

The senior entomological laboratory is 28 by 72 feet and has tables for 75 students, and the graduate laboratory will accommodate twenty.

The building is lighted by electricity and heated by steam from the central heat and light plant of the college.

The building was constructed from an appropriation of \$80,000 for its erection, and \$15,000 for equipment, this sum also including equipment in zoölogy.

Though entomology, zoölogy and geology are at present located in the building, it is understood that when the growth of the subjects requires it, the last two will be transferred to other quarters, leaving this as the Entomological Building.

The equipment in entomology includes microscopes, microtomes, and all the other apparatus usually required for such work, and an unusually full supply of books, journals and literature.

The dedicatory exercises were held November 11, and consisted of an address by Dr. W. E. Hinds of the Alabama Polytechnic Institute on the history of the Departments of Entomology and Zoölogy at the college, and the Dedicatory Address by Dr. L. O. Howard of the U. S. Bureau of Entomology.

H. T. FERNALD.

[We understand that the excellent address by Doctor Hinds will shortly be published by the Massachusetts Agricultural College, while the admirable résumé of the development of entomological work in this country by Doctor Howard appeared in full in the issue of *Science* for December 2, 1910.—ED.]

SCUTELLISTA CYANEA MOTSCH.

By H. J. QUAYLE, *Southern California Laboratory, Whittier*

Scutellista cyanea Motsch. is the most important insect enemy of the Black Scale (*Saissetia oleæ* Bern.) in California. This insect was introduced into the state in 1900 by the U. S. Department of Agriculture through Dr. L. O. Howard of the Bureau of Entomology. It is now well distributed in all parts of the state where the black scale occurs in injurious numbers. The percentage of scales parasitized also runs very high, amounting in many cases to 75 or 80%. But this varies greatly in different sections and in the same section in different years.

In spite of the frequently high parasitization by *Scutellista*, the

black scale still remains the most important citrus insect pest in the state. Taking the citrus belt over, more control work is directed against the black than any of the other scale pests. And, with all this control work, according to a statement by G. Harold Powell of the Bureau of Plant Industry, in 1908, from $\frac{1}{3}$ to $\frac{1}{2}$ of the oranges of California were washed because of the sooty mold fungus resulting from black scale infestation.

While, therefore, this parasite is well distributed, and the percentage of scales attacked is often large, as parasitization goes, yet, from a commercial standpoint, at least, the *Scutellista* is not often a very important factor in the control of the scale. Of course, in many places the *Scutellista* may not be abundant enough to check the scales. But again where they are most numerous the scale continues to thrive. There is not, therefore, necessarily a direct relation between the abundance of the parasite and the scarcity of the scale. It is not unusual to find the greatest parasitization where the scales are most abundant; and, again, where the scales are scarce there may be very few *Scutellista*. This might be answered by the fact that the *Scutellista* being an egg parasite affects only the progeny, and that the scarcity of scales should be attributed to the abundance of the parasite during the previous year. This may sometimes be the case, but there are often other and less tangible factors at work.

Many have been accustomed to judge of the efficiency of the *Scutellista* on the basis of the number of scales with exit holes, but this is not the only criterion. Since the *Scutellista* is an egg parasite, the real test of its efficiency is in its ability to prevent young from appearing. It might seem that this is directly related to the number of exit holes in the parent scales, but this is not necessarily so. A black scale may lay from 300 to nearly 3,000 eggs, the average number being from 1,500 to 2,000. A *Scutellista* larva will mature on the minimum number of eggs, but, if they are available, it will of course consume many more. But the *Scutellista* larva often does not consume the maximum number of eggs, so that in large healthy scales there may be several hundred young that will appear in spite of the presence of *Scutellista* larva. It is because of this failure to consume all of the eggs, in the case of the larger scales, and the fact that from each one of the 10, 15 or 25% of the scales not parasitized, there may appear 2,000 or more young, that a tree may continue to be badly infested, notwithstanding the large number of scales with exit holes. This may explain why more than 700 young black scales were counted on a single orange leaf growing from a twig that had 75% of the parent scales parasitized by *Scutellista*. On the other hand, where the scales are small or of medium size, the *Scutellista* consumes all of the eggs,

and must be an important factor in reducing the numbers for the succeeding year.

Since the *Scutellista* is generally distributed throughout the citrus belt of Southern California, little can be gained by turning loose a half dozen specimens in a grove of 10, 20 or 40 acres where there are already many hundreds or thousands, except for the moral effect on the grower. Sometimes the scale may largely disappear the following year, and sometimes the *Scutellista* may be a great help in this decrease, but in such cases it is on account of those already present in the grove rather than the supposed great impetus given by the half dozen introduced. Of course the artificial introduction of *Scutellista* in places where they do not occur, or are not well established, should be greatly encouraged.

The good that might result from the introduction of *Scutellista* is often rendered negligible because the scale is not in the proper stage to be attacked. With such introductions in most places in southern California during July and August, or even later of this year, nothing was left for the *Scutellista* but to perish. At this season all the eggs, or nearly all, had hatched and the parasite will not oviposit on the young scales. This is true also of those already present in the grove and hundreds or thousands must perish unless they find some scale out of season with those that have been attacked. Indeed, this is the most serious matter in the whole *Scutellista* economy and is a great drawback to their rapid multiplication. This parasite was hardly intended to depend, exclusively on the black scale, where there is a uniform hatch of the insect. Fortunately in most parts of California, and possibly other places where the black scale occurs, there are enough of the so-called "off hatch" to maintain the parasite until the bulk of the scales are in the proper stage again.

LIFE HISTORY AND HABITS

The egg is pearly white in color, ellipso-cylindrical in shape, with tapering appendage at one end. The length of the body of the egg is about .37 mm. and the appendage about one half that length. The eggs are inserted beneath the scale, usually under the arch at the posterior end. The scale need not necessarily be in the egg stage, for eggs have been found both in the field and insectary under scales that had not yet reached the egg-laying stage. The hatching period during the summer months is 4 to 6 days.

The young larva upon hatching soon begins to feed on the eggs of the scale by sucking out their contents, or, if eggs are not present, it attacks the insect itself. Several cases have been observed where

the larva had grown to considerable size under a scale that had not yet laid eggs. It is not, therefore, strictly an egg feeder, as generally supposed, but of course eggs constitute the normal food. Larvæ have been reared from the Soft Brown scale (*Coccus hesperidum*) in which cases no eggs were consumed for this scale lays no eggs. Larvæ have also been seen feeding on others of its kind. This cannibalistic habit must be rather common for in nature cases must often occur where several eggs are deposited under the same scale. This is not usually done by the same insect but by different individuals, as explained later.

The full grown larva preliminary to pupation hollows out a cell in the old egg skins and mats them together more or less with a small amount of silk. Strands of silk are also frequently, or usually, spun from the twig to the inner edge of the scale. Whether this is done in an effort to enclose itself on all sides with a small amount of silk, or whether it is an instinctive provision to assure the old scale adhering to the twig during pupal life, or both may only be conjectured. But it is a common conclusion that old scales harboring *Scutellista* pupæ are not lifted from the twig so readily as those not parasitized. Black scales that have been parasitized by *Scutellista* are more likely to remain longer on the tree than those that are not. These may remain on the tree for two or three years in many parts of Southern California where there is but little rain or wind to dislodge them. This fact is not often taken into consideration in estimating the amount of parasitization, so that those scales with exit holes increase with each year's infestation, while those without exit holes are more likely to drop off.

The amount of food consumed or the number of eggs of the scale necessary to bring the larva to maturity varies greatly. A scale has not yet been found too small to have a *Scutellista* pupa. The smallest mature black scale has been found to be less than one half the size of the largest. The smallest may have a maximum of 500 eggs and the largest from 2,700 to 3,000. The size of the mature larva varies greatly, according to the abundance of eggs, and likewise the adult. Males, of course, are much smaller than the females and there seems to be a preponderance of males in the smaller scales. No eggs hatch in the case of the smaller numbers of eggs, but several hundred may hatch in the case of the larger numbers. The length of the larval period varies from 16 to 21 days during the summer season.

The mature larva is white in color, with the darker gray of the digestive tract showing through the body wall in some of the specimens. The average size of the full grown larva is about 3 mm. and the width about 1 mm. It is broadest at the head end, while there

is a gradual tapering toward the posterior end. The external mouth parts consist of a pair of sharp pointed chitinous hooks which are used for piercing the egg shell or the body wall of the scales.

The pupa is almost jet black in color, having changed very quickly from that of the white larva. The length of the pupa varies from 1.5 to 3 mm. The large scutellum extends to the posterior margin of the second abdominal segment. The duration of the pupal stage is from 16 to 19 days. The most usual number under a single scale is one, but not infrequently two are found, more rarely three, and in but one case out of several thousand scales lifted, four pupæ were found in four separate cells beneath a single scale.

The adults upon transforming from the pupa eat out a round hole usually on the dorsal surface of the scale. They may remain a short time beneath the scale before emerging, since occasionally upon lifting a scale the mature insect will be seen to escape. They have been observed to oviposit within 24 hours after emerging. The ovipositor is inserted almost invariably under the arch at the posterior tip. Sometimes two or three insertions are made and the egg deposited, all within about half a minute. Oviposition has been observed to occur under scales from which all the eggs had hatched, under scales already occupied by *Scutellista* larva, under scales where not enough eggs remained to bring the larva to maturity, and where the young had hatched but died before emerging. In the field oviposition has been noted where the scales had not yet reached the egg laying stage, the so-called "rubber stage," and in the laboratory under forced conditions it has occurred on scales after the first molt. Oviposition has not been observed, even under laboratory conditions, in the case of very young scales. Several eggs may be laid in succession but these under different scales. Other individuals will lay eggs under these same scales and this probably accounts for two or more larvæ under the same scale.

Mr. E. W. Rust of this laboratory has apparently determined that this insect may reproduce parthenogenetically. Mature black scales with eggs were allowed to remain for a week under cover in order to allow any chance for *Scutellista* eggs that might be present to hatch. In the meantime several pupæ were put each in a separate box and the adults allowed to mature. Two of these unfertilized females were placed in a vial containing a twig with a single black scale. Several days later the scale was lifted and two *Scutellista* eggs and four newly hatched larvæ were found. Since the eggs hatch in from 4 to 6 days, the eggs and larvæ present must have come from the *Scutellista* liberated. Parthenogenetic reproduction is not necessarily common for the number of the sexes is approximately equal, and often even a slight excess in favor of the males.

The length of the adult life is from 9 to 12 days. Adults died within this period whether they were confined in a pill box with no food, or under practically natural conditions. Thus far they have not been seen feeding. It is possible that they feed on the surface tissue of the orange or something else, but this has not been observed. But that little food, if any, is taken in the adult stage seems likely, from the fact that the adult life is the same whether confined without food or in the presence of its probable food supply.

The stages and abundance of *Scutellista* are very much dependent upon the same conditions in the scale. Since the black scale is at the height of egg laying in this section in June, it is then that *Scutellista* larva or pupa will be most abundant. The period of greatest emergence of adults is during July. Many fail to lay eggs at this time because the scales are too young. It is necessary to find a scale out of season with the ordinary brood which developed the *Scutellista* in order for eggs to be deposited and the species perpetuated.

The number of broods in a season is not well defined. One record from egg to adult will serve to indicate the length of life and duration of the different stages. Egg laid July 22; egg hatched July 27; pupated August 12; adult emerged August 26; adult died September 4. The egg period is thus 5 days, larval 16, pupal 15, adult 9, or a total of 45 days for the life cycle from the egg to the death of the adult. If the scale were in the proper stage at the end of each generation there would appear from 3 to 4 generations of the parasite during the summer months, that is from May to September inclusive, and there may be 2 or 3 generations also during the winter season, but on account of the unfavorable conditions of the scale 4 or 5 will probably be nearer the actual number.

ON SOME PHASES OF PARASITISM DISPLAYED BY INSECT ENEMIES OF WEEVILS¹

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In a recent article Mr. W. F. Fiske² has defined a certain phenomenon as superparasitism, which has hitherto been recorded by the present writer as accidental secondary parasitism.³ In defining this

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²W. F. Fiske, *Superparasitism: An Important Factor in the Natural Control of Insects*. Journ. Econ. Ent., Vol. 3, pp. 88-97, February 15, 1910.

³W. D. Pierce. *Studies of Parasites of the Cotton Boll Weevil*, U. S. Bur. Ent., Bul. 73, p. 33, January 21, 1908.