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LOUIS PASTEUR AND HIS WORK

By Dr. Victor C. Vaughan,

(Dr. Victor C. Vaughan, author of this sketch, is especially fitted to describe the work of Pasteur. For over thirty years Dr. Vaughan was dean of the University of Michigan Medical School and he has been president of the American Medical Association. He is one of the foremost authorities in bacteriology, the science founded by Pasteur. Dr. Vaughan is author of the standard work on epidemiology and many other contributions to medical literature.)

On December 27, 1822, there was born in the village of Dole in the Jura, a child destined to play an important role in the progress of scientific medicine. If greatness be measured by the extent of the good done to one's fellowmen, the name of Louis Pasteur deserves to stand high not only among his contemporaries but among those of all ages.

His origin was from an humble class. This is not in contradiction but in conformity with the law of heredity. The history of the Pasteur family has been traced back to the middle of the 17th century. The great-great grandfather was a serf and neither he nor his wife could write their names as is shown by the record of their marriage. The great grandfather of Louis Pasteur was born a serf but purchased his freedom and both he and his wife signed their names to the marriage certificate. Of his grandfather there is but little known; he died in early manhood. His father served in the Napoleonic wars in the famous Third Regiment, renowned for the bravery and intelligence of its individual members. Jean Joseph Pasteur, Louis' father, at the time of the demobilization of the grand army, had won the rank of sergeant-major and wore the cross of the Legion of Honor. This short sketch of the history of the family along the male line shows consistent progress and is an illustrationtthat good blood often flows in the veins of the lowly. Of Pasteur's ancestry along the female line we know but little in detail but what little we do know indicates that the Pasteurs had shown good sens in the selection of their wives.

Between Louis Pasteur and his father there was a bond of intelligent love which held them closely together throughout life; this is in evidence in the fact that the father, as long as he lived, understood and appreciated the researches of his son. There is nothing wonderful to tell about the youth and pupilage of Louis Pasteur. It seems that at an early age his father determined that he should have a good education and both father and son looked forward to the normal school at Paris as the place where this training could be best acquired. It was a question whether the preliminary schooling necessary for admission to the normal school should be taken taken in some provincial institute or in Paris. At the age of 16 Louis was sent to

Paris and arrangement made whereby he was to fit himself for admission by study in a preparatory school located in that city. However, as has happened to many others, the 16 year-old boy found himself the victim of a severe attack of nostalgia in the great city and so longed for his old home and his father's tannery that he gave up his stay in Paris and finished his preparatory work in a provincial institution.

At the age of 20 he passed the examination for admission to the Normale but with no great brilliancy, the paper being marked mediocre. In the laboratories of the normal school he came under the instruction of some of the greatest French scientists of the time. This was especially true in chemistry, at that time under the direction of Dumas. He continued for a few years after graduation as a laboratory assistant in the normal school and it was during this time that he demonstrated his intelligence and skill in the solution of a perplexing problem in physics.

Later he taught for one year at Dijon where he had no facilities for experimental research. Then he was transferred to Strassburg where it appears that within a few weeks after his arrival he fell in love with, proposed to and was accepted by a daughter of M. Laurent, rector of the university. The letter to his future father-in-law on this occasion is an example of the unswerving honesty which characterized both the personal and scientific activities of Louis Pasteur. In this letter he spoke plainly of his humble origin, stated that he had only health and courage in bank, that he intended to devote his life to scientific work and had no prospects of being able to secure luxuries for his family.

At Strassburg, Pasteur continued his research on right and left handed tartaric acid. In pursuing these studies he made, at his own expense, visits to practically all the laboratories in continental Europe in which tartaric acid was obtained in quantity. The brilliant solution of the right-handed and left-handed tartaric acid puzzle which had so long perplexed great chemists and physicists like Biot, Mitscherlich and others brought the young chemist to the knowledge of his contemporaries in that line of work. But since this problem has only indirect connection with the great work of Pasteur's life, we will not go into detail concerning it.

In 1854, Pasteur, then only 32 years of age, was made dean of the new Faculty of Science at Lille. He remained in that position for only a short time but his stay in this place, the capitol of the richest center of industrial activity in northern France greatly broadened the horizon of the young chemist and opened up a new field of endeavor which he was soon to enter and in which he was to make discoveries beneficial to mankind and essential to the improvement of the welfare of the race. During his stay at Lille, Pasteur became interested in fermentation as manifest in the manufacture of wine, vinegar and beer. In one of his Lille speeches he said, "In the fields of observation, chance only favors the mind which is prepared". He demonstrated the truth of his statement in his own work. Leaving Lille, Pasteur returned to the normal school in Paris from which he had graduated, but this time as a member of the faculty. Here most of his great work was done. Before taking up Pasteur's most important researches it might be well to call attention briefly to the theories that had prevailed up to that time concerning fermentation, spontaneous generation and the causes of infectious disease.

Primitive man had observed and had utilized fermentation in the preparation of wine, vinegar, bread and cheese probably before the species developed into home sapiens. From time to time some unusually intelligent individual had theorized as he watched the bubbles rise in the fermenting grape juice as it was being converted into wine or as he saw the distension of the dough in the leavening of bread and had asked himself what the cause of these phenomena might be. Some went so far as to believe that fermentation might have something to do with the causation of disease. This view was held by that peripatetic, much abused philosopher, of the early 16th century who called himself Theophrastus Bombastus Paracelsus and came to the conclusion that even life was nothing more than a result of chemical activity. One hundred years later Jean Astruc reasoned that if infectious diseases are due to fermentation there must be a specific ferment for each disease and concluding that this reduced the proposition to an absurdity he cast it aside. The great authority on fermentation at the time when Pasteur began his work on this subject was the professor of chemistry at the University of Munich, Justus Liebig, who stood as the autocrat of chemical and physical science. Liebig believed that fermentation was entirely due to a process of oxidation, that it was a chemical procedure and depending in no way upon life. He recognized the fact that the inoculation of a fermentable substance with even a tiny bit of fermenting substance caused fermentation to proceed in the whole and that by transplanting from time to time, the process might be extended indefinitely. But he did not believe that fermentation was due to living organisms. Indeed, the demonstration of micro-organisms and the discovery that yeast is a living, growing, multiplying cell was not made until the thirties of the 19th century.

Only a short time before Pasteur began his work there had been a sharp discussion between Needham, an Irish Jesuit, and Spallanzani, an Italian priest, concerning spontaneous generation. The former made infusions of animal and vegetable matter and heated these on warm ashes in order to destroy any seeds that they might contain and found that subsequently these preparations swarmed with microscopic life and underwent putrefactive changes. This, Needham claimed, demonstrated scientifically that life does originate spontaneously. Others, for instance, Van Helmont, ear earlier had published recipes for generating vinegar eels and even for the creation of mice. Spallanzani repeated Needham's experiments with more care and scientific accuracy. He boiled his flasks for an hour then hermetically sealed them and found that when thus prepared they could be kept indefinitely without putrefaction. Indeed, before the time of Pasteur, Appert had devised the method now employed so largely in canning food, and had demonstrated its practical success. The explanation, however, was that the food is preserved because all the oxygen is driven out of the can. There was, at that time, no recognition of the presence of bacteria or their spores in the food subjected to these processes. The contest between Needham and Spallanzani as to spontaneous generation awakened, about the end of the 18th century, much discussion, some of which was jocose especially that contributed by Voltaire. After all, it was not regarded as a matter of any great importance.

The earliest theory concerning the causation of infectious disease, and one which still has a strong hold upon the belief of mankind, teaches that it is an infliction imposed on man by some supernatural power. Some have attributed disease to evil spirits while others have regarded it as a dispensation of their gods. There is no book of the middle ages down to the 18th century discussing an epidemic which does not attribute it, in part at least, to the wrath of God. Even those who were inclined to give rational explanations for epidemics did not dare to leave out the possibility, indeed, the probability, that the wrath of God was the most important element in causation. Luther wrote that pestilence and disease are naught else than the devil's work. Our own Cotton Mather described disease as "flagellum dei pro peccatis mundi". Another doctirne as to the cause of disease taught that all the joys and ills of man are determined by the position of the heavenly bodies. There are those that believe firmly that pestilences are caused by the spots on the sun or by the juxtaposition of certain planets. Our own great lexicographer, Noah Webster, wrote a two volume book to prove that epidemics are due to earthquakes and other terrestrial disturbances. Hippocrates and his followers for many centuries reasoned that when many people become ill simultaneously, the cause must lie in that to which all are exposed and this could be nothing else than the air. This gave rise to the belief that diseases, in large part at least, are due to miasms or vapors rising from the earth and carrying their deadly contents into the vitals of all. Less than fifty years ago the cause of infantile diarrhea was being sought in the exhalations from the earth, in the breezes from this or that point of the compass, or in some unknown terrestrial disturbance while the feeding of children with poisonous milk continued day after day and carried the infantile death rate higher and higher.

During the sixties the wine industry of France suffered severely because in some places the wine became too acid; in others it became unpleasant to the taste; while in still other localities it became ropy or oily. Pasteur had studied alcoholic fermentation until he had determined that yeast is the only ferment essential for the conversion of sugar into alcohol and when he examined these abnormal or diseased wines he found in all cases that they contained some other ferments than yeast. For the most part these adventitious and undesirable ferments appeared as bacteria. After a study of diseased wines Pasteur was able to tell with certainty the changes which had taken place in a given vintage by a microscopic examination of the sediment. It was therefore plain that if one could prevent the growth of these foreign bacteria deterioration of the wine would not occur. In order to destroy or inhibit the growth of these undesirable organisms two methods of procedure were open to him and both of these had been employed empirically and imperfectly in certain localities. He could add to the wine some germicide or antiseptic which would delay or wholly prohibit the growth of bacteria. It had long been the custom not only in France but in other wine growing countries to treat the interior of casks with fumes of burning sulphur. The sulphurous gas acts as a disinfectant and entirely destroys or delays the growth of the bacteria that might be in the wood. The other method was to heat the wine after it had reached a certain stage or had completed the alcoholic fermentation, but it had long been knowntthat if wine be boiled it does not age and remains stale quite indefinitely. Since wine is acid, Pasteur quickly saw that the growth of these foreign germs might be checked by heating the wine to a temperature of about 56 degrees centigrade and maintaining it at this temperature for only a short time. The low temperature and the shortness of exposure permits the oxygen in the wine to remain and does not interfere with the ripening process and does not depreciate the value of the vintage. It therefore became the custom to heat wine to the temperature just mentioned and while this does not wholly destroy the bacteria it is sufficient to prevent their development. This method of treating wine is now practised in all wine producing countries and is known as Pasteurization.

Later, French beers were found not to come up to the desired standard. They suffered in comparison with the German beers and the English ales. Pasteur went to work on the problem and found the cause to be foreign germs as was the case in the wine and the same remedy was proposed and proved to be effective. It might be added that there was no attempt to patent these procedures, to keep them secret or to prevent their adoption by foreign wine growers and brewers. Indeed, in his studies of beer Pasteur went to England and without cost pointed out to the manufacturers of ale how they could select pure yeast and prevent undesirable contamination with microorganisms. It was a Dane, who, profiting by the experiments and demonstrations of Pasteur, took up the trade of supplying brewers and others with pure yeast. Fortunes were made by an Austrian firm which did a similar thing for yeast in the preparation of bread. In this country for years we paid high prices for so-called pure yeast, the preparation of which was based upon Pasteur's discovery.

At the time when Pasteur was studying these fermentations there were two methods employed in the manufacture of vinegar. In France hogsheads containing dilute wine or other alcoholic solution were only partially filled and the surface freely exposed to the air. On these surfaces there grew a ropy fungus-like body and so long as it remained exposed to the air it converted the alcohol or other fluid into acetic acid or, in other words, it converted wine or other dilute solutions of alcohol into vinegar. If by any chance the growth on the surface of the hogshead fell to the bottom or was insufficiently supplied with air the contents of that hogshead went bad. In Germany dilute alcoholic solutions were allowed to drip into a cask filled with beech wood shavings. Pasteur studied the growth on the surface of the fluid in the casks and microscopically examined the delicate coating which formed on the beech wood chips and found that in both cases the growth consisted of a micro-organism known as the vinegar eel or mycoderma aceti. This discovery enabled the manufacturers of vinegar to put their processes on a scientific basis. It will be seen that already Pasteur had scientifically contributed to three great industries, the manufacture of wine, beer and vinegar, and had removed the processes of manufacture of these products from mere chance and empirical methods to the dignity and certainty of exact scientific procedures.

Pasteur's work had gone further than the study of alcoholic solutions and the conversion of alcohol into acetic acid, he had shown that the souring of milk is due to a ferment now known as the lactic acid bacillus. When, instead of souring naturally, milk grows ropy, becomes bitter or develops other abnormal and undesirable diseases there is, as in the case of wine and beer, an invasion by some other organism. In his study of butyric acid fermentation, Pasteur became aware of the fact that certain bacteria or ferments need an abundance of air for their full development, while others thrive only when the air is practically or completely cut off. Early in his work therefore he distinguished between those ferments growing best in air which he designated aerobes and those growing best when the air is excluded which he designated anaerobes. This explains why the vinegar ferment grows only on the top of the wine in the partially filled casks and also the more perfect aeration secured by allowing the alcoholic fluid to trickle over beech wood chips covered with the ferment.

Pasteur had by this time shown that all the fermentations which he had studied were due to specific organisms. He was able to grow each of these in what we now know as pure cultures, to sow the seed and to reap the harvest with the same certainty that the farmer scatters his wheat and his barley. It was now essential that the question of spontaneous generation should be settled with scientific finality. Do these ferments come into existence spontaneously without ancestors and without inheritances? If this is the case, there is no possibility of scientifically controlling fermentations whether they be in vinegar casks or in the animal body. Does smallpox or scarlet fever or diphtheria develop in a community de novo or as the result of the anger of some supernatural being or does each disease arise from a natural cause? It will be impossible in the time at my disposal to enter into the procedure by which Pasteur for all time settled the question of spontaneous generation and demonstrated that microscopic as well as macroscopic life is continuous, that the dictum of Harvey, "omne vivum ex vivo", is true, that the tubercle bacillus can boast an unbroken ancestry through a longer time than any son of woman, and quite likely that the pus germs which cause a boil on the back of your neck are lineal descendants of those which fed upon the body of Job. Suffice it to say that the work of Pasteur aided at that time by that of Tyndall and confirmed by thousands of experiments made now each day in the various laboratories of the world have settled all these points. Pasteur had been growing in the belief that each infectious disease has its own specific germ or micro-organism and to this, and to this only, the disease is due, and through this, and this only, is the disease distributed from man to man, from community to community and even, in the case of a pandemic, throughout the world.

About this time Pasteur was chosen to go to southern France to study a disease which was prevailing in that country and in northern Italy among the silk worms to such an extent that the silk industry was threatened with extinction. The selection of the man to undertake this work was made by Dumas, the great chemist whom Pasteur had always called master and whose advice he had for the most part followed. Pasteur knew nothing about silkworms, in fact he knew nothing about worms of any kind. When asked by Dumas to go on this trip he stated that he knew nothing about worms, but Dumas replied, "All the better, then you will have no preconceived ideas and will be guided by the results of your own work". This is one of the many illustrations which might be given that while experience is a good teacher it needs to be dominated by science. He did not find the solution of that problem easy. In fact, he spent six years on it and at last he found that there was not only one disease but two among the silk worms and having discovered their existence and their causative agencies he was able to point out how the diseases could be eradicated.

Called upon to investigate an outbreak of chicken cholera, Pasteur was soon able to demonstrate that this disease, highly fatal among fowls, is due to a bacterium. Here was opportunity to test an idea which had long been in his mind; would it be possible to so attenuate the virulence of the chicken cholera bacillus that it might be used as a vaccine. He transplanted the cultures of this organism day after day through more than a hundred generations and still he found that the inoculation of a fowl with the hundredth generation was just as fatal as inoculation with the first generation. Fortunately he and his assistants were called away from the Laboratory for some weeks during which time the cultures of chicken cholera bacillus stood without transplantation. On resuming work some of the old cultures were injected into chickens and it was found that while these old growths caused brief illness they did not kill and after the fowls had recovered, inoculation with the virulent bacillus had no effect. Jenner had discovered vaccination against smallpox but he had not isolated the virus nor has it been done with certainty up to the present time. Now Pasteur had discovered a vaccine for chicken cholera and had the micro-organisms which caused this disease in pure culture and subject to whatever control experiment he might make.

For centuries anthrax had been a most destructive disease among domestic animals especially among sheep and cattle throughout Europe. As early as 1837 a micro-organism had been found in the blood of animals dying from this disease. This bacterium had been studied and its causative relation to the disease demonstrated by Davaine and others. Pasteur inaugurated a line of experiments in order to determine whether the anthrax bacillus could be attenuated and made to serve the purpose of a vaccine. He succeeded in accomplishing this in two ways. First, by growing the organism in the presence of an antiseptic such as carbolic acid strong enough to inhibit and modify its growth but not strong enough to kill the organism. Another method of attenuation consisted in growing the cultures at a temperature of 42 degrees Centigrade, somewhat higher than that of the animal body. He found that when this was done through several generations the organism is so attenuated that it produces only a mild disease in animals from which they soon recover and after which they are wholly immune to virulent cultures. Probably the world has never seen so theatrical a demonstration of a scientific experiment as that made by Pasteur and his assistants on vaccination for anthrax at Melun. Having been convinced by experiments upon laboratory animals that he had a certain vaccine for anthrax and being continuously annoyed by criticism, he offered to make a public demonstration. A flock of sheep and a herd of cows were placed at his disposal and on a certain day there assembled at this farm a hundred or more, not only those interested in the work scientifically but those led by curiosity. Healthy sheep and healthy cows were vaccinated. At an appointed date later the assembly again came together at this place and all the sheep and all the cows were inoculated with virulent cultures. Two days later the assembly was called again and while every unvaccinated animal was dead or dying there was no mortality among the vaccinated.

Passing over certain minor studies in immunity conducted by Pasteur and his collaborators such as vaccination vor rouget or swine erysipelas, we come to the crowning work of this great life. I refer to his researches and his great achievements in the prevention of rabies after the bite of a rabid animal. There are graphic descriptions of rabies both in man and in animals written long before our era and during all the intervening centuries it has been known by those most competent to speak that this disease is transmitted from animal to animal and from animal to man by the bite or scratch of an infected animal. It is true that through all this time there were some who believed that the disease may originate spontaneously in animals and especially in dogs. A popular superstition attributes this disease to the effect of heat, to the partial or complete deprivation of water or to the positi position of the stars. It had been demonstrated before Pasteur began his work that the virus of the disease is contained in the saliva of rabid animals. Further it had been shown that inoculation of a healthy animal with a bit of the brain or cord of a rabid animal induces the disease. Pasteur and his co-workers had not proceeded far in their investigations before they felt that inoculation with rabid saliva was too uncertain and variable in its effect. They decided to use the spinal cord in their inoculations. The next things to do was to make this preparation of definite strength. This they accomplished by repeated inoculations subdurally of rabbits. Finally they obtained a fixed preparation, that is, one of definite strength. Then they found that by drying the infected cord they gradually attenuated its virus. The infected cord suspended in a jar, the atmosphere of which was kept dry by the absorption of moisture by means of potassium hydroxid or other drying agent for fourteen days, is wholly without effect when injected into animals. Then it was found that a dog or rabbit inoculated with a fixed virus did not develop the disease if it was treated successively by inoculation of cords of gradually ascending virus. It was as if one should be told on the first of January that on the first of July he would be compelled to submit to an injection of a fatal dose of morphine. With this knowledge such a man could go to work and receive day after day gradually increased doses and when the first of July comes around he could bear without fatal effect the dose administered to him.

Pasteur and his students had demonstrated by experiment after experiment on animals the protective value of their procedure but they were not quite ready to try it on human beings when a little Alsatian boy, Joseph Meister, who had received fourteen wounds inflicted by a rabid dog was brought to Pasteur's laboratory for treatment. Vallery-Radot, Pasteur's intimate historian, has described graphically the anxiety of Pasteur when this boy was submitted to the anti-rabic treatment. He was watched day after day until the time for the development of the disease was long past. It is not to be wondered at that Pasteur formed a fatherly attachment for this little boy which continued throughout his life. Neither is it strange that when the great contribution from Alsace for the building of the Pasteur Institute came in signed by a long list of contributors the name which struck and held the eye of Pasteur was that of his first patient, Joseph Meister. The treatment for rabies developed by Pasteur has demonstrated its great value and Pasteur Institutes, the principle purpose of which is this treatment, are today in operation in nearly every part of the civilized world.

Pasteur was fortunate in the recognition which he received during his life. Every possible scientific honor of real worth was conferred upon him. He was voted a member of every important academy and society. After his silkworm work he was given by the French government an annuity of twelve thousand francs. After the demonstration of his anti-rabic work this annuity was increased to twenty-five thousand francs. He lived to see the Paris Pasteur Institute built by contributions which came from widely separated parts of the world, from emperors and kings as well as from the poor. On the occasion of his 70th birthday in 1892 he received an ovation which probably no other scientific man has received.

In another and a little more important and extraordinary way Pasteur was fortunate. Personally, he was dearly beloved. Probably in the whole history of science no other man has had such devoted disciples. Many of the younger men absolutely effaced themselves in the service of their master. This certainly can be said of Roux, Chamberland, Duclaux and others. His disciples bestowed upon him a degree of reverence which would scarcely be exaggerated if termed adoration.

Great as were the researches of Pasteur they were greater still in the possibilities which they have opened up, Pasteur discovered the path which leads up the mountain of human achievement. He pointed out the way by means of which the race might wholly free itself from the infectious diseases. He led the world high up this mountain path, preaching as he did "Let peace be among you. Let science lead you. Under these conditions you may be able to reach the mountain peaks of human perfection." Under his guidance the world travelled far. In every land where his teachings were followed mortality and morbidity rates fell,the average life was prolonged, greater freedom from illness was secured, higher intellect developed. Under guidance we reached the hills where we were able to look down upon the pestilential marshes which we had left.

Having reached the limit permitted man to live he laid himself down to rest. The world built him a splendid mausoleum. For a few years after his death the race continued its progress with the best among nations in science in the lead, then came the great world cataclysm. The path being followed by the race toward the higher plateau has been broken. Across this path there are now chasms difficult to span. False teachers are urging the multitude to descend to the valley from which they came. They point out that the descent is easy, "descensus averno facile est". Many are following these false teachers, indeed, the descending crowds number not only hundreds and thousands but millions. Russia, the country that gave the world a Mendeleff in chemistry, a Metchnikoff in biology, has already as a nation reached the marshes that lie below the hills. Asiatic cholera confined to the mouth of the Ganges before the war has for the past six years implanted itself along the Volga and its tributaries and from January 1 to August 17, 1922, there were officially reported in Russia 55,000 cases of Asiatic cholera. In 1921 there were millions of cases of typhus and relapsing fever and in the same year for the first time in the history of the world malaria reached the Arctic circle and was in evidence at Archangel. As a scientist, I fear that the near future of the race is by no means certain. False prophets were never more numerous and credulity among the masses was never more evident.

It is fitting that we should do honor to the memory of that man who has done so much for the benefit of his race but the highest honor and the greatest homage that we can bestow upon him or manifest toward his spirit is to follow his teachings.

WHY THE WORLD HONORS LOUIS PASTEUR

Physicians honor him because of his work in prevention and cure of disease.

Chemists honor him because he threw light on the chemical basis of life.

Sanitarians honor him because he provided the means of controlling epidemics.

Bakers, brewers and grape-growers honor him because of his studies on fermentation.

Bacteriologists honor him because he was the founder of their science.

Agriculturists honor him because his studies of chicken cholera and anthrax led to relief from various diseases of domestic animals.

Mineralogists honor him because of his fundamental work on the structure of crystals.

Microscopists honor him because he was the discoverer of the wonderful world of micro-organisms.

Biologists honor him because he proved that all life comes from former life.

Mothers honor him because he has provided their children with milk free from disease.

All the world benefits from the results of the researches he began. They save thousands of lives and millions of dollars every year.

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CHRISTMAS TREES OLD IN LEGEND AND EVOLUTION

Christmas trees, as a family, are of the oldest of our trees today. For reasons connected with this antiquity, these evergreens have become so popular for Yule-tide decorations that between four and five million trees are consumed in this country every year, while plantations which raise Christmas trees as a farm crop are springing up to help supply the future demand.

These conifers or cone-bearing trees that hold the bright gifts and cheerful tinsel of this religious festival and winter holiday were the earliest of trees, and their direct ancestors were the first flowering plants on earth. They probably originated during a period of rigorous climate and their thin needle-leaves present less surface to cold and exposure than the broad-leaved trees which represent a later stage in plant evolution.

And these needles are probably responsible for the use of the conifers as Christmas trees. They present only a small surface to the effect of evaporation and so enable the tree to retain its moisture and keep green. This greenness added a touch of life to the dullness of winter and made the evergreens popular as decorations. Legends and custom did the rest.

There are many kinds of these evergreens, but the principal ones used for Christmas trees in various parts of the United States are the pines, spruces, firs and cedars. If you do not know what kind of a tree it is that bears your gifts, you can easily tell by looking at the needles on the branches. In the pines, the needles grow in bunches of from one to five needles to the bunch. If the individual needles in these bunches are pressed together they form a complete cylinder. Some kinds of pine have two needles to the bunch, but these two are each half cylinders, while in those having three needle bunches the three needles form a cylinder, and so on.

If the tree is a fir, the needles grow out from the sides of the stem, while in the spruce the needles grow out in all directions around the stems. In the cedar, the needles are like little twigs pressed compactly together in a sort of shingle-like formation.

Joy-killers frequently arise and bewail the cutting of these trees for Christmas use as wasteful. But aside from the joy they bring the kiddies, U. S. Forest Service officials believe that properly done the cutting of Christmas trees can reallyybe made a Christmas gift to the forests themselves.

In Maine and the Adirondacks, the principal localities that supply Christmas trees, there are frequently as many as 50,000 to 100,000 seedlings to the acre. Few of these can reach maturity. It is essential for the production of tall, clean timber that there should be at the beginning many trees to the acre, but unless these are thinned out, the poorer trees may hamper the development of the better ones.

Man, by interfering in the struggle and thinning out of all lagging trees, can hasten the growth of the remaining trees. In many localities, this work depends on the possibility of finding a market for the small trees to pay for the cost of the thinning, and the Christmas market solves the problem.

In Michigan, however, the state agricultural station several years ago started raising Christmas trees as a farm crop. They have just issued information telling how this can be done commercially and encouraging farmers to plant for this purpose.

PREDICTS WINTER WEATHER BY SUMMERTIME TEMPERATURES

Forecasting the rainfall for the coming winter and spring from the past summer's ocean temperatures, Dr. Geo. F. McEwen has predicted that the Southern California coastal region will receive about one half inch less than its average rainfall during the season 1922-23. He suggests the possibility of applying the same system to predictions over more extensive areas. Dr. McEwen is neither a goose-bone prophet nor a crystal gazer, but the oceanographer connected with the Scripps Institution for Biological Research here. He bases his system of forecasts on carefully worked out observations during the last six years.

These observations show that when the ocean temperature averages colder than usual the rainfall is heavier than usual and when the summer seas are warmer than the average the subsequent rainfall is smaller than the average rainfall. A fall of one degree in temperature corresponds on the average to an increase of about two inches in the rainfall.

Rainfall in the Southern California coastal region, depends, says Dr. McEwen, mainly upon the flow of the moisture-laden air from the Pacific and is proportional to the amount of the air transferred.

This in turn depends on the formation of a belt of high air pressure over the continent, he explains. In summer the barometric pressure is greater over the ocean than the land for two reasons. The wind velocity over the smooth water surface averages two or three times as great as that over the relatively uneven land and in summer the air flows from the land. But as the season advances to winter, air flows over the land from the water and carries a great mass of air from the Pacific ocean to the north American continent.

Enough pressure measurements over the North Pacific on which to base predictions being unavailable, Dr. McEwen used the known relation between pressures and surface ocean temperatures. The velocity of the winds which move clock-wise over the Pacific depends on the air pressure and the upwelling of cold bottom water along the coast and therefore the rate of cooling of the surface water is proporitional to the wind velocity. The lower the ocean temperature at or near the surface during the late summer and autumn, he declares, the greater must be the intensity of the ocean belt of high air pressure and accordingly the greater will be the expected seasonal rainfall over the coastal region of Southern California.

When asked which days would be the rainy ones, Dr. McEwen explained that long range forecasting is only done at the sacrifice of details and for daily information he advised waiting for the regular government forecast issued twenty-four to forty-eight hours in advance.

Another example of successful long range forecasting is the prediction of the monsoon rainfall of India, months in advance, by means of observations on atmospheric pressure distributions over vast areas of land and water.

CHEMISTS MAKE IMPORTANT DRUG ARTIFICIALLY

By making synthetic thymol, a drug that is used extensively as an antiseptic and a specific against the hookworm disease, Department of Agriculture chemists have again vanquished Nature at her own game. Thymol is now imported from India, where it is found in the seed of one of the plants growing there. The chemists have found that artificial thymol identical with the natural product can be made from cymene, a waste product in the paper industry. Thymol is now sold for $4.50 a pound but it is estimated that the synthetic product can be made for about $2.50 a pound. As there are 2,000,000 gallons of cymene wasted annually in this country and Canada, chemists expect that this country will soon be able to produce all the thymol consumed here.

Benjamin Franklin proposed a plan for "daylight saving" in 1784.

It is estimated that $10,000,000 worth of crops and live stock have been saved during the last year by the destnuction of predatory animals and injurious rodents by the U. S. Biological Survey.

It is estimated that 750,000,000 horsepower are being used for the world's factories, electric lighting, and street railways.

Successful experiments in obtaining gas from peat have been conducted in Germany.
