in the air at 1,200 or 1,500 feet altitude. He proposes the study of the map so as to find the habitual paths of storms, then to place advance guard posts which protect a certain region by firing the bombs and prevent the rain from changing to hail. The question of protection against storms is a scientific problem and the official observatories could greatly aid in the solution, which is so important in the agricultural districts.

INVENTIONS OF ANCIENT ROME: SOME FORERUNNERS OF MODERN INGENUITY.

BY ALEX. DEL MAR, M.E.

The mechanical and other inventions of the Romans, whether original with themselves or borrowed from the nations they conquered, were so numerous that, in order to describe them, first with the object to note how largely we are indebted to antiquity for the devices now in common use, and second, to derive from these inventions such practical advantages as they may suggest—for some of them yet await adoption—it is necessary to divide and classify them. In this arrangement, the inventions pertaining to agriculture naturally take precedence over all others.

Pliny's boast that "the Roman people has never shown itself slow to adopt all useful arts," is not without a substantial basis of truth. The notion which has been advanced in modern times, that the Romans were steeped in bloodshed, tyranny, and voluptuousness, is altogether erroneous. They were a warlike and pleasure-loving people; but they were also hard-working, industrious, and inventive. The number and prominence of their agricultural publications alone afford ample evidences of their industry. After twenty centuries of social cataclysms, we still possess the treatises of Cato, Varro, Columella, and Pliny, to say nothing of the bucolic almanacs of Ovid, Virgil, Manilius, and others.

One of the most important inventions or adaptations of the Romans was the two-course system, begun with cultivating the land and letting it lie fallow in alternate years, and ended with sowing it alternately with cereal and root crops. The specialization of guano was carried so far as to value the manure of thrushes, pigeons, and domestic fowls and other animals, in the order named. The sowing machine or seed drill is doubtfully credited by Beckmann to Theophrastus; at all events, it is plainly described by Pliny, who also mentions the Rhaetian (Swiss) wheel plow. His measure of a fair day's work for a yoke of oxen for the first plowing, nine inches deep, is an acre, and for the second plowing, an acre and a half; with the wheel plow, about two acres. The machine reaper was another Roman invention. With the scythe, an acre of grass was a fair day's work; with the scythe-chariot, or reaping-machine, four times as much. The grain harvester was a Frankish invention. "In the vast domains of Gaul, a large hollow frame, armed with teeth and supported on two wheels, is driven through the standing corn, the beasts being yoked behind it; the result being that the ears are cut off and fall within the frame." The wine press, which anciently was worked by levers, was much improved by the Greeks during the Augustan period, by adopting the screw. About A. D. 50 this press was still further improved by the Romans, who used thicker plank, reduced the size of the press boards and the height of the screw, and gave the latter more threads.

The city of Rome was supplied with no less than fourteen aqueducts, not necessarily for drinking purposes, because it always had the river, which afforded a copious flood of fresh water, but for the sake of convenience, and especially to supply the baths and drive the water mills, most of which were located under Mount Janiculum. It was these water mills which made Rome a great manufacturing city. They were employed in innumerable arts, and gave rise to endless mechanical inventions and improvements. When, in the sixth century, the Goths laid siege to Rome and cut off the aqueduct water, Belisarius established a series of floating boat-mills on the Tiber, which, being driven by the current, enabled the accustomed industries to be resumed. Grist mills driven by streams, or the wind, were common in the rural districts; the more ancient ones pounding the corn in gigantic mortars, the improved ones grinding it between revolving stones. Not only was flour produced in these mills, but also various cereal preparations, like our breakfast foods of the present day. Among these was one that yet remains to be reinvented. This was alica, a preparation of spelt, which the Roman writers allude to as a great delicacy.

It is not many years since the yeast cake was introduced into America as a novelty; yet it is an invention at least two thousand years old. Here are the words of the Roman encyclopedist on the subject: "Millet is more especially employed to make yeast. If kneaded with must (grape-juice) it will keep a whole year. The same is done, too, with fine wheat bran of the best quality. It is kneaded with white must, three days old, and then dried in the sun, after which it is made into small cakes."

The cultivation of alfalfa, which has made the fortunes of some of our far western farmers, is another "antiquity." It was brought from Media into Persia in the time of Darius, and afterward into Greece and Italy. Medica was its Persian, lucerne its Italian, and alfalfa its Arabian name. Amphilocus, an agricultural writer of Athens, devoted almost an entire work to the culture of this valuable grass; and the Roman writers were scarcely less enthusiastic on the subject.

The silo, for preserving grain in the earth, is evidently an Oriental invention, which, before the Augustan age, made its way westward through Bactria, Pontus, and Thrace to Egypt, Greece, Italy, and Spain. The Pontic name was *siri*. Varro says that wheat, properly stored in dry soil, will keep for fifty years; and millet, a hundred. He mentions an actual instance of beans, which were preserved for a period of more than 220 years.

The same ingenuity that could preserve grain from rotting, protected wood from burning; and this also was a Pontine and perhaps an Oriental invention. Aulus Gellius relates that at a period about a century before the Christian era, Archelaus, one of the generals of Mithridates, painted a wooden tower with a preparation of alum, and thus rendered abortive Sylla's attempt to fire it. Another method of protecting wood from fire is mentioned by the Greek tactician, Æneas, about 360 B. C. The Greeks also invented our roof gardens, and have left us very explicit directions how to construct them. The idea was doubtless taken from the hanging gardens of Babylon, while these again probably came from the Orient. But few things are entirely new. Roof gardens are as much an evolution as steam engines. They both saw the light in halcyon ages; were neglected or forgotten in times of retrogression; and were resurrected, with improvements, in more propitious days.

If now we turn from mechanical inventions to the agricultural products of the Roman period, especially those which are believed to be of modern introduction, we will find among the number esparto, silk, cotton, glucose, champagne, lard, and possibly tobacco. There will probably be no question about the first half dozen of these commodities; the disputable subject is tobacco.

Esparto, which is still largely used in Southern Europe for making sandals, mats, baskets, ropes, nets, sacks, etc., and which for similar purposes might be profitably cultivated in the United States, was known to the Romans as spartum. It was brought from Asia by the Carthaginians, and introduced by them into Spain during the fourth century B. C. At about the same time it was also cultivated in Greece, and employed in making the rigging of their light sailing craft. From these countries it spread to all the intervening ones. The story that the silkworm and the manufacture of silk were introduced into Europe by two monks, in the reign of Justinian, is unworthy of credit. Silkworms were cultivated in the Greek island of Cos nearly a thousand years before Justinian; and a tissue was made from their silk, which was then, as now, known as bombazine. The fact is mentioned by Aristotle and corroborated by Pliny, who remarked that the clinging garments made of it, disclosed almost as much as they concealed. The gossypium, or cotton plant, and manufacture, are fully described by the same author, who, after alluding to the culture of the plant in Egypt, says: "There is no tissue known that is superior to this thread, either for whiteness, softness, or dressing; the most valuable vestments worn by the Egyptian priests being made from it." To confirm his account, abundance of cotton tissues have been found in Egyptian tombs of the Alexandrian age. Glucose, known to the Greeks by nearly the same name, *ai gleucos*, or Always Sweet, and to the Narbonenses as *dulce*, or sweet, was gathered from raisins. "In order to make it," says Pliny, "they keep the grape hanging on the vine for a considerable time, taking care to twist the stalk." In many parts of Europe it is still made in the same way.

When we speak of champagne, it is neither cider, mead, nor perry that is meant, all of which were manufactured by the Romans, and are fully described in the works left to us; but of a wine made from grapes, and rendered sparkling and effervescent by artificial means. "As to wines which have been treated with marble, gypsum, or lime, where is the man, however robust he may be, who has not stood in dread of them?" inquires a Roman moralist. What is this but champagne? Strange as it may seem, this too appears to have been an Oriental invention; for previous to the Roman imperial era, both the Greeks and Egyptians had it. In Africa, says Pliny, it was prepared with gypsum or lime, and in Greece with powdered marble, precisely as is done in many countries at the present day.

Hog lard is invariably referred to by the Greek and Roman writers as *axungia*, or axle grease, that probably being its principal use in countries blessed with an abundance of pure olive oil. It was also largely used for ointments, unguents, and pomades.

It will not be disputed that the culture of tobacco was brought into Europe from America in the sixteenth century; what is contended is that the smoking of pipes is of great antiquity, and was practised in India, China, and Egypt, long before the discovery of America. Pliny mentions the smoking of colt's-foot, "inhaled through a reed," as a cure for a chronic cough. Apollodorus, a writer of the Ptolemaic age, says that: "The barbarians, by inhaling the fumes of the cypiros plant, diminish the size of the spleen. They never go out of the house," he adds, "till they have inhaled these fumes, through the agency of which they acquire strength and vigor." Pliny calls cypiros an Indian weed; says it resembles the ginger plant; that some people chew it; and that it tastes like saffron. All of which certainly suggests tobacco. If the Indian traders of Ptolemy could introduce it no farther west than Egypt, and Oviedo first introduced it from America into Spain, it took nearly two thousand years to carry it from one to the other of these distant frontiers of the empire. It would be a curious subject to inquire what pantascopic changes its soothing influences might have brought about, had the Romans encouraged its use during the interval!

SCIENCE NOTES.

Action of Liquid Air on the Activity of Seeds.—In a memoir read before the Académie des Sciences, M. Paul Becquerel publishes the results of his investigations on the action of cold on seeds, making use of liquid air. The interesting conclusion is reached that the resistance of seeds at low temperatures depends on the quantity of water and gas contained. If the quantity is sufficient, the cold disorganizes the protoplasm and nucleus and renders all return of life impossible. But if the protoplasm has already reached by desiccation its maximum of concentration, or maximum of activity, it escapes the influence of low temperatures, and the seed preserves its germinating power.

Within comparatively recent years, that is, since aniline dyes have almost completely supplanted the mineral and vegetable dyes formerly used in coloring cotton textiles, an extensive demand for castor oil has sprung up in the industry of dyeing and printing cotton goods. Without presuming to invade the intricacies of the dyer's art wherein secret recipes for the composition of colors and their application to cloth are the property of each individual dyer, it may be said that the general principle underlying the utility of this oil in coloring processes is that the aniline and alizarine dyes are soluble in sulphurated castor oil; in other neutral fats and oils these dyes, with few exceptions, are in general insoluble. In certain processes of dyeing and printing, therefore, castor oil enjoys a practical monopoly over all other oils.

The sphere of hygiene may be divided, as it often is, into the two hemispheres, public hygiene and personal hygiene, or it may be cut into one portion dealing chiefly with the human mechanism and its operation (personal hygiene), and another portion dealing chiefly with the environment of that mechanism (sanitation). The time has gone by when any one person can safely undertake to deal with the whole sphere of hygiene. The physiologist and the physician must in the future leave to the architect and the sanitary engineer such subjects as housing, heating and ventilation, water supply and sewerage, precisely as the sanitary engineer has never presumed to deal with foods and feeding, vaccines and antitoxins, exercise, sleep and rest. The former subjects deal chiefly with the control of the environment, the latter subjects chiefly with the control of the individual, and sanitation and hygiene must henceforward be regarded as separate hemispheres of the science of health.

A new apparatus, the "aquameter," has been devised for assisting in the compilation of weather forecasts. In such work it is pointed out that a very important factor is not taken sufficiently into consideration. This is the exactitude of the percentage of aqueous vapor in the approaching winds. The barometer gives some such indication, but the height of the barometer depends on wind pressure and temperature as well as on moisture. The wet and dry-bulb thermometers constitute an antiquated instrument and are not sufficiently reliable, as their variation depends on erratic circumstances and their indications are not represented in actual percentages of aqueous vapor. Rain results when an atmosphere nearly saturated with aqueous vapor becomes lowered in temperature. The nearness or otherwise of a wind to its saturation point, is, therefore, a most important question. It has had to be determined hitherto by recourse to elaborate apparatus, including a chemical balance, and, therefore, out of the usual province of a meteorologist. By using the aquameter, however, which is a simple instrument, the exact percentage of aqueous vapor can be obtained. By the opening and shutting of two taps and the raising and lowering of a mercury reservoir, a measured quantity of air is drawn into a glass vessel, and placed in contact with anhydrous phosphoric acid which is a rapid water absorbent. The rise of mercury in the narrow glass stem of the vessel then gives the exact percentage of the aqueous vapor in the air.