THE BIOSCOPE—AN INSTRUMENT FOR THE STUDY OF INSECT LIFE.

BY EMILE GUARINI.

The highly-improved and powerful microscope, to which modern science is indebted for most important discoveries, and the value of which is inestimable in certain domains, is becoming inadequate for the prosecution of some lines of study. It is capable of revealing the inmost structure of minute beings that escape our sight, and of counting the number of cells of which they are composed, but it is almost impossible to observe with it the phases of the normal life of such organisms. How, in fact, can we say that we observe the normal life of an organism when, in order to examine it, we are obliged to bring within a fraction of an inch of such an organism an apparatus that cannot fail to frighten it? In order to observe the normal life of microscopic organisms another instrument is therefore necessary, a long-focus microscope capable of being used in cases in which the ordinary instrument becomes inadequate. It is such an instrument that has recently been devised by M. De Gasparis, of the University of Naples, and constructed by the Contaldi establishment of the same city.

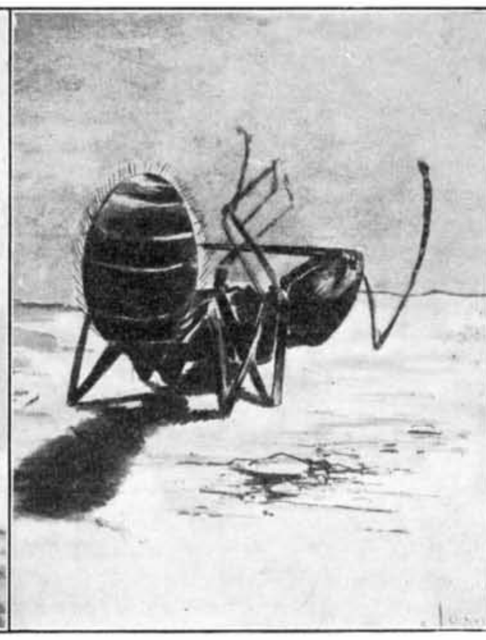
The apparatus, which is called a "bioscope" by its inventor, was recently exhibited to the Regio Instituto d'Incoraggiamento di Napoli. It is really a very long-focus microscope designed, as its name implies, for the study of the phenomena of animal life in all cases in which it is impossible for the observer to get close enough to the object that he is examining without running the risk of misinterpreting what he sees The apparatus therefore permits of obtaining the completest understanding possible of the normal life of insects, of the various manifestations of their intelligence, of their customs and habits, and of their relations with each other and the external world.

The apparatus, which is extremely simple, is shown in the first of the accompanying engravings. It is provided with a *camera lucida* to permit of the drawing of the objects observed. It consists of a tube with a rack provided internally with a system of achromatic objectives perfectly free from spherical aberration, and with a wide-field eye-piece. The apparatus is also provided with a system of mensuration and various arrangements for supporting diaphragms. At a distance of 19.5 inches, the microscope has a magnifying power of more than 12 diameters, say of 144 times the surface

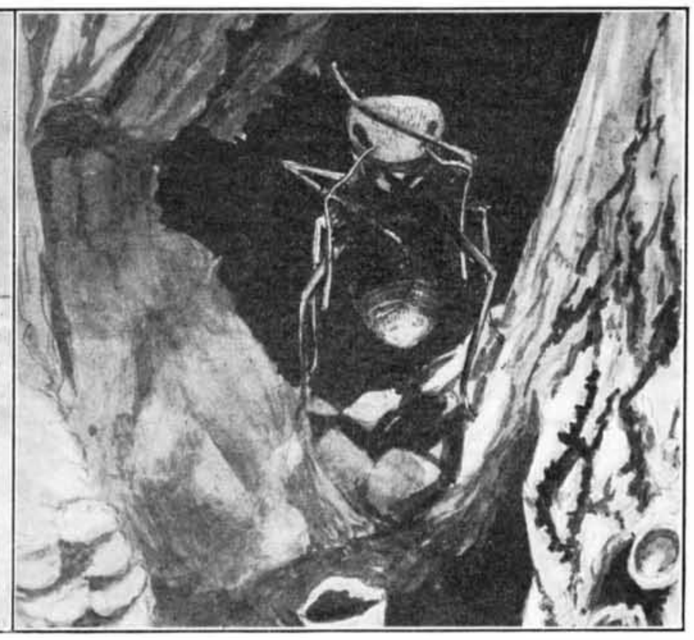
In the field of the bioscope, the astonished eye of the observer perceives a new world—a series of scientific surprises. Hatred, anger, joy, and love are depicted in the acts of the infinitely small; we distinguish their weapons and their wounds and observe their palpitating viscera through their sides, and see their minute bodies, in the last convulsions of the agony of death, trembling with a final spasm.

Ants furnish a particularly interesting field for observation. We see, in our various illustrations, an ant making its toilet at the entrance of a formicary covered externally with lichens and mosses; a battle be-

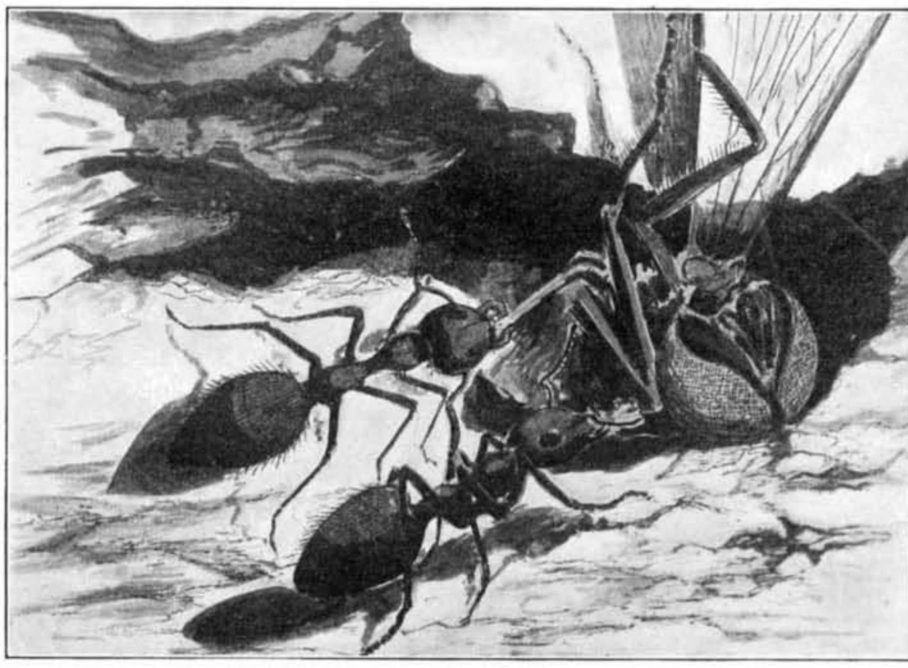
How the Bioscope is Employed.



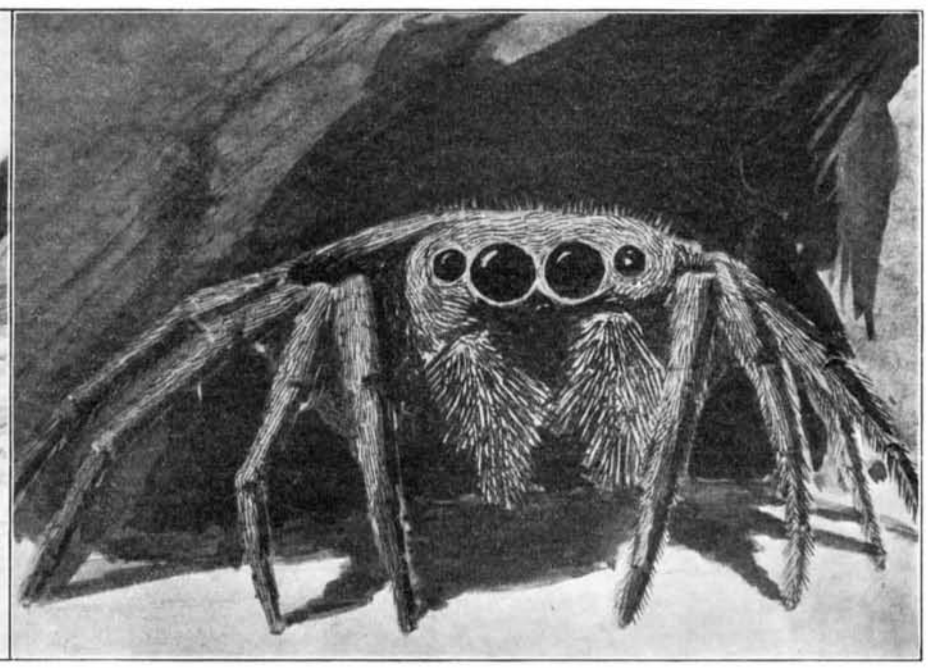
A Crippled Ant.



An Ant Cleaning Itself.

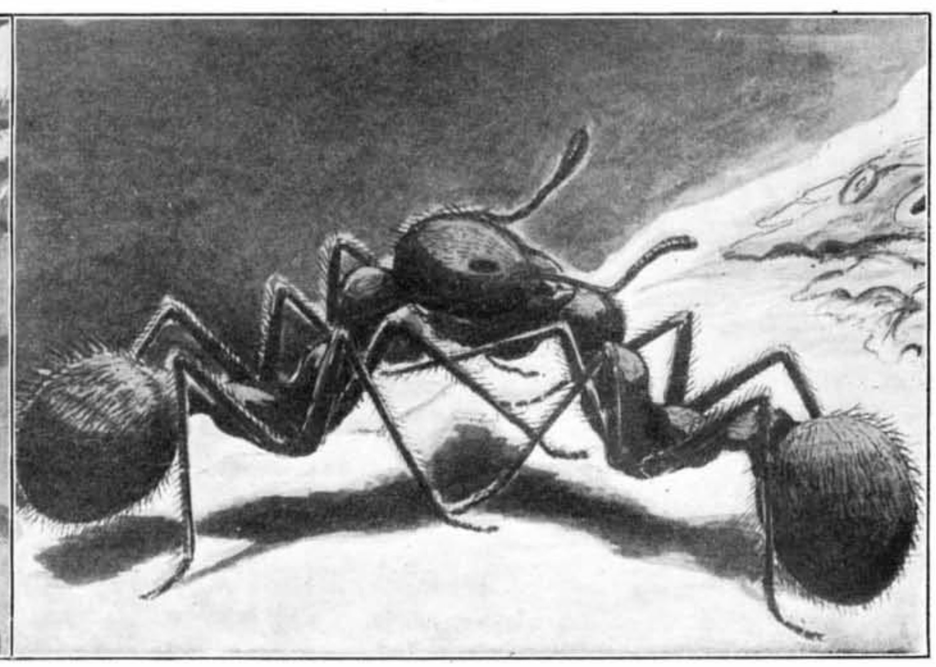


Two Ants Sharing a Victim.



Small Spider Preparing to Pounce on Its Prey.

What a Spider Looks Like Through the Bioscope.



The Fierce Battle of Two Ants.

DE GASPARIS'S BIOSCOPE—AN INSTRUMENT FOR STUDYING INSECTS.

tween two ants; an ant lacerating the abdomen of a fly; two ants sharing a large victim with each other; a sun-struck ant, etc. Spiders are no less curious objects for observation. We may see especially, with interest, the common leaping spider (*Satticus scenicus*) at the moment at which it is leaping from a fissure upon its prey, and remark its preparations previous to leaping, etc.

The struggle for existence among these small organisms takes on a character of almost human unsociableness. The smallest animals present themselves in the light of genuine monsters. Their rapid motions, evoked by no external cause, reveal their muscular power. The environment in which they live appears through the apparatus like a landscape with strange and fantastic forms, made attractive by multi-colored plants of which the transparent structure carries our thoughts into other worlds or toward the remote epochs of the prehistoric ages of our planet. The bioscope is no less valuable for scrutinizing the life of aquatic animals through the sides of an aquarium, or even in their natural element. It permits of studying bodies submitted to very high temperatures, electric discharges, etc. In the domain of medicine, it renders possible the observation, under a strong magnification, of dimly lighted cavities (the larynx, ears, etc.), and of formulating a diagnosis in many cases that have up to the present been doubtful.

The bioscope, therefore, cannot fail to give the sciences of observation a new impulse. It has the advantage over the microscope of not necessitating a knowledge of a special technique, delicate and difficult to acquire. In this respect it puts scientific observation within reach of the amateur, who, as there are many examples to prove, is not to be despised.

New Researches on Photographic Photometry.

BY THE BELGIAN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

MM. Carlo Cesari and Cesare Manicardi have recently made a very interesting double series of experiments upon photographic photometry, the results of which they have communicated to the Royal Academy of Sciences, Letters and Arts of Modena, and which are of too great importance to remain buried in the publications of this learned society, since the two new experimenters, contrary to the procedure of their predecessors, made it a point to conduct their researches in the interest of industrial practice. It is the result of such researches and the method employed for obtaining them that we shall endeavor to describe in the lines that follow.

A comparison between a standard source of light and any other luminous source may be effected by making a quantitative chemical analysis of a deposit of silver reduced upon a sensitized plate through the effect of light. In order, however, that the results shall present guarantees of accuracy, the operation must be performed very rapidly.

In order to obtain the most favorable conditions for their experiments, MM. Cesari and Manicardi decided to select a constant time of exposure; and for the purpose of obviating the inconvenience of the diversity of the images, the photographic objective was discarded and replaced by a system of lenses causing a parallelism of the rays that strike the plate at right angles. They also operated without any lens at all and caused the light to pass through the round aperture designed for the objective. In both cases, the results were exactly proportional. The first method, however, is preferable because it gives a sharper image upon the plate. The determination of the quantity of metallic silver liberated under the action of a source of light may be obtained directly or indirectly. The indirect method, instead of making known the quantity of silver liberated, shows the quantity that has not been reduced. It is based upon the dissolving action of hyposulphite of soda. Although it appears to be practical and permits of preserving the negative, it presents two drawbacks that compelled the experimenters to discard it. In the first place, there is no certainty that two plates contain exactly the same quantity of silver, and, in the second, the recovery of such silver requires a long and complicated operation. All that remains to be done, then, is to ascertain the quantity of reduced silver directly. With this object in view, the negative is treated with hot nitric acid, which converts the silver into nitrate and destroys the organic matter—the gelatine of the plate. The whole is then evaporated to dryness on a water-bath, and the residuum is taken up by dilute nitric acid. The solution obtained is very well adapted for volumetric quantitative analysis. Through treatment with chromate of potash and hydrochloric acid, diluted one-tenth, the results obtained are exact to within about a hundredth of a milligramme.

About fifty minutes suffice for obtaining the photometric results sought. The standard luminous source and the source to be studied are photographed under absolutely identical conditions, and then the determination of the reduced silver is proceeded with.

The following are some of the results obtained with this method. In order to obtain them use was made of Capelli plates and a system of biconvex lenses of 2 centimeters diameter and having a focal distance of 23 centimeters. A Carcel lamp of 9 English candle power was selected as the photometric unit. With this lamp, the experiments gave, for the silver reduced, an approximate value of 0.002 gramme, say about 0.00022 gramme per candle. With a gas flame, Bengel tube type, at a pressure of 15 millimeters, consuming 105 liters, and equivalent to the ordinary Carcel lamp photometer, there was obtained, in the first experiment, 0.0019 gramme, in the second, 0.00195 gramme, and, in the third, 0.0019 gramme of reduced silver.

A free bats-wing gas flame, with No. 7 burner, having a pressure of 28 millimeters and a consumption of 180 liters, and equivalent to the ordinary photometer at 1.2 carcel, gave 0.00242 gramme in the first experiment and 0.0024 gramme in the second.

A free gas flame, with No. 6 burner, with a pressure of 28 millimeters and a consumption of 125 liters, and a photometric value of 1 carcel, gave 0.0019 gramme of reduced silver in three successive experiments.

A circular tube gas burner, with a pressure of 28 millimeters and a consumption of from 200 to 250 liters, equivalent to a 1.8 carcel photometer, gave 0.0036 gramme in the first experiment and 0.0035 in two subsequent ones. Finally a No. 2 Auer burner with a mantle 1.5 centimeters in height, a pressure of 30 millimeters, a consumption of 110 liters, and a photometric value not exactly determined, gave 0.005 gramme of reduced silver in two experiments and 0.005 in another.

In the second part of their study, the experimenters made a comparison of various flames. For this purpose they employed panchromatic and orthochromatic plates with and without colored screens. The panchromatic plates were of the Lumière and the orthochromatic ones of the Capelli type. The *modus operandi* was slightly changed in order to prevent the rapid alteration of the nitrate. The negative, well washed with water, was placed in a porcelain tray containing nitric acid concentrated to a maximum, and provided with an opaque cover.

The nitric acid quickly destroyed the greater part of the organic matter, even when cold, and left the silver intact in the form of nitrate. The liquid thus obtained is not very limpid, but is very well adapted for volumetric quantitative analysis when it is diluted with distilled water. On the other hand, the analyses were made in employing a normal solution of chloride of sodium as a developing liquid.

Three experiments were made with the panchromatic plates. With the Carcel lamp the deposit of silver was respectively, in the three experiments, 0.004158, 0.004163, and 0.004161 gramme.

With a free bats-wing flame (consumption 125 liters, and equivalent to 1.5 carcel), the figures were 0.0061, 0.0063, and 0.00648 gramme of reduced silver. With a circular tube gas burner (consumption 200 liters, and equivalent to 1.8 carcel), 0.00701, 0.0072, and 0.00739 gramme of reduced silver were obtained. With an Auer mantle burner No. 2 (consumption 110 liters), 0.0225, 0.02245, and 0.0226 gramme of silver were deposited.

Two series of three experiments were performed with the orthochromatic plates, one with a grass-green screen, and the other with a bright orange-yellow one. With the first, the Carcel lamp gave respectively 0.002169, 0.0022 and 0.002142 gramme of reduced silver. With the free bats-wing flame (1.5 carcel), the figures were 0.0029, 0.00289, and 0.00291. With the circular gas burner (1.8 carcel), the figures were 0.0034, 0.00341, and 0.003402. Finally, with the Auer No. 2, 0.01001, 0.01, and 0.010002 gramme of reduced silver were obtained.

With the yellow screen, the Carcel lamp permitted of obtaining, respectively, in the three experiments, a silver deposit of 0.001854, 0.001852, and 0.001855 gramme. The free bats-wing flame gave 0.002012, 0.002169, 0.0022, and 0.002142 gramme of reduced silver. circular gas burner permitted of obtaining a silver deposit of 0.0031, 0.00314, and 0.003069 gramme. Finally, the Auer burner gave 0.0092, 0.009601, and 0.00902 gramme.

These experiments were supplemented by some others with ordinary plates. In these, as in the preceding, three were made with each luminous source. The results were not without interest. The Carcel lamp gave respective deposits of 0.002 gramme in the three experiments; the free bats-wing flame gave 0.0021, 0.00209, and 0.0021 gramme; the circular gas burner, 0.0032, 0.00324, and 0.00317; the Auer burner No. 2, 0.006, 0.00602, and 0.00589; the free flame of the Bengel type (1 carcel), 0.0019, 0.00195, and 0.0019; and, finally, another for bats-wing flame (consumption, 180 liters, and photometric value 1.2 carcel), 0.0028, 0.00282, and 0.0028 gramme.

In all these experiments the pressure of the gas was 28 millimeters. Among all the qualities of plates employed, those that behaved the best were the panchromatic ones. In the absence of such plates, it is possible to perform the experiments with orthochromatic ones with a bright orange-yellow screen, or, if this cannot be had, with a grass-green one; but, in the opinion of the experimenters, ordinary plates must be absolutely discarded as being capable of giving rise to greater deviations.

The results obtained may be very well represented in the form of diagrams of genuine industrial utility, although the curves are not absolutely accurate, on account of the small number of datum points. The accuracy is sufficient, however, for the requirements of ordinary and especially industrial practice.

The Electric Welding of Chain.

BY LESLIE B. POWELL.

Electricity, long acknowledged to be the most important factor in modern manufacture, is being almost daily adapted to new uses, and in most cases revolutionizes the various processes of previous manufacture. Especially is this the case in the recent adaptation of electric welding to the making of chain, doing away entirely with methods thought to be the most modern and labor saving; introducing a process that cheapens the cost of production, and raises the quality of the product.

To a native of France, Eugene François Giraud, belongs the honor of first adapting for commercial use in the manufacture of chain, the principles underlying the science of welding by the electric current. Used in connection with M. Giraud's electric welding machine, is his machine for forming links, an ingenious and complicated device, into which the wire rod is fed and automatically cut and formed into links. As each link is being formed, it is hooked through the link previously formed, so that the links emerge from the chain-making machine cut, formed, and linked together ready to weld.

An important feature of this machine is that the links made thereby are absolutely uniform in dimension and free from twist, and as the process of welding does not in any way alter the shape of the link, the result is a chain with every link exactly alike, increasing its commercial value.

The links thus formed are fed from the chain-making machine directly into the electric welder, where every other link is welded on the first pass through the welder, and the alternate links on the second and last pass.

This is necessitated by the fact that the links present themselves alternately in horizontal and vertical positions, and the welding machine can weld the horizontal links only.

The links are so formed in the chain-making machine that the two ends of the link to be welded are on the side of the link, with a space of probably not over 1-16 of an inch between the ends, which are cut at right angles with the length of the rod in such a manner that they can be "butted" together to be welded.

As each link reaches the proper position, it is firmly seized by jaws, and the ends of the link to be welded brought tightly together. At the same time, two dies are operated so as to close on the link at the point where it is to be welded; and the moment these two dies touch the link, the connection is made, bringing the parts of the link between the dies immediately to the welding heat.

By means of the pressure and the heat, the link is thus welded in such a manner that the welded portion of the link is as perfect as the rest of the link, with the exception of a slight ridge formed by the pressure.

As soon as welded, the link is carried automatically forward to a point where, by blows of a die, the ridge is reduced to the size of the balance of the link.

As this latter operation is taking place, the succeeding link is being welded, and so on indefinitely.

There are numerous features about this process of chain manufacture which tend to make it of extreme commercial value. The absolute certainty of the weld, and the fact that there is no waste heat, is an important item.

Skilled and high-priced labor will be done away with to a great extent, the cost of manufacture greatly reduced, and the daily production increased, one welding machine turning out about 18,000 links of 5-16-inch chain per day, equal to about 2,000 pounds in weight.

The current required for operating one machine is not more than 24 watts per square millimeter of double section of material used.

A great amount of time and money has been spent in experimenting, in order to make chain without welding, but to no practical avail; but here we have a process that guarantees a perfect weld, perfect links, and enormous production at a cost which is less than the most inferior chain to-day can be made under.

Steps are now being taken by prominent chain manufacturers in this country toward installing this process of chain manufacture.

It is stated that M. Pelletan has signed an order to begin building ten defensive submarines. Six of the small boats, which will not weigh more than 44 tons, will be constructed at Cherbourg and four at Rochefort.