Natural population life table of citrus spiny whitefly (Aleurocanthus spiniferus) in tea garden

HAN Bao-Yu, CUI Lin (Key Laboratory of Tea Chemical Engineering, Ministry of Agriculture, Tea Research Institute, Chinese Academy of Agricultural Sciences, Hangzhou 310008, China). Acta Ecologica Sinica. 2003. 23(9): 1781–1790.

Abstract: Citrus spiny whitefly, Aleurocanthus spiniferus (Quaintance), usually damages tea, citrus, palm and other horticultural and ornamental plants. It has been found in Hawaii, Guam, Mauritius and East Africa, etc. It is also found in tea and citrus gardens in Japan and Indian. Being of apparent Asian origin, it is occasional a serious pest in Asia. Its larvae locate on the leaf back and suck the sap. Moreover, the larvae and adults excrete honeydew which induces the sooty moulds and retards the photosynthesis of plant. The pest outbreaks throughout the tea regions in Hainan Province, the Southern China, the middle
and lower reaches of Changjiang River in the early 1960’s, the early 1970’s, the early 1980’s, and from the end of 1980’s to the beginning of 1990’s, respectively. The mechanism of its outbreaking has not been understood clearly yet. In 1989, the pest was outbroken all over the tea growing areas in China. We selected a plot of tea garden in the Southern Anhui Province, which is usually infested by the whitefly, to investigate the pest population fluctuation, the relationship between the changes in population and weather factors, and the population density difference amongst the different habitats of tea garden and the tea varieties. Three generations of natural population life tables were monitored, and the effect of the various death factors on the population outbreak and breakdown had also been analyzed. In 2002, the pest occurred in light degree, and the same investigations were carried out. The results showed that the whitefly prefers shady and humid habitats, and more than 80% of population distributes within the middle and lower parts of tea bush. During the winter of 1988, the weather was warm and relatively dry, and the death rate was low. However, the accumulative basic number of population was higher. In spring of 1999, the weather was warm and moist which was favorable to pupation, eclosion and hatch. So the first generation was outbroken severely. The suppressing effect of the parasitic wasps on the pest population did not exhibit obviously until the pupal stage of the whitefly. Then, a lot of these adult wasps deposited their eggs into the larvae of the first and second instars from the second generation. Several species of entomogenous fungi resulted in the epizootic in the third instar larvae of this generation. The population trend index of the first, second and third generation was estimated at 0.47, 0.09 and 0.02, respectively. A. spiniferus population decreased sharply from generation to generation, and finally collapsed in the late August. Over 10 species of parasitic wasps and 4 species of entomogenous fungi were jointly responsible for dynamics of the pest population. The dominant natural enemies were Prospaltella smithii, Amitus hesperidum, Pleurodesmospora cocora, Cladosporium sp., Acremonium sp. and Aegerita webberi.

Key words: Aleurocanthus spiniferus (Quaintance); outbreak; population dynamics; life table; natural enemy

Centered: 1000-0933(2003)09-1781-10

A 1 Aleurocanthus spiniferus (Quaintance)
一块面积约冬眠而进入蛹期
分粉虱死亡后虫体仍附于叶背
累积了一定的菌量

1. 2002

1. 1. 2

1989 6

1989 5

1989 10

1989 3

1989 20

1989 3

1989 3

1989 60

1989 60

1988 10～12

1988 10～12

1988 10～12

1988 10～12

1989 1～3

1989 1～3

1989 1～3

1989 1～3

1989 1～3

1989 1～3

1989 1～3

Neocapnadium theae Hara

2002 (1)
Table 1 Meteorological data

<table>
<thead>
<tr>
<th>Year-month</th>
<th>Average temperature (°C)</th>
<th>Average humidity (%)</th>
<th>Monthly precipitation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outbreak year</td>
<td>Past years</td>
<td>Outbreak year</td>
</tr>
<tr>
<td>1988-10</td>
<td>17.9</td>
<td>17.9</td>
<td>78</td>
</tr>
<tr>
<td>11</td>
<td>11.2</td>
<td>11.6</td>
<td>63</td>
</tr>
<tr>
<td>12</td>
<td>6.1</td>
<td>4.3</td>
<td>73</td>
</tr>
<tr>
<td>1989-01</td>
<td>4.41</td>
<td>2.95</td>
<td>88</td>
</tr>
<tr>
<td>02</td>
<td>4.59</td>
<td>4.52</td>
<td>84</td>
</tr>
<tr>
<td>03</td>
<td>9.58</td>
<td>8.21</td>
<td>78</td>
</tr>
<tr>
<td>04</td>
<td>15.7</td>
<td>15.6</td>
<td>82</td>
</tr>
<tr>
<td>05</td>
<td>20</td>
<td>21.7</td>
<td>80</td>
</tr>
<tr>
<td>06</td>
<td>24.68</td>
<td>24.4</td>
<td>80</td>
</tr>
<tr>
<td>07</td>
<td>26.8</td>
<td>28.3</td>
<td>86</td>
</tr>
<tr>
<td>08</td>
<td>26.7</td>
<td>27.9</td>
<td>85</td>
</tr>
<tr>
<td>09</td>
<td>22.7</td>
<td>22.9</td>
<td>88</td>
</tr>
<tr>
<td>2002-01</td>
<td>4.2</td>
<td>77</td>
<td>02</td>
</tr>
<tr>
<td>03</td>
<td>11.1</td>
<td>79</td>
<td>04</td>
</tr>
<tr>
<td>05</td>
<td>20.3</td>
<td>71</td>
<td>06</td>
</tr>
<tr>
<td>07</td>
<td>28.4</td>
<td>78</td>
<td>08</td>
</tr>
<tr>
<td>09</td>
<td>20.8</td>
<td>76</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>11.6</td>
<td>71</td>
<td>12</td>
</tr>
</tbody>
</table>

2. 2. 1 1989 4 8 9 7 0 3004 7834 16956 0 0 10.81% 28.18% 61.01%. The data in the figure show mean±SD. Different capital and small letters at the top of the columns indicate significant difference at p<0.01 and p<0.05 respectively by Duncan’s multiple range test. The same for the following figures

Fig. 1 Population dynamics of adult (A) and other stages (B) of Aleurocanthus spiniferus during its outbreak in 1988 and population fluctuation(C) in 2002 in tea gardens in the southern Anhui Province

Fig. 2 Densities of Aleurocanthus spiniferus in different parts of the same tea clump in the southern Anhui Province in 1989

\[ 0.01 \text{ or } 0.05 \text{ or } 0.01 \text{ or } 0.05 \]

The data in the figure show mean±SD. Different capital and small letters at the top of the columns indicate significant difference at p<0.01 and p<0.05 respectively by Duncan’s multiple range test. The same for the following figures
不同茶园生境中密度差异 由于该粉虱偏向低洼荫湿的生境
以致阴坡茶园的虫口密度显著大于阳坡茶园。

壮龄茶园虫口密度显著大于幼龄茶园。

图示皖南茶区不同茶树品种上密度差异

不同茶树品种上密度差异 茶树品种间虫口密度差异显著。
以毛蟹和上梅洲品种上虫口密度较大。

黑刺粉虱自然种群生命表的分析
第-代卵的孵化率较高。

从卵期进入幼虫期的幼虫虫口数量较大。

龄幼虫有少量被真菌侵染，至第-代蛹期
从蛹内羽化出大量寄生蜂。

粉虱的存活率下降。
第-代种群趋势指数只
表
羽化的寄生蜂恰逢第-代粉虱龄幼虫盛期
寄生率很高。
此时茶园中虫生真菌菌量逐渐累积而增大，侵染粉虱幼虫和蛹。

由于阴雨连绵茶园生境持续高湿，促进了虫生真菌侵染。
自龄幼虫起，蚧侧链孢霉和枝孢霉，顶孢霉造成的真菌病逐渐流行。
第-代种群趋势指数只有种群数量锐减。
表
从第-代起，斯氏寡节蚜小蜂，刺粉虱黑蜂长
等余种寄生蜂成群地在粉虱各龄幼虫和蛹之间搜索。
敲打和产卵。
韦伯虫座孢对幼虫和蛹的侵染率也显著加大，逐步在粉虱种群中流行。
第-代粉虱种群趋势指数仅为种群崩溃。
表
下旬之后茶园中存活的粉虱极少。
由上述分析可见每一代黑刺粉虱的死亡主要发生在生活史前中期。
存活曲线总体上呈凹线型为第四种类型。
该粉虱主要定居于茶丛中下层。
采茶可以带走产于茶梢上的少量虫口。
其它农事措施对其影响甚小。
捕食性天敌昆虫只发现刀角瓢虫和食螨瘿蚊。
二者主要捕食幼虫，对该粉虱的控制作用很小。
在第一代蛹期。
第二代和第三代。

大量虫口被菌类侵染和蜂类寄生，死亡率高为关键虫态。
寄生蜂和虫生真菌为关键制约因子。

讨论
茶树嫩梢是制作茶叶的原料，因其幼嫩富于营养而易于遭受多种病虫害。
生产上通常采用茶丛蓬面快速喷药法以保护芽梢免受病虫为害。
天敌多匿于茶丛中一般不向茶丛内喷药以减免杀伤。
本文对多种生境中粉虱虫口密度的研究表明，其偏嗜荫蔽的生境。
以上的个体分布于茶丛中下层成叶背面。

荫蔽，其幼虫和蛹体表的蜡层又较厚。
茶丛蓬面快速喷药对其杀伤甚微。
且世代重叠，难以根治。
这些因素，是关键。

寄生蜂和虫生真菌为关键制约因子。

利于粉虱虫口的逐步累积

1989年粉虱大发生，2002年则轻发生。

两年的种群波动趋势相似，第1代各虫态的发育进度都比较一致。然而，2002年累积的越冬代虫口基数已很大。

田间调查表明，茶丛上越冬死亡的虫口小。当地气象数据表明，2002年10～12月天气比历年稍温暖干燥，是利于越冬幼虫存活的。1989年的早春天气又比历年稍温暖湿润，有利于越冬幼虫的化蛹以及第1代卵的孵化。越冬代成虫产下的大量卵以高孵化率孵化后，茶园虫口骤增。2002年越冬代虫口基数小，天气因子也无反常现象，虫情较轻。

所以越冬期间至早春的天气状况对翌年第1代虫口密度有较显著的影响。越冬虫口基数较大时如逢适宜的天气条件，则易于大发生。

由于第1代的发育进度较一致，常年如果发现虫口较高，在越冬代羽化盛期和第1代1龄孵化盛期予以防治，可能较适宜。

寄生蜂在粉虱体内生长发育至粉虱的蛹期成熟，从蛹背钻出。羽化出的寄生蜂恰好寄生下代幼虫，衔接紧密。

1989年10月至1990年1月7种寄生蜂在各龄粉虱幼虫和蛹群之间用触角敲击，用产卵器刺探寻觅寄主。许多寄生蜂甚至重复向一些粉虱幼虫和蛹体内产卵，致使同一头蛹内可羽化出2～3头或1/2头蜂。

表2 第1代黑刺粉虱自然种群生命表

<table>
<thead>
<tr>
<th>Stage</th>
<th>Initial number</th>
<th>dxF</th>
<th>(n)</th>
<th>(%)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>lx</td>
<td>dx</td>
<td>100 qx</td>
<td>Sx</td>
<td></td>
</tr>
<tr>
<td>Egg</td>
<td>1000</td>
<td></td>
<td>135</td>
<td>13.50</td>
<td></td>
</tr>
<tr>
<td>1～2</td>
<td>565</td>
<td></td>
<td>300</td>
<td>30.60</td>
<td></td>
</tr>
<tr>
<td>1st &amp; 2nd</td>
<td></td>
<td></td>
<td>435</td>
<td>43.50</td>
<td></td>
</tr>
<tr>
<td>1st &amp; 2nd</td>
<td></td>
<td></td>
<td>435</td>
<td>43.50</td>
<td></td>
</tr>
<tr>
<td>1st &amp; 2nd</td>
<td></td>
<td></td>
<td>435</td>
<td>43.50</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
<tr>
<td>3rd larval</td>
<td></td>
<td></td>
<td>35</td>
<td>3.89</td>
<td></td>
</tr>
</tbody>
</table>
| 3rd larva
### Table 3  Life table of *A. spiniferus* natural population during the second generation

<table>
<thead>
<tr>
<th>Stage</th>
<th>Initial number</th>
<th>$d_x$</th>
<th>$(n)$</th>
<th>$(%)$</th>
<th>$(%)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>1000</td>
<td>Hatching failure</td>
<td>389</td>
<td>38.90</td>
<td></td>
</tr>
<tr>
<td>1~2</td>
<td>397</td>
<td>Farm work, etc.</td>
<td>214</td>
<td>21.40</td>
<td></td>
</tr>
<tr>
<td>1st &amp; 2nd larval instars</td>
<td></td>
<td>Subtotal</td>
<td>603</td>
<td>60.30</td>
<td>39.70</td>
</tr>
<tr>
<td>1~2</td>
<td>397</td>
<td>Unknown causes</td>
<td>68</td>
<td>17.13</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Predated by <em>Serangium japonicum</em> and <em>Acaroletes</em> sp.</td>
<td>28</td>
<td>7.05</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Parasited by <em>Prospaltella smithi</em> and <em>Amitus hesperidum</em>, etc.</td>
<td>21</td>
<td>5.29</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Subtotal</td>
<td>83</td>
<td>20.91</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Predated by <em>S. japonicum</em> and <em>Acaroletes</em> sp.</td>
<td>83</td>
<td>20.91</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Parasited by <em>P. smithi</em> and <em>A. hesperidum</em>, etc.</td>
<td>42</td>
<td>21.32</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Infected by <em>Pleurodesmospora coccorea</em> and <em>Cladosporium</em> sp., etc.</td>
<td>38</td>
<td>19.29</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Subtotal</td>
<td>138</td>
<td>70.05</td>
<td>29.95</td>
</tr>
<tr>
<td>3rd larval instar</td>
<td></td>
<td>Predated by <em>S. japonicum</em> and <em>Acaroletes</em> sp.</td>
<td>3</td>
<td>5.08</td>
<td></td>
</tr>
<tr>
<td>Pupa</td>
<td></td>
<td>Parasited by <em>P. smithi</em> and <em>A. hesperidum</em>, etc.</td>
<td>17</td>
<td>28.81</td>
<td></td>
</tr>
<tr>
<td>Pupa</td>
<td></td>
<td>Infected by entomogenous fungi</td>
<td>20</td>
<td>33.89</td>
<td></td>
</tr>
<tr>
<td>Pupa</td>
<td></td>
<td>Subtotal</td>
<td>48</td>
<td>81.36</td>
<td>18.64</td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td>Sex ratio 1:1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td>Eggs laid by per female averaged 17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td>Egg number of next generation; $N_2=11\times1/2\times17=94$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td>Index of population trend; $I=94/1000=0.09$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The second generation of *A. spiniferus* had a total population of 1000. The hatching failure rate was 38.90%. The predation rate by *Serangium japonicum* and *Acaroletes* sp. was 7.05%. The parasitization rate by *Prospaltella smithi* and *Amitus hesperidum* was 5.29%. The infection rate by *Pleurodesmospora coccorea* and *Cladosporium* sp. was 19.29%. The sex ratio was 1:1, and the eggs laid by each female averaged 17. The total population of the next generation was 94, with an index of population trend of 0.09.
Table 4  Life table of A. spiniferus natural population during the third generation

<table>
<thead>
<tr>
<th>Stage</th>
<th>Initial number</th>
<th>dxF ( (n) )</th>
<th>( (%) )</th>
<th>( 100 qx )</th>
<th>( Sx )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>1000</td>
<td>680</td>
<td>68.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>124</td>
<td>12.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>804</td>
<td>80.40</td>
<td>19.60</td>
<td></td>
</tr>
<tr>
<td>1~2</td>
<td>196</td>
<td>77</td>
<td>39.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st &amp; 2nd</td>
<td>Predated by Serangium japonicum and Acarotes sp.</td>
<td>20</td>
<td>10.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>larval instars</td>
<td>Parasited by Prospaltella smithi and Amitus hesperidum, etc.</td>
<td>33</td>
<td>16.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>41</td>
<td>20.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>171</td>
<td>87.24</td>
<td>12.76</td>
<td></td>
</tr>
<tr>
<td>3rd larval instar</td>
<td>Unknown causes</td>
<td>6</td>
<td>24.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupa</td>
<td></td>
<td>2</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>48.00</td>
<td>52.00</td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td>3</td>
<td>23.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>15.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>15.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>15.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>84.62</td>
<td>15.38</td>
<td></td>
</tr>
</tbody>
</table>

- Hatching failure
- Farm work, etc.
- Subtotal
- Unknown causes
- Predated by Serangium japonicum and Acarotes sp.
- Parasited by Prospaltella smithi and Amitus hesperidum, etc.
- Infected by Pleurodesmospora coccora and Cladosporium sp., etc.
- Farm work, etc.
- Subtotal
- Unknown causes
- Predated by S. japonicum and A. nigromarginatus, etc.
- Parasited by P. smithi and A. hesperidum, etc.
- Infected by entomogenous fungi
- Farm work, etc.
- Subtotal

Sex ratio 1:1

Eggs laid by perfemale averaged 17

Egg number of next generation; \( N_2 = 2 \times 1/2 \times 17 = 17 \)

Index of population trend; \( I = 17/1600 = 0.02 \)
起来联合防治黑刺粉虱。

**References:**


