Temperature Mortality Thresholds for insects and fungi in New Zealand

by

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THE JOINT FORCES OF CSIRO & SCION

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CSIRO scion

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INTRODUCTION

This document summarises data on the thermal mortality thresholds which specifically relates to both indigenous and exotic New Zealand insects and fungi. The data is of varying reliability, some derived under operational conditions, and some from carefully controlled laboratory trials. The data is summarised (Tables 1 and 2), its source identified, and its quality indicated.

DATA EVALUATION

Each of the six data sources is briefly discussed and the reliability of the data indicated.

Crabtree, unpublished data 2001

A range of insects were exposed directly to specified temperatures using a waterbath system. Temperature was controlled using a Tecam TE-7 Tempette thermostat/stirrer/heater unit capable of maintaining a temperature within 0.5ºC. Insects were held within a paper towel tube within a boiling tube to prevent contact with the glass. The internal tube rose to the surrounding water temperature within 1 minute. All exposures were replicated, involved a minium of 10 individuals, and controls were maintained at room temperature. The data is considered to have a high level of both precision and accuracy and therefore has high reliability.

Table 1 - Summary insects (by insect group)

Group	Life stage	Temp (ºC)	Time (mins.)	Dead/Alive	Reference
Mosquitoes (Culicidae)					
Culex rotoruae	larvae	50	5	dead	Crabtree, unpublished data 2001
Culex rotoruae	larvae	41	5	dead	Crabtree, unpublished data 2001
Culex perviglans	adults	50	5	dead	Crabtree, unpublished data 2001
Culex notoscriptus	adults	50	5	dead	Crabtree, unpublished data 2001
Ants (Formicidae)					
Iridomyrmex glaber	workers	50	5	dead	Crabtree, unpublished data 2001
Chelaner antartica	workers/pupae	50	5	dead	Crabtree, unpublished data 2001
Butterfly/moths (Lepidoptera)					
Pieridae					
Pieris brassicae	eggs	45	5	alive	Crabtree, unpublished data 2001
Saturniidae					
Opodiphthera eucalypti	eggs	40	10	alive	Ridley and Crabtree 2001
Opodiphthera eucalypti	eggs	40	15	alive	Ridley and Crabtree 2001
Opodiphthera eucalypti	eggs	50	10	partial kill	Ridley and Crabtree 2001
Opodiphthera eucalypti	eggs	50	15	partial kill	Ridley and Crabtree 2001
Opodiphthera eucalypti	eggs	70	10	dead	Ridley and Crabtree 2001
Opodiphthera eucalypti	eggs	70	15	dead	Ridley and Crabtree 2001
Opodiphthera eucalypti	larvae	40	10	alive	Ridley and Crabtree 2001
Opodiphthera eucalypti	larvae	40	15	alive	Ridley and Crabtree 2001
Opodiphthera eucalypti	larvae	50	10	dead	Ridley and Crabtree 2001
Opodiphthera eucalypti	larvae	50	15	dead	Ridley and Crabtree 2001
Opodiphthera eucalypti	larvae	70	10	dead	Ridley and Crabtree 2001
Opodiphthera eucalypti	larvae	70	15	dead	Ridley and Crabtree 2001
Beetles (Coleoptera)					
Cerambycidae					
Arhopalus ferus	adults	42	10	alive	Crabtree, unpublished data 2001
Arhopalus ferus	adults	44	10	alive	Crabtree, unpublished data 2001
Arhopalus ferus	adults	45	10	alive, not full recovery	Crabtree, unpublished data 2001
Arhopalus ferus	adults	45	10	alive, not full recovery	Crabtree, unpublished data 2001
Arhopalus ferus	adults	46	10	movement, died later	Crabtree, unpublished data 2001

(contd)

Group	Life stage	Temp (ºC)	Time (mins.)	Dead/Alive	Reference
Arhopalus ferus	adults	47	10	dead	Crabtree, unpublished data 2001
Arhopalus ferus	adults	47	10	dead	Crabtree, unpublished data 2001
Arhopalus ferus	adults	48	10	dead	Crabtree, unpublished data 2001
Arhopalus ferus	eggs	55	10	dead	Biosecurity Services 2001
Prionoplus reticularis	larvae	45	220	dead	Dentener et al 2001
Prionoplus reticularis	larvae	45	60	dead	Dentener et al 1999
Prionoplus reticularis	larvae	63	10	dead	Biosecurity Services 2001
Prionoplus reticularis	larvae	40	10	alive	Ridley and Crabtree 2001
Prionoplus reticularis	larvae	40	15	alive	Ridley and Crabtree 2001
Prionoplus reticularis	larvae	50	10	dead	Ridley and Crabtree 2001
Prionoplus reticularis	larvae	50	15	dead	Ridley and Crabtree 2001
Prionoplus reticularis	larvae	70	10	dead	Ridley and Crabtree 2001
Prionoplus reticularis	larvae	70	15	dead	Ridley and Crabtree 2001
Prionoplus reticularis	eggs	40	180	alive	Dentener et al 1999
Prionoplus reticularis	eggs	45	150	partial kill	Dentener et al 1999
Curculionidae					
Mitrastethus baridioides	adults	60	10	dead	Biosecurity Services 2001
Scolytidae					
Hylastes ater	adults	60	10	dead	Biosecurity Services 2001
Hylastes ater	larvae	65	10	dead	Biosecurity Services 2001
Hylastes ater	pupae	75	10	dead	Biosecurity Services 2001
Tenebrionidae					
Uloma tenebrionoides	adults	65	10	dead	Biosecurity Services 2001
Uloma tenebrionoides	adults	40	10	alive	Ridley and Crabtree 2001
Uloma tenebrionoides	adults	40	15	alive	Ridley and Crabtree 2001
Uloma tenebrionoides	adults	50	10	dead	Ridley and Crabtree 2001
Uloma tenebrionoides	adults	50	15	dead	Ridley and Crabtree 2001
Uloma tenebrionoides	adults	70	10	dead	Ridley and Crabtree 2001
Uloma tenebrionoides	adults	70	15	dead	Ridley and Crabtree 2001
Blattidae					
Drymaplaneta semivilla	adults	60	10	dead	Biosecurity Services 2001

Table 2 - Summary fungi

Species	Temp (ºC)	Time (mins.)	Dead/ Alive	Reference
Phlebiopsis gigantea	70	10	dead	Biosecurity Services 2001
Phlebiopsis gigantea	60	10	alive	Biosecurity Services 2001
Phlebiopsis gigantea	50	30	dead	Ridley and Crabtree 2001
Sphaeropsis sapinea	65	10	dead	Biosecurity Services 2001
Sphaeropsis sapinea	60	10	alive	Biosecurity Services 2001
Sphaeropsis sapinea	50	40	dead	Ridley and Crabtree 2001
Botryodiplodia theobromae	40	30	alive	Ridley and Crabtree 2001
Botryodiplodia theobromae	50	10	dead	Ridley and Crabtree 2001
Botryodiplodia theobromae	60	10	dead	Ridley and Crabtree 2001
Cladosporium herbarum	50	10	dead	Ridley and Crabtree 2001
Ophiostoma novo-ulmi	60	10	dead	Ridley and Crabtree 2001
Phellinus weirii	50	20	dead	Ridley and Crabtree 2001
Schizophyllum commune	70	10	dead	Ridley and Crabtree 2001
Fusarium circinatum	50	60	alive	G.Ridley, unpublished data
Fusarium circinatum	60	10	dead	G.Ridley, unpublished data
Phytophthora cinnamomi	40	30	alive	G.Ridley, unpublished data
Phytophthora cinnamomi	40	40	dead	G.Ridley, unpublished data

Ridley and Crabtree 2001

These exposure trials were carried out for Frontline Biosecurity Ltd and used the same methodology as Crabtree unpublished data 2001, however fungi were included in this series of trials. Fungi were grown on 1.5 ml of agar in glass test tubes and exposed in a similar way to the insects. Data is considered of high reliability. The fungi used in these trials were also exposed during vehicle heat treatments (see Biosecurity Services 2001). All samples were killed except at one monitoring site, the spare wheel well. All sites exceeded 60ºC during the 10 minute exposure period except the spare wheel well which only reached 45ºC. Data from the vehicle trial are considered of low reliability because of the extended heat-up time and local temperature variation.

Dentener et al 1999

Eggs and larvae of huhu were directly exposed in Perspex chambers of 18.75 litre volume in a moist air flow. Temperature was monitored throughout. The trial for eggs was complicated by high mortality in field collected control batches, but the high level of mortality at 45ºC suggest this is very close to the mortality threshold. Larvae showed higher survival than eggs at 45ºC. Because exposure temperatures did not exceed 45ºC the data can be considered only indicative of the true thermal mortality threshold.

Dentener et al 2001

The trials reported here involved the artificial infestation of pine logs with huhu larvae. Larvae were located 10 cm beneath the log surface which was exposed to heated air at 65ºC. The internal log temperature reached 45ºC after 3.7 hours. A further series of exposure trials using between 3.5 hours and 6 hours ramp rate took between 5.9 hours and 7.5 hours to reach an internal temperature of 45ºC. The zero ramp rate (directly exposed to 65ºC) produced 100% mortality of larvae once 45ºC was reached. The data has high reliability for the particular experimental conditions which involve prolonged exposure of larvae to sub 45ºC temperatures during heat-up.

Biosecurity Services 2001

A range of insects and fungi were exposed in the course of vehicle heat disinfestation trials where temperature at a range of sites was monitored with the vehicle exposed to specific temperature regimes in a timber drying kiln. The exposure sites for organisms was always at a temperature monitoring site such that exposure over the duration of the trial could be determined. Overall kiln temperatures were always over 60ºC, and some trials exceeded 70ºC, with the minimum exposure site recording 55ºC for 10 minutes. Because exposure temperatures were almost certainly well above the mortality threshold, the data is largely irrelevant in identifying threshold temperatures. However, actual recorded exposure temperatures are considered reliable.

G. Ridley, Unpublished data

The data for these two fungi formed part of the Ridley and Crabtree 2001 trials but was produced too late to be included in the report. The data therefore is considered to have a similar high reliability.

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