

## Florida red Scale, *Chrysomphalus ficus* Ashmead

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The infestation of Florida red scale on Citrus is just next to the black Parlatoria in Taiwan. The population is usually decreased during rainy season from June to September. It infests leaves, twigs and fruits. The severe infested leaves usually fall down and the twigs die. Resin soda wash could not control this species even though it has been extensively used for control unamored scales and mealybugs until the latest ten years ago. Fortunately 1.3% summer oil emulsive alone or 1% summer oil emulsive in combination with 0.05% malathion and 0.05% dimethoate alone were recommended for control it and *Aphytis chryso mphali* (Mercet) usually restranis a certain number of individuals.

Morphology, life history, natural enemies and chemical control of this species have been briefly studied and summarized in below. The writers wish to express their sincere thanks to Dr. T. W. Liu, Head of Plant Industry of Joint Commission on Rural Reconstruction and Dr. S. C. Hsu, Director of Taiwan Agricultural Research Institute whose encouragement was made this study possible.

**Common names:** *Chrysomphalus ficus* Ashmead known generally as Florida red scale, Egyptian black scale, citrus black scale.

**Synonyms:** *Aspidiotus aonidum* Linnaeus, *Chrysomphalus aonidum* (Linnaeus)

**Hosts:** Anonaceae: *Artabotrys uncinatus* (*A. odoratissimus*); Apocynaceae: *Carissa carandas*, *Thevetia* sp.; Berberidaceae: *Mahonia japonica*; Buraceae: *Buxus japonicus*; Coniferae: *pinus* sp.; Cycadaceae: *Cycas revoluta*; Guttiferae: *Calophyllum inophyllum*, *Garcinia spicata*; Lauraceae: *Cinnammum nominale* (*C. camphora*), *Laurus nobilis*, *Machilus* sp.; Marantaceae: *Maranta arundinaceae*; Moraceae: *Ficus retusa*; Musaceae: *Musa sapietum*; Myristiaceae: *Myristica heterophylla*, *M. laurifolia*; Myrtaceae: *Malaleuca leucadendra*; Oleaceae: *Ligustrum japonicum*, *Olea europaea*. *Osmanthus fragrans*; Palmae: *Areca catechu*, *Cocos nucifera*; Pandaceae: *Pandanus odoratissimus*; Podocarpaceae: *Podocarpus macrophylla*; Rhizophoraceae: *Kandelia rheedii*; Rosaceae: *Rosa* sp.; Rutaceae: *Citrus* spp., *Evodia roxburghiana*; Sapotaceae: *Palaquium formosanum*; Theaceae: *Camellia japonica* (*Thea japonica*), *C. sasanqua* (*Thea sasanqua*), *C. sinensis* (*Thea sinensis*), *Cleyera ochracea*.

**Distribution:** This species is very common in Tropical and Sub-Tropical regions. Sometime, it occurs in greenhouse in Temperate region. At present this species has been recorded in the following area.

Asia: Ceylon, Formosa, India, Isral, Labenon, Pakistan. Philippine, South China, South Japan, Syria.

Pacific Ocean: Australia (Queensland), Hawaii.

Africa: Egypt, Northeastern Union of South Africa (Natal, Transvaal), Northern Africa (Algeria, Morocco, Tunisia), Madagascar, Southern Rhodesia, Tropical Western Africa, Zanzibar.

Europe: Greece, Italy, Sicilia, Spain.

America: Barbados, Brazil, California, Chile, Colombia, Cuba, Florida, Gujana (British), Jamaica, Mexico, Northern Argentina (Corrientes, Entre Rios, Jujuy, Misiones, Tucuman), Panama, Paraguay, Trinidad, Uruguay, Venezuela.

### Morphology and Habits

It takes 4-6 generations a year in Taipei, Taiwan. Due to its long oviposition period, the early laid egg changes to nymph and adult already but the late one is still in the egg stage thus forming the generations overlapped.

**Egg:** Egg-shaped, pale yellow, regularly arranged at the posterior end of adult female under the scale, Number of eggs laid are more in summer usually from 30-40 to 70-80, Egg stage is very short, it takes 1 day in summer and 3-4 days in winter. The eggs and crawlers are usually seen under the scale at the same time. Number of eggs and duration of oviposition are different from time to time and will be discussed in below.

**Nymph:** Crawler comes out from the underside of scale and walks around a short time then settles down on the leaves, tender twigs or fruits, whenever, the body is surrounded by white secretion which comes from the caudal end of the body. The secretion becomes thickened, and enlarged to form pale white soft scale gradually. After first moult, the first formed secretion concentrated at central apex. The redish brown exuvia becomes ring shaped and encircles behind the secretion. Differences between female and male of first instar is not defined upon the external features. However the second instar, male has two visible purplish brown eyes but without them in the female. After second moult, female becomes adult and copulates with male. Male changes to prepupa. Body color of nymph is pale yellow or whitish yellow, whenever, color of second instar, male becomes gradually darker, similar to the color of prepupa and showing pale orange yellow.

**Adult:** Male: After second moult it changes to prepupa, the ecdysis differs from the female is that lacking second exuvia added, there is only one exuvia of the male in the prepupal stage since the degeneration of secretion at caudal end and cannot enlarge the scale afterward. This is the differences between the male and female. Body color of prepupa, pupa and adult male are quite same, orange yellow or purplish orange yellow. Male lacks mouth part. After copulation with the female dies within few days.

Female: (fig. 1) After second moult, the exuvia adds to the scale. The female

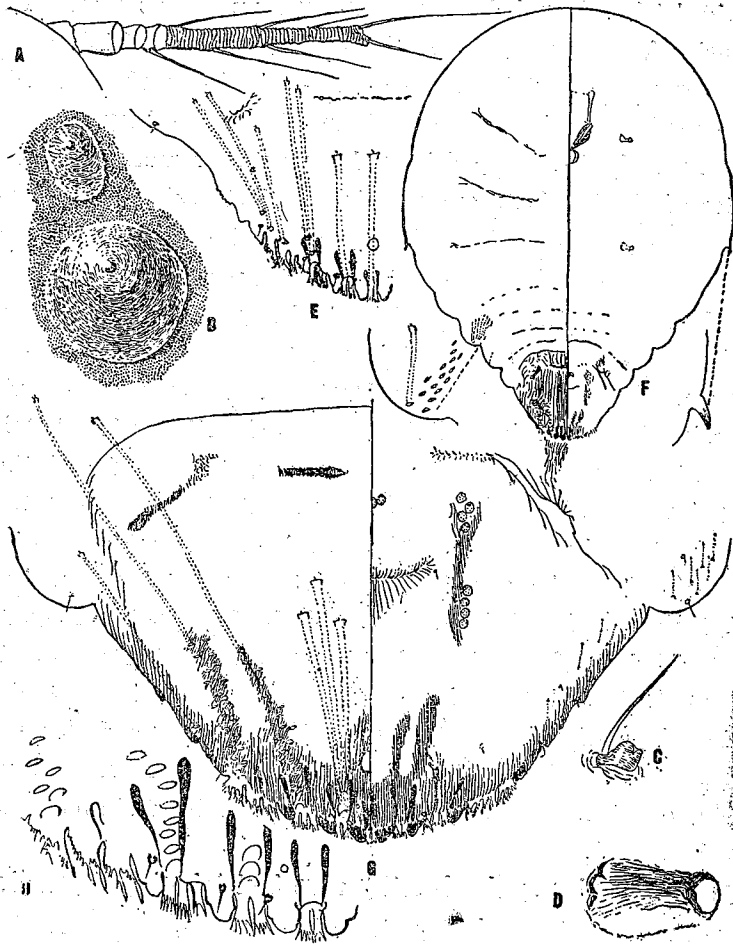


Fig. 1. *Chrysomphalus ficus* (after Ferris)

just comes out from the second moult, body color turns light yellow or light brownish yellow then shrinks and finally dies.

Body length about 1.1 mm. Dermal full maturity membranous or at times with very slight sclerotization in the cephalothoracic region. Perivulvar pores present in five groups of three to six pores in each. Pygidium short and broad, the apex quite obtuse. Three pairs of well developed lobes present, these all of about the same size and shape; fourth lobe indicated merely by a rounded projection. Beyond the fourth lobe to margin is sclerotized and is twice notched. Plates from the meson to the third lobe all finely and evenly fimbriate at the apex, those beyond the third lobe of a different form, the first two normally showing two large and somewhat club-shaped processes, the third with one club and a varying number of variously shaped fimbriations. Marginal scleroses or paraphyses distributed in the manner described for the genus, there being none

beyond the third lobe. Dorsal ducts of the pygidium of two sizes. Three or four stout ducts arise from pores between the median and second lobes and extend to about the center of the pygidium. From near the bases of the third and fourth lobes there extend zones of small pores from which arise long and slender ducts, the anterior most of which extend beyond the anterior margin of the pygidium. These bundles of slender ducts are conspicuous features of the species. In the zones of pores the striations of the derm tend to lie transversely. A conspicuous submarginal cluster of small short ducts is present on the dorsum of what is here considered to be the second abdominal segment, other than these being not more than one or two small ducts on any segment anterior to the fifth. Thoracic spur well developed, acute, sclerotized. Anal opening rounded.

The generic characters is that three pairs of well developed lobes present and the fourth indicated by at least a slight spur, the margin of the pygidium from this point for at least a short distance anteriorly tending to be heavily sclerotized. Slender scleroses or paraphyses arise from the bases of the median to third lobes and from the margin in the intersegmental areas, but none are present anterior to the fourth lobe. Plates well developed variously fimbriate, those between third and fourth lobes bearing processes that tend to be more or less club-shaped. Dorsal duct of the pygidium arranged in quite definite rows of variable lengths and sizes, but tending to be very long and slender.

Scale of the female almost always colored, ranging from yellow to black, circular, flate, exuviae subcentral or central; the male of similar color, oval, exuvia toward one end.

#### Comparison of other species infesting same host belonging *Chrysomphalus*

There are three species infesting citrus in Taiwan, they may be separated by the following key.

1. At least one pygidial abdominal segment with submarginal, dorsal cluster of macroducts; first two pygidial plates anterior to third lobes variously fringed..... 2  
 Prepygidial abdominal segments with at most three or four marginal ducts, without sudmarginal, dorsal cluster; first two pygidial plates anterior to third lobe clavate.....*dictyospermi* (Morgan)
2. Abdominal segment two only with dorsal submarginal cluster of macroducts.....*ficus* Ashmead  
 Abdominal segments two three, each with dorsal submarginal cluster of macroducts.....*bifasciculatus* Ferris

#### Life history

It completes of one generation from February to May of 1957, egg takes 4 days, first instar 17 days, second instar 32 days, third instar 22 days respectively, from egg to adult female 75 days. Male egg stage 4 days, first instar 17 days,

second instar 32 days, prepupa 3 days, pupa 4 days; from egg to adult male 60 days.

Life cycle from May of 1956 to June of 1957 as shown in the following table.

Table 1: Life history of *Chrysomphalus ficus* Ashmead

Generation	Duration					
	Egg	1st instar	2nd instar	3rd instar	Oviposition	One generation
2	2	10	19	16	11	60
3	1	7	15	15	14	54
4	1	8	15	17	18	52
5	4	20	45	52	26	150
1	4	19	30	19	20	95

Crawler after settling, injects its stylet into leaf, young twig. or fruit peel, and takes up nourishment from injected tissue. Male usually gathers on the upper surface of the leaf and female on both surfaces of leaf nearly the same population. The infested leaf usually turns yellow and falls down in heavy infestation.

#### Natural enemies

There are two groups of natural enemies, one is parasitic wasps which have 4 species namely *Aphytis chrysomphali* (Mercet), *Aspidiotiphagus citrinus* Craw, *A. lounsburyi* (Berles and Paoli) and *Casca chinensis* Howard. The former 3 species have been noted in Parlatoria chapter, the last one may be noted in below.

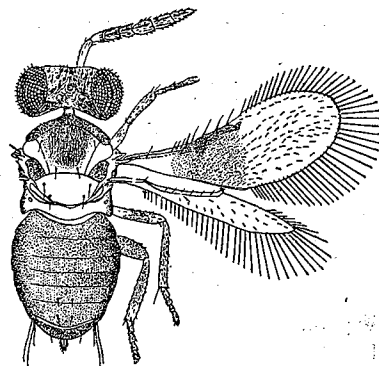


Fig. 2. *Casca chinensis* Howard (after Compere 1936)

Dorsum of the head orange yellow. Occiput, face across the mouth and the cheeks blackish. Antennae yellow. Pronotum, mesoscutum except the sides and posteriorly, axillae sides of thorax and abdomen blackish. Lateral and posterior sides of the mesoscutum and the parasides light lemon yellow. Scutellum, metanotum and of propodeum light lemon yellow with an iridescent pearly luster.

Hind legs dominantly fuscous; the knees, basal half of the tibiae and tarsi pallid; fore and middle legs faintly suffused with fuscous, less extensively distributed than the fuscous marking the hind legs.

Male: Coloration almost like that of the female, except that the legs are more extensively fuscous and the scape pallid with a dusky suffusion. The keel-like modification of the ventral margin of the scape.

The *Casca* genus comes to near the genus *Aspidiotiphagus* Howard but it can be separated by having four-jointed tarsi and seven jointed antennae.

Mr. Matsuda had noted that *Coccophagus hawaiiensis* Timberlake parasited on *Chrysomphalus ficus* Ashmead, it may be wrong, because this genus attacks on unarmored or soft scale only.

Another group is parasitic fungi. The following three species have been recorded from this scale, namely *Microcera fujikuroi* Miyabe et Sawada, *Ophionectria coccicola* (E. et E.) Berl. et Vogl and *Shaerostilbe coccophila* Tul.

#### Chemical control study

1.3% Summer oil and 0.05 % dimethoate have been recommended for control Florida red scale already, but parathion and gusathion have also been accepted by the citrus growers, however it is not accepted by the government. The present study is to know the control effectiveness of other than above mentioned insecticides such as diazinon, lebaycid, folithion, sumithion, dibrom and dimecron whether or not could be used for control this scale and their action on the parasitic (golden) wasp *Aphytis chrysomphali* (Mercet), because this golden wasp usually checks the scale population very well and the percentage of parasitism usually around 20 % in normal condition and can check up without infestation at proper time.

The field test was carried on Oct. 30, 1962 at the Horticultural Garden of National Taiwan University. Before 2 days of spraying picked up 5 infested citrus leaves for examination the percentage of parasitism of golden wasp, the results showed that 263 scales were examined, 63 having exit of the parasite, no exit but having larvae and pupae of parasite or dead due to other causes were 31, totally 35.73 % seemed to be died by the parasite. Moreover, the observed larvae and pupae of parasite were all alive and no dead was observed.

When taking the sample and spraying the insecticides, the parasite was very active on the citrus leaves, but unfortunately the dead wasps were found on the leaves after 3 days of spraying until 14 days later were active again as did in before the treatment. The dead percentage of parasite after receiving insecticide spray 15, 22, 27, 55 and 80 days was shown in table 2.

According to table 2. it showed that the dead larvae and pupae of parasite were significantly increased especially by applying parathion, summer oil, diazinon

Table 2: Results of chemical control of the adult of Florida red scale influenced to the parasite, golden wasp, *Aphytis chrysomphali* (Mercet)

Treatment	Nov. 14		Nov. 19		Nov. 26		Dec. 24		Jan. 19		Average
	No. of obser.	Mor-tality	No. of obser.	Mor-tality	No. of obser.	Mor-tality	No. of obser.	Mor-tality	No. of obser.	Mor-tality	
Summer oil 1.3%	50	14.00	85	95.30	87	94.30	117	88.88	131	68.75	72.26
Parathion 0.05%	23	78.30	31	77.40	78	88.50	63	83.33	—	—	65.50
Gusathion 0.05%	50	16.00	98	62.20	108	75.00	123	96.03	134	72.73	64.39
Diazinon 0.05%	84	16.70	127	85.30	141	85.10	117	71.57	125	75.00	66.73
Lebaycid 0.05%	112	21.40	53	17.00	85	23.50	93	17.86	139	25.00	20.95
Folithion 0.05%	98	18.40	104	47.10	112	44.90	111	93.02	95	68.00	54.28
Sumithion 0.05%	40	35.00	57	59.70	118	81.40	67	100.00	142	91.08	73.23
Dibrom 0.05%	50	14.00	30	56.70	30	56.70	58	92.30	104	76.30	59.20
Dimecron 0.05%	36	8.40	108	14.60	83	32.50	109	16.66	137	36.84	21.80
Check	90		247	0.40	77	2.60	55	9.09	163	34.30	9.27
Average		22.22		51.70		58.40		66.87		64.46	

L. S. D. of chemicals 0.05=13.85, 0.01=18.59.

L. S. D. of days after chemical application 0.05=19.50, 0.01=26.26.

Table 3: Results of Chemical control of the adult of Florida red scale

Treatment	Nov. 14		Nov. 19		Nov. 26		Dec. 24		Jan. 19		Average
	No. of obser.	Mor-tality	No. of obser.	Mor-tality	No. of obser.	Mor-tality	No. of obser.	Mor-tality	No. of obser.	Mor-tality	
Summer oil 1.3%	72	98.60	105	93.33	318	91.50	158	96.20	286	67.83	89.49
Parathion 0.05%	99	99.00	221	96.83	286	92.31	146	80.27	—	—	92.10
Gusathion 0.05%	44	63.60	116	98.20	379	93.93	255	99.60	277	90.97	89.26
Diazinon 0.05%	169	71.69	159	86.16	451	90.68	603	72.72	444	65.94	77.44
Lebaycid 0.05%	104	25.00	85	48.22	452	49.22	372	59.72	680	31.32	42.69
Folithion 0.05%	84	47.60	126	53.96	280	59.64	152	76.71	179	69.83	61.15
Sumithion 0.05%	67	71.69	103	79.61	361	94.64	193	98.96	296	94.93	87.96
Dibrom 0.05%	141	92.70	59	79.66	155	77.81	80	74.28	129	61.24	77.14
Dimecron 0.05%	104	35.20	267	35.92	404	58.81	166	61.92	248	38.70	46.11
Check	66	16.76	215	10.90	272	26.76	277	18.66	295	31.52	20.92
Average		62.18		67.38		73.53		73.90		65.76	

L. S. D. of chemicals 0.05=9.97, 0.01=13.37

L. S. D. of days after chemical application 0.05=14.09, 0.01=18.90

and sumithion, The insecticides tested against Florida red scale as shown in table 3, it showed that parathion and summer oil were still the best, gusathion, dibrom, diazinon, sumithion were also good, but folithion, dimecron and lebaycid were much inferior and could not be accepted for control this scale.

### Conclusion and Summary

The Florida red scale, *Chrysomphalus ficus* Ashmead was the next worse of Citrus armored scale insects in Taiwan. It takes 4-6 generations a year in Taipei, Taiwan. Duration of egg, 1st, 2nd, 3rd instar of the female, oviposition and one generation was varied 1-4, 7-20, 15-45, 15-52 11-26, 52-150 days, respectively and generation was overlapped.

The morphology of egg, nymph, adult male, female were briefly described, and characteristics of the genus *Chrysomphalus* and differences among others *dictyospermi* (Morgen), *bifasciculatus* Ferris were also given.

There are 4 species of parasitic wasps, namely *Aphytis chrysomphali* (Mercet), *Aspidiotiphagus citrinus* Craw, *A. lounsburyi* (Berles and Paoli) and *Casca chinensis* Howard, but the first mentioned wasp was very abundant in the heavy infestation of the host scale, the parasitism of this wasp was usually around 20%.

The chemical control was found that dibrom, diazinon and sumithion might be as good as summer oil, dimethoate which have been recommended already, but these chemicals also killed the parasitic wasp *Aphytis chrysomphali* (Mercet) at the time of application.

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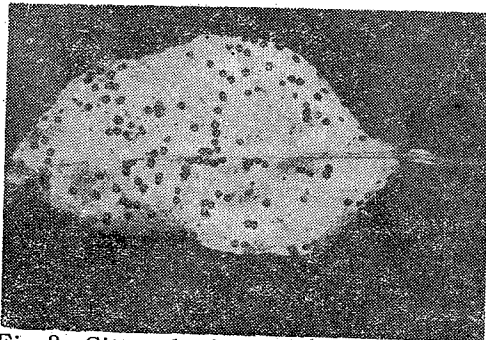


Fig.3. Citrus leaf infested by Florida red scale

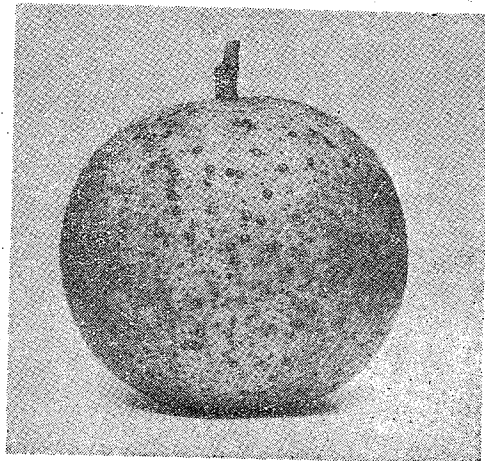


Fig.4. (Right) Citrus fruit infested by Florida red scale