following are the calorific values of various fuels, by means of which they may be compared.

California crude oil varies from 18,462 to 20,680 B. T.U.'s per pound, the average weight of which is 7.6 pounds per gallon.

The Beaumont Texas oil averages 19,060 B.T.U.'s per pound, and weighs about 7½ pounds per gallon. Forty-two gallons of crude oil, United States measure, equals one barrel.

Some Russia oils contain on an average 22,027 B.T. U.'s per pound.

Tar from coke ovens contains 16,263 B.T.U.'s per pound.

Tar from oil water averages 16,979 B.T.U.'s per pound, and varies in weight from 9 pounds to 10.29 pounds per gallon.

Fuel oil (or the residuum from oil refineries) varies from 18,350 to 19,342 B.T.U.'s per pound and averages 7.2 pounds per gallon in weight. Fifty gallons of fuel oil is considered one barrel.

Gasoline contains 14,200 B.T.U.'s per pound, weight 5.9 pounds per gallon. The evaporation of this fuel is very great unless confined.

Coke varies from 12,645 to 13,500 B.T.U.'s per pound. Coal gas varies in its calorific value from 552 to 567 B. T. U.'s per cubic foot.

Calorific value of wood compared with liquid fuel is as follows: 4,500 pounds of hickory equals 738 pounds crude oil; 3,250 pounds of beech or oak equals 610 pounds crude oil; 2,350 pounds of poplar, chestnut, or elm equals 483 pounds crude oil.

Bituminous coal contains from 11,963 to 15,622 B.T. U.'s per pound; a general average of coal in the United States can be placed at 13,180 B.T.U.'s per pound.

[Concluded from SUPPLEMENT No. 1591, page 25495.]

INFLUENCE OF LIGHT AND HEAT ON GERMINATION.—II.*

By CLEVELAND ABBE.

AFTER this preliminary historical survey, Pauchon communicates the results of his own experiments as to the influence of light on germination on the following twenty-two species of plants:

Cruciferae:	Leguminosae:
Brassica napus.	Arachis hypogaea.
Iberis amara.	Dolichos lablab.
Lepidium sativum.	Rubiaceae:
Sinapis alba.	Coffea arabica var. Rio.
Raphanus sativus.	Spilanthes fusca.
Ranunculaceae:	Helianthus annuus.
Delphinium Consolida.	Carthamus tinctorius.
Nigella sativa.	Malvaceae:
Cucurbitaceae:	Hibiscus esculentus.
Cucurbita melo var. me-	Polygonaceae:
lon vert.	Fagopyrum esculentum.
Papaveraceae:	Linaceae:
Papaver somniferum.	Linum usitatissimum.
Euphorbiaceae:	Bignoniaceae or Pedaliaceae:
Ricinus communis.	Sesamum orientale.
Gramineae:	Liliaceae:
Zea mays.	Pancreatum maritimum.

After deducting doubtful results or failures Pauchon gives the following conclusions (see p. 131 of his work above quoted):

(1) In 22 experiments germination occurred first in the light; in 26 experiments it occurred first in the dark.

(2) Five times we obtained duplicate results favorable to the light for the same species of plants (*Arachis*, *Zea mays*, *Dolichos*, *Sinapis*, and *Linum*). Eight times these duplicate results were favorable to specimens kept in the dark (*Helianthus*, *Delphinium*, *Pancreatum*, *Ricinus*, and *Papaver*). In one case (*Linum*) two results were obtained favoring light and two favoring darkness.

(3) Among the 22 species of plants used in the experiments, 14 gave mixed results equally favorable whether placed in the light or the dark.

(4) Among the eight other varieties only one gave negative results (*Coffea*); three gave results favorable to light (*Cucurbita*, *Spilanthes*, and *Carthamus*); four gave results favorable to darkness (*Delphinium*, *Pancreatum*, *Lepidium*, and *Nigella*).

It appeared to Pauchon impossible to draw any conclusion whatever from these facts. Should we be astonished at this? The problem is certainly much more complex than appears at first sight. There is every reason to suppose, for example, that the action of light is not the same under all the conditions of temperature which obtained during these experiments. Here again, however, we are confronted by the unknown; because, in order to draw from these researches the consequences which might flow from them it would be necessary to know precisely the thermic conditions favorable to the germination of each species. Unfortunately this is a very important gap to be still filled up, as the work accomplished in this direction gives only approximate results limited to a very small number of different kinds of seeds. On the other hand, looking to facts of another order, mentioned further on in this work, we think that we may be allowed to suppose that the influence of light can only be favorable to germination when it acts at temperatures below that which is most favorable to germination. A considerable number of observations already cited would seem to be in accord with this view of the subject. But unfortunately the many contradictions that we ob-

served in our results do not allow us to accept this opinion as based upon a solid foundation.

Pauchon then goes on as follows:

"Another reason, however, induces me to admit, only with many reserves, the results of experiments whose critical epoch is the visible development of the embryo. A method based on this special observation does not appear to me capable of furnishing a really scientific basis for the determination of the question before us. The process of germination is not, in reality, as simple a phenomenon as the greater number of botanists, perhaps too easily, take for granted. Its complexity is even so great that one can not judge of the actual development of the germ of the plant and of the degree of its physiological activity by the external characters observable by the eye, such as the bursting of the spermoderm and the more or less rapid protrusion of the radicle. I do not hesitate to say, according to observations frequently repeated, that this is an empirical process and entirely deceptive in the particular case that we are dealing with. Although it may be capable of furnishing valuable results when we wish to judge of the influence of some one of the fundamental conditions of germination, it becomes utterly insufficient when it is a question of observing the more delicate and fugitive influences, such as that of light. I have, in fact, in the course of chemical researches, given in the next chapter, demonstrated that for the same age of apparent development the absorption of oxygen by the seeds in the process of germination varies to a large extent with the temperature, and has no relation to the external growth of the embryo. It is, however, not surprising that the development of the embryo continues in the interior of the seed for a much longer time in one seed than in another of identical appearance; the unknown and variable relation between the reserved nutrition and the rudimentary vegetable is probably the explanation of these hitherto unexplained peculiarities.

"Although the researches given in this chapter do not give any positive result on the subject of my work, I have preserved them and publish them here in order to explain to observers the defects of an experimental process to which, in the future, they would themselves have been tempted to resort; this moreover, seems to me the more useful in that up to this time this danger does not seem to have struck the attention of botanists. On the other hand, my observations contain some new data relative to the temperatures favorable for the germination of certain exotic seeds.

"In consequence of the conclusions to which we have thus been led, it would be useless to study the action of the different portions of the solar spectrum on the apparent progress of germination. How, in fact, can we suppose, in view of the contradictory results already obtained for the condition of light and of darkness—that is to say, for the most extreme conditions—that the employment of the same method can reveal a difference of action for the various portions of the spectrum?

"Is it then necessary, after this first fruitless attempt, to give up the solution of the problem, or shall we seek it by another and better method? It is this latter alternative that I have adopted in that I have taken for the basis of a new series of observations the variations of a physiological process that, in an almost mathematical manner, measures the germinal activity of the vegetable embryo, namely, the respiration."

After giving the details of his experiments on respiration of plants, Pauchon draws the following conclusions (p. 166):

"The laws brought prominently forward by the results of these experiments are:

"(1) Light exercises a constant and more or less marked accelerating influence upon the absorption of oxygen by seeds in the process of germination. All the experiments made in a strong light have not, however, the same value in demonstrating this fact. But if we have doubts about the precision of the results furnished by experiments in which germination did not invariably take place (and we believe that we have shown by some preparatory experiments that these results have at least a relative value), this certainly is not the case with experiments Nos. 2 and 8, in which all the seeds did germinate. Thus experiment No. 2 showed in favor of light a result as to the oxygen absorbed twice as great as that given by the seeds placed in the dark. In the same way in experiment No. 8 this superiority reaches to one-third of the quantity of oxygen absorbed by the seeds placed in the dark. Finally, the other experiments, and particularly those classed under Nos. 3, 6, and 7, further confirm the generality of this action of light, which we will, besides, find again in a second series of experiments reported hereafter, several of which have shown unanimity of germination in both cases.

"(2) There exists a relation between the degree of light and the quantity of oxygen absorbed. Thus, in a diffuse light this accelerating influence shows itself in a most marked manner when the sky is very clear, and the solar radiation reaches us in its greatest intensity. Such was the case in experiments Nos. 2 and 8. Whenever the sky is cloudy this action is more and more weakened and ceases altogether when the sun is completely veiled, as in stormy weather, so that there is a semi-obscurity.

"However, in all the experiments where the final result has been favorable to the action of light I have convinced myself that a cloudy sky for twelve hours always showed itself in the amount of the absorption of oxygen in such a manner that the examination of these figures, noted day by day, would almost serve to show the state of the atmosphere during the day which

preceded the observation. A very conclusive instance of this action is given us by experiment No. 4 of the second series, in which the state of the sky being carefully observed it showed very marked changes.

"(3) The accelerating influence exercised upon seeds exposed to the action of light during the day did not stop at night; it continued to act in the dark with an equal, sometimes even with a greater intensity. I will cite as examples experiments Nos. 3, 4, 6, 7, and 8, when observations made twice a day, morning and evening, allowed of examining the fact I state. How can we explain this persistent action of light? One hypothesis only can be admitted. A portion of the action of the light absorbed by the grain during the day is stored up by it and used by it at night to accelerate its respiration. The proof of this is that the differences of elevation [or quantities of absorbed oxygen] shown in the morning by the instruments for seeds kept in the dark are always below those shown by the instruments and plants in the light. The influence of the light, then, continues for a certain time, at least several hours, even after the light itself has ceased to act; on the other hand, however, this action is not exerted immediately. There is one other phenomenon that we have demonstrated by our experiments. Suppose the sky to be very clear; the differences in favor of light are only apparent after two or three days and become much more marked toward the end of the experiment; that is to say, in proportion as the daily action of sunlight is more and more frequently repeated.

"(4) I should also call attention to still another peculiarity, viz., that the differences in the quantities of oxygen absorbed in the dark and in the light were generally much greater at the beginning of these researches than in the later experiments, and particularly in those of the second series. The temperature appears to me to be the only element that varied in these experiments. There must therefore be a more intense respiratory action exercised by light at low temperatures, and this influence would become weakened at high temperatures. This fact would be in entire agreement with the demands of physiology. It is easy of comprehension that a scarcity of heat should be counterbalanced by the action of light, which furnishes for the reaction of the respiratory organs the force that they could not obtain from an insufficient temperature. On the contrary, when the heat is intense the intervention of the light is no longer necessary, the first cause being sufficient to excite the process of germination in the protoplasm of the seeds.

"(5) This action of light seems to differ a little according as it acts upon seeds containing albumen or those without albumen. In the case of the albuminous seeds of the castor-oil plant the advantage was much more apparent in favor of those exposed to the light, which advantage appeared to me much less decided for the seeds without albumen, such as the haricot bean. Nevertheless, as the experiments were not invariable in their results, the cause of the variations observed can also be accounted for by attributing them to certain differences in the atmospheric conditions.

"(6) The more considerable absorption of oxygen by seeds under the influence of light explains the fact that asparagine (the medium for the conveyance of the reserved albuminous substances in the germination of leguminous plants) only disappears in plants exposed to the light and continues present in those raised in the dark. The comparative researches of Pfeffer (1872) upon the chemical composition of asparagine and other substances showed that asparagine is poorer in carbon and in hydrogen and richer in oxygen than legumine and other albuminoids. The transformation of legumine into asparagine is accompanied by the absorption of a certain quantity of oxygen. On the other hand, it is effected only by the influence of light; the reason being that light increases the quantity of oxygen absorbed, and therefore exerts only an indirect influence on this change, as had already been surmised even when we were not acquainted with the reasons.

"(7) Other new and important conclusions become apparent from these experiments and those which follow, and although they have no direct connection with the subject of my work I think it will be well to designate them briefly.

"The quantity of oxygen absorbed in a certain space of time by a seed in process of germination varies very considerably according to the temperature; it increases with it, as has been already proved in treating of the respiration of plants in the dark. The general results of my experiments, and particularly of Nos. 9 and 10, leave no doubt of this fact. We can therefore easily understand what errors have been committed by those experimentalists who have given calculations of this absorption of oxygen by certain seeds without taking into consideration the conditions as to temperature. Their figures have no value whatever, particularly in view of the fact stated by me several times already, viz., that the quantity of oxygen absorbed by a seed is not at all in proportion to its apparent development, but, on the contrary, undergoes considerable variation, depending upon the influence of the external agents affecting the phenomenon. According to my observations, this quantity may vary as two to one, or even more, in two plants of identically the same weight, but placed in different thermic conditions from the commencement of their germination to the emerging of the rootlet. From this point of view, then, the plant acts like a complete organism, its respiratory action being accelerated or retarded always, however, within physiological limits, like those of an animal under the influence of certain exterior changes."

Having thus shown that germinating seeds absorb more oxygen in the light than in darkness, Pauchon

* Abstracted from Bulletin 36 of the United States Department of Agriculture.

conducted some experiments to determine the ratio between the oxygen and the carbonic acid, and draws the following conclusions:

"Experiments Nos. 3 and 4 have a real value for the solution of the problem brought forward in this part of my work. As to the partial results given by experiments Nos. 1, 2, and 5, their accuracy cannot be doubted; therefore I shall make use of them as confirmatory documents. I must repeat that the numbers used for the proportions of carbonic acid are a little smaller than they should be in reality, in consequence of peculiarities inherent to the method and already explained; but as this diminution, which is almost insignificant, is equally present in all the quantities, the result is that the numerical quantities are always comparable, although the ratio may be diminished in an inappreciable degree. Finally, I may add that the conclusions which follow are only applicable to plants under precisely the same conditions as those under which my experiments were conducted.

"(1) I note, first, that experiments Nos. 3 and 4 confirm in the most precise manner the general fact of the accelerating influence exercised by light upon the absorption of oxygen; but, these experiments having been carried out at a higher mean temperature, the differences in the quantity of oxygen absorbed in the light and in the dark are generally less than in the first series of experiments.

"(2) As to the exact relative quantities of carbonic acid exhaled, it was a little more for the castor-oil plant in the dark than in the light, the contrary being the case for the scarlet runner bean. From this we might conclude that the influence of light produces doubly favorable effects upon the germination of the castor-oil plant, (a) by increasing the absorption of oxygen, and (b) by diminishing the exhalation of carbonic acid, thereby increasing the gain of oxygen by reducing the expenditure of carbon and oxygen. (It must not be forgotten, in this explanation, that one volume of carbonic acid gas contains one volume of oxygen.) From this particular point of view the scarlet runner bean seems to be less favored than the castor-oil plant, although the excess of the quantity of carbonic acid exhaled by either placed in the light is nearly insignificant when compared with that exhaled by the same species kept in the dark.

CO₂
O
"(3) In the dark the ratio — as determined by
four experiments divided equally between the seed of the castor-oil plant and those of the haricot bean, was at least a third more in favor of the latter than the ratio obtained for the castor-oil plant. The length of the experiment appears to me to have exercised a certain influence upon this ratio. Thus, for the castor-oil plant the figures reached 0.586 in experiment No. 2, which lasted about four days, and 0.771 in experiment No. 3, which lasted five days. The same was the case with the haricot bean; the result was 1.138 for experiment No. 4, which terminated during the fourth day, and 1.084 for experiment No. 5, which was prolonged until the sixth day. In a word, the prolongation of
CO₂
the experiment tends to render the ratio — equal to
O

unity. With the duration of the experiment this ratio rises in those cases where it is below 1, but diminishes where it is above 1, until the seed is consumed and the period of vegetation, properly so called, arrives, during which latter time the final limit may be reached when the quantities of oxygen absorbed and the carbonic acid exhaled balance perfectly.

CO₂
O
"(4) In the light the ratio — is about a third
more for the haricot bean than for the castor-oil plant. But the sum obtained in experiment No. 2 was very much below that stated in experiment No. 5. The duration of this experiment and its prolongation until the approach of the vegetating period appears to me to account for this difference. This hypothesis is supported by the results of experiments Nos. 1 and 4, the first having lasted six days and the other less than four.

CO₂
O
"(5) By comparing the ratio — for similar ex-
periments made in the light and in the dark, we see that there is always a difference of a quarter of the value of this ratio in favor of the dark; or, in other words, a seed placed in the dark always exhales more carbonic acid for the same quantity of oxygen absorbed than a seed kept in the light, even although sometimes, as we showed in experiment No. 3, the absolute quantity of carbonic acid exhaled is less in the light than it is in the dark. Finally, while in the light the carbonic acid released is always much less in quantity than the oxygen absorbed, the contrary may be the case in the dark, where the absolute amount of carbonic acid may even exceed the absolute quantity of oxygen, as is proved in experiment No. 4, where the absorption of oxygen 37.36 corresponds to an exhalation of 42.54 of carbonic acid.

CO₂
O
"(6) In order to consider the influence exerted upon the ratio — by the nature of the grain itself under
different conditions as to light and darkness, it is only necessary to consult the conclusions which precede, and note the marked differences that distinguish the albuminous and oily seed of the castor oil from the non-albuminous and starchy haricot bean.

"(7) The facts which precede complete the explanation already given of the transformation of legumin

into asparagin under the influence of light. In general, the absorption of a greater quantity of oxygen only assures the formation of asparagin in so far as the amount of carbonic acid exhaled is less than the amount of oxygen absorbed; since asparagin is poorer in carbonic acid and richer in oxygen than legumin, all the conditions favorable to that formation are to be found demonstrated in the results of experiment No. 4, with seeds exposed to the light. It is very probable that a portion of the oxygen which had disappeared and that was not found as carbonic acid was absorbed by the albuminoids when forming asparagin, and we know from other sources that this substance seems to form in the majority of seeds during the process of germination.

"This absorption of oxygen during the period of germination is still greater in the castor-oil seed than in that of the bean. The oily seed, therefore, seems to be more favored by nature from a physiological point of view.

CO₂
O
"(8) We might be tempted to compare the ratio —, obtained during the time of germination, with the same ratio during the period of vegetation. But the sum for the vegetating epoch has only been precisely fixed in the dark, which for green plants is entirely an abnormal state. As, on the other hand, it is impossible to gage exactly the quantity of oxygen absorbed, and the amount of carbonic acid exhaled by a plant placed in the light and under natural conditions, it will easily be understood why we refrain from making any comparison until we are in possession of all the data necessary to carry out the calculation.

"(9) The facts which precede convince me that the seeds of uncultivated plants germinating in the light are, all other conditions being equal, better distributed than the seeds of cultivated plants; that they possess a greater germinating power, an advantage which increases their chances for ulterior development."

PEARLS.

By DR. L. G. SEURAT.

THE pearls of greatest and most ancient renown are obtained from a mollusk of the genus *Margaritifera*, incorrectly known as the pearl "oyster." There are several species, which are distributed through the hot regions of the globe. The oldest pearl fisheries are those of the Red Sea, the Persian Gulf, and Ceylon.

Pearls obtained from fresh-water mussels were esteemed by the Romans but have little value to-day. The pearl oyster furnishes nearly all the pearls which come to the European market. At present the most important pearl fisheries are those of Ceylon and the Persian Gulf. The small melegrine (*Margaritifera vulgaris*) of those localities is, however, found also in the Red Sea, the Mediterranean (since the opening of the Suez canal), Torres Strait, and New Caledonia. Of less importance are the fisheries of the Dutch Indies, Torres Strait, western Australia, the Tuamotu and Gambier islands, the Gulf of California, the Bay of Panama, and Margarita Island, off the coast of Venezuela. Pearls, usually of no commercial value, are found occasionally in edible oysters.

The pearl oyster is found at depths of from 15 to 130 feet, attached to an empty shell or a branch of coral by a bundle of very strong, dark-green filaments called the byssus. In old specimens the byssus contains more than 500 threads. The mollusks are gathered by divers, with or without diving suits. The pearl divers of Ceylon and the Persian Gulf accelerate their descent by means of a large stone attached to a rope, in a loop of which the foot is placed. The Arabs of the Persian gulf employ the same method and also stop their ears with wax and compress their nostrils with a clamp made of horn.

The natives of the Tuamotu Islands, a French Pacific colony, may justly claim to be regarded as the best divers in the world. They descend to depths of more than 100 feet without the aid of weights. Arriving at the fishing ground early in the morning in pirogues or sloops, they anchor and examine the sea bottom with the water telescope. The use of this instrument, which is merely a square wooden tube with one end closed with a pane of glass, has been learned from the Europeans. Formerly the surface of the water was smoothed by applying coconut oil. When the diver has thus discovered the pearl oysters he breathes deeply for several minutes. Then with his lungs filled, he dives feet foremost, but at the depth of about 30 feet he inverts himself by a sudden movement of his arms and legs and thence descends, head downward, to the bottom, snatches his prey and ascends. On reaching his boat he at once opens the oysters by cutting the adductor muscle and searches them for pearls.

The pearls are usually found in closed pouches in the dorsal part of the body. Their presence is not betrayed by any external indication except that they are rarely found in very young oysters or within very clean shells. The oysters of certain beds yield more pearls than those of other beds.

Besides these fine pearls (as they are known in commerce) which are found unattached in the body of the oyster, other pearls are found adhering to the inside of the shell. The latter are called chicots, and have comparatively little value.

Fine pearls are graded according to form, size, color, and luster. Perfectly spherical white pearls are the most valuable. The value of a pearl, other things being equal, is proportional to the square of its weight in grains. Luster is the character of the surface which produces the soft but brilliant luminosity and play of color of fine pearls, an effect due to the exceedingly

thin concentric layers of which they are composed. A piece of mother-of-pearl cut to the form of a pearl has no luster.

Pearls perfectly matched in size, shape, and color command a far higher price than that of the same pearls sold separately. Irregularly shaped pearls, or baroques, are sold by weight.

Pearls are liable to deterioration from various causes. The acid secretions of the skin, foul gases, salt water, and soap injure them, and sudden changes of temperature may cause them to crack or even to burst. In the course of time the pearl becomes dull, or old, to use the technical term. When it has completely lost its luster it is said to be dead. Attempts have been made to restore the luster of dead pearls by various methods, none of which produces very satisfactory results. The most curious of these methods consists in feeding the pearls to fowls, and killing these after the superficial layers of the pearls have been removed in the process of digestion.

The structure of pearls, like that of shells, is studied by examining polished thin sections by transmitted polarized light. Many pearls exhibit a stratification similar to that of shells but with the order of the strata reversed. The center is formed of a yellowish-brown substance closely resembling the periostracum or outer layer of the shell. This is surrounded by a layer of prisms of carbonate of lime resembling the middle layer of the shell. The outer or nacreous layer of the pearl is composed of a number of independent concentric strata which can be peeled off one by one like the coatings of an onion. The jeweler sometimes takes advantage of this peculiarity to obtain a pearl of fine luster by removing the outermost opaque strata of a dark and dull specimen.

This typical structure, however, is subject to great variation. Some pearls have only one of the three layers and the middle prismatic layer is wanting in the very finest pearls, which are composed of exceedingly thin nacreous strata immediately surrounding the nucleus.

Chemically, pearls are composed of carbonate of lime, water, and a large amount of organic matter. To the last constituent they owe the hardness which enables genuine pearls to be easily distinguished from imitations. The density varies from 2.650 to 2.686. Pearls dissolve so very slowly in vinegar that the story of Cleopatra drinking a cup of vinegar in which she had dissolved a pearl must be relegated to the domain of fable.

The problem of the origin of fine pearls has been, and is to this day, a much discussed subject. Many writers have confounded them with shell pearls or chicots, which are formed in a very different way. Chicots are lumps of mother-of-pearl secreted by the epithelium which covers the mantle of the mollusk and which also secretes the innermost layer of the shell to which these pearls are attached. Their production is due to an irritation of the mantle by any cause, such as the introduction of a grain of sand or other foreign body between the mantle and the shell. Occasionally this foreign body is a fine pearl which has gone astray, and for this reason pearl merchants often pay good prices for chicots or shell pearls in the hope of finding fine pearls inside of them.

Linnaeus and some other naturalists attempted to provoke the secretion of pearls by perforating the shells of pearl-bearing mussels, introducing pellets of limestone, mother-of-pearl and other substances and covering the holes with bits of mother-of-pearl, fastened with cement. In time the pellets became covered with a deposit of mother-of-pearl and, usually, attached to the shell, but no very good pearls have ever been produced by this method.

Bouchon-Brandely repeated these experiments, with better success, on the pearl oyster of Tuamotu. More recently Boutan has endeavored to obtain pearls from the *Halotis* (sea ear or abalone) in this manner, and has produced in a few instances a luster suggesting that of fine pearls.

All these experiments have only theoretical value and are of interest merely because they exhibit in detail the mechanism of the secretion of mother-of-pearl.

Some writers of the sixteenth and seventeenth centuries regarded pearls as the eggs of the mollusk. As late as 1826 a modification of this theory was put forth by Home, who thought that pearls were formed about eggs that had failed to be expelled by the oviduct. Other authors have regarded pearls as calcareous concretions analogous to the calcospherites which are formed in the bodies of men and animals. Rondelet (1554) considered them to be concretions due to disease, like the urinary and other calculi of mammals. According to Diguët, who has studied the question in the pearl oyster of the Gulf of California, the development of a pearl comprises three stages. In the first stage there appears a sack filled with a translucent, serous liquid, the effusion of which is due, probably, to irritation caused by a parasite. In the second stage the liquid gradually thickens and assumes the appearance of jelly. Then it becomes converted into conchyoline and the mass divides into concentric layers separated by interstices. The third stage is the petrification or calcification of the pearl by the filling of these interstices with a crystallized calcareous deposit.

The theory which is most generally admitted at present is that pearls are the result of a secretion induced by the presence of parasites. This theory was abandoned by Filippi, who announced, in 1852, that the pearls of the fresh-water mussels in the royal park of Racconigi, near Turin, were caused by a parasitic worm or "fluke," a species of *Distoma* (closely allied to the parasite which causes "rot" in sheep). In 1856 Küch-