitiable Object

"Tom, I've seen a great big six-foot man, who you'd think could stand anything, sit down and cry for the mosquitoes. Positively all in, Tom. Yes, sir, that's honest to goodness truth. There were three of us on that little trip and it was only a day's journey from town to the claim we'd staked some days before, that is, two of the three of us; the third was our six-foot friend and I don't think I ever felt quite so ashamed in my life as I did then. I've seen big strong men break down once or twice, but that's the only time I've seen a man really and truly cry for skeeters. It was warm, sultry weather and the skeeters were rather more vicious than usual. They were giving all of us just about all we could stand, but this was our friend's first trip into the mountains, and I guess the thing was too much for his nerves. Instead of keeping a stiff upper lip and making up his mind to stick it, he was cussing those skeeters all the way up the hill and fighting them. We all had a bunch of cedar boughs in our hands, swishing 'em off as well as we could as we made our way up the hill with packs on our backs, but even at that they were having the best of us; but this chap was swearing and cussing and stopping every few yards on the way up, and I reckon he exhausted his energy in the fight.

"Anyway, he gave right in at last and sat down with the tears just streaming down his cheeks. He had a sweater with him and he pulled it over his head, hot as it was, and we couldn't get him to budge for a while. Honestly I believe the skeeters were the cause of that Johnny beating it out of the country, which he did a month or two later, and never came back. Yes, I guess even skeeters have their uses after all, Tom.

Nothing to Laugh at

"But it ain't fair to laugh at another man. I've been pretty nearly all in myself, with skeeters before now. I'll never forget a night I put in, well, never mind just where, but it wasn't on Vancouver Island, and that's a fact. We'd only a fly with us to sleep under and nothing whatever to keep the skeeters out, and they kept late hours did those same pests. That fly was good enough for them, especially with a couple of nice fat men inside to feed off, and they had some feed before they got through, believe me.

"Then there was that caribou hunt we made when we didn't take a tent or even a fly; just slept out in the open. Slept did I say? Divil a wink did I get that night. We were up pretty high and it was cold as the sun went down, pretty darned cold at that, but just an hour or so before sunset those skeeters were putting in solid licks trying to see how much of my blood they could suck before they hunted their holes to get out of the frosty night. Boys, I'm telling you my face, lips and eyes especially, were swollen up just as if I'd been having a one-sided argument with Jack Dempsey. Those were the most poisonous skeeters I think I ever got in amongst. Talk about getting inoculated. That ought to have done the trick for me if ever it was possible, but I guess I had an overdose and it didn't work. I was pretty near all in that night all right; could hardly see out of my eyes for the swelling and felt sick right through. They did let up a bit after sunset, 'count of the cold, I guess, and they didn't get on to our big fire till too late, or I suppose they'd have gathered round sociable like and kept the beano up.

A Favored Land

"I'm just telling you all this, Tom, so as you may be duly thankful that you are in a no-mosquito country. There may be an odd few around, Tom, but, practically speaking, there's no skeeters here. There's drawbacks to most places, and flies are some drawback, believe me, to countries where they're thick. Thank heaven Vancouver Island ain't one of 'em."

Pendulum Observations and Radio-Telegraphy on Mont Blanc

In 1899, Professor Jean Lecarme made some observations at the J. Vallot Observatory, which is situated near the top of Mont Blanc, about 450 m. below the summit. These observations were resumed recently with the further particular object of establishing a radiotelegraphic station there. (Comptes Rendus, May 29, pages 1413-1416.) The difficulties of making a prolonged stay on the top of the highest mountain in Europe, instead of the 76 cm. at sea level, are, of course, very great. The high winds never fell during the whole eight days, from August 18 to 26 last year, which Lecarme spent in the Observatory, and severe atmospheric electric disturbances were common. To support life in the rarefied air, Lecarme found subcutaneous injections of oxygen very useful. In erecting his radio-telegraphic plant he adopted several interesting devices. Instead of stretching the wires in the air, where they would be exposed to the storms and liable to be weighted with ice and snow, he buried them so far as possible in the dry snow, which is an insulator; this expedient greatly reduced the coronal discharges. For the sake of further protection he inserted glass tubes, charged with a highly-rarefied gas of low resistance and self-inductance, and provided with two electrodes having large surfaces, in the antenna-earth circuit; these tubes would normally bear currents of 25 milliampere at 50,000 volts and would, by their glow, give warning of the approach of electric storms. To make the observations taken at the observatory of scientific value, a very exact knowledge of the time is indispensable. Lecarme therefore took a pendulum clock and two chronometers, all tested for months, up to the observatory, conducting observations first at Chamonix, at an altitude of 1,050 m., and then at the observatory, altitude 4,365 m.; the summit is at 4,810 m. The second-pendulum, 1 m. in length, is made of a rod of invar and a lenticular bob of the same alloy, weighing 10 kg.; the oscillations are electrically maintained by the aid of a Fery battery of three cells, which can stand the cold of the high Alps. At Paris, the pendulum made 86,400 oscillations per solar day; at Paris the gravity constant g_0 is 980.94. At Chamonix the number of oscillations per day was diminished by 45, at the Observatory by 70; the theoretical value of g_1 at Chamonix is 980.3, the pendulum observations yielded g_1=979.63. At the Vallot Observatory g_2 should be 979.20; the pendulum indicated g_2=979.08. On the summit of Mont Blanc, assuming the height 4,810 m. to be correct, the constant should have the value g_3=979.065; the value deduced by extrapolation from the pendulum observations was g_3=978.83. Thus, all the gravity values found were too small; the chronometers, moreover, lost 30 seconds per day in the Observatory. These discrepancies are difficult to explain. The only previous Mont Blanc observations available are those obtained by Hansky in 1898 in the old Janssen Observatory.—Engineering.