the cell wall, became after a while resolved into its component zoospores.

WONDERS OF REPRODUCTION.

I very much regret that my descriptive powers are not equal to conveying a sufficient idea of the intensely absorbing interest possessed by this wonderful process of spore formation. I shall never forget the bright sunny morning when for the first time I witnessed the entire process under the microscope, and for over four hours scarcely moved my eyes from the tube. To a thoughtful observer I doubt if there is anything in the whole range of microscopy to exceed this phenomenon in point of startling interest. No wonder that its first observer published his researches under the caption of "The Plant at the Moment of becoming an Animal."

FORMATION OF OTHER SPORES.

The process of spore formation just described, it will be seen, is entirely non-sexual, being simply a vegetative process, analogous to the budding of higher plants, and the fission of some of the lower plants and animals. *Vaucheria* has, however, a second and far higher mode of reproduction, viz., by means of fertilized cells, the true oospores, which, lying dormant as resting spores during the winter, are endowed with new life by the rejuvenating influences of spring. Their formation may be briefly described as follows:

When *Vaucheria* has reached the proper stage in its life cycle, slight swellings appear here and there on the sides of the filament. Each of these slowly develops into a shape resembling a strongly curved horn. This becomes the organ termed the *antheridium*, from its analogy in function to the anther of flowering plants. While this is in process of growth, peculiar oval capsules or sporangia (usually 2 to 5 in number) are formed in close proximity to the antheridium. In some species both these organs are sessile on the main filament, in others they appear on a short pedicel (Figs. 3 and 4). The upper part of the antheridium becomes separated from the parent stem by a septum, and its contents are converted into ciliated motile antherozoids. The adjacent sporangia also become cut off by septa, and the investing membrane, when mature, opens at a beak-like prolongation, thus permitting the inclosed densely congregated green granules to be penetrated by the antherozoids which swarm from the antheridium at the same time. After being thus fertilized the contents of the sporangium acquire a peculiar oily appearance, of a beautiful emerald color, an exceedingly tough but transparent envelope is secreted, and thus is constituted the fully developed oospore, the beginner of a new generation of the plant. After the production of this oospore the parent filament gradually loses its vitality and slowly decays.

The spore being thus liberated, sinks to the bottom. Its brilliant hue has faded and changed to a reddish brown, but after a rest of about three months (according to Pringsheim, who seems to be the only one who has ever followed the process of oospore formation entirely through), the spore suddenly assumes its original vivid hue and germinates into a young *Vaucheria*.

CHARM OF MICROSCOPICAL STUDY.

This concludes the account of my very imperfect attempt to trace the life history of a lowly plant. Its study has been to me a source of ever increasing pleasure, and has again demonstrated how our favorite instrument reveals phenomena of most absorbing interest in directions where the unaided eye finds but little promise. In walking along the banks of the little stream, where, half concealed by more pretentious plants, our humble *Vaucheria* grows, the average passer by, if he notices it at all, sees but a tangled tuft of dark green "scum." Yet, when this is examined under the magic tube, a crystal cylinder, closely set with sparkling emeralds, is revealed. And although so transparent, so apparently simple in structure that it does not seem possible for even the finest details to escape our search, yet almost as we watch it mystic changes appear. We see the bright green granules, impelled by an unseen force, separate and rearrange themselves in new formations. Strange outgrowths from the parent filament appear. The strange power we call "life," doubly mysterious when manifested in an organism so simple as this, so open to our search, seems to challenge us to discover its secret, and, armed with our glittering lenses and our flashing stands of exquisite workmanship, we search intently, but in vain. And yet not in vain, for we are more than recompensed by the wondrous revelations beheld and the unalloyed pleasures enjoyed, through the study of even the unpretentious *Vaucheria*.

The amplification of the objects in the engravings is about 80 diameters.

JAPANESE CAMPHOR—ITS PREPARATION, EXPERIMENTS, AND ANALYSIS OF THE CAMPHOR OIL.*

By H. OISHI. (Communicated by Kakamatsu.)

LAURUS CAMPHORA, or "kusunoki," as it is called in Japan, grows mainly in those provinces in the islands Shikoku and Kinshin, which have the southern sea coast. It also grows abundantly in the province of Kishu.

The amount of camphor varies according to the age of the tree. That of a hundred years old is tolerably rich in camphor. In order to extract the camphor, such a tree is selected; the trunk and large stems are cut into small pieces, and subjected to distillation with steam.

An iron boiler of 3 feet in diameter is placed over a small furnace, the boiler being provided with an iron flange at the top. Over this flange a wooden tub is placed, which is somewhat narrowed at the top, being 1 foot 6 inches in the upper, and 2 feet 10 inches in the lower diameter, and 4 feet in height. The tub has a false bottom for the passage of steam from the boiler beneath. The upper part of the tub is connected with a condensing apparatus by means of a wooden or bamboo pipe. The condenser is a flat rectangular wooden vessel, which is surrounded with another one containing cold water. Over the first is placed still another trough of the same dimensions, into which water is supplied to cool the vessel at the top. After the first trough has been filled with water, the latter flows into the next by means of a small pipe attached to it. In order to expose a large surface to the vapors, the condensing trough is fitted internally with a number of vertical partitions, which are open at alternate ends, so that the vapors may travel along the partitions in the trough from one end to the other. The boiler is filled with water, and 120 kilogrammes of chopped pieces of wood are introduced into the tub, which is then closed with a cover, cemented with clay, so as to make it air-tight. Firing is then begun; the steam passes into the tub, and thus carries the vapors of camphor and oil into the con-

denser, in which the camphor solidifies, and is mixed with the oil and condensed water. After twenty-four hours the charge is taken out from the tub, and new pieces of the wood are introduced, and distillation is conducted as before. The water in the boiler must be supplied from time to time. The exhausted wood is dried and used as fuel. The camphor and oil accumulated in the trough are taken out in five or ten days, and they are separated from each other by filtration. The yield of the camphor and oil varies greatly in different seasons. Thus much more solid camphor is obtained in winter than in summer, while the reverse is the case with the oil. In summer, from 120 kilogrammes of the wood 2.4 kilogrammes, or 2 per cent, of the solid camphor are obtained in one day, while in winter, from the same amount of the wood, 3 kilogrammes, or 2.5 per cent., of camphor are obtainable at the same time.

The amount of the oil obtained in ten days, i. e., from 10 charges or 1,200 kilogrammes of the wood, in summer is about 18 liters, while in winter it amounts only to 5-7 liters. The price of the solid camphor is at present about 1s. 1d. per kilo.

The oil contains a considerable amount of camphor in solution, which is separated by a simple distillation and cooling. By this means about 20 per cent. of the camphor can be obtained from the oil. The author subjected the original oil to fractionated distillation, and examined different fractions separately. That part of the oil which distilled between 180°-185° C. was analyzed after repeated distillations. The following is the result:

Found.	Calculated as C ₁₀ H ₁₆ O.
C = 78.87.....	78.95
H = 10.73.....	10.52
O = 10.40 (by difference).....	10.52

The composition thus nearly agrees with that of the ordinary camphor.

The fraction between 178°-180° C., after three distillations, gave the following analytical result:

C = 86.95
H = 12.28
99.23

It appears from this result that the body is a hydrocarbon. The vapor density was then determined by V. Meyer's apparatus, and was found to be 5.7 (air = 1). The molecular weight of the compound is therefore $5.7 \times 14.42 \times 2 = 164.4$, which gives

$$H = \frac{164.4 \times 12.28}{100} = 20.18$$

or C₁₀H₁₆

$$C = \frac{164.4 \times 86.95}{100} = 11.81$$

Hence it is a hydrocarbon of the terpene series, having the general formula C₁₀H₁₆-4. From the above experiments it seems to be probable that the camphor oil is a complicated mixture, consisting of hydrocarbons of terpene series, oxyhydrocarbons isomeric with camphor, and other oxidized hydrocarbons.

Application of the Camphor Oil.

The distinguishing property of the camphor oil, that it dissolves many resins, and mixes with drying oils, finds its application for the preparation of varnish. The author has succeeded in preparing various varnishes with the camphor oil, mixed with different resins and oils. Lampblack was also prepared by the author, by subjecting the camphor oil to incomplete combustion. In this way from 100 c. c. of the oil, about 13 grammes of soot of a very good quality were obtained. Soot or lampblack is a very important material in Japan for making inks, paints, etc. If the manufacture of lampblack from the cheap camphor oil is conducted on a large scale, it would no doubt be profitable. The following is the report on the amount of the annual production of camphor in the province of Tosa up to 1880:

Amount of Camphor produced.	Total Cost.
1877.....504,000 kins....	65,520 yen.
1878.....519,000 ".....	72,660 "
1879.....292,890 ".....	74,481 "
1880.....192,837 ".....	58,302 "

(1 yen = 2s. 6d.)
(1 kin = 1½ lb.)

THE SUNSHINE RECORDER.

McLEOD's sunshine recorder consists of a camera fixed with its axis parallel to that of the earth, and with the lens

northward. Opposite to the lens there is placed a round-bottomed flask, silvered inside. The solar rays reflected from this sphere pass through the lens, and act on the sensitive surface.

The construction of the instrument is illustrated by the subjoined cut, A being a camera supported at an inclination of 56 degrees with the horizon, and B the spherical flask silvered inside, while at D is placed the ferro-prussiate paper destined to receive the solar impression. The dotted line, C, may represent the direction of the central solar ray at one particular time, and it is easy to see how the sunlight reflected from the flask always passes through the lens. As the sun moves (apparently) in a circle round the flask, the image formed by the lens moves round on the sensitive paper, forming an arc of a circle.

Although it is obvious that any sensitive surface might be used in the McLeod sunshine recorder, the inventor prefers

at present to use the ordinary ferro-prussiate paper as employed by engineers for copying tracings, as this paper can be kept for a considerable length of time without change, and the blue image is fixed by mere washing in water; another advantage is the circumstance that a scale or set of datum lines can be readily printed on the paper from an engraved block, and if the printed papers be made to register properly in the camera, the records obtained will show at a glance the time at which sunshine commenced and ceased.

Instead of specially silvering a flask inside, it will be found convenient to make use of one of the silvered globes which are sold as Christmas tree ornaments.

The sensitive fluid for preparing the ferro-prussiate paper is made as follows: One part by weight of ferricyanide of potassium (red prussiate) is dissolved in eight parts of water, and one part of ammonia-citrate of iron is added. This last addition must be made in the dark-room. A smooth-faced paper is now floated on the liquid and allowed to dry.—*Photo. News.*

BREAKING OF A WATER MAIN.

In Boston, Mass., recently, at a point where two iron bridges, with stone abutments, are being built over the Boston and Albany Railroad tracks at Brookline Avenue, the main water pipe, which partially supplies the city with water, had to be raised, and while in that position a large stone which was being raised slipped upon the pipe and broke it. Immediately a stream of water fifteen feet high spouted out. Before the water could be shut off it had made a breach thirty feet long in the main line of track, so that the entire four tracks, sleepers, and roadbed at that point were washed completely away.

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