Awarded Doctor of Philosophy
28.2.75

A LIFE SYSTEM STUDY OF *CRYPTOPHLEBIA OMBRODELTA* (LOWER) (LEPIDOPTERA : TORTRICIDAE) IN SOUTHEAST QUEENSLAND

VOLUME TWO

by

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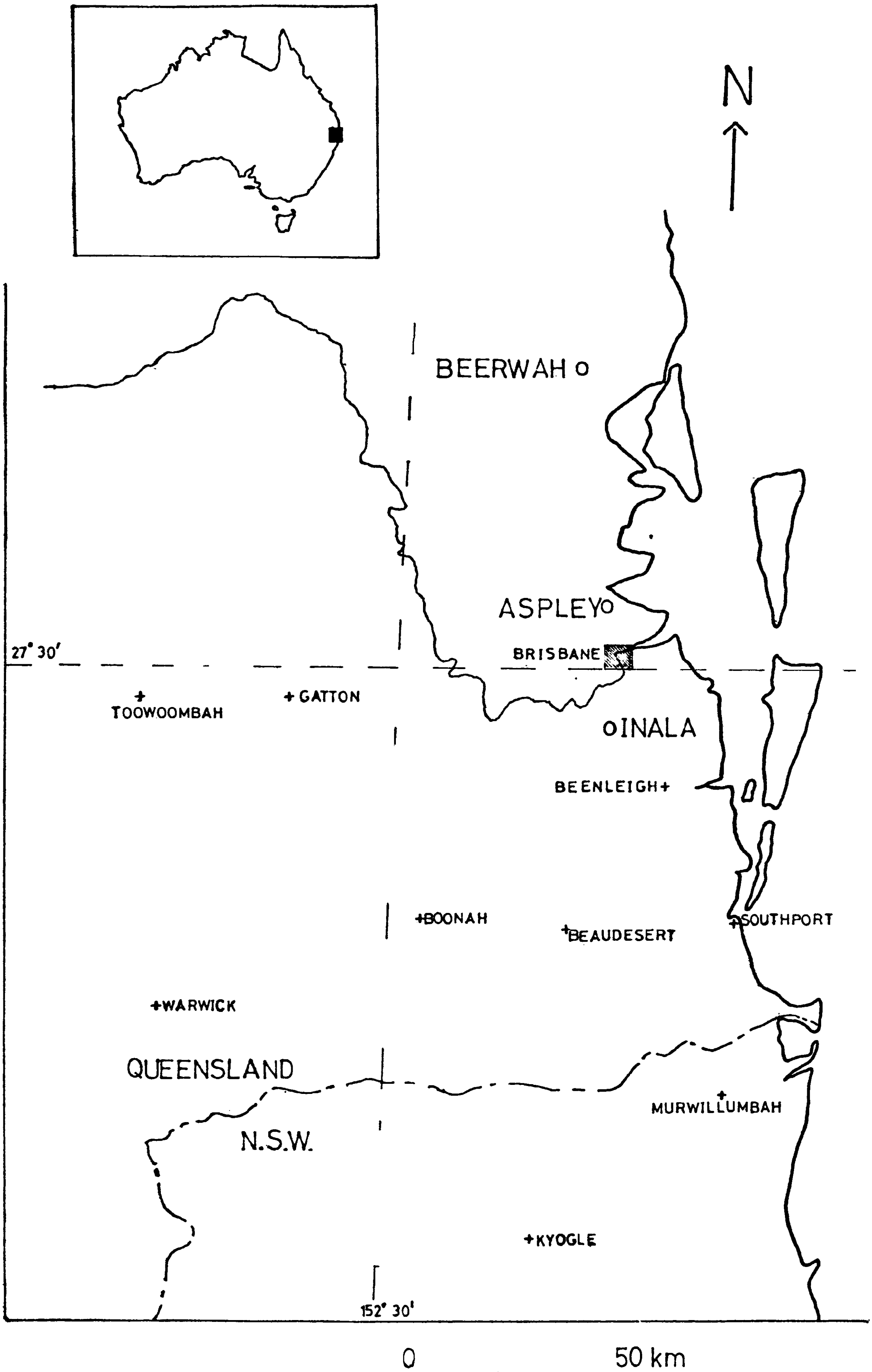


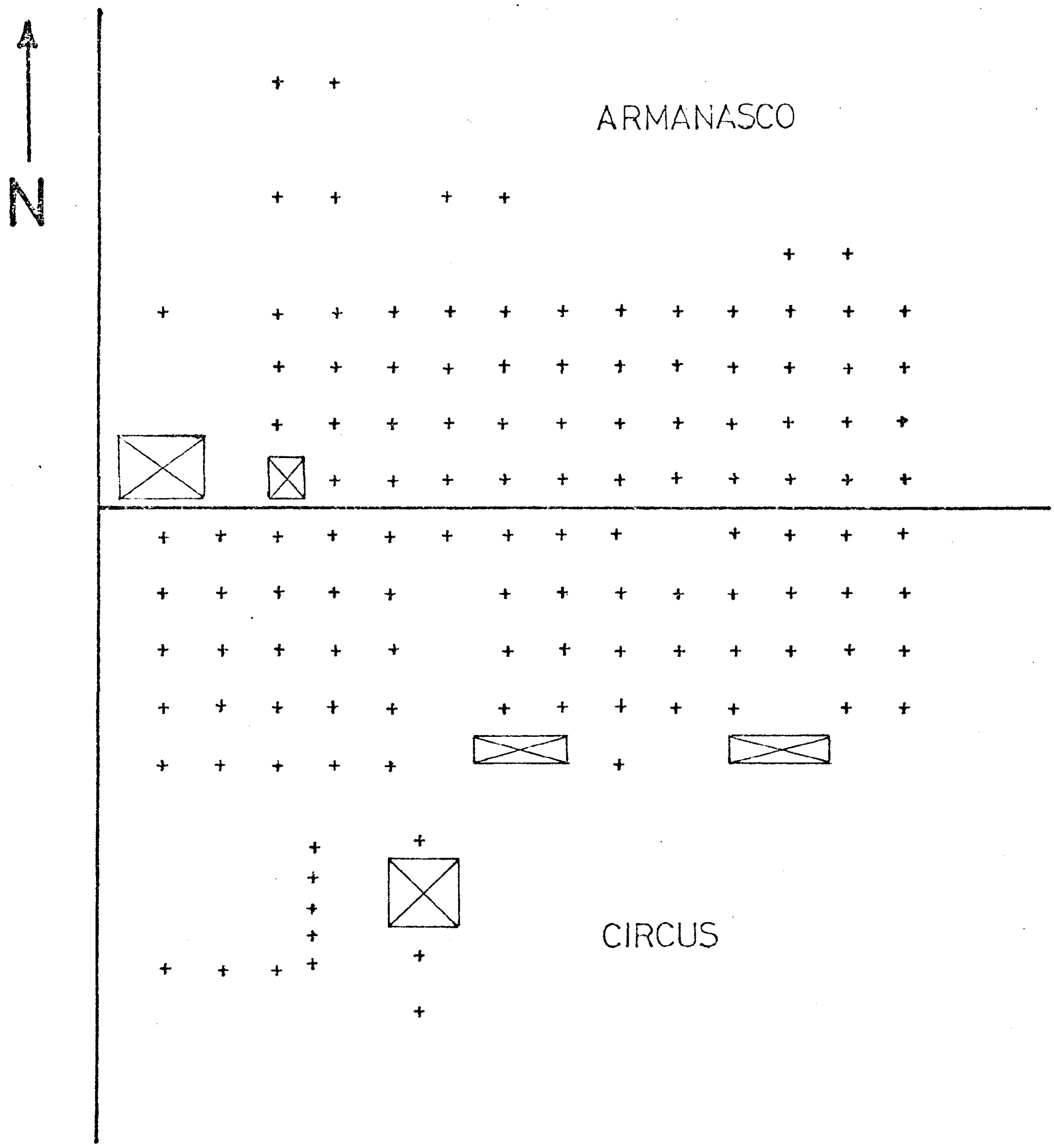
N
BEERWAH
ASPLEY
BRISBANE
27° 30′
TOOWOOMBAH
GATTON
INALA
BEENLEIGH
BOONAH
BEAUDESERT
SOUTHPORT
WARWICK
QUEENSLAND
N.S.W.
MURWILLUMBAH
KYOGLE
152° 30′
0
50 km

FIGURE 1

THE STUDY AREA

the macadamia orchards studied

the main sites of occasional alternative host collections

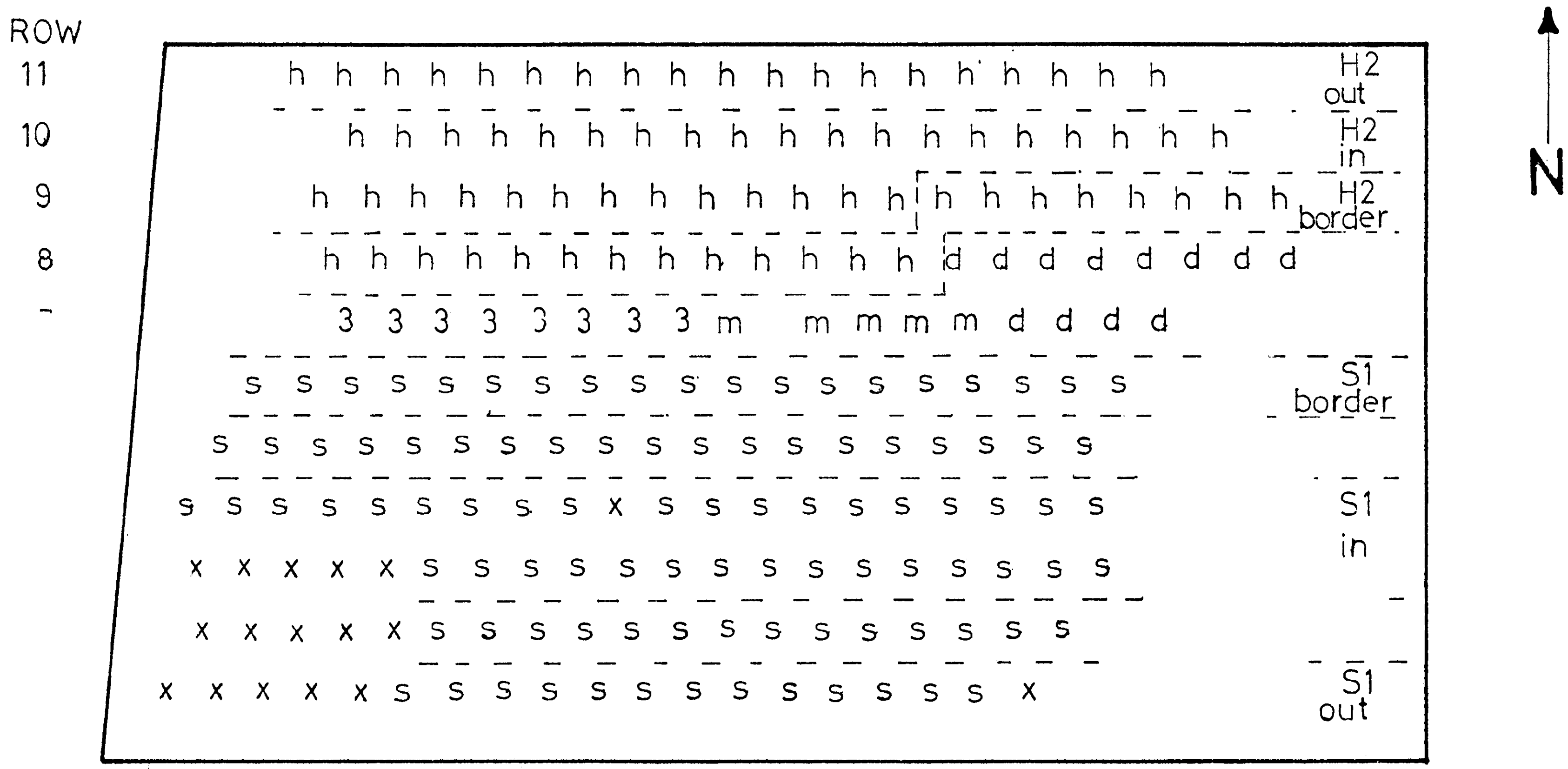


+ = one seedling tree

☒ = house, shed

FIGURE 2

THE INALA ORCHARDS



EACH SYMBOL REPRESENTS ONE TREE

s - S1   m - M2
h - H2   3 - H3
d - D8   x - Seedling

FIGURE 3

THE ASPLEY ORCHARD

Showing the division made of the major varieties into outside, inside, and border rows, for sampling purposes.

TABLE 1

BRISBANE CLIMATIC DATA

MONTH	Temperature °C. Monthly Means 86 years Max. (Actual extreme)	Min. (Actual extreme)	Relative Humidity % Monthly Mean 86 years 0900 hrs	1500 hrs	Rainfall Monthly Mean (mm) 121 Years	Mean Wet Days 113 Years
January	29.4 (43.2)	20.6 (14.9)	65	58	162.0	13
February	28.9 (40.9)	20.4 (14.7	69	60	163.4	14
March	27.8 (38.8)	19.2 (11.3)	71	59	146.0	15
April	26.0 (35.1)	16.4 (6.9)	71	55	88.2	12
May	23.1 (32.4)	13.1 (4.8)	71	53	69.4	9
June	20.8 (31.6)	10.7 (2.4)	72	53	69.8	8
July	20.3 (29.1)	9.4 (2.3)	70	49	54.6	7
August	21.8 (32.8)	10.1 (2.7)	67	47	47.0	
September	24.0 (38.3)	12.7 (4.8)	63	49	48.6	8
October	26.1 (40.7)	15.7 (6.3)	60	53	74.2	19
November	27.8 (41.2)	17.9 (9.2)	59	55	95.2	10
December	29.1 (41.1)	19.7 (13.5)	61	56	129.8	12
Year	25.4 (43.2)	15.5 (2.3)	67	54	1148.0	123

Compiled by Commonwealth Bureau of Meteorology, Regional Office for Queensland, Brisbane, Queensland.

TABLE 2

BEERWAH CLIMATIC DATA

MONTH	Temperature °C Monthly Means 18 years Max. Mean (extreme)	Min. Mean (extreme)	Relative Humidity % Monthly Mean 14 years 0900 hrs	1500 hrs	Rainfall Monthly Mean (mm) 43 yrs	Mean Wet Days 43 yrs
January	28.9 (34.8)	18.9 (15.1)	75	69	224	16
February	28.9 (34.0)	19.2 (15.7)	77	71	266	16
March	27.9 (32.7)	17.8 (14.0)	80	71	244	18
April	26.4 (31.2)	15.0 (10.3)	79	68	134	14
May	23.3 (27.6)	11.4 (5.4)	75	62	119	10
June	21.3 (25.3)	9.3 (4.1)	76	62	89	8
July	20.6 (25.3)	7.2 (1.5)	71	57	82	8
August	22.2 (27.5)	7.6 (2.1)	69	55	50	7
September	24.3 (30.7)	10.1 (4.6)	66	58	48	8
October	26.7 (34.0)	13.3 (6.8)	64	58	113	12
November	28.3 (35.0)	15.6 (9.8)	66	62	117	10
December	29.1 (35.7)	17.6 (12.8)	70	66	161	13
Year	25.7	13.6	72	63	1647	140

Compiled by Department of Forestry, Regional Forest Research Station, Beerwah, Queensland.

ASPLEY 1971-72

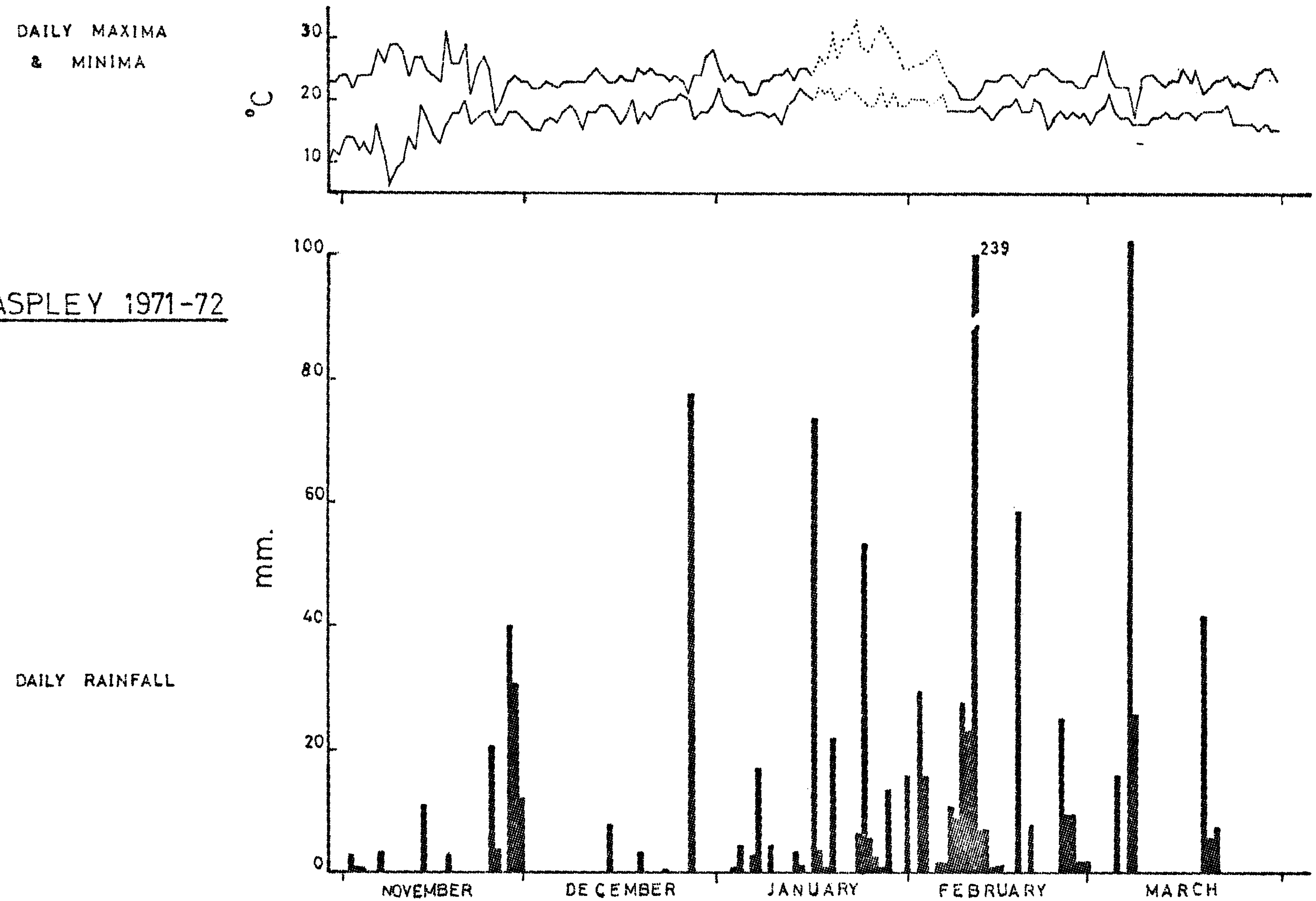


FIGURE 4

DAILY TEMPERATURE AND RAINFALL, ASPLEY 1971-72

The broken lines indicate equipment breakdown, data substituted from Bureau of Meteorology, Brisbane.

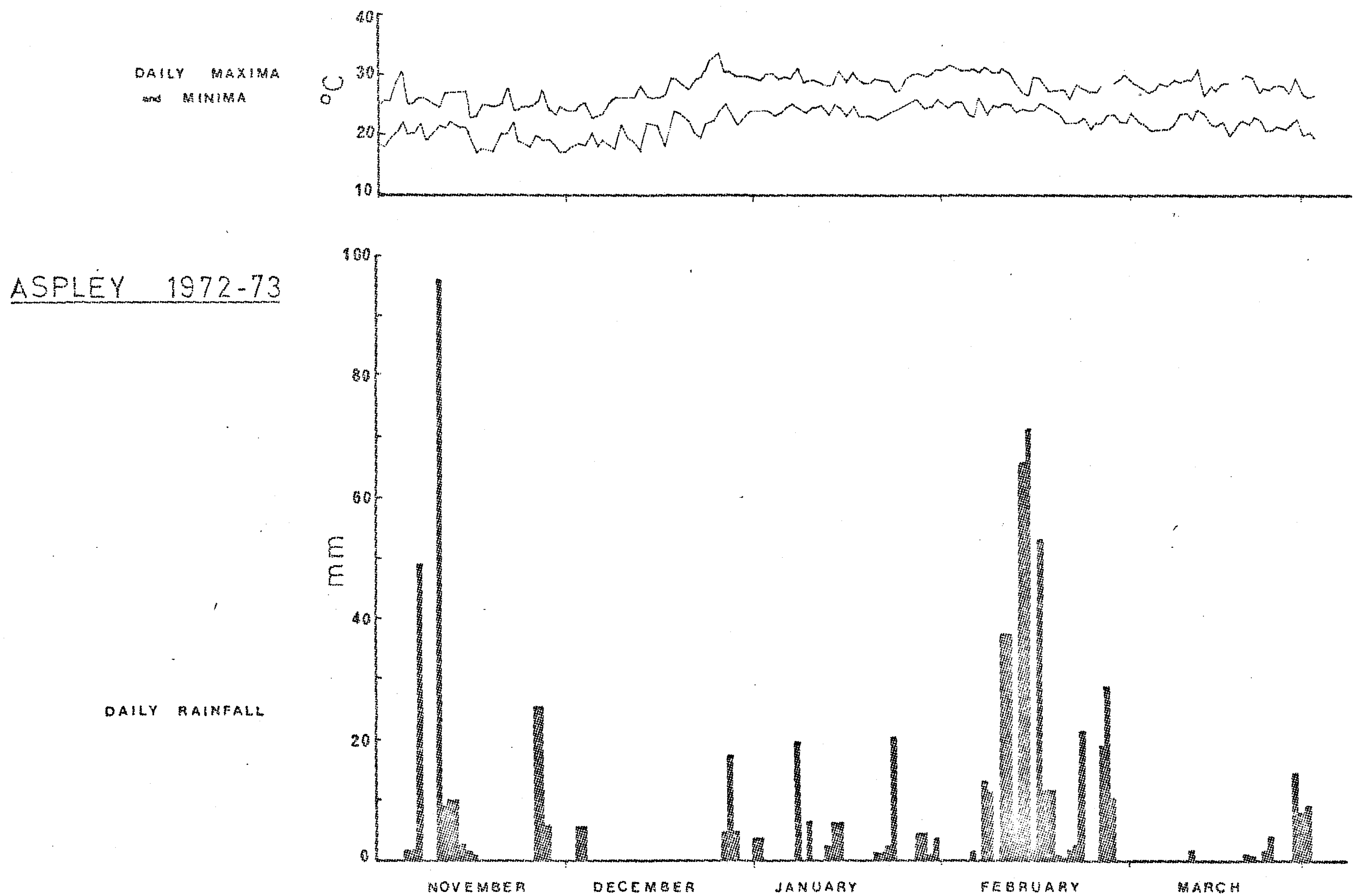

ASPLEY 1972-73
DAILY MAXIMA and MINIMA
°C
40
30
20
10
DAILY RAINFALL
mm
100
80
60
40
20
0
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 5

DAILY TEMPERATURE AND RAINFALL, ASPLEY 1972-73

Breaks in daily maxima were caused by a malfunction of the thermohygrograph pen.

ASPLEY 1973-74

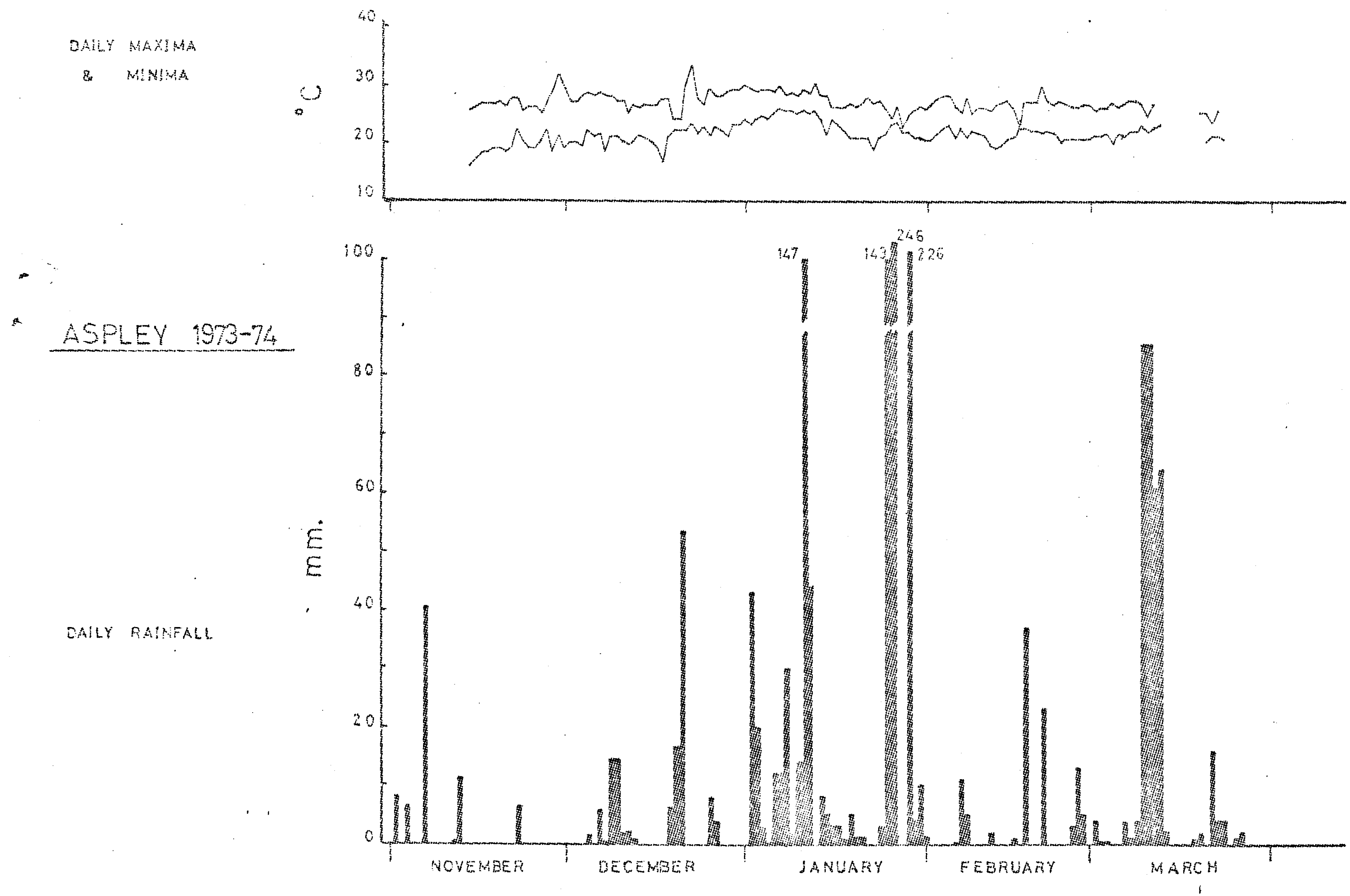


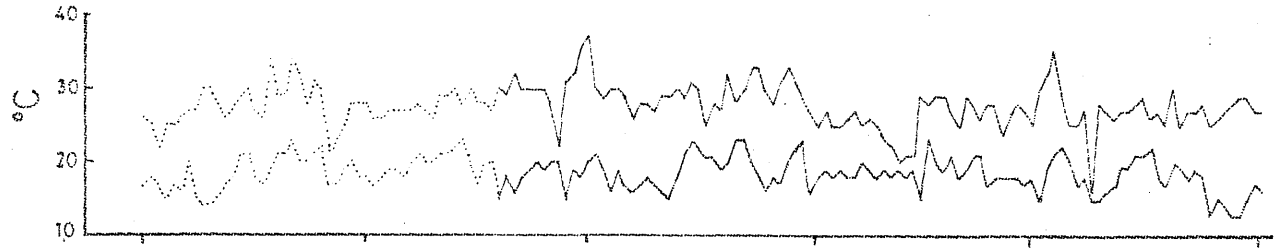
FIGURE 6

DAILY TEMPERATURE AND RAINFALL, ASPLEY 1973-74

Break in temperature records caused by break-
down of the thermohygrograph.

INALA 1971-72

DAILY MAXIMA
& MINIMA



DAILY RAINFALL

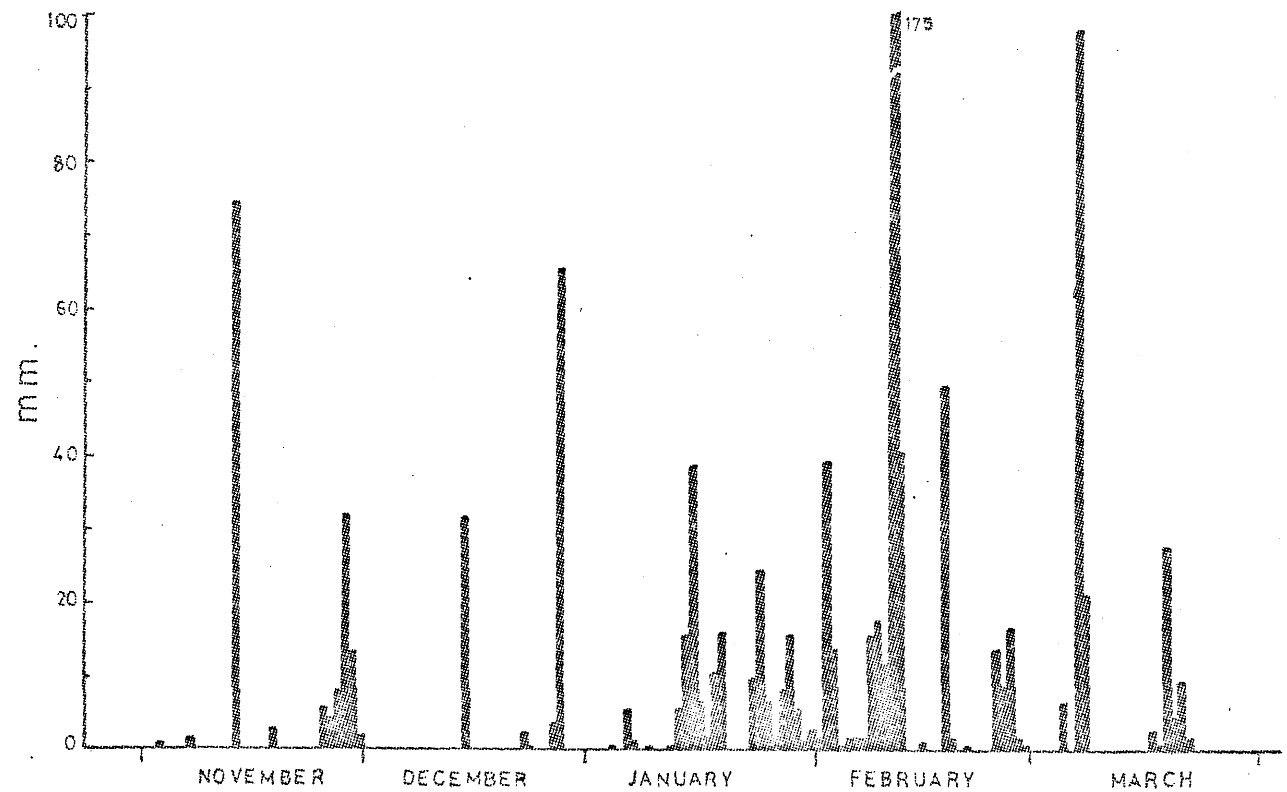
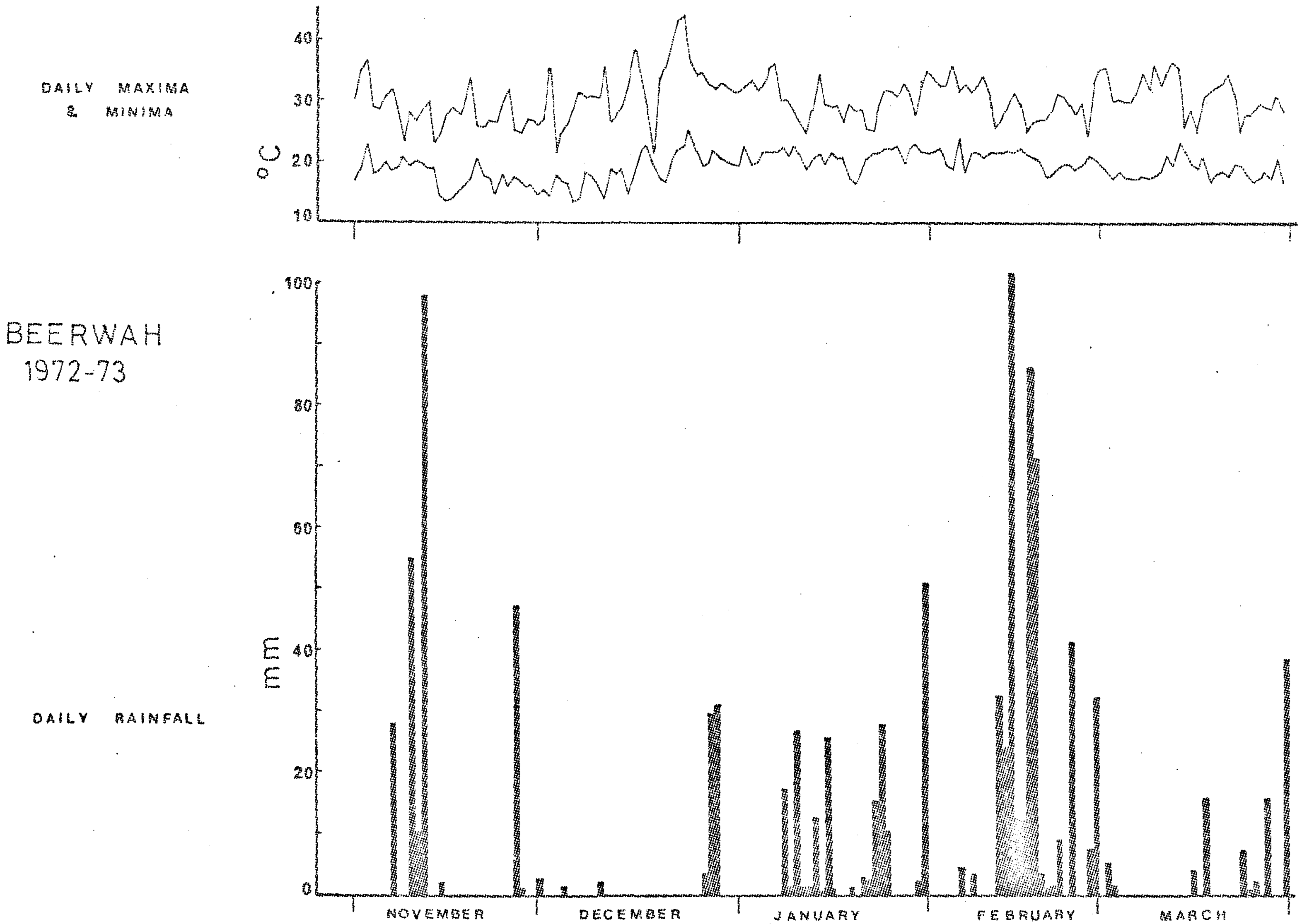


FIGURE 7

DAILY TEMPERATURE AND RAINFALL, INALA, 1971-72

In temperature records the solid line indicates those recorded in the Inala orchard, earlier records are from Bureau of Meteorology, Brisbane.



DAILY MAXIMA & MINIMA
BEERWAH 1972-73
DAILY RAINFALL
°C
40
30
20
10
mm
100
80
60
40
20
0
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 8

DAILY TEMPERATURE AND RAINFALL, BEERWAH 1972-73

TABLE 3

HOST PLANTS OF *C. ombrodelta*

Family and Species	Plant part affected	Authority
Family Leguminosae Sub-family Caesalpinioideae		
**Bauhinia galpinii*	pods, stems	Ironside (1974)
B. purpurea	pods	Bradley (1953)
***B. variegata*	pods, stems	
***B. variegata* var. *albens*	pods, stems	
Caesalpinia sepiaria[1]		Rao (1972 unpub.rep.) Mitchell (1973 pers.comm.)
**Cassia coluteoides*	pods	Ironside (1974)
**C. fistula*	pods	Fletcher (1920) Bradley (1953) Rao (1972 unpub.rep.) Ironside (1974)
C. javanica		Mitchell (1973 pers.comm.)
C. pulcherrima		Ironside (1970 unpub.rep.)
C. occidentalis	pods	Fletcher (1920) Bradley (1953)
C. tora		Mitchell (1973 pers.comm.)
**Delonix regia*[2]	seeds	Swezey & Zimmerman (1946) Rao (1972 unpub.rep.) Ironside (1974)
Parkinsonia aculeata	leaves, pods	Bradley (1953)
**Poinciana pulcherrima*[3]		Hamilton (1964) Ironside (1974)
**Schotia brachypetala*	pods	Rao (1972 unpub.rep.) Ironside (1974)
**Tamarindus indica*	fruit	Fletcher (1920) Bradley (1953) Rao (1972 unpub.rep.) Ironside (1974)

1. *C. decapetala* (Everist 1973 pers. comm.)
2. Reported by Swezey & Zimmerman (1946), and Rao (1972 unpub.rep.) as *Poinciana regia*.
3. *Caesalpinia pulcherrima* (Everist 1973 pers. comm.)

TABLE 3 (continued):

Family and Species	Plant part affected	Authority
Sub-family Mimosoideae		
Acacia arabica[1]		Fletcher (1920) Rao (1972 unpub.rep.)
A. concinnia	pods	Sankaran (1973 unpub.rep.)
**A. farnesiana*	pods, seeds	Froggatt (1897) Chong (1964) Ironside (1974)
***A. podalyriifolia*	pods	
Adenanthera pavonina	seeds	Swezey & Zimmerman (1946) Bradley (1953)
Pithecellobium dulce	seeds	Swezey & Zimmerman (1946) Bradley (1953) Hamilton (1964) Rao (1972 unpub.rep.)
Prosopis pallida	seed pod	Shiroma (1965b)
Samanea saman		Chong (1964)
Sub-family Papilionatae		
Indigofera suffruticosa[2]	terminal stems, seed pods	Nakao (1966)
Phaseolus limensis	seed pods	Sherman for Habeck (1962)
P. vulgaris		Hamilton (1964)
Phaseolus sp.		Mitchell (1973 pers.comm.)
Sesbania aculeata[3]	pods	Fletcher (1920) Bradley (1953)
S. grandiflora[4]	seeds	Fletcher (1920) Bradley (1953)

1. *A. nilotica* (Everist 1973 pers. comm.)
2. Reported by Nakao (1966) as *Indigo suffruticosa*
3. Everist (1973 pers.comm.) stated that there has been confusion in the naming of this species. It may be *S. cannabina*, in which case it is present in Australia.

. *S. formosa* (Everist 1973 pers. comm.)

TABLE 3 (continued):

Family and Species	Plant part affected	Authority
Family Palmae		
Cocos nucifera	stem end of young fruit	Shiroma (1965a)
Family Polygonaceae		
Coccoloba uvifera[1]	fruit	Davis (1962)
Family Proteaceae		
**Macadamia integrifolia*)[2] **M. tetraphylla*)	fruit	Officers Dept.Agric. & Stock (1951) Chong (1964) Cann (1965) Ironside & Davis (1969)
Family Rutaceae		
Aegle marmelos	fruit	Fletcher (1920) Bradley (1953)
Citrus aurantium	fruit	Fletcher (1920)
Feronia elephantum	fruit	Fletcher (1920)
Family Sapindaceae		
**Cupaniopsis anacardioides*	fruit	Common (1972 pers.comm.) Ironside (1974)
Euphoria longan		Hamilton (1964)
Filicium decipiens	terminal twigs	Davis (1962) Beardsley (1965)
**Litchi chinensis*[3]	fruit	Meyrick (1910) Fletcher (1920) Bradley (1953) Hamilton (1964) Ironside (1974)
Sapindus saponaria	terminal branches	Au for Bianchi (1968)

1. Reported by Davis (1962) as *Coccolobis uvifera*
2. Combined, as most specimens are now hybrids of the two
3. Reported by Fletcher (1920) as *Nephelium litchi*

* Ironside (1974) reports that these have been recorded as host plants in Australia

The present author has found these species as host in Australia

a

b

FIGURE 9

FALLEN NUT COUNTS

Ground cover control under Aspley macadamia trees

(a) prevailing conditions

(b) after treatment with paraquat dimethyl sulphate with hessian sheet in position.

FIGURE 10

SAMPLING STICK IN USE

Aspley macadamia

The netting grid is shown in position; co-ordinates of the large volume are (40, 3).

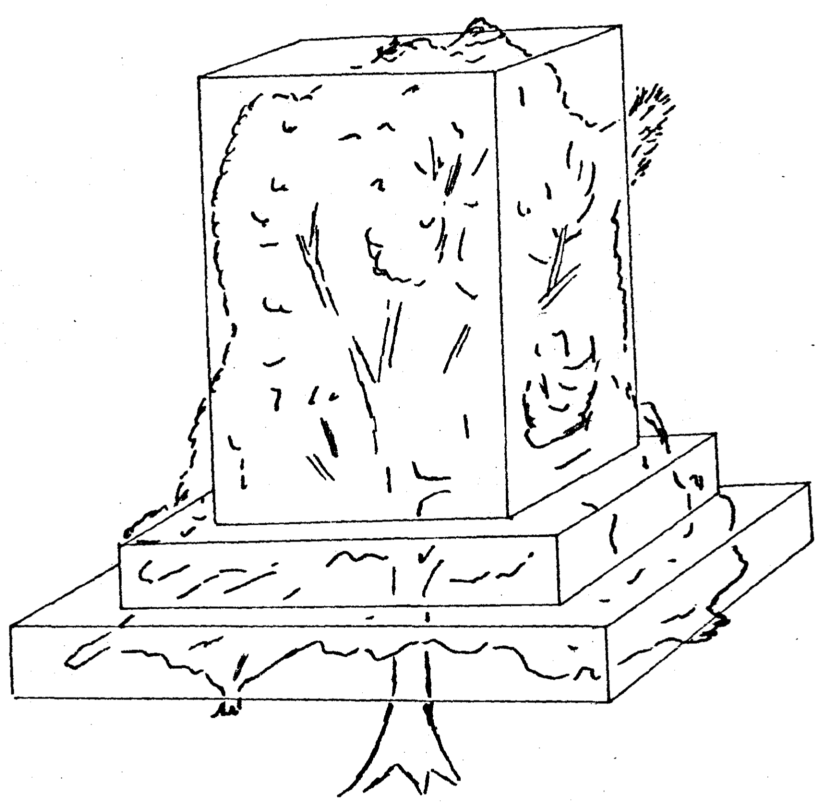


FIGURE 11

SAMPLING STICK

Concept of macadamia tree volume

TABLE 4

NUT NUMBER ESTIMATES

Inala and Aspley 1971-72
Early season direct counts

	INALA 20.X.71		ASPLEY 15.X.71	
	Armanasco	Circus	S1	H2
Total trees in each orchard	56	68	99	72
Tree units counted [1]				
Upper tree		8		
Lower tree		8		
Nuts per quadrant				
Upper tree	744.63±756.09[2]	104.00±183.39		
Lower tree	980.25±716.62	211.75±301.24		
Nuts per level				
Upper tree			4.17± 8.40	130.20±132.17
Lower tree			16.83±14.48	185.00± 93.76
Nut estimates per orchard	386,373	85,884	2,079	22,838

[1] Tree units - at Inala, quadrants (1/8th of a tree)
- at Aspley, levels (1/2 of a tree)

[2] Standard error(s)

TABLE 5

NUT NUMBER ESTIMATES

Inala and Aspley 1971-72. Seasonal variation in numbers by tagged raceme count.

INALA

Date	20.X (1971)	1.XI	16.XI	1.XII	14.XII	30.XII	24.I (1972)	23.II	19.III
No. tagged racemes	184	205[1]	177	161	159	154	147	102	53
No. nuts on tagged racemes	917	754	590	527	491	465	405	245	114
% loss of tagged nuts between dates		30.26	21.75	10.68	6.83	5.30	12.90	39.51	53.47
Estimated total nuts at site									
Armanasco	386,373	269,457	210,850	188,331	175,468	166,168	144,732	87,549	40,736
Circus	85,884	60,119	47,043	42,019	39,149	37,074	32,291	19,533	9,089

1. A new series of tags was begun between 20.X.71 and 1.XI.71.

ASPLEY

Date	15.X (1971)	26.X	8.XI	23.XI	7.XII	22.XII		1.II (1972)	29.II	27.III
S1										
No. of tagged racemes	98	117[2]	116	115	114	113	110	103	73	26
No. nuts on tagged racemes	282	312	299	283	273	262	251	205	128	45
% loss of tagged nuts between dates		17.50	4.17	5.35	3.53	4.03	4.20	18.33	37.56	64.84
Estimated total nuts at site	2,079	1,715	1,644	1,556	1,501	1,440	1,380	1,127	704	247
H2										
No. tagged racemes	96	112[2]	104	96	93	91	89	80	67	42
No. nuts on tagged racemes	1,176	968	835	759	710	673	653	546	369	255
% loss of tagged nuts between dates		17.69	13.74	9.10	6.46	5.21	2.97	16.39	32.42	30.89
Estimated total nuts at site	22,838	18,798	16,215	14,740	13,787	13,069	12,681	10,602	7,165	4,952

A new series of tags was begun between 15.X.71 and 26.X.71.

TABLE 6

NUT NUMBER ESTIMATES

Beerwah 1972-73

	TREE 146				TREE 194			
	nuts stripped	nut fall	nuts sampled	nuts on tree	nuts stripped	nut fall	nuts sampled	nuts on tree
6.XII.72				1,292				1,804
13.XII.72				1,216				1,723
20.XII.72				1,188				1,681
27.XII.72				1,132				1,621
3.I.73				1,075				1,557
10.I.73				1,019				1,485
17.I.73				961				1,407
24.I.73				902				1,303
3.I.73				839		178		1,069
7.II.73				745		246		767
14.II.73				633		264		447
21.II.73				538		114		[illegible]
28.II.73				426		[illegible]		169
7.III.73				343				125
14.III.73		38		256				97
21.III.73	183	24		183	80	[illegible]		80
TOTALS	183	315	794		80	1,091	633	

TABLE 7

NUT NUMBER ESTIMATES

Comparison of direct counts and fallen nut counts in five trees in Aspley inside rows, and two Beerwah trees.

ASPLEY

Week ending	Tree	S1 Fallen nut count estimate	S1 Direct count	S1 % deficiency of direct count to estimate	H2 Fallen nut count estimate	H2 Direct count	H2 % deficiency of direct count to estimate
12.XII.72	1	332	264	20.4	1,797	1,506	16.2
	2	106	88	17.0	957	909	5.0
	3	572	409	28.5	1,358	989	27.2
	4	560	501	10.5	1,430	1,262	11.8
	5	618	578	6.5	1,342	881	34.4
6.II.73	1	309	235	23.9	1,729	1,388	19.7
	2	94	66	29.8	890	792	11.0
	3	449	312	30.5	1,303	1,005	22.9
	4	534	418	21.7	1,390	1,171	15.8
	5	550	415	24.5	1,286	961	25.3
13.III.73	1	201	150	25.4	1,534	1,346	12.3
	2	56	44	21.4	763	507	33.6
	3	323	253	21.7	1,109	808	27.2
	4	448	349	22.1	1,153	917	20.5
	5	407	283	30.5	1,206	900	25.4
			MEAN DEFICIENCY	22.0%		MEAN DEFICIENCY	21.0%

BEERWAH

Week ending	TREE 146 Fallen nut count estimate	TREE 146 Direct count	TREE 146 % deficiency of direct count to estimate	TREE 194 Fallen nut count estimate	TREE 194 Direct count	TREE 194 % deficiency of direct count to estimate
6.XII.72	1,292	845	34.6	1,804	1,146	36.5
17.I.73	961	642	33.2	1,303	805	38.2

OVERALL BEERWAH MEAN DEFICIENCY = 35.6%

TABLE 8

NUT NUMBER ESTIMATES

Analysis of differences between direct counts, and fallen nut counts; tests of deficiency estimates between sites.

(A) ASPLEY

F values in the Analysis of Variance (data transformed to arcsin $\sqrt{x}$).

Source	Degree of freedom	F S1	F H2
Dates	2	3.79	0.65
Trees	4	0.89	1.68
Dates x Trees	8		
Total	14		

Neither treatment effect was significant (P=0.05)

	S1	H2
Mean deficiency of direct count for each variety (original data)	22.0%	21.0%

(B) BEERWAH

F values in the Analysis of Variance (data transformed to arcsin $\sqrt{x}$).

Source	Degree of freedom	F
Dates	1	0.01
Trees	1	4.92
Dates x Trees	1	
Total	3	

Neither treatment effect was significant (P=0.05)

Mean deficiency of direct count (original data) 36.0%

(C) "t" tests of differences in the deficiency of direct counts between sites (transformed data)

Test	Calculated "t" (P=0.05)	Tabular "t" (P=0.05)	Difference
S1 v H2	0.20	2.31	no
S1 v Beerwah	4.75	4.95	no
H2 v Beerwah	4.41	4.01	yes

TABLE 9

NUT NUMBER ESTIMATES

Aspley 1972-73. Nuts per tree for inside and border rows estimated by fallen nut counts.

Date	S1 nuts/tree±s	S1 No.trees for[1] C.I. of mean 10%	S1 No.trees for[1] C.I. of mean 20%	H2 nuts/tree±s	H2 No.trees for[1] C.I. of mean 10%	H2 No.trees for[1] C.I. of mean 20%
31.X.72	797.60 ± 311.06	469	117	2,803.00 ± 687.47	185	46
7.XI.72	722.80 ± 289.31	494	123	2,194.60 ± 511.25	167	42
14.XI.72	572.60 ± 208.39	408	102	1,747.40 ± 401.25	163	41
21.XI.72	476.60 ± 217.48	642	161	1,552.00 ± 339.34	147	37
28.XI.72	448.00 ± 216.42	719	180	1,430.20 ± 309.00	144	36
5.XII.72	437.60 ± 216.04	751	188	1,376.80 ± 298.83	145	36
12.XII.72	434.40 ± 213.77	746	187	1,348.20 ± 296.50	149	37
19.XII.72	431.80 ± 211.70	741	185	1,335.20 ± 296.31	152	38
26.XII.72	431.00 ± 210.98	739	185	1,333.60 ± 297.04	153	38
2.I.73	430.20 ± 210.66	739	185	1,333.20 ± 296.35	152	38
9.I.73	428.00 ± 209.47	738	185	1,332.00 ± 295.79	152	38
16.I.73	418.80 ± 203.09	725	181	1,329.60 ± 296.58	153	38
23.I.73	405.40 ± 198.00	735	184	1,326.20 ± 298.22	156	39
30.I.73	387.20 ± 189.71	740	185	1,319.60 ± 299.39	160	40
6.II.73	372.40 ± 186.23	771	193	1,309.20 ± 298.85	161	40
13.II.73	346.20 ± 181.31	845	211	1,283.80 ± 292.98	161	40
20.II.73	327.20 ± 174.78	880	220	1,256.60 ± 287.86	162	40
27.II.73	306.00 ± 168.02	929	232	1,213.60 ± 279.80	164	41
6.III.73	287.00 ± 160.00	958	295	1,153.00 ± 274.78	175	44
13.III.73	258.60 ± 150.66	1,046	262	1,004.00 ± 291.64	260	65
20.III.73	232.40 ± 140.39	1,125	281	598.80 ± 318.42	872	218
27.III.73	183.80 ± 112.27	1,150	288	352.20 ± 253.37	1,595	399
3.IV.73	148.80 ± 97.40	1,321	330	285.40 ± 225.10	1,917	479

1. C.I. = confidence interval

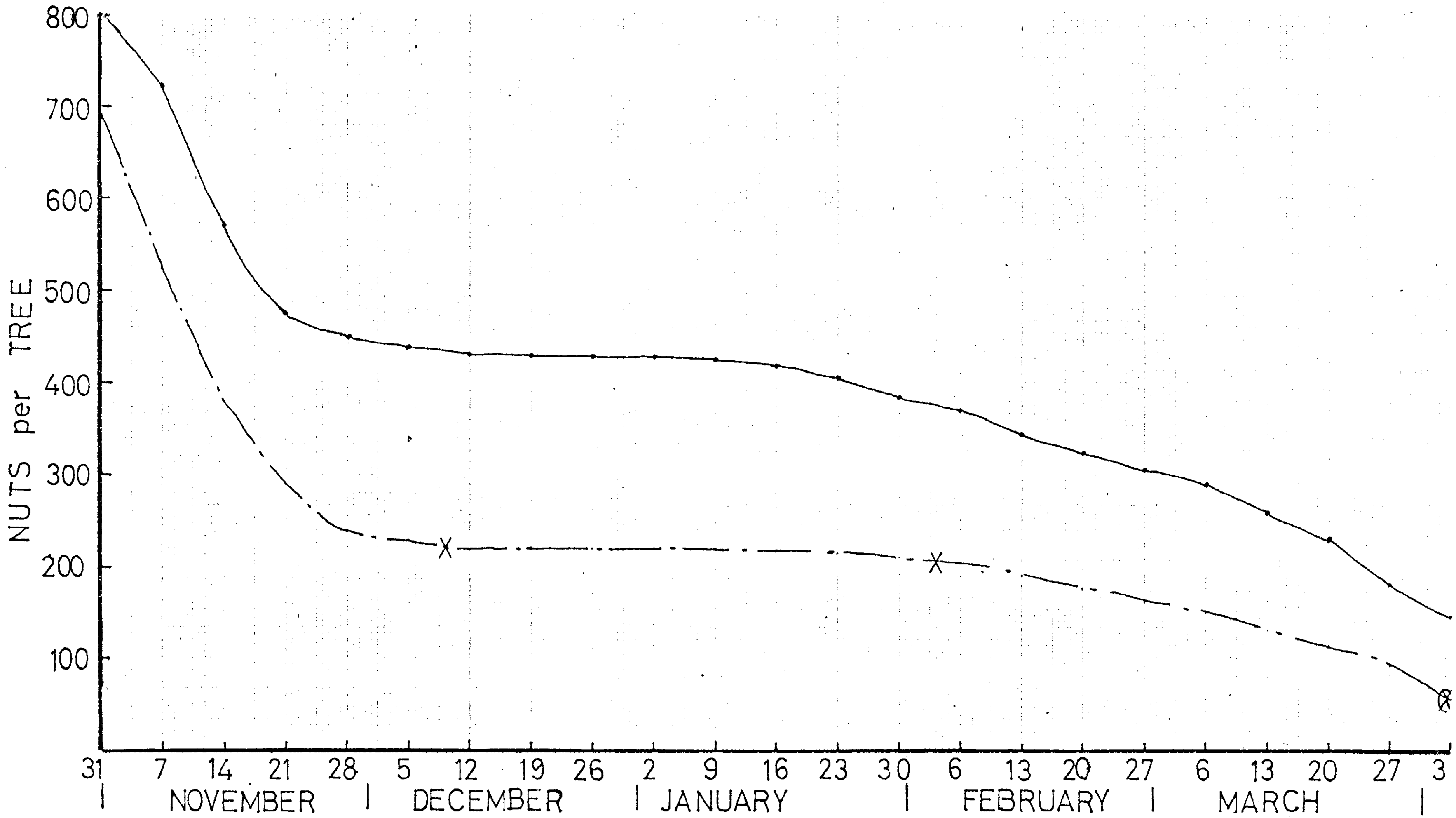

800
700
600
500
400
300
200
100
NUTS per TREE
31 7 14 21 28 5 12 19 26 2 9 16 23 30 6 13 20 27 6 13 20 27 3
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 12

NUT NUMBER ESTIMATES

Graphical estimates of outside row nuts

Aspley S1 1972-73

—— Nuts per tree, inside and border rows, by fallen nut count.

--- Subjective estimate of nuts per tree in outside row.

∧ Direct count of nuts per tree in the outside row, increased by observer deficiency.

⊗ Nuts per tree, estimated by stripping.

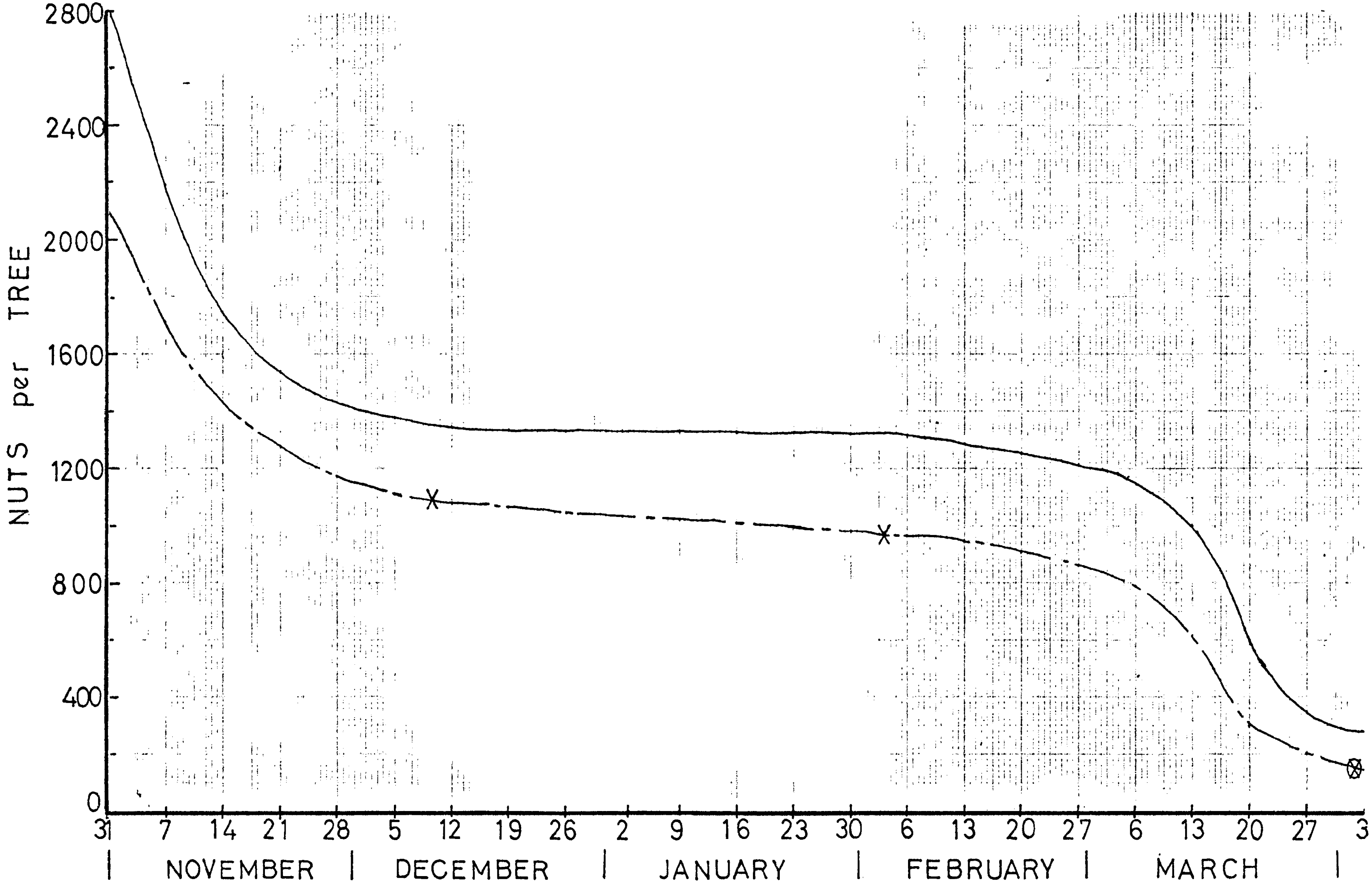

NUTS per TREE
2800
2400
2000
1600
1200
800
400
0
31 7 14 21 28 5 12 19 26 2 9 16 23 30 6 13 20 27 6 13 20 27 3
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 13

NUT NUMBER ESTIMATES

Graphical estimates of outside row nuts

Aspley H2 1972-73

——— Nuts per tree, inside and border rows, by fallen nut count.

—·—— Subjective estimate of nuts per tree in outside row.

X Direct count of nuts per tree in the outside row, increased by observer deficiency.

⊗ Nuts per tree, estimated by stripping.

TABLE 10

NUT NUMBER ESTIMATES

Aspley 1972-73. Graphically calculated nuts per tree in the outside rows.

	Nuts per tree	
	S1	H2
31.X.72	692	2,100
7.XI.72	525	1,710
14.XI.72	380	1,430
21.XI.72	289	1,280
28.XI.72	240	1,175
5.XII.72	229	1,115
12.XII.72	222	1,080
19.XII.72	222	1,062
26.XII.72	221	1,045
2.I.73	220	1,035
9.I.73	220	1,020
16.I.73	218	1,005
23.I.73	215	990
31.I.73	210	980
6.II.73	203	965
13.II.73	190	950
21.II.73	171	905
27.II.73	162	860
6.III.73	149	790
13.III.73	131	615
20.III.73	112	300
27.III.73	87	200
3.IV.73	53	148

TABLE 11

NUT NUMBER ESTIMATES

Aspley 1972-73
Total nuts per variety per week.

Date	S1 outside row 12 trees	S1 other rows 81 trees	TOTAL[1]	H2 outside row 18 trees	H2 other rows 51 trees	TOTAL[2]
31.X.72	8,304	64,606	72,910	37,800	142,953	180,753
7.XI.72	6,300	58,547	64,847	30,780	111,925	142,705
14.XI.72	4,560	46,381	50,941	25,740	89,117	114,857
21.XI.72	3,468	38,605	42,073	23,040	79,152	102,192
28.XI.72	2,880	36,288	39,168	21,150	72,940	94,090
5.XII.72	2,748	35,446	38,194	20,070	70,217	90,287
12.XII.72	2,664	35,186	37,850	19,440	68,758	88,198
19.XII.72	2,664	34,976	37,640	19,116	68,095	87,211
26.XII.72	2,652	34,911	37,563	18,810	68,014	86,824
2.I.73	2,640	34,846	37,486	18,630	67,993	86,623
9.I.73	2,640	34,668	37,308	18,360	67,932	86,292
16.I.73	2,616	33,923	36,539	18,090	67,810	85,900
23.I.73	2,580	32,837	35,417	17,820	67,636	85,456
30.I.73	2,520	31,363	33,883	17,640	67,300	84,940
6.II.73	2,436	30,164	32,600	17,370	66,769	84,139
13.II.73	2,280	28,042	30,322	17,100	65,474	82,574
20.II.73	2,052	26,503	28,555	16,290	64,087	80,377
27.II.73	1,944	24,786	26,730	15,480	61,894	77,374
6.III.73	1,788	23,247	25,035	14,220	58,803	73,023
13.III.73	1,572	20,947	22,519	11,070	51,204	62,274
20.III.73	1,344	18,824	20,168	5,400	30,539	35,939
27.III.73	1,044	14,888	15,932	3,600	17,962	21,562
3.IV.73	636	12,053	12,689	2,664	14,555	17,219

1. 6 of the 99 S1 trees had no nuts

2. 3 of the 72 H2 trees had no nuts

TABLE 12

NUT NUMBER ESTIMATES

Aspley 1973-74. Nuts per tree obtained graphically for outside rows, and from fallen nut count for inside and border rows.

	S1		H2	
Date	outside row	other rows ±s	outside row	other rows ±s
16.XI.73	372	782.40±281.09	714	833.60±361.21
23.XI.73	320	719.80±286.29	692	805.60±347.45
30.XI.73	248	626.40±300.36	640	752.40±301.72
7.XII.73	192	531.60±323.70	592	688.80±277.85
14.XII.73	152	494.00±332.95	558	658.80±262.54
21.XII.73	126	483.20±334.34	544	650.20±262.33
28.XII.73	112[1]	479.60±336.34	540[1]	647.60±262.94
4.I.74	104	477.40±337.47	536	643.40±268.40
11.I.74	100	472.40±336.23	532	639.20±264.47
18.I.74	95	465.00±332.73	516	630.40±252.81
25.I.74	90	453.80±329.72	492	604.20±249.31
1.II.74	84	440.00±323.23	472	588.20±244.00
8.II.74	80	430.80±318.00	456	579.60±247.68
15.II.74	72	416.00±307.99	440	566.00±242.01
22.II.74	66	386.80±291.56	420	545.60±238.42
1.III.74	56	363.20±277.60	388	517.20±241.89
8.III.74	47	322.20±241.42	333	487.60±243.06
15.III.74	32	257.00±190.59	272	416.40±224.59
22.III.74	17[2]	206.20±158.08	256[2]	393.80±211.97

From a direct count of five outside row trees, increased by the "observer deficiency" for direct counts.

Mean number of nuts stripped from five outside row trees.

TABLE 13

NUT NUMBER ESTIMATES

Aspley 1973-74
Total nuts per variety per week.

Date	S1 outside row 13 trees	S1 other rows 82 trees	TOTAL[1]	H2 outside row 18 trees	H2 other rows 53 trees	TOTAL[2]
16.XI.73	4,836	64,124	68,960	12,852	44,181	57,033
23.XI.73	4,160	59,024	63,184	12,456	42,697	55,153
30.XI.73	3,224	51,365	54,589	11,520	39,877	51,397
7.XII.73	2,496	43,591	46,087	10,656	36,506	47,162
14.XII.73	1,976	40,508	42,484	10,044	34,916	44,960
21.XII.73	1,638	39,622	41,260	9,792	34,461	44,253
28.XII.73	1,456	39,327	40,783	9,720	34,323	44,043
4.I.74	1,352	39,147	40,499	9,648	34,100	43,748
11.I.74	1,300	38,737	40,037	9,576	33,878	43,454
18.I.74	1,235	38,130	39,365	9,288	33,411	42,699
25.I.74	1,170	37,212	38,382	8,856	32,023	40,879
1.II.74	1,092	36,080	37,172	8,496	31,175	39,671
8.II.74	1,040	35,326	36,366	8,208	30,719	38,927
15.II.74	936	34,112	35,048	7,920	29,998	37,918
23.II.74	858	31,718	32,576	7,560	28,917	36,477
1.III.74	728	29,782	30,510	6,984	27,417	34,401
8.III.74	611	26,420	27,031	5,994	25,843	31,837
15.III.74	416	21,074	21,490	4,896	22,069	26,965
22.III.74	221	16,908	17,129	4,608	20,871	25,479

4 of the 99 S1 trees had no nuts

1 of the 72 H2 trees had no nuts

TABLE 14

NUT NUMBER ESTIMATES

Nut numbers recorded per sampling stick sample

A. LARGE SAMPLING STICK

	Aspley 1973-74						Beerwah 1972-73			
		S1			H2		Lower tree east		Lower tree west	
Tree		2			2		1	[illegible]	1	[illegible]
Sample										
1	0	0	0	0	47	0	0	5	0	0
2	0	0	0	0	0	0	0	0	17	0
3	8	0	0	4	0	0	8	3	10	11
4	0	0	0	3	0	3	3	0	0	8
5	6	0	0	0	0	5	0	2	0	0
6	0	0	0	0	4	0	2	1	0	0
7	0	0	0	0	0	1	2	5	0	5
8	0	1	0	0	1	0	0	4	10	1
9	0	2	0	0	0	0	9	0	0	0
10	0	0	0	0	0	0	3	2	0	0

B. SMALL SAMPLING STICK

	Aspley 1973-74					
		S1			H2	
Tree		2			2	
Sample						
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	22	0
12	0	0	0	0	0	0
13	0	0	0	0	7	0
14	0	0	0	0	0	0
15	6	0	0	0	0	0
16	0	0	0	0	0	0
17	0	1	0	0	0	0
18	0	1	0	0	0	0
19	0	1	0	0	0	0
20	0	0	0	0	0	0

TABLE 15

NUT NUMBER ESTIMATES

Nuts per tree; precision of sampling stick method. Untransformed data.

	ASPLEY Large sample	ASPLEY Small Sample	BEERWAH Large sample
(A) Estimate of nuts			
Mean nuts/sample	1.433	0.306	2.800
Standard error	6.200	2.216	4.059
95% confidence interval of mean	-0.168 to 3.034	-0.092 to 0.708	1.503 to 4.097
Nuts/tree with 95% confidence limits			
Multiplication factor	174.36	1,394.89	651.97
Lower limit	-29	-128	980
Central value	250	429	1,826
Upper limit	529	988	2,671
(B) Estimates of number of samples required for a 95% confidence interval of the mean of no more than 10% and 20% of the mean.			
10% of mean	30,157	96,226	3,433
20% of mean	7,502	21,384	858
(C) Comparison between large and small sampling units			
Size (cm^3)	98,218.75	12,276.97	
Comparative size	8.00	1.00	
Actual cost (minutes)	1.42	1.25	
Comparative cost (minutes) C_u	0.18	1.25	
Variance	38.45	4.91	
Comparative variance s_u^2	4.81	4.91	
$\frac{1}{C_u s_u^2}$	1.17	0.16	

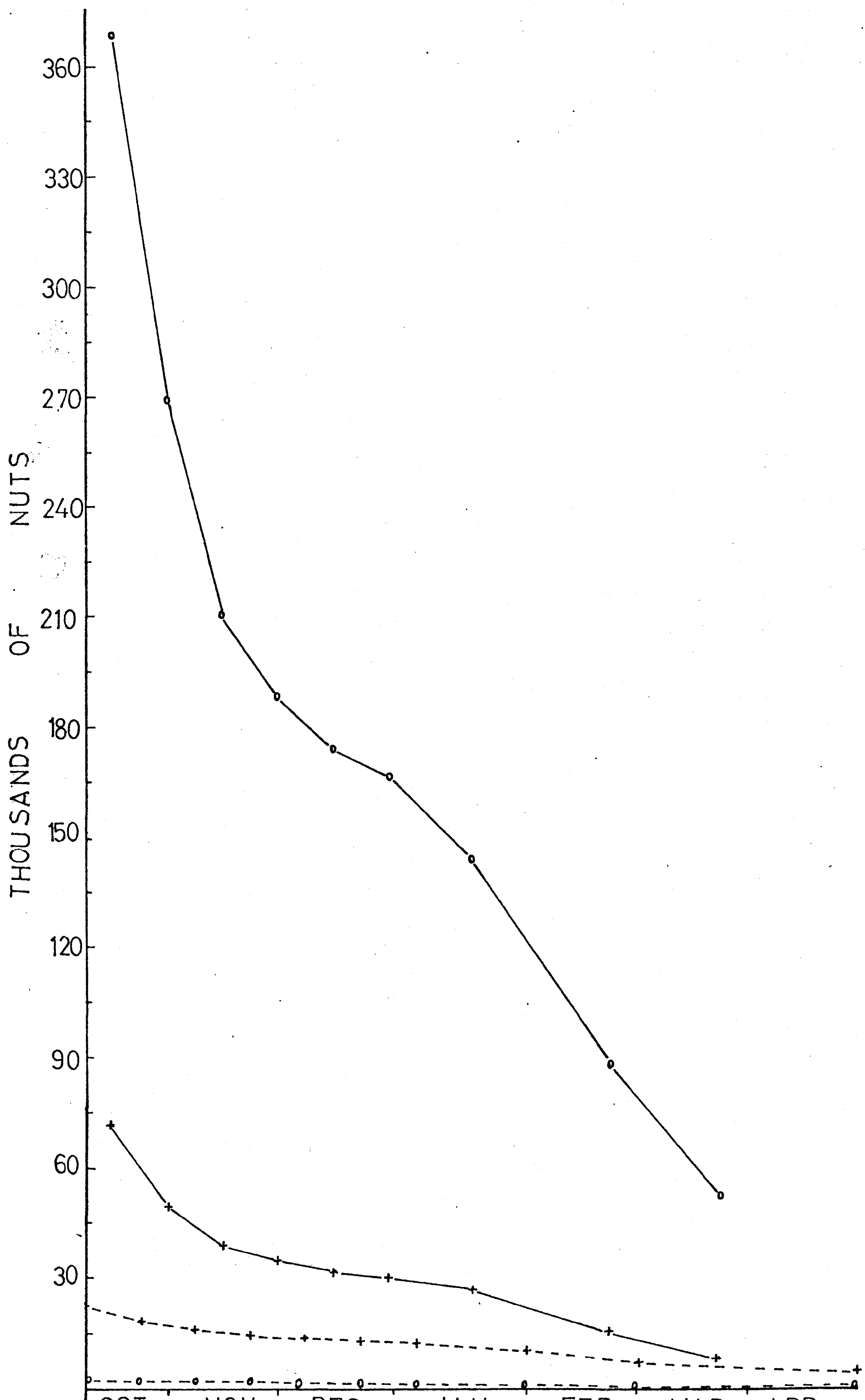
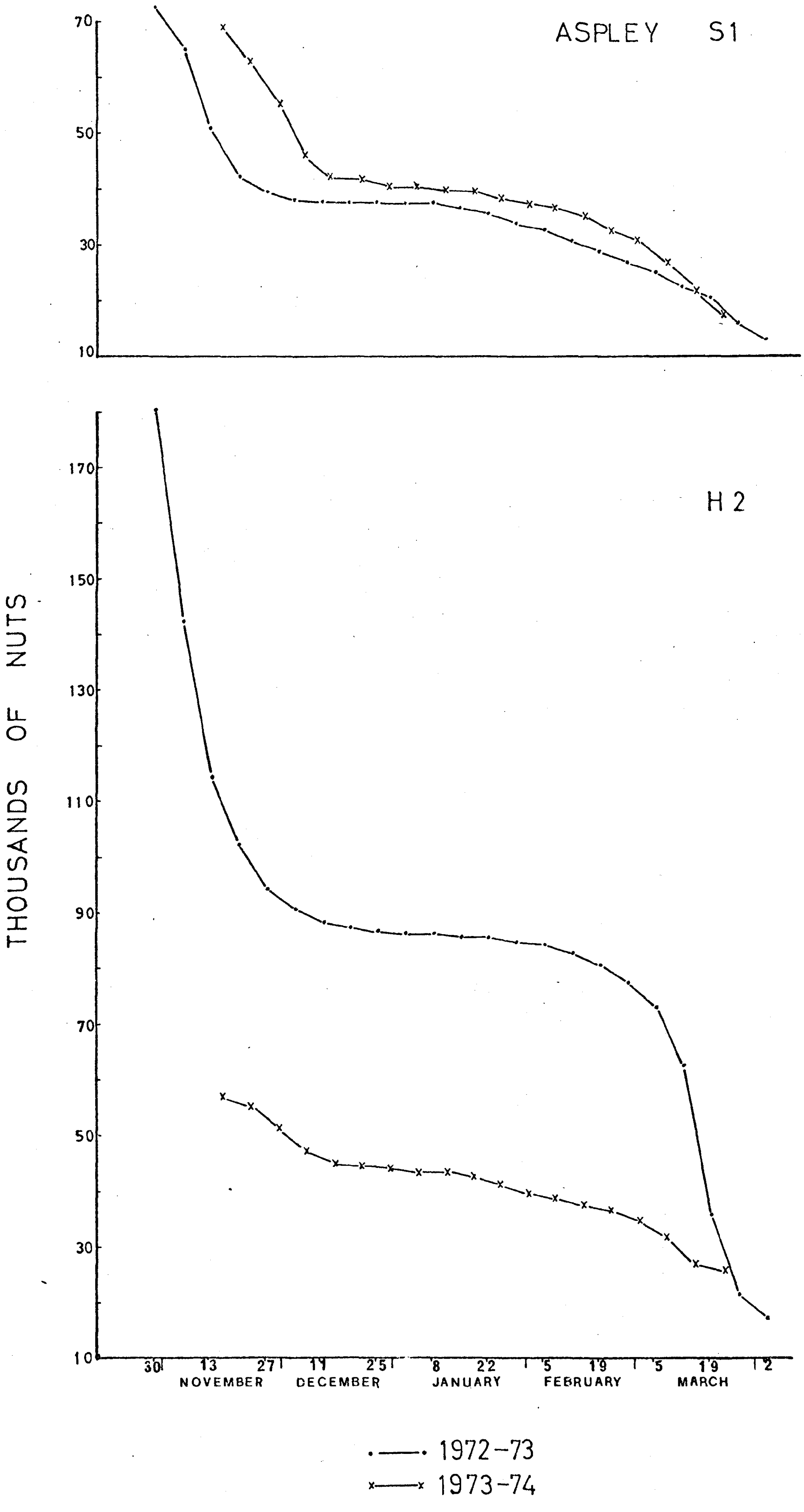

THOUSANDS OF NUTS
360
330
300
270
240
210
180
150
120
90
60
30
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.

FIGURE 14

NUT NUMBERS ESTIMATES

Totals for macadamia sites, 1971-72

o——o	Inala - Armanasco	56 trees
+——+	Inala - Circus	68 trees
o- - -o	Aspley S1	99 trees
+- - -+	Aspley H2	72 trees



ASPLEY S1
H 2
THOUSANDS OF NUTS
70
50
30
10
170
150
130
110
90
70
50
30
10
30
13
27
11
25
8
22
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
1972-73
1973-74

FIGURE 15

NUT NUMBER ESTIMATES

Totals for Aspley S1 and H2, 1972-73, 1973-74

TABLE 16

LEAF NUMBER ESTIMATES

Leaf numbers recorded per sampling stick sample

A. LARGE SAMPLING STICK

	Aspley 1973-74						Beerwah 1972-73			
	S1			H2			Lower tree east		Lower tree west	
Tree		2			2		1	2	1	2
Sample										
1	75	0	37	0	20	0	3	20	48	0
2	16	0	85	170	113	0	25	67	59	0
3	0	58	52	115	20	6	3	66	0	0
4	60	28	23	41	112	132	4	172	77	20
5	98	210	0	6	107	59	27	67	0	0
6	72	0	0	43	23	74	11	25	6	0
7	0	33	100	18	144	133	113	13	1	20
8	66	118	0	0	0	0	27	15	18	207
9	0	161	244	32	47	53	190	0	139	119
10	6	2	40	4	56	9	2	27	183	75

B. SMALL SAMPLING STICK

	Aspley 1973-74					
	S1			H2		
Tree		2			2	
Sample						
1	0	0	5	0	4	0
2	16	0	7	42	27	0
3	0	8	5	12	0	0
4	9	7	0	6	28	49
5	0	36	0	0	15	1
6	27	0	0	1	7	21
7	17	0	32	0	16	34
8	0	30	0	0	0	0
9	1	13	25	0	0	11
10	0	0	0	0	16	0
11	0	0	0	0	9	0
12	40	0	0	35	7	0
13	0	0	20	7	5	0
14	0	0	2	4	19	38
15	21	54	15	0	6	17
16	24	0	0	0	27	20
17	0	0	0	0	36	5
18	40	25	23	0	0	0
19	0	49	9	0	9	0
20	0	0	0	0	0	0

TABLE 17

LEAF NUMBER ESTIMATES

Leaves per tree, and precision of sampling stick methods. Untransformed data.

	ASPLEY		BEERWAH
	Large sample	Small sample	Large sample
(A) Estimate of Leaves			
Mean leaves/sample	52.017	9.117	46.225
Standard error	57.738	13.731	59.706
95% confidence interval of mean	37.109 to 66.925	6.635 to 11.599	27.146 to 65.304
Leaves/tree with 95% confidence limits			
Multiplication factor	174.36	1,394.89	651.97
Lower limit	6,470	9,255	17,698
Central value	9,070	12,717	30,137
Upper limit	11,669	16,179	42,576
(B) Estimate of the number of samples required for a 95% confidence interval of the mean of no more than 10% and 20% of that mean.			
10% of mean	1,971	3,557	2,726
20% of mean	493	889	681
(C) Comparison between large and small sampling units			
Size (cm^3)	98,218.75	12,276.97	
Comparative size	8.00	1.00	
Actual cost (minutes)	5.50	2.20	
Comparative cost (minutes) C_u	0.69	2.20	
Variance	3,333.71	188.54	
Comparative variance s_u^2	416.72	188.54	
$\frac{1}{C_u s_u^2}$	0.004	0.002	

TABLE 18

BRANCH LENGTH ESTIMATES

Branch length recorded per sampling stick sample

A. LARGE SAMPLING STICK

	Aspley 1973-74						Beerwah 1972-73			
	S1			H2			Lower tree east		Lower tree west	
Tree		2			2		1	2	1	2
Sample										
1	117	0	41	0	106	0	0	90	135	0
2	32	0	96	289	223	0	21	142	145	0
3	123	116	80	210	43	7	25	137	25	0
4	100	47	48	175	195	231	40	72	175	425
5	96	209	0	3	161	80	121	128	20	75
6	177	0	0	52	48	106	49	64	65	20
7	49	123	179	45	225	241	125	79	0	600
8	82	191	248	0	0	0	133	95	345	480
9	0	566	67	44	67	60	145	0	160	215
10	10	0	0	8	89	0	5	68	270	95

B. SMALL SAMPLING STICK

	Aspley 1973-74					
	S1			H2		
Tree		2			2	
Sample						
1	0	0	2	0	28	0
2	20	0	20	52	33	0
3	10	9	0	5	0	0
4	0	5	0	20	24	56
5	30	18	0	0	24	0
6	48	0	0	0	48	17
7	0	0	0	0	81	24
8	0	39	95	0	0	0
9	0	96	0	0	0	20
10	0	0	30	0	0	0
11	46	0	0	0	64	0
12	0	0	0	66	22	0
13	0	0	43	12	13	0
14	53	0	0	0	23	53
15	0	0	58	0	40	22
16	35	0	0	0	0	18
17	21	0	0	0	42	0
18	0	61	51	0	0	0
19	36	119	33	0	27	0
20	0	0	0	0	0	0

TABLE 19

BRANCH LENGTH ESTIMATES

Branch length per tree, and precision of sampling stick method. Untransformed data.

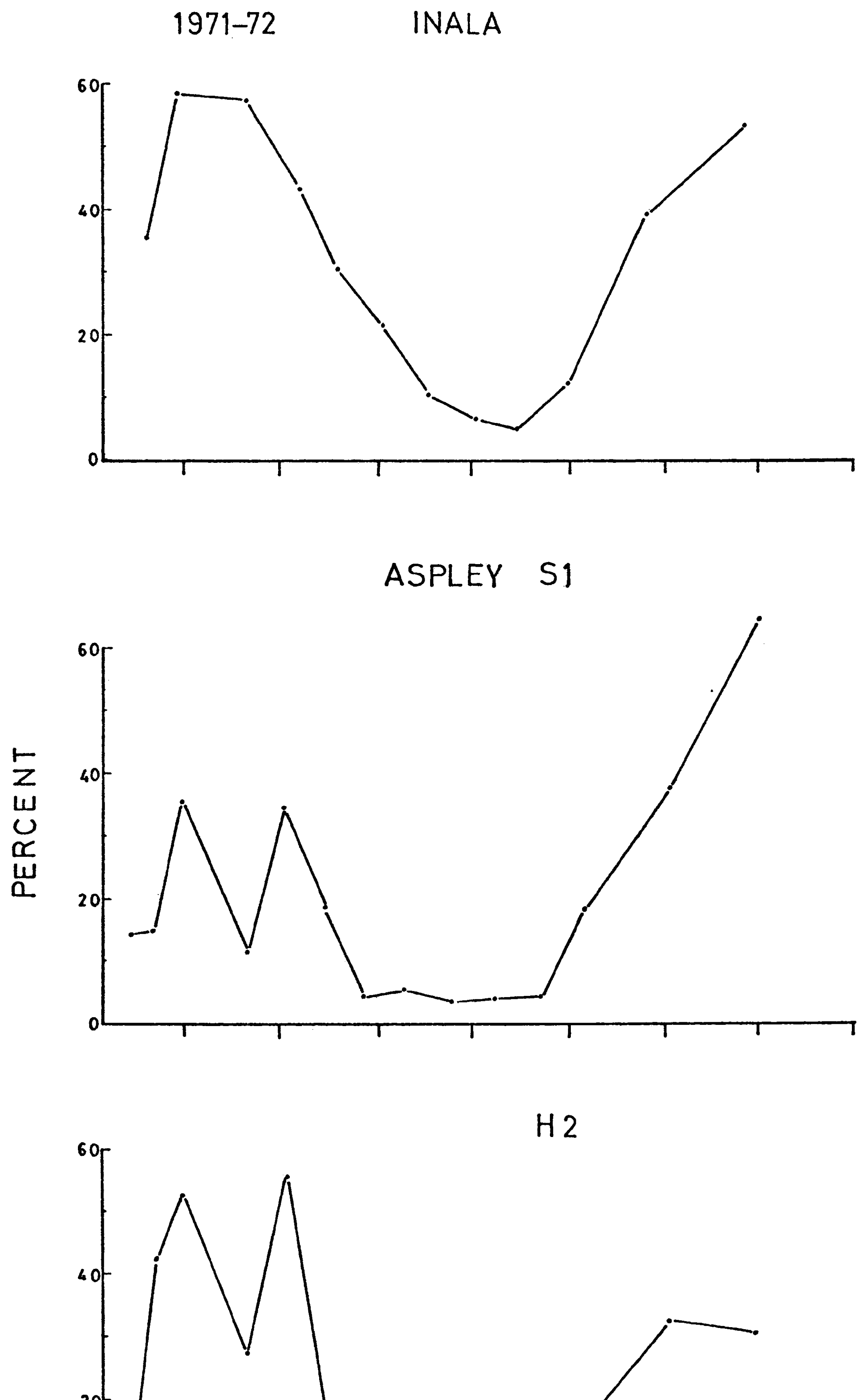
	ASPLEY Large sample	ASPLEY Small sample	BEERWAH Large sample
(A) Estimate of branch length			
Mean length/sample (cm)	91.750	15.100	119.725
Standard error	102.782	24.153	135.708
95% confidence interval of mean	62.212 to 118.288	10.735 to 19.466	77.240 to 162.211
cm branch/tree with 95% confidence limits			
Multiplication factor	174.36	1,394.89	651.97
Lower limit	11,370	14,974	50,358
Central limit	15,998	21,063	78,057
Upper limit	20,625	27,153	105,757
(B) Estimate of the number of samples required for a 95% confidence interval of the mean of no more than 10% and 20% of that mean			
10% of mean	2,008	4,012	2,099
20% of mean	502	1,003	525
(C) Comparison between large and small sampling units			
Size (cm^3)	98,218.75	12,276.97	
Comparative size	8.00	1.00	
Actual cost (minutes)	5.75	2.50	
Comparative cost (minutes) C_u	0.72	2.50	
Variance	10,564.14	583.37	
Comparative variance s_u^2	1,320.52	583.37	
$\frac{1}{C_u s_u^2}$	0.0011	0.0007	

TABLE 20

BRANCH LENGTH ESTIMATES

Total branch length, size of branch, number of junctions; estimated from sampling stick results.

	ASPLEY	BEERWAH
A.		
Total branch in cm	19,375	78,057
Centimetres of branch of diameter:		
less than 0.5 cm	10,656	
between 0.5 and 1.0 cm	5,231	
between 1.0 and 1.5 cm	1,162	
between 1.5 and 2.0 cm	1,008	
between 2.0 and 2.5 cm	698	
more than 2.5 cm	620	
B.		
Number of branch junctions	659	6,911
limits of 95% confidence interval	-	4,703 to 9,119



1971–72
INALA
ASPLEY S1
H2
PERCENT
0
20
40
60
AUG.
SEPT.
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.

FIGURE 16

PERCENT LIKELIHOOD OF NUT FALL

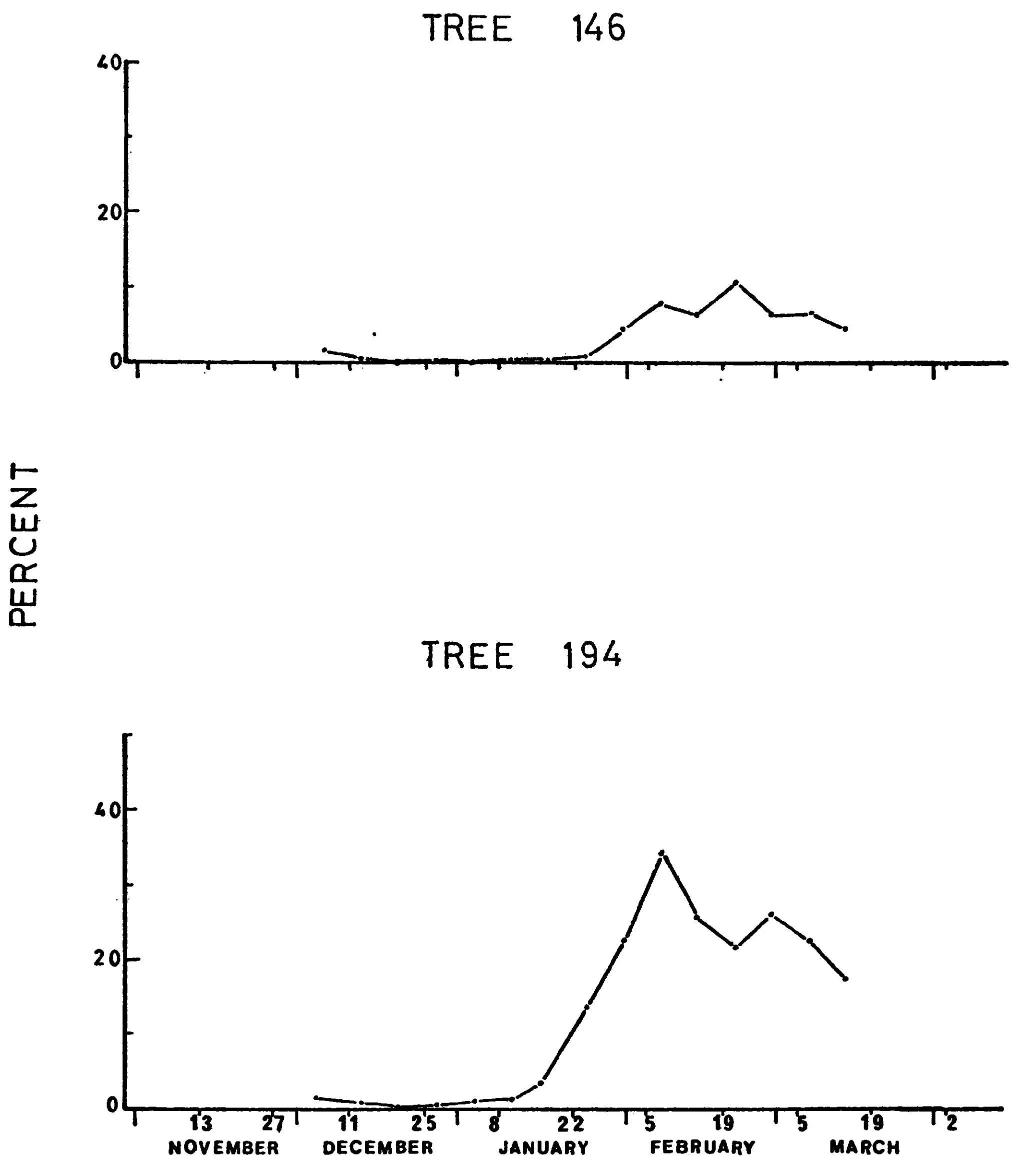
Macadamia sites 1971-72

TABLE 21

WEEKLY NUT FALL

Beerwah 1972-73; showing for each tree the percentage of fallen nuts infested by *C. ombrodelta*.

Week ending	TREE 146 Nut fall	TREE 146 % infested ±s	TREE 194 Nut fall	TREE 194 % infested ±s
13.XII.72	20		25	
20.XII.72	4		18	0
27.XII.72	0		4	75.00
3.I.73	1		8	75.00
10.I.73	0		16	87.50
17.I.73	2	100.00	22	90.90
24.I.73	3	33.33	48	97.92
31.I.73	7	100.00	178	100.00
7.II.73	38	100.00	246	100.00
14.II.73	56	96.43	264	98.50± 0.74
21.II.73	39	97.44	114	100.00
28.II.73	56	94.64	59	94.92
7.III.73	27	100.00	44	86.36
14.III.73	38	94.74	28	92.86
21.III.73	24	100.00	17	100.00
TOTALS	315		1,091	



TREE 146
40
20
0
PERCENT
TREE 194
40
20
0
13
27
11
25
8
22
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 17

PERCENT LIKELIHOOD OF NUT FALL

Beerwah 1972-73

TABLE 22

WEEKLY NUT FALL

Aspley 1972-73. Total for five trees in each variety showing percentage infested by *C. ombrodelta*.

Week ending	S1 Nut fall	S1 % infested ±s	H2 Nut fall	H2 % infested ±s
31.X.72	93	0	638	0.22± 0.11
7.XI.72	374	1.47± 0.20	3,042	0.20± 0.18
14.XI.72	751	0.67± 0.25	2,236	0
21.XI.72	480	0.60± 0.23	977	0.40± 0.20
28.XI.72	143	2.80	609	0.64± 0.18
5.XII.72	52	7.69	267	1.87
12.XII.72	16	25.00	143	0.70
19.XII.72	13	61.54	65	9.23
26.XII.72	4	100.00	8	12.50
2.I.73	4	75.00	2	100.00
9.I.73	11	100.00	6	33.33
16.I.73	46	97.83	12	75.00
23.I.73	67	97.01	17	64.71
30.I.73	91	100.00	33	54.55
6.II.73	76	89.47	52	48.08
13.II.73	129	94.57	127	48.82
20.II.73	95	95.79	136	55.15
27.II.73	106	92.45	215	56.74
6.III.73	95	84.21	303	37.89± 3.61
13.III.73	142	85.21	745	30.45± 2.26
20.III.73	131	67.94	2,026	19.20± 2.33
27.III.73	243	33.75± 2.19	1,233	16.40± 2.10
3.IV.73	175	46.71± 1.47	334	18.61± 1.42
TOTALS	3,337		13,226	

TABLE 23

WEEKLY NUT FALL

Aspley 1973-74. Total for five trees in each variety showing percentage infested by *C. ombrodelta*.

Week ending	S1 Nut fall	S1 % infested ±s	H2 Nut fall	H2 % infested ±s
23.XI.73	313		140	0.71
30.XI.73	467	0	266	0.38
7.XII.73	474	0.42	318	0.63
14.XII.73	188	0	150	0.67
21.XII.73	54	1.85	43	2.33
28.XII.73	18	5.56	13	0
4.I.74	11	0	21	57.14
11.I.74	25	60.00	21	38.10
18.I.74	37	97.30	44	61.36
25.I.74	56	87.50	131	52.67
1.II.74	69	75.36	80	53.75
8.II.74	46	89.36	43	44.19
15.II.74	74	82.43	68	61.76
22.II.74	146	69.90± 2.46	102	48.04
1.III.74	118	59.74± 3.31	142	29.03± 2.78
8.III.74	205	41.56± 4.47	148	25.81± 2.78
15.III.74	326	35.89± 4.25	356	37.00± 4.11
22.III.74	254		113	
TOTALS	2,881		2,199	

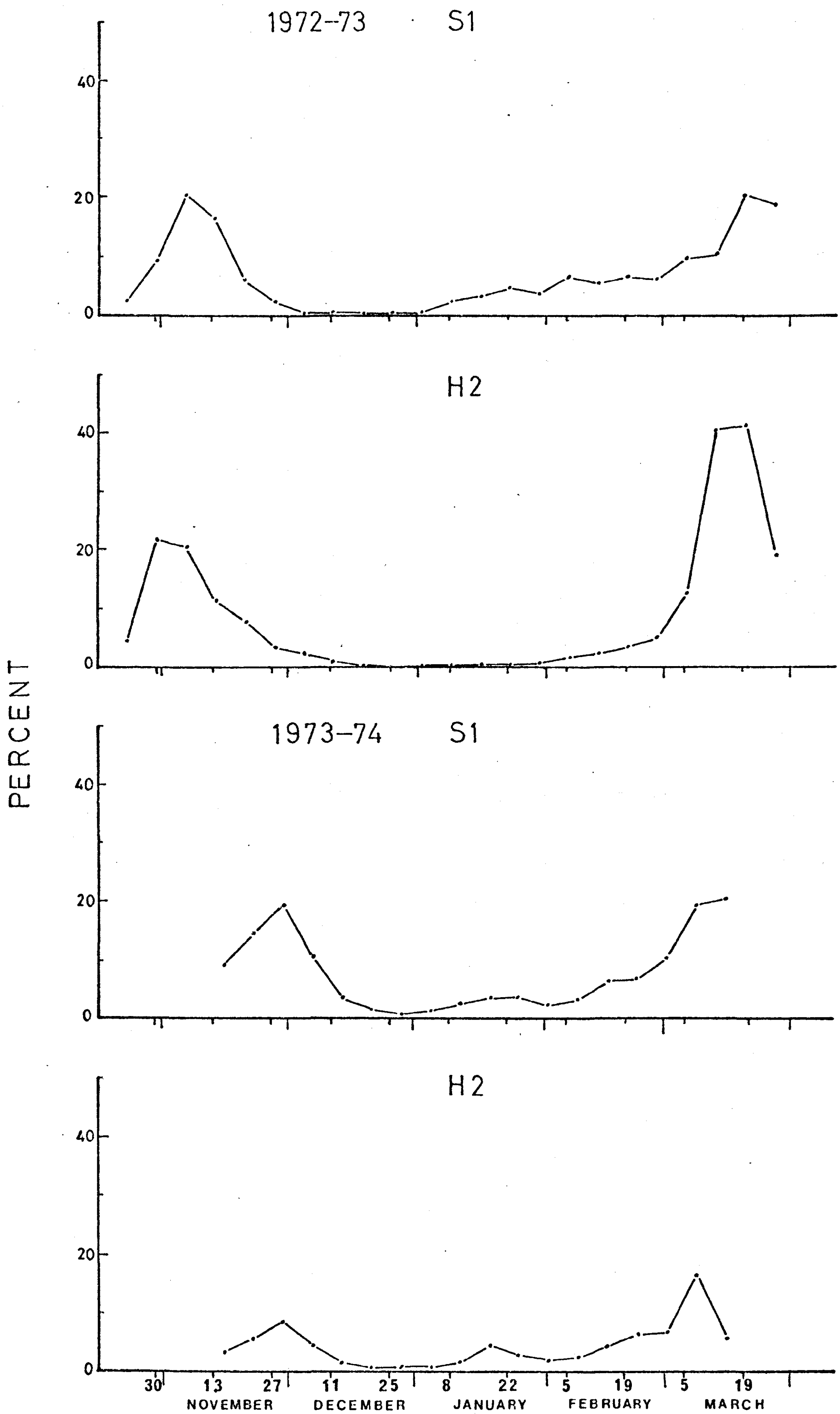

1972-73
S1
H2
1973-74
S1
H2
PERCENT
0
20
40
30
13
27
11
25
8
22
5
19
5
19
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 18

PERCENT LIKELIHOOD OF NUT FALL

Aspley S1 and H2 1972-73, 1973-74

TABLE 24

PERCENT LIKELIHOOD OF NUT FALL

Aspley 1972-73. Weekly mean and standard error(s); results of the analysis of variance.

	S1	H2
Week starting	Mean ± s	Mean ± s
24.X.72	7.46± 4.47	11.83± 1.59
31.X.72	17.54± 3.62	*27.17± 4.30
7.XI.72	26.33± 2.87	26.65± 2.09
14.XI.72	*24.39±13.56	19.23± 2.23
21.XI.72	15.44± 8.74	16.11± 1.47
28.XI.72	9.58± 6.54	11.03± 1.64
5.XII.72	3.85[a]±2.36	8.34± 1.25
12.XII.72	2.80[a]±3.01	5.64± 1.27
19.XII.72	1.35[a]±1.84	2.01[a]±0.78
26.XII.72	1.80[a]±1.69	0.38[a]±0.85
2.I.73	3.13[a]±3.12	1.21[a]±1.27
9.I.73	4.35[a]±6.78	2.44[a]±0.88
16.I.73	10.35± 3.04	2.66[a]±1.88
23.I.73	12.32± 2.58	4.08± 1.23
30.I.73	12.47± 4.29	5.08± 0.95
6.II.73	16.28± 4.26	8.07± 0.65
13.II.73	14.00± 2.26	8.33± 1.78
20.II.73	15.87± 2.85	10.58± 1.96
27.II.73	14.97± 2.33	*12.52± 4.14
6.III.73	19.66± 3.72	*21.17± 5.74
13.III.73	24.80± 7.35	*40.69± 8.87
20.III.73	24.99± 7.33	*42.23± 6.48
27.III.73	26.95± 6.09	*27.67± 4.23

(Data transformed to arcsin $\sqrt{x}$)

* Within each variety: a Barlett's test for homogeneity of variance (Sokal and Rohlf 1969), indicated analysis of differences between weekly means should be conducted in two groups: viz. those marked * and those remaining. For those without the asterisk LSD (0.05)=8.09 (S1), 3.37 (H2).

a Within each variety: means followed by "a" are not significantly different (P=0.05) to the lowest mean in that variety. All other means are significantly greater.

TABLE 25

PERCENT LIKELIHOOD OF NUT FALL

Aspley 1973-74. Weekly mean and standard error(s); results of the analysis of variance.

	S1	H2
Week starting	Mean ± s	Mean ± s
16.XI.73	16.36± 7.81	10.18[a]± 2.37
23.XI.73	*20.44±12.44	13.72 ± 3.44
30.XI.73	*23.84±13.55	16.30 ± 5.32
7.XII.73	17.14± 9.17	11.14 ± 4.13
14.XII.73	10.32[a]±4.95	6.38[a]± 3.31
21.XII.73	5.82[a]±5.11	3.66[a]± 1.80
28.XII.73	3.06[a]±1.75	4.64[a]± 3.36
4.I.74	6.14[a]±3.21	4.70[a]± 1.68
11.I.74	8.10[a]±3.50	6.64[a]± 3.86
18.I.74	10.08[a]±3.95	11.50 ± 2.97
25.I.74	10.82[a]±3.03	9.20[a]± 3.91
1.II.74	8.62[a]±1.86	7.46[a]± 3.98
8.II.74	9.76[a]±3.27	8.44[a]± 3.38
15.II.74	13.70± 5.64	11.44 ± 2.34
22.II.74	15.02± 2.53	13.62 ± 5.45
1.III.74	18.46± 3.24	14.48 ± 5.43
8.III.74	25.96± 3.89	23.22 ± 8.16
15.III.74	27.00± 2.48	13.54 ± 4.18

(Date transformed to arcsin $\sqrt{x}$)

* In S1, a Bartlett's test for homogeneity of variance (Sokal and Rohlf 1969) indicated that the analysis of variance should not include the data for the weeks whose means are preceded by *. For data without * LSD (0.05)=8.20 (S1) 7.24 (H2).

a Within each variety, means followed by "a" are not significantly different (P=0.05) to the lowest mean in that variety. All other means are significantly greater.

TABLE 26

WITHIN TREE NUT DISTRIBUTION
Beerwah 1972-73. Direct counts.

Dates	Levels	Tree 146 Quadrants				Tree 194 Quadrants			
		North	East	South	West	North	East	South	West
6.XII.72	upper	120	69	111	57	146	60	98	139
	lower	148	137	99	104	115	116	162	260
24.I.73	upper	133	57	51	36	112	35	37	98
	lower	92	94	87	92	121	112	85	205
21.III.73	upper	88	15	11	21	16	11	20	8
	lower	7	28	9	4	2	5	1	17

TABLE 27

WITHIN TREE NUT DISTRIBUTION

Aspley S1 1972-73. Direct counts of five trees in the inside rows and five trees in the outside row.

Date Level	Quadrant	INSIDE ROWS TREE					OUTSIDE ROW TREE				
		1	2	3				2	3		
10.XII.72											
UPPER	North	41	0	30	54	9	4	4	47	0	22
	East	21	0	10	12	0	8	0	44	0	22
	South	6	0	5	24	12	0	0	25	2	7
	West	7	0	17	97	9	1	0	22	5	4
LOWER	North	45	33	107	60	100	40	7	50	29	57
	East	52	18	134	57	218	37	15	55	11	38
	South	10	12	41	34	103	12	12	73	27	38
	West	82	25	65	163	127	34	26	72	46	26
TREE TOTAL		264	88	409	501	578	136	64	388	120	214
3.II.73											
UPPER	North	43	0	37	64	8	13	0	34	0	25
	East	27	0	14	10	0	4	0	37	0	28
	South	1	0	4	28	6	1	0	24	0	7
	West	17	0	17	71	5	0	0	22	0	4
LOWER	North	60	16	67	47	150	54	7	63	32	26
	East	38	15	101	58	130	51	13	43	8	28
	South	9	11	21	23	64	19	10	85	17	23
	West	40	24	51	117	52	18	13	60	44	37
TREE TOTAL		235	66	312	418	415	160	43	368	101	178
3.IV.73											
UPPER	North	19	0	12	27	2	0	1	21	0	3
	East	4	0	11	4	0	0	0	3	0	2
	South	0	0	4	13	0	0	0	7	0	0
	West	2	0	8	32	2	0	0	1	0	0
LOWER	North	24	6	64	34	62	13	3	22	8	9
	East	9	1	40	21	38	37	3	33	3	7
	South	2	9	23	17	46	9	4	28	0	6
	West	10	12	31	118	37	7	2	26	5	4
TREE TOTAL		70	28	193	266	187	66	13	141	16	31

TABLE 28

WITHIN TREE NUT DISTRIBUTION

Aspley H2 1972-73. Direct counts of five trees in the inside rows and five trees in the outside row.

Date		INSIDE ROWS					OUTSIDE ROW				
Level	Quadrant	TREE					TREE				
			2	3				2	3		
10.XII.72											
UPPER	North	118	24	28	64	21	1	0	42	29	91
	East	87	12	16	46	45	68	0	46	57	69
	South	51	1	14	31	45	8	0	59	115	154
	West	153	29	64	181	103	5	4	275	93	105
LOWER	North	428	298	247	318	173	155	199	227	184	102
	East	115	116	223	256	138	86	192	57	158	250
	South	237	186	57	150	182	152	60	21	155	229
	West	317	243	340	216	174	325	107	164	287	87
TREE TOTAL		1506	909	989	1262	881	800	562	891	1078	1087
3.II.73											
UPPER	North	96	18	62	62	20	1	0	47	12	63
	East	102	12	13	40	28	8	0	35	37	63
	South	49	1	11	24	38	5	0	23	82	163
	West	117	27	64	147	73	73	0	249	67	105
LOWER	North	417	230	249	375	258	189	158	203	169	103
	East	100	96	157	192	187	63	112	34	165	275
	South	142	188	109	152	148	131	53	22	193	187
	West	365	220	340	179	209	283	72	133	285	133
TREE TOTAL		1388	792	1005	1171	961	753	395	746	1010	1092
3.IV.73											
UPPER	North	27	2	3	1	1	0	0	8	3	1
	East	16	0	1	4	0	0	0	0	4	0
	South	15	0	0	4	0	0	0	24	11	3
	West	19	0	0	10	14	5	0	94	12	3
LOWER	North	241	22	58	167	47	21	46	78	29	3
	East	39	4	37	41	63	6	31	11	23	12
	South	88	22	18	26	17	21	9	10	31	11
	West	210	34	63	47	57	80	12	93	48	11
TREE TOTAL		664	84	190	300	199	133	98	318	151	44

TABLE 29

WITHIN TREE NUT DISTRIBUTION

Beerwah 1972-73. Analysis of variance of direct counts.

Source of Variance	df Tabular F	Accumulated denominator mean square	Calculated F
Dates	2, 30	0.0301	162.95 **
Trees	1, 30	0.0301	0.41
Levels	1, 30	0.0301	0.00
Quadrants	3, 30	0.0301	2.28
dates x trees	2, 30	0.0301	6.26 **
dates x levels	2, 30	0.0301	17.03 **
dates x quadrants	6, 24	0.0327	0.60
trees x levels	1, 23	0.0339	0.13
trees x quadrants	3, 23	0.0339	4.23 *
levels x quadrants	3, 23	0.0339	5.47 **
dates x trees x levels	2, 21	0.0362	0.27
dates x levels x quadrants	6, 15	0.0428	0.47
dates x trees x quadrants	6, 9	0.0653	0.14
trees x levels x quadrants	3, 6	0.0828	0.37
dates x trees x levels x quadrants	6, -	0.0828	

(data transformed log(x+1))

* significant at P=0.05

** significant at P=0.01

Tests were made from the last second order interaction upwards to main effects. Non-significant interaction effect was accumulated to increase the power of the test.

TABLE 30

WITHIN TREE NUT DISTRIBUTION

Aspley S1 1972-73. Analysis of variance of direct counts of five trees in the outside row and five trees in the inside rows.

Source of variance	df Tabular F	OUTSIDE ROW Computed F	INSIDE ROWS Computed F
Dates	2, 24	94.77 **	76.37 **
Trees	4, 24	103.68 **	165.45 **
Levels	1, 24	508.53 **	793.80 **
Quadrants	3, 24	8.28 **	48.01 **
dates x trees	8, 24	2.96 *	2.76 *
dates x levels	2, 24	0.84	1.71
dates x quadrants	6, 24	0.56	0.92
trees x levels	4, 24	15.06 **	63.35 **
trees x quadrants	12, 24	4.04 **	12.33 **
levels x quadrants	3, 24	4.45 *	7.50 **
dates x trees x levels	8, 24	4.33 **	1.89
dates x trees x quadrants	24, 24	1.26	0.87
dates x levels x quadrants	6, 24	1.02	2.42
trees x levels x quadrants	12, 24	1.99	5.12 **
dates x trees x levels x quadrants	24	0.0341	0.0214

(data transformed log(x+1))

* significant at P=0.05

** significant at P=0.01

TABLE 31

WITHIN TREE NUT DISTRIBUTION

Aspley H2 1972-73. Analysis of variance of direct counts of five trees in the outside row and five trees in the inside rows.

Source of variance	df Tabular F	OUTSIDE ROW Computed F	INSIDE ROWS Computed F
Dates	2, 24	197.50 **	283.96 **
Trees	4, 24	56.73 **	45.70 **
Levels	1, 24	448.27 **	673.91 **
Quadrants	3, 24	16.91 **	34.97 **
dates x trees	8, 24	9.20 **	3.50 **
dates x levels	2, 24	0.55	15.11 **
dates x quadrants	6, 24	1.90	0.42
trees x levels	4, 24	54.69 **	11.83 **
trees x quadrants	12, 24	6.25 **	1.61
levels x quadrants	3, 24	8.81 **	4.28 *
dates x trees x levels	8, 24	2.71 *	1.74
dates x trees x quadrants	24, 24	1.38	1.07
dates x levels x quadrants	6, 24	0.74	1.05
trees x levels x quadrants	12, 24	3.33 **	4.18 **
dates x trees x levels x quadrants	24	0.0453	0.0330

(data transformed log(x+1))

significant at P=0.05

** significant at P=0.01

TABLE 32

WITHIN TREE NUT DISTRIBUTION

Beerwah 1972-73. Two way tables of means for the significant first order interactions of the analysis of direct nut counts.

(A) Dates x Trees

Trees	Dates: 6.XII.72	24.I.73	21.III.73	Tree mean
146	2.01	1.88	1.21	1.70
194	2.13	1.95	0.92	1.67
Date mean	2.07	1.91	1.06	

LSD(0.05) for mean differences: dates x trees = 0.20
dates = 0.10
trees = 0.13

(B) Dates x Levels

Levels	Dates: 6.XII.72	24.I.73	21.III.73	Level mean
UPPER	1.98	1.79	1.27	1.68
LOWER	2.16	2.03	0.86	1.68

LSD(0.05) for mean differences: dates x levels = 0.18
levels = 0.10

(C) Trees x Quadrants

Tree	Quadrants: North	East	South	West
146	1.87	1.73	1.63	1.56
194	1.68	1.58	1.56	1.85
Quadrant mean	1.77	1.66	1.61	1.70

LSD(0.05) for mean differences: trees x quadrants = 0.22
quadrants = 0.15

(D) Levels x Quadrants

Level	Quadrants: North	East	South	West
UPPER	1.94	1.54	1.62	1.63
LOWER	1.61	1.77	1.57	1.78

LSD(0.05) for mean differences: levels x quadrants = 0.22

(data transformed log(x+1))

TABLE 33

WITHIN TREE NUT DISTRIBUTION

Aspley S1 1972-73. Outside row - two way tables of means for the significant first order interactions of the analysis of direct nut counts.

(A) Dates x Trees

Date	Tree 1	2	3	4	5	Date mean
10.XII.72	0.98	0.67	1.66	0.87	1.34	1.10
3.II.73	1.02	0.53	1.63	0.67	1.29	1.03
3.IV.73	0.58	0.34	1.12	0.29	0.57	0.58
Tree mean	0.86	0.51	1.47	0.61	1.07	

LSD(0.05) for mean differences: dates x trees = 0.19
dates = 0.08
trees = 0.11

(B) Trees x Levels

Level	Tree 1	2	3	4	5	Level mean
UPPER	0.34	0.08	1.26	1.05	0.82	0.52
LOWER	1.38	0.94	1.68	1.12	1.31	1.28

LSD(0.05) for mean differences: trees x levels = 0.14
levels = 0.07

(C) Trees x Quadrants

Quadrant	Tree 1	2	3	4	5	Quadrant mean
North	1.06	0.57	1.57	0.66	1.26	1.02
East	1.09	0.49	1.46	0.44	1.21	0.94
South	0.62	0.48	1.50	0.53	0.94	0.81
West	0.67	0.51	1.35	0.81	0.85	0.84

LSD(0.05) for mean differences: trees x levels = 0.22
quadrants = 0.10

(D) Levels x Quadrants

Level	Quadrants North	East	South	West
UPPER	0.72	0.59	0.42	0.37
LOWER	1.33	1.29	1.20	1.31

LSD(0.05) for mean differences: levels x quadrants = 0.14

(data transformed log(x+1))

TABLE 34

WITHIN TREE NUT DISTRIBUTION

Aspley S1 1972-73. Inside rows - two way tables of means for the significant first order interactions of the analysis of direct nut counts.

(A) Dates x Trees

Date	Tree 1	2	3	4	5	Date mean
10.XII.72	1.38	0.67	1.52	1.69	1.45	1.34
3.II.73	1.33	0.61	1.45	1.63	1.30	1.27
3.IV.73	0.80	0.41	1.27	1.38	0.95	0.96
Tree mean	1.17	0.56	1.41	1.57	1.23	

LSD(0.05) for mean differences: dates x trees = 0.15
dates = 0.07
trees = 0.09

(B) Trees x Levels

Levels	Tree 1	2	3	4	5	Level mean
UPPER	0.99	0.00	1.09	1.44	0.55	0.81
LOWER	1.35	1.12	1.73	1.70	1.91	1.57

LSD(0.05) for mean differences: trees x levels = 0.12
levels = 0.05

(C) Trees x Quadrants

Quadrants	Tree 1	2	3	4	5	Quadrant mean
North	1.57	0.60	1.64	1.67	1.40	1.38
East	1.30	0.46	1.51	1.29	1.01	1.11
South	0.61	0.53	1.09	1.36	1.24	0.97
West	1.20	0.65	1.42	1.95	1.28	1.30

LSD(0.05) for mean differences: trees x quadrants = 0.17
quadrants = 0.08

(D) Levels and Quadrants

Levels	Quadrants North	East	South	West
UPPER	1.08	0.64	0.62	0.91
LOWER	1.68	1.59	1:32	1.69

LSD(0.05) for mean differences: levels x quadrants = 0.11

(data transformed log(x+1))

TABLE 35

WITHIN TREE NUT DISTRIBUTION

Aspley H2 1972-73. Outside row - two way tables of means for the significant first order interactions of the analysis of direct nut counts.

(A) Dates x Trees

Dates	Trees 1	2	3	4	5	Date mean
10.XII.72	1.59	1.14	1.90	2.05	2.09	1.75
3.II.73	1.57	0.98	1.79	1.96	2.09	1.68
3.IV.73	0.78	0.66	1.29	1.10	0.67	0.90
Tree mean	1.31	0.92	1.66	1.70	1.62	

LSD(0.05) for mean differences: dates x trees = 0.22
dates = 0.10
trees = 0.13

(B) Trees x Levels

Level	Trees 1	2	3	4	5	Level mean
UPPER	0.71	0.06	1.57	1.37	1.45	1.03
LOWER	1.91	1.80	1.75	2.03	1.79	1.86

LSD(0.05) for mean differences: trees x levels = 0.18
levels = 0.08

(C) Trees x Quadrants

Quadrant	Trees 1	2	3	4	5	Quadrant mean
North	1.07	1.03	1.81	1.53	1.45	1.38
East	1.23	0.97	1.27	1.64	1.60	1.34
South	1.23	0.75	1.38	1.71	1.79	1.37
West	1.72	0.95	2.19	1.92	1.63	1.68

LSD(0.05) for mean differences: trees x quadrants = 0.25
quadrants = 0.11

(D) Levels x Quadrants

Level	Quadrant North	East	South	West
UPPER	0.81	0.91	1.04	1.37
LOWER	1.94	1.77	1.71	2.00

LSD(0.05) for mean differences: levels x quadrants = 0.16

(data transformed log(x+1))

TABLE 36

WITHIN TREE NUT DISTRIBUTION

Aspley H2 1972-73. Inside rows - two way tables of means for the significant first order interactions of the analysis of direct nut counts.

(A) Dates x Trees

Dates	Trees 1	2	3	4	5	Date mean
10.XII.72	2.19	1.69	1.84	2.08	1.95	1.95
3.II.73	2.14	1.64	1.88	2.04	1.93	1.92
3.IV.73	1.68	0.68	0.92	1.21	0.99	1.10
Tree mean	2.00	1.34	1.54	1.78	1.62	

LSD(0.05) for mean differences: dates x trees = 0.22
dates = 0.10
trees = 0.13

(B) Dates x Levels

Dates	Levels UPPER	LOWER
10.XII.72	1.59	2.31
3.II.73	1.55	2.30
3.IV.73	0.54	1.66
Level mean	1.23	2.09

LSD(0.05) for mean differences: dates x levels = 0.12
levels = 0.07

(C) Trees x Levels

Levels	Trees 1	2	3	4	5
UPPER	1.74	0.74	1.03	1.41	1.20
LOWER	2.27	1.93	2.05	2.14	2.05

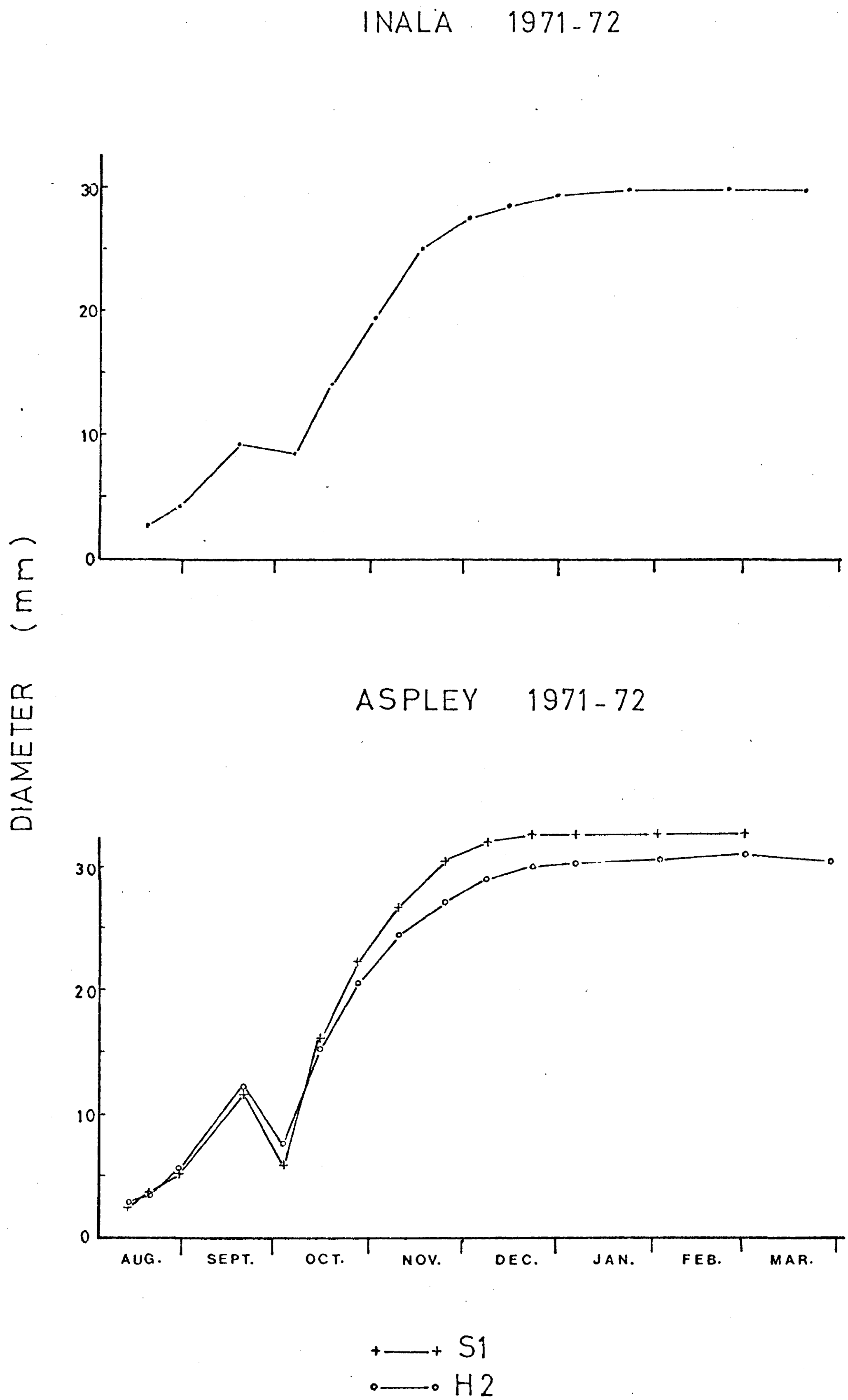
LSD(0.05) for mean differences: trees x levels = 0.15

(D) Levels x Quadrants

Levels	Quadrants North	East	South	West
UPPER	1.29	1.15	0.96	1.51
LOWER	2.27	1.94	1.93	2.21
Quadrant mean	1.78	1.54	1.44	1.86

LSD(0.05) for mean differences: levels x quadrants = 0.14
quadrants = 0.10

(data transformed log(x+1))

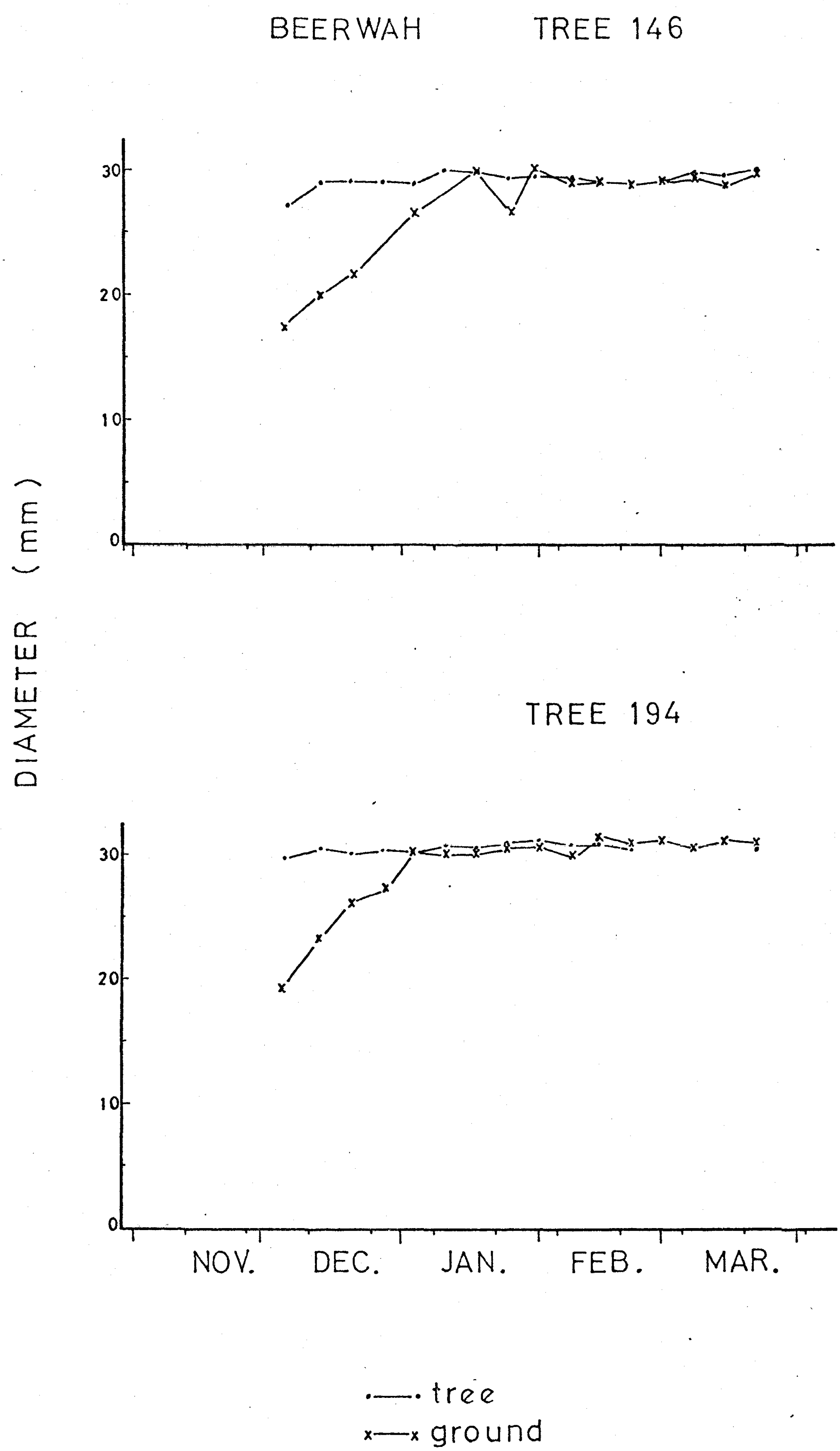


INALA 1971-72
ASPLEY 1971-72
DIAMETER (mm)
0
10
20
30
AUG.
SEPT.
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
S1
H2

FIGURE 19

NUT SIZE

Macadamia sites 1971-72. Mean equatorial diameter of tree nuts in husk.

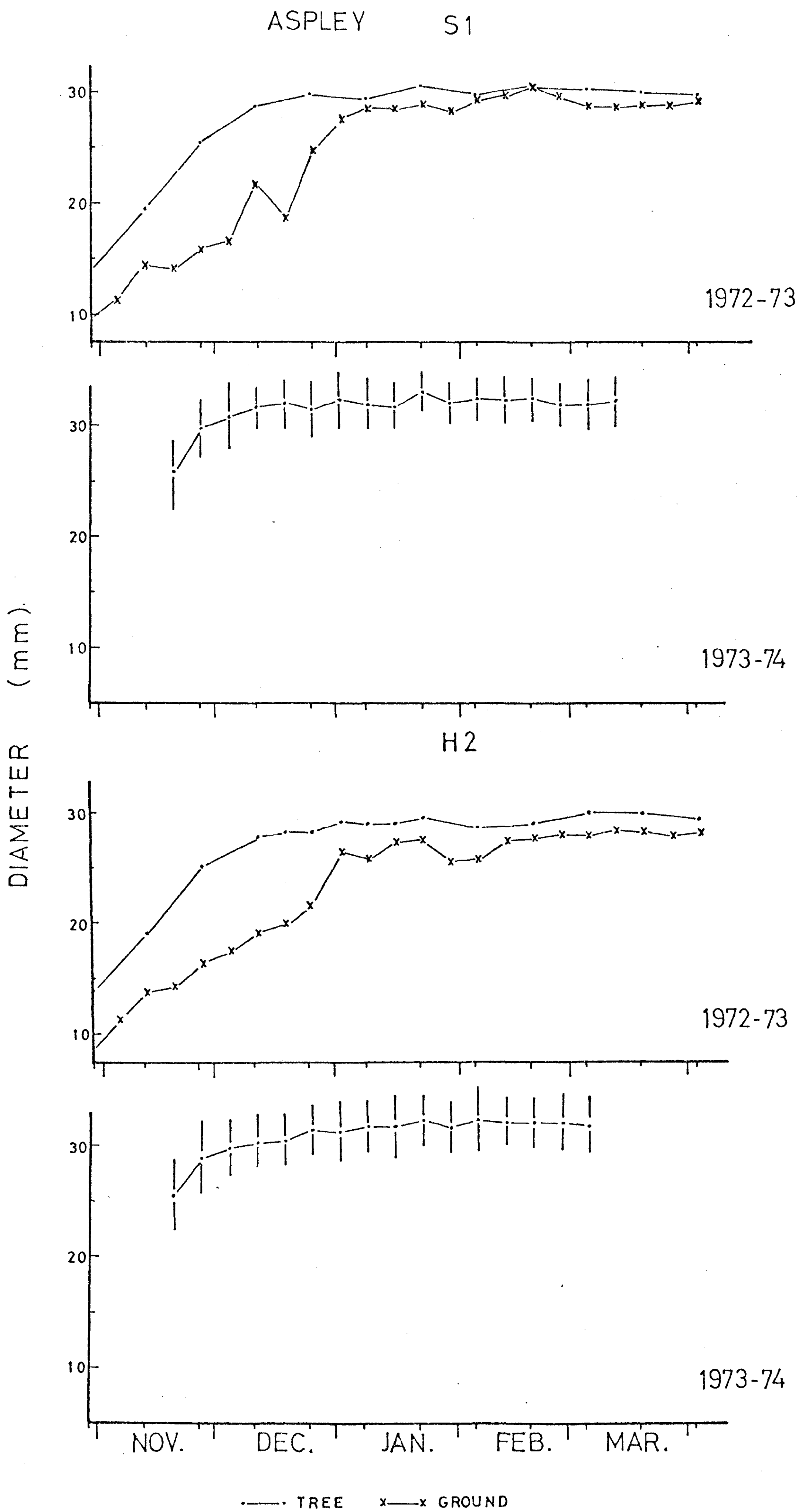


BEERWAH
TREE 146
TREE 194
DIAMETER (mm)
0
10
20
30
NOV.
DEC.
JAN.
FEB.
MAR.
tree
ground

FIGURE 20

NUT SIZE

Beerwah 1972-73. Mean equatorial diameter of nuts in husk.



ASPLEY S1
1972-73
1973-74
H2
1972-73
1973-74
DIAMETER (mm)
30
20
10
NOV.
DEC.
JAN.
FEB.
MAR.
TREE
GROUND

FIGURE 21

NUT SIZE

Aspley S1 and H2 1972-73, 1973-74. Mean equatorial diameter of nuts in husk.

For 1973-74, mean nut sizes are shown with the range of standard error(s).

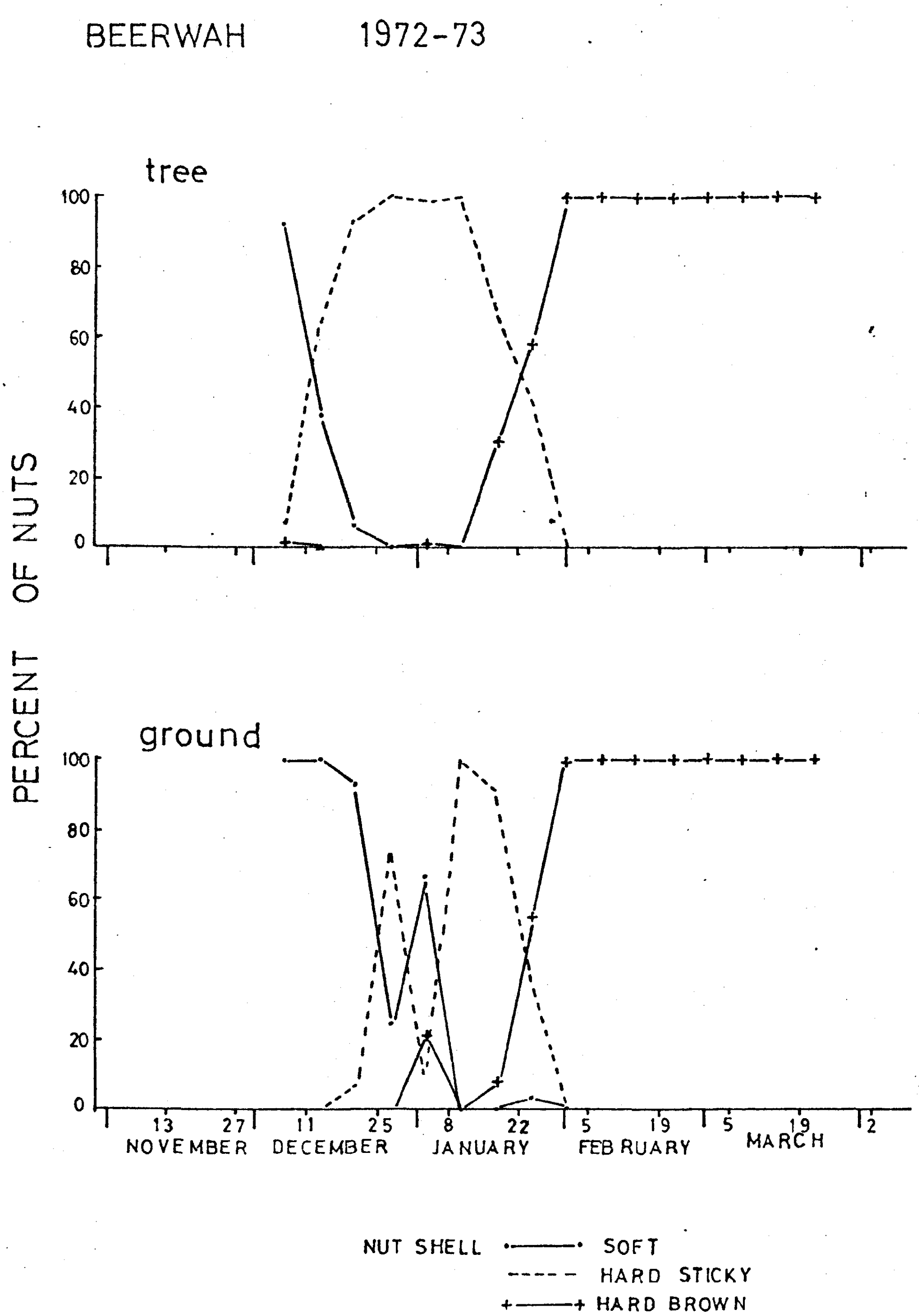

BEERWAH 1972-73
tree
ground
PERCENT OF NUTS
100
80
60
40
20
0
13
27
11
25
8
22
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
NUT SHELL
SOFT
HARD STICKY
HARD BROWN

FIGURE 22

VISUAL MATURITY

Beerwah 1972-73. Percent of sampled nuts in the three categories (both trees combined).

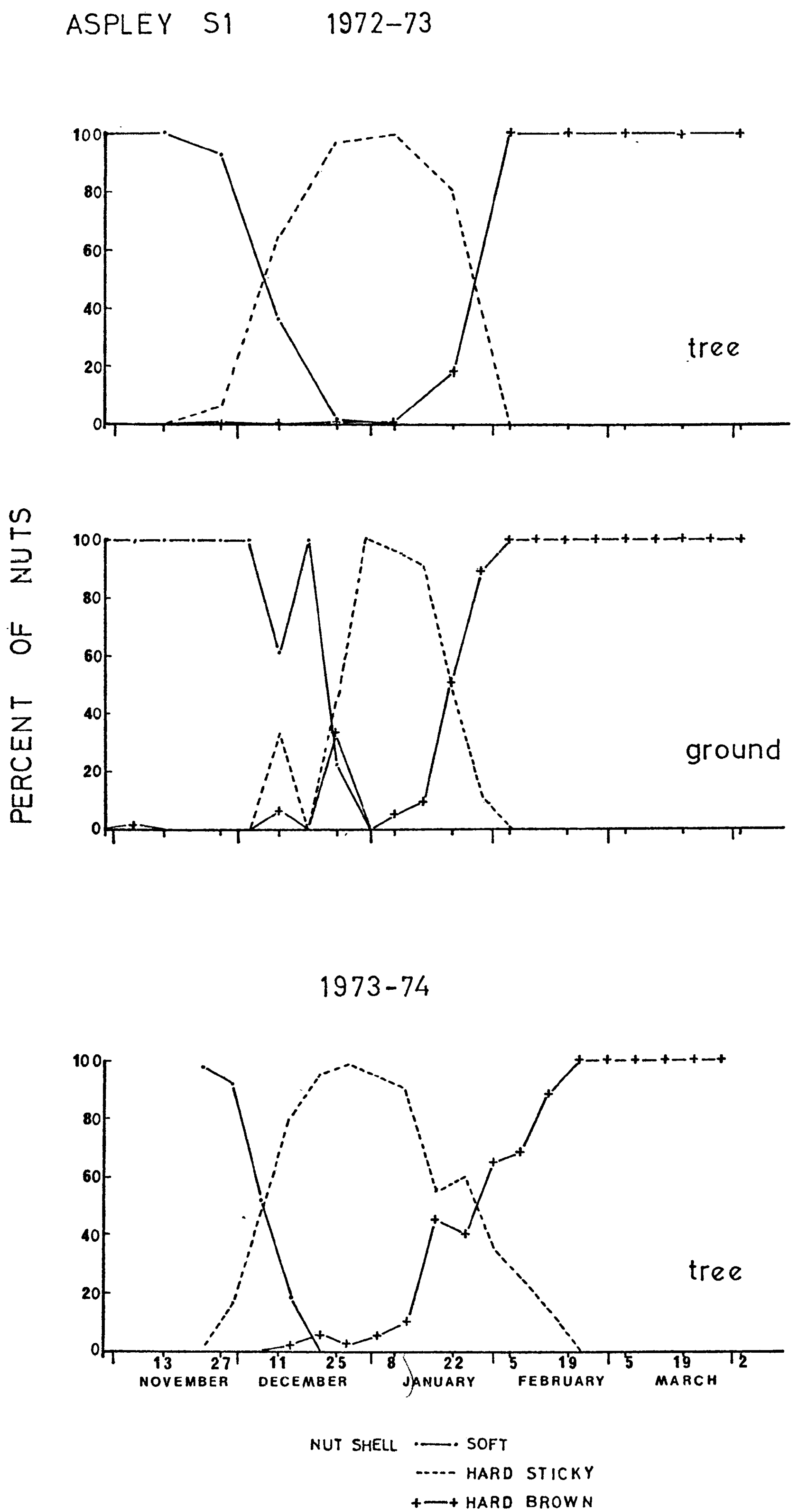
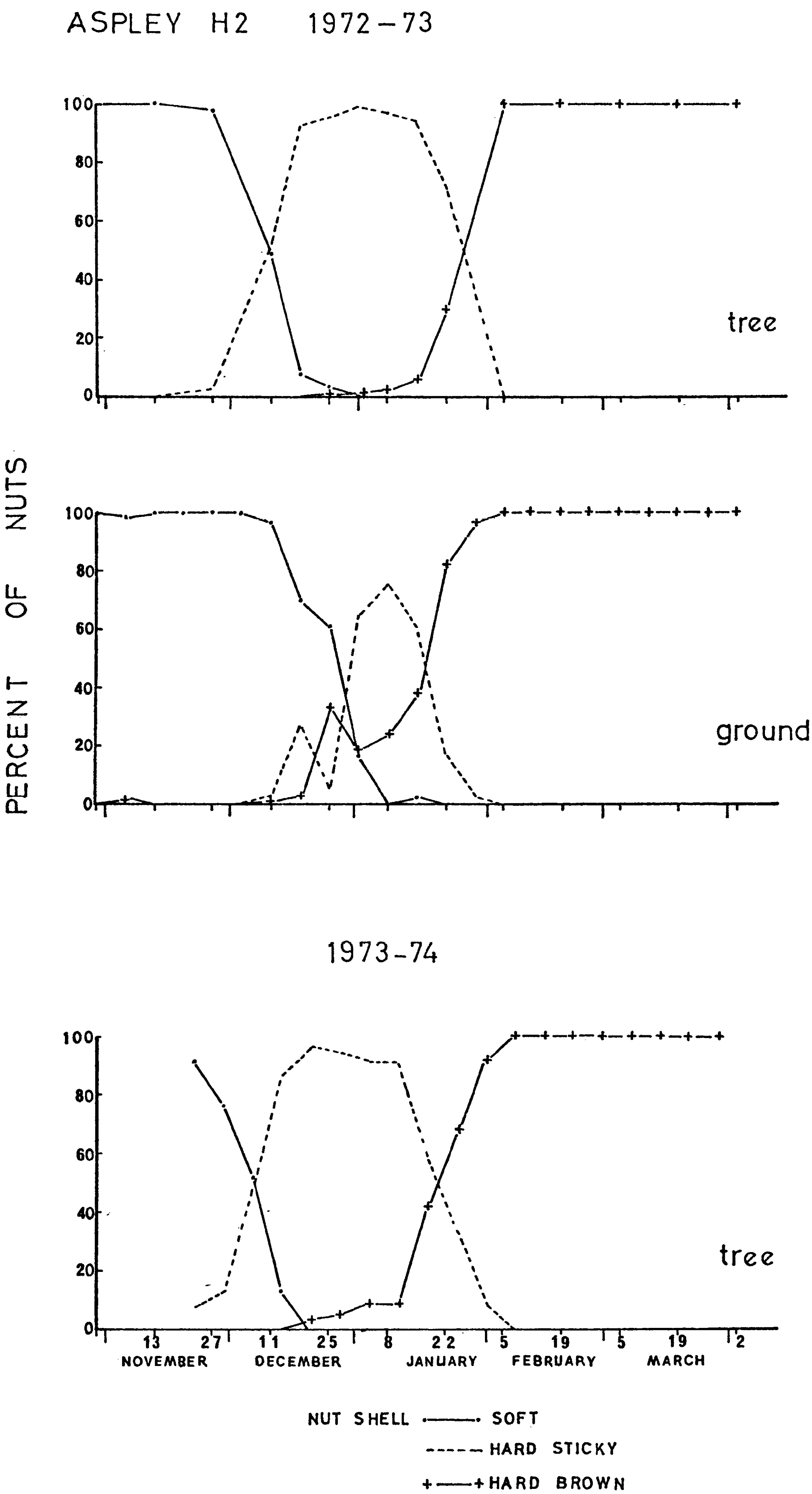

ASPLEY S1 1972-73
PERCENT OF NUTS
tree
ground
1973-74
tree
100
80
60
40
20
0
13
27
11
25
8
22
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
NUT SHELL
SOFT
HARD STICKY
HARD BROWN

FIGURE 23

VISUAL MATURITY

Aspley S1 1972-73, 1973-74. Percent of sampled nuts in the three categories.



ASPLEY H2 1972-73
PERCENT OF NUTS
tree
ground
1973-74
tree
0
20
40
60
80
100
13
27
11
25
8
22
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
NUT SHELL
SOFT
HARD STICKY
HARD BROWN

FIGURE 24

VISUAL MATURITY

Aspley H2 1972-73, 1973-74. Percent of sampled nuts in the three categories.

BEERWAH 1972-73

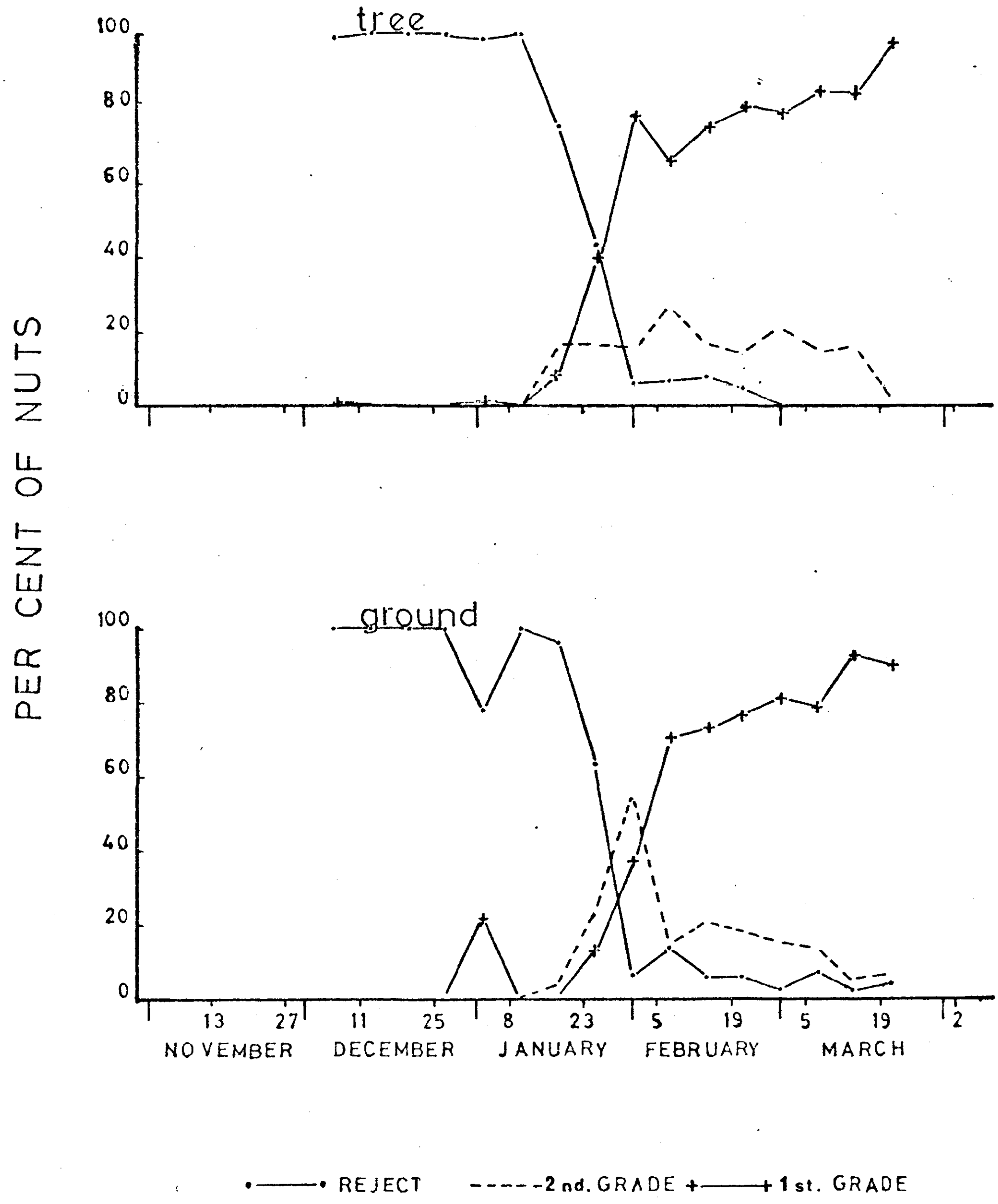
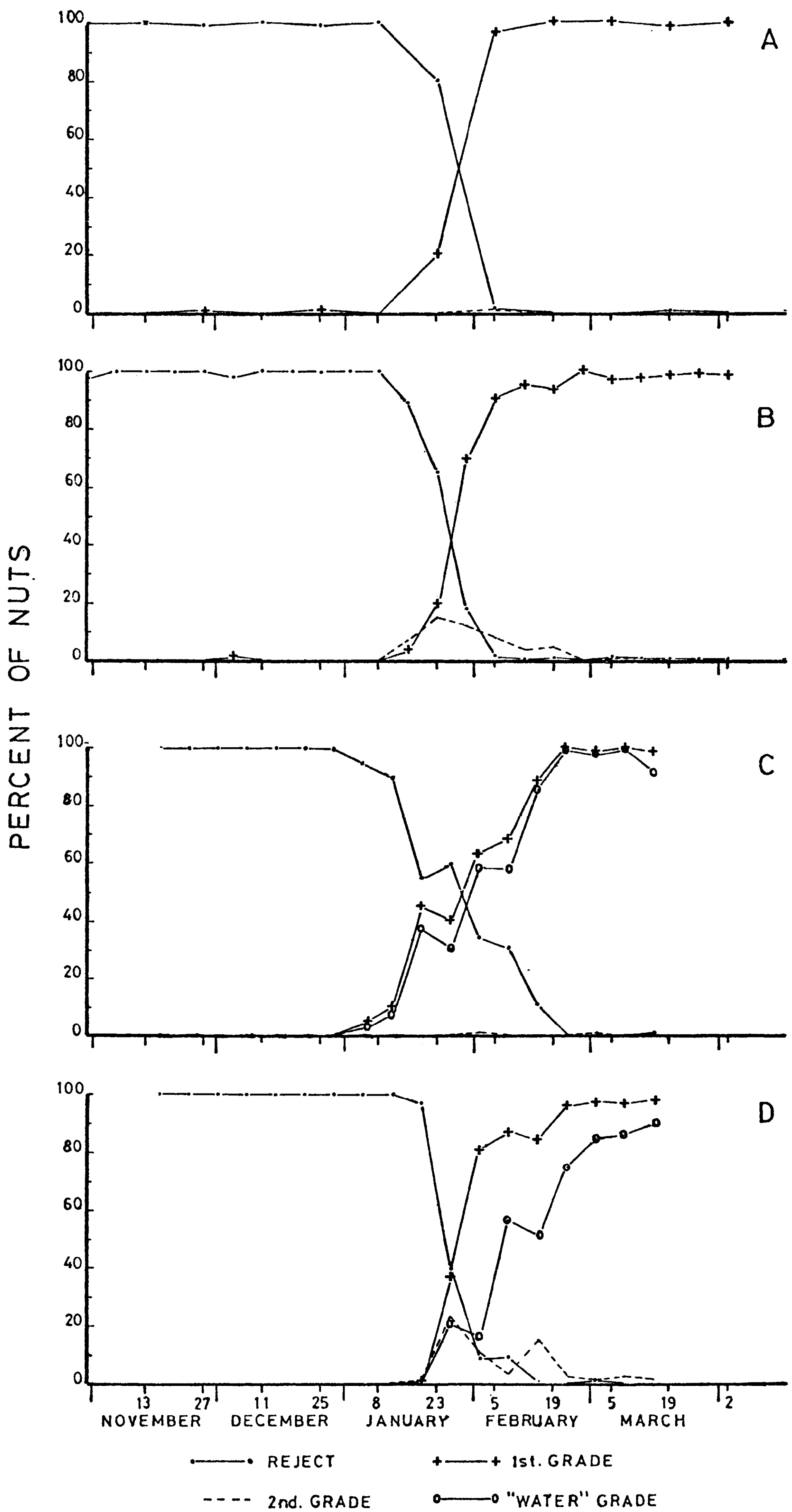


FIGURE 25

KERNEL QUALITY

Beerwah 1972-73. Percent of sampled nuts in each quality grade (both trees combined).



PERCENT OF NUTS
100
80
60
40
20
0
A
B
C
D
13
27
11
25
8
23
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
REJECT
1st. GRADE
2nd. GRADE
"WATER" GRADE

FIGURE 26

KERNEL QUALITY

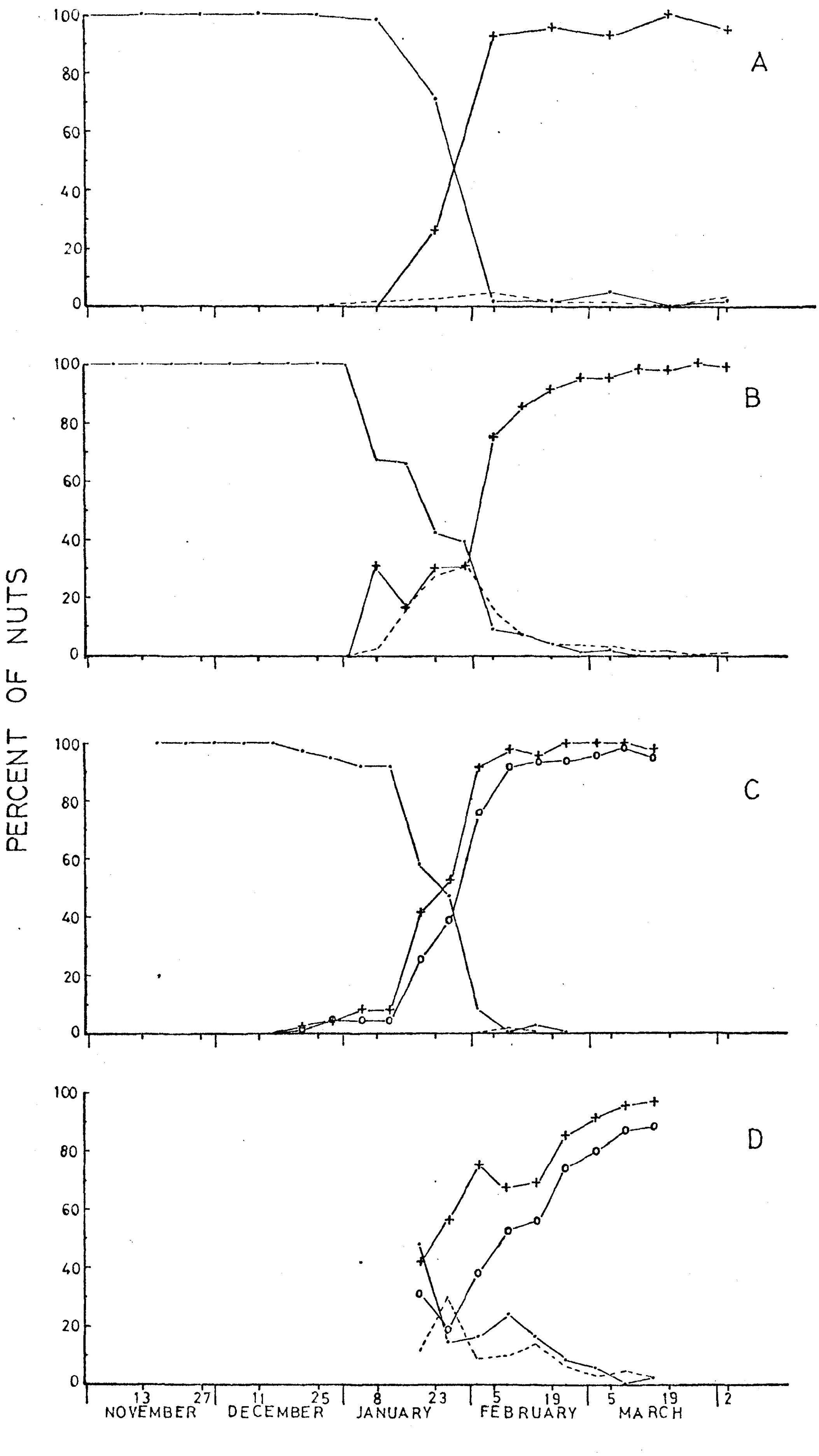
Aspley S1 1972-73, 1973-74. Percent of sampled nuts in each quality grade.

A. 1972-73 tree

B. 1972-73 ground

C. 1973-74 tree

D. 1973-74 ground



PERCENT OF NUTS
100
80
60
40
20
0
A
B
C
D
13
27
11
25
8
23
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
REJECT
1st. GRADE
2nd. GRADE
"WATER" GRADE

FIGURE 27

KERNEL QUALITY

Aspley H2 1972-73, 1973-74. Percent of sampled nuts in each quality grade.

A. 1972-73 tree

B. 1972-73 ground

C. 1973-74 tree

D. 1973-74 ground

TABLE 37

MAXIMUM POTENTIAL CROP

Site and year	Number of nuts	Date of occurrence
INALA 1971-72		
Armanasco (56 trees)	188,331	1.XII.71
Circus (68 trees)	42,019	1.XII.71
BEERWAH 1972-73		
Tree 146 (1 tree)	1,216	13.XII.72
Tree 194 (1 tree)	1,723	13.XII.72
ASPLEY 1971-72		
S1 (99 trees)	1,733	26.X.71
H2 (72 trees)	13,069	22.XII.71
ASPLEY 1972-73		
S1 (99 trees)	38,194	5.XII.72
H2 (72 trees)	87,211	19.XII.72
ASPLEY 1973-74		
S1 (99 trees)	42,484	14.XII.73
H2 (72 trees)	44,960	14.XII.73

TABLE 38

MACADAMIA CROP CHARACTERISTICS

Character	Time of Season Period 1	Period 2	Period 3
Nut size	increasing	stable	stable
Nut fall	high	low	high
Nut shell	soft	hard	hard
Maturity	immature	changing (a mixture)	mature
Time of year	late December		late February

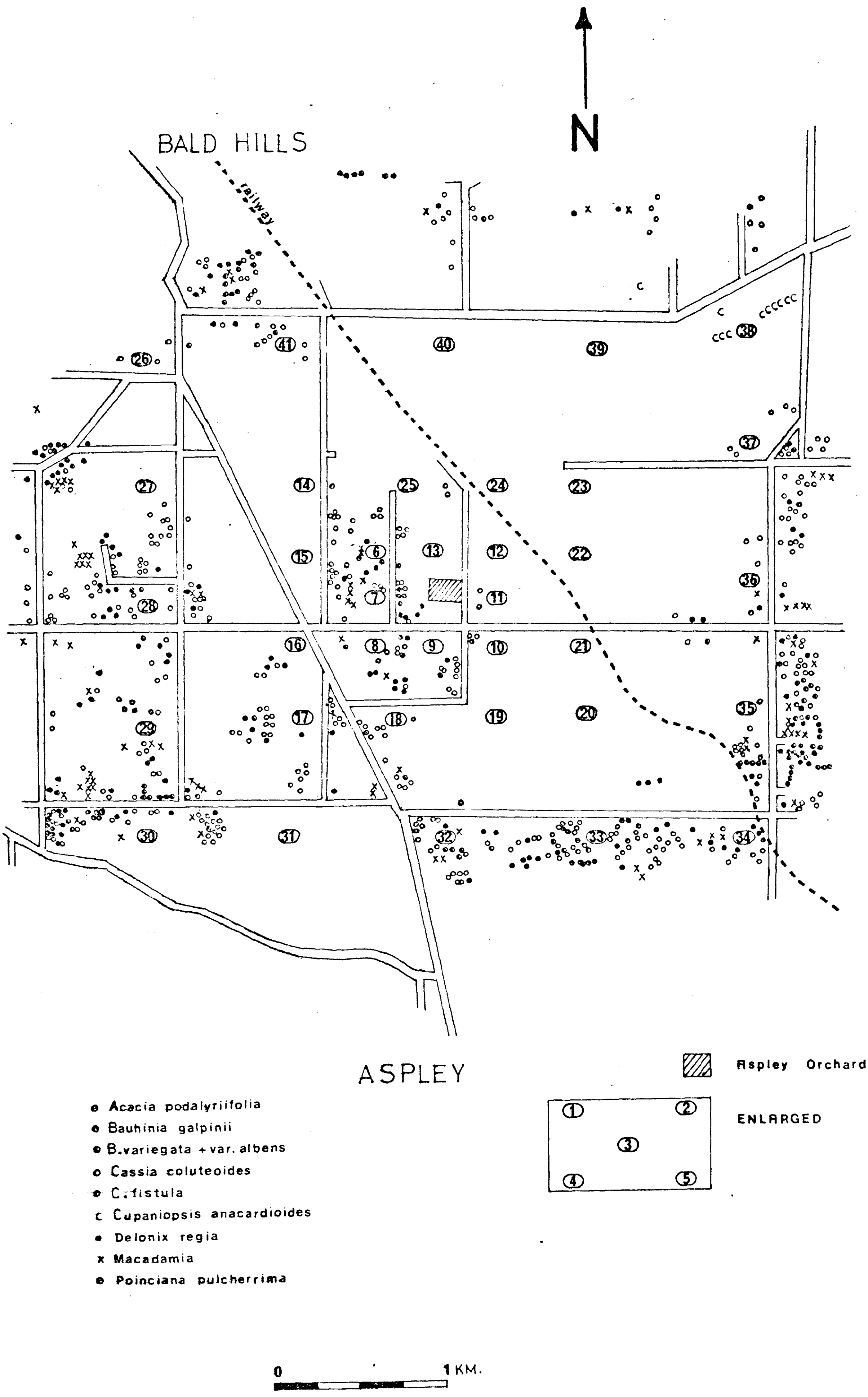

N
BALD HILLS
railway
ASPLEY
Aspley Orchard
ENLARGED
Acacia podalyriifolia
Bauhinia galpinii
B.variegata + var. albens
Cassia coluteoides
C. fistula
c Cupaniopsis anacardioides
Delonix regia
x Macadamia
Poinciana pulcherrima
0
1 KM.

FIGURE 28

ALTERNATIVE HOSTS

Species distribution of common *C. ombrodelta* hosts around the Aspley orchard.

ⓘ Male *C. ombrodelta* lure traps; to be discussed in Chapters 15 and 19.

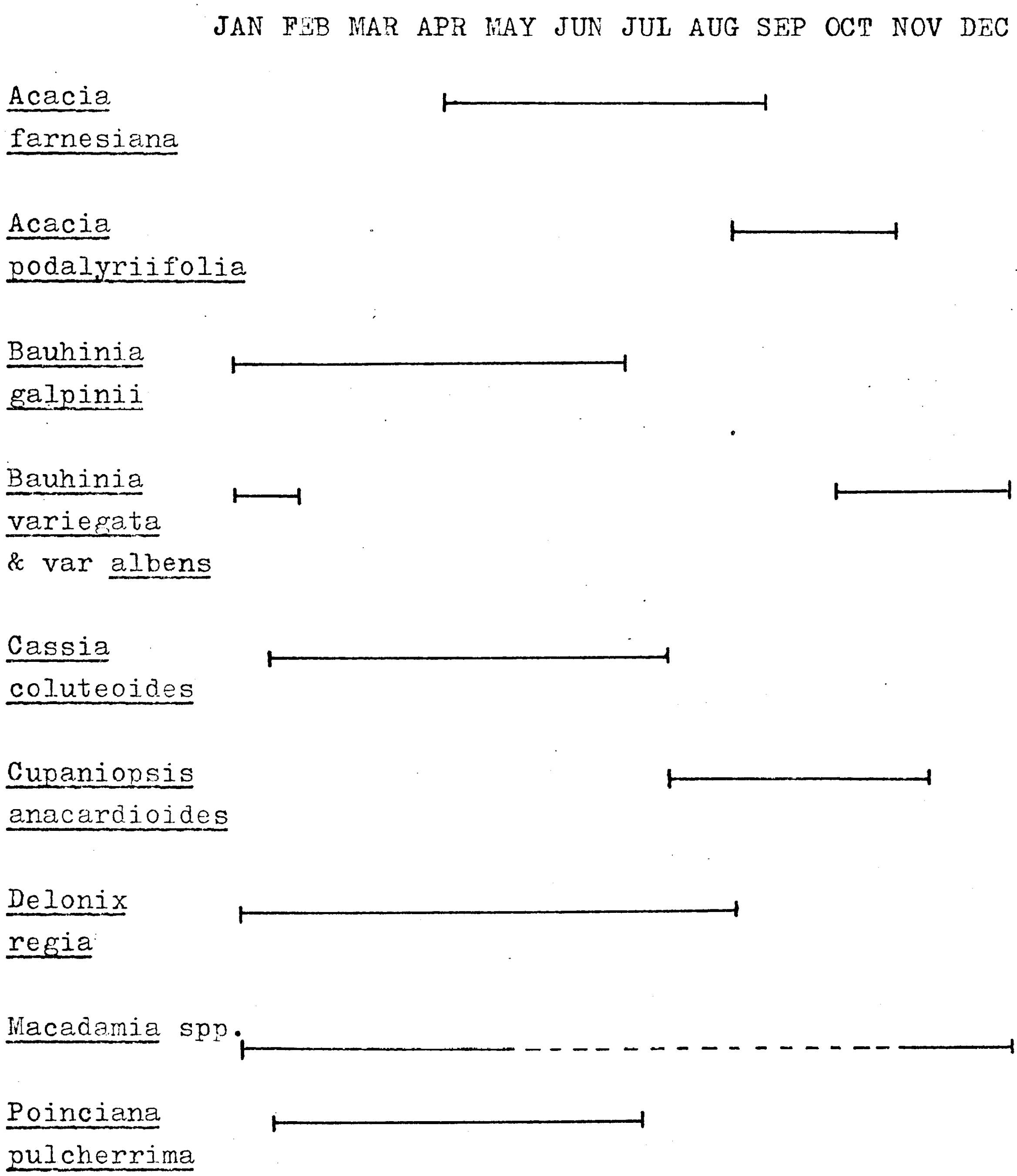

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Acacia farnesiana
Acacia podalyriifolia
Bauhinia galpinii
Bauhinia variegata & var albens
Cassia coluteoides
Cupaniopsis anacardioides
Delonix regia
Macadamia spp.
Poinciana pulcherrima

FIGURE 29

ALTERNATIVE HOSTS

The main fruiting periods of common hosts of *C. ombrodelta*.

├───┤ consistent fruiting

- - - - - sparse fruiting

a

b

FIGURE 30

ALTERNATIVE HOSTS

Acacia podalyriifolia, Cavendish-Cooke

a. The *Acacia* is the large tree with the light foliage. (The small bush in the foreground, covered with blossom is *Cassia coluteoides*.)

b. Shows foliage (left), pods infested with *U. robinsoni* (centre), and normal pods (right).

a

b

c

d

FIGURE 31

ALTERNATIVE HOSTS

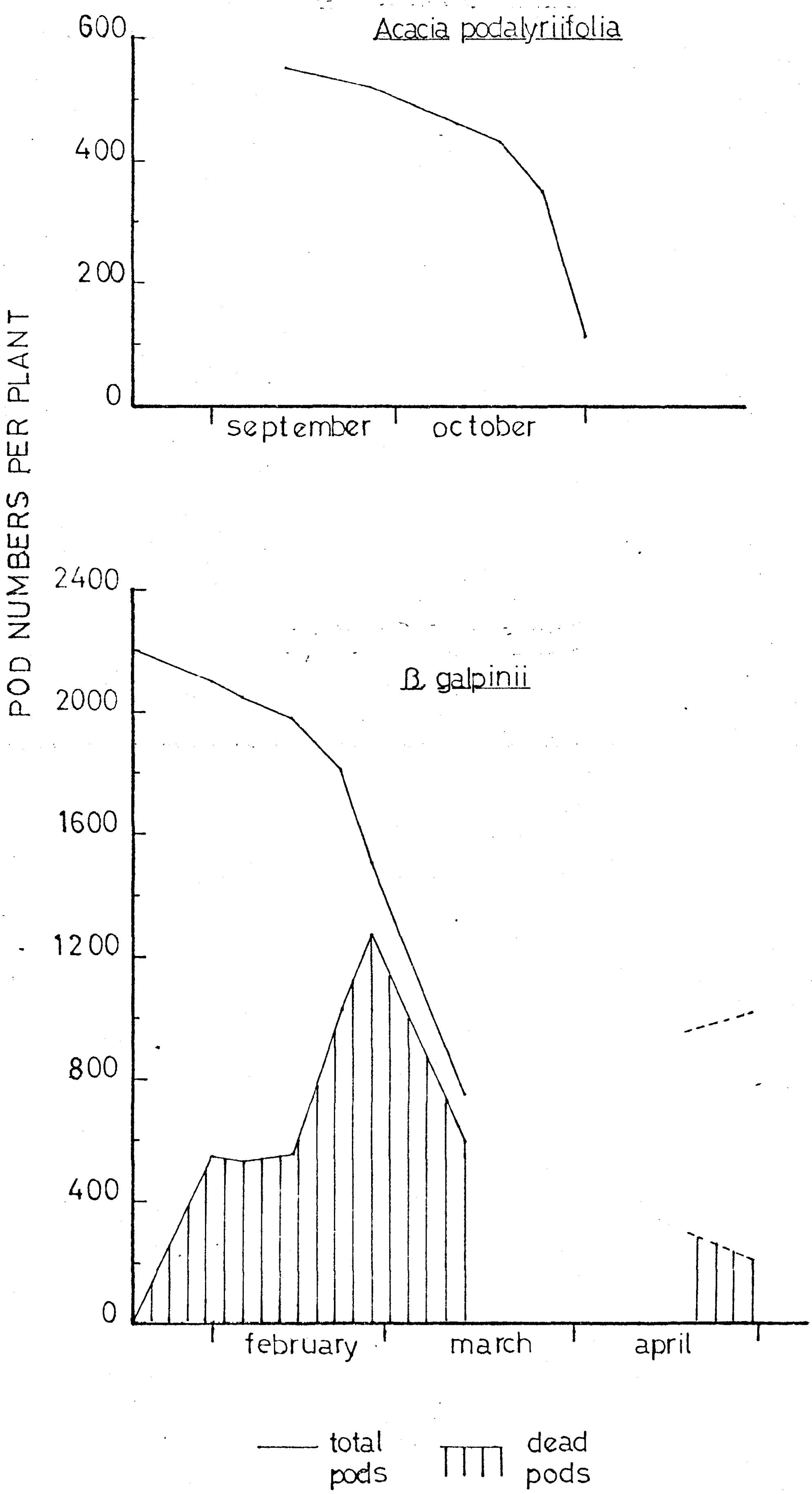
Bauhinia spp.

a *B. galpinii* - Aspley *Bauhinia*

b *B. galpinii* pods, that on the left is infested by *C. ombrodelta.*

c *B. variegata* pods, two pods in the foreground are infested by *C. ombrodelta*

d *B. variegata* - Grasspan Road

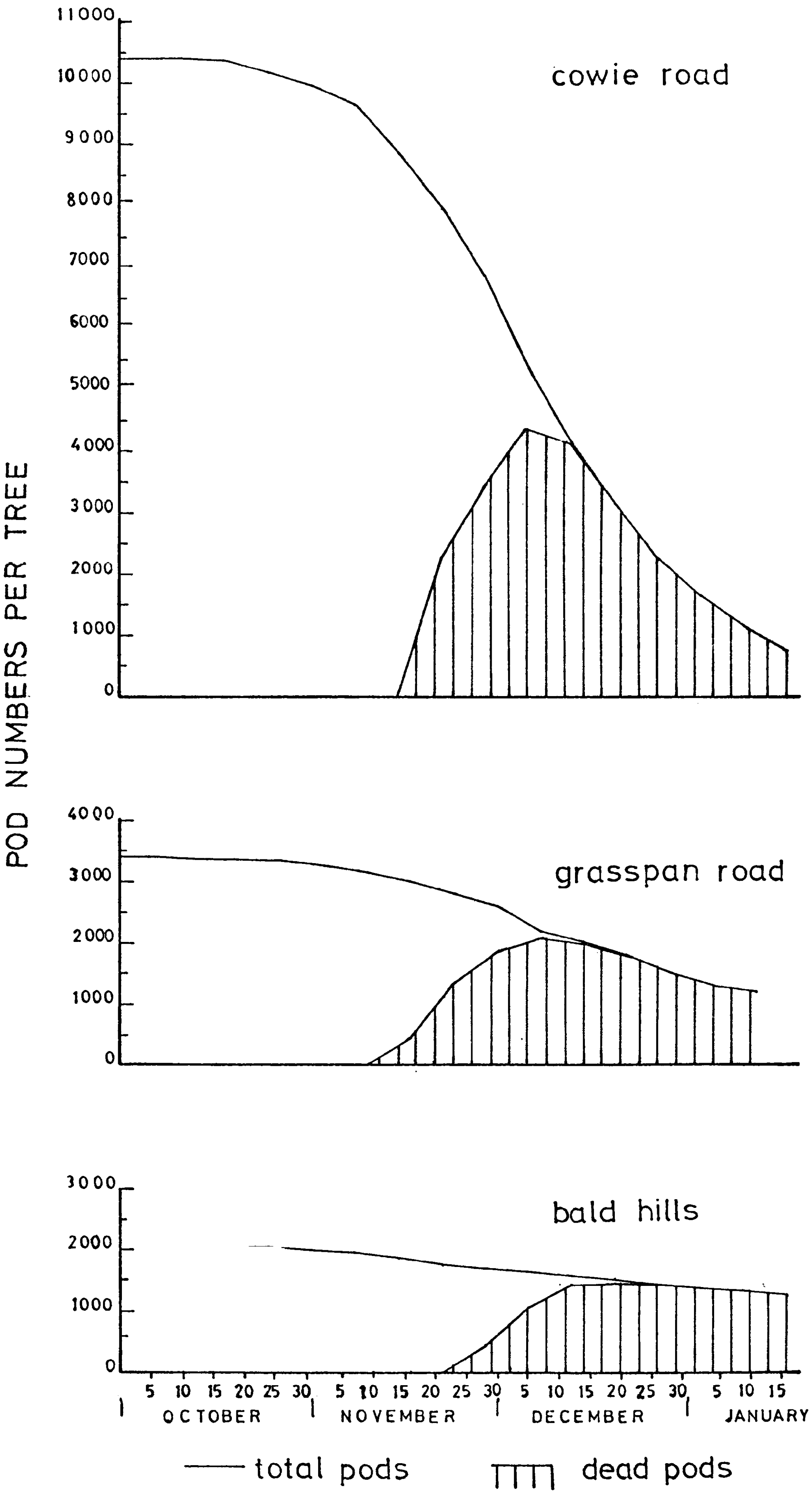


Acacia podalyriifolia
600
400
200
0
september
october
POD NUMBERS PER PLANT
2400
B. galpinii
2000
1600
1200
800
400
0
february
march
april
total pods
dead pods

FIGURE 32

ALTERNATIVE HOSTS

Pod estimates per plant, Cavendish-Cooke *Acacia* 1972 and Aspley *Bauhinia* 1972.



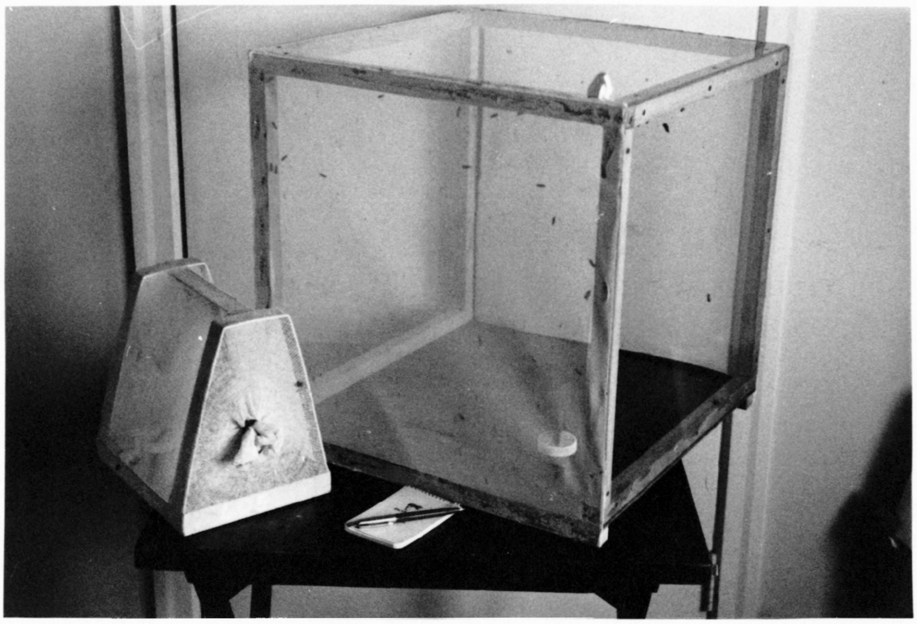
POD NUMBERS PER TREE
cowie road
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
grasspan road
4000
3000
2000
1000
0
bald hills
3000
2000
1000
0
5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25 30 5 10 15
OCTOBER
NOVEMBER
DECEMBER
JANUARY
total pods
dead pods

FIGURE 33

ALTERNATIVE HOSTS

Pod estimates per tree, Cowie Road, Grasspan Road and Bald Hills, 1972-73.

a



b

c

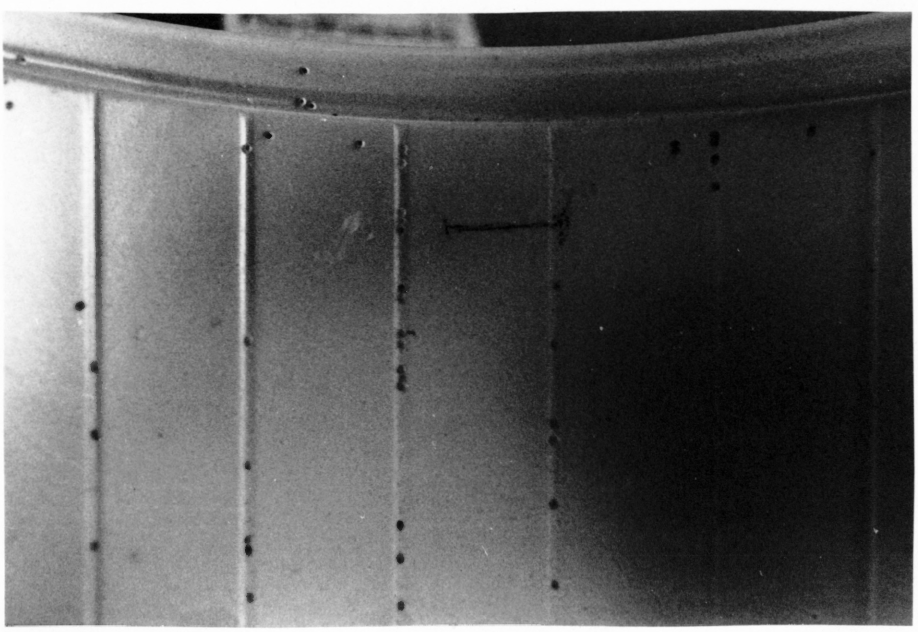


FIGURE 34

C. OMBRODELTA REARING

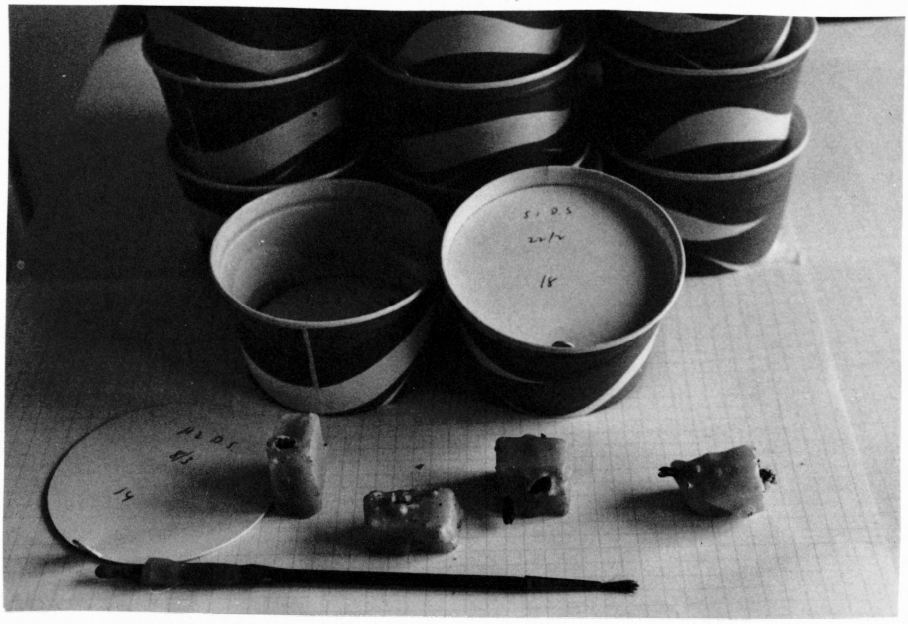
Mating and oviposition in the laboratory

The two types of mating cages

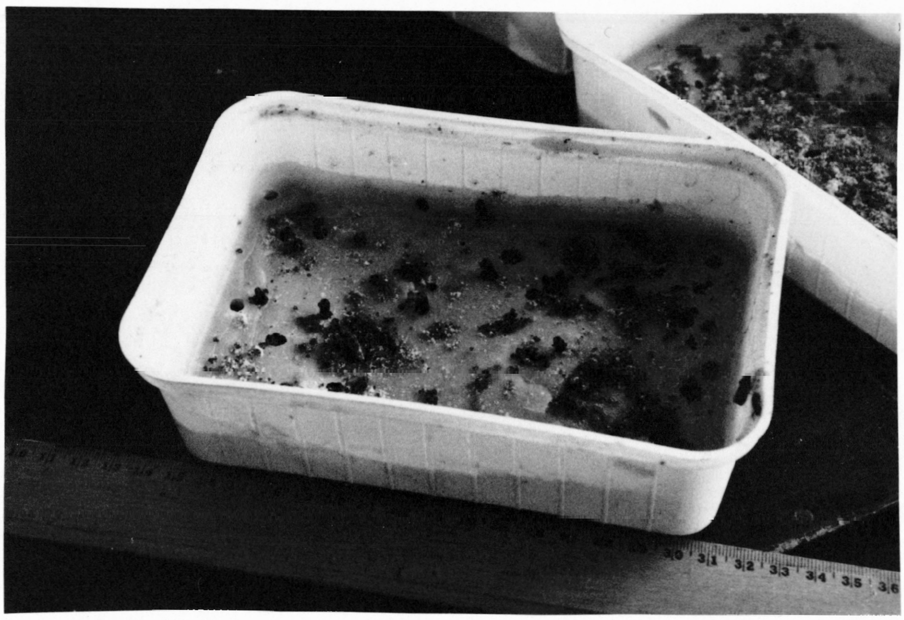
Oviposition cups

Section of an oviposition cup showing egg placement in the grooves.

a



b



c

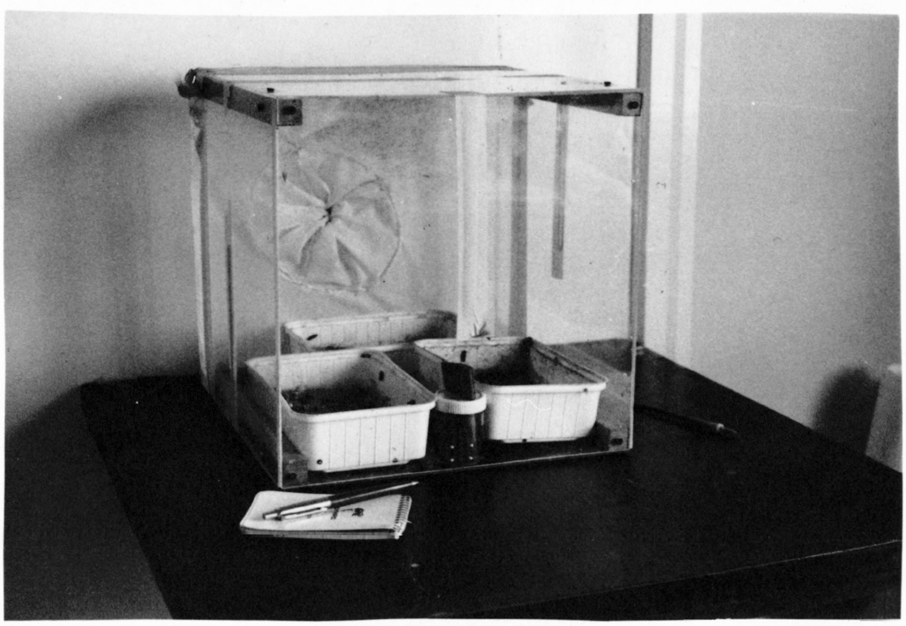


FIGURE 35

ARTIFICIAL MEDIUM REARING METHODS

C. ombrodelta larvae

a Showing S51S cups (in background) and waxed blocks. An empty pupal case is protruding from each of the two right hand blocks. A paint brush used to make the entrance holes is shown in foreground.

b Rearing trays showing wax covered medium with signs of feeding activity, and empty pupal cases. The scale is in centimetres.

c Rearing trays in an emergence cage.

TABLE 39

ARTIFICIAL MEDIUM REARING METHODS

Comparison of the waxed block and tray methods

	Waxed block	Tray
Unit numbers in comparison	100 blocks	7 trays
Mean larvae per unit	1	21.34 (±128.7)*
% larval acceptance of medium	**	87.5 (± 6.9)
Mean adult production per unit	0.88	40.3 (± 30.5)
Mean adult production per unit as a % of initial larval numbers	88	23.2 (± 16.6)
Mean preparation time per adult emerged (minutes)	3.75	0.87

* standard error(s)

** In the waxed blocks it is difficult to distinguish between death due to non acceptance of the medium, and death due to handling damage or other causes. Less than 5% of larvae die at a stage when diet non-acceptance could be the cause.

COMPUTER PROGRAMME HCAP

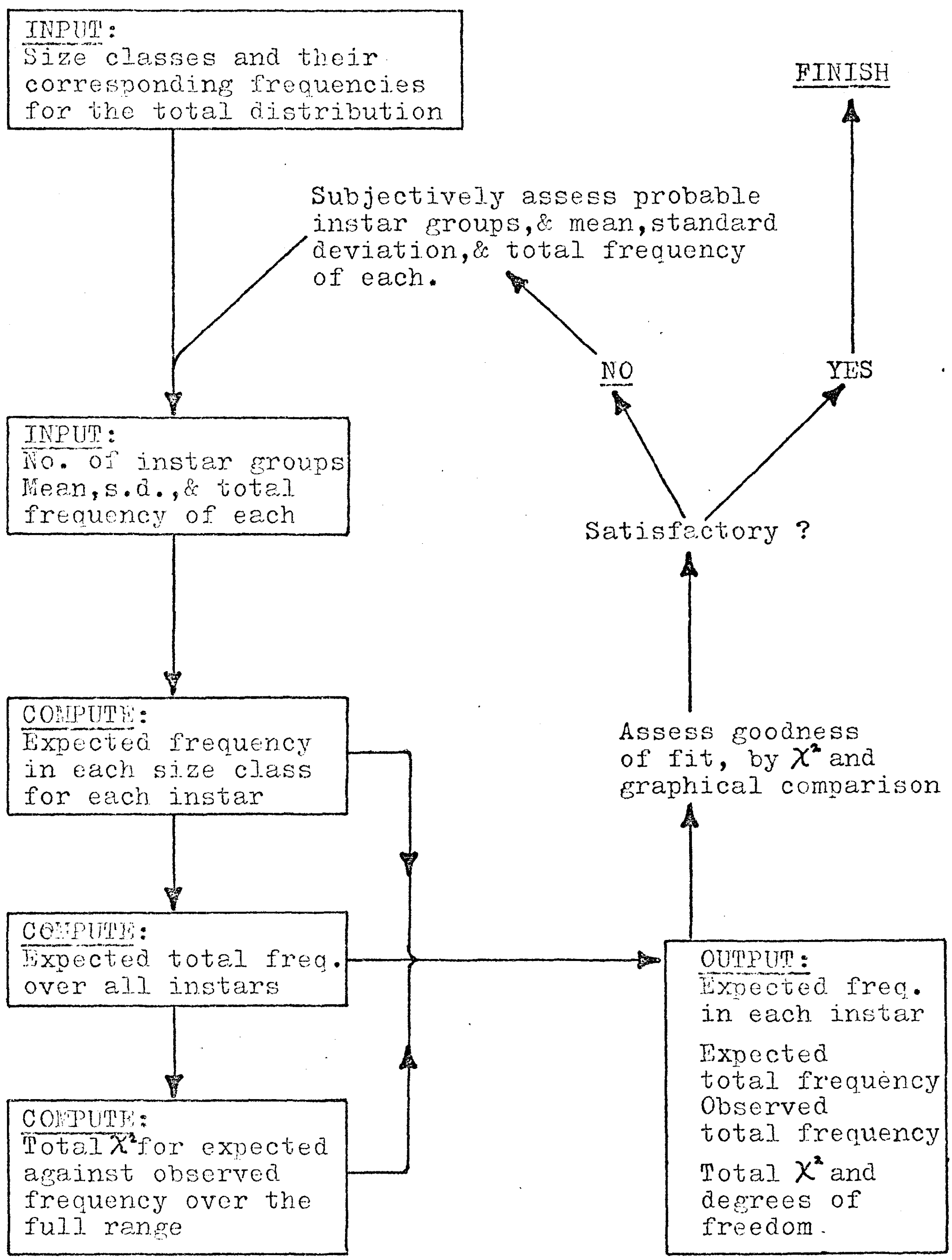


FIGURE 36

LARVAL HEAD CAPSULE WIDTH

Computer programme HCAP - flow chart of its operation.

The boxed areas indicate computer operations, operator assessments are not boxed.

TABLE 40

LARVAL HEAD CAPSULE WIDTH

Frequency distribution of laboratory reared larvae developing to prepupae.

Instar / Size class (mm)	1st of 5	1st of 6	2nd of 5	2nd of 6	3rd of 5	3rd of 6	4th of 5	4th of 6	5th of 5	5th of 6	6th of 6	TOTAL 5 Instars	TOTAL 6 Instars	Grand Total
< 0.299														
0.30 - 0.339	17											17		19
0.34 - 0.379	21											21		25
0.38 - 0.419														
0.42 - 0.459			1									1		1
0.46 - 0.499			22									22		24
0.50 - 0.539			19									19		22
0.54 - 0.579			4									4		4
0.58 - 0.619														
0.62 - 0.659												1		2
0.66 - 0.699					6							6		6
0.70 - 0.739					7							7		10
0.74 - 0.779					16							16		16
0.78 - 0.819					9							9		11
0.82 - 0.859					3							3		3
0.86 - 0.899												2		4
0.90 - 0.939												1		2
0.94 - 0.979												1		2
0.98 - 1.019														1
1.02 - 1.059							3					3		5
1.06 - 1.099							5					5		5
1.10 - 1.139							10					10		10
1.14 - 1.179							4					4		4
1.18 - 1.219							4					4		5
1.22 - 1.259							6					6		8
1.26 - 1.299							2					2		3
1.30 - 1.339							1							1
1.34 - 1.379														1
1.38 - 1.419														
1.42 - 1.459														1
1.46 - 1.499														1
1.50 - 1.539														1
1.54 - 1.579														
1.58 - 1.619														11
1.62 - 1.659														
1.66 - 1.699														
1.70 - 1.739														
1.74 - 1.779														
1.78 - 1.819														
1.82 - 1.859														
> 1.86														
TOTAL	38	[illegible]	46	[illegible]	43	[illegible]	38	[illegible]	1[illegible]	[illegible]	[illegible]	182		
MEAN WIDTH	0.338	0.343	0.499	0.500	0.754	0.729	1.134	0.943	1.591	1.223	1.756			
STANDARD DEVIATION	0.020	0.022	0.028	0.022	0.052	0.060	0.097	0.066	0.068	0.106	0.057			

TABLE 41

LARVAL HEAD CAPSULE WIDTH

Laboratory reared larvae; tests of geometric and linear increase between instars.

Instar	Observed mean	Ratio of increase	Calculated mean using ratio of increase	% deviation	Calculated mean using linear reg.	% deviation[1]
A. Larvae becoming prepupae after 5 instars						
1	0.338		-	-	0.211	-37.6
		1.476				
	0.499		0.498	-0.2	0.537	7.6
		1.507				
	0.752		0.734	-2.4	0.863	14.7
		1.508				
	1.134		1.082	-4.6	1.198	5.6
		1.403				
	1.591		1.596	0.3	1.524	-4.2
	mean ratio	1.474				
B. Larvae becoming prepupae after 6 instars						
1	0.343		-	-	0.208	-39.4
		1.458				
	0.500		0.476	-4.8	0.491	-1.8
		1.458				
	0.729		0.662	-9.2	0.774	6.2
		1.294				
	0.943		0.919	-2.5	1.057	12.1
		1.297				
	1.223		1.277	4.4	1.340	9.6
		1.436				
	1.756		1.773	1.0	1.623	-7.6
	mean ratio	1.389				

[1] $\left(\frac{\text{calculated mean head capsule width}}{\text{observed mean head capsule width}} \times 100\right)$ %

TABLE 42

LARVAL HEAD CAPSULE WIDTH

Laboratory reared larvae; interpretation of mean increase for five and six instar series.

	5 instar series				6 instar series			
Instar	Observed mean mm	Ratio of increase	Calc. mean	% deviation	Observed mean mm	Ratio of increase	Calc. mean	% deviation
1	0.339		-	-	0.339		-	-
		1.472				1.472		
2	0.499		0.499	0	0.499		0.499	0
		1.501				1.501		
3	0.749		0.735	-1.9	0.749		0.735	-1.9
		1.514				1.259		
4	1.134		1.082	-4.6	0.943		0.978	3.7
		1.403				1.633		
5	1.591		1.594	0.2	1.223		1.302	6.5
						1.436		
6					1.756		1.733	-1.3
	mean ratio	1.472			mean ratio 1st-3rd	1.472		
					mean ratio 3rd-6th	1.331		

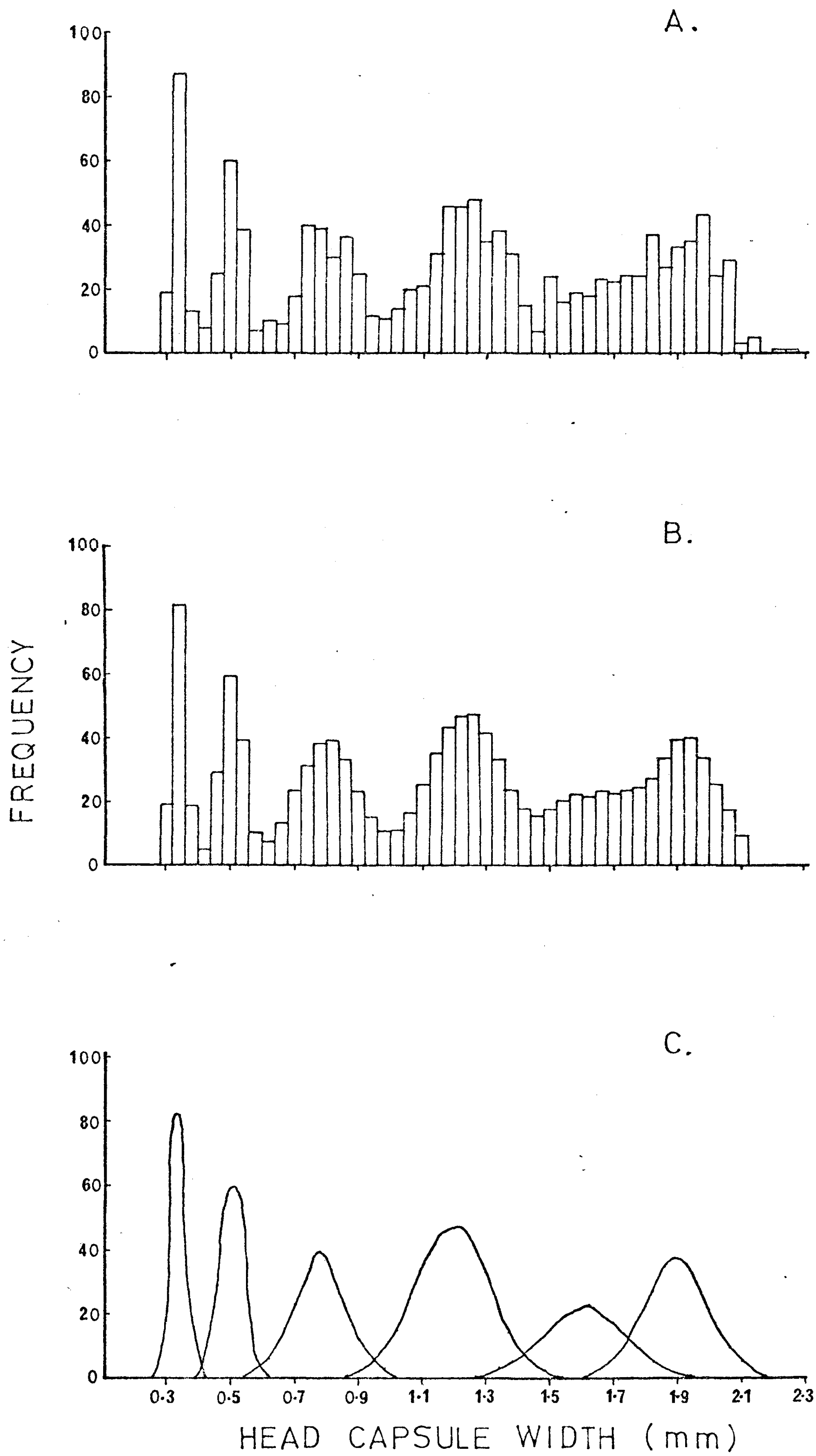

A.
B.
C.
FREQUENCY
100
80
60
40
20
0
0·3
0·5
0·7
0·9
1·1
1·3
1·5
1·7
1·9
2·1
2·3
HEAD CAPSULE WIDTH (mm)

FIGURE 37

LARVAL HEAD CAPSULE WIDTH

1971-72, all field data. Results of the manual analysis.

A. Observed frequency distribution

B. Calculated frequency distribution

C. Calculated component normal distributions

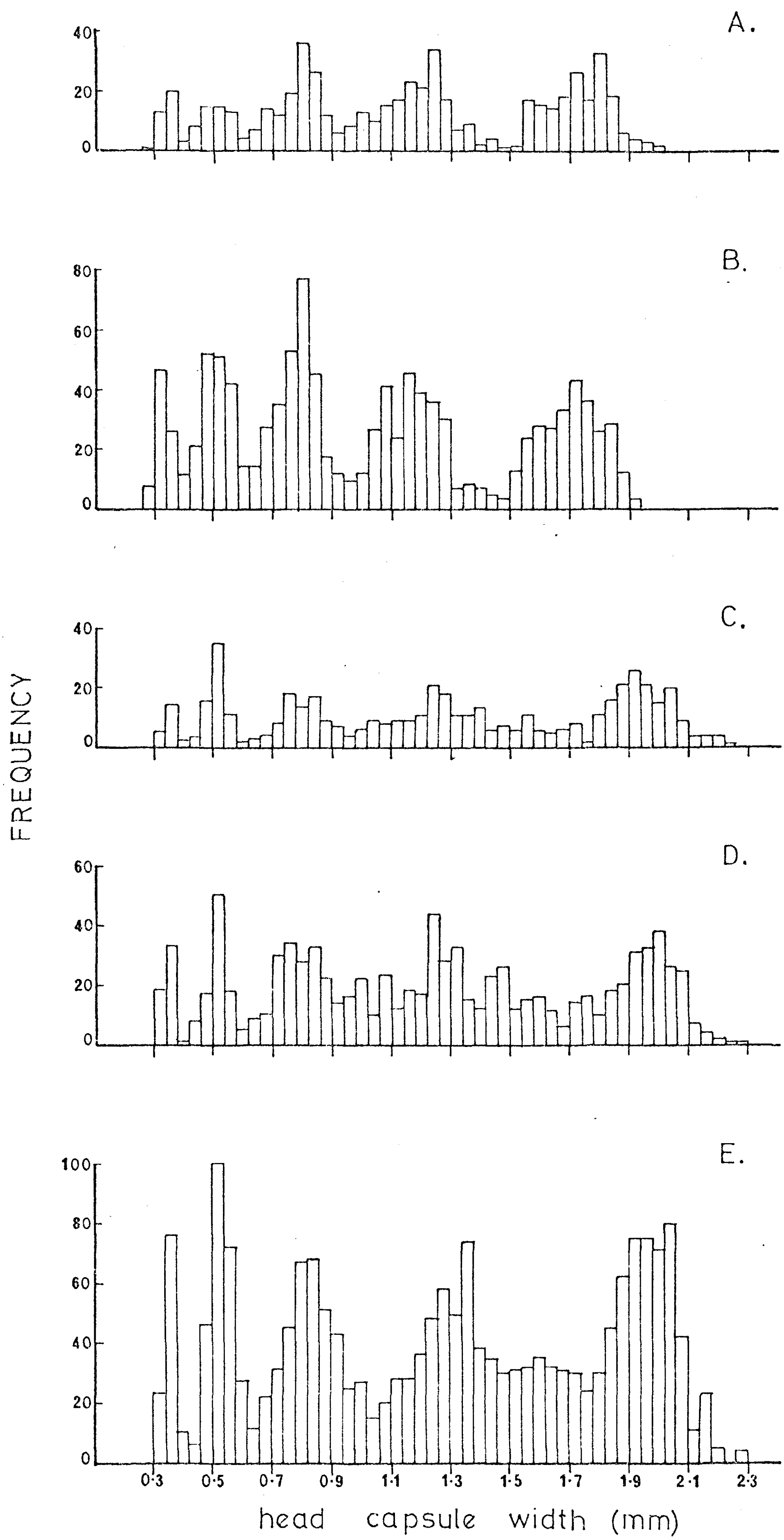

A.
B.
C.
D.
E.
FREQUENCY
0
20
40
60
80
100
0·3
0·5
0·7
0·9
1·1
1·3
1·5
1·7
1·9
2·1
2·3
head capsule width (mm)

FIGURE 38

LARVAL HEAD CAPSULE WIDTH

1972-73 field data. Observed frequency distributions.

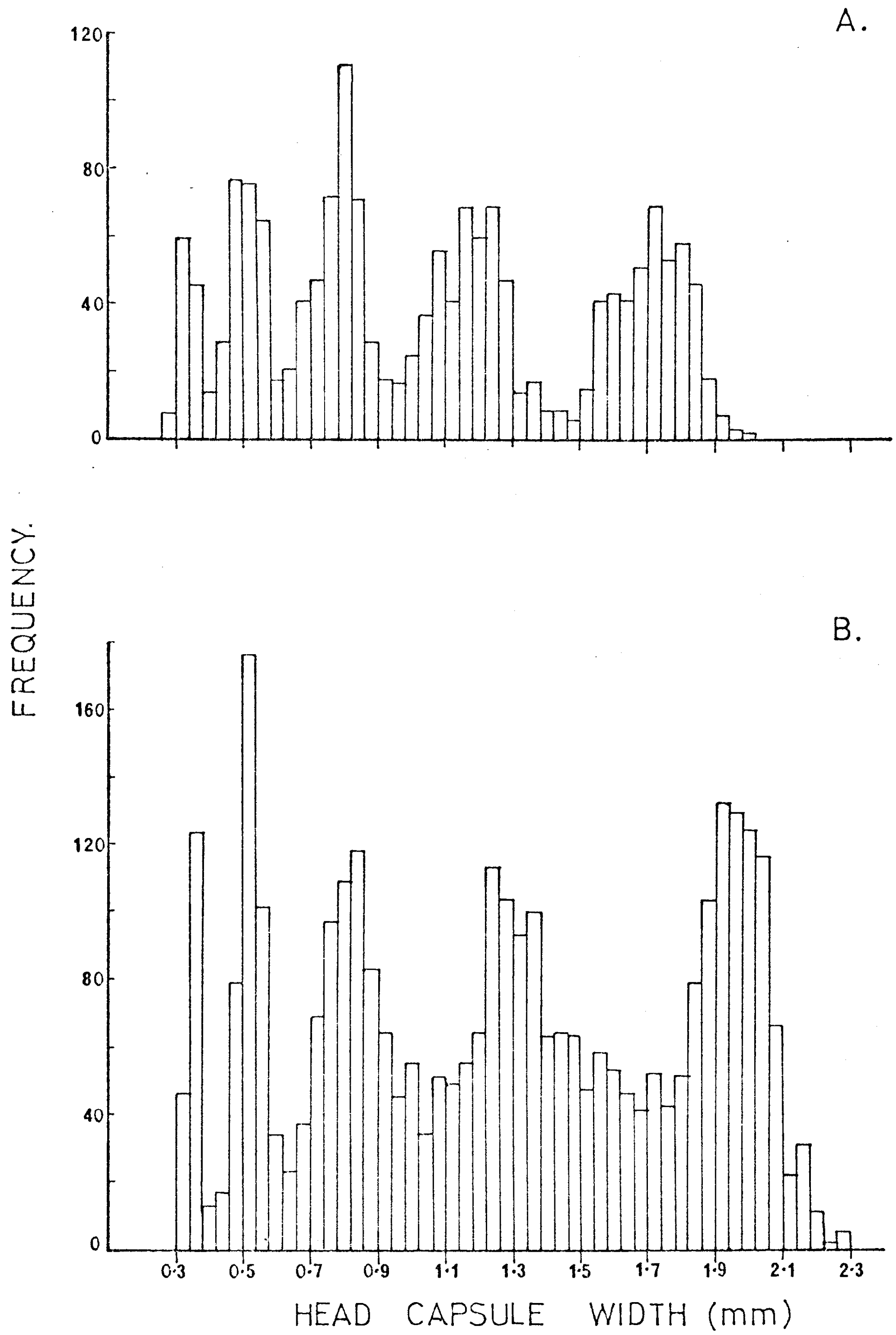
A. Grasspan Road and Bald Hills (*B. variegata*) and Cavendish-Cooke (*Acacia*) combined.

B. Cowie Road (*B. variegata*).

C. Aspley H2 (macadamia).

D. Aspley S1 (macadamia).

E. Beerwah, both trees combined (macadamia).



A.
B.
FREQUENCY.
120
80
40
0
160
120
80
40
0
0·3
0·5
0·7
0·9
1·1
1·3
1·5
1·7
1·9
2·1
2·3
HEAD CAPSULE WIDTH (mm)

FIGURE 39

LARVAL HEAD CAPSULE WIDTH

1972-73 field data. Observed frequency distributions for *C. ombrodelta* - combined for alternative hosts, and macadamia.

A. Alternative hosts

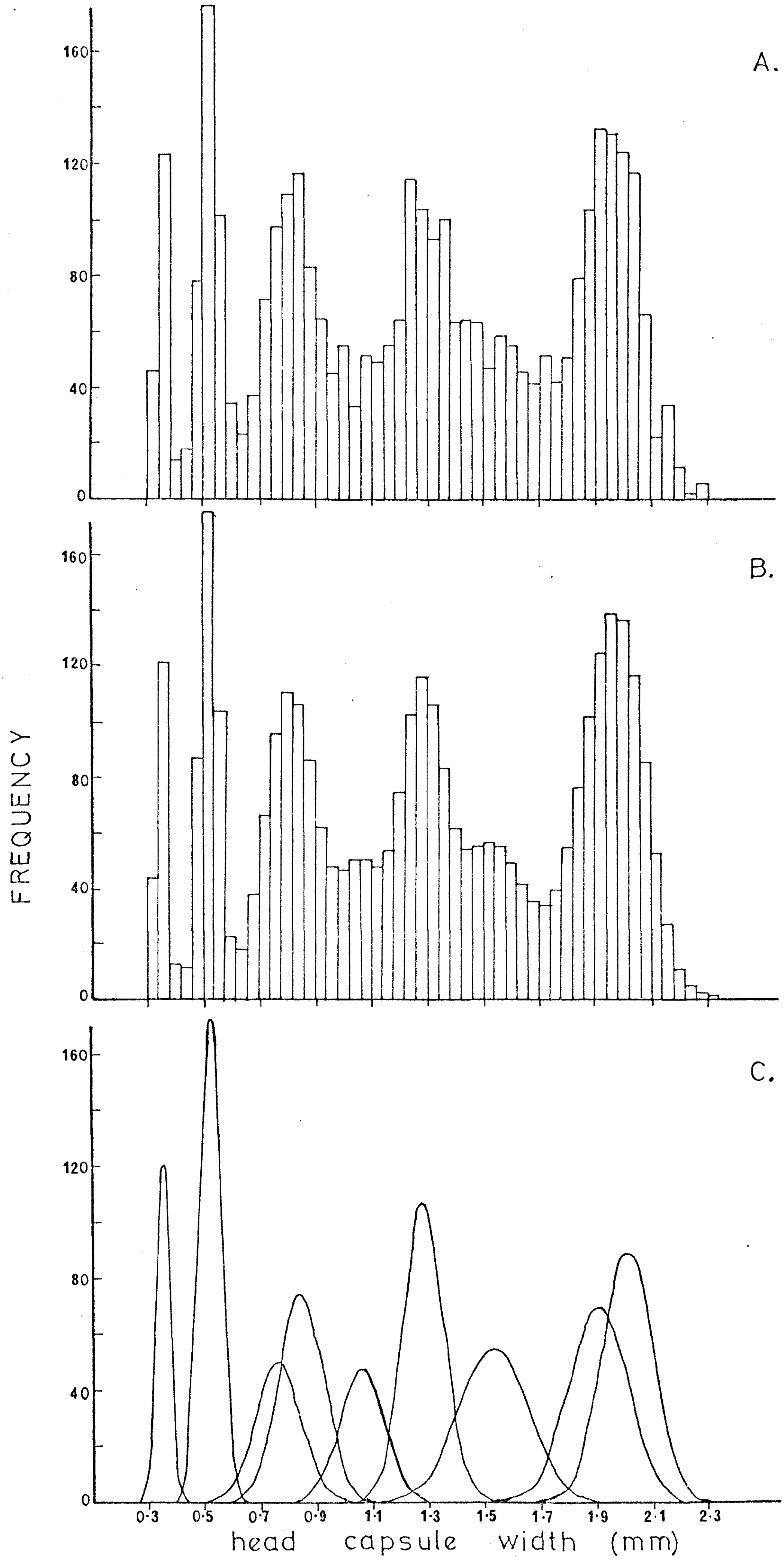
B. Macadamia

TABLE 43

LARVAL HEAD CAPSULE WIDTH

Field data 1971-72. Calculated instar parameters from manual analysis.

Instar	Mean mm	Standard deviation	No. of individuals
1st	0.340	0.020	119
2nd	0.505	0.035	138
3rd	0.800	0.093	229
4th	1.235	0.115	345
5th	1.650	0.128	177
6th	1.935	0.098	228
TOTAL			1,236



A.
B.
C.
FREQUENCY
0
40
80
120
160
0·3
0·5
0·7
0·9
1·1
1·3
1·5
1·7
1·9
2·1
2·3
head capsule width (mm)

FIGURE 40

LARVAL HEAD CAPSULE WIDTH

Macadamia data 1972-73, computer analysis

A. Observed frequency distribution

B. Calculated frequency distribution

C. Calculated component normal distributions

TABLE 44

LARVAL HEAD CAPSULE WIDTH

Macadamia data 1972-73. Calculated distribution parameters from computer analysis.

Distribution	Mean mm	Standard deviation	No. of individuals
	0.3525	0.0189	180
	0.5227	0.0341	395
	0.7600	0.0760	244
	0.8410	0.0775	368
	1.0600	0.0820	250
	1.2790	0.0735	500
	1.5300	0.1250	440
8	1.9050	0.1050	463
9	2.0100	0.0900	513
			3,353

TABLE 45

LARVAL HEAD CAPSULE WIDTH

Macadamia data 1972-73. Chi-square comparison of calculated distribution with observed distribution.

Size class mid point mm	Observed frequency	Calculated frequency	Chi-square
0.26	0	0.49)	0.001
0.30	46	45.26)	
0.34	123	121.14	0.028
0.38	13	13.59	0.025
0.42	17	12.55	1.575
0.46	79	86.90	0.718
0.50	176	174.69	0.010
0.54	101	104.35	0.107
0.58	34	23.96	4.208
0.62	23	18.61	1.033
0.66	37	38.56	0.064
0.70	69	67.00	0.060
0.74	97	94.64	0.059
0.78	109	109.94	0.008
0.82	118	105.82	1.402
0.86	83	85.73	0.087
0.90	64	62.43	0.039
0.94	45	48.62	0.270
0.98	55	47.11	1.323
1.02	33	50.48	6.051
1.06	51	50.60	0.003
1.10	49	48.39	0.008
1.14	55	53.83	0.025
1.18	64	74.34	1.439
1.22	113	101.89	1.212
1.26	104	116.33	1.307
1.30	93	106.28	1.660
1.34	100	81.72	4.088
1.38	63	61.31	0.046
1.42	64	53.58	2.026
1.46	63	54.48	1.333
1.50	47	56.41	1.570
1.54	58	54.78	0.189
1.58	55	48.97	0.741
1.62	46	41.13	0.576
1.66	41	34.75	1.124
1.70	52	33.43	10.317
1.74	42	39.73	0.129
1.78	51	54.41	0.214
1.82	79	76.13	0.108
1.86	103	101.49	0.023
1.90	132	124.86	0.409
1.94	129	138.75	0.684
1.98	124	136.40	1.127
2.02	116	116.34	0.001
2.06	66	84.74	4.143
2.10	22	52.09	17.378
2.14	31	26.81	0.656
2.18	11	11.49	0.021
2.22	2	4.09)	
2.26	5	1.21)	0.317
2.30	0	0.37)	
	3,353	3,353.00	69.942 with 30 df

TABLE 46

LARVAL HEAD CAPSULE WIDTH

Macadamia data 1972-73. Interpretation of instar series.

Instar	5 instar series: Mean head capsule size mm	Ratio of increase	Expected mean	% deviation	6 instar series: Mean head capsule size mm	Ratio of increase	Expected mean	% deviation
	0.3525				0.3525			
		1.483						
	0.5227		0.538	2.9	0.5227		0.538	2.9
		1.547						
	0.8087		0.820	1.4	0.8087		0.820	1.4
		1.582				1.311		
	1.279		1.251	-2.2	1.060		1.112	4.9
		1.489				1.443		
	1.905		1.908	0.2	1.530		1.508	-1.4
						1.314		
					2.010		2.045	1.7
	mean ratio	1.525			mean ratio 1st-3rd	1.525		
					mean ratio 3rd-6th	1.356		

TABLE 47

LARVAL HEAD CAPSULE WIDTH

Macadamia data 1972-73. Division of instars into age groups.

Age group	Dividing points mm	% data included
1st instar		99.93
	0.4134	
2nd instar		98.27
	0.5955	
3rd instar		94.13
	0.9490	
4th, 4A instars		89.74
	1.3723	
5A instar		84.36
	1.7330	
Final instars		97.55

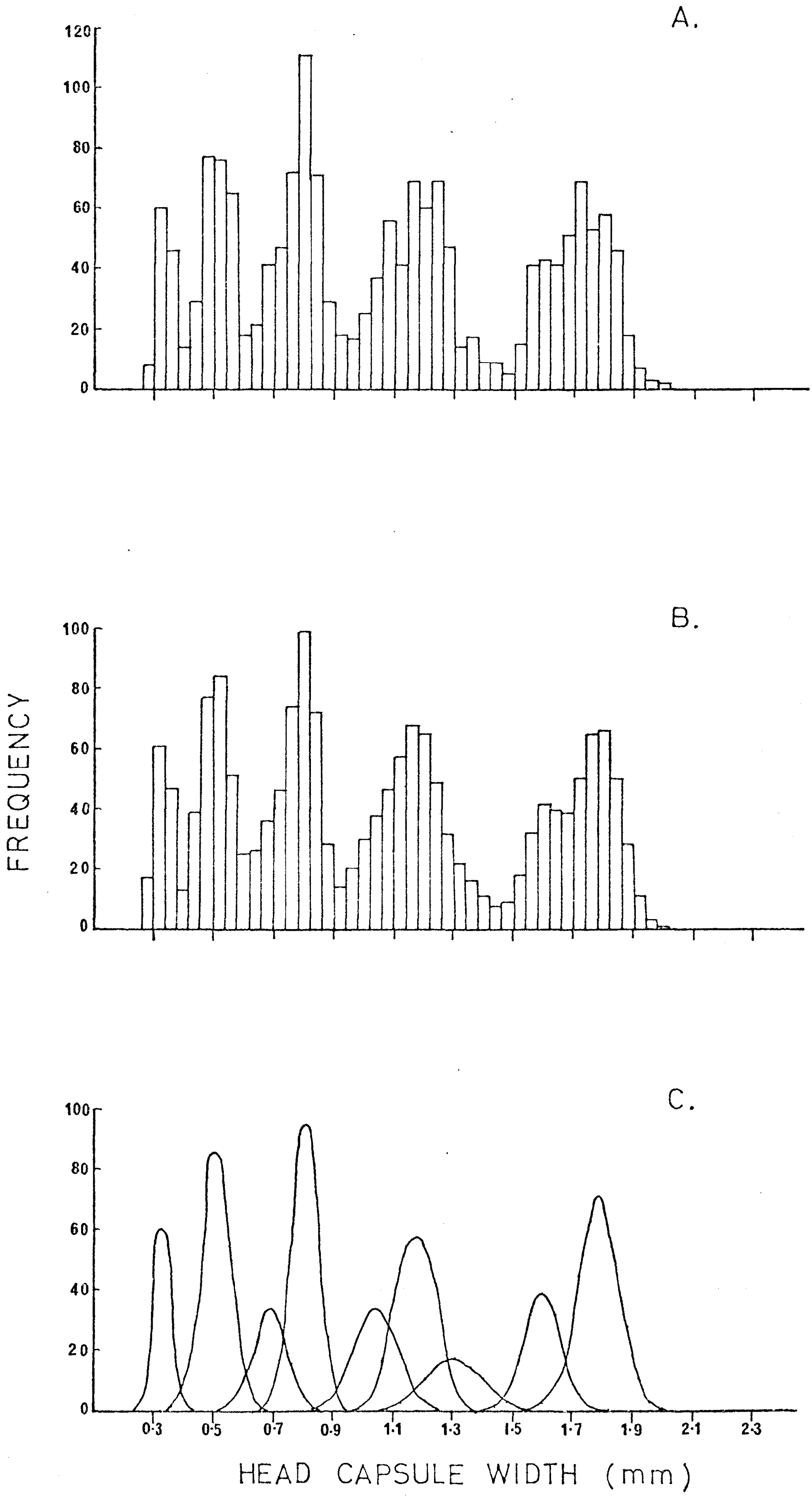

A.
B.
C.
FREQUENCY
0
20
40
60
80
100
120
0·3
0·5
0·7
0·9
1·1
1·3
1·5
1·7
1·9
2·1
2·3
HEAD CAPSULE WIDTH (mm)

FIGURE 41

LARVAL HEAD CAPSULE WIDTH

Alternative host data 1972-73, computer analysis

A. Observed frequency distribution

B. Calculated frequency distribution

C. Calculated component normal distributions

TABLE 48

LARVAL HEAD CAPSULE WIDTH

Alternative host data 1972-73. Calculated distribution parameters from computer analysis.

Distribution	Mean mm	Standard deviation	No. of individuals
	0.3350	0.0230	115
	0.5055	0.0500	280
	0.6900	0.0550	120
	0.8050	0.0440	270
	1.0400	0.0750	160
	1.1800	0.0625	230
	1.3200	0.0850	90
	1.6000	0.0600	150
	1.7850	0.0700	300
			1,715

TABLE 49

LARVAL HEAD CAPSULE WIDTH

Alternative host data 1972-73. Interpretation of instar series.

	5 instar series				6 instar series			
Instar	Mean head capsule size mm	Ratio of increase	Expected mean	% deviation	Mean head capsule size mm	Ratio of increase	Expected mean	% deviation
1	0.3350		-	-	0.3350		-	-
		1.5090						
2	0.5055		0.4959	-1.9	0.5055		0.4959	-1.9
		1.5232						
3	0.7700		0.7340	-4.7	0.7700		0.7340	-4.7
		1.5325				1.3506		
4	1.1800		1.0865	-7.9	1.0400		0.9718	-6.6
		1.3559				1.2692		
5	1.6000		1.6082	0.5	1.3200		1.2867	-2.5
						1.3523		
6					1.7850		1.7036	-4.6
		mean ratio	1.4802	mean ratio 1st-3rd		1.4802		
				mean ratio 3rd-6th		1.3240		

TABLE 50

LARVAL HEAD CAPSULE WIDTH

Alternative host data 1972-73. Division of instars into age groups.

Age group	Dividing points mm	% data included
1st instar		99.03
	0.389	
2nd instar		95.02
	0.593	
3rd instar		97.14
	0.892	
4th, 4A, and 5A instars		98.68
	1.484	
Final instars		99.11

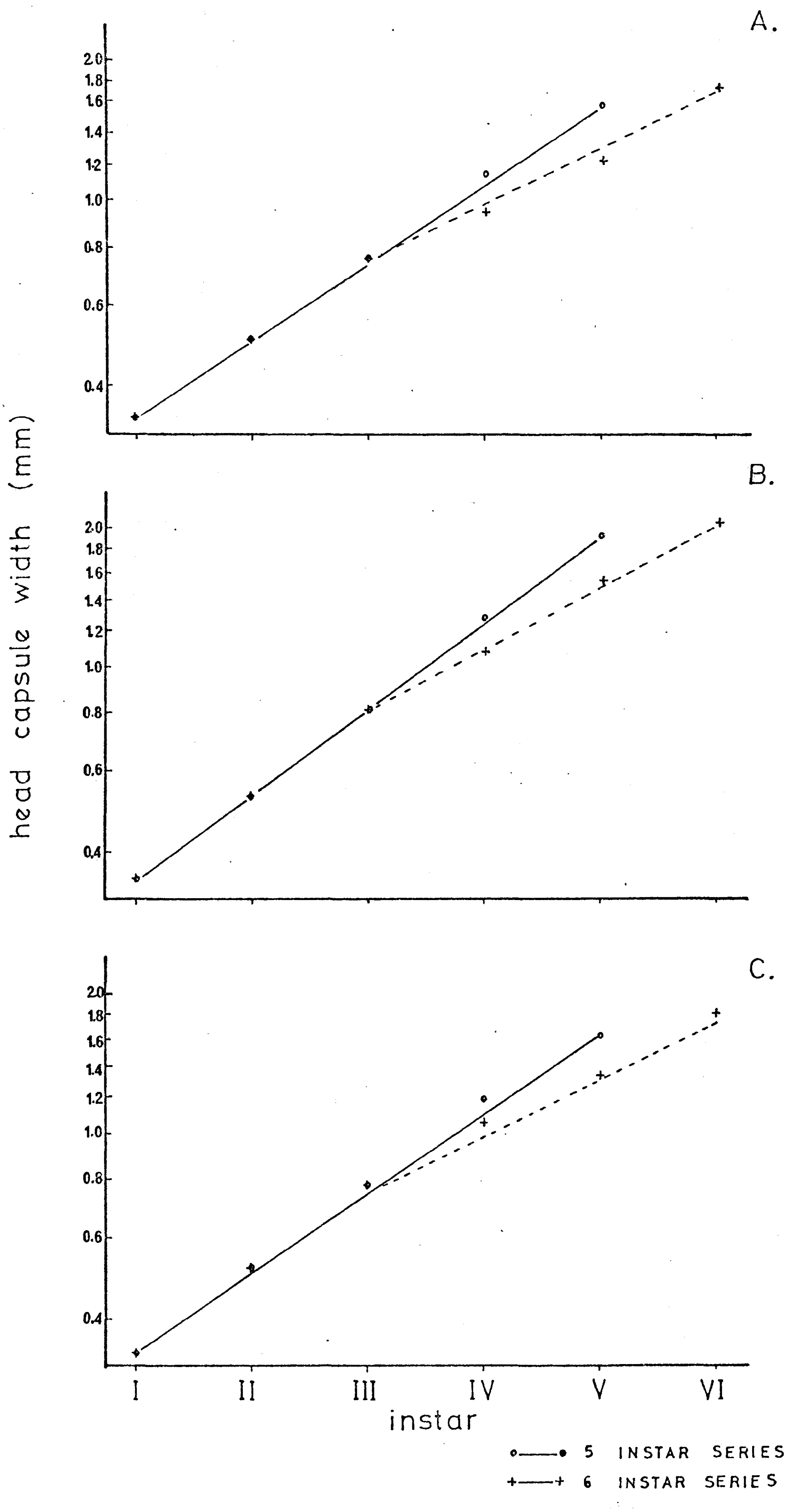

A.
B.
C.
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
head capsule width (mm)
I
II
III
IV
V
VI
instar
5 INSTAR SERIES
6 INSTAR SERIES

FIGURE 42

LARVAL HEAD CAPSULE WIDTH

Summary of the interpretation of geometric increase between *C. ombrodelta* instars.

A. Laboratory data

B. Macadamia data

C. Alternative host data

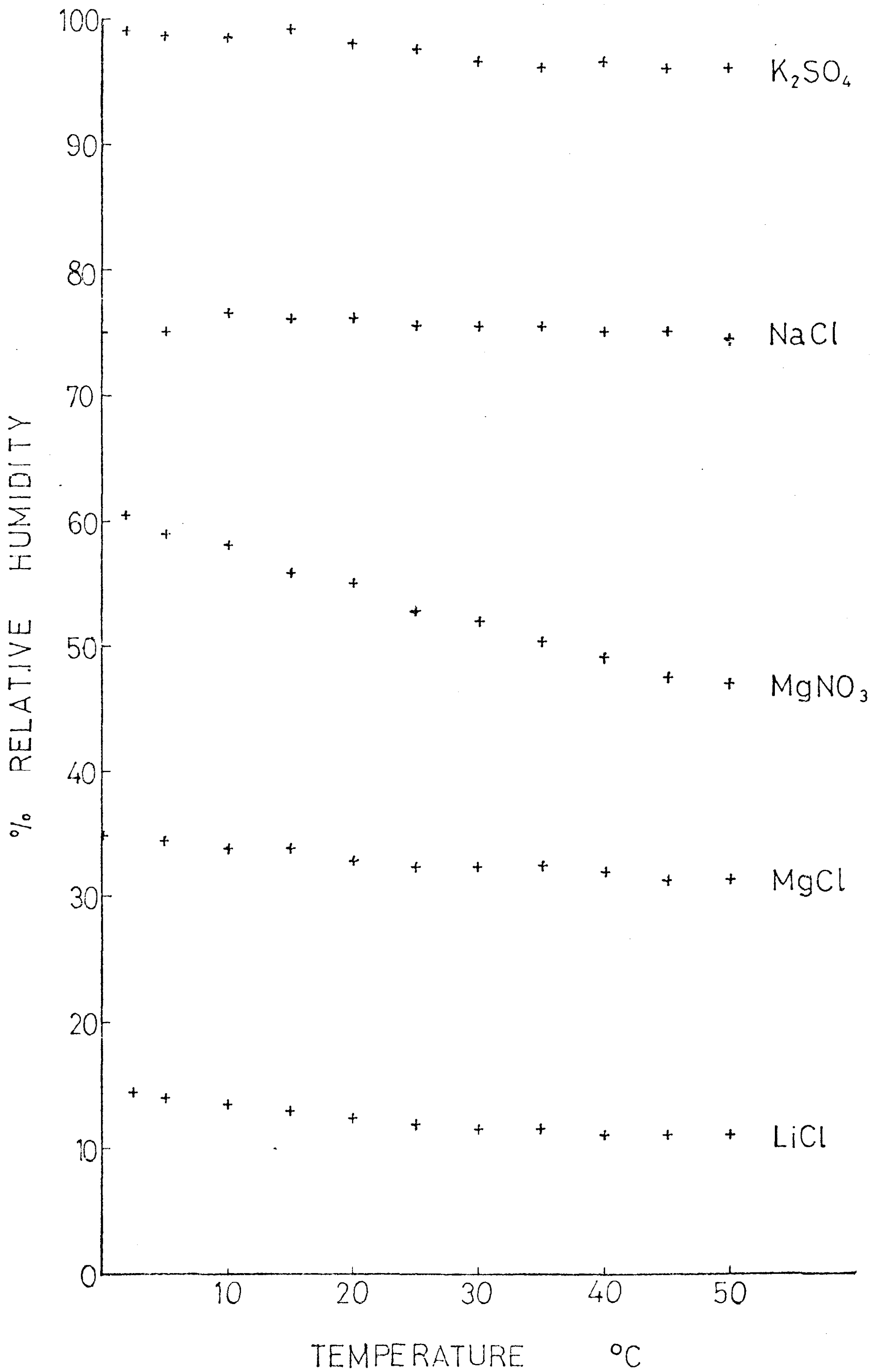
With the vertical axis in a geometric scale, the straight lines show perfect adherence to geometric increase between instars. The calculated points for each instar mean are shown by the appropriate symbol.

TABLE 51

DEVELOPMENT RATE

Temperature means and range recorded for multitemperature cabinet.

	April 1972		October 1972	
Chamber	mean ^oC	range ^oC	mean ^oC	range ^oC
1	5.0	4.5 - 5.5	-	-
2	8.5	8.0 - 9.3	11.0	nil
3	11.5	11.2 - 12.0	14.0	nil
4	15.0	14.8 - 15.5	17.8	17.5 - 18.0
5	18.5	18.2 - 18.8	20.6	20.5 - 21.0
6	21.5	21.2 - 22.0	23.6	23.5 - 24.0
7	25.0	24.5 - 25.5	26.6	26.2 - 27.0
8	29.0	28.5 - 29.5	29.7	29.5 - 30.0
9	32.5	32.0 - 33.0	33.0	32.7 - 33.5
10	36.5	35.8 - 37.2	36.3	35.7 - 37.0



100
90
80
70
60
50
40
30
20
10
0
% RELATIVE HUMIDITY
K2SO4
NaCl
MgNO3
MgCl
LiCl
10
20
30
40
50
TEMPERATURE °C

FIGURE 43

DEVELOPMENT RATE

Estimated percent relative humidity for each saturated salt solution at experimental temperatures.

Data from Winston and Bates (1960).

FIGURE 44

DEVELOPMENT RATE

Test containers for experiments with *C. ombrodelta* eggs

Left - assembled Pomade jar

Centre - egg container and sling

Upper scale shows centimetres

TABLE 52

DEVELOPMENT RATE

Eggs, mean development time in hours in multitemperature cabinet.

Temperature °C	Relative Humidity 10-20%	30-40%	50-60%	70-80%	90-100%	Temperature means
8.5	- (0)[1]	- (0)	- (0)	- (0)	- (0)	- (0)
15.0	439.44 (8)	439.20 (10)	418.80 (10)	415.20 (10)	376.80 (10)	417.89 (48)
18.5	241.92 (6)	283.92 (9)	237.60 (10)	255.60 (10)	247.20 (10)	235.57 (45)
21.5	174.00 (8)	175.20 (10)	152.40 (10)	171.60 (10)	153.60 (10)	165.00 (48)
25.0	132.00 (3)	125.28 (9)	120.00 (10)	121.44 (9)	118.80 (10)	122.06 (41)
29.0	120.00 (4)	112.80 (10)	103.20 (10)	97.20 (10)	98.40 (10)	104.45 (44)
32.5	- (0)	108.00 (1)	102.00 (4)	92.40 (10)	86.40 (10)	92.16 (25)
36.5	- (0)	- (0)	- (0)	- (0)	96.00 (1)	96.00 (1)

1. Each treatment initially had 2 jars, each with 5 eggs. The figure shown in parentheses is the number of eggs surviving each treatment, and on which each mean is based.

TABLE 53

DEVELOPMENT RATE

Larvae, prepupae and pupae; mean development time in hours, in the multi-temperature cabinet.

Temperature °C / Instar	17.8	20.6	23.6	26.6	29.7	36.3	TOTAL	25.0 C.T. room	GRAND TOTAL
1st of 5	198.00 (6)[1]	108.00 (1)	109.92 (6)	64.08 (3)	72.00 (9)	57.12 (4)	29	84.72 (17)	
1st of 6				84.48 (1)	60.00 (2)	60.00 (1)		84.00 (2)	
2nd of 5	120.00 (6)	78.00 (2)	69.60 (5)	60.00 (3)	46.56 (9)	48.00 (4)	29	56.40 (17)	
2nd of 6				48.00 (1)	42.00 (2)	48.00 (1)		60.00 (2)	
3rd of 5	133.68 (7)	81.60 (5)	70.08 (6)	52.08 (3)	43.92 (9)	63.12 (4)	4	69.12 (17)	
3rd of 6				48.00 (1)	42.00 (2)	48.00 (1)		84.00 (2)	
4th of 5	150.00 (6)	93.12 (4)	79.92 (6)	55.92 (3)	51.36 (11)	84.00 (4)	34	73.44 (17)	
4th of 6				72.00 (1)	60.00 (2)	96.00 (1)		72.00 (2)	
5th of 5	252.00 (1)	186.00 (4)	151.92 (6)	108.00 (3)	117.60 (10)	141.12 (4)	28	197.76 (17)	
5th of 6				60.00 (1)		96.00 (1)		84.00 (2)	
6th of 6				180.00 (1)				204.00 (2)	
prepupae of 5		144.93 (1)	123.46 (4)	107.53 (1)	83.33 (7)	72.00 (2)	5	59.17 (11)	
prepupae of 6					86.21 (2)			48.08 (2)	
pupae of 5, males			320.00 (3)	240.00 (1)	219.00 (4)		8	248.00 (3)	
pupae of 5, females			312.00 (1)					234.00 (4)	
pupae of 6, males								-	
pupae of 6, females					216.00 (1)				

1. The number of individuals on which the mean is based are shown in parentheses

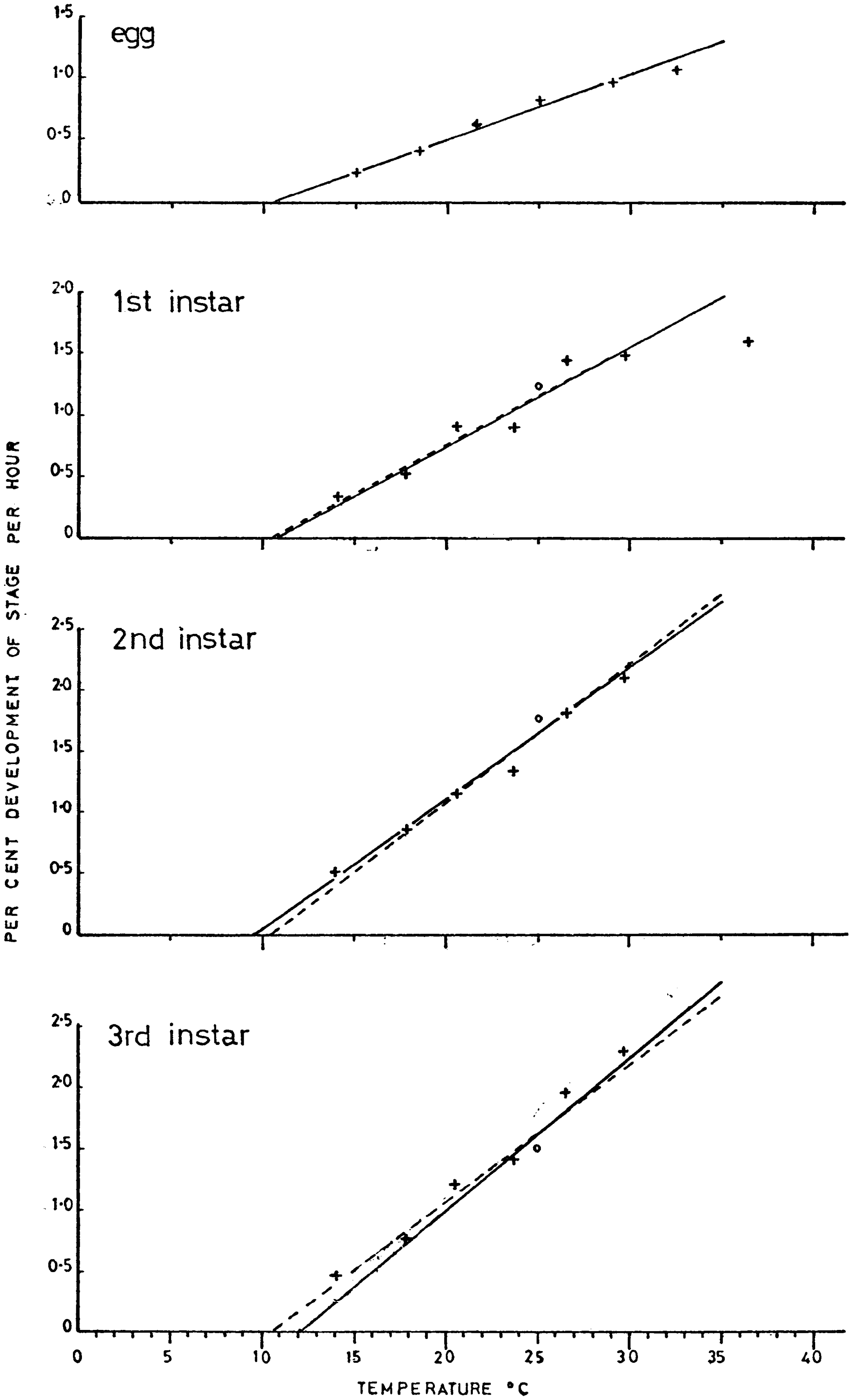
TABLE 54

DEVELOPMENT RATE

Immature stages; mean percentage development per hour at a number of constant temperatures.

Stage / Temperature °C	eggs	1st instar	2nd instar	3rd instar	4th instar	5th instar of 5	5th instar of 6	6th instar	prepupa	pupa
14.0		0.35±0.06[1] (3)[2]	0.53±0.02 (3)	0.46 - (1)	-	-	-	-	-	-
15.0	0.24±0.05 (48)									
17.8		0.53±0.08 (12)	0.86±0.16 (8)	0.76±0.10 (7)	0.67±0.04 (6)	0.40 - (1)	-	-	-	-
18.5	0.40±0.04 (45)									
20.6		0.93±0.00 (5)	1.18±0.19 (4)	1.22±0.15 (8)	1.12±0.09 (7)	0.54±0.05 (4)	-	-	0.69 - (1)	-
21.5	0.61±0.05 (48)									
23.6		0.92±0.09 (9)	1.35±0.26 (9)	1.41±0.30 (8)	1.34±0.27 (7)	0.67±0.08 (6)	-	-	0.81±0.03 (4)	0.32±0.01 (4)
25.0	0.82±0.03 (41)	1.25±0.17[3] (27)	1.78±0.37[3] (24)	1.52±0.40[3] (23)	1.42±0.31[3] (21)	0.53±0.11[3] (17)	1.91[3] - (2)	0.49[3] - (2)	1.66±0.56[3] (46)	0.36±0.04[3] (36)
26.6		1.47±0.27 (7)	1.83±0.29 (6)	1.98±0.20 (4)	1.81±0.34 (4)	0.93±0.11 (3)	1.67 - (1)	0.56 - (1)	0.93 - (1)	0.42 - (1)
29.0	0.96±0.08 (44)									
29.7		1.50±0.24 (20)	2.12±0.30 (15)	2.34±0.41 (12)	1.94±0.20 (12)	0.87±0.12 (10)	-	-	1.19±0.50 (9)	0.46±0.02 (5)
32.5	1.04±0.09 (25)									
36.3		1.61±0.26 (18)	1.95±0.28 (11)	1.74±0.37 (5)	1.36±0.56 (5)	0.73±0.14 (4)	1.04 - (1)	-	1.43 - (2)	-
36.5	1.04 - (1)									
TOTAL IMMATURES	252	101	80	68	62	45	4	3	63	46

1. Standard error(s)
2. Number of immatures on which the mean is based
3. Data from the University Constant Temperature Room



egg
1st instar
2nd instar
3rd instar
PER CENT DEVELOPMENT OF STAGE PER HOUR
TEMPERATURE °C
0
5
10
15
20
25
30
35
40
0·5
1·0
1·5
2·0
2·5

FIGURE 45

DEVELOPMENT RATE

Percent development per hour of *C. ombrodelta* immatures at each temperature tested.

+ observed rate in multitemperate cabinets.

o observed rate in University constant temperature room.

—— weighted regression of development rate on temperature.

--- weighted regression through 10.43°C of development rate on temperature (for the egg stage both lines coincide).

(continued)

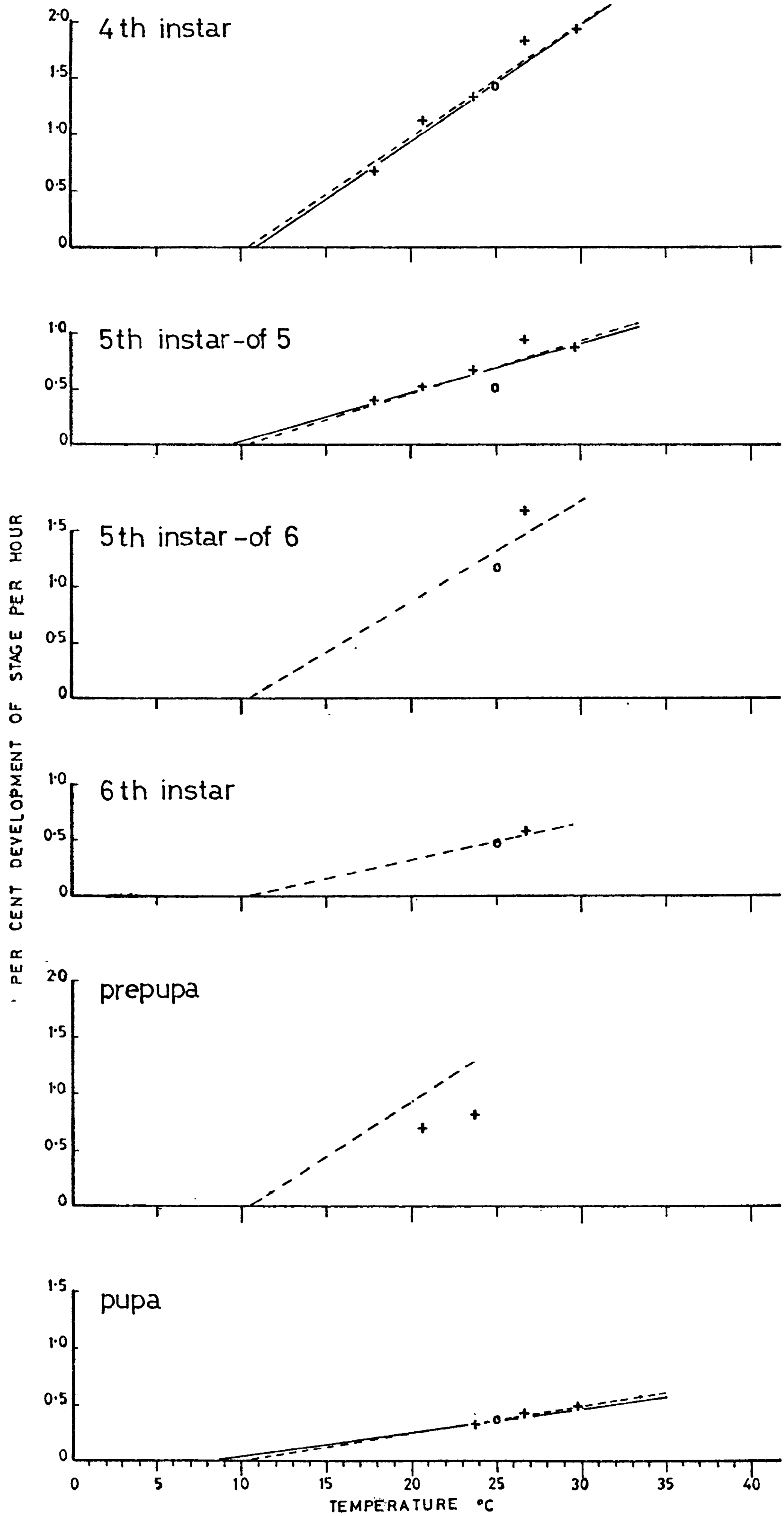

4th instar
5th instar-of 5
5th instar-of 6
6th instar
prepupa
pupa
PER CENT DEVELOPMENT OF STAGE PER HOUR
TEMPERATURE °C
0
0·5
1·0
1·5
2·0
0
5
10
15
20
25
30
35
40

FIGURE 45 (cont.)

DEVELOPMENT RATE

Percent development per hour of *C. ombrodelta* immatures at each temperature tested.

+ observed rate in multitemperature cabinets.

o observed rate in University constant temperature room.

—— weighted regression of development rate on temperature (in 5th instar - of 6, 6th instar, and prepupa data were insufficient to calculate this line).

--- weighted regression through 10.43°C of development rate on temperature.

TABLE 55

DEVELOPMENT RATE

Immature stages; weighted linear regression of percentage hourly development on temperature. Showing threshold of development and thermal constant.

Stage	Linear regression[1]	Threshold temperature °C	Thermal constant hour degrees
Eggs	$\hat{Y} = 0.054X - 0.576$	10.58	1,851
1st instar	$\hat{Y} = 0.083X - 0.883$	10.69	1,207
2nd instar	$\hat{Y} = 0.108X - 1.039$	9.60	925
3rd instar	$\hat{Y} = 0.127X - 1.541$	12.10	785
4th instar	$\hat{Y} = 0.103X - 1.095$	10.68	977
5th instar terminal	$\hat{Y} = 0.041X - 0.394$	9.52	2,409
pupa	$\hat{Y} = 0.022X - 0.192$	8.65	4,543

$\hat{Y}$ = % development per hour

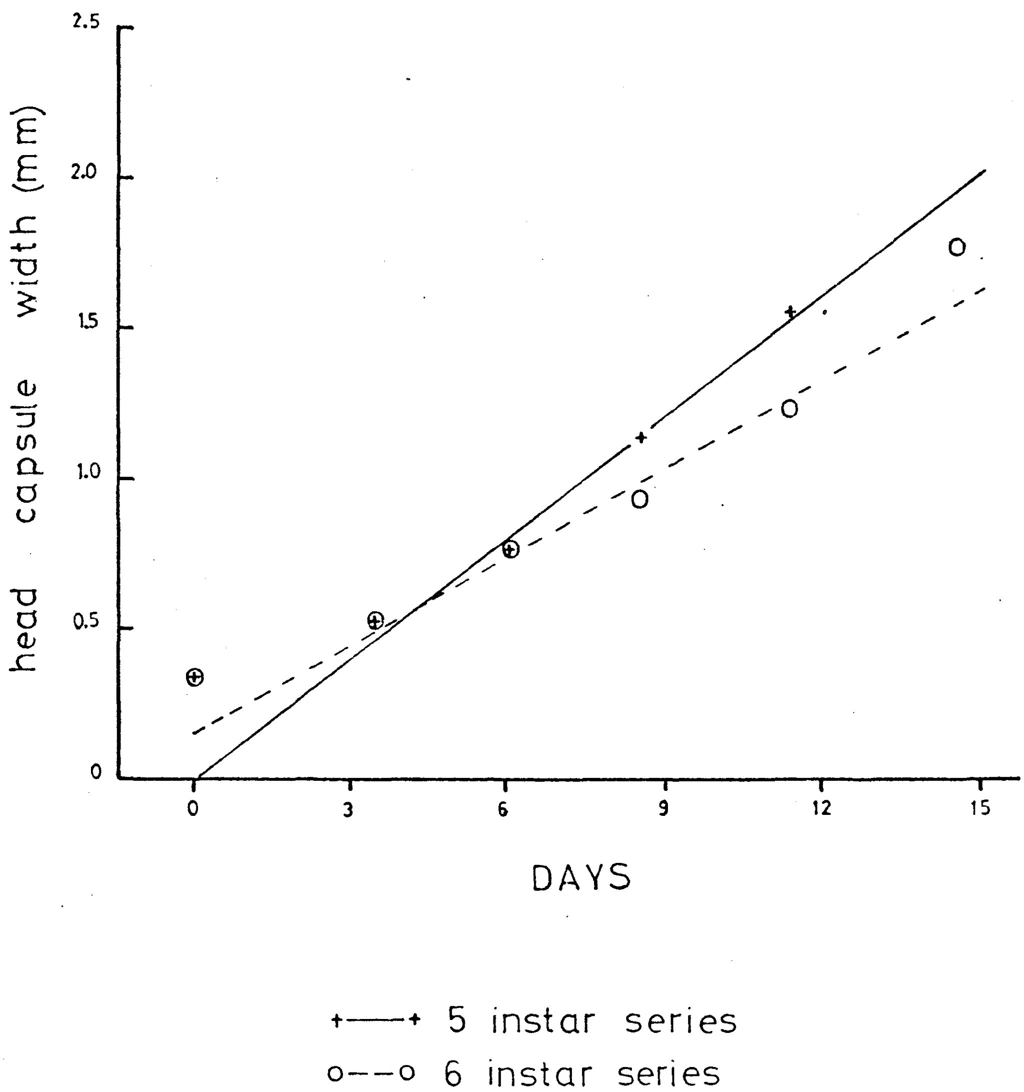
X = temperature (°C)

TABLE 56

DEVELOPMENT RATE

Immature stages; weighted linear regression of percentage hourly development on temperature through the common threshold temperature of 10.43°C and thermal constants for all stages.

Stage	Linear regression	Thermal constant hour degrees
Eggs	$\hat{Y} = 0.053X - 0.555$	1,891
1st instar	$\hat{Y} = 0.081X - 0.847$	1,236
2nd instar	$\hat{Y} = 0.114X - 1.189$	877
3rd instar	$\hat{Y} = 0.113X - 1.179$	885
4th instar	$\hat{Y} = 0.101X - 1.053$	990
5th instar terminal	$\hat{Y} = 0.044X - 0.457$	2,283
5th instar of 6	$\hat{Y} = 0.091X - 0.949$	1,099
6th instar terminal	$\hat{Y} = 0.034X - 0.355$	2,941
prepupa	$\hat{Y} = 0.098X - 1.022$	1,020
pupa	$\hat{Y} = 0.024X - 0.249$	4,158



2.5
2.0
1.5
1.0
0.5
0
head capsule width (mm)
0
3
6
9
12
15
DAYS
+——+ 5 instar series
o- -o 6 instar series

FIGURE 46

DEVELOPMENT RATE

Test of constant growth increment per day in larval *C. ombrodelta*.

+, o from left to right show mean head capsule width of laboratory reared larvae in successive instars.

The lines show the linear regression of instar head capsule width on accumulated days development time to that instar.

TABLE 57

DEVELOPMENT RATE

Analysis of variance for each instar series, testing the linear regression of instar head capsule width against accumulated development time.

5 INSTAR SERIES

Source	df	Sum of squares	Mean square	F
Between Instars	3	19.19	6.40	1600.00** a
Linear Regression	*1*	*18.91*	*18.91*	135.07** b
Deviations from Regression	*2*	*0.28*	*0.14*	35.00** c
Within Groups (error)	151	0.59	0.004	
Total	154	19.78		

6 INSTAR SERIES

Source	df	Sum of squares	Mean square	F
Between Instars	4	6.40	1.60	800.00** d
Linear Regression	*1*	*6.31*	*6.31*	210.33** e
Deviations from Regression	*3*	*0.09*	*0.03*	13.08** f
Within Groups (error)	109	0.25	0.002	
Total	113	6.65		

** significant at P=0.01

degrees of freedom for F

a	3,151	d	4,109
b	1,2	e	1,3
c	2,151	f	3,109

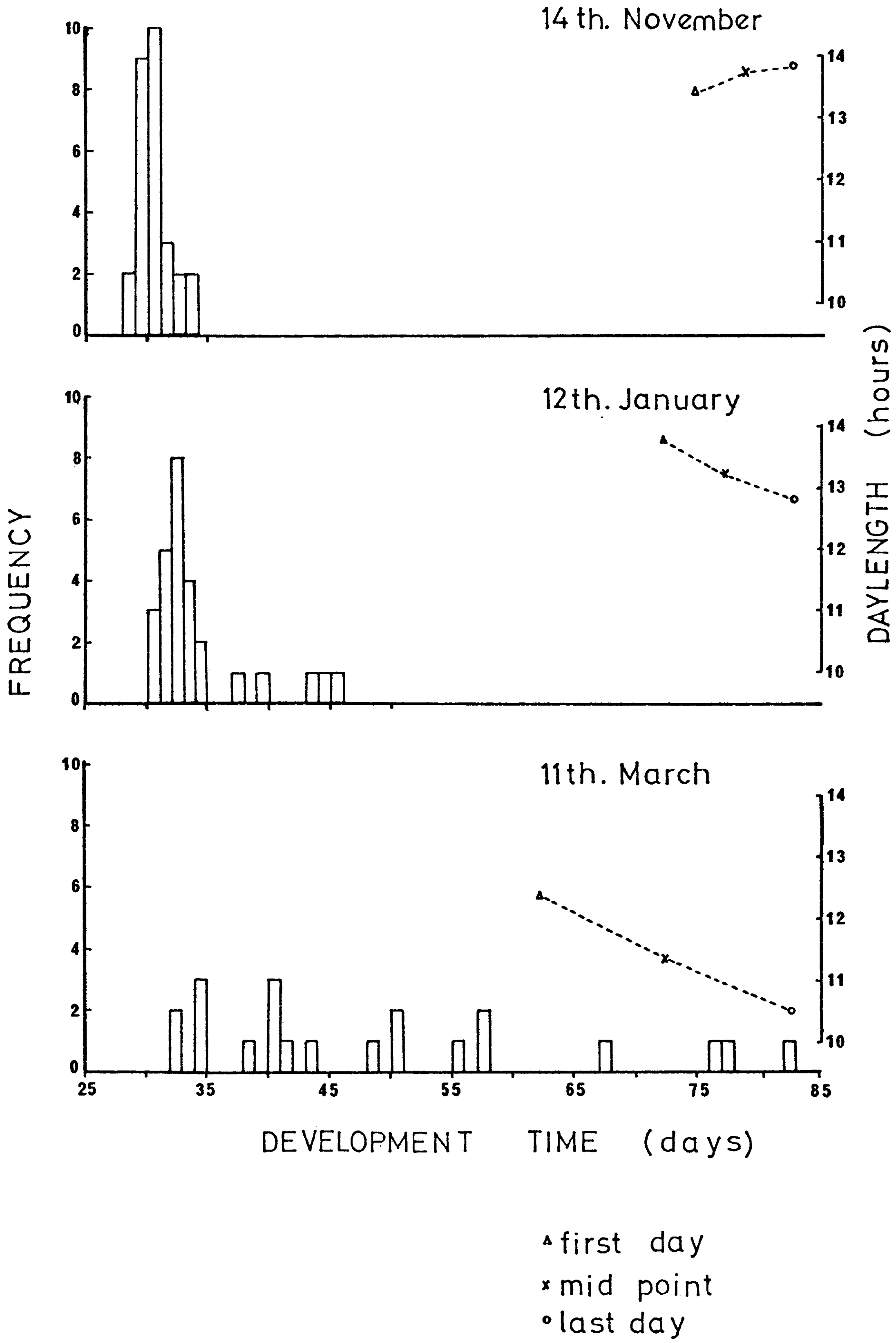

14 th. November
12th. January
11th. March
FREQUENCY
DAYLENGTH (hours)
DEVELOPMENT TIME (days)
25
35
45
55
65
75
85
first day
mid point
last day

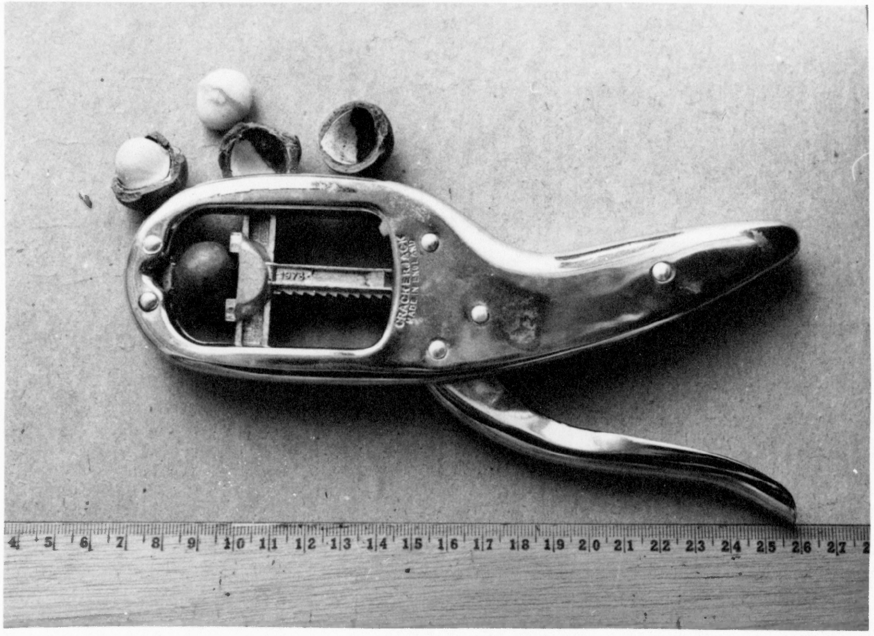
FIGURE 47

DEVELOPMENT RATE

Variation observed in the development rate of *C. ombrodelta* with changing daylength.

The histograms show the number of adults emerging after the indicated period. The broken lines show the change in daylength during the course of the experiment.

a



b

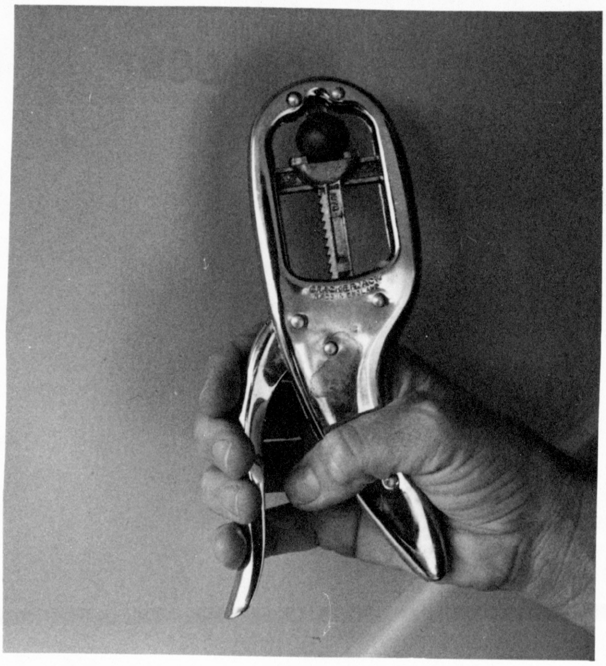


FIGURE 48

SAMPLING IMMATURES

A method for examining the kernels of damaged macadamia nuts.

The Crackerjack [R] showing the whole kernels obtained after cracking.

Scale in centimetres.

› Mode of action.

TABLE 58

SAMPLING IMMATURES

Data recorded for each fruit sampled

A. FRUIT		
Size	(i)	Nuts the equatorial diameter of nut in husk, measured in mm by Vernier caliper. 1972-73 all nuts 1973-74 60 nuts per variety sample.
	(ii)	*Bauhinia* length, breadth, thickness in mm for a sample of pods.
Maturity	(i)	Nuts shell and husk characteristics, e.g. hard sticky.
	(ii)	*Bauhinia* alive or dead
Damage		Nuts only kernel damage - penetration by the insect to the kernel.
B. INSECT		
Eggs		Numbers of hatched, unhatched, and dead eggs.
Other Immatures		Numbers head capsule widths alive or dead, cause of death.
Deserted Holes		Holes made by larvae, now empty for an unknown reason.
Gummed Holes		Holes made by 1st instar larvae, now filled by sap exudate. Larvae usually not found, if found are dead.

TABLE 59

SAMPLING IMMATURES

Macadamia. Summary of the main destructive samples.

	Nuts sampled			Nuts with 2	3		
				INALA 1971-72			
Unhatched eggs	1,852	1,823	24	5			
Other living immatures	1,852	1,675	145	28	4		
				ASPLEY S1 1971-72			
Unhatched eggs	304	296	6	2			
Other living immatures	304	263	33	7	1		
					1972-73		
Unhatched eggs	4,528	4,349	146	27	5		
Other living immatures	4,528	3,833	538	128	23	6	
					1973-74		
Unhatched eggs	4,610	4,305	249	41	13	2	
Other living immatures	6,978	6,461	449	60	7	1	
				ASPLEY H2 1971-72			
Unhatched eggs	680	633	37	8	2		
Other living immatures	680	568	87	19	5	1	
					1972-73		
Unhatched eggs	7,563	7,469	83	8	2	1	
Other living immatures	7,563	7,168	323	58	13	1	
					1973-74		
Unhatched eggs	5,250	4,996	224	23	6		
Other living immatures	7,212	6,916	255	38	2	1	
				BEERWAH 1972-73			
Unhatched eggs	3,043	2,703	256	68	14		1
Other living immatures	3,043	1,860	745	294	103	30	
				GRAND TOTALS			
Unhatched eggs	27,828	26,574	1,023	182	42	3	2
Other living immatures	32,160	28,744	2,575	632	158	40	

(continued)

TABLE 59 (continued):

Frequency per nut	Unhatched eggs	1st	2nd	3rd	Nuts with:- 4th	5A	Final	Pre-pupa	pupa	TOTAL living immatures (excluding eggs)
					TREE					
	15,493	16,273	16,251	16,266	16,299	6,555	16,289	16,508	16,491	15,403
	825	225	252	240	204	100	222	7	23	899
	156	16	11	8	12	0	4	0	1	164
	35	1	1	1	0	0	0	0	0	39
	3	0	0	0	0	0	0	0	0	8
5	2	0	0	0	0	0	0	0	0	2
6	1	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
Total nuts	16,515	16,515	16,515	16,515	16,515	6,655	16,515	16,515	16,515	16,515
Total insects	1,270	260	277	259	228	100	230	7	25	1,386
					GROUND[1]					
	11,081	15,502	15,378	15,215	15,163	10,974	14,807	15,477	15,341	13,344
	198	140	246	403	450	330	778	167	303	1,676
	26	3	19	25	31	11	54	0	1	468
	7	0	2	2	0	0	6	1	0	119
	0	0	0	0	1	0	0	0	0	32
	0	0	0	0	0	0	0	0	0	9
	0	0	0	0	0	0	0	0	0	0
7	1	0	0	0	0	0	0	0	0	0
Total nuts	11,313	15,645	15,645	15,645	15,645	11,315	15,645	15,645	15,645	15,645
Total insects	278	146	290	459	516	352	904	170	305	3,142

1. i.e. fallen nuts

TABLE 60

SAMPLING IMMATURES

Macadamia 1971-72. Sampling design and nuts taken.

A. INALA 8 dates x 25 trees x 3 levels x 2 nuts (each tree level) / 4 nuts (ground level)

	Ground	Lower tree	Upper tree
4.XI.71	100	50	50
18.XI.71	100	48	50
17.XII.71	95	50	50
31.XII.71	89	50	50
14.I.72	100	50	50
27.I.72	182	150	150
24.II.72	100	50	50
25.III.72	94	47	47

B. ASPLEY S1 7 dates x 15 trees x 3 levels x 2 nuts (each tree level) / 4 nuts (ground level)

	Ground	Lower tree	Upper tree
12.XI.71	0	14	10
10.XII.71	0	15	9
23.XII.71	0	13	10
7.I.72	2	30	12
19.I.72	6	30	20
17.II.72	27	38	10
15.III.72	27	27	4

C. ASPLEY H2 7 dates x 25 trees x 3 levels x 2 nuts (each tree level) / 4 nuts (ground level)

	Ground	Lower tree	Upper tree
12.XI.71	17	24	24
10.XII.71	12	23	22
23.XII.71	7	22	21
7.I.72	9	22	19
19.I.72	28	46	44
17.II.72	68	55	23
15.III.72	107	60	27

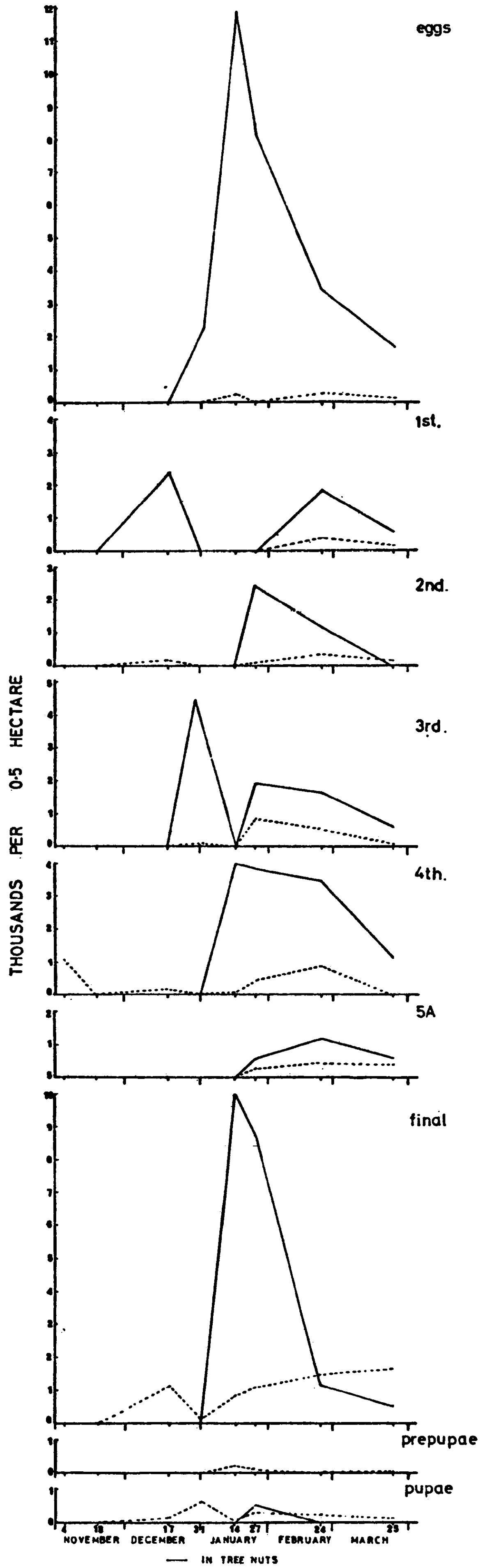

eggs
1st.
2nd.
3rd.
4th.
5A
final
prepupae
pupae
THOUSANDS PER 0·5 HECTARE
NOVEMBER DECEMBER JANUARY FEBRUARY MARCH
IN TREE NUTS
IN GROUND NUTS

FIGURE 49

SAMPLING IMMATURES

Inala 1971-72. Estimated absolute populations of *C. ombrodelta*.

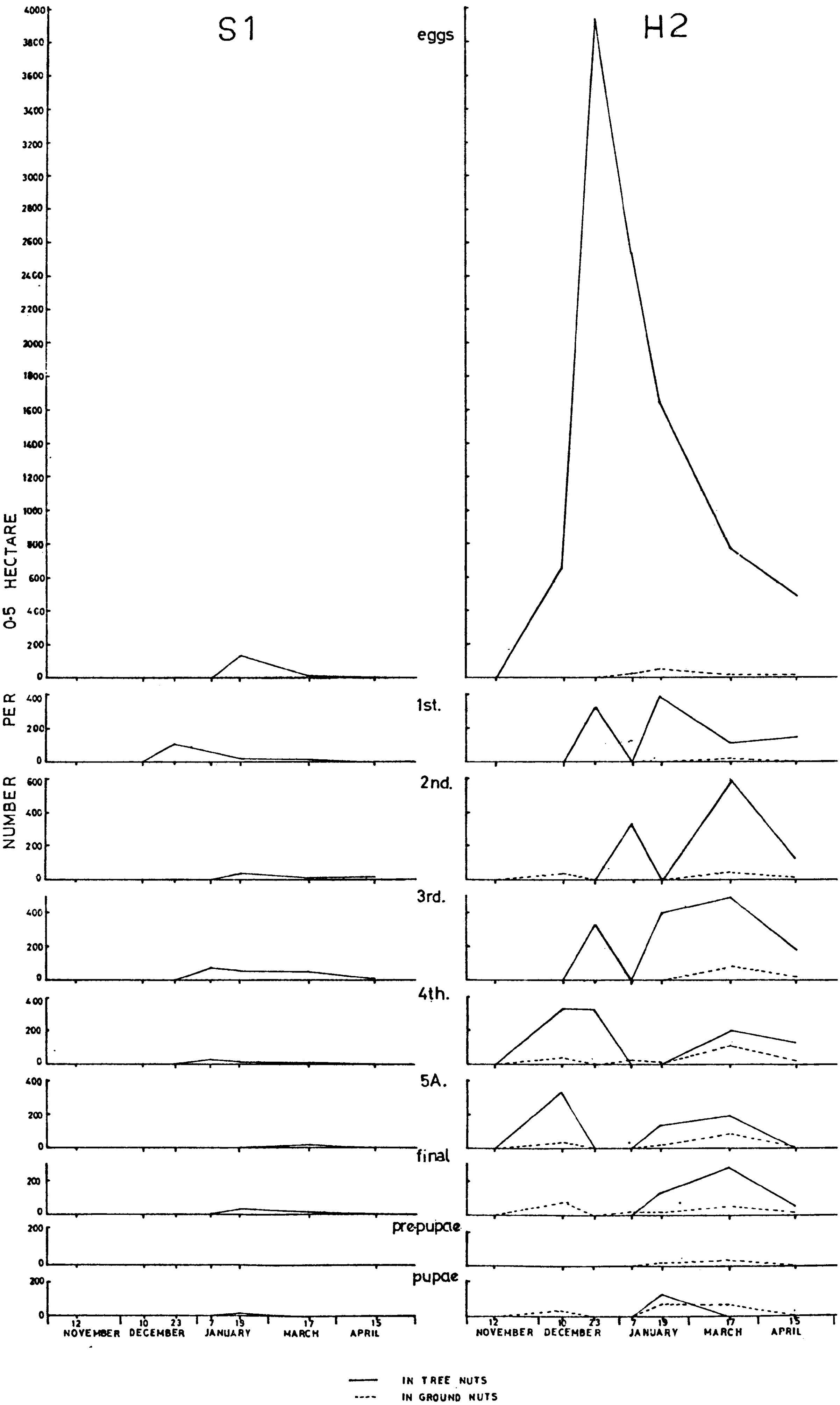

S1
H2
eggs
1st.
2nd.
3rd.
4th.
5A.
final
pre-pupae
pupae
NUMBER PER 0·5 HECTARE
NOVEMBER DECEMBER JANUARY MARCH APRIL
IN TREE NUTS
IN GROUND NUTS

FIGURE 50

SAMPLING IMMATURES

Aspley S1 and H2 1971-72. Estimated absolute populations of *C. ombrodelta*.

TABLE 61

SAMPLING IMMATURES

Macadamia 1972-73. Sampling design and nuts taken.

(A) ASPLEY S1

12 dates x 3 rows x 5 trees
x 3 levels x 4 nuts

Level	Ground			Lower tree			Upper tree		
Row[1]	1	2	3	1	2	3	1	2	3
Date									
30.X.72	16	7	8	20	20	20	20	20	20
13.XI.72	20	16	20	20	20	20	16	20	20
27.XI.72	12	20	20	20	20	20	16	20	20
11.XII.72	5	11	11	20	20	20	0	20	20
18.XII.72									
25.XII.72	0	5	0	20	20	20	16	20	20
1.I.73									
8.I.73	3	1	6	20	20	20	8	20	20
15.I.73									
22.I.73	12	12	16	20	20	20	16	20	20
29.I.73									
5.II.73	4	5	10	20	20	20	4	20	20
19.II.73	11	20	20	20	20	20	4	20	20
5.III.73	20	20	20	20	20	20	20	20	20
19.III.73	20	20	20	20	20	20	20	20	20
2.IV.73	12	16	20	20	16	20	0	12	20

(B) ASPLEY H2

16 dates x 3 rows x 5 trees
x 3 levels x 4 nuts

Level	Ground			Lower tree			Upper tree		
Row[1]	1	2	3	1	2	3	1	2	3
Date									
30.X.72	20	20	20	20	20	20	20	20	20
13.XI.72	20	20	20	20	20	20	20	20	20
27.XI.72	20	20	20	20	20	20	20	20	20
11.XII.72	20	20	20	20	20	20	20	20	20
18.XII.72	12	20	20	20	20	20	20	20	20
25.XII.72	8	6	7	20	20	20	20	20	20
1.I.73	10	11	16	20	20	20	16	20	20
8.I.73	15	1	14	20	20	20	16	20	20
15.I.73	9	9	12	20	20	20	20	20	20
22.I.73	20	8	20	20	20	20	20	20	20
29.I.73	20	12	10	20	20	20	16	20	20
5.II.73	20	19	17	20	20	20	20	20	20
19.II.73	20	20	20	20	20	20	20	20	20
5.III.73	20	20	20	20	20	20	20	20	20
19.III.73	20	20	20	20	20	20	20	20	20
2.IV.73	20	20	20	20	20	20	16	20	20

(C) Fallen nut count.

23 dates x 5 trees x various nut numbers

	S1	H2
31.X.72	95	638
7.XI.72	340	500
14.XI.72	446	500
21.XI.72	333	497
28.XI.72	143	470
5.XII.72	52	267
12.XII.72	16	143
19.XII.72	13	65
26.XII.72	4	8
2.I.73	4	2
9.I.73	11	6
16.I.73	46	12
23.I.73	67	17
30.I.73	91	33
6.II.73	76	52
13.II.73	129	127
20.II.73	95	135
27.II.73	106	215
6.III.73	95	162
13.III.73	140	266
20.III.73	131	250
27.III.73	160	250
3.IV.73	152	248

1. rows 1 = outside row 2 = inside row 3 = border row

(continued)

TABLE 61 (continued):

(D) BEERWAH

16 dates x 2 levels x 4 quadrants x 7 nuts
plus 16 dates x nuts on the ground

Level	Ground				TREE 146 Lower tree				Upper tree			
Quadrant	N[1]	E	S	W	N	E	S	W	N	E	S	W
6.XII.72	-	-	-	-	7	7	7	7	7	7	7	7
13.XII.72	7	3	5	5	3	3	3	3	3	3	3	3
20.XII.72	2	1	0	1	7	7	7	7	7	7	7	7
27.XII.72	0	0	0	0	7	7	7	7	7	7	7	7
3.I.73	1	0	0	0	7	7	7	7	7	7	7	7
10.I.73	0	0	0	0	7	7	7	7	7	7	7	7
17.I.73	1	0	0	1	7	7	7	7	7	7	7	7
24.I.73	0	2	0	1	7	7	7	7	7	7	7	7
31.I.73	1	2	3	1	7	7	7	7	7	7	7	7
7.II.73	16	8	11	3	7	7	7	7	7	7	7	7
14.II.73	22	19	5	10	7	7	7	7	7	7	7	7
21.II.73	12	13	7	7	7	7	7	7	7	7	7	7
28.II.73	21	16	9	10	7	7	7	7	7	7	7	7
7.III.73	17	6	3	1	7	7	7	7	7	7	7	-
14.III.73	14	10	5	9	7	7	7	7	7	7	7	-
21.III.73	9	8	4	3	20 nuts from the tree							
					TREE 194							
6.XII.72	-	-	-	-	7	7	7	7	7	7	7	7
13.XII.72	6	7	8	4	3	3	3	3	3	3	3	3
20.XII.72	3	3	1	11	7	7	7	7	7	7	7	7
27.XII.72	2	1	1	0	7	7	7	7	7	7	7	7
3.I.73	2	1	0	5	7	7	7	7	7	7	7	7
10.I.73	3	3	2	8	7	7	7	7	7	7	7	7
17.I.73	5	4	3	10	7	7	7	7	7	7	7	7
24.I.73	14	15	4	15	7	7	7	7	7	7	7	7
31.I.73	29	24	14	23	7	7	7	7	7	7	7	7
7.II.73	41	31	23	29	7	7	7	7	7	7	7	7
14.II.73	33	18	29	53	7	7	7	7	7	7	7	7
21.II.73	10	13	14	21	-	7	7	7	7	7	7	7
28.II.73	15	10	12	22	-	-	-	-	-	-	-	-
7.III.73	9	8	9	18	-	-	-	-	-	-	-	-
14.III.73	5	4	7	12	-	-	-	-	-	-	-	-
21.III.73	7	2	5	3	20 nuts from the tree							

1. N = North quadrant, E = East quadrant, S = South quadrant
W = West quadrant

TABLE 62

SAMPLING IMMATURES

Macadamia 1973-74. Sampling design and nuts taken.

Tree samples 18 dates x 3 rows x 10 trees x 10 nuts

Date		S1			H2		
	Row	Out	In	Border	Out	In	Border
16.XI.73		100	100	100	100	100	100
23.XI.73		100	100	100	100	100	100
30.XI.73		100	100	100	100	100	100
7.XII.73		50	100	100	100	100	100
14.XII.73		50	100	100	100	100	100
21.XII.73		50	100	100	100	100	100
28.XII.73		50	100	100	100	100	100
4.I.74		50	100	100	100	100	100
11.I.74		50	100	100	100	100	100
18.I.74		50	100	100	100	100	100
25.I.74		50	100	100	50	50	50
1.II.74		50	100	100	100	100	100
8.II.74		50	100	100	100	100	100
15.II.74		45	100	100	100	100	100
22.II.74		50	100	100	100	100	100
1.III.74		40	100	100	100	100	100
8.III.74		40	100	100	100	100	100
15.III.74		35	100	100	100	100	100

Ground samples

Pooled samples from 18 dates x 5 trees x fallen nut numbers plus 8 dates[1] x 3 rows x 10 trees x 1 nut

	S1	H2
16.XI.73	0	0
23.XI.73	313	140
30.XI.73	466	266
7.XII.73	474	318
14.XII.73	188	150
21.XII.73	54	43
28.XII.73	18	13
4.I.74	11	21
11.I.74	25	21
18.I.74	50	70
25.I.74	56	131
1.II.74	94	110
8.II.74	71	73
15.II.74	91	98
22.II.74	128	132
1.III.74	102	123
8.III.74	102	123
15.III.74	117	130

starting on 18.I.74, 25.I.74 not included

TABLE 63

SAMPLING IMMATURES

Macadamia 1971 to 1974. Chi-square tests of strata differences.[a]

	Observed nuts with *C. ombrodelta*	Observed nuts without *C. ombrodelta*	Total nuts sampled	Expected nuts with *C. ombrodelta*	Expected nuts without *C. ombrodelta*
1. 1971-72					
(a) Inala		Levels			
upper tree	28	469	497	37.08	459.92
lower tree	46	449	495	36.92	458.08
	74	918	992	74.00	918.00
	Total corrected χ^2 1 df = 4.83*				
(b) Aspley S1		Levels			
upper tree	9	66	75	10.54	64.46
lower tree	25	142	167	23.46	143.54
	34	208	242	34.00	208.00
	Total corrected χ^2 1 df = 0.49 N.S.				
(c) Aspley H2		Levels			
upper tree	27	153	180	34.17	145.83
lower tree	55	197	252	47.83	204.17
	82	350	432	82.00	350.00
	Total corrected χ^2 1 df = 3.25 N.S.				

. Interpretation of chi-square is explained on the last page of this table.

(continued)

TABLE 63 (continued):

	Observed nuts with *C. ombrodelta*	Observed nuts without *C. ombrodelta*	Total nuts sampled	Expected nuts with *C. ombrodelta*	Expected nuts without *C. ombrodelta*
2. 1972-73					
(a) Aspley S1		Rows			
out	88	292	380	84.95	295.05
in	86	382	468	104.63	363.37
border	122	354	476	106.42	369.58
	296	1028	1324	296.00	1028.00
	Total χ^2 df 2 = 7.35*				
		Levels - outer row			
upper	30	110	140	32.42	107.58
lower	58	182	240	55.58	184.42
	88	292	380	88.00	292.00
	Total corrected χ^2 df 1 = 0.41 N.S.				
		Levels - inner rows			
upper	35	197	232	42.63	189.37
lower	51	185	236	43.37	192.63
	86	382	468	86.00	382.00
	Total corrected χ^2 df 1 = 3.33 N.S.				
		Levels - border row			
upper	59	177	236	60.49	175.51
lower	63	177	240	61.51	178.49
	122	354	476	122.00	354.00
	Total corrected χ^2 df 1 = 0.11 N.S.				

(continued)

TABLE 63 (continued):

	Observed nuts with *C. ombrodelta*	Observed nuts without *C. ombrodelta*	Total nuts sampled	Expected nuts with *C. ombrodelta*	Expected nuts without *C. ombrodelta*
2. (cont'd)					
(b) Aspley H2		Rows			
out	45	579	624	36.06	587.94
in	34	606	640	36.97	603.03
border	31	609	640	36.97	603.03
	110	1794	1904	110.00	1794.00
	Total χ^2 df 2 = 3.63 N.S.				
		Levels			
upper	34	910	944	54.54	889.46
lower	76	884	960	55.46	904.54
	110	1794	1904	110.00	1794.00
	Total corrected χ^2 df 1 = 16.30**				
(c) Beerwah Tree 146		Levels			
upper	56	334	390	80.55	309.45
lower	108	296	404	83.45	320.55
	164	630	794	164.00	630.00
	Total corrected χ^2 1 df = 18.55**				
Tree 194		Levels			
upper	134	186	320	149.13	170.87
lower	161	152	313	145.87	167.13
	295	338	633	295.00	338.00
	Total corrected χ^2 1 df = 5.82*				

(continued)

TABLE 63 (continued):

	Observed nuts with *C. ombrodelta*	Observed nuts without *C. ombrodelta*	Total nuts sampled	Expected nuts with *C. ombrodelta*	Expected nuts without *C. ombrodelta*
3. 1973-74					
(a) Aspley S1	Rows				
out	127	883	1010	117.65	892.35
in	195	1605	1800	209.67	1590.33
border	215	1585	1800	209.68	1590.32
	537	4073	4610	537.00	4073.00
	Total χ^2 df 2 = 2.16 N.S.				
(b) Aspley H2	Rows				
out	130	1620	1750	114.67	1635.33
in	89	1661	1750	114.67	1635.33
border	125	1625	1750	114.66	1635.34
	344	4906	5250	344.00	4906.00
	Total χ^2 df 2 = 9.34**				

* significant at P=0.05

** significant at P=0.01

N.S. not significant at P=0.05

Where the corrected χ^2 is given, this was obtained using Yates' Correction (Snedecor 1956, p.218).

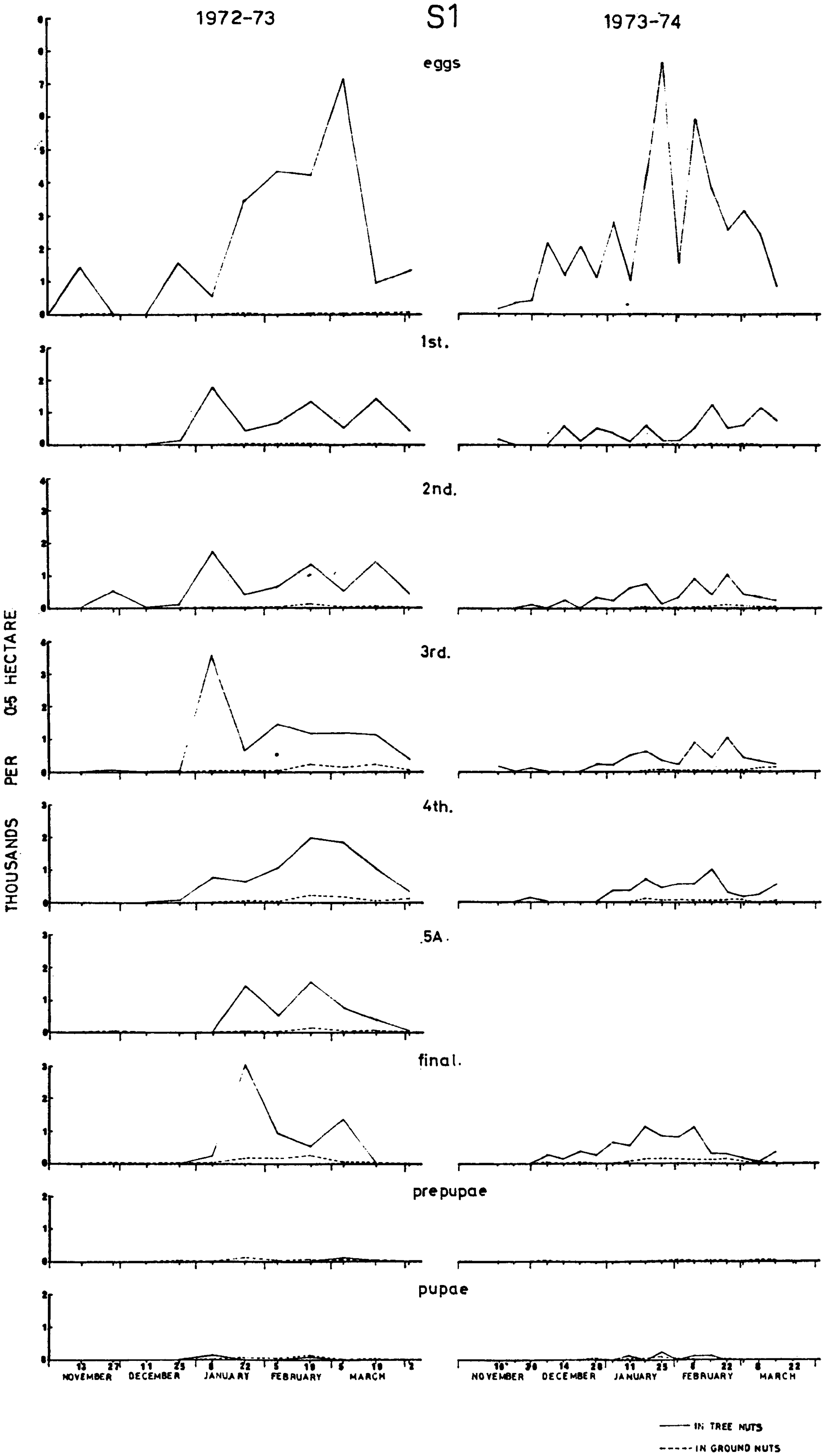
TABLE 64

SAMPLING IMMATURES

Macadamia 1971 to 1974. Summary of chi-square tests of strata differences.

Site	Year	Rows	Levels
Inala	1971-72	[1]	P = 0.05[2]
Aspley S1	1971-72	-	N.S.[3]
	1972-73	P = 0.05	N.S.
	1973-74	N.S.	-
Aspley H2	1971-72	-	N.S.
	1972-73	N.S.	P = 0.05
	1973-74	P = 0.01[4]	-
Beerwah			
Tree 146	1972-73		P = 0.01
Tree 194	1972-73		P = 0.05

1. no test
2. significant difference (P=0.05)
3. not significantly different
4. significant difference (P=0.01)

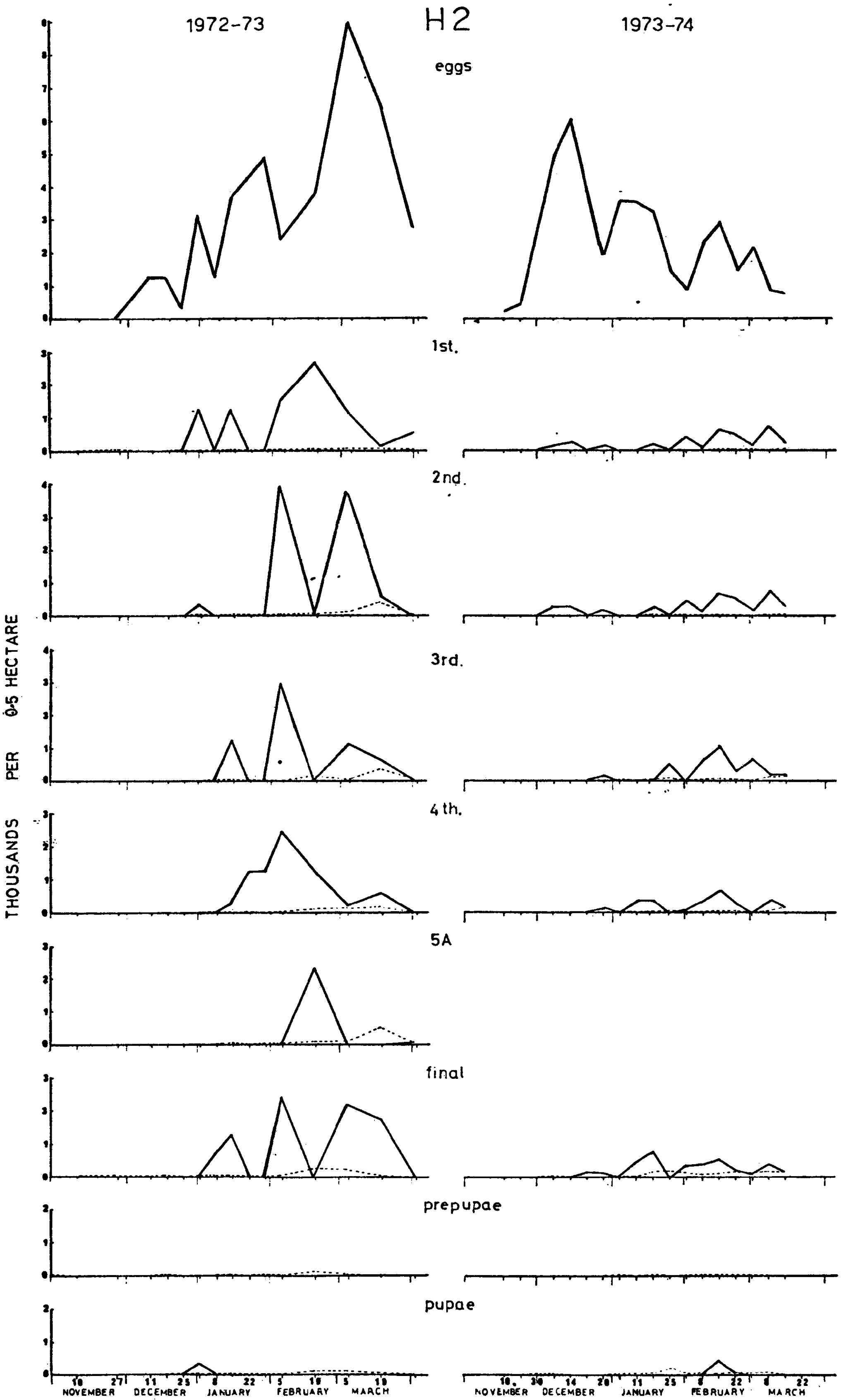


1972-73
S1
1973-74
eggs
1st.
2nd.
3rd.
4th.
5A.
final.
prepupae
pupae
THOUSANDS PER 0.5 HECTARE
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
IN TREE NUTS
IN GROUND NUTS

FIGURE 51

SAMPLING IMMATURES

Aspley S1 1972-73, 1973-74. Estimated absolute populations of *C. ombrodelta*.

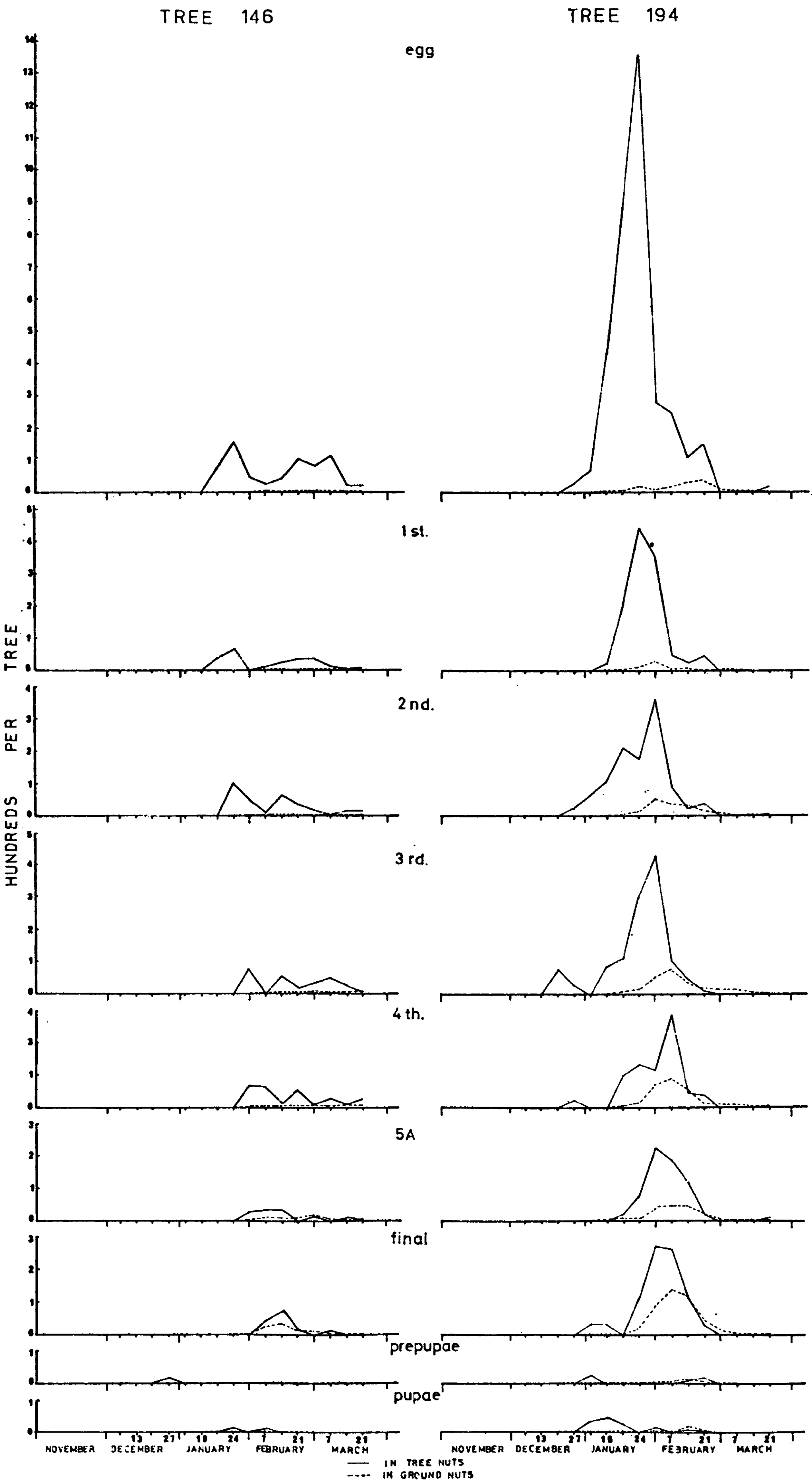


1972-73
H2
1973-74
eggs
1st.
2nd.
3rd.
4 th.
5A
final
prepupae
pupae
THOUSANDS PER 0·5 HECTARE
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 52

SAMPLING IMMATURES

Aspley H2 1972-73, 1973-74. Estimated absolute populations of *C. ombrodelta*.

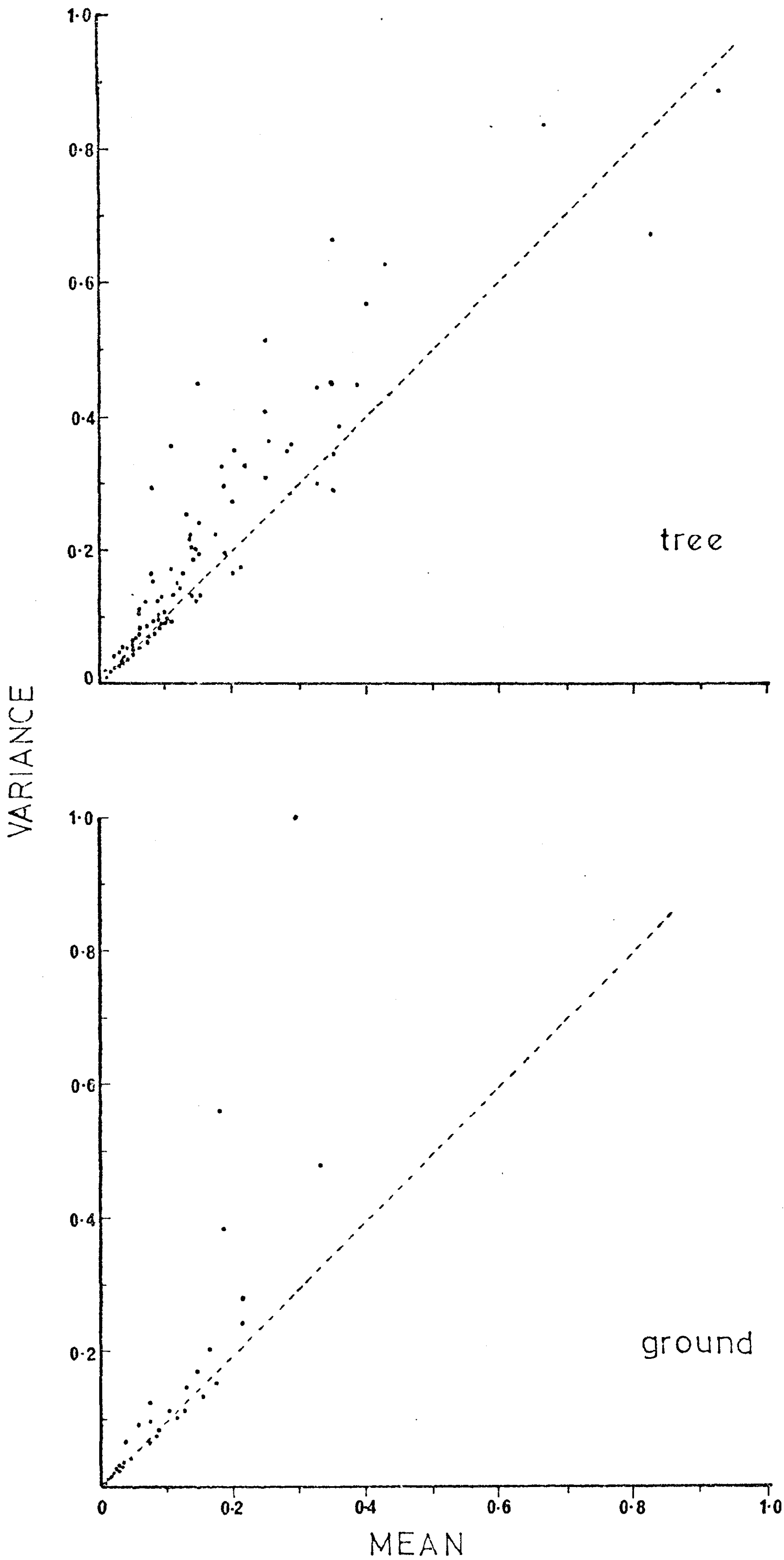


TREE 146
TREE 194
egg
1 st.
2 nd.
3 rd.
4 th.
5A
final
prepupae
pupae
HUNDREDS PER TREE
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
IN TREE NUTS
IN GROUND NUTS

FIGURE 53

SAMPLING IMMATURES

Beerwah 1972-73. Estimated absolute populations of *C. ombrodelta*.



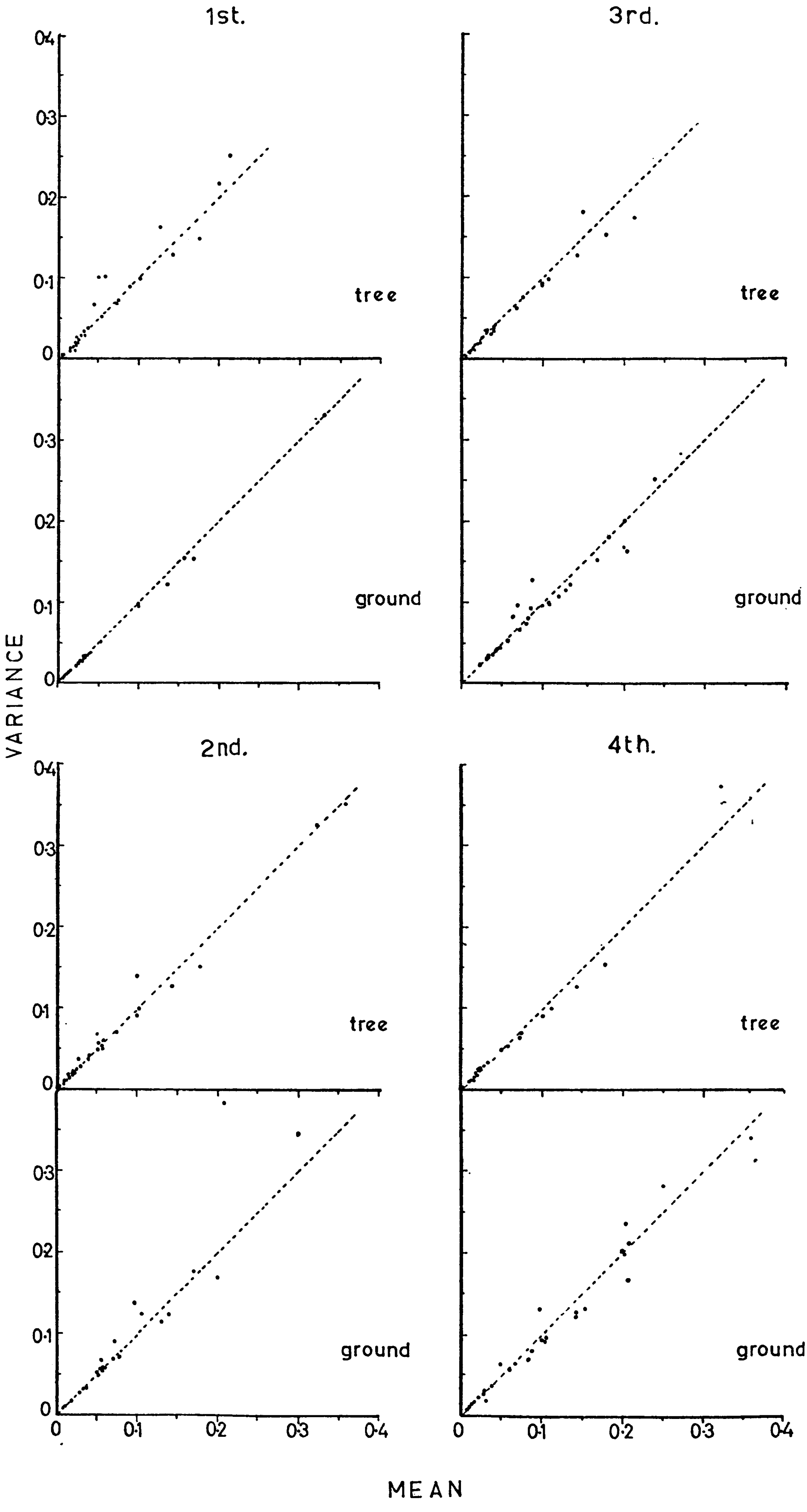
VARIANCE
MEAN
tree
ground
0
0·2
0·4
0·6
0·8
1·0

FIGURE 54

SAMPLING IMMATURES

C. ombrodelta eggs. Sample mean per nut and sample variance (s^2) for all macadamia data.

The broken line is variance = mean (Poisson distribution)



1st.
3rd.
2nd.
4th.
tree
ground
VARIANCE
MEAN
0
0·1
0·2
0·3
0·4

FIGURE 55

SAMPLING IMMATURES

C. ombrodelta larvae (1st to 4th instar). Sample mean per nut and sample variance (s^2) for all macadamia data.

The broken line is variance = mean (Poisson distribution)

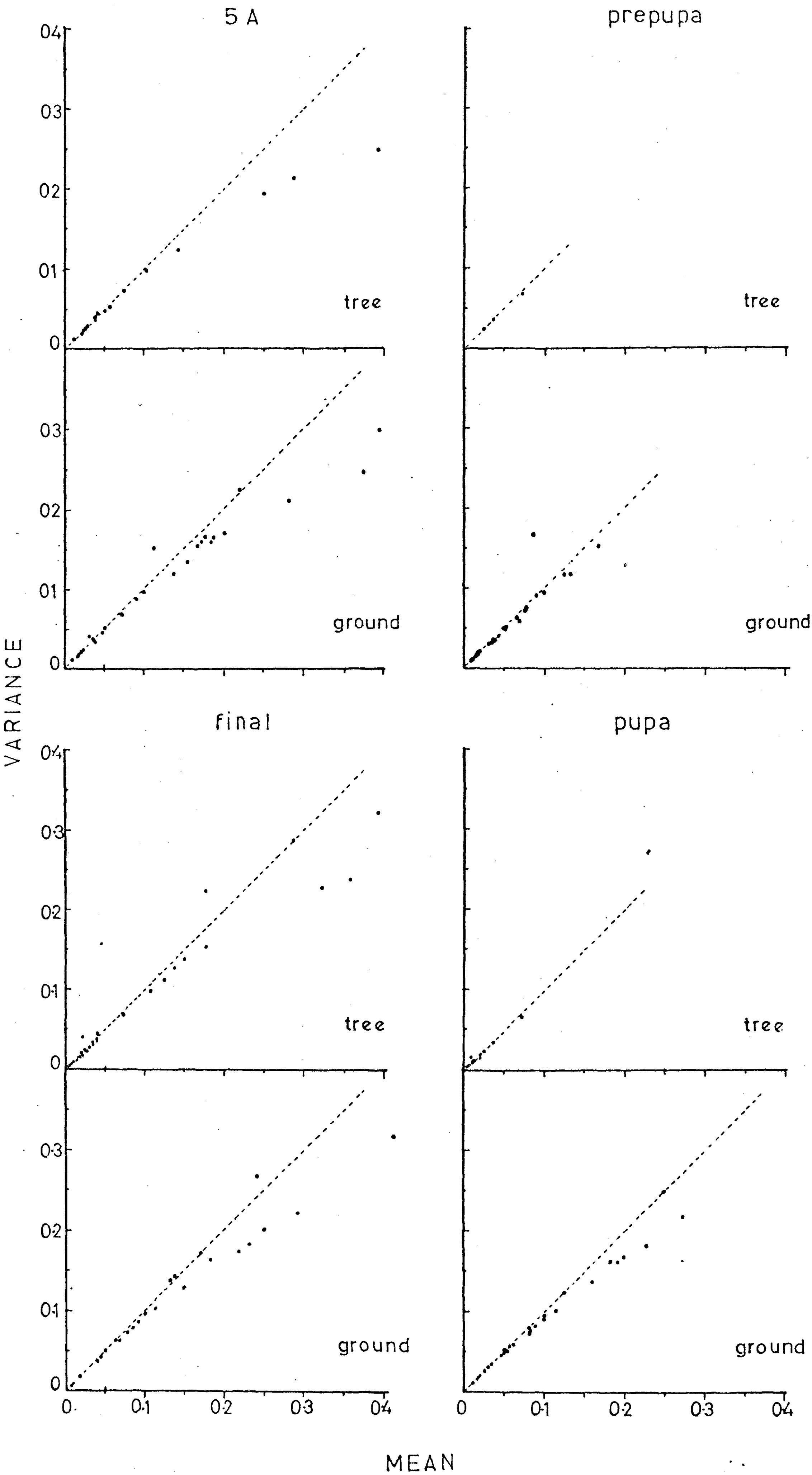
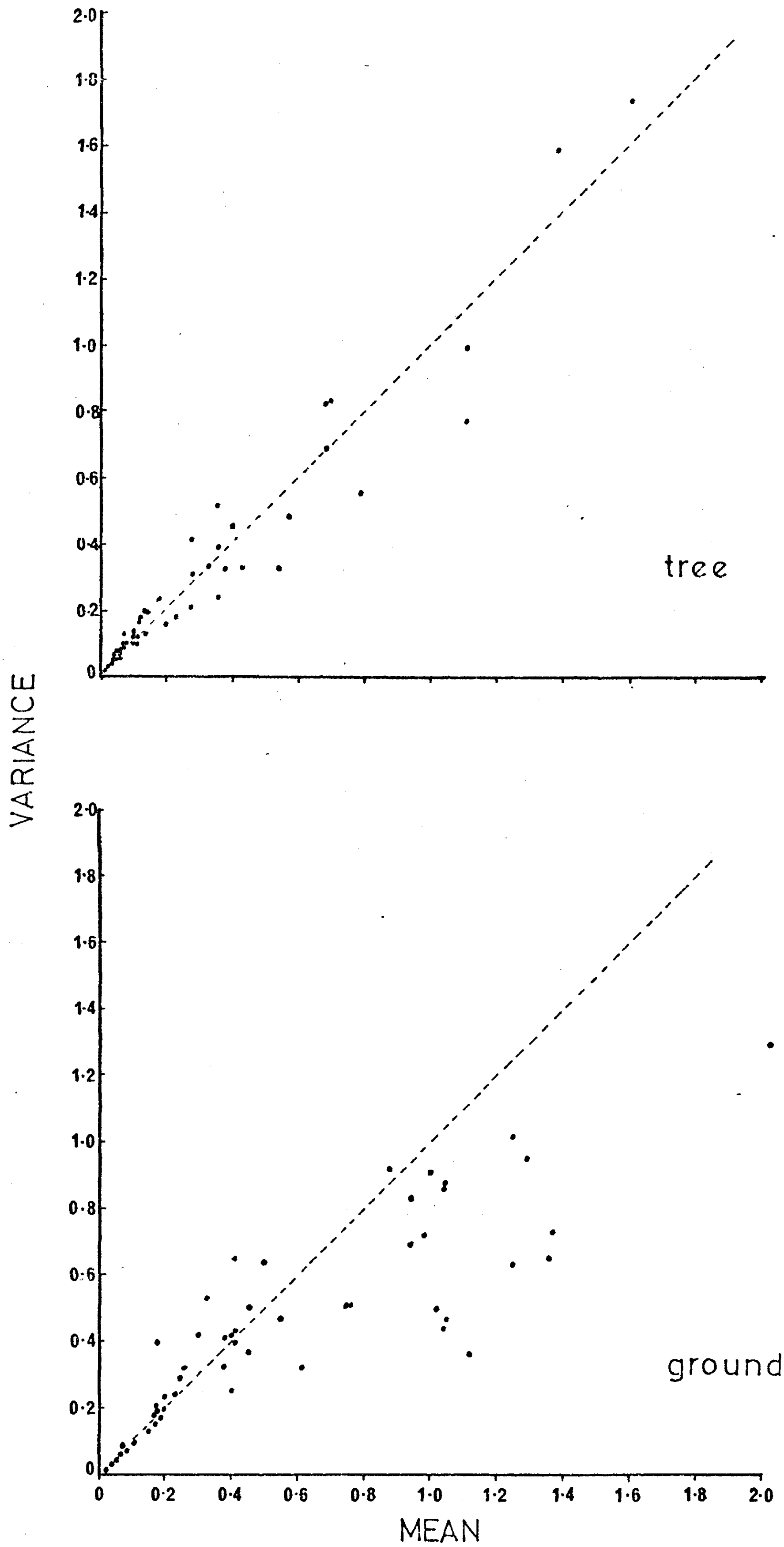

5 A
prepupa
final
pupa
tree
ground
VARIANCE
MEAN
0
0·1
0·2
0·3
0·4

FIGURE 56

SAMPLING IMMATURES

C. ombrodelta larvae (5A and Final instars), prepupae and pupae. Sample mean per nut and sample variance (s^2) for all macadamia data.

The broken line is variance = mean (Poisson distribution)



VARIANCE
2·0
1·8
1·6
1·4
1·2
1·0
0·8
0·6
0·4
0·2
0
tree
ground
0
0·2
0·4
0·6
0·8
1·0
1·2
1·4
1·6
1·8
2·0
MEAN

FIGURE 57

SAMPLING IMMATURES

C. ombrodelta immatures (excluding eggs). Sample mean per nut and sample variance (s^2) for all macadamia data.

The broken line is variance = mean (Poisson distribution)

TABLE 65

SAMPLING IMMATURES

Aspley S1 1973-74, tree nuts. Absolute population expectation with 95% confidence interval limits.

Date	Unhatched eggs		1st instar	2nd instar	3rd instar	4th instar	Final instars	Pre-pupa	Pupa
	a	b	b	b	b	b	b	b	
	-203[1]	4[1]	4	0	4	0	0	0	0
16.XI.73		*164*[2]	*164*	*0*	*164*	*0*	*0*	*0*	*0*
	782[2]	913[3]	913	605	913	605	605	605	605
	-92	40	0	0	0	0	0	0	0
23.XI.73		*350*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	591	1,205	646	646	646	646	646	646	646
	-78	89	0	4	4	4	0	0	0
30.XI.73		*433*	*0*	*130*	*130*	*130*	*0*	*0*	*0*
	510	1,264	480	803	803	803	480	480	480
	761	1,227	0	0	0	0	35	0	0
7.XII.73		*2,191*	*0*	*0*	*0*	*0*	*292*	*0*	*0*
	2,465	3,613	539	539	539	539	1,054	539	539
	581	555	147	33	0	0	3	0	0
14.XII.73		*1,211*	*539*	*269*	*0*	*0*	*135*	*0*	*0*
	1,481	2,300	1,379	972	498	498	750	498	498
	887	1,196	3	0	0	0	81	0	0
21.XII.73		*2,092*	*131*	*0*	*0*	*0*	*392*	*0*	*0*
	2,413	3,397	728	483	483	483	1,147	483	483
	436	532	141	80	31	0	31	0	0
28.XII.73		*1,163*	*517*	*387*	*258*	*0*	*258*	*0*	*0*
	1,431	2,208	1,323	1,133	933	477	933	477	477
	1,347	1,770	79	31	31	79	208	0	0
4.I.74		*2,824*	*385*	*257*	*257*	*385*	*642*	*0*	*0*
	3,042	4,275	1,126	927	927	1,126	1,498	473	473
	492	438	3	205	138	79	138	0	3
11.I.74		*1,015*	*127*	*635*	*508*	*380*	*507*	*0*	*127*
	1,259	2,000	707	1,481	1,299	1,113	1,299	469	707
	1,853	2,932	202	274	202	274	514	0	0
18.I.74		*4,242*	*624*	*749*	*624*	*749*	*1,123*	*0*	*0*
	4,222	5,926	1,456	1,629	1,456	1,629	2,131	461	461

a retransformed confidence interval limits calculated from data transformed to $\sqrt{x+\frac{1}{2}}$

b confidence interval limits of a Poisson variable - from Pearson and Hartley (1966, p.227)

1. lower limit of confidence interval
2. absolute population estimate
3. upper limit of confidence interval

(continued)

TABLE 65 (continued):

Date	Unhatched eggs		1st instar	2nd instar	3rd instar	4th instar	Final instars	Pre-pupae	Pupa
	a	b	b	b	b	b	b	b	
	3,988	6,130	3	3	75	133	342	0	3
25.I.74		*7,663*	*122*	*122*	*365*	*486*	*852*	*0*	*122*
	7,252	9,434	678	678	1,067	1,246	1,754	450	678
	678	815	3	73	29	191	331	0	0
1.II.74		*1,531*	*118*	*353*	*235*	*589*	*824*	*0*	*0*
	1,779	2,619	656	1,033	851	1,375	1,699	435	435
	2,857	4,376	187	398	398	187	553	0	3
8.II.74		*5,993*	*576*	*922*	*922*	*576*	*1,153*	*0*	*115*
	5,600	7,729	1,345	1,816	1,816	1,345	2,119	424	642
	1,886	2,720	622	124	124	467	70	0	3
15.II.74		*3,860*	*1,249*	*444*	*444*	*1,000*	*340*	*0*	*111*
	4,137	5,440	2,230	1,161	1,161	1,936	994	410	631
	1,271	1,670	167	113	496	64	64	0	0
22.II.74		*2,581*	*516*	*413*	*1,032*	*310*	*310*	*0*	*0*
	2,737	3,809	1,205	1,057	1,899	905	905	381	381
	1,498	2,065	222	415	110	24	24	0	0
1.III.74		*3,118*	*605*	*918*	*411*	*193*	*193*	*0*	*0*
	3,205	4,331	1,315	1,720	1,031	727	727	356	356
	1,078	1,587	617	683	97	55	2	0	0
8.III.74		*2,420*	*1,157*	*1,242*	*364*	*278*	*86*	*0*	*0*
	2,500	3,505	1,984	2,096	914	783	497	317	317
	372	449	348	348	79	250	117	0	0
15.III.74		*868*	*756*	*756*	*289*	*579*	*357*	*0*	*0*
	1,023	1,519	1,332	1,332	742	1,142	846	267	267
		Length of the 95% confidence interval as a % of each non zero estimate							
MEAN	110%	145%	310%	271%	294%	264%	284%		557%
Range	43-604%	43-554%	118-554%	114-615%	136-615%	147-615%	136-576%		553-566%

a retransformed confidence interval limits calculated from data transformed to $\sqrt{x+\frac{1}{2}}$

b confidence interval limits of a Poisson variable - from Pearson and Hartley (1966, p.227)

TABLE 66

SAMPLING IMMATURES

Aspley S1 1973-74, fallen nuts. Absolute population expectation with 95% confidence interval limits.[1]

Date	1st instar	2nd instar	3rd instar	4th instar	Final instars	Pre-pupa	Pupa
16.XI.73				no estimate			
	0[2]	0	0	0	0	0	0
23.XI.73	*0*[3]	*0*	*0*	*0*	*0*	*0*	*0*
	54[4]	54	54	54	54	54	54
	0	0	0	0	0	0	0
30.XI.73	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	54	54	54	54	54	54	54
	0	0	0	0	1	1	0
7.XII.73	*0*	*0*	*0*	*0*	*13*	*13*	*0*
	50	50	50	50	72	72	50
	0	0	0	0	0	0	0
14.XII.73	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	56	56	56	56	56	56	56
	0	0	0	0	1	0	0
21.XII.73	*0*	*0*	*0*	*0*	*18*	*0*	*0*
	66	66	66	66	100	66	66
	0	0	0	0	0	0	1
28.XII.73	*0*	*0*	*0*	*0*	*0*	*0*	*21*
	77	77	77	77	77	77	117
	0	0	0	0	0	0	0
4.I.74	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	75	75	75	75	75	75	75
	0	0	0	0	16	1	24
11.I.74	*0*	*0*	*0*	*0*	*59*	*14*	*73*
	52	52	52	52	151	82	172
	3	12	7	51	66	23	44
18.I.74	*21*	*43*	*32*	*106*	*128*	*64*	*96*
	77	109	93	195	222	138	181
	9	3	31	23	57	1	57
25.I.74	*39*	*28*	*83*	*69*	*125*	*14*	*125*
	122	100	181	163	237	77	237
	2	6	22	42	70	1	16
1.II.74	*20*	*31*	*61*	*92*	*132*	*10*	*51*
	73	89	133	174	226	57	118
	1	10	10	25	62	1	2
8.II.74	*9*	*36*	*36*	*63*	*116*	*9*	*18*
	50	91	91	129	198	50	64
	11	30	17	23	73	0	0
15.II.74	*42*	*74*	*53*	*63*	*137*	*0*	*0*
	108	152	123	138	234	39	39
	4	43	34	25	73	1	4
22.II.74	*32*	*108*	*92*	*76*	*153*	*16*	*32*
	110	221	200	179	281	85	110
	18	36	18	18	18	1	0
1.III.74	*64*	*97*	*64*	*64*	*64*	*17*	*0*
	166	211	166	166	166	90	60
	0	1	29	0	17	0	0
8.III.74	*0*	*28*	*108*	*0*	*80*	*0*	*0*
	100	150	276	100	237	100	100
	0	1	41	9	1	0	0
15.III.74	*0*	*40*	*149*	*74*	*40*	*0*	*0*
	148	223	381	269	223	148	148
	Length of the 95% confidence interval as a % of each non zero estimate						
MEAN	333%	296%	214%	202%	262%	500%	274%
Range	231-544%	165-555%	181-269%	136-352%	117-555%	180-579%	143-552%

1. confidence interval of a Poisson variable from Pearson and Hartley (1966, p.227)
2. lower limit of confidence interval
3. absolute population estimate
4. upper limit of confidence interval

TABLE 67

SAMPLING IMMATURES

Beerwah Tree 194 lower level. Absolute population expectation with 95% confidence interval limits.[1]

Date	Unhatched eggs	1st instar	2nd instar	3rd instar	4th instar	5th instar	Final instars	Pre-pupa	Pupa
	0[2]	0	0	0	0	0	0	0	0
6.XII.72	*0*[3]	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	99[4]	99	99	99	99	99	99	99	99
	0	0	0	0	0	0	0	0	0
13.XII.72	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
	215	215	215	215	215	215	215	215	215
	0	0	0	15	0	0	0	0	0
20.XII.72	*0*	*0*	*0*	*72*	*0*	*0*	*0*	*0*	*0*
	88	88	88	210	88	88	88	88	88
	1	0	1	1	0	0	0	0	0
27.XII.72	*23*	*0*	*23*	*23*	*0*	*0*	*0*	*0*	*0*
	129	86	129	129	86	86	86	86	86
	14	0	0	0	0	0	0	1	0
3.I.73	*68*	*0*	*0*	*0*	*0*	*0*	*0*	*23*	*0*
	198	83	83	83	83	83	83	126	83
	24	5	1	1	0	0	0	0	1
10.I.73	*89*	*22*	*44*	*22*	*0*	*0*	*0*	*0*	*44*
	227	124	160	124	82	82	82	82	160
	369	24	13	35	5	1	0	0	1
17.I.73	*565*	*87*	*65*	*109*	*43*	*22*	*0*	*0*	*22*
	827	222	190	253	157	121	80	80	121
	580	118	60	74	35	0	23	0	0
24.I.73	*816*	*236*	*150*	*172*	*107*	*0*	*86*	*0*	*0*
	1,116	422	310	338	250	79	220	79	79
	68	57	80	127	47	36	80	0	1
31.I.73	*149*	*133*	*166*	*232*	*116*	*99*	*166*	*0*	*17*
	283	261	305	389	239	216	305	61	92
	45	1	7	7	59	59	45	0	0
7.II.83	*97*	*11*	*32*	*32*	*119*	*119*	*97*	*0*	*0*
	185	60	95	95	213	213	185	40	40
	27	1	3	6	6	19	31	1	0
14.II.73	*56*	*11*	*17*	*23*	*23*	*45*	*62*	*6*	*0*
	104	41	49	58	58	89	111	31	21
	34	1	5	1	1	0	3	0	1
21.II.73	*62*	*4*	*18*	*4*	*4*	*0*	*13*	*0*	*4*
	104	25	45	25	25	16	39	16	25
	9	0	1	0	0	5	1	0	0
21.III.73	*16*	*0*	*4*	*0*	*0*	*12*	*4*	*0*	*0*
	86	31	61	31	31	74	61	31	31
	Length of the 95% confidence interval as a % of each non zero estimate								
MEAN	193%	346%	282%	326%	279%	253%	183%	522%	510%
Range	81-	129-	134-	113-	129-	129-	129-	500-	361-
	557%	600%	557%	600%	600%	545%	277%	543%	600%

1. confidence intervals of a Poisson variable from Pearson and Hartley (1966, p.227)
2. lower limit of confidence interval
3. absolute population estimate
4. upper limit of confidence interval

TABLE 68

SAMPLING IMMATURES

Leaf samples, Macadamia 1971-72. Leaf numbers sampled and eggs detected.

	Inala				Aspley S1				Aspley H2			
Date	Leaves	Eggs N	Eggs NH	Eggs D	Leaves	Eggs N	Eggs NH	Eggs D	Leaves	Eggs N	Eggs NH	Eggs D
14.I.72	150	0	0	0								
19.I.72					60	0	0	0	90	8	1	1
27.I.72	200	1	0	0								
17.II.72					50	0	0	0	60	0	0	0
24.II.72	100	0	0	0								
15.III.72					40	0	0	0	60	0	0	0
TOTALS	450	1	0	0	150	0	0	0	210	8	1	1

H = hatched

NH = not hatched

D = dead

TABLE 69

SAMPLING IMMATURES

Approximate estimates of egg numbers on Macadamia tree parts. 1972-74.

Site	Leaf	Rachis	Branch	Nut[1]
A. Number of plant parts examined				
Beerwah	2,150	274	4,300 cm	478
Aspley S1	500	50	1,000 cm	100
TOTAL	2,650	324	5,300 cm	578
B. Total eggs (hatched, unhatched, dead) detected				
Beerwah	5	24	22	565
Aspley S1	1	10	0	112
TOTAL	6	34	22	677
Eggs/100 units	0.226	10.494	0.415/m	171.128
C. Estimated total eggs in each site				
Beerwah, on each part	68	471	324	1,291
% of total	4.0	2.8	18.7	74.5
Aspley, on each part	26	21	80	385
% of total	5.1	4.1	15.6	75.2

from normal destructive sample on the same dates

TABLE 70

SAMPLING IMMATURES

Alternative hosts. Summary of the main destructive samples.

	Pods sampled	Pods with 0	1	2	3	4	5	6	7	8	9	10	11	12
							Aspley *Bauhinia* 1972							
Unhatched eggs	400	289	58	30	11	9	2			1				
Other living immatures	400	218	79	53	23	14	9	3	1					
							Cowie Road 1972-73							
Unhatched eggs	2,340	1,981	175	74	42	32	11	7	8	5	1	2		1*
Other living immatures	2,340	1,630	479	164	46	16	4	1						
							Grasspan Road 1972-73							
Unhatched eggs	3,558	3,404	121	21	6	3	1	1				1		
Other living immatures	3,558	3,190	308	46	12	1	1							
							Bald Hills 1972-73							
Unhatched eggs	450	426	14	7	1	1				1				
Other living immatures	450	399	37	12	1	1								
							Cavendish Cooke *Acacia* 1972							
Unhatched eggs	nil													
Other living immatures	210	130	59	19	1	1								
							Total regular alternative host samples							
Unhatched eggs	6,748	6,100	368	132	60	45	14	8	8	7	1	3		1*
Other living immatures	6,958	5,567	962	294	83	33	14	4	1					

* plus one pod with 18 eggs

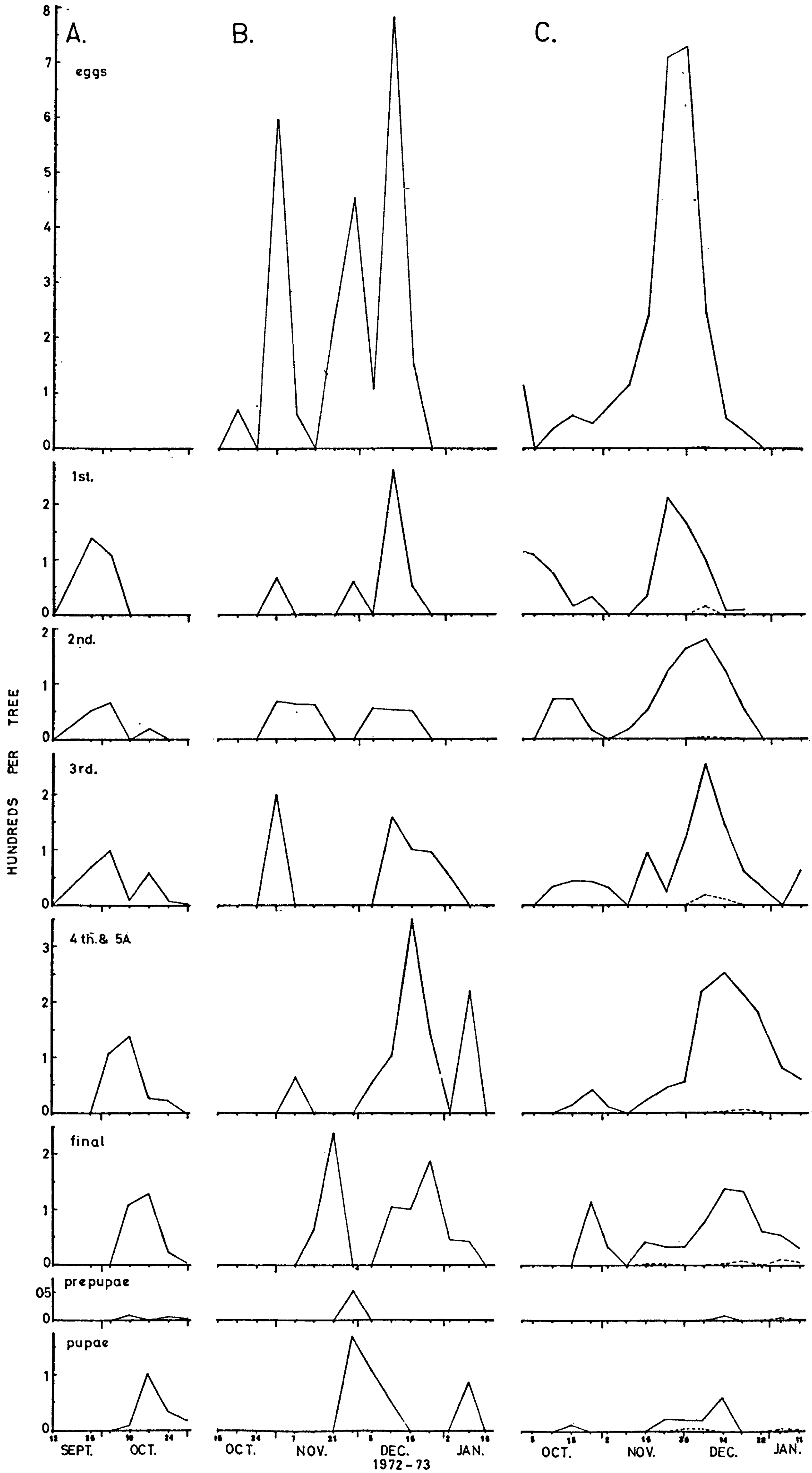
TABLE 71

SAMPLING IMMATURES

Alternative hosts. Design of the main samples.

Acacia	CAVENDISH COOKE
	7 dates x 30 infested fruit[1] (at random throughout the canopy)
Bauhinia galpinii	ASPLEY *Bauhinia*
	8 dates x 5 samples x 10 pods (samples taken from equally spaced points around the canopy)
B. variegata	BALD HILLS
	15 dates x 3 trees x 10 pods (pods taken randomly throughout each tree canopy)
	GRASSPAN ROAD
	16 dates x 4 trees x 3 levels x 2 positions[2] x 4 quadrants x 5 pods (only for 10 weeks, on other weeks fewer pods were taken from a similar distribution. Often no pods were found in certain positions)
	COWIE ROAD
	16 dates x 3 levels x 2 positions[2] x 4 quadrants x 10 pods (as for Grasspan Road)

1. infested by *U. robinsoni*
2. outside canopy and inside canopy



A.
B.
C.
eggs
1st.
2nd.
3rd.
4 th. & 5A
final
prepupae
pupae
HUNDREDS PER TREE
SEPT.
OCT.
NOV.
DEC.
JAN.
1972 - 73

FIGURE 58

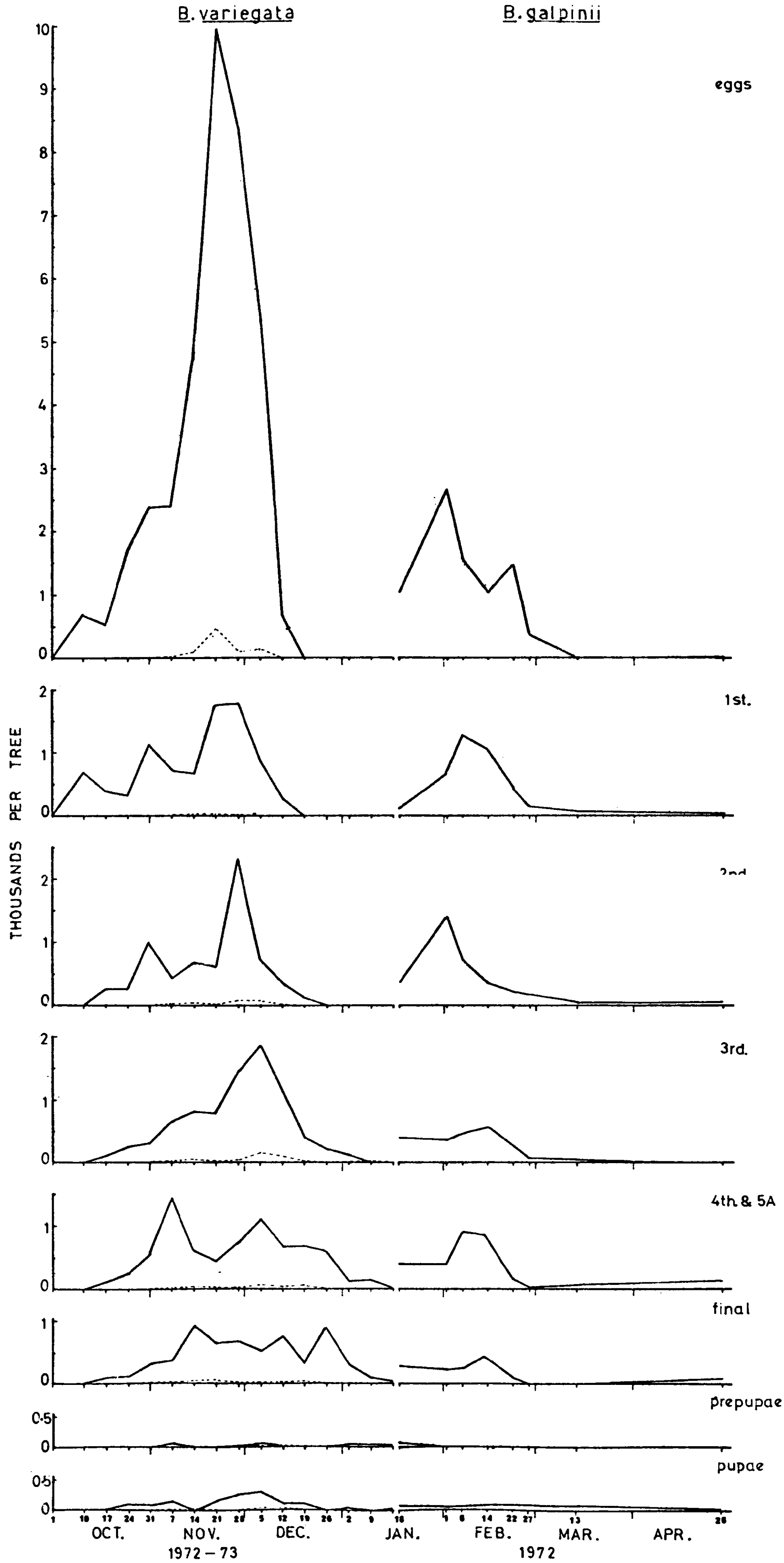
SAMPLING IMMATURES

Alternative hosts. I.Estimated absolute populations of *C. ombrodelta*.

A. Cavendish-Cooke *Acacia*

B. Bald Hills *(B. variegata)*

C. Grasspan Road *(B. variegata)*



B. variegata
B. galpinii
eggs
1st.
2nd
3rd.
4th. & 5A
final
prepupae
pupae
THOUSANDS PER TREE
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
APR.
1972 – 73
1972

FIGURE 59

SAMPLING IMMATURES

Alternative hosts. II. Estimated absolute populations of *C. ombrodelta*.

B. variegata	Cowie Road
B. galpinii	Aspley *Bauhinia*

TABLE 72

SAMPLING IMMATURES

Alternative hosts. Error estimates of unhatched eggs and 3rd instar larvae at Cowie Road, 1972-73.

Date	Pods in sample	Length of 95% C.I.[1] as % of population estimate	No. of pods for C.I. length[2] 10% of estimate	20% of estimate	Length of 95% C.I.[1] as % of population estimate	No. of pods for C.I. length[2] 10% of estimate	20% of estimate
24.X.72	160	58.7	5,518	1,380	238.8	89,077	22,622
7.XI.72	160	45.6	3,328	832	114.3	20,966	5,230
21.XI.72	160	86.4	11,949	2,987	107.9	18,685	4,659
5.XII.72	160	103.4	17,114	4,277	55.9	5,002	1,250
19.XII.72	160	-	-	-	84.2	11,347	2,837
2.I.73	30	-	-	-	284.1	24,263	6,052

1. C.I. = confidence interval
2. $n = \frac{t_1^2 s^2}{d^2}$ (Steel and Torrie 1960, p.86)

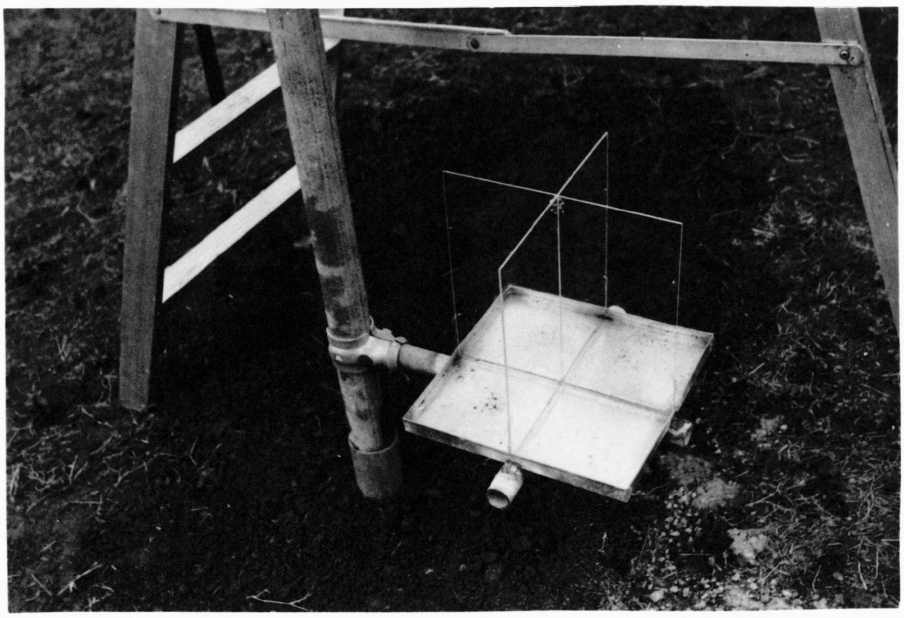
TABLE 73

SAMPLING IMMATURES

Comparison of within tree peak populations of unhatched eggs and 3rd instar larvae between the alternative hosts and Beerwah macadamia.

	Unhatched eggs	3rd instars
Acacia		98
B. galpinii	2,688	594
B. variegata		
Bald Hills	779	199
Grasspan Road	725	253
Cowie Road	9,992	1,679
Macadamia		
Tree 194	1,343	426
Tree 146	117	80

a



b

c

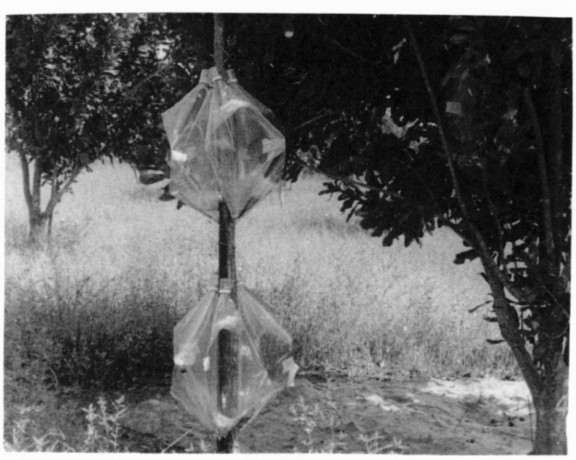


FIGURE 60

SAMPLING ADULTS

Flight traps

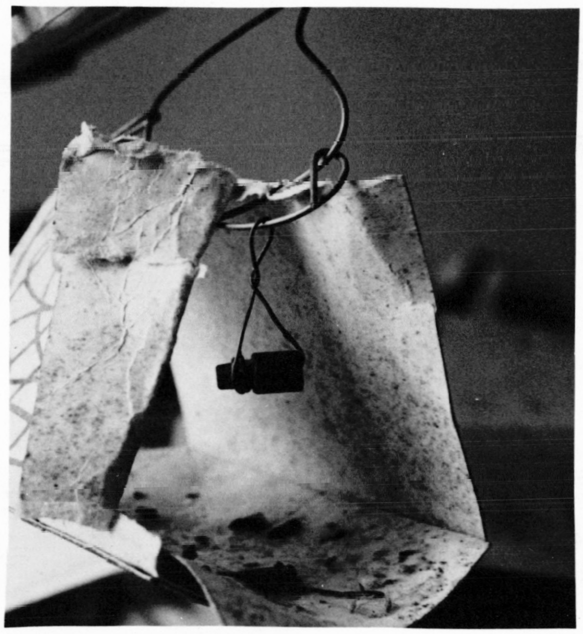
a. A 30.5 cm square rigid baffle trap

b. Rigid baffle flight traps at Aspley, 1971-72

c. Double cone flight traps. Aspley 1972-73

a

b



c

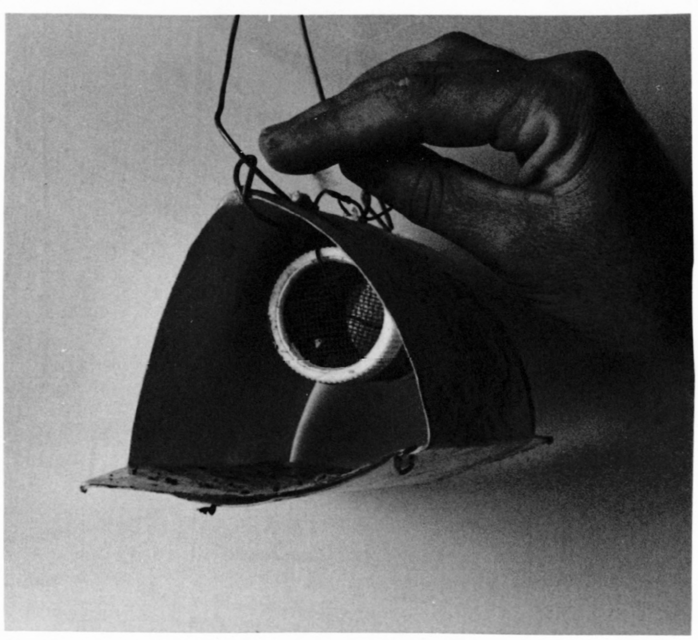


FIGURE 61

SAMPLING ADULTS

Lure traps

1973-74 Triangular cardboard trap

Exposed trap with side pulled back to show
Orfamone cap and sticky bottom

Virgin female cage in position

TABLE 74

SAMPLING ADULTS

Non pheromone traps. *C. ombrodelta* catch records

Trap	Site	Period	Number of traps	Test time per trap	Total catch
Malaise	Aspley	December 1971	2	40 hours	Nil
	Armanasco	December 1971	2	40 hours	Nil
Flight rigid baffle	Aspley	October 1971 - March 1972	16	145 days	2 males 1 female
	Inala	October 1971 - March 1972	8	140 days	1 male
Double cone	Aspley	October 1972 - March 1973	64	150 days	Nil
Sticky	Aspley	November 1971 - February 1972	20	110 days	Nil
		October 1972 - March 1973	21	152 days	Nil
	Armanasco	November 1971 - February 1972	20	95 days	Nil
Suction 22.9 cm	Beerwah	March, May 1972	1	40 days	6 males 13 females
	Beerwah	February, March 1973	1	20 days	2 males 14 females
30.5 cm	Beerwah	March 1974	1	14 days	Nil
Bait	Aspley	December 1972 - February 1973	4	42 days	Nil
	Beerwah	January - February 1973	8	42 days	Nil
Light New Jersey 6V	Aspley	November, December 1971	5	60 hours	Nil
	Armanasco	November, December 1971	5	60 hours	Nil
240V	Aspley	December 1971	1	8 hours	Nil
Rothamsted	Aspley	November, December 1971	1	28 hours	Nil
Black light	Aspley	December 1971	1	10 hours	Nil
Emergence	Cavendish Cooke-*Acacia*	August 1971	2	21 days	Nil
	Beerwah	January-March 1973	8	42 days	Nil

TABLE 75

SAMPLING ADULTS

Pheromone traps. Catch recorded for five different lures

A. Aspley

Lure	Exposure period		SW	Position centre	NE	NW	Totals	Catch/ day
Grapemone I	3.X.72 - 14.XI.72	0[1](7)[2]	0(7)	0(7)	0(11)	0(10)	0(42)	
Cablemone II	3.X.72 - 30.I.73	0(25)	0(24)	0(21)	0(28)	0(21)	0(119)	
Orfamone	14.XI.72 - 30.I.73	6(21)	4(14)	2(14)	2(14)	3(14)	17(77)	0.221
Orfamone II	3.X.72 - 30.I.73	57(24)	31(28)	7(21)	25(21)	28(25)	148(119)	1.244
Orfamone III	3.X.72 - 30.I.73	34(28)	20(25)	21(21)	11(17)	24(28)	110(119)	0.924
Control	7.XI.72 - 30.I.73	0(21)	0(21)	0(28)	0(21)	0(21)	0(112)	
Totals		97(126)	55(119)	30(112)	38(112)	55(119)	275(588)	
Catch/day		0.770	0.462	0.268	0.339	0.462		0.468

B. Beerwah

Lure	Exposure period		2	Position 3			Totals	Catch/ day
Grapemone I	3.X.72 - 24.XI.72	0(10)	0(9)	0(11)	0(11)	0(11)	0(52)	
Cablemone II	3.X.72 - 24.XI.72	0(11)	0(11)	0(10)	0(9)	0(11)	0(52)	
Orfamone	3.X.72 - 24.XI.72	4(11)	5(11)	1(11)	0(10)	0(9)	10(52)	0.192
Orfamone II	3.X.72 - 24.XI.72	15(11)	7(10)	2(9)	7(11)	4(11)	35(52)	0.673
Orfamone III	3.X.72 - 24.XI.72	5(9)	3(11)	3(11)	18(11)	4(10)	33(52)	0.635
Total		24(52)	15(52)	6(52)	25(52)	8(52)	78(260)	
Catch/day		0.462	0.288	0.115	0.481	0.154		0.300

1. catch recorded
2. days exposed

TABLE 76

SAMPLING ADULTS

Pheromone traps. Comparison of male *C. ombrodelta* catch in traps with Orfamone II lures and single virgin females.

A. Mean catch (untransformed)

Treatment	Position ..	B	C	[illegible]		Treatment mean
Orfamone II	10.00	1.67	1.67	4.00	1.67	3.80
Female 0-24 hours old	4.00	0.00	4.33	4.67	0.67	4.53
Female 24-48 hours old	6.00	4.67	2.00	3.00	3.67	4.47
Female 48-72 hours old	6.33	2.33	3.67	6.00	1.33	3.93
Position Mean	6.58	4.42	3.67	4.42	1.83	

B. Analysis of variance. F values (data transformed to log(x+1))

Source of variance	df	
Treatment		0.71
Positions	4	2.72*
Treatment x positions	12	0.67
Error	40	
Total	59	

* significant P=0.05

C. Means (transformed log(x+1))

Orfamone II	0.561
Female 0-24 hours old	0.525
Female 24-48 hours old	0.691
Female 48-72 hours old	0.592

LSD for mean treatment differences (0.05) = 0.241

TABLE 77

SAMPLING ADULTS

Pheromone traps. Comparison of male *C. ombrodelta* catch in Orfamone III lure traps at different heights in macadamia.

A. Catch (untransformed)

Area	Height	Week				TOTALS high	mid	low
			2	3				
East	high	1	9	71	20	101		
	mid	0	0	19	26		45	
	low	2	0	9	5			16
Central	high	0	0	51	15	66		
	mid	0	0	24	17		41	
	low	3	0	13	10			26
West	high	2	4	18	39	63		
	mid	0	1	19	6		26	
	low	0	0	1	7			8
TOTALS		8	14	225	145	230	112	50
Mean						19.17	9.33	4.17

B. Analysis of variance - F values
(data transformed log(x+1))

Source of variance	df	
Areas	2	1.25
Weeks	3	56.05**
Heights	2	11.26**
Areas x weeks	6	1.60
Areas x heights	4	2.51
Weeks x heights	6	2.81
Areas x weeks x heights	12	
TOTAL	35	

** highly significantly P=0.01

C. Mean catch (transformed log(x+1))

High	0.955
Mid	0.653
Low	0.521

LSD for mean differences (0.01)= 0.287

TABLE 78

SAMPLING ADULTS

Pheromone traps. Comparison of male *C. ombrodelta* catch in Orfamone III lure traps on poles and in macadamia trees.

A. Catch (untransformed)

Position	Week	Areas East	Centre	West	Total	Mean
Tree		17	36	18		
		26	27	37		
					161	26.83
Pole		22	.	8		
		31	17	30		
					115	19.17

B. Analysis of variance - F values (data transformed log(x))

Source of variance	df	
Areas		0.60
Positions		6.05
Weeks		9.75
Areas x positions		4.06
Areas x weeks		1.56
Positions x weeks		2.40
Areas x positions x weeks		
TOTAL	11	

C. Mean catch (transformed log(x))

Tree	1.215
Pole	1.409

LSD for mean differences (0.05) = 0.341

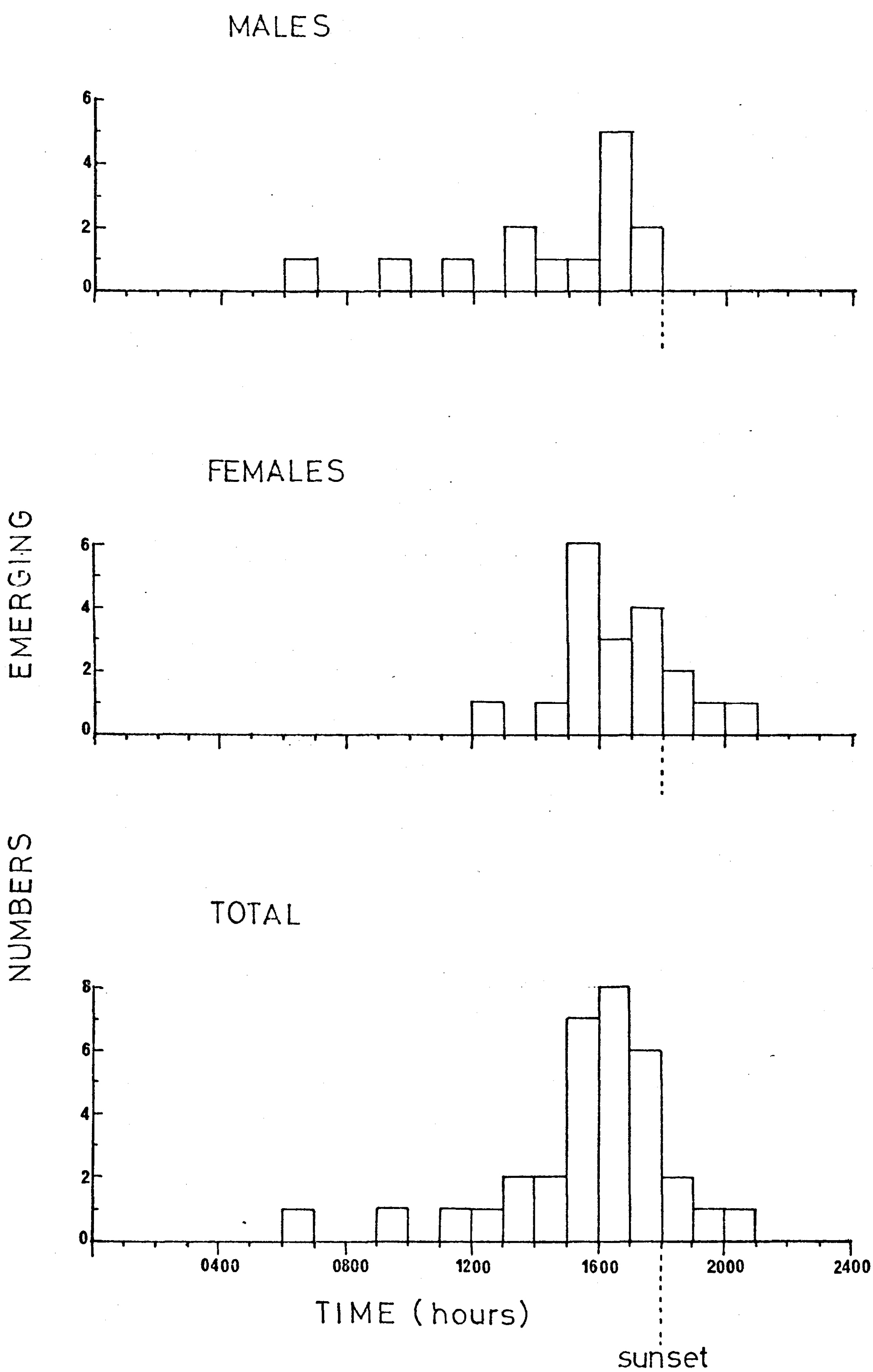

MALES
FEMALES
TOTAL
NUMBERS EMERGING
0
2
4
6
8
0400
0800
1200
1600
2000
2400
TIME (hours)
sunset

FIGURE 62

BIOLOGY AND BEHAVIOUR

Adult *C. ombrodelta* emergence times recorded in the laboratory.

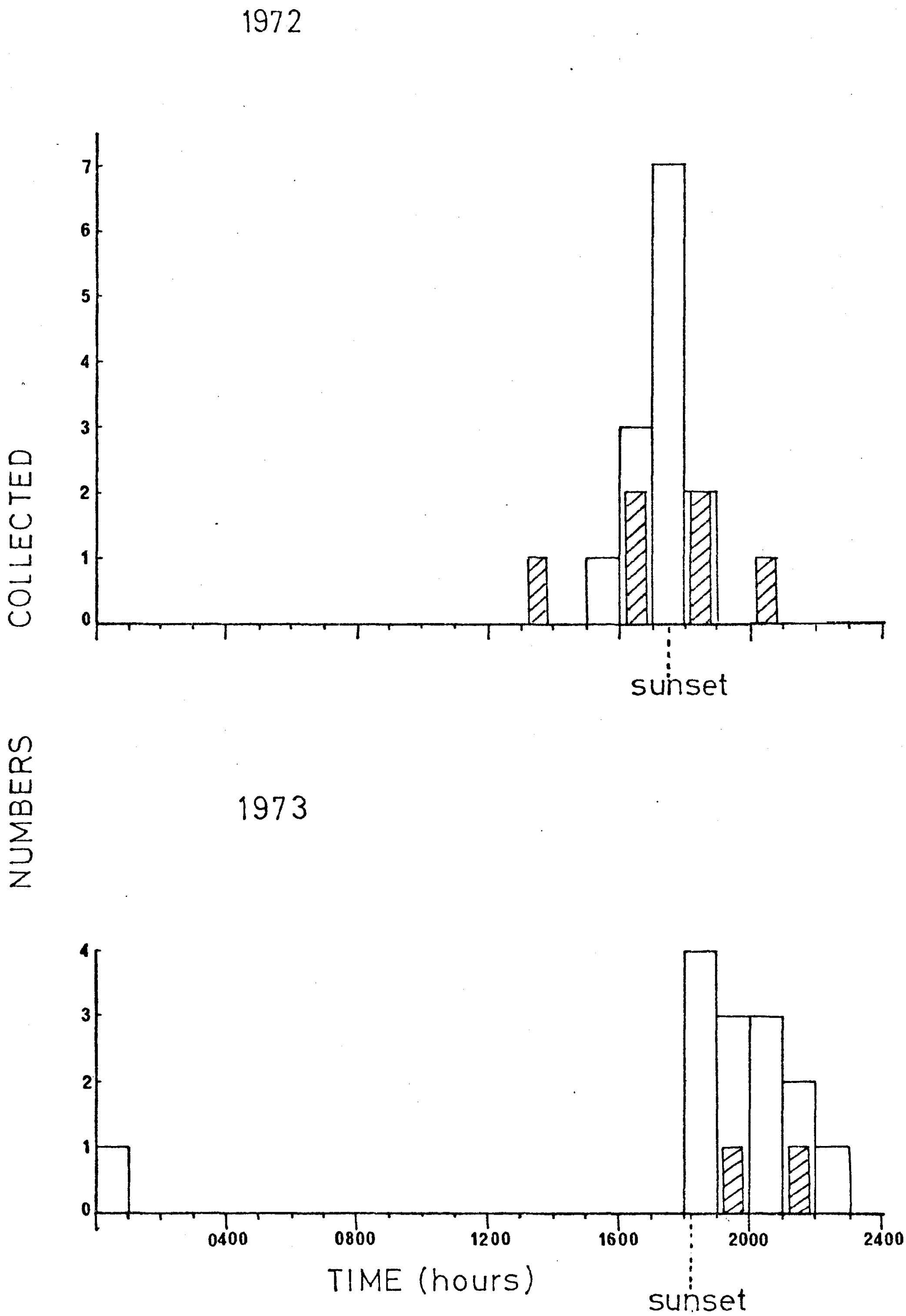

1972
NUMBERS COLLECTED
0
1
2
3
4
5
6
7
sunset
1973
0
1
2
3
4
0400
0800
1200
1600
2000
2400
TIME (hours)
sunset

FIGURE 63

BIOLOGY AND BEHAVIOUR

Time of adult *C. ombrodelta* catch in suction traps at Beerwah.

☐ female catch

▨ male catch

TABLE 79

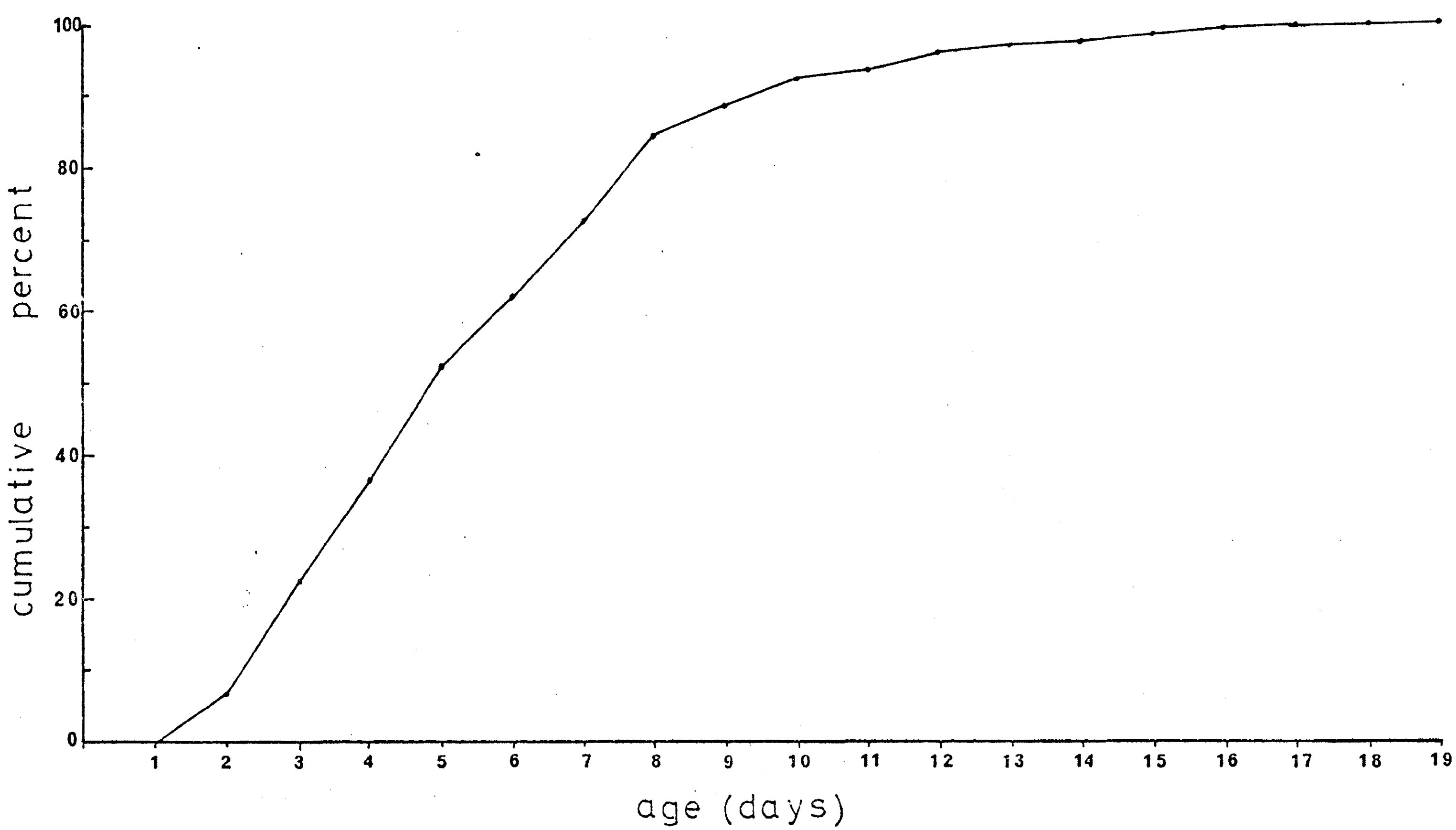
BIOLOGY AND BEHAVIOUR

Adults. Oviposition by 20 female *C. ombrodelta* in the laboratory

Eggs laid per day

Female	Days after emergence																					TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
1	0	5	81	21	27	18	15[1]																167
2	0	0	31	8	18																		57
3	0	19	42	13	2																		76
4	0	0	20	33	28	17	0	7	22	12	9	3	1	8	5	2							167
5	0	0	12	10	8	5	0	0	0	0	0	0	0	0	1	0	0						36
6	0	12	28	36	12	16	26	8	12	0	3	1	13	1	0								168
7	0	3	14	8	13	2	5	2	2	4	2	5	0	0	0	4							64
8	0	49	27	31	14	37	15	22	13	2	1	0	0	0	0	0							211
9	0	5	7	5	27	19	0	33	15	8	5	0	0										124
10	0	0	5	0	5	28	19	19	8	1	0	0	0	0									85
11	0	10	0	11	50	10	21	36	18	18	11	1	9	0	9	9	0	1					214
12	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0					4
13	0	0	0	0	0	1	2	1	0	3	0	2	0	0	0								9
14	0	0	0	7	17	3	11	13	4	7	0	9	3	1	4	12	2	1	1				95
15	0	1	0	3	15	11	9	22	6	1	4	2	0	0	0								74
16	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0								5
17	0	10	2	12	1	1	1	0	0	0	0	0	0										27
18	0	1	18	30	18	13	1	7	0	0	0	0											88
19	0	62	30	68	33	19	8	6	2	0	0	0	0	0	0	0	0	0	0				228
20	0	0	12	33	40	44	17	37	18	4	8	12	6	0	6	8	0	0	0	0	0	0[2]	245
TOTAL	0	177	329	329	330	244	154	216	120	60	43	35	32	10	25	35	2	2	1	0	0	0	2144
MEAN[3]																							107.20

1. In each horizontal line where no figures are shown, the female had died.
2. Female 20 died on day 22.
3. Mean life span was 14.50 days, standard error(s) 4.51.



cumulative percent
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
age (days)

FIGURE 64

BIOLOGY AND BEHAVIOUR

Accumulative percent egg laying per day of female *C. ombrodelta* age.

TABLE 80

BIOLOGY AND BEHAVIOUR

Adults. Cage trials showing variety and damage preference in oviposition.

A. Mean numbers of eggs per nut in a 24 hour period.

	S1		H2	
	Damaged	Undamaged	Damaged	Undamaged
Date 1	5.50	1.75	4.00	8.25
Date 2	4.75	1.25	6.25	7.50
Date 3	4.75	3.50	6.25	2.75
Date 4	5.75	3.50	6.75	5.25
Date 5	25.75	8.25	19.75	17.00
Date 6	1.00	0.25	2.50	0.75
Mean	7.92	3.08	7.58	6.92

B. Analysis of variance - F values (data transformed to log(x+1))

Source	df	
Dates	5	13.75**
Varieties	1	3.33
Damage	1	4.07*
Dates x varieties	5	0.21
Dates x damage	5	0.16
Varieties x damage	1	0.98
Dates x varieties x damage	5	0.88
Nuts within	72	
TOTAL	95	

** highly significant P=0.01

* significant P=0.05

C. Means (transformed log(x+1))

	S1	H2	Mean
Damaged	0.6985	0.7572	0.7278
Undamaged	0.4733	0.6854	0.5793
Variety mean	0.5859	0.7213	

LSD (0.05) for mean differences:

damage = 0.1414 variety = 0.1414

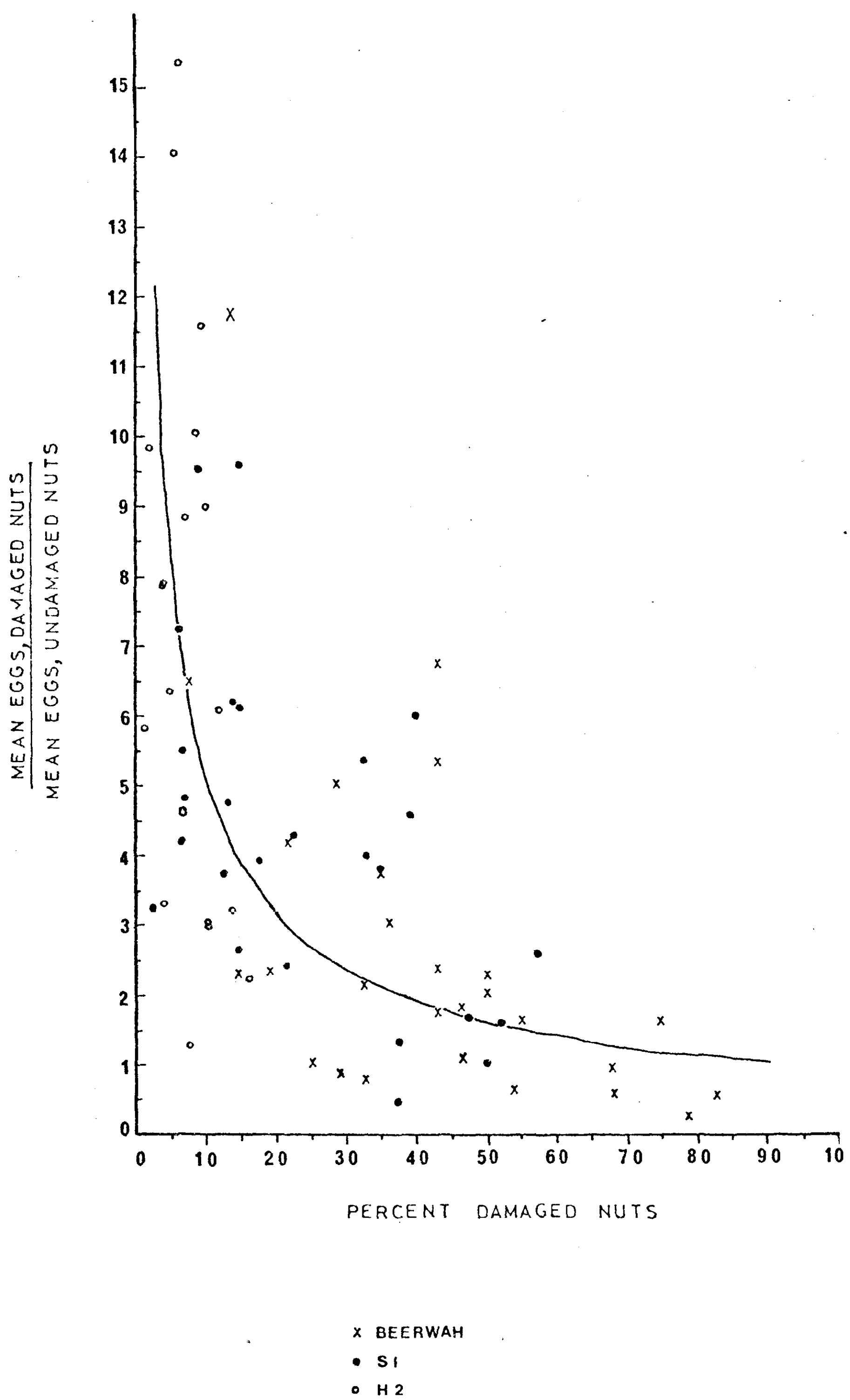

MEAN EGGS, DAMAGED NUTS / MEAN EGGS, UNDAMAGED NUTS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
10
20
30
40
50
60
70
80
90
10
PERCENT DAMAGED NUTS
x BEERWAH
• S1
o H2

FIGURE 65

BIOLOGY AND BEHAVIOUR

Female *C. ombrodelta* preference for oviposition on damaged nuts.

The curve depicts $\text{egg ratio} = \dfrac{26.29}{(\%\ \text{damage})^{0.709}}$

TABLE 81

BIOLOGY AND BEHAVIOUR

Adults. Linear regression of egg ratio (Y) against per-cent crop damage (X).

Site		Regression coefficient b	Number of observations N	Linear correlation coefficient r	Linear relationship
Beerwah	1972-73	-1.1424	28	-0.7332**	log $\hat{Y}$=-1.1424 log X+ 2.0573
S1	1972-73	-1.0596	17	-0.7206**	log $\hat{Y}$=-1.0596 log X+ 2.0499
S1	1973-74	+0.8070	12	+0.1140	
H2	1972-73	-1.1325	5	-0.5967	
H2	1973-74	-0.5516	16	-0.4640	

** significantly different from zero (P=0.01)

TABLE 82

BIOLOGY AND BEHAVIOUR

Adults. Analysis of covariance for the homogeneity of the regressions of egg ratio on percent crop damage at Beerwah and S1 1972-73.

Site	df	Σx^2	Σxy	Σy^2	Regression coefficient r	Deviations from regression df	$d^2_{y.x}$ [1]	Mean square	F
Beerwah	27	2.6325	-3.0074	6.3902	-1.1424	26	2.9545	0.1136	
S1 1972-73	16	1.6772	-1.7771	3.6265	-1.0596	15	1.7436	0.1162	
Within						41	4.6981	0.1146	
Reg.coeff.						1	0.0070	0.0070	N.S.
Common	43	4.3097	-4.7845	10.0167	-1.1102	42	4.7051	0.1120	
Adj.means						1	0.1375	0.1375	N.S.
Total	44	4.3809	-4.9634	10.4659		43	4.8426	0.1126	

N.S. no significant difference at P=0.05

1. $\Sigma y^2 - \frac{(\Sigma xy)^2}{\Sigma x^2}$

Regression of both sites pooled:-

$\log \hat{Y} = -1.1330 \log X + 2.0857$

Analysis of variance. Common regression of egg ratio on % crop damage at both sites.

Source of variance	df	Sum of squares	Mean square	
Total	42	10.4659		
Regression	1	5.6233	5.6233	47.61**
Deviation from regression	41	4.8426	0.1181	

** significantly different from zero (P=0.01)

N.S. not significant (P=.05)

TABLE 83

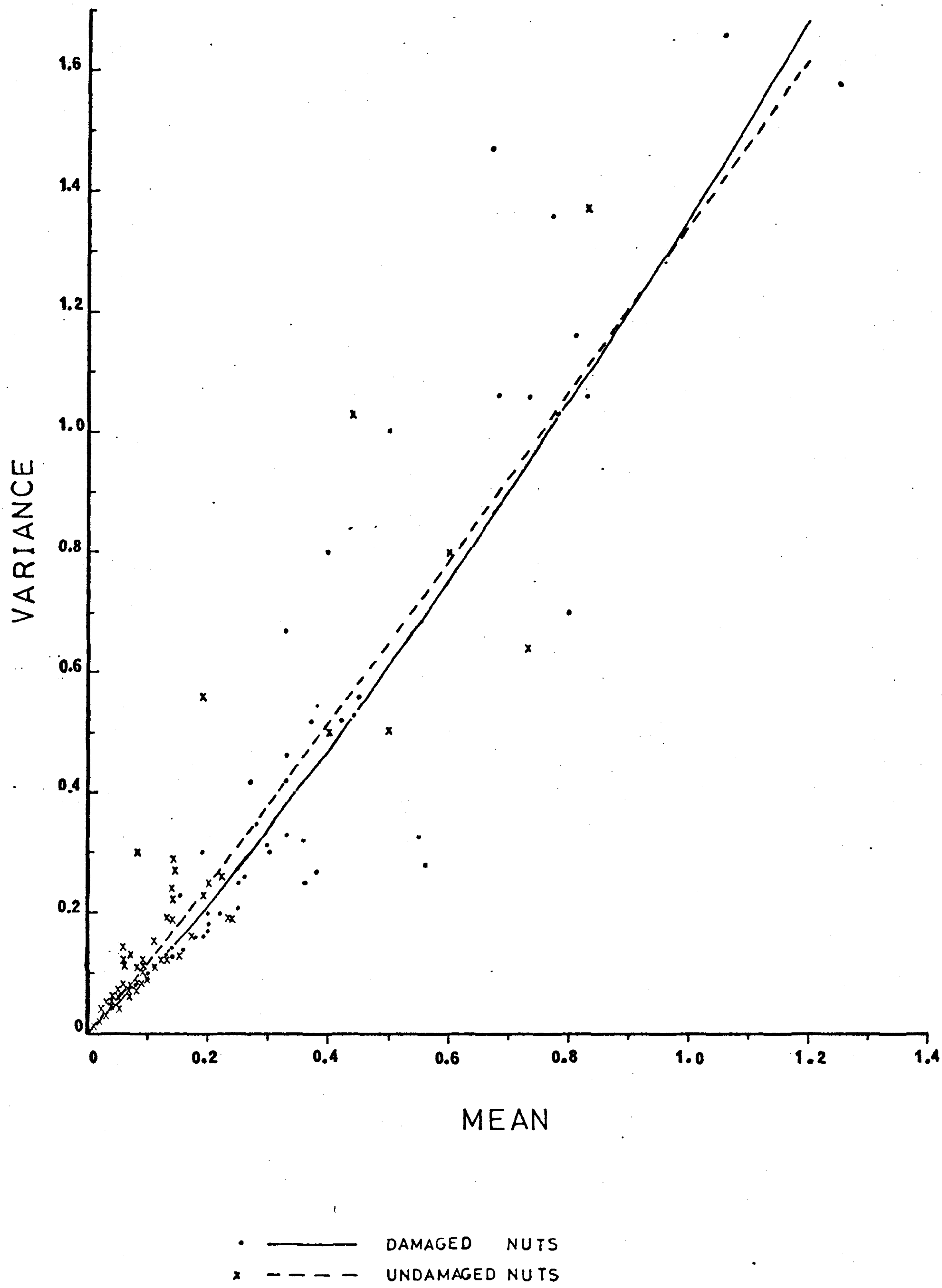
BIOLOGY AND BEHAVIOUR

Adults. Analysis of variance of the multiple regression of egg ratio (Y) against percent crop damage (X_1) and unhatched egg density (X_2)

Source of variance	df	Sum of squares	Mean square	
Total	77	17.0303		
Regression due to % crop damage		8.1984	8.1984	70.55**
Deviation from simple regression	76	8.8319	0.1162	
Additional regression due to unhatched egg density		0.2676	0.2676	2.34 N.S.
Deviation from multiple regression		8.5643	0.1142	

** regression significant at P=0.01

N.S. not significant, P=0.10



VARIANCE
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
MEAN
DAMAGED NUTS
UNDAMAGED NUTS

FIGURE 66

BIOLOGY AND BEHAVIOUR

Female *C. ombrodelta* oviposition: plot of sample variance (s^2) against mean eggs per nut in damaged and undamaged nuts.

For damaged nuts $s^2 = 1.357\bar{x}^{1.154}$

For undamaged nuts $s^2 = 1.346\bar{x}^{1.043}$

TABLE 84

BIOLOGY AND BEHAVIOUR

Analysis of covariance for homogeneity of the linear regression of log(variance - s^2) on log(mean - unhatched eggs/nut) for damaged and undamaged nuts.

Class	df	Σx^2	Σxy	Σy^2	Deviations from regression: Reg. coeff. r	df	$d^2_{y.x}$ [1]	Mean square	F
Damaged	52	4.3976	5.0760	6.9282	1.1543	51	1.0690		
Undamaged	64	10.6303	11.0882	12.7645	1.0431	63	1.1985		
Within						114	2.2675	0.0199	
Reg.coeff.						1	0.0385	0.0385	1.93 N.S.
Common	116	15.0279	16.1642	19.6927	1.0756	115	2.3060	0.0201	
Adj.means						1	0.0960	0.0960	4.78*
Total	117	23.7557	24.4033	27.4705		116	2.4020		

N.S. F for difference of regression coefficients $\frac{0.0385}{0.0199}$ was not significantly different (P=0.05)

F for difference between adjusted means $\frac{0.0960}{0.0201}$ was significantly different (P=0.05)

$$\Sigma d^2_{y.x} = \Sigma y^2 - \frac{(\Sigma xy)^2}{\Sigma x^2}$$

FIGURE 67

BIOLOGY AND BEHAVIOUR

A sticky cone used to detect *C. ombrodelta* larval movement from tree nuts.

a

b

c

FIGURE 68

BIOLOGY AND BEHAVIOUR

Cups and trays used to detect *C. ombrodelta* larval movement from fallen nuts.

Plastic tray used in large cage

Field cup with covering gauze removed

Field tray

TABLE 85

BIOLOGY AND BEHAVIOUR

Immatures. Sticky cone experiment to determine larval movement within macadamia trees.

Weekly summary of events

Week	Eggs laid	Dead eggs	Larvae fallen into cone	Larvae in medium
0	390			
1		10	61	14
2			31	2
3			0	0
4			1[a]	0
5			4[a]	0
6			0	0

, These larvae were final instars which emerged from nuts which had fallen to the bottom of the cones and been submerged after heavy rain. The larvae had drowned. The complete submergence of nuts is unnatural and these larvae should not be classified as having moved out of tree nuts.

Budget

Age interval	Number	Cause of loss	Number lost
Egg	390	infertility	10
Pre-establishment larvae	380	falling from nut	92
		death	1
		moving along branch	16
			109
Established larvae	271	falling in nuts	270[b]
Adults	1		

. by difference. The fallen nuts were transferred to field trays. In these only 11 adults emerged and only 12 other larvae could be accounted for; therefore 247 of 390 or 63.3% of the total was unaccounted for.

TABLE 86

BIOLOGY AND BEHAVIOUR

Immatures. Pupal bands : mean numbers of pupae collected; absolute populations for bands and tree nuts compared.

BEERWAH TREE 194

Date	Mean/band ± $s_{\bar{x}}$[1]	Tree band total[2]	Tree nut total[4]
3.I.73	0.091 ± 0.091	2	23
10.I.73	0.136 ± 0.075	6	44
17.I.73	0.136 ± 0.075	6	22
24.I.73	0.045 ± 0.046	2	0
31.I.73	0.033 ± 0.033	2	17
7.II.73	0.067 ± 0.046	4	0
14.II.73	0 -	0	6
21.II.73	0	0	4

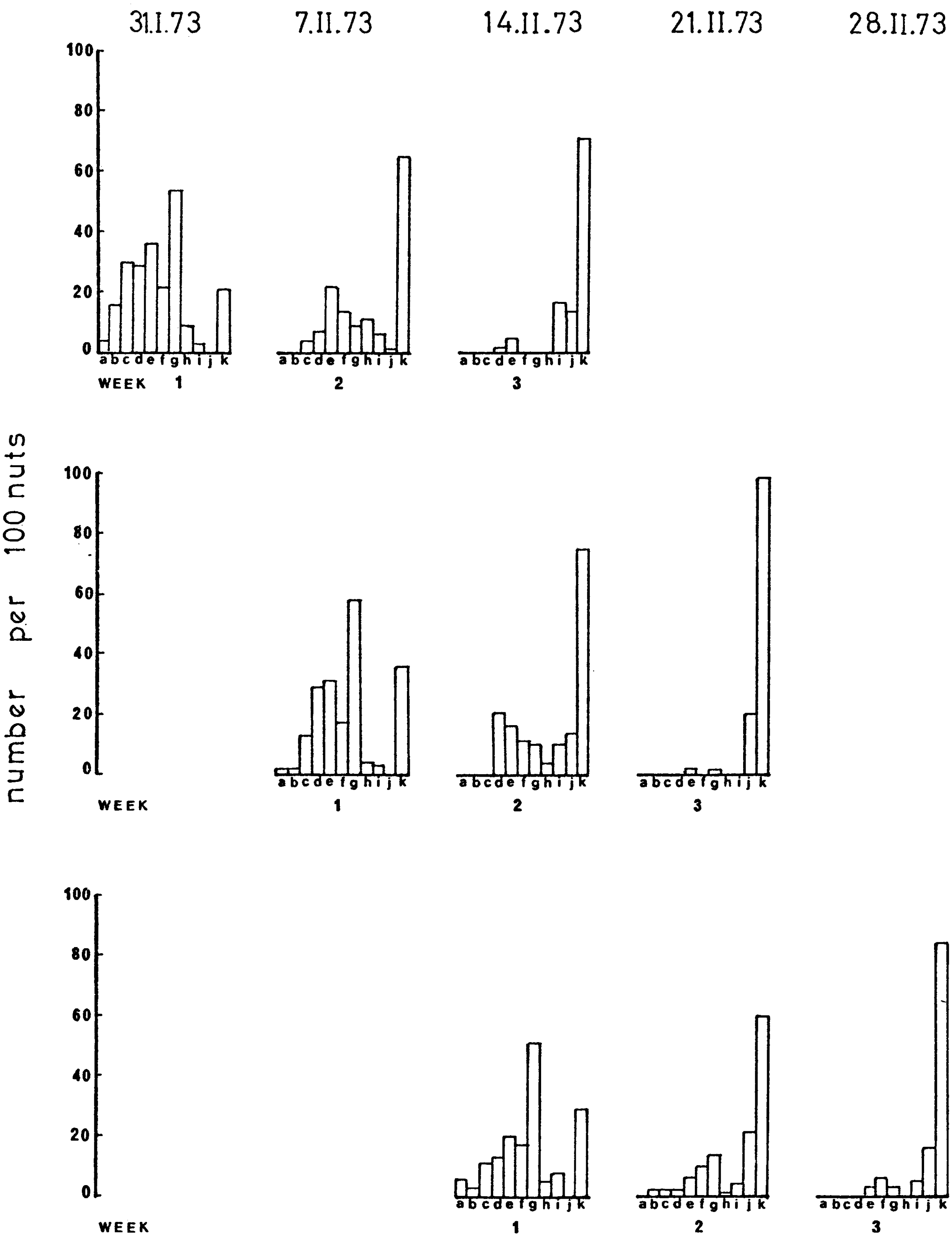
ASPLEY S1

	Outside row				Inside row			
Date	Trunk band Mean/band ± $s_{\bar{x}}$	Canopy band Mean/band ± $s_{\bar{x}}$	Row band total[3]	Row nut total[4]	Trunk band Mean/band ± $s_{\bar{x}}$	Canopy band Mean/band ± $s_{\bar{x}}$	Row band total[3]	Row nut total[4]
26.I.73			-	-	0.167 ± 0.167	0.042 ± 0.042	33	
2.II.73	- -	- -	-	-	0.167 ± 0.167	0.042 ± 0.042	33)	-
9.II.73	0.333 ± 0.211	0.125 ± 0.069	17	0	0.333 ± 0.211	0.125 ± 0.092	92	
16.II.73	0.333 ± 0.333	0.083 ± 0.058	13)		0.333 ± 0.211	0	9)	
23.II.73	0.333 ± 0.333	0 -	3		0 -	0	0	
2.III.73	0	0.083 ± 0.058	9)		0	0	0)	
9.III.73	0	0 -	0		0	0	0	
16.III.73	0	0	0)	0	0	0	0)	
23.III.73	0	0	0	0	0	0	0	

ASPLEY H2 (all rows)

Date	Trunk band Mean/band ± $s_{\bar{x}}$	Canopy band Mean/band ± $s_{\bar{x}}$	Variety band total[3]	Variety nut total[4]
26.I.73	0.167 ± 0.167	0	13	0
2.II.73	0 -	0	0	-
9.II.73	0.083 ± 0.121	0 -	6	
16.II.73	0.083 ± 0.121	0.083 ± 0.121	25)	
23.II.73	0.250 ± 0.250	0.083 ± 0.121	37	
2.III.73	0.167 ± 0.167	0.167 ± 0.112	51)	
9.III.73	0.083 ± 0.121	0.083 ± 0.121	25	
16.III.73	0.083 ± 0.121	0.083 ± 0.121	25)	
23.III.73	0.167 ± 0.167	0 -	13	0

1. $s_{\bar{x}} = \sqrt{\frac{s^2}{n}}$, where s^2 is the sample variance, n is the number in the sample.
2. Estimate if all the tree had had complete band coverage.
3. Estimate if all the trees had had full band coverage.
4. Estimate from the regular destructive samples.



a = unhatched eggs
b 1st.
c 2nd.
d 3rd.
e 4th.
f 5A
g final
h = prepupae
i pupae in nuts
j pupae in barriers
k deserted holes

FIGURE 69

BIOLOGY AND BEHAVIOUR

Beerwah Barriers: Estimates of the decline in numbers of *C. ombrodelta* immatures, in fallen nuts.

Week 1 - estimate of numbers in nuts which had fallen during that week.

Weeks 2 and 3 - estimates of numbers in the same nut series, after a further 1 and 2 weeks respectively, on the ground.

TABLE 87

BIOLOGY AND BEHAVIOUR

Immatures. Beerwah barriers: errors of estimation of larval numbers in nuts; estimation of population development in, and prepupal movement from, fallen nuts at Beerwah 1972-73.

A. The mean length of the 95% confidence interval of estimate as a % of that estimate for each week of each fallen nut series (excluding estimate of zeros).

	Week 1	Week 2	Week 3
Series 1	75.1%	127.7%	153.8%
Series 2	79.1%	136.1%	194.9%
Series 3	75.6%	211.0%	166.1%

B. Pooled estimates of stages per 300 nuts at examination times; 1, 2, 3 weeks after fall.

Stage	Week 1	Week 2	Week 3
Unhatched eggs	12	0	0
1st instar	21	1	0
2nd instar	54	5	0
"3rd instar"	70	28	2
"4th instar"	92	45	10
"5A"	57	35	7
Final instars	163	33	5
Prepupae	18	15	0
Pupae in nuts	11	21	22
Pupae in barriers	-	37	55
Deserted holes	88	209	253
Decrease in TOTAL LIVING STAGES (on those of previous week)	-	55.8%	54.1%
Increase in DESERTED HOLES (on those of previous week)	-	237.5%	121.1%
% of total prepupae or pupae in barriers	-	63.8%	71.4%

TABLE 88

BIOLOGY AND BEHAVIOUR

Immatures. Recorded fate of larvae from fallen nuts. Cups and trays 1973-74.

Source	Nuts	Pupae: In nuts	Pupae: Out of nuts	Larvae: Dead in nuts	Larvae: Dead out of nuts	Larvae: Passing barriers	Nuts where larvae vanished
A. Watered every 2 days							
(1) plastic trays over water. Large cage.							
Falling Dec.1973	17	22	0	0	0	1	0/17
Jan.1974	8	5	1	0	0	0	2/8
Mar.1974	25	1	0	0	0	5	17/25
(2) cups on Stickem. Roofed ambient conditions.							
Falling Jan.-Feb. 1974	20	[illegible]			[illegible]	10	3/20
B. Never watered							
(1) plastic trays over water. Large cage.							
Falling Dec.1973	18	9	3	0	5	1	0/18
Jan.1974	8	6	0	0	0	0	3/8
C. Field conditions							
(1) field trays							
Falling Jan.1974	31	13					13/31
(2) field cups							
Falling Jan.-Feb. 1974	19			[illegible]	[illegible]		9/19
ALL SOURCES	146	70		3[a]	10[b]	24[c]	47/146

a. 2 mature larvae, 1 2nd instar

b. 10 mature larvae

c. 23 mature larvae, 1 4th instar

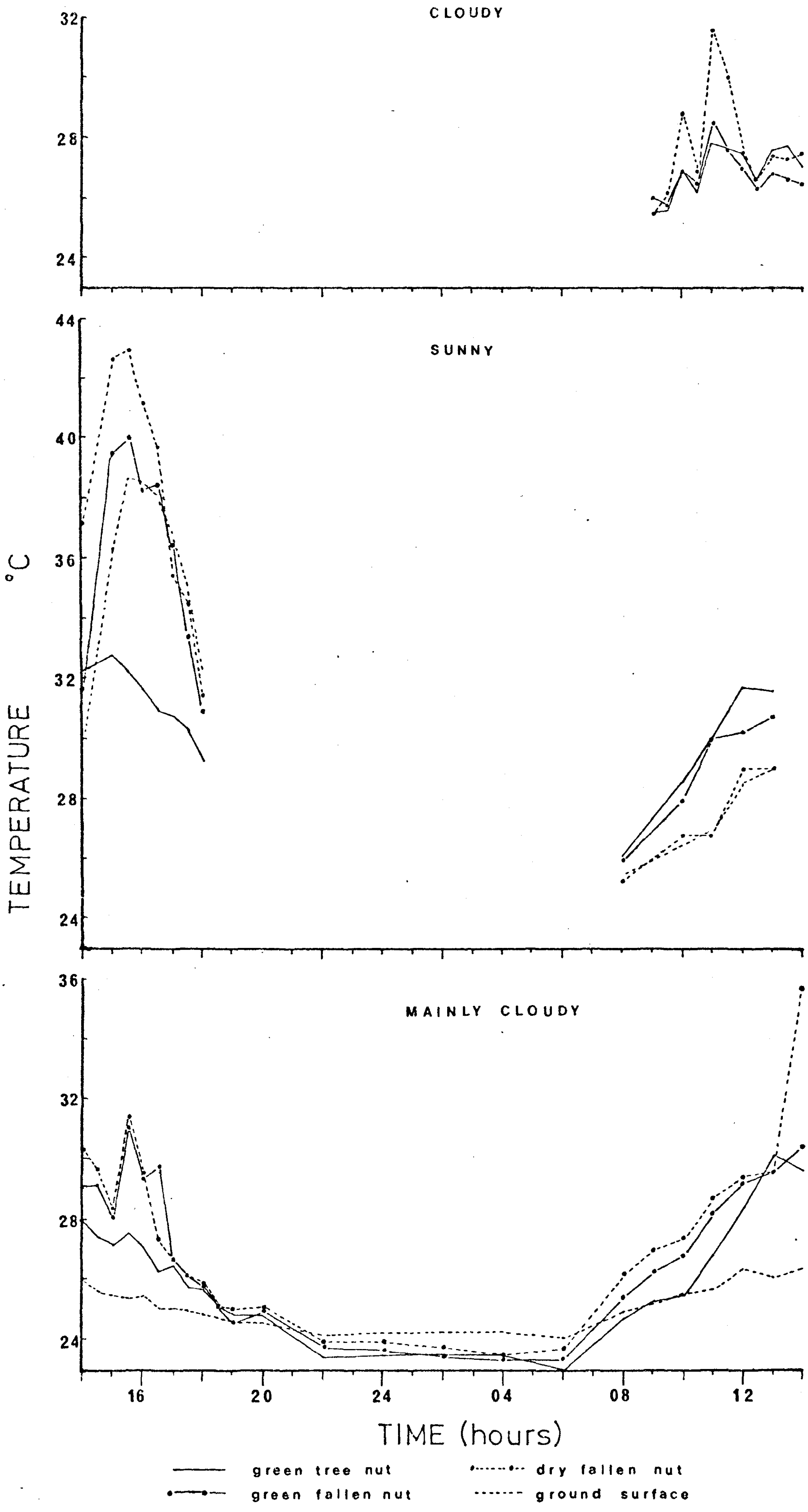

CLOUDY
SUNNY
MAINLY CLOUDY
TEMPERATURE °C
32
28
24
44
40
36
16
20
24
04
08
12
TIME (hours)
green tree nut
green fallen nut
dry fallen nut
ground surface

FIGURE 70

BIOLOGY AND BEHAVIOUR

Nut husk temperatures in tree and fallen nuts.

Recordings were made over three days with weather conditions as indicated.

Each plotted point is a mean of three readings.

TABLE 89

BIOLOGY AND BEHAVIOUR

Immatures. Multiple infestation in nuts, S1, H2 1972-73 and Beerwah Tree 146 1972-73.

A. Double infestations: % nuts with 2 living immatures of the following combinations

Largest Smallest	1st	2nd	3rd	4th		Final	Prepupa	Pupa
		1. Tree						
1st	6.3	6.3	3.2	6.3	4.8	9.5	0	1.6
2nd	-	1.6	7.9	7.9	4.8	4.8	0	0
3rd		-	0	1.6	3.2	7.9	0	0
4th			-	9.5	4.8	3.2	0	0
5A				-	0	1.6	0	0
Final						1.6	0	1.6
Prepupa							0	0
Pupa	-	-						0

Total nuts 63

Total % of nuts with larvae of the same age 19.0%

Largest Smallest	1st	2nd	3rd	4th		Final	Prepupa	Pupa
		2. Ground						
1st		1.1	2.2	1.1	2.2	5.9	1.1	0
2nd		1.6	2.2	2.2	3.2	8.0	2.7	2.7
3rd		-	2.2	6.9	3.2	10.7	2.7	4.8
4th				2.2	2.7	8.6	2.2	3.8
5A				-	0.5	5.8	1.1	0.5
Final						3.2	0	1.6
Prepupa						-	0	1.1
Pupa		-						0

Total nuts 186

Total % of nuts with larvae of the same age 9.7%

(continued)

TABLE 89 (continued):

B. Triple infestations: combinations of living immatures in nuts with triple infestations

1. Tree

3, 3, 2	4, 2, 1	5A, 1, 1	F, 1, 1
		5A, 2, 1	(F, 2, 2) x 2
		5A, 3, 2	F, 3, 3
			F, F, 3

Total nuts 10

nil with all three of one age
70% with two of one age
30% with each a different age

2. Ground

3, 1, 1	4, 2, 1	5A, 3, 1	F, 2, 2	pp, 2, 2	(P, 4, 2) x 2
(3, 3, 2) x 2	4, 3, 3	5A, 3, 2	(F, 3, 1) x 2	pp, 4, 1	(P, 4, 3) x 2
			(F, 3, 2) x 4	pp, F, 5A	P, F, 3
			(F, 3, 3) x 2		
			(F, 4, 3) x 3		
			F, 5A, 2		
			F, F, 1		
			(F, F, 2) x 2		
			F, F, 5A		
			F, F, F		

Total nuts 33

3% with 3 of one age
36% with 2 of one age
61% with each a different age

1 = 1st	4 = 4th
2 = 2nd	5A = 5th of 6 instars
3 = 3rd	pp = prepupa
	P = pupa

TABLE 90

BIOLOGY AND BEHAVIOUR

Immatures. Observations of mature *C. ombrodelta* larvae released on the ground, under Tree 194, Beerwah. 24.I.73.

Larva	Straight line distance trav-elled cm	Searching time minutes	Direction travelled	Pupation site	After 7 days	After 14 days
	104	4.5	NE	under leaf	alive pupa	lost
	not recorded			bare soil	alive[a] pupa	
	550	39.5	NW	under twig	alive[a] pupa	
	18	9.5	NNE	under leaf	alive[a] pupa	
	24	26.0	ENE	under leaf		lost
	130	79.0		bare soil		lost
	14	2.0	SW	beside twig		emerged as adult

removed for examination

TABLE 91

NATURAL ENEMIES

The parasites recorded from samples of *C. ombrod-delta* immatures.

PRIMARY PARASITES

ORDER DIPTERA	
Superfamily Muscoidea	
Family Tachinidae	(unidentified)
ORDER HYMENOPTERA	
Superfamily Chalcidoidea	
Family Chalcididea	*Brachymeria pomonae* (Cameron)
Family Eulophidae	*Euderus (Neoeuderus)* sp.
Superfamily Ichneumonoidea	
Family Braconidae	*Apanteles briareus* Nixon
	(probably) *Bracon* sp.[a]
Family Ichneumonidae	*Gotra bimaculata* Cheeseman

HYPERPARASITE

ORDER HYMENOPTERA	
Superfamily Chalcidoidea	
Family Encyrtidae	*Eupelmus* sp.
	(host *Apanteles briareus*)

the ectoparasite

TABLE 92

NATURAL ENEMIES

Summary of the apparent percent parasitism of the six parasites of *C. ombrodelta*.

Site and year	Total larvae	Ectoparasites % parasitism *Bracon* sp.	Total emerg- ences	*A. briareus*	*G. bimaculata*	Endoparasites % parasitism *B. pomonae*	*Euderus*	Tachinid
			A. Macadamia (including extra-orchard macadamia)					
Collins 1971-72	180	32.78 ± 3.50[1]	71	7.04 ± 3.04	1.41 ± 1.40	0	0	0
Inala 1971-72	236	2.12 ± 0.94	184	8.70 ± 2.08	0.54 ± 0.54	0	0	0.54 ± 0.54
Aspley S1 1971-72	58	12.07 ± 4.28	30	3.33 ± 3.28	0	0	0	0
1972-73	973	3.39 ± 0.58	694	20.32 ± 1.53	0	0	0	0.72 ± 0.32
1973-74	657	7.76 ± 1.04	277	8.30 ± 1.66	0.36 ± 0.36	0	0	0
Aspley H2 1971-72	162	11.11 ± 2.47	101	3.96 ± 1.94	0	0	0	0
1972-73	521	1.34 ± 0.50	324	12.35 ± 1.83	0.31 ± 0.30	0.31 ± 0.30	0	2.16 ± 0.81
1973-74	354	3.67 ± 1.00	116	1.72 ± 1.21	1.72 ± 1.21	0	0	0
Beerwah 1971-72	165	0	104	0	0	0	0	0
1972-73	1,823	0	0[a]	-[b]	-	-	-	-
TOTALS	5,129	3.76 ± 0.26	1,901	12.20 ± 0.75	0.32 ± 0.14	0.05 ± 0.05	0	0.68 ± 0.20
			B. Alternative hosts (excluding extra-orchard macadamia)					
Host *B. galpinii*	411	3.41 ± 0.89	233	9.01 ± 1.88	0	1.29 ± 0.74	0	0
B. variegata	1,665	6.56 ± 0.61	1,151	6.17 ± 0.71	0.35 ± 0.17	0.52 ± 0.21	0	0
C. anacardio-ides	82	0	42	11.90 ± 5.00	2.38 ± 2.35	0	0	0
A. podalyrii-folia	109	4.59 ± 2.00	6	0	0	0	0	0
various	390	1.54 ± 0.62	300	3.33 ± 1.04	0	0.33 ± 0.33	0.33 ± 0.33	0
TOTALS	2,657	5.04 ± 0.42	1,732	6.18 ± 0.58	0.29 ± 0.13	0.58 ± 0.18	0.06 ± 0.06	0

a. no sampled larvae kept

b. *Apanteles* present from 14.II.73; pupae recorded

1. Standard error see p.191.

TABLE 93

NATURAL ENEMIES

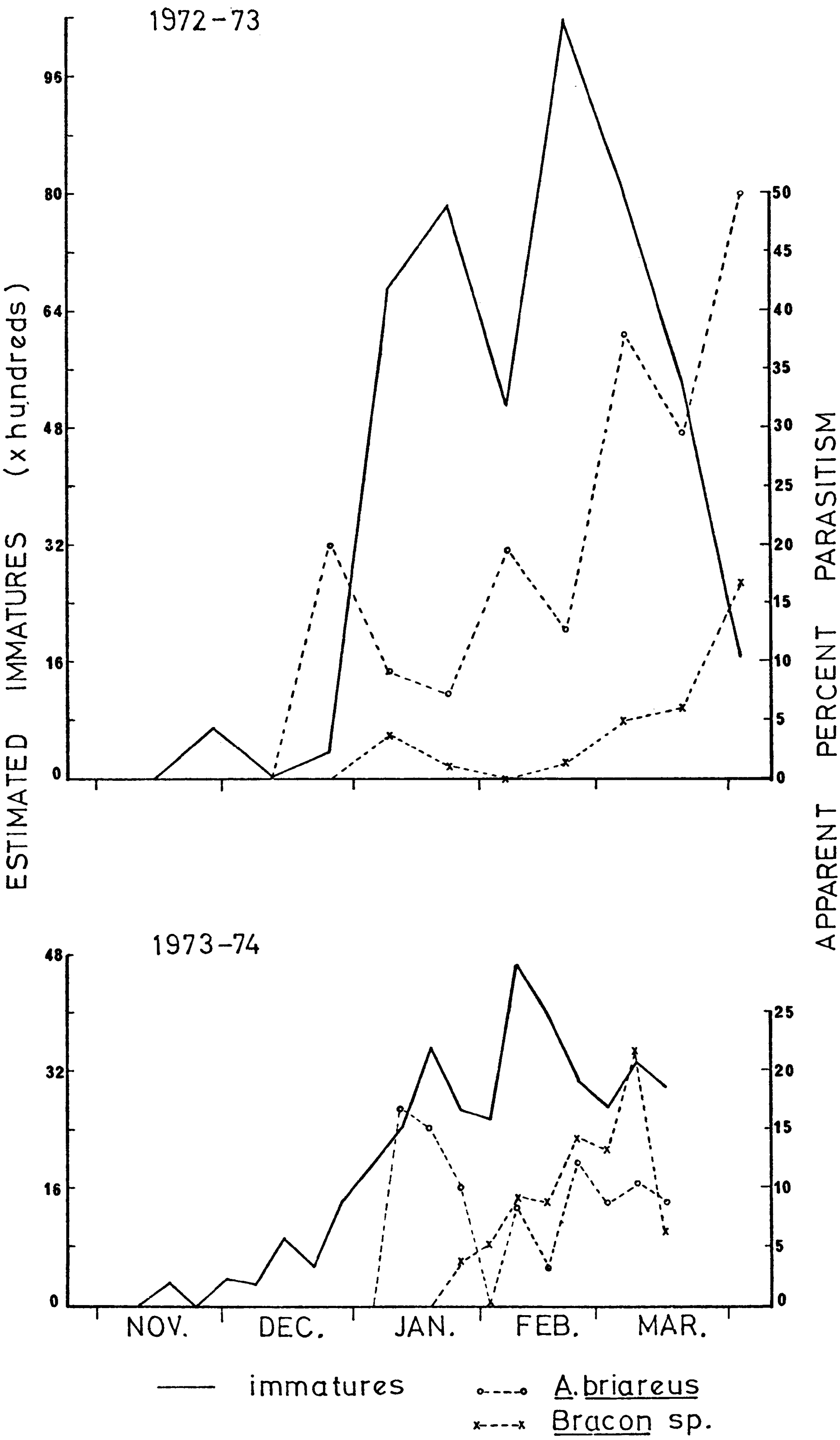
Recorded geographical distribution of the parasites of *C. ombrodelta*.

Site	Parasite occurrence *A. briareus*	*Bracon* sp.	*G. bimaculata*	*B. pomonae*	*Euderus*	Tachinid
Aspley S1[a]						
Aspley H2[a]						
Inala[a]						
Beerwah						
Collins[a]	+					
Cowie Road[a]	+[c]					
Grasspan Road[a]	+					
Bald Hills[a]	+[c]					
Aspley *Bauhinia*[a]	+					
Cavendish Cooke[a]						
Kyogle						
Pimpana[b]						
Bilambil[b]						
Terranorra[b]						
Gatton						
Warwick						
Toowoomba						
Boonah						
Beaudesert						
St Lucia[a]						
Newmarket[a]						
Bracken Ridge[a]						
Red Hill[a]						
Graceville[a]						
Total sites 24	14	10				

a. Sites within the Brisbane Greater Metropolitan area.

b. Villages between those towns marked in Figure 1, to the south and west of Brisbane.

c. Hyperparasite *Eupelmus* present.



1972-73
1973-74
ESTIMATED IMMATURES (x hundreds)
APPARENT PERCENT PARASITISM
96
80
64
48
32
16
0
50
45
40
35
30
25
20
15
10
5
0
48
32
16
0
25
20
15
10
5
0
NOV.
DEC.
JAN.
FEB.
MAR.
immatures
A. briareus
Bracon sp.

FIGURE 71

NATURAL ENEMIES

Fluctuations recorded in apparent percent parasitism and populations of *C. ombrodelta* immatures. Aspley S1.

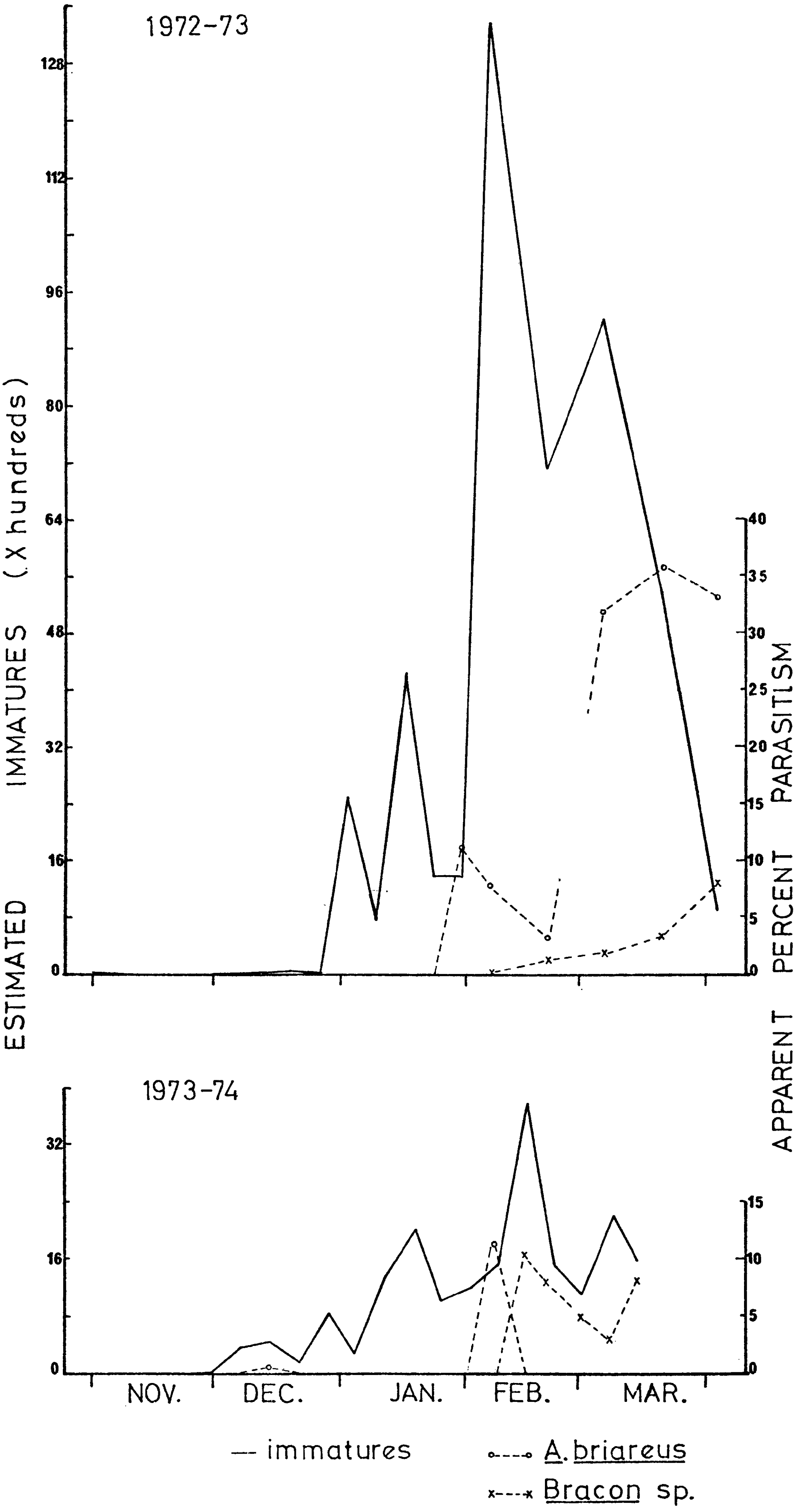

1972-73
1973-74
ESTIMATED IMMATURES (X hundreds)
APPARENT PERCENT PARASITISM
0
16
32
48
64
80
96
112
128
5
10
15
20
25
30
35
40
NOV.
DEC.
JAN.
FEB.
MAR.
— immatures
A. briareus
Bracon sp.

FIGURE 72

NATURAL ENEMIES

Fluctuations recorded in apparent percent parasitism and populations of *C. ombrodelta* immatures. Aspley H2.

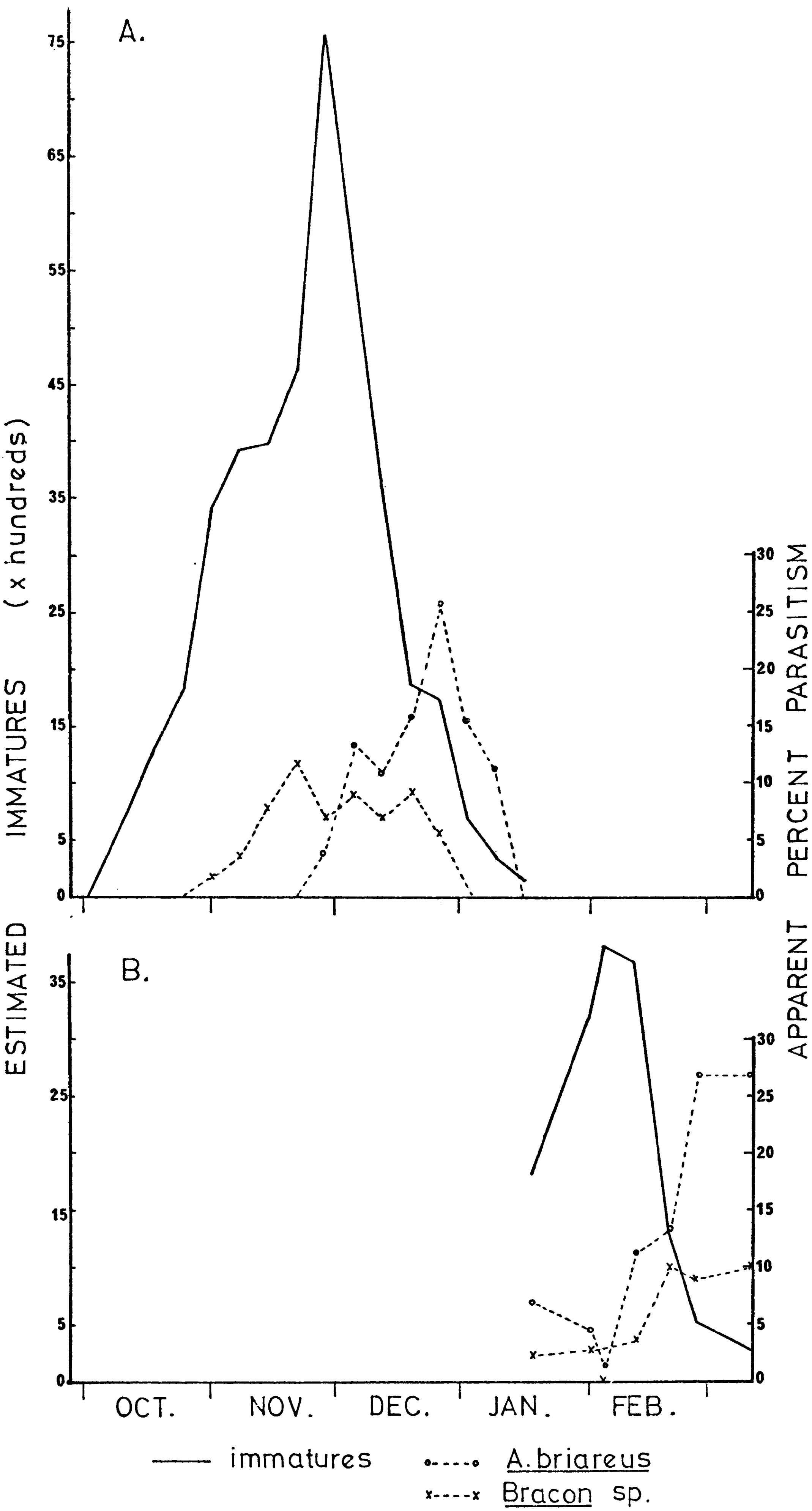

A.
B.
ESTIMATED IMMATURES (x hundreds)
APPARENT PERCENT PARASITISM
75
65
55
45
35
25
15
5
0
30
25
20
15
10
5
0
OCT.
NOV.
DEC.
JAN.
FEB.
immatures
A. briareus
Bracon sp.

FIGURE 73

NATURAL ENEMIES

Fluctuations in apparent percent parasitism and populations of *C. ombrodelta* immatures. Alternative hosts. I

A. Cowie Road (*B. variegata* var. *albens*) 1972-73

B. Aspley *Bauhinia* (*B. galpinii*) 1972

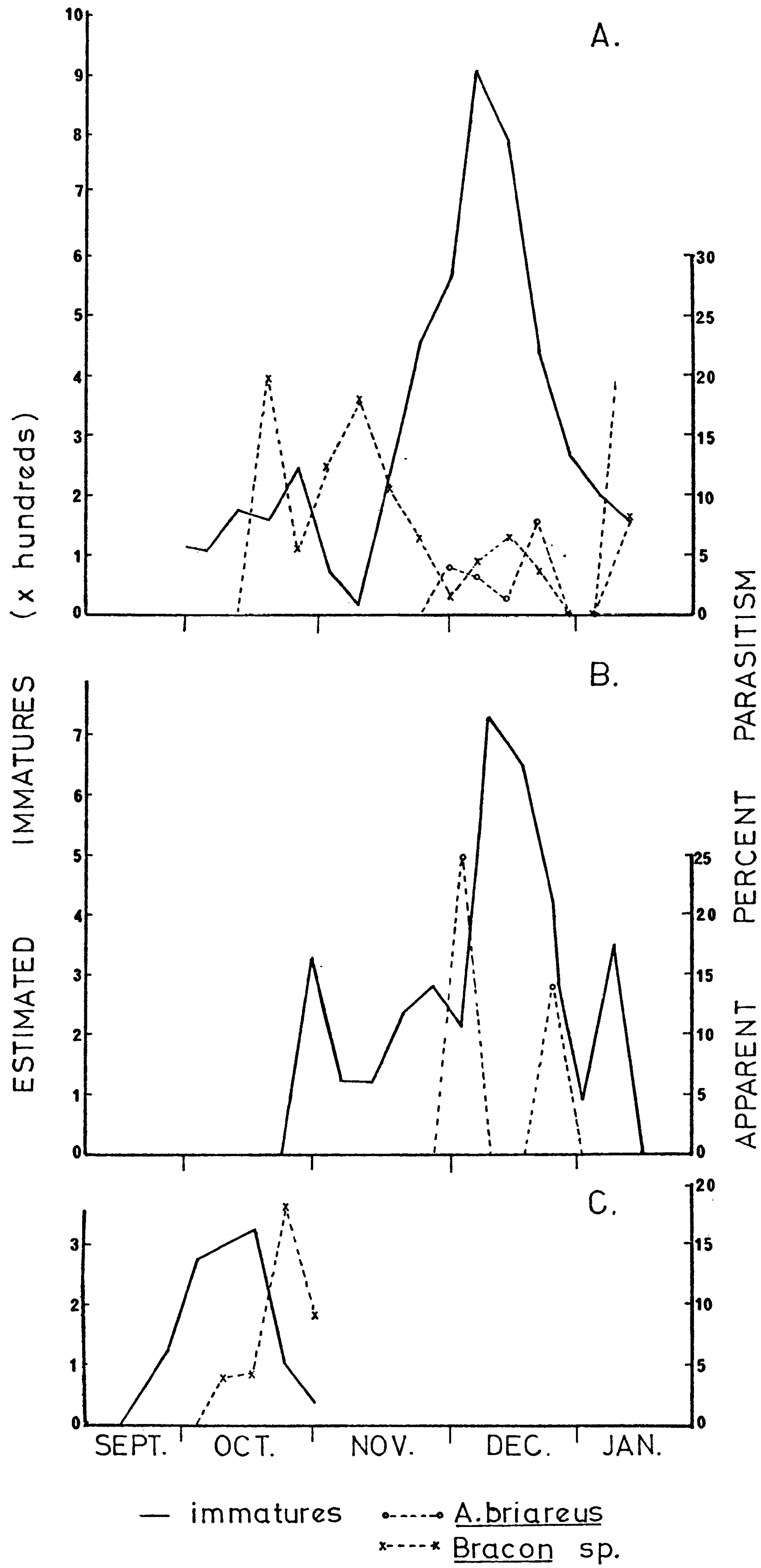

A.
B.
C.
ESTIMATED IMMATURES (x hundreds)
APPARENT PERCENT PARASITISM
SEPT.
OCT.
NOV.
DEC.
JAN.
— immatures
A. briareus
Bracon sp.

FIGURE 74

NATURAL ENEMIES

Fluctuations in apparent percent parasitism and populations of *C. ombrodelta* immatures. Alternative hosts. II.

A. Grasspan Road (*B. variegata*)

B. Bald Hills (*B. variegata*)

C. Cavendish-Cooke (*Acacia polalyriifolia*)

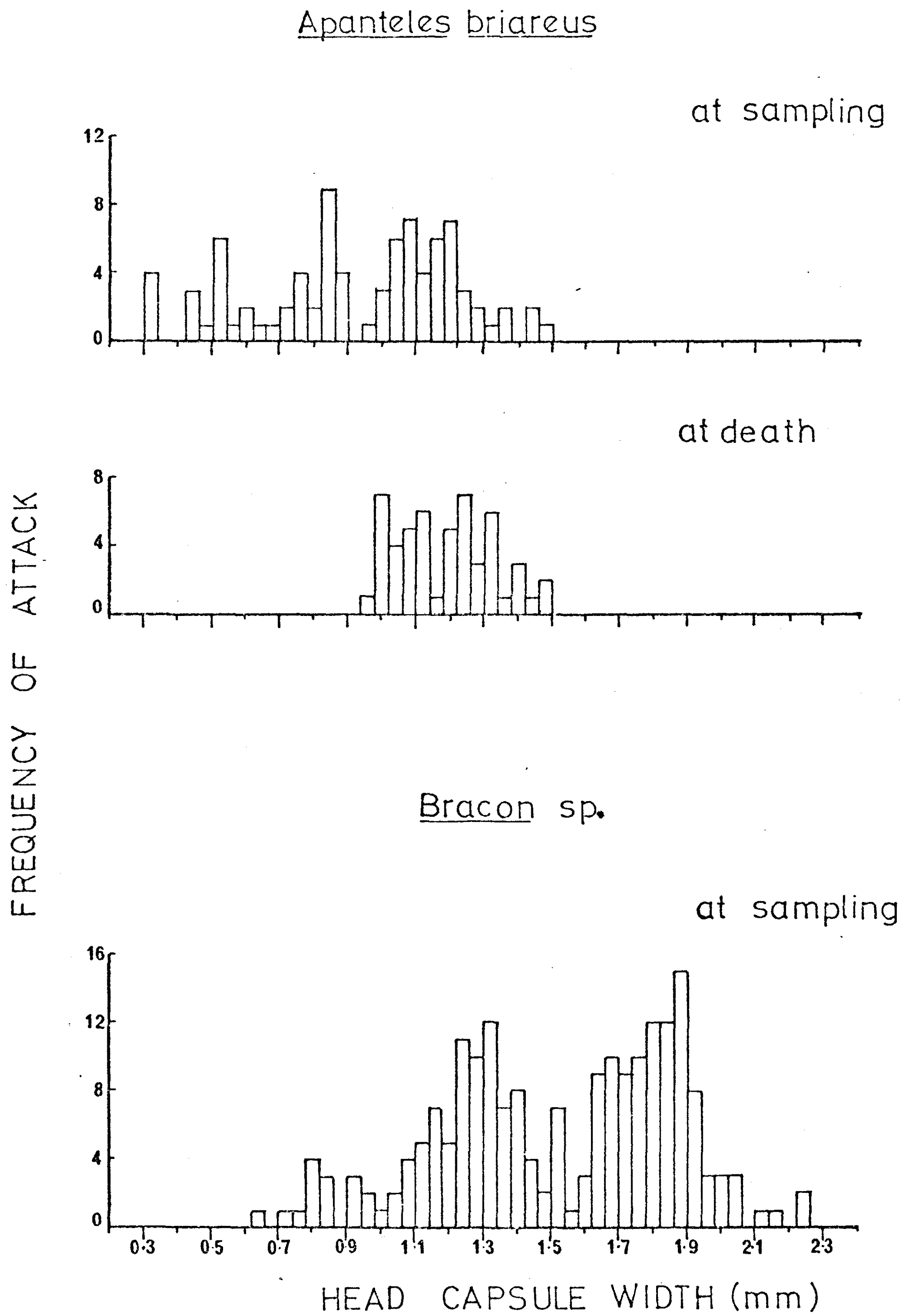

Apanteles briareus
at sampling
12
8
4
0
at death
8
4
0
FREQUENCY OF ATTACK
Bracon sp.
at sampling
16
12
8
4
0
0·3
0·5
0·7
0·9
1·1
1·3
1·5
1·7
1·9
2·1
2·3
HEAD CAPSULE WIDTH (mm)

FIGURE 75

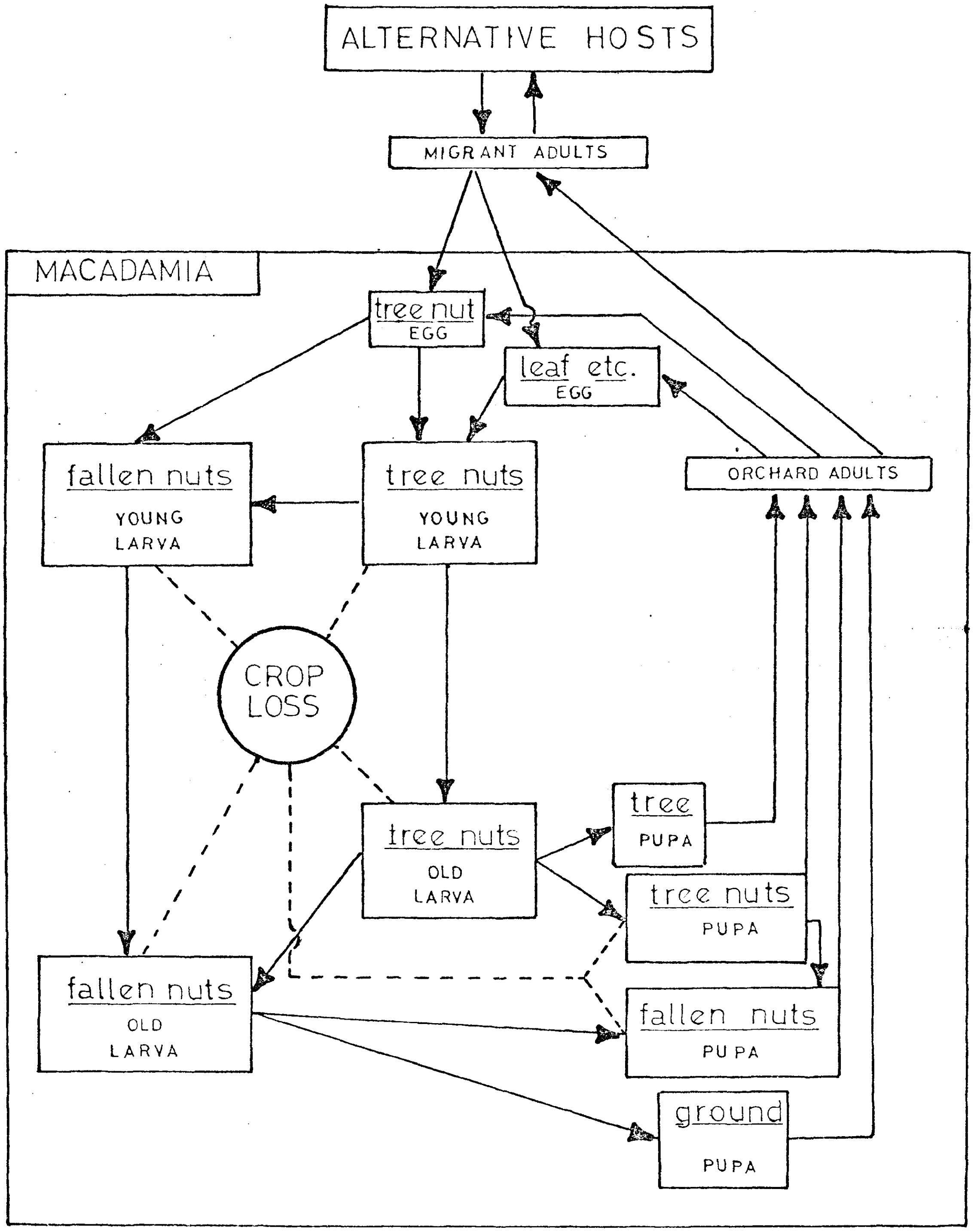
NATURAL ENEMIES

Head capsule widths of *C. ombrodelta* larvae attacked by the main parasites.

At sampling, the head capsule widths of larval *C. ombrodelta* attacked by

A. briareus, corresponded to those of 1st to 4th instars.

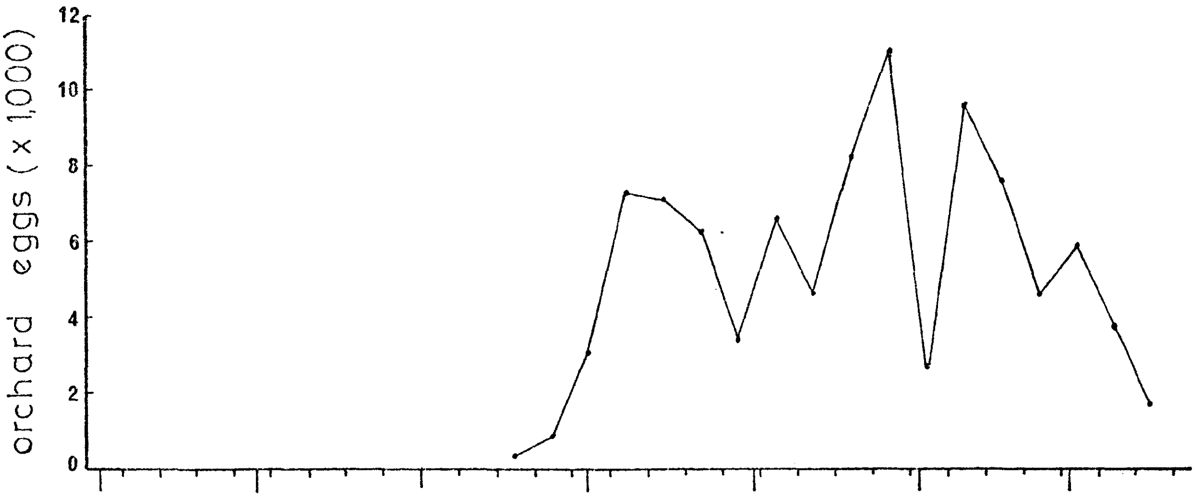
Bracon sp., corresponded to those of 2nd to Final instars.



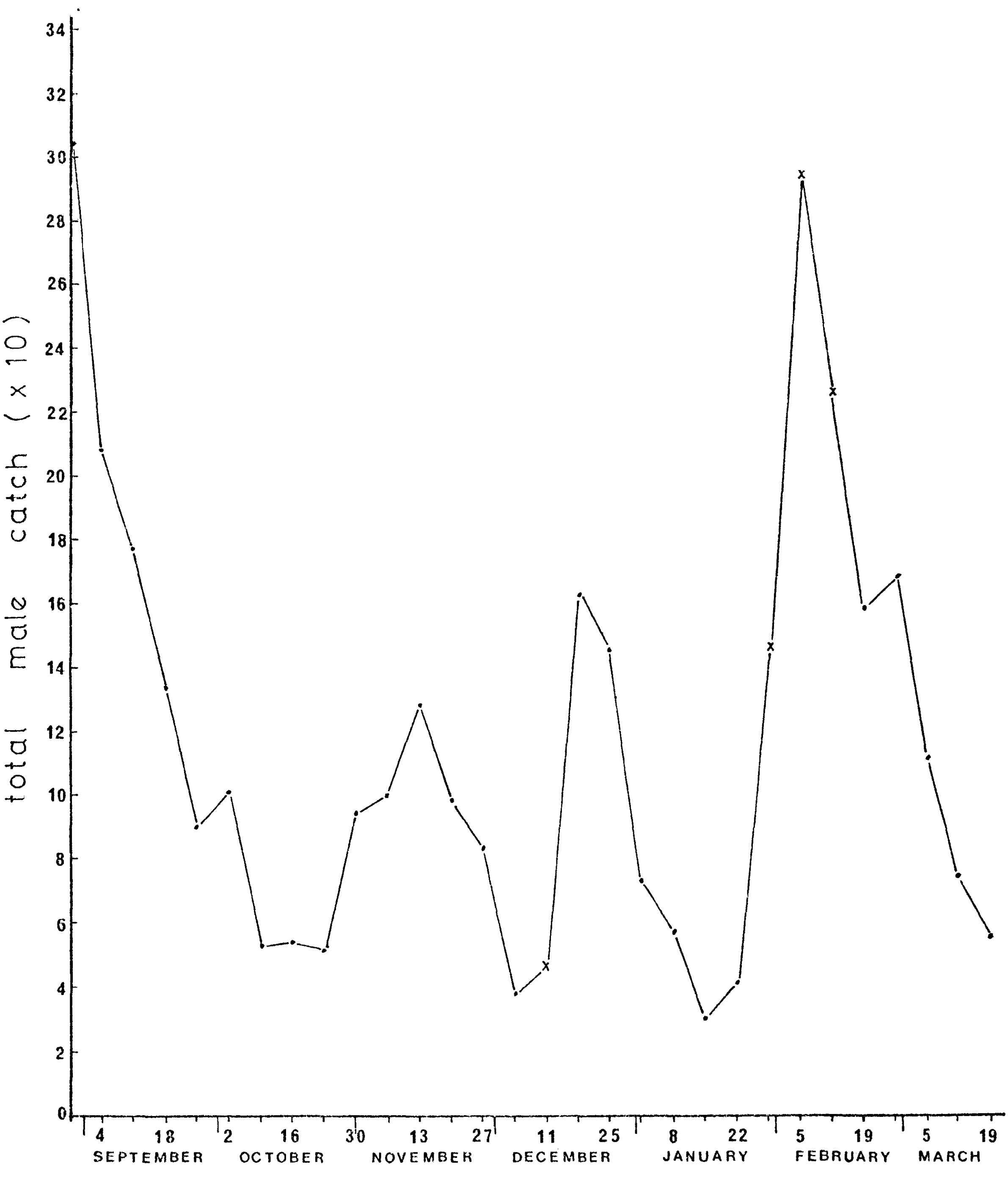
ALTERNATIVE HOSTS
MIGRANT ADULTS
MACADAMIA
tree nut EGG
leaf etc. EGG
fallen nuts YOUNG LARVA
tree nuts YOUNG LARVA
ORCHARD ADULTS
CROP LOSS
tree nuts OLD LARVA
tree PUPA
tree nuts PUPA
fallen nuts OLD LARVA
fallen nuts PUPA
ground PUPA

FIGURE 76

SUMMARY OF THE *C. OMBRODELTA* LIFE SYSTEM INTERACTIONS



orchard eggs (x 1,000)
0
2
4
6
8
10
12



total male catch (x 10)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
4
18
2
16
30
13
27
11
25
8
22
5
19
5
19
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

7

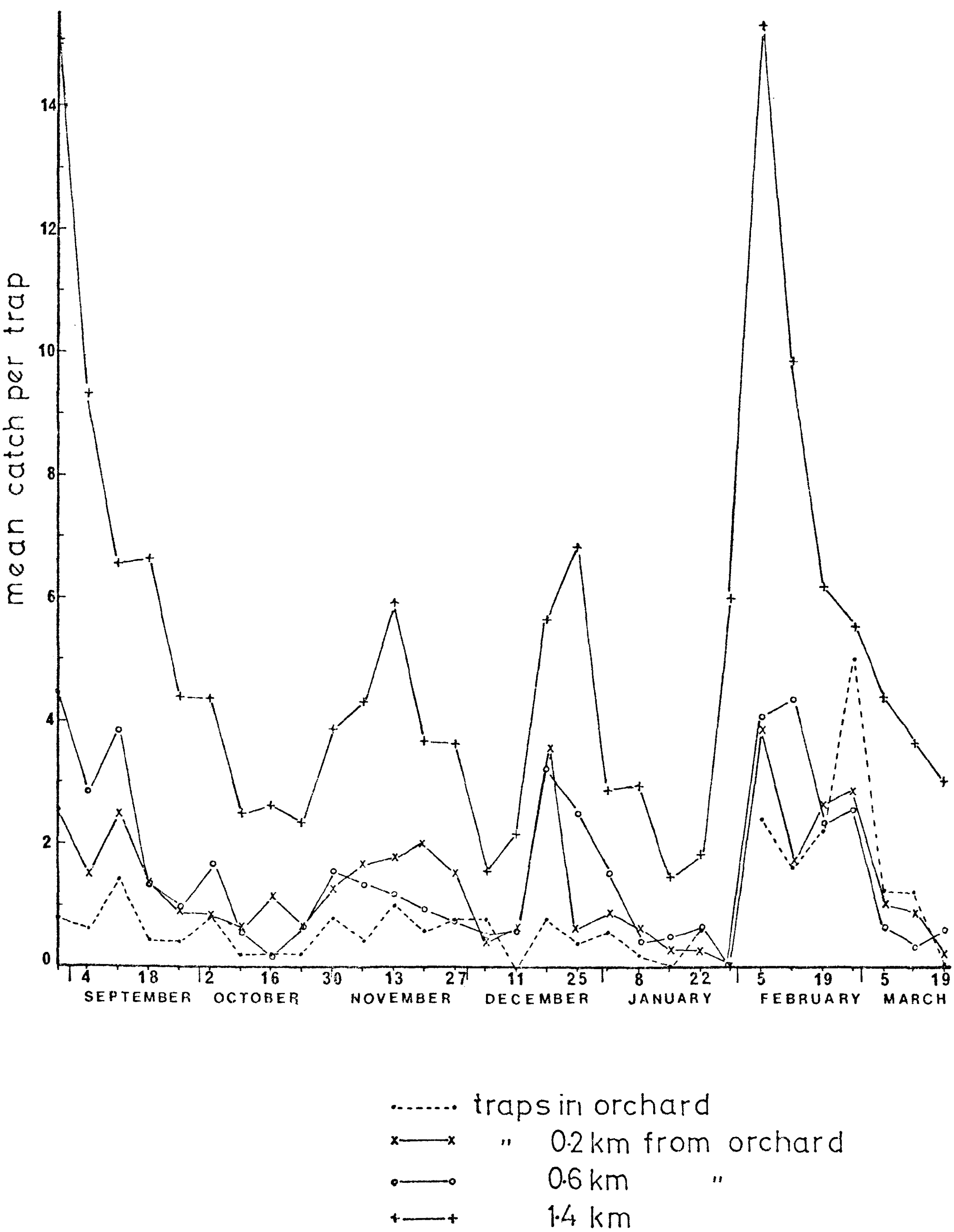
FIGURE 77

C. OMBRODELTA POPULATIONS IN THE ASPLEY AREA

Total male catch in Orfamone II lure traps, in and around the Aspley orchard, compared to egg laying in the orchard. 1973-74.

The position of lure traps is shown in Figure 28

In the total male catch x indicates an estimated catch on dates when some traps were missing.



mean catch per trap
0
2
4
6
8
10
12
14
4
18
2
16
30
13
27
11
25
8
22
5
19
5
19
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
traps in orchard
" 0·2 km from orchard
0·6 km "
1·4 km

FIGURE 78

C. OMBRODELTA POPULATIONS IN THE ASPLEY AREA

A comparison of mean male catch in Orfamone II lure traps placed within, and at increasing distances from the orchard. 1973-74.

The position of lure traps is shown in Figure 28.


TRAP NUMBER
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
4 18 2 16 30 13 27 11 25 8 22 5 19 5 19
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH

FIGURE 79

C. OMBRODELTA POPULATIONS IN THE ASPLEY AREA

Weekly male catch for each Orfamone II lure trap shown as a percentage of total catch in that week. 1973-74.

The position of lure traps is shown in Figure 28.

0% of weekly catch
< 1% " " "
1-3% " " "
4-7% " " "
8-15% " " "
16-31% " " "
> 31% " " "
trap missing

a

b

c

FIGURE 80

C. OMBRODELTA POPULATIONS IN THE ASPLEY AREA

Different vegetation types in the Orfamone II lure trapping area.

(a) Aspley orchard - traps 1-5

(b) Position of trap 30 which had one of the highest catches of the 41 traps.

(c) Position of trap 14 which had one of the lowest catches of the 41 traps.

TABLE 94

MORTALITY

Death of eggs held at various constant temperature and humidity conditions.

(A) Untransformed means at each temperature-humidity combination.

Temperature °C	Humidity 10-20%	30-40%	50-60%	70-80%	90-100%
8.5	1.00[a1]	1.00[a]	1.00[a]	1.00[a]	1.00[a]
15.0	0.20[b]	0.00[f]	0.00[f]	0.00[f]	0.00[f]
18.5	0.40[c]	0.10[f]	0.00[f]	0.00[f]	0.00[f]
21.5	0.20[d]	0.00[f]	0.00[f]	0.00[f]	0.00[f]
25.0	0.80[e]	0.10[f]	0.00[f]	0.10[f]	0.00[f]
29.0	0.60[e]	0.00[f]	0.00[f]	0.00[f]	0.00[f]
32.5	1.00[a]	0.90[a]	0.60[e]	0.00[f]	0.00[f]
36.5	1.00[a]	1.00[a]	1.00[a]	1.00[a]	0.90[a]

1. means followed by the same letter are not significantly different from each other in the analysis of transformed data (P=0.01).

(B) Degrees of freedom and F values of the analysis of variance of data (transformed $\sqrt{x+\frac{1}{2}}$)

Source	Degrees of freedom	F
Temperature	7	159.52**
Humidity	4	48.44**
Temperature x humidity	28	7.04**
Error	38	
Total	77	

** significant at P=0.01

TABLE 95

MORTALITY

The establishment of newly hatched larvae in undamaged nuts of various varieties.

(A) Analysis of variance of results

Source	Degrees of freedom	F
Variety	3	5.84**
Error	16	
Total	19	

** significant at P=0.01

(B) Mean percent rate of establishment

Variety -	H2	S1	246	508
Mean -	3.25[a]	65.89[b]	30.34[b]	55.56[b]

Figures followed by the same letter are not significantly different from each other (P=0.01)

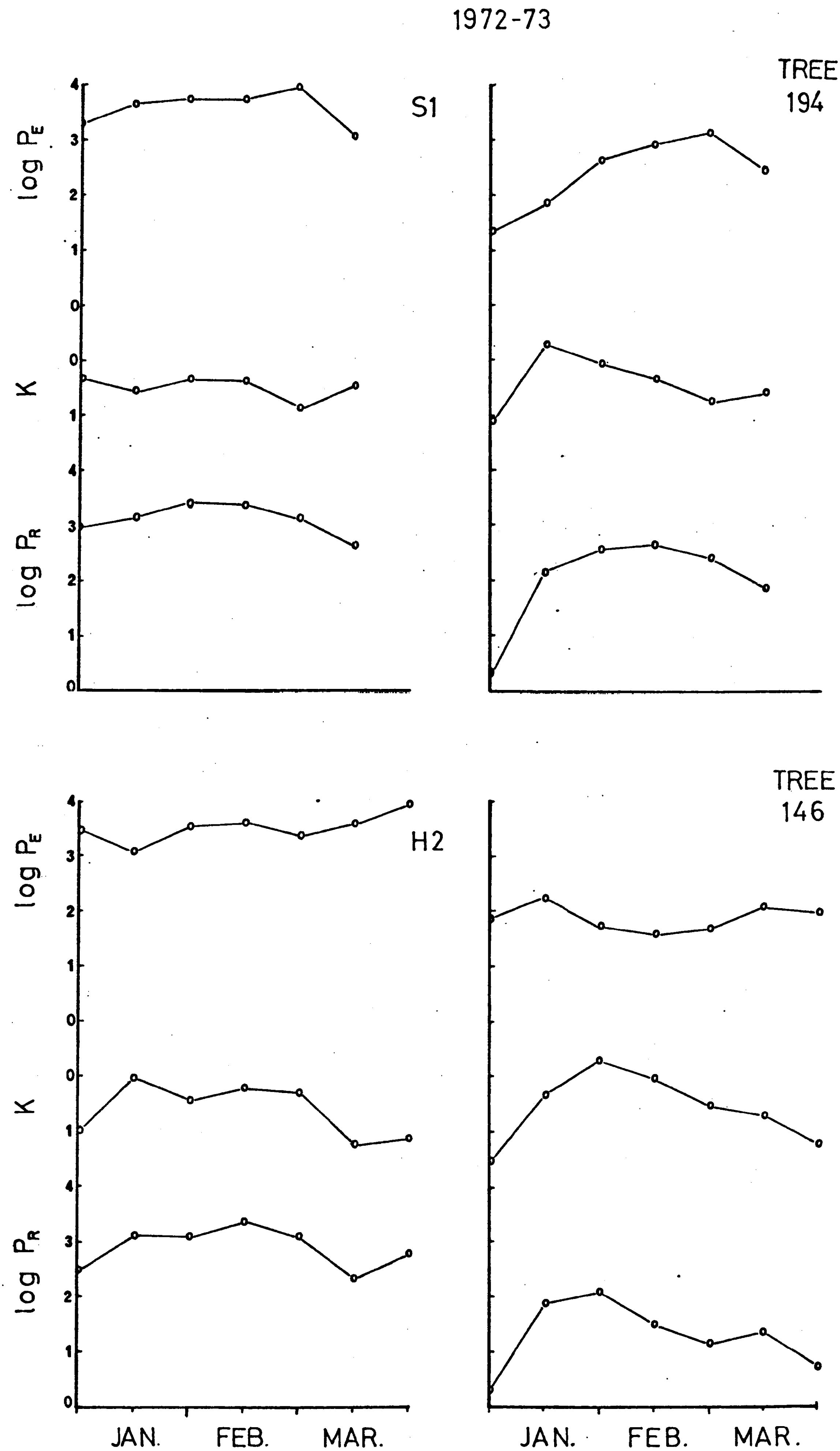

1972-73
TREE
194
S1
log P_E
K
log P_R
TREE
146
H2
JAN.
FEB.
MAR.
JAN.
FEB.
MAR.
4
3
2
1
0
0
1
4
3
2
1
0

FIGURE 81

MORTALITY

Partial budgets showing the contribution of natality and mortality to population fluctuations of immature *C. ombrodelta* in macadamia, 1972-73.

At Aspley S1 and H2 P_R is the absolute population of 4th instar larvae, two weeks after the plotted absolute egg population P_E.

At Beerwah, Trees 194 and 146 P_R is the absolute population of Final instar larvae, three weeks after the plotted absolute egg population P_E.

κ, the difference between log P_E and log P_R is plotted on an inverse axis.

Absolute populations are expressed as numbers per 0.5 ha at Aspley, and as numbers per tree at Beerwah.

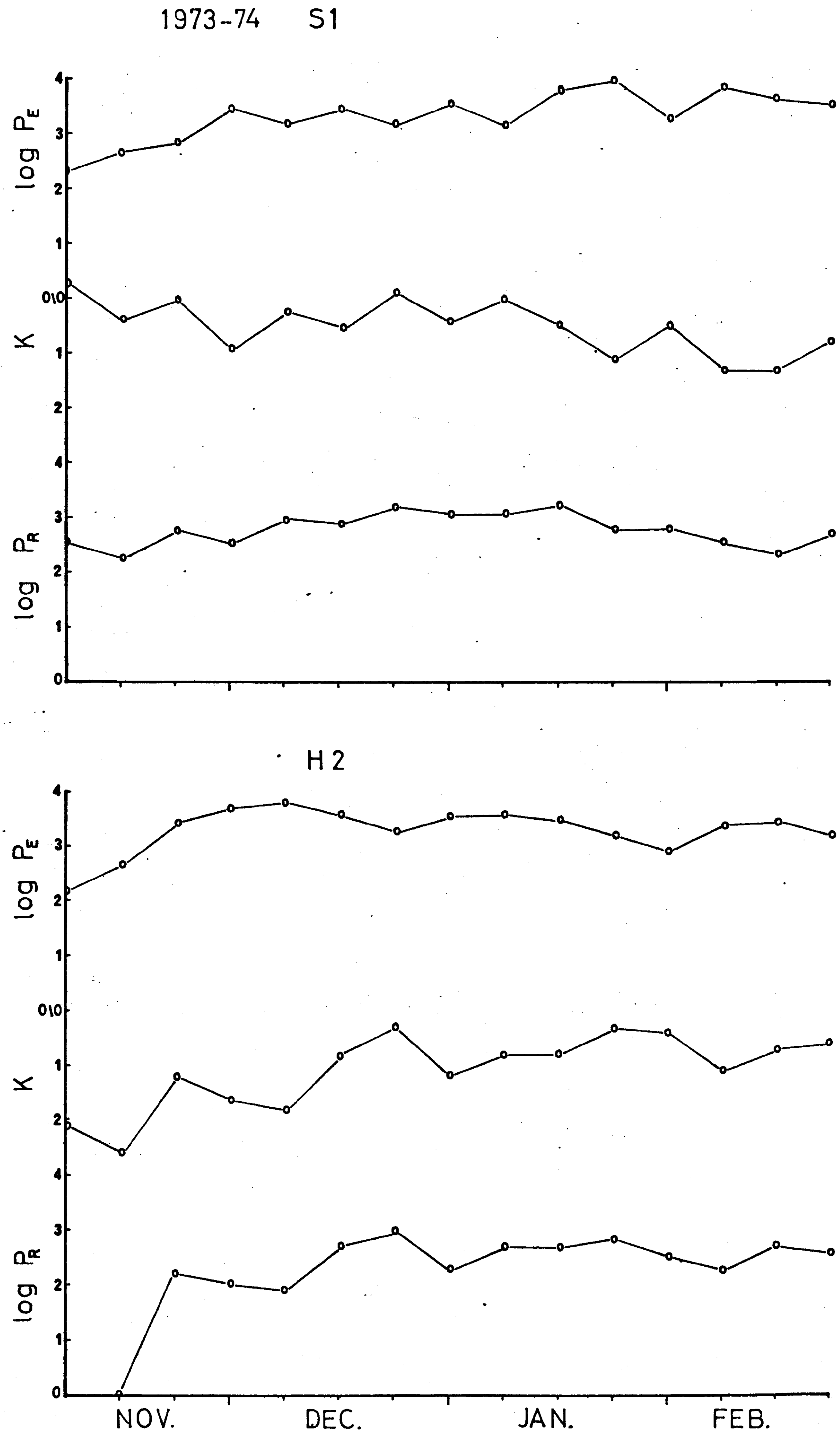

1973-74 S1
log P_E
K
log P_R
H 2
log P_E
K
log P_R
NOV.
DEC.
JAN.
FEB.

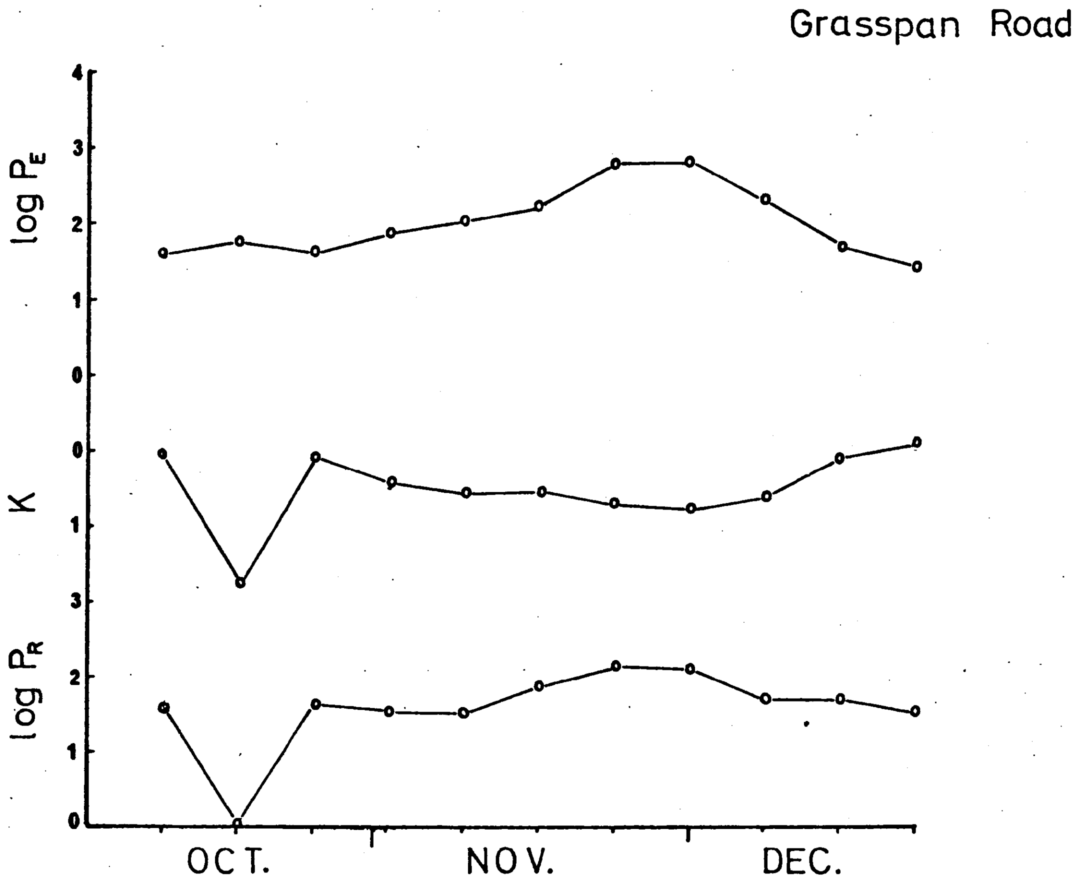
FIGURE 82

MORTALITY

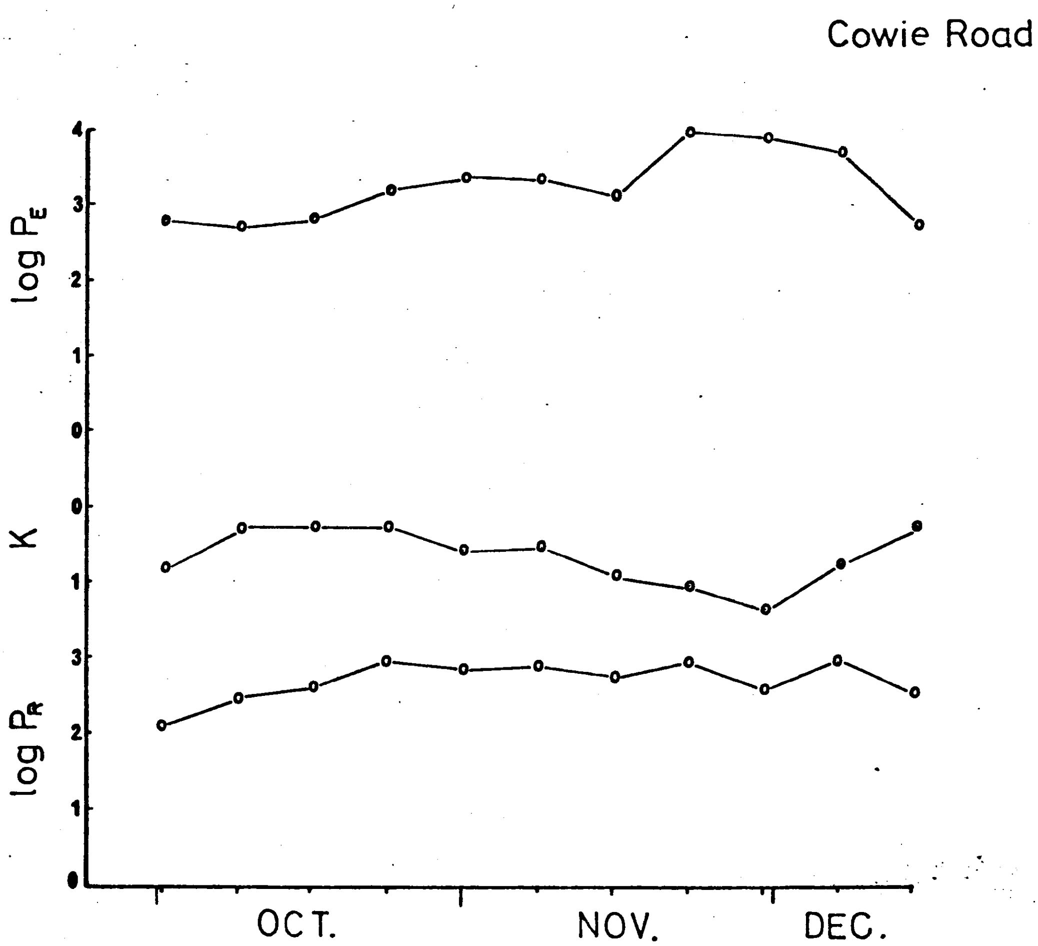
Partial budgets showing the contribution of natality and mortality to population fluctuations of immature *C. ombrodelta* in macadamia, 1973-74.

In both varieties P_R is the absolute population of Final instars, 3 weeks after the plotted absolute egg population P_E (where absolute populations are numbers per 0.5 ha).

κ, the difference between log P_E and log P_R is plotted on an inverse axis.



Grasspan Road
4
3
2
1
0
0
1
3
2
1
0
log P_E
K
log P_R
OCT.
NOV.
DEC.



Cowie Road
4
3
2
1
0
0
1
3
2
1
0
log P_E
K
log P_R
OCT.
NOV.
DEC.

FIGURE 83

MORTALITY

Partial budgets showing the contribution of natality and mortality to population fluctuations of immature *C. ombrodelta* in *Bauhinia variegata*, 1972-73.

At both sites, P_R is the absolute population of Final instars three weeks after the plotted absolute egg population P_E (where absolute populations are numbers per tree).

κ, the difference between log P_E and log P_R is plotted on an inverse axis.

TABLE 96

MORTALITY

Partial budgets. The coefficient of determination r^2 (expressed as a percent) of the correlation of larval population on egg population at major sampling sites.

Host	Year	Site	Number of consecutive samples	P_4^b/P_E^a r^{2d}	P_F^c/P_E r^2
Macadamia	1972-73	Aspley S1	7	33.6%	
		H2	7	3.2%	
	1973-74	S1	16		0.6%
		H2	15		0.3%
	1972-73	Beerwah Tree 146	7		0.1%
		Tree 194	6		37.6%*
B. variegata	1972-73	Grasspan Road	11		89.3%** or 95.2%**e
		Cowie Road	11		0.2% or 65.0%*f

a. Egg population
b. Population of 4th instars arising from egg population
c. Population of Final instars arising from egg population
d. Coefficient of determination expressed as a percentage
e. Correlation excluding the first two dates
f. Correlation of the first 6 dates only
* Correlation coefficient (r) significant at P=0.05
** Correlation coefficient (r) significant at P=0.01

TABLE 97

MORTALITY

Direct examination of macadamia samples; dead immatures of each stage expressed as a percent of living immatures of that stage at each site - pooled over the entire season.

	Beerwah Tree 146	Beerwah Tree 194	S1 1972-73	S1 1973-74	H2 1972-73	H2 1973-74	Pooled mean ± s[1]
Instar				1. Tree nuts			
1st	8.3	6.7	7.5	7.8	7.1	9.5	7.8 ± 1.7
2nd	0	1.7	2.1	2.6	21.4	6.9	3.7 ± 1.2
3rd	0	3.1	6.1	6.9	9.1	0	4.3 ± 1.3
4th	0	5.6	13.2	22.7	11.1	17.4	12.8 ± 2.2
5A	0	0	22.9	-	50.0	-	10.6 ± 3.0
Final	0	1.6	12.1	8.6	10.0	11.1	7.0 ± 1.7
prepupa	0	0	0	-	-	-	0 -
pupa	0	0	0	16.7	0	33.3	15.3 ± 7.1
				2. Fallen nuts			
1st	7.1	0	13.3	0	7.7	12.5	4.6 ± 2.0
2nd	13.3	2.0	15.0	5.4	9.5	0	6.0 ± 1.6
3rd	6.8	4.3	6.4	6.7	12.5	17.2	6.8 ± 1.4
4th	6.5	5.9	17.0	19.0	26.9	12.5	10.9 ± 1.6
5A	2.5	3.6	24.1	-	0	-	5.6 ± 1.5
Final	2.8	1.1	2.4	20.8	0	7.5	5.6 ± 0.9
prepupa	0	0	0	6.7	0	0	1.2 ± 1.2
pupa	0	0	0	5.7	9.5	3.6	4.0 ± 1.5

1. Standard error, binomial approximation (Steel and Torrie 1960, p.355)

TABLE 98

MORTALITY

Direct examination of macadamia samples; mean percent of dead immatures for the stage shown, pooled over all sites and seasons to give a chronological sequence.

Date[1]	Tree nuts 1st,2nd, 3rd	Tree nuts 4th,5A, Final	Tree nuts Prepupa pupa	Fallen nuts 1st,2nd, 3rd	Fallen nuts 4th,5th, Final	Fallen nuts Prepupa pupa
30.X.	-	-	-	-	-	-
13.XI.	0	-	-	-	-	-
20.XI.	-	-	-	-	-	-
27.XI.	0	0	-	0	-	0
4.XII.	0	0	-	-	0	0
11.XII.	0	0	-	100.0	0	-
18.XII.	20.0	0	-	-	0	-
25.XII.	12.5	0	0	0	0	0
1.I.	6.7	10.0	0	0	0	0
8.I.	7.7	5.0	0	16.7	0	0
15.I.	4.3	0	0	0	4.5	0
22.I.	10.6	2.2	0	2.8	3.6	7.3
29.I.	2.4	3.4	0	9.3	7.7	13.8
5.II.	6.0	6.4	33.3	1.2	5.3	4.3
12.II.	0	9.8	33.3	0	8.9	0
19.II.	2.3	6.6	0	6.9	6.2	0
26.II.	4.9	22.2	-	10.9	3.2	0
5.III.	2.3	19.3	0	9.8	17.5	0
12.III.	8.9	10.3	0	14.3	7.1	0
19.III.	2.6	29.2	-	13.2	9.1	0
2.VI.	27.8	55.6	-	6.7	50.0	0

1. Dates shown are for Aspley 1972-73

TABLE 99

MORTALITY

Summary of the causes of death in immature *C. ombrodelta* in macadamia.

(A) Total deaths recorded, partitioned into causes

Unknown	172
Cannibalism	15
Gummosis	5
Predation	15
Drowning	3
Ecdysis	1
Parasite (?) paralysis	1
Nut shrinkage	1
Total	213

(B) Causes shown for stage, and nut position

	Tree nuts			Fallen nuts		
Stage	1st,2nd, 3rd	4th,5th, Final	Prepupa pupa	1st,2nd, 3rd	4th,5th, Final	Prepupa pupa
Cause						
Unknown	66.7%	82.3%	66.7%	82.9%	92.0%	40.0%
Cannibalism	7.7%	6.7%		9.8%	6.7%	
Gummosis	10.3%			2.5%		
Predation	10.3%	8.8%	33.3%	2.4%		50.0%
Drowning	2.5%			2.4%	1.3%	
Ecdysis	2.5%					
Parasite (?) paralysis		2.2%				
Nut shrinkage						10.0%
Total numbers	39	45	3	41	75	10

TABLE 100

MORTALITY

Deserted holes and living larvae in samples of tree and fallen nuts. 1972-74.

	Aspley S1 Tree nuts		Fallen nuts		Aspley H2 Tree nuts		Fallen nuts	
Date	Deserted holes	Living larvae	Deserted holes	Living larvae	Deserted holes	Living larvae	Deserted holes	Living larvae
				1972-73				
30.X.72	0	0	0	0	0	0	0	2
13.XI.72	0	0	0	0	0	0	0	0
27.XI.72	279	623	0	40	0	0	0	34
11.XII.72	0	0	20	14	735	0	0	23
18.XII.72					1,452	0	0	54
25.XII.72	268	354	0	30	0	0	20	14
1.I.73					0	1,953	12	113
8.I.73	563	6,550	42	108	0	670	17	79
15.I.73					1,575	4,092	42	170
22.I.73	2,187	7,314	289	534	0	1,253	70	135
29.I.73					0	1,253	159	141
5.II.73	2,248	4,625	428	458	0	13,354	124	136
19.II.73	5,516	9,187	686	1,251	693	6,136	396	983
5.III.73	1,485	7,540	694	540	1,339	8,370	314	835
19.III.73	2,397	4,484	620	560	969	3,697	1,903	1,702
3.IV.73	2,273	1,390	1,071	222	798	614	234	265
TOTAL	17,216	42,067	3,849	3,757	7,561	40,778	3,291	4,686
Mean deserted holes/living larva								
	0.409		1.024		0.185		0.702	
				1973-74				
16.XI.73	0	164	0	0	0	0	0	0
23.XI.73	0	0	0	0	0	0	0	0
30.XI.73	0	390	0	0	0	0	0	16
7.XII.73	0	292	0	26	0	352	0	28
14.XII.73	135	943	0	0	0	456	16	0
21.XII.73	131	523	0	18	143	148	18	0
28.XII.73	0	1,420	0	21	332	839	0	0
4.I.74	0	1,926	0	0	472	146	60	135
11.I.74	127	2,284	59	146	1,406	1,056	30	75
18.I.74	125	3,869	170	490	460	1,694	256	339
25.I.74	243	2,190	278	483	309	465	540	598
1.II.74	177	2,119	408	397	128	1,012	462	214
8.II.74	173	4,264	207	287	1,259	1,385	220	177
15.II.74	1,027	3,582	486	369	1,227	3,461	356	265
22.II.74	723	2,581	903	509	669	1,198	353	318
1.III.74	1,208	2,320	738	370	482	934	419	217
8.III.74	707	3,127	1,000	216	1,476	1,807	359	452
15.III.74	1,379	2,737	1,387	303	494	1,029	1,214	531
TOTAL	6,155	34,731	5,636	3,635	8,857	15,982	4,303	3,365
Mean deserted holes/living larva								
	0.177		1.550		0.554		1.279	

(continued)

TABLE 100 (continued):

BEERWAH 1972-73

Date	Tree 146 Tree nuts Deserted holes	Tree 146 Tree nuts Living larvae	Tree 146 Fallen nuts Deserted holes	Tree 146 Fallen nuts Living larvae	Tree 194 Tree nuts Deserted holes	Tree 194 Tree nuts Living larvae	Tree 194 Fallen nuts Deserted holes	Tree 194 Fallen nuts Living larvae
6.XII.72	0	0	0	0	0	0	0	0
13.XII.72	0	0	0	0	0	0	0	0
20.XII.72	0	0	0	0	0	72	0	0
27.XII.72	0	17	0	0	0	81	0	2
3.I.73	0	0	0	0	28	155	0	4
10.I.73	0	0	0	0	0	287	0	9
17.I.73	0	35	0	1	0	662	0	34
24.I.73	0	182	0	1	0	1,227	9	86
31.I.73	0	227	0	8	0	1,771	40	362
7.II.73	0	194	8	53	0	957	91	403
14.II.73	0	281	13	70	0	383	77	341
21.II.73	38	162	9	40	50	191	45	113
28.II.73	15	118	11	58	-	-	25	62
7.III.73	0	109	7	29	-	-	17	32
14.III.73	10	66	13	29	-	-	15	17
21.III.73	0	63	6	30	4	20	3	19
TOTAL	63	1,454	67	319	82	5,806	322	1,484
Mean deserted holes/living larva	0.043		0.210		0.014			0.217

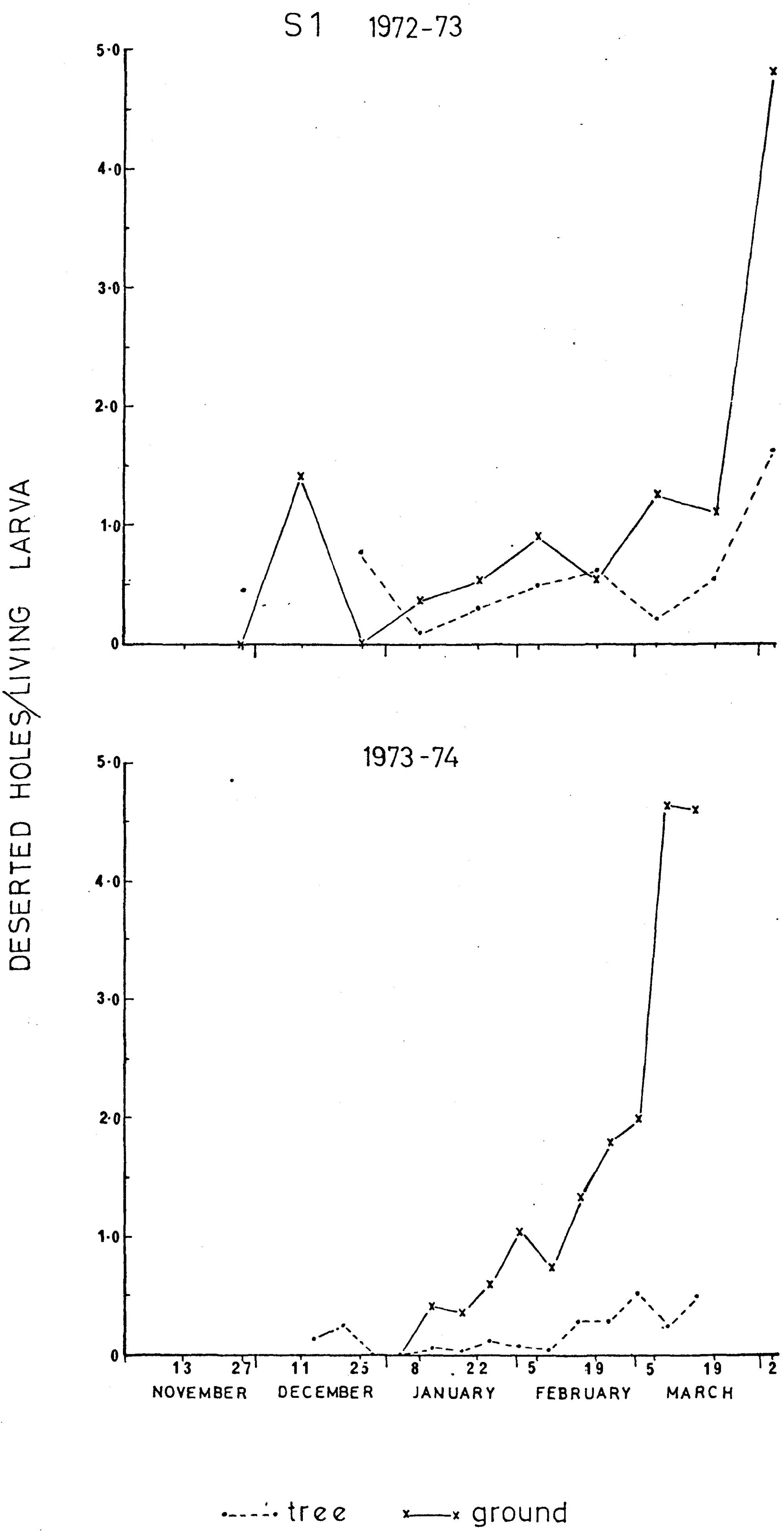

S1 1972-73
1973-74
DESERTED HOLES/LIVING LARVA
5·0
4·0
3·0
2·0
1·0
0
13
27
11
25
8
22
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
tree
ground

FIGURE 84

MORTALITY

Estimated mean deserted holes per living larva in Aspley S1 for tree and fallen nuts.

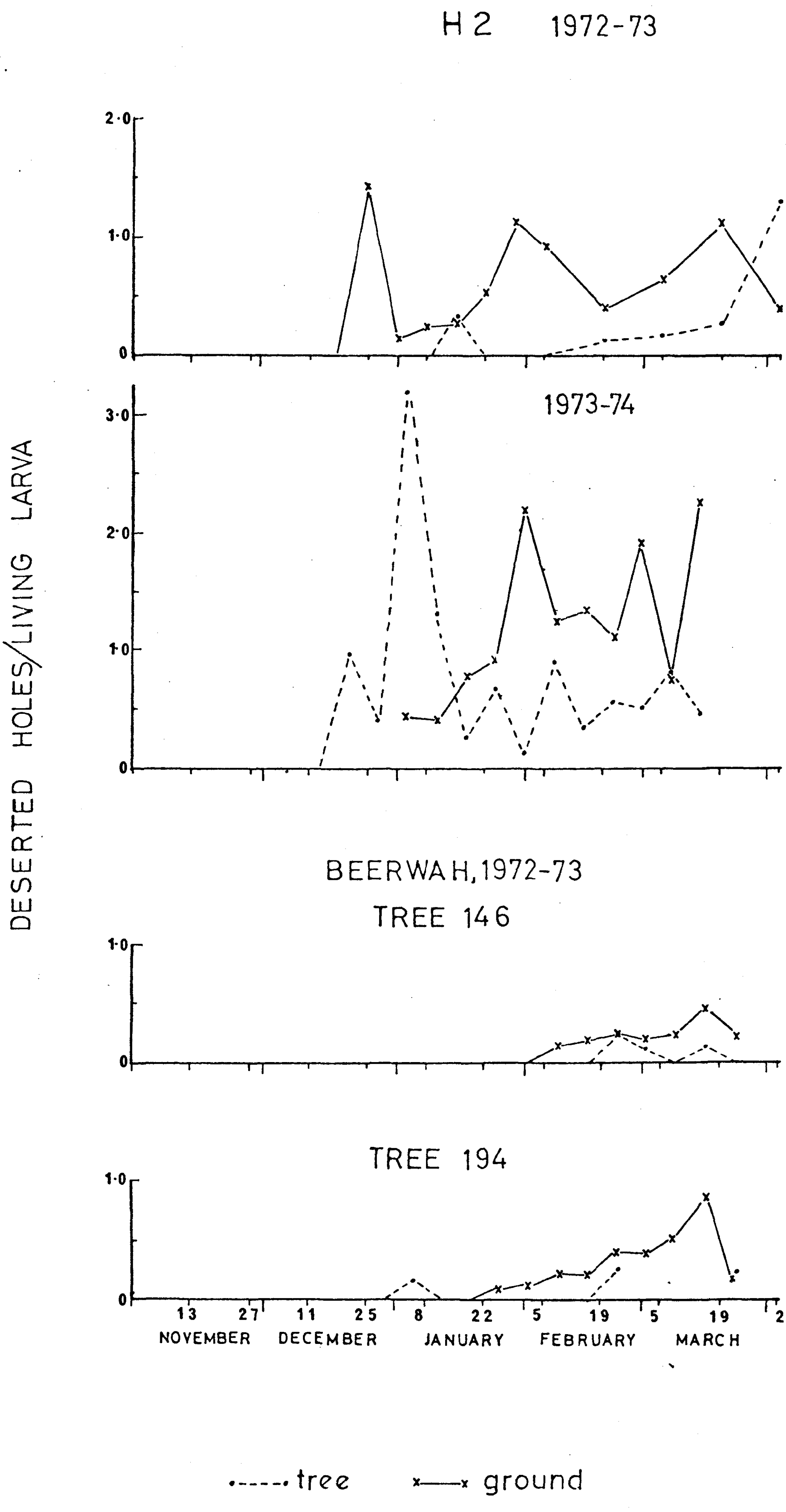

H 2 1972-73
1973-74
BEERWAH, 1972-73
TREE 146
TREE 194
DESERTED HOLES/LIVING LARVA
2·0
1·0
0
3·0
13
27
11
25
8
22
5
19
5
19
2
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
tree
ground

FIGURE 85

MORTALITY

Estimated mean deserted holes per living larva in Aspley H2 for tree and fallen nuts.

Data for Beerwah 1972-73, is shown for comparison with that for S1 and H2.

TABLE 101

MORTALITY

Multiples. Summary of results, Aspley
S1 1974

Larvae established per nut	Number of nuts	Number of larvae	Adults emerging from nuts	Larvae moving out of nuts after fall	Residual "mortality"
1	20	20	5 (25%)[1]	2 (10%)	65.0%
2	20	40	1 (2.5%)	6 (15%)	82.5%
4	20	80	6 (7.5%)	8 (10%)	82.5%
8	10	80	0	4 (5%)	95.0%

1. Percent of initial larval numbers

TABLE 102

MORTALITY

Cohort nuts. Numbers of living *C. ombrodelta* present during the experiment (corrected for numbers fallen and sampled), and the apparent percent mortality.

		Aspley S1		Aspley H2	
Day	Stage	Population	Apparent % mortality	Population	Apparent % mortality
0	eggs	640		1,078	
			49.7		91.4
9	1st 2nd 3rd	322		93	
			54.3		3.2
16	3rd 4th 5A Final	147		90	
			27.2		8.9
23	4th 5A Final Prepupa	107		82	
			76.6		47.6
30	Final Prepupa Pupa	25		43	
			72.0		67.4
37	Prepupa Pupa	7		14	
					85.7
44	Pupa	-		2	

TABLE 103

CROP DAMAGE

Kernel damage estimated at the sites sampled in 1972-73.

Date	Aspley 51 (99 trees) Nut fall	Aspley 51 Kernel damage % of nut fall	Aspley 51 Kernel damage % of damaged nut fall	Aspley H2 (72 trees) Nut fall	Aspley H2 Kernel damage % of nut fall	Aspley H2 Kernel damage % of damaged nut fall	Date	Beerwah (2 trees) Nut fall	Beerwah Kernel damage % of nut fall	Beerwah Kernel damage % of damaged nut fall
30.X.	?	0	0	?	0.1	100.0				
6.XI.	8063	1.2	100.0	38048	0.2	100.0				
13.XI.	13906	0.6	100.0	27848	0	0				
20.XI.	8868	0.6	100.0	12665	0.4	100.0				
27.XI.	2905	2.1	100.0 a	8102	0.8	100.0				
4.XII.	974	7.7	100.0	3803	1.9	100.0	6.XII.	?	0	0
11.XII.	344	4.7	80.0	2089	1.5	100.0 a	13.XII.	45	0	0 a
18.XII.	210	38.6	71.4 b	987	2.5	42.9	20.XII.	22	0	0
25.XII.	77	44.2	80.0	387	6.9	66.7 b	27.XII.	4	50.0	66.7 b
1.I.	77	50.7	66.7	201	7.5	37.5	3.I.	9	22.2	29.6
8.I.	178	4.5	6.3	331	16.6	54.6	10.I.	16	43.8	50.0
15.I.	769	6.5	6.7	392	9.4	22.2	17.I.	24	41.7	45.4
22.I.	1122	0.9	1.0	444	3.2	7.4	24.I.	51	21.6	22.9
29.I.	1534	0	0 c	516	7.9	15.0 c	31.I.	185	7.0	7.0
5.II.	1283	0	0	801	3.8	11.4	7.II.	284	2.8	2.8
12.II.	2278	0.8	0.8	1565	1.6	3.2	14.II.	320	4.7	4.8
19.II.	1767	0.7	0.7	2197	1.1	2.0	21.II.	153	5.9	3.5
26.II.	1825	0	0	3003	0.5	0.8	28.II.	115	4.4	4.6
5.III.	1695	0.7	0.8	4351	0.5	1.3	7.III.	71	5.6	6.1 c
12.III.	2516	0.7	0.9	10749	0	0	14.III.	66	1.5	1.6
19.III.	2351	0	0	26335	0	0	21.III.	41	4.9	9.8
26.III.	4236	0	0	14377	0.8	4.9				
2.IV.	3243	0.5	0.9	4343	0	0				

a. at this point the total potential crop is defined

b. at this point the shells of all nuts become hard

c. at this point the crop reached maximum maturity (Yamamoto's 1st grade)

TABLE 104

CROP DAMAGE

Multiples. Analysis of the period to nut fall,
Aspley S1 1974

1. First series 11.I.74 to 19.II.74

Analysis of variance (data transformed log(x))

Source	Degree of Freedom	F
Treatments	3	13.11**
Positions	1	0.08
Treatments x positions	3	0.15
Error	32	
Total	39	

Mean hour degrees to fall (untransformed)

	1 larva/nut	2 larvae/nut	4 larvae/nut	8 larvae/nut
	8,290[a1]	8,840[a]	6,435[b]	4,533[c]
Expected stage	pupa	pupa	6th prepupa	5th 5A

2. Second series 7.III.74 to 6.IV.74

Analysis of variance (data transformed log(x))

Source	Degree of Freedom	F
Treatments	4	0.56
Position	1	0.98
Treatments x positions	4	0.70
Error	40	
Total	49	

Mean hour degrees to fall (untransformed)

	Control	4 holes no larvae/nut	1 larva/nut	2 larvae/nut	4 larvae/nut
	8,513[d]	9,771[d]	7,708[d]	7,285[d]	6,563[d]
Expected stage	-	-	pupa 6th	prepupa 6th	6th prepupa

** significant at P=0.01

1. means followed by the same letter are not significantly different.

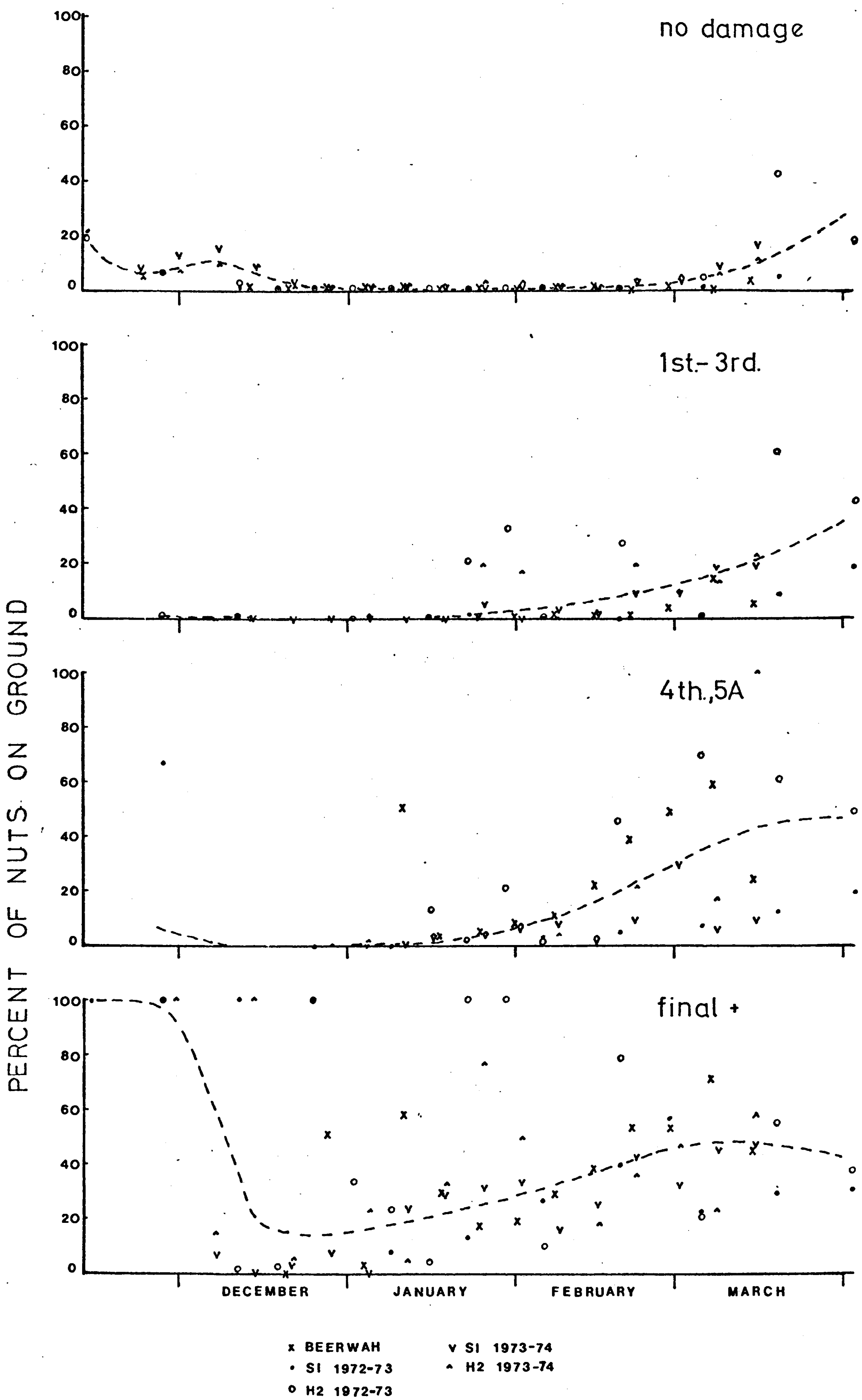

no damage
1st.- 3rd.
4th.,5A
final +
PERCENT OF NUTS ON GROUND
0
20
40
60
80
100
DECEMBER
JANUARY
FEBRUARY
MARCH
x BEERWAH
• SI 1972-73
o H2 1972-73
v SI 1973-74
^ H2 1973-74

FIGURE 86

CROP DAMAGE

Percent on the ground, of nuts sampled with each class of highest damage.

Points show the actual estimates for each sample; the broken lines were fitted subjectively as a guide to mean percent likelihood of fall of each damage class during the season.

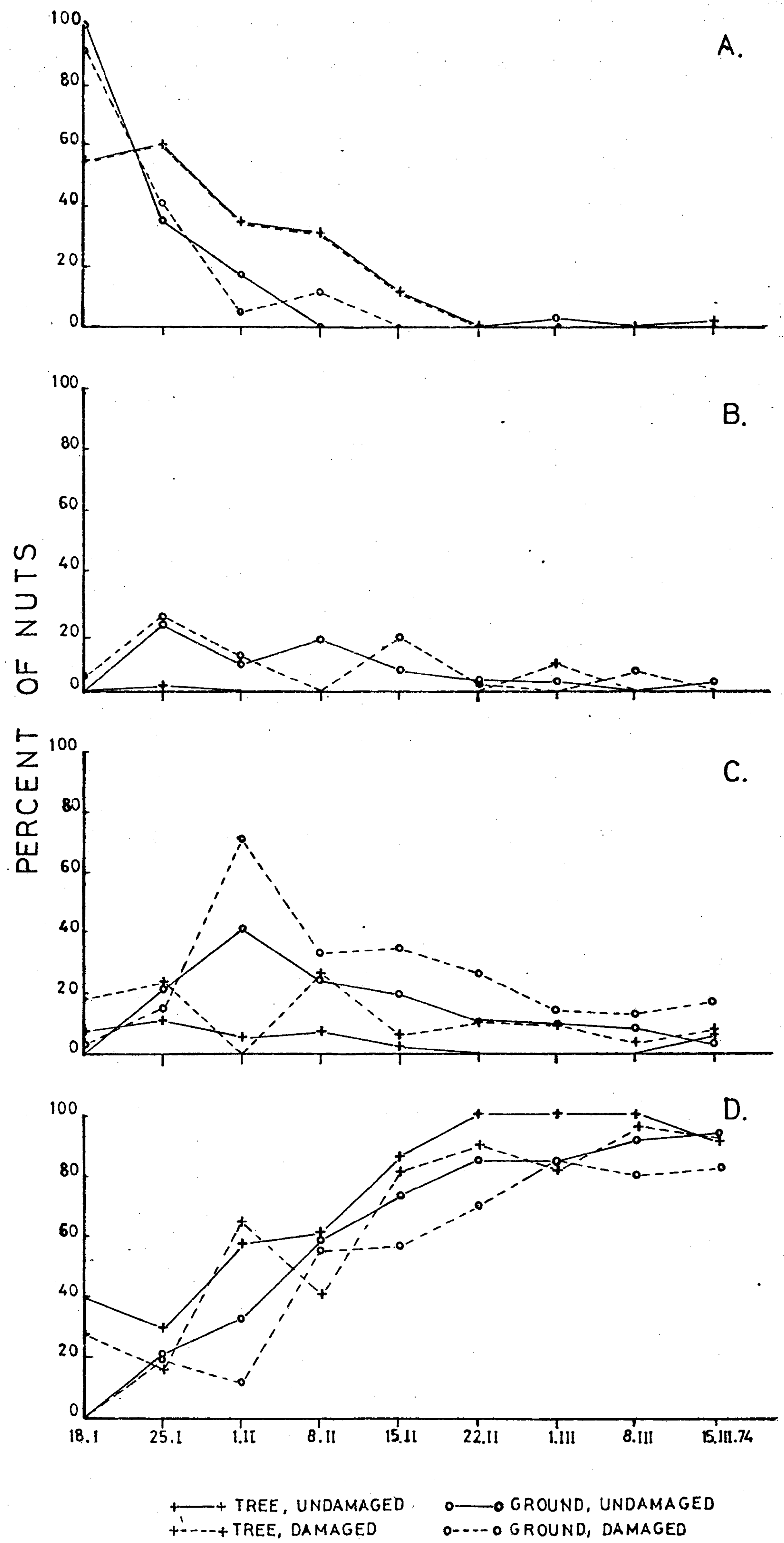

A.
B.
C.
D.
PERCENT OF NUTS
100
80
60
40
20
0
18.I
25.I
1.II
8.II
15.II
22.II
1.III
8.III
15.III.74
TREE, UNDAMAGED
TREE, DAMAGED
GROUND, UNDAMAGED
GROUND, DAMAGED

FIGURE 87

CROP DAMAGE

Kernel quality Aspley S1 1973-74. Percent in each quality grade of kernels from *C. ombrodelta* husk damaged, and undamaged nuts sampled.

A. Reject grade

B. 2nd grade

C. 1st grade

D. Water grade (considered suitable for processing).

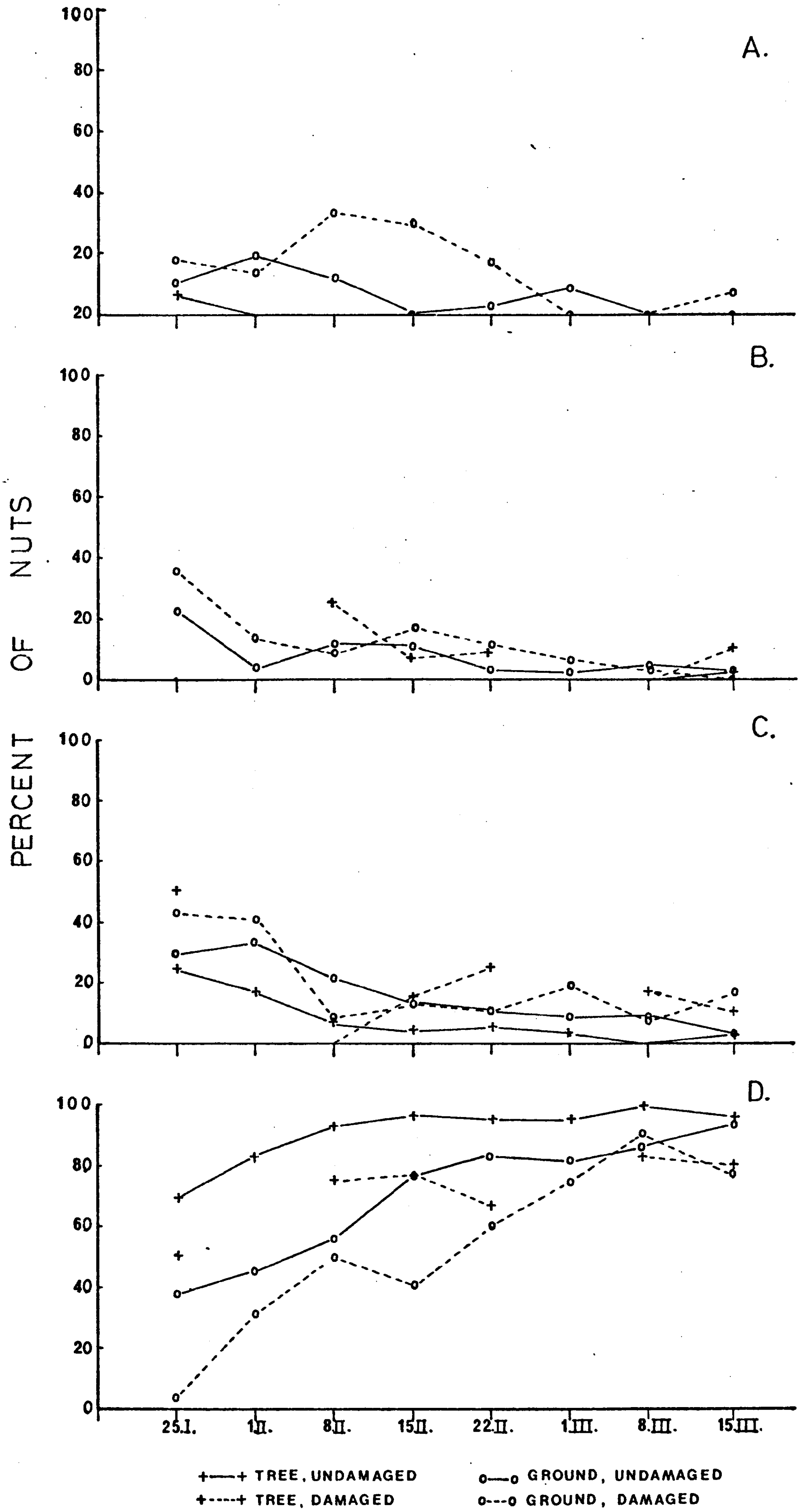

A.
B.
C.
D.
PERCENT OF NUTS
100
80
60
40
20
0
25.I.
1.II.
8.II.
15.II.
22.II.
1.III.
8.III.
15.III.
+——+ TREE, UNDAMAGED
+----+ TREE, DAMAGED
o——o GROUND, UNDAMAGED
o---o GROUND, DAMAGED

FIGURE 88

CROP DAMAGE

Kernel quality Aspley H2 1973-74. Percent in each quality grade of kernels from *C. ombrodelta* husk damaged, and undamaged nuts sampled.

A. Reject grade

B. 2nd grade

C. 1st grade

D. Water grade (considered suitable for processing)

Breaks in the plotted points indicate that on these dates no nuts in that class were found in the samples.

TABLE 105

CROP DAMAGE

The effect of *C. ombrodelta* husk damage on kernel quality. S1 and H2 1974. The difference in the percent of damaged nuts sampled in each quality grade compared with contemporaneous undamaged nut samples.

Variety	Period	Level	Grades Water	1st	2nd	Reject
	(A) from the beginning of maturity development to maximum maturity.					
S1	18.I.-15.II.	tree	- 8.3%	+8.7%	- 0.4%	0
		ground	-10.5%	+10.0%	+ 1.2%	- 0.6%
H2	25.I.-1.II.	tree	-18.8%	+25.0%	0	- 6.2%
		ground	-23.4%	+10.5%	+11.3%	+ 1.6%
	(B) period of maximum maturity.					
S1	22.II.-15.III.	tree	- 8.0%	+ 6.3%	+ 2.2%	- 0.5%
		ground	- 9.1%	+ 9.9%	0	- 0.8%
H2	8.II.-15.III.	tree	-19.6%	+ 9.8%	+ 9.8%	0
		ground	-14.0%	+ 1.3%	+ 1.8%	+10.9%

TABLE 106

CROP DAMAGE

Data for the calculation of crop loss in Aspley S1 1972-73.

	Nuts falling			Recorded maturity				Assumed maturity for each period			
Date	Clean	Husk damaged	Kernel damaged	1st	2nd	reject		Water	1st	2nd	reject
4.XII.[a]	899	75	-	0	0	1.00					
11.XII.	280	64	-	0	0	1.00					
18.XII.	80	129	-	0	0	1.00					
25.XII.	34	43	-	0	0	1.00					
1.I.	19	58	-	0	0	1.00					
8.I.	42	136	-	0	0	1.00					
15.I.	17	752	-	0.05	0.10	0.85					
sub-total	1,371	1,257									
22.I.[bc]	115	997	10	0.20	0.15	0.65					
29.I.	0	1,534	0	0.69	0.13	0.18					
sub-total	115	2,531	10				no damage	0.47	0.01	0.14	0.38
							damage	0.37	0.11	0.14	0.38
5.II.[d]	95	1,188	0	0.89	0.09	0.02					
12.II.	106	2,155	17	0.94	0.05	0.01					
19.II.	60	1,695	12	0.92	0.06	0.02					
26.II.	138	1,687	0	1.00	0	0					
5.III.	197	1,486	12	0.96	0.01	0.03					
12.III.	395	2,102	19	0.96	0.02	0.02					
19.III.	738	1,613	0	0.97	0	0.03					
26.III.	1,456	2,780	0	0.98	0	0.02					
2.IV.	1,719	1,510	14	0.97	0	0.02					
sub-total	4,904	16,216	74				no damage	0.97	0	0.02	0.01
							damage	0.88	0.08	0.02	0.02
TOTAL harvest	5,019	18,747	84								

a. This date is that on which maximum potential crop is defined

b. Harvest begins at this point - when tree nuts are more than 50% hard brown. Those falling previously are discarded.

c. This date and that following are in the period of increasing maturity

d. This date and those following are in the period of maximum maturity for tree nuts.

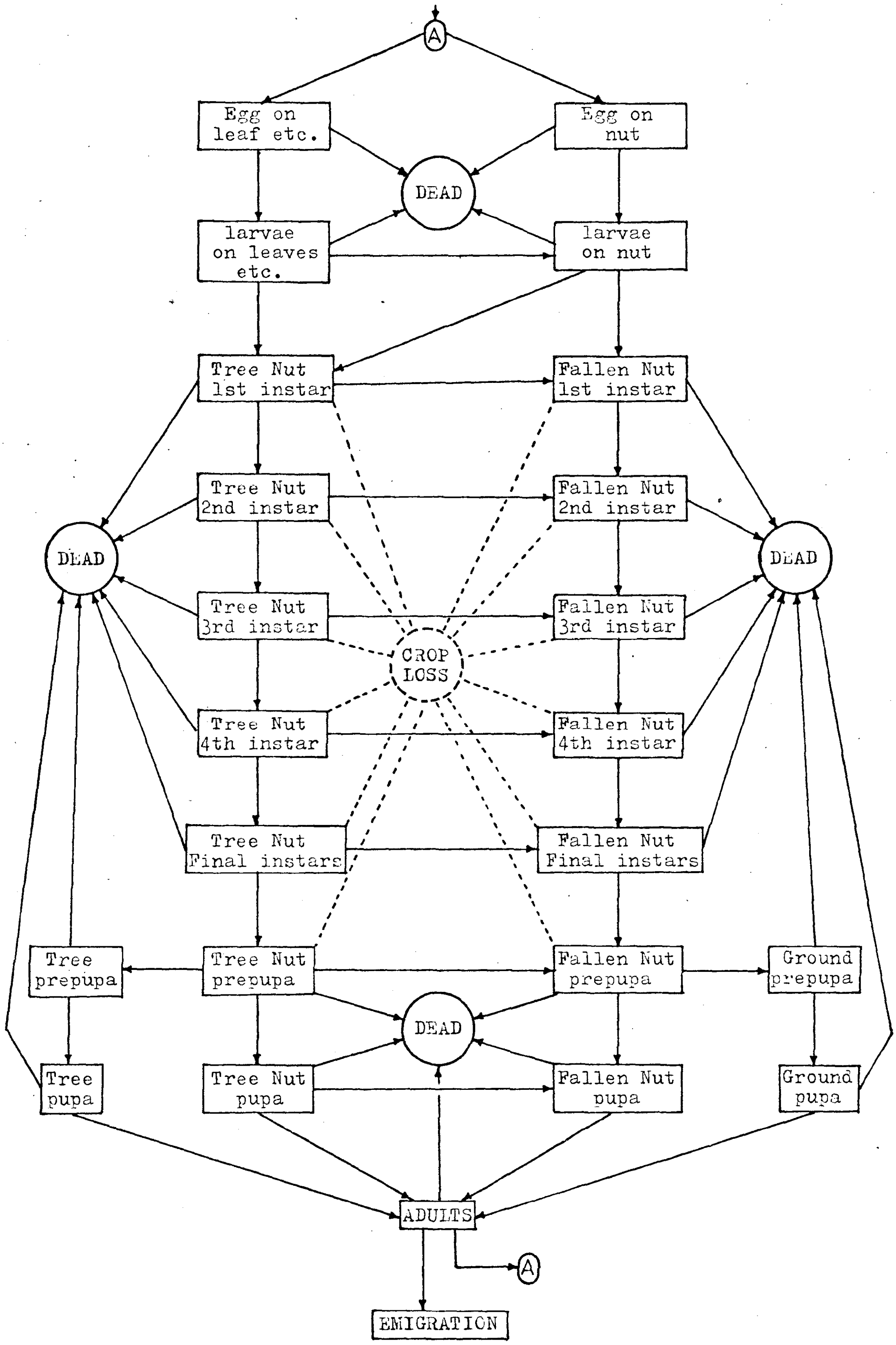

A
Egg on leaf etc.
Egg on nut
DEAD
larvae on leaves etc.
larvae on nut
Tree Nut 1st instar
Fallen Nut 1st instar
Tree Nut 2nd instar
Fallen Nut 2nd instar
DEAD
DEAD
Tree Nut 3rd instar
Fallen Nut 3rd instar
CROP LOSS
Tree Nut 4th instar
Fallen Nut 4th instar
Tree Nut Final instars
Fallen Nut Final instars
Tree prepupa
Tree Nut prepupa
Fallen Nut prepupa
Ground prepupa
DEAD
Tree pupa
Tree Nut pupa
Fallen Nut pupa
Ground pupa
ADULTS
A
EMIGRATION

FIGURE 89

MODELLING

Conceptual model of the *C. ombrodelta*-macadamia interaction

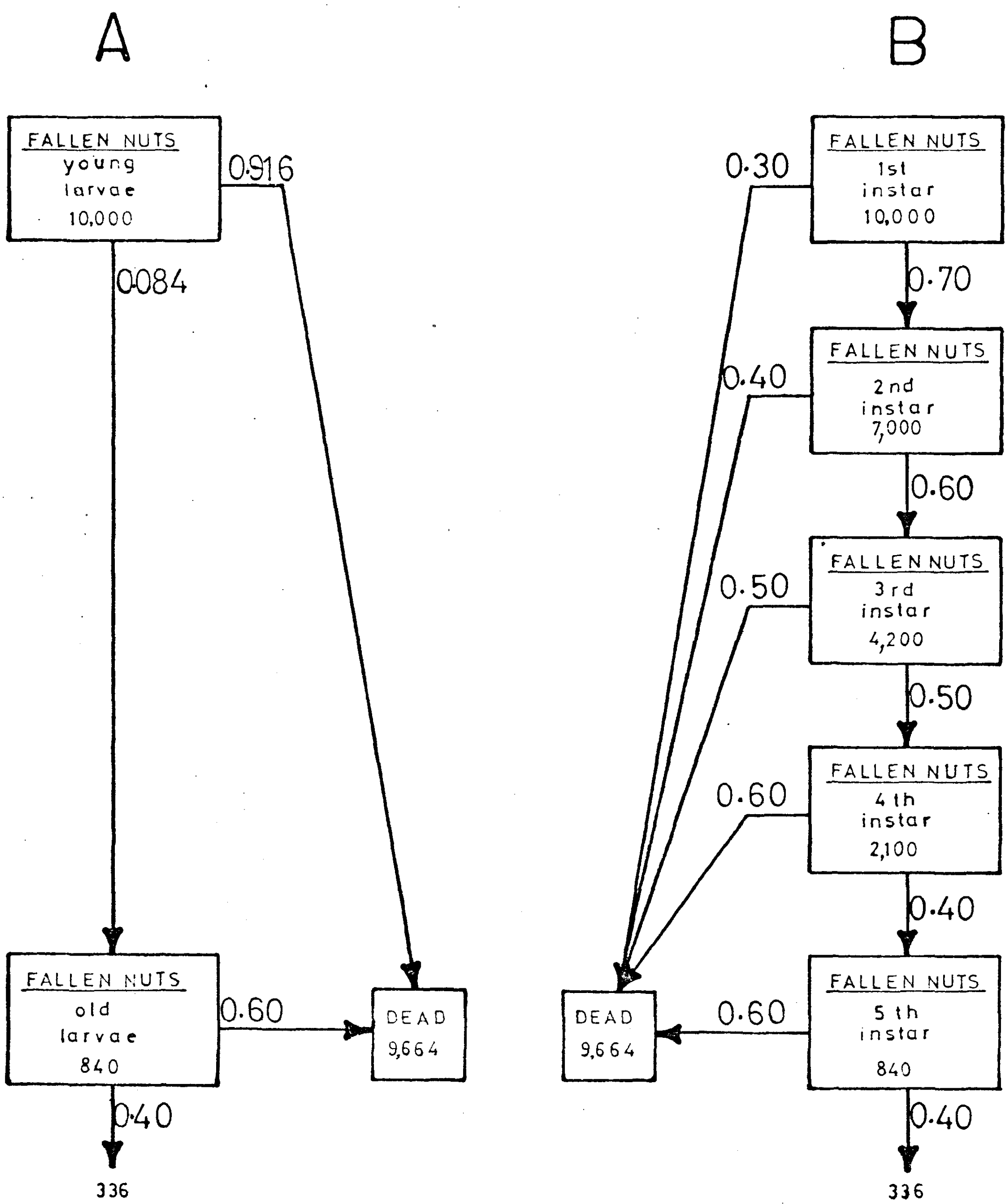

A
FALLEN NUTS
young
larvae
10,000
0.916
0.084
FALLEN NUTS
old
larvae
840
0.60
DEAD
9,664
0.40
336
B
FALLEN NUTS
1st
instar
10,000
0.30
0.70
FALLEN NUTS
2nd
instar
7,000
0.40
0.60
FALLEN NUTS
3rd
instar
4,200
0.50
0.50
FALLEN NUTS
4th
instar
2,100
0.60
0.40
FALLEN NUTS
5th
instar
840
0.60
DEAD
9,664
0.40
336

FIGURE 90

MODELLING

Illustration of the expansion of a model section

A. brief description

B. expanded description

Values within the boxes are numbers of larvae.

Values against arrows linking boxes are the probabilities of each event occurring.

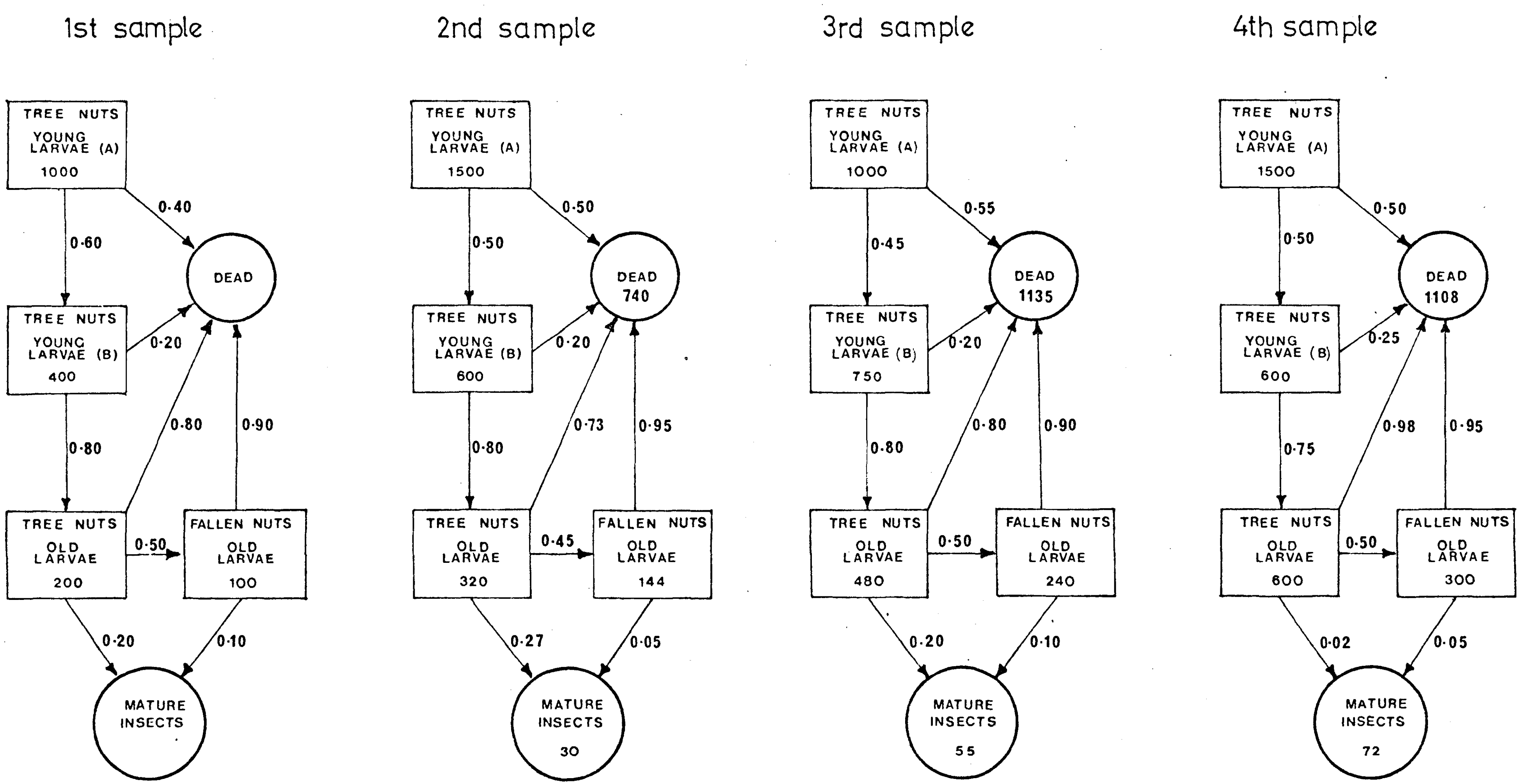

1st sample
TREE NUTS YOUNG LARVAE (A) 1000
TREE NUTS YOUNG LARVAE (B) 400
TREE NUTS OLD LARVAE 200
FALLEN NUTS OLD LARVAE 100
DEAD
MATURE INSECTS
0·40
0·60
0·20
0·80
0·80
0·90
0·50
0·20
0·10
2nd sample
TREE NUTS YOUNG LARVAE (A) 1500
TREE NUTS YOUNG LARVAE (B) 600
TREE NUTS OLD LARVAE 320
FALLEN NUTS OLD LARVAE 144
DEAD 740
MATURE INSECTS 30
0·50
0·50
0·20
0·80
0·73
0·95
0·45
0·27
0·05
3rd sample
TREE NUTS YOUNG LARVAE (A) 1000
TREE NUTS YOUNG LARVAE (B) 750
TREE NUTS OLD LARVAE 480
FALLEN NUTS OLD LARVAE 240
DEAD 1135
MATURE INSECTS 55
0·55
0·45
0·20
0·80
0·80
0·90
0·50
0·20
0·10
4th sample
TREE NUTS YOUNG LARVAE (A) 1500
TREE NUTS YOUNG LARVAE (B) 600
TREE NUTS OLD LARVAE 600
FALLEN NUTS OLD LARVAE 300
DEAD 1108
MATURE INSECTS 72
0·50
0·50
0·25
0·75
0·98
0·95
0·50
0·02
0·05

FIGURE 91

MODELLING

A series of hypothetical, time specific models

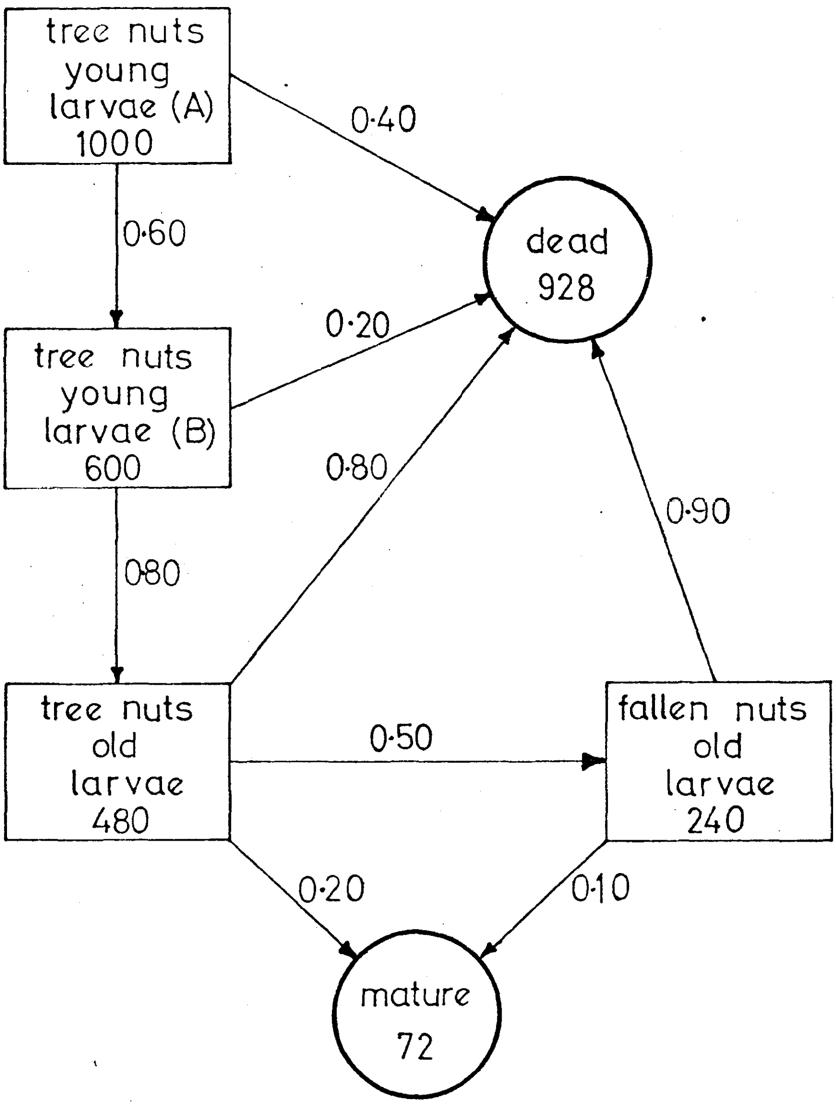

tree nuts young larvae (A) 1000
0·40
0·60
dead 928
0·20
tree nuts young larvae (B) 600
0·80
0·90
0·80
tree nuts old larvae 480
0·50
fallen nuts old larvae 240
0·20
0·10
mature 72

FIGURE 92

MODELLING

A hypothetical age specific model

This was constructed from the time specific models in Figure 91.

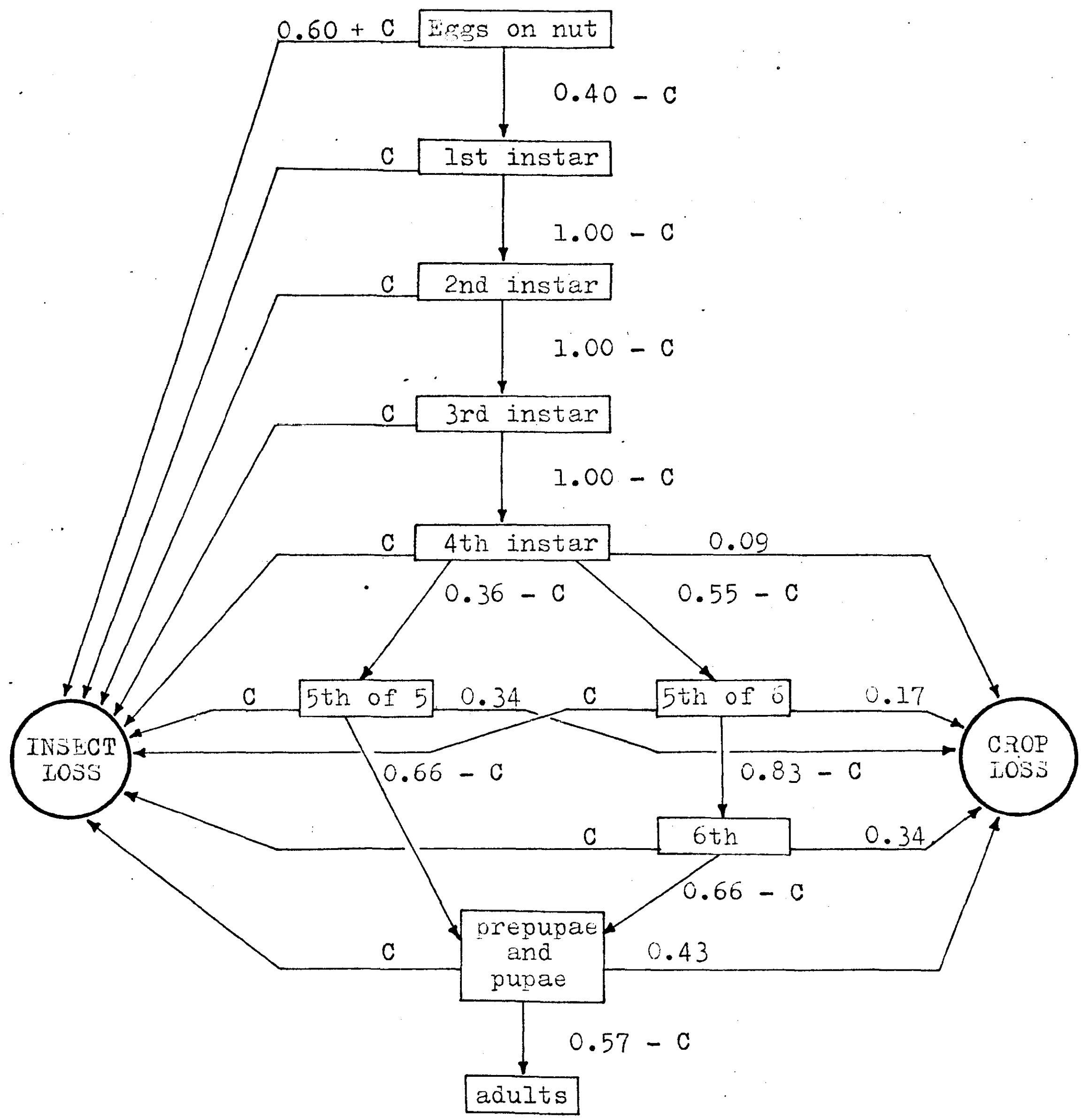

0.60 + C
Eggs on nut
0.40 - C
C
1st instar
1.00 - C
C
2nd instar
1.00 - C
C
3rd instar
1.00 - C
C
4th instar
0.09
0.36 - C
0.55 - C
C
5th of 5
0.34
C
5th of 6
0.17
INSECT LOSS
CROP LOSS
0.66 - C
0.83 - C
C
6th
0.34
0.66 - C
C
prepupae and pupae
0.43
0.57 - C
adults

FIGURE 93

MODELLING

The time specific diagram for the desk calculator model of *C. ombrodelta* in macadamia.

"C" represents the contagion factor, i.e. multiple infestations.

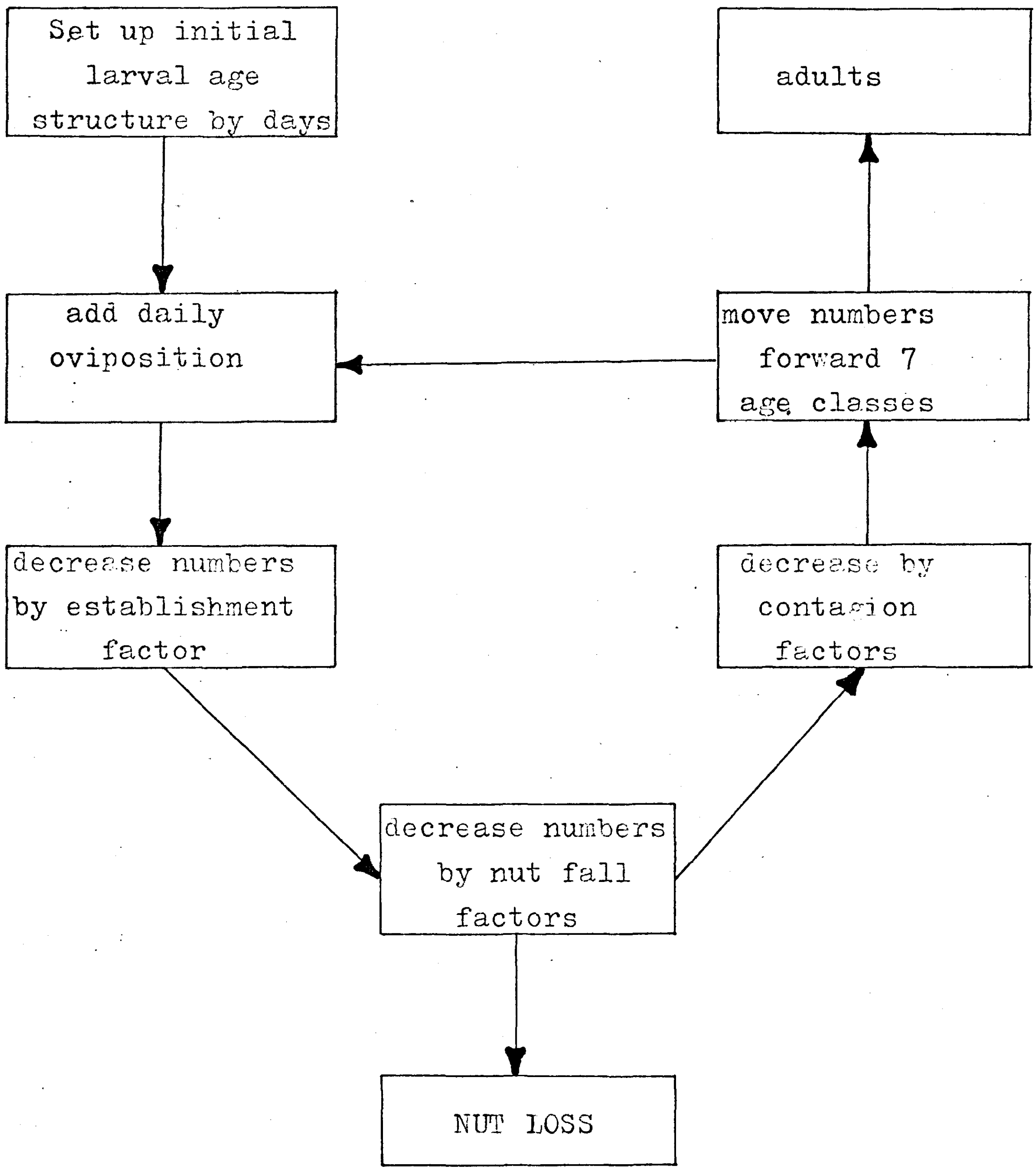

Set up initial larval age structure by days
adults
add daily oviposition
move numbers forward 7 age classes
decrease numbers by establishment factor
decrease by contagion factors
decrease numbers by nut fall factors
NUT LOSS

FIGURE 94

MODELLING

The flow chart for the desk calculator model of *C. ombrodelta* in macadamia.

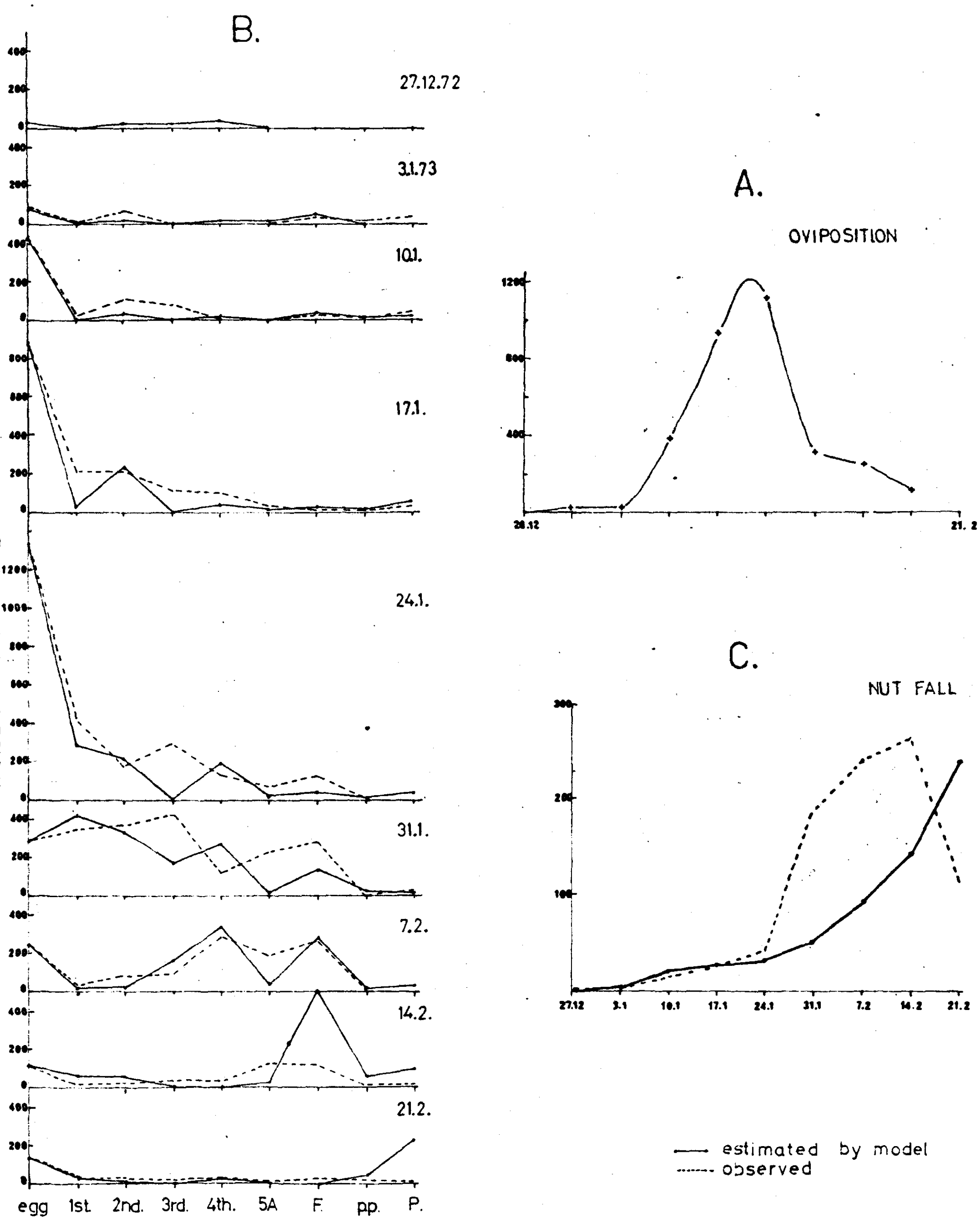

B.
27.12.72
3.1.73
10.1.
17.1.
24.1.
31.1.
7.2.
14.2.
21.2.
NUMBER PER TREE
egg
1st.
2nd.
3rd.
4th.
5A
F.
pp.
P.
A.
OVIPOSITION
21. 2
C.
NUT FALL
27.12
3.1
10.1
17.1
24.1
31.1
7.2
14.2
21.2
estimated by model
observed

FIGURE 95

MODELLING

Results from the desk calculator model of *C. ombrodelta* in macadamia.

A. Oviposition values estimated from field samples.

B. Numbers of immatures for each date of sampling, and model output.

C. Nut fall for sample dates, and model output.

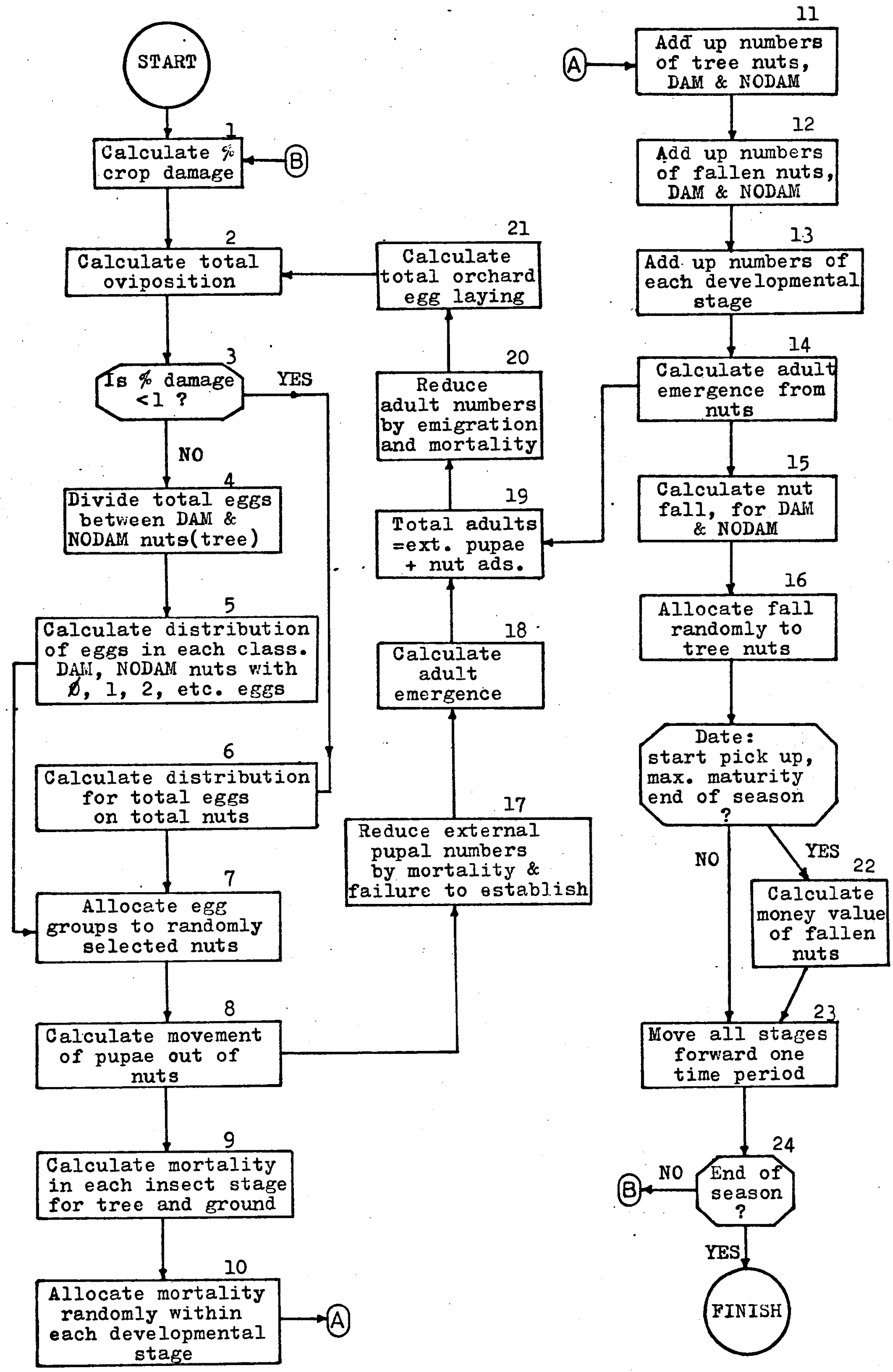

START
1 Calculate % crop damage
B
2 Calculate total oviposition
3 Is % damage <1 ?
YES
NO
4 Divide total eggs between DAM & NODAM nuts(tree)
5 Calculate distribution of eggs in each class. DAM, NODAM nuts with ∅, 1, 2, etc. eggs
6 Calculate distribution for total eggs on total nuts
7 Allocate egg groups to randomly selected nuts
8 Calculate movement of pupae out of nuts
9 Calculate mortality in each insect stage for tree and ground
10 Allocate mortality randomly within each developmental stage
A
11 Add up numbers of tree nuts, DAM & NODAM
12 Add up numbers of fallen nuts, DAM & NODAM
13 Add up numbers of each developmental stage
14 Calculate adult emergence from nuts
15 Calculate nut fall, for DAM & NODAM
16 Allocate fall randomly to tree nuts
Date: start pick up, max. maturity end of season ?
NO
YES
22 Calculate money value of fallen nuts
23 Move all stages forward one time period
24 End of season ?
NO
B
YES
FINISH
17 Reduce external pupal numbers by mortality & failure to establish
18 Calculate adult emergence
19 Total adults =ext. pupae + nut ads.
20 Reduce adult numbers by emigration and mortality
21 Calculate total orchard egg laying

FIGURE 96

MODELLING

Processes incorporated in the computer model of the *C. ombrodelta*-macadamia interaction.

Numbers above the boxes refer to descriptions of the processes given in the text.

DAM = nuts damaged by *C. ombrodelta*

NODAM = nuts not damaged by *C. ombrodelta*

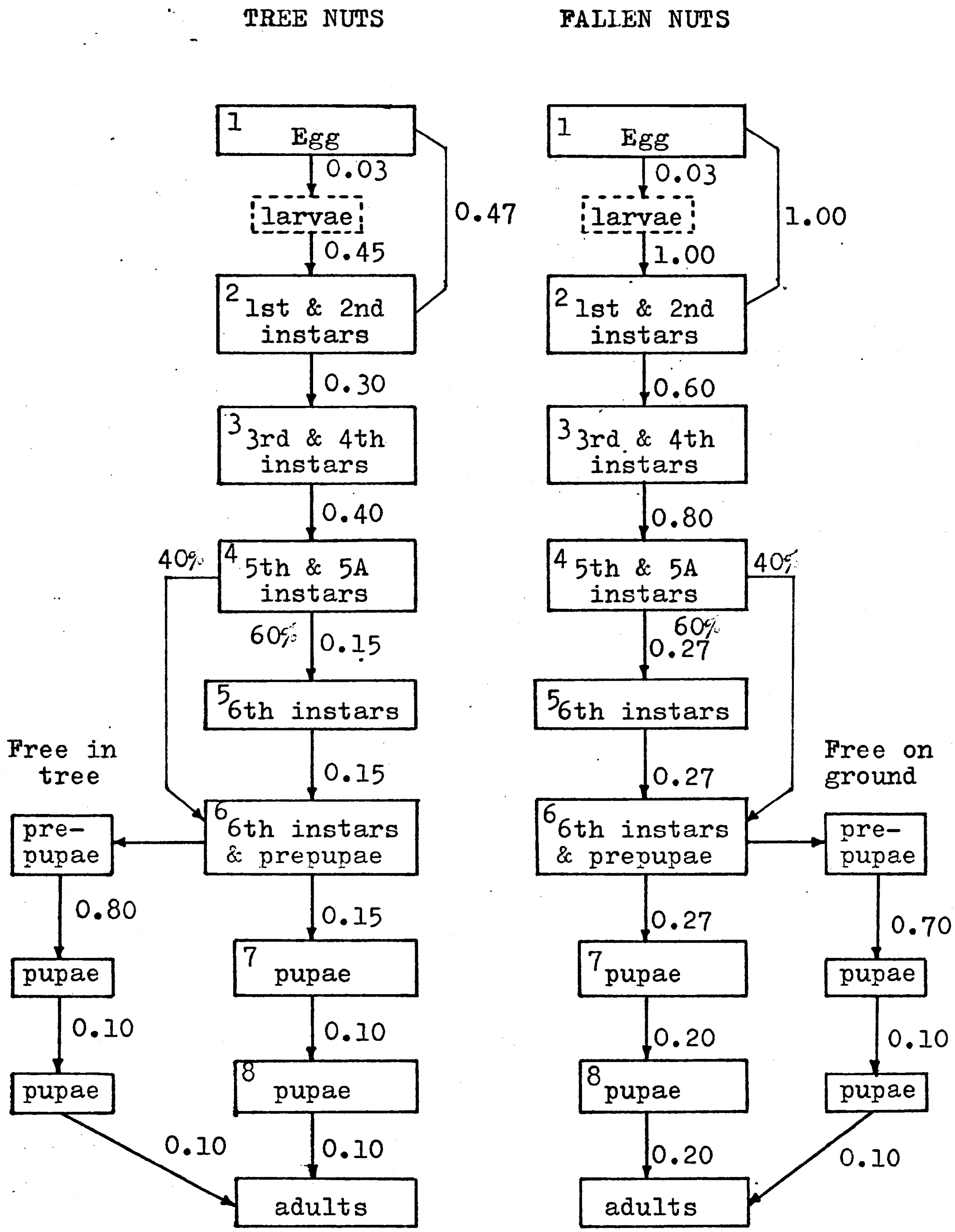

TREE NUTS
FALLEN NUTS
1 Egg
larvae
2 1st & 2nd instars
3 3rd & 4th instars
4 5th & 5A instars
5 6th instars
6 6th instars & prepupae
7 pupae
8 pupae
adults
Free in tree
Free on ground
pre-pupae
pupae
0.03
0.45
0.47
1.00
0.30
0.60
0.40
0.80
40%
60%
0.15
0.27
0.80
0.70
0.10
0.20

FIGURE 97

MODELLING

Basic mortalities proposed for *C. ombrodelta* immatures in macadamia.

The probabilities of mortalities shown result in a total mortality of approximately 0.98 which should result in a steady population size; this depends on the fall of tree nuts and the proportion of stage 6 larvae moving out of nuts (assumed to be of the order of 0.60).

It is assumed that 40% of larvae have only 5 instars (jumping stage 5).

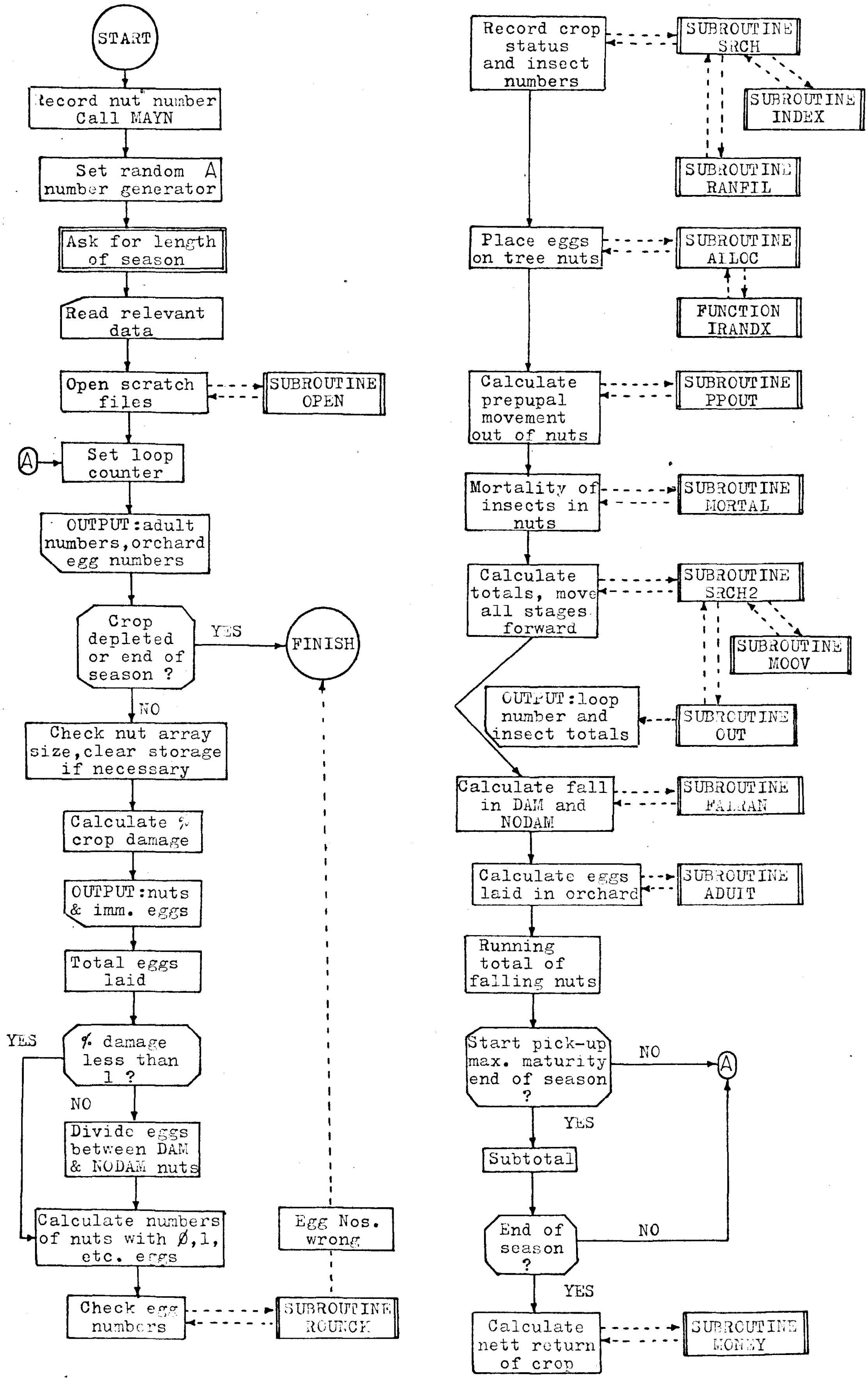

START
Record nut number Call MAYN
Set random number generator
Ask for length of season
Read relevant data
Open scratch files
SUBROUTINE OPEN
Set loop counter
OUTPUT: adult numbers, orchard egg numbers
Crop depleted or end of season ?
YES
FINISH
NO
Check nut array size, clear storage if necessary
Calculate % crop damage
OUTPUT: nuts & imm. eggs
Total eggs laid
% damage less than 1 ?
YES
NO
Divide eggs between DAM & NODAM nuts
Calculate numbers of nuts with Ø,1, etc. eggs
Egg Nos. wrong
Check egg numbers
SUBROUTINE ROUNCK
Record crop status and insect numbers
SUBROUTINE SRCH
SUBROUTINE INDEX
SUBROUTINE RANFIL
Place eggs on tree nuts
SUBROUTINE ALLOC
FUNCTION IRANDX
Calculate prepupal movement out of nuts
SUBROUTINE PPOUT
Mortality of insects in nuts
SUBROUTINE MORTAL
Calculate totals, move all stages forward
SUBROUTINE SRCH2
SUBROUTINE MOOV
OUTPUT: loop number and insect totals
SUBROUTINE OUT
Calculate fall in DAM and NODAM
SUBROUTINE FALRAN
Calculate eggs laid in orchard
SUBROUTINE ADULT
Running total of falling nuts
Start pick-up max. maturity end of season ?
NO
YES
Subtotal
End of season ?
NO
YES
Calculate nett return of crop
SUBROUTINE MONEY

FIGURE 98

MODELLING

The structure of the computer model describing the *C. ombrodelta*-macadamia interaction.

Box A is the first of Subroutine MAYN which may be considered an extension of MAIN.

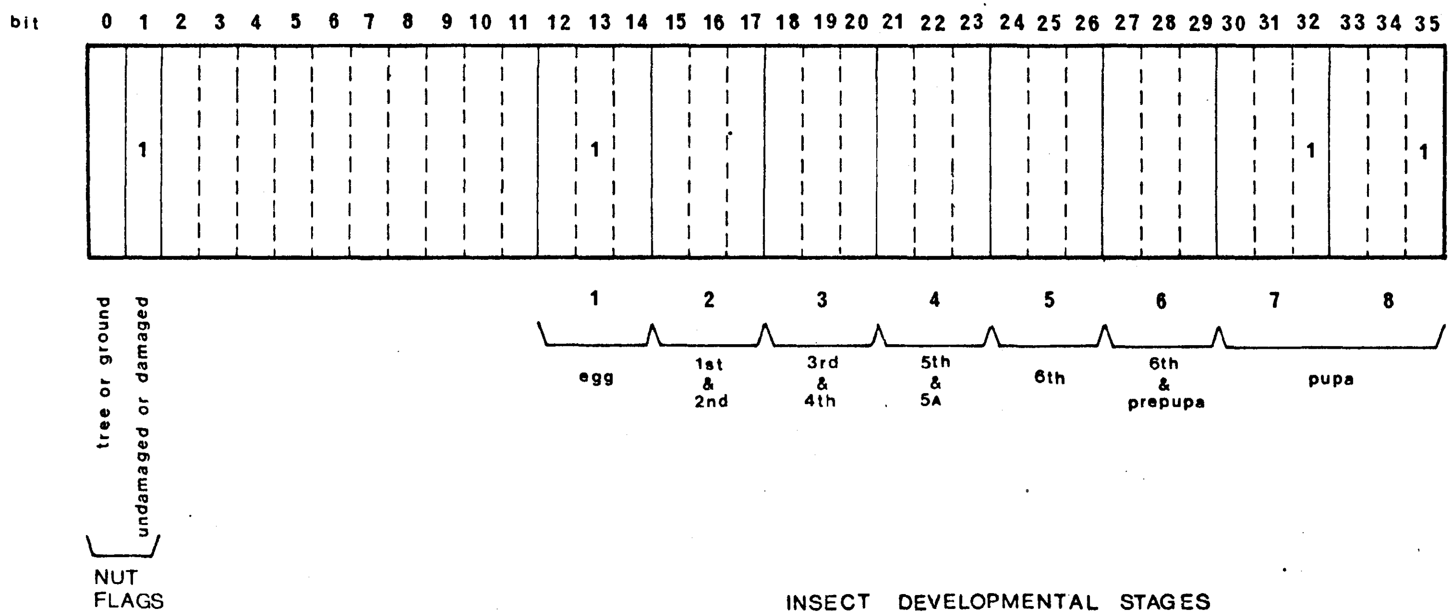
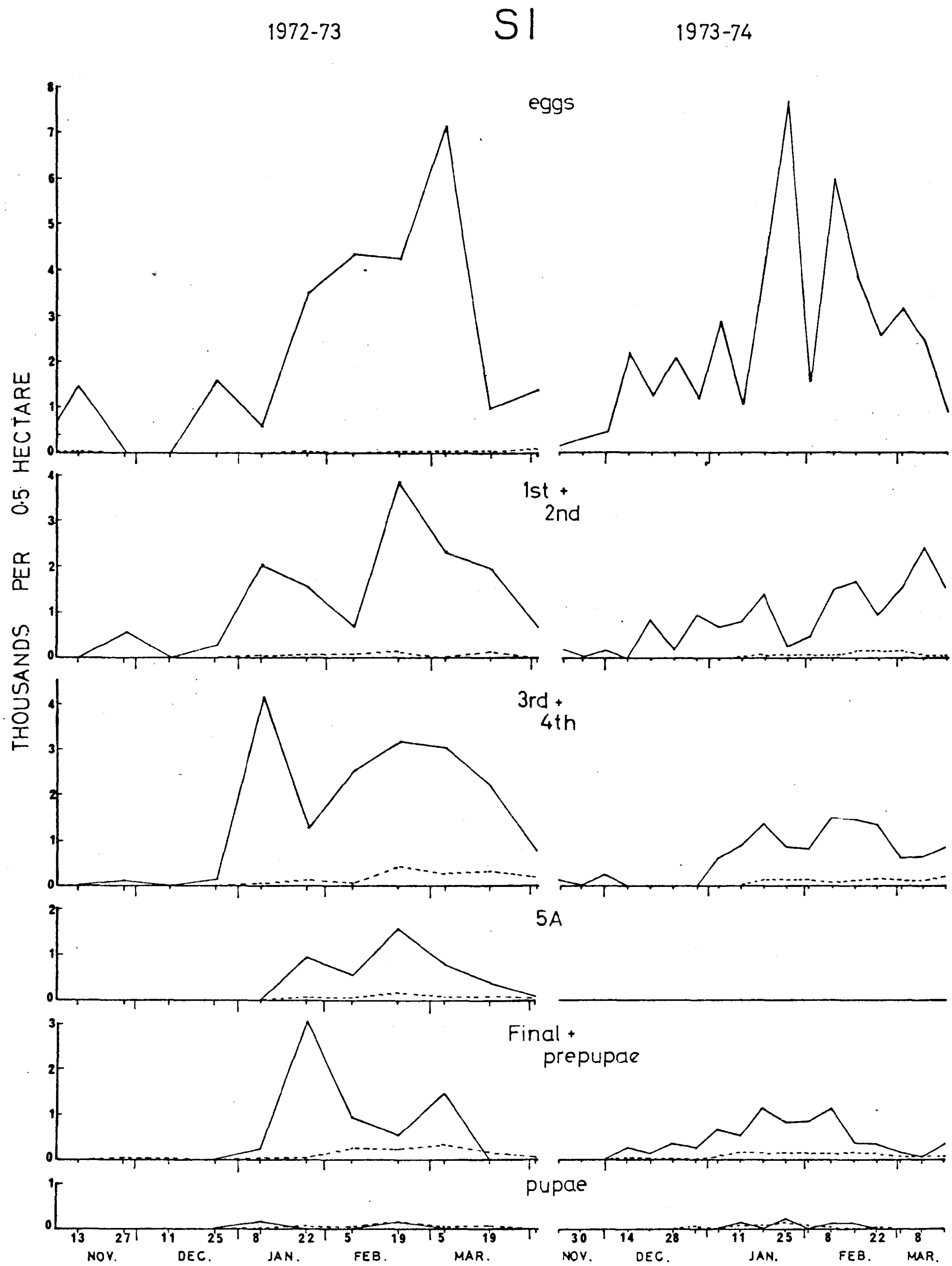

bit
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
1
1
1
1
tree or ground
undamaged or damaged
NUT FLAGS
1
2
3
4
5
6
7
8
egg
1st & 2nd
3rd & 4th
5th & 5A
6th
6th & prepupa
pupa
INSECT DEVELOPMENTAL STAGES

FIGURE 99

MODELLING

Computer model: the structure of the 36 bit word "nut".

The word illustrated represents a damaged fallen nut with two eggs and two pupae.



1972-73
SI
1973-74
eggs
1st +
2nd
3rd +
4th
5A
Final +
prepupae
pupae
THOUSANDS PER 0·5 HECTARE
13
27
11
25
8
22
5
19
5
19
NOV.
DEC.
JAN.
FEB.
MAR.
30
14
28
11
25
8
22
8
NOV.
DEC.
JAN.
FEB.
MAR.

FIGURE 100

MODELLING

Absolute field population estimates of *C. ombrodelta* immatures grouped in accord with those used in the computer model.   Aspley S1.

—— population in tree nuts

---- population in fallen nuts

This figure has been derived from Figure 51.

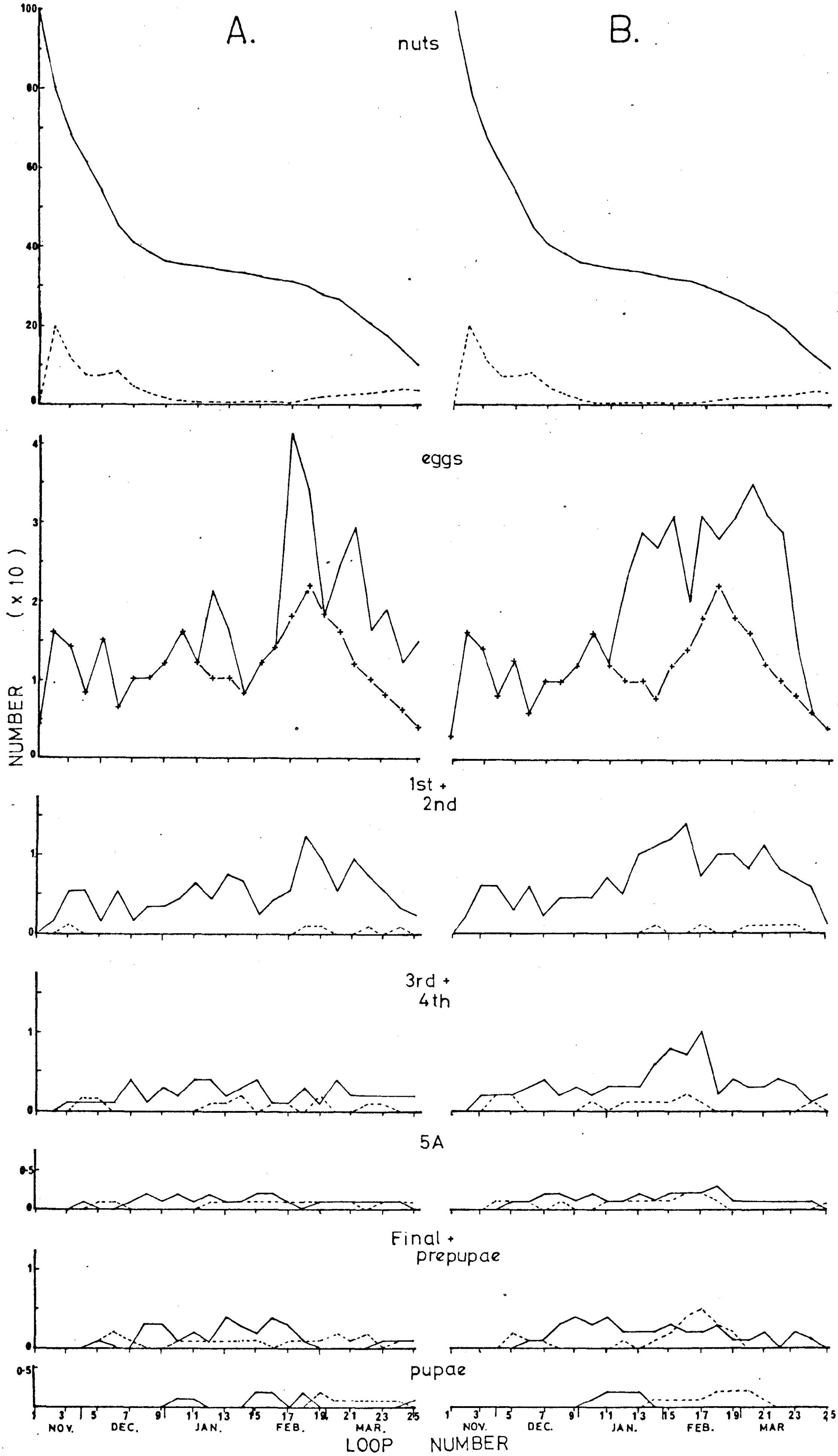

A.
B.
nuts
eggs
1st +
2nd
3rd +
4th
5A
Final +
prepupae
pupae
NUMBER
(x 10)
100
80
60
40
20
0
4
3
2
1
0
0·5
NOV.
DEC.
JAN.
FEB.
MAR.
LOOP NUMBER

FIGURE 101

MODELLING

Computer model output for two runs

—— numbers in the tree

---- numbers on the ground

Eggs: —— total laid per loop

+—+ immigrant eggs per loop (input data)

TABLE 107

MODELLING

Data used to produce the computer model results shown in Figure 101

1. Data common to runs A and B

60% of larvae have 6 instars

Immigrant eggs per loop	3	16	14	8	15	6	10	10	12	16
	12	10	10	8	12	14	18	22	18	16
	12	10	8	6	4					
Probability of damaged nuts falling in each loop	0.80	0.75	0.70	0.60	0.50	0.20	0.15	0.15	0.20	
	0.20	0.22	0.25	0.27	0.30	0.33	0.36	0.39	0.42	
	0.45	0.47	0.50	0.50	0.50	0.47	0.45			
Probability of undamaged nuts falling in each loop	0.20	0.15	0.10	0.12	0.15	0.10	0.07	0.05	0.02	
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.05	
	0.06	0.07	0.10	0.15	0.20	0.25	0.30			

Harvest begins in loop 16, maximum maturity achieved in loop 17.

Proportion of nuts suitable for cooking:

Early harvest, damaged 0.37 undamaged 0.47

Late harvest, " 0.88 " 0.97

Mortality of external pupae:

	Age Classes 1	2	3
ground	0.80	0.20	0.20
tree	0.70	0.20	0.20

Emigration of adults from the orchard: Nil

Mortality of adults in the orchard:

Age Classes 1	2	3
0.15	0.40	0.99

2. Variation in data

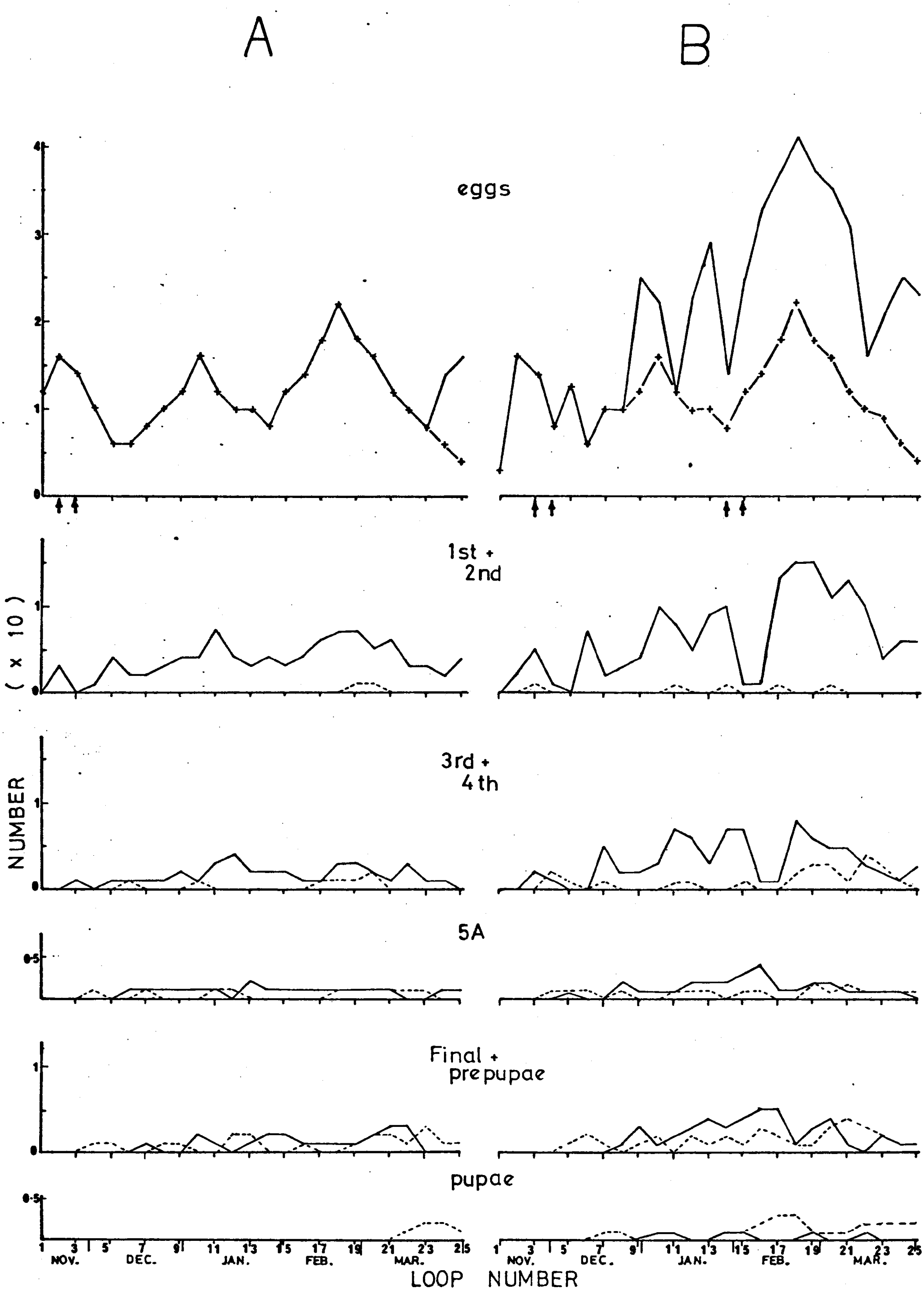
		Run A								Run B							
Adult oviposition age classes 1 to 3		14	12	6						16	12	4					
Mortality for each of the 8 insect stages, egg to old pupae.																	
Loops 1 to 17	ground	1.00	0.55	0.60	0.25	0.30	0.80	0.15	0.15	1.00	0.55	0.60	0.40	0.35	0.80	0.30	0.30
	tree	0.46	0.20	0.25	0.12	0.12	0.56	0.10	0.10	0.46	0.20	0.15	0.10	0.10	0.60	0.05	0.05
Loops 18 to 25	ground	1.00	0.80	0.90	0.40	0.40	0.70	0.40	0.40	1.00	0.80	0.90	0.50	0.50	0.80	0.40	0.45
	tree	0.46	0.30	0.45	0.25	0.25	0.65	0.20	0.20	0.46	0.30	0.45	0.25	0.25	0.65	0.20	0.20
Probability of prepupae leaving nuts.																	
	ground				0.60								0.60				
	tree				0.50								0.55				

TABLE 108

MODELLING

A comparison of statistics generated by the model with those for sample results. Tree nuts only.

	Model (Loop 14)										Aspley S1 (Field sample)						
	Nuts with:										Nuts with:						
Run	0	1	2	3	4	5	6	$\bar{x}$	s^2	Date	0	1	2	3	4	$\bar{x}$	s^2
TOTAL LIVING LARVAE																	
A	322	3	5	1				0.050	0.097	25.XII.72	111	4	1			0.052	0.067
B	1,301	18	7	1	2			0.033	0.066	8.I.72	92	12	3	0	1	0.203	0.332
C	309	12	3	4				0.091	0.175	22.I.72	94	14	7	1		0.267	0.371
D	271	17	11	3	1	0	1	0.191	0.426	4.I.73	239	10	0	1		0.052	0.074
E	315	9						0.028	0.027	11.I.73	233	16	1			0.068	0.076
F	333	3						0.009	0.009	18.I.73	224	23	2	0	1		
%	96.57	2.10	0.89	0.30	0.10	0	0.04				91.10	7.25	1.28	0.19	0.18		
1st & 2nd INSTARS																	
A	328	2	1					0.012	0.018	25.XII.72	113	2	1			0.034	0.051
B	1,320	7	1					0.010	0.020	8.I.72	101	6	1			0.074	0.088
C	317	8	2	1				0.046	0.074	22.I.72	109	6	1			0.069	0.082
D	287	9	7	1				0.086	0.144	4.I.73	244	5	0	1		0.032	0.055
E	320	4						0.013	0.012	11.I.73	243	7				0.028	0.027
F	355	1						0.003	0.003	18.I.73	242	7	0	1		0.040	0.063
FINAL INSTARS																	
A	328	2	1					0.012	0.018	25.XII.72	116					0	-
B	1,318	6	5					0.012	0.020	8.I.72	105	3				0.028	0.027
C	324	3	1					0.015	0.021	22.I.72	105	11				0.095	0.087
D	296	7	0	0	1			0.036	0.075	4.I.73	245	5				0.020	0.020
E	320	4						0.013	0.012	11.I.73	246	4				0.016	0.016
F	335	1						0.003	0.003	18.I.73	240	10				0.040	0.039
DESERTED HOLES PER LIVING LARVA																	
A								0.294									
B								0.302			1972-73 season average					0.400	
C								0.133									
D								0.121			1973-74 season average					0.177	
E								0.667									
F								0.746									



A
B
eggs
1st + 2nd
3rd + 4th
5A
Final + prepupae
pupae
NUMBER (x 10)
NOV.
DEC.
JAN.
FEB.
MAR.
LOOP NUMBER

FIGURE 102

MODELLING

Computer model output from simulated spraying

—— numbers in the tree

---- numbers on the ground

Eggs: —— total laid per loop

+—+ immigrant eggs per loop (input data)

↑ spray applications

A. During the spray application egg and 1st & 2nd instar mortality was increased. All other mortalities remained unchanged.

B. During spray applications egg mortality was increased. After applications, all mortalities were reduced to simulate the death of natural enemies and reduced intra-specific competition; mortalities were gradually returned to normal.

APPENDIX A

ARTIFICIAL REARING MEDIUM

Diet Ingredients:

PART A

Navy beans (wet weight)*	468 g
Dried yeast (Torula yeast)	70 g
Ascorbic acid	7 g
Nipagin M [R]	4.4 g
Formaldehyde (10%)	17.6 ml
Sorbic acid	2.2 g
Water (distilled)	700 ml

PART B

Agar agar	28 g
Water (distilled)	700 ml

* soak beans for 24 hours: dry weight *ca.* half wet weight.

Procedure:

Pressure cook beans for about two minutes - drain.

Blend the ingredients of Part A in an electric blender.

Dissolve the Agar in Part B water, bring to the boil and cool to *ca.* 60°C.

Mix Part A and Part B thoroughly and pour into containers immediately.

Store under refrigeration.

The above quantity will be enough for approximately six rearing trays.

APPENDIX B

ANALYSIS OF THE *C. OMBRODELTA* LARVAL HEAD CAPSULE WIDTH DISTRIBUTION

1. USE OF THE COMPUTER PROGRAMME IN THE ANALYSIS

The programme HCAP was adapted from Programme 38 of Davies (1971, p.344-358). Davies' programme is designed to fit a normal distribution to an ungrouped array of data, and to test the goodness of fit. Most of the coding adaptation was carried out by W. Goodman, Department of Agriculture, University of Queensland.

HCAP was operated on the University of Queensland PDP-10 computer, from a remote teletype terminal.

A copy of the programme and its output is enclosed in a pocket in the rear of this volume. Pages 1 to 3 of the enclosure are a print out of the programme; Pages 4 to 6 a print out of the results of a run to be described below.

A flow chart of the programme's computations is shown in Figure B1, p.511. In this figure, subroutines are connected to the main programme by broken lines. The numbers shown at various points in the main programme, refer to statement numbers on Pages 1 and 2 of the enclosure.

The Dimension statement. X - the individual head capsule readings to be analysed. CLMK - the class mark, or midpoint of the size classes used in the frequency distribution, e.g. 0.28 mm, 0.32 mm, 0.36 mm, F - the observed frequencies, FN - the expected frequencies summed over instar distributions, NX - the number of observations for each size class, FNI - the expected frequency in each of the instar distributions (a maximum of 10 instars may be fitted to any frequency), NAME - the classification of each analysis input, is read and included in output to avoid confusion.

Data Input. The data are read from an input file 'IND' illustrated in Figure B2, p. 512. This process starts at STATEMENT 1 (page 1 enclosure). A DO - loop ending at STATEMENT 3 counts the observations and transfers them to a vector A, where they are later reorganized to a frequency distribution of observed data. This procedure is probably more complicated than necessary. However, in Davies' programme it was needed, as the data could be transformed. It may be changed if required.

Teletype Communication. Whilst the programme is being run, the computer requires information to be typed in at the teletype. These requests are shown in Figure B1 in double borders. In the programme, they are of the form:

```
WRITE (6, n)
READ  (5, m) VALUE.
```

6 and 5 are logical unit numbers for the input - output from the teletype, n is the format of the form

```
n  FORMAT (' message ', $ )
m  FORMAT (3G).
```

The $ indicates that the computer should pause at this point until a value or message is returned. 3G indicates that three values are to be read. These may be integers or decimals.

Execution. Figure B3, p.513 shows the teletype printed during the run which yielded the results shown on Pages 4 to 6 of the enclosure.

Statements underlined are typed in at a remote terminal. Other statements are those typed at the terminal by the computer.

EXECUTE HCAP - initiates the analysis. All subsequent input from the terminal occurs while the programme is in execution. After typing a statement requiring a response, the computer waits until the appropriate response is made.

NOMINAL MIN., NOMINAL MAX. The response required is the mid point of the first and last size class in the distribution. The inclusion of this request was the easiest way of overcoming a deficiency in the programme that could not otherwise recognize the ends of the distribution.

The next response is self explanatory.

In the next nine responses the first figure is standard deviation (ST DEV), the second the mean (MEAN) and the third the total frequency (AN).

The figure typed by the computer after receiving the last distribution parameters is the total χ^2 for this run (in this case 95.049).

NO. OF DISTRIBUTIONS? is asked again. If it were decided to test a second combination of instar parameters in this execution, the number of distributions would be typed in. Otherwise the response is zero, and the execution is terminated.

A listing of the output is then obtained (enclosure P. 3-6). Page 3 shows the name of the data file being analysed, and the calculated frequencies of each instar distribution, for each size class. (In the first three distributions a very small residual frequency appears in the last size class. This does not affect the accuracy of the method.) Pages 4 and 5 show the size classes with their observed and calculated frequencies, and the total chi-square and its degrees of freedom.

An assessment of the results determines if further adjustment is necessary. A graph of the calculated frequencies (Figure B4, p.514), compared to the original frequencies assists this assessment.

In this case further adjustment is required. The fit of the first three instars is quite good. Some attention is required for the remaining instars. The mean of the 5th distribution should be moved slightly to the right. The standard deviations of the fourth and fifth distributions should be reduced, to increase the gap between the third and fourth major peak. Similarly the gap between the fourth and fifth major peaks should be filled by increasing the standard deviations of the seventh and eighth distributions. This will also reduce the prominance of the minor peak in this region.

2. DIVIDING POINTS BETWEEN THE INSTAR GROUPS

This procedure is iterative. The head capsule size at the apparent point of overlap between two distributions is chosen.

Then for each distribution

$$z = \frac{X - \mu}{\sigma} \text{ is calculated}$$

where X is the chosen point

μ is the distribution mean

σ is the distribution standard deviation.

If the probability of a random value of the distribution being greater than z (Steel and Torrie 1960, Table A-4, p.434) is not equal for each distribution, an adjustment is made and the probabilities recalculated.

For example. The dividing point between the 1st and 2nd instars, of the combined macadamia data (Figure 40).

The distributions cross at approximately 0.42 mm. Probability of a 1st instar being larger than 0.42 = 0.0002 $(z = \frac{0.42 - 0.3525}{0.20})$. Probability of a 2nd instar being smaller than 0.42 = 0.0013.

Therefore, the dividing line is moved to the left until at 0.4134 mm the probabilities are equal at 0.0007.

Thus any larva of head capsule width less than 0.04134 mm is deemed most likely to be a 1st instar.

COMPUTER PROGRAMME HCAP

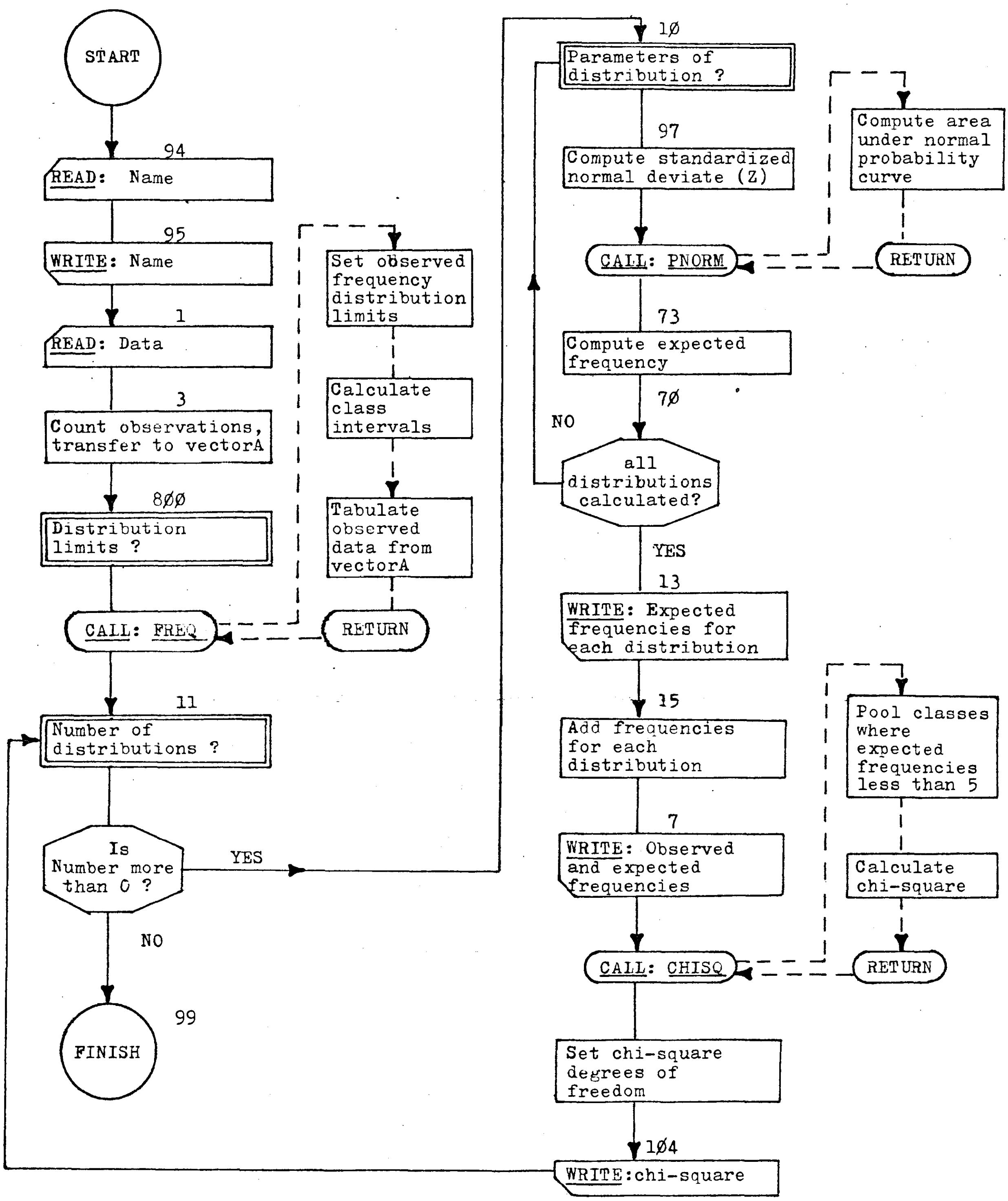


FIGURE B1

COMPUTER PROGRAMME HCAP

Flowchart showing the computer processes involved in analysing *C. ombrodelta* head capsule width distributions.

The main programme procedures are joined by solid lines.

Sub-routines, called by the main programme are indicated by broken lines.

Queries enclosed by double borders require information from the teletype operator.

Numbers throughout the main programme are statement numbers which may be found on Pages 1 and 2 of the enclosure.

ASPLEY + BEERWAH TOTALS .04
20 0 46 123 13 17 79 176 101 34 23 37 69 97 109 118 83 64 45 55 33
.28
.32
.36
.40
.44
.48
.52
.56
.60
.64
.68
.72
.76
.80
.84
.88
.92
.96
1.00
1.04
20 51 49 55 64 113 104 93 100 63 64 63 47 58 55 46 41 52 42 51 79
1.08
1.12
1.16
1.20
1.24
1.28
1.32
1.36
1.40
1.44
1.48
1.52
1.56
1.60
1.64
1.68
1.72
1.76
1.80
1.84
12 103 132 129 124 116 66 22 31 11 2 5 0
1.88
1.92
1.96
2.00
2.04
2.08
2.12
2.16
2.20
2.24
2.28
2.32

FIGURE B2

COMPUTER PROGRAMME HCAP

Input data file IND.

The heading gives the name of the data being analysed.

The first value in the next line is the number of frequencies to be read in; these follow in the horizontal line and their class marks are shown in the columns.

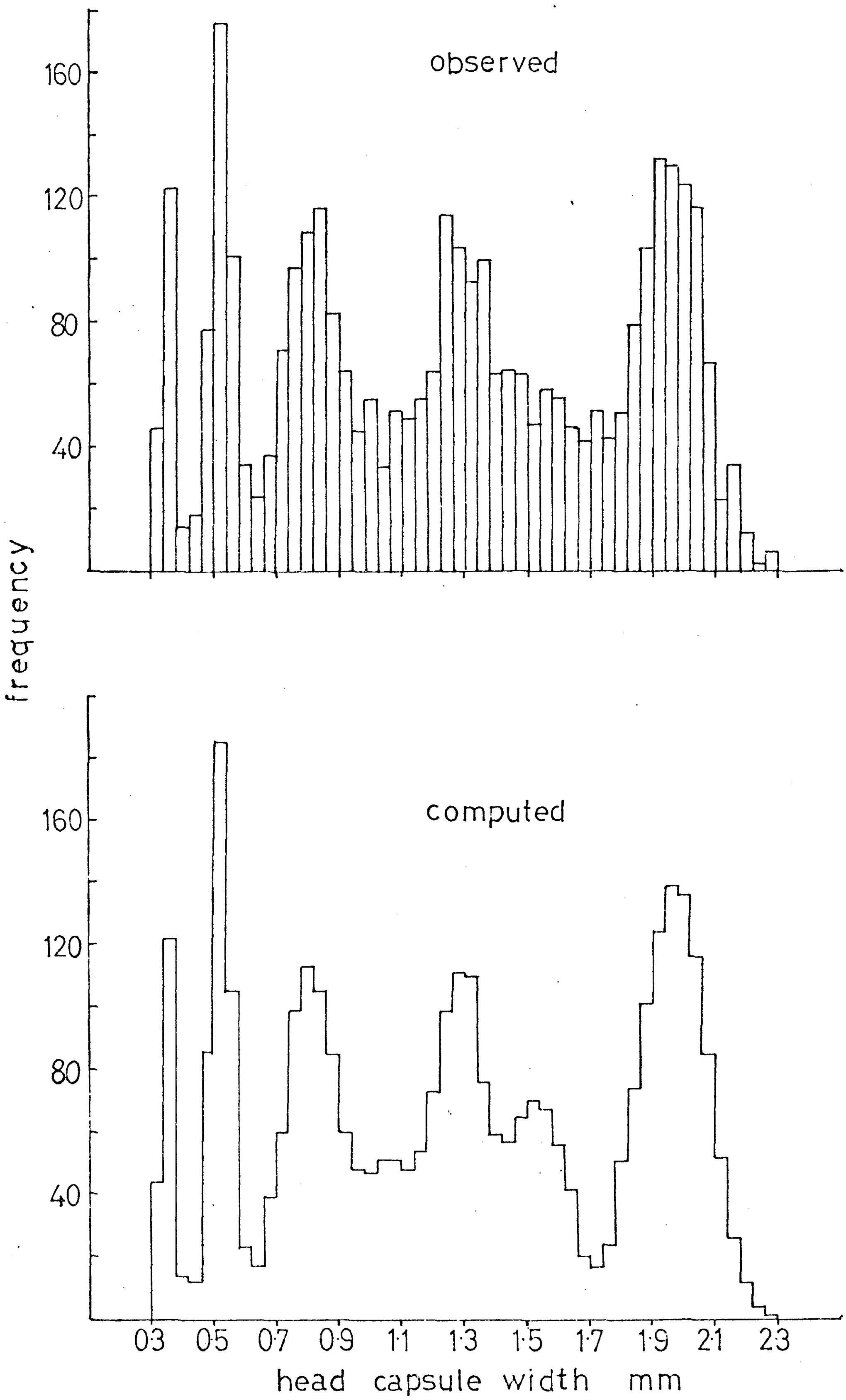
```
.EXECUTE HCAP
LOADING

HCAP 13K CORE
EXECUTION
NOMINAL MIN .28
NOMINAL MAXIMUM 2.32
NO. OF DISTRIBUTIONS ?    9
ST DEV MEAN AND AN RESP OF DIST.     1    .019 .353 180
ST DEV MEAN AND AN RESP OF DIST.     2    .034 .523 395
ST DEV MEAN AND AN RESP OF DIST.     3    .070 .760 244
ST DEV MEAN AND AN RESP OF DIST.     4    .078 .840 368
ST DEV MEAN AND AN RESP OF DIST.     5    .082 1.06 250
ST DEV MEAN AND AN RESP OF DIST.     6    .074 1.279 500
ST DEV MEAN AND AN RESP OF DIST.     7    .100 1.530 440
ST DEV MEAN AND AN RESP OF DIST.     8    .105 1.905 463
ST DEV MEAN AND AN RESP OF DIST.     9    .090 2.010 513
   95.049
NO. OF DISTRIBUTIONS ?    0

END OF EXECUTION
CPU TIME: 4.22  ELAPSED TIME: 2:59.64
EXIT

.
```

FIGURE B3

COMPUTER PROGRAMME HCAP

Execution of the programme from a teletype terminal.

Underlining indicates operator directions
or responses.



observed
computed
160
120
80
40
frequency
0·3
0·5
0·7
0·9
1·1
1·3
1·5
1·7
1·9
2·1
2·3
head capsule width mm

FIGURE B4

COMPUTER PROGRAMME HCAP

Comparison of observed and computed *C. ombrodelta* larval head capsule width frequency distributions.

The correspondence of the distributions and adjustment required is explained in the text.

APPENDIX C

NON-DESTRUCTIVE SAMPLING

Initially the investigation of non-destructive sampling was undertaken to devise a method which would reduce the time required to assess the *C. ombrodelta* population intensity in the regular intensive samples.

It soon became apparent that the development of any such method would be costly, and time consuming, and not warranted in the present study.

The investigation is reported briefly. Whilst it can only be regarded as cursory it provides some information on which future experiments may be based.

A. LITERATURE REVIEW

Considerable success has been achieved in the development of non-destructive sampling methods, for a variety of hidden insect infestations. The use of X-rays has been most common. Sound amplification accounts for most of the remaining publications.

(i) X-rays

X-rays were used as early as 1924 to detect boring insects (Yaghi 1924), and this method has been applied widely.

In forestry, it was used for boring insect detection, and sampling by Maloy and Wilsey (1930), and Johnson and Molatore (1961), Berryman and Stark (1962), Bletchly and Baldwin (1962), Berryman (1964), Wickman (1964), and Fatzinger and Dixon (1965).

Investigation of the use of X-ray for quarantine purposes was made by Yuasa (1926), and Wadhi *et al.* (1967).

As an aid to entomological investigations for agriculture and pest control, the method was used by: Fenton and Waite (1932) - cotton seed infestation; Fisher and Tasker (1940) - wood borers; Milner *et al.* (1950, 1952) - grain infestation; Crisp *et al.* (1953) - wood borers; Holling (1958) - parasites in pupae; Eidmann (1959) - tree borers; Goodhue and van Emden (1960) - stem borers; Pedersen and Brown (1960) - grain infestation; Graham *et al.* (1964) - cotton seed infestation; Kirkpatrick and Wilbur (1965) and Harris (1971) - grain infestations.

In some cases where the method was used to reduce sample examination time it has been quite successful. Fenton and Waite (1932) and Wickman (1964), reported that X-ray examination was quicker and cheaper than dissection, and it gave comparable results. Holling (1958) also found that the method was as good as dissections, for detecting parasites in sawfly pupae. However, Fatzinger and Dixon (1965) found that different growth stages of immature insects in timber could not be detected by X-ray examination. Harris (1971) concluded that dissection of sorghum heads to detect insect infestations was more accurate than X-ray examination.

The advantages of the method in determining the biology and behaviour of hidden insects was emphasized by Crisp *et al.* (1953) and Kirkpatrick and Wilbur (1965).

Maloy and Wilsey (1930), Berryman and Stark (1962), and Harris (1971), were able to achieve a degree of portability with their X-ray equipment.

Berryman and Stark (1962) give the most detailed description of the principles underlying the use of X-ray examination in entomology. X-rays penetrate most plant material more readily than they penetrate insects, because of the different chemical composition of the two. The longer wave-length "soft" X-rays are most suitable for entomological work as they produce the greatest contrast in the resultant image, between insect and plant material. These wavelengths are produced with low voltage.

The quantity of radiation obtained from the X-ray tube per unit of time may be controlled by the current (amps) supply.

A satisfactory image depends on the balance between voltage, current, and exposure time. The correct combination depends on the plant material, and insect being studied, the purpose of the study, and the equipment available.

(ii) Sound Detection

The detection of hidden insect infestations by the sound of insect activity was apparently first proposed by Brain in 1924 (reported in Adams *et al.* 1953).

Colebrook (1937) constructed a device to detect the sounds of insect larvae boring in timber. Voltage gain in the amplifier was of the order of one million, and background noise was troublesome. This was minimized by filtering out frequencies of less than 200 cycles per second (cps), and the use of a very cumbersome sound proof box, in which the test timber was placed. Colebrook also reported the development of a similar device by other workers in 1935, which could be used on the timber of actual buildings.

Sitophilus oryzae (L.) infestations in wheat kernels were detected aurally by Adams *et al.* (1953, 1954). They used a voltage gain in amplification of 77,000:1, and a less cumbersome portable sound proof box. Two distinct sounds were detected; one of low frequency (*ca.* 200 cps) was apparently due to insect movement, the other of higher frequency (1,200-1,500 cps) was believed to be caused by feeding. They were able to display the frequencies on a cathode ray oscilloscope.

Bailey and McCabe (1965) detected the movement of *S. oryzae* in individual wheat grains, by resting each grain directly on a crystal pick-up (transducer) normally used in gramophone record reproduction. Amplification voltage gain was only 75:1 and the authors stated that no special precautions against background noise were required.

Pesson and Ozer (1968) amplified the vibrations received by a microphone placed close to single wheat grains infested by *Sitophilus granarius* (L.), and translated these to a visual actograph record on paper. They were able to describe the normal development of this insect, and detect differences in development caused by varying dosages of gamma radiation.

(iii) Other Methods

Wirtz and Shellenberger (1963) described a method of determining grain insect infestation by measuring the electrical resistance of crushed grains. In the course of their investigation they noted that the electrical resistance of whole infested wheat kernels was lower than that for sound kernels. Movement of the insects in the kernels could be detected by changes in electrical resistance.

Freese (1970) found that ultrasonic scanning provided useful data on the number and distribution of parasite cysts in fish.

B. METHODS

(i) X-rays

Preliminary tests of this method were made using a FAXITRON 804 X-ray unit (Field Emission Corporation, U.S.A.). Voltage could be varied from 10 to 110 kilovolts (kv). Current was fixed at approximately 3 milliamps.

Images were produced on Polaroid Polapan ^{R} 4x5 Land Film/Type 52.

The results of each exposure could be detected within five minutes.

Twelve exposures of *C. ombrodelta* in macadamia nuts, and artificial medium, were taken to test the potential of the method, and obtain a measure of the optimum combination of voltage, and exposure time for insect detection.

(ii) Sound Detection

The equipment used in these preliminary tests was: an Akai R 707 tape recorded (mains supply, 240 volts), with both a dynamic and a crystal microphone.

An amplifier, built by the Department of Mechanical Engineering, University of Queensland was used. This operated on 24 volts direct current (supplied by two twelve volt batteries) and amplified the sound signal between the microphone and tape recorder. Amplification gain could be varied between 40 and 400.

A Dual R CDS 651 crystal pick up head (transducer).

When the microphone was being used, the infested nut was placed in a plastic vial, the microphone inserted to touch the nut, and the whole was wrapped in layers of cloth to deaden background noise.

The crystal pick-up was placed so that it was in light contact with the husk of an infested nut. No precaution was taken to eliminate background noise.

In each case, the amplification was set to the desired level, and the signals were recorded on the tape recorder. This could be played back to determine the results.

Tests were carried out in the laboratory and field.

(iii) Other Methods

The use of ultrasonics was considered briefly. However, there was no equipment available which was suitable to test this method in macadamia.

C. RESULTS AND DISCUSSION

(i) X-rays

The best X-ray images obtained are shown in Figure C1, p.522.

For nuts the most satisfactory image was obtained at 40 to 50 kv, for a duration of exposure of two minutes. At this exposure however, the larvae could not be distinguished. Some information may be obtained from the size of the feeding gallery, if sufficient experimentation were undertaken to correlate gallery size with larval activity. However, it does appear that the shape, and density of the nut, present difficulties in the use of this method. The long exposure time is also a disadvantage, as the larva is unlikely to remain still for this period.

Some of these difficulties may be overcome if equipment allowing variation in the current to the X-ray tube were used. An increase in current would be expected to reduce exposure time. The other difficulties would probably remain.

In artificial medium, penetration was much better, and exposure time could be reduced. The insect was also visible although its head capsule could not be distinguished.

The method, if developed further, would probably have greatest application in controlled experiments following the development of individual insects. Frequent X-ray inspections would reveal the progress of feeding and consequent development (similar to the technique of Johnson and Molatore (1961)). The effect of such exposure on the insect would have to be evaluated.

The method does not show promise as an aid to sampling. Dissection would reveal much more information for little more effort.

(ii) Sound Detection

The most distinct recordings were made using the Akai 707 tape recorder and its dynamic microphone, without additional amplification.

Two types of sound were heard; a low frequency "swishing", which was assumed to be that of larval movement in the nut, and a higher frequency "crunch", which was assumed to be the sound of larval feeding.

Background noise however, was too great to allow analysis of the recordings.

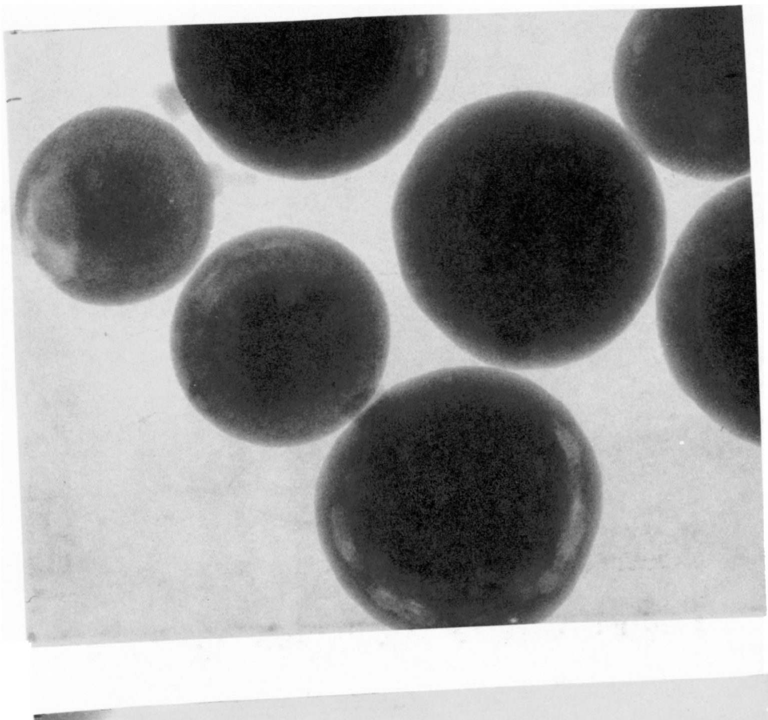
Other tests, using either the dynamic or crystal microphone, without or with amplification were also distorted by background noise - such as bird song, motor cars, and less distinct noises apparently due to wind, and consequent plant movement.

The use of the crystal pick-up, with amplification, also allowed the detection of sounds of hidden insects. Extraneous sounds were not so troublesome, but the recordings were less distinct. It appeared that the pressure of contact of the transducer and nut husk was critical.

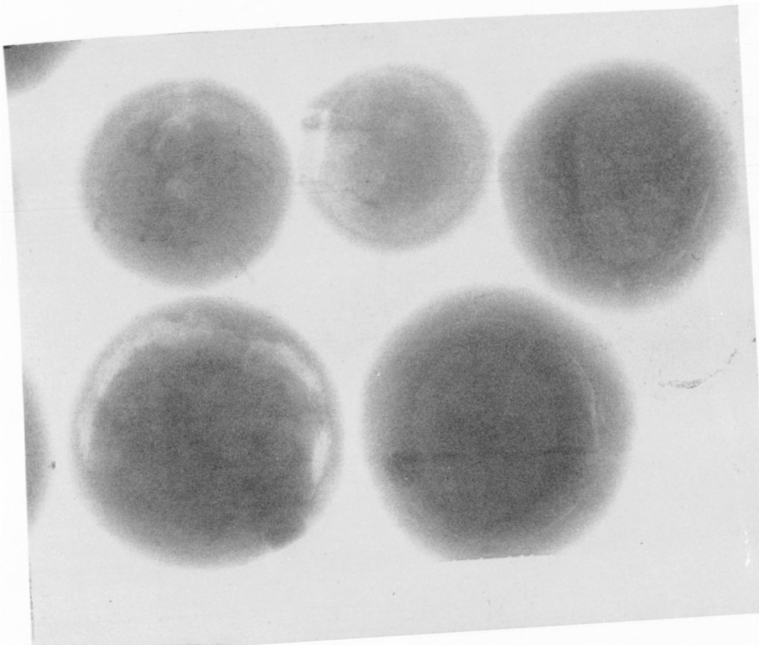
Time was not available to pursue these methods further. It is believed, however, that sound amplification is unlikely to be suitable for use in the field. The two major difficulties being those of extraneous noise, and the attachment of the equipment to the fruit.

It is felt that sound amplification may be a valuable aid in determining development, and behaviour patterns if individual infested fruit are monitored continuously in a sound proof container. The record of sound could be translated into a visual record of activity in the manner of Pesson and Ozer (1968). The difficulty of maintaining the fruit in a living condition would need to be overcome.

a



b



c

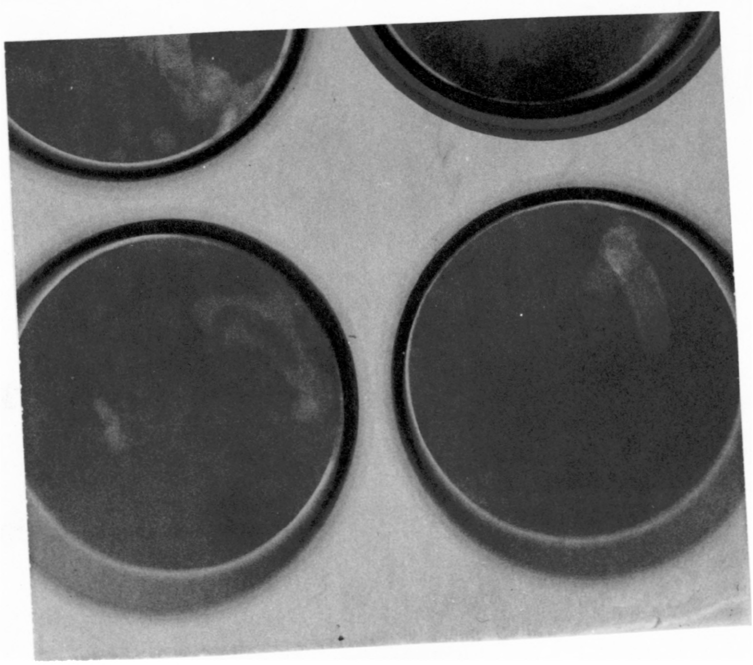


FIGURE C1

NON-DESTRUCTIVE SAMPLING

Exposure of nuts and artificial medium containing *C. ombrodelta* to X-rays.

(a) Exposure of nuts to 40 kv for two minutes. Feeding galleries are visible in the husk but individual larvae cannot be seen.

(b) Exposure of nuts to 50 kv for two minutes. The image appears over-exposed though feeding galleries are still visible.

(c) Exposure of artificial medium in petri dishes to 40 kv for 90 seconds. A larva (left dish) and a pupa (right dish) are visible.

APPENDIX D

COMPUTER PROGRAMME MACSAV

A listing of the programme is enclosed inside the rear cover of this volume (pages 7 to 24 of the enclosure).

To assist the interpretation of the programme, a glossary of the major variable names used is presented below. Following this there are a series of flow charts of MAIN, and each subroutine except OPEN (enclosure p.11). The flow charts do not show initialisations and other operations common to every programme.

The programme, as presented, has several features which are now redundant due to recent alterations in its structure. These do not affect its operation, but have been noted in the flow chart figures. Future work will probably result in further programme changes, and these corrections may then be made at little cost. The programme also has many D comments which were used during its development. During normal runs these are ignored by the computer, but should problems develop, a recompilation of the programme with an (I) switch would cause such comments to operate. The information printed out as a result would be useful in locating the fault.

Following the flow charts a figure is presented which explains the preparation of scratch files for the computer run, and a further figure illustrates DATA. An example of the output listing is contained in pages 25 to 27 of the enclosure.

GLOSSARY OF VARIABLES AND ARRAYS USED IN MACSAV

If no subroutine name appears in parenthesis before the definition, the variable or array is applicable to MAYN only, or applicable throughout the programme. In cases where such a name appears the definition is particularly applicable to that subroutine but may also appear in MAIN or MAYN.

ANS - the answer to the question "Is nut file to be generated?" Y for yes, any other symbol for no.

CLFAL - the running total of nuts which have fallen without insect damage.

CNUT - tree nuts in the model which are not affected in any way by *C. ombrodelta*. These are held as a single variable; their fall is determined by FLND(INC).

COOK - (MONEY) the number of nuts suitable for commercial processing (water grade).

COST - (MONEY) the cost in dollars of picking up and dehusking the nut harvest.

C4Ø - (SRCH2) the count of insects with only 5 larval instars.

C6Ø - (SRCH2) the count of insects with 6 larval instars.

D - (IRANDX) the total number of undamaged or damaged tree nuts available for the selection of a random index (=NDM in ALLOC; NDMCNT(3), NDMCNT(4) in MAYN).

DAM - (SRCH2, FALRAN) number of tree nuts which are damaged by *C. ombrodelta*.

DAMN(I) - (ROUNCK, ALLOC) the number of damaged or undamaged tree nuts with I eggs; I = 0 to 5 (=NDAM, NNODAM in MAYN).

DCRIT - insect development stage 2 - the first stage which causes nut damage.

DOLLA - (MONEY) the nett return on harvested crop in dollars.

E - (ROUNCK) total number of eggs on damaged or undamaged nuts, calculated from egg means and variances.

ED - (ROUNCK) the actual total number of eggs allocated to damaged or undamaged nuts (=EDAM, ENODAM in MAYN).

EDAM - total eggs on damaged tree nuts.

EGLAY(I)- (ADULT) the expectation of egg laying of adults in age class (I) (I=1 to 3).

EMAD(I) - (ADULT) the probability that an adult in age class I will not emigrate from the orchard.

ENODAM - total eggs on undamaged tree nuts.

EXMOR(I)- (PPOUT) the probability of survival of external prepupae and pupae of age I (I=1 to 3) in the tree and on the ground (=EXPGM, EXPTM in MAYN).

EXPGM(I))
EXPTM(I)) see EXMOR(I).

FALLD - the probability of damaged nut fall in each loop.

FALLND - the probability of undamaged nut fall in each loop.

FDAM(I) - the frequency of occurrence of damaged tree nuts with I eggs (I=0 to 5).

FLD(I) - the probability of fall of damaged tree nuts (I=1 to required loop numbers).

FLND(I) - the probability of fall of undamaged tree nuts (I=1 to required loop numbers).

FNDAM(I)- the frequency of occurrence of undamaged tree nuts with I eggs (I=0 to 5).

GOUT - the probability of prepupae in fallen nuts moving out of the nuts.

IBYTE - an internal function which reads a specified number of bits in a storage word, returning an integer value, e.g. IVAL=IBYTE (NUT(I),2,Ø,IDEST,34). IVAL (also IVL,IVX,IV1) is the integer value returned when the first 2 bits of NUT(I) (starting at bit Ø - i.e. bits Ø and 1) are read. IDEST (also ID1) may be considered an empty word, in which the required bits are to be placed, the left most bit to be read being placed in bit 34 of IDEST. IBYTE may also be used to place specified bits in a storage word, e.g. NUT(I)=IBYTE(J1,INCBIT,IS1,NUT(IND),INTBIT).

ICO(I,J) - (ALLOC, FALRAN, MORTAL, RANFIL) the number of insects of developmental stage I (I=1 to 8) in nuts in position J (J=1 -ground, 2 -tree).

IDEST - see IBYTE.

IDEV(I,J) (SRCH2, OUT) the number of insects of developmental stage J (J=1 to 8) in nuts in position I (I=1 -ground, 2 -tree).

IDG - (SRCH2) the number of damaged nuts present on the ground.

IDT - (SRCH2) the number of damaged nuts present on the tree, not including those damaged by 1st or 2nd instars.

IEDIFF - (ROUNCK) the absolute value of EDIFF.

IEXAD - (PPOUT) the number of adults emerging from external pupae in the tree or on the ground (=IEXAG, IEXAT in MAYN).

IEXAG)
IEXAT) - see IEXAD.

IFLG(I,J) (FALRAN) an array of (IxJ) storage words. In the programme I=2, J=6. When considering damaged nuts I=2, for undamaged nuts I=1. Each nut in NUT has a unique, corresponding bit position in IFLG. When a nut index is chosen, that bit is checked and, if empty, a flag is set indicating the nut has fallen. If the bit already has a flag another number must be chosen. As the programme is now structured, a single dimensional array would be sufficient, e.g. IFLG(J).

IM - (MORTAL) a counter for determining which mortality factors should be used.

IMOP - (PPOUT) the number of prepupae moving out of nuts on either tree or ground (=IPPOG, IPPOT in MAYN).

INBIT - (SRCH2) the starting bit of the 2nd insect developmental stage (=bit 15).

INC - the current increment (loop).

INCBIT - a group of three bits in the nut word covering an entire insect's developmental stage.

INCRE - the number of increments (loops) in each run.

INDG - (SRCH2) the number of undamaged nuts on the ground.

INDIC - (FALRAN) an indicator showing the call, i.e. damaged nuts (INDIC=1),undamaged nuts(INDIC=2).

INDT - (SRCH2) the number of undamaged nuts on the tree; after the call to MOOV this includes those damaged by 1st and 2nd instars.

INTBIT - the initial bit of the insect developmental stages (= Bit 12).

IP - bit in each half ITEMPT word where the nut index begins (=0, or 18).

IPERC - (SRCH2) the percentage of larvae which have been assigned to the 6 instar series.

IPPOG - the number of prepupae moving out of fallen nuts (=IMOP in PPOUT).

IPPOT - the number of prepupae moving out of tree nuts (=IMOP in PPOUT).

IRC(I,J)- (RANFIL, ALLOC, MORTAL, FALRAN) the number of records of a particular stage (I=1 to 8, J=1,2 - see ICO), i.e. if 5 tree nuts each had one 3rd or 4th instar (IRC(3,2)=5).

IREC - (RANFIL, ALLOC, MORTAL) the actual record position of a particular nut, e.g. the 5th tree nut in the above example of IRC would be record position 10 (for tree nuts IREC is even, fallen nuts odd).

ISELD(I)- (SRCH) data array to set ISL - the state of damage of the nut - from the value of each nut's flag bits I=2, or 4 - the nut is damaged, I=1,3 - undamaged.

ISELTG(I) (SRCH) data array to set ISLTG - the position of the nut - from the value of nut flag bits I=1,2 - ground, I=3,4 - tree.

IS1 - bit 33 in a 36 bit word.

ITDIM - the dimension of ITEMPT i.e. number of words in ITEMPT.

ITEMPT - this array is half the number of words that are contained in NUT. It is used to store the indices of tree nuts - two such indices per word. Indices are written left to right (each occupying 14 bits) starting at bit 0 or 18 in each word. Undamaged nut indices are written from the left hand word of the array, damaged nut indices from the right hand word.

ITOTCF - total fall of undamaged nuts for each loop.

ITOTF - total fall of all nuts for each loop.

IVAL)
IVL)
IVX) - see IBYTE
IV1)

IVDCK - (SRCH2) this value is used to check new damage resulting from a call to MOOV. If a nut had flag bit value 3 (=IVAL=IVDCK) before the move and after its insect stages have been moved on it is damaged, this damage is new and an adjustment must be made to NODAM or DAM.

IXDEV(I,J) (OUT) the output array of insect instars constructed from IDEV (I,K) (I=1,2 for tree and ground, J=1 to 5 for 1st & 2nd, 3rd & 4th, 5A, Final, pupa).

KK - (SRCH2) a flag which ensures that for each search the first insect encountered in development stage 4 has 6 instars. For subsequent insects instar numbers depend on the value of IPERC.

KCOUNT - count of fallen nuts, without living insects. It is used in clearing NUT of unnecessary storage.

KOUNT - (MORTAL) count of the number of random numbers selected during the search for a particular stage. If 20, the search is abandoned. This is a symptomatic cure for a fault in ALLOC.

LI - the first word in ITEMPT from the left, which contains a damaged nut index.

L2 - the far right hand limit of ITEMPT.

LF1 - the oldest insect developmental stage potentially present in any loop. If loop is less than 4, LF1=INC+1. If 3<loop<8 there may be INC+1 stages (5 instar series jumps one stage). If loop>7 all stages may be present and LF1=LIMFIL. This setting reduces the volume of computation during the early loops.

LIM - (FALRAN) the number of nuts which should fall (=NFALD, NFALND in MAYN).

LIMFIL - if loop<8, LIMFIL equals LIM, otherwise it equals NDEV.

LU - any one of the scratch files for the storage of indices of nuts containing living insects.

LUN(I) - the array of logical unit numbers used for each of the 8 scratch files, see BLOCK DATA (with subroutine OPEN) (p.12 of the enclosure).

M1,M2,M3- markers for the loops at which: harvest begins (M1), maximum kernel maturity is achieved (M2), harvest stops (M3).

MATAR(I)- (MONEY) an array containing the proportion of harvest which is suitable for commercial processing. I=1, the proportion for early harvest undamaged; I=2, that for early harvest damaged; I=3, that for late harvest undamaged; I=4, that for late harvest damaged.

MAXLIM - the number of nuts in NUT - this is the limit of searches and calculations carried out on nuts.

MAXLT - 3/4 of the size of NUT. When nut numbers equal or exceed MAXLT the process of eliminating empty fallen nuts commences.

MEDAM - the mean eggs per damaged nut.

MENOD - the mean eggs per undamaged nut.

MIXMAX - (SRCH2, OUT) the percentage of larvae which have 6 instars.

MORT - (MORTAL) the mortality of a particular stage of insect on the tree or on the ground.

MT(I,J) - (MORTAL) the array of mortality factors for each insect stage (J=1 to 8) in nuts in the tree (I=2) or on the ground (I=1).

NADL - (SRCH2) the number of final stage insects in a nut. These become adults after MOOV.

NDAM(I) - the number of damaged nuts with I eggs (I=0 to 5).

NDEV - the number of insect developmental stages (8).

NDM - (ALLOC) the number of undamaged nuts or damaged nuts available for selection (=D in INDEX, =NDMCNT(3) or (4) in MAYN).

NDMCNT(I) (SRCH) the count of nuts which are fallen undamaged (I=1) fallen damaged (I=2), tree undamaged (I=3), tree damaged (I=4).

NEC(I) - (MORTAL) loop numbers at which the mortality should change (I=1 to 24). The last NEC value should either be 24 or one more than the number of loops being run.

NEGG - number of immigrant eggs laid per loop.

NEGGS(I) - number of immigrant eggs in loop (I) (I=1 to the maximum loop).

NEWNUT - the nuts added to NUT, from CNUT, in each loop.

NFALD - number of damaged nuts which fall in a loop.

NFALND - number of undamaged nuts which fall in a loop.

NFCNUT - number of CNUTs which fall in a loop.

NNODAM(I) number of undamaged nuts which have I eggs (I=0 to 5).

NODAM - number of undamaged nuts present in NUT.

NOVAL - number of nuts which fell before harvest began.

NSTART - the position in NUT where addition of NEWNUTs should begin. One nut past existing nuts.

NUM - (ALLOC) the number of damaged or undamaged nuts to which eggs are to be allocated (=NUMDNUT (damaged), NUMNDNUT (undamaged) in MAYN).

NUMADL - (SRCH2) the total number of adults which emerge from nuts in each loop (=XX in ADULT).

NUMDNUT)
NUMNDNUT) see NUM

NUT(I) - the array of nuts which are, or have been, in some way affected by *C. ombrodelta*.

NUT FILE- the status of NUT in loop 14, written in octal e.g. 6ØØØØØØØØØØØ represents a damaged tree nut (deserted hole in this case), 2ØØØØØØØØØ1 represents a damaged fallen nut with 1 pupa.

NUTOT)
NUTT) - total nuts in tree.

OEGG(I) - (ADULT) the number of eggs laid by adults in age class (I). (I=1 to 3).

ORCHEG)
ORCHEGG) - (ADULT) the sum of OEGG.

PEDAM - the percentage of crop which is damaged.

PICK - (MONEY) the number of nuts harvested (Kg).

PRICE - (MONEY) gross return on harvested nuts (dollars).

RATIO - $\frac{\text{mean eggs/damaged nut}}{\text{mean eggs/undamaged nut}}$

SURVAD(I) (ADULT) the probability array of adults of age I surviving to the next age (I=1 to 3).

TOUT - the probability that prepupae will leave nuts in the tree.

VEDAM - variance of eggs on damaged nuts.

VENOD - variance of eggs on undamaged nuts.

XDAM)
XNODAM) - equal the same values of each variable without X; the addition
XNUTOT) of X changes them from integer to real.

XCLFAL - the total number of undamaged nuts which fell before harvest began.

XINFAL - the damaged nut equivalent to XCLFAL.

XX - (ADULT) equals NUMADL.

YCLFAL - the total number of undamaged nuts which fell between the start of harvest and maximum maturity.

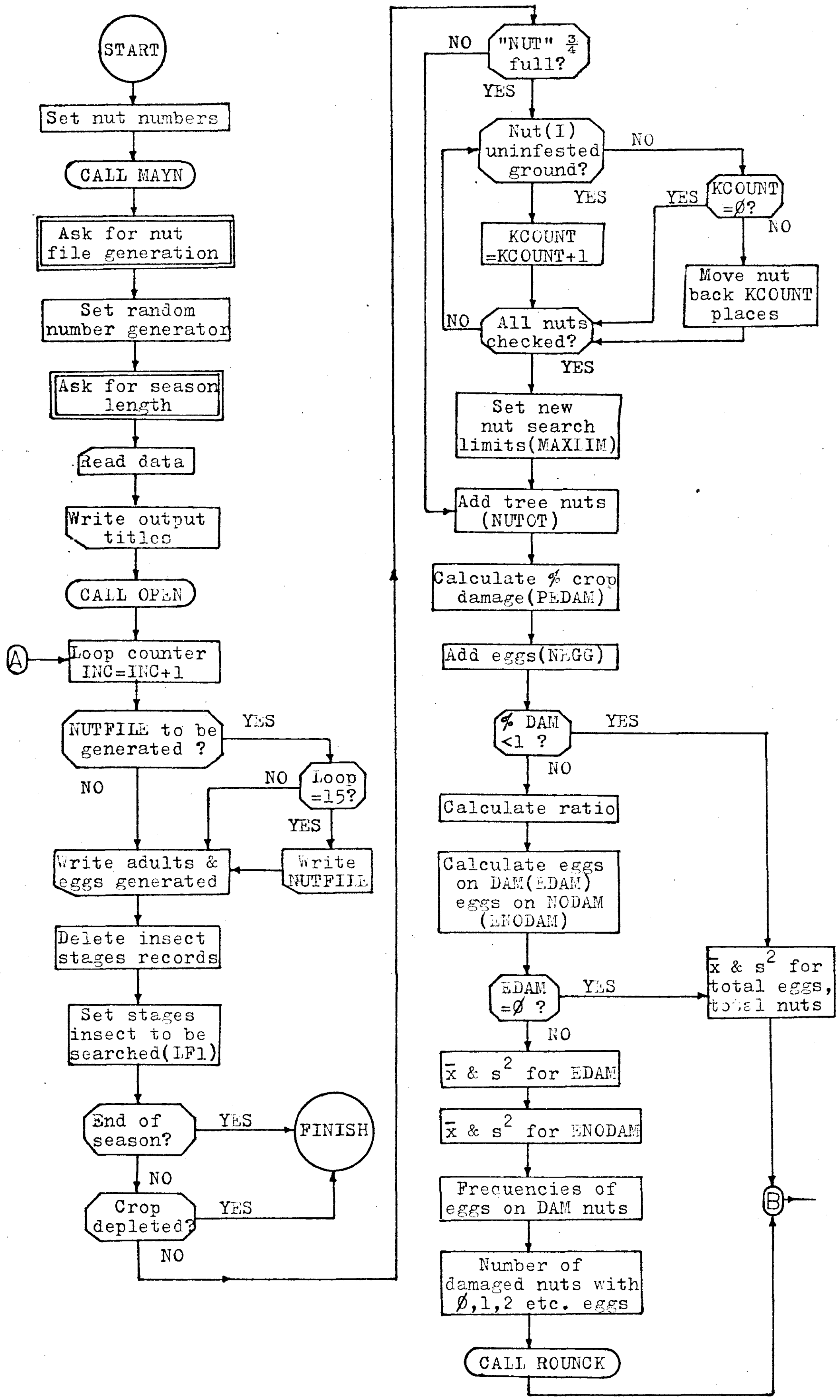
YINFAL - the damaged nut equivalent of YCLFAL.

YVAL - total of YCLFAL and YINFAL.

ZCLFAL - the total number of undamaged nuts which fell from the time of maximum maturity to the end of harvest.

ZINFAL - the damaged nut equivalent of ZCLFAL.

ZVAL - total of ZCLFAL and ZINFAL.



START
Set nut numbers
CALL MAYN
Ask for nut file generation
Set random number generator
Ask for season length
Read data
Write output titles
CALL OPEN
A
Loop counter INC=INC+1
NUTFILE to be generated ?
YES
NO
Loop =15?
NO
YES
Write adults & eggs generated
Write NUTFILE
Delete insect stages records
Set stages insect to be searched(LF1)
End of season?
YES
FINISH
NO
Crop depleted?
YES
NO
"NUT" 3/4 full?
NO
YES
Nut(I) uninfested ground?
NO
YES
KCOUNT =KCOUNT+1
KCOUNT =Ø?
YES
NO
Move nut back KCOUNT places
All nuts checked?
NO
YES
Set new nut search limits(MAXLIM)
Add tree nuts (NUTOT)
Calculate % crop damage(PEDAM)
Add eggs(NEGG)
% DAM <1 ?
YES
NO
Calculate ratio
Calculate eggs on DAM(EDAM) eggs on NODAM (ENODAM)
EDAM =Ø ?
YES
NO
x̄ & s² for total eggs, total nuts
x̄ & s² for EDAM
x̄ & s² for ENODAM
Frequencies of eggs on DAM nuts
Number of damaged nuts with Ø,1,2 etc. eggs
CALL ROUNCK
B

(continued)

FIGURE D1

COMPUTER PROGRAMME MACSAV

MAIN programme, Subroutine MAYN

(Enclosure pp.7-12)

Purpose: MAIN. To establish the numbers of nuts in the initial sample and set the dimensions of the arrays of NUT and ITEMPT.

MAYN. Reads most of the data, calculates total egg laying, the distribution of eggs on nuts, calculates nut fall and keeps an account of discarded and harvested nuts. It also deals with the accounting required for the array NUT.

Call: MAYN - from MAIN, only once every run. In practice the subroutine never returns to MAIN.

Comments: Originally these were one programme. The small programme MAIN has been divided from the remainder so that nut numbers may be changed cheaply, by merely editing and compiling MAIN and replacing it in the complete programme.

In the diagram, double boxed areas refer to requests to the teletype.

(continued)

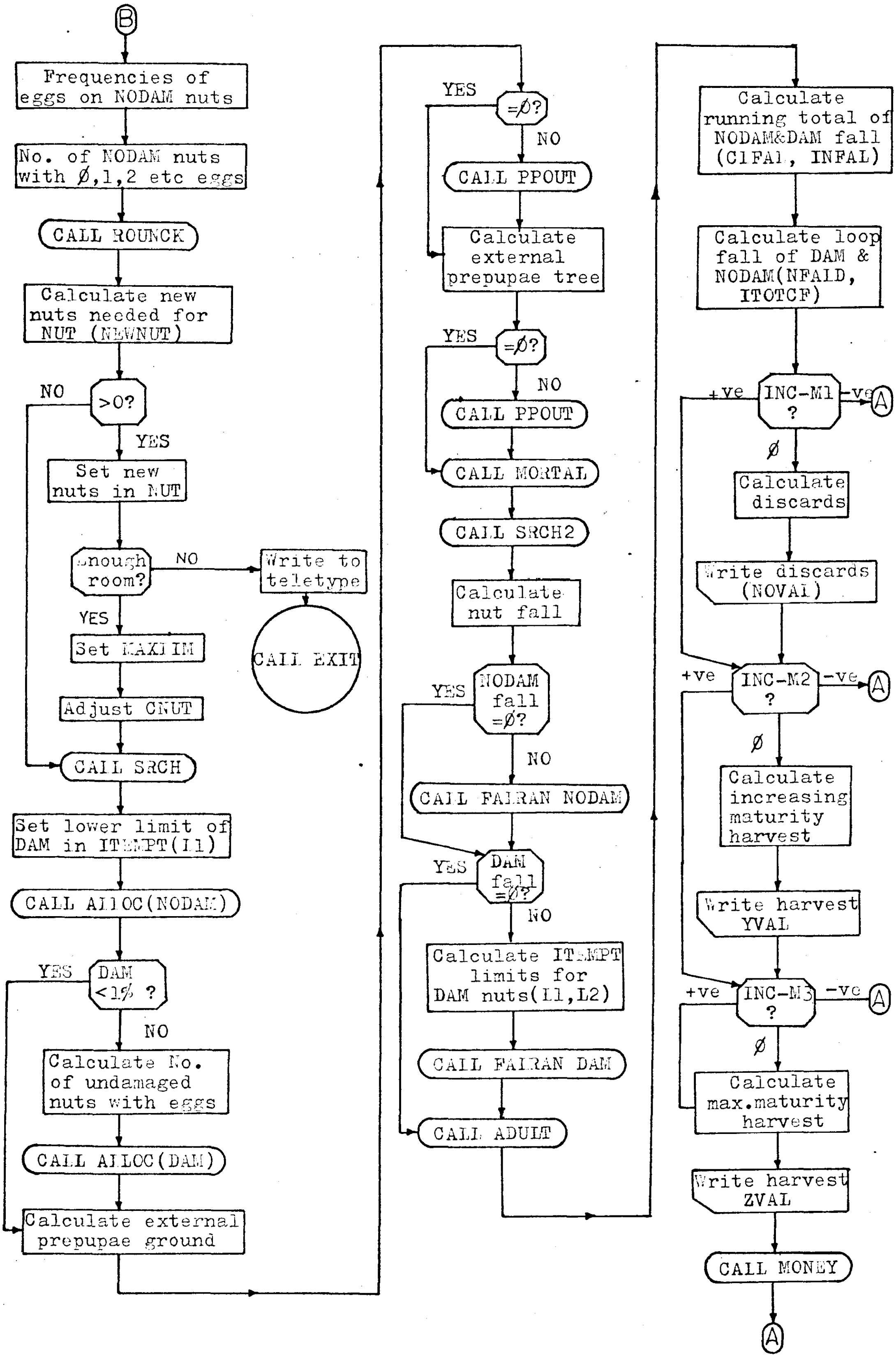

B
Frequencies of eggs on NODAM nuts
No. of NODAM nuts with Ø,1,2 etc eggs
CALL ROUNCK
Calculate new nuts needed for NUT (NEWNUT)
>0?
NO
YES
Set new nuts in NUT
Enough room?
NO
Write to teletype
CALL EXIT
YES
Set MAXIIM
Adjust CNUT
CALL SRCH
Set lower limit of DAM in ITEMPT(I1)
CALL ALLOC(NODAM)
DAM <1% ?
YES
NO
Calculate No. of undamaged nuts with eggs
CALL ALLOC(DAM)
Calculate external prepupae ground
=Ø?
YES
NO
CALL PPOUT
Calculate external prepupae tree
=Ø?
YES
NO
CALL PPOUT
CALL MORTAL
CALL SRCH2
Calculate nut fall
NODAM fall =Ø?
YES
NO
CALL FALRAN NODAM
DAM fall =Ø?
YES
NO
Calculate ITEMPT limits for DAM nuts(I1,L2)
CALL FALRAN DAM
CALL ADULT
Calculate running total of NODAM&DAM fall (CIFAL, INFAL)
Calculate loop fall of DAM & NODAM(NFALD, ITOTCF)
INC-M1 ?
+ve
-ve
A
Ø
Calculate discards
Write discards (NOVAL)
INC-M2 ?
+ve
-ve
A
Ø
Calculate increasing maturity harvest
Write harvest YVAL
INC-M3 ?
+ve
-ve
A
Ø
Calculate max.maturity harvest
Write harvest ZVAL
CALL MONEY
A

FIGURE D1 (continued)

COMPUTER PROGRAMME MACSAV

MAIN programme, Subroutine MAYN (continued)

(Enclosure pp.7-12)

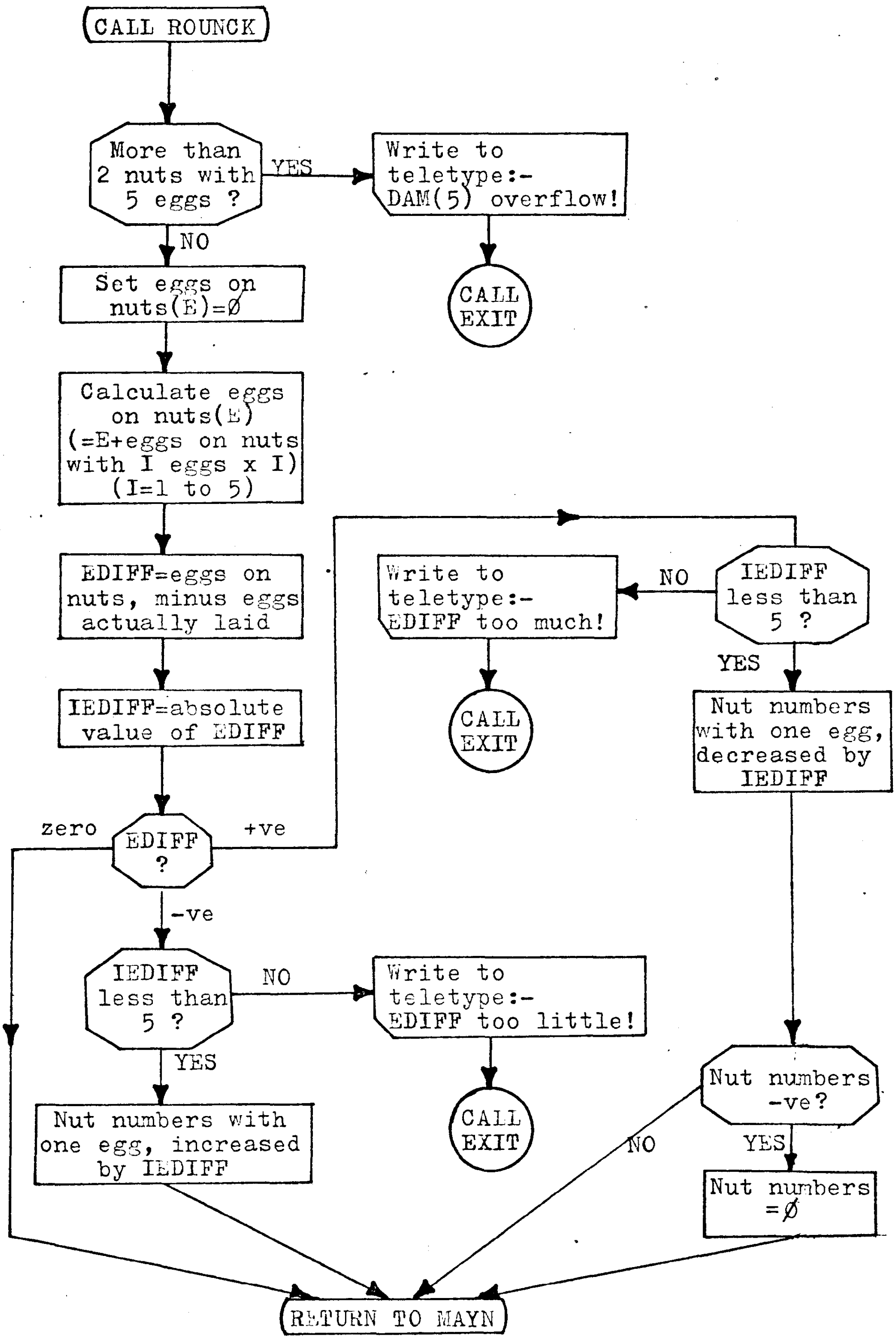

CALL ROUNCK
More than 2 nuts with 5 eggs ?
YES
Write to teletype:- DAM(5) overflow!
CALL EXIT
NO
Set eggs on nuts(E)=∅
Calculate eggs on nuts(E) (=E+eggs on nuts with I eggs x I) (I=1 to 5)
EDIFF=eggs on nuts, minus eggs actually laid
IEDIFF=absolute value of EDIFF
zero
EDIFF ?
+ve
-ve
IEDIFF less than 5 ?
NO
Write to teletype:- EDIFF too little!
CALL EXIT
YES
Nut numbers with one egg, increased by IEDIFF
IEDIFF less than 5 ?
NO
Write to teletype:- EDIFF too much!
CALL EXIT
YES
Nut numbers with one egg, decreased by IEDIFF
Nut numbers -ve?
NO
YES
Nut numbers =∅
RETURN TO MAYN

FIGURE D2

COMPUTER PROGRAMME MACSAV

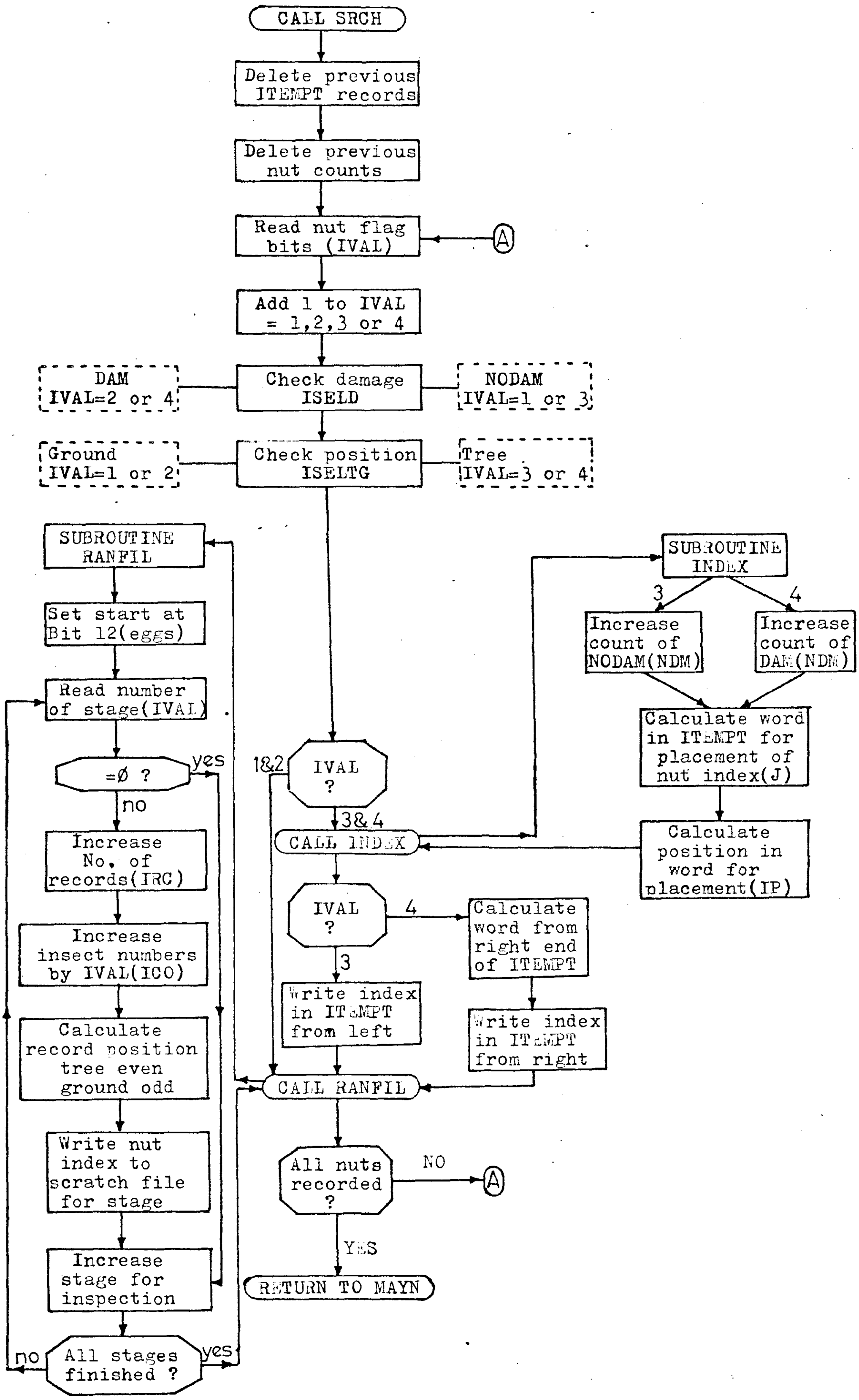
Subroutine ROUNCK

(Enclosure p.13)

Purpose: To check for rounding errors in the calculation of nuts with 1, 2, 3, 4, 5 eggs, and correct these if the errors are small, or stop the run if they are large.

Call: From MAYN - once for damaged, once for undamaged nuts.

Comments: As it stands ROUNCK can result in a temporary imbalance in nut and egg accounting. To overcome this, provision would have to be made for the subroutine to create nuts in NUT if EDIFF were negative, and delete nuts from NUT if EDIFF were positive.



CALL SRCH
Delete previous ITEMPT records
Delete previous nut counts
Read nut flag bits (IVAL)
A
Add 1 to IVAL = 1,2,3 or 4
DAM IVAL=2 or 4
Check damage ISELD
NODAM IVAL=1 or 3
Ground IVAL=1 or 2
Check position ISELTG
Tree IVAL=3 or 4
SUBROUTINE RANFIL
Set start at Bit 12(eggs)
Read number of stage(IVAL)
=Ø ?
yes
no
Increase No. of records(IRC)
Increase insect numbers by IVAL(ICO)
Calculate record position tree even ground odd
Write nut index to scratch file for stage
Increase stage for inspection
All stages finished ?
no
yes
SUBROUTINE INDEX
3
4
Increase count of NODAM(NDM)
Increase count of DAM(NDM)
Calculate word in ITEMPT for placement of nut index(J)
Calculate position in word for placement(IP)
1&2
IVAL ?
3&4
CALL INDEX
IVAL ?
4
3
Calculate word from right end of ITEMPT
Write index in ITEMPT from left
Write index in ITEMPT from right
CALL RANFIL
All nuts recorded ?
NO
A
YES
RETURN TO MAYN

FIGURE D3

COMPUTER PROGRAMME MACSAV

Subroutines SRCH, INDEX, RANFIL

(Enclosure pp.14-15)

Purpose: SRCH checks each nut's status and writes its index in the appropriate position of ITEMPT.

INDEX compiles a count of the numbers of damaged and undamaged tree nuts, calculates the word in ITEMPT, and the position in that word in which the index is to be written.

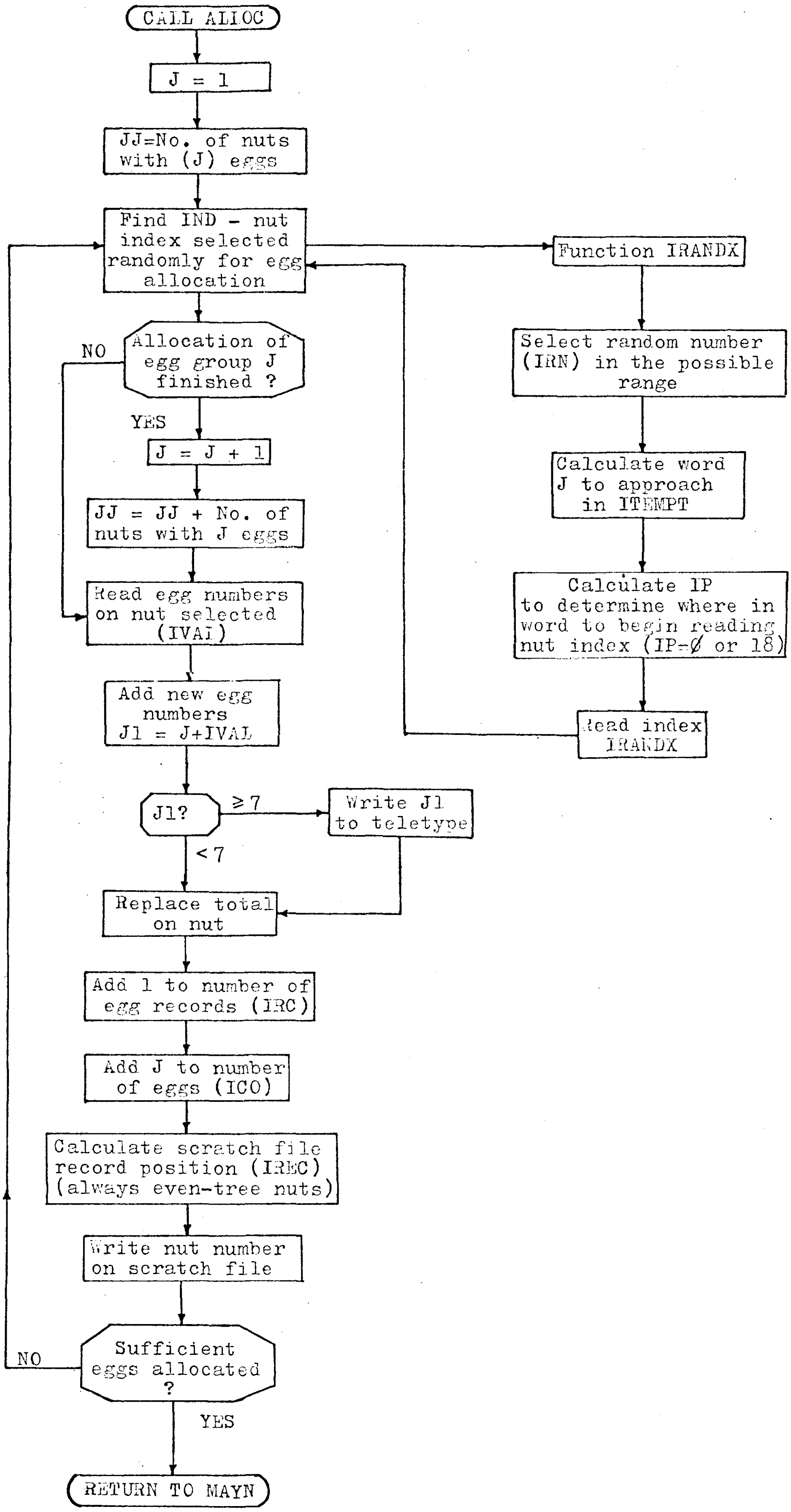
RANFIL calculates the total number of insects in each stage of development for tree and ground nuts, and writes the index of the nut with such stages to the appropriate scratch file.

Call: SRCH from MAYN

INDEX from SRCH

RANFIL from SRCH

Comments: The GO TO statement between statements 30 and 40 in SRCH does not need 1Ø2, 1Ø2 as the programme is now arranged.



CALL ALLOC
J = 1
JJ=No. of nuts with (J) eggs
Find IND - nut index selected randomly for egg allocation
Function IRANDX
Select random number (IRN) in the possible range
Calculate word J to approach in ITEMPT
Calculate IP to determine where in word to begin reading nut index (IP=Ø or 18)
Read index IRANDX
NO
Allocation of egg group J finished ?
YES
J = J + 1
JJ = JJ + No. of nuts with J eggs
Read egg numbers on nut selected (IVAL)
Add new egg numbers J1 = J+IVAL
J1?
≥7
Write J1 to teletype
<7
Replace total on nut
Add 1 to number of egg records (IRC)
Add J to number of eggs (ICO)
Calculate scratch file record position (IREC) (always even-tree nuts)
Write nut number on scratch file
NO
Sufficient eggs allocated ?
YES
RETURN TO MAYN

FIGURE D4

COMPUTER PROGRAMME MACSAV

Subroutine ALLOC and Function IRANDX
(Enclosure p.16)

Purpose: ALLOC - to allocate the groups of eggs calculated in MAYN to damaged or undamaged nuts. The indices of nuts with eggs on them are written to scratch file 1.

IRANDX - to select and return a nut index at random from those available.

Call: ALLOC from MAYN, once for undamaged nuts, once for damaged nuts.

IRANDX from ALLOC.

Comments: Ideally a check at statement 11 such as:

```
IF (IVAL.GT.Ø) GO TO A
```

where A is the statement IND-IRANDX (etc.) should be incorporated in ALLOC. This would avoid a nut's receiving more than the calculated number of eggs. To do this would complicate ROUNCK. At present, if total eggs on a nut is greater than 6, the actual number is written to the teletype so that error will be detected.

The ID referred to in the comments in ALLOC is now redundant.

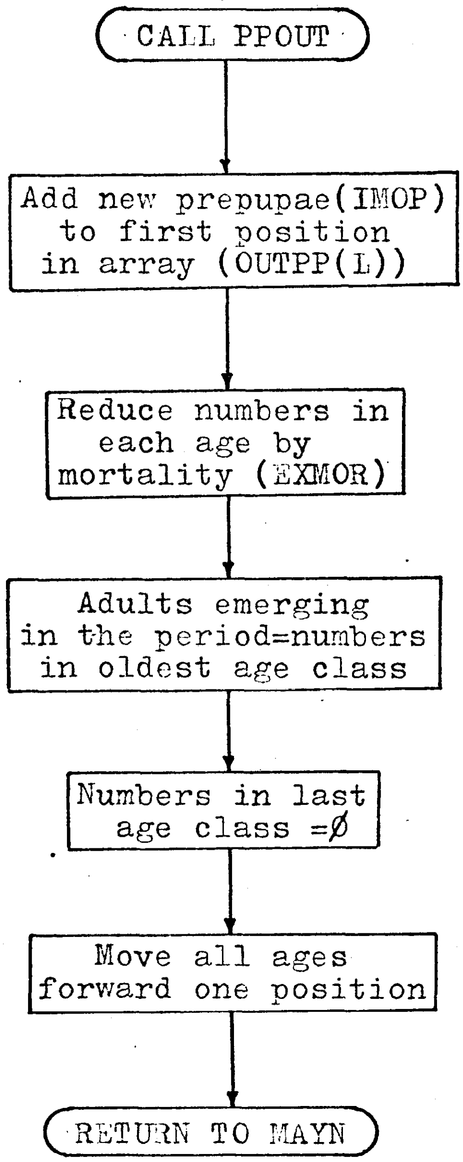

CALL PPOUT
Add new prepupae(IMOP) to first position in array (OUTPP(L))
Reduce numbers in each age by mortality (EXMOR)
Adults emerging in the period=numbers in oldest age class
Numbers in last age class =∅
Move all ages forward one position
RETURN TO MAYN

FIGURE D5

COMPUTER PROGRAMME MACSAV

Subroutine PPOUT

(Enclosure p.17)

Purpose: To calculate the emergence of adults from pupae external to nuts in the tree and on the ground.

Call: From MAYN - once for fallen nuts, once for tree nuts.

Comments: EXMOR is actually an array of probabilities of survival for each age class. This allows a simpler calculation than an array of mortalities.

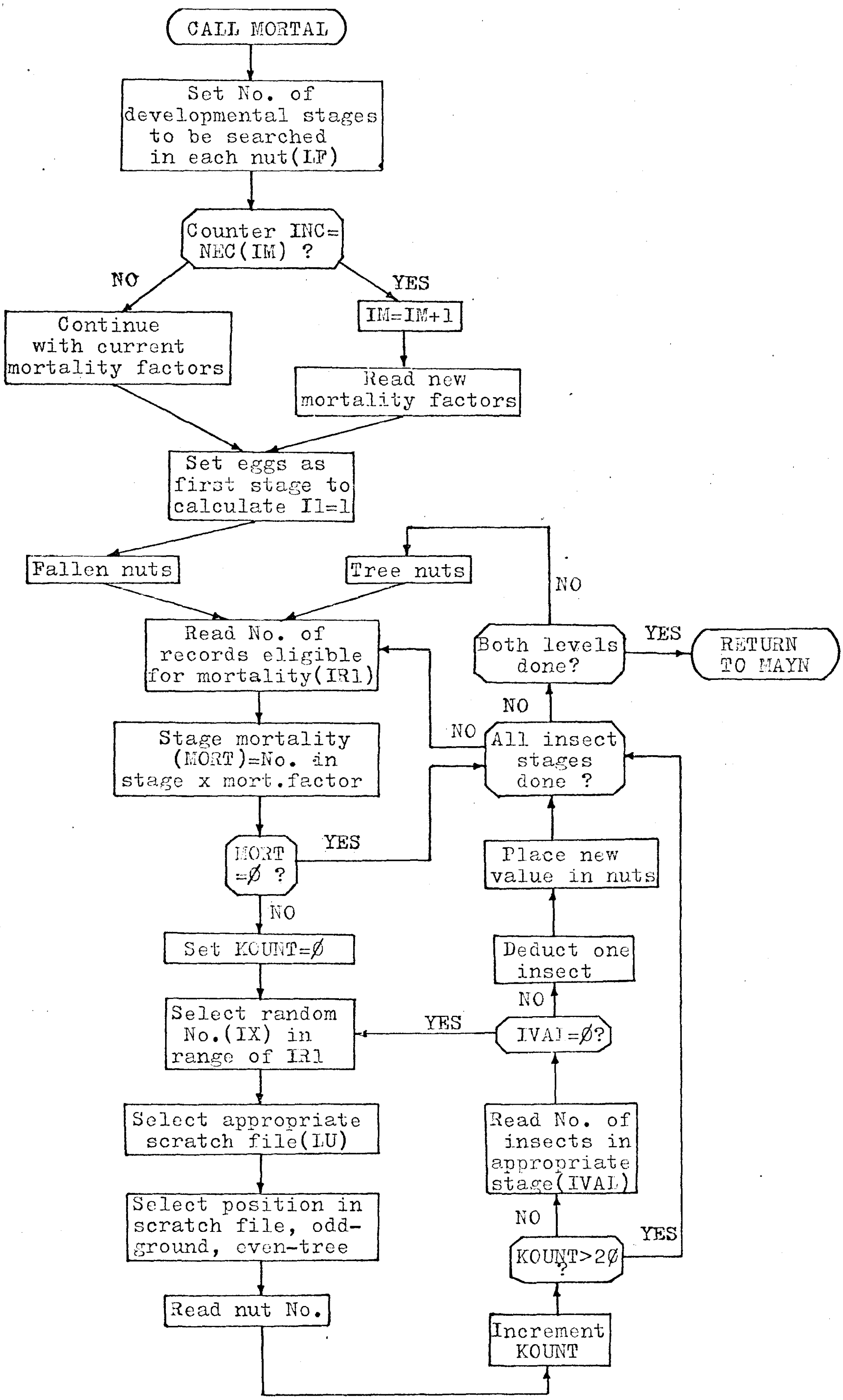

CALL MORTAL
Set No. of developmental stages to be searched in each nut(LF)
Counter INC= NEC(IM) ?
NO
YES
Continue with current mortality factors
IM=IM+1
Read new mortality factors
Set eggs as first stage to calculate I1=1
Fallen nuts
Tree nuts
NO
Read No. of records eligible for mortality(IR1)
Both levels done?
YES
RETURN TO MAYN
NO
NO
All insect stages done ?
Stage mortality (MORT)=No. in stage x mort.factor
MORT =Ø ?
YES
Place new value in nuts
NO
Set KOUNT=Ø
Deduct one insect
NO
Select random No.(IX) in range of IR1
YES
IVAL=Ø?
Select appropriate scratch file(LU)
Read No. of insects in appropriate stage(IVAL)
NO
Select position in scratch file, odd-ground, even-tree
YES
KOUNT>2Ø ?
Read nut No.
Increment KOUNT

FIGURE D6

COMPUTER PROGRAMME MACSAV

Subroutine MORTAL

(Enclosure p.18)

Purpose: To calculate and allocate mortality factors to each insect developmental stage in fallen and tree nuts.

Call: From MORTAL

Comments: The KOUNT in this subroutine is a precaution against an infinite loop occurring. If the correct mortality has not been assigned after 20 attempts the search is abandoned. It is believed that such errors (very rare) arise through the allocation of more than 7 eggs to a nut.

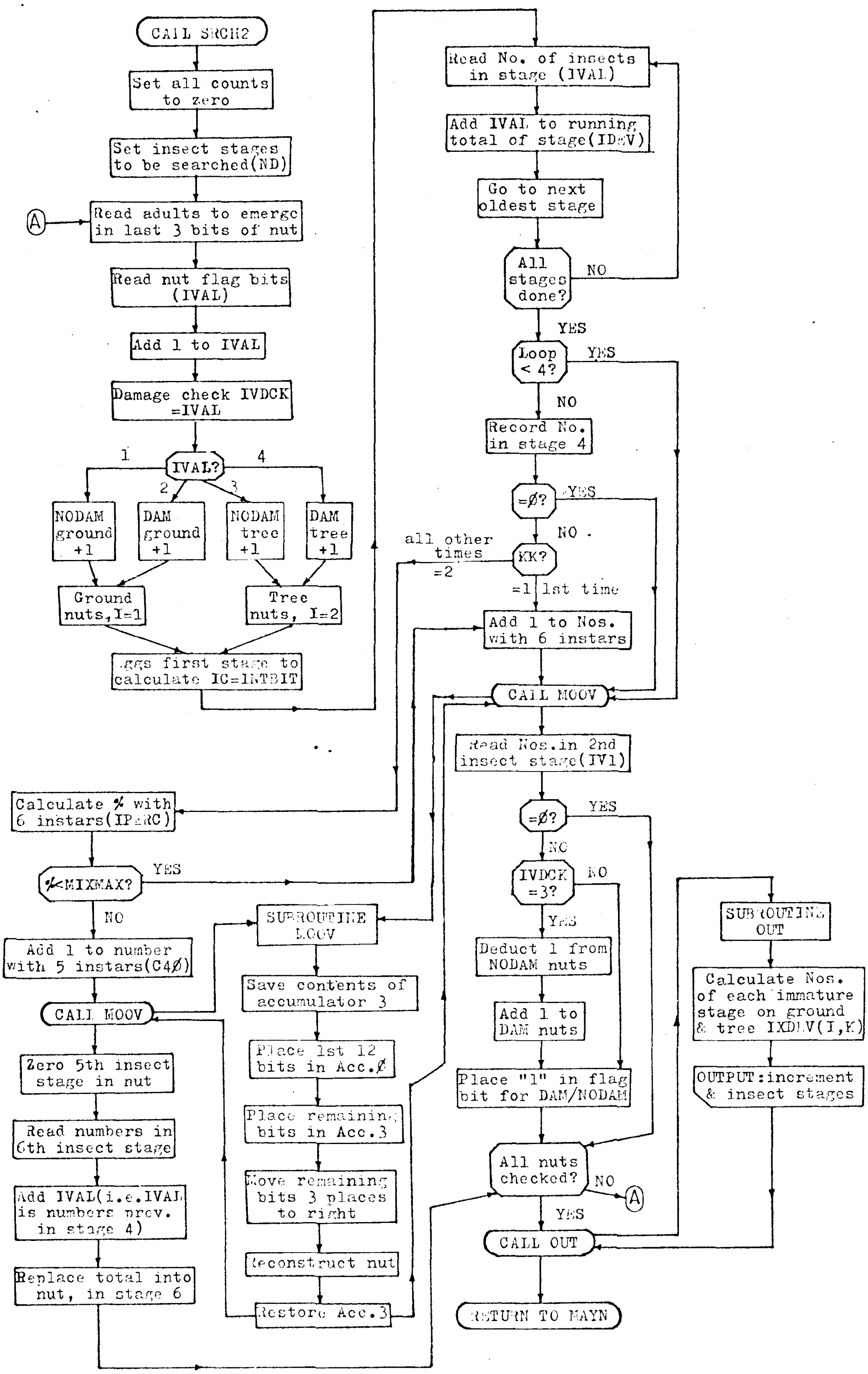

CALL SRCH2
Set all counts to zero
Set insect stages to be searched(ND)
A
Read adults to emerge in last 3 bits of nut
Read nut flag bits (IVAL)
Add 1 to IVAL
Damage check IVDCK =IVAL
IVAL?
1
2
3
4
NODAM ground +1
DAM ground +1
NODAM tree +1
DAM tree +1
Ground nuts,I=1
Tree nuts, I=2
calculate IC=INTBIT
Read No. of insects in stage (IVAL)
Add IVAL to running total of stage
Go to next oldest stage
All stages done?
NO
YES
Loop < 4?
YES
NO
Record No. in stage 4
=Ø?
YES
NO
KK?
all other times =2
=1 1st time
Add 1 to Nos. with 6 instars
CALL MOOV
Read Nos.in 2nd insect stage(IV1)
=Ø?
YES
NO
IVDCK =3?
NO
YES
Deduct 1 from NODAM nuts
Add 1 to DAM nuts
Place "1" in flag bit for DAM/NODAM
All nuts checked?
NO
A
YES
CALL OUT
RETURN TO MAYN
Calculate % with 6 instars
%<MIXMAX?
YES
NO
Add 1 to number with 5 instars(C4Ø)
CALL MOOV
Zero 5th insect stage in nut
Read numbers in 6th insect stage
Replace total into nut, in stage 6
Save contents of accumulator 3
Place 1st 12 bits in Acc.Ø
Place remaining bits in Acc.3
bits 3 places to right
Restore Acc.3
SUBROUTINE OUT
Calculate Nos. of each immature stage on ground & tree
OUTPUT:increment & insect stages

FIGURE D7

COMPUTER PROGRAMME MACSAV

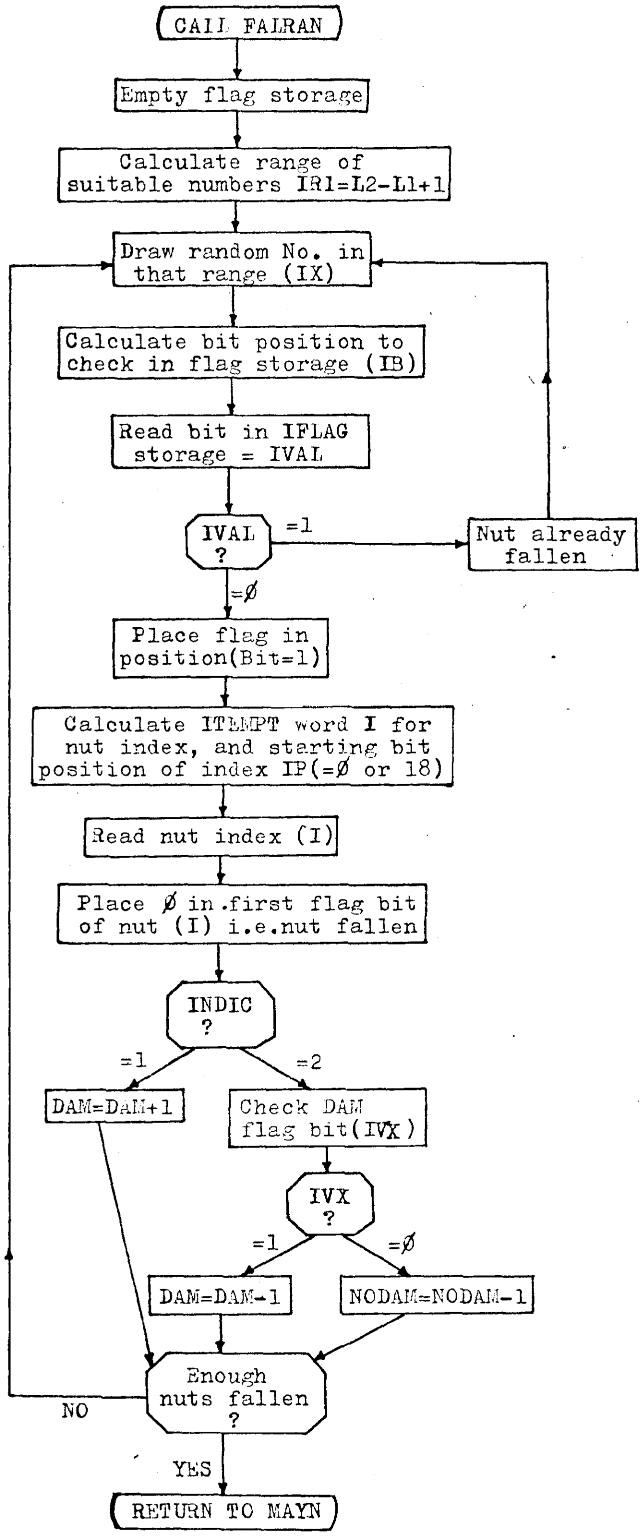
Subroutines SRCH2, MOOV, OUT
(Enclosure pp.19-21)

Purpose: SRCH2 calculates the adult emergence from nuts, the total numbers of damaged nuts, and undamaged nuts on tree and ground. It also directs the movement of 4th stage insects through one or two age classes (5 and 6 instar series), and makes the appropriate adjustment for the move through 2 age classes. It adjusts the flag bits of newly damaged nuts.

MOOV moves the insects in each age class 3 bits to the right.

OUT calculates instar numbers in the tree and on the ground, and writes these, and the loop number to the output file.

Call: SRCH2 from MAYN
MOOV from SRCH2
OUT from SRCH2



CALL FALRAN
Empty flag storage
Calculate range of suitable numbers IR1=L2-L1+1
Draw random No. in that range (IX)
Calculate bit position to check in flag storage (IB)
Read bit in IFLAG storage = IVAL
IVAL ?
=1
Nut already fallen
=Ø
Place flag in position(Bit=1)
Calculate ITEMPT word I for nut index, and starting bit position of index IP(=Ø or 18)
Read nut index (I)
Place Ø in first flag bit of nut (I) i.e.nut fallen
INDIC ?
=1
=2
DAM=DAM+1
Check DAM flag bit(IVX)
IVX ?
=1
=Ø
DAM=DAM-1
NODAM=NODAM-1
Enough nuts fallen ?
NO
YES
RETURN TO MAYN

FIGURE D8

COMPUTER PROGRAMME MACSAV

Subroutine FALRAN
(Enclosure p.22)

Purpose: To allocate the fall of damaged and undamaged nuts, and adjust the totals of tree nuts accordingly.

Call: From MAYN - once for undamaged nuts, once for damaged nuts.

Comments: Damaged nuts (IDT) do not include those damaged by 1st and 2nd instars; these are included in undamaged nuts (INDT). Such grouping allows a differential fall between heavily and lightly damaged nuts.

The arrangement of IFLG (2,6) is at present, more complicated than required. Originally the subroutine was called before MORTAL,and a separate array of flags was required for damaged and undamaged nuts. As the programme is arranged now, a single dimension array would suffice. K would then be eliminated. IFLG (28) would allow a maximum NUT array size of 1008 (28x36=1008 bits).

The arguments IRC, ICO, LF1, LIMFIL, and IS1 are also now redundant for the same reason.

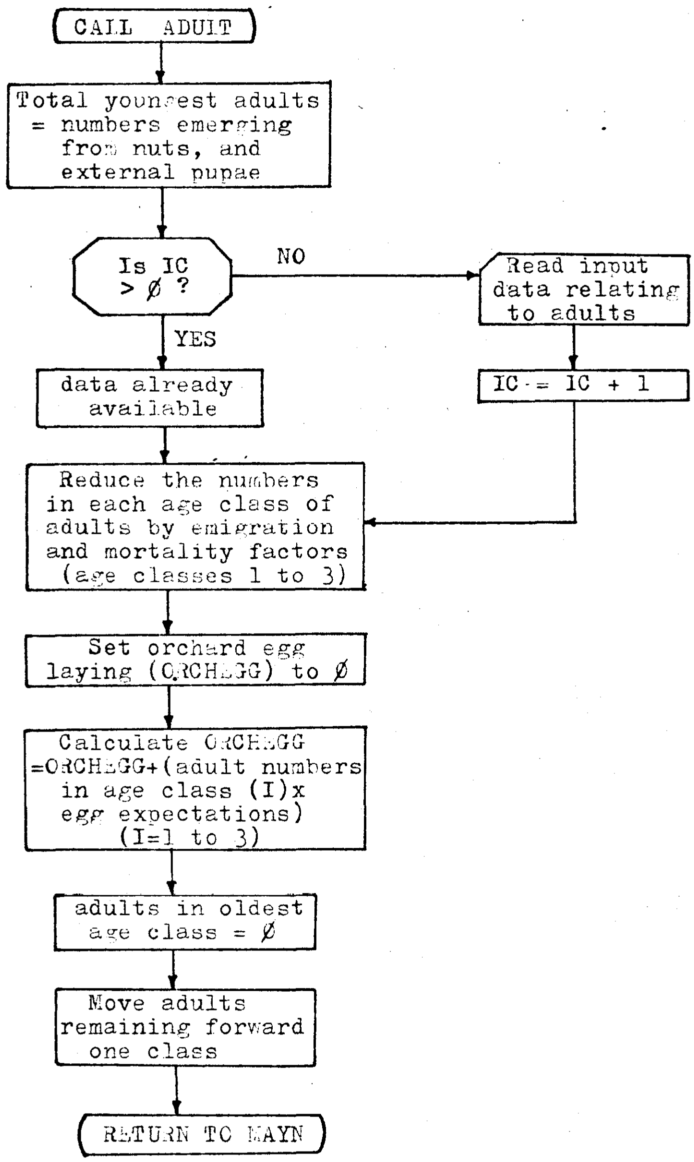

CALL ADULT
Total youngest adults = numbers emerging from nuts, and external pupae
Is IC > Ø ?
NO
YES
Read input data relating to adults
IC = IC + 1
data already available
Reduce the numbers in each age class of adults by emigration and mortality factors (age classes 1 to 3)
Set orchard egg laying (ORCHEGG) to Ø
Calculate ORCHEGG =ORCHEGG+(adult numbers in age class (I)x egg expectations) (I=1 to 3)
adults in oldest age class = Ø
Move adults remaining forward one class
RETURN TO MAYN

FIGURE D9

COMPUTER PROGRAMME MACSAV

Subroutine ADULT

(Enclosure pp.23-24)

Purpose: To calculate total orchard adult populations, to apply mortality and emigration factors to these populations, and to calculate the eggs laid by adults emerging within the orchard.

Call: From MAYN

Comments: Data relating to the orchard adult population are read after the first call. These data then remain constant throughout the run.

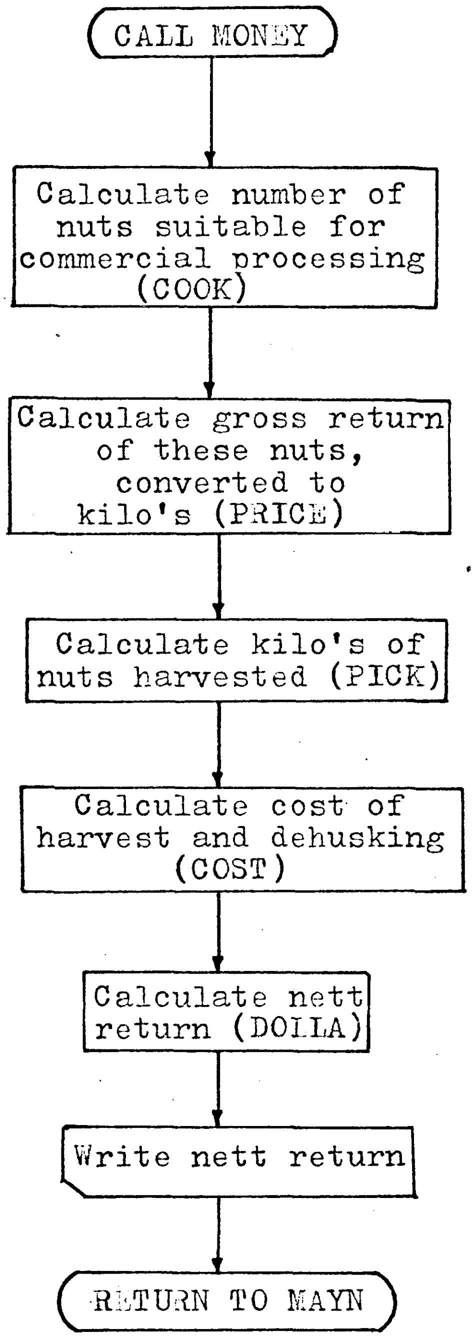

CALL MONEY
Calculate number of nuts suitable for commercial processing (COOK)
Calculate gross return of these nuts, converted to kilo's (PRICE)
Calculate kilo's of nuts harvested (PICK)
Calculate cost of harvest and dehusking (COST)
Calculate nett return (DOLLA)
Write nett return
RETURN TO MAYN

FIGURE D10

COMPUTER PROGRAMME MACSAV

Subroutine MONEY

(Enclosure p.24)

Purpose: To calculate the price received for harvested nuts, and deduct the cost of harvest and dehusking. The nett return is then written to the output file.

Call: From MAYN

A

```
.CREA F10.DAT
 INPUT:

 *DIRECT 5
 *I
 INPUT:
      1
      1
      1
      1
      1
      1
      1
      1
      1
      1
      1
      1
      1
      1

 *SAVE
      1
 *GET. F10.DAT
 *GET. F10.DAT
 *FILE

 EXIT

 .COPY F1.DAT=F10.DAT

 .COPY F2.DAT=F10.DAT

 .COPY F3.DAT=F10.DAT

 .COPY F4.DAT=F10.DAT

 .COPY F5.DAT=F10.DAT
```

B

```
.TYPE F1.DAT
  1
 83
  1
 69
  1
 95
  1
 74
  1
 81
  1
 69
  1
 47
  1
 89
  1
 86
  1
 73
  1
 42
  1
 64
  1
 73
  1
 31
  1
 73
  1
  1
  1
  1
  1
  1
  1
  1
  1
```

C

```
.TYPE F2.DAT
   3
   6
  13
   8
  29
  11
  41
  25
  51
  38
 106
  52
   1
  58
   1
  63
   1
  46
   1
  48
   1
  50
   1
  56
   1
 142
   1
 144
   1
 149
   1
 135
   1
```

FIGURE D11

COMPUTER PROGRAMME MACSAV

Scratch files

A. Before MACSAV is run for the first time eight scratch files must be prepared. These should be as long as the number of nut indices likely to be written. In this study F10.DAT was created and retained as a reserve.

Preparing the scratch files: under the command DIRECT 5 a series of 4 spaces and a 1 is input, and saved. This is then lengthened by the GET command. A file of 56 places has been created in this example.

This file is then copied to create the 8 files needed. Copying is required only before the first run.

B. Section of the first scratch file after a run. Not all the file was used. These nuts are all tree nuts (even places) with eggs. In this run nut 73 had eggs allocated to it on three occasions.

C. Section of the second scratch file after a different run. These nuts contain 1st & 2nd instars. Some are fallen nuts (odd places).

```
     .TYPE DATA.DAT
a    60
     3 16 14 8 15 6 10 10 12 16
     12 10 10 8 12 14 18 22 18 16
b    12 10 8 6 4
     .8 .75 .7 .6 .5 .2 .15 .15 .2 .2
     .22 .25 .27 .30 .33 .36 .39 .42 .45 .47
c    .50 .50 .50 .47 .45
     .20 .15 .10 .12 .15 .10 .07 .05 .02 .01
     .01 .01 .01 .01 .01 .01 .03 .05 .06 .07
d    .10 .15 .20 .25 .30
e    15 16 25
     1 3 5 6 7 8 9 10 11 14
     16 17 18 19 20 21 26
f
g    .47 .37 .97 .88
h    .60 .55
i    .20 .80 .80
j    .30 .80 .80
     1.0 .55 .60 .40 .35 .80 .30 .30
k    .46 .20 .15 .10 .10 .60 .05 .05
m    1. 1. 1.
n    .85 .6 .01
o    16 12 4
     1.0 .55 .60 .40 .35 .80 .30 .30
p +  .90 .20 .15 .10 .10 .60 .05 .05
     1.0 .55 .40 .35 .30 .60 .24 .25
     .46 .15 .10 .05 .05 .45 .01 .01
     1.0 .55 .41 .35 .25 .60 .20 .20
     .46 .16 .11 .06 .06 .46 .02 .02
     1.0 .55 .45 .35 .25 .60 .20 .20
     .46 .17 .12 .07 .07 .47 .03 .03
     1.0 .55 .50 .36 .26 .61 .21 .21
     .46 .18 .13 .08 .08 .50 .04 .03
     1.0 .55 .55 .37 .28 .63 .23 .23
     .46 .19 .14 .09 .09 .53 .05 .04
     1.0 .55 .60 .40 .30 .70 .25 .25
     .46 .20 .15 .10 .10 .60 .05 .05
     1.0 .55 .60 .40 .35 .80 .30 .30
     .46 .20 .15 .10 .10 .60 .05 .05
     1.0 .55 .60 .40 .35 .80 .30 .30
  +  .90 .20 .15 .10 .10 .60 .05 .05
     1.0 .55 .40 .35 .30 .60 .24 .25
     .46 .15 .10 .05 .05 .45 .01 .01
     1.0 .55 .41 .35 .25 .60 .20 .20
     .46 .18 .15 .10 .10 .50 .05 .05
     1.0 .65 .46 .42 .40 .70 .33 .35
     .46 .21 .27 .15 .15 .55 .10 .10
     1.0 .75 .48 .45 .45 .75 .38 .40
     .46 .25 .35 .18 .18 .60 .15 .15
     1.0 .85 .50 .50 .50 .80 .40 .45
     .46 .28 .40 .23 .23 .65 .20 .20
     1.0 .90 .50 .50 .80 .40 .45 .45
     .46 .30 .45 .25 .25 .65 .20 .20

     .
```

FIGURE D12

COMPUTER PROGRAMME MACSAV

Data input file

The data file is that used in the run which produced the output on pp. 24-27 of the enclosure.

a MIXMAX

b NEGGS

c FLD

d FLND

e M1, M2, M3

f NEC (the third line is blank)

g MATAR

h GOUT, TOUT

i EXPGM

j EXPTM

k MT (the first line is for fallen nuts, the next for tree nuts)

m EMAD

n SURVAD

o EGLAY

p MT (+ indicates spray applications)

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```
C
C
C         THIS PROGRAM FITS A NORMAL FREQUENCY DISTRIBUTION TO AN
C         ARRAY OF UNGROUPED OBSERVATIONS.
C         FUNCTION SUBROUTINES PNORM AND  SUBROUTINES
C         FREQ,AND CHISQ ARE CALLED.
C
C
          DIMENSION X(8ØØØ),CLMK(12Ø),F(2ØØ),FN(2ØØ)
          1,NX(2ØØ),FN1(1Ø,2ØØ),NAME(14)
          CALL IFILE(1Ø,'IND')
          CALL OFILE(11,'CAPO')
          READ(1Ø,94)NAME
 94       FORMAT(14A5)
          WRITE(11,95)NAME
 95       FORMAT(1X,14A5)
          NCLT=Ø
          N=Ø
 1        READ(1Ø,1ØØ,END=12)NCL,(NX(I),I=1,NCL)
 1ØØ      FORMAT(21I)
          NCLT=NCLT+NCL
          DO 1Ø5 IJK=1,NCL
          K=NX(IJK)
 2        READ(1Ø,98)XR
 98       FORMAT(3G)
          IF(K.EQ.Ø)GO TO 1Ø5
          DO 3 I=1,K
          N=N+1
 3        X(N)=XR
 1Ø5      CONTINUE
          GO TO 1
C         FORM FREQUENCY DISTRIBUTION
C         AND COMPUTE MEAN AND STANDARD DEVIATION
 12       NCL=NCLT
          WRITE(6,8ØØ)
 8ØØ      FORMAT(' NOMINAL MIN ',$)
          READ(5,98)XMIN
          WRITE(6,8Ø2)
 8Ø2      FORMAT(' NOMINAL MAXIMUM ',$)
          READ(5,98)XMAX
          CALL FREQ(X,N,NCL,CLINT,CLMK,F,XMIN,XMAX)
 71       WRITE(6,11)
 11       FORMAT(1X,'NO. OF DISTRIBUTIONS ?',3X,$)
          READ(5,98)NDS
          IF(NDS.LE.Ø)GO TO 99
          DO 7Ø II=1,NDS
          WRITE(6,1Ø)II
 1Ø       FORMAT(1X,'ST DEV MEAN AND AN RESP OF DIST. ',I4,3X,$)
          READ(5,98)SDEV,XBAR,AN
C
C         COMPUTE NORMAL FREQUENCY DISTRIBUTION
          P1=Ø.
 97       DO 6 I=1,NCL-1
          Z=(CLMK(I)+.5*CLINT-XBAR)/SDEV
          IF(ABS(Z).GT.6.)GO TO 73
          P2=PNORM(Z)
          FN1(II,I)=(P2-P1)*AN
          P1=P2
          GO TO 6
 73       FN1(II,I)=Ø.Ø
```

```
6         CONTINUE
70        FN1(II,NCL)=(1.-P1)*AN
C
C         TEST GOODNESS OF FIT
          DO 13 I=1,NCL
13        WRITE(11,14)(FN1(II,I),II=1,NDS)
14        FORMAT(1X,10G13.5)
          DO 15 I=1,NCL
          FN(I)=Ø.
          DO 15 II=1,NDS
15        FN(I)=FN(I)+FN1(II,I)
C
C         OUTPUT RESULTS
          WRITE(11,1Ø2)
1Ø2       FORMAT('1NORMAL DISTRIBUTION'//' PROBLEM'///13X,'CLASS',
          111X,'CLASS',9X,'OBSERVED',8X,'THEORETICAL'/13X,
          2'NUMBER',1ØX,'MARK',1ØX,'FREQUENCY',7X,'FREQUENCY'//)
          DO 7 I=1,NCL
7         WRITE(11,1Ø3)I,CLMK(I),F(I),FN(I)
1Ø3       FORMAT(I16,F18.3,F16.1,F18.3)
          CALL CHISQ(F,FN,NCL,CHI2,NDF)
          NDF=NDF-NDS*2
          WRITE(11,1Ø4)CHI2,NDF
1Ø4       FORMAT(//'CHI-SQUARED=',F1Ø.2,'WITH',I6,'DEGREES OF FREEDOM')
          WRITE(6,14)CHI2
          GO TO 71
99        CALL EXIT
          END
C
C
          SUBROUTINE FREQ(A,N,NCL,CLINT,CLMK,F,XMIN,XMAX)
C
C
C         THIS SUBROUTINE TABULATES A FREQUENCY DISTRIBUTION WITH
C         NCL CLASSES FROM DATA IN VECTOR A OF LENGTH N. ON RETURN
C         CLINT CONTAINS THE CLASS INTERVAL,CLMK THE CLASS-MARKS AND
C         F THE OBSERVED FREQUENCIES(IN FLOATING POINT MODE)
C         IF THE SELECTED MINIMA AND MAXIMA ARE INSIDE XMIN AND XMAX
C         ,THE LATTER ARE USED
C
C
C
C
          DIMENSION A(N),CLMK(NCL),F(NCL)
          AMAX=A(1)
          AMIN=A(1)
          DO 2 I=2,N
          IF(AMAX.GE.A(I))GO TO 1
          AMAX=A(I)
1         IF(AMIN.LE.A(I))GO TO 2
          AMIN=A(I)
2         CONTINUE
          IF(AMIN.GT.XMIN)AMIN=XMIN
          IF(AMAX.LT.XMAX)AMAX=XMAX
          CL=NCL
          CLINT=(AMAX-AMIN)/(CL-1.Ø)
          DO 3 I=1,NCL
          AIM=I-1
3         CLMK(I)=AMIN+AIM*CLINT
          AMIN=AMIN-Ø.5*CLINT
```

```
      DO 4 I=1,NCL
4     F(I)=Ø.Ø
      DO 5 I=1,N
      XXXX=(A(I)-AMIN)/CLINT+1.Ø
6     K=XXXX
5     F(K)=F(K)+1.Ø
      RETURN
      END
      SUBROUTINE CHISQ(O,E,N,CHI2,NDF)
C
C
C     THIS SUBROUTINE COMPUTES CHI-SQUARED FOR VECTORS OF OBSERVED
C     AND EXPECTED FREQUENCIES,O AND E,BOTH OF LENGTH N, ALSO
C     RETURNED ARE DEGREES OF FREEDOM(NDF)
C
C
      DIMENSION O(N),E(N)
      CHI2=Ø.
      DO 1Ø I=N,1,-1
      IF(E(I).GE.5.) GO TO 2Ø
      E(I-1)=E(I)+E(I-1)
      O(I-1)=O(I)+O(I-1)
      N=N-1
1Ø    CONTINUE
2Ø    NDF=N-1
      DO 4Ø I=1,N
      IF(E(I).GE.5.) GO TO 35
      E(I+1)=E(I)+E(I+1)
      O(I+1)=O(I)+O(I+1)
      NDF=NDF-1
      GO TO 4Ø
35    CHI2=CHI2+(O(I)-E(I))*(O(I)-E(I))/E(I)
4Ø    CONTINUE
      END
      FUNCTION PNORM(X)
C
C
C     THIS FUNCTION SUBPROGRAM COMPUTES THE AREA UNDER THE NORMAL
C     PROBABILITY CURVE FROM MINUS INFINITY TO X,USING AN
C     APPROXIMATION DUE TO HASTINGS(APPROXIMATIONS FOR DIGITAL
C     COMPUTERS)
2Ø    FX=EXP(-X*X/2)*Ø.3989423
3Ø    W=1./(1.+ABS(X)*Ø.2316419)
4Ø    PNORM=1.-FX*W*((((1.330274*W-1.821256)*W+1.781478)*W-Ø.3565638)
     1*W+Ø.3193815)
      IF(X)1,2,2
1     PNORM=1.-PNORM
2     RETURN
      END
```

ASPLEY + BEERWAH TOTALS .04

0.47515	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43.971	0.14715E-04	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
121.58	0.51237E-02	0.72718E-05	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13.939	0.47882	0.13816E-03	0.13709E-04	0.00000	0.00000	0.00000	0.00000	0.00000
0.37930E-01	12.134	0.20779E-02	0.18919E-03	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	85.883	0.22644E-01	0.22044E-02	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	174.63	0.17926	0.19678E-01	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	103.38	1.0315	0.13583	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	17.640	4.3154	0.72433	0.93132E-05	0.00000	0.00000	0.00000	0.00000
0.00000	0.84448	13.131	2.9847	0.12480E-03	0.00000	0.00000	0.00000	0.00000
0.00000	0.11010E-01	29.065	9.5050	0.12815E-02	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	46.815	23.396	0.10492E-01	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	54.876	44.515	0.67940E-01	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	46.815	65.482	0.34822	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	29.065	74.471	1.4128	0.37253E-05	0.00000	0.00000	0.00000
0.00000	0.00000	13.131	65.482	4.5380	0.70781E-04	0.00000	0.00000	0.00000
0.00000	0.00000	4.3154	44.515	11.540	0.10841E-02	0.00000	0.00000	0.00000
0.00000	0.00000	1.0315	23.396	23.238	0.12182E-01	0.98348E-05	0.00000	0.00000
0.00000	0.00000	0.17926	9.5050	37.054	0.10300	0.65565E-04	0.00000	0.00000
0.00000	0.00000	0.22644E-01	2.9847	46.789	0.65415	0.49829E-03	0.00000	0.00000
0.00000	0.00000	0.20779E-02	0.72433	46.789	3.1212	0.31865E-02	0.00000	0.00000
0.00000	0.00000	0.13816E-03	0.13583	37.054	11.191	0.17411E-01	0.00000	0.00000
0.00000	0.00000	0.00000	0.19678E-01	23.238	30.155	0.81206E-01	0.00000	0.00000
0.00000	0.00000	0.00000	0.22044E-02	11.540	61.082	0.32340	0.00000	0.00000
0.00000	0.00000	0.00000	0.18919E-03	4.5380	93.022	1.0997	0.00000	0.00000
0.00000	0.00000	0.00000	0.13709E-04	1.4128	106.51	3.1931	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.34822	91.705	7.9167	0.17248E-04	0.00000
0.00000	0.00000	0.00000	0.00000	0.67940E-01	59.365	16.760	0.11729E-03	0.00000
0.00000	0.00000	0.00000	0.00000	0.10492E-01	28.892	30.298	0.75892E-03	0.00000
0.00000	0.00000	0.00000	0.00000	0.12815E-02	10.570	46.771	0.43293E-02	0.00000
0.00000	0.00000	0.00000	0.00000	0.12480E-03	2.9063	61.655	0.21346E-01	0.00000
0.00000	0.00000	0.00000	0.00000	0.93132E-05	0.60046	69.405	0.91191E-01	0.45866E-04
0.00000	0.00000	0.00000	0.00000	0.00000	0.93199E-01	66.719	0.33753	0.40897E-03
0.00000	0.00000	0.00000	0.00000	0.00000	0.10867E-01	54.770	1.0823	0.33138E-02
0.00000	0.00000	0.00000	0.00000	0.00000	0.94995E-03	38.394	3.0069	0.22073E-01
0.00000	0.00000	0.00000	0.00000	0.00000	0.67055E-04	22.983	7.2372	0.12096
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	11.748	15.092	0.54573
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	5.1281	27.265	2.0269
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.9113	42.678	6.1972
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.60825	57.880	15.600
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.16529	68.011	32.330
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.38352E-01	69.241	55.167
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.75990E-02	61.077	77.510
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.12851E-02	46.679	89.670
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.18358E-03	30.910	85.418
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.26226E-04	17.733	66.999
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	8.8146	43.271
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	3.7959	23.010
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.4163	10.074
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.45779	3.6313
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.12820	1.0776
0.13411E-05	0.38259E-04	0.72718E-05	0.00000	0.00000	0.00000	0.00000	0.39050E-01	0.32630

Lamson Paragon Formaline Paraflo Ref. No. 279 x 381

NORMAL DISTRIBUTION

PROBLEM

CLASS NUMBER	CLASS MARK	OBSERVED FREQUENCY	THEORETICAL FREQUENCY
1	0.280	0.0	0.475
2	0.320	46.0	43.971
3	0.360	123.0	121.582
4	0.400	13.0	14.418
5	0.440	17.0	12.175
6	0.480	79.0	85.908
7	0.520	176.0	174.825
8	0.560	101.0	104.545
9	0.600	34.0	22.679
10	0.640	23.0	16.960
11	0.680	37.0	38.582
12	0.720	69.0	70.221
13	0.760	97.0	99.460
14	0.800	109.0	112.645
15	0.840	118.0	104.949
16	0.880	83.0	83.150
17	0.920	64.0	60.372
18	0.960	45.0	47.677
19	1.000	55.0	46.841
20	1.040	33.0	50.451
21	1.080	51.0	50.640
22	1.120	49.0	48.398
23	1.160	55.0	53.494
24	1.200	64.0	72.948
25	1.240	113.0	98.660
26	1.280	104.0	111.120
27	1.320	93.0	99.970
28	1.360	100.0	76.193
29	1.400	63.0	59.201
30	1.440	64.0	57.346
31	1.480	63.0	64.583
32	1.520	47.0	70.097
33	1.560	58.0	67.150
34	1.600	55.0	55.867
35	1.640	46.0	41.424
36	1.680	41.0	30.342
37	1.720	52.0	27.386
38	1.760	42.0	34.420
39	1.800	51.0	50.787
40	1.840	79.0	74.088
41	1.880	103.0	100.506
42	1.920	132.0	124.447
43	1.960	129.0	138.595
44	2.000	124.0	136.350
45	2.040	116.0	116.328
46	2.080	66.0	84.732
47	2.120	22.0	52.085
48	2.160	31.0	26.806
49	2.200	11.0	11.491
50	2.240	2.0	4.089
51	2.280	5.0	1.206

6

```
     52          2.320          0.0          0.365

CHI-SQUARED=    95.05WITH    30DEGREES OF FREEDOM
```

```
C       C.SINCLAIR 87/74 MAIN PROGRAM
        COMMON IUN(8)
        DIMENSION IPT(2000),ITEMP(100)
        INTEGER CNUT
        CNUT=10.0
        ITDIM=100
        CALL MAIN(IPT,ITEMP,CNUT,ITDIM)
        END
        SUBROUTINE MAIN(IPT,ITEMP,CNUT,ITDIM)
        COMMON IUN(8)
        DIMENSION IPT(1),ITEMP(1),ICO(6,2),IRC(6,2)
        1,FDAM(075),IDAM(075),FNDAM(075),NDAM(075),
        2NEG(8),FLD(48),FLND(48),SEC(24),MATAR(4),
        3EXPGN(3),LPRIN(3),NUMCIT(4)
        INTEGER HRS,CLFAL,XCLFAL,YCLFAL,ZCLFAL,XINFAL,YINFAL,ZINFAL,YVAL
        1,ZVAL,RCNEG,EDAM,ENDAM,DAM,CNT
        REAL NEWDD,NEDAM,MATAR
        CALL IFILE(20,'DATA')
        CALL OFILE(21,'OUT')
C       CALL OFILE(22,'CHECK')
C       RANDOMISE STARTING POINT OF RANDOM NO. GENERATOR
        WRITE(6,87)
87      FORMAT(X,'NO. FILE ?',3X,$)
        READ(5,88)ADS
88      FORMAT(A1)
89      CALL TIME(T)
        DECODE(5,11,T)HRS,MINS
11      FORMAT(I2,1X,I2)
        K=MINS*6398227+HRS
        CALL SETRAN(K)
C       STARTING VALUE DEPENDS ON TIME OF DAY
C
C
C       INITIALISATIONS
        MAXLIN = 1
        INCBIT = 3
        INTBIT = 12
        MAXLI=100*1.5
        DO 5 I = 1,100
5       NUT(I) =0.0000000000
9       CLFAL =0
        INFAL =0
        XCLFAL =0
        XINFAL =0
        YCLFAL =0
        YINFAL =0
        ZCLFAL =0
        ZINFAL =0
        INC    =0
        WRITE(6,97)
97      FORMAT(X,'INCRE = ',$)
        READ(5,*)INCR
        IDIF=0
        NDIF=0

        NDAM =0
        DAM  =0
        DCNT =0
        IDENT =0
        NDEV =0
```

```
      IS1  = 16 - INCRIT
      NCHEG =0
      NFALND=0
      NFALL=0
      READ(20,2)INHA
      READ(20,2)(HEGG(I),I=1,INCRE)
      READ(20,2)(FLD(I),I=1,INCRE)
      READ(20,2)(FLND(I),I=1,INCRE)
      READ(20,2)A1,A2,A3
      READ(20,2)(REC(I),I=1,24)
      IM=1
      READ(20,2)(HAHA(I),I=1,4)
      READ(20,2)GDI,HDI
      READ(20,2)(EXPG(I),I=1,3)
      READ(20,2)(EXPT(I),I=1,3)
      WRITE(21,92)
92    FORMAT( /4X,'LOOP',1X,'GROUND NUTS',2X,'TREE NUTS'
     1,5X,'1ST & 2ND',3X,'3RD & 4TH',6X,'RA',9X,
     2'FINAL',7X,'PUPA',/36X,
     3'G',5X,'T',5X,'G',5X,'T',5X,
     4'G',5X,'T',5X,'G',5X,'T',5X,'G',5X,'T')
C
C
C
C     START MAIN LOOP
C     OPEN RANDOM ACCESS FILES?
      CALL OPEN(1,5)
100   INC=INC+1
      IF(ANS.EQ.'Y'.AND.INC.EQ.15)GO TO 78
      GO TO 79
78    WRITE(3,80)(NT(IZ),IZ=1,MAXLIM)
C
C
C     INITIALISATIONS
79    WRITE(21,91)NMADL,IEXAG,IEXAT,NCHEG
91    FORMAT( /92X,'NUM ADL= ',I5,5X,'EX AD G= ',I5,/92X,'EX AD T= ',
     1I5,5X,'NCHEGG= ',I5)
      NUMADL=0
      IEXAG=0
      IEXAT=0
      DO 15 I=1,8
      DO 15 J=1,2
      NDC(I,J)=0
15    INC(I,J)=0
      EGAD =0
      LIMFIL =6
      IF(INC.LT.8)LIMFIL=INC+1
      LF1 = LIMFIL
C
C
      IF(INC.LT.INCRE)GO TO 9999
C
C     ESTIMATE % DAMAGE OF CROP
      IF (GAD .LE.0) GO TO 9999
      WRITE(6,4000)MAXLIM
4000  FORMAT(1X,'MAXLIM= ',I5)
      IF(MAXLIM.LT.MAXL)GO TO 5000
      NCOUNT=0
      DO 4000 I=1,MAXLIM
      IF(ND(I).EQ.'2000000000000'.OR.NT(I).EQ.'000000000000')GO TO 3001
```

```
      GO TO 5000
3001  KCOUNT=KCOUNT+1
      GO TO 4000
3010  IF(KCOUNT.EQ.0)GO TO 4000
      NUT(I-KCOUNT)=NUT(I)
4000  CONTINUE
      MAXLIM=MAXLIM-KCOUNT
5000  CONTINUE
      NUTOT=DAM+NODAM+CNUT
      IF(DAM.EQ.0)GO TO 1113
      PEDAM=DAM*100./NUTOT
      GO TO 1114
1113  PEDAM=0.
1114  NEGG=NEGG(INC)
      WRITE(2?,16)IDATE,NUT?,NEGG
16    FORMAT(I2,I5,6X,I5,75X,'IMMIGRANT EGGS = ',I5)
2     FORMAT(I80)
      NEGG = NEGG + 0?*NEGG
      IF(PEDAM.LE.1)GO TO 2000
      RATIO=2?.?9/(PEDAM**.709)
      EDAM=NEGG*RATIO*DAM/(RATIO*DAM+NODAM+CNUT)
      ENODAM=NEGG-EDAM
      IF(EDAM.EQ.0)GO TO 2040
C
C     CALCULATE MEAN & VARIANCE OF EGGS ON DAM & NODAM
C
      XDAM=DAM
      MEDAM=EDAM/XDAM
      VEDAM=1.357*(MEDAM**1.154)
      XNODAM=NODAM+CNUT
      MENOD=ENODAM/XNODAM
      VENOD=1.346*(MENOD**1.043)
      GO TO 2040
2000  XNUT?=NUTOT
      MENOD = EGG/NUTOT
      VENOD = 1.346*(MENOD**1.043
      ENODAM=EGG
      GO TO 2050
C
C     FREQUENCIES OF EGGS 0'S,1'S,2'S ETC. DAMAGED NUTS
C
2040  C=MEDAM/(VEDAM-MEDAM)
      P=MEDAM*C
      FDAM(0)=(C/(C+1.))**P
      FDAM(5)=1-FDAM(0)
      DO 2041 I=1,4
      FDAM(I)=FDAM(I-1)*(P+I-1)/(I*(C+1))
      FDAM(5)=FDAM(5)-FDAM(I)
2041  CONTINUE
      DO 2043 I=0,5
2043  NDAM(I)=DAM*FDAM(I)+.5
      WRITE(2?,7?)NDAM
      CALL ??? (NDAM,EDAM?)
C
C     FREQUENCIES OF EGGS 0'S,1'S,2'S ETC. NODAM NUTS
C
2050  C=MENOD/(VENOD-MENOD)
      P=MENOD*C
      FNDAM(0)=(C/(C+1))**P
      FNDAM(5)=1-FNDAM(0)
```

```
      DO 2051 I=1,4
      FNDAM(I)=FNDAM(I-1)*(M+I-1)/(I*(C+1))
      FNDAM(5)=FNDAM(5)-FNDAM(I)
2051  CONTINUE
      DO 2053 I=1,5
2053  NNODAM(I)=NNODAM+CONT*FNDAM(I)+.5
C     WRITE(20,70)NNODAM
      CALL [illegible](NODAM,FNODAM)
C
C     RANDOMLY ALLOCATE EGGS
C     ALLOCATE ON [illegible] DAMAGED
C
C     WRITE(20,70)EDAM,ENODAM,MEDAM,[illegible]NOD,[illegible]EDAM,VENOD,DAM,[illegible]DAM
70    FORMAT(1X,10G13.5)
C     WRITE(20,70)PEDAM,NDAM,NNODAM,EDAM,[illegible]DAM,CNOT
      [illegible]=0
      DO 121 I=1,5
      [illegible]=[illegible]+NNODAM(I)
121   CONTINUE
      NEWNOT=[illegible]-NODAM
      IF(NEWNOT.LE.0)GO TO 1120
      NODAM=NODAM+NEWNOT
      NEWLIM=MAXLIM+NEWNOT
      IF(NEWLIM.LT.IDIM*2)GO TO 102
      WRITE(6,103)NEWLIM
103   FORMAT(1X,'[illegible] ARRAY OVERFLOW,MAXLIM = ',I6)
      CALL EXIT
102   NSTART=MAXLIM+1
      DO 1111 I=NSTART,NEWLIM
1111  NUT(I)=40000000000
      MAXLIM=NEWLIM
      CNOT=CNOT-NEWNOT
1120  CONTINUE
60    FORMAT(1X,6I)
      CALL [illegible](ITEMPT,MAXLIM,NUT,IDENT,L[illegible]FIL,LF1,IRG,ICO,[illegible]TRIC,
     1INCOLL,IS1,IODIM,NOMCNT)
      LI=IDIM*2-NOMCNT(4)+1
      CALL ALLOC(ITEMPT,NUT,IDENT,INTRIT,INCBIT,ISL,NOMCNT(3),NUMNOT
     1,1,NNODAM,IRG,ICO)
61    FORMAT(//)
C
C     ALLOCATE ON DAMAGE NUTS
C
      IF(INC.[illegible].OCRIT.OR.PEDAM.LE.1)GO TO 2120
      NUMNOT=1
      DO 101 I=1,5
      NUMNOT=NUMNOT+NDAM(I)
101   CONTINUE
C     WRITE(20,70)NUMNOT,NUMNOT
      CALL ALLOC(ITEMPT,NUT,IDENT,INTRIT,INCBIT,ISL,NOMCNT(4),NUMNOT,
     1,1,NDAM,IRG,ICO)
      IF(INC.[illegible].4)GO TO 2120
      IPROG=1.0/(5.1*G[illegible])+.5
      IF(IPROG.EQ.0)GO TO 42
      CALL [illegible](IPROG,IEXAG,EXPG)
42    IPROT=1.0/(6.2*[illegible])+.5
      IF(IPROT.EQ.0)GO TO 2120
      CALL [illegible](IPROT,IEXAT,EXPT)
C
C
```

```
C        CALCULATE MORTALITY
C
C
C
0120     CALL MORTAL(LF1,NDEV,LIMFIL,INTBIT,INC,IDD,NOT,INCBIT,IDEST,IS1,
         1INC,INDNEG)
C
C
C        SEARCH AND CALCULATE TOTALS FOR OUTPUT AND MOVE ON
C
C
C
C
         CALL SRCH2(HAYLEN,NDEV,INC,NOT,IDEST,INTBIT,INCBIT,IS1,NUMADD,
         1LIMMAX,DAM,NODAM,IDT,INDT)
C
C        READ FALL FACTORS  DAMAGE,NO DAMAGE
C
         FALLD=FD(INC)
         FALLND=FND(INC)
         NFALD=IDT*FALLD
         NFALND=NOT*FALLND
         NFCNOT=NOT*FALLND
         CNOT=CNOT-NFCNOT
         WRITE(22,75)IDT,INDT,DAM,NODAM,NFALD,NFALND,NFCNOT
C
C        CALCULATE FALL
C
         IF(NFALND.EQ.0)GO TO 104
         CALL FALRAN(ITEMPT,NOT,LF1,LIMFIL,INC,ICO,IS1,1,INDT,1,NFALND,
         1DAM,NODAM,2)
104      IF(NFALD.EQ.0)GO TO 122
         L2=IDT*2
         L1=L2-IDT+1
         CALL FALRAN(ITEMPT,NOT,LF1,LIMFIL,INC,ICO,IS1,L1,L2,2,NFALD,
         1DAM,NODAM,1)
122      CONTINUE
C
C
C
C
         CALL ADULT(NUMDAM,URCHEG,IEMAG,IEXAM)
         IOUTCF=NFALND+NFCNOT
         CLFAL = CLFAL + IOUTCF
         INFAL = INFAL + NFALD
         IOGTF=IOUTCF+NFALD
         NOTT=CNOT+DAM+NODAM
         IF(INC-1)103,95,105
95       XCLFAL = CLFAL
         XINFAL = INFAL
         NOVAL = XCLFAL + XINFAL
         WRITE(22,96)XCLFAL,XINFAL,NOVAL
96       FORMAT( /2X,'XCLFAL = ',I5,2X,' XINFAL= ',I5,2X,'NOVAL= ',I5)
         GO TO 103
105      IF(INC-2)103,115,120
115      YCLFAL = CLFAL-XCLFAL
         YINFAL = INFAL - XINFAL
         YVAL = YCLFAL + YINFAL
```

```
      WRITE(20,126)YCLFAL,YINFAL,YVAL
126   FORMAT(/2X,' YCLFAL= ',I5,2X,' YINFAL= ',I5,2X,'YVAL= ',I5)
      GO TO 1[illegible]
1200  IF(IRC-3)[illegible],130,130
130   ZCLFAL = CLFAL-YCLFAL-XCLFAL
      ZINFAL = INFAL-YINFAL-XINFAL
      ZVAL  = ZCLFAL + ZINFAL
      WRITE(20,131)ZCLFAL,ZINFAL,ZVAL
131   FORMAT(/2X,'ZCLFAL= ',I5,2X,'ZINFAL= ',I5,2X,'ZVAL= ',I5)
      CALL [illegible](YCLFAL,YINFAL,ZCLFAL,ZINFAL,YVAL,ZVAL,MATAR)
      GO TO 100
9999  WRITE(6,99)
99    FORMAT(/1X,'I HAVE FINISHED!'//)
      CALL EXIT
      RETURN
      END


       SUBROUTINE [illegible](I,J,K)
       COMMON [illegible](8)
       DIMENSION FILE(8)
       DATA FILE/'F1','F2','F3','F4','F5','F6','F7','F8'/
C      OPEN 8 [illegible] RANDOM ACCESS [illegible] FILES J TO K
       DO 10 I = J,K
       I=LU(I)
10     CALL [illegible](I,5,IV,FILE(I),0,0)
       RETURN
       END
       BLOCK DATA
       COMMON [illegible](8)
       DATA LU /[illegible],23,24,10,11,12,13,14/
       END
```

```
      SUBROUTINE ROUNCK(DAMN,ED)
      DIMENSION DAMN(5)
      INTEGER DAMN,E,ED,EDIFF
C     S/R TO CHECK ROUNDING AGREEMENT OF
C     EGGS ON DAMAGED NUTS AND ADJUSTING IF
C     NECESSARY.
C     DAMN = NO. OF NUTS WITH I EGGS(I=0,5)
C     E = TOTAL OF EGGS ON DAMAGED NUTS
C     AS CALCULATED AFTER ROUNDING FROM FREQUENCIES.
C     ED = ACTUAL NO. OF EGGS ON DAMAGED NUTS.
C     EDIFF= DIFFERENCE BETWEEN E AND ED USED
C     TO DETERMINE IF ANY ADJUSTMENT IS NECESSARY.
C     (SIGN DETERMINES TYPE OF ADJUSTMENT).

      IF(DAMN(5).LT.2) GO TO 70
      WRITE(6,56) DAMN(5)
56    FORMAT(/1X,' DAMN(5) OVERFLOW ',I10//)
      CALL EXIT
70    E = 0
      DO 71 I = 1,5
71    E = E + DAMN(I)*I
      EDIFF = E - ED
      IEDIFF = IABS(EDIFF)
      IF(EDIFF)400,420,410
400   IF(IEDIFF.LE.5) GO TO 401
      WRITE(6,402)EDIFF
402   FORMAT(/1X,' EDIFF TOO LITTLE ',I10)
      CALL EXIT
401   DAMN(1) = DAMN(1) + IEDIFF
      RETURN
410   IF(IEDIFF.LE.5) GO TO 411
      WRITE(6,412) EDIFF
412   FORMAT(/1X,' EDIFF TOO LARGE ',I10)
      CALL EXIT
411   DAMN(1) = DAMN(1) - IEDIFF
      IF(DAMN(1).LT.0)DAMN(1)=0
420   RETURN
      END
```

```
      SUBROUTINE SEARCH(ITEMPT,NAVLIM,NUT,IDEST,LIMFIL,LF1,IRC,ICO,
     1INTBIT,INCBIT,IS1,ITOTN,NDMCNT)
      COMMON J(8)


      DIMENSION ICNT(4),NDMCNT(4),ISELD(4),ITEMPT(1),NUT(1)
     1,ISELTG(4),ICO(8,2),IRC(8,2)

      DATA ISELD/1,2,1,2/
      DATA ISELTG/1,1,2,2/


C     S/R SEARCHES OUT FOR TREE NUTS AND STORES
C     SUBSCRIPTS IN ITEMPT FOR DAMAGE AND NO DAMAGE
C     ALSO CALLS RANFIL TO SET UP MORTALITY SCRATCH
C     FILE SUBSCRIPT SELECTION
C     ITEMPT = ARRAY OF TREE SUBSCRIPTS - NO DAMAGE
C     STORED IN LEFT HAND END OF ARRAY, DAMAGE SUBSRIPTS
C     STORED IN RIGHT HAND END.

C     INITIALISATION.

      DO 104 I = 1,ITOTN
104   ITEMPT(I) = 0
      DO 105 I = 1,4
      ICNT(I) = 0
105   NDMCNT(I) = 0
      DO 102 I = 1,NAVLIM
      IVAL = IBYTE(NUT(I),2,3,IDEST,34)
      IVAL = IVAL + 1
      ISL = ISELD(IVAL)
      ISLTG=ISELTG(IVAL)
      GO TO (102,101,20,20),IVAL

20    CALL INDEX(NDMCNT(IVAL),ICNT(IVAL),IP,J,ISL)
      GO TO (102,102,30,40),IVAL
30    ITEMPT(J) = IBYTE(1,14,22,ITEMPT(J),IP)
      GO TO 101
40    J =ITOTN-J+1
      ITEMPT(J) = IBYTE(1,14,22,ITEMPT(J),IP)
101   CALL RANFIL(IRC,ICO,INTBIT,INCBIT,IDEST,NUT,IS1,ISLTG,1,LF1,I)
102   CONTINUE
C     WRITE(6,72)ITEMPT
70    FORMAT(1X,40)
103   RETURN
      END



      SUBROUTINE INDEX(NDM,IC,IP,J,K)
      DIMENSION IT(2,2)
      DATA IT/0,15,15,0/
      [illegible]=[illegible]+1
      J=([illegible]+1)/2
      [illegible]=[illegible]+1
      [illegible]=IT([illegible],[illegible])
      IF([illegible].EQ.[illegible]) [illegible]
      RETURN
      END
```

```
      SUBROUTINE WRFILE(IRC,ICO,I[illegible]IB) ,INCRI,IDEST,NU,ISI,ISL,L1,L2,
     1IVL)
      COMMON [illegible](8)

      DIMENSION [illegible](1),IRC(8,2),ICO(8,2)

C     WRITES TO SCRATCH FILES (1 FOR EACH DEVELOPMENT
C     STAGE) THE SUBSCRIPT OF THE UNIT PROVIDED THAT
C     STAGE IS PRESENT.
C     A RANDOM MORTALITY CAN THEN BE CARRIED OUT ON
C     SUBSCRIPTS OF THE SCRATCH FILE.
C     ICO=ARRAY OF COUNTS FOR EACH OF 8 DEVELOPMENTAL
C     STAGES FOR THE TREE AND GROUND.
C     IRC=ARRAY OF RECORD COUNTS FOR EACH OF 8
C     DEVELOPMENTAL STAGES FOR TREE AND GROUND.
C     L1,L2 = RANGE OF STAGES BEING [illegible].
C     ISL = SUBSCRIPT OF TREE OR GROUND
C     (1 = GROUND,2 = TREE)

      IC = I[illegible]
      DO 51 L = L1,L2
      IVAL = [illegible](NU(IVL),INCRI ,IC,IDEST,ISI)
      IF(IVAL.EQ.0)GO TO 52
      IRC(L,ISL) = IRC(L,ISL) + 1
      ICO(L,ISL)=ICO(L,ISL)+IVAL
      IREC = (IRC(L,ISL) - 1)*2 + ISL
      LU=LUN(L)
      WRITE(LU'IREC,20)IVL
20    FORMAT(I5)
52    IC=IC+INCRI
51    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE ALLOC(ITEMPT,NOT,IDEST,INCBIT,INCWI[illegible],IS1,NDM,NUM,L1,
     1DAMN,IRC,ICO)
      DIMENSION DAMN(375),ITEMPT(1),NOT(1),IRC(8,2),ICO(8,2)
      INTEGER DAMN
C     S/R ALLOCATES EGGS AND ADDS THEM TO [illegible]
C     NDM = NO. OF DAMAGED OR UNDAMAGED EGGS
C     AVAILABLE FROM WHICH SELECTION IS MADE
C
C
C     NUM = NUMBER TO BE SELECTED.
C
C     ID = LEFT BIT OF BYTE IN DESTINATION WORD.
C     L1 = RANDOM NUMBER SELECTION STARTING POINT.
C
      J=1
      JJ=DAMN(J)
      DO 10 I=1,NUM
      IND=IRAND(NDM,L1,ITEMPT,IDEST)
      IF(I.LE.JJ)GO TO 11
      J=J+1
      JJ=JJ+DAMN(J)
11    IVAL=IBYTE(NOT(IND),INCBIT,INCBIT,IDEST,IS1)
      J1=J+IVAL
      IF(J1.LE.7)GO TO 14
      WRITE(6,15)J1
15    FORMAT(1X,'J1= ',I2)
14    NOT(IND)=IBYTE(J1,INCBIT,IS1,NOT(IND),INCBIT)
      IRC(1,2)=IRC(1,2)+1
      ICO(1,2)=ICO(1,2)+J
      IREC=(IRC(1,2)-1)*2+2
      WRITE(10'IREC,20)IND
20    FORMAT(I5)
10    CONTINUE
12    RETURN
      END


      FUNCTION IRAND(NX,L1,ITEMPT,IDEST)
      DIMENSION ITEMPT(1)
      INTEGER [illegible]
C     FUNCTION CALCULATES A RANDOM INDEX FOR [illegible]
C     FOR ALLOCATION OF EGGS
      I[illegible] =[illegible]
      J = [illegible] 2
      L = J 2
      I[illegible] = 10
      IF([illegible].[illegible]
      IRAND[illegible](ITEMPT(J),14,[illegible],22)
      RETURN
      END
```

```
      SUBROUTINE [illegible](IMOR,IEXAD,[illegible])
      DIMENSION EXMOR(3),OUTPP(3)
      INTEGER OUTPP
C
C     SUBROUTINE UPDATES OUTPP - AN ARRAY OF PREPUPAE
C     EXTERNAL TO FRUIT, CALCULATES THE ADULTS EMERGING
C     RETURNS THESE TO MAIN,AND MOVES ALL
C
C     EXTERNAL PREPUPAE FOWARD ONE PLACE
      OUTPP(1) =OUTPP(1)+IMOR
C     REDUCE NUMBERS BY MORTALITY
      DO 2 I=1,3
      OUTPP(I) =OUTPP(I)*EXMOR(I)
    2 CONTINUE
C     CALCULATE ADULTS
      IEXAD=OUTPP(3)
C     MOVE ALL VALUES FOWARD
      OUTPP(3) =0
      DO 3 I=3,2,-1
      OUTPP(I) =OUTPP(I-1)
    3 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE MORTAL(LF1,NDEV,LIMFIL,INBIT,IRC,
     1ICO,NU ,INCBIT,IDEST,IS1,INC,IN,NEC)
      COMMON NU(8)
      DIMENSION IRC(8,2),ICO(8,2),NUT(1), MT(8,2),NEC(24)
      DATA IU ,IO2/0,1/
      REAL MT
C     S/R CALCULATES MORTALITY OF INSECT STAGES AND
C     ADJUSTS NUT ACCORDINGLY
C
C     MT(I,J) = ARRAY OF MORTALITY FACTORS (READ IN),.
C     I = 1 = GROUND, I = 2 = TREE.
C
C     IRC = COUNT OF NUMBER OF RECORDS IN PARTICULAR
C     BINARY  SCRATCH FILE.
C
C     ICO = NUMBER OF INSECTS IN A PARTICULAR STAGE
C      OF DEVELOPMENT.
C
C     IREC = RECORD NUMBER RANDOMLY SELECTED OF
C     SRATCH FILE
C
C     IJ = SUBSCRIPT OF NUT TO BE ADJUSTED.
C

      LF = LF1
      IF(INC.LE.NEC(IN))GO TO 17
      IN=IN+1
      DO 9 I = 1,2
9     READ(20,1) (MT(J,I),J = 1,NDEV)
1     FORMAT(8G)
17    I1 = 1
110   DO 100 JJ = 1,2
      IC = INBIT
      DO 100 II = I1,LF
      IR1 = IRC(II,JJ)
      MORT = ICO(II,JJ)*MT(II,JJ)+.5
D     WRITE(6,15)MORT
15    FORMAT(1X,'MORT = ',I6)
      IF(MORT.EQ.0)GO TO 13
      DO 11 J =1,MORT
      KOUNT=0
12    IX = (INTPER(IR1*RAN(0) + 1))
      LU=LUNIT
      IREC=(IX -1)*2+JJ
      READ (LU #IREC,20)IJ
20    FORMAT(I5)
      KOUNT=KOUNT+1
      IF(KOUNT.GE.20)GO TO 21
      IVAL = IBYTE(NU(IJ),INCBIT,IC,IDEST,IS1)
      IF (IVAL.EQ.0) GO TO 12
      IVAL = IVAL - 1
      NU(IJ) = IBYTE(IVAL,INCBIT,IS1,NU(IJ),IC)
      GO TO 11
21    WRITE(6,22)INC,II,JJ,IX,IJ,IRC(II,JJ),ICO(II,JJ),MORT
22    FORMAT(1X,I3,2I2,5I3)
11    CONTINUE
13    IC = IC + INCBIT
100   CONTINUE
16    RETURN
      END
```

```
      SUBROUTINE SRCH2(MAXLIN,NDEV,INC,NUT,IDEST,
     1INTBIT,INCBIT,IS1,NUMADL,NTAMAX,DAM,NODAM,IDT,INDT)
      DIMENSION NUT(1),IDEV(2,8)
      INTEGER C60,C40,DAM
      DATA ID/1/
C
C
C     SUBROUTINE SEARCHES NUT; EXTRACTS TOTALS FOR OUTPUT
C     MODIFIES FOR EXTRA DEVELOPING STAGES OF INSECT,
C     AND MOVES STAGES ON.
C
C     INDG = NO. NODAMAGED NUTS - GROUND
C     IDG  = NO.DAMAGED NUTS - GROUND
C     INDT = NO. OF NODAMAGED NUTS - TREE
C     IDT  = NO. DAMAGED NUTS - TREE
C     IDEV = ARRAY OF TOTALS FOR STAGES, TREE AND GROUND.
C     ( 1 = GROUND, 2 = TREE)
C
C     KK   = FLAG FOR FIRST LOOP.
C
C     C60  = COUNT OF 60% INSECTS WITH EXTRA STAGES.
C     C40  = COUNT OF 40% INSECTS WITHOUT EXTRA STAGES.
C     IPERC= CALCULATED % TO TRY TO ESTIMATE 60%/40%
C     ALLOCATION.

      C60  = 0
      C40  = 0
      KK   = 1
      ND   = NDEV
      IF(INC.LT.NDEV) ND = INC+1
      INDG = 0
      IDG  = 0
      INDT = 0
      IDT  = 0
      DO 10 I = 1,2
      DO 10 J = 1,ND
10    IDEV(I,J) = 0
      NUMADL=0
      INBIT=INTBIT+3
      DO 100 K = 1,MAXLIN
      NADL = IBYTE(NUT(K),INCBIT,33,IDEST,IS1)
20    NUMADL=NUMADL+NADL
      IVAL = IBYTE(NUT(K),2,0,IDEST,34)
21    IVAL = IVAL + 1
      IVDCK=IVAL
      GO TO (1,2,3,4),IVAL
1     INDG = INDG +1
      I= 1
      GO TO 5
2     IDG = IDG +1
      I = 1
      GO TO 5
3     INDT = INDT + 1
      I = 2
      GO TO 5
4     IDT = IDT +1
      I = 2
5     IC   = INTBIT
      DO 101 J1 =1,ND
      IVAL = IBYTE(NUT(K),INCBIT,IC,IDEST,IS1)
```

```
12      IDEV(I,11) = IDEV(1,11) + IVAL
        IC = IC+INCBIT
101     CONTINUE
        IF(INC.LT.4)GO TO 30
        IVAL = IBYTE(OUT(K),INCBIT,21,IDEST,IS1)
23      IF(IVAL.EQ.0)GO TO 30
        GO TO (5,7),KK
5       KK = 2
        C60 = C60 + IVA
        GO TO 30
7       IZERO = C60*100/(C60 + C40)
        IF(IZERO.LT.MIXAX)GO TO 6
6       C40 = C40 + IVAL
        CALL MOVE(OUT(K))
        OUT(K) = IBYTE(IDEST,INCBIT,IS1,OUT(K),24)
        IV1 = IBYTE(OUT(K),INCBIT,27,IDEST, IS1)
        IV1 = IV1 + IVAL
        OUT(K)= IBYTE(IV1,INCBIT,IS1,OUT(K),27)
        GO TO 100
5       C60 = C60 + IVAL
30      CALL MOVE(OUT(K))
        IV1=IBYTE(OUT(K),INCBIT,INBIT,IDEST,IS1)
        IF(IV1.EQ.0)GO TO 100
        IF(IVDC.NE.3)GO TO 103
        NODAM=NODAM-1
        DAM=DAM+1
103     OUT(K)=IBYTE(ID2,1,35,OUT(K),1)
100     CONTINUE
        CALL OUT(NDOG,IOG,INDT,IDT,IDEV,INC,IXMAX)
102     RETURN
        END
```

```
        INTERN  GOI
GOI:    0
        MOVEM   3,SAVE3          ; SAVE AC3
        MOVE    3,@(16)          ; 1ST WORD IN AC3
        MOVE    4,@(16)          ; 1ST WORD IN AC4
        AND     4,MASK1          ; AC4 CONTAINS IDENTITY CODE
        AND     3,MASK2          ; AC3 ALL BUT IDENTITY CODE
        LSH     3,-3             ; SHIFT RIGHT 3 BITS AC3 & AC4
        IOR     3,4              ; PUT BACK IDENTITY CODE
                                 ; INTO AC3
        MOVEM   3,@(16)          ; INTO 1ST WORD
        MOVE    3,SAVE3          ; RESTORE AC3
        JRA     16,1(16)         ; RETURN
MASK1:  777700000000
MASK2:  000077777777
SAVE3:  BLOCK 1
        END
```

```
      SUBROUTINE [illegible](IDOG,IDG,IND[illegible],ICT,IDEV,INC,MIXMAX)
      DIMENSION IDEV(2,8),INDEV(2,5)
      INDEV(1,1)=IDEV(1,2)+.5
      INDEV(2,1)=IDEV(2,2)+.5
      INDEV(1,2)=IDEV(1,3)+.5
      INDEV(2,2)=IDEV(2,3)+.5
      INDEV(1,3)=IDEV(1,4)*MIXMAX/100.+.5
      INDEV(2,3)=IDEV(2,4)*MIXMAX/100.+.5
      INDEV(1,4)=IDEV(1,4)*(1-MIXMAX/100.)+IDEV(1,5)+IDEV(1,6)+.5
      INDEV(2,4)=IDEV(2,4)*(1-MIXMAX/100.)+IDEV(2,5)+IDEV(2,6)+.5
      INDEV(1,5)=IDEV(1,7)+IDEV(1,8)+.5
      INDEV(2,5)=IDEV(2,7)+IDEV(2,8)+.5

      WRITE(2,[illegible])[illegible],INDEV
 1    FORMAT([illegible]X,I5,2[illegible],10I6)
      RETURN
      END
```

```
      SUBROUTINE FALRAN(ITEMPT,NUT,LF1,LIMFIL,IRC,ICO,IS1,L1,L2,K,LIM,
     1DAM,NODAM,INDIC)
      DIMENSION ITEMPT(1),NUT(1),IFLG(2,6),IRC(8,2),ICO(8,2)
      DATA ID1,ID2 /0,1/
      INTEGER DAM
C
C
C     S/R CALCULATES RANDOM FALL VALUES FOR DAMAGE
C
C     AND NO DAMAGE NUTS AND UPDATES NUT. A FLAG BIT
C     IS SET IN     IFLG(2,6). IFLG(1,I) REFERS
C     TO NODAMAGE, IFLG(2,I) REFERS TO DAMAGE
C     IFLG = FLAG ARRAY DIMENSION(IP + 35)/36
C
C     L1,L2 = RANGE FOR SELECTION OF RANDOM NUMBERS
C
C     K = 1 WHEN USING LEFT HAND END OF ITEMPT
C     K = 2 WHEN USING RIGHT HAND END OF ITEMPT
C
C     LIM =   LIMIT TO NUMBER OF RANDOM NUMBERS REQUIRED.
C
C     ITEMPT = ARRAY OF SUBSCRIPTS HALF WORD STORAGE
C     FROM WHICH SELECTION IS TO BE MADE.
C
C     LEFT HAND END CONTAINS NODAMAGE SUBSCRIPTS OF TREE NUTS
C
C     RIGHT HAND END CONTAINS DAMAGE SUBSCRIPTS OF TREE NUTS
C
C     IP= BIT POSITION NUMBER IN ITEMPT,0,18
C
C     I = WORD NUMBER IN ITEMPT TO BE EXAMINED FOR
C     SUBSCRIPT ADDRESS
C
C     IX = RANDOM BETWEEN L1 AND L2
C
C
      DO 10 II = 1,6
   10 IFLG(K,II) = 0
      IR1 = L2 -L1 + 1
      DO 11 J = 1,LIM
   12 IX = INT(IR1*RAN(0) + L1)
   13 II = (IX +35)/36
      JJ = IX - L1
      IB = JJ - (JJ/36)*36
      IVAL = IBYTE(IFLG(K,II),1,IB,ID1,35)
    1 IF(IVAL.EQ.1) GO TO 12
      IFLG(K,II) = IBYTE(ID2,1,35,IFLG(K,II),IB)
    2 I = (IX+1)/2
      LL = I*2
      IP = 18
      IF(LL.GT.IX)IP=0
      I = IBYTE(ITEMPT(I),14,IP,ID1,22)
    3 NUT(I) = IBYTE(ID1,1,35,NUT(I),0)
      IF(INDIC-2)15,16,16
   15 DAM=DAM-1
      GO TO 11
   16 IVX=IBYTE(NUT(I),1,1,ID1,35)
      IF(IVX-1)17,18,18
   17 NODAM=NODAM-1
      GO TO 11
   18 DAM=DAM-1
   11 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE ADULT(XX,ORCHEG,IEXAG,IEXA1)

      INTEGER XX,ORCHEG

      DIMENSION ORCHAD(3),EMAD(3),SURVAD(3),OEGG(3),EGLAY(3)

C     SUBROUTINE USES ORCHAD - THE ARRAY OF ADULT NUMBERS
C     EMERGED WITHIN THE ORCHARD.
C     EMAD IS THE ARRAY OF PROBABILITIES OF ADULTS REMAINING
C     IN THE ORCHARD AFTER EMMIGRATION.
C     SURVAD  IS THE ARRAY OF PROBABILITIES OF ADULTS
C     SURVIVING THE AGE PERIOD.
C     EGLAY  IS THE ARRAY OF EGG EXPECTATIONS FOR
C     EACH ADULT AGE GROUP.
C     ORCHEG - THE RESULTANT NUMBER OF EGGS LAID IN THE
C     ORCHARD.
C     SUBROUTINE CALCULATES ORCHEG ,AFTER HAVING REDUCED
C     THE ADULT NUMBERS BY EMAD AND SURVAD. IT THENMOVES
C     ALL THE VALUES FOR ADULTS IN EACH AGE CLASS
C     FOWARD BY ONE TIME PERIOD.
C
C     ADD NEWLY EMERGED ADULTSTO ORCHAD(1 .
      ORCHAD(1) = XX+IEXAG+IEXA1
C     REDUCE NUMBERS OF ADULTS
C
C
C
C
C
      IF(IC.GT.0)GO TO 10
      READ(20,1)EMAD
      READ(20,1)SURVAD
      READ(20,1)EGLAY
1     FORMAT(3G)
C     READ EMAD, SURVAD EGLAY.
C
C
C
C
      IC=IC+1
10    DO 50 I =1,3
      ORCHAD(I) = ORCHAD(I)*EMAD(I)
      ORCHAD(I) = ORCHAD(I)*SURVAD(I)
50    CONTINUE
C
C     CALCULATE ORCHEG
C
      ORCHEG = 0
      DO 70 I = 1,3
      OEGG(I) = ORCHAD(I) *EGLAY(I)
      ORCHEG = ORCHEG + OEGG(I)
70    CONTINUE
C
C
C     MOVE ALL ADULT VALUES FORWARD.
C
      ORCHAD(1) = 0
      DO 80 I = 3,2,-1
      ORCHAD (I) = ORCHAD(I-1)
```

```
50        CONTINUE
          WRITE(6,71)(RCHAD,XY,URCHEG
71        FORMAT(1X,5G14.5)
          RETURN
          END




          SUBROUTINE NETE (YCLFAL,YINFAL,ZCLFAL,ZINFAL,YVAL,ZVAL,DATAS)
          DIMENSION DATA(4)
          REAL DATAS


C         COOK = NUTS SUITABLE FOR COOKING - KILO'S
C         PRICE= GROSS RETURN ON COOKING NUTS - %
C         PICK = TOTAL NUTS FOR FARM PROCESSING - KILO'S
C         COST = COST OF FARM PROCESSING - $
C         DOLLAR= NET RETURN - $
C
          INTEGER YCLFA ,YINFAL,ZCLFAL,ZINFAL,YVAL,ZVAL
C
          COOK =  YCLFAL*DATA(1)+YINFAL*DATA(2)+ZCLFAL*DATA(3)+ZINFAL*DATA(4)
          PRICE = (COOK*5.64)/150
          PICK =  (YVAL+ZVAL)/150
          COST =  (PICK*.11) + (PICK/125*2.5)
          DOLLAR=  PRICE - COST
          WRITE(2,1)DOLLAR
1         FORMAT(/1X,'NET RETURN = $ ',F10.3)
          RETURN
          END
```

[illegible] GROUND [illegible]		REF UNITS	1ST & 2ND G	1ST & 2ND T	3RD & 4TH G	3RD & 4TH T	5A G	5A T	FINAL G	FINAL T	PUPA G	PUPA T				
1	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	[illegible]	Ø	[illegible] AD= Ø	EX AD G= Ø	EX AD T= Ø	ORCHEGG= Ø, IMMIGRANT EGGS = 3
2	197	881	Ø	2	Ø	Ø	Ø	Ø	Ø	Ø	[illegible]	Ø	[illegible] AD= Ø	EX AD G= Ø	EX AD T= Ø	ORCHEGG= Ø, IMMIGRANT EGGS = 16
3	119	662	1	5	Ø	2	Ø	Ø	Ø	Ø	[illegible]	Ø	[illegible] AD= Ø	EX AD G= Ø	EX AD T= Ø	ORCHEGG= Ø, IMMIGRANT EGGS = 14
4	7[illegible]	611	Ø	1	2	1	1	Ø	Ø	Ø	[illegible]	Ø	[illegible] AD= Ø	EX AD G= Ø	EX AD T= Ø	ORCHEGG= Ø, IMMIGRANT EGGS = 8
5	7[illegible]	538	Ø	Ø	1	Ø	1	1	1	Ø	[illegible]	Ø	[illegible] AD= Ø	EX AD G= Ø	EX AD T= Ø	ORCHEGG= Ø, IMMIGRANT EGGS = 15
6	8[illegible]	457	Ø	7	Ø	Ø	1	Ø	2	Ø	[illegible]	Ø	[illegible] AD= Ø	EX AD G= Ø	EX AD T= Ø	ORCHEGG= Ø, IMMIGRANT EGGS = 6
7	4[illegible]	412	Ø	2	1	5	Ø	Ø	1	Ø	[illegible]	Ø	[illegible] AD= [illegible]	EX AD G= Ø	EX AD T= [illegible]	ORCHEGG= [illegible], IMMIGRANT EGGS = 1[illegible]
8	2[illegible]	364	Ø	3	Ø	2	1	2	1	1	1	Ø	[illegible] AD= [illegible]	EX AD G= Ø	EX AD T= [illegible]	ORCHEGG= [illegible], IMMIGRANT EGGS = 1[illegible]
9	1[illegible]	365	Ø	4	Ø	2	Ø	1	1	3	[illegible]	Ø	[illegible] AD= 1	EX AD G= Ø	EX AD T= [illegible]	ORCHEGG= 13, IMMIGRANT EGGS = 12

OUT AD= [illegible] EX AD G= 0
EX AD T= [illegible] ORCHEGG= 6
IMMIGRANT EGGS = 16
10 [illegible] 357 0 10 0 3 0 1 2 1 [illegible] 1

OUT AD= 7 EX AD G= 0
EX AD T= [illegible] ORCHEGG= [illegible]
IMMIGRANT EGGS = 12
11 [illegible] 350 1 8 1 7 1 1 [illegible] 2 [illegible] 1

OUT AD= 1 EX AD G= 0
EX AD T= [illegible] ORCHEGG= 13
IMMIGRANT EGGS = 1[illegible]
12 [illegible] 342 0 5 1 6 1 2 2 3 [illegible] 0

OUT AD= 1 EX AD G= 0
EX AD T= [illegible] ORCHEGG= 19
IMMIGRANT EGGS = 1[illegible]
13 [illegible] 334 0 9 0 3 1 2 [illegible] 4 [illegible] 0

OUT AD= 3 EX AD G= 0
EX AD T= [illegible] ORCHEGG= 6
IMMIGRANT EGGS = 8
14 [illegible] 327 1 10 0 7 0 2 2 3 [illegible] 1

OUT AD= 1 EX AD G= 0
EX AD T= [illegible] ORCHEGG= 13
IMMIGRANT EGGS = 12
15 [illegible] 318 0 1 1 7 1 3 1 4 [illegible] 1

XOTFAL = 647 XIMFAL= 43 XOTAL= 69[illegible]

OUT AD= 1 EX AD G= 0
EX AD T= [illegible] ORCHEGG= 17
IMMIGRANT EGGS = 14
16 [illegible] 310 0 1 0 1 1 4 3 5 [illegible] 0

YOUFAL= 2 YIMFAL= 5 YTAL= 7

OUT AD= 1 EX AD G= 0
EX AD T= [illegible] ORCHEGG= 17
IMMIGRANT EGGS = 13
17 [illegible] 303 1 13 0 1 [illegible] 1 2 5 [illegible] 0

OUT AD= 1 EX AD G= 0
EX AD T= [illegible] ORCHEGG= 19
IMMIGRANT EGGS = 22
18 [illegible] 290 0 15 2 6 0 1 1 1 [illegible] 0

```
                                                                              NUT AD=    1     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=    19
                21        269                                                          IMMIGRANT EGGS =    18
   19                              Ø   15    3    6    2    2    1    3    1    1

                                                                              NUT AD=    1     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=    19
                23        246                                                          IMMIGRANT EGGS =    16
   2Ø                              1   11    3    5    1    2    3    4    1    Ø

                                                                              NUT AD=    1     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=    19
                24        222                                                          IMMIGRANT EGGS =    12
   21                              Ø   13    1    5    2    1    4    1    1    Ø

                                                                              NUT AD=    Ø     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=     6
                28        194                                                          IMMIGRANT EGGS =    1Ø
   22                              Ø   1Ø    4    3    1    1    3    Ø    2    1

                                                                              NUT AD=    1     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=    13
                34        16Ø                                                          IMMIGRANT EGGS =     8
   23                              Ø    4    3    2    1    1    2    2    2    Ø

                                                                              NUT AD=    1     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=    19
                34        126                                                          IMMIGRANT EGGS =     6
   24                              Ø    6    1    1    1    1    1    1    2    Ø

                                                                              NUT AD=    1     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=    19
                32         94                                                          IMMIGRANT EGGS =     4
   25                              Ø    6    Ø    3    1    Ø    1    1    2    Ø

 ZCLFAL=   174  ZINFAL=    63  ZVAL=   237

 NETT RETURN = $     Ø.624Ø7

                                                                              NUT AD=    1     EX AD G=    Ø
                                                                              EX AD T=    Ø     ORCHEGG=    19
```

COMPUTER PROGRAMME LISTINGS: HCAP
MACSAV

for:

A LIFE SYSTEM STUDY OF *CRYPTOPHLEBIA OMBRODELTA* (LOWER) (LEPIDOPTERA : TORTRICIDAE) IN SOUTHEAST QUEENSLAND

by

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September, 1974