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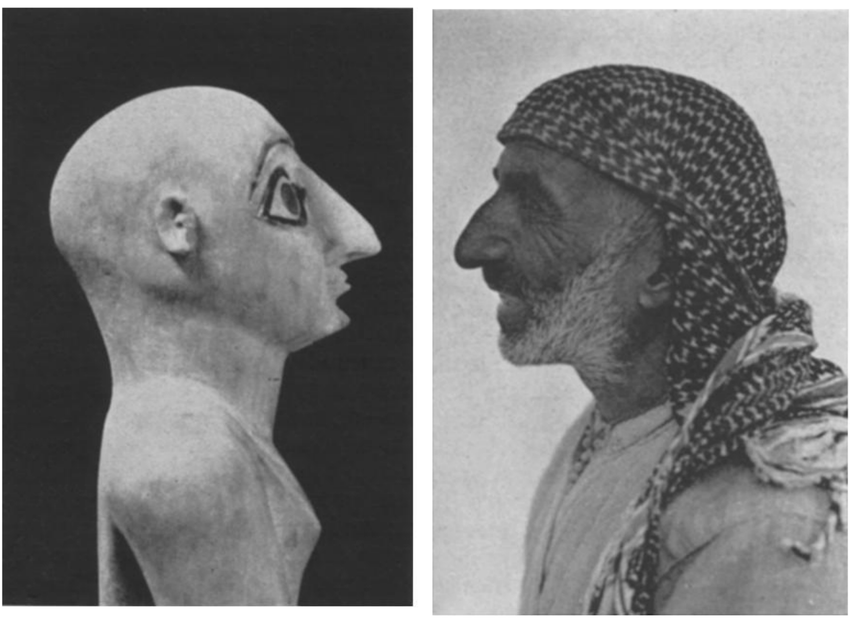

Fig. 1. An ancient Sumerian and his modern representative. This veined gypsum statue, perhaps of a priest, which so excels in the balance and clarity of its composition and the carefulness of its modelling, is probably forty-seven centuries old; in spite of shell eyeballs set in bitumen, and black stone pupils, the face strikingly resembles that of an Iraq workman employed by a modern archaeological expedition. (Oriental Institute, University of Chicago)

THE BABYLONIAN SCIENTIST AND HIS HEBREW COLLEAGUE

George G. Cameron

Oriental Institute, University of Chicago

The overwhelming advance of knowledge in our own "Age of Science"

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Editor: G. Ernest Wright, McCormick Theological Seminary, 2330 N. Halsted St., Chicago 14, Ill. (Only editorial correspondence should be sent to this address.)

Editorial Board: W. F. Albright, Johns Hopkins University; Millar Burroughs, Yale University; E. A. Speiser, University of Pennsylvania.

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often blinds us to the significant achievements made long since; and if we would attain proper perspective, we must frequently go back to man's beginnings. This is not to say that we shall always be well tutored, at least if we endeavor to learn about the attitude of the Babylonian or Hebrew toward what we call Science. For the student of the Bible knows that the book with which he deals is primarily a religious book which only incidentally reveals certain aspects of the Hebrew knowledge of the sciences. The archaeologist finds not the processes but merely the finished products, often in a sad state of preservation.

The poor Assyriologist, from whom we expect the most information, and whose task it is to explain plainly and simply the results he has secured from an examination of the thousands upon thousands of clay documentary sources, is perhaps the least well-equipped to be our teacher; for he must embody within himself the knowledge of a hundred disciplines. Though he may be working today with tablets expounding the theory of quadratic equations as it was understood by the Babylonians, next week he may be intent on a medical series presupposing an intimate acquaintance with the functions, the appearance, and the diseases of the liver, and the week after he may be involved in tablets dealing with the precession of the equinoxes or the determination of the moon-sun perigee! In other words, his knowledge is expected to be encyclopedic, and if only too often he has failed to explain his results in a way the layman can understand, it is also true that students of the modern sciences have frequently failed to take advantage of such of his results as were available—or, when called for help, have neglected to give it. The modern student of the social sciences, engrossed in the strides man has taken in the last two thousand years, is sometimes only too willing to ignore man's hesitant gropings and first steps, made two or three thousand years before; the modern astronomer, poring over the star catalogues and classification systems compiled since the founding of the Greenwich Observatory one hundred and eighty years ago, is seldom even made aware of the fact that the Babylonian astronomer catalogued and classified with meticulous care for over *three* hundred years and that many of his classifications are ready for study.

But, after all, we must plead also some tolerance for the modern scientist. Neither he nor we can be too sympathetic with a civilization in which there was so little diversification of professions, where the scribes and their philological cohorts, as well as the botanists, were priests, and where the student of internal medicine is actually an exorciser, a reciter of incantations—or, among the Hebrews, a prophet (II Kings 5:3; 8:7 ff.).

We may go further: the modern student of the sciences cannot be expected to be overly tolerant with a civilization whose approach to the individual sciences appears so diametrically opposed to his own, to a civilization in which only magic and divination, the foretelling of the future, would be considered "Science," while jurisprudence, medicine, philology, mathematics, and astronomy served practical aims.

Of course, the contrast is really not so glaring as at first it seems to to be. Especially in wartime no one can assert that the pursuit of truth for

Fig. 2. Unearthing records of the past. Excavators must show great skill in removing from the mud of centuries the little clay tablets on which are written the story of man's achievements. Once they have been brought to light, the soft lumps must be dried slowly and carefully; then, unaffected by their long interment, they may be read with ease and reveal materials bearing on science, history, economics, and many other disciplines. Here a part of an enormous number of records kept at Persepolis, a capital of the Persian king Darius, is being uncovered. (Oriental Institute, University of Chicago)

its own sake is the sole object of the sciences. When we subordinate the study of the cosmic rays to the usages of the stratosphere plane or analyze the content of rubber merely to produce its substitute through butadiene, we are in perfect agreement with the Babylonian scientist, and ultimately with his Hebrew colleagues, to whom only wisdom, the knowledge that produced a practical result, was of paramount value. Thus, the practical aspects of calendar-making led the Babylonian to examine the phases of the moon (on which he based his months), or to an interest in the sun (which gave him his year) and its satellites (many of which were his everyday gods): that is, into astronomy. The surveying of fields and the computation of interest led to his geometry and mathematics; the many tongues of the racial melting pot Babylon, Tower of Babel of Biblical fame, induced a sincere interest in philology and linguistics.

And so at this point we meet him on common ground. We know his aims; to a certain extent we share his goal. When and how did he achieve it?

THE FIRST SCIENTIFIC RECORDS

It is an amazing fact that among the earliest inscribed documents of man, documents which come from a building level dated to about 3500 B.C. and constituting one of a long series of strata which represent the remains of ancient Erech (see Gen. 10:10 and Fig. 1), there is a small collection of *scientific* records, the earliest known to man to date. Now it is extremely unlikely that records of a similar nature, but of still greater antiquity, will ever be found either in or outside of Babylonia. For, from the evidence now at hand, we are compelled to conclude that the compilation of these scientific notes went hand in hand with the very introduction of writing. Writing, from all the other ancient centers of civilization, is clearly of later date. Therefore, these notes, or scientific documents, bear witness both to the first sign of intellectual activity in Babylonia and to the oldest effort of this kind on record from anywhere in the world.

What is the nature of these documents that they permit us to apply to them the term "scientific"? They are lists of related entries: groupings of birds, fish, domestic animals, plants, vases, professional titles, personal names, and the like. But as such they have little relationship with the administrative documents or inventories in the economic field so well known to us in later times. These serve an intellectual rather than a material purpose. We know today that they were intended to aid in the preservation of the knowledge of writing. We may assume, with a great degree of probability on our side, that they were intended to be the teacher's handbooks from which he drew the materials for the instruction of his students in writing. But regardless of their original purpose, these same compilations —of birds, fish, and so on—presuppose careful observation and imply an ability to organize and to analyze the materials at hand, to catalogue and classify materials botanical, zoological, geological, astronomical, and the like. Further, these types of documents are destined to continue and to spread over the neighboring countries in a fashion that will set them off sharply from the usual run of business records which can claim only a transitory and local importance. They will be copied and recopied for many centuries and in more than one city or country. Samples of such copies, often modified and expanded—but still in a clear line of descent from the very first prototypes—have been dug up in Babylonian, Elamite, Syrian, and Hittite sites of much later age (Fig. 2). In these texts, then, we have the beginning of a family of scholarly notes that is significant at once for its continuity, distribution, and purposeful adherence to an established tradition, in spite of the fact that each successive compilation is subject to expansion and revision.

From all this we may therefore draw two important conclusions: First, in this recording of accumulated experience, and in the ability to apply such records to centers separated by time and space, we have the essential ingredients of scientific performance. Second, and more important, such groupings of birds or plants or rocks lead in course of time to the independent study of the subject matter involved. A list of plants, drawn up to remember how to write the names of plants, leads in its turn to a study of the plants themselves. Although these texts started out as an aid in the preservation of the knowledge of writing (that is, they were primarily philological—and philology is itself a science, of course), they led directly to the examination of things zoological, chemical, and so on. Thus the first recognition of all these subjects as so many separate disciplines may be traced back to the oldest inscribed records of Babylonia. And that recognition was due ultimately to the fact that man had just dis-

Fig. 3. Near Eastern communities are predominantly agricultural in nature. Camels laden with grain majestically pass a small village near Megiddo, the Biblical Armageddon, and demonstrate anew that the most important early home of man in Western Asia was in reality a "Fertile Crescent" — a cultivable fringe having mountains on one side and desert on the other — extending north through Palestine to Syria and then curving south again in the basins of the Tigris and Euphrates Rivers. (Oriental Institute, University of Chicago)

covered in writing a way to halt the relentless flow of *time,* and was bending all his effort and ingenuity to the task of keeping this way alive.[1]

It is well known that Babylonia, like Palestine, was primarily the site of agricultural and trading communities (Fig. 3). The individual Babylonian or Hebrew was above all a practical minded man. His life was not an easy one; his climate, running from the dreadful heat of summer with its inevitable parched ground and dust storms to the dreary rains and cold of winter, was not a particularly pleasant one. Climate, as well as the kind of life he lived, brought about the practical minded individual whose

1. See the excellent survey of the significance of these documents by E. A. Speiser in **Studies in the History of Culture** (Menasha, Wis., 1942), pp. 51-62.

primary objective was the turning of newly acquired information into effective use in everyday life. His whole experience was empirical and pragmatical: because a thing worked with little or no error then it was so and there was no arguing about it. His adoption into the accepted medical treatises of homemade, time-tested remedies for various ills is a case in point.

THE BABYLONIAN CALENDAR

The example of Babylonian empiric mentality is visible in his calendar-making.[2] After the day (based, of course, on the sun), we come to his first

Fig. 4. An Assyrian plow and seed drill, portrayed in the middle register of a memorial stone of Esarhaddon, king of Assyria (680-669 B.C.). (From **Guide to Babylonian and Assyrian Antiquities in the British Museum,** 1922, p. 228)

calendaric unit, the month, dependent on the wanderings of the moon-god. Twelve moon months make the year, beginning at the time of the spring equinox; but the sun-god ruled the day as well as the year: the Babylonian himself said, "The sun-god Shamash reigns over the way of heaven and earth." A year of twelve lunar months, each consisting of only 29½ days, as we know, totals up to merely 354 days and does not agree with the solar year, based on the earth's orbit around the sun and comprising 365 and about ¼ days. Something was wrong, he knew; how could the discrepancy be solved?

The Egyptians (who were to this point in close agreement) cut the

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2. Cf. A. T. Olmstead, "Babylonian Astronomy—Historical Sketch" in American Journal of Semitic Languages and Literatures, LV (1938), 113-129.

Gordian knot by having a year of 12 months (each of 30 days) and by adding (to the 360 days thus secured) five additional days at the end of the year which were not assignable to any month. This gave the Egyptians a year of 365 days but, as we now see, the nearly 1/4 day left out of the reckoning produced a calendar which slipped out of place one day every four years until, in 1,460 years, New Year's day had appeared on every day of the solar year and was only then back to its starting point.

The practical Babylonian had no desire to see his seasons thus shifting through all the months. His solution may not have been "scientific," but at least it did bring the months to their proper—if approximate—seasons. Whenever it was discovered that a month, for example the month of plowing (Figs. 4-5), was close to 30 days off from the regular agricul-

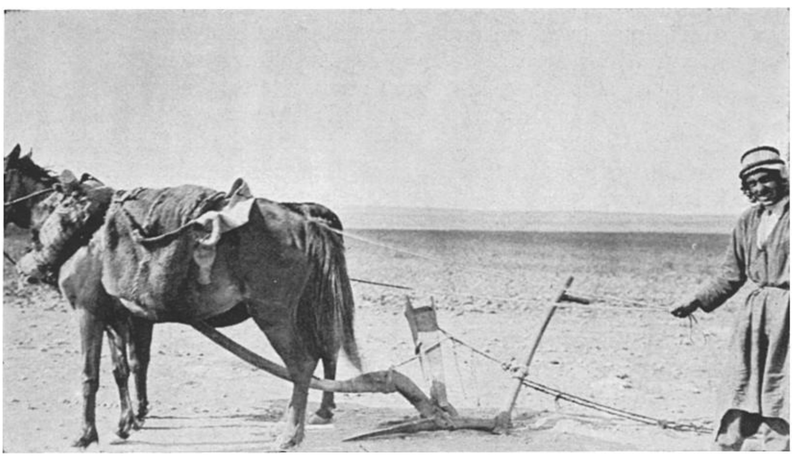

Fig. 5. The modern descendant of the Assyrian plow and seed drill, illustrating the conservatism innate in an agricultural community. The ancient seeder doubtless slung seed bags over his animal in the same way as his descendant. (Oriental Institute, University of Chicago)

tural and seasonal calendar, he added an extra thirteenth month, making that particular year not 354 but 384 days long. This added month we call the "intercalated" month, and henceforth his system of intercalation was followed not only in Babylonia but in the surrounding countries as well. It was the basis of the Hebrew calendar (for the early Canaanite month names gave place, after the exile, to those from Babylonia), as well as that of the Greeks and Romans before the calendar reform of Julius Caesar; it is weakly present in our own calendar, in February 29, when it occurs, and—amazingly enough—it still determines many of our church feasts; thus the determination of Easter, which governs all movable feasts, is an affair of considerable nicety and complication.

CHANGE AND RESISTANCE TO IT

But what we must here stress is the empirical procedure of the Babylonian's mind. And once a matter had been decided on, the conservatism, innate in a predominantly agricultural community, produced a resistance to change, a desire to maintain the status quo. He maintained it in his language and in the way it was written—and this in spite of the fact that he was aware of new systems of writing which were far easier than his complicated cuneiform. He maintained it in the way he compiled his dictionaries, remarkably similar in form from the earliest to the latest edition; in the way he penned his prayers to his gods and wrote his historical records; in the way he revered his gods and honored his rulers. For his was a hybrid civilization; in him met at least two peoples: the Sumerian and the Semite. In the mingling of the one with the other new social outlooks had been brought in, and with them a means of stabilizing the result—that is, writing. But the disturbance of the traditional modes of life, the result of this intermingling, merely intensified the emotional attachments to the old and contemporary social outlooks. The new rendering of the fundamental tradition embodying these effects had a resistance to further change which made almost certain its persistence.

Furthermore, this innate, stubborn resistance to change meant in both the Babylonian and the Hebrew (see Fig. 6) far greater scientific advance than would have been the case had he been merely a fancy adopter of fashions, an obsequious follower of new ideas. For inevitably such a plodding spirit is subject to change, but it is not the adopting but the adapting which emerges; there is no going "all out" for this new fad or that radical theory, but the assimilation of the important elements of truth within the new theory into the older long established body of knowledge.

DISEASES AND THEIR REMEDY

This is why the practical Babylonian mind added to the traditional incantation, as a remedy for baldness, the equivalent of alcohol massages and oil shampoos, and, for earache, added to the eating of hot stew the application of warm sweet oil. In similar fashion the Hebrew counseled a poultice of figs in addition to the customary prayer as a remedy for the plague boil (II Kings 20), and we are even told that, just as in Babylonia, the Hebrew king had recourse to the near and mundane physician rather than to the distant and heavenly God for his healing (II Chron. 16:12). Regarding the Babylonian prescription, we may object to the eating of the stew—but, after all, it hurt the patient not a whit. We may object to the incantation and question why a prayer to a god should be mixed up with purely scientific effort, but our own practice differs only slightly. We first call the doctor and secure his prescription, then we call the minister to pray for the sick, simply because we want our science and religion to be administered by different persons. In ancient times, one and the same individual attended to both.

Naturally, in such a field as medicine the early physician made a number of mistakes. When he observed that a sick man sometimes recovered but that someone else in the family came down with the same illness, he concluded that the demon of the disease had passed from the one to the other and devoted all his effort toward casting it out in fashions similar to those related in the four Gospels. We differ from him in that we call the cause of the illness not a demon but a germ, but just because he spoke of it as a demon (and sometimes portrayed it as we see in Fig. 7) does not justify our viewing it always as some sort of a little Mephistopheles with horns and a barbed tail, for the difference between our "germ" and a tiny "demon" who can go everywhere, through waste water and walls, is a little difficult to see.

Progress was made; the Babylonian physicians came a long way from the view that toothache is caused by a demon or worm that gets in between the tooth and the gum. One Assyrian doctor, brought into consultation in regard to a patient, writes as follows:

> "The 'burning' of his head, hands, and feet, wherefrom he has suffered, was on account of his teeth; his teeth were falling out; on account of them he 'burned'."

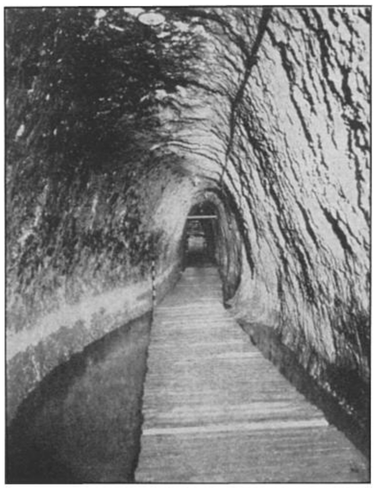

Fig. 6. A monument to Hebrew engineering: part of the ancient Megiddo water system. Lack of water within the walls of Megiddo, city of continual strife and the marching ground of many armies, would have rendered it powerless to withstand siege. Consequently, a cave-well, quite outside the city wall, was connected by means of this more than one hundred and fifty foot tunnel to a shaft sunk inside the wall. By an amazing feat of engineering skill, tunnelling proceeded from both ends at the same time (from the vertical shaft as from the well), as it did at the famous tunnel of Siloam. (Oriental Institute, University of Chicago)

Like Hippocrates, reputed founder of the medical tradition, our physician has noticed through a long experience that bad teeth were sometimes accompanied by painful conditions in other parts of the body. Although he may have had no theory as to the relationship between the two, we should at least give him ample credit for a sound clinical observation whether the real condition was represented by a referred (or sympathetic) pain or by an actual focal infection. The long eulogy of the physician in Ecclesiasticus (38:1-15) is indicative of the position he attained in later Jewish thinking.

Part of his progress was attributable to his empiric method—for there is no doubt but that many of the herbs and drugs he administered were effective even if we cannot always tell just what the "serpent's ear" or the "horned alkali" was in terms of our own pharmacopeia (although we have identified such medicaments as the oil from the castor bean). *Of course*

(continued on p. 32)

temple in Egypt and in Mesopotamia, as the background for additional articles on the significance of the Solomonic Temple in Israelite times, and of Temple, synagogue, and church in the New Testament period. Another article in preparation, intended for February, 1945, is on the subject of immortality by Professor O. R. Sellers. Most textbooks contain many foolish statements about what the ancients believed concerning the future life, and this article will do much to clarify the matter for those who are not acquainted with the archaeological discoveries.

G. E. W.

THE BABYLONIAN SCIENTIST

(continued from p. 29)

ancient medicine was empirical; if a remedy worked it was good. But modern medicine advanced along exactly the same lines until a few years ago, and it is still taking lessons. The modern Arab baby is never washed until it is four weeks old, for, say the Arabs, washing is not good for a baby; the natural skin covering with which it comes into the world is better than anything man can apply. Although this is in contrast to the ancient Biblical practice (see Ezek. 16:3), it conforms to the recent "discovery" that only oil and not water should be applied to an infant if a post-natal rash is to be avoided.

Much of that progress effected by the Babylonian arose also from the fact that the remedies he applied, by the empirical method of trial and error, were specifically named in his written textbooks which had been compiled down through the ages and which therefore represented an enormous body of recorded experience. It matters little to us whether bitter or pungent herbs were, according to the religious rites, supposed to drive out the demon of illness because of their unpleasantness, while milk, honey, and butter, because of their pleasant properties, coaxed it out. What does matter is that our scientist had learned that fumigation, the application of poultices, powders, and lotions containing saffron, mustard, cassia, and dozens of other identifiable ingredients were effective, and had recorded that fact for future use. Prescriptions of Assyrian physicians, known to us by texts from their capital which are certainly no later than the eighth century B.C., have only a secondary interest in magic, but take the form: "If a man has such and such a disease, then apply (or give to drink) such and such drugs and he may recover." This form was retained in later Jewish medicine. Diseases and ailments of every part of the body are dealt with in these texts, from the crown of the head (wherein the "itch" is treated with sulphur) to feet which cannot walk.

The tabulations of the plants adopted into the medical literature adhere to a definite botanical order of their own, but quite interesting are the botanist's comments interspersed amid the columns, such as that opium (in its narcotic effect) is like mandrake (a word that comes to us from the Babylonian), and that it is gathered by women and children, as it is to this day; that a poppy is called a rose by the common people, as it is by the modern Arab; that hemp (marijuana) is an antidote for sorrow and, in his own words, a "robber of the mind"; or that sumach is a dye for leather.

In the light of these remarks botanists will not be surprised to learn that many of the terms which they use today have sprung from the Babylonian names: thus cassia, sesame, chicory, crocus, saffron, hyssop, nard, and myrrh, to mention but a few.[3] Most of these have become familiar chiefly through the pages of the Bible, although the materia medica themselves are still in use. In the Old Testament these are mentioned only as ingredients of incense, oils for anointment, and perfumes for embalming, but Talmudical writings (post-Biblical) give adequate proof of their medicinal uses.

Fig. 7. An Assyrian demon. In a world peopled with demons of sickness, strife, troubles, and minor irritations, one of the cruelest sources of misery was the demon of the southwest wind Pazuzu, "king of the evil spirits of the air," who "rules the world quarters and devastates the pure mountains." Such figures as this bronze representation of Pazuzu (hitherto unpublished and of unknown provenience; Oriental Institute Number A 25413) were made to insure the exact application of a charm or incantation uttered against him. and perhaps also to neutralize his power and secure his help against others of his kind.

From what has so far been written it should be quite obvious that the utmost elasticity must be conceded to him who would attempt the delimitation of the ancient scientific frontier. That this is no unfair postulate should be clear also from the astonishing results shown in the field of ancient Oriental history during the last hundred years. With every advance in our discovery of the capacity and resources of the old peoples we have held up our hands metaphorically in wonder at their unexpected knowledge. A century ago, when cuneiform was still in its infancy and winged bulls

3. R. Campbell Thompson, **The Assyrian Herbal** (London, 1924).

were still below ground, we could see only the dawn breaking in Babylonian and Hebrew archaeology. Then, even after the nineteenth century had blazoned forth its archaeological wonders, it remained for the twentieth century to reveal the truth behind the Old Testament references to the Hittites, who wrote a dialect in cuneiform bearing close analogies to Greek and Latin near a land which knew the Indian gods in the middle of the second millennium, and it devolved upon the same twentieth century to prove that a thousand years before, and more, there had been traffic between the merchants of India and those of Babylonia.

Therefore it would not befit us to set any arbitrary limitation to the forgotten labyrinth of old discoveries in the natural sciences; for even though time has left but little record of the technical processes in which the old guilds of craftsmen excelled, this lack of record will by no means permit that tyrannic extreme of the modern world which would arrogate to itself and to recent times the credit for this or that advance along a path which has been so slowly built up on the experiments of unknown predecessors. Clearly, we must in many cases admit our ignorance of the actual processes, partly because the records themselves are still too scanty, partly because it has always been the outrageous custom of certain learned circles to conceal their knowledge from the lay world, and partly because the knowledge of technical methods by one guild has always been closely guarded from all other guilds. We find instructions for this secrecy as far back as the middle of the second millennium when a scribe-scientist added this colophon to an explanatory text:

> "Let the learned man instruct the learned man, but let the unlearned not hear about it, for that is taboo."

ANCIENT METALLURGY

The latest discovery in ancient chemistry, a Babylonian tablet of the seventeenth pre-Christian century, gives a formula for making a lead glaze colored with copper (Fig. 8), but it is written in just the same cryptographic method which was so beloved by the secretive alchemists of our own Middle Ages. And let it be noted that such a palisade of concealment is not confined to antiquity but has persisted to the present day, particularly among the glass makers, who preserve not only the tradition of their ancestors' skill but also their secretiveness.[4]

We cannot say at what period the Babylonian began to work gold and silver, for these are precious metals and as such are the first forms of booty which an invader takes. But he had learned how to treat both most artistically by the time of the burials in the so-called "royal" tombs at "Ur of the Chaldees". From a very early time we have evidence for copper, then bronze, and finally iron—not only meteoric, but also iron free from nickel. It was through experimenting with fire, accidentally or intentionally (note that Noah offered burnt-offerings), that prehistoric man learned so much about the properties of these and other minerals. In the latest periods the Assyrian method of producing fire was by flint and steel, although the properties of pyrites were also known and it is even possible

4. See R. Campbell Thompson, **A Dictionary of Assyrian Chemistry and Geology** (Oxford, 1936), Introduction.

that a sulphur match was used. The persistent tests with fire on various substances showed the Babylonian its effects on the alkaline plants, which gave him potash from wood ashes for washing; on rocks, which gave plaster and lime in addition to the glaze mentioned before to both him and the Hebrews (cf. Isa. 27:9; Amos 2:1). While we have no date for the smelting of ores, it was a familiar practice, and we now know that Solomon had not only his own workmen in the Lebanons who hewed cut stone and prepared timber for his buildings (I Kings 5:13-18) but also his own mines and smelting factories south of the Dead Sea, the workings of which are described rather technically in Job, Chapter 28, and Ezekiel, Chapter 22.

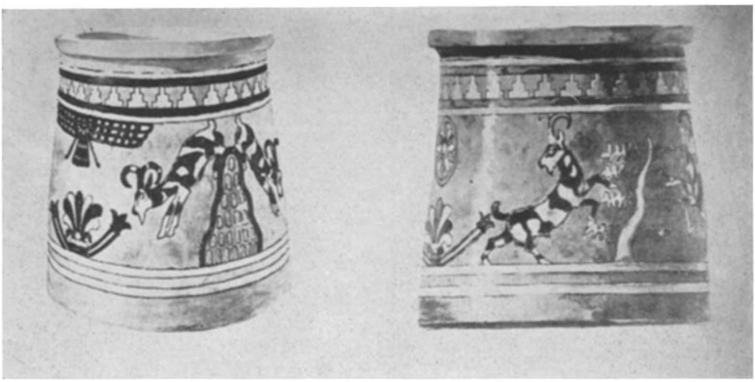

Fig. 8. Lead glazed pottery jar from Assyria. The Assyrian ability to apply a lead glaze over clay is exemplified by this varicolored vase, perhaps from a temple, which shows two pairs of antelopes and the representation of a mountain, a winged sun disk, and the star of the goddess Ishtar. The custom of glazing stones and beads existed in both early Egypt and Babylonia, and there has survived to our day from the latter country a fairly elaborate description of the furnace employed for glass making. (From Andrae, **Assur farbige keramik,** pls. 22-23)

We can, indeed, set an approximate per:od to the mixing of ingredients for bronze casting in Babylonia, and the damaged 'blue prints" of Solomon's temple in the book of I Kings (cf. also Exod. 25 ff.) provide ample evidence that bronze casting, the hammering of metal, soldering, welding, polishing, and overlaying were all well known practices in Hebrew times (Fig. 9). The Babylonian knew that copper would give black and red oxides for glass, that white lead would produce red lead, that green vitriol or copperas would give sulphuric acid. Sal ammoniac, secured from dung fires, paved the way for the discovery of mercury from cinnabar; by leaching the soil he obtained various salts, and he possessed a wide knowledge of vegetable acids such as vinegar. He surely had a test for the relative hardness of rocks; he certainly had one to inquire into the degree of purity and impurity of his coins. A document from the reign of Darius the Great, dated, fortuitously enough, on December 30, 502 B.C., revaluates the money submitted as taxes in terms of a pure and undebased coinage.

SUMERIAN, THE "DEAD" LANGUAGE

Many of the formulas at the disposal of the Babylonian were clothed in secrecy, as we have already discovered, and a potent factor which contributed to his ability to write thus cryptographically in his Middle Ages (that is, around 1500 B.C.) was the employment of two languages, Sumerian and Semitic. True enough, to all intents and purposes Sumerian was dead by that time, but most of the literary masterpieces were composed in it, the legal and administrative terminology was based upon it, and—somewhat like Latin in our Medieval Period—a barbarized form of it was still the medium for scientific writing, not understood by the average citizen. Practical mindedness demanded that the lists of birds, plants, stars and so on, once conceived as a means of maintaining the knowledge of script, now be brought up to date. The signs by which the names of these objects had been written had long since undergone great change, and now there must be included Semitic translations, equivalents, or loan words, for with the study of script there was linked perforce the study of vocabulary, and this in its turn led to the study of language. Thus, although memory of certain rare synonymous Sumerian meanings for some signs permitted the scientist to hide his newly-won information in a cloud of obscurity, the process itself led to the master philologist. There is scarcely a single branch of philology which was not subsequently attacked in and for itself; morphology, syntax, vocabulary, each came in for its full share of attention.

OMENS AND ASTRONOMY

This was not foresightedness; it was but practical necessity. Foresightedness was left to the omens and the many means of divination, whether it be by examination of the liver of the sacrificial sheep, by interpretation of dreams, by observation of the troubled patterns (to rephrase an old saw) assumed by oil when it is poured upon water, or by observation of the heavenly bodies whose movements (as indeed the whole of the natural world) were supposed to exert an influence over the fate of mankind. In a discussion of the Babylonian or Hebrew scientist we are not concerned with the details of his omen literature more than to indicate how great a part it played in the education of observation. Wrong-headed and illogical as the omen literature may have been (through primitive inability to distinguish cause and effect—or, more accurately, between *post hoc* and *propter hoc*), nevertheless it played a significant part in the training of observers, and shows, even at its worst, no more retrogressive bearing on the normal rate of human progress than the gypsy fortune teller, or the articles entitled "Your Horoscope" in our daily papers.

We cannot cite the precedent of the *early* Babylonians in the field of astrology—despite the attention given to "Chaldean astrologers" both in and outside of the Bible—to disprove our picture of the scientist's mind as one saturated with both practical mindedness and reverence for, as well as use of, the past. For there is little witness to astrology in our earlier sources; it never held the favor of kings, as did divination by means of the liver; the common people much preferred divination by observing animals or insects, the misbirths of animals or women, and the like. It was only in the last few centuries B.C. that astrology began to be considered in the lives of ordinary men and women. This was likewise true among the Hebrews, as may be adequately seen from the many references in the book of Daniel, although Amos 5:26 introduces us to the subject of star-worship, and II Kings, Chapter 23, relates the measures taken in 621 to root out this "heathenish" practice. As has been well said, although astrology did contribute to astronomical terminology, it is a question whether it did not actually delay investigation of the scientific aspects of astronomy. On the contrary, Babylonian astronomy developed particularly from the need of adjusting the calendar, and we have already observed how practical was this consideration.[5]

Fig. 9. Bronze stand from Megiddo: proof of the Hebrew ability in bronze-casting. This bronze openwork stand with square base and round top shows on each side a worshiper or priest presenting a gift or standing in an attitude of adoration before a seated deity. Associated in some manner with the religion of ancient Megiddo, it resembles a bronze stand of the same period from Cyprus on which wheels have survived and which has been compared to the stands in Solomon's temple (I Kings 7:27-37). (Oriental Institute, University of Chicago)

But we must disabuse our minds of certain widely held ideas about the Babylonians in this scientific field. In spite of numerous assertions to the contrary, astronomy was not a science at a fabulously early time, for its beginnings as a science date back only to the late Assyrian period, merely 2,700 years ago, while its greatest triumphs were some 500 years later. But even so we should never be afraid to admit the fact, or to fear that the glory that was Greece will rob us of the just fame of the Babylonian

5. Cf. Olmstead, **op. cit.**

astronomers, for whom the Greeks had the warmest admiration. And now with the recognition that there was a Babylonian in the Academy of Plato, we have perhaps not far to seek for him who could explain in astronomical terms the results of the Babylonians named Naburianus and Cidenas, both of whom were so well known to the Greeks themselves. It was Cidenas who discovered the difference in the length of the year as measured from equinox to equinox and as measured between two successive arrivals of the earth at its nearest point to the sun. This, then, is the discovery of the slow change in the obliquity of the earth's axis, like the wobbling of a spinning top, which causes the precession of the equinoxes. It was the other Babylonian we have named, Naburianus, who endeavored to determine the true date of the new or full moon, with which was connected, of course, the determination of lunar or solar eclipses. It is amazing to discover that his calculations on the apparent diameter of the moon's face are far more accurate than were the estimates of Ptolemy, Copernicus, or even Kepler before the latter employed the telescope.

MATHEMATICS AND GEOMETRY

But it is in the fields of mathematics and geometry that the psychological bent of our scientist is perhaps best exemplified. The one was developed in the elaborate inventories and administrative documents which bulk so large in the total number of tablets excavated—assisted, naturally enough, by the calculations essential to astronomy. The other, geometry, originated in the necessity of measuring and surveying the fields and estates sold in a predominantly agricultural community.[6]

Like all the other Semites, the Hebrews, so far as we know, used only the decimal system for their computations — that is, their basic unit was ten, like ours. But when we turn to Babylonia we are at first appalled by the basic unit with which we must deal; it is not ten, but sixty, and we find ourselves in the throes of a sexagesimal numerical system which seems to have no counterpart in the heavens, on the earth, or in the waters under the earth. Our first feeling of irritation is somewhat mollified when we discover that in the business documents proper a decimal system is employed as an assistant or adjunct to the sexagesimal, that there are the units up through nine, then a symbol for ten, another for 100 and another for 1,000. But in the pure mathematical texts, in the astronomical and geometrical calculations, the decimal system has been discarded almost altogether. Here sixty, or a multiple of it, is the unit. Our astonishment grows apace, and with it our wonder at its origin.

From time to time there have been numerous explanations put forth as to the source of this curious and apparently senseless system. Most of them are in themselves irrational, or presuppose philosophical or astronomical premises far beyond the capacity of our primitive ancestors. If we can but divest ourselves of the professorial atmosphere and project ourselves into the mental pattern of the early practical-minded Babylonian accountant, we shall doubtless find the real explanation for this sexagesimal system *in its effectiveness*: the unit of 60 worked better for him than any other he could devise.

Modern professional mathematicians tell us that to be supremely

6. See F. Thureau-Dangin, **Textes mathématique babylonien** (Leiden, 1938), Introduction.

effective the basic unit of a numerical system should permit, without a continuing fraction or decimal, the factoring of all or as many as possible of the smaller numbers comprising that unit. In other words, that unit, whatever it may be, should be evenly divisible by 1, 2, 3, 4, and so on. Our vaunted unit, 10, may be factored in this manner by only 1, 2, 5, and itself. Sixty, the Babylonian unit, is evenly factored by 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and itself. The Babylonian accountant had doubtless discovered, by his use of what we call fractions but what are more properly *individual units or parts of a larger whole,* that the unit of 60, better than any other number, permitted him to express this "fraction" as a whole number: 1/3 in terms of 60 being 20; 1/6 being 10; and so on. Sixty worked admirably; his empiric logic demanded that it be adopted as his basic unit, and so it was.

Once a symbol for the unit 60 had been accepted, two 60's would of course be indicated by writing the symbol twice, three 60's by writing it three times, and so on up to 59. The next largest unit is, then, according to our thinking, 60x60. But this next largest is only a multiple of 60, and can therefore be written by exactly the same symbol as the first unit, 1; it is but a new order of 60.

Already, therefore, we comprehend a fundamental Babylonian discovery: it is the *position* of any individual integer or number within the whole number that determines its value. When we write 111, the first figure indicates hundreds, the second tens, the third units. When the Babylonian wrote 111, each figure represented merely a different order or value of the unit 60; nevertheless, there is no "absolute" position: any particular number, such as 30, may mean 30 units of 60, 30 units of 60x60, 30 units of 60x60x60, or even the number 30 in its relation to 60, our fraction 1/2. Practical mindedness has produced an almost perfect system of enumeration which permits every number, whole or fractional, to be interpreted in terms of a whole number.

Obviously it would be impossible to explain in these few pages the achievements of the Babylonian in the realm of mathematics, to demonstrate how he worked with numbers which at first sight cannot be divided evenly by 60, or how he multiplied, divided, subtracted, squared, cubed, performed quadratic equations, or solved geometrical problems. Suffice to say that he who would understand the operations will *at his peril* express them in terms of modern mathematics, such as $xy - x + y = 43$. Likewise it will not do to discard the Babylonian expression of a number and interpret it in terms of our own fractions, units, hundreds, or thousands; if we accept his figures and deal only with his whole numbers, when we attempt to follow one of his mathematical problems, we shall discover not only that the process is faster, more direct, and simpler, but also that because we are performing the operation his way we are securing a much clearer picture of his mental set and psychological bent.

The fields of mathematics and geometry provide us with one further insight into the Babylonian character which may not be disregarded. The surveying of estates demanded that the irregular contours be divided into such squares, rectangles, parallelograms, and, especially, triangles whose areas and sides could easily be computed. The Babylonian was familiar with the rudiments of the Pythagorean theorem that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the other two sides; there is even some evidence to show that certain applications of this theorem, which were supposed to originate with Leonard of Pisa in the thirteenth Century A. D., were known to him and that he had transmitted them to the Arabs, from whom Leonard himself drew. Unfortunately, the Babylonian did not take full advantage of this theorem. Usually he solved the triangle problem by a different method, but he was not satisfied with this solution and found still another method which produced a slightly different result. His reasoning was sound: the two formulas are capable of giving better results according to the relationships between the two sides of the triangle. When this relationship is close to 1 to 3, one formula is more correct; when it is as much as 1 to 7, the other formula is better. Thus we are continuously in the presence of an empirical type of logic, one which consists in the orderliness of the results, in the system with which the problem is solved, and one which has been acquired by the pure and simple method of trial and error. We may well question why he should bother to calculate the diagonal when, with the small numbers which he generally uses, measuring would be a simple task. The answer to our question makes clear the real point in common between our scientist and Galileo, for in both we see at work disinterested curiosity, pure science as we ourselves have known it.

An important difference between our method and that of the Babylonian is this: we attempt to prove, to verify, the correctness of our results; we justify the answer we have secured. There is no trace of such proof in his mathematical texts; there is merely the explanation. We have already discovered, however, that he is constantly changing his geometrical formulas, or giving a second or third method of solution; and although he makes his astronomical calculations and affirms that the New Moon *should* appear on the twenty-ninth day of the month, he then adds: "Watch for it *and see!*" We must, therefore, doubt if a Babylonian scientist ever put down a formula, discovered by himself or handed down by tradition, without his tongue in his cheek. We must assume that he tacitly declared, "This method should work, but if it does not, then try another!" Here speaks the empirical scientist, the pragmatist, the man who knows his past and yet looks toward the future.

In these pages we have entered not so much into the laboratory of an old scientist as into his library; we have observed not how he solved problems but how he was prepared to solve them. Our cursory treatment has admittedly been decidedly unfair, both to him and to ourselves; for, like an ancient religion, the subject should be treated by periods, chronologically—that is, historically—although an over-all view, like an aerial survey, has some value. We may decry the static character of his mental pattern, but by and large it was no more static than the idea that the last two thousand years have shown man how to live and that he may with impunity forget or ignore the two thousand years before that. Those who search in the records of the past are not endeavoring to present the past on its own merits, to make it live in and for itself, to show, for example, that socialism will not work simply because it was once tried and found wanting—in other words, to offer merely a "New Past." Rather are they interested in the future and in how that past fits into the eternal scheme of universal things. The old Babylonian or Hebrew scientist, for whom the past had an inordinate charm, fitted his past into his present to the best of his abilities, and one can ask for little more.

Archaeological News and Views

Dr. George Cameron, the author of the article on the Babylonian scientist in this issue, is the Editor of the *Journal of Near Eastern Studies* and an expert on the history of ancient Iran. This country is comprised of three territories whose names frequently appear in the Old Testament, Persia, Media, and Elam. The Medes in northern Iran had established a large empire by the time of Jeremiah in the last quarter of the seventh century B.C., and they played an important role in the annihilation of Assyria, capturing the city of Asshur in 614 B.C. and assisting the Babylonians in the capture of the Assyrian capital, Nineveh, in 612. During the third quarter of the sixth century the Persian monarch Cyrus united Media and Persia, captured Babylonia, and established the Persian Empire.

Elam was a smaller country than Persia or Media, and we have comparatively little information about its history. Babylonian tradition preserves the record of a brief surge to power of this kingdom about 1600 B.C. (according to the new "low" chronology), during which a king of that country sacked and burned the cities of lower Babylonia. One of the four eastern kings who fought with Abraham was a certain "Chedorlaomer, king of Elam" (Gen. 14:1), and various efforts have been made to identify him with one of the kings of this age, but the matter is very uncertain. Exiles from the country were deported to Samaria by the Assyrians during the seventh century (Ezra 4:9), and Judean exiles were settled there during the early sixth century (Isa. 11:11). In Shushan (Susa), the capital, Nehemiah was stationed. The city was also the scene of the story of Esther and of one of Daniel's visions (Dan. 8:2).

On April 14 Dr. Cameron described an exceedingly important discovery of Elamite documents at Persepolis, the Persian capital, in a paper before the mid-west branches of the American Oriental Society and the Society of Biblical Literature and Exegesis. The discovery was made by the Oriental Institute of the University of Chicago during excavations at Persepolis, and was totally unexpected because the city is many miles from Elam. One group of the documents, consisting of some 30,000 clay tablets and fragments, was found in a fortification wall in 1933, though only three to five thousand of them are legible. They date from the twelfth to the twenty-eighth years of the reign of the Persian monarch Darius I (521-486), the builder of Persepolis, and they record the dispersal of grain, flour, wine, oil, and other commodities to men, women, and children who were working on the city's buildings. In other words, among the laborers hired by Darius to work on Persepolis were a large number of Elamites.

A second group of tablets, nearly 800 in number, were found in the royal treasury; but when the city was destroyed by Alexander the Great, many of them were reduced to tiny fragments from which little could be learned, and melted iron had obliterated whole lines on others. Of the 800 found, only 112 are suitable for publication, and these date from the thirty-second year of Darius I through the reign of Xerxes (called Ahasuerus in Esther — 485-465) to the first year of Artaxerxes I (464-424). Dr. Cameron reported: "A rare half dozen of these are strictly speaking writs of mandamus, for the king himself by a court order commands the distribution to certain individuals of as much as 904 *karsha* of silver (the equivalent of at least $12,000 in our currency). The rest are reports to the treasurer (often in the form of a letter) concerning the payments of monies to people who have been working on particular projects on the terrace. They are notices to the treasurer by responsible officials that he must alter his official balance by the amount paid out, and with typical oriental promptness they are issued anywhere from two to four months after the funds have already been issued. There is, of course, a catch in this. The workers receive, not the actual money reported, but commodities at a fixed rate of exchange: sheep worth three shekels, or a jug of wine worth one shekel. It is interesting to discover that the prices quoted at Persepolis are identical with those in contemporary Babylon."

The importance of these Elamite documents is not merely in their contents, however, but also in the progress made toward their decipherment. The Elamite language has no modern descendants and no certain ancient relatives. Persian royal inscriptions were usually translated into Elamite and Babylonian, and these translations have been of great help in learning to read Elamite. But the Persepolis documents described by Dr. Cameron "are not formal literary compositions; theirs is the language of commerce, of Wall Street, and of the building trades. Whole phrases of words hitherto unknown may occur twenty to thirty times with varying degrees of similarity. A few such phrases have already yielded their secrets; others have not, but Captain Parker Hitt must have had them in mind when, in the first U. S. Army manual dealing with cryptography, he opened the first chapter of his treatise with the following sentence: 'Success in dealing with unknown ciphers is measured by these four things in the order named: perseverance, careful methods of analysis, intuition, luck' . . . But the most difficult stage of our journey has already passed, and I am confident that by the date of publication many of the remaining questions will have been resolved."

The work being done on this collection of tablets is typical of that being done on numerous other documents from the ancient Near East, and which are not yet published. Oriental research is an exceedingly hard and arduous work, demanding great patience and vast learning on the part of its participants. But during the two decades between the two world wars the life and thought of the Biblical world have been opened to a degree which no one could have foretold, and the decades which follow the present conflict promise even richer results.

FUTURE ISSUES

During the fall and winter it is hoped that we can publish in the *B. A.* a treatment of "The Significance of the Temple in the Life of the Ancient Near East," with articles by leading authorities on the temple in Egypt and in Mesopotamia, as the background for additional articles on the significance of the Solomonic Temple in Israelite times, and of Temple, synagogue, and church in the New Testament period. Another article in preparation, intended for February, 1945, is on the subject of immortality by Professor O. R. Sellers. Most textbooks contain many foolish statements about what the ancients believed concerning the future life, and this article will do much to clarify the matter for those who are not acquainted with the archaeological discoveries.

G. E. W.

THE BABYLONIAN SCIENTIST

(continued from p. 29)

ancient medicine was empirical; if a remedy worked it was good. But modern medicine advanced along exactly the same lines until a few years ago, and it is still taking lessons. The modern Arab baby is never washed until it is four weeks old, for, say the Arabs, washing is not good for a baby; the natural skin covering with which it comes into the world is better than anything man can apply. Although this is in contrast to the ancient Biblical practice (see Ezek. 16:3), it conforms to the recent "discovery" that only oil and not water should be applied to an infant if a postnatal rash is to be avoided.

Much of that progress effected by the Babylonian arose also from the fact that the remedies he applied, by the empirical method of trial and error, were specifically named in his written textbooks which had been compiled down through the ages and which therefore represented an enormous body of recorded experience. It matters little to us whether bitter or pungent herbs were, according to the religious rites, supposed to drive out the demon of illness because of their unpleasantness, while milk, honey, and butter, because of their pleasant properties, coaxed it out. What does matter is that our scientist had learned that fumigation, the application of poultices, powders, and lotions containing saffron, mustard, cassia, and dozens of other identifiable ingredients were effective, and had recorded that fact for future use. Prescriptions of Assyrian physicians, known to us by texts from their capital which are certainly no later than the eighth century B.C., have only a secondary interest in magic, but take the form: "If a man has such and such a disease, then apply (or give to drink) such and such drugs and he may recover." This form was retained in later Jewish medicine. Diseases and ailments of every part of the body are dealt with in these texts, from the crown of the head (wherein the "itch" is treated with sulphur) to feet which cannot walk.

The tabulations of the plants adopted into the medical literature adhere to a definite botanical order of their own, but quite interesting are the botanist's comments interspersed amid the columns, such as that opium (in its narcotic effect) is like mandrake (a word that comes to us from the Babylonian), and that it is gathered by women and children, as it is to this day; that a poppy is called a rose by the common people, as it is by the modern Arab; that hemp (marijuana) is an antidote for sorrow and, in his own words, a "robber of the mind"; or that sumach is a dye for leather.