

*The Antagonistic Action of Calcium upon the Inhibitory Effect of Magnesium.*

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Calcium and magnesium are chemically closely related elements. They are also close companions in the tissues of the animal body. It is the prevailing view that the physiological effects of both elements are similar in character. Many physiologists are at present of the opinion that calcium as well as magnesium exerts an inhibitory influence in the functions of the animal body. Loeb published, in 1899, his observations of the inhibitory action of calcium upon the twitchings of the frog muscles brought on by solutions of sodium chloride.\* It was then assumed by Loeb that all the members of the group of alkali earths possess inhibitory properties, including, at first, even barium. In the numerous subsequent papers by Loeb and his pupils, the discussion turned, however, essentially around the inhibitory effect of calcium.

As to magnesium, we have within the last few years published several studies in support of the hypothesis that magnesium salts favour inhibitory processes. The first fact which gave rise to that hypothesis was demonstrated in 1899 to the American Physiological Society, when an intracerebral injection of a few drops of a solution of magnesium sulphate caused a state of paralysis in a rabbit, while the injection of other solutions brought on convulsions.

In a series of recent studies which we have carried out upon the relations of the effects of calcium to magnesium, many facts came to light which demonstrate unmistakably that calcium is the most available agent to neutralise inhibitory effects of magnesium. We shall not enter here upon details; we wish only to report the following striking and instructive experiment.

\* (*Note by E. H. Starling.*—The inhibitory action of calcium salts on the twitching brought on by sodium chloride solutions was observed by Dr. Ringer, F.R.S., many years before Loeb, and is fully described by him in a paper in the 'Journal of Physiology,' vol. 7, p. 291, 1886. In reference to the subject of the present communication, it is interesting to note that Ringer observed a similar antagonism between barium and calcium (*vide* 'Practitioner,' vol. 31, p. 81, 1897).)

By subcutaneous injections of a magnesium salt (for instance, Epsom salt—about 7 c.c. of a 25-per-cent. solution per kilogramme) rabbits are brought to a profound state of anæsthesia and paralysis. The slow and shallow respirations indicate the approaching danger. Now 6 or 8 c.c. of an M/6 or an M/8 solution of a calcium salt are given through the ear vein. Within a few seconds the respiration becomes quicker and deeper, and within one minute the animal turns over, sits up, and appears normal.

Here calcium not only did not add an inhibitory effect, but completely neutralised the profound inhibitory effect of magnesium. The companionship of calcium and magnesium within the body means, at least in many instances, not a concerted action of similar effects, but rather a resultant effect of antagonistic actions.

We may add that the experiment calls to mind similar relations existing in plant physiology; the retardation of growth on account of the presence of too much magnesium in the soil is promptly corrected by the addition of a calcium salt; the process is termed “liming.” In animals, therefore, as well as in plants, calcium is antagonistic to magnesium.

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