the evening at six-thirty. Professor Erwin Raisz, of the Institute of Geographical Exploration at Harvard University, will be a guest speaker. The special committee on the status of geography in the schools of New York State will present its report.

THE Division of Biology of the University of Georgia announces a meeting on May 7 and 8 of the biologists of the southeastern states at Athens, Georgia. Papers on original research and accounts of biological work in southeastern institutions will be presented. The principal address will be given by Dr. L. O. Kunkel, member of the Rockefeller Institute for Medical Research, who will speak on some of the recent developments in virus research.

THE Missouri Public Health Association will hold its thirteenth annual meeting on April 29 and 30 at the Kentwood Arms Hotel, Springfield. A program of particular importance to the public health interests of Missouri will be presented. Papers on tuberculosis, cancer, venereal diseases, maternal welfare, crippled children's service, oral hygiene and malaria are among those that will be given. The final paper which will be given pertains to the future of public health in Missouri under the Social Security Program.

DISCUSSION

RUBBER PRODUCTION FROM CASTILLA AND HEVEA

CAUCHUC, guttapercha, balata, chicle and guayule belong to a series of organic materials sharing such properties as plasticity, resilience and tensile elasticity, dissolving in ether, chloroform, benzol and other liquid hydrocarbons, combining readily with sulfur and the halogen elements, but otherwise inert. No general function in the plant economy has been demonstrated, but the various forms of rubber may be viewed as excretory products and associated with resins, tannins and lignins. As with sugar from cane and beet, rubber of the same nature is obtainable from the Castilla or Central American rubber tree, and from the Hevea or Para rubber tree of Brazil, cultivated in the East Indies, although the trees belong to unrelated families and different methods of extraction are required.

Many kinds of rubber-bearing trees, vines and shrubs have been exploited in the wild state, but only three systems of cultural production have been worked out, one with manual tapping of the Hevea tree, the others with mechanical extraction of guayule and gutta-percha. The mechanical processes are definitely unsuited to the thin Hevea bark, but may be adapted to the thicker latex layer of the Castilla tree. Both trees have been introduced in southern Florida and have reached the stage of flowering and seeding, so that local tests of cultural behavior and methods of extraction may be made.

The special value of Hevea as a plantation tree lies in its system of microscopic latex tubes branching and anastomosing as a continuous network through the inner bark, seeping the creamy fluid to a single cut, replenishing the wound area and restoring the bark pressure. Tapping is repeated by paring the rim of the cut, with the latex supply becoming more liquid and the flow increasing in successive days, the so-called "wound response." The method of wound renewal was discovered by Ridley at Singapore in 1889 and led to commercial planting in 1896, twenty years after Wickham took the seeds from Brazil.

Castilla has simple latex tubes, not branched or connected, so that the Ridley tapping method does not apply, but the latex of Castilla is more abundant and was much easier to collect by the native methods, though the trees were soon exterminated. Castilla was tapped with many cuts, in Mexico by climbing the trees and gashing the bark obliquely, in South America by felling and circling the trunks. Several pounds of rubber were obtained, 30 to 50 pounds from large trees being credibly reported, though only a small part of the latex is forced out by the bark pressure.

An oxidizing enzyme in the sap of Castilla blackens and softens the rubber to a sticky paste, but simple heat treatments avoid such damage. Even in logs lying in the sun the enzyme may be destroyed, and the latex then coagulates in pale elastic threads that separate readily from decaying bark, as in retting for mechanical extraction. Small drops of pure latex sometimes exude when "scrap rubber" is pulled from tapping cuts and coagulate without discoloring. Castilla latex corked in glass bottles shows no visible changes, and was the "liquid rubber" brought from Central America for the early experiments in England by Hancock and Faraday, in 1822 and 1826. Records of Castilla go back to Bernardino de Sahagun, who reached Mexico in 1529 and wrote of "ulli" as a black elastic resin with many medicinal uses, and made into bouncing balls.

Many reference works convey the impression of Castilla being confined to Central America and Mexico, whereas even greater areas were occupied in South America, from Panama through Colombia, Ecuador, Peru, Bolivia and Brazil, including practically the entire range of *Hevea brasiliensis* in the Amazon valley, to Matto Grosso and Para. When Richard Spruce reached Brazil in 1849 commercial tapping of Hevea was "limited to the immediate environs" of Para, but

a few years of rising prices turned thousands of people to gathering rubber "nearly throughout the Amazon and its principal tributaries." Spruce learned of an earlier period when the rubber trees had been cut down, and supposed that a discovery had been made, of obtaining more rubber "by successive tappings of the same tree," but a recent transition from Castilla is indicated, and some of the up-river tribes still did not know of rubber being obtained from Hevea. Exports of Castilla rubber from eastern Peru, previously carried over the Andes, began to move down the Amazon in 1853, as Schurz has recognized, and "caucho" still comes in commercial quantities from many outlying districts in Brazil.

The discovery of Hevea often is dated from 1736 when the French astronomer La Condamine landed at Manta and traveled to Quito through the Pacific coast province of Esmeraldas where the elastic resin called "caoutchouc" was obtained, but from the methods of collecting the latex and forming long rolls of rubber to burn as candles or torches, the trees could not have been Hevea. West of the Andes no Hevea has been found, but Castilla still grows in Esmeraldas and in the upper Amazon valley, where rubber-gathering apparently was in progress in 1743, when La Condamine went down from Quito. The early Castilla industry carried the Peruvian name *caucho* eastward across Brazil, and later the Portuguese name for Hevea rubber, *borracha,* spread westward from Para. Even in Brazil it appears that Castilla was the principal source of rubber to the middle of the last century, only a few decades before Hevea was carried to the East Indies.

Pioneer plantings of Castilla in southern Mexico were dated as far back as 1867 by Olsson-Seffer, and still older planted trees were found around Pichucalco by Collins and Doyle. Larger Castilla projects were stimulated by developments with Hevea in the East Indies, before the radical differences in the latex systems of the two trees were appreciated. By 1908 more than a hundred thousand acres of Castilla had been planted in Mexico and Central America, which soon became a total loss, estimated at thirty to fifty million dollars. Interest in Castilla lapsed completely, leaving many plantations to grow up as forests, though some of these may yet serve in working out mechanical methods of separating the rubber from the bark and making the wood into paper or other by-products. Lumbering the logs to the mill may be the only labor required in Castilla forests, volunteer replacement being indicated by abundant undergrowth of seedling trees.

Planting of rubber reserves has been urged for economic and military reasons, and large denuded areas in southern Florida need to be reforested to reduce the fire and frost hazards. Castilla is an ornamental tree, better adapted than Hevea for growing in open places, shading out grass and mulching the soil surface. Even as a nurse-crop for Hevea, the planting of Castilla might prove worth while. Cuttings and seedlings grow rapidly, and hurricane hazards would be less than with Hevea, since the rubber of broken or uprooted trees could still be extracted.

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U. S. DEPARTMENT OF AGRICULTURE

ROOF FALLS IN MINES

AN investigation into the number of accidents resulting from roof falls in Pennsylvanian coal mines showed an annual distribution with maxima in the early spring and in the summer. The first maximum coincides with a high ground-water table in the overlying strata. The summer maximum occurs during those months in which the moisture contained in the ventilating air condenses in the mine because of lower temperature underground. The roof rocks expand under the influence of moisture, and it is suggested that this expansion gives rise to an increased number of roof falls, with the consequence of higher accident rates. The moisture expansion of rocks corresponds closely to the dangerousness of various types of roof rocks. Preliminary measurements gave the following linear expansions for rocks when wetted to saturation with water:

Brittle shale	3×10^{0} per cent.
Solid shale	5×10^{-2} " "
Sandy shale	1.2×10^{-2} " "
Sandstone	9.7×10^{-3} " "
Limestone	$< 1 \times 10^{-4}$ " "

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THE OLDEST AMERICAN FOSSIL ECHINOID

PROFESSOR HERMAN L. FAIRCHILD, of Rochester, N. Y., has brought to my attention a notice in the *Cornell Alumni News* (Vol. 37, No. 28, p. 2, May, 1935) concerning two specimens of *Lepidechinoides ithacensis,* purported to be the oldest fossil echinoids ever found in America. These were found in Devonian rocks in the vicinity of Ithaca, N. Y. An older specimen, *Koninckocidaris silurica* Jackson, dates from the Silurian. This fossil was found in 1908 by Professor A. W. Giles, who was at that time studying under Professor Fairchild. It was collected from the Rochester shale about 10 feet above the Irondequoit Limestone, in the Genesee ravine at Rochester, N. Y. The specimen shows an internal view of the dorsal portion