

## FEEDING RATES AND SURVIVAL OF LIVE WOOD TERMITES IN WOODY PLANTS\*

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Feeding rates and survival of two common live wood termite pests of tea, *G. dilatatus* and *P. militaris* were investigated in the laboratory. In this study, five regions of tea stems, twelve types of tropical wood and three kinds of common timber were used. It was observed that the feeding rates were positively correlated to survival. There was evidence for development of neotenic reproductives in *P. militaris*. The trunk region of tea was observed to have the highest percentage of survival. Wood preference was also shown by one species of termite.

### INTRODUCTION

The two species of termites, *Glyptotermes dilatatus* and *Postelectrotermes militaris* are pests of tea in Sri Lanka. The former commonly known as "The Low Country Live Wood Termite" is widely distributed below 750 m elevation. The latter referred to as "The Up Country Live Wood Termite" occurs mostly at elevations between 1000 m and 1700 m, particularly in the Dimbula and Maskeliya Districts (Danthanarayana and Fernando, 1970). *G. dilatatus* gains entry through exposed tea branches and the gallery system is discontinuous. *P. militaris* finds its way through the roots and moves up the main stem and branches forming a continuous gallery system. Other than tea, both species are known to attack many shade trees in tea plantations. *G. dilatatus* also attacks *Albizia* sp, *Erythrina lithosperma* and *Grevillea robusta* and is also known to infest *Gliricidia sepium* (Sivapalan, Karunaratne and Jayatilake, 1980). *P. militaris* is also known to attack *Acacia decurrens*, *Albizia falcata*, *Casuarina* sp, *Cedrella toona*, *Crotalaria anagyroides*, *Erythrina lithosperma*, *Eucalyptus* sp, *Grevillea robusta* and *Tephrosia vogelli* (Cranham, 1966).

To date, information on the wood preference of these two species of termites and their feeding rates and survival in different trees, is scanty and is a drawback to implement any successful pest management programme for the control of these pests. This study was undertaken in the laboratory with the aim of gaining more information on the feeding rates and survival of these two species of termites.

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## MATERIALS AND METHODS

To study this problem four experiments were initiated almost concurrently which were designed in keeping with the limitations of material and time available :

IA — Effect of *G. dilatatus* on 5 regions of tea stems : (a) collar, (b) trunk, (c) live branches, (d) branches with die-back and (e) branches with wood-rot.

IB — Effect of *P. militaris* on the same five regions of tea stems as IA.

II — Effect of *P. militaris* on 12 types of tropical wood :

<i>Types of wood</i>	<i>No. of replicates</i>
1. <i>Albizia chinensis</i>	2
2. <i>Agathis alba</i>	3
3. <i>Artocarpus integra</i>	3
4. <i>Dipterocarpus cornutus</i>	3
5. <i>Durio zipethinus</i>	3
6. <i>Eugenia polyantha</i>	3
7. <i>Eusideroxylon zwageri</i>	2
8. <i>Ficus ampelas</i>	3
9. <i>Mangifera caegia</i>	2
10. <i>Mangifera indica</i>	3
11. <i>Metrosideros</i> sp	3
12. <i>Zygia jiminga</i>	2

III — Effect of *P. militaris* on three types of common timber :

1. *Fagus sylvatica* — beech
2. *Pinus* sp. — pine
3. *Tectona grandis* — teak

### Collection of Materials

Specimens of *G. dilatatus* workers and the different regions of tea stems were received from Ratnapura, Sri Lanka. Specimens of *P. militaris* were supplied by the Termite Unit, TDRI, British, Museum (Natural History), London, U.K. The 12 types of tropical wood were obtained from Indonesia. The 3 types of common timber were collected at the Chemical Entomology Unit, The University, Southampton.

### Experiments IA and IB

Due to the limited amount of tea stems made available, the 'splinter technique' was used. All tea stems were cut into match stick like splinters, except those of wood-rot. Each splinter was 1.0 to 1.5mm thick and 3.5cm in length and were

packed in glass tubes of 2.5cm diameter and 4.5cm height. Since termites normally live in the heartwood of stems, only the latter was splintered discarding the sapwood. As tea stems affected by wood-rot could not be splintered they were cut into small pieces (see Fig. 1).

Each region of stem was replicated five times. There were 25 tubes each for *G. dilatatus* and *P. militaris*, totalling 50 tubes in all. Active termite nymphs were individually collected at random from the cultures and placed in each tube. In experiment IA each tube contained 6 workers of *G. dilatatus* while in experiment IB each tube contained 6 workers and one soldier of *P. militaris*.

### Experiment II

The 12 types of tropical wood made available were solid cubes 2.0 cm in thickness. Of these, 8 types were replicated thrice and the other 4 types twice so that there were 32 cubes in all. Each cube was put into a celluloid tube. Active termite nymphs of *P. militaris* were individually collected at random and 9 workers and one soldier were placed in each tube (see Fig. 2).

### Experiment III

Each type of common timber was cut into a definite size of 4.0 x 4.0 cm and 0.8 cm in thickness. There were 6 replicates of each type of timber totalling 18. Each piece was kept in a plastic petri dish, 9.0 cm diameter and 1.5 cm height. Active termite nymphs of *P. militaris* were individually collected at random and in each dish 22 workers and 3 soldiers were placed totalling 25 termites per dish (see Fig. 3).

### Conditioning of Humidity and Shade

The tubes and dishes of the different types of wood (tea, tropical wood and common timber) of all the experiments were kept in two chambers at low humidity (65-70% RH) for 6-8 days. Weights of wood materials in each tube or dish were taken, and the humidity was raised to 95-100% RH for 2-3 days before the respective numbers of termites were placed in the containers. Likewise, at the end of the periods of observation, the humidity was brought down to 65-70% RH before respective weighings of frass were taken. The two chambers were covered with black polythene sheets to provide darkness.

### Temperature Ranges and Relative Humidity

Daily temperature and relative humidity, were measured in each chamber (glass cabinet) where the tubes and dishes were kept, during the entire period of observation. The range of temperature recorded was 21-25°C while that of humidity (relative) was 95-98%. The temperature and humidity change within these ranges were gradual and uniform conditions prevailed during the entire period of observations.

### Daily Observations

Daily observations were made of the number of termites alive and those dead, development of neotenic forms, if any and of the activity of termites, etc in each tube or dish.

### Duration of Experiments

The experiments were set up in June—July 1984 and run until *either* all termites died out (in Expt. II) *or* up to 70 days (in Expts. IA and IB) and up to 60 days (in Expt. III).

## RESULTS

Results obtained from the experiments are presented in the following tables and figures. Table 1 and figure 4 represent experiment IA. Table 2 and figure 5 represent Experiment IB. Table 3 and figure 6 represent Experiment II. Table 4 and figure 7 represent Experiment III.

### Experiments IA and IB

#### (a) *G. dilatatus* in Tea Stems

Since the 'splinter technique' was used, the termites were observed to be hidden within the splinters most of the time. As a result, daily counts of the termites that were alive or dead were not possible. Instead, the numbers of termites that survived at the end of the period of experimentation i.e. after 70 days, are given in Table 1. None of the termites showed any colour change during this period. Table 1 also shows the weight of frass and the termites added in each tube. Figure 4 shows the relationship between feeding rate and survival.

#### (b) *P. militaris* in Tea Stems

As in the case of *G. dilatatus*, here too the termites were observed to hide within splinters, most of the time. Hence only the numbers of termites that survived at the end of the period of experimentation are given in Table 2. In contrast to *G. dilatatus* colour changes (to brown) were observed in *P. militaris* in the trunk and live branch regions. Table 2 also shows the numbers of termites that changed colour as well as the weights of frass and termites added. Figure 5 shows the relationship between the feeding rate and survival.

#### (c) *P. militaris* in Tropical Wood

Since the wood materials used were in the form of cubes it was possible to record daily counts of termites that were dead or alive. Table 3 shows the mean numbers of days of survival of termites in each tube, obtained by the number of days each termite survived in each sample as well as the weight of frass and termites added. It also gives the mean number of days of survival of termites and the mean weights of frass and termites for each type of tropical wood. Figure 6 shows the relationship between the feeding rate and survival, in terms of mean number of days.



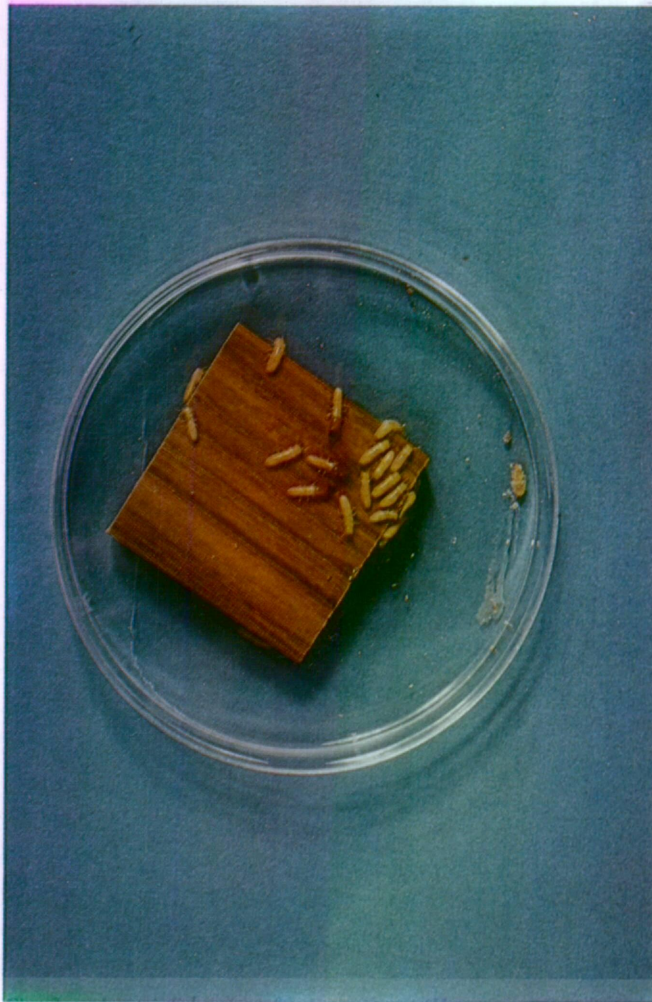
*Fig. 1 - A tube set-up for Experiment IA and IB*

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*Fig. 2 – A tube set-up for Experiment II*

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*Fig. 3 - A petri-dish set-up for Experiment III*

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TABLE 1—Feeding Rate and Survival of *G. dilatatus* in Tea Stems (Experiment 1A)  
(6 termites/sample)

Sample No.	Weight (mg) of Frass	Weight (mg) of 6 Termites	No. of termites		% Alive
			Alive (after 70 days)	Changed Colour	
<b>Collar</b>					
1	25	35	4	0	
2	33	38	5	0	
3	16	40	3	0	
4	06	42	3	0	
5	21	35	5	0	
<b>Total</b>	<b>101</b>	<b>190</b>	<b>20</b>	<b>0</b>	<b>67</b>
<b>Trunk</b>					
6	36	39	6	0	
7	21	40	3	0	
8	20	43	5	0	
9	41	38	4	0	
10	32	44	5	0	
<b>Total</b>	<b>150</b>	<b>204</b>	<b>23</b>	<b>0</b>	<b>77</b>
<b>Branches, live</b>					
11	09	40	3	0	
12	22	38	6	0	
13	18	35	5	0	
14	17	41	4	0	
15	11	42	3	0	
<b>Total</b>	<b>77</b>	<b>196</b>	<b>21</b>	<b>0</b>	<b>70</b>
<b>Branches, die-back</b>					
16	04	41	0	0	
17	03	41	0	0	
18	02	41	0	0	
19	03	51	0	0	
20	05	43	0	0	
<b>Total</b>	<b>17</b>	<b>217</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Branches wood-rot</b>					
21	01	47	0	0	
22	04	46	1	0	
23	03	42	0	0	
24	02	43	0	0	
25	01	35	0	0	
<b>Total</b>	<b>11</b>	<b>213</b>	<b>1</b>	<b>0</b>	<b>3</b>

Note: Envisaged colour change (if any) was to brown colour



**TABLE 2—Feeding Rate and Survival of *P. militaris* in Tea Stems (Experiment IB)**  
(7 termites/sample)

Sample No.	Weight (mg) of Frass	Weight (mg) of 7 Termites	No. of Termites		%		
			Alive (after 70 days)	Changed Colour	Alive	Changed Colour	
<b>Collar</b>							
26	..	23	83	0	0		
27	..	33	76	4	0		
28	..	42	101	4	0		
29	..	61	88	5	0		
30	..	33	85	3	0		
<b>Total</b>	..	<b>192</b>	<b>433</b>	<b>16</b>	<b>0</b>	<b>46</b>	<b>0</b>
<b>Trunk</b>							
31	..	91	92	7	7		
32	..	84	91	7	7		
33	..	89	81	7	7		
34	..	76	88	6	5		
35	..	67	90	6	6		
<b>Total</b>	..	<b>407</b>	<b>442</b>	<b>33</b>	<b>32</b>	<b>94</b>	<b>91</b>
<b>Branches, live</b>							
36	..	51	91	5	4		
37	..	54	89	4	0		
38	..	78	98	5	3		
39	..	52	84	4	1		
40	..	81	78	6	3		
<b>Total</b>	..	<b>346</b>	<b>440</b>	<b>24</b>	<b>11</b>	<b>69</b>	<b>31</b>
<b>Branches, die-back</b>							
41	..	6	88	0	0		
42	..	20	95	1	0		
43	..	22	99	3	0		
44	..	10	85	0	0		
45	..	11	104	0	0		
<b>Total</b>	..	<b>69</b>	<b>471</b>	<b>4</b>	<b>0</b>	<b>11</b>	<b>0</b>
<b>Branches, wood-rot</b>							
46	..	3	87	0	0		
47	..	2	99	0	0		
48	..	4	98	0	0		
49	..	3	91	0	0		
50	..	5	100	0	0		
<b>Total</b>	..	<b>17</b>	<b>475</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

Note: Envisaged colour change (if any) was to brown colour .



TABLE 3—Feeding Rate and Survival of *P. militaris* in Tropical Wood  
(Experiment II)  
(10 termites/sample)

Sample No.	Name of Wood	Weight (mg) of Frass	Weight (mg) of 10 Termites	Mean No. of days of Survival	Weight of Frass/g. weight of termites (mg)
1	<i>Agathis alba</i>	11	160	17.5	
2	"	12	159	19.2	
3	"	18	176	25.6	
Mean		14	165	20.8	85
4	<i>Durio zipethinus</i>	19	161	25.1	
5	"	12	179	19.0	
6	"	21	169	26.0	
Mean		17	170	23.4	100
7	<i>Dipterocarpus cornutus</i>	11	167	15.2	
8	"	12	185	16.1	
9	"	10	168	11.1	
Mean		11	173	14.1	64
10	<i>Metrosideros sp.</i>	16	174	21.4	
11	"	15	190	19.8	
12	"	14	177	17.4	
Mean		15	180	19.5	83
13	<i>Mangifera indica</i>	15	165	18.1	
14	"	16	178	18.7	
15	"	14	179	13.2	
Mean		15	174	16.7	86
16	<i>Artocarpus integra</i>	19	171	20.3	
17	"	25	158	27.8	
18	"	19	172	21.0	126
Mean		21	167	23.0	126

Table 3 (Contd.)—Feeding Rate and Survival of *P. militaris* in Tropical Wood  
(Experiment II)  
(10 termites/sample)

Sample No.	Name of Wood	Weight (mg) of Frass	Weight (mg) of 10 Termites	Mean No. of days of Survival	Weight (mg) of Frass termites
19	<i>Eugenia polyantha</i>	11	155	13.6	
20	"	12	154	17.5	
21	"	13	173	17.1	
		12	161	16.1	75
22	<i>Ficus ampelas</i>	23	166	28.1	
23	"	16	149	18.0	
24	"	12	168	14.3	
		17	161	23.1	106
25	<i>Zysia jiringa</i>	16	144	18.2	
26	"	16	162	19.2	
		16	153	18.7	105
27	<i>Mangifera caesia</i>	20	176	23.1	
28	"	20	152	24.0	
		20	164	23.6	122
29	<i>Albizia chinensis</i>	24	156	25.2	
30	"	21	142	20.3	
		23	149	22.8	154
31	<i>Eusideroxylon zwageri</i>	6	174	20.4	
32	"	5	164	19.3	
		6	169	19.9	36

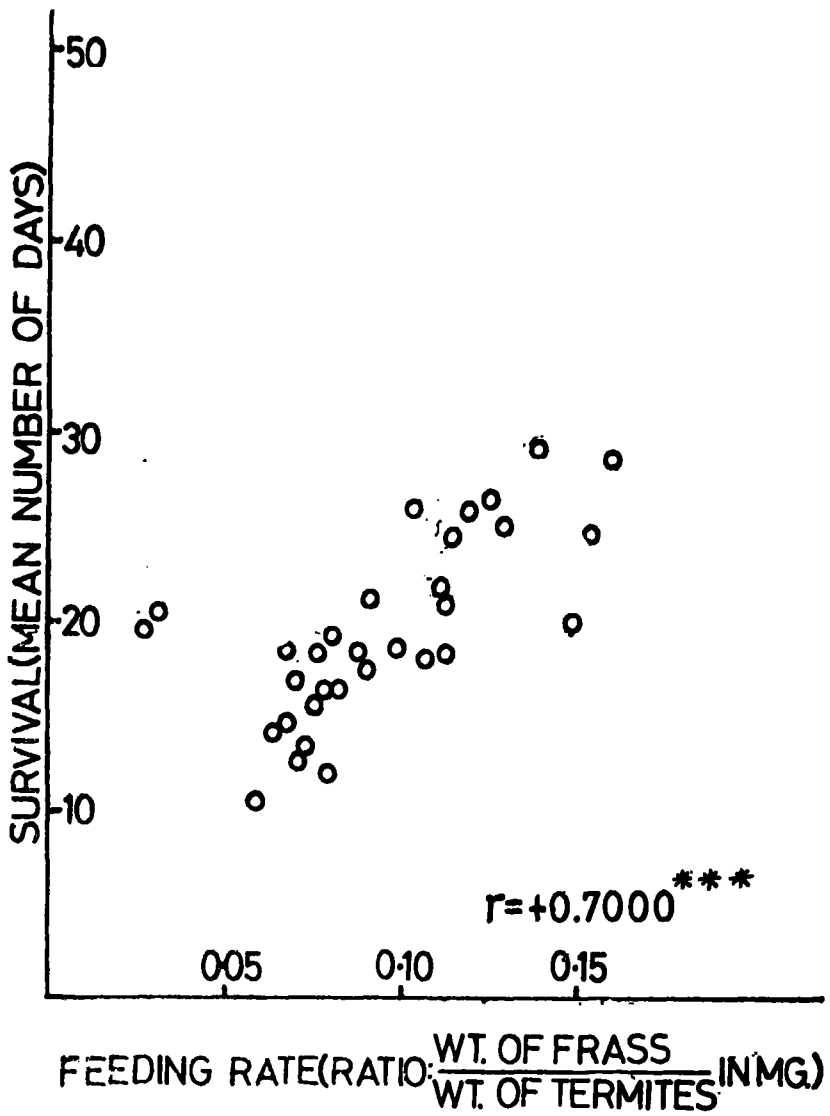


Fig. 6 — Relationship between feeding rate and survival of *P. militaris* in tropical wood (Expt. II)

(d) *P. militaris* in common timber

As in tropical wood, daily counts of termites that were dead or alive were possible in the common timber since the timber materials used were in the shape of cuboids. Table 4 shows the mean numbers of days of survival of termites in each dish, obtained by the number of days each termite survived in each sample as well as the numbers of termites alive at the end of the period of experimentation, i.e. after 60 days. Weights of frass and termites added are also shown along with the mean numbers of days of survival, mean numbers of termites alive after 60 days, and the mean weights of frass and termites added for each type of common timber. Figure 7 shows the relationship between feeding rate and survival, in terms of mean number of days of survival.

TABLE 4—Feeding Rate and Survival of *P. militaris* in common timber  
(Experiment III)  
(25 termites/sample)

Sample No.	Weight (mg) of frass	Weight (mg) of 25 termites	No. of termites Alive (after 60 days)	Mean No. of Days of Survival
<i>Fagus sylvatica</i>				
1	11	459	0	26.9
2	20	479	3	30.4
3	23	464	4	32.9
4	31	486	9	40.5
5	43	497	13	43.3
6	18	539	0	37.4
Total	146	2924	29	Mean 35.2
<i>Pinus sp.</i>				
7	43	438	11	43.4
8	29	440	0	34.6
9	43	461	12	44.2
10	46	500	10	49.4
11	41	476	8	41.0
12	24	500	3	34.6
Total	226	2815	44	Mean 41.2
<i>Tectona grandis</i>				
13	10	424	0	14.4
14	13	469	5	33.1
15	24	420	6	38.0
16	13	442	0	14.0
17	18	417	2	33.4
18	11	412	0	27.3
Total	89	2584	13	Mean 26.7

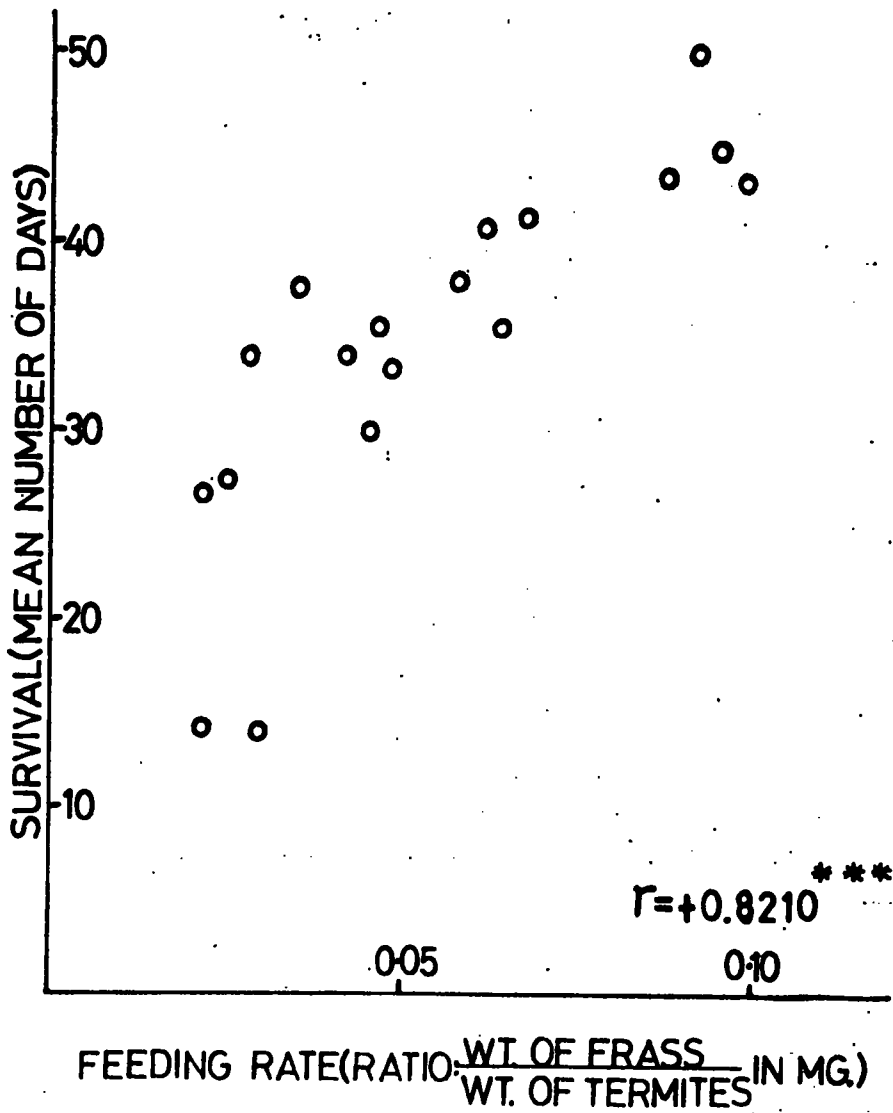


Fig. 7 — Relationship between feeding rate and survival of *P. militaris* in common timber (Expt. III)

## DISCUSSION

In all the experiments, a strong positive correlation between the feeding rates (in terms of frass, standardized by the weights of termites) and the rates of survival, either in number of termites alive at the end of experimentation or in mean numbers of days termites lived has been seen consistently (Tables 1-4 and Figures 4-7). This trend indicates that a measure of the quantities of frass would give a fair estimate of the rates of survival in laboratory studies.

Development of neotenic reproductives as observed by the change of body colour to brown, was seen only in *P. militaris* in tea stems, in the regions of trunk and live branches and not in the collar region (Table 2). Such changes were not observed with *G. dilatatus* in tea stems or with *P. militaris*, in tropical wood or common timber. This may perhaps be due to the shorter duration of the study. Senaratne (1973) observed that the nymphs of live wood tea termites did not survive beyond this stage under laboratory conditions. In the natural habitat, nymphs may take many months to develop. However, Williams and Morales (1983) found that, as few as 4 individuals could form a potentially successful colony by developing neotenic forms.

In tea stems, highest percentage survival was in the trunk region for both *G. dilatatus* and *P. militaris* (Tables 1 and 2). This trend declined in the collar region. These findings along with the observations of high neotenic development of *P. militaris* in the trunk region but not in the collar, strongly suggest that live wood tea termites tend to produce reproductive forms when the colony reaches the trunk region. This may possibly be due to differences in biochemical composition of the tea stems in different regions which study merits consideration. It is also desirable to extend this study to many varieties of clonal tea that exhibit varying degrees of tolerance and susceptibility to tea termites.

Among the two species of termites, *P. militaris* was more successful in breeding and colony maintenance than *G. dilatatus* in tea stems. This is evident in the high percentage of survival in the trunk region and information of neotenic reproductives. It was generally observed during the entire period of experimentation that *P. militaris* nymphs were more active than *G. dilatatus* under identical laboratory conditions.

In many varieties of tropical wood tested, there is evidence of wood preference both in terms of feeding rate and mean number of days of survival. This may be due to the hardness of wood (Supriana, 1983), or due to differences in biochemical composition. Some of the tropical wood are known to contain insect repellants, thus avoiding termite attack.

In the three types of common timber tested, *Tectona grandis* (teak) shows fair resistance to *P. militaris*, both in terms of feeding rate and survival (Table 4). *Pinus* sp. was more favoured than the beech (*Fagus sylvatica*).

A limitation in this study was the unavailability of sufficient wood (tea as well as tropical wood) and of termites (*G. dilatatus*) which caused restrictions in the weight of wood, the number of termites that could be accommodated in each sample and in replication. Nevertheless within the short period of this study it was possible to obtain some information on the preferential feeding habits and survival of those live wood termites that cause serious problems in tea plantations in Sri Lanka.

### CONCLUSIONS

1. Feeding rates, in terms of frass and survival are positively correlated for *G. dilatatus* and *P. militaris* in tea stems, tropical wood and common timber.
2. There is evidence for development of neotenic reproductives of *P. militaris* in the trunk and live branches of tea stems.
3. The highest percentage of survival of *G. dilatatus* and *P. militaris* was in the trunk region of tea stems.
4. *P. militaris* lived better than *G. dilatatus* in tea stems.
5. *P. militaris* exhibit wood preference in the tropical wood tested.
6. Teak wood shows fair amount of resistance, while pine wood is more susceptible than beech, for *P. militaris*.

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