which it hangs, stopping its precession so that this end falls. Then the other end precesses and so on alternately with a motion that simulates walking or going hand over hand down the two rods.

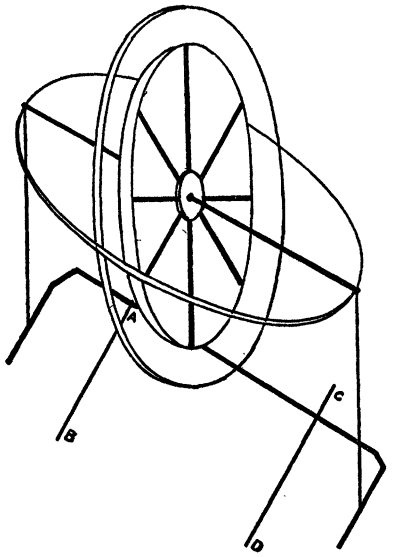

FIG. 2. This top when rotating will walk down an inclined plane. There must be two wires parallel to the board shown by AB and CD.

If the top is provided with feet it will waddle down an inclined plane. It is necessary, however, to have two wires (AB and CD of Fig. 2) at a height of an inch or so above the inclined plane and parallel to it. The wires stop and start the precession.

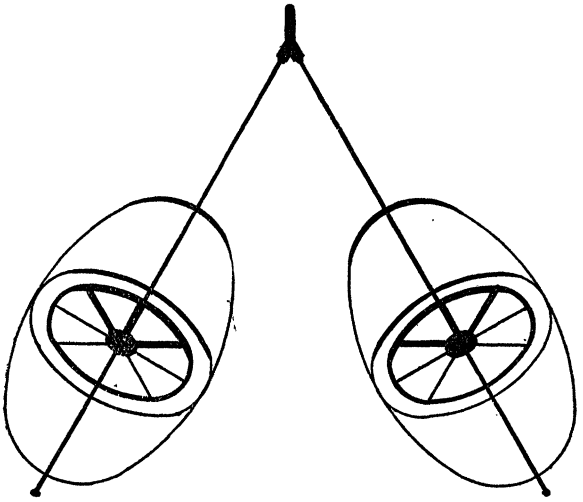

FIG. 3. A double top to show precession.

Two gyroscopic tops hinged to the end of a metal rod form a useful device for illustrating the action of precession. If both tops are spinning in the same sense, they will rise when the rod is spun clockwise (say) and fall when the rod is spun in an anti-clockwise rotation. If, however, the tops are spinning in opposite directions and the rod rotated, one top rises while the other falls.

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THE PRECIPITIN REACTION AS A MEANS OF DETERMINING THE CONGENIALITY OF GRAFTS

RIVES[1] has suggested the possibility of using serodiagnostic methods for predicting the "affinity" between stock and scion in the grape. He reports success with this method for a number of common grape stocks. Green[2] found that by using extracts of seeds differences between families could be demonstrated, but not differences between species of the same genus. With this in mind, a test involving two plums, Beauty and Santa Rosa (*Prunus salicina*), and the almond (*Prunus communis*) was carried out. The former plum makes an unsuccessful union with the almond, while the latter makes a good union. Since the vegetative portion of the plant is the part involved in grafting, we followed Rives in using one-year-old shoots as a source of material, but followed Green's procedure for the most part.

Sap was extracted by pressure of about 6,000 pounds per square inch, a special press made from a concrete tester being used. After filtration the extract was injected, at first in the dilution of 2 to 1, later without dilution. Three pairs of rabbits were used, one for each extract. The schedule called for injection at four-day intervals for a period of six weeks. A total of 80 cc extract (on the basis of undiluted sap) was injected into each rabbit. None of the six showed any infection or other disorder save loss in weight toward the close of the experiment. Each extract was tested with each immune serum at the end of the period and with normal serum at the beginning and the end of the experiment.

It was found that although a distinct reaction was obtained, showing a precipitate in dilution of 1 to 1,600, there was no differentiation between them. This confirms Green's data on the lack of differentiation in closely related species, but does not confirm the conclusion that the method can be used to predict affinity. Green has apparently overlooked the fact that many varieties of the genus Prunus can not be intergrafted, and that the apple and pear (which give an indication of affinity by the precipitin test) rarely make successful unions. It seems to the authors that the uniformity of the reaction in reciprocal tests and in the comparative tests indicates that more

[1] Rives, L., "Sur l'emploi du sero-diagnostic pour la determination de l' 'affinite' au greffage des hybrides de vigne." Prog. Agr. et Vit., 79: 118–119. 1923.

[2] Green, F., "The Precipitin Reaction in Relation to Grafting." *Genetics*, 11 (1): 73–82. 1926.

refinements in procedure must be developed before these slight differences can be demonstrated.

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IN RE "SINGING EARTHWORMS"

SINCE the publication in 1926 of a popular article entitled "When Earthworms sing Together,"[1] quoting Dr. Mangold, of Freiburg, Germany, and which has been previously referred to in these columns,[2] considerable publicity has been given the subject by the American press.

For "lo these many days," it has been the writer's custom to keep captive, in numbers as large as one hundred or more, adult specimens of the large cosmopolitan earthworm, *Lumbricus terrestris* Linn. They are kept in a five-gallon earthenware crock in a cool corner of the cellar for use in a pursuit which in some states of the Union is considered immoral or at least illegal when indulged in on Sunday. In the course of my dealings with these worms I have many times heard the sounds recently referred to as "singing" and, although personally fond of music, have failed to notice anything in the least musical about these faint clicking sounds or stridulations, recently termed "song." The singing of insects, for instance, could be considered as symphonic poems when compared with these insignificant rustlings. Previous to the publication of the recent somewhat sensational statements, little attention was paid to them as it had seemed to me that these sounds were probably produced by the movements of the worms in their burrows, possibly by the escape of air between the viscid lining of the burrow and the mucous surface of the worm's body. It is quite evident, however, that this is not the case, because these stridulations have continued after the worms were transferred from the soil to damp sphagnum moss, which is an ideal medium in preparing the worms for the rites to which I have previously alluded. The determination of the manner in which earthworms produce these mysterious sounds is fraught with difficulty because the species with which I have dealt at least is very sensitive to the presence of light intense enough to permit one clearly to observe its actions and movements, when on the surface of the soil. That this sense of light resides in the extreme anterior end of the body is abundantly evident from the fact that the worms instantly withdraw to their burrows when the light from an electric torch is flashed upon them even when but a half inch or less of the "head" end of the body protrudes from the soil. In point of fact, the worms seem most sensitive to the light when this is the case. When the entire body is exposed it often requires as much as fifteen or twenty seconds for the worm to become alarmed at the light. The production of the stridulating sounds, however, is not by any means confined to those individuals at the surface, but may be heard plainly, at least under captive conditions, when no worms are visible.

The anonymous author of the original article, previously cited, refers to the earthworm as "dumb both in a legitimate and colloquial sense," but the story of the earthworm as recorded long ago by Charles Darwin[3] abundantly indicates that these lowly creatures are indeed far from stupid, but apparently possess a seemingly disproportionate degree of intelligence.

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[1] *Literary Digest*, October 9, 1926.

[2] Ruedemann, Rudolph, SCIENCE, February 11, 1927, p. 163.

[3] "Formation of Vegetable Mould through the Action of Earthworms," London, 1881; D. Appleton and Co., New York, 1882.

SCIENTIFIC BOOKS

Vorlesungen über die Entwicklung der Mathematik im 19. Jahrhundert, Teil 1. By FELIX KLEIN. Verlag von Julius Springer, Berlin, 1926, pp. XIII + 385.

NEVER before was the mathematical literature enriched by a general historical work written by such an eminent mathematician, and those who are especially interested in the history of science will be glad to find that the extremely difficult task of writing a history of the mathematical developments during the nineteenth century has been so well begun. Even during the eighteenth century the leading mathematicians were familiar with the main known facts of all the sciences, and they seldom aimed in their writings to introduce the reader into new fields of mathematical research. On the contrary, this became more and more a characteristic feature of the mathematical writings during the nineteenth century and gave rise to extensive cooperation and to an enormous technical literature, leading to the establishment of numerous special mathematical periodicals and being, in turn, fostered by these periodicals.

Felix Klein, who died in 1925, was not only one of the leading mathematical investigators during the last half century but also one of the most influential mathematical organizers. He worked with extraordinary success in various fields of mathematics, including mathematical physics as well as the teaching and history of our subject. A number of leading Amer-