

grand retrospective exhibit which is the *raison d'être* of the Exhibition of 1900; that is, to show to the world the progress of the past hundred years.

It is the intention of the Exposition authorities to beautify the grounds surrounding the Palaces of Art in such manner that the landscape will connect naturally with existing shrubbery and trees, giving a park-like aspect, which will harmonize with the famous promenade, the Avenue des Champs Elysées, immediately to the north.

Passing from this grand promenade and drive, through the new Avenue Nicholas II., to a point south of the Art Palaces, the visitor comes to the Seine, and to the extensive works now in progress on the new Alexander III. bridge, which will doubtless be one of the architectural features of the Exposition. The corner stone of this structure was laid in October, 1896, by the Czar of Russia. The architects of the bridge are Messieurs Cousin and Cassien-Bernard, while the construction is under the immediate supervision of Messieurs Resal and Alby. It is to be a single span bridge, 110 meters in length over all, with a width of 40 meters. While the main arch, naturally, will be of steel, the foundations will be of granite, though other stone will be used in the structure, even marble, in connection with bronze, with which some very beautiful ornamental effects will be produced. The general style is Louis Quatorze, with many statues and decorations; some of the models for which it was my pleasure to see in the workshops of the Exposition. Among the artists represented are Fremiet, Dalou, Gardet, Cordonnier, and others. During the construction period an iron foot bridge will span the Seine, just beneath which the work will go on. This foot bridge was built in sections and "thrown" or "launched" into position from the north side of the river. One of our illustrations shows its appearance when it had only extended as far as mid-stream. The other small illustration gives an idea of the solidity of the arch springing from the abutment. Beyond are arches to support the esplanade above, and in the distance are the walls of the great Art Palace. One peculiarity of the Alexander III. bridge is that the span is to have a rise of only one foot from ends to center.

The series of palaces on the Esplanade des Invalides will be devoted largely to exhibits in manufactures and the various industries. The United States has secured ground space in this portion of the Exposition, near the Alexander III. bridge, upon which to erect a building which will give about 15,000 square feet of space for various groups of exhibits.

On the Seine embankment, west of the Alexander III. bridge, will be placed some of the most interesting and beautiful structures of the Exposition. On the south embankment, between Pont des Invalides and Pont de l'Alma, will be constructed the Palaces of Nations, in the midst of which our own beautiful national building will have a prominent position. While the plans of this building show a structure worthy of this great nation, it is believed that one or two buildings, to be erected by other nations, will cost more money, as they will be veritable palaces. The United States building, which will house a few exhibits of national interest, will be the headquarters and home of all good Americans at the Exposition. A little further along, likewise on the south side of the river, between Pont de l'Alma and Pont de l'Éna, will be placed the Exposition building, to be devoted to army and navy exhibits, and beyond this the Palace for Commerce and Navigation. The United States will erect an annex near to this building on Quai d'Orsay, in which will be housed exhibits relating to our merchant marine and the United States Weather Bureau. The building has been specially planned with regard to the uses of the United States Weather Bureau, and a novelty in this exhibit will be a working Weather Bureau observatory on the roof, accessible to the general public by an easy flight of stairs leading to a tower, with exit on the roof level. The instruments on the roof are to be connected with those displayed in the exhibit hall below, in order that the public may be able to study every phase of weather observation and forecasting, including preparations for publication and the printing of daily reports.

Another prominent building, just beyond the Merchant Marine, is the Forestry and Fisheries building, almost under the shadow of the Eiffel Tower. On the north bank of the Seine, opposite to the palaces of the foreign powers, will be located the Palace of Horticulture and the Palaces of Social Economy and the city of Paris. The United States will have a very desirable location in the Horticultural building, and extensive arrangements are being made for the exhibits in this special department.

The work upon the new Seine embankments, upon which the buildings bordering the Seine will be constructed, has been in progress for many months. The manner in which the Seine is being encroached upon in order to give available space for these new buildings is shown in two of the small illustrations from photographs taken in the autumn of 1898 by the writer. Just beyond the proposed limits of the new embankment in the river double lines of piles are driven a few feet

apart and parallel with the shore. The space between is then filled in and a bulkhead is thus formed. Other bulkheads are raised at intervals, running from the main line of piles to the shore, and, after pumping out the water which fills a particular section, the masonry work is begun. The other small illustration shows the appearance of the completed embankment, the incline on the right being the line of the river prior to the improvement. Additional temporary foot bridges are to be built over the Seine to provide ample facilities for crossing the river from one part of the exhibition grounds to the other.

We have now reached the main portion of the Exposition, which may be designated as the Eastern Section, and which includes the Champ de Mars and the Trocadero grounds. The latter plot, lying north of the Seine, will be devoted to the groups of buildings forming the Colonies Exhibits, some thirty in number, not including the Palace of the Trocadero, which was erected for the Exposition of 1878.

By far the larger portion of the Champ de Mars is covered by a series of palaces, practically under one immense roof system, which will house the following groups of exhibits: Agriculture and food products, machinery and electricity, textiles and clothing, mines and metallurgy, chemical industries, civil engineering, education, science and arts, etc. Just north of this series of connected palaces stands the Eiffel Tower, to the left of which is the palace devoted to the monster telescope, illustrated in a recent number of the SCIENTIFIC AMERICAN. Mention should also be made of the Annex to Agriculture, which is to be erected by the American Commission, and which fully doubles the space originally allotted to the agricultural groups.

The old Palace of Machines which was used in 1889 is to be devoted to agriculture and food products, and will be known as the Palace of Agriculture. Nearly one-third of the central portion of the floor space of this structure, on Champ de Mars, is to be given up to the magnificent festival hall of the Exposition.

As previously remarked, the principal entrance, which is located very near the Place de la Concorde, and close to the Seine, will be in the form of a triumphal arch, upon the face of which will be emblazoned the arms of the city of Paris, while it will be surmounted by a colossal statue of Liberty. It is claimed that it will be possible to admit 60,000 persons per hour without difficulty.

Mr. F. E. Drake, Director of Machinery and Electricity for this country, states that the part which machinery and electricity will play in the coming Exposition is a more important one than ever assumed by these two great industries in former expositions. In a general way it may be said that but few important changes or improvements will be shown in the service of the Paris Exposition over the Columbian Exposition of 1893.

The great service power plant of the Exposition will occupy a favorable position in the main group of buildings. It will be installed immediately adjoining the space allotted for the exhibits of electrical and other machinery, and any benefits which might naturally accrue to the builder of machinery installed in the service plant will be accentuated by reason of its being located in close proximity to the exhibits not offered for regular service. The capacity of the boiler plants for the service of the Exposition will be approximately 20,000 horse power.

It is the Palace of Electricity to which all eyes will naturally turn at night, and as its main façade reaches across the entire width of the open plaza in the center of the Champ de Mars, splendid opportunity will be afforded for the attractive treatment of the architectural features of the exterior of this palace.

While the city of Paris will doubtless supply the "Midway" attractions, ad lib., there will be many novelties at the Exposition of 1900. Just across Avenue de Suffren from the Palace of Agriculture, there will be a mammoth wheel, some 25 feet higher than the famous Ferris wheel of Chicago, but built on a somewhat different principle. To the writer it appeared like a pair of mammoth suspension bicycle wheels, with swinging cars hung at intervals around the rims. It will be illuminated at night by electricity.

The Luminous Palace will be another novel feature, as it is said that it will be the greatest piece of glass and stained glass work ever produced. It will be over 100 feet in height. Its staircases are of crystal, and as electricity will be used for the lighting, the effect of a palace in fairyland will be produced.

Another novelty is the panorama of a tour of the world, which will require about 27,500 square feet of canvas. It will include a theater, cafés, etc.; and men and women of the countries represented will give performances in the foreground of the panorama. A history of costume has also been suggested, and "A Street of Paris" will doubtless be a little "Midway" all to itself.

There is no question but what the 1900 Exposition will be superior in its artistic decorations to any previous exposition, and stand as a monument of the remarkable skill and genius of the French nation in that direction.

#### THE HORNET AND ITS HOME.

In the study of nature we are bewildered by so many wonderful things that the real goes far beyond imagination; and the little insect we are about to look at through the eyes of original investigation presents such notable features of architectural construction in its home building that we can but wonder whence all this knowledge comes; for the hornet's nest is commenced in the early spring time by one lonely female hornet, who has succeeded in passing the winter buried in some old tree stump or rotten trunk, whither she repaired the fall previous, after impregnation, to hibernate until spring shall come.

When the warm rays of the sun succeed in making their presence felt in the hornet's hiding place, she becomes awakened to a sense of her duty, and repairs to a convenient place, be it bush or tree, and selects a site for her and her family's future home.

When a suitable place has been found, she goes to some old weatherbeaten log or rail, and gathers the wood fiber that has been set free by the elements, takes a mouthful, chews it, and mixes it with a peculiar caustic secretion of her mouth, whereby it becomes pasty, applies it to the limb, and thereby forms a nucleus for her home. This she continues to do until she has succeeded in forming twenty-four little cells or cups, which are intended for the depository of her eggs.

When this has been accomplished, she will put a covering over the nest for protection from weather. Then she will place an egg in each cell, and go on improving the home by putting another cover over the one already made, with sufficient space between the two to allow her to move about with freedom.

While these eggs are incubating she proceeds to tear down the first covering and make more cells from that material.

Meanwhile, the former eggs have materialized into tiny worms, which she feeds with small insects until they arrive at the period when the transformation from the worm or larva to the pupa or semi-insect takes place. Then she carefully places in the cell food enough to last the pupa until it matures into an insect, seals it over with a parchment-like substance, beautifully white, evidently understanding the law of the need of light for the development of the mature insect.

When the hornet comes from its cell, it does so as a full-fledged worker, and, without any previous experience, he goes to work straightway, and work of a royal kind he does. When these new-born workers come to the assistance of the lonely worker, she welcomes them by showing them every courtesy that a mother can. She leads them to the places where water and building material for the home construction are to be found.

The nest is of intricate workmanship, made from paper manufactured from wood fiber. It may be stated, in passing, that the hornets were the original discoverers of the fact that paper could be made from such materials, and the study by man of the hornet may have led him to adopt the same material, which discovery has since developed one of the greatest industries of the world, viz., the manufacture of paper from wood fiber.

Mr. T. W. Harris, in his interesting work, "Insects Injurious to Vegetation," published in 1852, says what sounds to our ears curious and interesting, viz.: "The hornets are natural paper makers, who are not obliged to use rags and ropes in the formation of their durable paper combs, but have applied to this purpose fibers of wood—a material that the art of man has not yet been able to manufacture into paper."

The insect has a scissors-like arrangement that protrudes out of the mouth, and the fine fibers that stand up from the surface of the weathered rail or log, like so many fine hairs, are clipped off, and, as before stated, are mixed with a caustic secretion of the mouth, and thereby become a paste.

The hornet, when leaving his home for more material, does so very deliberately, never seeming to be in a hurry. He will take a stroll over the nest and apparently chat with the other workmen, and, when he has loafed long enough, he will take his departure for more fiber. When he returns he reports to the master workman on the inside of the nest, then returns to where he left off and begins to force the pulp from his mouth by placing the edge of the work, already done, between his lips. His mouth opens vertically. He walks backward always in one direction, building up the leaf from the edge, and where he joined the fresh to the other material there is a distinct line, and from this mark you can tell precisely how many trips it took to make a complete nest, and the change in color of the material shows exactly when he changed his base of supplies.

No two insects work at the same portion of the nest, each one reserving a certain portion for himself, and no one dare encroach on his territory.

Different styles of architecture exist among the hornets, and there is a vast difference in the workmanship. Some do the work in a magnificent, workmanlike manner, building compactly and gracefully, while others

are careless both in form and manner of using material. Some nests will be full of nice little nooks and corners of exquisite design, while others will be built on regular lines with no effort at ornamentation.

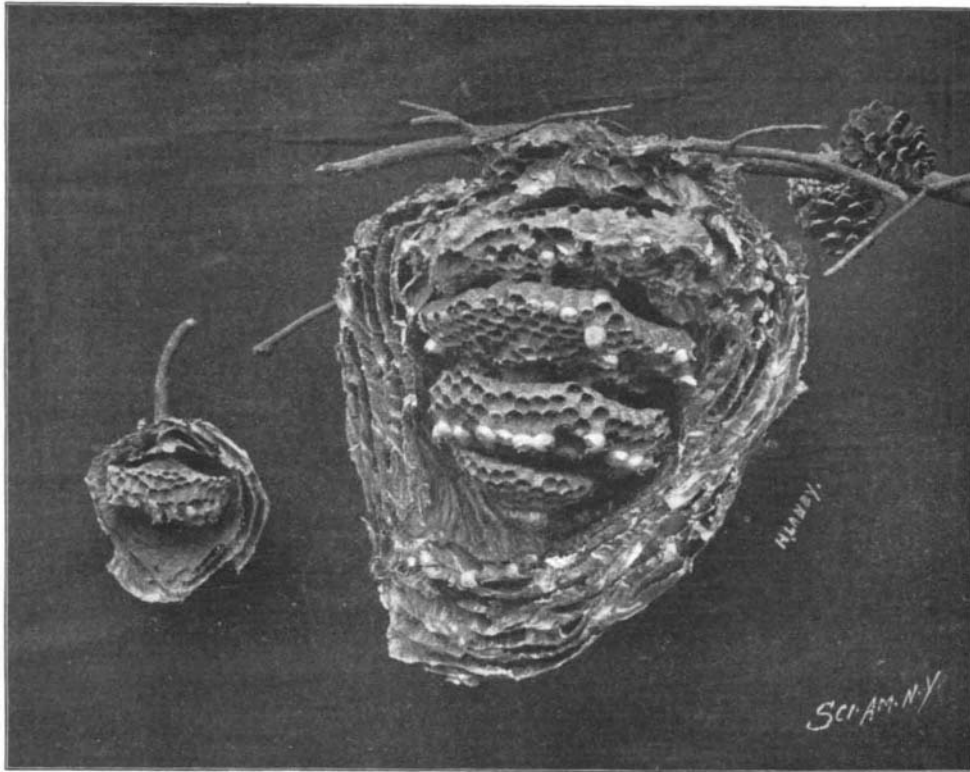
The site selected for the nest influences the style of architecture. Nests built on limbs of trees and bushes frequently include various branches with their leaves, the cells being always arranged in such a manner as not to be interfered with by the included parts of the tree.

If the nest is placed under the cornice of a house (which frequently occurs), the outside upper contour of the nest follows the line of the cornice, but the cells on the inside are horizontal.

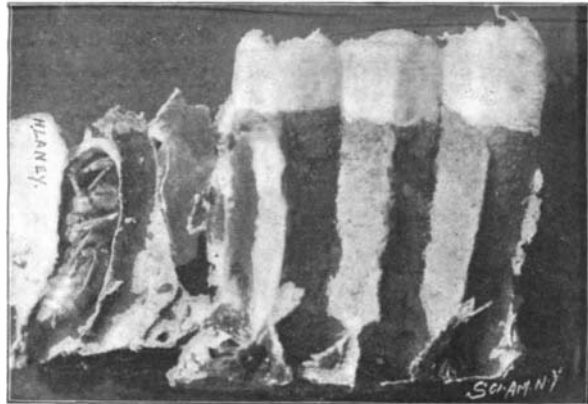
The hornet, like the bee and other insects of like nature, makes the cell of the most economical geometric figure, that of the hexagon.

They have three broods a year, which is ascertained by three fine linings that fill the cells; these are made of white material, one inside the other, in the following order: When the first young makes its exit from the cell, all the debris that remains from the shell of the previous larva is not removed, but a new bottom is placed over it, and a cup modeled up entirely independent of the original cell. This prevents any contamination from the filth left behind, and thus three, sometimes four linings, which can be removed from within each other without injury to either, are successively constructed. And the wonderful skill of making these linings perfectly free from each other, yet in perfect juxtaposition, must be seen to be appreciated. The heavy clublike antennæ are used in shaping these interior delicate cups.

The floor of each successive tier of cells is held to the previous one by tiny hollow columns which do not in-



SECTION OF HORNET'S NEST. BEGINNING AND END OF SEASON.



CELLS SHOWING WHITE CAPPING AND IMMATURE PUPA.

terfere in the least with the system of cells out of which they rise; for these little fellows never waste either space or material. The material used in these columns is much tougher (evidently intentionally) than that used merely for cell walls.

The hornets are quite rapid at the work. A nest measuring about twenty inches in length was set on fire by some mischievous boys who wanted to see some fun, and they saw it! Somehow the nest was not wholly consumed, only the outside covering burning away. The boys, nevertheless, concluded they had enough, and did not disturb the hornets further. The unroofed house was completely mended by the clever workers within four days. Cases are known where nests were almost completely destroyed by stones thrown at them, yet in a short space of time they were remodeled, showing clearly where the new parts were joined to what remained of the old structure.

Two nests are never found in close proximity to each other, as hornets do not swarm, but continue in one community for the whole season.

In these nests there is no place provided for the comfort of the mature insects, they having to rest themselves on the roof of the cell tiers, and the only intention of the nest seems to be for the purpose of raising the young. The nest is never used more than one season; in the fall it is abandoned. One very remarkable thing is that hornets seem to have the faculty of marking the direction of a missile that is thrown at their nest.

There is always at the entrance a sentinel who will note and give warning of the approach of an enemy, and when a stone is delivered at the nest, the hand that threw it has been marked as sure as the sun shines, and before the attacking party can possibly turn the head he will feel a stunning blow in the forehead, and possibly drop to the earth with pain, for

the hornet flies with such velocity at his enemy that the human body is not swift enough in its movement to get out of the way. Then the hornet flies with head and tail together, and the stinger is inserted deeply: but if the enemy gets behind a tree or bush,

and throws from there at the nest and keeps his hiding place, the hornet will not likely be able to locate him, as they seem to have no power of location but by sight.

The stings of the female or neuters of hymenopterous insects, such as the honey bee, the wasp, and the hornet, are much alike, but perhaps the sting of the hornet is more to be dreaded than that of the other insects similarly armed. The sting, to the naked eye, appears to be a single needle-like organ, but when examined under the microscope it is seen to consist of three pieces, as shown in the larger engraving, a short, stout cylindrico-conical outer sheath cleft through its length on the under side and obtuse at the end, within which are partly contained two long curved lances thickened at the end and furnished on one margin with teeth directed backward. The other margin is exceedingly sharp. These lances play within the sheath, and both the sheath and the lances can be protruded and retracted. A poison duct leads from a poison sac to the ducts opening between the teeth of the lances, as shown in the enlarged view of one of the lance points.

The effect of the poison introduced through the sting needs no description. Besides serving a defensive purpose, it is used also to paralyze its prey, so that it may be kept in store for future use.

Should you be taking a meal with a farmer and see a hornet come in at the window, do not hit at him or display any nervousness. It is not you he is after, it is smaller game. Watch him catch a fly and quickly tear off its legs and wings, then immediately make his escape through the window, with a morsel of food for the babies. They will attack insects very much larger

than themselves in mid-air. A locust, for instance, will be conquered in a few seconds by one of these rascals, and when they have overcome their prey, they will tear the wings and legs off, and quickly repair to the nest. Sometimes the fun that the boys intend to have at the expense of the hornets is reversed, as the following instance will show:

A number of farmers came across a nest in the field in which they had been working one hot summer day, and one of them suggested the fun of taking it home and burning it to see the struggles of the insects under the fire. The nest was duly plugged, the limb was cut and the branch thrown over the shoulder of one of the boys. The procession started. On the way one of the more venturesome ones slipped up under the nest, pulled the plug of grass out, but not quick enough for the carrier. Immediately the latter raised the nest high in the air hit the meddler over the head with the nest, and there was a mighty scramble for the tall grass in the immediate vicinity by the smart one, who had to do some tall wallowing before he got the hornets dislodged from himself, and when he came to dinner his mother knew him not.

The way to capture a nest so that there will be no danger from being stung is to locate the nest in the daytime. Do not disturb it until after dark. The hornets will then all be at home, and as the nest has but one exit, carefully plug

up this hole, carry the nest carefully to a box in which you have placed a few small pieces of cyanide of potassium. This box should be airtight. Place the nest in it, having the lid ready. Deftly remove the plug from the nest, close the box, and allow it to remain so for three or four days. When opened, you will find all will be dead except the pupæ, which will be found



HORNET, SHOWING STING.

sealed up in the cells, so that the fumes of the cyanide cannot get at them. Then you can watch the developing insects cut their way through the cover and come out. Then catch them and make investigations for yourself.

HERVY LANEY.

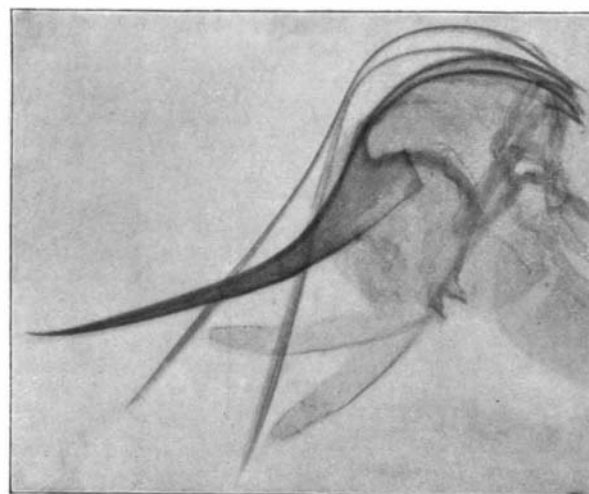
The Current Supplement.

The current SUPPLEMENT, No. 1214, contains a number of very valuable articles. "The Periar Dam" describes an important engineering work which is carried on by the government of India for irrigation purposes. "Dirigible Air Vessels" is an article by Carl E. Myers, the aeronautical expert. There is published in this number a very large collection of formulas for varnishes, sixty formulas in all, many of them being for varnishes which our correspondents are constantly needing. "The Preparation of Some Properties of Pure Argon" is an important paper by Prof. Ramsay and Mr. Travers. "Bacteria and Their Uses" is a popular lecture by Dr. Seneca Egbert.

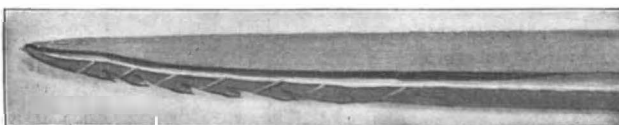
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STING SHOWING LANCES DETACHED FROM THE SHEATH. X 35 DIAMETERS.



POINT OF ONE OF THE LANCES. X 150 DIAMETERS. (STUDY FROM LIFE.)