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THE PURPLE SCALE

By H. J. QUAYLE

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THE PURPLE SCALE.

Lepidosaphes beckii Newm.

By H. J. QUAYLE.

EARLY HISTORY.

The purple scale, *Lepidosaphes beckii*, was first made known by Newman in an account appearing in the English publication "The Entomologist" in February, 1869.¹ In August of the same year Packard² in this country gave a brief description of the same insect, calling it *Aspidiotus citricola*. Newman had given it the genus name *Coccus*, which has since been changed, while his species' name *beckii* still stands. From 1870 to 1876 a few articles appeared on this insect in France and Italy. Glover has the second notice of its occurrence in the United States in the United States Department of Agriculture Year Book for 1876. He stated that it was found on imported lemons in Jacksonville, Florida, in 1857.

The description of this insect given by Packard was made simply from unpublished figures and, of course, was inadequate. The first complete description was given by Comstock in his 1880 report, but he adopted the same specific name as that given by Packard.

Introduction into California.—The purple scale seems to have been introduced into California directly from Florida in 1888 or 1889. In the report of the California State Board of Horticulture for 1893 Alexander Craw states that "four years ago two carloads of orange trees were received in this State from Florida and planted in Los Angeles and San Diego counties without disinfection. The result is that the climate that has been preached us by importers of Florida stock as unfavorable to the development of this species of scale has proved to be the opposite, for on a visit to the above counties last summer I was shown trees completely covered with purple scale." The May number of the *Rural Californian* for 1889 was largely occupied with discussions of the probable damage which would result from the importation of Florida scales, among which the purple was the most important. Dr. Riley, writing in *Insect Life* in 1889, states that "we have received a number of letters from California asking our opinion on the necessity for quarantine, and have replied that while there seems reason to believe, and we are inclined to believe, from the evidence at hand, that the scales men-

¹The Entom. IV, p. 217 (1869).

²Guide to the Study of Insects, p. 527 (1869).

FIG. 1.—Map indicating distribution of purple scale over world.

tioned will not flourish in certain parts of southern California, like Riverside, where the heat and dryness are great, yet it will be unwise to depend too much on the limited experience of the past. We have, therefore, reiterated our convictions as to the necessity of using every precaution to prevent their introduction."

FIG. 2.—Map showing distribution of the purple scale over the southern California citrus belt.

DISTRIBUTION.

Over World.—The purple scale is widely distributed over the world, as reference to the map will indicate. The localities as represented by the +s on the map are as follows: Europe, Maderia, West Africa, Mauritius, Ceylon, Japan, Australia, Tasmania, New Zealand, Fiji, Hawaiian Islands, Bermuda, Java, West Indies, Paraguay, Florida, Louisiana, Colorado, and California.

The Paraguay locality given above is based upon material received in July, 1911. Mr. C. F. Mead collected some orange leaves that had a sickly appearance from Pirapo, Paraguay, and sent them to Professor Coit of this station. The leaves proved to be infested with typical purple scale. Hitherto there have been no published records, to our knowledge, of this scale occurring in that locality or even on the continent of South America.

In California.—At the present time the purple scale occurs in the following counties in California: San Diego, Los Angeles, Orange,

Ventura, and Santa Barbara. It does not occur, thus far at least, in the citrus sections of the San Joaquin and Sacramento valleys. Neither does it occur in Riverside or San Bernardino counties. From its distribution in the above coast counties it would appear that it thrives best in a cooler and moister climate, and in this respect it is similar to the

FIG. 3.—Half of orange tree defoliated by purple scale.

black scale. But the fact that it does not occur in the warmer and drier locations may be due to the very rigid quarantine that has prevailed against this scale in those sections. Its present eastern limit, or distance from the coast, is in the eastern part of Los Angeles County, but here the climatic conditions approach that of the still more interior sections

of Redlands and Riverside, so that there are no well defined climatic zones, and therefore it is not improbable that the purple scale would establish itself in those sections.

ECONOMIC IMPORTANCE.

Considering the scales of the whole of the southern California citrus belt, the purple is probably entitled to rank as the third most important. Its distribution is not so general as that of either the black, red or yellow, but where it does occur it is the most serious of them all, because it yields less readily to treatment. Where this scale occurs among others, fumigation work is directed primarily against the purple, and usually successful treatment against it readily controls the red or black scales.

The purple scale infests leaf, branch and fruit, often becoming completely incrustated upon these, but it is usually only a portion of the tree that becomes thus infested. The lower side or interior of the tree is where the insect thrives best, and here it is that the injury is most evident. We have never seen the greater part of a citrus tree actually killed by this scale, but a goodly portion of one side or the lower and interior branches are very frequently thus killed. The scale causes a marked yellowing of the leaves and there is consequently a heavy dropping so that many of the branches will be completely denuded.

The injury is due directly to the feeding, as is the case with the red scale, since no honeydew is excreted. The scales on the ripening fruit often have a tendency to delay the coloring, and a marked green spot will be seen about the scale while the rest of the surface is yellow. On account of their firm attachment to the fruit they are with great difficulty removed therefrom, so that the ordinary brushing or washing of the packing-house has little effect upon them.

The economic status of this scale is due largely to its resistance to such treatments as fumigation or spraying. It is not a particularly prolific insect for the maximum number of eggs will not exceed eighty, and there are not more than three, or at most four, generations a year. It is in the egg stage that it is most resistant to fumigation. This must be largely on account of the very complete protection afforded the eggs by the secretion of the ventral scale, which together with the dorsal scale completely envelops them. The only opening is at the posterior tip where the young upon hatching emerge. It has frequently been noticed that in cases of incomplete fumigation a few eggs at the extreme tip will be killed by the gas while the more interior and better protected ones will remain unharmed.

FIG. 4.—Orange leaf infested with purple scale. x2.

FOOD PLANTS.

Lepidosaphes beckii is essentially a citrus fruit scale, and while it may occur on several other plants, it is restricted as a pest in California entirely to the different varieties of citrus. Fortunately, it does not

FIG. 5.—A cluster of oranges badly infested with purple scale.

attack, or at most but very rarely, any of the common trees or shrubs growing in the vicinity of citrus trees, so that the problem of treatment and control is limited to the commercial grove.

The complete list of food plants from which *Lepidosaphes beckii* has been recorded is as follows: Orange, lemon, citron, grape fruit, fig, olive, croton, oak, *Elaeagnus*, *Banksia integrifolia*, *Taxus cuspidata*, *Cercidiphyllum japonicum*, *Pomaderris apetala*.

FIG. 6.—Purple scale after first molt, and mature female. x90.

DESCRIPTION OF THE STAGES.

The egg is oval in shape measuring .25 mm. long and .15 mm. broad. The color is pearly white with the surface very minutely granulate.

FIG. 7.—Active larva of purple scale. x35.

The active larva is a flat, oval-shaped creature, white in color with the posterior tip brown. The total length is .78 mm. and the greatest width is .64 mm. The antennæ are six jointed, the first joint broadest, the last longest and distinctly annulate. There are two small lobes widely separated at posterior end, and near each of these on the inner side is a spine which extends beyond the tip of the lobes. There are two other similar spines beyond the lobes.

The second stage male length .8 mm., width .25 mm.; general color purple. In the earlier part of this stage the purple pigment is confined largely to the anterior lateral margins. The rest

of the insect, excepting the posterior tip which is brown, is white in color. There are no distinct eyes at this time, but later the purple granules coalesce into definite areas forming the two pairs of eyes which are conspicuous in the latter part of the stage. The dorsal and ventral eyes are connected by a narrow neck so that they are continuous. These

FIG. 8.—Stages of the purple scale male. 1. Second stage. 2. Propupa with exuvium of second stage still adhering to tip of body. 3. Propupa. 4. Pupa. 5. Adult male. $\times 40$.

are very dark purple. The median lobes are large and broad at base with the margin serrate. The second pair of lobes which are not conspicuous are strongly notched in middle. Two long tapering plates occur between the median lobes and also two similar in size and shape

between the first and second, and second and third lobes. Two other similar plates or spines are found beyond the third pair.

The propupa is purple in general color and measures .8 mm. long and .25 mm. wide. The sheaths enclosing the antennæ legs and wings may be distinguished, but they are closely associated with the body and are not conspicuous. The pygidial characters have disappeared and the posterior end is now truncate with no evidence of the style. The ventral eyes are large, very dark purple in color, and lie close together. The dorsal eyes are smaller and farther apart.

The pupa, length exclusive of style .1 mm., width .28 mm. at widest part, which is near posterior end. Color purple. Sheaths of the appendages conspicuous and more or less free from the body. Eyes purple, the ventral pair closer together than the dorsal.

Adult male, length exclusive of style .58 mm., style .21 mm., wing expanse 1.6 mm., antennæ 10 jointed; comparative lengths 5, 5, 19, 23, 22, 20, 20, 18, 20, 15. General color, yellowish with purple pigment scattered about with most at anterior end. This pigment also extends into the joints of the antennæ excepting the last two joints. The thorax is light brown with a darker band extending between the wings.

FIG. 9.—Pygidium of adult female purple scale. x160.

The adult female will average 1.2 mm. in length and .7 mm. in width. On the lateral margin, beginning at the anterior end, are from three to four broadly rounded extensions, and following these from three to four pointed protuberances, all excepting the most anterior having short, blunt spines at tip. There are always three pairs of lobes visible and often a fourth. The median lobes are broad and bluntly pointed, with more or less indication of serrations. The second pair is broad and deeply notched, the third short and broad with serrated edge.

FIG. 10.—Purple scale. 1. Development of scale covering. x13. 2. The beginning of the formation of the scale covering. x120. 3. Male and female scales, showing comparative size and shape. x27. 4. Dorsal and ventral view. 5. Two stages of larva of *Aspidiotiphagus citrinus* within purple scale. 6. Pupæ of same within scales. 7. Exit holes of *A. citrinus*. 8. Formation of covering after first molt.

FIG. 10.—See opposite page for legend.

There are two spine-like plates between the median pair between the first and second, and second and third. There are also two between the third and what might be called the fourth pair, which show distinctly in some of the specimens. Another pair of these spine-like plates is found at the extreme edge of the segment. The spines that are conspicuous are two on each of the median lobes and one at the incision of the second.

LIFE HISTORY AND HABITS.

The Egg.—The eggs of the purple scale are protected, not only on the upper side of the scale covering, but on the under side, by a lighter and more cottony secretion, so that they are practically surrounded on all sides excepting at the posterior end. They are arranged in regular rows and standing partly on end. The number will vary from forty to eighty. These are deposited over a period of three or four weeks. The time of hatching will vary from fifteen days in summer to three weeks or longer in the winter months. Those nearest the tip are the oldest and are the first to hatch. As the quota of eggs are deposited, the insect diminishes in size and contracts toward the anterior end of the scale, filling the space thus left with eggs.

THE ACTIVE LARVA.

The active larva usually wanders about over the plant for a short time before settling. This period will vary from a few hours to two or three days, the majority becoming fixed within one day after emerging from the parent scale. The scales upon hatching may not make their way from beneath the scale immediately, especially if the weather is cool. But not many, generally not more than two or three, will be found hatched and not yet emerged.

Locomotion.—The rate at which the young larva will crawl over smooth paper varies considerably, according to the temperature. With a temperature of 64° F., the maximum distance traveled during a two-hour period was 27½ inches, while a distance of 111 inches was covered when the temperature was 89°.

LOCOMOTION OF YOUNG PURPLE SCALE.

Number examined.	Date.	Time.	Temperature.	Distance.	Average distance.
1	November 18, 1910_____	9:20-12:20 p. m.	64°	9 inches	
1	November 18, 1910_____	9:20-12:20 p. m.	64°	21 inches	
1	November 18, 1910_____	9:20-12:20 p. m.	64°	27.50 inches	19 inches
2	November 2, 1910_____	9:30-11:30 p. m.	68°	28 inches	
2	November 2, 1910_____	9:30-11:30 p. m.	68°	37.75 inches	33 inches
3	July 21, 1910_____	1:20-3:20 p. m.	89°	111 inches	111 inches

FIG. 11.—Actual tracings of the movement of young purple scales for a two-hour period; reduced 7 times. Above, the temperature was 64° and the average distance covered was 19 inches. Below, the temperature was 89° and the distance covered was 111 inches.

The rate and distance of travel noted above was on smooth paper. The conditions were thus more favorable than will ever be likely to obtain in nature. Counting the maximum length of life as an active larva when deprived of food at four days, the highest possible record under the most favorable conditions would be a total of 444 feet. But obstacles to travel, such as a pulverized soil, make a very different story.

With a temperature of 86° at 9 a. m., twenty-five active young were placed unharmed in the center of an area of sand, having a five-inch radius. None reached the edge during the same day or the day following. Another similar experiment resulted negatively. A third, similar to the others, was started, and out of twenty-five scales liberated, one reached the margin in $5\frac{3}{4}$ hours. This was the only one that succeeded in crossing a five-inch strip of sand.

The following records were made on a three-inch radius of sand:

Number liberated.	Temperature.	Time.	Results.
20	63°F	1:30 p. m.	None reached margin
20	82°F	9:45 a. m.	2 out at 12:30
10	65°F	9:30 a. m.	2 out at 1 p. m.

Other tests were made with orchard soil, but there seemed to be little difference over that of sand. It will thus be seen that the young purple scales are able to make but little progress over soil that is well cultivated. Only an exceedingly small percentage of those liberated crossed but three or five inches of such soil. If the soil is compacted as after heavy rains or in irrigation furrows considerable progress may be made, but even here the factor of their own powers of locomotion in their distribution is very small.

Settling.—Out of 240 scales liberated in leaf cages at different times from March to September, 122 or about 50 per cent became established. This should represent a fair average, or, if anything, an under estimate of the percentage, since the young were liberated on suitable leaves and protected from all outside agencies. There seems no doubt that conditions as they ordinarily obtain in nature would decrease the above percentage considerably. It may, therefore, be counted that at least 50 per cent of the scales fail to become established even under the most favorable conditions.

The young purple scale may settle either on the branch, leaf, or fruit. The branches or leaves are the first to become infested, but if they are abundant on these, the fruit in the vicinity will become badly infested also. Where the numbers are not large there is a tendency for the young scales to settle along the midrib or large veins of the leaf. This tendency was usually strongly shown in our breeding cages. They do

not migrate far from the parent as a rule. It is most usual to find this scale limited to but a portion of the tree, and while this portion may be so severely infested as to be killed, the rest of the tree may be in a healthy condition and comparatively free from the scale. The infested portion is nearly always on the lower side of the tree and later extends upward covering the greater part of one side of the tree. This side is not necessarily away from the sun for it has been noted on the east, south and west sides of the trees.

Formation of the Scale.—Upon settling, the young larva of the purple scale very soon secretes a couple of rather coarse cottony threads from the anterior end of its body, apparently from just under the margin of the anterior end. These are long entangling threads that extend entirely over and around the insect. The function of these is undoubtedly a provision for protection while the more compact covering is being secreted. At any rate these entangling threads answer this purpose, for it has been many times observed that a young *Coccinelid* larva upon striking them will immediately back away or turn in another direction without molesting the insect thus protected. These entangling threads remain until the insect is about half grown, and, where the young scales are numerous, they form a fuzzy coating over the infested surface. Some practical fumigators use this as a criterion that the insect is in the best stage for treatment; and this is correct, for such threads are lost as they approach maturity.

After these two long protecting threads are formed the insect begins the secretion of the permanent scale. These threads are very much finer than the first ones and cover the insect more compactly. The covering for a day or two is of course thin enough to make out very readily the insect beneath. This covering is started at the posterior end, and, after about one day, only the anterior one fourth of the insect is free. The long, entangling threads are still present and these remain for a considerable time. Later, however, after the scales are about one half grown they are lost. After the covering has reached the anterior end and the insect is completely covered, it still extends the covering in two horn-like projections as shown in Figs. 10-12. If these are carefully lifted the antennæ will be found beneath so that they serve as a protection to the antennæ for a time. As the insect grows older, the scale becomes more compacted. When the first molt occurs, the entire skin is incorporated in the dorsal scale. The insect works its way out beneath, leaving the covering which has been secreted, and the cast skin, above it. Very soon, however, the scale is extended posteriorly so that the cast skin becomes an oval, dark brown plate at the anterior tip of the scale. The second cast skin, which is very much larger than the first, is also incorporated into the dorsal scale covering. The secretion is continued and the scale extended beyond the second exuvium until the

part beyond becomes the length of the rest of the covering. As the female becomes mature and egg laying begins, a considerable secretion is formed on the under side. This is secreted from the sides of the insect, the two films meeting down the central line. A narrow strip of this ventral scale is formed on either side of the scale beneath during the earlier stages, particularly at the anterior end, and this gradually widens and extends more posteriorly as the insect becomes mature. But no part of the cast skins are found in this ventral scale which is entirely the secretion of the insect.

In the case of the male only the first cast skin is incorporated into the scale covering. This is exactly similar to that of the female, since there is no difference in the sexes until after the first molt. But all succeeding cast skins of the male are pushed back and from beneath the scale covering. The narrow, elongate covering, typical of the male insect, is formed entirely during the second stage of the insect.

The Process of Molting.—In the case of the purple scale the molting process is very different from that of *Chrysomphalus aurantii* and also different from that of the unarmored scales as represented by *Saissetia oleæ*. In the case of the red scale, the rent in the old skin occurs along the margin of the body, so that the dorsal half becomes incorporated in the dorsal scale and the ventral half of the ventral scale. In *Saissetia oleæ*, *Coccus hesperidum*, and others of the unarmored group, the skin is split at the anterior end and pushed backward and entirely free from the insect.

FIG. 12.—First cast skin of purple scale; ventral view, showing how skin is split and ventral portion with legs and mouth parts pushed back.

The rent in the skin of the purple scale occurs on the ventral side in a more or less irregular line a short distance from the margin. At the anterior end this is between the rostrum and the antennæ, on the sides, between the legs and the body margin; and at the posterior end, just anterior to the pygidium. The insect first emerges, presumably at the anterior end (the process can not actually be observed) and later pulls the posterior end forward and downward,

leaving the old skin directly above it. From the appearance of the cast skin the insect could very readily, simply by a contraction of the body, free itself from the narrow projecting portion of the ventral scale at the anterior end. In the case of the posterior end, the rent does not occur so near the margin, hence the projecting scale is somewhat broader than that at the anterior end. But once the anterior end of the insect was free, it would be easy to liberate itself from this posterior pocket. That

the anterior end is first freed from the old scale is further shown by the fact that the old ventral skin is pushed backward, which would not be possible in any other case.

The exuvium, therefore, is entirely in the upper or dorsal part of the scale covering. After clearing in potash it will be seen that the antennae are intact at the anterior end, the rent having occurred posterior to them, so that their position has not been changed in the molting process. At the posterior end all the characters of the pygidium can be made out as clearly as in the perfect insect, for these, likewise, have not been disturbed. As in the opposite end the insect has simply pulled itself from within, leaving all the characters undisturbed. The ventral portion of the molted skin, instead of being simply laid down beneath the insect, is pushed posteriorly as far as the pygidium, or to the edge of the rent at the posterior end. Here the legs and rostrum may be made out, the whole being more or less doubled up from the process of pushing backward underneath the insect.

Development.—The first molt of the purple scale occurs about twenty-six days after birth. Up to this period there is no difference between the sexes, but the difference becomes sharply marked immediately after this stage. In the case of the female, the period between the first and second molts is about the same as that from birth to the first molt. The second molt brings the female to maturity, at least so far as the molting is concerned.

Ten or twelve days after the first molt, the male undergoes a second molt, bringing it to the propupal stage. This stage is distinguished from the true pupa chiefly by the less fully developed appendages, as shown by their enclosing sheaths. After eight or ten days in this stage, it changes to the true pupal condition, and a similar period is passed in this stage before emerging as an adult. The male, therefore, issues as an adult about sixty days from birth. The period will be from ten to twelve days less during the warmest part of the season, and extended as much as twenty or twenty-five days in winter.

The female will begin depositing eggs about seventy-five days from birth, or fifteen days after fertilization by the male. Egg laying will continue for three or four weeks. The eggs hatch and young will emerge from the scale on an average of three months from birth; this again varying from ten or twelve days less in midsummer to a month or more in winter. After the female has deposited her quota of eggs, numbering from thirty to eighty, she dies, making the complete life cycle from four months in summer to from five to six months in winter.

LEPIDOSAPHES BECKII. DEVELOPMENT.

Number examined.	Date.	Number settled.	Number hatched.	First molt.	Second molt, female.	Second molt, male.	Protopupa.	Pupa.	Male emerged.	Male dead.	Eggs.	Young hatched.
103.	3-19-09	10	3						6-10			
125.	3-30-09	12	3						6-6	6-10		
116.	3-24-09								6-10	6-15		
152.	5-19-09	17	5				7-6					
153.	5-20-09			6-18								
154.	5-20-09			6-18		6-26	7-1	7-8	7-16			8-16
155.	5-20-09											
162.	5-22-09	52	28						7-21	7-24	8-10	8-16
163.	5-22-09	37	21		7	6	6-14				8-1	8-18
166.	5-25-09	46	36		7-10							
167.	6-25-09				7-6	6-30	7-6					8-18
199.	6-28-09	6	1					8-6				
206.	7-1-09						8-1	8-9	8-18		9-16	
205.	7-1-09						8-1	8-9			9-20	9-26
250.	7-19-09	15	5	8-11								
305.	8-20-09								10-27	11-2		11-30
308.	8-21-09											
580.	6-18-10			7-10	7-26		7-17		8-6			9-11
581.	6-18-10							7-24	8-5			9-10
582.	6-18-10	15	7		7-25				8-10	8-14		
583.	6-18-10	15	9				7-17	7-24				9-9
584.	6-18-10	15	4						8-7			9-11
	2-18-11			3-6	4-17				5-6			
	6-8-11			6-30	7-25	7-13	7-20		7-30			
Summary averages				26 days	50 days	36 days	44	52	60	65	75	90

SEASONAL HISTORY.

Since the time required for the life cycle, from young to young, during the summer months is about three months and in winter may be prolonged a month or more longer, the number of generations will not exceed four. In fact, during ordinary seasons there will be but three generations, with probably a partial fourth. From May to October, inclusive, they will go through their development in three months, or slightly less, so that there will be two full generations during this period. A third will get fairly well started before the colder wet weather of January and February. But the development of this generation will be prolonged by the lower temperature so that it may require four months for the cycle. This will bring it into March again, when at best the fourth generation will only be partially developed by the last of April. During May, and also in June, young scales begin appearing in large numbers, which is the first definite spring hatch. It is altogether likely that in many cases these are the progeny of the third generation. During the remainder of the summer young scales will be found continuously in considerable numbers. Eggs will be found at any season of the year, but during the winter months the young will appear mostly during the warmer periods.

PARASITE.

Practically nothing has been written about any parasites of the purple scale in California. This scale has been considered to be freer from parasites than any of the other citrus fruit scales. While this, in general, is true, yet in certain places the purple scale is as heavily parasitized as the red or yellow, and the parasite in question has been known to occur in the State since 1891. But in many sections of the citrus belt where the purple scale occurs, little or no trace of this parasite will be seen. In sections, as Whittier, where fumigation is so generally practiced as it was in 1910 (98 per cent of the acreage) there is no doubt about its effect on the parasites. In considerable purple scale material collected from this vicinity during the past two or three years, there have been but occasional instances where parasites were obtained. But just outside the Whittier section, where trees infested with purple scale had never been fumigated or sprayed, as high as 30 per cent or 40 per cent of the scales at one time were found parasitized.

This same fact holds true for the yellow scale parasite, for it is the same parasite that attacks both scales. Yellow scale material has frequently been obtained from sections where fumigation is generally practiced, but none or few parasites were secured. But yellow scale material taken from Santa Barbara County, and in the northern sections where no fumigation is practiced, had a considerable percentage of the scales parasitized in many instances.

Aspidiotiphagus citrinus Craw.*

Aspidiotiphagus citrinus Craw. is the only parasite that we have taken thus far from the purple scale. This is the insect referred to above, and, while occurring in certain limited localities in considerable numbers, it is not common throughout the purple scale belt. This is a strictly internal parasite and attacks the scale only between the first and second molt. The scale has shed its first skin and approaches very nearly the time when it should cast its second skin. But thus far no instance has been observed where the scale had actually molted the second time.

The egg is deposited within the insect and there hatches a very minute, white larva, with a tail-like appendage. This is afterward lost, and as the larva becomes mature it is about .85 mm. long and .35 mm. wide, tapering slightly toward the anterior and more strongly toward the posterior end. It pupates within the scale, the pupa at first being white or light colored but later turning very dark. The adult makes its way out through a circular exit hole in the posterior one third

*For a more detailed account of this parasite, see Cal. Exp. Sta. Bull. 222.

of the scale, these being found only in the partly grown scales. The age of the scale when grown is stopped by the effects of the parasite, judging entirely from the condition of the scale, appears to be about forty or forty-five days, when the second molt would occur in about fifty or fifty-five days. During the past two years a large number of these parasites have been found issuing in December. This may be on account of the fact that the scales are, or have been, in the proper stage for attack.

PREDACEOUS ENEMIES.

The several species of native *Coccinellidæ*, together with the larva of *Chrysopus* and *Hemerobius*, may all attack the purple scale as well as other scale insects. But the one *Coccinellid* that has been seen most frequently attacking the purple scale is *Rhizobius lophanthæ*. This species also occurs commonly on the red scale. The larva of this beetle is distinguished by having rectangular areas of light gray on the otherwise dark dorsal surface. When full grown it is 4 mm. long and about 1 mm. wide. The adult beetle measures from 2 to $2\frac{1}{2}$ mm. in length, and is black in color with a strong metallic luster.

Scymnus marginicollis Mann. is another species that is often found with the purple scale. This beetle is similar in size to that of *R. lophanthæ*, but is of a dull black color instead of the metallic bronze-like luster of that of *lophanthæ*.

RELATED SPECIES.

Aside from the species *beckii*, there are three others recorded from California as belonging to the genus *Lepidosaphes*. These are *L. gloverii* Pack., *L. ulmi* Linn., and *L. crawii* Ckll. *L. crawii* has been recorded only from the oak and *Elæagnus*, and is therefore of no economic importance. *L. ulmi* is the common and widely distributed oyster-shell scale and occurs on many deciduous fruit trees. In the shape and appearance of the scale covering, it closely resembles the purple scale, but if the insect itself be examined it is readily distinguished by the fact that the lobes are not serrate as in the case with *L. beckii*, *L. gloverii* or Glover's scale is the other member of the genus that is primarily a citrus fruit scale. It has been only rarely met with in California, while in Florida it is of very common occurrence. This scale covering is much more linear in shape than the purple and is not so often curved. The distinguishing characters of the insect itself are that the lobes are pointed and are not serrate.

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