minimum width of streets in Manchester was 36 feet, and he thought it would be wise to have this materially increased. Streets were not laid out in the centers of cities where land was dear, consequently what had been perpetuated in the center need not be continued in the outskirts.

On the outskirts building operations were in progress which threatened to create new slums in the future. Up to the present no distinction appeared to have been made in by-laws between the center of a city where land was dear and the outer fringe or undeveloped portions toward the boundaries where land could be obtained at a comparatively low rate. As a consequence by-laws had to be considered with regard to their effect upon building operations in the center of large cities, and builders under more favorable conditions on the outskirts took advantage of the prescribed minimum. To remedy this defect he suggested that by-laws in degrees should be framed. By aid of the lantern Mr. Fildes showed pictures of several condemned areas as they formerly existed, in contrast with the tenement dwellings and cottages which the corporation have built in various parts of the city. He mentioned that the total amount spent by the corporation in housing schemes under the Laborers' Dwellings Improvement Act since it was adopted in 1889 was £416,432, and that an additional sum of £35,500 had been spent in work under local acts.

ON CHEMICAL METHODS BY WHICH THE EGGS OF A MOLLUSK (*LOTTIA GIGANTEA*) CAN BE CAUSED TO BECOME MATURE.*

By JACQUES LOEB.

(From the Herzstein Research Laboratory at New Monterey, f.)

Two years ago I published the fact that I was able to produce larvæ from the unfertilized eggs of certain limpets (*Acmaea*, *Lottia gigantea*) by submitting these eggs for about two hours to hypertonic sea-water of a certain concentration; but that I was not able to produce larvæ by fertilizing the eggs of the same females with sperm. Soon after I found my new method of artificial parthenogenesis, I tried it also on the eggs of limpets, especially *Lottia gigantea*. In cases where the treatment with hypertonic sea-water alone did not lead to the formation of parthenogenetic larvæ the combination of a treatment of the eggs of the same female with hypertonic sea-water and a fatty acid led in most cases to the formation of larvæ from the unfertilized eggs of *Lottia*. As a rule I proceeded in this way: I exposed the eggs for from 1½ to 2 hours to a mixture of 100 cubic centimeters sea-water and 17 cubic centimeters 2½ n KCl or NaCl and then five or ten minutes later for from 2 to 3 minutes to a mixture of 50 cubic centimeters sea-water, and 3 cubic centimeters n/10 butyric, valeric, or capronic acid.

But even in this case the number of eggs which developed was always small and rarely exceeded a few per cent. The segmentation of the developing eggs was perfectly regular, but the larvæ, as a rule, lived not longer than two days. They began to disintegrate into several fragments as a rule the first day. In order to find out how they differed from the normal larvæ which arise from the fertilized eggs I tried at various times from April to the end of October to fertilize the eggs of *Lottia* with sperm. But while I always succeeded in producing artificial parthenogenesis in the eggs of *Lottia*, I practically never was able to fertilize the eggs with sperm. Occasionally an egg in many thousands was noticed to develop when sperm was added, but the resulting larva was always as imperfect and of no better or even of less vitality than the parthenogenetic larvæ.

The fact that the eggs could not be fertilized with sperm suggested the possibility that they were not mature and instead of waiting any longer for the period of maturity to arrive I decided to try whether it was not possible to cause the eggs to become mature by artificial means. I put eggs into mixtures of 50 cubic centimeters of sea-water to which 0, 0.5, 0.75, 1.0, 1.25, and 1.5 n/10 NaOH had been added, and added to each dish the same amount of sperm. None of the eggs which had been put into normal sea-water segmented or produced a larva. A few eggs were fertilized in the mixture of 50 cubic centimeters + 0.5 cubic centimeter n/10 NaOH, more developed in the mixture with 0.75 cubic centimeter NaOH, and a very large percentage was fertilized in 50 cubic centimeters sea-water plus 1.0 cubic centimeter n/10 NaOH. Eggs which were left in the same solutions without the addition of sperm neither segmented nor formed any larvæ. When the same amount of acid (HCl or CH₃COOH) was added to the sea-water no eggs were fertilized. It was therefore obvious that eggs of *Lottia* which could not be fertilized in normal or acidulated sea-water could easily be fertilized in alkaline sea-water.

The next question was whether the alkaline sea-water brought about the fertilization by modifying the egg, the spermatozoon, or both. It could be shown that the alkali rendered fertilization possible by modifying the egg. When eggs were put for several hours (4 to 6 hours) into a mixture of 50 cubic centimeters sea-water + 1 cubic centimeter n/10 NaOH and then put back into normal sea-water to which sperm was added, just as many—practically all the eggs—were

fertilized as if the sperm were added to the eggs in the alkaline sea-water. When, on the other hand, the sperm was put into alkaline sea-water and was added afterward to eggs that had been in normal sea-water, not a single egg developed. It was therefore obvious that the egg underwent a modification in the alkaline sea-water by which it became ready to be fertilized. This conclusion was supported by the microscopic examination of the eggs. The eggs which remained in normal sea-water and could not be fertilized had an irregular outline and were surrounded by a chorion. The eggs which had been put long enough into alkaline sea-water and could be fertilized had become spherical and lost their chorion. While these changes occurred in alkaline sea-water they did not occur in normal sea-water. After the eggs had once become mature in alkaline sea-water they, of course, remained so when brought back into normal sea-water and left there.

Was this influence of the alkaline sea-water upon the maturation of the egg a chemical or a physical effect? The influence of temperature upon the rate of the process of maturation renders a decision possible. We know that an increase in temperature accelerates the velocity of chemical reactions more rapidly than it modifies any physical quality. Eggs of the same female were put in two dishes each containing 50 cubic centimeters sea-water + 1 cubic centimeter n/10 NaOH. One dish was kept at a temperature of about 18 deg. C., the other at 8 deg. C. At various intervals some eggs of each dish were taken out, put into normal sea-water of 18 deg. C. and sperm was added. It was found that the process of maturation occurred about twice as rapidly at 18 deg. C. as at 8 deg. C. The individual eggs of a female do not all become mature equally rapidly in alkaline sea-water, so that at first the number of eggs which can be fertilized increases until finally all are mature. Moreover it is possible that the eggs whose process of maturation has been started to some extent in alkaline sea-water may complete it, though slowly, in normal sea-water. I first determined the time the eggs had to remain in the alkaline sea-water until fertilization became possible. The solution used was 50 cubic centimeters sea-water + 1 cubic centimeter n/10 NaOH. I found that this time was in one experiment for eggs kept at 19 deg. 40 minutes and for eggs kept at 8 deg. 105 minutes. When the following day the relative amount of larvæ was counted in the various lots taken out at different intervals the result was as follows:

Time of exposure to alkaline sea-water.	Number or percentage of larvæ found in watch glass full of eggs.	
	at 18 deg.	at 8 deg.
40 min.	1 larva	0 larvæ
55 min.	about 6 larvæ	0 larvæ
83 min.	about 12 larvæ	0 larvæ
105 min.	10%	2 larvæ
130 min.	40%	about 6 larvæ
205 min.	over 50%	about 12 larvæ
270 min.	over 75%	5%
315 min.		10%

I do not lay any stress on those observations where only a few, half a dozen or a dozen larvæ, were found in a watch glass full of eggs, inasmuch as an individual larva might easily be overlooked. But we notice that while about 10 per cent of the eggs become mature after 105 minutes' stay in alkaline sea-water at 18 deg., the same percentage became mature only after about 315 minutes at 8 deg. The temperatures chosen for comparison are no extremes and are within the limits where life and development are normal. None of the control eggs kept in normal sea-water at 18 deg. could be fertilized. It therefore seems as if the effect of alkaline sea-water on the maturation of the egg of *Lottia* were chemical and not physical.

It can, moreover, be shown that oxygen is necessary for the maturation of the eggs of *Lottia* in alkaline sea-water. Eggs of the same female were distributed into three lots; one was kept in normal sea-water as a control, two others were put each into 50 cubic centimeters sea-water + 1.1 cubic centimeters n/10 NaOH. One of these latter solutions was exposed to a current of hydrogen for four hours. After that time the eggs kept in alkaline sea-water in the presence of oxygen were all mature and upon the addition of sperm all developed into larvæ; while the eggs kept in alkaline sea-water in the absence of oxygen were all immature and none developed upon the addition of sperm. The experiment was repeated several times and special precaution was taken to wash the hydrogen before it went through the sea-water containing eggs so as to free it from all traces of acid. I convinced myself by titration that this source of error was avoided. None of the eggs left in normal sea-water were fertilized, although they showed after twenty-four hours a beginning of maturation.

A simpler way of showing the influence of oxygen upon maturation was this, to put a layer of eggs at the bottom of a long test tube filled with alkaline sea-water which was closed tightly. When the eggs were left in such a tube for five hours no eggs or very few were found ripe and could be fertilized; while the eggs of the same female when left in the same alkaline solution, but in a shallow dish and in a very thin layer, were about all ripe and could be fertilized after the same time.

Since it was possible that the HO ions acted catalytically I expected that the eggs of *Lottia* would mature also in normal sea-water if they were kept long enough. While this is probably correct the eggs did not become mature in the experiments I have thus far tried, even if they were kept for 48 hours in normal

sea-water. Some eggs were kept at 25 deg. for 6 hours in normal sea-water without ripening. The eggs became usually round after 24 hours and began to lose the chorion, but could not be fertilized.

The fact that very frequently during the last six months I was able to produce artificial parthenogenesis in the eggs of *Lottia* without being able to fertilize them with sperm, suggested the probability that the methods which cause artificial parthenogenesis must cause incidentally the eggs to ripen, since it did not seem likely that immature eggs could develop parthenogenetically. This supposition was found to be correct. Eggs of *Lottia* were put into solutions of 100 cubic centimeters sea-water + 18 cubic centimeters 2½ n KCl or NaCl and left there for from 40 minutes to 4 hours at a temperature of about 18 deg. C. When taken out from such a solution after about 1½ to 2 hours a small percentage of the eggs could, as a rule, be fertilized. KCl seemed to be a little more effective than NaCl and it should be stated that as a rule in experiments with hypertonic sea-water KCl is generally more effective also for the production of artificial parthenogenesis. Sodium acetate was a little better than NaCl, probably on account of the slightly alkaline reaction of the solution. When the eggs were kept too long in hypertonic sea-water they suffered and could no longer be fertilized.

These observations explain the fact that I was never able to cause more than about 5 per cent of the eggs of *Lottia* to develop parthenogenetically by treating them with hypertonic sea-water, the reason being that no more than that number were caused to become mature by this method. And, moreover, it explains the fact that the osmotic method of artificial parthenogenesis is not always successful in *Lottia*, since the hypertonic sea-water does not in all cases cause eggs to become mature. These observations on the influence of hypertonic sea-water on the process of maturation are of special interest since they seem to pave the way for the decision of another question that I have often alluded to in my papers on artificial parthenogenesis; namely, whether the hypertonic sea-water caused the development of the unfertilized egg by a merely physical or by a chemical influence upon the latter. At first I was inclined to assume that there existed a direct physical influence of the extraction of water from the egg upon the colloids in the egg and I used to discuss this possibility in my lectures more fully than in my papers, especially in connection with the work of Hardy. But at the same time a possibility of a chemical effect existed and could be accounted for by the fact that the loss of water on the part of the egg must alter the degree of electrolytic dissociation unequally for the different salts contained in the egg. One of the results might be a change in the concentration of the HO or H ions in the egg and this might lead to a catalysis of certain chemical processes. Since our experiments indicate that the influence of alkali upon the process of maturation is a chemical one, it is probable that the equal though weaker effect of the hypertonic sea-water upon the same process is also chemical. I intend to continue this line of inquiry.

It occurred to me to try whether a treatment of the eggs with a fat solvent, such as benzol, could not also cause the eggs to become mature. It was found, indeed, that when 1 cubic centimeter of benzol was added to 50 cubic centimeters of sea-water and an emulsion brought about by shaking the mixture, the eggs of *Lottia*, after having been exposed to this emulsion for from ¼ to ¾ of a minute, and put back to normal sea-water, became slowly mature within from 1 to 2 hours. If the eggs are left longer in this emulsion they undergo cytolysis. The benzol acted much better upon eggs that had been previously exposed for two hours to 100 cubic centimeters of sea-water + 16 or 18 cubic centimeters 2½ n NaCl than upon eggs that had been in normal sea-water, i.e., more eggs of the former were caused to become mature by the benzol treatment than of the latter. After the eggs treated with benzol had become mature they practically all developed when sperm was added. The eggs that had been treated with benzol matured in larger numbers in normal sea-water and in an abundant supply of oxygen than in sea-water through which a stream of hydrogen was carried. But the difference was not as striking as in the case of the eggs treated with alkaline sea-water. This may have been due, however, to the fact that the eggs mature much more quickly after treatment with benzol than during treatment with alkaline sea-water and therefore the initial quantity of oxygen present in the sea-water will last through a comparatively larger fraction of the time required for maturation in the former than in the latter case.

In view of the effect of benzol upon fats and lipoids I tried whether ether and esters (e.g., ethylacetate) did not act in the same way as benzol. The few experiments carried out thus far gave entirely negative results, though I do not consider them as final.

As far as the parthenogenetic development of *Lottia* is concerned, I may mention that the eggs that had matured in alkaline sea-water or in normal sea-water after benzol treatment never developed without the addition of sperm; nor was it possible to cause such eggs to develop by merely putting them for several minutes into 50 cubic centimeters of sea-water + 3 cubic centimeters of a fatty acid. In all the experiments on the artificial parthenogenesis of *Lottia* the treatment of the eggs with hypertonic sea-water formed an indispensable part of the procedure.

Through the application of the above-mentioned method it will be possible to utilize the material of *Lottia* with the same ease for at least six months of the year as has heretofore been possible only with the

* From University of California Publications.

† Through the munificence of Dr. Morris Herzstein, of San Francisco, a marine laboratory for biological research has been built and equipped at New Monterey, Cal. The work of the Physiological Department will be carried on in both the Rudolph Spreckels Laboratory in Berkeley and the Herzstein Research Laboratory at New Monterey.

material of Echinoderms. The larvæ produced from the eggs caused artificially to mature rise to the surface of the water and seem to be entirely normal.

SCIENCE NOTES.

A source of considerable loss in the operation of steam plants, particularly large ones, is the insufficient size of piping, causing the pressure to be reduced between the boiler and engine, and imperfect drainage, which is an enemy both to economy and the life of the engine. In many of the newer plants, it has been found a great advantage to install large receivers to equalize the pressure and to collect the water before it reaches the engine.

As the study of weight led to the idea of atoms, so the study of volume and density led to our idea of molecules. These molecules, which might be described as constellations of atoms, were a necessity with Dalton's conception; but, in a binary compound, for instance, they might consist of two atoms or of twenty. Now, it hardly needs to be recalled that Gay-Lussac, and especially Avogadro, in following the volume relations of gases in chemical action, drew the conclusion that the molecules of gases occupy equal volumes under identical conditions. Thenceforward we had a reliable method for determining the relative weights of such molecules.

The position of any spot on the earth's surface can be ascertained in two ways: either by careful measurement by means of an accurate system of triangles from another spot already fixed, or by independent observations of the heavenly bodies and calculations from them, which give the precise latitude and longitude of the place. The former is suitable for positions inland, but entails much time and labor, and is only adopted when a perfect map is to be made, for which it is the indispensable foundation. The latter can be carried on from a ship, and in most circumstances only from a ship, because of the limitations of the methods of determining longitudes. Longitude can now be satisfactorily and rapidly ascertained in two ways—by the electric telegraph or by use of chronometers. The places served by the electric telegraph are still few, and its use is therefore restricted; but the chronometer has been in working use for more than a hundred years.

The discoveries on sleeping sickness ushered in by researches of Castellani, of the School of Tropical Medicine, have been confirmed and extended by Bruce and his collaborators of the sleeping sickness commission. The relation of the flies belonging to the genus *Glossina* to the transmission of the trypanosomes is being actively studied, and many important questions we must hope are nearing their solution in connection with this most fatal malady. A contribution has just come to hand from Gray and Tulloch with regard to the multiplication of the parasites in *Glossina*, indicating that the belief recently expressed is warranted, namely, that the parasites undergo a cycle of development within the insects. Of importance in their bearing on the question of the development of trypanosomes in other than their vertebrate hosts are the investigations of Schaudinn on *Trypanosoma noctuae* in *Culex*, those of Brumpt on certain trypanosomes of fishes which undergo their cycle of development in leeches, and those of Prowazek on the rat trypanosome, which he has demonstrated undergoes development in the rat louse (*Haematopinus spinulosus*).

Of the many destructive agencies at work in the forests of the United States, fire holds first place, and the loss which it inflicts equals, if it does not surpass, that from all other causes combined. Insect hordes occasionally destroy large areas of valuable forest growth; wasteful and short-sighted lumbering methods, resulting from involved economic conditions, have brought about the rapid conversion of much of the finest timberland into unproductive barrens; and in the far West excessive and unrestricted grazing has seriously reduced the regenerative power of the forest and exposed vast areas to injury by flood and erosion. But great as is the damage from these causes, compared with fire they are of secondary importance. Further, it is to the fires which usually precede, accompany, or follow these other agencies that their most serious consequences are often due. Insect attacks often follow when fire has killed or reduced the vitality of timber; the cut-over timberlands of the Great Lakes and other regions would not present such a discouraging aspect had not fire killed the seed trees and young growth, which otherwise would have survived even the most pernicious logging; and in the forests of the West fire again is a potent source of difficulty in adjusting the conflicting claims of the grazing, timber, and water interests.

In 1901, Freidel made the surprising report of success in securing outside of the living plant a gas exchange similar to the photosynthetic action of chlorophyll. He was later unable to confirm his previous conclusions, nor were the subsequent results of Macchiata and Herzog concordant. Recently, Molisch has employed upon this problem the photobacterial method of Beijerinck. He finds that the expressed sap of certain plants may for a time maintain photosynthetic activity, but since usually the sap loses this power when filtered through a Chamberlain filter, it is believed to be due to the presence of living plasmatic particles. Nevertheless, it is claimed that an exchange of gases characteristic of photosynthesis may proceed in a solution of the leaves of *Lamium album* dried crisp at 35 deg. C. and then "rubbed up" in water and filtered. The observation demands much further study, for it must be

remembered that the test is by means of the liberation of oxygen, and Ewart has shown that some bacterial pigments may have the power of evolving oxygen. In the last-named case the gas evolved appears to be, as he states, "occluded oxygen absorbed from the air by the pigment substance excreted by the bacteria." It cannot be stated at the present time, however, as was assumed from Freidel's first work, that there is any enzyme concerned in the photosynthetic activity.

ELECTRICAL NOTES.

The discovery of Roentgen rays at once increased the claims of electricity to proper medical recognition. The demands for X-ray apparatus have kept the instrument makers busy from that time to this and the developments of the therapeutic uses of X-rays as well as the diagnostic uses have had the effect of overshadowing the rest of the applications of medical electricity so that they have been in danger of being forgotten by the general mass of the profession. The list of real gains in X-ray therapeutics is large and highly important. If we pass by the question of malignant disease, in which nevertheless X-rays may be of considerable value in prolonging life, we yet find a goodly list: rodent ulcer, lupus, psoriasis, chronic eczema, ringworm, syphilis, acne, pruritus, and leukæmia. All these may be confidently claimed as conditions in which X-rays give results of great value.

The maximum temperature which may be obtained theoretically by the combustion of carbon in oxygen is higher than that which has been attained in the electric furnace, but practical conditions place a greater restriction upon it. At high temperatures carbon cannot be consumed to CO₂, but rather to CO, and this gaseous product escapes rapidly and carries the heat away from the furnace. Further, it is impossible under practical conditions to supply pure oxygen, and in utilizing the atmospheric supply not only must the large quantity of accompanying nitrogen be heated, but the excess of air which must always be supplied also carries away a large amount of heat. The maximum temperature which has been attainable in the combustion of fuel in the gaseous, solid, or liquid form, from which volatile products of combustion are formed, probably does not exceed 2,000 deg. C., and even this value can be obtained only at a low efficiency and under most favorable conditions for the conservation of heat.

It is stated that the Continental Gesellschaft of Nuremberg has drawn up a complete project for a suspended monorail system analogous to the Barmen-Elberfeld road which is now operating successfully. The new line is intended to be run in the city of Berlin and will pass along some of the main streets and avenues. The total duration of the trip is to be 22 minutes, with stops on an average every 4.4 minutes. The smallest distance between stations is 2.8 minutes and the longest 5 minutes. A greater average speed is to be reached on the suspended road than is now used on the overhead and subway lines of Berlin, seeing that the cars are not obliged to slow up when going around curves in the case of the suspended system. The double overhead track will be supported either on each side of a T-shaped structure placed in the middle of the street, or else on a long beam support which passes across the street and is upheld at either side. The cars are to be about 50 feet long and will hold 85 persons, with smoking compartments, and will have a door at each end and one in the middle. The cars will be suspended about as in the Barmen-Elberfeld system. The trains are expected to transport 50 million passengers per year. Such a system is said to be more economical than other traction systems.

A great deal has been said by rival inventors as to the possibilities of wireless telegraphy, and some exaggerated claims have been made on their behalf which have led to counter-statements by some interested in other methods of communication. While, on the one hand, it may be fairly assumed that wireless telegraphy is not, under any circumstances, likely to supplant, or even to compete seriously with, inland methods of intercommunication, there is no doubt that there is a very distinct and important sphere of utility awaiting its further development. For intercommunication between ship and shore, and ship and ship, much has been done, although much remains to be done. For intercommunication between neighboring coasts there is also a possible future; but this depends almost wholly on the further development of the methods of syntonization, or tuning. There appears to be no doubt that in cases in which the wave-lengths used on two systems differ to a considerable extent, a very marked degree of success has been obtained in the avoidance of mutual interference. Where the wave-lengths, however, are not very widely apart in frequency, there is in each case a definite range within which interference arises, and simultaneous working is impossible. That the tuning methods will be improved there can be very little doubt. The progress that has been made between the year 1896, when it took a week to receive a few elementary signals over a distance of nine miles, and the present time, when such remarkable results have actually been obtained, is so great that it does not imply the possession of an unduly sanguine disposition if one ventures to predict further improvements, which may be expected to increase the freedom from mutual interference, the speed, and the reliability of this method of communication. It does not appear to be very probable that it will seriously compete with the highly-developed cable communication in the near future, although it may in many instances supplement that service.

ENGINEERING NOTES.

The proper and most convenient measure of boiler furnace efficiency would be the composition of the gases leaving it, as determined by analysis. According to the above definition, a furnace would not be a portion of some steam generating apparatus; for example, when a grate is located immediately under the boiler. In other cases, such as with many stokers, the furnace feature is only partially developed. With such fuel as anthracite coal or coke, a furnace would have a minimum value, and its maximum value would be realized with bituminous coal.

A collision recently occurred on the Uganda Railway, British East Africa, that would be possible nowhere else on earth. A huge bull rhinoceros rushed out of the bush and charged at full speed the so-called "up-mixed" train, which was slowing down as it approached the station Sultan Hamoud, 218 miles from Mombasa. The train was stopped, and the "rhino" was discovered about 100 yards down the track. Slowly he returned to the jungle, and was lost to sight. He did not escape unharmed, for pieces of his thick skin were found adhering to the train, but the fierceness of his assault smashed the engine step and splintered the inch-and-a-half footboard of the first carriage.—Railway and Locomotive Engineering.

Long-span bridges have, of late, not only become more numerous, but their length has been gradually increased, until the long-span bridges of former years are now considered spans of moderate size only. The necessity for the great number of long-span bridges in the United States arose from the fact that many wide navigable rivers had to be bridged where the interests of navigation demanded long spans, or where they were required on account of deep and expensive foundations, or on account of other conditions determining the length of spans. There are now in existence in America about fifty railroad bridges containing simple spans of 400 feet or more, eighteen of which exceed 500 feet, the longest one being the Ohio River Bridge at Louisville, with a span of 546 feet, completed in 1894; there are also a number of highway bridges exceeding 400 feet span. The length of spans practicable for simple trusses has not yet been reached.

The question is often asked whether in case of installing a certain horse-power of boilers, say 300 horse-power, it would be more economical to have three boilers of 100 horse-power each or two boilers of 150 horse-power each. By all means have the two larger units, as it will always be found that the larger boilers have less radiation, less air leakage, and better combustion than a corresponding horse-power in small units. If it is necessary to have a spare unit for cleaning, let there be another one provided of the same size. In regard to the pressure to be carried, it is well known that a high pressure gives a greater amount of expansion and better economy in proportion to the fuel burned. Even with simple engines in which it is not possible to obtain the full advantage of expansion, the high pressure of steam, which is drier and contains a larger number of heat units in proportion to the volume, gives the best results. Every boiler should be designed for not less than 150 pounds pressure per square inch. Even if it is not possible to utilize the full pressure, the boiler will be stronger, last longer, and be a better investment in the long run.

Of the manufacturing industry to which castor beans give rise in the United States, there is not much to be said. The activities of this industry have for almost a half century been limited to supplying the varying domestic demand for castor oil, for no noteworthy export trade exists and imports are of negligible quantities. The domestic uses of this oil, moreover, important as they are from an economic point of view, are peculiar, in that they absorb only moderate quantities. This is true even in the textile industry. However, there has been an increase, especially in recent years, in the demand in this country for castor oil. Notwithstanding the continuous decline for two decades past in the domestic crop of castor beans, additional capital has occasionally been attracted to the manufacture of this oil, and there has been some expansion in the total productive capacity, especially on the Atlantic coast. In the eighties a mill was erected in Brooklyn, in the nineties another was started in Boston, and within the last few years the manufacture of this oil has been taken up in Memphis, Tenn. But, beyond the mere fact of noting their existence, little significance attaches in this industry to a mere enumeration of mills. The irregularity of operation in some establishments, the long periods of inactivity in others, and a natural reticence among operators to reveal the workings of their plants render it impossible to form any exact idea from productive capacity of the country's actual output of oil. Moreover, except in 1899, no statistics as to the total castor-bean crop have ever been collected. The only factor in the annual supply that is known with exactness is the quantities imported. In recent years that factor has become very important. Instead of Kansas and Oklahoma, the chief source of supply is now the port of New York. In the fiscal year 1902-3 imports of castor beans into the United States amounted to 380,270 bushels, or potentially 760,540 gallons of oil; in 1903-4 the quantity imported amounted to 498,039 bushels, representing in oil 996,078 gallons. The domestic crop of castor beans, though statistically an unknown quantity, is known to have fallen greatly below the 150,000 bushels reported for 1899 by the United States census. Assuming the crop to have been a round 100,000 bushels in 1903, the quantity of castor beans available for manufacture in the year