source of infection to insect vectors. The disease is not tranmitted through the seed.

In the insectary at Ames yellow dwarf has been transmitted to a large number of onion plants by three species of aphids[2]—the bean aphid (*Aphis rumicis* Linn.), the corn leaf aphid (*Aphis maidis* Fitch) and the apple grain aphid (*Rhopalosphium prunifoliae* Fitch), and by the six-spotted leaf-hopper (*Cicadula sexnotata* Fall.). Observations indicate that the bean aphid and the corn leaf aphid are responsible for a large percentage of the transmission of the disease. These two plant lice are quite common in the fields at Pleasant Valley and feed very readily on the leaves of the onion. Moreover, cage experiments with these two forms gave the highest percentage of transmission. The apple grain aphid does not feed as readily on the onion and only a few cases of transmission were secured with it, as was also the case with the six-spotted leaf-hopper. Although the latter is very common in the fields and readily feeds upon the onion plant further experimentation is needed to substantiate its rôle as an important vector of yellow dwarf.

For the experiments the different species of aphids were reared in separate rooms on some of their preferred hosts. From eight to twelve individuals of a species, after having been confined on a diseased plant for twenty-four hours, were transferred to disease-free plants in individual cages. When so confined on an onion, practically all the aphids died within a period of three to six days. In more than 200 definite transmissions the symptoms of yellow dwarf appeared on an average of seven to twelve days after the initial exposure to feeding by viruliferous lice. Plants thus infected were then successfully used as sources of inoculum to infect other plants. As controls, plants not exposed to the feeding of lice and plants supporting lice which had not been exposed to a source of inoculum were used. The symptoms of the disease have not yet appeared in any of these control plants, whereas in those exposed to aphids which had previously fed on diseased plants a high percentage of infection has resulted. In fact, in more than 100 tests during the month of February, 1932, 91 per cent. of the caged plants showed typical disease symptoms within 12 days.

The viruliferous aphids were confined on seedlings, sets and mother bulbs in various types of cages. In a number of tests the vectors were limited to small portions of an individual leaf, whereas in others they were permitted to run at large over a caged plant and to feed upon any part of this plant. Regardless of the portion of the plant upon which the aphids had been confined the first visible evidence of the disease always made its appearance in the new shoots. Frequently, in the larger onions no indications of the disease were ever apparent in older leaves upon which the insects had been confined, whereas the new shoots of these plants disclosed typical symptoms of yellow dwarf.

[2] Aphidae determined by Dr. F. C. Hottes.

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THE PRE-OLIGOCENE STRATIGRAPHY OF PORTO RICO

LATE in 1930 Mr. James Thorp, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, discovered fossils in moderate numbers in the older rocks of Porto Rico. The several localities found are situated in the central part of the island at points where fossils had not previously been reported. The discovery was followed by an energetic search, in which Dr. N. L. Britton, chairman of the Scientific Survey of Porto Rico and the Virgin Islands, Mr. W. D. Noble, of San Juan, and Mr. Thorp were the chief participants. In March and April, 1931, at the invitation of Dr. Britton, the author examined the fossiliferous localities, supplementing the collections already made. Pending detailed studies of the material, a preliminary statement of its stratigraphic significance is herewith offered.

The collections contain approximately twenty species in a sufficiently good state of preservation for specific description, and there are a dozen additional forms which give some promise of ultimate identification. The majority of the species either are new or are closely related to, and perhaps identical with, species known in the older rocks of other Antillean islands. The assemblage is dominantly molluscan, but it also contains one or two species of algae, at least three of corals, one echinoid and one or two belonging to the arthropods.

The rarest specimen is that of an ammonite, the third thus far discovered in Porto Rico.[1] With the two ammonites previously found, it has been referred to Dr. John B. Reeside, Jr., of the U. S. Geological Survey, who has kindly submitted the following opinion:

> The small specimen with strong sculpture (Fig. 6, right)[1] seems to me a *Barroisiceras* very close to *B. haberfellneri* (von Hauer) in the strict sense (*cf.* Grossouvre, Les ammonites de la Craie superieure, pl. 1, fig. 1a, 1b). The large fragment [among the recent discoveries] seems to be a *Parapuzosia* close to *P. corbarica* (Grossouvre). I do not know any forms like these in the Lower Cretaceous [but] think them to indicate middle Upper Cretaceous age—Coniacian of the European nomenclature.

[1] H. A. Meyerhoff and I. F. Smith, "The Geology of the Fajardo District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. II, pp. 224–225 and Fig. 6, 1931.

Among the other molluscan types the rudistids are at once most numerous and most significant. They are present in the majority of the newly discovered faunules, usually dominating them. The specimens do not appear referable to any described species but have much in common with the genus *Barrettia,* which characterizes the Upper Cretaceous of Jamaica. Several of the other molluscs are also related closely to Jamaican, Saint Thomas and Saint Croix forms of Upper Cretaceous age.

Fossils are not abundant in the older rocks of the Antillean islands, and this collection is larger and more varied than any other thus far reported. Its discovery promises ultimately to settle the differences of opinion that exist regarding the age of the pre-Oligocene rocks of Porto Rico,[2] and the facts already established warrant the following conclusions:

(1) The claim of E. T. Hodge[3] that the stratified rocks situated in the center of the island near Aibonito are Comanchean must be set aside. The specimen identified by Dr. Reeside as *Barroisiceras aff. habnerfellneri* was found in rocks which Hodge assigned to the Comanchean, and a reexamination of the unconformity which he postulated between the "Barranquitas-Cayey" shales of assumed Lower Cretaceous age and the Upper Cretaceous "Sierra de Cayey" conglomerates has shown the two formations to be clearly intergradational.

(2) Upper Cretaceous rudistids occur profusely in the "Rio Jueyes series," which, on the basis of a single specimen referred to the Eocene species *Venericardia alticosta,*[4] Hodge considered to be early Tertiary and Maury dated as Middle Eocene. Mr. Thorp and the writer visited the reported *Venericardia* locality and obtained a collection of rudistids from it.

(3) G. J. Mitchell[5] resolved Hodge's "Coamo Spring limestone," another postulated Eocene horizon, into two calcareous members, the Guayabal and Coamo tuff limestones, both of which he found to contain Upper Cretaceous rudistids.

(4) Mitchell[6] has demonstrated that Hodge's "Rio Descalabrados series," also assigned to the Eocene, is composed essentially of strata belonging to the "Rio Jueyes series" and Coamo Spring limestone," repeated in consequence of folding. Its limestone members contain Upper Cretaceous rudistids.

(5) The possible equivalence of the Corozal limestone and the Upper Cretaceous La Muda limestone has already been pointed out.[7] No additional support can be given that suggestion at present, but a study of the fauna of the Corozal limestone has demonstrated its Upper Cretaceous affinities.

Thus, nearly all the evidence adduced in arguing the presence of Lower Cretaceous and Eocene strata among the older rocks of Porto Rico has been contradicted by the discoveries of the past six years; and Matley and Earle's opinion that pre-Mesozoic materials are present in Porto Rico and the Virgin Islands is without foundation, other than the physical appearance of some of the rocks. The paleontological and stratigraphic data now at hand, although incomplete, indicate that all the ancient sediments and associated volcanic and intrusive igneous rocks are Upper Cretaceous, not only in Porto Rico, but also in the Virgin Islands.

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THE DEPENDENCE OF PHYSICS ON THE MATHEMATICAL PREPARATION

AT the beginning of last school year a number of questions in mathematics were prepared by the author to be given to the students of elementary physics at various institutions. The object of giving the test was to find out what correlation, if any, there is between the mathematical preparation of the student and his successes in the course of physics that he is about to take.

Some work of this kind was done at the University of Florida in 1929. The students of elementary physics were given an examination in the essentials of arithmetic and algebra, and the grades made in mathematics were later compared with those made in physics. As the correlations proved to be very high, it seemed worth while to ascertain this correlation on a larger scale by inviting the cooperation of a number of institutions in administering the necessary tests.

The institutions who cooperated in this enterprise were Cornell University, University of Virginia, Oberlin College, Virginia Polytechnic Institution, University of Richmond, University of West Virginia

[2] *Cf.* C. A. Matley and F. Higham, "The Basal Complex of Jamaica, with Special Reference to the Kingston District." *Quart. Jour. Geol. Soc.,* Vol. lxxxv, pp. 472 and *ff.;* also pp. 490–491, 1929; C. J. Maury, "Porto Rican and Dominican Stratigraphy," SCIENCE, n.s., 70: 1825, 609, 1929; H. A. Meyerhoff, "The Pre-Oligocene Stratigraphy of Porto Rico," SCIENCE, n.s., 71: 1838, pp. 322–323, 1930; C. J. Maury, "Correlation of Antillean Fossil Floras," SCIENCE, n.s., 72: 1862, pp. 253–254, 1930; H. A. Meyerhoff and I. F. Smith, *op. cit.,* pp. 219–229, 1931.

[3] E. T. Hodge, "The Geology of the Coamo-Guayama District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. I, pp. 138, 192–193, 1920.

[4] This specimen can not be found, and it is therefore impossible to verify the identification.

[5] G. J. Mitchell, "The Geology of the Ponce District, Porto Rico," N. Y. Acad. Sci., "Scientific Survey of Porto Rico and the Virgin Islands," Vol. I, 255–257, 1922.

[6] *Ibid.,* pp. 255–257; plate VI, section H-H′; geologic map. *Cf.* Hodge, *op. cit.,* pp. 161–164 and geologic map.

[7] H. A. Meyerhoff and I. F. Smith, *op. cit.,* pp. 221–225 and 263, 1931.