

VG14T

**Penicillium, temperature and humidity
monitoring of onions between Tasmania
and Europe**

Keith Chapman

**Tasmanian Department of Primary
Industries and Fisheries**



Know-how for Horticulture™

VG14T

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TASMANIA



**PENICILLIUM TEMPERATURE AND
HUMIDITY MONITORING OF
ONIONS BETWEEN TASMANIA AND
EUROPE 1991**

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ABSTRACT

Growth of *Penicillium sp.* during shipment of onions between Tasmania and Europe has been identified by importers as a serious problem over the last two export seasons. This project aimed to determine when *Penicillium* grows and how environmental factors and transport methods influence growth. Spore release (following *Penicillium* growth) occurred 2-3 days after any period when the relative humidity was above 80%, surface moisture was present and the temperature was above 18°C. These conditions occurred regularly between Tasmania and the Suez Canal. Efficient ventilation was identified as the most important factor in reducing the severity of infection. Areas of reduced ventilation (identified by continuous monitoring of temperature and humidity changes) in both fantainers and the lower tiers of the hold were more susceptible to *Penicillium*. Ventilation can be improved by minor changes in fantainer design and by directing ventilation air to the most susceptible areas of the lower tier and centre of the hold. This project has provided important new information on the factors influencing *Penicillium* infection and has also demonstrated the value of carefully monitoring the performance of shipping technology and relating this information to detailed outturn assessments.

SUMMARY

1. Bulk fantainers performed well with adequate ventilation throughout and little serious *Penicillium*. Even with continuous high humidity at the lower level in the hold onions in the bulk fantainer did not suffer from serious *Penicillium* infection. Ventilation was least efficient near the door (above the fan). Loss of skins during unloading removes most *Penicillium* spores but can lead to a skinning problem if there are insufficient skins. Up to 20% of bulbs suffered pressure bruising at the bottom of the container (this is probably no worse than with palletised stows).
2. Palletised fantainers appeared to provide a less efficient method of ventilation throughout the entire stow. *Penicillium* infection was detected in pallets near the door and the build-up of high humidity at the top of the fantainer suggested that some short-circuiting of air directly from vent to fan may have occurred.
3. Ventilation of the hold was less efficient in the lower level.
4. *Penicillium* growth occurred when:
 - the relative humidity was above 80%
 - surface moisture was present
 - the temperature was above 18-20°These conditions were satisfied soon after leaving Devonport and growth of the fungus occurred regularly until monitoring ceased in the Red Sea. The rate of spore release appeared to be decreasing when monitoring ended.
5. *Penicillium* growth, pressure bruising and most physical damage could be attributed to product handling, stow density and transit conditions but skinning and the development of other diseases was the same in samples stored at Devonport as at outturn in the UK. There was no evidence of the development and curing of new skins on bulbs suffering from skinning at loading.
6. It must also be stated that the calculations of *Penicillium* infection are based on only small isolated samples with the aim being to access the highest possible level of infection in the most unfavourable relative positions. The results do not bear any relationship to packer outturn assessment, market suitability of product or overall outturn of the total shipment. The assessment undertaken

on the small random samples was very comprehensive and would never be possible under commercial circumstances as experienced by prepackers/clients.

Based on the serious concerns expressed by the industry over the high incidence of *Penicillium* infection over previous seasons, it would appear as though significant improvements have been achieved in the areas of equipment design and modification and the management of the total transit environment during this season.

RECOMMENDATIONS

Efficient ventilation is the key to reducing *Penicillium* growth.

1. The palletised fantainer needs minor redevelopment to improve ventilation throughout the stow.
2. The bulk fantainer could be improved by increasing ventilation near the door; probably by changing hole size or distribution in the central duct.
3. Ventilation of the lower tier of the hold could/should be improved.
4. Intermittent ventilation of fantainers and hold, as determined by ambient humidity and temperature, should be investigated. This will require careful monitoring of the fantainers and hold to ensure that areas of high humidity do not develop.

OBJECTIVES

1. To determine when *Penicillium* grows during shipment of onions between Tasmania and Europe.
2. To correlate *Penicillium* growth with temperature humidity and surface moisture measurements monitored continuously during shipment.
3. To monitor the performance of bulk and palletised fantainers.
4. To correlate outturn assessments with the monitored performance.

METHODS

1. Penicillium spore counts

Sterile agar plates, prepared at Stoney Rise Centre, Devonport were used by the electrician on the ship to monitor spore release from fantainers and from the ship's hold.

Plates were exposed for 10 seconds to exhaust air from fantainers at 0800 and 2000hr each day and ventilation air from the hold at 1400 hr. Exposed plates were then sealed and incubated in the cabin for 3-5 days before counting the number of Penicillium colonies on the surface of the plates. Colony colour and texture were also recorded after a further 4 days growth. A period of more intensive monitoring was undertaken as the ship moved into the tropics, with samples taken at 0800, 1200, 1600 and 2000 hr, to investigate diurnal fluctuations in spore release.

Fantainers monitored were:

TROU 2723630	(Tier 82, Bay 21, aft)
TOLU 2411698	(Tier 82, Bay 21, aft)
LANU 0093074	(Tier 82, Bay 07, fore)

2. Temperature and Humidity monitoring

Dataloggers, each containing four temperature probes, one humidity probe and two surface moisture detectors, were installed in two bulk fantainers and one palletised fantainer during loading. Dataloggers were also installed in three flatracks in the ship's hold after the flatracks had been loaded into the ship.

The containers monitored were:

TOLU 2411698	bulk fantainer, deck, tier 82
TOLU 2651277	bulk fantainer, hold, tier 02
TROU 2723630	pallet fantainer, deck, tier 82
SCXU 8141885	flatrack, hold, tier, 02, aft
SCXU 8153823	flatrack, hold, tier 06, aft
SCXU 8159117	flatrack, hold, tier 08, fore

Thermocouple probes installed in the three fantainers were read by the electrician with a hand-held meter at 0800 and 2000 hr each day. These were

intended as back-up for the dataloggers and data are only used where failure of datalogger equipment occurred.

The positions of probes in each container are indicated in Figures 1 and 2.

3. Outturn assessment

Where possible detailed quality assessments were made of containers which had been monitored with dataloggers. Flatracks SCXU 8141885 and SCXU 8159117 consigned to Dublin and Hamburg, respectively, were not assessed. A similar flatrack from tier 02, SCXU 2479005, was assessed as a substitute for SCXU 8141885. Other containers were assessed where possible.

Bulk fantainers unloaded into bulk bins (about 20 bins for each container) were assessed by removing samples of 70-100 bulbs from every second or third bin after unloading was completed. Palletised bags from fantainers and flatracks were assessed by removing bags from the centre of the pallet. The second or third bag from the top was assessed as representing one of the poorest ventilated parts of the container; in some cases the top bag was assessed, representing the best ventilated area at the top of the pallet.

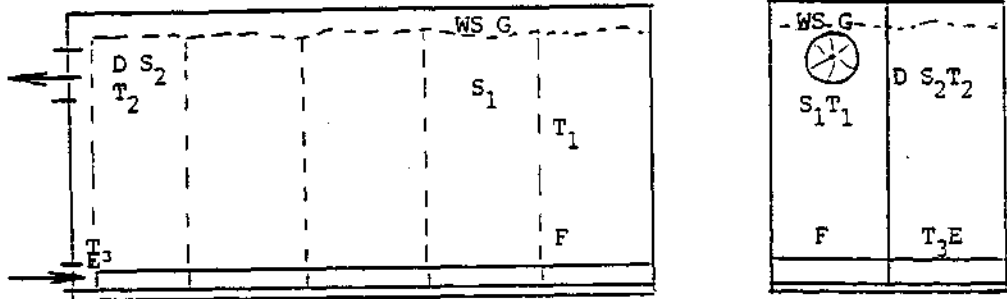
The factors assessed (number of bulbs) were:

- Penicillium incidence in grades of:
 1. mild infection, surface skin only
 2. severe infection, surface skin only
 3. severe infection with spores under inner skins
 4. very severe infection with bulk breakdown
- Other disease - mostly Botrytis neck rot or bacterial soft rots.
- Skinning
- Damage
- Pressure bruising

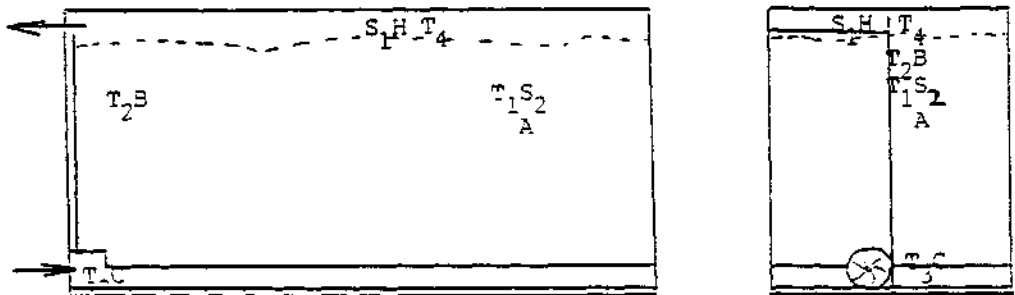
Surface examination was made of as many other bulk fantainers, palletised bags and bulk bins as possible and quality assessments made by importers have been used where available.

Figure 1. Positions of monitoring probes in Fantainers.

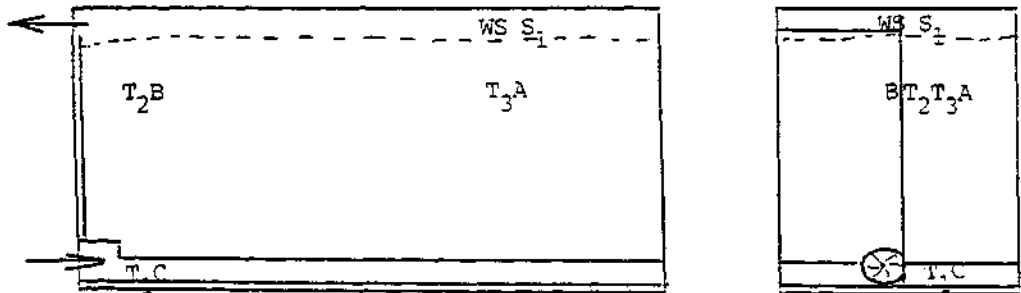
a. Palletised TROU 2723630 Deck Tier 82



b. Bulk TOLU 2411698 Deck Tier 82



c. Bulk TOLU 2651277 Hold Tier 02

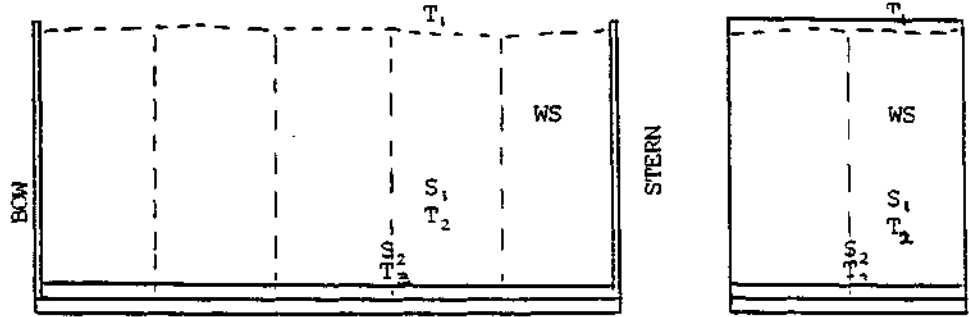


Legend

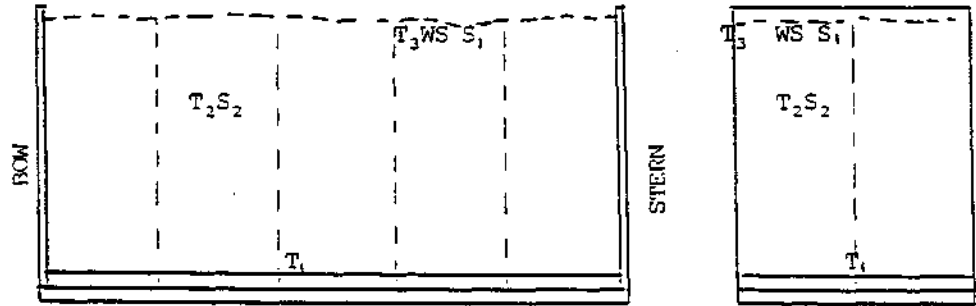
- WS Weather Station - temperature + humidity
- T₁T₂T₃T₄ Thermistor temperature probes (datalogger)
- H Vaisala humidity probe
- S₁S₂ Surface moisture detectors
- ABCDEF Thermocouple temperature probes (manual readings)

Figure 2. Positions of monitoring probes in Flatracks

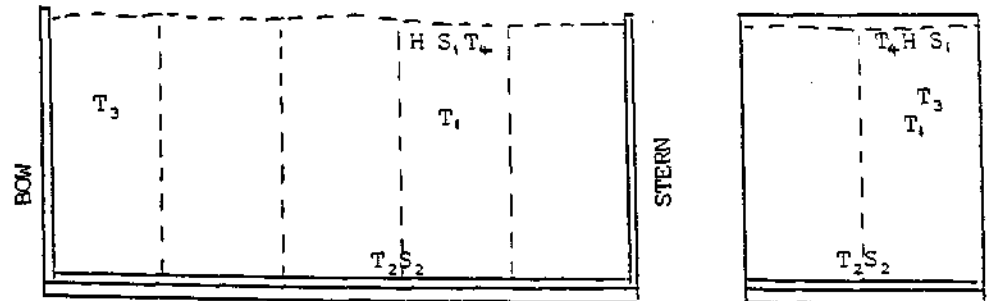
a. Flatrack SCXU 8141885 Hold Tier 02 aft



b. Flatrack SCXU 8153823 Hold Tier 06 aft



c. Flatrack SCXU 8159117 Hold Tier 08 fore



Legend

- WS Weather Station - temperature + humidity
- T₁, T₂, T₃, T₄ Thermistor temperature probes (datalogger)
- H Vaisala humidity probe
- S₁, S₂ Surface moisture detectors

RESULTS

A. FANTAINERS

1. Bulk fantainer on deck (TOLU 2411698)

The outturn assessment of this container is shown in Table 1. Low levels of *Penicillium* infection were observed and most were only on the surface skin (levels 1 and 2). Infection was distributed throughout the container. The low level of infection is influenced by the loss of skins during unloading and although this is what the client sees, it probably underestimates the infection occurring in the container.

Other disease (mostly neck rot and bacterial soft rots), skinning and damage occurred throughout the container but pressure bruising was lower at the top of the container (Bin 20).

The sample stored at Devonport and assessed on 30 April indicated that most *Penicillium* infection, damage and pressure bruising could be attributed to conditions experienced during transport, but the incidence of other diseases and skinning was almost as high in the sample stored at Devonport.

The relative humidity, surface moisture and spore counts are shown in Figure 4 and temperature in Figure 5. Relative humidity on top of the onions was mostly in the range of 70-90% from Devonport to the Suez Canal (20 April) and above 80% for several extended periods. Surface moisture was detected both on top of the onions (S1) and in the onions (S2) whenever the relative humidity on top of the onions was higher than about 70%. The first release of *Penicillium* spores occurred about four days after leaving Devonport (26 February) and occurred regularly thereafter (monitoring ceased on 18 March). Spore release correlated closely with a lag of 2-3 days after periods of relative humidity greater than 80% (and the presence of surface moisture). During the first two weeks from Devonport *Penicillium* growth also tended to occur only when the temperature was greater than 18-20° (Figure 5).

The temperature recordings (Figure 5) demonstrate that all parts of the container lagged behind the incoming air temperature (T_3) during both heating and cooling. The lag was greatest at T_2 (near the door) indicating that ventilation was least efficient at this end of the container.

Table 1. Outturn assessment of bulk fantainer TOLU 2411698 (Deck) on 10 April

Bin ^a	Class I ^b (%)	Penicillium(%)				Other disease	Skinning (%)	Damage (%)	Pressure bruising(%)
		1	2	3	4				
1	66.0	2.2	0.7	-	-	6.6	12.4	2.9	11.7
7	62.0	5.0	0.8	-	-	5.0	16.5	1.6	8.2
10	73.8	-	0.8	0.8	-	8.2	5.7	-	10.7
14	63.0	2.5	-	-	-	6.7	8.4	3.4	16.0
19	68.7	3.8	0.8	-	0.8	6.9	7.6	3.1	14.5
20	74.4	-	-	-	-	6.6	12.4	2.5	4.1
Stored at Stoney Rise Centre and assessed 30 April									
	86.2	-	-	1.6	-	4.9	7.3	-	-

- a bins were numbered in the order they were filled from the container and bulbs come from the approximate fantainer positions shown in Figure 3.
- b Values are % of total sample of bulbs assessed. Most bulbs graded as Penicillium grades 1 and 2 and pressure bruising could be included in Class I.

Figure 3. Estimated sequence of bin filling from bulk fantainers.

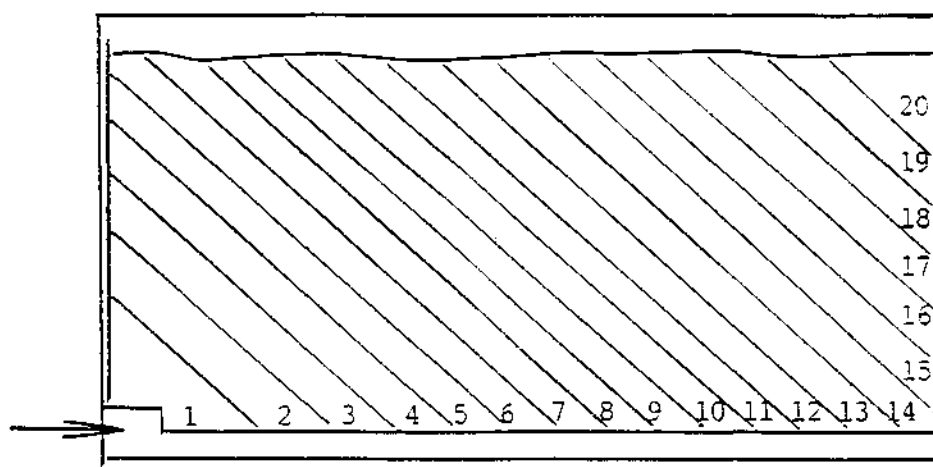
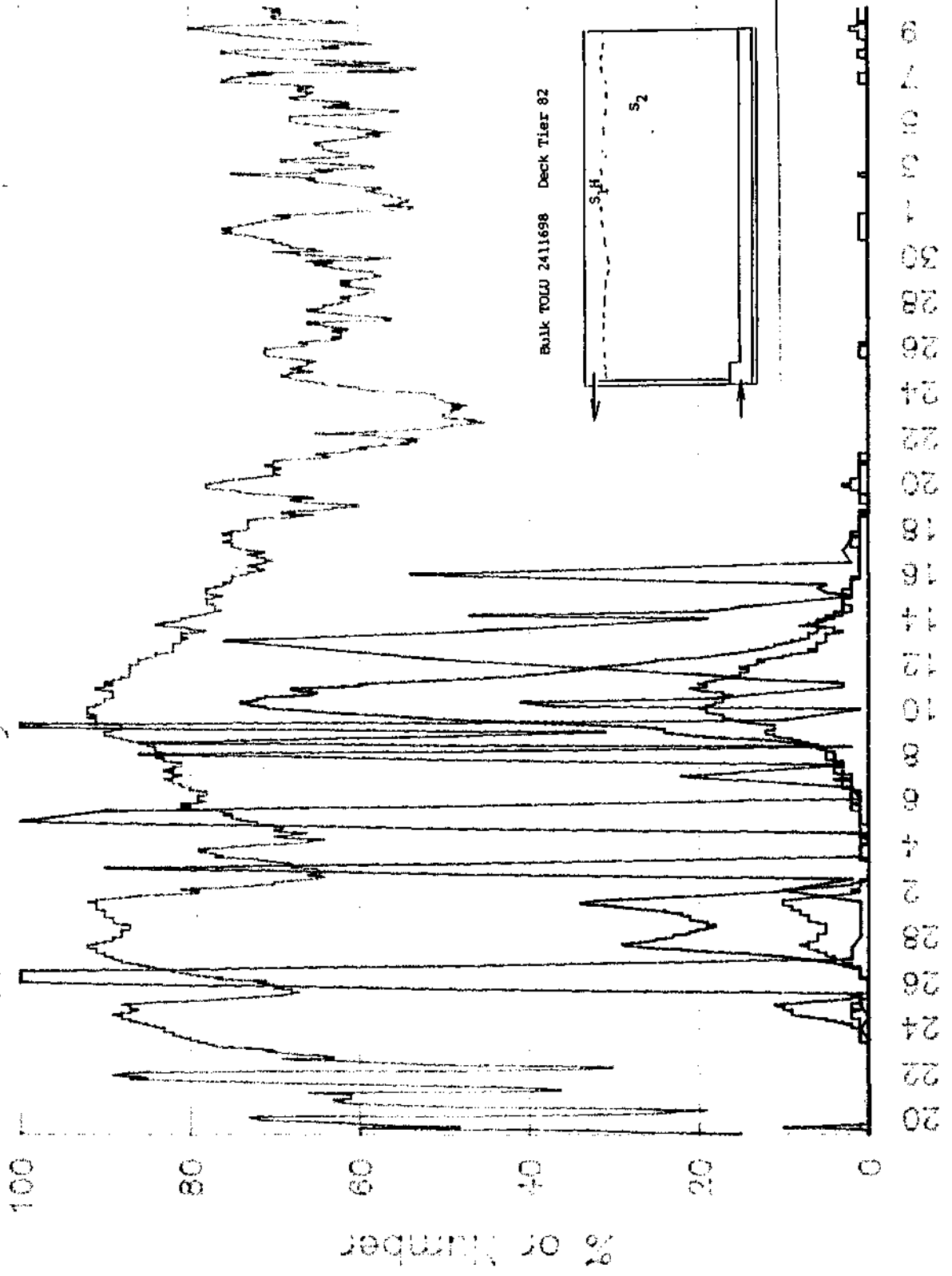


Figure 4

Bulk Faintiner TOLU 2411698

Relative Humidity - Surface Moisture - Spore Counts

- s1 moist
- s2 moist
- rh (H)
- spore



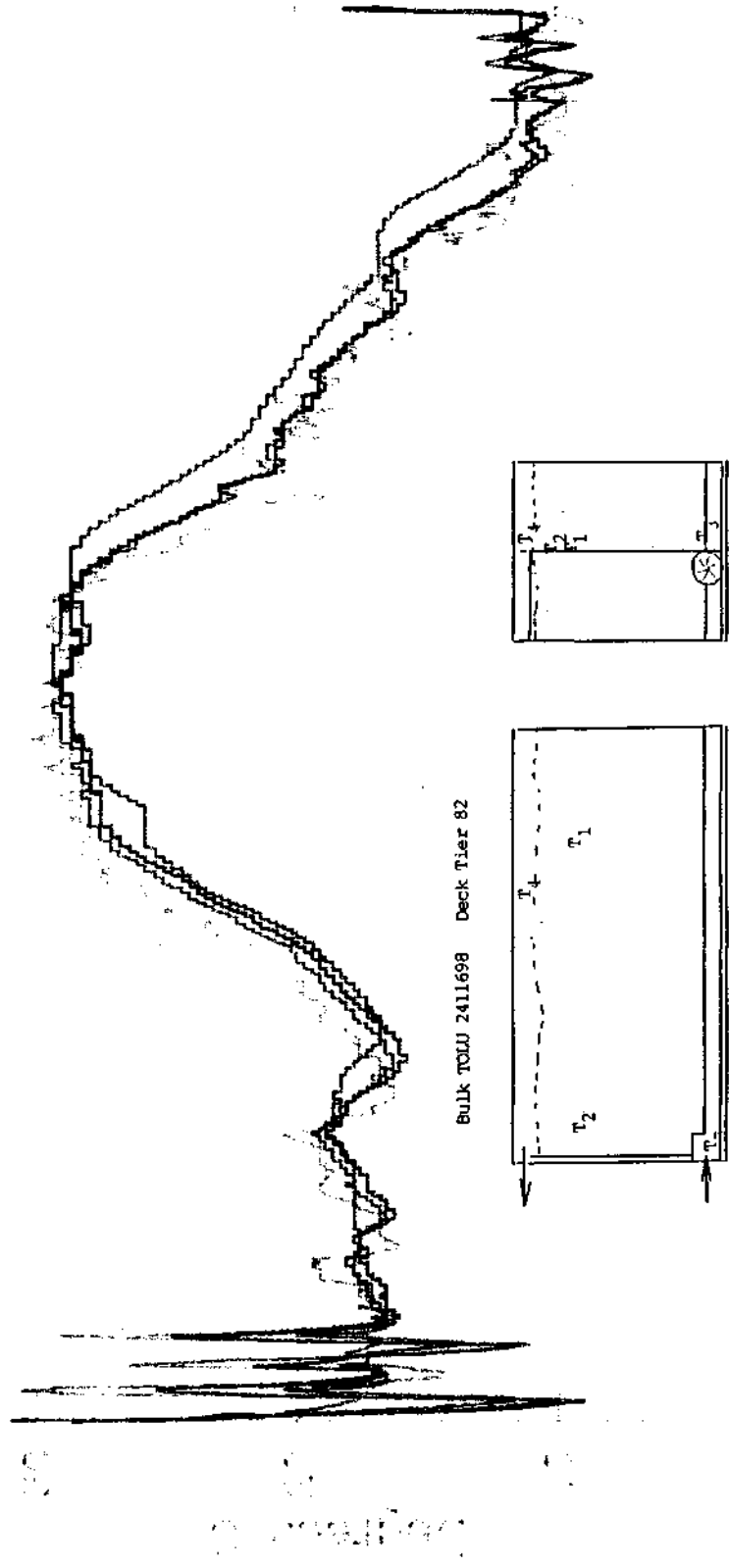
Date (Feb - April)

Figure 5

Bulk Packaging Temperature Profile

10/15/82

- T1 Temp
- T2 Temp
- T3 Temp
- T4 Temp



Severe fluctuations in temperature and relative humidity occurred in the time between filling the container at Latrobe and the ship sailing (20-23 February) but little condensation occurred (surface moisture).

2. Bulk fantainer in hold (TOLU 2651277)

The outturn of onions from this container (Table 2) was similar to the bulk container on deck. Penicillium infection was low and mostly confined to the outer skin and pressure bruising was least at the top of the container (Bins 18 and 20) and greatest at the bottom (Bin 1). Other diseases and skinning did not show any consistent trend with bin position.

The sample stored at Devonport had much less Penicillium and damage and no pressure bruising but levels of other diseases and skinning as high or higher than the samples assessed in the UK.

The relative humidity remained above 80% for most of the journey (Figure 6) with high levels of surface moisture until the Suez Canal. The low level of Penicillium observed therefore suggests that even at high humidity the incidence of Penicillium can be minimised by efficient container ventilation.

The temperature recordings (Figure 7) again indicate that ventilation was least efficient near the door (T_2) where the temperature changes lag behind the intake air (T_1).

3. Other bulk fantainers

A summary of the bulk fantainers inspected (Table 3) shows that Penicillium was generally not serious when examined after the containers had been emptied. However, there was a suggestion by one importer that the worst Penicillium occurred near the door, which could be expected from evidence of poorer ventilation in this area (Figure 5 and 7).

The data in Tables 1-3 suggest that there is no correlation between container position on the ship and outturn quality. Fantainer LANU 0094281 with no rots and relatively low skinning was between ARDU 2063960 and TOLU 2500347 with extensive skinning and rots.

Table 2. Outturn assessment of bulk fantainer TOLU 2651277 (Hold) on 10 April

Bin ^a	Class I ^b (%)	Penicillium(%)				Other disease	Skinning (%)	Damage (%)	Pressure bruising(%)
		1	2	3	4				
1	53.0	1.5	1.5	1.5	-	3.0	15.1	3.0	21.2
3	66.7	2.7	4.0	-	1.3	4.0	9.3	1.3	10.7
8	62.5	-	-	1.1	-	3.4	21.6	1.1	10.2
10	63.8	3.2	1.1	-	-	4.3	11.7	3.2	12.8
12	66.3	-	1.2	2.4	1.2	6.0	9.6	-	13.3
16	64.9	3.9	1.3	-	-	1.3	13.0	6.5	9.1
18	76.4	2.8	-	1.4	2.8	1.4	6.9	-	8.3
20	69.9	3.0	-	-	-	4.0	16.8	2.0	5.0
Stored at Stoney Rise Centre, Tasmania and assessed 30 April									
	74.6	-	-	-	1.4	7.2	15.2	1.4	-

- a Bins were numbered in the order they were filled from the container and bulbs come from the approximate fantainer positions shown in Figure 3.
- b Values are % of total sample of bulbs assessed. Most bulbs graded as Penicillium grades 1 and 2 and pressure bruising could be included in Class I.

Figure 6

Bulk Fantainer TOLU 2651277

Relative Humidity - Surface Moisture

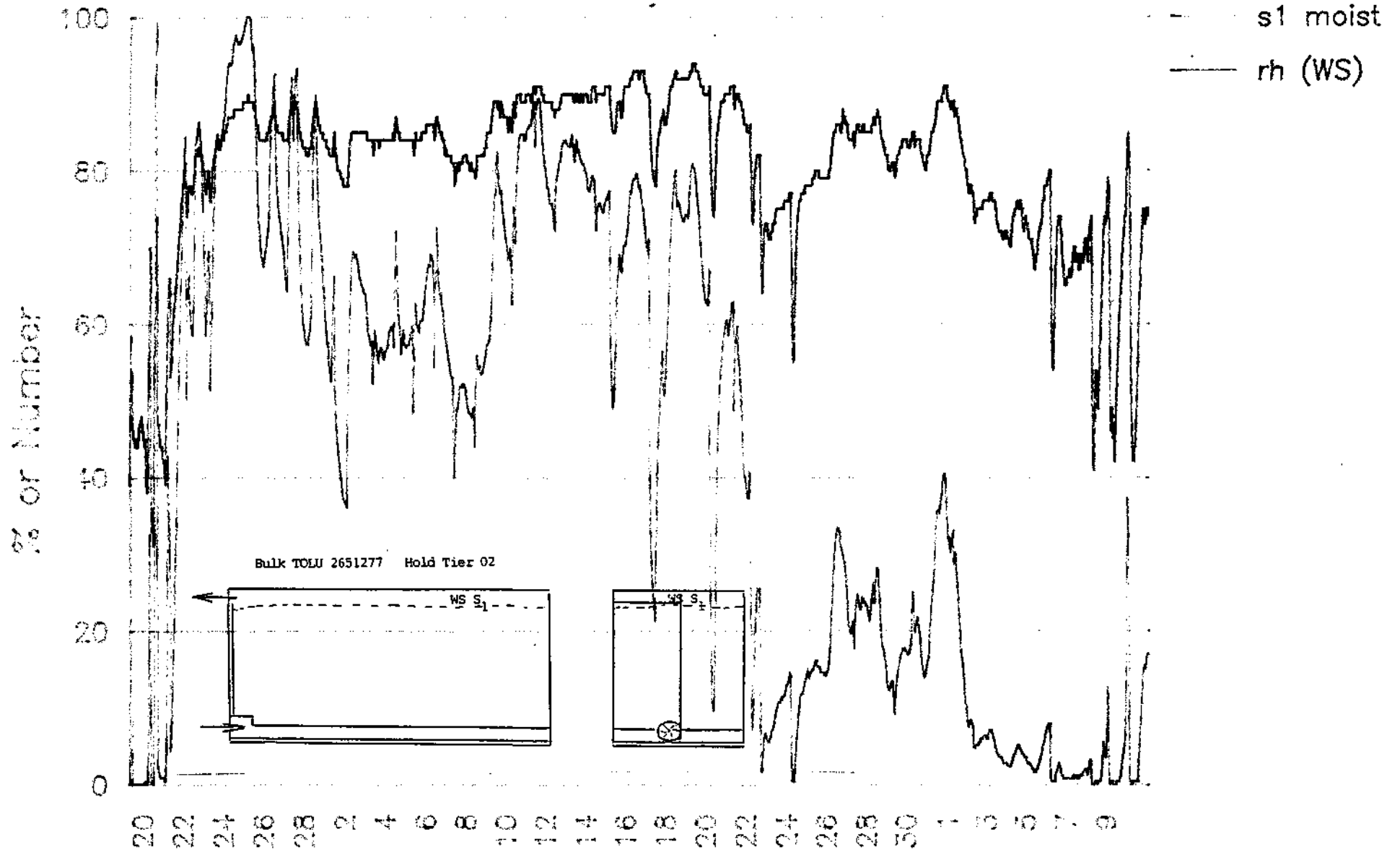


Figure 7

Bulk Fantainer TOLU 2651277

Temperature

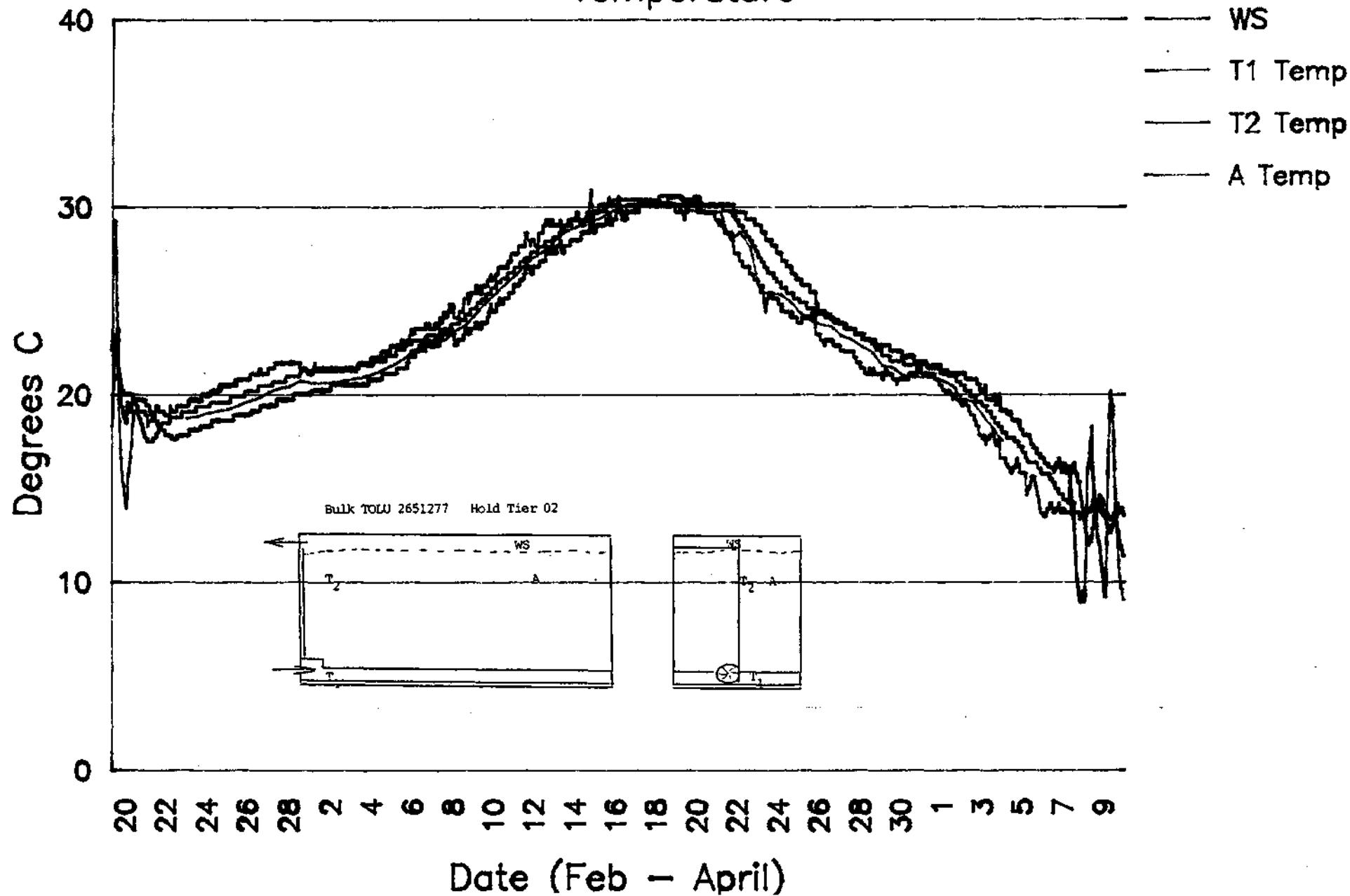


Table 3. Outturn observations of other bulk fantainers

Container No.	Position in ship (tier)	Comments
LANU 0094281	Deck (82)	no rots 25% skinning 74% Class I
ARDU 2063960	Deck (82)	6% rots 44% skinning 49% Class I
TROU 2728117	Deck (82)	3% rots 27% skinning 69% Class I
TOLU 2799109	Deck (84)	2% rots 14% skinning 80% Class I
TOLU 2500347	Deck (82)	Reported that Penicillium was bad during unloading, particularly near door (when first opened) but very little was visible in bins.
NLSU 2635352	Deck (82)	Serious rots

4. Palletised fantainers on deck

Extensive Penicillium infection was observed in fantainer TROU 2723630 (Table 4) with the most seriously affected pallets being those nearest the door (Figure 8), particularly the one (No.10) immediately inside the plywood door (and fan). There was no consistent correlation between pallet position and other diseases or skinning.

The relative humidity in the palletised fantainer (Figure 9) was higher than the adjacent bulk fantainer (TOLU 2411698, Figure 4) suggesting that ventilation at the top rear of the container was less efficient than in the bulk fantainer. Extensive condensation occurred during the periods of high humidity at both the front (S₂) and rear (S₁) of the container.

As with the bulk container Penicillium spore release began soon after leaving Devonport and correlated closely with a lag of 2-3 days after periods of humidity greater than about 75-80%, the presence of surface moisture and temperatures of greater than 18-20° (Figure 10).

The temperature recordings (Figure 10) indicate rapid ventilation of the rear pallet (T₁) where the temperature follows the intake air very closely (T₃), but less efficient ventilation of the front pallet (T₂). No measurement of the air short-circuiting between intake and fan (immediately inside the door) could be made but the higher humidity of the top of this container compared with the bulk container suggests that the overall ventilation could be improved.

Table 4. Outturn assessment of palletised fantainer (TROU 2723630) on 11-12 April

Pallet ^a No	Bag ^b	Class I (%)	Penicillium(%)				Other disease (%)	Skinning ^c (%)	Corrected ^c skinning (%)
			1	2	3	4			
1	centre	34.9	40.1	10.5	2.0	1.3	3.3	7.9	18.5
4	centre	32.9	44.1	13.7	3.1	1.2	1.9	3.1	8.6
4	side	53.1	28.1	2.5	1.3	1.9	5.0	8.1	13.2
5	centre	23.0	38.8	21.7	7.2	-	5.3	3.9	14.5
6	centre	75.9	5.0	1.9	-	-	5.6	11.2	14.7
8	centre	52.6	26.9	7.2	1.7	-	2.6	9.2	17.5
8	side	46.5	33.3	6.9	1.9	-	2.5	8.8	15.9
9	centre	23.7	46.7	19.1	4.6	1.3	2.0	2.6	9.9
10	centre	17.3	46.7	14.7	8.0	2.7	3.3	7.3	29.7

- a The position of pallets in the fantainer is shown in Figure 8.
- b The second bag from the top in the centre of the pallet was assessed from each pallet and also the second bag from the top on the side from pallets 4 and 8.
- c Many skinning bulbs were included in Penicillium grades so the "corrected skinning" is the % of skinning bulbs in Class I + skinning.

Figure 8 Incidence of Penicillium (% of total bulbs) in bag removed from the centre trump of each pallet of fantainer TROU 2723630.

5	67.7	72.1	10
4	62.1	71.7	9
3		35.8	8
2			7
1	53.9	6.9	6

Penicillium grades 1-4

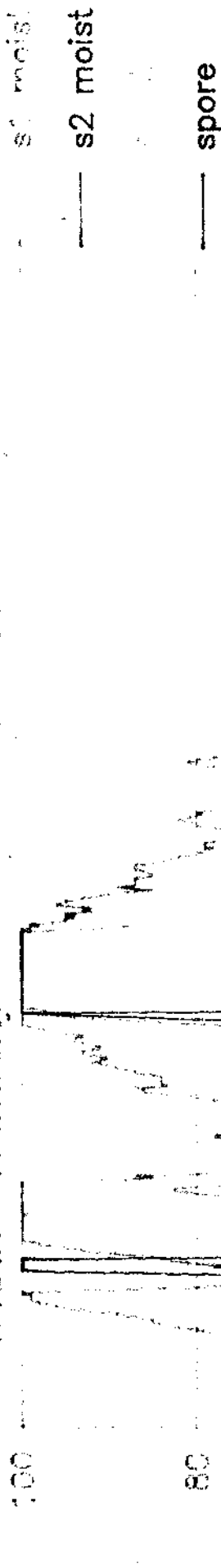
5	7.2	10.7	10
4	4.3	5.9	9
3		1.7	8
2			7
1	3.3	0	6

Penicillium grades 3-4

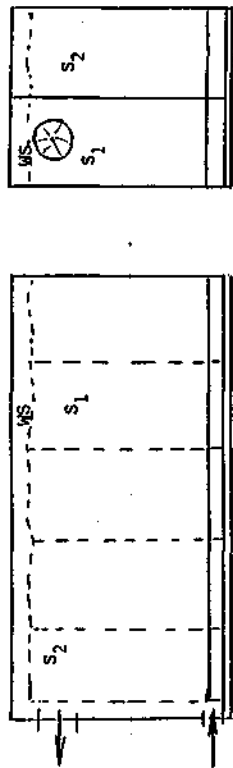
Palletised Fertiliser TROU 2723630

Figure 9

Relative Humidity - Surface Moisture - Spore Counts



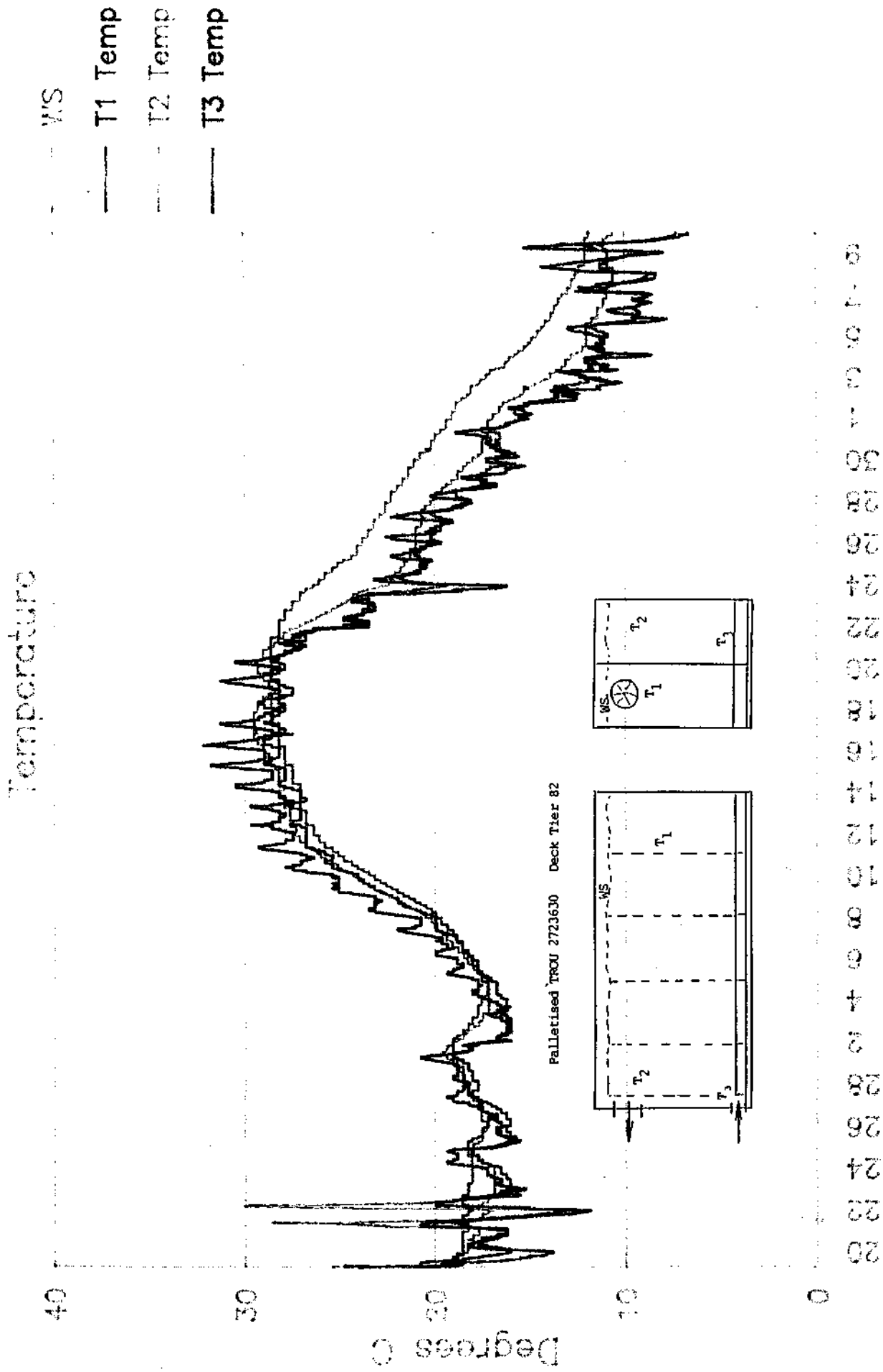
Palletised TROU 2723630 Deck Tier 82



20 22 24 26 28 20 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

Date (Feb - April)

Figure 10 Palletised Fantainer TROU 2723630



The distribution of air in the container could also be improved. Most air moved directly to the back of the container and up through pallets 1 & 6 which had the lowest Penicillium infection. Ventilation of the front pallets 4, 5, 9 and 10 was less effective with a higher incidence of Penicillium.

Spore counts from a palletised container in the forward section of the ship (LANU 0093074) were similar in both numbers and patterns of release to the two containers in the aft section.

B. FLATRACKS IN HOLD

1. Outturn assessment

A higher level of Penicillium infection was found in the lower deck of the hold (Tier 02, Table 5). The internal bag (4/3) from a flatrack in the centre of the hold (SCXU 2479005) was selected as the area of poorest ventilation in the ship. Flatrack SCXU 8138840 on the outside of tier 02 had less Penicillium.

Most Penicillium in flatrack SCXU 8153823 on tier 06 (Table 5) was on the outer skin and therefore not likely to seriously reduce quality.

At all positions in the hold bags in the middle of pallets had higher levels of Penicillium infection than the top bag indicating that ventilation through the pallets requires additional development.

Observation of other flatracks (Table 6) confirmed the detailed assessments in Table 5. Onions on tiers 06 and 08 suffered only minor Penicillium infection while a higher incidence of infection was observed in bulk bins from tier 02.

Table 5 **Outturn assessment of flatracks from hold of ship**

Pallet/Bag ^a	Class I (%)	Penicillium (%)				Other disease (%)	Skinning (%)	Damage & pressure bruising (%)
		1	2	3	4			
<u>SCXU 2479005 (Tier 02 centre)</u>								
4/1	10.0	15.9	30.4	26.1	13.0	4.3	not assessed	
4/3	-	-	5.7	25.7	68.6	-	not assessed	
2/3	20.3	10.9	12.5	40.6	15.6	-	not assessed	
<u>SCXU 8138840 (Tier 02 outside)</u>								
2/1	36.7	23.0	23.0	12.2	2.2	2.9	not assessed	
2/3	26.0	21.3	28.3	20.0	3.9	-	not assessed	
<u>SCXU 8153823 (Tier 06 centre)</u>								
4/1	86.7	2.7	1.8	-	-	0.9	5.3	2.7
4/3	57.8	16.5	8.3	2.8	-	2.8	9.2	2.8
2/1	73.8	7.5	2.8	-	0.9	-	12.1	2.8
2/3	48.2	20.9	10.9	1.8	0.9	0.9	6.4	10.0 (mostly pressure bruising)

a Pallets were numbered as shown for the fantainer in Figure 8. Bags were sampled from the centre of the pallet and numbered 1-4 from the top to the bottom of the pallet.

Table 6 Outturn observations of other flatracks

Container no.	Position in ship (Tier)	Comments
<u>Pallets</u>		
SCXU 8145047	Hold (06)	No serious Penicillium found in any of these flatracks inspected at Tilbury
SCXU 8156777	Hold (08)	
SCXU 8162173	Hold (08)	
SCXU 8120410	Hold (08)	
SCXU 8117087	Hold (08)	
SCXU 8167508	Hold (08)	
SCXU 8145833	Hold (06)	Penicillium on outer skins of some bulbs in top bags but not serious - lower bags not inspected.
<u>Bulk bins</u>		
SCXU 8136955	Hold (06)	Mild Penicillium on outer skins of most onions at surface of bins but does not appear to be any worse lower in bins. Only serious when associated with damaged bulbs or other rots.
SCXU 8144190	Hold (06)	

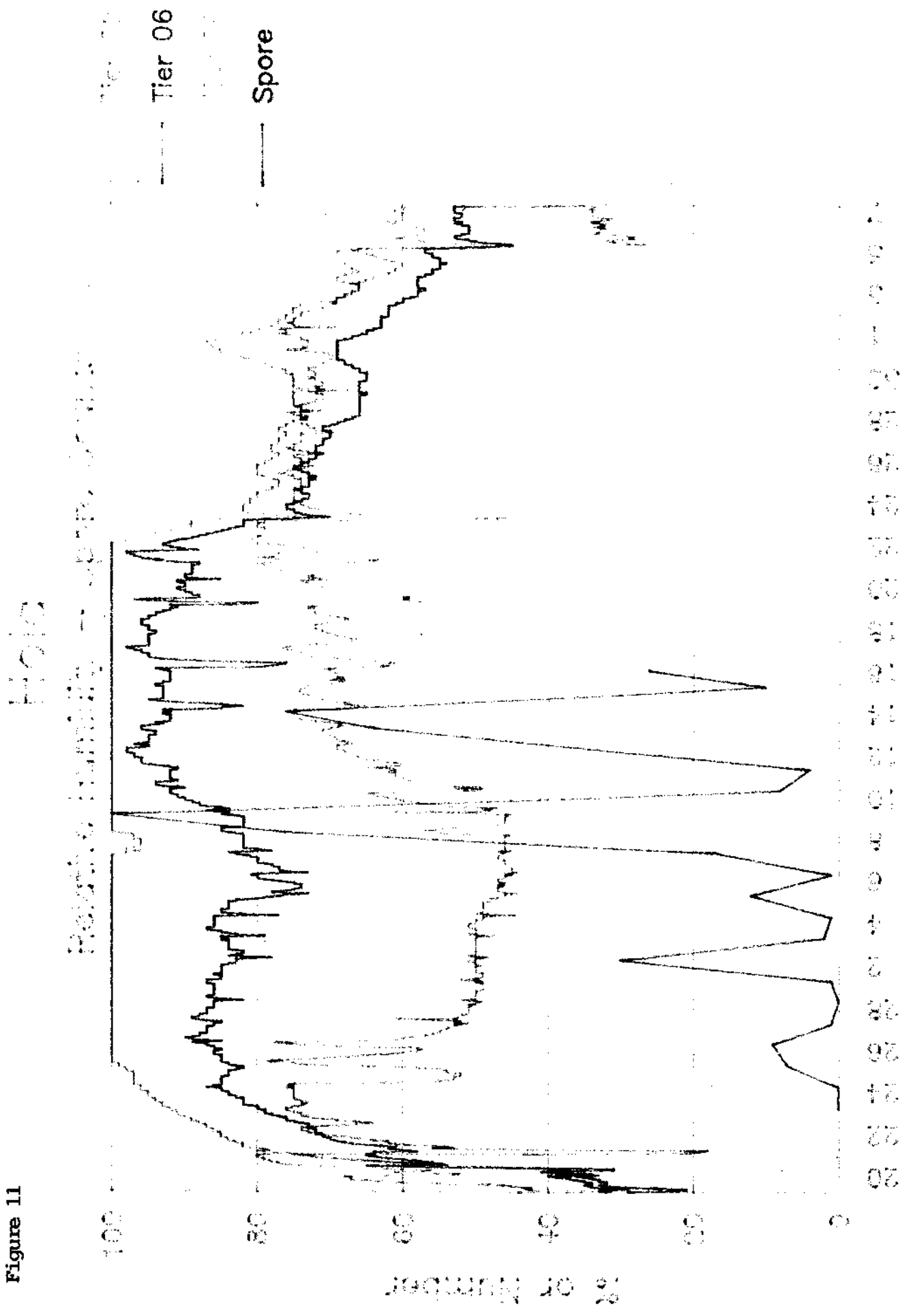
2. Relative humidity and spore counts

The relative humidity measured at or near the surface of the flatracks in the centre of the ship varied significantly between tiers until the ship reached the Suez Canal (Figure 11). On tier 02 the relative humidity was very high throughout this period and obviously would have encouraged Penicillium growth at all times. On tier 06 the relative humidity was lower but still remained above 80% for most of the period.

Penicillium spores were released regularly throughout the voyage (Figure 11) with the major releases being soon after changing direction for Suez on 6 March and approaching the Equator. Quantitative comparisons are not possible because of the changing patterns of hold venting.

Further details of humidity and surface moisture at each level are presented in Figures 13, 15 and 17.

Figure 11

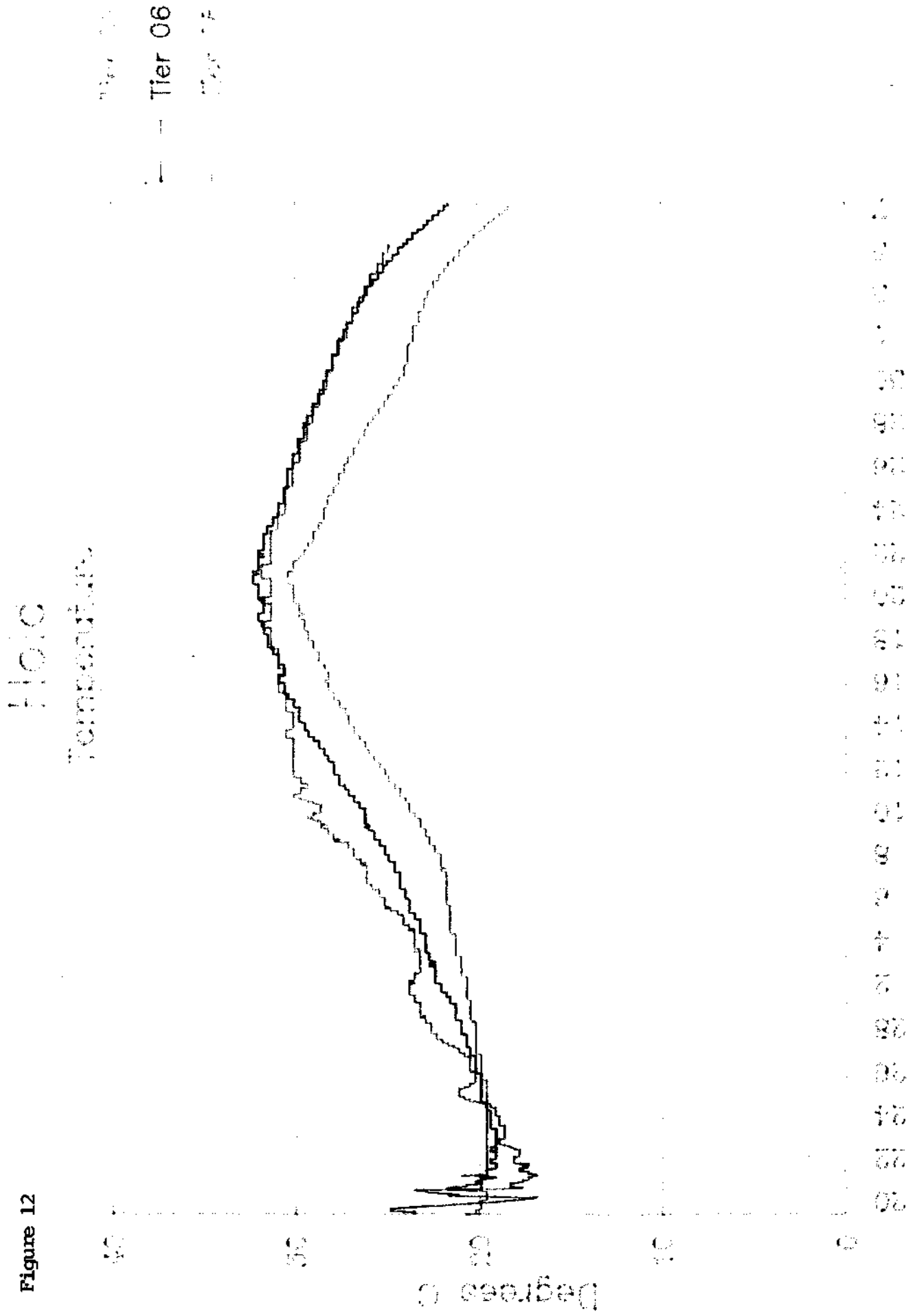


3. Temperature

Figure 12 presents temperatures at or near the top surface of the three monitored flatracks in the hold. The temperature of the upper tiers rose much more rapidly than tier 02 and reached a higher temperature. Tier 08 (the top level) also rose more rapidly than 06. While tier 02 is probably influenced by water temperature more than the upper tiers, the large temperature difference indicates that exchange of air between upper and lower tiers was poor.

Complete temperature monitoring results for each tier are presented in Figures 14, 16 and 18. Temperature deviations for T3, figure 14 and T4, Figure 18 may be due to instrument malfunction.

Figure 12



Flatrack SOXU 8141885

Relative Humidity -- Surface Moisture

— s1 moist
 — s2 moist
 — rh (WS)

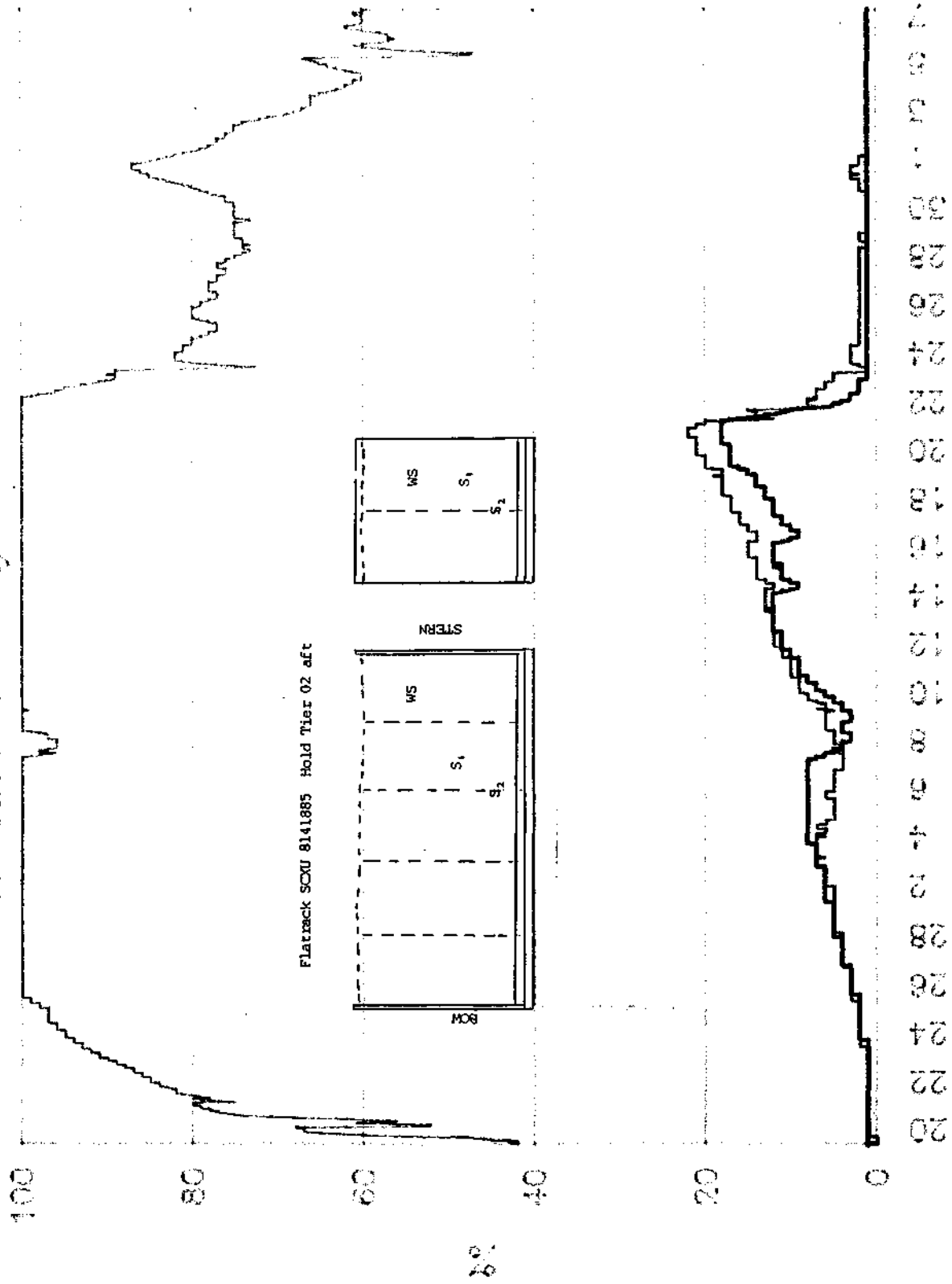
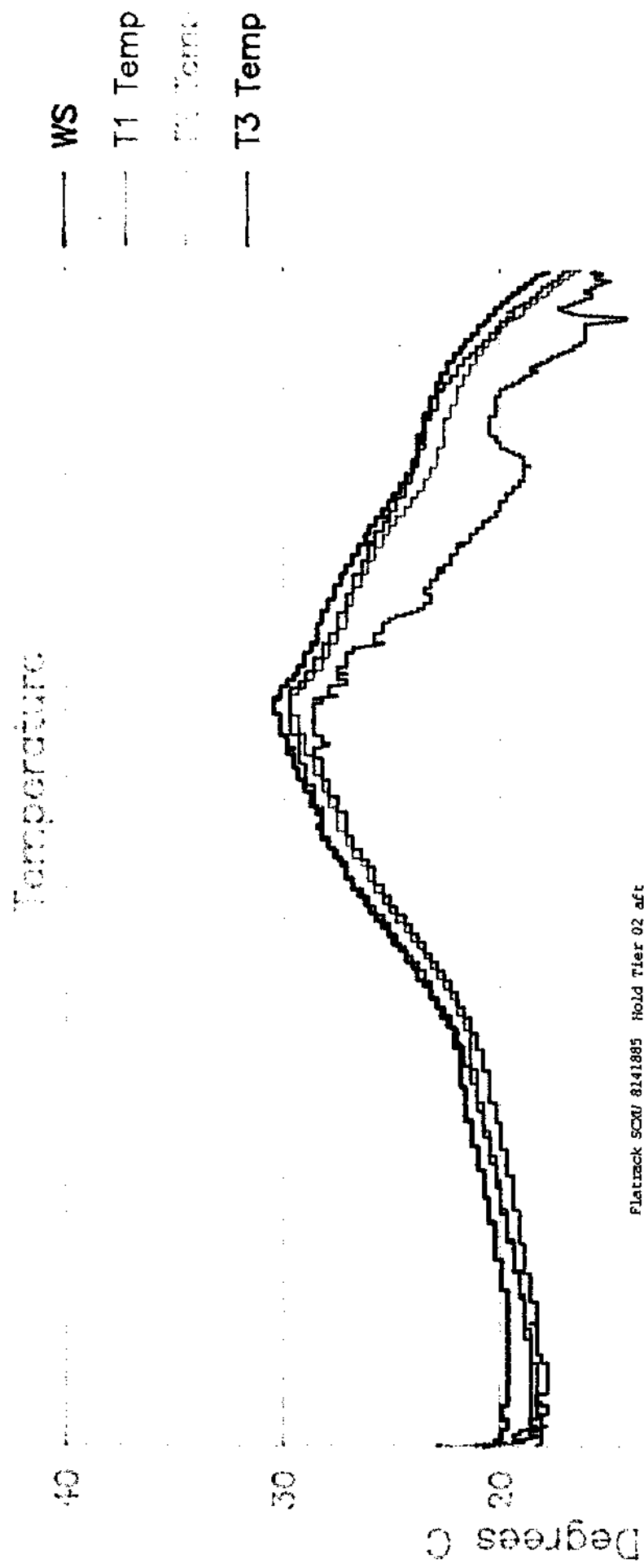


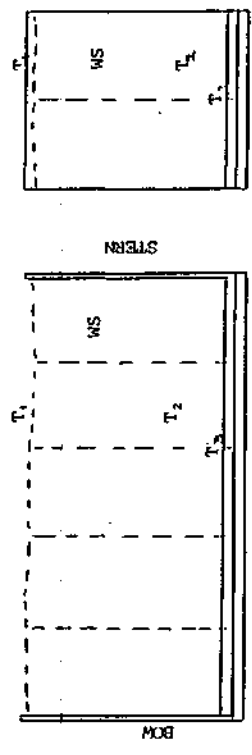
Figure 13

Flatrack SCXU 8141885

Figure 14



Flatrack SCXU 8141885 Hold Tier 02 aft



Date (Feb - April)

Figure 15

Flatrack SCXU 8153823

Relative Humidity -- Surface Moisture

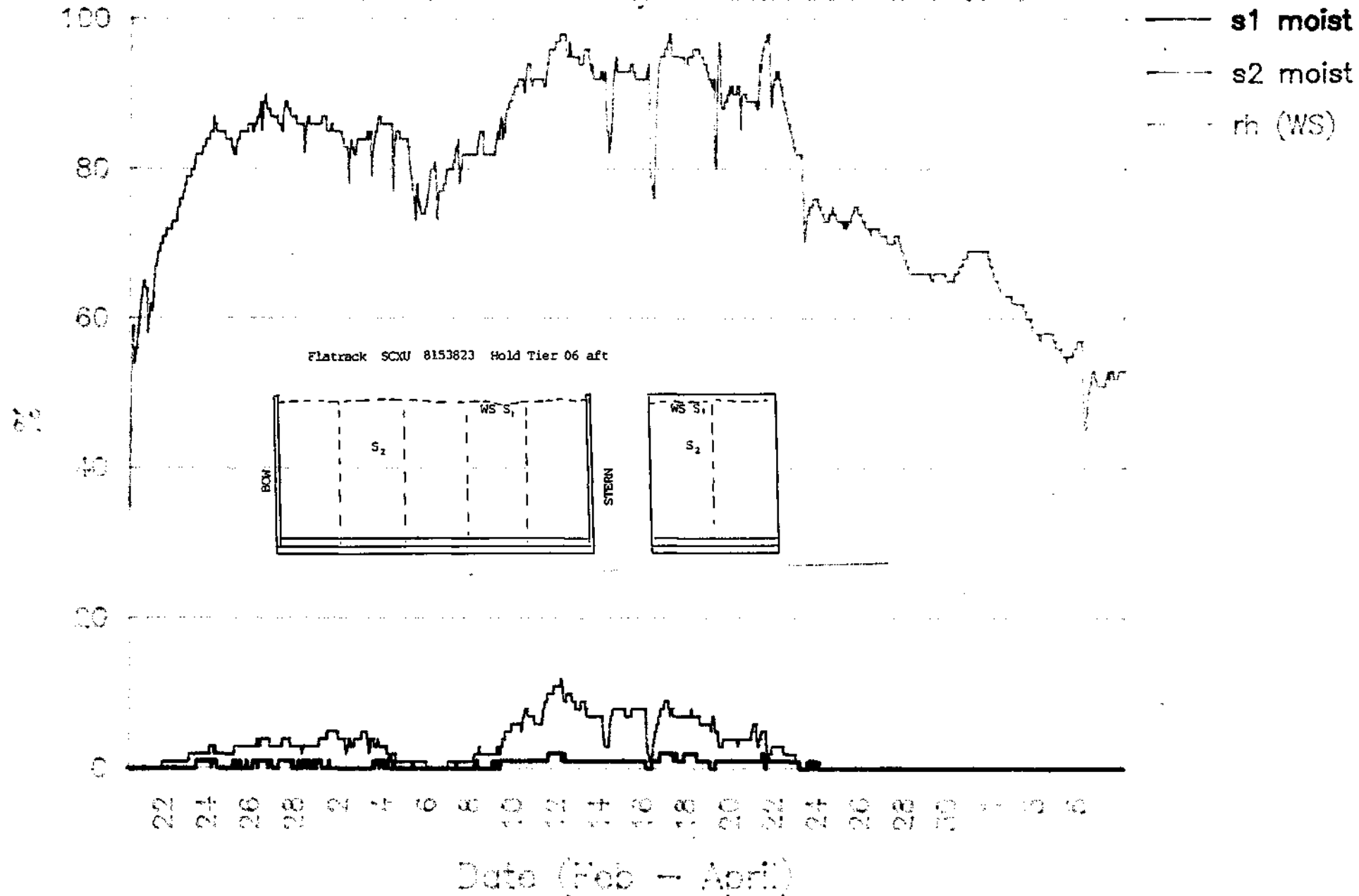
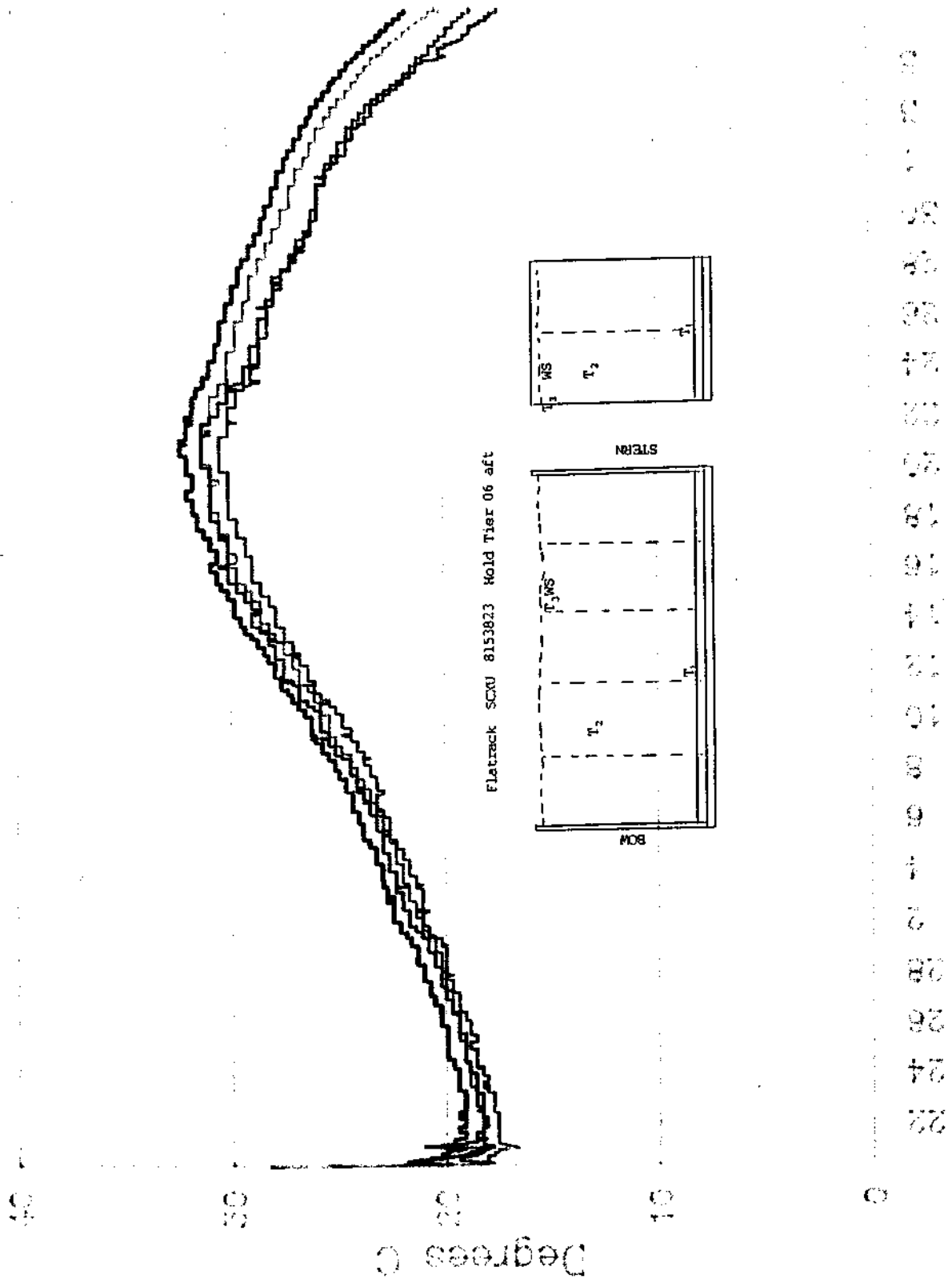


Figure 16

Flatrack SCXU 8153823

Temperature

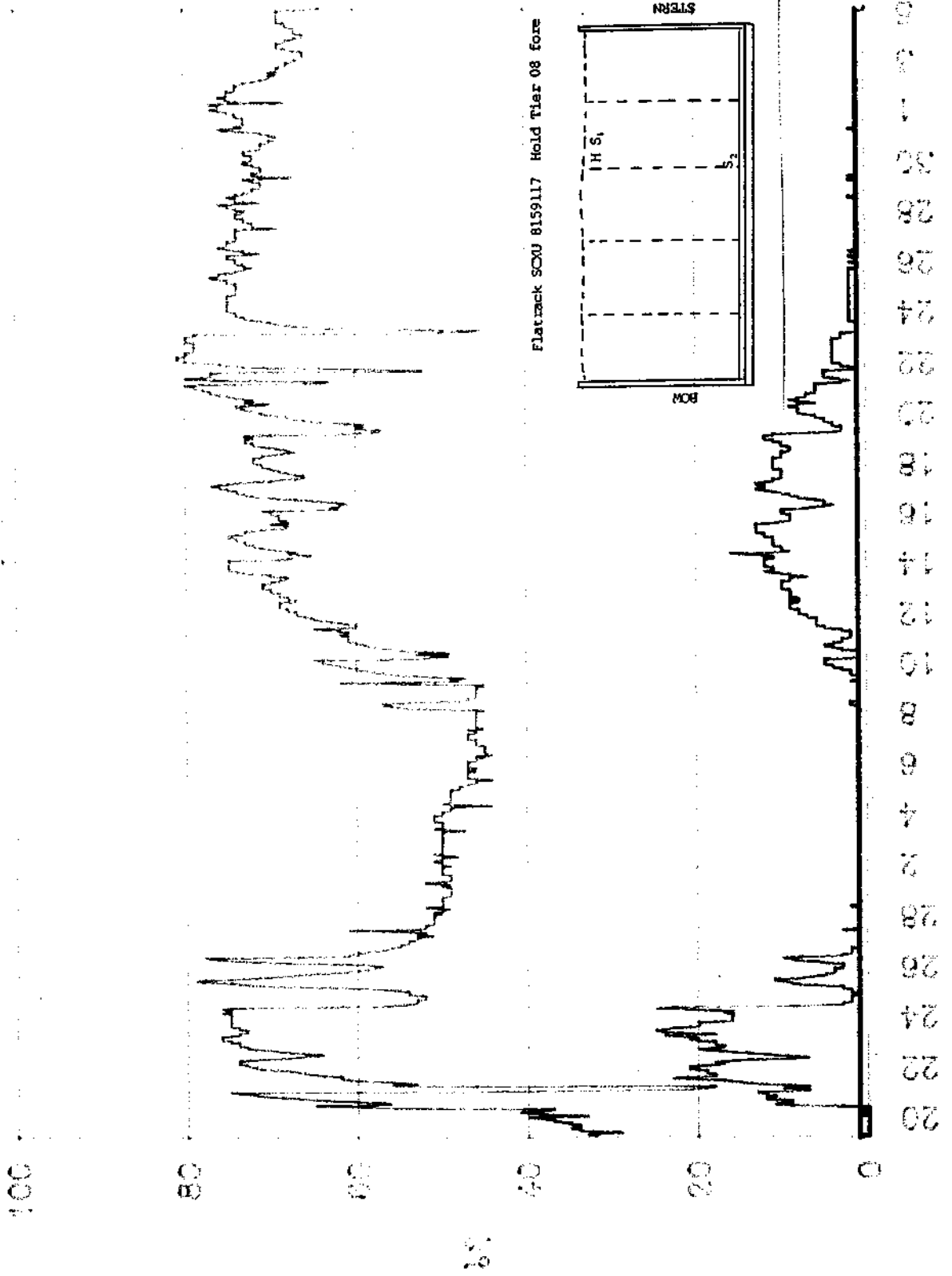
- WS
- - - T1 Temp
- - - T2 Temp
- T3 Temp



Flatrack SCOU 8159117

Relative Humidity -- Surface Moisture

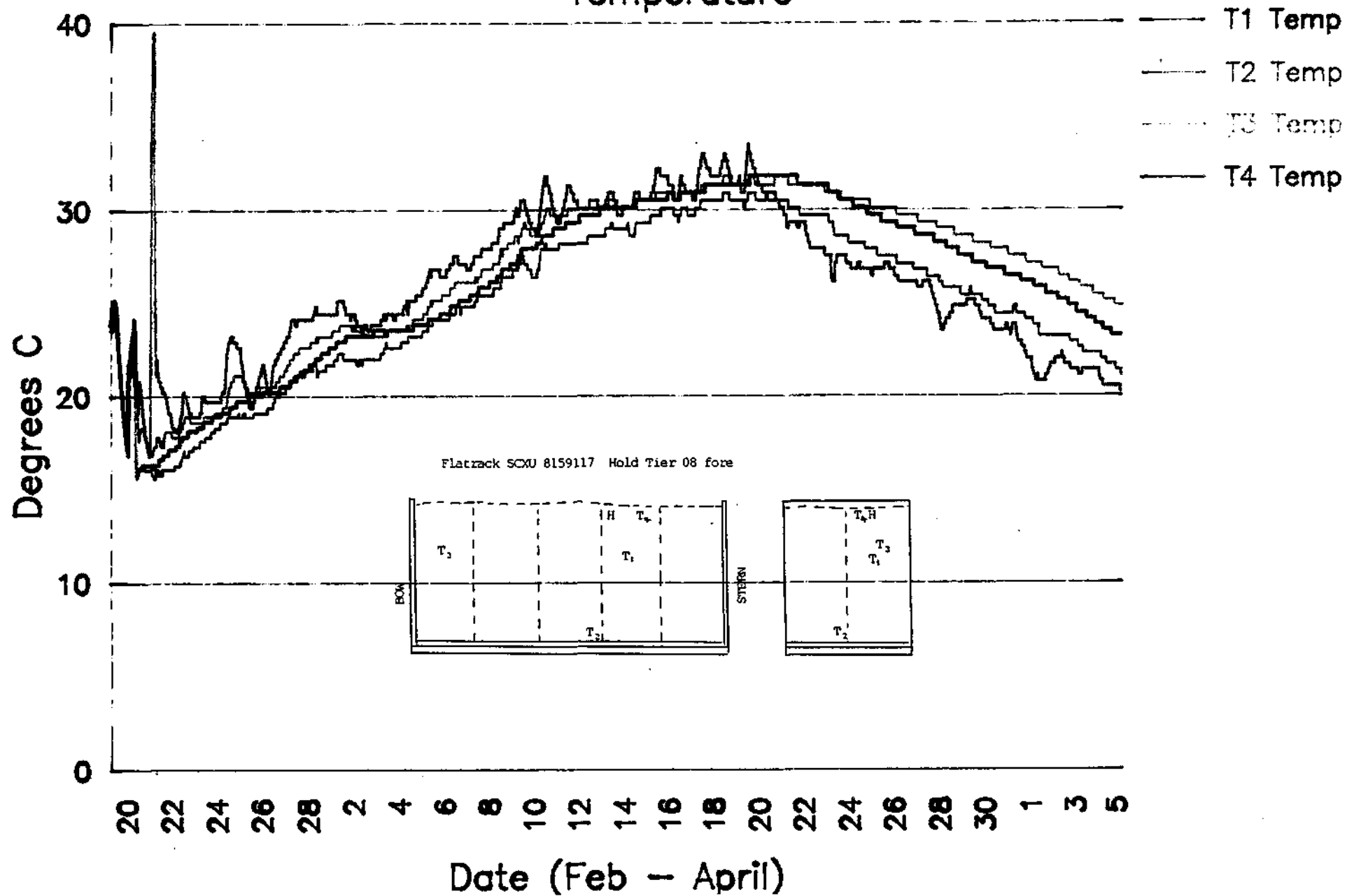
- s1 moist
- - - s2 moist
- · · rh (11)



Date (Feb - April)

Figure 18

Flatrack SCXU 8159117 Temperature



**C. UK VISIT TO ASSESS PAUWGRACHT
EXPERIMENTS 4-21 APRIL 1991**

*Keith Chapman
Senior Horticulturist
Vegetables and Allied Crops Branch
Devonport*

4.4.91	10.30	Left Launceston for Melbourne
	11.30	Checked in at BA desk Tullamarine
	13.30	Left Melbourne for London via Sydney and Singapore on BA12.
5.4.91	6.00	Arrived Heathrow collected luggage and cleared customs and immigration
	7.00	Underground to London
	8.30	Arrived Bedford Hotel, checked in, shower etc.
	12.30	Australia House
6.4.91		London
7.4.91	8.00	To Tilbury to meet ship and observe unloading
	14.00	Return to London
8.4.91	8.00	To Tilbury to assess Penicillium levels in pallets on flatracks
	16.00	Return to London
9.4.91	9.00	Valepower to discuss onion distribution
	12.00	To Tilbury to follow bulk onion container to Bedfordshire
	17.00	Left Tilbury
	19.00	Arrived Bedfordshire
10.4.91	7.00	Observed bulk fantainer unloading
	9.00	Return to London for luggage
	12.00	Returned to Bedfordshire by rail
	13.00	Arrived Bedfordshire and began assessment of first bulk fantainer
	14.00	Observed unloading, second bulk fantainer and continued assessment
	18.00	To hotel
12.4.91	8.00	Assessment palletised fantainers
	18.00	To London
	20.00	Arrived house Canning Town
13.4.91	10.30	To Tilbury to assess flatrack onions
	15.00	Return London
14.4.91		London

15.4.91	8.00	Tilbury to complete assessment of onions from flatracks
	14.00	Return London
	15.30	To Heathrow to collect car from John Hawkins and Nigel Carey (Clements & Marshall)
	18.00	To New Covent Gardens Market to return keys to Mike Weaver, Valepower
	20.00	Return to Canning Town
16.4.91	9.00	To New Covent Gardens Market for discussions with Mike Weaver and inspection of market
	13.00	Return to Canning Town for washing and cleaning of house
17.4.91	8.00	Shopping to restock house
	9.30	Depart for Cambridgeshire
	13.30	Visit ADAS at March and Arthur Rickwood Research Farm - Mike Tuckwell and David Norman
	16.30	Leave to drive to Norfolk
	19.00	Arrive Lessingham
18.4.91	8.00	Leave Norfolk
	11.00	Inspect onions at Hickman & Co., Wisbeck
	14.00	Visit ELGRO (David Hodgson) to inspect onions in store on farms and inspect onion and brassica packing lines
	16.30	To Huntingdon
	17.30	Overnight Old Bridge Hotel
19.4.91	9.30	Visit Munters (Peter Hartwell) to discuss dehumidification of onion stores and ships
	11.00	To J & B Seymour, Consultants to discuss onion assessment etc. with Stephen Smith and Nigel Russell
	14.00	To London (Canning Town)
	17.00	Underground to Heathrow
	19.00	Check in
	22.00	Board BA 009 for Melbourne
20.4.91		London - Melbourne via Bangkok
21.4.91	5.30	Arrive Tullamarine, Melbourne
	6.30	Clear customs
	8.30	Board AN3 for Launceston
	9.30	Arrive Launceston