Oviposition and survival of *Schizotetranychus bambusae* females (Acari: Tetranychidae) feeding on young and old bamboo leaves

YANXUAN ZHANG\(^1\), ZHI-QIANG ZHANG\(^2\), JIANZHEN LIN\(^1\), JIE JI\(^1\) & AIPING HOU\(^3\)

\(^1\) Institute of Plant Protection, Fujian Academy of Agricultural Sciences, Fuzhou 350013, China; e-mail: zyxlj@pub3.fz.fj.cn

\(^2\) Landcare Research, Private Bag 92170, Auckland, New Zealand; e-mail: zhangz@landcare.cri.nz

\(^3\) Science and Technology Bureau of Jingan District, Fuzhou, Fujian, China

Abstract

The effects of the age of moso bamboo (*Phyllostachys pubescens*) leaves on the survival and oviposition of *Schizotetranychus bambusae* females were examined in the laboratory. The survival rate of mite females decreased much more rapidly when feeding on old leaves from old (second year or older) plants (OO) than feeding on young leaves, but this trend was stopped when the surviving females were transferred from OO to young leaves from young (first year) plants (YY) on days 11-13. These females quickly started oviposition on YY, although their ovipositional rate and fecundity was less and the duration of their oviposition period was shorter than mites feeding on young leaves from old plants (YO) or YY from the begining. These results confirm previous field observations that *S. bambusae* females were rarely found on old leaves and their damage was only observed on young leaves during spring and early summer in a big-harvest year when moso bamboo changes leaves.
Key words: Fecundity, rate of oviposition, longevity, mite-plant relationship, leaf age, *Schizotetranychus bambusae*

Introduction

The moso bamboo (*Phyllostachys pubescens*) is a major forestry crop in southern China. Many species of phytophagous mites have been found on bamboo plants in China and a few of them cause economic injury to the crop (Lin et al. 2000). In Fujian Province, three species of the genus *Schizotetranychus* (Acari: Tetranychidae) are found on moso bamboo leaves: *Schizotetranychus nanjingensis* Ma & Yuan, *S. bambusae* Reck and *S. tenuinidus* Zhang & Zhang in Zhang et al. (2000). *Schizotetranychus bambusae* causes economic injury to moso bamboo only during spring and early summer in a big-harvest year (the year of the two-year cycle when moso bamboo changes leaves). Rarely is it found during other periods of the year, when leaves mature. Nor is this species found during a small-harvest year, when there is no change of leaves (i.e. all leaves are old leaves). This observation leads to our hypothesis that this mite may not be able to reproduce on old bamboo leaves (Zhang et al. 2001). In this paper we test this hypothesis by experiments on the reproduction and survival of *S. bambusae* on young and old bamboo leaves.

Material and methods

Sources of mites and bamboo leaves

Moso bamboo leaves and *S. bambusae* were both collected during May and June 2000 from natural forests in Shoushan, Fuzhou, China. Bamboo leaves with spider mites were brought back to the laboratory in black plastic bags and these were used in observations and experiments on the same day.
Experimental arenas and conditions

Petri dishes (diameter 12 cm) were used as platforms for observing mites in the laboratory (Zhang et al. 1999). Moso bamboo leaves were placed on a piece of filter paper soaked with water in a Petri dish. The two ends of the leaves were covered with strips of wet cotton to prevent the leaves from drying out and rolling. Leaves were replaced every 5-10 days. The experiments were conducted under natural light in an air-conditioned room (24-26°C).

Reproduction and survival on young and old leaves

Three kinds of leaves with different physiological ages were used in the experiments: 1) new leaves from the young (first year) plants (YY); 2) young leaves from old (second year or older) plants (YO); and 3) old leaves from old plants (OO).

A quiescent female nymph of *S. bambusae* was transferred to a bamboo leaf along with an adult male. The pair was then checked daily for reproduction and survival until they either died or escaped. Six such pairs were observed on separate YY leaves, 18 pairs on YO and 26 pairs on OO (another 7 pairs on OO were transferred to YY on days 11-13 to test if this temporal switch of host can change mite reproduction). The eggs laid each day were removed by killing with an insect pin after counting.

| Table 1. Oviposition of *Schizotetranychus bambusae* feeding on young and old leaves of moso bamboo at 24-26°C. Data are in the format: mean±SE (n) |
|------------------|------------------|------------------|
| YY | YO | OO-YY |
| Oviposition rate (d⁻¹) | 1.86±0.43 (n=5) | 2.90±0.23 (n=17) | 1.42±0.36 (n=7) |
| Fecundity | 34.3±11.7 (n=3) | 45.2±4.9 (n=17) | 16.7±0.7 (n=7) |

YY: Feeding on young leaves from young (first year) plants
YO: Feeding on young leaves from old (second year or older) plants
OO: Feeding on old leaves from old plants
OO-YY: Feeding on OO first and then on YY (switching on days 11-13).
Data analyses

ANOVAAs were performed using SYSTAT 7.0 (SPSS Inc. 3/1997). LSD was used to separate the means.

Results

The survival rate of *S. bambusae* females sharply decreased during the first 10 days when feeding on old leaves from old plants (OO) and 50% of the mites died within a week (Fig. 1). When the surviving females were transferred from OO to young leaves from first year old young plants (YY) on days 11-13, the drop in their survival rate was slowed immediately. In contrast, 50% of mites were still alive after two weeks when feeding on YY and after nearly 3 weeks when feeding on young leaves from old plants (YO).

![FIGURE 1. Survivorships of *Schizotetranychus bambusae* females feeding on young leaves from first year young plants (YY), young leaves from old plants (YO) and old leaves from old plants (OO). In the OO-YY experiment, mites were switched from OO to YY on days 11-13 (indicated by the arrow).](image)
FIGURE 2. Oviposition of *Schizotetranychus bambusae* females feeding on young leaves from first year young plants (YY), young leaves from old plants (YO) and old leaves from old plants (OO). In the OO-YY experiment, mites were switched from OO to YY on days 11-13 (indicated by the arrow).
Mite females hardly produced any eggs when feeding on OO (Fig. 2). However, after they were transferred to YY, they quickly started oviposition and the rate quickly increased to about 4 eggs per day (Fig. 2), a pattern similar to females feeding on YO. Variation in the number of eggs laid per day was great among individuals, but was also evident among treatments (Fig. 2). A maximum of 10 eggs per day was observed for a female feeding on YO on day 10. The overall ovipositional rate was significantly different among treatments (Table 1; $F_{2,26}=6.821, P<0.01$) and was highest on YO (averaging about twice as many as on OO-YY; $P<0.01$; Fig. 2 and Table 1).

The fecundity of mites was also significantly different when feeding on leaves of different ages (Table 1; $F_{2,24}=4.902, P<0.05$). Mite females feeding on OO first and then transferred to YY had significantly lower fecundity than mites feeding on YO ($P<0.01$). Mites feeding on YY also had slightly lower fecundity than mites on YO, but the difference was not statistically significant.

The duration of the oviposition period was also significantly different among treatments (Table 2; $F_{2,23}=3.613, P<0.05$). Females transferred from OO to YY had shorter oviposition period than females feeding on YO and YY ($P<0.05$).

### TABLE 2
Duration (in days) of different periods of *Schizotetranychus bambusae* females feeding on young and old leaves of moso bamboo at 24-26°C.

<table>
<thead>
<tr>
<th></th>
<th>YY</th>
<th>YO</th>
<th>OO-YY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oviposition</td>
<td>21.3±4.4 (n=3)</td>
<td>16.0±1.9 (n=16)</td>
<td>8.5±0.4 (n=7)</td>
</tr>
<tr>
<td>Post-oviposition</td>
<td>1.0±0.3 (n=3)</td>
<td>1.0±0.2 (n=12)</td>
<td>1.0±0.2 (n=7)</td>
</tr>
<tr>
<td>Longevity</td>
<td>23.3±5.3 (n=3)</td>
<td>19.1±2.4 (n=15)</td>
<td>16.6±3.5 (n=7)</td>
</tr>
</tbody>
</table>

YY: Feeding on young leaves from first year young plants
YO: Feeding on young leaves from old plants
OO: Feeding on old leaves from old plants
OO-YY: Feeding on OO first and then on YY (switching on days 11-13).
The post-oviposition period was similarly short in all treatments (Table 2; \( F_{2,19} = 0, P = 1.00 \)).

The longevity of females was very variable and there was no significant difference among treatments (Table 2; \( F_{2,22} = 0.548, P = 0.556 \)).

**Discussion**

Moso bamboo has a two-year growth cycle and leaves change every other year. The year of the two-year cycle when moso bamboo changes leaves is known as a big-harvest year and the other year when there is no change of leaves a small-harvest year. An interesting observation is that *S. bambusae* is found on bamboo leaves only during spring and early summer in a big-harvest year, when there are young leaves. Rarely is it found during other periods of the year, when leaves are old. Nor is this species found during a small-harvest year. It seems, therefore, young leaves are essential to the reproductive success of this mite.

In this paper, we showed that mite females indeed had higher mortalities on old leaves than on young leaves, and they could not reproduce normally on old leaves. However, they were able to produce eggs soon after they were transferred from old leaves to young leaves, although their fecundity was lower and the duration of oviposition period shorter than those feeding on young leaves from the beginning. It is unknown why *S. bambusae* could not reproduce on old bamboo leaves. It does not seem that the old leaves are toxic to *S. bambusae*, because *S. bambusae* females could quickly resume oviposition after they had been on old leaves for over 10 days and then transferred to young leaves. Rather, it is more likely that old bamboo leaves do not provide enough nutrients for *S. bambusae*. It may be hypothesized that old bamboo leaves may lack certain chemicals that *S. bambusae* needs to properly digest nutrients from old leaves. It has been shown in *Tetranychus cinnabarinus* that the presence of NaCl, KNO3 and glutamine solutions could activate digestive enzymes (Akimov & Barabanova 1977).
The relationship between *Schizotetranychus* spider mites and the age of bamboo leaves has also been observed in other species. Another major pest of moso bamboo in Fujian, *Schizotetranychus nanjingensis* Ma & Yuan, is more often found on young leaves than old ones, whereas *Schizotetranychus tenuinidus* Zhang & Zhang, is more often found on old leaves than new ones (Zhang *et al.* 2001b). It should be noted that these two species can reproduce successfully on both old and young leaves, and thus the influence of leaf age is less strong than in *S. bambusae*.

Damage caused by *S. bambusae* to bamboo plants has been reported from Shandong (Sun *et al.* 1997) and Sichuan (Liu *et al.* 2000) in China. However, these authors did not mention the effects of leaf age on mites. Our study is the first experimental demonstration that *S. bambusae* can not reproduce on old bamboo leaves. Future studies are needed to investigate the biochemical/physiological processes underlying this phenomenon.

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**References**


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