## A WIDE-SPREAD ERROR RELATING TO THE PYTHAGOREANS

THE "Pythagorean symbol" is defined in some of our dictionaries as the hexagram. This is done, in particular, in Webster's "New International Dictionary," second edition, 1935, under the entry "hexagram," as well as in the "Century Dictionary," 1906. On the contrary, recent writers on the history of Greek mathematics, including M. Cantor and T. L. Heath, call attention to the fact that the star-pentagon is said to have been used by the Pythagoreans as a symbol of recognition between members of the same school and to have been called by them Health, according to Lucian and the scholiast to the *Clouds* of Aristophanes; *cf.* "Manual of Greek Mathematics," by T. L. Heath, 1931, page 108. According to Murray's "English Dictionary," under the entry "Pythagorean," 1909, the capital Greek letter upsilon was used by the Pythagoreans as a symbol of the two divergent paths of virtue and of vice.

The construction of the regular pentagon is related to what is now commonly called the "golden section," *viz.*, the division of a straight line segment into extreme and mean ratio. Therefore, it is of great historical interest to know whether the early Pythagoreans were familiar with this section. The construction of the regular hexagon, on the other hand, is very much simpler and does not involve the solution of a quadratic equation. Hence the assertion that the Pythagorean symbol is the hexagram instead of the pentagram is not only misleading but it also fails to exhibit the mathematical advancement of the Greeks at about the time of Pythagoras. It is natural to assume that the symbol of recognition among the Pythagoreans was selected because it involves something that was then regarded as somewhat abstruse rather than something that was even then regarded as elementary.

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## MORE THAN TWO PRE-CAMBRIAN GRANITES IN THE CANADIAN SHIELD

IN the May 24, 1935, issue of SCIENCE Professor Andrew C. Lawson has objected to a statement of mine that "from geologic evidence, the Laurentian, Algoman and Killarney granites appear to be so different in age that radioactive age determinations should distinguish between them."[1] This statement of the distinction between the Algoman and Killarney granites and statements of like import in most of the text-books on historical geology which have appeared in the last dozen years are characterized as dogmatic, and Professor Lawson calls upon me to set forth the geologic evidence that these granites are of different age. Professor Lawson's view is that "the Killarney granite is the Algoman granite."

The point urged in the address under criticism was that the methods of determining the age of igneous rocks by radioactive disintegration are now apparently becoming sufficiently accurate to raise hopes of differentiating the granites of the Canadian Shield on a time basis and of obtaining a few reliable dates in the pre-Cambrian time scale between which may be fitted in the various geologic events and rock formations. There seem to be enough different granites to make this possible. Investigations along the lines advocated should give us the facts of the case, whatever they may prove to be, and Dr. Lawson's view that the Algoman and Killarney granites are of the same age would be put to the test and its correctness or incorrectness presumably determined. The spirit of the address to bring to bear new evidence of seemingly great value in discrimination to check current views of correlation seems to me not one of dogmatism, but the reverse of it. It calls attention to an additional method of appraisal.

Belief was expressed in the existence of three granites of widely different age in the Canadian Shield. For convenience the three familiar names, Laurentian, Algoman and Killarney, were used. One should not be the slave of these names, however, in considering the main problem. Dr. Lawson asks for geologic evidence. Some of this evidence may be listed as follows.

I. Granitic rocks older than the Timiskaming system have been reported by many observers as the result of studies covering a period of many years. To be sure, most of the granite originally called Laurentian is now thought to be of later date, but the later studies by no means eliminate the Laurentian granites as a whole. Pebbles of a granite older than the Timiskaming are found as important constituents of the conglomerates in the lower part of the Timiskaming series.[2]

II. Important granitic intrusions cut through the Timiskaming succession in large volume without penetrating the overlying Cobalt system of strata, which is separated from the Timiskaming by a great unconformity. These masses of granite were intruded, therefore, after deposition of the older Timiskaming and before deposition of the younger Cobalt formations, for whose basal conglomerates they have furnished numerous pebbles.[3]

III. In certain other areas there is granite which is younger than the Cobalt. For this I will quote Dr. Lawson himself, who comments on a report on the

[1] SCIENCE, February 22, 1935, p. 186.

[2] H. C. Cooke, W. F. James and J. B. Mawdsley, Geol. Surv. of Canada, Mem. 166 (1931), p. 56 and pp. 104–106.

[3] Geol. Surv. Canada, Mem. 166, pp. 108–138.

Sault Ste. Marie area by R. G. McConnell as follows: "The young granite clearly cuts the whole of the Huronian, including the latest Cobalt rocks. It also cuts certain quartz-diabase dikes in the Huronian, but is older than the olivine diabase dikes of the region. It is lithologically similar to the Killarney and is correlated with it. This appears to settle the question of the relation of the Killarney granite to the Cobalt series and proves its post-Cobalt age."[4]

Just what is the proper use of the term Algoman is another question which may be left to others better qualified to judge. Dr. Lawson himself proposed the name Algoman and first applied it to the post-Seine granites in western Ontario.[5] He believed it to be post-Huronian in age and has since referred to it as post-Huronian "by definition." Unfortunately the post-Huronian age of the granites in the Seine River area is based on the assumed equivalence of the Seine and the Huronian—an unproved supposition. Perhaps ultimately it may be found advisable to avoid confusion by adopting new names in the place of one or more of the three now so commonly used, or by redefining the present terms. Whichever granite Dr. Lawson prefers to call Algoman, there seems to me sufficient justification for the contention that there are at least three granites in the Canadian Shield of widely different age.

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## TRANSFORMATION OF COORDINATION AFTER CROSSING THE ACHILLES TENDONS IN THE FROG

IN 1934 W. Manigk[1] reported observations which, if confirmed, would overthrow the accepted theories of reciprocal innervation. He found that frogs whose hind legs had been sewn together in such a way that only the feet were movable, walked with a characteristic front-leg–hind-foot rhythm. This rhythm persisted after excision of all the extensor muscles of the feet except the gastrocnemii. He then crossed the distal ends of these muscles to the opposite feet in such a way that contraction of the right gastrocnemius would extend the left foot, while contraction of the left gastrocnemius would extend the right foot. The flexors of the feet were left unchanged.

Manigk stated that there was no difference between the walking of frogs so operated and frogs with uncrossed gastrocnemii. Both groups of animals walked with the same front-leg–hind-foot rhythm. From this fact he concluded that the crossing of the gastrocnemii in some way brought about a transformation in the innervation rhythm of these muscles, which caused them to cease acting as the antagonists of the flexors of the same side and to take on the function of antagonists of the flexors of the opposite side.

The writer repeated Manigk's experiments and obtained the same results. However, further investigation failed to substantiate his conclusion that the transposition of the gastrocnemius muscles occasions a change in their innervation rhythm. It was found that *denervation* of the crossed gastrocnemii does not affect in any way the walking behavior of the frogs. Since this is the case, we must conclude that the crossed un-denervated gastrocnemii do not produce foot movement. In view of this fact, it is obvious that no conclusion as to a change in the innervation rhythm of the extensors can be drawn from Manigk's experiment. Extensive studies of the movement mechanism revealed that the observed foot extension was produced by other muscles in the leg and thigh acting through a lever system introduced by the crossing operation.

Further evidence against Manigk's conclusions is furnished by the following experiment. In a number of frogs all the muscles moving one hind foot, except the gastrocnemius, were excised and the two legs were sewn together. The distal portion of the gastrocnemius was transposed in such a way that contraction of the muscle now produced flexion of the foot instead of extension, as is normally the case. The righting response of animals so operated was compared with that of control animals whose legs had been sewn together. If a control frog is placed on its back, both hind feet extend as the animal turns over. If now a frog with one of its legs operated in the manner just described is placed on its back, the operated foot is seen to flex strongly when the unoperated foot extends in the righting reaction. These results show that, in spite of its transposition, the gastrocnemius still contracts when it would have contracted had its location not been changed. This experiment furnishes positive evidence that under certain conditions at least, the transposition of the distal end of the gastrocnemius does not affect its innervation rhythm.

On the basis of these observations we must conclude that Manigk has not demonstrated any change in innervation rhythm of the gastrocnemii as a result of their transposition and that such a transformation is extremely unlikely. There, therefore, seems to be no necessity for a revision of the existing theories of reciprocal innervation.

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[4] Andrew C. Lawson, *Bull. Geol. Soc. Amer.*, Vol. 40, p. 366, 1929.

[5] Andrew C. Lawson, Geol. Surv. of Canada, Mem. 40 (1913), pp. 103–109.

[1] Wolfgang Manigk, *Pflüger's Arch.*, 234: 176–181, 1934.