Henry Draper	—1884
E. C. Pickering	—1886, 1901
S. C. Chandler	—1896
E. E. Barnard	—1897
G. E. Hale	—1904
W. W. Campbell	1906
W. S. Adams	—1917
H. N. Russell	—1921
A. A. Michelson	—1923
F. Schlesinger	—1927
R. G. Aitken	—1932
V. M. Slipher	—1933
Harlow Shapley	—1934

The dates may offer material for speculation on the part of the reader. The contacts, outside the realm of the organizations, as for example, the interesting correspondence of Sir David Gill and Simon Newcomb, are another and longer chronicle.

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THE FIRST KNOWN LONG MATHEMATICAL DECLINE

WHILE mathematical attainments have usually been preserved and increased from generation to generation there have also been periods during which not only no important progress was made but many of the earlier achievements were temporarily forgotten. The earliest known such long period relates to the ancient Babylonians and started about 2000 B.C. According to the recent volume 3, page 25, of the favorably known "Geschichte der Elementar-Mathematik," by J. Tropfke, there was a period of 1,500 years during which no cuneiform texts are now known which include the solving of equations. In particular, the known solutions of quadratic equations, which are however restricted to the determinations of only one root according to most students of the subject, originated during two periods of time about the year 2000 B.C. and 200 B.C., respectively.

There is still considerable uncertainty in regard to the mathematical attainments of the ancient Sumerians and the ancient Babylonians, but enough has recently been discovered to show that our histories of mathematics which were published about a dozen years ago are in need of many modifications as regards ancient mathematics. In particular, the quadratic equation was treated on 27 pages in the preceding edition (1922) of the volume to which we referred in the preceding paragraph, while 68 pages are devoted to the same equation in this volume and much of this increase is due to the recent discoveries by O. Neugebauer and others in regard to the mathematics of the ancient Sumerians and the ancient Babylonians.

It should not be inferred that the first known mathematical decline started from a high state of mathematical attainments. The later attainments of the ancient Greeks were of a much higher order than those which had been reached by the ancient Sumerians and the ancient Babylonians. General methods for solving the quadratic equation represent the peak of this early advance, and these methods were then only partially understood since the number concepts had not yet been developed so as to include complex numbers. Even the ancient Greeks failed to reach a sufficiently high mathematical advance to master the solution of the quadratic equation, although they got much further in this direction than their predecessors. Their work, too, was followed by a long mathematical decline, which was again followed by an advance. The latter reached a sufficient point to really master the solution of the quadratic equation as it is now taught in our high schools.

Until recently the study of the civilizations preceding that of the ancient Greeks required very meager mathematical knowledge, but the recent discoveries relating to the mathematics of the ancient Babylonians and the ancient Egyptians have effected a considerable change in this direction. It is now necessary to know fully the difficulties involved in the solution of the quadratic equation in order to evaluate the intellectual advances made by the ancients before the times of Greeks. From the standpoint of modern mathematics this is still meager, but it is a great advance beyond the fundamental operations with positive rational numbers. In particular, it has recently been discovered that such rules in multiplication as − times − is plus, and − times + is minus were already used by the ancient Babylonians.

There has been considerable discussion in regard to the question whether the ancient Babylonian mathematics preceding the long decline in question should be regarded as extending into algebra. Since no generally accepted definition of the term algebra now exists it is clearly impossible to decide this question in a satisfactory manner. One of the most senseless efforts to distinguish between arithmetic and algebra appears in Webster's "New International Dictionary" (1938) under the entry "algebra" in the following words: "The essential difference between arithmetic and algebra is that the former deals with concrete quantities while the latter deals with symbols whose values may be any out of a given number field."

Even the ancient Babylonian arithmetic which preceded the noted long decline dealt mainly with abstract numbers according to their extant literature. One of the chief objectives of pre-Grecian mathematics was the development of methods to perform the fundamental operations with respect to number aggregates composed of the positive rational abstract numbers. It seems probable that integers were used before the common fractions were employed, but the fact that in our modern languages the number one-half has a name which is independent of the name for two points to the very early use of common fractions. The scale downwards from unity was probably almost as important in the early steps towards civilization as the scale upwards, but such questions can obviously never be decided from historical evidences.

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CROSS REFERENCES IN SCIENTIFIC LITERATURE

THE effective compilation of data is almost inevitably complicated by the necessity of a suitable means of indicating cross references. Since the secretarial work involved often becomes burdensome, the following system is suggested:

References are taken on standard size index cards, the six by four inch cards being very satisfactory. These are filed alphabetically according to the name of the author. The subject being investigated is divided into appropriate topics and a key card is prepared. The top margin of the key card is divided into vertical spaces about one fourth inch apart, and a topic assigned to each space so provided. If, for example, the first topic selected is "the reaction of the culture media," all cards treating this subject will be marked on the upper margin one fourth inch from the left margin. If "culture characteristics" is the next topic, all references concerning this subject will be marked one half inch from the left margin. "Scotch tape" in various colors, red, blue and green can be used to mark the upper margin of each card. If a reference card contains information concerning more than one of the topics suggested it may be marked in as many places as necessary on the upper margin. The use of various colors makes it possible to divide the upper margin into more spaces than would otherwise be possible. If three colors are used there will be a repetition of one color every three fourths of an inch. Brass paper clips were previously used but the top margin of the cards was so thickened that the index became unwieldy. In addition to the variety of colors, the "Scotch tape" has the advantages of being thin and its use on the card does not cause the upper margins to become unduly thick. The number of cross references is limited by the size of the index card, but the simplicity makes an effective system possible with a minimum amount of effort.

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OVEREXERTION AS CAUSE OF DEATH OF CAPTURED FISH

MOST kinds of fishes die very quickly when removed from the water. As an example, herring on being taken out of the water flop about very vigorously and die in a few minutes with the symptoms of asphyxia. Some kinds, however, remain alive for a considerable time under such conditions. The eel (*Anguilla*) may remain alive for days out of water in moist situations, and the same is true for the catfish (*Ameiurus*). Since the obvious changes in the dying fish are those associated with suffocation in air-breathing vertebrates, such as mammals and birds, and since the fish is out of its natural environment, water, for which its respiratory mechanism is suitable, it is natural to conclude that the death of the fish is due to interference with respiration. Nevertheless, proof has been lacking that in air the gills are less able to transmit oxygen to, and remove carbon dioxide from, the blood than when they are in water.

As a matter of fact, death occurs in many captured fish, such as herring, even when they are not removed from the water. Herring do not survive very long when caught in nets, whose meshes permit them to pass through as far as the dorsal fin, but no farther. Although the fish are said to be gilled since the gills prevent them from backing out, there is no interference with respiration, the net holding them by the middle of the body. Among sea fish that are taken regularly by baited hooks on set lines (the "long lines" of British fishermen and the "bultows" or "trawls" of fishermen on the western side of the North Atlantic), the haddock is one that dies very quickly whether removed from the water or merely caught and held. It may be maintained that, with a hook in its mouth, the haddock is unable to breathe properly, but I have failed to get evidence that this is true.

Ritchie,[1] in studying *rigor mortis* in fish, particularly members of the cod family (*Gadidae*), found captured haddock, cod and hake (*Urophycis*) to have 0.15, 0.08 and 0.05 per cent. respectively of lactic acid in their muscles, representing increases above the amount in resting muscle due to various degrees of fatigue. The differences in degree of fatigue between the three species was considered to correspond with differences in the "usual notion of their muscular activity." Macleod and Simpson[2] found that haddock captured on "trawls" and examined within 2½ hours after being hooked had practically no glycogen in the muscles, but those taken quickly on hand lines had from 0.04 to 0.22 per cent., the difference being attributed to more struggling when a long time on the "trawls." The absence of glycogen would be due to

[1] A. D. Ritchie, *Jour. Physiol.*, 60: 1–2, 1925.

[2] J. J. R. Macleod and W. W. Simpson, *Contr. Can. Biol. N. S.*, 3: 439–456, 1927.