ment of clearance fires still continues in backward parts of Europe, and that the Danish archæologist G. Hatt had already indicated the probability that it was in use in prehistoric Denmark.

It follows naturally that if we accept the argument of Iverson thus far, we must expect to find that when the 'Sub-atlantic' climatic period began, no less important vegetational changes took place. For at this time not only the swift climatic 'deterioration' occurred, but also the establishment of a new people with iron implements and the permanent regular settlement associated with village culture. In fact, Iverson is able to demonstrate that the pollen diagrams and peat profiles do reflect such changes. There is the extensive water-logging of low-lying land and the formation of aquatic 'precursor' peat with *Scheuchzeria palustris* above the uniform and highly humified Sphagnum-Calluna peat of raised bogs, and there is the considerable extension of Fagus (beech) at the expense of Quercus (oak) in the pollen diagrams. Both these are climatic effects. In addition, there is a progressive forest destruction by human activity which is indicated by a further considerable increase in the pollen of herbaceous plants, and, in the heathy areas, by increase in the pollen of the ling, *Calluna vulgaris*. The pollen diagrams indicate that in the heath region of central Jutland it was not until the Early Iron Age that great and continuous areas of heath were formed, although some heath was doubtless produced by Neolithic and Bronze Age clearance, and even in Pre-neolithic times the woodlands were much more open than those on the heavier soils.

Iverson's most stimulating piece of research emphasizes what was already dimly recognized, that an *ecological* approach to the interpretation of the results of pollen-analysis is logical and profitable, and indicates that the pollen-analysis method has proved its flexibility by application to yet another aspect of post-glacial history. We may now look for confirmatory results in this special field from many other parts of Europe.

ANCIENT ASTROLOGY

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IN A.D. 1605 Sir Francis Bacon appended to the "Advancement of Learning" some prescriptions for posterity. These contain an injunction to construct "A Just Astrology". Bacon had previously assessed the then condition of this science in his main text. Like alchemy, astrology had a noble aim; like alchemy again, it had been more imaginative than rational; and, once more like alchemy, it needed the corrective and the purge. Astrology, as Bacon conceives it, is central and fundamental, for he defines it as "the real effects of the celestial bodies upon the terrestrial". This includes the action of the sun on the earth: without which there would be no astrology, because there would be no astrologers.

Posterity has obeyed Bacon in one way by sharpening and deepening its sense of absolute dependence on the sun. The cosmic course has made continuing human life possible by isolating the humble solar system in the vastness of space, and by placing the modest earth, with all its appropriate conditions, in nice adjustment to the solar rays. If the sun cooled down, mankind would freeze out; if it exploded into a fierce burst of radiation, the earth would become a great crematorium. If an invading body tore the earth too far away from the sun, or the sun from the earth, men would freeze; if it drove the earth and sun too near, or collided with the sun to make too fierce a furnace, men would burn. Invaders have far to come to reach an earth 4½ light-years away from the nearest star and very remote from the galactic depths. Though the importance of the sun is too obvious to be missed, the ancient mind probably grasped man's absolute dependence on it less completely than modern astronomy.

Plato's "Timæos" is very preoccupied with the sun as a measure of time, a revealer of number and a teacher of arithmetic. The moon, the planets and their motions share in the lessons. The Platonic Socrates, however, gives the sun its due in the "Republic" as the author of visibility, generation, nourishment and growth, though the sun itself is not generated. Modern astronomy, or, in Bacon's sense, astrology, does not confine celestial actions to the sun. The moon pulls more than the sun at the tides to produce their effects—on navigation, for example, or on some marine organisms. The cosmic rays still have their enigmas. If they do come partly from the stars and do act on genes, modern astrology will recognize some stellar influence. According to Aristotle's "De Cælo", the moving celestial bodies emit heat and light by rubbing against the air. The "Meteorologica" supplements this. Neither the moon nor any star gives out much heat: the moon is near but too slow, and the star is rapid but too far off. The sun is both swift enough and near enough to warm the earth well. Though the two passages claim little for non-solar influences, they do indicate how readily celestial bodies could be presumed to affect the earth. The ancient mind did, in fact, as ancient astrology shows, very liberally supplement the celestial action of the sun.

Greek science, including astronomy, began on May 28, 585 B.C.: Thales predicted an eclipse of the sun for that day, and Nature obligingly darkened a battle between the Lydians and the Medes. This statement is too dramatic to be literally true, but Thales and the eclipse conveniently date the still accepted origin of Greek science (and philosophy) in the sixth century B.C. Thales was lucky, as Heath notes, for the Babylonian period on which he depended is less reliable for solar than for lunar eclipses. In 2159 B.C. the Chinese astronomers Hi and Ho were unlucky. Thales predicted an eclipse and gained prestige; Hi and Ho did not predict an eclipse and were executed.

From Thales the current of science runs to one great decisive century of thought—the fourth century B.C., the century dominated by Plato and Aristotle. In drastic summary, and so far as possible from the scientific point of view, a mathematical tradition runs from the anti-experimental Plato and a second trend of thought runs from Aristotle. Mathematics had its hand in astronomy and astrology. Science reaches an acme in the third century. In mathematics it includes Euclid and Archimedes; in astronomy it includes Eratosthenes, who measured the earth's diameter very accurately, and Aristarchos, who anticipated the Copernican theory. Herophilos founded scientific anatomy and Erasistratos founded scientific physiology. Then science begins to run into relative, though recognizable, termini. In the first century B.C. Lucretius stores the fundamentals of atomism in his famous poem, "De Rerum Natura",

for still far future centuries. Fortune has been capricious towards atomic theories. When the atoms tried to enter physics they were soon defeated; their more determined attempt to enter medicine was finally foiled by Galen at the end of the great Greco-Roman period in A.D. 200. Many centuries after, the atoms became an extraordinarily fertile concept—one of the most fertile, perhaps the most fertile, of all physical theories.

Science is considerably consolidated from the first century B.C. to the first century A.D. in such writings as those of Cicero, Vitruvius and Plutarch. In the first and second centuries A.D. science drops into four relatively permanent and authoritative consolidations. In A.D. 77 Pliny pours a miscellany of facts, presumed facts and ideas into his "Natural History"—that "immense register", as Gibbon says, in which were "deposited the discoveries, the arts and the errors of mankind". It had its own authority and its own influence over future centuries, though it does state that elephants worship the stars.

Clarke, in his translation of Seneca's "Quæstiones Naturales", under the title "Physical Science in the Time of Nero", calls it the last deliverance of the classical world on physical speculation. Seneca authoritatively consolidates physics for coming centuries.

Singer, in "A Short History of Science", heads his chapter on the divorce of science and philosophy, from 300 B.C. to A.D. 200, "The Failure of Nerve". This expresses the decline of science rather oddly, for Ptolemy and Galen, in the second century A.D., are experimental and have at least a notion of the nature of scientific hypothesis. If the "Optics" as now known is as Ptolemy wrote it—and Thorndike thinks it is so substantially—it represents the most remarkable experimental research in antiquity. The oddness seems less when a candle is seen to flicker up before it dies. Science has before it the long path through the Middle Ages to the decisive seventeenth century. Ptolemy's consolidation of astronomy remains authoritative until Copernicus and Kepler in the sixteenth and seventeenth centuries. Galen's great biological, anatomical and medical synthesis, which includes his own inductive and experimental inquiries, remains authoritative until the sixteenth-century Vesalius. Seneca, the neo-Stoic, Ptolemy, the mathematician and astronomer, Galen, the physician—each consolidates the results of science in his own way. They have one belief in common—the control of human destiny by the planets and the stars.

In 1609 Kepler introduced the elliptical planetary orbit. This decisive step effectively made the transition from the geocentric Ptolemaic system to the heliocentric Copernican astronomy. Astrology had persisted during fourteen centuries after Galen, for Kepler still checked his own horoscope on his own life.

The horoscope displays the dispositions of the celestial bodies, or relevant celestial bodies, at a particular moment. When Johnson accused Dryden of "great confidence in the prognostications of judicial astrology", he meant that Dryden believed in the casting of nativities and even calculated them himself. Such *judicial* astrology casts the horoscope of birth or conception to determine the destiny of the born. Webster's "New International Dictionary" (1914) distinguishes *judicial* astrology, which predicts the destinies of individuals or nations, from *natural* astrology, which predicts natural events. Bacon included horoscope astrology in his purge. Seneca and Galen include the horoscope in their doctrine, though Galen's astrology is largely medical. Ptolemy describes the philosophy of horoscope astrology.

Nothing is too strange or incredible for some philosopher to believe—so judged the young Descartes when he was at college. Men have believed very many strange things, and perhaps they still do. A universe created as a compact mass and expanding from its terrific initial concentration may be among them. A modern cosmologist fortifies the doctrine by mathematics and dates the primal pack so far as 2×10^9 years ago. Horoscope astrology, however, is too significant a phase of thought to be eyed merely as a curious error.

Human thought has been fated to tread a predestined path, as an acorn steps its way to the oak. This is a good working principle if taken widely, if used in Sir Thomas Browne's "soft and flexible sense" and if not made a fetish by reason. The mind seems to have been committed to a magical phase, for example, though not to every magical detail. In any event, the route to such insight as has been attained has been through many illusions and errors. This is true of astronomy and astrology. The historian should consult the acorn and be wise, for the phases of thought should be contemplated as acorns and not merely chided for not being oaks. The future historian will probably see many acorns in the twentieth century—some promising, some sterile. Discarded hypotheses strew the devious path of science, and many astrological notions lie among them. These notions have at least one value still, for they give glimpses of the mind at work. Analysis conveniently derives them doubly from the concepts of their time and from impressions made by natural phenomena, though the two are ultimately and intimately connected.

Most men accept happiness as the chief good, though they disagree about its nature. This statement from the opening pages of Aristotle's "Ethics" has a modern ring. An otherwise well-educated man who knows nothing of Greek thought might conceivably mistake the "Ethics" or "Rhetoric" or "Poetics" of Aristotle for a modern work. This peculiarly educated man is a legitimate expository expedient to point a contrast. "A man's language ought to be easy for another to read, pronounce and point": this sentence from the "Rhetoric" is modern enough. So is the notion adopted from Agathon in the "Poetics": it is probable that many improbable things will happen. The supposititious reader would never mistake Aristotle's "De Cælo" or "Meteorologica" for a modern work. Intelligent stars, the roles of the four elements, easily credited spontaneous generations, for example, and the whole range of physical ideas date the two works relentlessly. Physics, in one very real sense, is the most fundamental science. It is very fundamental if men emerged from the cosmic course among the ephemeridæ of the universe Greek philosophies almost invariably had their physics, and the earlier philosophies, at least, if they were assessed for the first time to-day, would probably be called philosophies of physics, as Eddington calls his work "The Philosophy of Physical Science". The physical world is more alien to us, in a recognizable sense, than the more domestic circle of human experience. Aristotle can deal with courage in the "Ethics", for example, or with the qualities of metaphors in the "Poetics" and the "Rhetoric", with more immediate success than he can secure in physics. A defective physics is one important item in the conceptual system that

promoted early astrologies. Greek philosophies regularly had their astronomies and astrologies.

Prospero's isle seemed to Caliban to be full of noises; the universe seemed to Seneca and Ptolemy to be pervaded by forces. The four traditional powers—dry, moist and, eminently, hot and cold—dynamically inter-connect the earth and the celestial bodies in the Ptolemaic universe. The heavens also send a force on to the earth. In Seneca's cosmology lightning has its subtle divine power, underground forces convert air into water, and a mighty force pervades Nature. Seneca's *force* is constantly modelled on the air, and the air itself, in various forms, is for him virtually a ubiquitous agent. It is the greatest of all powers for it kindles fire. The air drives trees up, holds our bodies together and stirs our souls, themselves a kind of air; a robust air keeps the earth compact and a fresh vital air from the earth supports life. The breath of the earth sustains the sun, the stars and the whole heavenly concourse. The inverted astrology of this statement contains a vivid sense of pervading cosmic forces. A crude physics assists this sense, and the cosmic spread of air provides an astrological agent.

Britain is great through the muscles of her sons, beef feeds the muscles, clover nourishes the cattle and bees fertilize the clover. Field-mice would destroy the bees, but cats kill the mice and old maids make Britain because they keep the cats. An item in the Hippocratic writings, whenever it was inserted, expresses the interconnexion of things less facetiously: if any one thing perished, all things would vanish. Every event, says Seneca, is a sign of an event to come. The sense of interconnected events is vivid in Stoicism.

Einstein's "cosmic religious feeling", stirred by the "sense of universal causation" and "the harmony of natural law", has its ancient analogue in the sense of the divine. In the "Apology" Socrates affirms a universal belief in the godhead of the sun or moon. Anaxagoras had been indicted because he called the sun a red-hot stone and the moon an earthy mass. In Plato's "Laws" the Athenian Stranger claims divinity for the sun, moon and stars against the earth and stones of mischievous philosophers. In the "Timæos" the stars and the planets are created gods; for Aristotle the stars, made of purest æther, are intelligent and divine. The divinity of the celestial bodies, as gods or godlike, persisted from Babylonian and Egyptian lore through the Greco-Roman tradition far into the Christian era. As Thorndike notes, Seneca studying the natural forces suggests the worshipper in the temple.

The Stoic Fate, however finally assessed, embodies two compelling concepts. It contains the belief in determinate causal connexions and natural law that emerged in Greek thought as the working faith of science. It contains also the sense of purpose, or aiming at ends, from which the Greek, or Greco-Roman, estimate of *cause* seldom got far away. Atomism had affronted this sense of the purposive too much to be welcomed for its sense of strict causality when Galen gave it the *coup de grâce* in medicine.

The ancient universe is physically misconstrued, pervaded by forces, interconnected throughout by determinately connected causes, a realm of natural law, a domain of sympathies or antipathies, suffused with purpose and impressively divine. "Astrology fell upon the Hellenistic mind as a new disease falls upon a remote island people": so writes Sir Gilbert Murray. Men realized truly that astronomy must finally achieve an astrology of some sort, though they tried to achieve it too quickly by inadequate means—this is a fair précis of a paragraph from Coleridge. The stars probably do mean something, John Selden thought in the seventeenth century, but astrologers cannot get at them to determine what. The stars *do* mean something and something can be known about the *what*—so thought Seneca, Ptolemy, Galen and many ancients.

Thucydides records how a lunar eclipse kept an Athenian host in port until the twenty-seven days prescribed by the soothsayers had passed. Samuel Pepys looked more imperturbably on the unfortunate comet that had lost its tail than many other eyes had looked on other comets. Eclipses, comets and many other astronomical or meteorological items took a hand in promoting astrologies. One item, in particular, had as many hands in the matter as Briareus. Pepys was recompensed for his toilsome studies of the moon's motions when it lighted him home on a dark night. Tiberius hoped to save his shorn poll from baldness by having his hair cut as the moon waxed. The belief in lunar control, the response of things or events to the lunar wax by increase and to the lunar wane by decrease, began early, extended to innumerable items and persisted pertinaciously.

Aristotle refers to the presumed connexion between moon and menstruation which runs through the tradition. In Galen the lunar phases still rule conception, birth and the "beginnings of actions": a belief rich in astrological possibilities. The innocent indifferent moon, which presumably knows nothing of such speculations, has been suspected of setting the whole astrological system going—horoscopes and all.

Neither Pythias, in the later fourth century B.C., when he correlated the lunar phases with the tides, nor Posidionius, about the first century B.C., when he recognized the combined tidal action of the moon and sun, drove the moon out of horoscope astrology. The moon hauls the tides; according to Galen it changes the air. If polluted air spreads disease, and the Hippocratic "Breaths" refers both life and sickness to the air, it may be infected from the skies. Pestilence can come from the sky if atoms from the great beyond can derange the air, as Lucretius sings, or atoms from the celestial bodies can spread epidemics, as Democritus affirms. Though the atomists are condemned by Galen for refusing astrology, they can accept widespread celestial actions by invading atoms.

In Aristotle and Galen the air connects the earth with the heavenly bodies. Under "Astronomy" in James's "A Medicinal Dictionary" (A.D. 1743), the sun, moon, planets and stars are said to act on terrestrial bodies through the æther and the atmosphere: even the distant stars affect human bodies by disturbing the air. Astrology, horoscopic or non-horoscopic, constantly trusts in the moon's power and relies on the astrological agency of air.

The astrological tradition is perceptible in the "Timæos", in the terrors sent and intimations given to expert calculators by the combined motions of the planets. The horoscope invades Stoicism, Rome and Greco-Roman thought during the second and first centuries B.C. Two dissentients mark the invasion: Panætios the Stoic in the second century and Cicero in the first. The signs of the zodiac connect modern astronomy with astrology and with

its origin, for they admittedly come from Babylonia. The tradition insistently refers the origin of astrology to the Chaldæans.

Berossos the Babylonian wrote a history of his country in the third century B.C. As the tradition appears in Vitruvius, for example, the Chaldæans cast nativities, Berossos presses their astrology on his school at Cos, Antipater and Archinapolos alter the horoscope from birth to conception, and astrology grips Greco-Roman thought. The encyclopædic history of Diodoros, about 30 B.C., describes the theory and method of the Chaldæans: the events of the heavens intimate the thoughts of the gods, so the stars were observed for many ages. So astrological theory promoted astronomy. The Babylonians are said to have checked horoscopes on the recorded lives of Babylonian boys. Even if they did this for less than the 470 years of one more moderate estimate, their inductive effort, if not their deductive doctrine, must be reckoned as scientific righteousness.

Did all the Romans who fell at Cannæ have the same horoscope? Cicero's question sounds pertinent. When the birth of Firminus was nigh, a slave-woman of his father's house was also near her delivery. Messengers were posted in either house to run to the other with news of each birth. The two messengers met so exactly in the middle of the way that the two births must have happened at precisely the same instant. Yet, St. Augustine further records, Firminus was born to increasing riches and honours, but the slave-born child was born to continued slavery. Cicero and St. Augustine argue inversely against the horoscope: Cicero from one fate and different horoscopes; St. Augustine from one horoscope and different fates. Either argument might be valid if, and only if, the disposition of the heavenly bodies at birth is the singly decisive decider of destiny. Ptolemy denies that it is singly decisive.

An anticipatory reply to St. Augustine can be shortly constructed from Ptolemy's "Tetrabiblos". Famines, pestilences, wars and the like, which affect large areas, whole peoples and cities, are more surely predicted than single human actions. The effect of the stars on the human individual is conditioned by his nationality, his country and his domicile. It is also conditioned by his period, for time varies the celestial actions. Firminus and the slave were born at the same time, in the same city and among the same people, but under different social conditions. They were also differently educated. Ptolemy disclaims an astrological narrowness if previous astrologers had ignored place, weather and heredity, as Cicero, in the "De Divinatione", says they did.

Ptolemy insists on the complexities of the celestial dispositions, on the manifold causes acting on the individual, and on the present imperfections of astrology. Predictions often fail because the science is immature, but frequent shipwrecks do not destroy the art of navigation. Ptolemy's frank admission of predictive failures contrasts with the bold statement by Diodoros that when the Chaldæans prophesied about kings they were always right.

Ptolemy repudiates impostors. He claims that the science has present value in spite of imperfections or failures, and that time will increase the value. Astrology is not useless because the stars decree inevitably: if they do cause a disease, a drug may cure it. Ptolemy manifests a recognizably scientific temper in handling a now discredited hypothesis.

Scientific inquiry is not incompatible with cosmic purposes, for Galen inquired how purposive Nature purposes. It is not incompatible with Providential ordering, for Galen inquired into the natural law through which God works, though the existence of God did not seem to him to be proved. If the stars do operate divine purposes, astrology can still have its operative scheme, as Galen had his attractive forces. A force radiated from the stars is central in early astrological doctrine—Cicero notes how the Chaldæans lodge it in the zodiac, Ptolemy speaks of the force diffused from the heavens on terrestrial things, and according to Galen "we receive the force of all the stars above". This force is variously affected by the sun, moon and planets according to their positions, conjunctions and relations to the signs of the zodiac. Other powers may co-operate, such as hot or cold, and an eye is often kept on the astrological agency of the air.

The moon is constantly prominent in the astrological versions. It has no more power than the other planets, Galen explains, but it is nearer. The Chaldæans, Cicero tells us, were careful to note the condition of the moon and its conjunctions with the stars at the moment of birth. The moon is usually peculiarly important in astrological theory, Thorndike notes, and more distant planets often act on the earth through it. It is quite reasonably, even if unjustifiably, suspected of inflicting genethlialogy, the science of nativities, upon many minds through many centuries.

The Chaldæan type of astrology is one hypothesis which marks the route of science. It seems to be an intelligible consequence of one phase in human thinking, and perhaps more so because man very earnestly wants to know what will happen.

PRE-NEANDERTHAL MAN IN THE CRIMEA

By SIR ARTHUR KEITH, F.R.S.

IN 1925 there appeared an annotation in *L'Anthropologie*[1] directing attention to the discoveries of ancient man and of his cultures then being made in the Crimea by G. A. Bonč-Osmolovskij, conservator of the Russian Museum in Leningrad. The chief site of these discoveries was the grotto or rock-shelter of Kiik-Koba, situated in the foothills of the Yaila Mountains, which run from Sebastopol towards the Kerch Straits. In the deepest and oldest stratum of the grotto were found fossil remains of part of a human skeleton; these were reported to be Neanderthal in character; they were examined by the late Dr. Marcelin Boule, who confirmed this diagnosis. The Crimea was then the most easterly point from which Neanderthal man had been reported. Students of early man were deeply interested in the discoveries reported by their Russian colleague and have eagerly awaited his full report—so far in vain. Recently my interest in Kiik-Koba was heightened by an article published in *Man* by Prof. Gordon Childe[2], in which the strata of the grotto are identified as similar in age and in sequence to those which yielded the fossil men of Mount Carmel—the subject of a report published by Dr. Theodore McCown and myself in 1939[3]. In February of the present year (1944) a pleasant surprise awaited me; on opening a parcel bearing the Moscow postmark, I found within a volume entitled