POPULATION ECOLOGY OF LASIUS FLAVUS F.

ON CHALK GRASSLAND.

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by

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PART SIX

THE ANALYSIS AND INTERPRETATION OF THE RESULTS, PART TWO

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CHAPTER FIFTEEN

The field estimates of colony size.

15.1. General comments on the mark-release-recapture colony size estimates.

15.1.1. The first set of estimates. The first set of estimates, from July/August 1985, gave a range of 2,215 to 51,450 worker ants in a colony, with a mean of 13,933. In 4 of the 30 colonies no marked ants were recovered (all at OWH). In these 4 colonies the number of marked workers released was low, 52 to 149, as opposed to a mean of 274. In fact of the 30 colonies, these were 4 of the lowest 7 figures for the number of marked workers released. In a population, the smaller the number of marked individuals is, then the larger is the possibility of no marked individuals being recaptured. Thus, in these 4 colonies it seems likely that that number of marked ants was insufficient to ensure the probability of a recapture was high enough, given the second sample sizes.

15.1.2. The second set of estimates. The second set of estimates, from September/October 1985, gave a range of between 476 and 78,106 workers in a colony, with a mean of 10,465. In 4 of the 35 colonies no recaptures were made, and again in these colonies the number of marked ants released was low, from 32 to 190, with these being 4 of the lowest 6 figures for numbers of marked ants released.

Taken with the similar statistics from the first set of estimates it illustrates the importance of marking as large a number of individuals as possible. In this study it was only possible to visit each slate once, in the available time, and so sample sizes were limited. A number of repeated visits to the sample colonies would have produced larger numbers of marked ants to be released.

15.1.3. The accuracy of the estimates. The varience of all the estimates was high, but this is to be expected in estimates of this type (Odum and Pontin 1961, Waloff and Blackith 1962, Boomsma et al 1982 for example), due to the difficulty of getting a sample of more than a small percentage of the population in any one attempt. At the time of the second estimates there was a distinct change in the weather patterns (maximum day temperatures dropping from 20°C to around 16°C) and it became much harder to get satisfactory samples of the workers, as can be particularly seen from some of the second sample sizes, in the second set of estimates (Appendix Two). The mean second sample size for the first set of estimates was 372+/-29, and for the second set of estimates it was 269.6+/-59. This was not significantly different when tested with a paired t test ($t = 0.1587$, $P>0.15$) but was using a Wilcoxon paired sign rank test ($T = 136$, $P<0.05$).

Some of the second estimates would appear to be obviously inaccurate, for example colony 3 in MD 7B. The estimate of 476 +/- 168 workers is not compatible with a sexual production of 156 queens and 695 males in the same year (see Chapter Ten).

It was expected that the colony sizes would change in the period between the two estimates, as after the first one the major eclosion of worker pupae occured. There were also an unknown number of deaths. Overall, 8 of the 24 colonies for which comparison was possible, had larger estimated populations in the second sample, and 16 had lower estimated populations. This was not as was expected.

There was no significant correlation between the two sets of estimates for the same colonies. For colonies where correlation was possible, $r = +0.124$, $P>0.10$, $n = 24$, product moment correlation.

It seems likely that the second estimates are less reliable than the first set. Possibly in some cases only a subset of the population was being sampled, as in MD 7B colony 3, with the cooler weather and late time of year contributing to a lack of activity among the worker ants and thus of mixing in the population of the colonies. In later considerations of the population sizes of individual colonies, most reliance will be placed on the first set of estimates.

15.2. The direct digging estimates.

The worker populations of the nests that were dug up cover a similar range to the mark-release-recapture estimates, indicating that the mark-release recapture estimates are not grossly inaccurate. In the two quadrats where comparisons are possible, the mean of the mark-release-recapture first estimates is 18,290, while that from the digging is 13,463. There is no significant difference between the two sets of figures (two tailed t-test, $n = 10$, $t = 0.942$, $P>0.20$).

Digging up a nest cannot ensure that all of the workers are extracted in the soil taken. Mark-release-recapture should however estimate the complete population of the nest, as long as there is free mixing of all the workers. Thus, if accurate, it is possible that mark-release-recapture estimates would be higher than digging and counting estimates. The digging counts also confirmed the excessive amount of time needed for this method, a single mound taking 2 or more days to sort through properly.

15.3. Conclusions on typical worker populations of *L. flavus* colonies on chalk grassland.

The colony sizes of *L. flavus* have been estimated a number of times previously. These estimates are given in Table XXXIV, together with the method used to obtain each of them.

Table XXXIV.

Numbers of worker ants in individual colonies as reported by previous authors.

Author/s	Methods used	Range	Mean
Pickles (1940)	Direct digging	606 to 5,743	2,273
Odum and Pontin (1961)	Mark-release-recapture using phosphorus 32 marks	2,150 to 11,091	5,767
Waloff and Blackith (1962)	Mark-release-recapture using aluminium paint marks, and direct digging	8,700 to 24,500	15,183
Nielsen et al (1976)	Direct digging. Relating population to mound size	1,035 to 70,500	22,100
Pontin (1978)	Estimates made from ants extracted from soil cores	-	18,900 19,600

Digging up of colonies:- Pickles (1940) and Waloff and Blackith (1962) dug up the whole of the ant mound and counted all of the worker ants found. Nielsen et al (1976) dug up only a portion of the mound, counted the workers in it, and then extrapolated the population up to the whole of the mound.
Mark-release-recapture:- Waloff and Blackith (1960) painted marks with aluminium paint onto individual worker ants. Odum and Pontin (1961) dipped ants into a solution of P32.
Soil cores:- Pontin (1978) collected ants from soil cores by extraction with a Tullgren Funnel. The cores were 12 cm. in diameter.

The sizes of the first estimates from mark-release-recapture are consistent with those of Waloff and Blackith (1962) and Nielsen et al (1976). They are often very much larger than those of Pickles (1940) and Odum and Pontin (1961). Pickles' (1940) results come from digging up of nests which, as has already been noted, could underestimate the true population size. The area from which the results of Odum and Pontin (1961) were taken was one that had been colonised by *L. flavus* in 1940, the estimates being made in 1958. The flora and fauna of the area developed from scratch at this time, and it is possible that further time was needed before the maximal population size of *L. flavus* was reached. Taking all of these figures together it seems reasonable to suggest that colony sizes of 10,000 to 30,000 for mature *L. flavus* colonies are quite typical, and that they may sometimes be larger.

As has been previously mentioned, the size of the mound can be related to the population within it, (see Chapter Fourteen). Such a relationship was demonstrated from the direct digging estimates, when the estimated population is correlated with the diameter of the soil mound (product moment correlation, $n = 15$ pairs, $r = +0.816$, $P<0.01$). This relationship is less clear with the mark-release-recapture results, (first estimates correlated with the diameter of the mounds, product moment correlation, $n = 26$ pairs, $r = +0.366$, $0.10>P>0.05$).

15.4. The density of *L. flavus* workers on chalk grassland.

If an average colony population of 13,933 is assumed (this being the mean of the first mark-release-recapture estimates) then the mean of 87.4 mounds per quadrat (see Chapter Eleven) would yield a density of 3,044 worker ants/m^2. In some quadrats the estimated density would be much higher, for example in AR 15, with 126 mounds there would be 4,389 worker ants/m^2. It is possible that even this is an underestimate considering the mark-release-recapture and digging results from the quadrat. When these are used to give a mean colony size, then the figure becomes 6,006 ants/m^2.

Such estimates are similar to those of other authors for habitats other than chalk grassland. For example, Nielsen et al (1976) estimated up to 7,290 worker ants/m^2 on a Danish tidal meadow. Cowdy (1973) suggested up to 15,000 workers/m^2 for grassland areas used as feeding grounds by the Chough, although the basis for this estimate was not made clear. Odum and Pontin (1961) estimated a density of 1,130 workers/m^2, for the area of grassland mentioned in the previous section. These estimates indicate the ability of _L. flavus_ to reach large densities on a variety of grassland ecosystems.

15.5. The use of radioisotopes in field experiments.

It seems appropriate to comment on the technique of mark-release-recapture when it is used with a radio-isotope. There is currently a continuous process of reappraisal of the effects of radiation and of the desirability of using radio-active substances. Although it could be difficult, it seems that in future it would be better to find alternative methods of marking the worker ants. The use of radio-active substances such as P32 involves considerable attention to safety details and this naturally requires the checking of experimental methods by qualified officers. The attention to such details may now be such that the benefits of the technique are not justified.

15.6. Management, environment and colony sizes.

The variabity of the data obtained from the mark-release-recapture estimates has already been noted. Is there, though, any way it can used in combination with the direct digging data to examine any aspects of the possible effects of management or environment on colony sizes.

15.6.1. Management. The only possible aspect of management that it was possible to test was the intensity of grazing. A broad analysis of the difference between heavily and lightly grazed areas was done. To do this, the sample areas in which colony sizes had been estimated, were divided into the two categories as follows.

Highly grazed	Lightly grazed
OWH SS11	OWH SS 4
AR 16	OWH C10
MD 4B	AR 15
	MD 7B

OWH SS11 had been grazed in 4 of the 5 years prior to the population estimates, OWH SS 4 in only 1 year. OWH C10 was ungrazed. AR 15 and 16 represent the lightly grazed and heavily grazed areas of the barn plots at Aston Rowant. MD 7B and 4B represent lightly and heavily grazed areas at Martin Down.

Combining the results of the first mark-release-recapture estimates and the direct digging estimates, gives 19 estimates of colony size in the highly grazed category and 22 in the lightly grazed category. In the heavily grazed category the mean colony size is 10,802 +/- 1,549. In the lightly grazed category the mean colony size is 17,123 +/- 2,796. An F test shows a significant difference between the two sets of figures ($F = 3.77$, $P<0.05$). A one-tailed t test demonstrated that the lightly grazed areas showed significantly higher worker populations than the more heavily grazed areas ($t = 1.893$, $P<0.05$).

There is thus evidence that colonies of L. flavus, on areas of chalk grassland that are lightly grazed, have larger worker populations than colonies on more heavily grazed areas.

15.6.2. Environment. The evidence for an impact of aspect on colony size is complicated because of the very small sample size for colonies on south facing slopes. All the Martin Down estimates were made on areas that can be considered level. All the Aston Rowant sample areas and OWH C10 face north. The only sample from a south facing slope is that from OWH SS 4 and 11. No direct digging estimates were made here and not all of the mark-release-recapture first estimates were successful. Thus there are only 6 estimates of colony size for south facing slopes and therefore it was felt that an analysis based on these figures would not be reliable. No significant correlation was found between any of the other aspects of the environment and the mean colony sizes estimated in each sample area.

15.7. The ants extracted from the soil cores.

The ants that were extracted from the soil cores gave another measure of the relative density of *L. flavus* workers in the sample areas. A Kruskall-Wallis analysis of variance on the results from all of the individual cores gave an overall significant difference ($H = 18.07$, $P<0.05$) between the sample areas. Mann-Whitney tests were then used to establish which of the sample areas were significantly different from each other. The results of the analysis are summarised below.

	Ants/core	SS4	SS11	C10	AR15	AR16	MD7B	MD4A
OWH SS 4	8.49							
OWH SS11	8.49	-						
OWH C10	12.44	-	-					
AR 15	9.51	-	-	-				
AR 16	6.12	+	+	+	+			
MD 7B	11.55	-	-	-	-	+		
MD 4A	3.86	-	-	-	-	+	-	
MD 4B	2.60	-	-	-	+	-	+	-

+ = significant difference at the 5% level.

- = no significant difference.

The main feature of this analysis is that AR 16 had a significantly lower median number of worker ants extracted per core than the other sample areas. It was significantly different from all except MD 4B. While the mean figure is higher than some of the other quadrats, this is due to the finding of a high number of ants in a few cores. In one case 134 worker ants were extracted from a single core. A few larvae were also found indicating that this may have been a core which passed through a small developing colony of L. flavus. These were thus not foraging worker ants.

MD 4B and AR 16 are more heavily grazed areas and have low mound densities. There was no overall significant correlation between the mean number of ants extracted per core for each sample area and the mound density (Spearman rank correlation, $r = +0.558$, $P>0.05$), but again it is the more heavily grazed areas that come out as having lower foraging ant populations.

15.8. Conclusions.

Despite difficulties with some of the mark-release-recapture estimates it was possible to conclude that more intense management will cause reduced colony sizes in L. flavus. The numbers of worker ants extracted from the cores suggested that foraging ants were also less dense in the more heavily grazed areas.

CHAPTER SIXTEEN

Sexual production of the sample colonies.

16.1. Introduction.

The final characteristic of the ant populations to be considered was the production by the colonies of sexuals. A substantial proportion of the productivity of a colony can be directed to the development of sexuals and it may be supposed that the ability of a colony to use its resources in their production could be affected by both the environment and the management of the habitat.

Three elements of this production were considered, firstly the phenology of the production of sexuals, secondly the amount of production and thirdly the sexual investment ratio as a result of that production. Also in this Chapter observations made on a sexual flight at Old Winchester Hill are discussed.

16.2. The phenology of the production of sexuals in 1985, 1986 and 1987

Across the sample colonies studied, the time at which the first pupae were seen in 1986 varied by 15 days, with no consistency as to whether these were the small male/worker pupae or the large gyne pupae. For the individual colonies the period between the sighting of small pupae and adult males averaged 29.8+/-2.6 days, while the period between gyne pupae and adults was 22.8+/-2.0 days. As the figures (shown in Appendix Five) indicate there was considerable variation between the colonies. There was, though, no tendency for the colonies in one quadrat to be more advanced in development than colonies from any other quadrat.

The gyne larvae and pupae are placed in the 'best' parts of the nest, ie. those at the temperature and humidity most suitable for maximum growth (Peakin 1960). It is therefore probable that they are more likely to be seen at any one visit, particularly as the visits were timed to coincide with the periods when ant activity was greatest beneath the slates, when conditions were at their optimum. For these reasons it was thought the data on the gynes was more reliable.

The results above might then indicate that gynes take a shorter period from pupation to eclos~~ure~~ion than the males but this cannot be confirmed. Without further study it is impossible to compare accurately the development of the males and queen pupae in the nests.

Eggs were seen infrequently under the slates. They could sometimes be found when digging up overwintering colonies. There is one record of eggs being found under a slate early in the year, 27/5/86 in OWH SS 11 colony 5. These are presumably worker potential eggs but this cannot be confirmed. It seems unlikely that at this late stage these represented eggs that overwintered in the colony and it is possible that these were eggs produced in the spring. Aside from this, eggs were most often seen in colonies after the sexual flight had taken place. For example, in 1985 eggs were seen in the following colonies at the dates given, all after the sexual flight had occured.

23/9/85 -	MD 7B colony 2
	MD 4B colony 2
25/9/85	AR 15 colonies 2 and 3.
	AR 16 colonies 1, 3 and 4.

The only exception to this was in MD 7B colony 4, on 29/7/86. This was a date after the gynes had started eclosing but before the sexual flight in the area.

The eclosion of new workers can be determined by the presence of callows in the nest, ie. workers of a very pale colour, whose cuticle has yet to fully harden and develop its full depth of colour. Observations in 1986 indicated that in the majority of mature colonies workers emerge after the sexual flight. In a minority of colonies large numbers of workers were seen to have emerged before the flight.

Compared to 1986, in 1985 the first adult males and gynes were seen 1 to 2 weeks later, and in 1987 about 2 weeks earlier. The times at which these events occur can clearly vary annually by several weeks and probably depend on factors such as the seasonal temperature variation and the state of nutrition of the colony after winter.

We thus end with a picture of this species showing some variation in the timing of development from colony to colony within sample areas. It was not possible to conclude that there are any consistent differences between the sample areas that could be attributed to aspects of their management or environment.

16.3. Sexuals production by the colonies.

16.3.1. Previous records of **L. flavus** sexual production.

Data on sexual production in *L. flavus* is limited. Odum and Pontin (1961) and Pontin (1963, 1969) collected only the gynes from their sample nests. Pickles (1940) collected both males and gynes from his nests, although as he himself points out, not too much reliance can be placed on the figures. He collected male and gyne pupae from a very small sample of colonies which he dug up and examined. It is likely that this underestimated the numbers of sexuals, it being difficult to guarantee that all the pupae were in the excavated material, or that the efficiency of extraction was 100%.

The data from this study thus represents, as far as is known, the first set of figures on production of both males and gynes that has been published (Wright 1990).

16.3.2. Productivity of the individual colonies.

There is a wide range of production exhibited by the 35 sample colonies. In any one year, some colonies produced no sexuals at all, some colonies produced only gynes, and some only males. In 1985 the mean number of males produced by a colony was 688+/-114, with a range of 0 to 2,509. The mean number of gynes produced was 82+/-13, with a range of 0 to 362. In 1986 there was an increase in productivity. The mean number of males produced was 1,079+/-151, with a range of 0 to 3,565. The mean number of gynes was 193+/-33, with a range of 0 to 798.

In 1987 the highest number of males produced by a colony was 7,602. This was in MD 4A colony 3 and is the highest male production in any colony yet recorded anywhere (as far as is known). Because results in MD 4A were not obtained in the previous 2 years these results are not included in the following analysis. Thus the number of colonies in all the following analyses was 35. Excluding MD 4A the mean male production was 1,442+/-216 with a range of 0 to 5,190. For the gynes the highest production was again in MD 4A, 1,325 gynes in colony 5. Excluding MD 4A the mean was 195+/-32, with a range of 0 to 584.

Using the Wilcoxon sign test, the increase in the sexual production of both males and gynes was significant in 1986 (males: $P<0.03$, gynes: $P<0.01$) but there was no significant difference between 1986 and 1987 (males: $P>0.08$, gynes $P>0.86$). The 1987 production of males was significantly higher than 1985 ($P<0.01$) but the production of gynes was not ($P>0.22$).

Product moment correlations on the male and gyne productions from each colony were not significant in 1985 and 1986 (1985: $r = +0.215$ $P>10\%$, 1986: $r = +0.244$, $P>10\%$) but was in 1987 ($r = +0.465$, $P<0.05$, n

= 35 pairs in all cases). This indicates that only in 1987 (the year of highest overall productivity) was there a correlation between male and gyne production in the individual colonies.

Some, but not all, of the colonies seemed to maintain a similar pattern of production over the three seasons. Overall there was a significant product moment correlation between the numbers of males produced by each colony in 1985 and 1986 but not between 1987 and 1985 or 1986 There were no significant correlations between the gyne productions of the colonies in any of the years. The values of r are shown below. In all cases n = 35 pairs and P>0.05.

	Gynes			Males	
	1985	1986		1985	1986
1986	+0.248		1986	+0.351*	
1987	+0.095	+0.326	1987	+0.194	+0.065

* Significant correlation at the 5% level.

Oneway ANOVA was carried out on the production of males and gynes in the sample areas for each year. The results were as follows, with the values of F (with 6 and 28 degrees of freedom) being given for each of the analyses.

Year	Males	Gynes
1985	2.14	5.78***
1986	1.07	1.36
1987	3.24*	0.99
Total	1.72	0.73

* Significant at the 5% level

*** Significant at the 0.1% level.

Further analysis was done using the Minitab statistical package. This package generates a plot of the means and 95% confidence intervals of the different treatments (ie. sample areas) calculated from a pooled standard deviation, similar to that shown by Sokal and Rohlf (1981, p. 247). When the confidence intervals of the treatment means do not overlap they are considered to be significantly different.

By this method it was found that in 1985, gyne production was significantly higher in OWH C10 and MD 7B, than in the other sample areas, except OWH SS 4. OWH C10 and MD 7B represent two of the most lightly grazed of the sample areas.

In 1987 male production was significantly higher in AR 16 and MD 4B than OWH SS 11. AR 16 and MD 4B represent two of the heavier grazed areas. OWH SS 11 had not been grazed in the previous two and a half years.

There are thus effects of grazing on the production of males and gynes. However, the effects are somewhat different. 1985 was the year of lowest productivity overall and gyne production was higher in the more lightly grazed areas. 1987 was the year of highest productivity overall, and male production was higher in the heavily grazed areas.

Further analysis of the total productivity and the investment ratios in the rest of this Chapter may help explain this.

16.3.3. Head widths and dry weights of the sexuals.

One way ANOVA on the mean headwidths and dry weights of the males collected in 1985 gave significant differences between the sample areas (headwidths, $F = 4.28$, $P<0.01$, dry weights, $F = 5.589$, $P<0.01$). There was no such significant differences for the gynes (headwidths, $F = 0.995$, $P>0.05$, dry weights, $F = 0.526$, $P>0.05$).

Further analysis was done using the Minitab package as described above. Using this it was found that OWH C10 males were significantly different from males in the other quadrats. The difference between the males from this sample area and the rest was extraordinary. All of the samples of males from this area had larger mean dry weights than the largest from any of the other sample areas.

For the head widths, using the same procedure, it was found that the males from OWH C10 again stood out, having much larger headwidths than the other colonies. They were significantly different from all of the other male samples except MD 7B. Thus, the OWH C10 males are both heavier and larger than the males from the other areas sampled. This is an ungrazed and north facing area. MD 7B was a lightly grazed area in 1983-1985. Thus it appears that light grazing may be a factor in the production of larger males.

The other point that emerges from this analysis is that the males are far more variable in headwidth and dry weight than the gynes. Presumably the gynes need to be of a minimum size in order to be able to successfully establish a colony. It would be interesting to see if male size differences affect the sperm load that they carry. Would mating with a small male be a disadvantage to a gyne in the long term?

16.3.4. Sexual productivity in terms of energy.

Because estimates have been made of the energy content of samples of males and gynes (section 9.8) it is possible to calculate how much the colonies are producing in terms of energy. The ants on which energy content estimates were made were from more than one colony and thus give a mean value of energy content of the sexuals rather than a value specific for each colony.

In the ant species *L. niger*, closely related to *L. flavus* both in taxonomical terms and in sexual production, the gynes have been shown to need to reach a minimum weight before flight is possible. For *L.*

niger this weight was approximately 13 mg., although final weights were typically about 15 mg. (Boomsma and Isaaks 1985). From the dry weights of the *L. flavus* gynes that have been recorded in this study a minimum weight of about 8 to 9 mg is suggested, with final dry weights perhaps nearer to 10 mg. on average. Cases where much lower weights were recorded for the gynes, such as OWH SS 4, colony 3 and AR 16, colony 2, may well have underestimated the true final weight of the gynes that would have been produced.

Thus a mean weight value for the gynes of 10 mg. each was used to calculate the final sexual energy production of the colony. For the males the dry weights have been shown not to change significantly during the period as adults in the nest and so the dry weights of males as recorded from each of the colonies, was used for calculations of the energy of production. To estimate the sexual production in terms of energy for each colony, the number of gynes produced was multiplied by 10 mg. and then by 32.11 KJ/g and added to the weight of males produced multiplied by 23.097 KJ/g, to give a total figure. When the dry weight for males from a colony had not been obtained in 1985, the mean value of 0.33 mg. was used. This was done for each year 1985-7. The results are shown in Table XXXV. This calculation does make the major assumption that the dry weights of the males produced by each colony was consistent over the three years.

The production of each of the colonies was first analysed to see if it was related to the characteristics of the colonies mound. Product moment correlations showed no significant correlation between the total productivity over the three years and the diameter or height of the mounds, or the distance to the 1st three nearest neighbouring mounds (diameter; $r = +0.247$, $P>0.20$, height; $r = +0.281$, $0.10>P>0.05$,

Table XXXV.

Sexual production of the sample colonies in 1985-1987.

QUADRAT	NEST NO.	PRODUCTION (in Kilojoules) 1985	1986	1987	MEAN
OWH SS4	1	23.92	24.89	0.79	16.54
	2	43.87	118.51	65.62	76.00
	3	13.57	115.37	89.14	72.69
	4	25.12	193.71	93.88	104.24
	5	47.95	192.49	124.54	121.66
OWH SS11	1	38.16	72.15	0	36.77
	2	18.95	126.59	122.71	89.41
	3	1.57	62.57	74.39	9.58
	4	11.41	51.09	9.58	24.03
	5	0	9.63	0.08	3.24
OWH C10	1	27.26	106.34	18.15	50.58
	2	43.46	0	20.54	21.34
	3	121.10	29.21	107.68	86.00
	4	42.80	25.61	40.18	36.20
	5	72.63	147.83	151.97	124.14
AR 15	1	11.31	3.51	162.56	59.13
	2	21.85	88.82	204.52	105.06
	3	29.60	93.88	202.11	108.53
	4	0.32	7.31	27.82	11.81
	5	28.85	24.77	37.07	30.23
AR 16	1	32.64	74.50	50.52	52.55
	2	6.58	11.25	15.51	11.11
	3	22.37	152.58	156.27	110.40
	4	3.22	6.73	123.16	44.37
	5	0	46.21	160.45	68.89
MD 7B	1	46.87	0.02	9.08	18.66
	2	58.68	56.57	2.89	39.38
	3	56.11	270.09	29.46	118.55
	4	94.11	94.50	139.36	109.32
	5	68.68	63.08	13.96	48.57
MD 4B	1	10.22	29.01	17.75	18.99
	2	0.61	23.24	4.19	9.35
	3	20.59	97.77	183.57	100.65
	4	42.48	31.23	52.86	42.19
	5	26.17	9.91	3.53	13.21

The production of the colonies was assessed in terms of energy. Estimates, using a bomb calorimeter (section 9.8.) gave gynes as 32.11 KJ/g and males as 23.097 KJ/g. The dry weights used were measured for each colony in 1985. The gynes were assigned a dry weight of 10 mg each. Full details are given in section 16.3.4.

1st nearest neighbour distance; r = +0.176, P>0.20, mean of distances to the three nearest neighbours; r = +0.079, P>0.20).

However, in the mounds where worker population had been successfully estimated there was almost a significant correlation between the estimated worker population, from the first set of mark-release-recapture estimates, and the total production over the three years (r = +0.355, n = 26 pairs, 0.10>P>0.05).

One way analysis of variance was then performed on the data to look at the differences between the colonies from the seven sample areas. This was also done for the production in each year and for the summed production over the three years. The results are as follows.

Year	F.	Significance level
1985	6.26	P<0.01
1986	1.29	P>0.05
1987	1.24	P>0.05
Total	0.70	P>0.05

The 1985 data was then examined using the Minitab statistical package as described above. It was shown that the energetic production of OWH C10 and MD 7B was significantly different from all of the other sample areas, except OWH SS4. From Chapter Ten it will be recalled that OWH C10 was ungrazed, MD 7B only lightly grazed and OWH SS4 had not been grazed in the previous 4 years. Thus we have some evidence of increased sexual production in the more lightly grazed sample areas in 1985.

In the following years this distinction was lost. Overall production increased and was significantly higher in 1986 and 1987. Differences between the sample areas may only be emphasized at times of low production, which may correspond to generally worse environmental conditions.

16.3.5. Miscellaneous correlations. There were also a number of interesting correlations found in the 1985 data which reflect upon the internal organisation of the colonies.

There was a negative correlation between the number of males collected from a colony and the head width of the gynes found in that colony, (product moment correlation, $n = 29$ pairs, $r = -0.355$, $0.10>P>0.05$). This is likely to relate to the period of development as larvae, when it would seem that the males can compete successfully for the available food resources of the colony. There was no such correlation between the number of males in the colony and the final dry weight of the gynes, (product moment correlation, $n = 29$ pairs, $r = +0.2271$, $P>0.20$). As adults there is no competitive element, as the males receive little, if any, food.

There was also a correlation between the number of gynes collected from a colony, and the dry weight of those gynes, (product moment correlation, $n = 29$ pairs, $r = +0.4092$, $P<0.05$). This might indicate that the colonies able to provide enough resources to produce more gynes, are also better able to feed them after eclosion. There was no correlation between the number of gynes and their head width, (product moment correlation, $n = 29$ pairs, $r = +0.2071$, $P>0.20$). Head widths correlated well with dry weights in the males, (product moment correlation, $n = 30$ pairs, $r = +0.8756$, $P<0.05$), but not in the gynes, (product moment correlation, $n = 29$ pairs, $r = +0.221$, $P>0.05$). This reflects the different development of the two sexes. The dry weight and head width of the males are established during their larval development. They do not change weight to any great extent after pupal eclosure (see section 3.8.3.). In contrast, while the head width of the gynes is also established during larval development, their dry weight increases after pupal eclosion and any correlation may thus be lessened.

16.4. Sexual investment ratios of the colonies.

16.4.1. Sex ratios in social Hymenopterans.

In most species of sexually reproducing animals equal investment in male and female offspring seems to be the rule. Fisher (1958) explained this as the only evolutionary stable outcome of frequency dependent natural selection. Hamilton (1967) outlined the rationale behind this.

1) Suppose male births are less common than female.

2) A newborn male then has better mating prospects than a newborn female, and therefore can expect to have more offspring.

3) Therefore parents genetically disposed to produce males tend to have more than average numbers of grandchildren born to them.

4) Therefore the genes for male-producing tendencies spread, and male births become commoner.

5) As the 1:1 sex ratio is approached the advantage dies away.

6) The same reasoning holds if females are substituted for males throughout. Therefore 1:1 is the equilibrium ratio.

Animals that appear to diverge from this rule have been of great interest (Hamilton 1967 for example). Male biased sex ratios at birth have been found in a variety of mammals (Clutton-Brock and Alson 1982) but can be explained by differential mortality after birth. This means that males are, on average, more expensive to raise to maturity. In some reptiles, for example in Map Turtles, it has been found that environmental conditions of the newly laid eggs can determine the sex of the offspring, resulting in biased clutches of eggs (Vogt and Bull 1984).

The eusocial Hymenoptera show particularly biased sex ratios (Trivers and Hare 1976, Nonacs 1986). Kinship theory, as proposed by Hamilton (1964, 1967, 1972) has been used to explain this bias towards female investment. Hamilton (1972) has proposed that in some circumstances it is in the interests of the individual to invest in siblings or the offspring of siblings rather than breeding themselves. As stated by Boomsma (1988) "altruistic tendencies to invest in sibs or in their offspring are likely to evolve if the cost imposed by the loss in gene copies in own offspring is less than the gain in the offspring of sibs".

The haplodiploid system of sex determination (males being haploid and gynes and workers diploid, first shown in the genus Lasius by Bier 1958) confers particular stresses within the colony. The workers each carry half the genome of the queen and the full genome of their fathers. Thus, in monogynous colonies with singly mated queens, their genetic relatedness to each other, is on average 75%. As the gynes that are produced are also their sisters, the relatedness of the workers to the gynes is also 75%. The male offspring of the colony carry 50% of the genome of the queen only. Their relatedness to the workers is thus on average only 25%. The queen is equally related to the males and the gynes, with a genetic relatedness of 25% to both.

Trivers and Hare (1976) showed that as a consequence of this, if the workers were in control of the sexual production of the colony there should be a 3:1 sex ratio of gynes to males. This can also be expressed as a gyne investment ratio of 0.75, where:

$$\text{Investment ratio} = \frac{\text{Investment in gyne production}}{\text{Investment in male production + gyne production}}$$

In contrast, if the queen was in control a 1:1 ratio would be expected (investment ratio = 0.50). Trivers and Hare (1976) presented data to support this hypothesis, which can be termed the genetic relatedness hypothsis (GRH).

This data was subsequently critised by several authors. Notably, Alexander and Sherman (1977) proposed that the data was incorrectly analysed and could be explained by an alternative hypothesis, that of local mate competition (LMC). This hypothesis assumes that mating is non-random. In a restricted population of sexuals such as that produced by a single colony, it is only necessary for a queen to produce enough males to ensure that her own gynes are mated.

LMC has been confirmed to occur in species of non-social Hymenoptera, where there is such restricted mating. Fig Wasps, of a variety of species, have proved to be of particular interest. The degree of LMC occurring has been found to vary with the number of foundress wasps infecting the fig. As the number of foundresses increases, the degree of LMC decreases (Herre 1987). This was predicted by several theoretical studies (Charnov 1982, Herre 1985, Franz 1985). However, Boomsma (1988) concluded that the mating behaviour of the large majority of ant species does not satisfy the conditions needed for LMC to have a major effect. L. flavus is included in this large majority by virtue of its large mixed mating flights.

Meanwhile the theoretical aspects of GRH were being investigated. Population genetics models such as those of Oster et al (1977), Charnov (1978), Macnair (1978), Craig (1980) and Pamilo (1982) supported the conclusions of Trivers and Hare (1976). Nonacs (1986) then sought to reanalyse the data of Trivers and Hare (1976) and to include new data, to examine whether the hypotheses of LMC or GRH were supported. He concluded that on the whole more of the variation and patterns in ant sex ratios could be explained by GRH than by LMC.

Boomsma (1987, 1988, 1989) has since criticised the data analysis by Nonacs (1986). He points out that Nonacs (1986), as did Trivers and Hare (1976) before him, used dry weights of males and gynes in his estimates of cost ratios, and in some cases even fresh weights were used. This takes no account of variations in the energy content per unit weight of the two sexes or of differences in respiration rates of the two sexes during development. Boomsma (1989) also points out that the small sample size of many of the species considered may result in inaccuracies in the analysis.

In a thorough re-analysis of the Nonacs (1986) data and other new data (including some from this study) Boomsma (1989) estimated that the average sex ratio for monogynous ant species was 1.82:1 in favour of gynes, but both significantly different from 3:1 and 1:1. He concluded that sexual production was probably under worker control in these ant species, but that the frequent occurrence of multiple mating (Page 1986) and worker reproduction (Bourke 1988) affected the predicted sex ratio.

Boomsma (1987) emphasized that while the theoretical side of sex ratio work had advanced considerably over the past 20 years, the field data lagged behind. Good data sets for ant species would be valuable in helping test the theoretical framework that had been established. The data from this study provides just such a dataset.

16.4.2. The overall investment ratio of the colonies 1985-87. The investment ratios are calculated throughout this section from the formula given in section 16.4.1.

The total numbers of males and gynes produced by the colonies in each year are as follows.

Year	Total no. males	Total no. gynes
1985	24,078	2,885
1986	37,765	6,770
1987	50,472	6,630
Total	112,315	16,285

If the dry weight figures of 10 mg. per gyne and 0.33 mg. per male (see above) and the energy values of 32.11 and 23.097 KJ/g are used to calculate an investment ratio then the following figures are obtained.

Year	Investment ratio (final energy production)
1985	0.835
1986	0.883
1987	0.847
Total	0.858

These figures overestimate the ratio towards the gynes because no account has been taken of respiration rates of the two sexes. Male respiration rates are much higher per unit weight than gynes, as pupae and adults and possibly as larvae as well (Peakin et al 1985, 1989, Nielsen et al 1985). It is difficult to be precise about how the respiration rates of the sexes differ because of the variation throughout the period of growth and maturity. Figures of Peakin et al

(1989) and Nielsen et al (1985) would suggest that, at the least, male respiration is twice that of gynes over the period of pupae and adults in the nest.

It is thus important to take account of this, as was first suggested by Trivers and Hare (1976). They suggested a 25-30% correction to the male dry weights would be sufficient, if the dry weights alone were used to calculate the investment ratio. From the results of this study the ratios become as follows.

Year	Investment ratio (dry weights, males + 30%)
1985	0.795
1986	0.853
1987	0.810
Total	0.823

Boomsma and Isaacs (1985) examined the investment ratio of the ant L. niger, closely related to L. flavus. They concluded that a 25-30% correction to dry weight was adequate for species where there was little sexual dimorphism, but in the case of species such as L. niger where the sexual dimorphism is great, then a 50% correction would be more appropriate. L. flavus too shows great sexual dimorphism, similar to L. niger, and so a 50% correction was used. When this was done the investment ratios became;

Year	Investment ratio (dry weights, males + 50%)
1985	0.708
1986	0.784
1987	0.726
Total	0.745

The final ratios are highly dependent on several estimates of factors that are not precisely known, such as the estimates of gyne dry weight, which as has been explained are difficult to be precise on, and the degree of correction needed to compensate for male respiration differences. Final, flying gyne, dry weights would probably give the most satisfactory estimate.

Nevertheless, these data suggest then that populations of L. flavus on chalk grassland are typically far closer to a 3:1 investment ratio than a 1:1 ratio. This would suggest that the sexual production of the colonies is under worker control.

The ratio over the three years changes very little. The time series is too short to do any analysis of the effects of annual changes in environmental conditions (eg. mean annual temperatures) and the ratio.

16.4.3. The investment ratios of the individual colonies To calculate these the dry weights that were measured in 1985 for samples of sexuals from each colony were used, rather than the mean figures used in the calculations of the overall investment ratio. This was done in order to emphasize the observed differences between the colonies. Thus the number of gynes or males was multiplied by the dry weight mean recorded for the colony in 1985. Then the male dry weight was increased by 50% to calculate the ratio. The resulting investment ratios are shown in Table XXXVI.

The results show the considerable variation between colonies, both within and between years. While some colonies show a very stable investment ratio, for example colony 2 in OWH SS 11 had successive ratios of 1.00, 0.98 and 0.96, some colonies show great changes, for example colony 5 in MD 4B went from 0.32 to 0.06 to 1.00 over the three years. Is there any pattern to these changes?

A plot of the investment ratio of the colonies against their total production for each of the three years (Figure 16.1.) shows these big

Table XXXVI.

Gyne investment ratios of the sample colonies 1985-1987.

QUADRAT	NEST NO.	INVESTMENT RATIO 1985	1986	1987	TOTAL
OWH SS4	1	0.64	0.26	0	0.41
	2	0.88	1.00	0.53	0.82
	3	0.80	0.79	0.64	0.73
	4	0.85	0.91	0.70	0.84
	5	0.83	0.74	0.71	0.74
OWH SS11	1	0.56	0.69	---	0.65
	2	1.00	0.99	0.96	0.97
	3	0	0.90	0.89	0.88
	4	0.90	0.82	0.74	0.82
	5	---	1.00	0	0.98
OWH C10	1	0.82	0.59	0.21	0.57
	2	0.71	---	0	0.37
	3	0.92	0.65	0.89	0.87
	4	0.49	0.47	0.63	0.53
	5	0.91	0.92	0.94	0.92
AR 15	1	0.91	0	0.70	0.68
	2	0.90	0.89	0.83	0.85
	3	0.62	0.75	0.69	0.70
	4	0	0.84	0.84	0.83
	5	0.73	0.46	0.66	0.62
AR 16	1	0.99	0.78	0.41	0.68
	2	0.04	0.12	0.01	0.05
	3	0.30	0.81	0.56	0.64
	4	0.99	0.41	0.80	0.77
	5	---	0.87	0.86	0.86
MD 7B	1	0.84	0	0.20	0.69
	2	0.80	1.00	1.00	0.90
	3	0.79	0.89	0.33	0.81
	4	0.74	0.79	0.90	0.82
	5	0.51	0.66	0.77	0.60
MD 4B	1	0.30	0.81	0.27	0.50
	2	0	0.16	0.99	0.23
	3	0.09	0.71	0.75	0.66
	4	0.58	0.34	0.53	0.49
	5	0.32	0.06	1.00	0.28

The gyne investment ratio for each colony was calculated as described in section 16.4.3., based on the dry weights of the sexuals that were measured in 1985, with a correction factor of 50% to the males. The total column added the sexual production over the three years and calculated the investment ratio of that production.

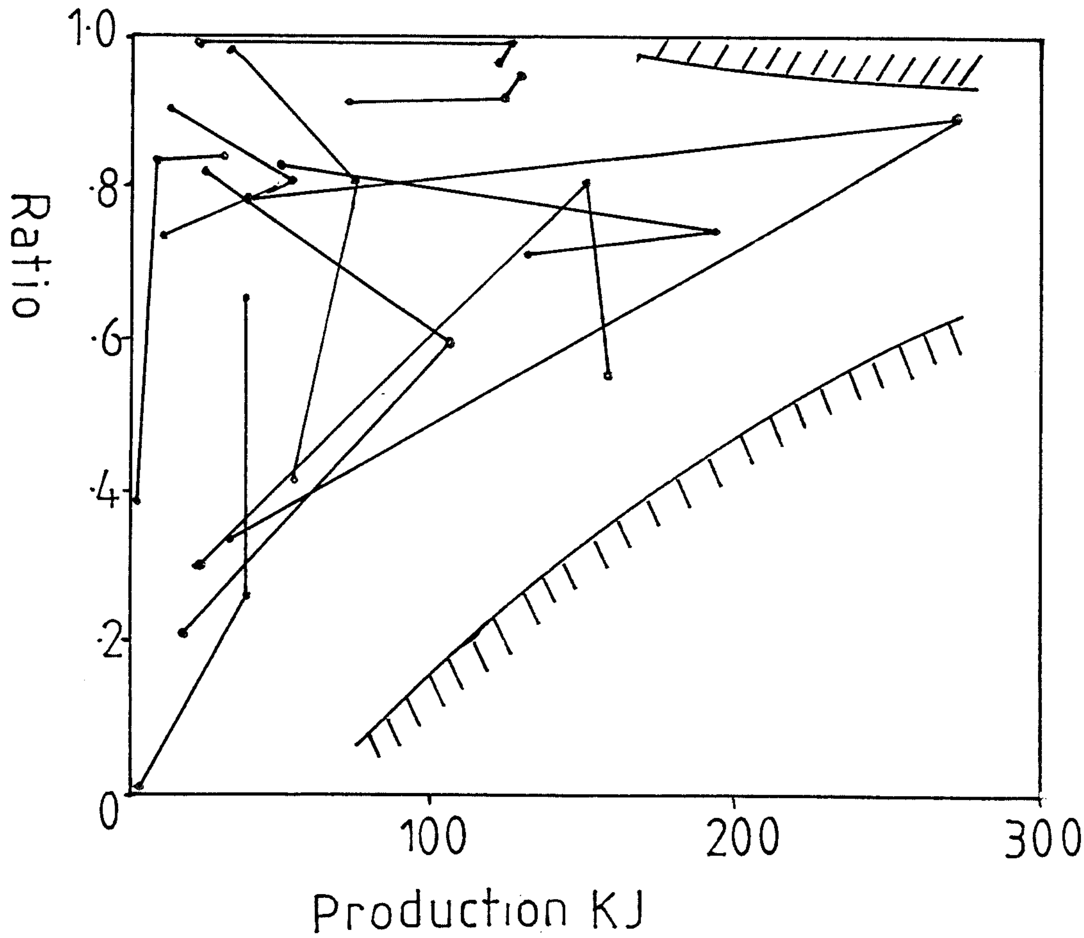


Figure 16.1.

Changes in productivity and investment ratios of the sample colonies 1985 - 1987.

Each line represent a single colony over the three years. To avoid too crowded a graph, only a representative sample of the colonies (selected at random) have been included (one third of the total).

The figures used are the gyne investment ratios from Table XXXVI and the total production in Kilojoules from Table XXXV. As productivity increases the investment ratio tends to converge to between 0.6 and 0.9.

changes. However, there is a clear tendency for the investment ratio to converge to between about 0.6 and 0.9 as the production increases. This pattern is very similar to that found in L. niger by Boomsma et al (1982) (see also Boomsma 1988). This pattern suggests that investment ratios tend to the 3:1 ratio (0.75) as productivity increases. A gyne investment ratio of 0.75 will be most frequently seen in high productivity colonies, ie. those in optimum conditions.

Histograms of the distribution of the ratios in each year and in total are shown in Figures 16.2, 16.3, 16.4 and 16.5. The pattern is similar in the three years and like that observed for a population of L. niger in a presere dune valley in Holland (van der Have, Boomsma and Menken 1988) and Formica spp. (Pamilo and Rosengren 1983). Colonies show a range from producing no sexuals at all, to producing only males or to producing only gynes. However, the majority of colonies are biased towards gyne production.

There was no correlation between the arc-sine transformed mean investment ratios of the colonies and their worker populations from the first set of mark-release-recapture estimates ($n = 26$, $r = -0.053$, $P>0.20$) or to the diameter, height or distance to nearest neighbours (in all cases $n = 35$, $-0.12<r<0.12$, $P>0.20$)

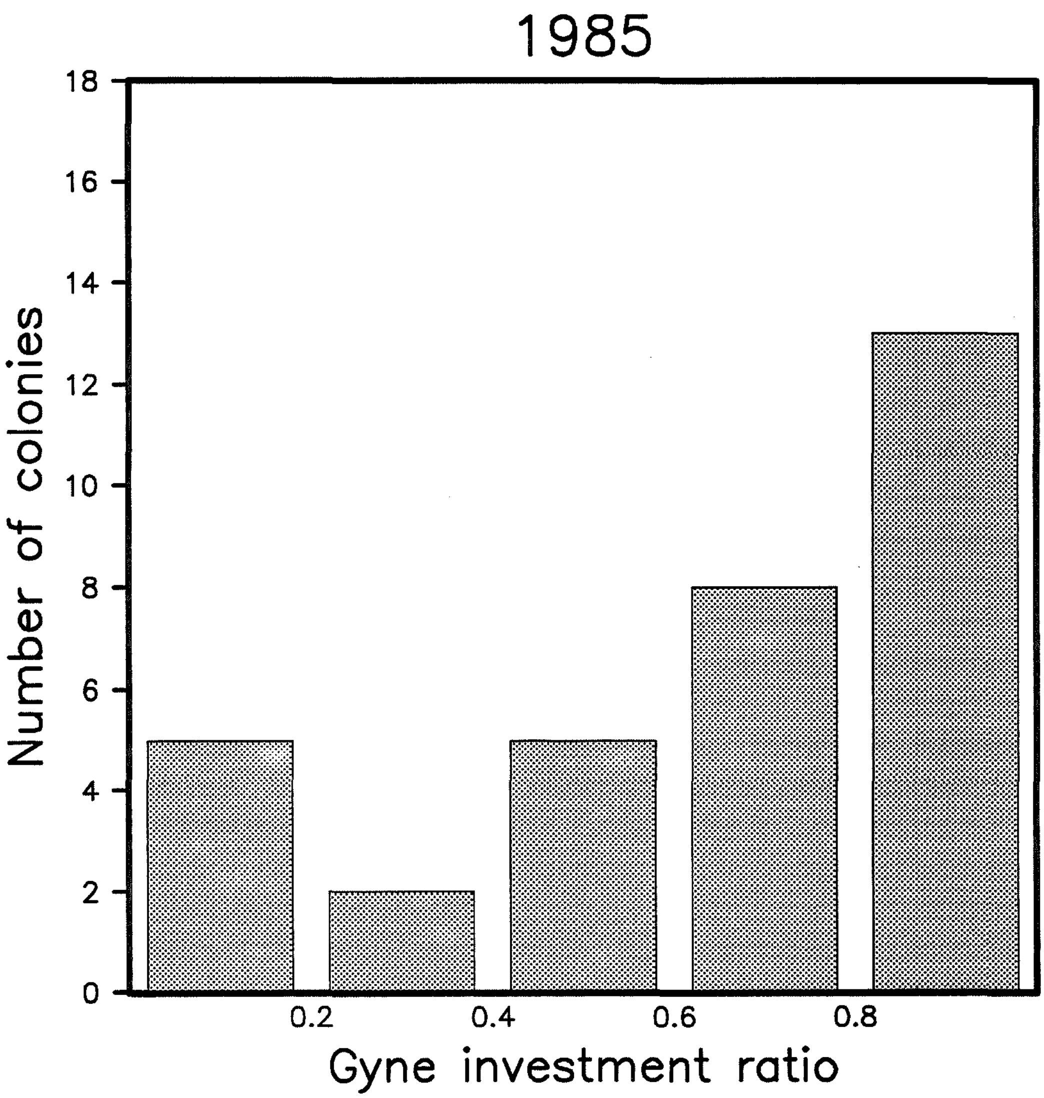
One way analysis of variance on the arc-sine transformed values, showed no overall significant difference between the sample areas in each of the three years.

Year	F	
1985	1.44	$P>0.20$
1986	1.39	$P>0.30$
1987	0.47	$P>0.15$

On the summed production, for the three years in each colony,

Figure 16.2.

Gyne investment ratios of the sample colonies in 1985.

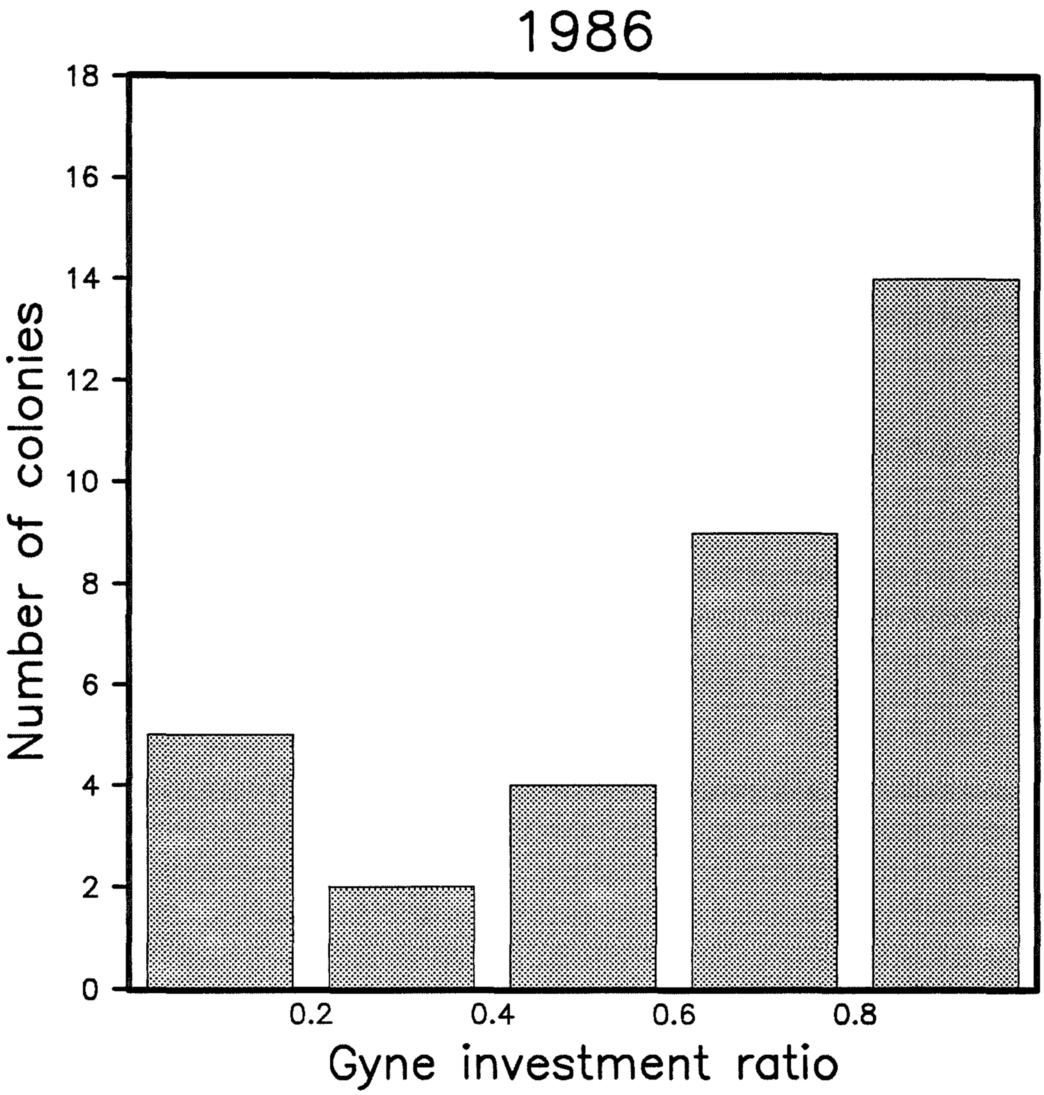


A total of 35 colonies were included in the analysis. The gyne investment ratio was calculated as described in section 16.4.3., based on the dry weights of the sexuals produced by each colony, with a correction factor of 50% to the males.

The investment ratios were divided into the groups, 0 - 0.2, 0.21 - 0.4, 0.41 - 0.6, 0.61 - 0.8, 0.81 - 1.00 and the number of colonies in each group is shown.

Figure 16.3.

Gyne investment ratios of the sample colonies in 1986.

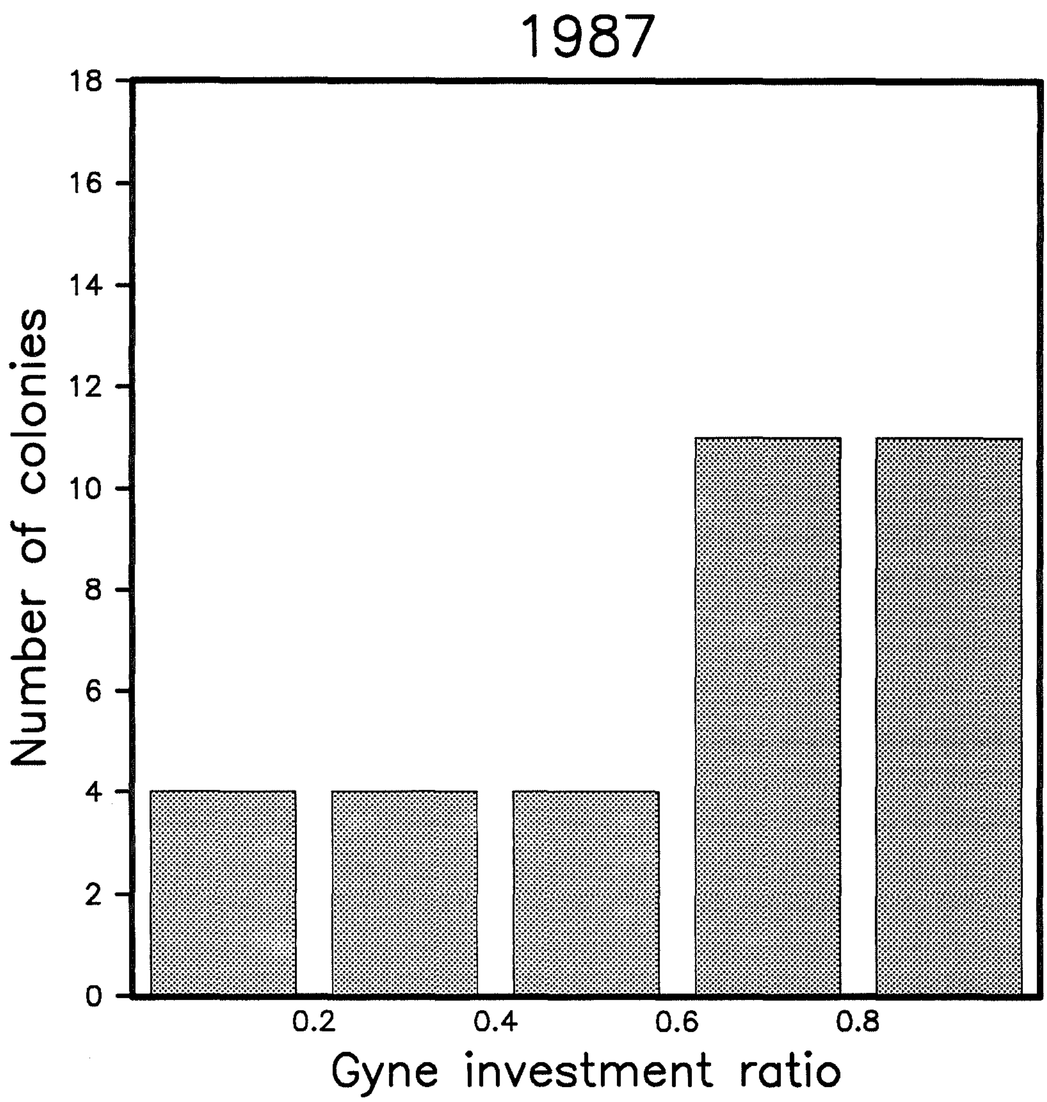


A total of 35 colonies were included in the analysis. The gyne investment ratio was calculated as described in section 16.4.3., based on the numbers of sexuals produced by each colony and the dry weights of sexuals measured in 1985, with a correction factor of 50% to the males.

The investment ratios were divided into the groups, 0 - 0.2, 0.21 - 0.4, 0.41 - 0.6, 0.61 - 0.8, 0.81 - 1.00 and the number of colonies in each group is shown.

Figure 16.4.

Gyne investment ratios of the sample colonies in 1987.

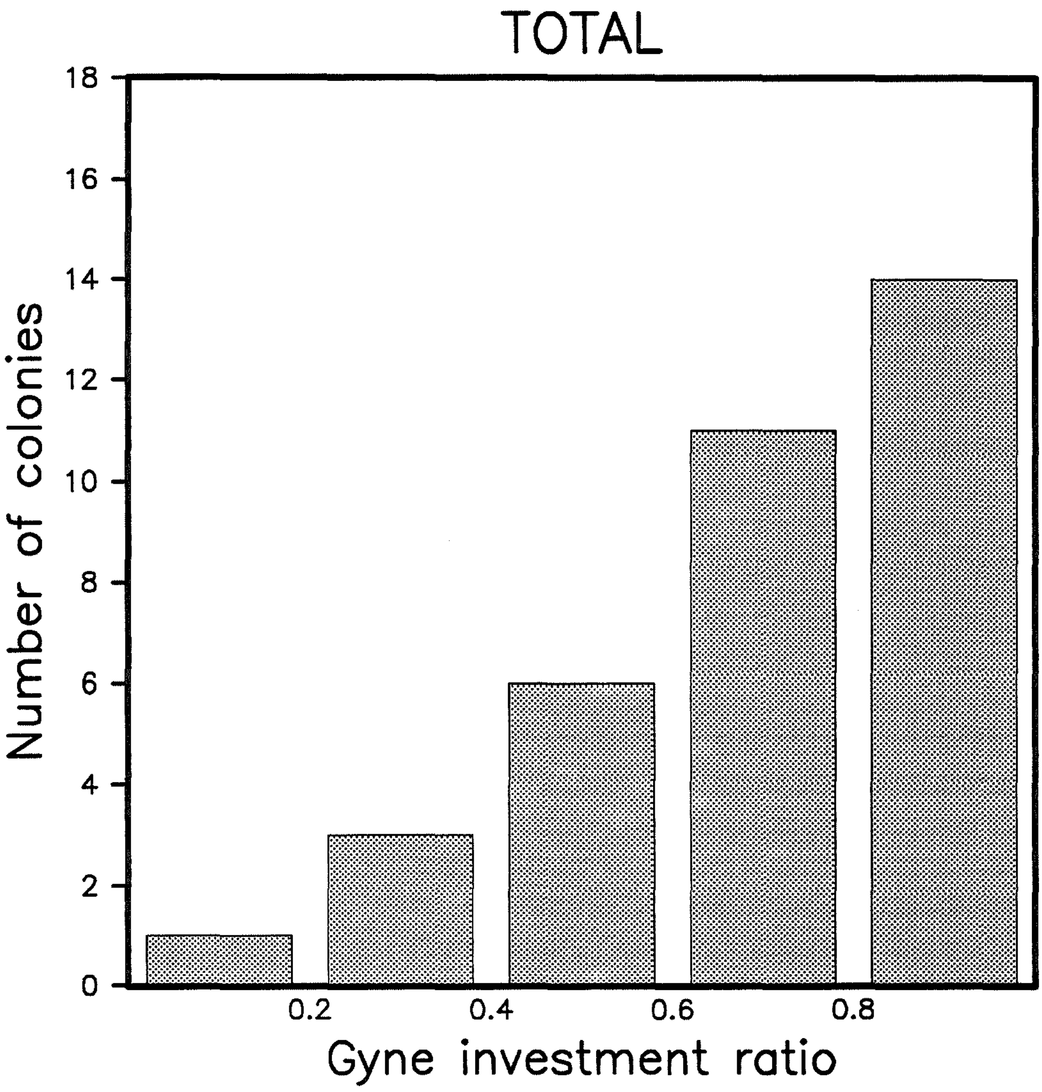


A total of 35 colonies were included in the analysis. The gyne investment ratio was calculated as described in section 16.4.3., based on the numbers of sexuals produced by each colony and the dry weights of sexuals measured in 1985, with a correction factor of 50% to the males.

The investment ratios were divided into the groups, 0 - 0.2, 0.21 - 0.4, 0.41 - 0.6, 0.61 - 0.8, 0.81 - 1.00 and the number of colonies in each group is shown.

Figure 16.5.

Gyne investment ratios of the sample colonies in 1985-1987.



A total of 35 colonies were included in the analysis. The gyne investment ratio was calculated as described in section 16.4.3., based on the total number of sexuals produced by each colony, over the three years, and the dry weights of sexuals measured in 1985, with a correction factor of 50% to the males.

The investment ratios were divided into the groups, 0 - 0.2, 0.21 - 0.4, 0.41 - 0.6, 0.61 - 0.8, 0.81 - 1.00 and the number of colonies in each group is shown.

there was a significant overall difference ($F = 2.71$, $P<0.05$). Further analysis, as described above, showed that OWH SS 11 was significantly different from MD 4B. Neither OWH SS 11 or MD 4B were significantly different from any of the other sample areas.

Sample area	Mean investment ratio over 3 years
OWH SS 4	0.71
11	0.86
C10	0.65
AR 15	0.74
AR 16	0.60
MD 7B	0.76
MD 4B	0.43

It is possible to see a reason for the large difference between the two areas in the management they have received. MD 4B had a consistently low ratio and was a hard grazed area while OWH SS 11 was not grazed at all over the period the sexuals were collected.

The same sort of pattern emerges for the areas as a whole. If we take the two areas on the south slope first, over the years the sexuals were collected OWH SS 4 was grazed each year and OWH SS 11 was ungrazed. OWH SS 11 had a higher investment ratio. At Aston Rowant, AR 15 was more lightly grazed than AR 16 and had the higher ratio. At Martin Down, MD 4B was much more heavily grazed than MD 7B. MD 7B had a much higher ratio.

OWH C10 somewhat goes against this pattern. An ungrazed area, it did not show as high a mean ratio as might might be expected from the consideration of the other sample areas. Possibly other factors are at work here and a more detailed study of this area would be necessary to indicate this.

16.5. The sexual flight.

16.5.1. Introduction. On 3/8/89 at Old Winchester Hill a nuptial flight of *L. flavus* and other ant species was observed. There are few detailed accounts of the sexual flights of L. flavus, although they have been frequently observed. As temperature records were being made during the flight it was possible to combine observations with known temperatures.

16.5.2. Myrmica spp. A few winged individuals of a Myrmica species had been observed throughout the afternoon. These turned out to be M. scabrinodis gynes. At 5.20 PM (BST) while on the top part of the reserve, a large number of winged Myrmica were seen gathering over a path, and alongside some tall shrubs at the side of the path. This path was located at the extreme southern end of the picnic area shown on the map in Figure 5.2. It was then observed that many of these, mostly males were landing on this path and running about, apparently searching for gynes. The estimated ratio of males to gynes was 10:1.

When a gyne was found copulation rapidly occured. More than one male could attempt to mate with the gyne, resulting in small "scrums" around a gyne. At 5.30 PM this process was occurring on a large scale with many hundreds and probably thousands of ants involved. At 6.35PM there were still apparently just as many of these ants in the same area, and this continued until 7.50PM when observation ceased. Thus this mating flight may have continued for longer.

The main swarm was found to consist of males of M. rubra and M. ruginodis. Only gynes of M. rubra were identified, but because of the smaller numbers of gynes, those of M. ruginodis could have been missed. Gynes and males of M. scabrinodis were not found.

16.5.3. **L. flavus.** The air temperature at the start of the nuptial flight was 22°C and at the end of it (7.50PM) 21°C. There was virtually no wind and there was 100% cloud cover.

Sexuals of L. flavus were first observed on the mounds in OWH NES at 6.15PM. Males and gynes emerged together from a small area of the south side of the mounds. The flight was so synchronous that although the first winged ants were seen emerging at 6.15PM. by 6.30PM virtually all mounds on the north facing slope had emerging sexuals on them. At this time it was estimated that there were approximately 3 males per cubic metre of air up to at least 5 metres high.

On emerging into the air the ants (both males and gynes) climbed as high as possible, onto grass stalks for example, and then took off. Both males and gynes appeared to fly virtually sraight up from the mound. At 6.30PM there were large numbers of sexuals in the air. On the north slope there appeared to be clouds of males drifting slowly down the hill. At 6.37PM the first dealate queen was seen.

At 7.10PM on the south slope sexuals were still emerging from the mounds. A the top of the south slope the density of males was estimated at up to 10 per cubic metre of air. At 7.15PM large numbers of dealate queens could be found. Brief examinations of grassland in OWH SS11 revealed 5, 6 and 6 queens in samples of approximately 1 square metre. At 7.30PM on the top of the south slope on a pathway 20 dealate queens were counted in under 1 m^2 of ground. The flight was virtually over at 7.15PM. At 7.30PM very few flying ants could be seen.

The air temperature during the flight was 22^{o}C. The average temperature on the surface of the south side of the mounds in OWH NFS when the flight began was 25.0^{o}C, at 10 cm. depth it was 23^{o}C. Cloud cover was 100% and there was almost no wind at all.

Several predators were observed to take the sexuals during the flight period. In the air a flock of Black Headed Gulls (<u>Larus ridibundus</u>) were present the whole time. Various other small birds were seen including Yellowhammers (Emberiza citrinella) and Linnets (Carduelis cannabina) but it was not clear whether these were taking the sexuals or not. Also, a few wasps (Dolichovespula spp. or Vespula spp.) were seen flying at about 4 metres high, but again it was not clear whether they were taking any sexuals.

On the ground both queens and males were being collected in appreciable numbers by workers of the ant Myrmica scabrinodis and some sexuals were attacked by L. flavus workers. Several Crab Spiders, Xysticus bifasciatus were seen to take both males and females. A queen was found in the web of a Garden Cross Spider, Araneus diadematus.

On leaving the reserve it was observed at 8.00PM. that in the valley below a flight of L. niger sexuals had also taken place. A winged L. niger gyne was also seen in London (at the start of the M1 motorway) at 10.00PM. Thus within a few hours on the same day flights took place of L. flavus, L. niger, M. rubra, M. scabrinodis and M. ruginodis.

16.5.4. Comments on these observations. The general events of flights of L. flavus are well known (Brian 1977 for example) but the precise details seem to have been seldom recorded. An exception to this is Boomsma and Leusink (1981). Hanks, Parsons and Lee (1980) have also recorded some observations on a flight. It is the amazing synchronicity of such large flights that needs to be explained. How do so many colonies over such large areas (up to and possibly larger than countywide in Britain) of several different species manage to all have their nuptial flights so close together?

Boomsma and van Leusink (1981) recorded details of the flights of L. flavus, L. niger, M. rubra and M. scabrinodis on a small Dutch Island near to Amsterdam, over 3 years. They concluded that there were two important factors in determining the time at which ant flights took place, firstly the light intensity and secondly the temperature.

All of the ant species would tend to fly when the air temperature was similar to the soil temperature, in the top few centimetres of soil. However, there was also a correlation between the global radiation and the size of the gynes of each species. The global radiation, ie. the light energy per unit area reaching the ground, determines how the individual gynes can warm up before starting to fly. This is clearly important for maximum flight efficiency. The larger ants have a smaller suface area to volume ratio and thus will absorb solar radiation less efficiently. It was not suggested by Boomsma and Leusink (1981), but it is also interesting to note that the large L. niger gynes are the darkest in colour of the 4 species, which would also aid solar radiation absorption.

Thus, the large L. niger gynes tended to fly at the highest levels of global radiation, followed by the slightly smaller L. flavus gynes and then the small Myrmica species gynes.

The observations of the flight at Old Winchester Hill partially support these conclusions. For the L. flavus flight no observations were made on the global radiation, but it was clear that this was not terribly high at the flight time due to the cloud cover. As regards the temperatures, at the start of the flight there was a difference of only 1 or 2 degrees in the mound and air temperatures. At the peak of the flight this was reduced to only 1 degree. Temperatures on the south slope were measured at 22^{o}C in the air and a mean of 23.2^{o}C in the top 1 cm. of soil on the south side of the mound. Earlier in the day at 3.00PM. the equivalent temperatures were 25 and 33^{o}C. Just before the flight began, in OWH C10 the differential was slightly higher, at 22 and 25.8^{o}C.

The Myrmica flights were underway in OWH C10 at this time, and the relevant temperatures were 22^{o}C in the air and 20.8^{o}C on the soil surface. Mymica ants do not normally make mounds in these areas and thus the temperature in the upper soil layer is equivalent to that of the upper regions of the nest. Earlier in the day when a few M. scabrinodis sexuals were seen the equivalent temperatures were 22 and 24^{o}C. Boomsma and van Leusink (1981) suggest that M. scabrinodis can fly at a greater range of times due to the greater range of its habitats, thus allowing the correct conditions to be found more frequently.

Collingwood (1979) states that copulation in M. scabrinodis occurs in the air. Thus this is probably the reason why none were found in the mating "swarm" of Myrmica spp. on the ground. The observations of the copulation of M. rubra gynes would suggest that the gynes are releasing a sex pheromone to which large numbers of males are attracted. However, this release may only occur when the queens are on the ground. Further observations and chemical analysis, comparable to that done on the Dufour gland secretions of the workers of these species (Attygalle et al (1983) would appear to be desirable.

No differences were observed between the sample areas. As far as is known, the nuptial flight took place in all of the sample areas at OWH at the same time. It is clear that differences in management and environment did not affect the timing of the flight.

16.5.5. Dates of other flights of **L. flavus.** Apart from the flight described above no others were observed in detail. However, dates of flights were recorded on site by the reserve Wardens, and other dates for other areas were noted. These are given below.

Location	Date
London	30/7/84
OWH	14/8/84
OWH	15/8/84
London	15/8/84
OWH	30/8/84
Hampshire (many areas)	17/8/85
London	28/8/85
London	9/9/85

The timings of flights recorded above falls within the periods suggested by Donisthorpe (1915) who said that adult sexuals are in the nest from June to September, but that the principal flight time is in August in this country.

16.6. Conclusions.

The data set obtained in this work has been adequate to determine some effects of management policy on the sexual production of the colonies, namely that intensive management is likely to reduce the total sexual production of colonies, and to reduce the sexual investment ratio of the colonies at the same time. It is also clear that larger sample sizes would be advantageous to show more clearly these relationships. No effects of management or environment on the phenology of sexual reproduction, from the laying of eggs, through to the sexual flight have been observed.

It has been noted in previous Chapters of this thesis, that the effects of management can only be detected over a long period, which makes short term experimentation of a limited value. However, it seems probable from these results that sexual production and the investment ratios could be used as a short term indicators of the well-being of colonies of *L. flavus*. The differences in investment ratio between OWH SS 4 and 11 suggest that over a period as short as 2 or 3 years, changes in the investment ratio may have occurred in response to changes in the management pattern. Pontin (1961, 1963) successfully used gyne productivity as a measure of the success of colonies, but it is clear that males need to be taken account of and that the investment ratio itself is an important indicator. Changes in sexual productivity and investment ratio over time, could be used as part of studies on the impact of management policy on L. flavus. Investment ratios and sexual productivty of individual colonies have been shown to fluctuate greatly over even the short period considered in this project. The investment ratio over the lifetime of the colony would be interesting to follow.

When considering these results we must acknowledge the possibility that all the observations and interference with these colonies might have affected them. During the collection of the sexuals and the worker samples for the population estimates, many workers were removed from, and lost to the colonies.

As the sexual production of the colonies increased during the period of the study it appears that the vitality of the colonies has not been adversely affected. The presence of the slates on the mounds may indeed have afforded them some advantage, due to the enhanced temperature regime provided.

CHAPTER SEVENTEEN

Further consideration of the physical environment of the sample areas.

17.1. Introduction.

The aspects of the physical environment that were investigated in only a limited number of the sample areas, were firstly the physical characteristics of the soil cores that were collected, and secondly the temperature regime.

17.2. The soil cores.

17.2.1. Water contents of the soil cores. The changes in water contents of the soil cores, collected at different times throughout the year, have already been graphed for each of the sample areas (see Chapter Ten).

A series of product moment correlations were carried out on the minimum and maximum soil core percentage water contents, recorded for each sample area and the ant population characteristics. The minimum and maximum soil core water contents appeared to reflect well the relative differences between the sample areas throughout the year. The correlation coefficients are summarised below. In all cases n = 8 pairs.

	Minimum water content	Maximum water content
Density of mounds	+0.525	+0.370
Diameter of mounds	+0.839**	+0.822*
Height of mounds	+0.730*	+0.671
Volume of mounds	+0.849**	+0.828*
Area covered by mounds	+0.784*	+0.710*

* Significant correlation at the 5% level.
** Significant correlation at the 1% level.

The size of mounds, measured by the maximum mean diameter and height and the mean volume, correlates well with both the maximum and minimum recorded water contents of the cores. The percentage area of the quadrat covered by the mounds also showed a significant correlation to both maximum ad minimum soil core water contents. The area covered by the mounds is a function of both the size and the density of the mounds in the sample quadrat. In all cases it is the minimum water content that shows the higher correlation.

It is known that L. flavus workers are sensitive to moisture conditions (see section 3.4.1.) and that chalk grasslands are prone to dry conditions (section 2.3.1.). It has already been demonstrated in Chapter Twelve that L. flavus populations are generally more dense on damp north facing slopes than on dryer south facing ones, and that their mounds are larger. In section 12.3 it was suggested that the damper conditions on north facing slopes allowed colonies more time in which to manipulate soil, with the result that more soil was 'thrown up' onto the mound. These correlations support this idea. In more moist areas, the mean mound sizes are larger.

The water regimes of the sample areas are clearly extremely important to L. flavus, both in terms of the sizes of mounds that are built and their density.

No significant correlations were found between the minimum or maximum water contents and the mean sexual production of the colonies in each of the sample areas, or the mean investment ratios of those colonies.

17.2.2. The soil core densities. No significant correlation was found between the mean soil core densities and the ant population characteristics of any of the areas (density, diameter, volume of mounds etc.). (In all cases using a product moment correlation,

$r<0.55$, $P>0.10$, $n = 8$ pairs). Soil densities were generally low compared to published figures (Cox and Atkins 1979) but as the top layer of vegetation and litter was not removed from the cores this would be expected.

However, the soil core densities could be related to the grazing intensity in the sample areas. At MD, the most intensely grazed area, MD 4B had the most dense soil cores and the lightest grazed area MD 7B, the least dense. At AR the cores from AR 16, the more highly grazed area, were slightly more dense on average than the cores from AR 15. A series of paired t tests on the data from each sample area (shown in Appendix Four) comparing the mean densities of the soil cores from each sampling date, did not show any significant differences.

At OWH, the heaviest grazed sample area over the last three years (SS 4) had the most dense soil cores. There was a significant difference between the mean density on each sampling date of the cores collected in SS 4 and those in SS 11 (paired t test, $n = 13$ pairs, $t = 5.74$, $P<0.0001$). SS 11 had only been grazed for one period in the four previous years. The lightest grazed area, OWH C10, had the least dense cores and was also significantly different from both SS 4 and SS 11.

These results suggest that more intense grazing will lead to increased soil core density. There are two reasons for this. Firstly, the vegetation at the top of the core and the litter layer are reduced by grazing. However, this is a small component of the total dry weight of the cores and no obvious differences were seen between the sample areas in this respect, except in OWH C10 which appeared to have a thicker litter layer than the other sample areas and had the least dense cores. Secondly, grazing and trampling of an area leads to soil compaction, a feature of grazing which has been demonstrated in a wide variety of studies in different ecosystems. (Cox and Atkins 1979).

Soil density also showed a significant correlation with the pH of the sample areas ($n = 8$ pairs, $r = +0.946$, $P<0.001$). This may be due to the more dense soils containing more raw chalk in them. This would give a higher pH and due to the density of the chalk particles, a higher core density. There was also a significant negative correlation between soil density and the maximum recorded water contents of the cores collected from each sample area ($r = -0.734$, $P<0.05$) and between the pH of the sample areas and the maximum recorded water contents ($r = -0.876$, $P<0.01$). These factors, water regime, soil density and pH seem to be closely related in this set of sample areas.

Water flow can be restricted by higher soil densities, due to the low proportion of pore space (Cox and Atkins 1979). Water flow can also be important in determining ion availability and the leaching of minerals, which also affects the pH (Cox and Atkins 1979). Thus it would seem that there are a set of complex interactions in soil, relating soil water regiimes, pH and densities in the sample areas. However, the most important underlying factor may well be the water regime of the sample areas and it is this which shows a close relationship to the ant mound characteristics.

In Chapter Twelve, the complexity of the relationships between soil depth, slope and the ant mound sizes of the sample areas was commented upon. Again, it may be the water regime of the sample areas which is the underlying factor of importance in relating these characteristics to the ant mound sizes.

In most of the sample areas there was a general trend for the density of the soil cores to increase in the Summer months, ie as the cores dried out. Density was greatest when the soil was at its driest.

This appeared to be due to soil shrinkage and the length of the soil cores that were collected also tended to decrease (see Appendix Four).

17.2.3. Conclusions. The water regime of the sample areas, as measured by the minimum and maximum percentage water contents of soil cores, is significantly correlated with the characteristics of the ant mounds in the sample quadrats. Soil core density was also significantly correlated to the maximum water contents of the soil cores, but was also affected by the grazing intensity of the sample areas.

17.3. The temperatures of the sample areas and the ant mounds.

17.3.1. Past investigations of ant mound temperatures. A review of the literature on mounds of *L. flavus* reveals that the temperatures attained on and in them have been investigated on five previous occasions (Steiner 1929, Richards and Waloff 1954, Cloudsley-Thompson and Sankey 1958, Haarlov 1960 and King 1977a).

The most extensive study of mound temperatures has been by Steiner (1929). Temperatures of the nests of four ant species which build soil mounds were measured (*L. flavus*, *L. niger*, *Formica fusca* and *F. exsecta*). Temperatures were also recorded in nests built under stones by *L. flavus*, *F. fusca*, *Manica rubida* and *Myrmica ruginodis*. Temperatures were recorded throughout the day on a sample of nests in July and August in 1924 to 1928.

The conclusions of Steiner (1929) were summarised by Dumpert (1981). The raised level of the mound meant that it received "three times as many sunrays" as surrounding flat ground. The temperature under the top of a soil ant mound was 3 to 7°C higher than surrounding ground. The ant hill, being more exposed, cooled quicker than flat soil in windy conditions.

Nests under stones appeared to maintain the same temperature advantages as those in mounds. Three factors are important in determining the advantage given by the stone:

1) The greater absorption of heat by the stone as it is raised above the soil surface.

2) The greater heat conductability of the stone compared to the soil.

3) A higher heat capacity (this is largely dependant on the moisture content). This means that the stone have a slower rate of heat loss compared to soil.

Amongst species which nest both under stones and in mounds the stone nesting habit is usually found in higher mountain sites. Stones have advantages over mounds in this area because:

1) Moisture level tends to increase at altitude. Stones lose less heat than soil when they dry out.

2) Winds are stronger and more frequent leading to cooling of the mound compared to soil.

3) When a mound freezes it requires to lose heat to warm up (enthalpy of fusion), whereas a stone warms up immediately.

Cloudsley-Thompson and Sankey (1958) recorded the temperatures and humidities of 9 ant mounds over 2 days during a student field course. Temperatures were recorded in the shade on the surface of the mound and at 1, 5 and 10cm. depth. In all cases mound temperatures were higher than corresponding temperatures in the surrounding soil, on the surface by as much as 10°C.

King (1977a) merely recorded a few spot temperatures as illustrative of the stress plants face when growing on the surface of ant mounds. Temperatures of over 40°C were found on bare patches of soil on the south facing sides of mounds on days when the air temperature was over 21°C. These high temperatures were reduced when there was vegetation present on the mound. For example, 1cm. under bare soil a temperature of 36.3°C was recorded while, 2 or 3 cm. away, under vegetation, the temperature was only 26 to 27°C.

Richards and Waloff (1954) again merely recorded a few spot temperatures. They found that at a time when the air temperature was 25.5°C and the ground temperature was 32.5°C, a bare patch of soil on an ant mound was 39.9°C. This was important because the particular species of grasshoppers that they were studying showed a distinct preference for laying eggs in such warm and bare patches of soil.

Haarlov (1960) recorded temperatures from the north and south facing sides of Danish ant mounds from level pasture land for 17 continuous months in 1942 and 1943, with temperatures measured every 3 or 6 days. Maximum temperatures on the south facing side of the mounds were 44°C and on the north side 29°C. The large amount of data that he collected is only briefly discussed. However, Haarlov (1960) notes that during the whole time of the study (excepting January and February) the south side of the ant mound was able to attain a temperature above that of the air at some time during the day, due to the insolation. Temperature fluctuations (the difference between maximum and minimum daily temperatures were noticeably much greater on the south side of the mounds than on the north side or the surrounding level pasture land.

The current study both supports the conclusions of these previous authors and adds to them. It is by far the most extensive study so far done and enables the temperature regime of the mounds to be studied throughout the year in areas with different environments, namely on grasslands with different aspects in which we might expect the importance of the mounds as solaria to vary.

17.3.2. The ant mound temperatures summarised.

The data collected have been presented in the results section for each of the 10 quadrats examined as annual mean temperatures at the 4 times during the day. The collecting of this data into one overall graph, taking the means of all the data sets is shown in Figure 17.1.

As expected the highest mean temperatures were found on the south side of the mounds in the top 1 cm. of soil. The temperature of the top 1 cm. of soil on the north side of the mound and that of the surrounding non-mound soil are very similar. At a depth of 10 cm. the highest temperatures are again found in the south facing side of the mound and the temperatures of the north side and the non-mound soil are again very similar. All temperatures at 10 cm. are lower than the corresponding surface temperatures except for the 6.00PM south side temperature which is slightly higher than the north side surface temperature.

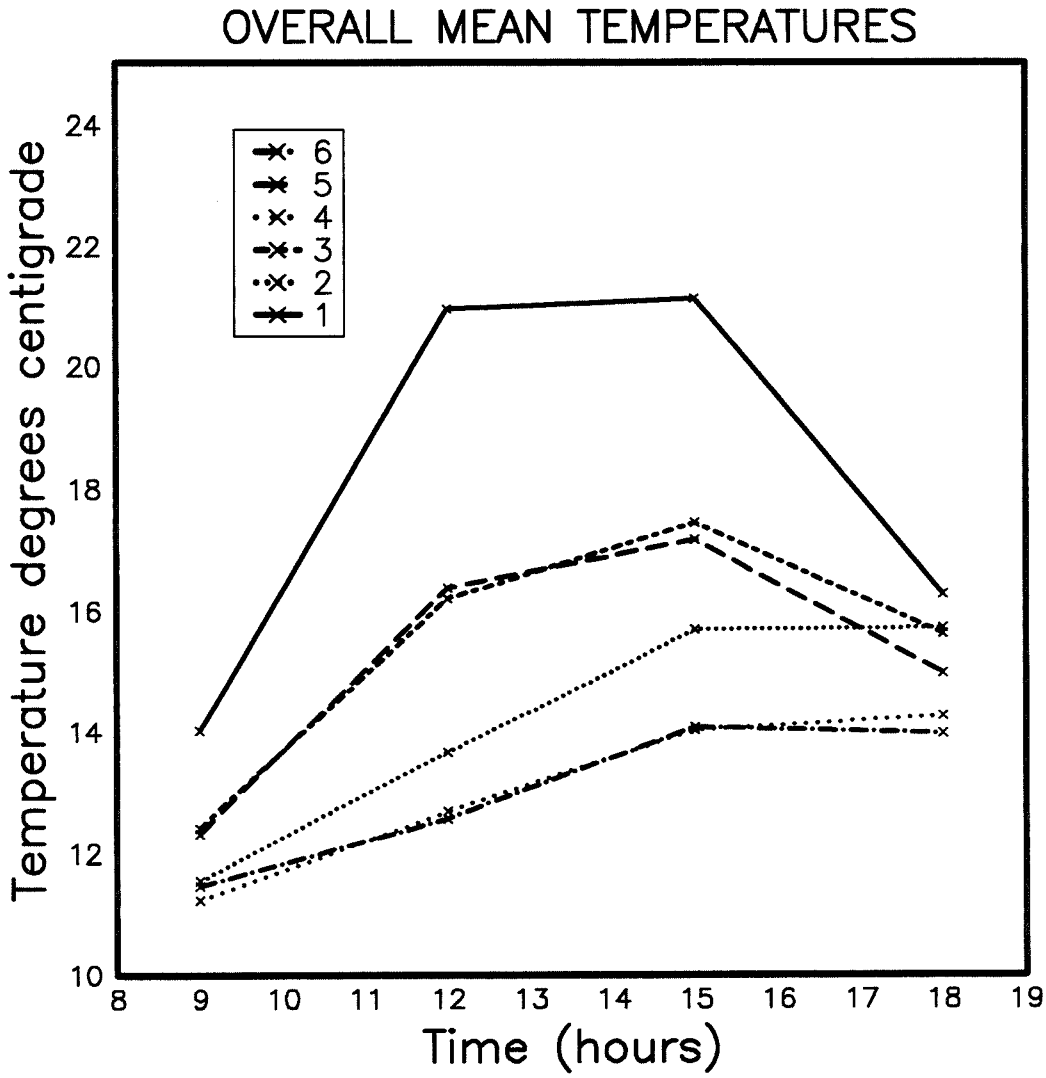
The convergence of the lines in Figure 17.1. at 9.00AM and 6.00PM indicates that the enhanced temperature regimes, made available by the mound, only last during daylight hours. At night the temperatures in all the locations measured tend to converge. However, between 12.00NOON and 3.00PM the south surface of the mounds enjoy a temperature advantage of over 3^{o}C on average above the surface of the north side of the mound and the surrounding soil.

Observations indicate, though, that the surface galleries of the mounds are abandoned by the worker ants when temperatures over about 19 - 20^{o}C are reached. In comparison, when given a choice, the ant L. niger places brood at temperatures of 23 - 24^{o}C (Boomsma and Isaaks 1985). The movement of L. flavus at lower temperatures may be due to

Figure 17.1.

Summary of the annual mean temperatures of ant mounds.

The mean annual temperatures at four times of day are shown. Times are British Summer Time. In the table below the graph, the mean figures are shown.
1 - 6 refer the locations as follows.
1, south side of mound, top 1 cm. of soil. 2, same location 10 cm. deep. 3, north side of mound top 1 cm. of soil. 4, same location 10 cm. deep. 5, ground, top 1 cm. of soil. 6, same location 10 cm. deep.



	1	2	3	4	5	6
9.00	14.0	11.6	12.4	11.2	12.3	11.5
12.00	21.0	13.7	16.2	12.7	16.4	12.6
15.00	21.1	15.7	17.4	14.0	17.2	14.1
18.00	16.3	15.7	15.6	14.3	15.0	14.0

The temperature raw data is given in Appendix Eight. The methods are further explained in section 7.3.2. Each point represents the mean of the means from each sample area. The individual sample area results are shown in Chapter Ten.

the ants being unable to tolerate such high temperatures, or possibly the drying out of the soil that occurs in these conditions may be the primary cause. The worker ants (and brood and sexuals when present) will then be found in galleries deeper within the mound. Thus the temperatures recorded at 10 cm. depth may give a better reflection of the typical temperature advantage that the ants themselves receive.

At 9.00AM there is little if any advantage at 10 cm. depth in the south side of the mound compared to the surrounding soil. However, at 12.00NOON the advantage is on average about $1^{\circ}C$, at 3.00PM about $1.6^{\circ}C$ and at 6.00PM over $1.7^{\circ}C$.

This may not seem a great deal but if the increase in respiration and metabolism that could be provided by such conditions is considered it becomes more significant. Studies on the respiration of L. flavus by Jensen and Nielsen (1975), Nielsen et al (1985), Peakin et al (1985) and Peakin et al (1989) have established that the Q10 for the respiration rate of worker ants, sexual brood and larvae and adults at this type of range of temperatures is at least 2.0 and often higher. Thus a simple $1^{\circ}C$ rise in temperature would result in a significant increase in respiration and presumably a significant effect on the time to maturity of all types of brood. Many of the workers would, of course, often be foraging away from the main centres of increased temperature and would not benefit as greatly.

The highest individual temperatures were recorded on the south facing sides of mounds that had had a large amount of soil thrown up on them by the worker ants. The bare soil was much warmer, when the sun was out, than similar parts of mounds covered by vegetation (cf. King 1977a). Covering vegetation acts as an insulating layer on the mounds. It both insulates from direct sun and will keep heat in the mounds when outside conditions are cooler.

The highest temperature recorded was one of 55°C in the top 1 cm. of soil on the south facing side of a mound in OWH C10 at 3.00PM on 23/6/89. These details are important because we can associate this record with the hottest part of the day at a time of year only 2 days away from mid-summers day (21/6) when the day is longest, thus giving a longer period for warming up during the day, and also when the sun is at its azimuth. The mean temperature of the top 1 cm. of soil of the south facing side of the mounds in the quadrat at that time, was also the highest recorded, at 46.6°C.

In comparison, the mounds in OWH SS11, at the same time as these figures were recorded, had a mean temperature of 33.4°C on their south facing sides in the top 1 cm. of soil. These mounds retained a substantial covering of vegetation which insulated them from these extreme temperatures.

The lowest temperature recorded on the mounds was -2.0°C also in OWH C10 in the top 1 cm. of soil, also on the south facing side of the mound, on 30/11/89 at 9.00AM. At this time the mean temperature of the mounds in this quadrat was only -1.0°C on the south facing slope surface and the mounds were frozen also at a depth of 10 cm. The lack of insulating vegetation had allowed the loss of heat by radiation in cold air temperatures. The vegetated north sides of the mounds in this quadrat were also frozen at the surface but were well above zero (3.0°C) at a depth of 10cm, here the vegetation acting to partially insulate the north side of the mound.

17.3.3. <u>The individual quadrats.</u>

17.3.3.1. <u>The ground temperatures.</u> As would be expected the coolest areas, on mean annual temperatures, are the north facing slopes. Taking the mean annual 3.00PM temperatures at 10 cm. depth as representative of the the temperatures the ants would experience, then the four coldest areas are AR 15, AR 16, MD 3B and OWH C10, the four north facing areas. The mean temperatures in degrees centigrade are given below.

OWH SS 4	16.2^{o}
OWH SS 11	15.5^{o}
OWH NFS	13.5^{o}
OWH C10	12.7^{o}
AR 15	12.7^{o}
AR 16	12.8^{o}
MD 7B	13.4^{o}
MD 4A	13.8^{o}
MD 4B	13.4^{o}
MD 3B	13.3^{o}

The hottest areas by this criterion are the two OWH south slope areas, SS 4 and SS 11. The more level areas at MD lie intermediate to these extremes. Aspect is clearly important in determining the temperature regime of the sample areas. A Spearman rank correlation gave a significant negative correlation between the mean temperatures shown above and the density of ant mounds in the sample quadrat from each of these areas ($r = -0.87$, $P<0.01$). A Spearman rank correlation between the temperatures recorded above and the minimum soil core water contents of the 8 sample areas in which both results were obtained, was almost significant ($r = -0.727$, $0.10>P>0.05$, $n = 8$ pairs).

Ants are highly dependent on adequate temperature regimes for survival and L. flavus is no exception. However, the results of this study indicate that, on chalk grasslands in the locations studied, higher ground temperatures are, in fact, a disadvantage. This is again related to the water regimes of the sample areas. Hotter areas on chalk grasslands are drier areas and the importance of the water regime has already been indicated. The cooler areas have less hostile water regimes and are able to support more dense ant populations.

17.3.3.2. The mound temperatures.

Old Winchester Hill

The sample areas on this reserve provide a good example of the effect an ant mound can have on changing the temperature regime available to an ant colony.

On ground temperatures OWH C10 is on average cooler than the OWH south slope quadrats. From the top 1 cm. of soil, OWH C10 is about 2.9 to 4.0°C cooler at 9.00AM, 4.8 to 5.2°C at 12.00NOON, 4.0 to 4.6°C at 3.00PM and 2.1 to 2.3°C at 6.00PM. At a depth of 10 cm. in the soil the corresponding differences are 1.5 to 1.8°C at 9.00AM, 2.2 to 2.7°C at 12.00NOON, 3.0 to 3.5°C at 3.00PM and 2.9 to 2.4°C at 6.00PM.

Having considered these figures it is then interesting to note that the ant mound figures do not correspond to this pattern. On the south side of the mound in the top 1 cm. of soil the corresponding differences are, at 9.00M 3.7 to 4.5°C cooler, at 12.00NOON 0.9 to 1.1°C warmer at 3.00PM 2.1 to 2°C warmer and at 6.00PM 0.5 to 0.6°C warmer.

Table XXXVII further illustrates this point. In this Table the differences between the south side mound temperatures and the corresponding ground temperatures at 3.00PM on all the sampling dates are shown for OWH C10 and the south slope quadrat OWH SS4 (OWH SS11 could equally have been used).

This Table illustrates the comparatively small differences in temperature between ground and mound in SS 4 compared to those in OWH C10. Again the 10 cm. depth figures are probably more relevant to the ants, although the 1 cm. figures do illustrate how large a difference

Table XXXVII.

Summary of the temperature differences measured between the south facing side of ant mounds and the surrounding ground in two quadrats at Old Winchester Hill, from measurements taken at 3.00PM.

	OWH SS4		OWH C10	
date	top 1 cm.	10cm. deep	top 1 cm.	10 cm. deep
15/3	0.2	0.6	3.4	1.6
19/4	1.4	1.4	4.6	3.4
10/5	0.6	1.8	3.6	2.8
24/5	0.6	0.0	7.0	7.8
7/6	2.6	0.6	6.2	2.2
23/6	1.2	1.8	22.0	8.8
19/7	-5.6	-0.2	17.0	7.0
3/8	1.8	0.2	8.0	3.0
23/8	-3.0	0.8	19.6	7.2
27/9	-0.2	0.8	3.4	3.0
30/11	7.0	2.4	-0.2	-2.8
18/1	3.4	1.0	-0.4	-3.0

Temperatures recorded in degrees centigrade. The figures represent the mean reading from the south side of the mound minus the mean reading from the ground. Thus a negative figure indicates that the temperature on the south side of the mound was below that of the soil.

The raw data for the temperatures is contained in Appendix Eight.

there can be between ground and mound at times (up to 22°C on 23/6/89). The south slope mounds lie in an area which by virtue of its topography is already a very warm area. The smaller vegetated mounds are not as effective solaria as in OWH C10, but they do not need to be. It is also interesting to note that the largest differences in OWH C10 occur between June and August, a time at which the brood are in a critical stage of developement, reaching maturity as larvae, pupating, eclosing and for the gyne larvae being 'fattened up'.

Thus the ant mounds have managed to be so effective in acting as solaria that for a large part of the day they have completely succeeded in changing the temperatures available to the ants in OWH C10, from on average, cooler than mounds situated on south facing slope, to equal in temperature or warmer. It is possible that this attribute of the mounds is partially responsible for allowing such a large population of ants to develop in this area.

In contrast to the south side of the mounds, the north side of the mounds were on average colder than the south slope mounds. The vegetation cover and aspect lead to this side of the mounds being cooler than the comparable north sides of mounds on the south facing slope.

On several occasions in both SS4 and OWH C10 it will be noted that the mounds are cooler than the ground. In OWH SS4 this occurred particularly on 19/7/89 when conditions were windy. The breeze acted to cool the mounds in comparison to the ground by introducing a wind chill factor.

In OWH C10 mounds were cooler than the ground on 30/11/89 and 18/1/90. On both of these occasions the mounds remained at or close to freezing all day long. The sun did not penetrate into this area on either of these occasions and so there was no chance of warming up. The mounds in freezing conditions radiate heat out and thus stay cooler than the ground. These observations concur with those of Steiner (1929).

OWH NFS is intermediate to OWH C10 and the south slope quadrats. It was not as sheltered or shaded as C10 but as a north facing slope the ground temperatures were not as warm as the south slope. The mounds which were larger than, and had more bare soil than those on the south slope, again reached comparable temperatures, on average, on the south side.

Aston Rowant

At Aston Rowant the two sample areas examined, AR15 and 16 show no consistent differences in either temperatures of the mounds or of the ground. Both areas have a similar aspect and lie close to each other and thus have a very similar physical environment. The mounds are larger in AR 15 but this clearly is not significant in this case. We cannot use temperature differences to explain the different characteristics of the ant populations in the two quadrats, but the importance of management has already been noted.

Martin Down

There is little to choose between the Martin Down sample areas in terms of ground temperatures, when they are expressed as annual means. The variation between the sample areas is small and not consistent, compared to that at Old Winchester Hill for example. MD 3B despite being on a north facing slope is still quite open and exposed to the sun and there is no south facing slope to compare it with. The other areas are essentially on level ground. The recorded air temperatures in MD 3B were on average slightly lower than in the other Martin Down sample areas, perhaps due to increased altitude and greater mean wind speeds. The ground temperatures are also slightly lower.

The most striking feature of the data from this site is the rapidity with which the south sides of the mounds in MD 7B warmed up in the early part of the day. At 9.00AM the mean annual temperature for the top 1 cm. of soil of the mounds is 16.3°C, which is in fact the warmest, at this time of day, of any of the sites at which temperatures were recorded.

How is this explained? This was not a naturally warm location such as the south slope at Old Winchester Hill. There are two possible reasons for this feature of MD 7B. Firstly, in this sample area we can recall that the light grazing regime has led to a tall grass habitat leading to some shading of the mounds (See section 10.19.4.). As a consequence of this the worker ants were, as in OWH C10, throwing up large amounts of soil on the surface of the mounds, leading to the formation of bare patches of soil on the south facing side of the mounds. As already noted, such bare patches will warm up much more readily than vegetated surfaces. This feature means that the mounds in this sample area are the warmest at Martin Down at 9.00Am and 12.00PM for the top 1 cm. of soil on the south side of the mounds.

At a depth of 10 cm. in the south side of the mounds MD 7B recorded the coldest mean temperature in this location of the Martin Down sample areas at 9.00AM. This is probably due to radiation of heat out from the uninsulated bare soil during the night. In contrast, at 12.00NOON, MD 7B had the warmest mean annual temperature, as a consequence of the heat, resulting from the faster warming of the bare soil patches, being conducted down into the mound.

A second reason for the higher early morning mean temperatures is the physical location of the site. The sample areas MD 4A and particularly MD 4B are shaded from direct sun for longer in the morning than MD 7B by the chalk escarpment lying to the south of them. MD 3B lying on the north side of this escarpment also has a delay in receiving direct sunlight in the morning. The extent of the delay depends on the time of year.

The mounds in MD 3B were able to compensate for the slightly decreased ground and air temperatures in this location. The mounds in this sample area were the largest on average at Martin Down. The mean temperatures of the their south facing sides were similar to those of the mounds in the other sample areas on the reserve.

17.3.4. Conclusions.

Areas with hotter temperature regimes on the chalk grasslands studied, tend to have less dense ant populations, with smaller mounds. This is due to the less favourable water regime associated with these areas. However, the larger ant mounds in the cooler areas are more effective in providing an enhanced temperature regime. There is a larger differential between ground temperatures and those of the south sides of the ant mounds, in the cooler areas, such as OWH C10, than in the hotter areas, such as the south slope at OWH.

CHAPTER EIGHTEEN

Further consideration of the biological environment of the sample areas.

18.1. Introduction.

This Chapter considers two aspects of the biological environment of the sample areas, firstly the flora and secondly the invertebrates that were extracted from the soil cores collected from the sample areas.

18.2. Analysis of the flora, the cover-abundance data.

18.2.1. The analysis of the data. For the same reasons that were discussed in section 13.1.2., it was decided to produce an ordination, using the cover-abundance data collected for the subset of sample areas. The steps followed in the production of this ordination, were the same as for the first ordination, except for the following variations.

1. For each of the sample areas there were the results of the examination of four 1 m^2 quadrats. Each of the species present in each quadrat has a Domin scale number according to its cover-abundance. To condense this data for the analysis, the mean Domin number for each species in each sample area was calculated. These are the figures used in the calculation of the similarity indices between the sample areas. The raw data and mean Domin numbers are given in Appendix Nine.

2. The similarity index used was that of Czekanowski (1909). This was recomended by Whittaker (1978) as suitable for such data.

$$IS = \frac{2(MC)}{MA + MB} \times 100$$

MA = Total cover of species in Sample A
MB = Total cover of species in Sample B
MC = Total cover of species found in both Sample A and Sample B, using the lowest figure from the two samples.

An example of how this formula is used is given in Barbour, Burke and Pitts (1980).

3. The matrix of IS values so generated was treated in the same way as those for the first ordination. Because there are less sample areas though the process was correspondingly quicker. Thus, first, a matrix of dissimilarity values (ID = 100 - IS) was calculated and the two most dissimilar areas selected as the end points of axis 1 (the X axis). The IS and corresponding ID values are shown in Appendix Thirteen.

4. The two most dissimilar areas were numbers 9 and 17 (OWH C10 and MD 4A) with an ID of 87.8. The positions of the other areas on this axis were then calculated by the formula:

$$X = \frac{(87.8)^2 + (ID-1)^2 - (ID-6)^2}{2(87.8)}$$

5. The poorness of fit of each of the samples was calculated by the following formula.

$$e = (ID-1)^2 - x^2$$

The sample showing the worst fit to the line was number 1 (OWH SS 4). This sample thus became the first endpoint of axis 2 (the Y axis). Using the same procedure as in the first ordination, the other endpoint was found to be sample 16 (MD 7B) with an ID to 1 of 49.6. Thus the length of the second axis is 49.6 units and positions on it were calculated by:

$$Y = \frac{(49.6)^2 + (ID-4)^2 - (ID-5)^2}{2(49.6)}$$

The values of X, e and Y are shown in Table XXXVIII.

The ordination produced is shown in Figure 18.1.

18.2.2. <u>The results of the ordination.</u> There appears to be a clear grouping of the vegetation of the north facing areas included in this

Table XXXVIII.

Values of X, Y and e for the sample areas for the second ordination.

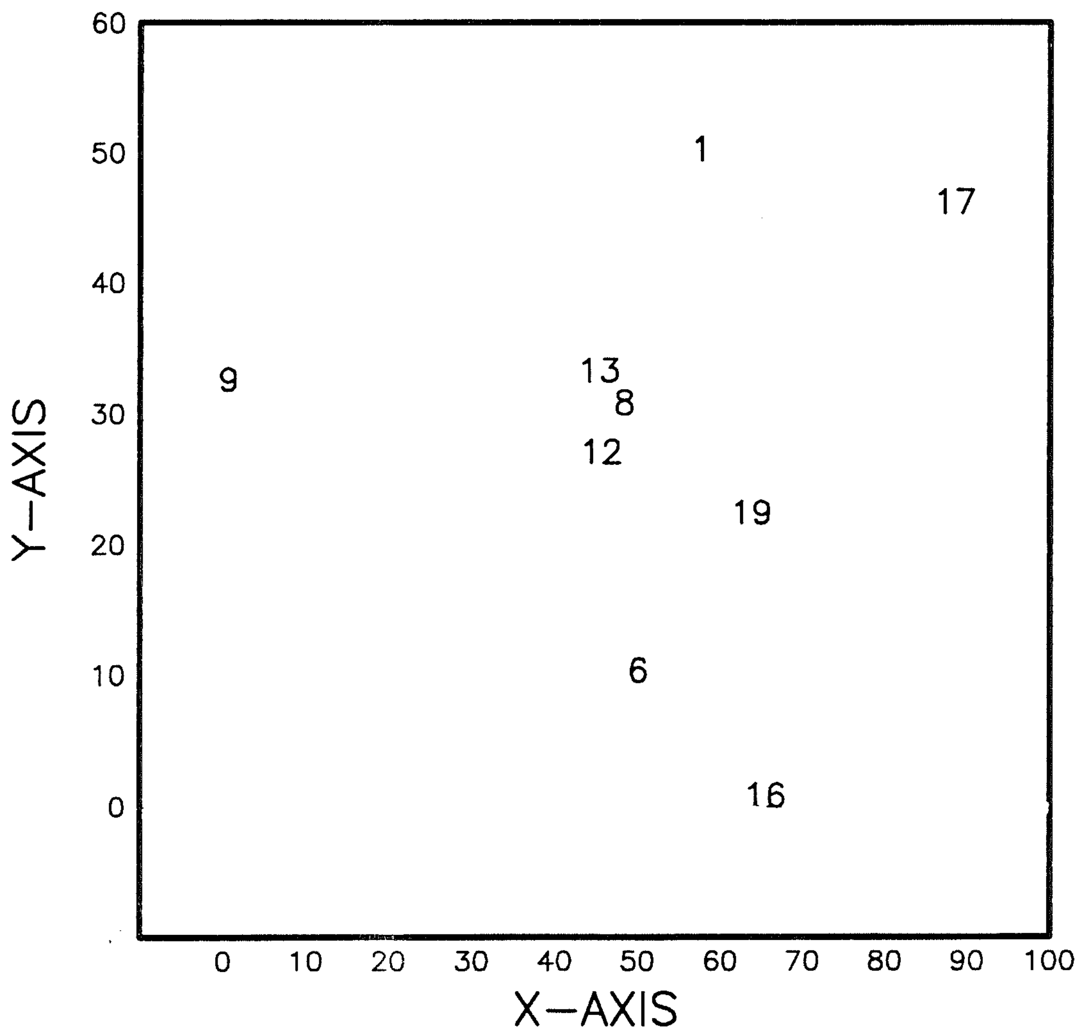
Sample Area	x	e	y
9	0	-	31.7
8	48.4	53.4	29.4
6	50.3	60.3	9.8
1	57.4	62.8	49.6
16	65.2	48.1	0
17	87.8	-	45.5
19	64.1	56.4	21.6
12	47.3	54.5	29.0
13	45.5	40.6	32.5

1 = OWH SS 4, 6 = OWH SS 11, 8 = OWH NFS, 9 = OWH C10, 12 = AR 15, 13 = AR 16, 16 = MD 7B, 17 = MD 4A, 19 = MD 3B.

Figure 18.1.

An ordination of the floras of nine of the sample quadrats.

Cover-abundance of plant species was assessed using the Domin scale in four 1 m^2 quadrats in each sample quadrat. The index of Czekanowski (1909) was used to calculate similarity of the sample quadrats. The ordination was calculated as shown by Barbour, Birk and Pitts (1980).



1 = OWH SS 4, 6 = OWH SS 11, 8 = OWH NFS, 9 = OWH C10, 12 = AR 15, 13 = AR 16, 16 =MD 7B, 17 = MD 4A, 19 = MD 3B.

assessment. The three sample areas 8, 12 and 13 are situated very close together on the ordination. These correspond to OWH NFS, AR 15 and AR 16. They are also closer than any of the other sample areas to 9, (OWH C10) also north facing. Sample area 19 (MD 3B) is also on the fringes of this group. The other sample areas are not so closely connected in any apparent way. The is no clear trend of management in the arrangement of the sample areas.

A series of Spearman rank correlation analyses were carried out between the positions on the axes and the characteristics of the ant populations. The results are as follows, with the correlation coefficient being given, and n = 9 pairs in all cases.

	X axis	Y axis
Density of mounds	-0.317	-0.267
Mean mound diameter	-0.783*	0.033
Mean mound height	-0.867**	0.200
Mean mound volume	-0.683	0.033
Area covered	-0.633	-0.350

* Significant correlation at the 5% level.
** Significant correlation at the 1% level.

The positions on the Y axis did not show any significant correlation to the characteristics of the ant population, but on the X axis there were negative correlations to the size of the mounds, as described by their diameter and height. No significant correlations were found with any of the physical characteristics of the environment

It is difficult to conclude much from this ordination, but nonetheless it is interesting to note that there appears to be a link between the size of the mounds and flora of the quadrats, as shown by their positions on the X axis. The factor that seems to correlate best to the positions of the sample areas on this axis, is their water regime, although a correlation between the X axis positions and the minimum water contents recorded for the soil cores, was not significant

(Spearman rank, r = -0.732, 0.1>P>0.05) although the correlation could only be done with seven of the sample areas because cores were not collected in two of them.

Thus, in conclusion, the ordination shows a grouping of sample areas with north facing aspects. The sizes of the ant mounds correlate significantly to the the positions of the sample areas on the X axis, but no factors of the environment or management can be singled out as significantly related to the positions of the sample areas. The water regime of the sample areas, which as has been shown in Chapter Seventeen is important to the ants, shows the closest correlation to the X axis positions.

18.3. The miscellaneous observations.

18.3.1. **Carex caryophyllea.** On 10/5/89 at the south slope at Old Winchester Hill (quadrats OWH SS 4 to 12) it was noticed that there was a wide range in the apparent density of the sedge C. caryophyllea (Spring Sedge). Could there be any correlation with the density of the ant mounds on the slope. In SS 4, 5, 7, 8, 9, 11 and 12, ten 25 x 25 cm. quadrats were randomly positioned and the number of flowering shoots of the sedge present in the quadrat were counted. The flowering shoots appeared to be the most simple way of assessing the density of this plant. The results were as follows.

Quadrat	No. of sedge shoots.	Time of last grazing	No. mounds
SS 4	0.1	September 1988	67
5	2.2	April 1988	64
7	1.1	June 1988	8
8	1.1	December 1988	66
9	1.7	June 1988	99
11	0.6	April 1989	57
12	1.5	December 1987	71

It quickly became apparent that the flowering of the sedge was determined more by the time since the last period of grazing than anything else. There was no correlation between the ant mound density and the sedge shoot density (Spearman rank correlation, r = +0.07, P>0.5, n = 7).

By refering to the grazing plan for the slope shown in Figure 10.1. the time of the last grazing period in each area was determined and this is also shown above. A Spearman rank analysis of the data gave a positive correlation between the time since last grazing and the amount of sedge shoots, although it was not a significant one (n = 7, r = +0.6875, 0.10>P>0.05).

18.3.2. **Cruciata laevipes** (Crosswort). On 24/5/89 it was noticed in OWH C10 that this plant appeared to be much more frequent on the ant mounds than in the surrounding soil. To confirm this the percentage cover of this species was subjectively estimated in 10 randomly positioned 25 x 25 cm. quadrats both on the mounds and in the surrounding grassland.

The plant was only found in OWH NFS of the other sample areas and was uncommon there.

The percentage covers of all the quadrats are given below.

	On mounds	Off mounds
1	0	0
2	50	0
3	1	0
4	70	5
5	100	40
6	60	0
7	100	5
8	0	0
9	0	0
10	100	0
Mean	48.1%	5%

While Cruciata laevipes can be found off the mounds it is clearly more abundant on them. (Mann-Whitney test, U = 131 P<0.05). Observations of the mounds showed that it was most abundant on the areas in which the largest amount of soil was being thrown up by the ants. This plant clearly has a competitive advantage over other species in the quadrat under these conditions.

King (1977a) does not mention this plant in his discussion of ant mound floras (nor do any of the other authors on this subject, see section 3.7.). However, it clearly belongs to the class of plants favoured by ant mounds. Cruciata laevipes prefers to grow in reasonably lightly grazed situations. It is excluded from closely grazed chalk grasslands on the reserve.

18.3.3. **Veronica chamaedrys** (Germander Speedwell). This species is a common plant on most chalk grasslands in this country. King (1977a) describes it as a plant which was equally abundant on both ant mounds and the surrounding pasture. On 24/5/89 this plant was observed growing on mounds and in the grassland in OWH C10. However, in OWH NFS, close by, it was only seen on the mounds. This was investigated by examining 9 small quadrats both on and off the mounds in both areas. A 25 x 25cm. quadrat was used.

The results are shown below as estimated percentage cover of the plant in each quadrat.

	OWH C10		OWH NFS	
	On mound	Off mound	On mound	Off mound
	40	40	15	0
	7	15	15	0
	0	20	45	0
	0	18	0	0
	0	40	0	0
	0	25	15	0
	60	0	0	0
	0	25	100	0
	60	15	15	0
Mean	18.6	22.0	22.8	0

In OWH C10 there was no significant difference in the frequency of the plant on or off the mounds (Mann-Whitney test, U = 96, P>5%).

Observations indicated, though, that it was slightly more erratic in its distribution on the mounds than off. In OWH NFS though, the plant was just as common on the mounds as in OWH C10 but was absent off of the mounds.

The results in OWH C10 support the findings of King (1977a) who found equally distributed on and off ant mounds. The results from OWH NFS are at odds with this view. In OWH NFS it has been generally excluded from the grassland but still finds a niche to grow on the ant mounds. OWH C10 is ungrazed, while OWH NFS is moderately grazed (see section 10.10.2.).

This data points out the complexity of the relationships between the ant mounds and the plants growing on them. In OWH C10 Veronica chamaedrys is not a plant favoured by ant mounds compared to surrounding grassland, but in OWH NFS it is. There is a clear interaction between grazing of the an area and the plants which are favoured by the conditions on ant mounds.

Also regarding this plant, it was noticed in OWH C10 that the plants on the mounds were at a more advanced stage than those in the grassland. The very warm conditions of the south face of the mounds at this time of year (see section 17.3.3.2.) probably cause this.

18.3.4. **Triticum aestivum.** One of the more surprising observations made on the flora of the sample areas was to find the plant Triticum aestivum, the common Bread Wheat, growing in the middle of MD 7B. This is not the sort of plant one expects to find growing on a chalk grassland and the reason for its presence was unclear until the presence of large numbers of ripe heads of wheat plants were found all over the south slope at Old Winchester Hill. These heads, full of seeds had been brought on to the slope by Carrion Crows or Rooks (Corvus frugilegus and C. corone) which often feed on the seeds. Martin Down, as most chalk grasslands is surrounded by fields of wheat and thus the presence of wheat plants growing in the grassland can be explained by transfer of seed by corvids. One other point is that it is only in an area such as MD 7B that the plants would be likely to develop. In the tighter highly grazed short turf of other areas develpment to maturity would be impossible.

18.4. Root aphids and other invertebrates

18.4.1. Introduction

In this section the invertebrates extracted from the soil cores collected from the subset of sample areas will be considered. The most important to the ants are the root aphids which are known to have intimate associations with and form a large part of the food of L. flavus (see section 3.9.). However, other groups are also important such as the Collembolans which are eaten by the ants and also other predators within the chalk grassland ecosystem which may compete with the ants for resources and even predate upon them, eg. pseudoscorpions, soil living centipedes (the Geophilomorphs) and even other ant species.

The invertebrates extracted only give an indication of the relative numbers present in the different sample areas. They cannot be considered as absolute estimates as the efficiency of extraction is not known and varies for different groups (Marshall 1972). As an example Petersen and Luxton (1982) estimated the extraction efficiency of Collembolans by a Tullgren funnel as only 45%.

18.4.2. Root aphids

18.4.2.1. Previous work on root aphids and **L. flavus.** The most important work on the root aphids that associate with British ant species has been done by Paul (1978). In his thesis he summarised the data on the species of root aphids known to be associated with *L. flavus* (Muir 1959, Pontin 1958, 1960, 1961, Zwolfer 1957, 1958) and also added a considerable volume of new data.

He lists the following species as being connected with *L. flavus* to some degree.

o	*Protrama flavescens*	f	*Colopha compressa*
o	*Protrama radicis*	f	*Tetraneura ulmi*
o	*Neotrama caudata*	o	*Paracletus cimiciformis*
o	*Trama rara*	o	*Smynthurodes betae*
o	*T. troglodytes*	o	*Forda formicaria*
o	*Aphis etiolata*	o	*F. marginata*
o	*Dysaphis bonomii*	o	*F. skorkini*
o	*Anoecia furcata*	x	*Aploneura lentisci*
f	*A. corni*	o	*Baizongia pistaciae*
f	*A. major*	o	*Geoica setulosa*
o	*Neanoecia zirnitzi*	o	*G. eragrostidis*
o	*Paranoecia pskovica*		

Of these *Colopha compressa* and *Forda skorkini* were recorded by Zwolfer (1958) and are not British records. In the list above,

o = obligate mymecophiles

f = facultative myrmecophiles

x = mymecoxenous (only very rarely associated with ants)

Since this thesis Pontin (1978) has published more records on root aphids extracted from soil cores and thought to be asociated with *L. flavus*. He recorded the frequency of 13 species of aphid. Of these only *Neanoecia krizusi* and *Anoecia vagans* are not on the above list. The *Geoica utricularia* he records is a synonym of *G. eragrostidis*. *N.*

krizusi and A. vagans were only recorded in very low numbers.

These three species are amongst a number of species that have been collected in samples with L. flavus, but for which there is no definite proof of an association between them and the ant. Also included in this category are Aphis chloris, A. poterii, A. jacobeae and A. hypochoeridis. Geoica pellucida and Tetraneura gallarum recorded by Waloff and Blackith (1962) are again synonyms of aphids on the first list, namely Geoica eragrostidis and Tetraneura ulmi. Names and authorities of these species are summarised by Kloet and Hinck (1964).

Eggs of a number of species of root aphid have also been found in the nests of L. flavus, being tended by the workers. Pontin (1960) recorded the eggs of Paranoecia pskovica, Dysaphis bonomii and Neanoecia krizusi. However, Pontin (1960) concluded that there was no evidence of the newly hatched aphids being placed onto food plants by the workers. The aphids seemed to find food plants entirely by chance.

18.4.2.2. Current study results. The results from each of the sample areas shown in Chapter Ten, are summarised in Table XXXIX. In this study, in a total of 330 cores 863 root aphids were extracted. In Table XXXIX the species are shown, with the percentage that each species made up of the total. The second largest category is that of unidentified aphids. This consists mainly of very small first instar aphids which are far more difficult than the adults to identify satisfactorily. Many of them appeared to belong to the genus Neanoecia, but identification to species level was not possible without adults. A few of the aphids could could not be identified using the key of Paul (1978). For example a species of Aphis was found which appeared to key out well to Aphis verbasci, found on species of Verbascum, a plant to be found in some of the sample areas. However, examination of the details known about the

Table XXXIX.

Summed results of root aphids extracted from soil cores

Species	Percentage of identifications
Aphis vandergooti	0.58
Aploneura lentisci	3.13
Brachycaudus spp.	2.90
Dysaphis spp.	0.35
Forda formicaria	0.93
F. marginata	13.09
Geoicia eragrostidis	3.36
G. setulosa	1.74
Jacksonia papillata	2.55
Neanoecia corni	3.94
Neanoecia zirnitsi	23.87
Neotrama caudata	13.56
Paracletus cimiciformis	0.46
Paranoecia pskovica	0.35
Protrama radicis	0.12
Tetraneura ulmi	9.27
Trama troglodytes	0.35
Unidentified	19.47

The numbers of each species found on the individual sample areas are given in the results section. In total 863 aphids were extracted in 330 cores.

species (Stroyan 1984) showed that it had in fact been found only once before in Britain (in Dungerness, Kent) possibly as a temporary immigrant. Furthermore, the morphological details given by Stroyan (1984) were not in accordance with the specimen. Thus, we can conclude that this aphid is not catered for by the key of Paul (1978). Further work is necessary to produce a more complete key for such root aphids.

The most common species found was Neanoecia zirnitsi with 23.87% of individuals, followed by Neotrama caudata (13.56%), Forda marginata (13.09%) and Tetraneura ulmi (9.27%). No other species recorded over 4% of individuals. How does this compare with the results of other authors?

On old pasture at Staines Moor, Surrey, England, Pontin (1978) found that the most common root aphids he extracted from core samples were Tetraneura ulmi (33%) and Baizongia pistaciae (34%). Of other species Anoecia furcata accounted for 14% of individuals Forda marginata 6%, Geoecia eragrostidis 5% and G. setulosa 5%. These results do not include unidentified individuals. There is thus a very different pattern to the results from chalk grassland. T. ulmi and F. marginata are common in both studies but in contrast the two most common species found by Pontin (1978) B. pistaciae and A. furcata were not found in this study at all. Both are described by Paul (1978) as feeding on roots of Gramineae. Thus lack of a host plant would not appear to be a problem.

The most common species found in this study, Neanoecia zirnitsi and Neotrama caudata were not found by Pontin (1978) at all. Pontin (1958) recorded aphids that he found being eaten by L. flavus colonies on calcareous grassland near Oxford. No details of the frequency of individuals is given but included on the list is Neotrama caudata (misprinted as candata in the paper).

Muir (1959) collected aphids from a variety of sites in Dumbartonshire, Scotland. The most common aphids found associated with *L. flavus* were *Neanoecia corni*, *Forda formicaria* and *Tetraneura ulmi*. Waloff and Blackith (1962) listed the results of a limited number of identifications of root aphids found associated with *L. flavus* workers. The most common were *Tetraneura ulmi*, *Geoica eragrostidis* and *Forda formicaria*. Again *Neotrama caudata*, *Neanoecia zirnitsi* and *Forda marginata* were not recorded at all.

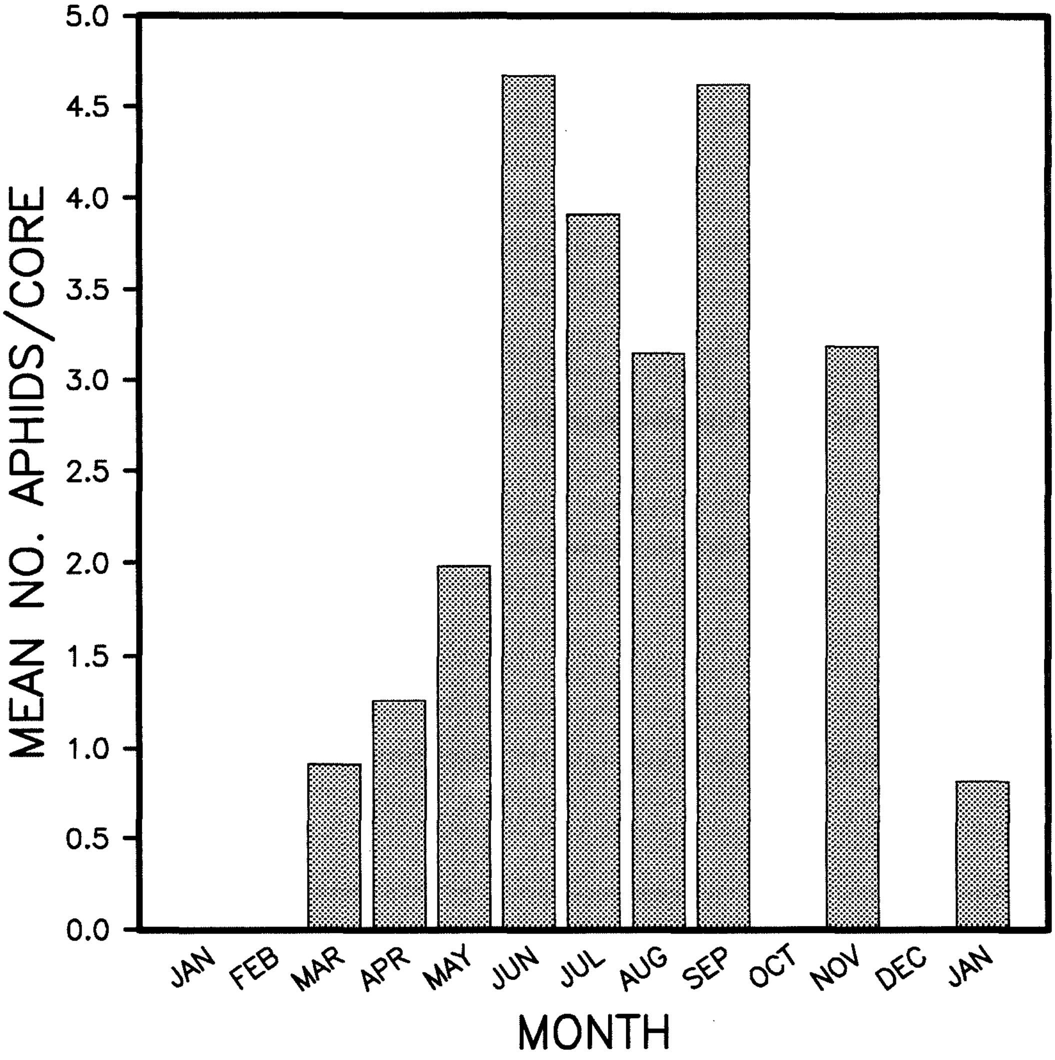
Pontin (pers. comm.) has suggested that *N. caudata* is a species found more in drier conditions, and also in drier conditions *F. marginata* will tend to replace *F. formicaria*. On the driest areas investigated in this study, OWH SS 4 and SS 11 on the south facing slope at OWH, *N. caudata* and *F. marginata* formed 72.3% of the total aphids found, much higher than in any of the other areas. Thus dryness of the habitat is clearly an important factor in determining the root aphid fauna associated with *L. flavus* on chalk grasslands.

The results summarised above indicate that *L. flavus* has some aphids which it habitually associates with in a variety of habitats, namely *Tetraneura ulmi*, *Forda formicaria* and *Geoica* spp., but that these are not necessarily the most common species in any one site. A variety of species can occur in great numbers with *L. flavus* depending on the habitat. A study of the factors that influence which species of aphid are associated with in particular habitats would be valuable.

18.4.2.3. Density of aphids throughout the year In Figure 18.2. the mean number of root aphids extracted per core averaged for each month is shown. No cores were collected in October and December 1989. The bar chart shows a distinct peak in aphid numbers in the middle of the year

Figure 18.2.

Mean numbers of root aphids extracted from soil cores throughout the year.



Collections of cores began in March 1989 and ended in January 1990. No cores were collected in October and December. Cores were collected with a 6.5 cm. diameter soil corer and the aphids extracted using Tullgren funnels. This graph shows the summed results from all of the sample areas in which cores were collected. The mean number of aphids per core was calculated for each calendar month.

and this peak is maintained until September and possibly to December. General temperatures were very mild in the late part of 1989 (ref met office reports) and this may have contributed to this. In contrast to this bar chart, Pontin (1978) did not find evidence of a mid-season peak in aphid numbers. Numbers found were remarkably consistent throughout the year.

Another contrast with the work of Pontin (1978) is in the number of aphids extracted from cores. Pontin (1978) found a total of about 4,600 aphids in the 170 cores he took, a mean of about 27 aphids per core. In contrast in this study the mean was only about 2.6 aphids per core, clearly a very large difference. There are 2 major contributing factors to this. Firstly, Pontin (1978) took cores of a diameter of 12 cm. diameter, an area of 113 $cm.^2$, in contrast to the 33 $cm.^2$ of the cores in this study. Thus there is immediately a factor of about 3.4 times in the size of the cores. Secondly, Pontin (1978) took his core samples at a maximum distance of about 1 metre from the centre of an ant mound and the majority of samples were closer than this. In this study, all of the samples were taken at a distance of 1 metre from the centre of the ant mound. As Pontin (1978) shows the density of aphids does tend to decrease with distance from the mound. Thus Pontin (1978) would have taken the majority of his samples in areas in which more dense aphid populations would be expected.

18.4.2.4. Aggregation of the aphids. Analysis of the catches per core for the summed data, ie. the 330 cores, indicated that the distribution of aphids found was not random. There was a highly significant deviation from the expected Poisson distribution ($P<0.01$). There were more cores than expected with no aphids in them and too many cores with large numbers in them. This indicates that the distribution of aphids in the cores is aggegated. This is as expected because of the nature of aphid reproduction and feeding.

18.4.2.5. Differences between the sample areas. Statistical analysis of data such as was collected is not straightforward (Wardlaw 1985). The normal procedure for such data which is not normally distributed is to apply the Taylor (1961) power law transformation. However, as Taylor (1961) points out data with large numbers of values of 0 or 1 are not amenable to such manipulation. Calculation of the regression line of the plot of log variances and log means of the 8 sets of data (as described by Wardlaw 1985) gave the following equation.

$$Y = 0.824 + 1.569X$$

The value of b (the slope of the line, in this case 1.569) is then used to calculate the necesary transformation of the data, using the formula,

$$p = 1-(b/2)$$

where p is the power to which to raise the original raw data. However, raising all of the 0 values to any power does not normally distribute them. This procedure is therefore not useful in this case. The value of b is though another indication of the aggregated nature of the data. Taylor (1961) states that b tending to 0 is an indication of regularity in the data, b = 1 indicates that the data is randomly distributed and b tending to infinity is an indiction of aggregation in the data.

Following the failure of attempts to normalise the data for analysis of variance or t-tests, the option remaining was to try non-parametric statistics, notably the Kruscal-Wallis analysis of variance by ranks, as recommended by Wardlaw (1985). The results of this did not show a significant difference between the medians of the samples, again perhaps not surprising when considering that the median value of 5 out of the 8 classes were 0 and in the other 3 classes 1. Thus the problem of the large numbers of values of 0 and 1 in the data again prevented a meaningful analysis.

It was clear that larger sample sizes should have been used, ie. cores with a larger diameter, to ensure that the number of values of 0 and 1 was reduced.

Having considered the difficulties of analysis of this data, what can be gleaned from it? The data can be summarised as follows.

Quadrat	Mean no. of aphids per core.
OWH SS 4	1.71 +/- 0.50
OWH SS 11	2.78 +/- 0.92
OWH C10	3.76 +/- 1.00
AR 15	2.31 +/- 0.65
AR 16	1.94 +/- 0.90
MD 7B	3.37 +/- 1.31
MD 4A	2.49 +/- 0.73
MD 4B	3.20 +/- 1.12

No correlation could be found between the aphid population and any of the physical characteristics of the sample areas, unlike some of the other invertebrate groups which showed correlations with the water regimes of the sample areas.

There is no significant correlation between the mean number of aphids per core in each sample area and the number of mounds in each sample quadrat ($r = +0.359$, $P>0.05$, $n = 8$ pairs). Within the major sites, though, the highest numbers of aphids were consistently found in the area with the most dense population of ant mounds. At Old Winchester Hill the mean number of aphids per core was highest in OWH C10 which had 119 mounds recorded in the sample quadrat, compared to the 67 and 57 of the south slope quadrats. At Aston Rowant, the mean number of aphids per core was highest in AR 15, the sample area with the highest density of mounds. At Martin Down the highest number of aphids per core was in MD 7B which had 86 mounds compared to the 61 and 67 of the other two sample quadrats on the reserve. Thus despite the lack of overall significance of correlation between ant mound density and aphid density there is some evidence of a link. Other factors may be important in modifying the relationship.

One of these factors may, of course, be the management of the sample areas. At Martin Down the density of aphids was greatest in the lightest grazed area (MD 7B). In the other two areas, lying next to each other, and with similar populations of mounds (MD 4A and 4B) more aphids were found in MD 4B which was more heavily grazed than MD 4A. So on this reserve the picture is somewhat mixed.

At Aston Rowant the density of aphids in the two sampled areas was quite close despite the great disparity in the density of the ant mounds. However, it was slightly greater in the sample area that has been more heavily grazed in the past. The grazing regime has more recently been relaxed with the two areas being grazed as one unit.

The grazing plan for the south slope at OWH (Figure 10.1.) shows that prior to and during the collection of the cores in 1989/90 OWH SS 4 was grazed in 1985, 86, 87, 88 and 89. In contrast OWH SS11 was grazed only in early 1989. The corresponding aphid densities from the cores were recorded as 1.71 and 2.78 per core. The aphid population was larger in the less grazed area. In the other OWH sample areas, OWH C10, there was no grazing at all and the aphid density was even higher. Thus at this reserve there seems to be a relationship between grazing intensity and aphid populations.

Overall the highest aphid densities do seem to be found in the most dense ant mound populations and also in areas that are more lightly grazed. These observations, while they cannot be considerd a conclusive arguement, nonetheless suggest, that heavy grazing reduces the aphid population in some areas. This may then be important in determining the food supply available to the ant population and thus the density of population that the area can support.

18.4.3. Mites. Mites were the most numerous group of invertebrates extracted from the cores. A wide variety of types were found but these were not separated into groups. A one way analysis of variance on the number of mites extracted from each core in the different sample areas showed an overall significant difference ($F_{7,322}$ = 12.4, P<0.001). Using the procedure described previously for the further analysis of such data on the Minitab package, OWH C10 is highly significantly different from all of the other sample areas and OWH SS 11 is significantly higher than AR 16 and MD 4A. OWH C10 had many more mites than the other sample area cores, a mean of 269 per core, compared to the next nearest of 167 per core in OWH SS 11. OWH C10 is ungrazed and OWH SS 11 had only been grazed once in the previous five years. However, MD 4A had the lowest numbers of mites per core and was a lightly grazed area. Thus, whilst the grazing regime may be of some importance in determining the density of mites, it does not explain all the variation present in the sample areas.

The mean number of mites per core extracted in each sample area correlated strongly with the water regimes, soil density and pH of the sample areas. It also showed significant correlation to the sizes of the ant mounds. The details are as follows, with in all cases, n = 8 pairs:

Characteristic	Product-moment Correlation coefficient	Significance
Soil core minimum water content	0.774	$P<0.05$
Soil core maximum water content	0.905	$P<0.01$
Soil core density	-0.884	$P<0.01$
Soil pH	-0.964	$P<0.001$
Mean mound diameter	0.809	$P<0.02$
Mean mound volume	0.828	$P<0.02$

As discussed in Chapter Seventeen the pH, soil core density and water regimes of the sample areas appear to be closely interrelated. The most important factor may be the water regime of the sample areas and as has been shown already, water regimes are also related to the sizes of the ant mounds.

One species of mite which was identified during this study was a member of the genus *Antennophorus*. This was not extracted from the core samples but was found in samples of workers that were collected. *Antennophorus* is a genus of parasitic mites, the species of which infest colonies of ants, begging food from the worker ants (Janet 1897).

This mite was found infesting several colonies of *L. flavus* during this study, particularly on the south slope at OWH. Nests of *L. flavus* have been noted as harbouring a particulary high number of mymecophilus mites (Lehtinen 1987). However, knowledge of mite-social insect interactions is limited and Eickwort (1990) was able to state that except in artificial conditions (for example beekeeping and *Varroa*) no studies have ever demonstrated beneficial or harmful effects on social insect ecology. As *Antennophorus* mites solicit food directly from the worker ants it would seem likely that some drain on the colony occurs, but that unless there is an extremely large infestation this would not be significant. The infestations observed in the sample colonies were not of such a level.

18.4.4. Collembolans.

Collembolans were the second most common group extracted from the cores. The majority were small white soil dwelling species with the occasional larger surface living individual. No overall correlation was found, using a product moment correlation, between the minimum or maximum recorded water contents of the soil cores from each area and the numbers of collembolans (minima, $r = +0.702$, $0.10>P>0.05$, maxima, $r = +0.503$, $P>0.1$). However, a one way analysis of variance on the number of collembolans extracted from the cores in each sample area was significant ($F_{7,322} = 14.28$, $P<0.001$). Further analysis as described previously sorted the sample areas into two groups. In the first group AR 15, AR 16 and OWH C10 had higher mean numbers of colembolans and were significantly different from the other four sample areas in the second group. Collembolans are very sensitive to moisture contents of soil and it is no coincidence that the three sample areas in the first group are north facing slopes with generally higher soil moisture contents than in the other group.

The only other feature that the mean number of collembolans per core for each sample area showed aignificant correlation to, was the mean height of mounds in the sample area ($r = +0.779$, $P<0.05$). As has already been noted in Chapter Seventeen the height of the mounds is related to the water regime of the sample areas.

Christiansen (1964) noted that the main factors affecting the abundance of Collembola were the moisture, structure and hydrogen ion levels of the soil. The most important factor on the chalk grassland sites investigated in this study appears to be the moisture levels. No significant correlations were found between the abundance of the Collembola and either the pH or the soil core density of the sample areas (pH, r = -0.130, P>0.1, density, r = 0.129, P>0.1). This is contrast to the results on the abundance of the mites.

There is no indication that management of the sample areas has led to consistent differences in the sample areas, with, for example, the two lightest grazed areas (OWH C10 and MD 7B) being the two most different in terms of numbers of collembolans.

Pontin (1961a) did not record any collembolans among the prey items of L. flavus. They are a very common soil organism group and it seems unlikely they would be ignored by the ants. If they form a significant part of the diet of L. flavus the large differences between the sample areas could be important.

18.4.5. Beetle larvae. Beetle larvae are one of the commonest large prey items of L. flavus (Pontin 1961a). However, no significant correlation was found between the numbers of beetle larvae extracted from the cores and any feature of the ant populations or physical characteristics of the sample areas.

18.4.6. Geophilomorph centipedes. These common soil invertebrates are predators that may compete for food with L. flavus, or even feed apon the ants themselves. Again, though, no significant correlation was found between the numbers of the centipedes extracted from the cores and any feature of the ant populations or of the environment of the sample areas. Only two different species of Geophilomorph centipedes were found throughout this study. The first and by far the most common, was Schendyla nemorensis and the second and much rarer was Haplophilus subterraneous.

18.4.7. Other ant species. As outlined in Chapter Ten, several different ant species were found in the study areas. Pontin (1963, 1969) has indicated how other ant species can compete with L. flavus causing it reduced productivity. However, no significant correlation could be found between the mean numbers of other ant species found and the characteristics of the L. flavus populations. No correlation was found between the number of workers of other ant species found and any aspect of the environment.

18.4.8. **Platyarthrus hoffmanseggi.** This small mymecophilous isopod (or sowbug) is a well known associate with many ant species and is seldom found away from ants (Standen 1912, Brooks 1943, Vandel 1962, Bernard 1968). It can often be seen in quite large numbers with L. flavus. The biology of the species has been investigated by Brooks (1943) and Williams and Franks (1988). It seems to live in the nests of ants simply as a scavenger, feeding on the waste products of the ants and being generally ignored by them (Williams and Franks 1988).

Since the isopod may be dependent on the ants for food it may be possible that there is a link between ant density and isopod density. The data from the soil cores has the same problem for analysis as the aphid data, ie. it consists largely of values of 0. The mean number of P. hoffmanseggi per core ranges from 0.14 in MD 4A to 1.32 in OWH SS 4. There was no relationship with the ant mound density of the sample areas ($r = -0.144$, $n = 8$ pairs). In fact, no relationship could be determined with any of the factors considered in this study.

P. hoffmanseggi will associate with many other ant species as well as L. flavus. It has also been reported as occuring away from ants, although a preference is shown for ants (Brooks 1943). Thus there may be numerous factors affecting its abundance and from these results the density of L. flavus would appear not to be the critical one.

18.4.9. Pseudoscorpions. Pseudoscorpions are small soil dwelling predators that may feed on ants or compete with them for invertebrate prey. However, only very small numbers were extracted from the core samples, insufficient to compare numbers from the different sample areas. The following species of pseudoscorpions were found.

Dinocheirus panzeri

Pselaphochernes dubius

Roncus lubricus

Chthonius sp. (Probably *Chthonius ischnocheles*)

The number of pseudoscorpions found was low and no meaningful analysis could be done on the numerical differences between the sample areas. Only single individuals of *D. panzeri* and *Chthonius* sp. were found, the *D. panzeri* from Aston Rowant (AR 16) and the *Chthonius* sp. from Old Winchester Hill (C 10). It is thus not possible to come any conclusions regarding these species. Surprisingly this last individual was the only pseudoscorpion found at Old Winchester Hill. Pontin (1961) records *Chthonius ischnocheles* as among the larval food items of *L. flavus*. At the other locations pseudoscorpions were not frequent but reasonable numbers were extracted from the cores. Legg and Jones (1988) state that *D. panzeri* has been found in a wide range of habitats and these include ants nests, although the species of ant is not mentioned.

Of the other two species all of the *R. lubricus* came from Martin Down and all of the *P. dubius* came from Aston Rowant. The distribution maps of these species shown by Legg and Jones (1988) show that Martin Down and Aston Rowant are both in the range of distribution of these two species. *P. dubius* is described as being associated with calcareous situations and thus is not an unexpected species to find. The dominance displayed by *R. lubricus* at Martin Down is though more difficult to explain and further investigation would be necessary.

18.4.10. Conclusions. The most important soil invertebrates for the ants are the root aphids. There were statisitical difficulties in analysing the data on these, but there was some indication that the aphids were more frequent, where *L. flavus* colonies were more dense, and that increased grazing intensity reduced the numbers of aphids. Aphid numbers were not related to any aspect of the environment, although there were differences in the frequency of different species in the different areas, some of which were due to the water regime.

Most of the invertebrate groups were found in low numbers only and could not be related to the characteristics of the ants or of the environment. However, the frequency of the most common groups, the mites and the collembolans, showed clear relationships to the environment of the sample areas, in particular the water regime, and in the case of the mites, some linkage to the intensity of management. Drier areas supported less of these two groups, and more intense management reduced the numbers of mites found. If these groups are used as food by *L. flavus*, then the differences between the sample areas could be important.

PART SEVEN

THE DISCUSSION OF THE RESULTS AND THE CONCLUSIONS

CHAPTER NINETEEN

Discussion of results.

19.1. The results and the hypotheses.

The original null hypothesis of this project was:

The characteristics of *L. flavus* populations on chalk grasslands are not significantly affected by variation in:

1) management procedures,

2) the physical environment,

3) the biological environment.

To summarise how the results of this project support or disagree with this hypothesis, tables have been drawn up collating the conclusions from this study.

19.2. Management procedures and the ant population characteristics.

Table XXXX considers the first aspect of the hypothesis, management procedures. It summarises the effects of increasing the intensity of the management regime on a chalk grassland inhabited by *L. flavus*. By this it is considered that the starting point would be a typical ant population on chalk grasslands, shown by this study to be about 80 mounds in a 400 m^2 area (a density of 0.20 mounds/m^2) with the mean mound sizes about 45 cm. maximum diameter and 12 cm. maximum height.

It is likely that such an area would have had a fairly light grazing intensity in the past, under 1,000 sheep days/hectare/year. The Table considers how a short period (up to 4 years) and how a longer period (10 or more years) of grazing at well over 1,000 sheep days/hectare/year would affect the characteristics of the ant population present.

It should be emphasized that the intensities of management considered are valid conservation management for many chalk

Table XXXX

Table to summarise the effects of increasing the intensity of management of chalk grassland, on the characteristics of a typical population of the ant L. flavus

Ant population characteristics	result of intense management short term (to 4 years)	long term >10 years
Size of mounds		
a) diameter	unaffected	reduced
b) height	reduced	reduced
c) volume	reduced	reduced
d) area covered	unaffected	reduced
Density of mounds	unaffected	reduced
Spatial distribution of mounds	unaffected	unaffected*
Worker populations of colonies	unaffected	reduced
Sexual reproduction of colonies		
a) productivity	reduced	reduced
b) investment ratio	reduced	reduced

In the context of this table the management being considered is grazing intensity of sheep. Intense management is defined as a grazing level of greater than 1,000 sheep days/hectare/year.

* intensity of management does not affect spatial distribution. A consistent history of management is the major factor. Variation in the management procedures adopted over long periods or disturbance will cause the spatial distribution to be random. Long term stability of management will lead to overdistribution of the mounds.

If management changes the carrying capacity of the environment changes, which in turn affects the degree of competition between the colonies. Any disturbance resulting in the death of colonies, such as ploughing, results in new colonies coming into the area and these new colonies take time to establish an overdispersed distribution.

grasslands, typical of what might well be used on Nature Reserves. Intense management is not meant to imply the extreme levels of grazing that would be involved on commercial sheep pastures. As part of a conservation management strategy, hard grazing, at intensities of well over 1,000 sheep days/hectare/year, is used in some areas to produce a short herb rich sward. For example on the south slope at OWH the intensity of grazing, over the nine year rotation, averages out at approximately 1,400 sheep days/hectare/year. In other areas, to produce a taller sward, favouring less grazing tolerant plants, such as in MD 7B, grazing regimes of well under 1,000 sheep days/hectare/year will be used.

Table XXXX shows that many characteristics of the ant population are affected by even relatively short term periods of increased intensity of management. It also shows that almost all aspects of a population will be altered by long term intense management. The size and density of the mounds and the productivity of the individual colonies, as shown by the colony size and sexual reproduction, will all be reduced.

The reverse situation to that described will also occur. If a low population of L. flavus mounds is present in a heavily grazed area, for example a density of about 0.125 mounds/m^2 in an area grazed at well over 1,000 sheep days/hectare/year, then a relaxation in the grazing regime, down to about 500 sheep days/hectare/year, will, over a 10 year period or longer, result in an increase in the size and density of the mounds, and an increase in the productivity of the colonies.

It has also been demonstrated in this thesis how management procedures such as mowing and scrub cutting can damage ant mounds.

Careless use of such procedures resulting in persistent damage to colonies over many years could also affect the population characteristics.

It can therefore be concluded that the null hypothesis, that management of a chalk grassland does not affect the characteristics of the ant population, is rejected, and the alternative hypothesis accepted.

19.3. The physical environment and the ant population characteristics.

Table XXXXI summarises the effects of particular physical environmental factors on the characteristics of the ant population that would develope under those conditions. A plus indicates that the feature of the environment being considered is one that would increase the characteristic of the ant population (eg. increased mound sizes, colony densities or sexual production) or in the case of spatial distribution, increase the degree of overdispersion present. In contrast a minus indicates that that particular feature would reduce the characteristic being considered (eg. reduced mound sizes, colony densities etc.). An N indicates no effect.

The Table shows that the effects of the physical environment are confined to the sizes and the density of the ant mounds. It has not been possible to establish that different physical environmental factors affect the spatial distribution or productivity of the ant colonies (colony sizes or sexual production). A physical environmental factor, such as a relatively dry soil, can serve to limit the density of colonies that develope on an area, but then the colonies that are present have a larger territory in which to achieve the same productivity as more dense colonies, with a smaller territory, in a more favourable environment. The density of ant colonies is reduced

Table XXXXI

Summary of the effects of physical environmental characteristics on populations of the ant L. flavus.

Ant population characteristics	Aspect N	Aspect S	Increased slope	Soil water high	Soil water low	Soil depth
Size of mounds						
a) diameter	+	-	-	+	-	-
b) height	+	-	N	+	-	N
c) volume	+	-	N	+	-	N
d) area covered	+	-	N	+	-	N
Density of mounds	+	-	N	+	-	N
Spatial distribution of mounds	N	N	N	N	N	N
Worker populations of colonies	N	N	N	N	N	N
Sexual reproduction of colonies						
a) productivity	N	N	N	N	N	N
b) investment ratio	N	N	N	N	N	N

+ = the characteristic is increased, eg. size of mound is increased.
- = the characteristic is decreased, eg. the density of mounds is decreased.
N = there is no effect on the characteristic of the ants.

Aspect: N indicates a north facing slope.
S indicates a south facing slope.
Slope: the gradient of the slope.
Soil water: - an area with a dry soil water regime with low summer minimum water contents of soil cores.
+ an area with a relatively wetter soil water regime, with higher summer minimum water contents of soil cores.
Soil depth: the depth of soil as measured by inserting a probe, until an obstruction is reached.

Table XXXXI continued.

Ant population characteristics	Higher soil pH	Higher Soil core density	Higher altitude	Hotter temperature regime
Size of mounds				
a) diameter	-	N	N	-
b) height	-	N	N	-
c) volume	-	N	N	-
d) area covered	N	N	N	-
Density of mounds	N	N	N	-
Spatial distribution of mounds	N	N	N	N
Worker populations of colonies	N	N	N	N
Sexual reproduction of colonies				
a) productivity	N	N	N	N
b) investment ratio	N	N	N	N

+ = the characteristic is increased, eg. size of mound is increased.
\- = the characteristic is decreased, eg. the density of mounds is decreased.
N = there is no effect on the characteristic of the ants.

Soil core density: dry weight density of soil cores collected throughout the year from each of the sample areas.
Altitude: measured from Ordnance Survey maps.
Temperature regime: the annual mean temperatures measured at 1 cm. and 10 cm. depth in the soil.

but the productivity of the individual colonies is the same.

No significant effect of variation in altitude on the characteristics of the ants could be determined, but the range within the sample areas was small (79 - 243 metres) within the context of the altitudes that L. flavus could be found on in this country. For the temperature regime it has been noted that, within the range seen in the sample areas, hotter temperature regimes found on the south facing slopes cause reductions in the density and size of the ant mounds. Hotter temperature regimes correlate with reduced water availibility, which as seen in Chapter Seventeen, correlates with reduced density and sizes of mounds. The cooler temperature regimes found on north facing slopes are not disadvantageous, the ant mounds acting as efficient solaria, are able to compensate for the reduced ground temperatures, and the cooler temperatures produce a less dry soil water regime. Further north in the British Isles , for example on the Derbyshire Dales, L. flavus is not found on north facing slopes (pers. obs.). This is because the temperature regime of such areas is below the threshold needed for the succesful rearing of brood in a single season, and thus the establishment of colonies.

Of the characteristics of the physical environment, the water regime seems to correlate best to the characteristics of the ant population. The aspect of the sample areas is important but this too affects the water regime, south facing slopes being drier than north facing ones. Soil pH differences correlate to mound size differences, but this may again be related to the water regime of the sample areas. Of the other characteristics, the slope and soil depth have been shown to correlate to variation in the diameter of the mounds but the causes of this are unclear.

It can therefore be concluded that the general null hypothesis that the physical environment of a chalk grassland does not affect the characteristics of the ant population, is rejected, and the alternative hypothesis accepted.

19.4. The biological environment and the ant population characteristics.

Table XXXXII summarises whether any of the aspects of the biological environment have been shown to affect the characteristics of the ant population. In the table a + indicates that variation in the factor has been shown to be significantly correlated with variation in the ant population characteristic. A N indicates no correlation.

The ordinations of the flora of the sample areas, showed that there was a relationship between the flora of the sample areas and the sizes and densities of the ant mounds present (Chapter Thirteen). They also showed that there were differences between the flora of the north and south facing slopes amongst the sample areas, and the differences between the ant populations of north and south facing slopes have been commented on above.

The flora of the sample areas is affected by the management of the sample areas. If management is relaxed or abandoned, as happened at Martin Down in the period 1960 - 1978, for example, the flora changes, the grasses increase in height and scrubbing up commences, leading in the short term to the shading of the ant mounds and, eventually, to the death of the colonies.

In Chapter Thirteen it was shown how rabbit dropping densities, a measure of the activity of rabbits within the sample areas, correlated to the mean sizes of the ant mounds, more droppings gave smaller

Table XXXXII

Summary of the interaction of the biological environment with the characteristics of the ant population.

Ant population characteristics	Flora	Rabbit density	Root aphids	Other invertebrates
Size of mounds				
a) diameter	+	+	N	+
b) height	+	+	N	+
c) volume	+	+	N	+
d) area covered	+	+	N	+
Density of mounds	+	N	+	N
Spatial distribution of mounds	N	N	N	N
Worker populations of colonies	+	N	+	N
Sexual reproduction of colonies				
a) productivity	+	N	+	N
b) investment ratio	+	N	+	N

\+ = differences in the factor result in differences in the ant characteristic
N = differences in the factor do not result in differences in the characteristic of the ant population.

Flora: as measured by the species present and their cover-abundance. Floristic differences, as shown by an ordination of the sample areas, correlated with differences in the size and density of the ant mounds.

Rabbit density: as measured by the density of droppings present. The presence of more rabbit activity was correlated with smaller mound sizes.

Root aphids: root aphids were extracted from sample soil cores using a Tullgren funnel. More root aphids were present in areas that had larger and more dense ant mound poplations.

Other invertebrates: also extracted from soil cores using the Tullgren funnels. Some groups of invertebrate were more frequent in areas with larger ant mounds.

mounds. Root aphid populations were related to the density of the ant mounds in Chapter Eighteen, but were also shown to be related to the intensity of management that the sample areas received. Areas in which the intensity of grazing was high, showed reduced aphid populations, and the ant colonies had reduced worker populations and sexual productivity. Other invertebrate groups too, showed relationships to the ant population characteristics, in particular the mites.

It is clear that the original null hypothesis that the characteristics of populations of L. flavus on chalk grassland are unaffected by variation in the biological environment, must also be rejected.

19.5. The causes of change in the ant population.

Having found that the null hypothesis does not hold, it begs the question as to the major underlying causes of the observed differences between the ant populations of the sample areas. Whilst a number of relationships have been established, the data point to two major factors as being the most important, firstly grazing intensity and secondly the water regimes of the sample areas.

The intensity of sheep grazing has been shown to be the major management influence on the ant populations (Chapter Twelve). Rabbit grazing may also be important in some of the sample areas. Differences in grazing intensity also produce changes in the flora of chalk grassland, which has also been shown to correlate to the ant population characteristics.

Of the physical environmental characteristics, the temperature regime and the soil core water contents showed the closest relationship to the ant mounds sizes and densities. The temperature regime is related to the water regime of the sample areas, hotter areas being drier. Aspect too is important, the hotter south facing slopes being drier than the cooler north facing slopes.

If these two factors in the sample areas (intensity of grazing and water regime) are the most important to the ants, how might they cause their effects?

19.6. The impact of grazing on grassland ecology.

19.6.1. A general review. Grazing has a widespread effect on many aspects of temperate grassland ecosytems. Marrs, Rizand and Harrison (1989) observed that intense grazing may have different effects on grassland fertility, depending on the time scale. In the short term, fertility may be increased due to nutrient release in faeces and urine, and the prevention of accumulation of organic matter in the form of litter (McLachlan and Norman 1966, Floate 1970, Harrison 1985). In the longer term intense grazing may cause a decline in the soil fertility, due to a continuous drain on available nutrient resources (Mclachlan 1968, Floate 1973, Harrison 1985).

Maarel and Titlyanova (1989) demonstrated that above ground biomass is reduced with increasing grazing intensity, and that below ground biomass is highest at moderate grazing levels. Noy-Meir et al (1989) showed that species richness could be reduced by more intense grazing. Watt and Gibson (1988) showed that the survival of small seedlings would be reduced by intense grazing and Gibson et al (1987) demonstrated that the direction of succession in immature grassland could be influenced by the intensity and timing of grazing. Other studies have indicated that the invertebrate community of grasslands can be adversely affected by grazing, both in terms of abundance and diversity (Morris 1969a,b, Siepel and van de Bund 1988).

One of the major effects of grazing on grasslands, that has implications for the whole of the plant and animal community, is the impact of grazing on the primary productivity of the ecosystem.

19.6.2. Grazing and productivity. There has been considerable debate in the past few years on the impact of herbivory on plant productivity. Some authors have suggested that plants benefit from herbivory by increasing their productivity, known as overcompensation (McNaughton 1983). Other authors suggested that herbivory generally results in plants reducing their productivity, known as undercompensation. Belsky (1986) and McNaughton (1986) are representative of the opposing views.

However, recent experimental studies have suggested that there is in fact a "complex continuum of plant responses" depending on the biotic and abiotic conditions prevailing at the time (Maschinski and Whitham 1989). Maschinski and Whitham (1989) concluded that overcompensation from herbivory will result when competition is low, undercompensation when competition is high or resources are limited.

Chalk grassland is an environment which is generally highly competitive and in which many resources are limited (Smith 1980) and thus it seems likely that herbivory will result in undercompensation. The view of Stout et al (1980) that "grazing normally decreases plant growth and vigour........the more frequent and intense the grazing the greater the decrease" is likely to be true of chalk grasslands.

Another aspect of grazing that is perhaps underconsidered in the above papers and has already been shown to be important in affecting the ant mounds (section 12.2.1.) is trampling.

19.6.3. Trampling. Trampling has widespread and significant influences on grassland ecosystems (Duffey 1974). Several studies have shown that trampling affects the flora, causing damage in the short term (eg. Burden and Randerson 1972 in a study on chalk grasslands) and changes in species composition over the long term (Westhoff 1966, Chappell et al 1971). Trampling can also reduce the productivity of grassland species (Liddle 1975b, Smith 1978). Human trampling on amenity grassland areas has been the subject of most attention (Burden and Randerson 1972, Allcock 1973, Liddle 1975a).

Aside from the sometimes obvious results of trampling such as on pathways or sheep tracks, lesser levels of trampling can also have significant outcomes, leading to increased soil density as a result of compaction (Lull 1959, Burden and Randerson 1972, Howard and Howard 1976) this in turn affecting soil water flow, aeration of soil and plant growth (Lull 1959). Soil invertebrates are also influenced. A study by Ito (1980) demonstrated that even small amounts of trampling can result in major changes in the abundance and diversity of major soil invertebrate groups. This includes the most common chalk grassland groups recorded in this study, the mites and collembolans. The density of these groups was greatly reduced by small amounts of trampling.

The most intensive study of the effects of human trampling on chalk grassland has been by Chappell et al (1971). They showed that on chalk grassland, at a location in Hampshire, trampling affected the flora, the soil and the invertebrates. The flora was changed and diversity decreased. Soil density was increased and the number and diversity of soil invertebrates reduced. It was also noted that ants nests (presumably mounds of _L. flavus_) were only found in the least trampled areas.

Chappell et al (1971) suggested that trampling by animals during grazing would have the same effects as human trampling on chalk grassland. As a result of their study, Chappell et al (1971) concluded that, because of these effects, the use of intensive sheep grazing would not be suitable for chalk grassland management and that the mild trampling associated with lower grazing intensities would be better.

19.7. Water levels and chalk grassland ecology.

Even in a climate as apparently damp as England appears to have, water levels are a frequent limiting factor to plant growth (Penman 1952, Fogg 1970). Productivity of plants is greatly reduced in dry conditions.

As was noted in Chapter Two, water level is a major limiting factor for the flora of chalk grasslands. Summer drought is common and as seen from the analysis in this thesis, minimum water levels are correlated to both differences in the flora and in the invertebrate communities, including the ants, of chalk grassland. Indeed one of the major problems of reserve management on chalk grassland is finding enough grass for livestock to eat in dry periods.

Thus drier sites on chalk grassland are likely to be at a serious disadvantage in terms of primary productivity compared to wetter areas.

19.8. The consequences of intense grazing and lower soil water contents.

The above review shows how the effect of both reduced water levels and more intense grazing can lead to reduced grassland productivity and reductions in the diversity and abundance of the soil invertebrate community. As noted in section 3.9. *L. flavus* has two major food sources, firstly, and perhaps most important, the root aphids and secondly other small invertebrate prey.

If the productivity of the grassland plants is reduced, either by intense grazing or by dry conditions, then it is likely that, in turn, the productivity of the root aphids will also be reduced, as they feed directly on these plants. Other invertebrates that may form a part of the food of *L. flavus* are also reduced by grazing and trampling, and also by decreased water levels, as demonstrated in Chapter Eighteen.

It is thus possible to see how a reduction in the productivity of the ants could be caused by both increased grazing levels and reduced soil water levels. The reduction in the available food to a colony would result in that colony requiring a larger territory to support the same level of productivity, this meaning that a chalk grassland with a dry water regime or intense grazing would be able to support fewer ant colonies.

Pontin (1978) suggested that the feeding by ants as part of the grass-aphid-ant chain reduced the grass crop available to other herbivores. It seems probable from this thesis that, via the same chain, reductions in the grass productivity due to herbivory will result in a reduction in available food to the ants. An experimental study of this food chain would be interesting, as Pontin (1978) suggests.

The extent to which *L. flavus* relies on invertebrates other than aphids for food on chalk grassland, is unclear. A study of this would be valuable, although difficult to undertake. Examination of prey items of *L. flavus* has so far relied on chance findings of remains in the colony (Pontin 1961a). The use of a collection system for prey, as devised by Skinner (1980) for use with *Formica rufa*, is extremely difficult with *L. flavus* because the ants live below ground.

An experimental examination of variation in the abundance and diversity of the food sources of *L. flavus* in environments subject to differing management, either by controlled clipping or grazing could be considered as the next step forward from this thesis.

19.9. Conclusions.

a) The overall null hypothesis of this study, that the characteristics of populations of the ant L. flavus on chalk grasslands are not significantly affected by variation in:

1) management procedures,
2) the physical environment,
3) the biological environment,

is comprehensively rejected and the alternative hypothesis accepted.

The way in which the aspects of management and the environment influence the ant population is summarised in Tables XXXX to XXXXII.

b) The most important aspect of the management in affecting the ant populations is the intensity of grazing. Increased grazing intensity causes reductions in the mound sizes and sexual productivity in the short term, and reductions in the density of colonies in the longer term.

c) Soil water contents have been determined to be the most important aspect of the physical environment in controlling the characteristics of the ant populations. Drier areas, for example on hot south facing slopes, will have colonies with smaller mounds at a lower density. Other elements of the physical environment can also influence the ant populations.

d) Several aspects of the biological environment show relationships with the ant population characteristics, but it is difficult to decide if some of these relationships are causal. The physical environment and the management of the sample areas acts to modify many elements of the biological environment.

e) It is suggested that both lower soil water contents and increased grazing intensity act to reduce the productivity of the grassland plants and thus, that of the root aphids, the major ant food source. Increased grazing and reduced water levels also reduce the diversity and abundance of soil invertebrates which may also be an important food source for L. flavus.

f) The results of this thesis have been used to suggest methods for the conservation of L. flavus on chalk grasslands. These suggestions are made in the last Chapter of this thesis.

CHAPTER TWENTY

The establishment and conservation of *L. flavus*.

20.1. Introduction.

This Chapter has been formatted as a set of procedures to follow, the aim of which, is to lay out the management procedures necessary to establish, and or, build up, a population of *L. flavus* on a chalk grassland. It can be seen as a sort of written flow chart. The constraints of A4 pages in this thesis prevent the drawing out of the whole set of instructions without it becoming confused and overcomplex.

It is intended to cater for any situation on chalk grasslands where a healthy population of this ant is desired. Particular emphasis has been given to the process to go through if reclaiming grassland from arable or other uses, as current set aside agricultural policy is likely to release areas of former chalk grassland.

A series of notes at the end should not be ignored when going through the procedures. These notes give the necessary details of some of the procedures referred to by rather sweeping statements.

Parts of the procedures may well be applicable to areas other than chalk grassland, but probably not outside the south of England. For example environmental conditions are such that it would probably not be possible to establish dense populations of *L. flavus* on north facing slopes, in areas north of the Midlands (approximately Birmingham).

As a starting point questions are asked about the area of land in which it is intended to establish or conserve the population of the ant.

20.2. <u>The procedures necessary for the establishment and conservation of **L. flavus** on chalk grasslands.</u>

1. Is the area likely to be a suitable environment for dense populations of *L. flavus*? See note a).

   If area is suitable proceed to......................2

   If not..28

2. Chalk grassland absent..............................3

   Chalk grassland present.............................9

3. Area is isolated from other chalk grasslands........4

   Area is surrounded by other chalk grasslands........8

4. Natural regeneration of chalk grassland is extremely unlikely.

   Appropriate steps must be taken to establish chalk grassland.....5

5. A short term policy to establish chalk grassland is desired (under 10 years).........6

   A long term policy is acceptable (over 10 years).................7

6. Transplant in chalk grassland turves, and manage appropriately, see note b)..........12

7. Reseed with a suitable mixture and manage appropriately see note c)..........12

8. Allow natural regeneration of chalk grassland see note d)..........12

9. Is the chalk grassland in good condition? See note e).

   If it not.........................10

   If it is..........................11

10. Chalk grassland overgrazed, institute reduced intensity managment regime, see note e)..........11

    Chalk grassland undergrazed, scrubbing up, institute reclamation management policy, see note e)..........11

11. Chalk grassland now in good condition

L. flavus absent.......................................12

L. flavus present on the grassland, see note f)...........18

12. L. flavus present in nearby areas (under 1 mile)................13

L. flavus absent from nearby areas..............................15

13. Long term policy (>10 years)....................................14

Short term policy (<10 years)...................................15

14. Allow natural recolonisation. See note g)...................19

15. Very short term policy (<5 years)..............................16

Medium term policy (5 - 10 years)..............................17

16. Transplant in mature colonies of L. flavus

See notes g) and h)..19

17. Establish young fertilized queens of L. flavus

See notes g) and i)..17

18. L. flavus established in the area, colonies are

building mounds and producing sexuals. (see note j)...........18

19. Desire is now to try and increase the density of the

population.

Large area available (>2 hectares) and with a selection

of areas with different physical environments.............20

Small area available (<1 or 2 hectares)...............21

20. Select the best area for L. flavus,

See notes k) and l)...................................21

For the areas not selected............................28

21. Can the population be improved. See note m),

If it can...22

If it cannot..23

22. Establish past management, See note n),

If not possible..24

If possible..25

23. Establish past management, See note n)

If not possible..24

If possible..26

24. Past management unknown. It is necessary to establish a sympathetic management system. See note o)...................27

25. It is necessary to relax the management regime. The intensity of management needed depends on the particular area. See note p)..................................27

26. Maintain the management system as far as possible..............27

27. Monitor the population to test the success of the management policy. See note q). Modify as necessary.

28. Find another conservation aim See note r).

20.3. Notes to the procedures.

Note a). If the ant is already present, then this question is redundant. However if there is only a very low population present it is worth considering the points below. Is the ant going to be able to successfully colonise the area or build up a large population, even if suitable management is adopted? Points to consider are;

1) Is *L. flavus* present in dense populations in similar areas nearby that may have been more suitably managed in the past.

2) Might the area be too dry for *L. flavus*. One of the major limiting

factors for *L. flavus* is the water regime of the environment. In dry conditions in the extreme south east *L. flavus* may be naturally replaced by *L. alienus*.

3) Is it going to be possible to maintain the necessary management of the area over the long period necessary for the outcome to be successful. Chalk grassland management can be labour intensive, can the commitment to maintain the management procedures required, be guaranteed for as long as ten or more years.

Areas that are scrubbed up or overgrown, or have been heavily overgrazed in the past, can be quite quickly recovered by suitable management as indicated in further of the notes to this key.

Note b). The transplanting of magnesian limestone grassland turves (which contained many typical chalk grassland plants) has been successfully tried at Thrislington in County Durham. There is no reason why such a procedure should not also work on chalk grassland.

Note c). Reclamation of chalk grassland from scratch is not simple. Wells (1978, 1987) has done the most work on recreating chalk grasslands, using a variety of seed mixtures. However, it is likely that there would be many difficulties in this approach. It is an area where more research would be valuable and expert advice should be taken when considering doing this.

Note d). Natural regeneration of chalk grassland is a variable process. In some places it can be extremely rapid and successful (Wright 1985) and in other places infuriatingly slow. On Martin Down for example, a large area ploughed during the war is only recovering very slowly.

Work by Graham and Hutchings (1988a,b) indicates that former arable land is unlikely to maintain a good seed bank of chalk grassland plants and that natural recolonisation will be slow.

One encouraging factor is the presence in neighbouring areas of mature chalk grassland, which can act as a suitable seed source. However, even in these conditions development can be slow, relying more on the spreading of perennial plants by vegetative means, than the natural colonisation of plants by seed (Graham and Hutchings 1988a).

Management of the newly developing grassland is important and can influence the speed and direction of the plant succession. Studies by a group at Oxford University, on succession in an old agricultural field on oolitic limestone, should be referred to for useful information (Gibson et al 1987a,b Watt and Gibson 1988). Gough and Marrs (1990) also discuss the creation of species-rich grasslands on abandoned agricultural land, in particular the problem of soil fertility, which may be too high on abandoned agricultural land. De Leeuw and Bakker (1986) discuss the level of sheep grazing necessary for suitable recovery management of abandoned agricultural land.

Note e). If the area is likely to be suitable but has been neglected or overgrazed in the past then suitable management can quite rapidly restore the area.

If the area is overgrown and has a lot of scrub present, it is necessary to start a rapid recovery program. Machine or hand scrub cutting can be done to remove the scrub. If a lot of coarse grass such as Brachypodium pinnatum or Bromus erectus is present, then sheep grazing may not be sufficient to control it effectively in the short term. Cattle could be used at this stage as they are less selective feeders and can control the coarser grasses. Other than in this situation cattle should not be used, as the erosion problems and trampling they produce are not good for the ants. Brachypodium can also be controlled by mowing, and when under better control, Spring sheep grazing on the younger shoots is effective. If sheep grazing is used initially, then the grazing intensity should be maintained at over 1,000 sheep days/hectare/year.

Intensive managment of the grassland should not be maintained for long periods. As soon as the grassland is under better control, management should be relaxed, although monitored to ensure that development of coarser grasses is held in check.

If the grassland has been overgrazed in the past, shown by bare patches of soil and a lack of flowering plants, then it is necessary to adopt a less intense management policy. Grazing could even be stopped altogether for a short period. Close monitoring of the grassland flora will help establish the correct grazing levels. Rabbit populations should also be considered, and if necessary a control program adopted.

Note f). L. flavus may either have been already present on the chalk grassland or naturally colonised as the grassland was established. If L. flavus is naturally colonising the area, this colonisation should be encouraged, possibly by the procedures suggested in note g).

Note g). Establishment of L. flavus may not be successful as rapidly as would be liked. However, several procedures could be tried to improve chances of success.

1) Colonies of L. flavus are often started with queens gathering under stones. If none are present in an area, stone slates could be scattered around in order to encourage this. This also has other advantages. The stone slates can be raised to see whether queens are naturally finding the slates.

2) Other species of ant (Myrmica spp. predominantly) will almost certainly find and utilise the slates as nest sites. As these too will then be easily seen, it is possible to poison those colonies. Ants such as Myrmica spp. and L. niger will kill queens of L. flavus that they come into contact with. By poisoning, or otherwise removing these colonies from an area, the chances of success by founder queens of L. flavus will be improved. This procedure could also benefit young or mature colonies of L. flavus by reducing the competition from these other ant species.

Note h). Transplantation of mature colonies of L. flavus has been successfully achieved on at least two occasions (Box 1987, and Pontin 1969). Pontin (1969) moved colonies into areas already inhabited by other ant species, in order to observe the competitive effects on the sexual productivity of the colonies. He demonstrated that other ant species will compete with L. flavus for resources.

Pontin (1969) transplanted mounds on a warm day in March. The whole mound was removed to a depth of 15-20 cm. below ground level and transferred onto a corregated iron sheet for moving to the new site. At the new site, a ring of turf was removed and the mound placed in the hole.

Box (1987) moved colonies of L. flavus over considerable distances in order to save them from being destroyed by the building of a new by-pass road in Shropshire. Initial attempts to remove colonies using a JCB digger were unsuccessfull. Box (1987) first removed the tops of the mounds and then separately a layer of soil down to 30 or 60 cm. The mixture of soil and ants was moved to a new site and placed in excavated holes of a similar size and depth to that originally dug out.

The ant mound material and soil was moved to the new location in a wheelbarrow. The wheelbarrow could be placed on the back of a light lorry for transport over longer distances. Over 30 ant mounds were moved in Spring 1985 and all were found still to contain worker ants in August 1986.

When transplanting ant mounds in this way it is important that the queen of the colony is not either missed or damaged or killed. If the queen is lost the mound may well still contain worker ants for a considerable period, up to, or over a year perhaps. However, the sign of a successfull transplantation would be the production of sexuals in the year following the move. The development of sexuals could be checked throughout the year by placing a stone slate on top of the mound under which galleries will be built (see section 7.2.1).

Note i). Young fertilised queens of L. flavus can be collected in great numbers after a sexual flight. They can be kept in small containers for quite long periods as long they remain in moist conditions and can thus be transferred over long distances. These queens can then be placed under stones in the area in order to initiate colonies. Mortality at this stage is likely to be very high (Pontin 1960), many queens probably falling prey to other ants. This being the case, a large number of queens should be placed out in the area, at least one for each m^2. Reasearch by Waloff (1958) shows that young queens do better if in small groups of two or three rather than if on their own, so that small groups of 2 to 4 queens could be used.

It may be possible to start queens off before putting them out in the field. New queens wil readily lay eggs and workers can be produced very quickly. If these starter colonies can be maintained until the following spring these could placed out. This may increase the chances of success. Again groups of 2 to 4 queens will produce workers more quickly and in greater numbers.

Note j). The establishment of a population of L. flavus to this level of development may take a long time. If the longer term policies are used, certainly 10 years may be necessary and often longer. If colonies are failing to establish themselves successfully it is necessary to again ask the question as to whether the area is in fact suitable at all for L. flavus, or whether another management policy may be more successful.

Note k). On chalk grasslands in the south of England the best area is likely to be a sheltered north facing slope. If this is not available then the best area will be one in which is least affected by drought throughout the summer, ie. in which grass growth remains good for as long as possible. Soil moisture contents should not drop below 16%. On south facing slopes the best conditions are likely to be at the base of a hillside.

Note l). Chalk grasslands under conservation management are not very abundant. There are a great number of alternative conservation strategies available for chalk grasslands many of which will still allow _L. flavus_ to be present, although not in great densities. Where a large area is available it would not be wise to devote too large a part of it to the conservation of the ant. One of the aims of reserve management should be to encourage diversity. Thus it is necessary to select the most suitable area for _L. flavus_ and concentrate management on that area.

Note m). Can the population be improved, ie. increased in density? In some areas it is likely that only relatively low densities of _L. flavus_ can be mainatained. For example on adry south facing slope it may be possible to exceed a density of approximately 0.175 mounds/m^2. Any population on a north facing slope whose density is already at 0.25 mounds/m^2 may take a lot of improving. If this is the case then maintenance of the population may be a more realistic management policy.

Note n). It is necessary to establish the way the grassland has been managed for the last 10 or more years. Other factors to take into account are past disturbances such as ploughing, even up to 50 years ago, and if possible the general level of rabbit activity in the area. These factors should all be taken into account when establishing what management is necessary for the future. Each area of chalk grassland will have its own set of management requirements. Detailed knowledge of the past management, and what has resulted from this, can help establish what these requirements are.

Note o). If it appears that the population of ants is low because the area has been intensively grazed in the past then it is necessary to establish a more sympathetic regime for the ants. This should not involve cattle grazing as they are too heavy footed for use, except when there is no alternative. Sheep grazing is most effective. Initially it is suggested that a grazing regime is introduced that totals no more than 500 to 700 sheep days/hectare/year. This could be split into a Spring grazing period and an Autumn grazing period. On a north facing slope this type of grazing regime has produced the type of ant population seen in Figure 10.33 of this thesis.

Alternatively one period of grazing could be used a year. A late season grazing period (September onwards) would have the advantage of leaving the ants undisturbed during their most active part of the year (May to August). Another alternative is to only graze the area every second or third year, but at a higher intensity so that the average level of grazing over each year is maintained. This has the advantage of making management easier, as less sheep movements are required.

Whatever policy is adopted, it is necessary to carefully monitor the progress of the management on both the ants and the vegetation.

Note p). As the past management is known it should be a simple process to introduce a less intense system. The different management options have been described above in Note o).

Note q). It may be possible to monitor the success of colonies in the short term by checking on their sexual production. Again, slates placed on the mounds are useful. It is labour intensive and perhaps not desirable to remove all the sexuals from a colony as they are produced. However, gynes production can be monitored to some extent by looking for the gyne potential larvae in Spring. The conditions for collecting ants from underneath a slate have been discussed in section 7.2.1. In the Spring the large larvae to be found in the nests will be the gyne larvae. The numbers present early in the year are an indication of how successfull the colony has been in the past year. To avoid counting larvae in the field when the worker ants are removing them as fast as they can, it is a simple process to simply lift the slate and quickly take a photograph of the ants in the surface galleries, see Figure 7.2. for example. The photograph can then be examined at leisure. A sample of 10 or more colonies is advisable and progress should be monitored for several years.

The model of an ant colony proposed by Brian et al (1981) suggests that the level of sexual production depends on the amount of surplus energy available after the food requirements of the workers have been taken care of. Thus as the environment of the colony becomes more productive the amount of energy available for sexual reproduction should increase, providing the efficiency of the worker population is not reduced due to overcrowding or other factors.

The colonies can also be monitored by measuring the size of the mounds. A sample of mounds can be measured each year to see if size is increasing, decreasing or stable. Consistently decreasing size is likely to be an indication that the management intensity needs to be reduced. At least 20 mounds, selected at random, should be measured. It would also be possible to monitor the progress of individual mounds over many years.

Any information on the progress of ant colonies from the early stages of colony foundation through to maturity and beyond would be valuable in adding to our limited knowledge of the growth of small colonies of L. flavus.

The flora of the area should be monitored as well. Development of scrub (*Crataegus monogyna*, *Cornus sanguinea*, etc) and of coarse grasses, such as *Brachypodium pinnatum* and *Bromus erectus* should be kept in check. The light grazing regimes which are best for *L. flavus* may allow some development of these plants. This should be controlled by hand cutting of scrub and mowing of grasses if necessary. Short term periods of more intense grazing can also be used.

Note r). As discussed in note l) chalk grasslands under conservation management are not very common. Thus an initial aim of establishing new chalk grassland, even without *L. flavus* present, is worthwhile. Management strategies can be adopted to encourage a wide range of both plants and animals. The particular strategy adopted should be considered after consultation with local and national conservation organisations.

20.4. Conclusions.

Like any conservation project, the conservation of *L. flavus* is not something to undertaken without a great deal of thought and preplanning. If possible expert advice should be obtained. While these guidelines apply to the typical situations on chalk grasslands, each area has its own individual characteristics. If large areas are available it may be best to try variations on the basic recommendations, for example by slightly varying the grazing intensity or time of grazing etc.

The conservation of *L. flavus* may not be compatible with other goals of chalk grassland conservation in some areas. For example, in a species rich grassland, the relaxation of a grazing regime may lead to a loss of diversity amongst the plants. It is also likely that the above ground invertebrate community will be modified.

Thus the desire to improve a population of *L. flavus* must be tempered with the knowledge that there may be other less desirable consequences of the management policy adopted.

PART EIGHT

SPECIES INDEX AND REFERENCES

SPECIES INDEX

This section contains a list of the latin names of all of the species mentioned in this thesis, together with the authority, and in some cases the common name. The first page number on which the species is mentioned in the thesis is given. A9 indicates the species will only be listed in Appendix 9, the lists of the flora of the sample areas.

Latin names and authorities of the species follow these authors. (Common names do not necessarily follow the same authors).

Flowering plants, grasses and sedges - Clapham et al (1987).

Mosses and liverworts - Watson (1981).

Lichens - Hawksworth et al (1980).

Fungi - Phillips (1981).

Insects - a variety of sources depending on the group. For some species it has not been possible to find an authority, regrettably some authors of papers do not give authorities with the names.

General - RESL keys.

Coccids - Williams (1962).

Aphids - Paul (1978).

European ants - Collingwood (1979), Agosti (1989).

American ants (some) - Yensen and Clark (1977).

Butterflies - Howarth (1973).

Spiders and Harvestmen - Jones (1983).

Pseudoscorpions - Legg and Jones (1988).

Flowering plants

Grasses/Sedges

Mammals

Birds

Reptiles

Insecta

Diplura

Hymenoptera

Hemiptera: Homoptera

References.

Agosti D. (1989). Versuch einer phylogenetischen wertung der Merkmale der Formicini (Hymenoptera: Formicidae), revision der Formica exsecta-gruppe und liste der Formicidae Europas. Diss. Eth. No. 8774. Doctoral thesis from Eidgennossischen Technischen Hochschule Zurich 277pp.

Alexander R. D. and Sherman P. W. (1977). Local mate competition and parental investment in social insects. Science 196, 494-500.

Allcock P. J. (1973). Treading of chalk grassland. Journal of the Sports Turf Research Institute 49, 21-28.

Amour C. J. and Thompson H. V. (1955). Spread of myomatosis in the first outbreak in Great Britain. Annals of Applied Biology 43, 511-511.

Anderson R. E. (1970). An investigation into the colony odour of the ant Lasius flavus F. Ph.D. thesis, University of Cambridge, England.

Attygalle A. B., Evershed R. P., Morgan E. D. and Cammaerts M. C. (1983). Dufour gland secretions of workers of the ants Myrmica sulcinodis, Myrmica lobicornis and comparison with six other species of Myrmica. Insect Biochem. 13 (5), 507-512.

Ayre G. L. (1962). Problems in using the Lincoln index for estimating the size of ant colonies. J. N. Y. Ent. Soc. 70, 159-166.

Avery B. W. (1964). The soils and land use of the district around Aylesbury and Hemel Hempstead. Mem. Soil Survey Grt. Brit.

Baaker J. P. (1989). Nature management by grazing and cuting. Dr. W. Junk, The Hague, Netherlands.

Bailey N. T. J. (1951). On estimating the size of mobile populations from recapture data. Biometrika 38, 293-306.

Bailey N. T. J. (1952). Improvements in the interpretation of recapture data. J. Anim. Ecol. 21, 120-127.

Bailey R. E. and Putman R. J. (1981). Estimation of fallow deer (Dama dama) populations from faecal accumulation. J. Applied Ecology 18, 697-702.

Baldwin W. F. and Cowper G. (1969). The use of radioactive platinum-iridium wire (Ir-192) as an internal tag for tracing insects. Canadian Entomologist 101, 151-152.

Ballard J. B. and Pruess K. P. (1980). Ant population estimation by removal sampling. Journal of the Kansas Entomological Society 53 (1), 179-182.

Barbour M. G., Burk J. H., and Pitts W. E. (1980). Terrestrial plant ecology. Benjamin/Cummings series in the life sciences. Menlo Park, California.

Baroni-Urbani C. (1979). Territoriality in social insects. In: The Social Insects. Ed. H. R. Hermann. Academic Press. New York.

Barrett K. E. J. (1979). Provisional Atlas of the Insects of the British Isles. Part 5. Hymenoptera: Formicidae. 2nd. Ed. Biological Records Centre. I.T.E. Monkswood, Huntingdon.

Bartlett M. S. (1975). The statistical analysis of spatial pattern. Chapman and Hall, London.

Beattie A. J. (1985). The evolutionary ecology of ant-plant mutualisms. Cambridge Studies in Ecology. Cambridge University Press, Cambridge.

Belsky A. J. (1986). Does herbivory benefit plants? A review of the evidence. American Naturalist 127, 870-892.

Bernard F. (1968). Les fourmis d'Europe occidentale et septentrionale. Masson, Paris.

Bier K. (1952). Zur scheinbaren thelytokie der ameisgattung Lasius. Naturwissenschaften 39, 433.

Bhatkar A. P. and Vinson S. B. (1987). Colony limits in Solenopsis invicta Buren. In, Chemistry and biology of social insects. Ed. Eder J. and Rembold H. 599-600. Verlag J. Peperny, Munich.

Blackith R. E. (1958). Nearest neighbour distance measurements for the estimation of animal populations. Ecology 39, 147-150.

Blackith R. E., Siddorn J. W., Waloff N. and Van Emden H. F. (1963). Mound nests of the Yellow ant Lasius flavus F. on water-logged pasture in Devonshire. Ent. Mon. Mag. 99, 48-49.

Blackwood J. W. and Tubbs C. R. (1970). A quantitative survey of chalk grassland in England. Biological Conservation 3, 1-5.

Blower J. G., Cook L. M. and Bishop J. A. (1981). Estimating the size of animal populations. George Allen and Unwin Ltd. London.

Bolton B. and Collingwood C. A. (1975). Handbooks for the identification of British Insects. Volume 6 (3), 34pp.

Bonavita A. and Poveda A. (1970). Mise en evidence d'une division du travail chez une Fourmi primitive. Comptes Rendus Acad. Sc. Paris, Serie D. 270, 515-518.

Boomsma J. J. (1987). The empirical analysis of sex allocation in monogynous ants. In. Chemistry and biology of social insects, Eds. Eder J. and Rembold H., Verlag J. Peperny, Munich. pp. 355-357..

Boomsma J. J. (1988). Empirical analysis of sex allocation in ants: from descriptive surveys to population genetics. In. Population genetics and evolution. Springer-Verlag, Berlin. Ed. Jong G. de. pp. 42-51.

Boomsma J. J. (1989). Sex-investment ratios in ants: has female bias been systemmatically overestimated? The American Naturalist 133

(4), 517-532.

Boomsma J. J. and De Vries A. (1980). Ant species distribution in a sandy coastal plain. Ecological Entomology 5, (3), 189-204.

Boomsma J. J. and Isaaks J. A. (1985). Energy investment and respiration in queens and males of Lasius niger (Hymenoptera: Formicidae). Behavioural Ecology and Sociobiology 18, 19-27.

Boomsma J. J. and Leusink A. (1981). Weather conditions during nuptial flights of four European ant species. Oecologia 50 (2), 236-241.

Boomsma J. J., Van Der Lee G. A. and Van Der Hawe T. M. (1982). On the production ecology of Lasius niger (Hymenptera: Formicidae) in successive coastal dune valleys. J. Anim. Ecol. 51, 975-991.

Bourke A. F. G. (1988). Worker reproduction in the higher eusocial Hymenoptera. Quarterly Review of Biology 63, 291-311.

Bourne R. A. (1973). A taxonomic study of the ant genus Lasius Fabricius in the British Isles (Hymenoptera: Formicidae).

Box J. D. (1987). Simple technique for the translocation of anthills. Field Studies 6 (4), 617-618.

Bray J. R., and Curtis J.T. (1957). An ordination of the upland forest communities of northern Wisconsin. Ecological Monographs 27, 325-349.

Breen J. (1979). Worker populations of Formica lugubris Zett. nests in Irish plantation woods. Ecol. Ent. 4, 1-7.

Brian M. V. (1951). Summer population changes in colonies of the ant Myrmica. Physiologia Comp. Oecol. 2, 242-262.

Brian M. V. (1965). Social Insect Populations. Academic Press. London.

Brian M. V. (1971). Ants and Termites. In, Methods of study in quantitative soil ecology: population, production and energy flow. IBP Handbook no. 18 Ed. Phillipson J. pp. 247-261. Blackwell

Scientific Publications. Oxford.

Brian M. V. (1977). Ants. New Naturalist No. 77. Collins. London.

Brian M. V. (1983). Social Insects: Ecology and Behavioural Biology. Chapman and Hall. London.

Brian M. V. and Brian A. D. (1951). Insolation and ant population in the West of Scotland. Trans. Roy. Ent. Soc. London. 102, 303-330.

Brian M. V. and Downing B. M. (1958). The nests of British ants. Proc. Xth Int. Cong. Entomol., Montreal, 2, 539-540.

Brian M. V., Elmes G. and Kelly A. F. (1967). Populations of the ant Tetramorium caespitum Latr. J. Anim. Ecol. 36, 337-342.

Brian M. V., Hibble J. and Stradling D. J. (1965). Ant pattern and density in a Southern English Heath. J. Anim. Ecol. 34, 545-555.

Brooks J. L. (1942). Notes on the ecology and occurrence in America of the myrmecophilous sowbug, Platyarthrus hoffmannseggi Brandt. Ecology 23, 427-437.

Brown A. D. (1975). A test of randomness of nest spacing. Wildfowl 26, 102-3.

Buckley W. H. (1934). The rabbit problem in agriculture.

Burden R. F. and Randerson P. F. (1972). Quantitative studies of the effects of human trampling on vegetation as an aid to the management of semi-natural areas. Journal of Applied Ecology 9 (2), 439-457.

Buren W. F. (1944). The ants of Iowa. Iowa State Journal of Science 18, 297.

Cain S. A. and Castro G. M. de Oliveira (1959). Manual of vegetation analysis. Harper, New York.

Campbell D. J. and Clarke D. J. (1971). Nearest neighbour tests of significance for non-randomness in the spatial distribution of singing crickets (<u>Tetrogryllus commodus</u> Walker). Animal behaviour. 19, 750-756.

Carey E. and Diver C. (1937). Territory in the Yellow Field Ant <u>Lasius flavus</u>. J. Anim. Ecol. 6, 193-194.

Chappell H. G., Ainsworth J. F., Cameron R. A. D. and Redfern M. (1971). The effect of trampling on a chalk grassland ecosystem. Journal of Applied Ecology 8, 869-882.

Charnov E. L. (1978). Sex ratio selection in eusocial Hymenoptera. The American Naturalist 112, 317-326.

Charnov E. L. (1982). The theory of sex allocation. Monographs in population biology. Volume 18. Princeton University Press.

Chatters C. (1990). Rape of our country. Hants and Wight Wildlife. January 1990.

Chew R. M. (1959). Estimation of ant colony size by the Lincoln index method. J. N. Y. Ent. Soc. 67, 157-161.

Chew R. M. (1987). Population dynamincs of colonies of 3 species of ants in desertified grassland, Southeastern Arizona, 1958-1981. The American Midland Naturalist 118, (1), 177-188.

Christiansen K. (1964). Bionomics of Collembola. Ann. Rev. Ent. 9, 147-178.

Clapham A. R. (1936). Overdispersion in grassland communities and the use of statistical methods in plant ecology. J. Ecol. 24, 232-251.

Clapham A. R., Tutin T. G. and Moore D. M. (1987). Flora of the British Isles, 3rd Edition. Cambridge University Press, Cambridge.

Clark P. J. and Evans F. C. (1954). Distance to nearest neighbour as a measure of spatial relationships in populations. Ecology 35, 445-453.

Clark P. J. and Evans F. C. (1979). Generalization of a nearest neighbour measure of dispersion for use in K dimensions. Ecology 35, 445-453.

Cloudsley-Thompson J. L. and Sankey J. H. P. (1958). Some aspects of the fauna of the district around Juniper Hall, Mickleham, Surrey, IV. Entomologists Monthly Magazine 94, 43-47.

Clutton-Brock T. H. and Albon S. D. (1982). Parental investment in male and female offspring in mammals. In. Current problems in sociobiology. Cambridge University press. pp. 223-248.

Cobbett W. (1830). 'Rural rides.' William Cobbett, London.

Collingwood C. A. (1957). The species of ants of the genus Lasius in Britain. J. Soc. Brit. Ent. 5, (7), 204-214.

Collingwood C. A. (1979). Fauna entomologica Scandinavia. Volume 8. The Formicidae (Hymenoptera) of Fennoscandia and Denmark. Scandinavian Science Press Ltd. Klampenborg. Denmark.

Connell J. H. (1963). Territorial behaviour and dispersion in some marine invertebrates. Researches on Population Ecology 5, 87-101.

Coombs F. (1978). The crows. Batsford, London.

Costin A. B. and Moore D. M. (1960). The effects of rabbit grazing on the grasslands of Macquarie Island. J. Ecol. 48, 729-732.

Cottam G. and Curtis J. T. (1949). A method for making rapid surveys of woodlands by means of pairs of randomly selected trees. Ecology 30, 101-104.

Cottam G. and Curtis J. T. (1955). Correction for various exclusion angles in the random pairs method. Ecology 36, 767.

Cottam G. and Curtis J. T. (1956). The use of distance measurements in phytosociological sampling. Ecology 37, 451-461.

Cottam G., Curtis J. T. and Hale B. W. (1953). Some sampling characteristics of a population of randomly dispersed individuals.

Ecology 34, 741-757.

Cowdy S. (1973). Ants as a major food source of the Chough. Bird Study 20, 117-120.

Cox G. W. (1976). Laboratory manual of general ecology. 3rd Ed. Dubuque IA: W. C. Brown.

Cox G. W. and Atkins M. D. (1979). Agricultural ecology. W. H. Freeman and Co., San Francisco.

Craig R. (1980). Sex investment ratios in social Hymenoptera. The American Naturalist 116, 311-323.

Crawley W. C. and Donisthorpe H. St. J. K. (1913). The founding of colonies by queen ants. Int. Ent. Cong. Oxford 1912, Volume 2, 11-77.

Crozier R. H. (1979) Genetics of sociality. In: Herman H. R. Ed, Social Insects. Volume 1. pp. 223-286. Academic Press. London.

Crutchley J. (1794) General view of the agriculture of the county of Rutland. Board of Agriculture, London.

Curtis J. T. (1950). Original forest structure. Paper at the AAAS Symposium on structure of plant communities, Cleveland 30/12/50.

Cushman J. H., Martinsen G. D. and Mazeroll A. I. (1988). Density and size dependant spacing of ants nests: evidence for intraspecific competition. Oecologia 77, (4), 522-525.

Czekanowski J. (1909). Zur differential diagnose der Neandertalgruppe. Korrespbl. dt. Ges. Anthrop. 40, 44-47.

Czekanowski J. (1913). Zarys Metod Statystcznyck. Warsaw.

Czerwinski Z., Jakubczyk H. and Petal J. (1971). Influence of ant hills on the meadow soils. Pedobiologica 11, 277-285.

Defoe D. (1724). 'A tour through the whole Island of Great Britain'. Straton, London.

De Bruyn L. L. A. and Conacher A. J. (1990). The role of termites and ants in soil modification: a review. Australian Journal of Soil Research 28 (1), 55-94.

De Leeuw J. and Bakker J. P. (1986). Sheep grazing with different foraging efficiencies in a Dutch mixed grassland. J. Applied Ecology 23, 781-793.

De Vos S. (1973). The use of nearest neighbour methods. Tijdschrift voor econ. en. Soc. Geografie 64 (5), 307-319.

Diggle P. J. (1976). Note on the Clark and Evans test of spatial randomness. In: Spatial analysis in archaeology. Ed. Hodder I. and Orton C., Cambridge University Press, Cambridge.

Diggle P. J. (1983). Statistical analysis of spatial point patterns. (Mathematics in biology). Academic Press, London.

Dlusskij G. M. (1981). Nester von Lasius flavus (Hymenoptera: Formicidae). Pedobiologia 21 (2), 81-99.

Dobrzanski J. (1966). Contribution to the ethology of Leptothorax acervorum. Acta Biologia Experimentalis. 26, 71-78.

DOE (1975-). Atlas of the environment, England and Wales. Vol. 1. Department of the Environment, London.

Doncaster C. P. (1981). The spatial distribution of ants nests on Ramsey Island, South Wales. J. Anim. Ecol. 50, 195-218.

Donelly K. (1978). Simulations to determine the varience and edge effect of total nearest neighbour distance. In, Simulation Methods In Archaeology. Ed. Hodder I. Cambridge University Press, London, England.

Donisthorpe F. Z. S. (1915). British Ants their life history and classification. William Brendon and Son Ltd. Plymouth.

Donisthorpe F. Z. S. (1927). The guests of British ants, their habits and life histories. G. Routledge and Sons Ltd. London.

Duckett D. P. (1975). Further studies of ant-aphid interaction. Ph.D. Thesis. London University.

Duffey E. (1974). Lowland grassland and scrub: management for wildlife. In: Conservation in practice, Eds. Warren A. and Goldsmith F. B. John Wiley and Sons, London. p167-183.

Duffey E., Morris M. G., Sheail J., Ward L. K., Wells D. A. and Wells T. C. E. (1974). Grassland ecology and wildlife management. Chapman and Hall. London.

Dumpert K. (1981). The social biology of ants. (Translated by C. Johnson). Pitman International series in neurobiology and behaviour. Boston.

Duncan P. M. (1896). (Ed.). Cassell's Natural History, Volume V, Peoples Edition. Cassell and Co. Ltd. London.

Edington J. M. and Edington M. A. (1972). Spatial patterns and habitat partition in the breeding birds of an upland woodland. J. Anim. Ecol. 41 (2), 331-357.

Ehrlich P. R., Dobkin D. S. and Wheye D. (1986). The adaptive significance of anting. The Auk 103 (4), 835.

Eidmann H. (1926). Die Koloniegrundung der einheimischen Ameisen. Z. Ver. Physiol. 3, 776-826.

Eickwort G. C. (1990). Associations of mites with social insects. Annual Review of Entomology 35, 469-488.

Eisner T. E. and Wilson E. O. (1958). Radioactive tracer studies of food transmission in ants. 10th Int. Cong. Entomol. 2, 509-513.

Elmes G. W. (1974). The spatial distribution of a population of two ant species living in limestone grassland. Pedobiologica Bd. 14, 412-418.

Elmes G. W. and Wardlaw J. C. (1982). A population study of the ants Myrmica sabuleti and Myrmica scabrinodis, living at two sites in the south of England. I. A comparison of colony populations. J. Anim. Ecol. 51, (2), 665-680.

Elton C. S. (1966). The pattern of animal communities. Methuen, London.

Erickson J. M. (1972). Mark-recapture techniques for population estimates of Pogonomyrmex and colonies: an evaluation of the 32P technique. Ann. ent. Soc. Am. 65, 57-61.

Fellers G. M. (1982). Scavenging rates of invertebrates in an eastern deciduous forest. The American Midland Naturalist 107 (2), 389-392.

Fenner F. and Ratcliffe F. N. (1965). Myxomatosis. Cambridge University Press, London.

Fisher R. A. (1958). The genetical theory of natural selection. 2nd. Ed. Dover, New York.

Floate M. J. S. (1970). Decomposition of organic materials from hill soils and pastures. IV. The effects of moisture content on the mineralization of carbon, nitrogen and phosphorus from plant materials and sheep faeces. Soil Biology and Biochenistry 2, 275-283.

Floate M. J. S. (1973). Soils associated with grass and heather moorland and some long-term changes related to grazing influences. Journal of Science, Food and Agriculture 24, 1149.

Fogg G. E. (1970). The growth of plants. Penguin Books, Middlesex.

Forel A. (1928) The social world of the ants. The County Press, Bradford.

Fowler H. G. (1983). Individual specializations on nectaries of Euphorbia esula by Formica pallidefulva workers. Sociobiology 8

(2), 99-103.

Frank S. A. (1985). Hierachical selection theory and sex ratios. II. On applying the theory, and a test with fig wasps. Evolution 39, 949-964.

Franks N. R. and Scovell E. (1983). Dominance and reproductive success among slave-making ants. Nature 304, 724-725.

Fresneau D. and Charpin A. (1977). Une solution photographique au probleme du marquage individuel des petits insectes. Annals of the Entomological Society of France (N. S.) 13 (3), 423-426.

Frisch von K. (1923). Uber die "Sprache" der Bienen, eine tierpsychologishche Untersuchung. Zoologische Jahrbucher Abteilung fur Allgmeine Zoologie und Physiologie der Tiere 40, 1-186.

Frisch von K. (1965). Tanzsprache und Orientierung der Bienen. GFR: Springer Verlag, Berlin.

Gary N. E. (1971). Magnetic retrieval of ferrous labels in a capture-recapture system for honey bees and other insects. Journal of Economic Entomology 64, 961-965.

Gauld I. and Bolton B. (1988). The Hymenoptera. Oxford University Press, Oxford.

Georgiadis N. J., Ruess R. W., McNaughton S. J. and Western D. (1989). Ecological conditions that determine when grazing stimulates grass production. Oecologia 81, 316-322.

Gibson C. W. D., Dawkins H. C., Brown V. K. and Jepsen M. (1987a). Spring grazing by sheep: effects on seasonal changes during early old field succession. Vegetatio 70, 33-43.

Gibson C. W. D., Watt T. A. and Brown V. K. (1987b). The use of sheep grazing to recreate species-rich grassland from abandoned arable land. Biological Conservation 42, 165-183.

Gillham M. E. (1955). Some possible consequences if rabbits should be exterminated by myxomatosis on Skokholm Island, Pembrokeshire. Northwestern Naturalist ??, 30-34.

Goldberg J., Garnier Sillam E. and Guilles-Escuret G. (1983). Zoology of invertebrates - a method of collective markage in Reticulitermes (Rhinotermitidae). Compte Rendus des Sceances de L'Academiedes Sciences. Serie III. 297, (3), 127-129.

Goldsmith F. B., Harrison C. M. and Morton A. J. (1986). Description and analysis of vegetation. In, Methods in plant ecology. Ed. Moore P. D. and Chapman S. B., pp 437-524.

Gosswald K. (1932). Okologische Studien uber die Ameisenfauna des mittleren Main-gebieties. Z. Wiss. Zool. 142, 1-156.

Gosswald K. and Kloft W. (1963). Tracer experiments on food exchange in ants and termites. In, Radiation and radioisotopes applied to insects of agricultural importance. International Atomic Energy Agency, Vienna.

Gotwald W. H. Jr. (1982). Army ants. In. Social Insects. Ed. Hermann H. R. IV, 157-254, Academic Press, New York.

Gough M. W. and Marrs R. H. (1990). A comparison of soil fertility between semi-natural and agricultural plant communities: Implications for the creation of species-rich grassland on abandoned agricultural land. Biological Conservation 51 (2), 83-96.

Gould W. (Rev.) (1747). An account of English Ants. Millar, London.

Grace J. K. and Abdally A. (1989). Evaluation of the dye marker Sudan red 7B with Reticulitermes flavipes (Isoptera: Rhinotermitidae). Sociobiology 15 (1), 71-78.

Graham D. J. and Hutchings M. J. (1988a). Estimation of the seed bank of a chalk grassland ley established on former arable land. J.

Applied Ecology 25 (1), 241-252.

Graham D. J. and Hutchings M. J. (1988b). A field investigation of germination from the seed bank of a chalk grassland ley on former arable land. J. Applied Ecology 25 (1), 253-263.

Green B. H. (1973). Practical aspects of chalk grassland management in the Nature Conservancy's south-east region. In, Chalk grassland - studies on its conservation and management in the south-east. Eds. Jermy A. C. and Stott P. A., Kent Trust for Nature Conservation, Kent. pp. 42-47.

Green P. J. and Sibson R. (1978). Computing Dirichlet tessellations in the plane. Computing Journal 21, 168-173.

Green R. D. and Askew G. P. (1965). Observations on the biological development of macropores in soils of Romney Marsh. J. Soil. Sci. 16, 342-349.

Greig-Smith P. (1952). The use of random and contiguous quadrats in the study of the structure of plant communities. American botanist 16, 293-316.

Griffiths J. W. (1968). Studies in chalkland ecology with special reference to the flora of ant-hills. M. I. Biol. thesis. Institute of Biology, London.

Grubb P. J., Green H. E. and Merrifield R. C. J. (1969). The ecology of chalk heath: its relevance to the calcicole-calcifuge and soil acidification problems. J. Ecol. 57, 175-212.

Haarlov N. (1960). Microarthropods from Danish soils. Oikos, Supplement 3. 175pp.

Hamilton W. D. (1964). The genetical evolution of social behaviour I. and II. J. Theoretical Biology 7, 1-52.

Hamilton W. D. (1967). Extraordinary sex ratios. Science 156, 477-488.

Hamilton W. D. (1972). Altruism and related phenomena, mainly in social insects. Annual review of systemmatics and ecology. 3, 193-232.

Hamming R. and Gilbert E. (1954). Probability of occurence of a constant number of isolated pairs in a random population. University of Wisconsin Computing News, No. 32.

Hanks J., Parsons M. and Lee H. (1980). Swarming observations on the ant Lasius flavus. Newsletter Ins. Behav. Ants. Study Group. No. 21, 2-3.

Harding D. A. (1973). Chalk grassland soils and angiosperm diversity. In, Chalk grassland - studies on its conservation and management in the south-east. Eds. Jermy A. C. and Stott P. A., Kent Trust for Nature Conservation, Kent. pp. 16-26.

Harrison A. F. (1985). Effects of environment and management on phosphorus cycling in terrestrial ecosystems. Journal of Environmental Management 20, 163-180.

Harrison J. S. and Gentry J. B. (1981). Foraging pattern, colony distribution and foraging range of the Florida harvester ant Pogonomyrmex badius. Ecology 62, 1467-1473.

Hawksworth D. L., James P. W. and Coppins B. J. (1980). Checklist of British lichen forming, lichenicolous and allied fungi. Lichenologist 12 (1), 1-115.

Hayashida K. (1960). Studies on the ecological distribution of ants in Sappora and its vicinity (I. and II.) Insectes Sociaux 5 (2), 125-162.

Henson W. R. (1961). Laboratory studies on the adult behaviour of Conopthorus coyperda (Schwartz) (Coleoptera: Scolytidae) II. Thigmotropic aggregation. Annals of the entomological society of

America. 54, 810-819.

Herre E. A. (1985). Sex ratio adjustment in fig wasps. Science 228, 896-898.

Herre E. A. (1987). Optimality, plasticity and selective regime in fig wasp sex ratios. Nature 329, 627-629.

Hodder I. (1971). The use of nearest neighbour analysis. Cornish Archaeology 10, 35-36.

Hodder I. and Orton C. (1976). Spatial analysis in archaeology. Cambridge University Press, Cambridge.

Hodgson J. M. (1967). Soils of the West Sussex coastal plain. Bulletin no. 3, Soil Survey Grt. Brit.

Holldobler B. (1974). Home range orientation and territoriality in harvesting ants. Proc. Nat. Acad. of Sciences USA 71, 3274-3277.

Holldobler B. (1976). Recruitment behaviour, home range orientation and territoriality in harvester ants, *Pogonomyrmex*. Behavioural ecology and sociobiology 4, 163-181.

Holt S. J. (1955). On the foraging activity of the wood ant. J. Anim. Ecol. 24, 1-34.

Hopkins B. (1954). A new method for determining the type of distribution of plant indiividuals. Annals of Botany N. S. 18, 213-217.

Hopkins B. (1955). The species area relations of plant communities. J. Ecol. 409-426.

Horton C. C. and Wise D. H. (1983). The experimental analysis of competition between two syntopic species of orb-web spiders (Aranea: Araneidae). Ecology 64 (4), 929-944.

Howard P. J. A. and Howard D. M. (1976). Respiration, litter nutrients and soil organic matter in grazed and ungrazed upland limestone grassland. Merlewood Research and Development Paper No. 67.

Howarth T. G. (1973). South's British Butterflies. Frederick Warne, London.

Huber P. (1810). 'Vie et moeurs des fourmis indigenes.' Paris and Geneva.

Hubbell S. P. and Johnson L. K. (1977). Competition and nest spacing in a tropical stingles bee community. Ecology 58, 949-963.

Hudson W. H. (1928). Nature in downland. Longmans, Green and Co., London.

Hutchings M. J. and Discombe R. J. (1986). The detection of spatial pattern in plant populations. Journal of Biogeography 13, 225-236.

Imai H. T. (1965). Nuptial flight and multiple mating observed in the formicine ant, Lasius niger. Ann. Rep. Natl. Inst. Genet. Japan 16, 54-55.

Ito M. (1980). Trampling impact on soil fauna at the summit of Mt. Jimba. Edaphologia 21, 5-15.

Janet C. (1897). Sur les rapports de l'Antennophorus uhlmanni Haller avec le Lasius mixtus Nyl. Comptes Rendu de l'Academie des Sciences, Paris 124 (11), 583-585.

Jensen T. F. and Nielsen M. G. (1975). The influence of body size and temperature on worker ant respiration. Natura Jutlandica 18, 21-25.

Jermy A. C. and Stott P. A. (1973). Chalk grassland - studies on its conservation and management in the south-east. Kent Trust for Nature Conservation, Kent.

Jones D. (1983). The country life guide to spiders of Britain and Northern Europe. Country Life, Feltham.

Jones G. E. (1987). The conservation of ecosystems and species. (Croom Helm natural environment; problems and management series) London.

Kay Q. O. N. and Woodell S. R. J. (1976). The vegetation of ant-hills in West Glamorgan saltmarshes. Nature in Wales 15, 81-87.

King T. J. (1972). The plant ecology of ant-hills in grasslands. D. Phil thesis, University of Oxford.

King T. J. (1977). The plant ecology of ant-hills in calcareous grasslands. a. I. Patterns of species in relation to ant-hills in southern England. J. Ecol. 65, 235-256.

King T. J. (1977). The plant ecology of ant-hills in calcareous grasslands. b. II. Succession on the mounds. J. Ecol. 65, 257-278.

King T. J. (1977). The plant ecology of ant-hills in calcareous grasslands. c. III. Factors affecting the population sizes of selected species (of plants). J. Ecol. 65, 279-315.

King T. J. (1981a). Ant-hill vegetation in acidic grasslands in the Gower Peninsula, south Wales. New Phytologist 88 (3), 559-572.

King T. J. (1981b). Ant-hills and grassland history. Journal of Biogeography 8, 329-334.

King T. J. and Woodell S. R. J. (1975). The use of the mounds of Lasius flavus in teaching some principles of ecological investigation. Journal of Biological Education 9, 109-113.

Kloet G. S. and Hincks W. D. (1964). A check list of British insects, part 1. RESL, London.

Kloft W. B., Holldobler B. and Haisch A. (1960). Traceruntersuchungen zur Abgrenzung von Nestarealen holzzerstorenden Rossameisen Camponotus herculeanus (L.) und C. ligniperda (Latr.). Entomologica exp. appl. 8, 20-26.

Kruk-de Bruin M., Rost L. C. M. and Draism F. G. A. M. (1977). Estimates of the number of foraging ants with the Lincoln-index method in relation to the colony size of Formica polyctena. J.

Anim. Ecol. 46, 457-470.

Kusnetskov-Urgamskij N. N. (1929). Die Ameisen des Sud-Ussuri-Gebietes. Zool. Anz. 83, 16-34.

Lamberti G. A. and Resh V. H. (1983). Stream periphyton and insect herbivores: an experimental study of grazing by a caddis-fly population. Ecology 64, (5), 1124-1135.

Lambley P. W. (1967). Special investigation into ant-hills. B.Sc. honours thesis, University of Leicester.

Legg G. and Jones R. E. (1988). Pseudoscorpions. Synopses of the British Fauna (New Series) No. 40. Linnean Society of London (E. J. Brill/Dr. W. Backhuys), Leiden.

Lehtinen P. T. (1987). Association of uropodid, prodinychid, polyaspidid, antennophorid, sejid, microgynid and zerconid mites with ants. Entomol. Tidskr. 108, 13-20.

Levings S. and Traniello J. F. A. (1981). Territoriality, nest dispersion and community structure in ants. Psyche 88, 265-319.

Liddle M. J. (1975a). A selective review of the ecological effects of human trampling on natural ecosystems. Biological Conservation 7, 17-36.

Liddle M. J. (1975b). A theoretical relationship between the primary productivity of vegetation and its ability to tolerate trampling. Biological Conservation 8, 251-255.

Linder C. (1908). Observations sur les fourmilieres-boussoles. Bull. Soc. Vaud. Sci. Nat. 44, 303-310.

Lindsey A. A., Barton J. D. and Miles S. R. (1958). Field efficiences of forest sampling methods. Ecology 39, 428-444.

Lloyd H. G. (1970). Post myxomatosis rabbit populations in England and Wales. European plant protection organisation publications, Series

A, 58, 197-215.

Lockley R. M. (1956). The observed effects of myxomatosis on rabbit populations and behaviour and on wildlife generally. Terre et la Vie 103, 211-219.

Lofgren C. S. and Vander Meer R. K. (1986). Fire ants and leaf cutting ants. Westview studies in insect biology. Westview Press, Boulder, Colorado, U.S.A.

Lousley J. E. (1950). Wild flowers of chalk and limestone. New Naturalist no. 16. Collins. London.

Lubbock J. Sir (1882). Ants, bees and wasps. Kegan Paul, Trench and Co. London.

Lull H. W. (1959). Soil compaction of forest and range lands. Washington U.S.D.A. Forest Service, Misc. Publication No. 768.

Maarel E. van der and Titlyanova A. (1989). Above-ground and below-ground biomass relations in steppes under different grazing conditions. Oikos 56, 364-370.

Mabelis A. A. (1979). The relationship between aggression and predation in the red wood ant (_Formica polyctena_ Forst). Netherlands Journal of Zoology 29, 451-620.

Marrs R. H., Rizand A. and Harrison A. F. (1989). The effects of removing sheep grazing on soil chemistry, above ground nutrient distribution, and selected aspects of soil fertility in long-term experiments at Moor House National Nature Reserve. J. Appl. Ecol. 26, 647-661.

Marshall V. G. (1972). Comparison of two methods of estimating efficiency of funnel extraction for soil microarthropods. Soil biology and biochemistry 4, 417-426.

Maschinski J. and Whitham T. G. (1989). The continuum of plant responses to herbivory: the influence of plant association, nutrient availability, and timing. American Naturalist 134 (1), 1-19.

May R. M. (1989). An inordinate fondness for ants. Nature 341, no. 6241, 386-387.

McClure M. S. (1976). Spatial distribution of pit making ant lion larvae (Neuroptera: Myrmeliontidae): density effects. Biotropica 8, 179-183.

Mclachlan K. D. (1968). Stocking rate and the superphosphate requirements of sown pasture on acid soil. Australian Journal of Experimental Agriculture and Animal Husbandry 8, 33-39.

Mclachlan K. D. and Norman B. W. (1966). Observations on the superphosphate requirements of two grazing experiments. Australian Journal of Experimental Agriculture and Animal Husbandry 6, 22-24.

Macnair M. R. (1978). An ESS for the sex ratio in animals, with particular reference tothe social Hymenoptera. J. Theor. Biol. 70, 449-459.

McNaughton S. J. (1983). Compensatory plant growth as a response to herbivory. Oikos 40, 329-336.

McNaughton S. J. (1986). On plants and herbivores. American Naturalist 128, 765-770.

Mead-Briggs A. R. (1977). The European rabbit, the European rabbit flea and myxomatosis. Applied Biology 2, 183-261.

Medlar J. T. and Wagner R. O. (1964). Isotopes to estimate colony size of Formica cinerea Mayr. (Hymenoptera: Formicidae). J. N. Y. Ent. Soc. 72, 151-159.

Menozzi C. (1922). Contribution ala faune myrmecologique de l'Espago. Bol. Soc. Esp. Hist. Nat. 22, 324-332.

Moore I. (1966). Grass and grasslands. New Naturalist no. 48. Collins, London.

Moore P. D. and Chapman S. B. (1986). Methods in plant ecology. Blackwell Scientific Publications, Oxford.

Morisita M. (1954). Estimation of population density by spacing method. Memoirs of the Faculty of Science of Kyushu University, Series E. 1, 187-197.

Morley D. W. (1953). Ants. Collins, New Naturalist, London.

Morris M. G. (1967). Differences between the invertebrate faunas of grazed and ungrazed chalk grassland. 1. Response of some phytophagous insects to cessation of grazing. J. Appl. Ecol. 4, 459-474.

Morris M. G. (1968). Differences between the invertebrate faunas of grazed and ungrazed chalk grassland. 2. The faunas of sample turves. J. Appl. Ecol. 5, 601-611.

Morris M. G. (1969a). Differences between the invertebrate faunas of grazed and ungrazed chalk grassland. 3. The heteropterous fauna. J. Appl. Ecol. 6, 475-487.

Morris M. G. (1969b). Populations of invertebrate animals and the management of chalk grasslands in Britain. Biological Conservation 1, 225-231.

Morris M. G. (1971). Differences between the invertebrate faunas of grazed and ungrazed chalk grassland. 4. Abundance and diversity of Homoptera-Auchenorhynca. J. Appl. Ecol. 8, 37-52.

Morris M. G. (1971b). The management of grassland for the conservation of invertebrate animals. Symp. Br. ecol. Soc. 11, 527-552.

Morris M. G. (1973). Chalk grassland management and the invertebrate fauna. In. Chalk grassland - studies on its conservation and management. Eds. Jermy A. C. and Stott P. A. Kent Trust for Nature Conservation, Maidstone, p27-34.

Mueller-Dombois D. and Ellenberg H. (1974). Aims and methods of vegetation ecology. Wiley, New York.

Muir D. A. (1959). The ant-aphid-plant relationship in West Dumbartonshire. J. Anim. Ecol. 28, 133-140.

Myers K. and Poole W. E. (1963). A study of biology of the wild rabbit, Oryctolagus cuniculus (L.) in confined populations. IV. The effects of rabbit grazing on sown pastures. J. Ecol. 51, 435-451.

NCC (1977). Old Winchester Hill, NNR. NCC South Region, Newbury.

NCC (1982). Chalk grassland, its conservation and management. NCC, Peterborough.

Neave H. R. (1978). Statistics Tables. George Allen and Unwin, London.

Neff D. J. (1968). The pellet group count technique for big game trend, census and distribution. J. Wildlife Management 29, 723-729.

Newcombe H. R. (1970). The spacial distribution of hill forts in West Penrith. Cornish Archaeology 9, 47-52.

New G. (1969). Old Winchester Hill National Nature Reserve Soils Report. NCC unpublished document.

Newton I., Marquiss M., Weir D. and Moss D. (1977). Spacing of sparrowawk nesting terrritories. J. Anim. Ecol. 46, 425-445.

Nielsen M. G. (1972). An attempt to estimate the energy flow through a population of workers of Lasius alienus (Foerst) (Hymenoptera: Formicidae). Natura Jutlandica 16, 99-107.

Nielsen M. G. (1982). The ant fauna on the high salt marsh. In. Terrestrial and freshwater fauna of the Wadden Sea area. Ed. Smit C. J., den Hollander J., van Wingerden W. K. R. E. and Wolff W. J.; A. A. Balkema, Rotterdam.

Nielsen M. G., Skyberg N. and Winther L. (1976). Studies on Lasius flavus F. (Hymenoptera, Formicidae): I. Population density, biomass and distribution of nests. Entomologiske Meddeleser 44, 65-75.

Nielsen M. G., Skyberg N. and Peakin G. J. (1985). Respiration in the sexuals of the ant Lasius flavus. Physiological Entomology 10 (2), 199-204.

Nixon G. E. J. (1951). The association of ants with aphids and coccids. Commonwealth Institute of Entomology, London.

Nonacs P. (1986). Ant reproductive strategies and sex allocation theory. Quarterly review of biology. 61 (1), 1-22.

Noy-Meir I., Gutman M. and Kaplan Y. (1989). Responses of Mediterranean grassland plants to grazing and protection. J. Ecol. 77, 290-310.

Odum E. P. and Pontin A. J. (1961). Population density of the underground ant Lasius flavus as determined by tagging with 32P. Ecology 42, (1), 186-188.

O'Rourke F. J. (1950). Distibution and general ecology of the Irish Formicidae. Proc. R. Irish Acad. B. 52, 383-410.

Oster G., Eshel I. and Cohen D. (1977). Worker-queen conflict and the evolution of social insects. Theoretical Population Biology 12, 49-85.

Otto D. (1985). Ueber die Arbeitsteilung im Staate von Formica rufa rufo-pratensis minor Gossw. und ihre verhaltenphysiologischen Grundlagen. Wissenschaftliche Abhandlungen der Deutschen Akademie der Landwirtschaftswissenschaften zu Berlin. No. 30.

Page R. E. Jr. (1986). Sperm utilization in social insects. Ann. Rev. Entomol. 31, 297-320.

Painter R. B. (1971). A hydrological classification of the soils of

England and Wales. Proceedings of the Institute of Civil Engineers 48, 93-95.

Pamilo P. (1982). Genetic evolution of sex ratios in eusocial Hymenoptera: allele frequency simulations. The American Naturalist 119, 638-656.

Pamilo P. and Rosengren R. (1983). Sex ratio strategies in Formica ants. Oikos. 40, 24-35.

Paul R. G. (1978). Aspects of the biology and taxonomy of British myrmecophilous root aphids. Ph.D. Thesis, Imperial College of Science and Technology, University of London.

Peakin G. J. (1960). The influence of humidity on the organisation of ant colonies both in the field and in the laboratory. Ph.D. thesis University of London.

Peakin G. J. (1972). Aspects of productivity in Tetramorium caespitum L. Ekologia Polska. 20 (6), 55-63.

Peakin G. J. (1985). The growth and development of the overwintering larvae of the ant Lasius flavus (Hymenoptera, Formicidae). J. Zool., Lond. (A). 205, 179-189.

Peakin G. J., Nielsen M. G., Skyberg N. and Pedersen J. (1985). Respiration in the larvae of the ants Myrmica scabrinodis and Lasius flavus. Physiological Entomology 10, 205-214.

Peakin G. J., Nielsen M. G. and Skyberg N. (1989). Respiration during the metamorphosis of sexuals in Lasius flavus (Hymenoptera: Formicidae). Physiological Entomology 14 (2), 203-210.

Pearson E. S. and Hartley H. O. (1966). Biometrika tables for statisticians, Vol 1. Cambridge University Press, Cambridge.

Peebles P. J. E. (1974). The nature of the distribution of galaxies. Astronomy and Astrophysics. 32, 197-202.

Penman H. L. (1952). Water and plant growth. Agric. Prog. 27, 147-154.

Petal J. (1978). The role of ants in ecosystems. In: M. V. Brian. Ed. Production ecology of ants and termites. pp. 293-331. Cambridge University Press. Cambridge.

Petersen H. and Luxton M. (1982). A comparative analysis of soil fauna populations and their role in decomposition processes. Oikos 39 (3), 287-388.

Perring F. H. (1959). Topographical gradients of chalk grassland. J. Ecol. 47, 447-481.

Phillips R. (1981). Mushrooms and other fungi of Great Britain and Europe. Pan, London.

Pickles W. (1940a). Fluctuations in the populations, weights and biomasses of ants at Thornhill, Yorkshire, from 1935 to 1939. Trans. R. Ent. Soc. Lond. 90, 467-485.

Pickles W. (1940b). The effects of ants on the acidity of the soil. Ent. Mon. Mag. 76, 49-52.

Pickles W. (1942). Mound building by the ant Lasius flavus F. Ent. Mon. Mag. 78, 38-39.

Pielou E. C. (1960). A single mechanism to account for regular, random and aggregated populations. J. Ecol. 48, 575-584.

Piggott C. D. (1955). Biological flora of the British Isles: Thymus L. J. Ecol. 43, 365-387.

Pontin A. J. (1958). A preliminary note on the eating of aphids by ants of the genus Lasius (Hymenoptera, Formicidae). Ent. Mon. Mag. 94, 9-11.

Pontin A. J. (1960). Field experiments on colony foundation by Lasius niger L. and L. flavus F. (Hymenoptera: Formicidae). Insectes Sociaux 7, 227-230.

Pontin A. J. (1961a). The prey of <u>Lasius niger</u> (L.) and <u>L. flavus</u> F. (Hymenoptera, Formicidae). Ent. Mon. Mag. 97, 135-137.

Pontin A. J. (1961b). Population stabilization and competition between the ants <u>Lasius flavus</u> (F.) and <u>L. niger</u> (L.). J. Anim. Ecol. 61, 47-54.

Pontin A. J. (1963). Further considerations of competition and the ecology of the ants <u>Lasius flavus</u> (F.) and <u>L. niger</u> L. J. Anim. Ecol. 32, 565-574.

Pontin A. J. (1969). Experimental transplantation of nest mounds of the ant <u>Lasius flavus</u> (F.) in a habitat containing also <u>L. niger</u> (L.) and <u>Myrmica scabrinodis</u> Nyl. J. Anim. Ecol. 38, 747-754.

Pontin A. J. (1978). The numbers and distribution of subterranean aphids and their exploitation by the ant <u>Lasius flavus</u> F. Ecol. Ent. 3, (3), 203-207.

Porter S. D. and Jorgensen C. D. (1980). Recapture studies of the Harvester Ant, <u>Pogonomyrmex owyheei</u> Cole, using a fluorescent marking technique. Ecol. Ent. 5, 263-269.

Potts G. R. (1970). Recent changes in the farmland fauna with special reference to the decline of the grey partridge. Bird Study 17, 145-166.

Praeger R. (1901). Irish topographical botany.

Prescott R. (1983). Hampshires Countryside Heritage, No. 6. Chalk Grassland. Gabare Ltd, Hampshire.

Provost E. (1983). Une nouvelle methode de marquage permettant l'indentificaton des membres d'une societe de fourmis. Insectes Sociaux 30, (3), 255-558.

Ranwell D. S. (1960). Newborough Warren, Anglesey III. Changes in the vegetation on parts of the dune system after the loss of rabbits by myxomatosis. J. Ecol. 48, 385-395.

Ratcliffe D. (Ed.) (1977). A Nature Conservation Review. 2 vols. Cambridge University Press, England.

Ratcliffe F. N. (1956). The ecological consequences of myxomatosis in Australia. Terre et la Vie 3, 153-166.

Raunkiaer C. (1934). The life forms of plants and statistical plant geography. Oxford.

Richards O. W. and Waloff N. (1954). Studies on the biology and population dynamics of British grasshoppers. Anti-Locust Bulletin 17, 1-182.

Richardson. (1894). Letter to editor. Ent. Mon. Mag. 30, 213.

Ridley H. N. (1930). The dispersal of plants throughout the world. Ashford.

Riordan D. F. (1960). The location of nests of carpenter ants (Camponotus spp.) by means of a radioactive isotope. Insectes Sociaux 7, 353-355.

Ripley B. D. (1979). Tests of randomness for spatial point patterns. J. R. Statistical Soc. B. 41, 368-374.

Ripley B. D. (1981). Spatial statistics. Wiley, Chicester.

Rizand A., Marrs R. H., Gough M. W. and Wells T. C. E. (1989). Long term effects of various conservation management treatments on selected soil properties of chalk grassland. Biological Conservation 49, 105-112.

Robinson G. E., Underwood B. A. and Henderson G. E. (1984). A highly specialised water-collecting honey-bee. Apidologie 15, 355-358.

Rogers C. A. (1964). Packing and Covering. Cambridge University Press, London.

Rooum D. (1989). Karl von Frisch and the 'spot codes' for marking insects. The bee world 70 (3), 120-126.

Ryti R. T. and Case T. J. (1986). Overdispersion of ant colonies: a test of hypotheses. Oecologia (Berlin) 69, 446-453.

Ryti R. T. and Case T. J. (1988). Field experiments on desert ants; testing for competition between colonies. Ecology 69, (6), 1993-2003.

Sanders C. J. and Baldwin W. F. (1969). Iridium 192 as a tag for Carpenter ants of the genus Camponotus (Hymenoptera: Formicidae). The Canadian Entomologist 101, 416-418.

Seber G. A. F. (1973). The estimation of animal abundance and related parameters. Griffin, London.

Sheail J. (1971). Rabbits and their history. David and Charles, Newton Abbot.

Shimwell D. W. (1971a). The description and classification of vegetation. Sidgewick and Jackson, London.

Shimwell D. W. (1971b). Festuco-Brometea Br.-Bl. and R. Tux. 1943 in the British Isles: The phytogeography and phytosociology of limestone grasslands. Vegetatio 23, 1-60.

Shimwell D. W. (1973). An introduction to the geography and ecology of chalk grassland. In: Jermy A. C. and Stott P. A. (Eds.) Chalk grassland: studies on its conservation and management in the south-east. 1-5. Kent Trust for Nature Conservation.

Siepel H. and van der Bund C. F. (1988). The influence of management practices on the microarthropod community of grassland. Pedobiologia 31, 339-354.

Sinclair D. F. (1985). on tests of spatial randomness using mean nearest neighbour distance. Ecology 66, (3), 1084-1085.

Simberloff D. S., Dillon P., King L., Lorence D., Lowries S. and Schilling E. (1978). Holes in the doughnut theory: The dispersion of ant-lions. Bresnesia 14/15, 13-46.

Simberloff D. (1979). Nearest neighbour assessments of spatial; configurations of circles rather than points. Ecology 60 (4), 679-685.

Skinner G. J. (1980). The feeding habits of the wood ant Formica rufa (Hymenoptera: Formicidae) in limestone woodland in North West England. J. Anim. Ecol. 49, 417-433.

Skinner G. J. (1988). The use of ants in field work. Journal of Biological Education 22 (2), 99-106.

Skwarra E. (1929). Die ameisenfauna des Zehlaubruches. Schriften der physikalisch-okonomischen. Gesellschaft zu Konigsberg. 66, 3-174.

Small R. W., Wrattan S. D. and White R. J. (1985). Comments on the literature concerning the nearest neighbour technique. Oikos 44 (3), 511-512.

Smith C. J. (1980). Ecology of the English chalk. Academic Press.

Smith M. V. (1972). Marking bees and queens. Bee World 53, 9-13.

Smith P. E. (1978). The functional response of plants to trampling pressure. Ph.D. Thesis, University of Keele.

Sokal R. R. and Rohlf F. J. (1981). Biometry. 2nd Ed. W. H. Freeman and Co., San Francisco.

Sorensen I. (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. Kong. Dan. Vidensk. Selsk. Biol. Skr. 5, 1-34.

Southern H. N. (1956). Ecologists are excited by Englands "Rabbit Disease". Animal Kingdom 59, 116-123.

Southwood T. R. E. (1978a). Ecological Methods. (2nd. Ed.) Chapman and Hall. London.

Spain A. V., Sinclair D. F. and Diggle P. J. (1986). Spatial distributions of the mounds of harvester and forager termites (Isoptera: Termitidae) at 4 locations in tropical north-eastern Australia. Acta Oecologia (Oecologia Generalis). 7, 335-352.

Standen R. (1912). Notes on Platyarthrus hoffmannseggi Brandt, and its 'hosts'. Lancashire and Cheshire Naturalist 5, 61-63.

Stearns F. W. (1949). Ninety years change in a northern hardwood forest in Wisconsin. Ecology 30, 350-358.

Steiner A. (1929). Temperaturuntersuchungen in ameisennestern mit erdkuppeln im nest von Formica exsecta Nyl. und in nestern unter steinen. Zeitschrift fur vergleichende Physiologie 9, 1-66.

Step E. (1924). The ant. Hutchinson and Co., London.

Step E. (1932). Bees, wasps, ants and allied insects. Warne, London.

Stout D. G., McLean A., Brooke B. and Hall J. (1980). Influence of simulated grazing (clipping) on pinegrass growth. Journal of range management 33 (4), 286-291.

Stradling D. J. (1970). The estimation of worker ant populations by the mark-release-recapture method: an improved marking technique. J. Anim. Ecol. 39, 575-591.

Stroyan H. L. G. (1984). Aphids - Pterocommatinae and Aphidinae (Aphidini). Handbooks for the identification of British insects. Volume 2. part 6. RESL, London.

Stuart R. J. (1986). Use of polyester fibres to mark small Leptothoracine ants (Hymenoptera: Formicidae). Journal of the Kansas Entomological Society. 59, 566-569.

Sudd J. H. (1967). An introduction to the behaviour of ants. Edward

Arnold. London.

Sudd J. H. and Franks N. R. (1987). The behavioural ecology of ants. Chapman and Hall, New York.

Sumption K. J. and Flowerdew J. R. (1985). The ecological effects of the decline in rabbits (Oryctolagus cuniculus L.) due to myxomatosis. Mammal Rev. 15 (4), 151-186.

Talbot M. (1965). Populations of ants in a low field. Insectes Sociaux 12. (1), 19-48.

Tansley A. G. (Ed.) (1911). Types of British Vegetation. Cambridge University Press.

Tansley A. G. (1922). Studies on the vegetation of the English chalk II. Early stages of redevelopment of woody vegetation on chalk grasslands. J. Ecol. 10, 173-179.

Tansley A. G. (1939). The British Isles and their vegetation. Cambridge University Press.

Taylor L. R. (1961). Aggregation, variance and the mean. Nature 189, 732-735.

Taylor R. W. (1978). Nothomyrmecia macrops: A living fossil ant rediscovered. Science 201, 979-985.

Theakstone W. and harrison C. (1970). The analysis of geographical data. Heinemann Educational, London.

Thomas A. S. (1956). Biological effects of the spread of myxomatosis among rabbits. Terre et la Vie 3, 239-242.

Thomas A. S. (1960). Changes in vegetation since the advent of myxomatosis. J. Ecol. 48, 287-306.

Thomas A. S. (1962). Ant hills and termite mounds in pastures. J. Brit. Grasslands Soc. 17, 103-108.

Thomas A. S. (1963). Further changes in vegetation since the advent of myxomatosis. J. Ecol. 51, 151-183.

Thompson H. R. (1956). Distribution of distance to nth nearest neighbour in a population of randomly distributed individuals. Ecology 37, 391-394.

Thompson H. V. and Worden A. N. (1956). The Rabbit. Collins, New Naturalist, London.

Tobin J. E. (1989). A neotropical canopy ant community: some ecological considerations. Poster at the conference: Interactions between ants and plants Oxford 1989.

Trivers R. L. and Hare H. (1976). Haplodiploidy and the evolution of the social insects. Science 191, 249-263.

Turner F. B. (1960). Size and dispersion of a Louisiana population of the cricket frog Acris gryllus. Ecology 41, 258-68.

Underwood A. J. (1976). Nearest neighbour analysis of spatial distribution of intertidal Prosobranch Gastropods within two substrata. Oecologia 26, 257-266.

Upton G. and Fingleton B. (1985). Spatial data analysis by example. Volume 1: Point pattern quantitative data. Wiley, New York.

Usher M. B. (1973). Biological management and conservation. Chapman and Hall, London.

Vandel A. (1962). Isopodes Terestres. Faune Fr. No. 66, 441-449.

Van der Have T. M. (1987). Polyandry in Lasius ants. In, Chemistry and biology of social insects. Ed. Eder J. and Rembold H. 352. Verlag J. Peperny, Munich.

Van der Have T. M., Boomsma J. J. and Menken S. B. J. (1988). Sex investment ratios and relatedness in the monogynous ant Lasius niger (L.). Evolution 42 (1), 160-172.

Van Emden H. F. (Ed.). (1972). Aphid technology. Academic Press, London.

Vickery P. J. (1972). Grazing and net primary production of a temperate grassland. J. Applied Ecology 9 (1), 307-314.

Vogt R. C. and Bull J. J. (1984). Ecology of hatchling sex-ratios in map turtles. Ecology 65, 582-587.

Waloff N. (1958). The effect of the numbers of queens of the ant Lasius flavus F. (Hymenoptera, Formicidae) on their survival and on the rate of development of the first brood. Insectes Sociaux 4, 391-408.

Waloff N. and Blackith R. E. (1962). The growth and distribution of the mounds of Lasius flavus (Fabricius) (Hym: Formicidae) in Silwood Park, Berkshire. J. Anim. Ecol. 31, 421-437.

Wardlaw A. C. (1985). Practical statistics for experimental biologists. Wiley, Chichester.

Wasmann S. J. (1910). Nachtrage zum sozialen Parasitismus und der Sklaverei beiden Ameisen. Biol. Zbl. 30, 453-464.

Watson E. V. (1960). A quantitative study of the brytophytes of chalk grassland. J. Ecol. 48, 397-414.

Watson E. V. (1981). British mosses and liverworts. 3rd ed. Cambridge University zpress, Cambridge.

Watt A. S. (1957). The effects of excluding rabbits from grassland B (Mesobrometum) in Breckland. J. Ecol. 45, 861-878.

Watt A. S. (1960). The effects of excluding rabbits from acidophilous grassland in Breckland. J. Ecol. 48, 601-604.

Watt T. A. and Gibson C. W. D. (1988). The effect of sheep grazing on seedling establishment and survival in grasslands. Vegetatio 78, 91-98.

Way M. J. (1963). Mutualism between ants and honeydew producing homoptera. Ann. Rev. Ent. 8, 307-344.

Wells T. C. E. (1965). Chalk grassland nature reserves and their management problems. Handbk. a. Rep. Soc. Promot. Nat. Reserves. 1-9.

Wells T. C. E. (1969). Botanical aspects of conservation management of chalk grasslands. Biological Conservation 2, 36-44.

Wells T. C. E. (1971). A comparison of the effects of sheep grazing and mechanical cutting on the structure and botanical composition of chalk grassland. In. Scientific management of plant and animal communities for conservation. Eds. Duffey E. and Watt A. S., 497-515.

Wells T. C. E. (1973). Botanical aspects of chalk grassland management. In. Chalk grassland - studies on its conservation and management in the south-east. Eds. Jermy A. C. and Stott P. A. Kent Trust for Nature Conservation. p. 10-15.

Wells T. C. E. (1978). Establishment of herb rich swards. Interim Report to the NCC. London.

Wells T. C. E. (1980). Management options for lowland grassland. In Amenity grassland, an ecological perspective. Eds. Rorrison I. H., Hunt R. John Wiley and Sons, Chichester. pp. 175-195.

Wells T. C. E. (1987). Reconstruction of calcareous grassland. Proceedings of joint symposium on calcareous grasslands, British Ecological Society and the NCC. In press.

Wells T. C. E., Sheail J., Ball D. F. and Ward L. K. (1976). Ecological studies on the Porton Ranges. J. Ecol. 64, 589-626.

Westhoff V. (1966). The ecological impact of pedestrian, equestrian and vehicular traffic on vegetation. Proceedings and papers of the Tenth Technical Meeting of I.U.C.N., Morges. pp 218-223.

Whittaker R. H. (Ed.) (1978). Ordination of plant communities. Dr. W. Junk, The Hague.

White Rev. G. (1789). The natural history and antiquities of Selbourne in the county of Southampton. B. White and Son, London.

White J., Lloyd M. and Zar J. H. (1979). Faulty eclosion in crowded suburban periodical cicadas: populations out of control. Ecology 60, 305-315.

Willems J. H. (1978). Observations on north west European limestone grassland communities: Phytosociological and ecological notes on chalk grasslands of southern England. Vegetaio 37 (3), 141-150.

Williams D. J. (1962). The British Pseudococcidae (Homoptera: Coccoidea). The Bulletin of the British Museum (Natural History), Entomology. 12 (1), 1-79.

Williamson P. (1976). Above ground primary production of chalk grassland allowing for leaf death. J. Ecol. 64, 1059-1075.

Williams T. and Franks N. R. (1988). Population size and growth rate, sex ratio and behaviour in the ant isopod, Platyarthrus hoffmannseggi. J. Zool. Lond. 215, 703-717.

Wilson E. O. (1955). A monographic revision of the ant genus Lasius. Bull. Mus. Comp. Zool. Harvard No. 113. 199pp.

Wilson E. O. (1971). The insect societies. Belknap Press of Harvard University Press. Cambridge, Massachusetts.

Wilson E. O. (1987). The arboreal ant fauna of Peruvian Amazon forest: a first assessment. Biotropica 19 (3), 245-251.

Wilson E. O., Carpenter F. M. and Brown W. L. Jr. (1967). The first mesozoic ants. Science 157, 1038-1040.

Wood T. G. and Lee K. E. (1971). Abundance of mounds and competition among species of some Australian termite species. Pedobiologia 11, 341-366.

Wood T. G. and Sands W. A. (1978). The role of termites in ecosystems. In: M. V. Brian, Ed. Production ecology of ants and termites. Cambridge University press, Cambridge.

Woodell S. R. J. (1974). Anthill vegetation in a Norfolk Saltmarsh. Oecologia 16, (3), 221-225.

Woodell S. R. J. and King T. J. (1990). The influence of ants on British lowland vegetation. In, Ants and Plants. Eds. Cutler D. F. and Southwood T. R. E. In press.

Wrattan S. D. and Fry G. L. A. (1980). Field and laboratory exercises in ecology. Edward Arnold, London.

Wright P. J. (1984). The flora of walls in County Durham. M.Sc. Thesis, University of Durham.

Wright P. J. (1985). Roadside verges - informal reserves? Newsletter: Hampshire and Isle of Wight Naturalists Trust. September 1985.

Wright P. J. (1989). Energy turnover in a population of the ant <u>Lasius flavus</u> F. Actes des colloques Insectes Sociaux 5, 69-73.

Wright P. J. (1989). Observations on the queens of the ant <u>Lasius mixtus</u>. The Entomologists Record 101 (3-4), 46.

Wright P. J. (1990). Sexual production in <u>Lasius flavus</u> (F.) (Hymenoptera: Formicidae). Entomologists Monthly Magazine. In press.

Yeaton R. I. and Cody M. L. (1976). Competition and spacing in plant communities: the northern Mohave desert. J. Ecol. 64, 689-696.

Yensen N. P. and Clark W. H. (1977). A checklist of Idaho ants (Hymenoptera: Formicidae). The Pan-Pacific Entomologist 53, 181-187.

Zwolfer H. (1957). Zur systematik, Biologie und Okologie unterirdisch lebender Aphider. Z. Angew. Ent. 40, 182-221.

Zwolfer H. (1958). Zur systematik, Biologie und Okologie unterirdisch lebender Aphiden (Anoeciinae, Tetraneurini, Pemphigini und Fordinae). Z. angew Entomol. 43, 1-52.

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PART NINE

THE APPENDICES

APPENDIX ONE

Raw data from the mapping and measuring of the ant mounds in each sample quadrat.

The position of each mound in the sample quadrat is given by an X and a Y coordinate, within the range 0 to 20 metres.

The diameter and heights of the mound are the maximum measurements (in centimetres) described in section 6.6.2.2.

The nearest neighbour measurement is the distance in centimetres from the centre of the mound to the centre of the nearest neighbouring mound.

Quadrat OWH SS4 EXAMINED 19/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.33	1.55	50	17	199
2	0.94	3.25	25	12	199
3	3.20	4.20	20	7	233
4	1.44	6.20	50	18	99
5	2.44	6.35	35	11	83
6	3.00	6.93	42	14	83
7	4.07	6.85	35	11	110
8	2.95	8.95	20	7	67
9	3.62	8.85	30	8	67
10	2.15	10.23	50	18	131
11	1.26	11.15	45	13	131
12	4.01	10.53	27	6	79
13	4.35	0.35	20	3	240
14	7.59	1.40	40	14	119
15	6.71	2.23	50	14	101
16	7.69	2.45	20	3	81
17	8.24	3.35	40	7	81
18	5.21	3.60	45	15	204
19	5.56	6.90	60	28	154
20	6.74	10.53	40	12	82
21	4.61	10.90	37	9	79
22	7.44	11.10	40	7	71
23	7.05	11.65	40	12	71
24	4.48	11.85	50	8	101
25	5.24	12.50	30	5	102
26	6.03	15.95	30	6	200
27	4.10	16.80	40	17	202
28	6.08	17.96	66	20	110
29	5.24	18.60	33	8	72
30	5.38	19.32	30	11	72
31	4.75	19.97	35	14	104
32	11.95	0.98	80	22	165
33	11.30	2.65	55	10	165
34	10.42	4.40	55	2	202
35	8.38	6.00	40	11	160
36	11.68	7.10	40	10	203
37	8.25	7.70	50	10	160
38	10.23	8.95	40	8	100
39	9.14	9.30	60	10	118
40	11.20	9.10	20	2	77
41	12.06	9.15	25	2	64
42	11.72	9.65	27	2	64
43	10.64	10.45	40	13	81
44	10.37	11.25	40	8	81
45	11.55	11.05	30	3	101
46	9.20	11.63	40	8	129
47	11.77	12.62	30	5	139
48	8.71	15.50	40	11	180
49	9.73	17.12	40	15	180

Quadrat OWH SS 4 EXAMINED 19/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	13.29	2.38	40	12	150
51	14.15	3.60	70	20	150
52	12.71	4.30	45	14	163
53	14.08	7.57	30	10	79
54	14.82	7.40	22	2	79
55	16.19	6.95	40	10	145
56	15.17	10.90	40	10	161
57	13.67	13.55	40	11	241
58	14.47	15.80	40	5	116
59	13.65	16.60	65	17	116
60	13.45	18.10	75	15	147
61	19.95	3.95	65	15	263
62	17.32	4.15	35	11	263
63	18.95	7.20	16	3	275
64	16.48	9.70	45	16	160
65	17.50	15.05	40	10	245
66	18.80	17.20	60	8	245
67	15.95	18.15	40	8	255

Quadrat OWH SS5 EXAMINED 31/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.69	1.15	35	12	86
2	0.91	3.20	25	3	133
3	0.31	7.62	60	20	131
4	1.53	8.03	50	17	131
5	0.28	9.75	75	22	206
6	3.10	5.95	60	22	262
7	0.20	12.80	35	5	120
8	3.55	13.10	40	5	88
9	3.82	13.85	30	5	88
10	3.09	14.45	20	2	89
11	3.83	14.95	30	1	76
12	4.50	15.20	45	8	76
13	1.45	15.15	45	16	156
14	2.68	16.07	23	1	156
15	2.08	19.07	50	10	300
16	4.43	3.45	45	15	163
17	6.00	3.90	60	15	162
18	7.57	4.35	30	10	162
19	6.64	6.25	60	20	215
20	5.76	8.75	70	20	182
21	7.57	8.75	25	2	137
22	6.43	10.45	70	17	204
23	4.75	11.95	40	11	160
24	6.22	12.51	20	3	131
25	5.55	13.65	27	3	131
26	4.95	15.85	45	9	80
27	5.80	16.60	35	5	110
28	7.88	17.32	70	10	166
29	6.44	19.55	35	9	247
30	8.90	18.77	35	8	53
31	9.82	3.02	65	15	87
32	9.00	3.20	35	5	87
33	8.74	7.65	40	7	74
34	9.27	8.15	45	14	74
35	10.81	10.05	60	17	206
36	8.98	11.00	12	2	195
37	8.75	13.00	40	12	195
38	11.68	13.70	65	17	300
39	9.20	19.05	40	8	53
40	11.52	18.40	20	1	84
41	12.35	18.30	40	13	80
42	12.29	19.00	25	3	80
43	15.58	0.90	35	1	204
44	15.72	2.92	50	15	204
45	18.48	2.45	15	1	240
46	13.75	4.65	40	12	268
47	15.90	7.38	25	2	212
48	18.00	7.40	35	10	179
49	19.95	7.00	55	17	200

QUADRAT OWH SS 5   EXAMINED 31/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	18.51	9.10	25	2	179
51	13.23	8.50	50	18	290
52	14.62	11.60	35	5	112
53	14.98	12.60	55	14	112
54	18.10	12.45	40	12	213
55	16.33	15.00	25	1	68
56	15.68	15.20	30	4	68
57	15.83	16.11	25	1	91
58	16.30	17.17	30	5	64
59	15.73	17.45	33	7	64
60	15.09	18.70	35	2	144
61	17.15	19.79	55	18	236
62	19.52	19.63	50	18	143
63	19.55	18.25	40	10	143
64	19.69	15.70	20	2	257

Quadrat OWH SS7   EXAMINED 1/8/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.31	11.12	25	8	331
2	4.90	0.41	80	10	404
3	4.14	4.30	50	10	404
4	14.03	0.28	80	32	267
5	13.22	3.95	38	5	339
6	18.48	6.55	100	41	160
7	16.69	9.35	55	21	325
8	18.93	13.80	45	16	487

Quadrat OWH SS8 EXAMINED 19/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.15	0.05	40	4	189
2	0.35	2.25	80	15	142
3	0.72	3.65	40	12	142
4	0.70	7.95	80	5	121
5	3.31	9.85	40	11	217
6	0.28	13.25	40	8	128
7	1.60	13.50	50	9	128
8	2.71	16.00	40	13	126
9	2.58	17.25	50	8	126
10	1.16	19.30	75	15	111
11	0.02	19.42	35	5	111
12	5.28	0.45	65	22	191
13	7.56	1.10	55	8	100
14	8.39	1.80	50	12	93
15	7.08	2.10	50	19	110
16	5.04	2.25	35	6	162
17	4.74	3.85	35	19	162
18	5.05	7.50	55	16	175
19	7.57	6.55	35	11	270
20	5.49	9.32	25	7	175
21	7.37	10.15	25	5	220
22	5.71	12.10	60	17	257
23	4.55	16.90	50	16	197
24	7.91	16.75	65	20	116
25	6.94	17.90	35	9	107
26	6.01	18.62	25	2	107
27	8.86	0.20	50	25	146
28	9.00	2.15	43	21	93
29	11.76	1.85	25	2	178
30	10.20	4.15	75	25	180
31	11.97	3.95	80	28	180
32	12.59	5.55	30	4	185
33	9.81	7.82	70	18	195
34	9.56	9.72	80	40	195
35	8.77	14.17	30	5	179
36	10.69	15.80	55	22	95
37	9.27	16.60	40	12	95
38	11.81	16.10	65	17	149
39	11.12	17.62	35	17	149
40	8.60	18.70	8	1	185
41	10.52	19.60	50	18	185
42	14.65	0.60	60	23	209
43	15.09	2.50	65	20	116
44	14.77	3.80	80	25	116
45	15.57	5.70	70	26	218
46	15.05	8.90	45	6	163
47	15.61	10.35	20	7	163
48	13.09	13.85	60	23	67
49	13.64	14.32	55	21	67

QUADRAT OWH SS 8   EXAMINED 19/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	14.50	14.75	55	23	95
51	15.84	17.62	20	2	234
52	16.60	19.50	60	20	188
53	18.77	1.05	30	5	193
54	16.84	1.85	20	5	170
55	18.73	2.90	30	2	87
56	19.58	3.15	35	10	82
57	19.14	3.90	30	8	82
58	17.62	3.55	40	18	125
59	19.32	5.85	30	4	160
60	18.71	8.50	40	13	135
61	17.90	9.58	70	15	135
62	19.00	11.80	30	8	188
63	17.21	12.45	40	18	85
64	17.20	13.20	40	16	85
65	17.62	15.52	65	29	226
66	19.26	17.55	37	21	175

Quadrat OWH SS9 EXAMINED 31/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	2.17	3.15	30	20	201
2	2.13	5.07	55	26	201
3	0.81	7.85	35	10	197
4	3.38	9.35	85	25	171
5	1.69	9.68	45	20	171
6	0.75	11.26	40	15	177
7	3.12	13.00	60	22	246
8	1.09	14.54	55	18	96
9	0.24	15.15	35	11	80
10	0.48	15.90	50	21	80
11	2.47	16.45	60	28	176
12	0.85	18.48	50	18	257
13	3.30	19.95	45	15	108
14	4.80	0.75	20	12	120
15	5.12	2.95	70	25	170
16	6.48	3.93	30	11	85
17	7.01	4.63	40	28	85
18	8.19	4.10	40	15	91
19	7.29	5.32	50	23	59
20	7.01	5.85	40	18	59
21	5.36	6.15	65	28	112
22	4.45	6.40	50	16	112
23	6.07	7.31	30	23	134
24	7.55	7.05	40	14	110
25	8.07	7.67	65	30	110
26	7.64	8.95	35	18	122
27	4.94	10.00	50	23	113
28	5.36	11.07	30	10	113
29	6.60	11.05	40	15	71
30	7.50	11.95	40	12	131
31	7.45	13.35	35	13	124
32	6.66	14.30	45	18	124
33	5.63	15.16	45	25	131
34	4.24	16.35	60	21	144
35	4.23	17.40	70	25	70
36	4.45	18.10	25	6	70
37	5.52	19.30	35	11	127
38	4.30	19.50	30	5	108
39	7.52	16.85	55	22	127
40	7.38	18.22	35	10	122
41	7.32	19.75	15	1	120
42	6.80	10.35	25	1	71
43	9.84	0.55	15	1	99
44	8.42	0.63	40	19	112
45	10.80	0.38	30	10	56
46	10.80	0.94	45	13	56
47	11.08	2.45	50	17	128
48	12.37	2.60	30	15	128
49	8.55	2.45	35	12	125

QUADRAT OWH SS 9   EXAMINED 31/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	9.00	3.55	25	1	91
51	9.74	5.30	55	23	129
52	11.64	5.65	40	11	133
53	10.44	6.35	30	12	115
54	9.31	6.60	30	13	115
55	12.05	7.30	20	3	163
56	10.50	7.85	55	21	78
57	9.86	8.35	55	14	78
58	11.24	10.50	50	23	175
59	8.96	10.95	40	10	65
60	8.34	10.55	50	19	71
61	9.28	11.40	25	9	65
62	9.24	13.15	30	6	172
63	12.01	13.20	75	25	135
64	11.85	14.80	45	17	121
65	9.12	15.45	80	25	167
66	10.03	16.85	50	18	167
67	8.34	17.50	45	4	106
68	9.82	19.23	27	14	221
69	15.97	0.10	33	14	102
70	13.60	1.95	60	26	136
71	12.34	2.40	35	14	128
72	12.94	3.65	65	25	129
73	14.84	5.20	50	20	155
74	15.01	6.80	55	20	106
75	14.93	7.80	45	15	88
76	15.81	7.80	25	10	88
77	14.56	8.65	60	18	95
78	15.61	8.95	50	16	107
79	14.21	9.80	60	21	116
80	12.93	10.50	45	15	145
81	13.16	12.45	28	13	141
82	12.84	14.20	40	16	121
83	15.98	14.10	35	4	230
84	13.60	18.20	35	14	229
85	15.00	20.00	25	2	159
86	12.45	16.30	30	2	148
87	16.04	6.55	25	2	107
88	18.27	1.35	40	19	222
89	19.57	3.15	55	23	211
90	17.29	5.60	65	23	152
91	19.61	5.40	45	18	95
92	18.23	8.30	63	23	150
93	17.05	9.25	50	17	150
94	17.22	10.90	35	19	132
95	17.22	12.15	35	9	132
96	17.86	13.40	40	12	132
97	19.45	15.80	55	21	125
98	16.61	18.10	40	13	146
99	16.50	19.70	65	16	146

Quadrat OWH SS11 EXAMINED 18/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.20	0.65	30	8	163
2	2.15	1.30	90	10	202
3	0.66	3.30	50	18	248
4	1.85	5.98	20	2	85
5	2.20	6.78	15	1	85
6	2.30	8.15	55	15	135
7	0.05	14.40	25	2	120
8	1.04	15.10	10	1	109
9	0.42	15.95	5	1	109
10	6.96	0.35	60	20	311
11	6.55	3.50	30	5	300
12	4.05	5.15	20	2	242
13	5.80	6.83	70	10	242
14	6.65	9.10	45	5	230
15	5.65	11.20	65	10	230
16	8.08	11.80	35	8	155
17	6.66	13.75	75	20	118
18	7.37	14.80	35	7	118
19	6.10	15.30	100	20	102
20	6.63	16.30	20	2	102
21	7.88	16.45	45	15	126
22	7.45	18.35	30	8	198
23	5.20	19.15	75	25	158
24	9.70	2.70	40	15	220
25	4.30	11.15	35	5	220
26	10.06	10.00	25	5	72
27	9.83	10.68	50	10	72
28	8.55	13.15	20	2	158
29	9.05	15.55	65	20	145
30	9.02	17.10	65	13	102
31	9.20	18.15	20	2	102
32	14.35	0.35	55	20	239
33	13.48	2.60	30	5	166
34	14.03	4.15	25	3	166
35	15.73	5.00	60	15	186
36	15.20	6.70	35	10	126
37	15.83	7.77	50	18	126
38	14.55	9.10	35	10	128
39	14.95	10.40	25	5	128
40	13.25	13.95	60	8	172
41	13.75	15.63	25	6	61
42	14.30	15.90	40	7	61
43	11.84	17.75	35	7	264
44	15.63	19.40	40	8	323
45	19.20	0.30	65	20	74
46	19.16	1.05	40	12	74
47	19.03	3.10	45	3	131
48	18.40	5.75	30	10	246
49	18.20	9.20	46	20	210

QUADRAT OWH SS 11 EXAMINED 18/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	16.75	10.75	45	10	191
51	18.00	13.60	45	10	165
52	16.30	14.50	80	15	195
53	18.45	15.25	30	8	165
54	17.75	17.70	60	15	107
55	18.59	18.30	45	8	107
56	19.25	19.80	40	5	155
57	17.75	3.65	35	3	135

Quadrat OWH SS12 Examined 8/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.80	0.22	35	10	112
2	2.30	0.75	55	25	147
3	1.77	3.65	40	4	102
4	2.00	4.65	30	5	102
5	0.59	5.15	25	2	123
6	2.25	8.06	45	7	222
7	2.30	10.30	25	5	198
8	1.20	13.52	30	3	144
9	2.10	14.65	25	7	74
10	2.75	14.25	45	8	76
11	2.47	15.30	35	5	74
12	5.30	0.70	50	20	123
13	4.50	2.65	55	20	123
14	5.68	2.90	50	18	123
15	4.40	4.65	60	22	164
16	5.43	6.00	60	20	164
17	5.46	8.40	30	8	79
18	4.35	8.80	30	7	79
19	6.97	1.15	50	15	130
20	7.85	8.10	70	20	180
21	6.57	9.85	55	20	154
22	5.90	11.75	35	10	83
23	5.80	12.57	35	10	83
24	7.35	12.50	35	7	150
25	6.45	14.40	80	20	192
26	6.30	17.10	50	10	181
27	5.40	18.65	40	7	173
28	7.20	18.70	75	15	166
29	8.40	2.40	50	15	83
30	8.65	3.20	55	20	83
31	8.00	9.75	35	10	151
32	9.63	10.70	45	7	53
33	9.40	11.15	15	3	53
34	12.30	0.01	50	10	130
35	11.50	1.40	20	7	116
36	10.35	1.35	60	15	116
37	12.95	1.55	35	10	82
38	13.78	1.40	55	20	78
39	13.46	0.70	30	8	78
40	11.27	3.27	55	20	164
41	12.67	4.10	25	2	79
42	13.40	3.80	40	12	79
43	10.95	6.85	30	5	144
44	11.45	8.25	25	2	86
45	12.30	8.35	40	7	86
46	12.87	9.35	30	3	107
47	11.16	11.50	50	15	165
48	13.42	12.20	20	2	166
49	13.53	14.60	15	2	140

Quadrat OWH SS12 Examined 8/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	11.70	15.40	60	25	193
51	12.90	17.35	50	15	123
52	15.40	1.00	55	20	170
53	15.48	3.80	50	18	89
54	15.58	4.85	50	18	89
55	15.75	6.00	45	15	105
56	14.53	7.65	30	7	205
57	14.33	9.75	30	5	99
58	14.05	10.75	50	15	99
59	15.87	11.90	25	5	175
60	14.80	14.25	30	5	140
61	13.90	16.70	60	20	76
62	14.30	17.35	25	8	76
63	17.60	0.85	35	15	222
64	19.20	2.90	25	2	157
65	17.00	4.20	40	10	144
66	16.85	6.20	45	12	104
67	16.70	8.25	70	20	202
68	17.10	13.20	70	15	175
69	19.64	16.03	40	15	189
70	17.65	19.15	35	10	127
71	18.80	19.70	40	8	127

Quadrat OWH NFS Examined 1/8/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	2.79	1.35	60	20	131
2	3.67	2.35	90	25	131
3	0.01	2.42	70	15	298
4	2.61	4.15	30	7	209
5	0.32	5.68	75	25	245
6	2.21	7.90	65	15	270
7	0.68	11.50	45	8	106
8	0.95	14.00	60	19	116
9	2.06	14.40	50	13	87
10	1.67	15.18	65	15	87
11	3.63	11.55	20	2	167
12	3.70	13.30	45	18	167
13	4.03	17.60	50	16	195
14	1.20	19.62	35	10	263
15	3.92	19.48	40	11	69
16	4.50	19.71	40	10	69
17	7.26	0.09	125	35	282
18	5.32	3.65	40	8	97
19	6.00	4.30	115	30	97
20	4.78	5.60	75	23	165
21	6.57	6.30	110	30	193
22	4.88	7.50	80	22	179
23	5.57	9.20	60	21	113
24	7.27	8.65	35	11	177
25	6.12	10.15	90	20	113
26	6.62	13.10	90	24	202
27	5.80	16.18	60	17	222
28	9.74	1.10	75	22	214
29	12.92	0.23	30	8	96
30	9.45	3.25	50	13	106
31	10.47	3.45	35	10	79
32	11.20	3.92	45	15	64
33	11.07	4.60	40	13	64
34	9.13	5.70	30	10	118
35	10.06	6.38	15	5	118
36	8.98	8.52	50	2	165
37	8.80	12.45	45	8	137
38	8.62	13.85	30	8	112
39	9.96	14.44	30	9	154
40	8.50	14.82	45	9	112
41	11.99	12.68	60	21	166
42	12.08	14.40	90	24	156
43	10.98	15.70	50	15	80
44	11.77	15.80	35	10	80
45	9.39	16.50	50	9	63
46	8.72	17.02	30	7	63
47	10.56	16.80	23	1	67
48	10.58	17.55	12	5	67
49	9.70	19.25	50	18	176

Quadrat OWH NFS   Examined   1/8/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	11.50	19.05	50	11	149
51	15.40	2.40	65	17	272
52	13.70	4.50	20	1	137
53	12.70	5.45	40	15	137
54	16.16	9.20	80	18	160
55	13.75	10.83	60	16	169
56	12.50	10.00	40	14	169
57	15.45	13.55	85	20	198
58	13.50	14.97	40	8	166
59	12.78	16.55	45	19	132
60	16.99	17.15	90	21	228
61	12.93	19.02	50	12	149
62	17.75	0.40	120	30	108
63	19.76	1.60	35	13	224
64	17.16	4.60	105	28	285
65	17.36	9.62	45	8	160
66	19.35	10.80	40	10	145
67	18.55	12.75	25	5	218
68	16.82	14.80	25	5	198
69	19.05	16.73	70	27	183
70	19.34	18.50	55	15	135

Quadrat OWH C10   Examined 25/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.60	0.50	50	20	330
2	2.85	3.20	20	5	100
3	3.33	4.00	40	15	100
4	0.95	4.25	55	13	126
5	1.13	5.55	75	30	95
6	1.06	6.50	55	20	95
7	2.33	5.67	90	35	121
8	1.73	7.35	35	13	112
9	0.86	8.12	40	13	84
10	0.04	8.34	50	18	84
11	1.90	9.43	35	12	89
12	2.50	8.77	80	23	89
13	2.17	12.00	120	25	162
14	0.12	12.80	60	23	130
15	2.13	13.64	25	12	147
16	3.76	14.05	60	20	115
17	2.90	14.80	25	12	115
18	1.01	15.05	70	21	94
19	0.41	15.95	50	20	94
20	0.58	17.54	75	25	81
21	0.60	18.35	22	7	64
22	1.17	18.65	35	10	64
23	0.63	19.25	37	11	58
24	0.05	19.35	20	8	58
25	2.08	19.25	40	15	82
26	2.76	19.75	55	15	82
27	5.37	3.30	60	25	191
28	7.50	3.75	60	17	117
29	6.85	4.70	100	28	117
30	6.00	5.70	75	18	125
31	4.52	5.40	35	10	135
32	4.09	6.50	85	16	107
33	4.23	7.75	55	15	107
34	7.44	6.10	35	18	97
35	6.70	6.90	85	20	97
36	7.89	8.30	85	16	188
37	5.35	8.70	75	24	125
38	5.78	9.83	110	28	86
39	6.65	9.90	25	7	86
40	7.26	10.85	130	29	110
41	5.84	11.85	55	15	203
42	6.90	13.00	135	30	154
43	8.18	14.00	100	17	106
44	8.70	12.70	45	14	106
45	5.31	13.70	35	18	142
46	5.12	15.10	40	19	142
47	3.00	17.20	70	35	157
48	4.53	17.20	55	18	84
49	5.12	17.70	60	16	83

Quadrat OWH C10 Examined 25/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	4.38	18.10	50	22	83
51	6.11	17.72	35	15	84
52	6.81	18.10	30	7	84
53	7.00	15.65	18	7	153
54	7.60	16.95	105	25	133
55	7.97	18.50	55	15	120
56	8.93	3.45	75	20	100
57	9.20	4.35	40	8	100
58	11.63	3.32	70	15	197
59	9.82	6.77	55	20	110
60	8.73	6.70	70	25	110
61	11.74	7.40	85	35	128
62	12.60	6.30	100	20	128
63	12.20	8.80	140	30	120
64	9.75	11.02	85	30	170
65	11.36	11.60	40	8	137
66	12.23	12.70	75	20	126
67	8.67	13.05	55	18	106
68	9.20	14.70	65	16	109
69	10.55	13.65	55	15	127
70	10.28	14.95	80	20	109
71	10.42	17.15	28	10	43
72	10.80	17.35	35	9	43
73	9.51	17.85	65	23	112
74	12.25	19.60	60	12	152
75	13.75	3.85	35	10	182
76	15.10	2.70	40	10	117
77	15.18	1.65	15	8	117
78	16.10	4.80	110	33	222
79	14.21	6.95	100	33	145
80	13.70	9.45	50	15	120
81	16.45	7.25	40	13	122
82	16.15	8.15	40	10	122
83	13.51	10.85	60	15	79
84	13.07	11.55	80	22	79
85	15.85	11.05	65	25	145
86	13.54	13.42	45	10	126
87	15.01	13.50	55	14	108
88	15.80	12.70	50	14	108
89	11.95	14.95	100	25	153
90	14.65	15.25	90	25	150
91	13.20	15.55	55	13	125
92	13.07	16.80	60	14	125
93	15.95	15.70	35	12	126
94	14.01	17.86	120	22	60
95	14.40	18.30	32	15	60
96	17.87	0.94	25	9	168
97	19.55	0.40	25	10	153
98	19.27	2.05	90	27	153

Quadrat OWH C10 Examined 25/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
99	19.19	4.20	35	14	70
100	19.91	4.22	45	25	70
101	18.93	7.15	70	30	162
102	17.54	8.58	65	25	125
103	19.26	8.80	75	27	160
104	18.00	10.20	50	20	86
105	18.10	11.05	30	10	86
106	17.22	11.60	65	23	105
107	18.90	12.25	70	30	144
108	16.89	13.50	20	7	95
109	16.50	14.45	60	17	95
110	18.94	14.80	70	22	76
111	18.46	15.44	55	12	76
112	17.12	16.20	90	13	87
113	17.04	17.05	35	18	87
114	16.76	18.00	60	28	93
115	18.54	17.65	120	37	106
116	18.99	18.55	40	17	103
117	19.70	18.05	85	23	103
118	17.70	19.90	35	14	108
119	18.80	19.90	35	12	108

Quadrat AR 11   Examined 27/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.60	0.07	40	5	114
2	2.40	0.82	50	10	114
3	1.14	3.65	40	2	72
4	0.92	4.30	35	2	72
5	1.90	6.00	35	5	78
6	2.30	6.95	45	5	78
7	0.67	7.70	40	5	78
8	1.33	8.10	45	23	78
9	2.65	11.30	55	20	177
10	1.80	12.90	45	8	93
11	1.00	13.20	25	5	75
12	0.13	12.35	40	15	126
13	0.40	13.65	45	12	60
14	0.88	14.00	45	10	60
15	1.55	17.95	50	20	115
16	2.70	18.15	25	2	115
17	2.65	17.00	65	20	132
18	0.43	18.95	45	15	97
19	1.20	19.70	60	20	97
20	3.46	19.85	60	12	170
21	4.65	0.51	65	12	165
22	5.80	1.70	50	8	110
23	5.55	2.80	50	8	110
24	3.55	3.60	25	3	52
25	4.20	4.05	65	20	75
26	3.10	4.05	40	8	52
27	3.65	5.25	45	8	120
28	7.05	5.65	50	10	155
29	8.56	5.45	40	15	139
30	8.30	3.85	65	12	139
31	4.40	6.95	65	15	192
32	5.70	8.75	40	15	147
33	5.20	10.20	60	20	147
34	7.80	9.00	35	10	127
35	6.86	10.45	60	8	134
36	4.35	14.65	40	8	147
37	5.85	14.60	30	5	124
38	5.70	17.30	35	8	170
39	4.05	18.00	15	1	140
40	8.78	0.30	60	7	90
41	9.65	0.10	50	12	90
42	10.35	1.60	50	7	108
43	9.20	2.40	40	5	138
44	12.00	1.70	45	7	59
45	11.45	1.55	10	2	59
46	12.55	1.40	40	5	63
47	12.10	3.70	50	10	193
48	11.05	5.55	60	15	125
49	11.05	6.85	55	20	125

Quadrat AR 11 Examined 27/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	11.28	8.50	80	20	399
51	9.30	8.90	20	1	130
52	8.98	7.05	30	5	118
53	7.80	7.25	55	25	105
54	8.38	8.03	35	20	105
55	8.10	10.65	40	8	125
56	9.30	10.25	35	15	125
57	5.75	13.35	50	13	134
58	8.25	12.60	75	25	160
59	9.60	13.55	50	12	160
60	11.40	14.60	60	20	175
61	9.05	16.75	75	25	212
62	10.45	18.35	45	18	119
63	10.65	19.60	50	10	119
64	9.20	19.30	50	17	130
65	13.52	0.10	35	15	110
66	13.85	1.37	25	8	92
67	14.30	2.03	55	20	92
68	15.14	0.75	50	18	96
69	15.60	1.50	20	2	96
70	13.10	2.10	30	5	89
71	13.20	5.45	40	10	110
72	13.50	6.50	60	15	110
73	15.48	5.90	45	10	139
74	14.80	8.10	40	12	191
75	15.90	10.05	45	15	163
76	13.25	9.35	50	10	191
77	14.35	10.82	55	15	108
78	13.40	11.00	30	5	108
79	11.65	11.85	60	25	188
80	14.00	12.60	45	12	109
81	14.85	13.30	55	15	100
82	14.30	14.15	55	17	100
83	13.15	14.45	40	15	122
84	16.40	12.30	35	14	130
85	15.10	15.30	35	10	145
86	13.45	16.20	20	2	92
87	13.65	17.00	40	8	65
88	12.75	17.50	30	7	65
89	15.08	16.70	60	20	135
90	17.20	1.10	35	10	69
91	17.70	1.55	60	12	69
92	18.70	1.75	40	15	103
93	19.35	0.75	35	5	76
94	19.54	1.45	50	10	76
95	17.25	4.30	85	25	125
96	16.75	5.55	40	10	99
97	17.25	6.30	55	12	99
98	18.80	4.80	55	10	83

Quadrat AR 11 Examined 27/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
99	18.45	5.56	35	10	64
100	19.10	5.60	30	10	64
101	19.80	7.15	15	3	97
102	18.40	7.75	50	18	151
103	16.85	8.30	35	10	151
104	18.90	9.80	40	20	85
105	19.00	10.65	35	8	85
106	17.55	11.70	40	10	66
107	17.10	12.30	25	8	66
108	19.03	15.00	60	20	140
109	17.70	15.50	75	27	140
110	17.25	17.20	35	15	69
111	16.60	17.40	50	18	69
112	16.35	19.10	60	20	163
113	17.90	18.00	40	5	105

Quadrat AR 12 Examined 13-17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.07	0.02	25	3	91
2	0.90	0.90	15	1	91
3	1.03	1.82	10	1	48
4	0.61	2.05	10	2	26
5	0.37	2.16	9	1	26
6	1.10	2.40	25	2	54
7	0.91	2.95	7	1	54
8	1.75	3.17	45	7	74
9	1.80	3.90	45	10	74
10	0.66	4.25	25	2	55
11	0.20	4.47	27	4	55
12	1.66	5.02	32	10	99
13	0.30	5.85	50	10	126
14	1.07	7.00	13	2	95
15	1.75	6.30	35	5	95
16	2.09	8.30	12	2	113
17	1.00	9.05	22	1	65
18	1.15	9.55	12	2	65
19	0.41	9.90	23	2	81
20	2.14	10.33	20	1	45
21	2.22	10.80	18	1	45
22	0.84	11.20	55	15	112
23	2.55	11.70	25	3	97
24	0.72	12.30	30	2	112
25	2.00	13.73	35	8	112
26	0.89	14.40	14	1	112
27	0.61	15.87	5	1	49
28	0.19	16.22	30	5	49
29	0.92	16.65	40	3	72
30	1.40	17.15	40	3	72
31	2.01	17.85	30	3	90
32	1.46	18.55	35	3	69
33	0.95	19.10	45	5	72
34	1.57	19.51	20	1	49
35	1.25	19.85	15	2	49
36	3.55	0.77	50	10	61
37	3.20	1.35	25	4	61
38	2.90	2.20	25	3	91
39	3.87	2.45	45	7	68
40	3.60	3.05	9	1	66
41	3.03	3.57	25	4	66
42	4.03	3.65	10	2	75
43	3.67	4.07	15	1	61
44	2.99	4.70	5	1	42
45	2.60	4.80	15	1	42
46	3.91	5.00	15	4	72
47	4.35	5.53	25	2	49
48	2.65	5.90	20	2	82
49	3.36	6.35	65	10	83

Quadrat AR 12   Examined 13-17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	4.15	6.60	15	1	83
51	3.95	7.50	11	1	76
52	3.18	7.93	30	5	86
53	4.26	8.20	20	2	73
54	4.95	8.92	20	2	73
55	4.22	9.73	13	2	30
56	4.50	9.80	16	2	30
57	3.61	10.13	25	3	73
58	3.40	12.25	40	7	101
59	4.40	14.63	20	2	83
60	3.67	15.25	19	3	75
61	2.92	15.50	15	1	75
62	4.20	16.55	15	1	82
63	3.33	16.40	35	7	74
64	4.06	17.37	25	3	47
65	4.14	17.87	40	6	47
66	4.76	17.78	45	8	62
67	3.75	19.05	55	2	71
68	4.20	19.61	30	3	71
69	2.40	19.95	43	12	97
70	5.71	0.70	12	3	92
71	4.93	1.50	35	4	102
72	3.27	2.60	30	5	65
73	5.85	2.95	25	1	56
74	6.41	3.00	18	1	58
75	6.47	3.70	40	6	58
76	4.92	4.10	50	10	98
77	6.05	4.35	20	1	79
78	6.84	4.85	28	2	38
79	7.15	5.10	10	1	38
80	5.81	5.35	20	3	50
81	5.13	5.50	10	1	33
82	4.83	5.75	10	1	33
83	5.16	6.15	25	1	61
84	5.29	6.95	25	2	80
85	5.80	7.90	32	6	73
86	5.24	8.45	30	3	73
87	6.22	9.02	43	3	84
88	5.05	9.35	15	2	64
89	5.78	10.05	35	7	75
90	6.48	9.85	22	1	46
91	6.64	10.30	15	2	40
92	5.90	11.10	40	2	103
93	5.23	11.92	60	5	103
94	5.78	13.35	50	2	87
95	5.20	14.05	25	3	86
96	5.01	15.05	35	4	70
97	5.63	15.35	20	1	55
98	6.16	15.53	20	2	55

Quadrat AR 12 Examined 13-17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
99	5.33	16.65	30	1	48
100	5.65	16.95	20	1	48
101	6.74	16.20	20	3	87
102	5.77	18.30	16	1	58
103	5.18	18.35	25	1	60
104	4.94	19.35	45	2	80
105	6.05	18.95	30	3	69
106	6.54	18.25	35	7	75
107	6.40	17.15	30	2	75
108	6.40	10.60	10	1	38
109	7.80	0.65	10	4	62
110	7.21	0.85	20	1	62
111	7.65	1.85	30	5	106
112	7.20	3.30	10	2	74
113	7.67	3.85	10	2	74
114	6.85	4.90	25	3	38
115	7.14	5.07	8	1	38
116	7.08	6.65	8	2	68
117	7.09	7.40	35	5	64
118	7.09	8.05	25	3	64
119	8.00	7.42	9	1	73
120	8.00	8.16	7	1	73
121	7.29	9.62	30	5	90
122	7.32	11.70	50	9	128
123	6.94	13.25	40	5	126
124	6.80	15.25	64	15	88
125	7.67	16.55	20	2	61
126	7.72	19.33	43	10	86
127	9.33	1.08	8	1	55
128	8.74	2.70	35	4	75
129	8.30	3.30	65	13	75
130	9.24	4.70	15	1	87
131	8.54	6.90	13	1	88
132	9.10	7.90	30	6	94
133	9.02	9.40	25	1	56
134	8.84	9.95	20	3	56
135	8.10	10.65	20	1	103
136	9.23	10.80	25	5	87
137	8.62	11.60	25	4	96
138	8.60	13.55	30	3	145
139	8.44	15.10	20	2	85
140	9.08	15.75	30	4	59
141	8.18	16.25	25	1	63
142	8.72	16.80	15	1	82
143	8.92	19.20	25	6	77
144	9.35	19.85	20	3	77
145	9.90	1.20	20	2	55
146	10.78	2.75	20	1	101
147	10.05	3.50	25	3	65

Quadrat AR 12 Examined 13-17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
148	10.61	3.90	30	3	65
149	9.77	5.40	25	5	87
150	10.65	6.95	25	1	94
151	10.55	7.05	20	1	94
152	9.95	8.42	30	5	93
153	11.00	8.75	40	6	93
154	10.32	10.10	30	5	76
155	10.10	10.80	15	2	76
156	10.48	11.52	40	10	82
157	10.15	12.62	40	10	60
158	10.05	13.28	15	2	62
159	10.65	13.00	20	2	61
160	9.93	14.22	25	1	92
161	10.74	15.27	20	1	59
162	10.00	16.11	20	2	99
163	10.94	15.90	15	1	59
164	10.47	17.70	55	15	70
165	11.15	17.58	25	4	70
166	10.56	19.95	13	1	112
167	11.15	0.55	35	5	83
168	12.78	0.20	30	5	89
169	11.95	0.93	20	3	83
170	12.91	1.91	45	5	137
171	12.86	4.77	9	1	72
172	12.15	4.77	5	1	72
173	12.27	5.85	17	2	69
174	13.08	6.24	45	8	91
175	11.85	6.45	50	5	69
176	11.92	8.19	15	2	54
177	12.45	8.08	25	2	54
178	11.88	9.15	7	1	93
179	11.68	9.95	45	12	88
180	12.87	12.04	50	14	159
181	12.20	14.55	35	4	113
182	13.14	15.10	12	1	108
183	12.18	15.72	23	4	80
184	11.54	16.20	42	6	65
185	11.29	16.82	15	2	63
186	11.90	17.16	47	8	73
187	12.34	17.75	10	1	50
188	12.88	18.06	50	11	50
189	12.20	18.30	15	2	41
190	12.12	18.71	16	2	41
191	14.78	1.22	15	2	155
192	14.33	2.70	10	2	118
193	13.73	3.75	11	2	68
194	14.36	4.05	20	2	68
195	14.77	5.20	20	3	85
196	13.80	5.92	28	4	83

Quadrat AR 12 Examined 13-17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
197	14.16	6.65	50	10	82
198	14.93	6.90	35	5	81
199	14.10	8.40	30	8	76
200	14.62	8.95	6	1	76
201	13.02	9.35	25	4	138
202	14.80	9.95	40	9	105
203	14.18	11.78	17	1	158
204	13.93	13.62	40	10	87
205	14.73	13.97	8	1	58
206	15.09	13.43	30	3	58
207	13.74	16.15	35	3	61
208	14.17	16.52	14	1	47
209	13.80	16.78	9	1	44
210	13.43	17.03	38	4	44
211	12.67	16.45	20	2	113
212	13.71	19.30	45	6	105
213	14.51	18.62	35	2	51
214	14.94	18.90	12	1	51
215	16.55	0.98	45	5	92
216	15.66	2.95	9	1	45
217	15.84	3.35	7	1	45
218	16.10	3.80	32	5	50
219	17.15	3.35	50	10	103
220	15.67	4.65	14	2	86
221	16.68	4.95	40	1	104
222	16.18	6.00	40	10	92
223	15.83	7.32	14	1	81
224	16.67	7.65	35	4	54
225	16.87	7.10	27	3	54
226	17.08	6.40	45	8	76
227	16.72	8.34	11	1	54
228	17.24	8.45	4	1	42
229	16.20	10.63	60	14	122
230	16.90	12.70	32	4	77
231	16.53	17.33	35	3	164
232	16.92	19.22	20	1	112
233	17.28	1.35	45	5	92
234	19.25	1.55	20	3	113
235	18.29	2.20	9	1	56
236	17.83	2.51	7	1	56
237	18.78	2.92	35	11	61
238	18.20	2.96	6	1	57
239	17.46	4.27	7	1	102
240	18.52	3.73	50	10	87
241	18.36	5.02	50	10	61
242	18.36	5.65	40	3	61
243	19.02	4.95	11	2	58
244	19.54	5.40	33	2	58
245	19.18	6.23	44	2	95

Quadrat AR 12   Examined 13-17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
246	19.49	7.75	15	1	132
247	18.02	8.10	40	5	51
248	17.67	8.48	12	1	42
249	18.66	8.75	45	5	57
250	20.00	8.95	45	11	92
251	17.32	9.37	15	1	52
252	17.19	9.83	10	1	52
253	18.82	9.30	6	1	47
254	18.21	9.63	30	2	60
255	18.80	9.76	7	1	37
256	18.83	10.22	6	1	37
257	19.66	9.88	25	2	89
258	17.85	11.07	26	1	47
259	17.42	11.26	20	4	47
260	18.63	11.38	8	1	81
261	17.58	12.92	25	4	75
262	18.38	13.30	15	1	91
263	17.18	14.75	45	10	176
264	18.81	14.52	35	8	86
265	19.44	15.05	8	1	53
266	19.74	15.60	40	5	53
267	17.90	16.35	6	1	111
268	18.84	15.85	30	3	91
269	19.93	17.70	27	5	71
270	19.41	17.32	9	1	71
271	18.75	18.35	25	4	65
272	18.25	18.77	30	4	65
273	18.06	19.87	25	2	103

Quadrat AR 15 Examined 28/6/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.17	2.00	15	3	115
2	0.45	5.20	20	5	75
3	0.90	4.60	40	15	75
4	1.10	7.50	68	25	105
5	1.80	8.20	45	20	105
6	2.30	10.00	40	10	105
7	1.30	9.75	60	15	105
8	0.75	11.45	70	25	152
9	0.15	14.15	60	17	122
10	0.45	15.50	95	25	107
11	1.45	16.10	20	10	62
12	2.00	16.20	50	20	62
13	1.20	16.60	55	20	63
14	0.90	18.20	40	15	130
15	0.45	19.75	50	15	101
16	4.10	0.50	55	20	90
17	4.30	1.75	65	15	120
18	3.30	3.40	55	27	85
19	3.80	4.10	15	2	85
20	3.50	6.20	65	30	175
21	4.20	10.80	70	23	150
22	2.75	11.40	95	25	129
23	3.15	12.90	50	20	133
24	4.45	13.00	15	1	133
25	3.80	14.80	40	10	110
26	3.25	15.80	50	20	110
27	4.35	16.90	70	25	95
28	3.80	17.80	50	20	95
29	3.90	19.90	30	10	205
30	7.30	3.30	30	2	160
31	6.10	4.45	45	20	97
32	5.15	4.90	40	20	97
33	6.20	5.45	50	15	99
34	7.15	5.90	75	27	95
35	5.50	6.30	55	17	75
36	5.05	7.00	55	15	75
37	6.45	7.20	35	5	65
38	6.90	7.60	55	10	65
39	5.05	9.80	60	17	145
40	6.70	11.30	50	20	230
41	4.85	14.60	17	1	125
42	6.35	16.90	30	5	160
43	7.00	18.20	15	3	108
44	8.00	1.40	60	25	105
45	8.90	0.70	65	20	113
46	8.75	2.00	40	10	105
47	8.00	5.30	62	20	95
48	7.80	8.70	60	30	124
49	7.67	14.80	60	25	115

Quadrat AR 15 Examined 28/6/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	8.60	14.25	70	30	115
51	7.95	17.55	20	5	108
52	7.90	19.20	50	20	123
53	9.08	17.90	80	30	118
54	9.00	20.00	75	25	130
55	10.65	1.40	70	20	92
56	10.30	5.85	40	10	130
57	9.58	7.00	75	15	130
58	9.85	9.60	60	17	145
59	10.60	10.60	30	5	133
60	9.50	11.80	25	7	155
61	10.95	12.80	35	7	68
62	10.35	13.10	25	10	68
63	9.60	13.30	60	15	75
64	11.36	15.85	60	17	128
65	10.10	19.00	57	15	150
66	11.70	1.20	40	10	90
67	12.00	2.10	50	10	90
68	13.40	1.60	50	25	125
69	12.90	6.40	73	20	220
70	12.40	3.50	55	15	160
71	13.10	8.60	60	25	104
72	13.50	9.80	30	12	104
73	11.80	11.35	30	10	98
74	12.70	11.80	75	22	98
75	12.10	13.40	50	20	125
76	12.20	16.90	40	15	80
77	11.80	17.10	60	27	80
78	13.05	17.65	45	15	125
79	14.47	2.20	80	27	127
80	15.47	4.30	40	12	96
81	15.50	5.05	50	12	60
82	15.75	5.70	35	5	60
83	15.15	6.10	35	20	75
84	14.92	7.35	75	37	120
85	15.55	9.55	60	20	73
86	14.85	9.40	10	1	45
87	14.75	9.70	35	10	45
88	14.20	10.30	65	25	80
89	15.20	13.00	27	2	112
90	14.35	13.70	50	5	112
91	15.05	14.50	40	10	104
92	15.05	14.10	45	17	114
93	15.10	16.00	65	18	110
94	16.20	3.10	60	28	125
95	17.50	3.00	50	19	87
96	17.00	5.60	60	27	103
97	17.05	6.60	40	20	103
98	16.30	7.75	50	28	87

Quadrat AR 15 Examined 28/6/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
99	17.15	7.90	70	25	87
100	16.85	12.20	60	15	75
101	17.36	11.70	25	3	75
102	17.60	13.20	50	10	122
103	16.79	15.00	35	10	67
104	16.20	15.30	35	10	67
105	15.85	16.80	50	17	110
106	16.97	17.35	80	25	127
107	15.30	19.30	50	20	173
108	18.15	0.02	40	20	77
109	18.15	1.80	45	15	138
110	18.98	3.20	35	10	64
111	19.50	3.20	45	18	64
112	17.85	3.80	75	15	87
113	18.47	5.85	55	20	151
114	19.71	7.00	30	10	62
115	19.17	7.30	50	15	62
116	18.27	8.55	55	20	130
117	17.90	9.75	40	15	118
118	18.75	10.45	70	18	118
119	19.88	12.00	35	14	99
120	19.87	13.10	35	10	99
121	18.82	13.75	40	10	75
122	19.15	14.35	50	17	75
123	19.50	15.90	50	20	156
124	18.00	19.10	40	20	82
125	18.65	18.45	40	15	82
126	19.30	19.80	115	30	141

Quadrat AR 16 Examined 19/6/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.60	2.50	65	25	152
2	0.00	4.05	55	15	96
3	2.10	3.90	70	25	148
4	1.20	5.40	25	8	171
5	0.23	8.05	20	1	200
6	1.90	13.80	50	15	216
7	2.05	16.34	35	17	137
8	1.75	17.90	10	1	160
9	4.15	2.30	55	10	120
10	3.45	3.20	60	15	78
11	3.85	3.90	70	10	78
12	3.30	5.40	30	3	117
13	4.33	5.90	7	1	117
14	2.90	9.30	25	2	93
15	2.80	10.20	20	1	93
16	2.70	11.80	50	10	149
17	4.54	12.10	35	12	170
18	4.05	14.00	40	7	200
19	3.30	16.00	50	15	109
20	4.40	15.40	80	25	109
21	3.45	18.40	45	10	180
22	5.90	3.50	25	5	85
23	5.90	4.35	30	10	82
24	5.30	4.95	25	2	82
25	6.70	4.70	35	10	85
26	5.75	7.10	25	5	185
27	6.10	11.05	40	15	95
28	6.85	10.55	40	10	95
29	6.30	13.15	50	25	170
30	6.90	14.70	75	15	170
31	6.10	17.62	70	20	215
32	7.25	2.20	55	15	159
33	8.80	2.40	60	20	159
34	8.40	6.35	30	3	106
35	8.15	7.35	25	10	106
36	8.70	12.30	5	30	172
37	9.10	14.20	60	15	184
38	7.05	19.50	25	5	90
39	10.55	7.30	50	15	233
40	10.20	11.50	45	3	172
41	11.80	0.95	30	15	115
42	12.80	1.40	55	15	115
43	11.20	2.30	25	2	150
44	11.40	4.50	60	10	103
45	12.15	5.25	60	10	103
46	13.25	12.60	55	15	168
47	12.30	14.30	40	5	84
48	11.75	15.00	50	10	84
49	11.45	16.95	45	12	196

Quadrat AR 16 Examined 19/6/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	13.45	5.00	45	10	145
51	14.50	10.50	50	15	168
52	14.80	15.20	40	8	180
53	13.35	16.30	60	25	180
54	15.80	1.60	25	10	255
55	15.20	6.70	25	2	250
56	15.80	9.20	25	3	250
57	16.40	14.30	45	3	180
58	17.10	18.10	70	15	280
59	18.50	2.00	60	25	215
60	18.50	7.00	35	2	246
61	19.80	11.00	55	15	283
62	19.98	15.55	60	15	185
63	19.70	17.45	50	7	185

Quadrat AR NWS   Examined 27/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.12	1.15	15	3	82
2	0.34	1.34	35	7	82
3	0.05	2.12	25	5	76
4	0.75	2.40	40	10	76
5	0.45	4.65	40	15	150
6	1.85	5.77	20	2	52
7	1.55	6.35	15	1	58
8	1.50	6.90	15	2	58
9	0.35	7.72	20	5	173
10	0.50	16.45	30	7	125
11	1.80	16.95	5	1	64
12	1.38	18.70	8	1	95
13	0.45	19.55	15	1	116
14	3.30	0.75	35	2	63
15	3.22	1.30	25	2	63
16	3.65	2.15	45	10	89
17	2.60	3.20	45	15	150
18	3.68	4.30	20	3	150
19	2.38	5.84	25	3	52
20	2.72	9.67	15	3	59
21	3.30	9.47	40	5	51
22	3.53	9.95	45	10	51
23	3.95	11.08	50	7	115
24	2.00	12.40	45	15	84
25	2.72	12.86	10	1	84
26	3.45	13.65	50	12	72
27	2.10	14.32	20	2	72
28	3.72	14.00	25	5	82
29	3.45	14.80	45	10	82
30	3.43	16.46	5	1	62
31	2.45	17.08	8	1	60
32	2.82	17.55	15	3	60
33	2.30	18.35	5	1	94
34	3.15	19.55	10	1	114
35	3.75	17.88	20	3	96
36	3.90	16.45	40	12	77
37	4.50	0.50	35	10	98
38	5.06	1.78	15	2	138
39	5.93	3.74	15	3	75
40	5.62	5.33	15	3	70
41	4.57	10.70	20	3	70
42	5.02	11.55	15	3	97
43	4.40	14.75	35	10	95
44	4.62	16.62	30	3	76
45	7.17	3.10	10	1	67
46	6.66	3.58	35	10	67
47	6.20	4.34	30	5	65
48	6.32	5.18	15	3	72
49	7.42	5.30	25	6	99

Quadrat AR NWS Examined 27/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	6.20	10.66	55	15	132
51	7.00	15.25	25	5	101
52	7.87	15.75	5	1	76
53	9.43	0.20	10	1	87
54	9.70	1.05	25	5	87
55	9.70	2.10	20	3	102
56	8.07	2.03	15	3	83
57	8.65	2.65	25	7	83
58	8.68	4.70	45	12	155
59	8.60	7.02	70	15	215
60	8.45	15.25	35	15	75
61	10.85	1.18	35	7	113
62	11.45	2.32	30	8	64
63	10.25	13.98	20	3	127
64	10.52	15.22	10	3	58
65	10.15	15.69	15	2	58
66	11.70	15.77	10	1	129
67	10.34	16.95	15	1	39
68	10.60	17.25	5	1	39
69	10.00	18.60	10	3	148
70	12.25	0.47	25	5	73
71	13.00	0.48	15	3	54
72	13.19	1.30	25	5	75
73	12.25	1.42	70	20	87
74	12.05	2.25	5	1	63
75	13.18	2.15	15	3	56
76	13.70	2.00	15	2	56
77	13.33	3.00	35	3	38
78	13.70	3.00	5	1	38
79	12.55	3.58	10	1	51
80	12.75	4.05	15	3	51
81	12.13	4.10	10	1	61
82	13.51	4.80	5	1	109
83	12.30	8.22	35	7	252
84	13.82	18.30	30	5	183
85	15.15	0.57	30	7	124
86	14.83	1.78	50	15	57
87	14.25	1.79	15	3	57
88	14.40	2.45	20	2	66
89	14.32	5.83	25	5	129
90	14.72	7.43	10	1	49
91	15.20	7.43	5	1	49
92	15.15	8.90	20	5	138
93	15.23	13.00	35	10	200
94	15.55	17.70	15	5	183
95	16.93	0.35	10	1	45
96	17.37	0.52	20	5	45
97	16.84	1.07	20	5	69
98	17.35	2.45	15	5	75

Quadrat AR NWS   Examined 27/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
99	17.72	3.08	10	1	45
100	17.20	3.28	5	1	56
101	17.17	5.65	10	1	121
102	16.16	6.40	15	3	126
103	16.95	9.20	38	13	178
104	17.95	11.40	10	1	94
105	17.15	12.50	5	1	60
106	17.71	12.80	20	3	60
107	18.80	1.85	30	8	114
108	19.10	3.00	20	2	100
109	18.12	3.27	20	3	45
110	18.10	4.85	15	3	119
111	18.97	6.35	5	1	51
112	18.74	6.85	5	1	51
113	19.44	11.50	5	1	80
114	18.89	11.58	20	5	80
115	18.80	12.95	5	1	40
116	18.55	13.21	5	1	40
117	18.62	14.93	10	2	66
118	19.41	15.09	25	4	70
119	18.90	15.53	25	7	66

Quadrat AR 5 Examined 23/8/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	1.25	1.15	30	2	174
2	2.90	1.21	35	2	130
3	0.42	4.00	25	1	88
4	0.53	5.00	30	3	107
5	1.55	6.45	55	7	79
6	1.05	7.10	35	3	79
7	0.05	7.68	35	3	107
8	0.92	8.60	50	6	118
9	1.30	10.07	50	8	122
10	0.13	12.55	55	7	95
11	0.57	13.35	40	6	95
12	1.80	13.50	40	5	125
13	0.70	14.60	35	6	122
14	1.51	15.58	35	3	136
15	2.70	4.70	45	4	80
16	2.00	4.36	35	2	80
17	4.00	4.90	65	9	130
18	3.95	6.25	55	7	160
19	3.85	8.47	25	4	88
20	3.85	9.40	50	6	88
21	2.33	9.60	65	8	122
22	2.92	12.65	35	4	131
23	3.02	13.90	65	10	125
24	5.20	1.20	55	3	215
25	5.40	3.85	30	1	172
26	7.75	6.45	50	5	80
27	6.00	11.25	40	5	140
28	6.64	12.50	70	10	140
29	6.60	15.15	45	4	107
30	6.41	16.30	20	2	107
31	4.45	16.00	20	2	62
32	3.95	15.70	30	4	62
33	4.45	17.30	30	3	120
34	7.90	14.90	40	2	95
35	7.60	15.90	30	2	96
36	5.75	12.83	20	3	165
37	5.00	19.70	50	5	176
38	11.65	0.60	65	5	121
39	12.82	0.20	70	10	121
40	8.38	0.08	50	7	102
41	8.92	0.93	50	6	102
42	9.27	3.65	60	8	268
43	8.60	6.40	40	6	80
44	10.80	7.30	60	7	155
45	12.00	8.30	50	5	133
46	8.86	8.40	40	6	132
47	9.63	9.55	40	1	132
48	10.75	11.52	20	2	230
49	8.50	14.25	60	8	100

Quadrat AR 5 Examined 23/8/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	9.28	14.85	30	4	100
51	9.59	16.84	45	7	197
52	11.85	17.60	50	5	182
53	14.20	0.77	40	3	140
54	14.00	2.95	50	7	142
55	13.25	4.10	30	2	142
56	15.25	5.85	40	3	265
57	13.40	7.95	35	3	133
58	13.15	9.50	60	8	156
59	15.28	9.40	60	10	208
60	15.25	11.90	45	3	143
61	15.25	13.30	40	1	104
62	14.58	14.20	50	3	104
63	13.80	16.10	50	1	205
64	13.65	18.20	60	10	182
65	16.47	2.00	60	7	265
66	19.70	1.80	50	10	270
67	19.95	4.60	55	6	155
68	18.56	5.30	20	2	92
69	18.32	6.20	30	2	92
70	19.60	12.15	50	5	170
71	16.60	11.10	40	2	170
72	16.40	14.90	25	2	58
73	16.00	15.40	35	1	58
74	16.57	16.00	35	2	91
75	18.20	16.25	55	10	173

Quadrat MD 7B   Examined 17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	2.00	2.00	30	10	147
2	2.90	3.00	55	5	147
3	0.65	5.40	30	5	284
4	1.10	8.20	45	5	150
5	2.60	8.25	35	5	150
6	0.25	15.70	65	10	190
7	3.35	15.70	25	5	105
8	3.55	14.70	35	3	105
9	4.05	0.30	25	7	130
10	5.10	1.00	15	3	130
11	5.45	7.40	20	2	220
12	5.70	9.50	30	5	220
13	4.75	10.70	15	2	52
14	4.20	10.80	20	2	42
15	4.20	11.10	20	2	42
16	5.70	12.40	30	5	73
17	5.10	12.80	70	20	73
18	6.00	17.10	55	10	60
19	6.60	17.10	30	5	60
20	6.50	17.80	35	10	77
21	7.45	0.00	55	15	110
22	6.70	0.80	50	10	100
23	7.35	4.30	50	3	170
24	8.45	3.00	40	10	170
25	9.40	7.90	60	15	165
26	8.00	11.30	25	5	85
27	7.15	11.60	45	10	85
28	8.15	12.15	45	5	90
29	8.90	11.10	20	1	98
30	8.20	13.55	30	5	128
31	8.10	14.80	60	20	128
32	9.00	17.40	40	3	63
33	8.80	18.80	30	2	63
34	8.40	19.20	30	4	90
35	9.25	19.20	15	3	90
36	10.10	0.30	60	2	80
37	11.15	1.70	40	4	65
38	11.75	1.40	10	1	65
39	10.70	4.10	60	10	90
40	10.80	7.50	30	4	160
41	9.30	8.10	55	10	160
42	10.15	12.05	10	1	55
43	9.80	12.45	50	15	55
44	9.25	13.00	40	10	74
45	9.85	14.70	35	10	163
46	10.80	16.70	40	10	85
47	10.80	17.55	50	5	85
48	13.15	2.00	30	2	157
49	10.50	4.80	50	10	90

Quadrat MD 7B   Examined 17/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	11.85	9.70	65	15	183
51	11.85	11.50	25	3	138
52	11.80	12.90	50	3	138
53	11.45	14.65	50	4	166
54	14.30	0.90	15	1	68
55	14.93	1.10	40	3	68
56	14.90	2.80	20	1	170
57	13.55	7.40	60	5	253
58	13.75	14.10	70	10	178
59	14.90	15.35	50	5	150
60	13.65	16.20	75	15	75
61	13.35	16.90	35	3	75
62	12.90	19.20	15	2	155
63	16.30	1.75	15	2	40
64	16.50	2.10	20	3	40
65	17.30	3.90	20	2	115
66	15.55	6.80	15	1	165
67	15.60	8.50	45	3	165
68	16.80	10.15	45	3	115
69	15.95	12.30	20	2	165
70	16.50	13.80	40	5	145
71	16.60	15.25	40	5	145
72	15.20	17.30	35	5	195
73	16.80	18.45	40	10	114
74	18.60	0.50	40	3	110
75	17.80	1.20	35	3	90
76	18.40	1.85	15	1	90
77	18.45	3.50	35	3	115
78	17.40	4.00	20	3	115
79	19.00	5.00	60	15	165
80	18.25	10.30	40	3	115
81	18.90	12.30	80	15	200
82	18.70	14.20	55	10	200
83	18.10	15.70	30	1	150
84	19.05	17.55	40	5	108
85	19.80	18.30	40	3	108
86	18.00	18.75	50	5	114

Quadrat MD 4A Examined 20/6/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.59	6.82	45	12	218
2	1.95	10.20	25	6	102
3	2.20	11.10	55	15	92
4	0.22	11.32	90	20	210
5	2.20	13.25	60	20	215
6	0.38	15.20	55	5	280
7	2.00	19.25	40	12	110
8	2.80	9.65	22	2	103
9	2.45	7.90	35	5	180
10	4.80	0.65	50	15	89
11	5.40	9.70	50	12	260
12	4.50	12.80	45	17	212
13	5.32	14.70	15	1	79
14	6.00	15.15	22	2	79
15	3.25	15.30	35	13	112
16	4.30	15.70	40	5	112
17	3.25	16.80	45	3	160
18	5.35	17.40	40	15	190
19	8.08	8.00	15	1	154
20	9.20	11.80	35	7	150
21	8.24	13.37	40	15	150
22	6.80	12.95	55	7	150
23	10.20	2.20	60	27	232
24	9.50	4.45	35	5	223
25	9.30	6.95	45	18	150
26	11.00	6.24	25	3	57
27	10.85	6.80	45	15	57
28	10.53	9.30	35	5	145
29	11.30	10.65	40	10	145
30	9.75	14.40	35	5	102
31	10.75	14.40	30	5	102
32	9.45	16.25	25	7	185
33	13.40	3.40	75	20	170
34	12.90	5.05	30	15	163
35	12.82	8.30	40	10	205
36	12.65	15.80	33	5	120
37	14.82	1.65	45	15	115
38	14.45	4.90	45	7	150
39	14.80	6.45	35	5	136
40	14.70	9.10	30	4	155
41	13.80	12.23	35	3	152
42	15.30	12.65	55	5	152
43	15.70	14.60	35	4	190
44	13.87	15.85	50	9	114
45	13.45	17.35	30	6	163
46	16.00	1.70	48	5	92
47	16.85	2.10	55	10	92
48	17.15	4.15	30	10	218
49	16.20	6.40	45	15	135

Quadrat MD 4A   Examined 20/6/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	16.75	9.55	50	13	112
51	15.85	10.20	40	7	112
52	17.52	13.25	45	7	142
53	17.50	14.60	25	3	142
54	16.00	17.00	30	3	89
55	16.45	17.82	30	5	81
56	17.25	17.45	55	15	81
57	17.90	6.89	35	10	165
58	18.85	10.55	23	5	73
59	18.25	11.00	20	2	73
60	18.95	12.55	65	25	150
61	19.30	16.40	55	10	225

Quadrat MD 4B Examined 3/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.40	0.60	60	20	147
2	0.80	2.80	30	5	155
3	1.55	4.20	25	5	100
4	2.50	4.05	45	5	100
5	2.15	5.35	40	5	100
6	1.15	5.50	45	12	100
7	2.45	8.50	75	10	205
8	1.20	10.35	35	5	170
9	0.70	12.05	45	15	169
10	2.43	13.93	30	5	50
11	2.95	13.90	20	3	50
12	1.62	17.00	35	10	233
13	0.85	19.40	25	3	36
14	0.50	19.45	20	2	36
15	3.65	18.30	50	10	144
16	4.55	1.00	50	5	158
17	5.00	3.60	90	18	256
18	4.71	7.50	40	10	106
19	4.50	8.50	35	12	106
20	4.00	9.90	25	5	54
21	4.25	10.40	40	10	54
22	4.94	10.50	30	7	69
23	4.97	12.20	55	5	162
24	4.97	18.95	27	5	53
25	5.50	19.00	30	3	53
26	6.10	5.90	25	4	207
27	6.70	1.30	40	12	210
28	8.71	3.10	35	5	89
29	8.69	3.95	85	12	89
30	8.48	7.30	40	10	230
31	9.00	9.55	30	8	193
32	9.58	14.65	60	15	112
33	9.07	15.65	70	17	112
34	7.83	19.70	40	13	200
35	10.05	0.83	55	17	169
36	11.12	4.10	30	8	100
37	10.91	5.15	30	10	100
38	10.77	8.80	35	7	198
39	10.10	11.13	45	10	194
40	10.80	15.45	55	18	150
41	9.77	17.22	50	12	168
42	13.55	0.66	35	7	70
43	12.65	2.90	30	10	206
44	11.80	7.00	50	8	168
45	13.42	7.35	65	17	113
46	12.57	11.00	40	10	163
47	12.25	12.65	50	17	168
48	15.40	1.17	25	5	58
49	14.00	6.23	20	6	112

Quadrat MD 4B   Examined   3/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	14.10	11.30	32	7	137
51	15.12	12.10	25	5	137
52	14.15	14.55	40	8	260
53	14.05	18.05	55	16	270
54	16.00	1.12	44	15	58
55	16.65	1.45	35	12	68
56	15.83	5.15	40	3	168
57	15.88	10.38	25	3	191
58	16.28	19.70	35	11	270
59	18.00	2.00	20	2	103
60	18.36	2.95	30	15	103
61	19.99	4.05	85	15	187
62	19.80	6.70	60	15	197
63	18.20	10.55	30	15	97
64	18.02	11.50	20	10	97
65	17.70	13.65	40	15	189
66	18.68	15.30	45	12	145
67	19.85	14.40	45	5	145

Quadrat MD 3B   Examined   4/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	2.35	0.05	35	10	170
2	0.75	3.85	60	12	220
3	2.50	5.30	15	3	126
4	3.10	6.90	30	5	170
5	1.00	7.05	55	20	102
6	0.50	8.00	15	2	102
7	0.22	9.63	55	11	168
8	3.00	9.49	55	7	112
9	2.53	10.57	55	12	100
10	2.00	11.35	45	12	100
11	3.10	11.65	55	10	117
12	2.00	13.10	30	5	60
13	1.40	12.90	30	3	60
14	0.68	12.87	55	17	78
15	0.57	13.95	15	2	74
16	0.87	14.62	20	3	74
17	2.07	15.47	35	5	144
18	1.67	17.50	45	15	162
19	0.18	18.08	45	6	162
20	1.61	19.85	60	15	222
21	5.22	0.25	65	18	280
22	5.24	3.30	100	25	215
23	3.68	4.80	70	20	126
24	5.17	6.55	50	10	206
25	4.00	12.72	55	10	131
26	4.38	16.03	50	15	128
27	3.53	17.01	35	5	128
28	6.58	4.61	15	3	198
29	7.31	6.45	35	7	163
30	6.59	9.67	27	5	131
31	6.15	13.92	25	5	80
32	5.37	13.96	45	13	80
33	6.15	15.38	35	7	73
34	6.22	16.10	45	8	73
35	8.94	6.55	20	4	163
36	9.19	9.00	75	23	200
37	7.70	10.40	75	15	131
38	9.18	13.83	50	12	111
39	8.46	14.70	35	8	54
40	7.95	14.82	45	12	54
41	7.33	17.95	58	12	120
42	8.28	18.68	40	5	120
43	8.10	19.93	20	5	122
44	10.89	3.75	20	2	76
45	10.88	4.45	60	15	76
46	10.61	6.85	60	15	167
47	10.38	11.20	60	15	217
48	10.44	16.72	65	17	106
49	10.14	18.82	30	3	110

Quadrat MD 3B   Examined   4/7/84

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	10.55	19.80	60	10	110
51	12.34	1.55	65	18	198
52	12.05	8.40	55	15	165
53	12.56	10.00	40	8	165
54	11.60	13.15	60	12	220
55	11.19	17.55	30	3	72
56	11.65	18.10	30	5	72
57	14.75	0.35	20	1	265
58	13.36	3.15	60	20	198
59	14.34	10.25	75	20	180
60	13.80	13.80	30	5	134
61	14.60	14.87	30	6	101
62	14.89	16.20	55	13	103
63	15.12	19.65	80	25	268
64	4.05	15.52	45	12	245
65	17.20	5.95	57	17	207
66	16.58	7.85	80	12	207
67	16.00	11.95	60	20	120
68	16.48	13.08	50	10	120
69	15.49	15.26	60	15	100
70	19.66	3.80	55	14	193
71	18.85	8.80	80	17	187
72	19.02	10.68	40	6	104
73	18.45	11.58	30	4	104
74	18.26	13.20	85	22	163
75	19.53	14.75	80	25	122
76	17.37	16.35	45	17	176
77	18.94	17.15	40	9	131
78	18.14	18.18	47	10	131

Quadrat ST C   Examined   1/6/85

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
1	0.48	0.12	85	20	238
2	1.55	3.25	70	20	215
3	0.29	5.00	55	15	177
4	0.48	6.75	25	4	102
5	1.50	7.00	42	14	102
6	3.05	6.30	45	15	132
7	2.96	9.10	45	8	106
8	2.98	10.00	55	12	106
9	1.53	14.25	70	22	183
10	0.74	16.00	35	4	183
11	1.00	18.00	50	14	210
12	3.90	0.70	45	10	223
13	3.88	3.30	55	13	208
14	4.03	5.40	30	3	132
15	4.32	12.30	35	7	115
16	4.20	13.40	40	10	115
17	5.10	15.75	60	15	237
18	3.70	18.10	35	8	277
19	5.93	2.43	40	14	168
20	7.45	3.15	40	14	168
21	6.44	5.52	55	14	252
22	5.34	8.30	25	3	182
23	8.00	9.12	65	14	203
24	8.27	11.00	35	8	178
25	6.56	10.70	40	8	95
26	5.95	10.10	45	7	95
27	5.85	13.20	25	4	178
28	7.00	17.10	40	13	256
29	8.95	0.15	50	17	278
30	10.55	2.45	55	15	240
31	12.20	5.30	130	21	180
32	11.05	6.95	65	14	177
33	9.85	8.30	45	15	177
34	10.35	10.77	35	8	136
35	11.50	11.35	50	14	136
36	11.80	9.65	40	1	160
37	8.78	13.50	25	3	148
38	8.85	14.40	25	4	136
39	10.10	15.77	55	17	136
40	12.15	17.40	40	12	241
41	12.60	1.18	55	5	112
42	14.00	1.14	35	2	98
43	13.45	1.90	20	1	98
44	15.92	1.30	30	2	130
45	14.87	3.35	25	5	190
46	13.66	6.35	50	16	180
47	15.75	7.25	48	14	136
48	16.51	8.46	40	5	136
49	12.95	8.35	30	9	125

Quadrat ST C   Examined   1/6/85

Mound no.	X coordinate	Y coordinate	diameter of mound	height of mound	nearest neighbour
50	13.95	9.21	60	16	125
51	15.83	11.30	45	7	136
52	14.99	13.90	75	3	208
53	14.30	16.00	40	8	86
54	14.40	17.20	45	5	86
55	16.92	0.20	50	5	130
56	19.21	0.93	25	6	83
57	19.85	0.40	60	13	83
58	16.80	3.65	55	18	190
59	19.55	9.65	40	5	166
60	17.10	11.30	20	5	116
61	18.23	11.43	25	7	116
62	19.40	12.68	25	2	138
63	17.50	14.25	30	3	94
64	17.76	15.13	40	10	94
65	19.18	15.05	45	7	142
66	18.99	16.96	55	7	153

APPENDIX TWO

Full details of the mark-release-recapture estimates.

This Appendix gives the details of the dates and sample sizes of the mark-release-recapture estimates of colony sizes. The methods used are as described in section 9.7. The final estimate is given with its standard deviation.

Table XXXXIII

The first mark-release-recapture estimates at Old Winchester Hill.

QUADRAT	NEST NUMBER	MARKED ANTS RELEASED	SECOND SAMPLE	RECAPTURES	ESTIMATE
OWH C10	1	393	462	21	8646 +/- 1843
	2	386	647	26	9605 +/- 1846
	3	556	558	8	34534 +/- 10832
	4	341	309	6	15101 +/- 5279
	5	* 652	197	21	6116 +/- 1262
OWH SS4	1	216	329	30	2369 +/- 412
	2	207	381	11	6590 +/- 1799
	3	149	432	0	-
	4	* 106	250	0	-
	5	* 100	336	0	-
OWH SS11	1	109	364	2	13269 +/- 6604
	2	271	358	8	10810 +/- 3375
	3	107	210	5	3763 +/- 1402
	4	228	378	13	6172 +/- 1564
	5	52	165	0	-

1st sample 27/7/85 (* 5/7/85)   Fed 32P on 26/7/85 (*15/7/85)
Release 3/8/85 (*23/7/85)   Removed on 27/7/85 (*16/7/85)
2nd sample 5/8/85 (*27/7/85)

Table XXXXIV.

The second mark-release-recapture estimates at Old Winchester Hill.

QUADRAT	NEST NUMBER	MARKED ANTS RELEASED	SECOND SAMPLE	RECAPTURES	ESTIMATE
OWH C10	1	492	173	19	4280 +/- 879
	2	116	0	0	-
	3	190	19	0	-
	4	585	392	15	14369 +/- 3413
	5	389	395	14	10270 +/- 2518
OWH SS4	1	249	87	9	2191 +/- 622
	2	536	220	24	4913 +/- 947
	3	547	922	30	16811 +/- 3019
	4	349	115	19	2024 +/- 402
	5	288	1355	4	78106 +/- 31828
OWH SS11	1	450	75	5	5700 +/- 2068
	2	619	57	6	5129 +/- 1700
	3	581	785	42	10859 +/- 1630
	4	557	477	15	16640 +/- 3968
	5	98	36	0	-

1st sample 23/9/85 Fed 32P on 30/9/85
Released 7/10/85 Removed on 3/10/85
2nd sample 11/10/85

Table XXXXV.

The first mark-release-recapture estimates at Aston Rowant.

QUADRAT	NEST NUMBER	MARKED ANTS RELEASED	SECOND SAMPLE	RECAPTURES	ESTIMATE
AR 15	1	181	256	20	2215 +/- 453
	2	404	368	8	16564 +/- 5174
	3	441	349	2	51450 +/- 25615
	4	96	213	1	10272 +/- 5903
	5	286	912	8	29299 +/- 9220
AR 16	1	286	295	5	14109 +/- 5279
	2	269	612	6	23557 +/- 8281
	3	422	511	9	21606 +/- 6451
	4	390	225	19	4407 +/- 918
	5	334	394	13	9424 +/- 2370

1st sample 30/7/85 Fed 32P on 1/8/85
Release 8/8/85 Removed on 2/8/85
2nd sample 12/8/85

Table XXXXVI.

The second mark-release-recapture estimates at Aston Rowant.

QUADRAT	NEST NUMBER	MARKED ANTS RELEASED	SECOND SAMPLE	RECAPTURES	ESTIMATE
AR 15	1	499	116	14	3892 +/- 909
	2	378	60	3	5765 +/- 2492
	3	770	71	6	7920 +/- 2661
	4	203	57	5	1962 +/- 702
	5	448	40	4	3674 +/- 1405
AR 16	1	425	178	3	19019 +/- 8410
	2	327	71	4	4709 +/- 1854
	3	825	51	3	10725 +/- 4608
	4	192	37	2	2432 +/- 1167
	5	184	32	2	2024 +/- 965

1st sample 25/9/85 Fed 32P on 30/9/85
Released 8/10/85 Removed on 3/10/85
2nd sample 13/10/85

Table XXXXVII.

The first mark-release-recapture estimates at Martin Down.

QUADRAT	NEST NUMBER	MARKED ANTS RELEASED	SECOND SAMPLE	RECAPTURES	ESTIMATE
MD 4B	1	346	398	38	3624 +/- 559
	2	240	239	2	19200 +/- 9540
	3	150	231	1	17400 +/- 10002
	4	251	391	4	19678 +/- 7982
	5	249	390	39	2490 +/- 378

1st sample 19/7/85 Fed 32P on 22/7/85
Released 29/7/85 Removed on 23/7/85
2nd sample 31/7/85

Table XXXXVIII.

The second mark-release-recapture estimates at Martin Down.

QUADRAT	NEST NUMBER	MARKED ANTS RELEASED	SECOND SAMPLE	RECAPTURES	ESTIMATE
MD 4B	1	183	499	18	4816 +/- 1056
	2	762	732	24	23241 +/- 4666
	3	206	208	8	4784 +/- 1480
	4	567	470	39	6833 +/- 1048
	5	366	358	28	4680 +/- 849
MD 7B	1	323	49	1	8075 +/- 3729
	2	380	57	2	7347 +/- 3577
	3	238	5	2	476 +/- 168
	4	32	55	0	-
	5	517	832	13	30762 +/- 7876

1st sample 23/9/85 Fed 32P on 30/9/85
Released 7/10/85 Removed on 3/10/85
2nd sample 11/10/85

APPENDIX THREE

Sizes and nearest neighbours of the sample colonies.

In this Appendix the maximum heights and diameters and the distance to the first three nearest neighbouring mounds are given for the colonies whose worker population estimates and sexual production was measured. Firstly the same information is given for the sample colonies that were dug up for population estimates, in three of the sample areas.

Table XXXXIX.

The sizes and distance to the three nearest neighbours of the mounds that were dug up.

QUADRAT	COLONY NUMBER	MAX. DIAMETER	MAX. HEIGHT	DISTANCE TO THREE NEAREST NEIGHBOURS		
AR 15	1	50	17	125	128	170
	2	52	23	135	140	155
	3	35	17	110	125	145
	4	43	14	80	200	235
	5	50	18	150	200	225
AR 16	1	40	13	127	175	230
	2	37	12	185	225	240
	3	40	11	100	180	185
	4	35	20	137	200	220
	5	42	17	120	130	175
MD 7B	1	60	13	100	200	220
	2	45	10	180	270	275
	3	45	11	100	110	130
	4	50	14	175	235	250
	5	35	7	80	280	300

Table XXXXX.

The sizes and distance to the three nearest neighbours of the mounds in each sample area for which worker ant populations and sexual production were measured.

QUADRAT	COLONY NUMBER	MAX. DIAMETER	MAX. HEIGHT	DISTANCE TO THREE NEAREST NEIGHBOURS		
OWH SS4	1	45	12	100	230	235
	2	42	11	80	95	180
	3	50	14	100	130	140
	4	48	11	164	202	350
	5	50	15	160	310	365
OWH SS11	1	43	7	225	240	260
	2	45	12	90	220	285
	3	35	10	215	280	290
	4	50	14	107	200	260
	5	45	6	170	266	300
OWH C10	1	80	22	200	230	290
	2	60	22	100	245	255
	3	90	25	175	260	305
	4	70	25	165	225	280
	5	65	21	155	180	230
AR 15	1	51	23	80	190	195
	2	65	20	150	213	260
	3	60	16	117	143	190
	4	65	20	100	196	211
	5	50	13	120	140	143
AR 16	1	53	13	76	163	168
	2	45	13	96	245	270
	3	50	15	157	260	270
	4	35	10	105	190	272
	5	47	10	173	210	350
MD 7B	1	55	10	147	200	300
	2	35	2	65	175	265
	3	45	12	150	150	190
	4	60	18	160	300	360
	5	50	14	190	200	240
MD 4B	1	40	10	130	190	280
	2	40	12	100	180	195
	3	45	20	150	260	320
	4	35	7	70	155	200
	5	40	14	185	375	390

APPENDIX FOUR

Details of the sample cores collected from the sample areas.

In this Appendix the details of the sizes, densities an water contents of the sample cores that were collected for the extraction of invertebrates are given. The numbers of root aphids, L. flavus workers, mites, collembolans and Platyarthrus hoffmanseggi extracted from each set of cores are given. Means are given with their standard errors.

The results from each study site are given in turn.

Table XXXXXI.

The mean percentage water contents of the soil cores collected at Old Winchester Hill.

Date	N	SS 4	SS 11	C 10
2/3	3	41.07+/-2.58	45.43+/-1.23	52.03+/-1.36
16/3	3	41.71+/-1.21	42.67+/-0.68	48.47+/-3.85
10/4a	3	44.11+/-1.79	45.39+/-0.48	51.28+/-1.32
10/4b	3	42.21+/-0.83	43.27+/-1.57	54.12+/-0.48
19/4	3	36.60+/-1.17	39.15+/-1.82	45.62+/-2.06
10/5	3	29.84+/-0.58	30.47+/-0.63	45.83+/-1.92
24/5	3	25.56+/-0.31	27.02+/-0.55	34.78+/-2.40
7/6	3	27.73+/-1.76	32.69+/-1.99	41.32+/-1.03
23/6	3	18.96+/-1.85	21.54+/-0.82	26.72+/-0.27
19/7	3	19.42+/-1.87	20.94+/-1.02	26.35+/-0.70
3/8	3	18.84+/-0.58	16.84+/-2.61	23.76+/-0.66
23/8	3	19.02+/-2.21	21.88+/-1.18	29.18+/-2.18
27/9	2	18.38	22.00	32.38
30/11	3	29.91+/-0.55	32.24+/-1.70	45.56+/-2.77
18/1	3	33.64+/-0.79	41.90+/-1.69	42.08+/-0.47

Table XXXXXII.

The mean lengths of the soil cores collected at Old Winchester Hill.

Date	N	SS 4	SS 11	C 10
2/3	3	12.2+/-1.4	10.3+/-0.7	11.0+/-1.8
16/3	3	12.2+/-0.4	10.8+/-0.4	11.5+/-2.0
10/4	6	10.1+/-0.6	10.8+/-0.4	10.2+/-0.6
19/4	3	10.5+/-0.3	10.2+/-0.6	9.7+/-0.4
10/5	3	10.0+/-0.3	8.3+/-1.2	7.7+/-1.6
24/5	3	10.3+/-0.7	8.2+/-0.8	9.0+/-0.9
7/6	3	11.2+/-1.1	8.3+/-0.7	9.0+/-0.5
23/6	3	9.2+/-0.9	9.2+/-0.6	8.5+/-2.0
19/7	3	10.0+/-0.5	8.3+/-0.4	7.2+/-0.2
3/8	3	11.0+/-0.6	11.0+/-2.0	9.7+/-1.2
23/8	3	11.0+/-0.3	8.5+/-0.6	#6.3
27/9	2	12.3	10.3	8.5
30/11	3	11.1+/-1.0	9.9+/-0.6	9.0+/-1.8
18/1	3		NOT MEASURED	

N = 2

Table XXXXXIII.

The mean densities of the soil cores collected at Old Winchester Hill.

Date	N	SS 4	SS 11	C 10
2/3	3	0.70+/-0.08	0.62+/-0.01	0.48+/-0.03
16/3	3	0.68+/-0.02	0.65+/-0.03	0.61+/-0.10
10/4	6	0.65+/-0.04	0.63+/-0.06	0.46+/-0.03
19/4	3	0.67+/-0.03	0.63+/-0.06	0.61+/-0.07
10/5	3	0.75+/-0.06	0.64+/-0.03	0.48+/-0.03
24/5	3	0.63+/-0.03	0.53+/-0.02	0.59+/-0.08
7/6	3	0.71+/-0.03	0.59+/-0.03	0.55+/-0.05
23/6	3	0.68+/-0.05	0.57+/-0.04	0.47+/-0.10
19/7	3	0.65+/-0.05	0.53+/-0.04	0.60+/-0.02
3/8	3	0.69+/-0.03	0.72+/-0.03	0.49+/-0.08
23/8	3	0.77+/-0.04	0.60+/-0.03	*0.53
27/9	2	0.76	0.58	0.51
30/11	3	0.73+/-0.03	0.62+/-0.04	0.41+/-0.02
18/1	3		NOT MEASURED	

* N = 2

Table XXXXXIV.

<u>The mean numbers of root aphids extracted from soil cores collected at Old Winchester Hill.</u>

Date	N	SS 4	SS 11	C 10
2/3	3	2.33+/- 1.86	0.66+/- 0.66	0.33+/- 0.33
16/3	3	0.33+/- 0.33	0.33+/- 0.33	0
10/4	3	0.33+/- 0.33	0	5.00+/- 5.00
19/4	3	5.83+/- 2.73	1.67+/- 1.20	0.67+/- 0.33
10/5	3	0.33+/- 0.33	1.33+/- 0.88	2.67+/- 1.67
24/5	3	2.33+/- 2.33	0.66+/- 0.66	3.00+/- 2.08
7/6	3	1.66+/- 0.33	2.33+/- 1.86	0.67+/- 0.67
23/6	3	0	1.33+/- 1.33	13.00+/- 8.00
19/7	3	2.67+/- 2.67	0.33+/- 0.33	6.33+/- 5.36
3/8	3	0	0	5.67+/- 3.84
23/8	3	6.67+/- 4.06	7.00+/- 4.00	5.00+/- 4.51
27/9	2	0	11.50	5.50
30/11	3	0.33+/- 0.33	11.33+/- 9.84	4.67+/- 4.67
18/1	3	1.00+/- 1.00	3.33+/- 1.76	0

Table XXXXXV.

<u>The mean number of **Lasius flavus** worker ants extracted from soil cores collected at Old Winchester Hill.</u>

Date	N	SS 4	SS 11	C 10
2/3	3	17.00+/-17.00	3.00+/- 2.10	55.70+/-48.40
16/3	3	4.70+/- 4.70	1.00+/- 1.00	45.70+/-45.70
10/4	3	8.33+/- 3.83	0.66+/- 0.33	0
19/4	3	9.33+/- 5.49	8.67+/- 6.33	0.67+/- 0.33
10/5	3	1.33+/- 0.67	9.00+/- 4.93	4.00+/- 2.65
24/5	3	7.67+/- 4.63	5.67+/- 2.85	3.33+/- 0.67
7/6	3	5.00+/- 2.10	12.33+/- 6.40	1.00+/- 0.60
23/6	3	22.00+/-18.00	4.33+/- 3.40	11.67+/- 1.90
19/7	3	3.67+/- 3.67	0.33+/- 0.33	7.67+/- 4.60
3/8	3	0.67+/- 0.67	1.33+/- 1.33	16.67+/- 3.50
23/8	3	14.00+/- 6.56	13.67+/-10.27	12.67+/- 9.17
27/9	2	6.00	59.50	13.00
30/11	3	4.67+/- 4.67	7.33+/- 6.84	0.33+/- 0.33
18/1	3	10.33+/- 9.35	9.00+/- 5.20	2.00+/- 2.00

Table XXXXXVI.

The mean numbers of mites extracted from the soil cores collected at Old Winchester Hill.

Date	N	SS 4	SS 11	C 10
2/3	3	104.0+/-12.9	132.3+/-14.3	113.6+/-34.7
16/3	3	81.3+/-31.9	81.3+/-25.6	99.7+/-30.0
10/4	3	80.0+/-22.0	166.7+/-60.1	206.4+/-14.0
19/4	3	102.3+/-14.7	133.7+/-37.3	326.3+/-42.9
10/5	3	81.3+/-26.3	185.3+/-61.8	186.7+/-56.8
24/5	3	186.7+/-62.4	129.3+/-16.2	249.3+/-43.4
7/6	3	105.3+/-10.4	149.3+/-40.8	280.7+/-46.4
23/6	3	72.3+/- 9.3	93.3+/-19.4	91.3+/-23.4
19/7	3	308.0+/-84.7	276.0+/-51.6	311.3+/-82.3
3/8	3	112.0+/-34.2	111.0+/-41.1	312.3+/-30.0
23/8	3	121.3+/-11.6	106.7+/-17.3	286.7+/-86.7
27/9	2	154.0	226.0	156.0
30/11	3	106.0+/-35.6	220.0+/-22.0	358.7+/-69.3
18/1	3	232.2+/-29.6	341.3+/-18.8	513.3+/-74.5

Table XXXXXVII.

The mean numbers of Collembola extracted from the soil cores collected at Old Winchester Hill.

Date	N	SS 4	SS 11	C 10
2/3	3	42.3+/-20.1	61.0+/-10.8	78.7+/-18.8
16/3	3	22.7+/- 5.8	25.3+/- 9.6	58.7+/-31.2
10/4	3	31.0+/-13.8	13.3+/- 3.5	56.7+/-15.7
19/4	3	25.3+/- 3.5	29.3+/- 3.5	54.7+/- 2.7
10/5	3	12.0+/- 4.6	16.0+/- 8.3	19.9+/- 6.7
24/5	3	29.3+/- 9.6	44.0+/- 2.3	186.7+/-35.4
7/6	3	17.3+/- 3.5	19.3+/- 4.7	68.0+/- 6.1
23/6	3	8.3+/- 5.9	20.7+/-15.8	21.3+/- 8.7
19/7	3	68.0+/-18.0	18.7+/- 8.1	65.3+/-11.4
3/8	3	53.3+/- 8.7	38.7+/-17.9	52.0+/-15.1
23/8	3	48.0+/-19.7	21.3+/- 6.7	85.3+/-21.8
27/9	2	50.0	36.0	30.0
30/11	3	14.7+/- 3.5	45.3+/-20.2	105.3+/-35.4
18/1	3	61.3+/- 3.2	109.3+/-43.0	249.3+/-74.0

Table XXXXXVIII.

The mean numbers of the isopod **Platyarthrus hoffmanseggi** extracted from soil cores collected at Old Winchester Hill.

Date	N	SS 4	SS 11	C 10
2/3	3	6.67+/-6.67	0.67+/-0.67	0.33+/-0.33
16/3	3	0.66+/-0.66	0	0
10/4	3	0	0	0
19/4	3	0	0	0
10/5	3	0	0	0.33+/-0.33
24/5	3	0.33+/-0.33	0.33+/-0.33	0
7/6	3	2.66+/-2.19	0.66+/-0.66	0
23/6	3	1.00+/-1.00	1.66+/-1.66	0
19/7	3	2.33+/-2.33	0.67+/-0.67	0
3/8	3	0	0	0.66+/-0.66
23/8	3	4.33+/-3.84	0	0
27/9	2	0.50	4.50	0.50
30/11	3	0	0	0
18/1	3	0	1.00+/-1.00	0.33+/-0.33

Table XXXXXIX.

The mean percentage water contents of the soil cores collected at Aston Rowant.

Date	N	AR 15	AR16
15/3	4	41.33+/-0.58	44.23+/-0.93
13/4	4	41.39+/-1.22	41.18+/-0.36
20/4	4	39.51+/-0.83	40.82+/-1.69
3/5	4	39.08+/-0.91	42.02+/-0.61
25/5	4	30.40+/-1.30	31.45+/-1.58
9/6	3	31.25+/-0.78	28.15+/-1.14
4/7	4	22.82+/-0.37	23.05+/-0.96
20/7	4	22.03+/-1.05	#19.98+/-0.82
15/8	4	26.27+/-1.73	26.30+/-0.82
24/8	3	17.97+/-1.13	20.18+/-1.16
28/9	3	26.67+/-0.30	25.03+/-2.17
20/11	5	34.21+/-1.03	33.49+/-0.79
12/1	4	33.88+/-1.01	35.17+/-0.43

N = 3

Table XXXXXX.

The mean lengths of the soil cores collected at Aston Rowant.

Date	N	AR 15	AR16
15/3	4	14.6+/-0.4	12.9+/-0.6
13/4	4	14.2+/-0.5	14.0+/-0.5
20/4	4	13.8+/-0.5	13.5+/-0.6
3/5	4	12.3+/-0.4	12.9+/-0.6
25/5	4	13.9+/-0.3	13.4+/-0.5
9/6	3	12.7+/-0.2	12.8+/-0.6
4/7	4	12.4+/-0.7	12.9+/-0.8
20/7	4	11.3+/-1.1	# 12.6+/-0.5
15/8	4	12.9*/-0.8	14.5+/-0.9
24/8	3	12.8+/-0.9	13.7+/-0.4
28/9	3	11.8+/-1.6	12.8+/-0.4
20/11	5	13.2+/-0.9	14.1+/-0.6
12/1	4	NOT MEASURED	

N = 3

Table XXXXXXI.

The mean densities of the soil cores collected at Aston Rowant.

Date	N	AR 15	AR16
15/3	4	0.75+/-0.01	0.74+/-0.04
13/4	4	0.78+/-0.02	0.80+/-0.02
20/4	4	0.82+/-0.01	0.80+/-0.03
3/5	4	0.75+/-0.02	0.70+/-0.04
25/5	4	0.80+/-0.02	0.84+/-0.05
9/6	3	0.78+/-0.02	0.79+/-0.02
4/7	4	0.76+/-0.02	0.81+/-0.05
20/7	4	0.74+/-0.09	#0.88+/-0.04
15/8	4	0.85+/-0.07	0.81+/-0.03
24/8	3	0.84+/-0.04	0.87+/-0.01
28/9	3	0.75+/-0.02	0.79+/-0.09
20/11	5	0.74+/-0.06	0.76+/-0.56
12/1	4	NOT MEASURED	

N = 3

Table XXXXXXII.

The mean numbers of root aphids extracted from soil cores collected at Aston Rowant.

Date	N	AR 15	AR16
15/3	4	0	0
13/4	4	0.75+/-0.48	0.25+/- 0.25
20/4	4	0	0
3/5	4	2.75+/-1.11	0.50+/- 0.50
25/5	4	1.00+/-0.41	0.25+/- 0.25
9/6	3	0.67+/-0.33	18.67+/-12.34
4/7	4	0.75+/-0.25	0.75+/- 0.25
20/7	4	0.25+/-0.25	# 1.25+/- 0.75
15/8	4	0.25+/-0.25	1.75+/- 0.75
24/8	3	6.67+/-2.19	3.33+/- 1.33
28/9	3	14.33+/-3.93	2.67+/- 2.67
20/11	4	6.75+/-3.35	* 0
12/1	4	0.25+/-0.25	0

N = 3   * N = 5

Table XXXXXXIII.

The mean number of **Lasius flavus** worker ants extracted from the soil cores collected at Aston Rowant.

Date	N	AR 15	AR16
15/3	4	1.75+/- 1.75	0.50+/- 0.50
13/4	4	5.25+/- 4.31	0
20/4	4	15.50+/-12.68	1.75+/- 1.11
3/5	4	2.75+/- 1.11	0.50+/- 0.50
25/5	4	5.75+/- 3.07	1.00+/- 1.00
9/6	3	20.00+/-14.01	21.00+/-13.80
4/7	4	4.25+/- 1.25	1.25+/- 1.25
20/7	4	5.75+/- 1.49	# 6.50+/- 6.50
15/8	4	6.00*/- 4.71	5.25+/- 2.87
24/8	3	16.33+/- 6.33	44.67+/-44.67
28/9	3	21.33+/-17.34	9.00+/- 5.20
20/11	4	10.25+/- 8.02	* 0.40+/- 0.40
12/1	4	16.00+/-14.70	3.25+/- 2.02

N = 3   * N = 5

Table XXXXXXIV.

The mean number of mites extracted from the soil cores collected at Aston Rowant.

Date	N	AR 15	AR16
15/3	4	165.0+/-22.4	163.0+/-22.1
13/4	4	118.5+/-20.5	142.3+/-19.9
20/4	4	148.5+/-24.4	89.5+/-22.2
3/5	4	156.3+/-50.6	82.0+/-28.4
25/5	4	91.8+/-19.8	113.3+/-13.9
9/6	3	60.7+/- 7.5	83.3+/-15.1
4/7	4	51.0+/-11.8	77.5+/-13.8
20/7	4	56.0+/- 8.5	# 44.0+/-11.9
15/8	4	111.0+/-32.0	127.0+/-39.7
24/8	3	148.0+/-42.8	80.0+/-22.3
28/9	3	138.7+/-40.7	217.7+/-76.0
20/11	4	199.3+/-37.2	*121.8+/-17.1
12/1	4	143.3+/-46.4	236.5+/-69.9

N = 3 * N = 5

Table XXXXXXV.

The mean number of collembola extracted from the soil cores collected at Aston Rowant.

Date	N	AR 15	AR16
15/3	4	110.8+/-17.6	120.8+/-27.7
13/4	4	50.3+/-20.4	88.0+/-19.3
20/4	4	76.0+/-13.2	58.0+/-17.7
3/5	4	30.5+/- 6.9	40.0+/-18.8
25/5	4	110.8+/-54.4	99.5+/-32.1
9/6	3	130.3+/-50.9	67.7+/-14.8
4/7	4	87.0+/-23.2	123.0+/-38.0
20/7	4	35.0+/-10.2	# 35.0+/- 7.2
15/8	4	71.0+/-12.4	81.0+/-17.2
24/8	3	100.0+/-20.1	106.0+/-23.1
28/9	3	72.0+/-11.6	138.7+/-48.8
20/11	4	72.0+/-14.0	* 83.2+/-13.6
12/1	4	100.0+/-19.7	144.0+/-33.7

N = 3 * N = 5

Table XXXXXXVI.

The mean numbers of the isopod **Platyarthrus hoffmanseggi** extracted from soil cores collected at Aston Rowant.

Date	N	AR 15		AR16
15/3	4	0		1.25
13/4	4	0		0.25
20/4	4	0.25		0
3/5	4	0		0
25/5	4	0.25		0
9/6	3	0.25		1.33
4/7	4	0.5		0
20/7	4	0	#	0
15/8	4	2.25+/-1.31		0
24/8	3	1.33+/-0.88		0
28/9	3	2.67+/-2.67		1.33+/-0.67
20/11	4	0.50+/-0.50	*	0
12/1	4	0.50+/-0.50		2.25+/-2.25

N = 3 * N = 5

Table XXXXXXVII.

The mean percentage water contents of the soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	40.35+/-0.48	39.12+/-0.88	40.07+/-0.67
29/3a	3	38.17+/-0.50	39.86+/-0.39	39.99+/-0.79
29/3b	3	36.52+/-0.40	39.66+/-0.13	40.19+/-1.32
26/4	3	37.13+/-0.20	40.09+/-0.72	38.84+/-1.51
18/5	3	23.63+/-0.33	27.82+/-0.99	26.46+/-1.13
1/6	3	24.30+/-0.77	---	---
8/6	3	30.82+/-0.86	32.98+/-2.32	29.25+/-1.50
22/6	3	17.46+/-0.81	20.07+/-0.54	19.69+/-1.18
12/7	3	24.62+/-0.75	24.20+/-0.33	24.16+/-0.92
2/8	3	18.30+/-0.97	17.13+/-0.23	17.16+/-0.62
22/8	2	21.98	21.31	19.06
26/9	3	28.31+/-0.30	27.11+/-0.38	26.34+/-0.94
29/11	3	30.75+/-0.60	32.28+/-0.60	*32.45
17/1	3	35.88+/-0.76	35.42+/-1.17	35.66+/-0.76

* N = 2

Table XXXXXXVIII.

The mean lengths of the soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	13.2+/-0.9	11.3+/-0.9	14.0+/-0.6
29/3a	3	12.0+/-1.3	12.0+/-1.6	12.7+/-0.3
26/4	3	14.5+/-0.3	11.3+/-0.7	12.2+/-0.2
18/5	3	14.2+/-0.4	12.5+/-0.8	12.3+/-1.0
1/6	3	14.3+/-0.7	---	---
8/6	3	12.5+/-1.4	11.0+/-1.8	13.2+/-0.6
22/6	3	12.2+/-1.7	12.3+/-0.6	13.0+/-1.0
12/7	3	11.7+/-1.5	13.0+/-1.5	13.2+/-0.7
2/8	3	14.2+/-0.4	11.7+/-0.7	14.8+/-0.3
22/8	2	15.0	15.3	16.5
26/9	3	14.0+/-1.0	11.5+/-1.0	12.3+/-0.9
29/11	4	13.6+/-1.1	12.8+/-1.1	14.3+/-0.9
17/1	3	NOT MEASURED		

Table XXXXXXIX.

The mean densities of the soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	0.69+/-0.01	0.78+/-0.01	0.68+/-0.04
29/3a	3	0.71+/-0.02	0.67+/-0.04	0.67+/-0.02
26/4	3	0.70+/-0.01	0.67+/-0.03	0.77+/-0.04
18/5	3	0.62+/-0.02	0.69+/-0.04	0.66+/-0.02
1/6	3	0.62+/-0.06	---	---
8/6	3	0.70+/-0.05	0.76+/-0.05	0.75+/-0.02
22/6	3	0.75+/-0.04	0.65+/-0.06	0.75+/-0.03
12/7	3	0.70+/-0.04	0.61+/-0.05	0.71+/-0.03
2/8	3	0.69+/-0.02	0.76+/-0.05	0.67+/-0.03
22/8	2	0.75	0.72	0.68
26/9	3	0.70+/-0.04	0.68+/-0.04	0.76+/-0.05
29/11	3	0.72+/-0.02	0.76+/-0.07	*0.75
17/1	3	NOT MEASURED		

* N = 2

Table XXXXXXX.

The mean numbers of root aphids extracted from the soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	2.67+/- 2.67	0.33+/- 0.33	4.33+/- 3.84
29/3	3	0.33+/- 0.33	0	1.67+/- 0.88
26/4	3	0.33+/- 0.33	3.00+/- 2.52	0.33+/- 0.33
18/5	3	4.00+/- 2.65	1.00+/- 1.00	7.00+/- 6.51
1/6	3	7.67+/- 2.96	-	-
8/6	3	1.33+/- 0.88	13.00+/- 3.21	4.67+/- 3.71
22/6	3	1.67+/- 1.20	2.33+/- 1.45	1.00+/- 1.00
12/7	3	15.67+/-15.67	4.00+/- 3.06	11.33+/-10.33
2/8	3	2.00+/- 2.00	4.67+/- 1.33	0.67+/- 0.67
22/8	2	6.00	1.00	1.00
26/9	3	0	0	4.33+/-2.40
29/11	3	1.67+/- 1.67	0	1.67+/-1.67
17/1	3	2.00+/- 2.00	0.33+/- 0.33	0

Table XXXXXXXI.

The mean number of **Lasius flavus** worker ants extracted from the soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	38.33+/-35.38	1.00+/- 1.00	0.67+/- 0.33
29/3	3	2.67+/- 2.67	1.67+/- 0.88	0.33+/- 0.33
26/4	3	8.67+/- 8.17	5.00+/- 3.21	0
18/5	3	20.33+/- 8.88	1.33+/- 0.67	1.67+/- 0.67
1/6	3	36.67+/-25.37	-	-
8/6	3	4.00+/- 1.53	8.00+/- 0.58	5.00+/- 3.61
22/6	3	4.67+/- 2.91	1.67+/- 1.20	1.67+/- 0.88
12/7	3	3.33+/- 1.86	5.00+/- 2.00	6.67+/- 2.33
2/8	3	5.33+/- 4.33	7.33+/- 1.20	4.00+/- 2.52
22/8	2	5.50	7.00	0
26/9	3	2.33+/- 1.86	1.00+/- 0.58	6.67+/- 4.41
29/11	3	3.33+/- 3.33	7.33+/- 7.33	2.67+/- 2.67
17/1	3	15.66+/-11.05	1.00+/- 0.58	1.00+/- 1.00

Table XXXXXXXII.

The mean numbers of mites extracted from the soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	108.7+/-14.3	80.3+0-36.3	94.7+/-19.6
29/3	3	78.7+/-21.8	125.0+/-21.6	102.7+/-27.6
26/4	3	115.0+/-27.4	132.7+/-40.5	101.3+/-15.4
18/5	3	145.3+/-38.8	101.3+/-27.7	69.3+/-21.5
1/6	3	133.0+/-36.9	-	-
8/6	3	73.7+/-11.8	92.0+/-14.4	70.7+/-11.4
22/6	3	190.7+/-79.8	132.0+/-10.1	193.3+/-18.7
12/7	3	109.3+/-16.4	110.7+/-17.3	141.3+/-24.0
2/8	3	147.0+/-15.0	125.3+/-24.3	269.3+/-79.5
22/8	2	112.0	126.0	142.0
26/9	3	56.0+/-12.9	96.0+/- 4.0	122.7+/-13.1
29/11	3	197.3+/-34.6	139.3+/-39.4	129.3+/-30.8
17/1	3	203.7+/-44.9	150.0+/-11.1	290.7+/-67.6

Table XXXXXXXIII.

The mean numbers of Collembola extracted from the soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	6.3+/- 3.0	35.3+/-16.3	30.0+/-17.1
29/3	3	24.0+/- 9.5	54.7+/-17.5	34.7+/-11.9
26/4	3	17.3+/- 3.5	28.0+/- 9.2	16.7+/- 1.8
18/5	3	26.7+/- 8.1	49.3+/-12.7	12.7+/- 6.4
1/6	3	57.3+/- 1.3	-	-
8/6	3	34.3+/-11.4	32.0+/-18.0	25.3+/- 4.8
22/6	3	36.0+/-26.2	76.0+/-12.2	29.3+/- 9.6
12/7	3	25.3+/- 5.8	56.0+/-33.3	30.7+/-10.9
2/8	3	18.7+/- 5.8	68.0+/-29.5	61.3+/-15.4
22/8	2	20.0	76.0	76.0
26/9	3	17.3+/- 7.1	16.0+/- 8.0	30.7+/-10.9
29/11	3	45.3+/- 2.7	36.7+/-13.0	60.0+/- 4.6
17/1	3	42.0+/- 5.0	52.0+/-18.6	53.0+/-14.5

Table XXXXXXXIV.

The mean numbers of the isopod **Platyarthrus hoffmanseggi** extracted from soil cores collected at Martin Down.

Date	N	MD 7B	MD 4A	MD 4B
1/3	3	0.33+/-0.33	0	0
29/3	3	0	0	0
26/4	3	0.33+/-0.33	0.33+/-0.33	0
18/5	3	3.67+/-3.18	0	0
1/6	3	0.33+/-0.33	-	-
8/6	3	0	0.33+/-0.33	0.33+/-0.33
22/6	3	0	0	1.00+/-1.00
12/7	3	0.33+/-0.33	0.67+/-0.67	0.67+/-0.67
2/8	3	0.67+/-0.67	0	0.67+/-0.67
22/8	2	1.00	0	0
26/9	3	0	0	1.33+/-0.67
29/11	3	0.33+/-0.33	0	1.33+/-1.33
17/1	3	2.67+/-2.67	0	0

APPENDIX FIVE

Dates at which particular stages were first seen in 1986.

Quadrat and Colony		First small pupae	First gyne pupae	First adult gynes	First adult males
OWH SS 4,	1	26/6	26/6	17/7	17/7
	2	4/6	26/6	8/7	--
	3	26/6	26/6	--	22/7
	4	26/6	26/6	17/7	24/7
	5	4/6	26/6	17/7	17/7
OWH SS11,	1	26/6	4/6	17/7	17/7
	2	26/6	26/6	17/7	22/7
	3	26/6	26/6	8/7	17/7
	4	4/6	26/6	17/7	22/7
	5	27/5	26/6	31/7	--
OWH C10,	1	26/6	4/6	17/7	8/7
	2	26/6	26/6	--	--
	3	26/6	26/6	8/7	17/7
	4	26/6	4/6	26/6	17/7
	5	26/6	4/6	8/7	8/7
AR 15,	1	12/6	--	--	--
	2	27/5	12/6	16/7	16/7
	3	12/6	31/6	16/7	16/7
	4	12/6	--	24/7	24/7
	5	12/6	12/6	24/7	16/7
AR 16,	1	--	--	16/7	16/7
	2	12/6	12/6	16/7	16/7
	3	31/6	31/6	16/7	16/7
	4	27/5	--	18/7	16/7
	5	12/6	--	16/7	16/7
MD 7B,	1	4/6	8/7	--	13/8
	2	26/6	26/6	8/7	7/8
	3	26/6	26/6	17/7	17/7
	4	8/7	26/6	22/7	22/7
	5	12/6	8/7	22/7	22/7
MD 4B,	1	8/7	8/7	8/7	17/7
	2	4/6	26/6	17/7	17/7
	3	8/7	26/6	8/7	8/7
	4	4/6	8/7	22/7	17/7
	5	8/7	8/7	22/7	22/7

APPENDIX SIX

Full details of individual soil depth measurements.

Quadrat	Measurements									
OWH SS 4	10.5,	28.5,	10.0,	9.5,	6.5,	12.5,	13.0,	13.5,	12.5,	11.5
5	8.5,	13.5,	10.0,	8.5,	11.0.	11.0,	12.0,	14.0,	16.0,	10.5
7	9.0,	8.0,	11.0,	7.0,	5.5,	10.0,	10.0,	9.0,	7.5,	8.0
8	9.0,	10.5,	10.5,	9.0,	9.5,	13.5,	7.0,	8.0,	10.0,	8.5
9	12.5,	7.0,	11.0,	9.5,	7.5,	7.5,	13.0,	7.5,	14.5,	11.0
11	9.5,	9.5,	8.0,	10.0,	7.5,	8.5,	9.0,	9.5,	10.0,	7.5
12	10.0,	8.0,	15.5,	7.5,	12.5,	7.0,	9.5,	8.0,	7.5,	11.5
OWH NFS	11.0,	5.5,	12.0,	10.0,	13.0,	7.5,	10.0,	5.0,	8.5,	9.0
OWH C10	7.0,	10.0,	13.0,	13.0,	14.5,	10.5,	7.0,	9.5,	9.0,	14.0
AR 11	12.0,	19.0,	17.0,	8.0,	14.0,	17.0,	6.5,	6.5,	18.0,	18.0
AR 12	23.0,	12.0,	22.0,	15.0,	22.0,	18.0,	15.5,	20.0,	17.0,	10.0
AR 15	9.5,	15.0,	17.0,	16.5,	13.0,	13.0,	22.0,	14.0,	15.0,	21.0
AR 16	9.0,	20.0,	15.0,	22.0,	13.0,	12.5,	13.0,	17.0,	19.5,	15.0
AR NWS	15.0,	27.0,	21.0,	13.0,	10.5,	14.0,	12.5,	19.0,	17.5,	12.0
AR 5	1.0,	5.0,	5.0,	3.0,	5.0,	14.0,	9.0,	15.0,	3.5,	8.0
MD 7B	22.0,	19.0,	12.0,	23.5,	28.0,	16.0,	17.0,	21.5,	18.0,	77.0
4A	14.0,	15.5,	19.5,	19.0,	20.0,	16.5,	21.5,	18.5,	19.5,	19.0
4B	13.0,	14.0,	17.5,	14.5,	12.0,	15.0,	15.0,	10.0,	15.0,	15.5
3B	11.0,	11.0,	9.0,	6.0,	8.5,	14.0,	15.0,	7.5,	11.5,	14.5

APPENDIX SEVEN

Full details of individual soil pH measurements.

Quadrat	Measurements	Mean
OWH SS 4	7.40, 7.40, 7.40, 7.40, 7.40, 7.50.	7.42
5	7.60, 7.60, 7.50, 7.50, 7.55.	7.55
7	7.40, 7.40, 7.50, 7.05, 7.35, 7.25, 7.20.	7.31
8	7.55, 7.60, 7.50, 7.50.	7.54
9	7.50, 7.55, 7.50, 7.50, 7.55, 7.65, 7.65.	7.56
11	7.25, 7.30, 7.30, 7.25, 7.40, 7.45.	7.33
12	7.40, 7.40, 7.55, 7.60.	7.49
OWH NFS	7.50, 7.60, 7.70, 7.90.	7.68
OWH C10	6.35, 6.10, 7.65, 7.65, 7.05, 7.00.	6.97
AR 11	7.65, 7.70, 7.70, 7.80.	7.71
AR 12	7.70, 7.70, 7.65, 7.60.	7.66
AR 15	7.70, 7.45, 7.45, 7.45, 7.70, 7.70.	7.58
AR 16	7.60, 7.60, 7.70, 7.65, 7.65.	7.64
AR NWS	7.55, 7.65, 7.60, 7.55.	7.59
AR 5	7.65, 7.80, 7.90, 7.85.	7.80
MD 7B	7.60, 7.60, 7.30, 7.30, 7.65, 7.70.	7.53
4A	7.60, 7.60, 7.50, 7.45, 7.55, 7.55.	7.54
4B	7.50, 7.50, 7.55, 7.50.	7.51
3B	7.45, 7.50, 7.50, 7.45, 7.55.	7.49

APPENDIX EIGHT

Temperature measurements raw data

In the following tables all temperature measurements made in the quadrats are detailed. They are listed quadrat by quadrat. For each quadrat the data and time of the measurements are given together with the prevailing weather conditions. The five values and the mean are given for each location.

In the tables the numbers refer to the following measurements:

1) The temperature measured at the surface of the south sides of mounds.

2) The temperature measured at a depth of 10 cm. on the south side of mounds.

3) The temperature measured at the surface of the north side of mounds.

4) The temperature measured at a depth of 10 cm. on the north side of mounds.

5) The temperature measured on the surface of the ground inbetween the mounds.

6) The temperature measured at a depth of 10cm. in the soil inbetween the mounds.

In rows 1) to 4) the columns of figures represent measurements from a single mound.

See also section 7.3.2. for further details.

A * indicates that the mound measurements in that column were taken on one of the mounds which had a slate on it. This allowed observation of the ants beneath the slates at known temperatures. Comments on the ants are given beneath the table.

DATE 2/3/89

9.00PM Air temp. 5°C

100% cloud, very windy, horizontal rain.

1)	5,	5,	4,	4,	4.	4.4
2)	5,	4,	4,	4,	4.	4.2
3)	4,	4,	4,	4,	4.	4.0
4)	4,	4,	4,	4,	4.	4.0
5)	4,	4,	4,	4,	4.	4.0
6)	4,	4,	4,	4,	4.	4.0

DATE 15/3/89

9.00AM Air Temp. 10°C

50% cloud, breezy.

1)	8,	8,	8,	7,	8.	7.8
2)	7,	7,	7,	7,	7.	7.0
3)	8,	7,	8,	8,	8.	7.8
4)	7,	7,	7,	7,	7.	7.0
5)	8,	8,	8,	7,	8.	7.8
6)	7,	7,	7,	7,	7.	7.0

12.00AM Air temp. 10°C

60% cloud, steady breeze.

1)	13,	12,	13,	13,	11.	12.4
2)	7,	8,	8,	8,	8.	7.8
3)	10,	11,	11,	12,	11.	11.0
4)	7,	8,	8,	8,	7.	7.6
5)	11,	13,	11,	10,	11.	11.2
6)	8,	8,	8,	8,	8.	8.0

3.00PM Air temp. 9°C

100% cloud, steady breeze.

1)	12,	11,	11,	10,	12.	11.2
2)	10,	9,	9,	10,	10.	9.6
3)	10,	11,	11,	10,	11.	10.6
4)	8,	9,	9,	8,	9.	8.6
5)	11,	11,	11,	11,	11.	11.0
6)	9,	9,	9,	9,	9.	9.0

6.00PM Air temp. 7°C

100% cloud, dull, still.

1)	7,	8,	8,	8,	8.	7.8
2)	9,	9,	9,	9,	9.	9.0
3)	8,	7,	9,	8,	8.	8.0
4)	9,	9,	9,	9,	9.	9.0
5)	8,	8,	8,	8,	8.	8.0
6)	9,	9,	9,	9,	9.	9.0

DATE 10/4/89
10.00AM Air temp. 9^{O}C
80% cloud, steady breeze.
1) 10, 10, 10, 10, 10, 10, 10, 10, 10, 10. 10.0
2) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0
3) 10, 10, 10, 10, 10, 10, 10, 10, 10, 10. 10.0
4) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0
5) 10, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.1
6) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0

1.00PM Air temp. 8^{O}C
90% cloud, breezy, showers.
1) 11, 10, 10, 10, 11, 9, 10, 10, 10, 9. 10.0
2) 9, 9, 9, 9, 10, 9, 9, 9, 9, 9. 9.1
3) 11, 11, 12, 11, 11, 12, 11, 11, 11, 12. 11.3
4) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
5) 11, 10, 10, 11, 11, 11, 10, 11, 10, 11. 10.6
6) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0

6.00PM Air temp. 9^{O}C
60% cloud, breezy, showers.
1) 10, 10, 11, 10, 9, 9, 9, 9. 9.6
2) 10, 10, 10, 9, 10, 9, 9, 9. 9.5
3) 11, 10, 10, 10, 11, 9, 10, 10. 10.1
4) 10, 10, 10, 10, 10, 9, 9, 9. 9.6
5) 10, 10, 10, 10, 9, 9, 9, 9. 9.5
6) 10, 10, 10, 9, 10, 9, 10, 10. 9.8

DATE 19/4/89

9.00AM Air temp. 9°C
5% cloud, steady breeze.
1) 12, 14, 14, 12, 11. 12.6
2) 9, 9, 9, 9, 9. 9.0
3) 10, 10, 10, 9, 8. 9.4
4) 8, 8, 8, 8, 8. 8.0
5) 10, 10, 11, 10, 10. 10.2
6) 8, 8, 8, 8, 8. 8.0

12.00AM Air temp. 12°C
30% cloud, breezy.
1) 29, 27, 27, 27, 23. 26.6
2) 13, 13, 13, 12, 11. 12.4
3) 17, 18, 17, 18, 18. 17.6
4) 9, 10, 10, 10, 10. 9.8
5) 19, 19, 20, 23, 19. 20.0
6) 10, 11, 10, 11, 12. 10.8

3.00PM Air temp. 10°C
90% cloud, light breeze.
1) 16, 17, 16, 18, 19* 17.2
2) 12, 13, 14, 14, 15. 13.6
3) 17, 16, 14, 16, 16. 15.8
4) 13, 13, 12, 12, 13. 12.6
5) 16, 16, 16, 15, 16. 15.8
6) 12, 12, 12, 12, 13. 12.2
* Large numbers of workers and gyne larvae at surface.

6.00PM Air temp. 8°C
100% cloud, light breeze.
1) 12, 13, 12, 14, 13. 12.8
2) 14, 15, 14, 15, 14. 14.4
3) 12, 12, 12, 12, 12. 12.0
4) 11, 11, 11, 11, 11. 11.0
5) 13, 12, 12, 12, 12. 12.2
6) 12, 12, 12, 12, 12. 12.0

DATE 10/5/89

9.00AM Air temp. 11°C
100% cloud, breezy.
1) 15, 16, 17, 17, 17. 16.4
2) 14, 14, 14, 14, 15. 14.2
3) 15, 16, 15, 15, 15. 15.2
4) 13, 14, 14, 13, 14. 13.6
5) 15, 16, 16, 16, 15. 15.6
6) 14, 14, 14, 14, 14. 14.0

12.00AM Air temp. 16°C
85% cloud, breezy.
1) 25, 23, 24, 24, 24. 24.0
2) 16, 17, 17, 17, 17. 16.8
3) 23, 22, 21, 22, 21. 21.8
4) 15, 15, 15, 15, 15. 15.0
5) 21, 21, 19, 20, 21. 20.4
6) 15, 15, 15, 15, 15. 15.0

3.00PM Air temp. 15°C
100% cloud, almost still.
1) 20, 19, 19, 20, 19. 19.4
2) 19, 17, 18, 18, 18. 18.0
3) 21, 21, 20, 19, 21. 20.4
4) 16, 16, 17, 16, 16. 16.2
5) 19, 19, 18, 19, 19. 18.8
6) 16, 16, 16, 16, 17. 16.2

6.00PM Air temp. 11°C
100% cloud, almost still.
1) 13, 15, 15, 14, 13. 14.0
2) 16, 17, 16, 15, 15. 15.8
3) 15, 16, 15, 14, 15. 15.0
4) 17, 16, 16, 16, 16. 16.8
5) 15, 15, 15, 14, 14. 14.6
6) 16, 16, 16, 16, 16. 16.0

DATE 24/5/89

9.00AM Air temp. 23°C
30% hazey cloud, light breeze.
1) 25, 23, 24, 24* 24. 24.0
2) 19, 18, 18, 19, 18. 18.6
3) 25, 23, 24, 24, 26. 24.4
4) 19, 18, 18, 18, 19. 18.4
5) 23, 22, 24, 24, 25. 23.6
6) 18, 18, 18, 18, 18. 18.0
* ~300 gyne pupae up.

12.00AM Air temp. 26°C
75% cloud, light breeze.
1) 32, 31, 29, 31, 29. 30.4
2) 21, 21, 21, 21, 21. 21.0
3) 32, 32, 31, 32, 29. 31.2
4) 20, 21, 20, 22, 20. 20.6
5) 29, 28, 28, 30, 28. 28.6
6) 21, 21, 20, 21, 20. 20.6

3.00PM Air temp. 20°C
95% cloud, breezy.
1) 24, 25, 25, 24, 25. 24.6
2) 22, 21, 21, 21, 21. 21.2
3) 24, 23, 23, 23, 24. 23.6
4) 21, 21, 21, 21, 21. 21.0
5) 23, 25, 24, 24, 24. 24.0
6) 21, 22, 21, 21, 21. 21.2

6.00PM Air temp. 18°C
100% cloud, windy.
1) 20, 21, 21, 20, 20. 20.4
2) 21, 21, 21, 20, 21. 20.8
3) 20, 20, 20, 20, 20. 20.0
4) 20, 20, 20, 20, 20. 20.0
5) 20, 20, 19, 20, 20. 19.8
6) 20, 20, 20, 20, 20. 20.0

DATE 7/6/89

9.00AM Air temp. 11°C
99% cloud, light breeze.
1) 13, 15, 14, 13, 13. 13.6
2) 11, 11, 11, 11, 10. 10.8
3) 14, 14, 13, 13, 13. 13.4
4) 11, 11, 11, 11, 11. 11.0
5) 13, 13, 12, 13, 13. 12.8
6) 11, 11, 11, 11, 11. 11.0

12.00AM Air temp. 14°C
80% cloud, breezy.
1) 22, 22, 23, 22, 22. 22.2
2) 13, 13, 13, 12, 12. 12.6
3) 19, 19, 19, 21, 20. 19.6
4) 12, 12, 12, 12, 13. 12.2
5) 17, 18, 18, 17, 18. 17.6
6) 12, 13, 13, 13, 13. 12.8

3.00PM Air temp. 17°C
60% cloud, light breeze.
1) 24, 22, 22, 22, 22. 22.4
2) 15, 15, 16, 16, 16. 15.6
3) 22, 19, 21, 22, 20. 20.8
4) 14, 14, 14, 14, 15. 14.2
5) 19, 19, 20, 20, 20. 19.8
6) 15, 15, 15, 15, 15. 15.0

6.00PM Air temp. 14°C
10% cloud, light breeze.
1) 18, 19, 19, 18, 18. 18.4
2) 16, 16, 17, 16, 17. 16.4
3) 19, 18, 18, 18, 18. 18.2
4) 15, 15, 15, 16, 16. 15.4
5) 17, 18, 17, 17, 17. 17.2
6) 16, 15, 15, 15, 15. 15.2

DATE 23/6/89
9.00AM Air temp. 18°C
0% cloud, light breeze.
1) 21, 20, 22, 20, 25. 21.6
2) 19, 18, 18, 19, 19. 18.6
3) 22, 23, 22, 22, 23. 22.4
4) 18, 19, 18, 19, 19. 18.6
5) 20, 22, 21, 21, 21. 21.0
6) 18, 18, 18, 18, 18. 18.0

12.00AM Air temp. 22°C
5% cloud, light breeze.
1) 33, 31, 33, 31, 34. 32.4
2) 21, 21, 23, 22, 22. 21.8
3) 31, 34, 29, 31, 31. 31.2
4) 22, 23, 22, 22, 22. 22.2
5) 32, 32, 32, 29, 32. 31.4
6) 21, 21, 22, 21, 22. 21.4

3.00PM Air temp. 23°C
5% cloud, breezy.
1) 28, 35, 32, 33, 36. 32.8
2) 24, 26, 24, 24, 27. 25.0
3) 28, 32, 32, 31, 30. 30.6
4) 23, 26, 25, 24, 23. 24.2
5) 33, 31, 30, 31, 33. 31.6
6) 24, 23, 21, 25, 25. 23.2

6.00PM Air temp. 24°C
1% cloud, light breeze.
1) 31, 30, 29, 28, 30. 28.6
2) 26, 26, 25, 24, 31. 26.4
3) 32, 30, 29, 29, 26. 29.2
4) 25, 24, 24, 24, 25. 24.4
5) 30, 29, 30, 29, 31. 29.8
6) 27, 24, 25, 26, 26. 25.6

DATE 19/7/89
9.00AM Air temp. 21°C
2% cloud, light breeze.
1) 22, 23, 23, 22, 21. 22.2
2) 17, 18, 18, 18, 18. 17.8
3) 22, 22, 23, 23, 23. 22.6
4) 19, 19, 19, 19, 19. 19.0
5) 21, 21, 23, 23, 25. 23.0
6) 19, 19, 19, 19, 19. 19.0

12.00AM Air temp. 21°C
75% cloud, breezy.
1) 28, 29, 27, 27, 26. 27.4
2) 22, 22, 22, 22, 21. 21.8
3) 31, 30, 27, 29, 31. 29.6
4) 23, 22, 22, 23, 22. 22.4
5) 30, 30, 28, 28, 27. 28.6
6) 22, 22, 20, 22, 21. 21.4

3.00PM Air temp. 23°C
0% cloud, breezy.
1) 28, 26, 28, 24, 25. 26.2
2) 25, 23, 23, 22, 23. 23.2
3) 28, 28, 31, 29, 28. 28.8
4) 23, 23, 24, 23, 22. 23.0
5) 31, 32, 32, 32, 32. 31.8
6) 24, 24, 23, 23, 23. 23.4

6.00PM Air temp. 19°C
0% cloud, breezy.
1) 20, 20* 22, 21, 22. 21.0
2) 21, 21, 21, 22, 23. 21.6
3) 23, 24, 24, 23, 24. 23.6
4) 21, 24, 22, 22, 23. 22.4
5) 24, 24, 24, 25, 24. 24.2
6) 24, 24, 24, 25, 24. 24.2
* Nothing up.

DATE 3/8/89

9.00AM Air temp. 19^{o}C
95% cloud, light breeze.
1) 21, 22, 23, 22, 22. 22.0
2) 18, 18, 18, 17, 18. 17.8
3) 22, 21, 21, 21, 21. 21.2
4) 18, 18, 18, 18, 18. 18.0
5) 21, 21, 22, 20, 22. 21.2
6) 18, 18, 18, 17, 18. 17.8

12.00AM Air temp. 23^{o}C
99% cloud, light breeze.
1) 28, 27, 25, 27, 27. 26.8
2) 19, 20, 19, 20, 20. 19.6
3) 28, 27, 27, 27, 27. 27.2
4) 20, 20, 20, 19, 20. 19.8
5) 26, 25, 27, 26, 26. 26.0
6) 19, 19, 20, 20, 20. 19.6

3.00PM Air temp. 25^{o}C
40% cloud, breezy.
1) 30, 30, 29, 35, 34. 31.6
2) 22, 22, 22, 22, 23. 22.2
3) 30, 30, 27, 32, 32. 30.2
4) 22, 22, 22, 23, 23. 22.4
5) 29, 30, 30, 30, 30. 29.8
6) 22, 22, 22, 22, 22. 22.0

6.00PM Air temp. 21^{o}C
90% cloud, almost still.
1) 23, 22, 23, 22, 23. 22.6
2) 22, 22, 22, 21, 21. 21.6
3) 23, 24, 23, 23, 23. 23.6
4) 21, 22, 22, 22, 22. 21.8
5) 22, 23, 23, 24, 23. 23.0
6) 21, 21, 21, 22, 21. 21.2

DATE 23/8/89

9.00AM Air temp. 16^{o}C
0% cloud, almost still.
1) 18, 22, 20* 19, 20. 19.8
2) 15, 16, 15, 15, 15. 15.2
3) 16, 20, 16, 19, 20. 18.2
4) 14, 15, 15, 15, 14. 14.6
5) 16, 18, 16, 17, 18. 17.0
6) 15, 15, 15, 15, 15. 15.0
* 30 workers only up.

12.00AM Air temp. 20^{o}C
0% cloud, windy.
1) 25, 24, 30, 29* 30. 27.6
2) 19, 17, 21, 20, 20. 19.4
3) 28, 26, 26, 27, 26. 26.6
4) 19, 19, 18, 21, 18. 19.0
5) 26, 28, 24, 25, 29. 26.4
6) 18, 19, 17, 18, 18. 18.0
* Nothing up.

3.00PM Air temp. 21^{o}C
0% cloud, windy.
1) 25, 22, 22, 25, 25. 23.8
2) 22, 21, 21, 22, 21. 21.4
3) 28, 25, 25, 24, 25. 25.4
4) 21, 21, 20, 19, 20. 20.2
5) 26, 26, 27, 26, 29. 26.8
6) 23, 22, 22, 21, 23. 22.2

6.00PM Air temp. 20^{o}C
0% cloud, breezy.
1) 22, 21, 21, 21, 21. 21.2
2) 22, 20, 20, 20, 22. 20.8
3) 22, 21, 21, 20, 21. 21.0
4) 21, 20, 20, 19, 20. 20.0
5) 22, 22, 22, 21, 21. 21.6
6) 22, 22, 22, 21, 21. 21.6

DATE 27/9/89

9.00AM Air temp. 15°C
90% cloud, light breeze.
1) 16, 17, 17, 16, 17. 16.6
2) 15, 16, 16, 15, 16. 15.6
3) 16, 16, 17, 16, 17. 16.4
4) 16, 16, 16, 16, 16. 16.0
5) 17, 16, 17, 16, 17. 16.6
6) 16, 16, 16, 16, 16. 16.0

12.00AM Air temp. 18°C
60% cloud, light breeze.
1) 24, 27, 25, 24, 22. 24.4
2) 19, 19, 19, 19, 18. 18.8
3) 21, 22, 22, 22, 22. 21.8
4) 17, 17, 18, 17, 18. 17.4
5) 21, 22, 21, 23, 21. 21.6
6) 17, 17, 17, 18, 17. 17.2

3.00PM Air temp. 15°C
100% cloud, light breeze.
1) 18, 19, 19, 19* 18. 18.6
2) 19, 18, 19, 18, 19. 18.6
3) 19, 19, 19, 19, 18. 18.8
4) 19, 18, 18, 19, 18. 18.4
5) 19, 19, 19, 19, 18. 18.8
6) 18, 18, 18, 18, 17. 17.8
* 20 workers only up.

6.00PM Air temp. 14°C
100% cloud, light breeze.
1) 15, 16, 16, 16, 16. 15.8
2) 17, 17, 18, 17, 18. 17.4
3) 16, 16, 17, 16, 16. 16.2
4) 17, 17, 17, 17, 17. 17.0
5) 16, 16, 16, 16, 16. 16.0
6) 17, 17, 17, 17, 17. 17.0

DATE 30/11/89

9.00AM Air temp. 1°C
0% cloud, breezy.
1) 1, 3, 2, 2, 2. 2.0
2) 3, 4, 4, 3, 4. 3.6
3) 1, 2, 1, 1, 0. 1.0
4) 3, 3, 3, 3, 3. 3.0
5) 1, 1, 1, 2, 1. 1.2
6) 4, 4, 4, 4, 4. 4.0

12.00AM Air temp. 5°C
3% cloud, light breeze.
1) 9, 11* 11, 13, 11. 11.0
2) 4, 6, 6, 6, 6. 5.6
3) 2, 2, 3, 2, 6. 3.0
4) 3, 3, 3, 3, 4. 3.2
5) 6, 6, 6, 6, 5. 5.8
6) 4, 4, 5, 4, 5. 4.4
* nothing up.

3.00PM Air temp. 5°C
0% cloud, light breeze.
1) 12, 15, 15, 15* 13. 14.0
2) 9, 10, 8, 8, 7. 8.4
3) 6, 5, 5, 5, 5. 5.8
4) 4, 4, 3, 4, 5. 4.0
5) 6, 7, 7, 8, 7. 7.0
6) 6, 6, 6, 6, 6. 6.0

6.00PM Air temp. 4°C
0% cloud, light breeze.
1) 6, 7, 7, 7, 6. 6.6
2) 9, 8, 8, 10, 9. 8.8
3) 4, 4, 3, 3, 4. 3.6
4) 4, 4, 4, 4, 5. 4.2
5) 4, 5, 5, 4, 4. 4.4
6) 6, 7, 6, 6, 6. 6.2

DATE 18/1/90

9.00AM Air temp. 2°C
0% cloud, v. light breeze.

1)	1,	1,	1,	1,	1.	1.0
2)	4,	3,	4,	4,	4.	3.8
3)	0,	1,	1,	1,	1.	0.8
4)	4,	4,	4,	4,	4.	4.0
5)	1,	1,	1,	1,	1.	1.0
6)	4,	5,	4,	5,	4.	4.4

12.00AM Air temp. 5°C
0% cloud, v. light breeze.

1)	9,	12*	9,	9,	9.	9.6
2)	4,	5,	4,	4,	4.	4.2
3)	2,	2,	2,	2,	2.	2.0
4)	4,	4,	4,	4,	3.	3.8
5)	5,	5,	6,	7,	7.	6.0
6)	5,	5,	5,	5,	5.	5.0

* nothing up.

3.00PM Air temp. 8°C
20% cloud, breezy.

1)	11,	12,	13,	12,	14*	12.4
2)	6,	8,	7,	7,	8.	7.2
3)	6,	6,	7,	6,	7.	6.4
4)	4,	4,	5,	5,	6.	4.8
5)	9,	8,	9,	10,	9.	9.0
6)	6,	6,	6,	7,	6.	6.2

6.00PM Air temp. 5°C
5% cloud, almost still.

1)	6,	6,	6,	6,	5.	5.8
2)	7,	7,	8,	7,	8.	7.4
3)	4,	4,	4,	4,	4.	4.0
4)	5,	5,	5,	5,	5.	5.0
5)	5,	5,	6,	5,	5.	5.2
6)	6,	7,	7,	7,	7.	6.8

DATE 2/3/89
9.00AM Air temp. 5^{o}C
100% cloud, very windy, horizontal rain.
1) 4, 5, 4, 5, 4. 4.4
2) 4, 4, 4, 5, 4. 4.2
3) 4, 4, 4, 4, 4. 4.0
4) 4, 4, 4, 4, 4. 4.0
5) 4, 4, 4, 5, 4. 4.2
6) 4, 4, 4, 4, 4. 4.0

DATE 15/3/89
9.00AM Air temp. 9^{o}C
30% cloud, breezy.
1) 8, 8, 8, 7, 7. 7.6
2) 7, 7, 7, 7, 7. 7.0
3) 8, 7, 8, 8, 8. 7.8
4) 7, 7, 7, 7, 8. 7.4
5) 7, 7, 7, 7, 8. 7.2
6) 7, 7, 7, 7, 7. 7.0

12.00AM Air temp. 9^{o}C
80% cloud, steady breeze.
1) 13, 13, 13, 12, 15. 13.2
2) 8, 8, 8, 7, 9. 8.0
3) 12, 12, 12, 12, 11. 11.8
4) 8, 8, 8, 8, 8. 8.0
5) 11, 10, 10, 11, 11. 10.6
6) 8, 8, 8, 8, 8. 8.0

3.00PM Air temp. 9^{o}C
95% cloud, steady breeze.
1) 12, 12, 12, 13, 11. 12.0
2) 9, 9, 9, 9, 9. 9.0
3) 11, 12, 12, 12, 11. 11.6
4) 8, 9, 9, 9, 9. 8.8
5) 11, 11, 11, 11, 11. 11.0
6) 9, 9, 8, 9, 9. 8.8

6.00PM Air temp. 8^{o}C
100% cloud, dull, still.
1) 8, 8, 7, 8, 8. 7.8
2) 10, 9, 9, 9, 10. 9.4
3) 8, 8, 8, 8, 9. 8.2
4) 9, 9, 9, 9, 9. 9.0
5) 8, 9, 9, 8, 8. 8.4
6) 9, 9, 9, 9, 9. 9.0

DATE 10/4/89
10.00AM Air temp. 10°C
80% cloud, steady breeze.

1)	10,	10,	10,	10,	10,	11,	10,	11,	11,	11.	10.4
2)	8,	9,	8,	8,	8,	8,	8,	8,	8,	8.	8.1
3)	10,	11,	10,	11,	10,	11,	10,	11,	11,	11.	10.6
4)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8
5)	9,	9,	10,	10,	10,	10,	10,	10,	10,	10.	9.8
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8

1.00PM Air temp. 11°C
100% cloud, breezy, showers.

1)	13,	12,	11,	11,	11,	11,	12,	11,	10,	10.	11.2
2)	9,	9,	10,	10,	11,	11,	9,	11,	10,	10.	10.0
3)	12,	12,	12,	12,	13,	12,	12,	12,	11,	13.	12.1
4)	9,	9,	10,	10,	9,	10,	9,	9,	9,	9.	9.3
5)	11,	11,	10,	11,	11,	11,	11,	11,	11,	11.	10.9
6)	9,	9,	10,	9,	10,	10,	9,	9,	10,	9.	9.4

6.00PM Air temp. 9°C
60% cloud, breezy.

1)	9,	10,	9,	10,	9,	9,	9,	10,	11,	11.	9.7
2)	11,	12,	11,	10,	11,	10,	10,	10,	11,	10.	10.6
3)	10,	11,	10,	10,	10,	10,	10,	10,	10,	11.	10.2
4)	10,	9,	9,	9,	9,	10,	9,	10,	9,	9.	9.3
5)	10,	10,	11,	9,	9,	10,	10,	10,	10,	10.	9.9
6)	10,	10,	10,	10,	10,	10,	10,	10,	10,	10.	10.0

DATE 19/4/89

9.00AM Air temp. $8^{\circ}C$
5% cloud, steady breeze.

1)	13,	12,	12,	13,	12.	12.4
2)	9,	9,	9,	9,	8.	8.8
3)	10,	10,	8,	9,	10.	9.4
4)	7,	7,	8,	8,	8.	7.6
5)	9,	8,	8,	8,	9.	8.4
6)	8,	8,	8,	8,	8.	8.0

12.00AM Air temp. $11^{\circ}C$
30% cloud, breezy.

1)	25,	27,	26,	24,	28.	26.0
2)	10,	12,	11,	11,	12.	11.2
3)	13,	18,	19,	18,	18.	17.2
4)	8,	10,	10,	9,	9.	9.2
5)	21,	16,	20,	19,	20.	19.2
6)	11,	9,	9,	10,	10.	9.8

3.00PM Air temp. $11^{\circ}C$
95% cloud, light breeze.

1)	18,	16,	17,	18,	19.	17.6
2)	13,	11,	13,	14,	11.	12.6
3)	15,	15,	15,	15,	17.	15.4
4)	12,	11,	11,	11,	12.	11.4
5)	16,	15,	16,	15,	15.	15.4
6)	11,	11,	11,	11,	11.	11.0

6.00PM Air temp. $8^{\circ}C$
100% cloud, slight breeze.

1)	12,	13,	13,	14,	13.	13.0
2)	14,	15,	14,	15,	14.	14.4
3)	12,	13,	12,	13,	12.	12.4
4)	11,	11,	11,	11,	11.	11.0
5)	12,	12,	12,	12,	13.	12.2
6)	12,	12,	12,	12,	12.	12.0

DATE 10/5/89

9.00AM Air temp. $11^{\circ}C$
100% cloud, light breeze.

1)	13,	16,	16,	16,	16.	15.4
2)	13,	14,	14,	14,	14.	13.8
3)	14,	14,	14,	15,	16.	14.6
4)	13,	13,	13,	13,	12.	12.8
5)	14,	14,	13,	15,	14.	14.0
6)	13,	13,	13,	14,	13.	13.2

12.00AM Air temp. $14^{\circ}C$
90% cloud, almost still.

1)	22,	21,	22,	23,	24.	22.4
2)	17,	15,	16,	16,	17.	16.2
3)	21,	19,	19,	21,	19.	19.8
4)	14,	14,	14,	15,	14.	14.2
5)	19,	19,	20,	21,	20.	19.8
6)	14,	14,	14,	14,	14.	14.0

3.00PM Air temp. $15^{\circ}C$
100% cloud, still.

1)	19,	19,	19,	19,	19.	19.0
2)	16,	18,	18,	18,	18.	17.6
3)	21,	20,	20,	21,	20.	20.4
4)	15,	15,	17,	16,	16.	15.8
5)	19,	18,	18,	18,	18.	18.2
6)	15,	16,	17,	16,	16.	16.0

6.00PM Air temp. $12^{\circ}C$
100% cloud, almost still.

1)	12,	15,	15,	14,	15.	14.2
2)	16,	16,	17,	14,	17.	16.0
3)	15,	15,	15,	14,	15.	14.8
4)	15,	16,	15,	16,	15.	15.4
5)	15,	14,	14,	14,	14.	14.2
6)	15,	15,	16,	15,	15.	15.2

DATE 24/5/89

9.00AM Air temp. 22°C
30% hazey cloud, light breeze.
1) 22, 22, 24, 25, 25. 23.6
2) 18, 18, 19, 19, 19. 18.6
3) 25, 24, 25, 24, 26. 24.8
4) 19, 18, 19, 18, 19. 18.6
5) 22, 23, 22, 23, 23. 22.6
6) 18, 17, 17, 17, 18. 17.4

12.00AM Air temp. 25°C
50% cloud, steady breeze.
1) 31, 35, 32, 31, 32. 32.2
2) 21, 22, 20, 22, 21. 21.2
3) 31, 33, 32, 31, 32. 31.8
4) 19, 21, 20, 20, 21. 20.2
5) 29, 31, 31, 27, 28. 29.2
6) 19, 19, 20, 19, 19. 19.2

3.00PM Air temp. 20°C
95% cloud, breezy.
1) 27, 24, 27, 25, 24. 25.4
2) 21, 22, 22, 22, 22. 21.8
3) 24, 25, 24, 24, 24. 24.8
4) 22, 23, 20, 22, 20. 21.4
5) 24, 24, 24, 23, 23. 23.6
6) 21, 21, 20, 20, 21. 20.6

6.00PM Air temp. 18°C
100% cloud, windy.
1) 19, 22, 21, 20, 21. 20.6
2) 20, 21, 20, 20, 21. 20.4
3) 19, 20, 20, 19, 20. 19.6
4) 20, 18, 20, 19, 20. 19.4
5) 19, 19, 19, 19, 20. 19.8
6) 19, 19, 19, 19, 20. 19.8

DATE 7/6/89

9.00AM Air temp. 10°C
100% cloud, breezy.
1) 12, 12, 13, 12, 13. 12.4
2) 11, 11, 11, 11, 11. 11.0
3) 11, 12, 12, 12, 12. 11.8
4) 10, 10, 11, 11, 10. 10.4
5) 12, 12, 12, 11, 11. 11.6
6) 11, 10, 11, 11, 11. 10.8

12.00AM Air temp. 14°C
90% cloud, breezy.
1) 18, 17, 20, 19, 20. 18.8
2) 12, 12, 13, 13, 13. 12.6
3) 18, 18, 18, 17, 17. 17.6
4) 12, 12, 13, 13, 12. 12.6
5) 16, 16, 17, 18, 17. 16.8
6) 12, 13, 12, 13, 13. 12.6

3.00PM Air temp. 15°C
60% cloud, light breeze.
1) 20, 22, 22, 22, 23. 21.8
2) 13, 15, 14, 15, 16. 14.6
3) 18, 20, 21, 19, 22. 20.0
4) 13, 14, 13, 14, 15. 13.8
5) 18, 19, 19, 20, 22. 19.6
6) 14, 14, 14, 13, 14. 13.8

6.00PM Air temp. 15°C
10% cloud, breezy.
1) 19, 17, 18, 18, 18. 18.0
2) 16, 16, 16, 16, 16. 16.2
3) 17, 17, 16, 17, 18. 17.0
4) 14, 15, 15, 14, 15. 14.6
5) 16, 17, 17, 18, 17. 17.0
6) 13, 16, 15, 16, 15. 15.0

DATE 23/6/89

9.00AM Air temp. 18°C
No cloud, light breeze.
1) 20, 20, 19, 19, 20* 19.6
2) 17, 18, 17, 18, 17. 17.4
3) 18, 18, 22, 22, 22. 20.4
4) 17, 17, 17, 17, 18. 17.2
5) 19, 19, 20, 19, 19. 19.2
6) 17, 17, 17, 18, 18. 17.4
* 100's of gyne and small pupae up.

12.00AM Air temp. 22°C
1% cloud, light breeze.
1) 35, 34, 31, 33, 29. 32.4
2) 22, 22, 21, 22, 21. 21.6
3) 27, 28, 27, 31, 37. 30.0
4) 19, 19, 19, 21, 24. 20.4
5) 30, 29, 27, 31, 28. 29.0
6) 19, 20, 19, 19, 19. 19.2

3.00PM Air temp. 25°C
5% cloud, light breeze.
1) 33, 35, 31, 38, 30. 33.4
2) 25, 24, 22, 28, 24. 24.6
3) 30, 31, 31, 34, 32. 31.6
4) 22, 22, 22, 23, 22. 22.2
5) 30, 32, 31, 33, 32. 31.6
6) 23, 21, 22, 23, 23. 22.4

6.00PM Air temp. 24°C
1% cloud, breezy.
1) 28, 28, 28, 29, 29. 28.4
2) 25, 23, 24, 24, 25. 24.2
3) 29, 28, 29, 28, 29. 28.6
4) 23, 23, 23, 24, 24. 23.4
5) 28, 28, 27, 28, 29. 28.0
6) 22, 24, 22, 25, 24. 23.4

9.00PM Air temp. 17°C
0% cloud, light breeze.
1) 17, 19, 20, 19, 19. 18.8
2) 22, 21, 22, 21, 22. 21.6
3) 20, 20, 20, 19, 20. 19.8
4) 21, 21, 22, 22, 22. 21.6
5) 20, 20, 21, 20, 20. 20.2
6) 22, 21, 22, 22, 21. 21.6

DATE 19/7/89

9.00AM Air temp. 21°C
2% cloud, light breeze.
1) 28, 23, 23, 20, 21* 23.0
2) 19, 18, 18, 18, 18. 18.2
3) 22, 22, 22, 22, 19. 21.4
4) 19, 18, 18, 19, 19. 18.6
5) 22, 20, 20, 23, 22. 21.4
6) 18, 18, 18, 19, 18. 18.2
* Few males and gynes up,
some small pupae.

12.00AM Air temp. 25°C
70% cloud, light breeze.
1) 31, 31, 25, 32, 29. 29.6
2) 21, 21, 20, 23, 22. 21.4
3) 33, 31, 32, 30, 31. 31.4
4) 21, 22, 22, 22, 21. 21.6
5) 29, 28, 32, 28, 27. 28.8
6) 21, 20, 21, 21, 20. 20.6

3.00PM Air temp. 22°C
0% cloud, breezy.
1) 30, 31, 29, 26, 29. 29.0
2) 23, 23, 25, 22, 25. 23.6
3) 30, 33, 28, 30, 31. 30.4
4) 23, 23, 22, 23, 23. 22.8
5) 30, 29, 30, 29, 30. 29.6
6) 23, 22, 22, 22, 23. 22.6

6.00PM Air temp. 20°C
0% cloud, breezy.
1) 21, 23, 22, 23, 24. 22.6
2) 21, 23, 22, 23, 24. 22.6
3) 25, 24, 25, 25, 27. 25.2
4) 23, 24, 23, 23, 24. 23.4
5) 26, 24, 25, 26, 25. 25.2
6) 23, 22, 23, 23, 23. 22.8

DATE 3/8/89

9.00AM Air temp. 19°C
95% cloud, v. light breeze.
1) 21, 20, 20, 18, 23. 20.2
2) 17, 18, 17, 17, 19. 17.6
3) 21, 21, 22, 21, 24. 21.8
4) 17, 18, 17, 17, 18. 17.4
5) 22, 20, 20, 20, 22. 20.8
6) 18, 17, 17, 18, 18. 17.6

12.00AM Air temp. 23°C
90% cloud, v. light breeze.
1) 27, 24, 33, 29, 28. 28.2
2) 19, 19, 20, 20, 18. 19.2
3) 27, 27, 27, 27, 29. 27.4
4) 19, 19, 19, 19, 20. 19.2
5) 27, 26, 27, 27, 28. 27.0
6) 19, 19, 19, 19, 20. 19.2

3.00PM Air temp. 25°C
50% cloud, breezy.
1) 39, 31, 35, 31, 29. 33.0
2) 23, 21, 21, 22, 21. 21.6
3) 34, 34, 31, 29, 30. 31.6
4) 23, 21, 21, 22, 21. 21.6
5) 34, 30, 31, 29, 30. 30.8
6) 22, 21, 21, 21, 21. 21.2

6.00PM Air temp. 22°C
100% cloud, still.
1) 24, 22, 24, 23, 23. 23.2
2) 22, 20, 23, 22, 20. 21.4
3) 24, 24, 25, 23, 23. 23.8
4) 22, 21, 23, 22, 21. 21.8
5) 23, 22, 24, 23, 23. 23.0
6) 22, 21, 22, 21, 21. 21.4

DATE 23/8/89

9.00AM Air temp. 16°C
0% cloud, still.
1) 17, 20, 21, 16, 20. 18.8
2) 15, 15, 16, 15, 14. 15.0
3) 16, 16, 15, 16, 18. 16.2
4) 15, 15, 14, 15, 15. 14.8
5) 16, 16, 16, 18, 17. 16.6
6) 15, 15, 15, 15, 15. 15.0

12.00AM Air temp. 21°C
0% cloud, windy.
1) 32, 28, 30, 28, 34. 30.4
2) 18, 19, 22, 18, 20. 19.2
3) 22, 27, 27, 25, 27. 25.6
4) 17, 18, 18, 18, 19. 18.0
5) 25, 26, 26, 27, 27. 26.2
6) 18, 18, 19, 19, 19. 18.6

3.00PM Air temp. 21°C
0% cloud, windy.
1) 26, 26, 24, 21, 27. 24.8
2) 21, 21, 22, 21, 23. 21.6
3) 22, 24, 27, 25, 26. 24.8
4) 18, 20, 22, 20, 21. 20.2
5) 24, 26, 28, 25, 24. 25.4
6) 19, 21, 23, 20, 20. 20.6

6.00PM Air temp. 20°C
0% cloud, breezy.
1) 21, 23, 24, 21, 22. 22.2
2) 19, 21, 23, 20, 20. 20.6
3) 20, 20, 22, 21, 21. 20.8
4) 19, 19, 20, 21, 20. 19.8
5) 21, 21, 23, 23, 21. 21.8
6) 20, 20, 22, 22, 21. 21.0

DATE 27/9/89

9.00AM Air temp. 14°C
90% cloud, light breeze.
1) 14, 16, 16, 16, 16. 15.6
2) 15, 15, 15, 16, 15. 15.2
3) 15, 15, 15, 15, 15. 15.0
4) 15, 15, 15, 15, 15. 15.0
5) 15, 15, 15, 15, 15. 15.0
6) 15, 16, 15, 15, 16. 15.4

12.00AM Air temp. 18°C
80% cloud, breezy.
1) 25, 25, 25, 30, 28. 26.6
2) 18, 18, 18, 20, 19. 18.6
3) 20, 19, 20, 23, 21. 20.6
4) 17, 16, 17, 18, 17. 17.0
5) 20, 20, 23, 28, 21. 22.4
6) 16, 16, 17, 17, 17. 16.6

3.00PM Air temp. 16°C
100% cloud, light breeze.
1) 18, 19, 17, 18, 18. 18.0
2) 18, 18, 17, 19, 18. 18.0
3) 18, 19, 18, 18, 18. 18.2
4) 18, 18, 17, 18, 17. 17.6
5) 18, 18, 18, 18, 18. 18.0
6) 17, 17, 17, 18, 17. 17.2

6.00PM Air temp. 13°C
100% cloud, light breeze.
1) 14, 16, 16, 16, 16. 15.6
2) 17, 17, 17, 17, 18. 17.2
3) 16, 16, 16, 16, 16. 16.0
4) 17, 16, 16, 17, 16. 16.4
5) 16, 16, 16, 17, 16. 16.2
6) 16, 16, 16, 17, 17. 16.4

DATE 30/11/89

9.00AM Air temp. 1°C
0% cloud, light breeze.
1) 0, 1, 1, 1, 2. 1.0
2) 3, 4, 3, 3, 4. 3.4
3) 0, 1, 0, 0, 0. 0.2
4) 3, 3, 2, 3, 3. 2.8
5) 0, 1, 0, 1, 2. 0.8
6) 4, 4, 4, 5, 5. 4.4

12.00AM Air temp. 5°C
3% cloud, light breeze..
1) 10, 8, 13, 9, 13. 10.6
2) 6, 5, 6, 5, 6. 5.6
3) 1, 2, 2, 3, 1. 1.8
4) 4, 2, 3, 4, 3. 3.2
5) 5, 4, 5, 4, 4. 4.4
6) 5, 5, 5, 5, 5. 5.0

3.00PM Air temp. 5°C
0% cloud, light breeze.
1) 14, 12, 13, 15, 11. 13.0
2) 9, 8, 9, 9, 9. 8.8
3) 5, 4, 4, 4, 5. 4.4
4) 4, 3, 4, 3, 4. 3.6
5) 7, 6, 6, 6, 6. 6.2
6) 6, 6, 6, 6, 6. 6.0

6.00PM Air temp. 4°C
0% cloud, light breeze.
1) 4, 6, 7, 6, 7. 6.0
2) 7, 7, 9, 7, 8. 7.6
3) 3, 3, 3, 3, 3. 3.0
4) 4, 4, 4, 4, 4. 4.0
5) 4, 4, 4, 4, 4. 4.0
6) 6, 7, 6, 6, 6. 6.2

DATE 18/1/90

9.00AM Air temp. 2°C
0% cloud, light breeze.

1)	0,	1,	1,	1,	1.	0.8
2)	4,	4,	4,	4,	4.	4.0
3)	0,	1,	1,	0,	0.	0.4
4)	3,	4,	5,	3,	3.	3.6
5)	0,	1,	1,	1,	1.	0.8
6)	4,	5,	5,	5,	5.	4.8

12.00AM Air temp. 6°C
0% cloud, v. light breeze.

1)	7,	6,	6,	6,	11.	7.2
2)	4,	4,	5,	4,	4.	4.2
3)	2,	1,	1,	2,	1.	1.4
4)	4,	4,	4,	4,	4.	4.0
5)	5,	4,	5,	5,	6.	5.0
6)	5,	5,	5,	5,	5.	5.0

3.00PM Air temp. 7°C
20% cloud, breezy.

1)	11,	12,	13,	12,	12.	12.0
2)	7,	7,	7,	7,	8.	7.2
3)	4,	5,	5,	2,	3.	3.8
4)	4,	5,	4,	4,	4.	4.2
5)	8,	8,	8,	8,	8.	8.0
6)	6,	6,	6,	6,	6.	6.0

6.00PM Air temp. 5°C
5% cloud, v. light breeze.

1)	5,	6,	6,	5,	6.	5.6
2)	7,	7,	7,	8,	7.	7.2
3)	3,	4,	3,	4,	4.	3.6
4)	3,	5,	4,	5,	4.	4.2
5)	4,	5,	4,	5,	4.	4.4
6)	6,	7,	7,	6,	6.	6.4

DATE 2/3/89 QUADRAT OWH NFS
9.00PM Air temp. 5°C
100% cloud, sheltered, rain.

1)	4,	4,	4,	4,	4.	4.0
2)	3,	4,	3,	4,	4.	3.6
3)	5,	4,	4,	4,	4.	4.2
4)	4,	4,	4,	4,	4.	4.0
5)	4,	4,	4,	4,	4.	4.0
6)	4,	4,	4,	4,	4.	4.0

DATE 15/3/89 QUADRAT OWH NFS
9.00AM Air Temp. 9°C
90% cloud, slight breeze.

1)	8,	8,	8,	8,	8.	8.0
2)	7,	7,	7,	7,	7.	7.0
3)	8,	8,	8,	9,	8.	8.2
4)	7,	7,	8,	8,	7.	7.4
5)	8,	8,	7,	8,	7.	7.6
6)	7,	7,	7,	7,	7.	7.0

12.00AM Air temp. 10°C
60% cloud, slight breeze.

1)	16,	14,	15,	16,	17.	15.6
2)	9,	8,	8,	8,	8.	8.2
3)	10,	12,	10,	12,	13.	11.4
4)	7,	8,	8,	8,	8.	7.8
5)	10,	10,	11,	12,	10.	10.6
6)	7,	7,	7,	8,	7.	7.2

3.00PM Air temp. 13°C
80% cloud, almost still.

1)	16,	15,	14,	15,	17.	15.4
2)	10,	12,	11,	10,	12.	11.0
3)	12,	12,	12,	11,	13.	12.0
4)	9,	10,	9,	8,	10.	9.2
5)	11,	12,	11,	10,	10.	10.8
6)	8,	8,	8,	8,	8.	8.0

6.00PM Air temp. 8°C
100% cloud, dull, still.

1)	10,	8,	10,	9,	9.	9.2
2)	10,	9,	9,	11,	10.	9.8
3)	9,	9,	10,	10,	9.	9.4
4)	9,	9,	9,	9,	9.	9.0
5)	8,	8,	8,	8,	8.	8.0
6)	8,	8,	9,	8,	9.	8.4

DATE 10/4/89 QUADRAT OWH NFS
12.00AM Air Temp. 11°C
60% cloud, steady breeze.

1)	14,	16,	17,	18,	17,	16,	14,	15,	16,	14.	15.7
2)	9,	9,	9,	9,	9,	9,	8,	9,	9,	9.	8.9
3)	12,	13,	14,	14,	15,	12,	13,	13,	13,	14.	13.3
4)	9,	9,	9,	9,	10,	9,	9,	9,	9,	9.	9.1
5)	14,	12,	12,	13,	11,	11,	12,	11,	11,	13.	12.0
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0

5.00PM Air temp. 10°C
30% cloud, steady breeze.

1)	11,	11,	11,	11,	10,	10,	10,	11,	10,	10.	10.5
2)	10,	10,	9,	10,	9,	9,	10,	9,	9,	8.	9.3
3)	11,	11,	11,	10,	10,	10,	10,	10,	10,	10.	10.3
4)	9,	9,	10,	10,	9,	9,	8,	9,	9,	8.	9.0
5)	10,	10,	10,	10,	10,	10,	9,	9,	10,	9.	9.8
6)	8,	9,	9,	8,	8,	8,	8,	8,	9,	8.	8.3

DATE 19/4/89 QUADRAT OWH NFS

9.00AM Air Temp. 7°C
25% cloud, slight breeze,

1)	13,	14,	12,	11,	14.	12.8
2)	7,	7,	7,	8,	8.	7.4
3)	8,	10,	8,	8,	7.	8.2
4)	7,	7,	6,	7,	7.	6.8
5)	7,	8,	7,	7,	7.	7.2
6)	7,	8,	7,	6,	7.	7.0

12.00AM Air temp. 9°C
15% cloud, slight breeze.

1)	24,	20,	24,	21,	25.	22.8
2)	9,	9,	11,	11,	10.	10.0
3)	11,	9,	12,	13,	11.	11.2
4)	8,	7,	8,	7,	8.	7.6
5)	11,	13,	11,	11,	12.	11.6
6)	8,	8,	7,	8,	8.	7.8

3.00PM Air temp. 9°C
100% cloud, light breeze.

1)	16,	15,	15,	15,	18.	15.8
2)	11,	10,	11,	9,	11.	10.4
3)	14,	11,	13,	13,	13.	12.8
4)	9,	8,	10,	10,	11.	9.6
5)	11,	12,	11,	12,	13.	11.8
6)	8,	9,	8,	9,	9.	8.6

6.00PM Air temp. 9°C
100% cloud, still.

1)	14,	13,	14,	14,	12.	13.4
2)	12,	15,	15,	15,	14.	14.2
3)	12,	10,	13,	12,	13.	12.0
4)	10,	8,	10,	10,	11.	9.8
5)	12,	11,	10,	11,	11.	11.0
6)	10,	10,	9,	9,	10.	9.6

DATE 10/5/89 QUADRAT OWH NFS

9.00AM Air Temp. 12^{o}C
95% cloud, light breeze.
1) 19, 14, 15, 17, 17. 16.6
2) 14, 13, 13, 12, 14. 13.2
3) 13, 14, 13, 15, 15. 14.0
4) 12, 12, 11, 12, 12. 11.8
5) 13, 14, 13, 12, 13. 13.0
6) 12, 12, 12, 11, 12. 11.8

12.00AM Air temp. 15^{o}C
95% cloud, almost still, hazey sun.
1) 21, 20, 20, 21, 22. 20.8
2) 14, 14, 14, 14, 15. 14.2
3) 20, 20, 20, 20, 20. 20.0
4) 14, 15, 14, 14, 14. 14.2
5) 18, 17, 17, 16, 18. 17.2
6) 12, 12, 13, 13, 12. 12.4

3.00PM Air temp. 16^{o}C
100% cloud, still, humid.
1) 22, 23, 23, 21, 21. 22.0
2) 16, 16, 16, 15, 16. 15.8
3) 18, 21, 22, 21, 21. 20.6
4) 13, 16, 16, 16, 16. 15.4
5) 17, 18, 18, 17, 19. 17.8
6) 12, 13, 13, 14, 14. 13.2

6.00PM Air temp. 12^{o}C
100% cloud, light breeze.
1) 14, 15, 15, 14, 15. 14.6
2) 16, 16, 17, 16, 16. 16.2
3) 16, 17, 16, 17, 16. 16.4
4) 15, 16, 16, 16, 15. 15.6
5) 15, 15, 15, 14, 14. 14.6
6) 14, 14, 14, 13, 14. 13.8

DATE 24/5/89 QUADRAT OWH NFS

9.00AM Air Temp. 21^{o}C
80% cloud, (high, hazey), still.
1) 24, 23, 25, 25, 23. 24.0
2) 19, 18, 19, 18, 17. 18.2
3) 22, 23, 22, 22, 21. 22.0
4) 18, 18, 18, 18, 18. 18.0
5) 21, 20, 21, 22, 21. 21.0
6) 17, 16, 17, 17, 16. 16.6

12.00AM Air temp. 26^{o}C
5% cloud, light breeze, hazey.
1) 39, 36, 33, 40, 40. 37.6
2) 22, 22, 21, 22, 21. 21.6
3) 29, 30, 26, 28, 27. 28.0
4) 19, 20, 19, 19, 19. 19.2
5) 24, 28, 26, 26, 28. 26.4
6) 17, 18, 18, 17, 17. 17.6

3.00PM Air temp. 23^{o}C
100% cloud, breezy.
1) 26, 28, 26, 26, 28. 26.8
2) 24, 26, 26, 24, 24. 24.8
3) 25, 27, 26, 26, 26. 26.0
4) 21, 22, 23, 22, 22. 22.0
5) 23, 23, 23, 22, 23. 22.8
6) 20, 19, 18, 18, 18. 18.6

6.00PM Air temp. 19^{o}C
100% cloud, breezy.
1) 23, 22, 21, 21, 21. 21.6
2) 22, 21, 20, 22, 21. 21.2
3) 22, 22, 21, 21, 21. 21.6
4) 20, 19, 21, 20, 20. 20.0
5) 20, 20, 20, 20, 20. 20.0
6) 18, 18, 18, 18, 18. 18.0

DATE 7/6/89 QUADRAT OWH NFS

9.00AM Air temp. $10^{\circ}C$
100% cloud, light breeze.
1) 11, 12, 13, 13, 13. 12.4
2) 10, 10, 11, 11, 10. 10.4
3) 11, 12, 12, 12, 12. 11.8
4) 10, 10, 10, 10, 10. 10.0
5) 11, 12, 12, 12, 12. 11.8
6) 11, 11, 11, 11, 11. 11.0

12.00AM Air temp. $12^{\circ}C$
90% cloud, breezy.
1) 17, 16, 18, 21, 20. 18.4
2) 12, 11, 11, 12, 12. 11.6
3) 14, 17, 18, 13, 17. 15.8
4) 11, 11, 12, 11, 12. 11.4
5) 14, 15, 17, 17, 15. 15.6
6) 11, 11, 11, 12, 11. 11.2

3.00PM Air temp. $13^{\circ}C$
90% cloud, still.
1) 19, 18, 18, 18, 18. 18.2
2) 14, 13, 13, 12, 13. 13.0
3) 15, 16, 17, 18, 16. 16.4
4) 11, 12, 12, 14, 13. 12.4
5) 16, 17, 14, 15, 15. 15.4
6) 13, 12, 12, 12, 13. 12.4

6.00PM Air temp. $15^{\circ}C$
10% cloud, breezy.
1) 18, 17, 18, 17, 17. 17.4
2) 15, 15, 15, 15, 15. 15.0
3) 16, 16, 20, 18, 19. 17.8
4) 13, 14, 14, 14, 15. 14.0
5) 17, 16, 17, 16, 16. 16.4
6) 14, 13, 14, 13, 13. 13.4

DATE 23/6/89 QUADRAT OWH NFS

9.00AM Air temp. $16^{\circ}C$
No cloud, light breeze.
1) 21, 23, 25, 21, 23. 22.6
2) 17, 18, 17, 18, 18. 17.6
3) 18, 19, 18, 19, 24. 19.6
4) 17, 17, 16, 17, 17. 16.8
5) 19, 18, 17, 17, 18. 17.8
6) 16, 16, 16, 17, 17. 16.4

12.00AM Air temp. $22^{\circ}C$
No cloud, light breeze.
1) 42, 38, 37, 39, 42. 39.6
2) 25, 23, 23, 22, 25. 23.6
3) 25, 27, 31, 28, 29. 28.0
4) 19, 20, 21, 21, 20. 20.2
5) 26, 25, 24, 27, 23. 25.0
6) 18, 19, 17, 19, 18. 18.2

3.00PM Air temp. $25^{\circ}C$
10% cloud, light breeze.
1) 43, 42, 40, 43, 38. 41.2
2) 25, 26, 29, 28, 26. 26.8
3) 30, 31, 37, 29, 30. 31.4
4) 21, 23, 23, 23, 21. 22.2
5) 26, 28, 27, 31, 26. 27.6
6) 21, 21, 21, 21, 21. 21.0

6.00PM Air temp. $23^{\circ}C$
1% cloud, very light breeze.
1) 26, 29, 30, 29, 28. 28.4
2) 25, 26, 26, 25, 26. 25.6
3) 27, 32, 30, 27, 25. 28.2
4) 23, 26, 24, 24, 21. 23.6
5) 24, 26, 24, 26, 24. 24.8
6) 20, 22, 19, 23, 21. 21.0

DATE 19/7/89 QUADRAT OWH NFS

9.00AM Air temp. 20°C
2% cloud, almost still.
1) 25, 26, 23, 26, 26. 25.2
2) 18, 18, 18, 17, 18. 17.8
3) 19, 20, 19, 20, 20. 19.8
4) 17, 18, 17, 18, 18. 17.6
5) 21, 20, 20, 20, 19. 20.0
6) 17, 17, 17, 17, 17. 17.0

12.00AM Air temp. 21°C
45% cloud, almost still.
1) 37, 35, 33, 38, 35. 35.6
2) 25, 22, 21, 21, 24. 22.6
3) 24, 25, 23, 24, 28. 24.8
4) 18, 20, 19, 19, 20. 19.2
5) 25, 24, 26, 26, 26. 25.4
6) 18, 18, 19, 19, 19. 18.6

3.00PM Air temp. 23°C
2% cloud, light breeze.
1) 40, 38, 34, 30, 33. 35.0
2) 26, 23, 27, 24, 22. 26.4
3) 30, 29, 25, 28, 25. 27.4
4) 23, 21, 19, 21, 22. 21.2
5) 25, 26, 27, 25, 25. 25.6
6) 19, 20, 20, 19, 20. 19.6

6.00PM Air temp. 22°C
0% cloud, light breeze.
1) 29, 28, 25, 25, 26. 26.6
2) 25, 26, 25, 26, 25. 25.4
3) 29, 27, 26, 27, 25. 26.8
4) 24, 24, 23, 25, 22. 23.6
5) 25, 25, 23, 24, 24. 24.2
6) 22, 22, 20, 23, 21. 21.6

DATE 3/8/89 QUADRAT OWH NFS

9.00AM Air temp. 19°C
20% cloud, almost still.
1) 25, 25, 25, 31, 28. 26.8
2) 19, 18, 19, 19, 18. 18.6
3) 25, 20, 24, 21, 22. 22.4
4) 19, 17, 18, 17, 18. 17.8
5) 21, 20, 21, 22, 20. 20.8
6) 16, 17, 16, 17, 17. 16.6

12.00AM Air temp. 23°C
90% cloud, v. light breeze.
1) 31, 31, 31, 37, 31. 32.2
2) 19, 19, 19, 21, 20. 19.6
3) 25, 25, 25, 24, 27. 25.2
4) 19, 17, 19, 18, 18. 18.2
5) 23, 25, 25, 24, 22. 23.8
6) 17, 17, 18, 18, 18. 17.6

3.00PM Air temp. 25°C
60% cloud, almost still.
1) 41, 39, 31, 37, 36. 36.8
2) 24, 23, 23, 24, 25. 23.8
3) 31, 29, 25, 28, 27. 28.0
4) 21, 21, 20, 21, 21. 20.8
5) 29, 28, 27, 25, 26. 27.0
6) 21, 20, 20, 20, 19. 20.0

6.00PM Air temp. 22°C
100% cloud, still.
1) 24, 26, 25, 26, 24. 25.0
2) 21, 23, 24, 24, 23. 23.0
3) 24, 21, 25, 24, 22. 23.2
4) 21, 18, 21, 21, 19. 20.0
5) 25, 20, 22, 22, 21. 22.0
6) 21, 19, 20, 20, 19. 19.8

DATE 23/8/89 QUADRAT OWH NFS

9.00AM Air temp. 13°C
0% cloud, almost still.
1) 17, 17, 17, 16, 18. 17.0
2) 14, 14, 14, 13, 15. 14.0
3) 13, 15, 13, 14, 14. 13.8
4) 13, 15, 14, 14, 14. 14.0
5) 14, 14, 15, 15, 15. 14.6
6) 14, 14, 15, 14, 14. 14.2

12.00AM Air temp. 19°C
0% cloud, breezy.
1) 29, 30, 34, 33, 38. 32.8
2) 19, 20, 24, 20, 20. 20.6
3) 18, 19, 19, 17, 23. 19.2
4) 15, 16, 15, 17, 18. 16.2
5) 18, 21, 19, 21, 18. 19.4
6) 15, 16, 16, 16, 15. 15.6

3.00PM Air temp. 23°C
0% cloud, light breeze.
1) 37, 31, 36, 36, 34. 34.8
2) 26, 23, 24, 26, 23. 24.4
3) 22, 21, 23, 23, 22. 22.2
4) 18, 17, 17, 19, 17. 17.6
5) 20, 22, 22, 22, 20. 21.2
6) 17, 17, 18, 18, 17. 17.4

6.00PM Air temp. 21°C
0% cloud, light breeze.
1) 26, 24, 24, 22, 22. 23.6
2) 24, 23, 22, 23, 23. 23.0
3) 21, 22, 20, 19, 20. 20.4
4) 17, 19, 18, 17, 18. 17.8
5) 19, 20, 19, 19, 19. 19.2
6) 18, 19, 18, 18, 18. 18.2

DATE 27/9/89 QUADRAT OWH NFS

9.00AM Air temp. 14°C
85% cloud, light breeze.
1) 14, 15, 15, 15, 15. 14.8
2) 15, 14, 15, 15, 15. 14.8
3) 15, 14, 15, 15, 15. 14.8
4) 15, 15, 15, 15, 15. 15.0
5) 14, 15, 15, 15, 15. 14.8
6) 15, 15, 15, 15, 15. 15.0

12.00AM Air temp. 17°C
65% cloud, light breeze.
1) 25, 29, 23, 23, 24. 24.8
2) 17, 18, 17, 17, 17. 17.2
3) 18, 17, 17, 18, 17. 17.4
4) 16, 16, 16, 15, 15. 15.6
5) 18, 17, 18, 18, 17. 17.6
6) 16, 15, 15, 15, 15. 15.8

3.00PM Air temp. 16°C
100% cloud, breezy.
1) 20, 19, 19, 18, 19. 19.0
2) 18, 18, 17, 18, 18. 17.8
3) 19, 17, 17, 18, 17. 17.6
4) 17, 16, 15, 16, 15. 15.8
5) 17, 16, 17, 17, 17. 16.8
6) 16, 15, 16, 16, 16. 15.8

6.00PM Air temp. 14°C
100% cloud, light breeze.
1) 15, 16, 15, 16, 14. 15.2
2) 17, 18, 17, 18, 16. 17.2
3) 17, 17, 16, 17, 16. 16.6
4) 16, 16, 16, 16, 16. 16.0
5) 16, 15, 16, 15, 15. 15.4
6) 16, 15, 16, 16, 15. 15.6

DATE 30/11/89 QUADRAT OWH

9.00AM Air temp. $1^{o}C$
0% cloud, still.

1)	0,	0,	0,	0,	0.	0.0
2)	1,	1,	1,	1,	1.	1.0
3)	0,	0,	0,	0,	0.	0.0
4)	1,	1,	1,	1,	1.	1.0
5)	0,	0,	0,	1,	1.	1.4
6)	3,	2,	2,	3,	3.	2.6

12.00AM Air temp. $3^{o}C$
5% cloud, still.

1)	0,	0,	0,	0,	0.	0.0
2)	1,	1,	2,	1,	1.	1.2
3)	0,	0,	0,	0,	0.	0.0
4)	1,	1,	2,	1,	2.	1.4
5)	0,	0,	1,	2,	1.	0.8
6)	2,	3,	2,	4,	3.	2.8

3.00PM Air temp. $5^{o}C$
0% cloud, still.

1)	4,	2,	2,	3,	2.	2.6
2)	1,	2,	1,	1,	1.	1.2
3)	1,	1,	0,	1,	0.	0.6
4)	1,	2,	1,	1,	1.	1.2
5)	1,	0,	1,	0,	0.	0.4
6)	3,	3,	3,	2,	2.	2.6

6.00PM Air temp. $2^{o}C$
0% cloud, almost still.

1)	0,	1,	1,	1,	1.	0.8
2)	1,	1,	1,	1,	1.	1.0
3)	2,	1,	0,	0,	1.	0.8
4)	3,	1,	1,	1,	1.	1.4
5)	1,	1,	1,	0,	1.	0.8
6)	3,	2,	4,	2,	4.	3.0

DATE 18/1/90 QUADRAT OWH

9.00AM Air temp. $3^{o}C$
0% cloud, light breeze.

1)	1,	1,	1,	1,	0.	0.8
2)	3,	3,	4,	3,	3.	3.2
3)	1,	0,	1,	2,	0.	0.8
4)	4,	3,	3,	4,	3.	3.4
5)	1,	0,	0,	0,	2.	0.6
6)	5,	4,	5,	4,	6.	4.8

12.00AM Air temp. $6^{o}C$
0% cloud, light breeze.

1)	1,	1,	1,	2,	1.	1.2
2)	3,	4,	3,	3,	3.	3.2
3)	1,	1,	1,	1,	1.	1.0
4)	3,	3,	3,	4,	3.	3.2
5)	1,	1,	1,	2,	1.	1.2
6)	5,	5,	4,	5,	5.	4.8

3.00PM Air temp. $6^{o}C$
20% cloud, light breeze.

1)	8,	8,	5,	4,	5.	6.0
2)	5,	4,	4,	3,	3.	3.8
3)	4,	3,	2,	1,	3.	2.6
4)	4,	4,	3,	3,	4.	3.6
5)	4,	4,	4,	4,	4.	4.0
6)	5,	5,	5,	5,	5.	5.0

6.00PM Air temp. $5^{o}C$
5% cloud, light breeze.

1)	3,	3,	3,	4,	3.	3.2
2)	3,	3,	3,	4,	4.	3.4
3)	1,	3,	3,	4,	4.	3.0
4)	3,	4,	3,	5,	4.	3.8
5)	3,	4,	4,	4,	4.	3.8
6)	5,	5,	5,	5,	6.	5.2

DATE 2/3/89
9.00AM Air temp. 5°C
100% cloud, sheltered, rain.

1)	4,	3,	3,	3,	3.	3.2
2)	3,	3,	3,	3,	3.	3.0
3)	3,	3,	4,	4,	3.	3.4
4)	3,	3,	3,	3,	3.	3.0
5)	4,	4,	4,	4,	4.	4.0
6)	4,	4,	4,	4,	4.	4.0

DATE 15/3/89
9.00AM Air temp. 8°C
90% cloud, slight breeze, sheltered.

1)	8,	8,	7,	8,	8.	7.8
2)	7,	7,	7,	7,	7.	7.0
3)	8,	7,	8,	8,	8.	7.8
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	8,	7,	7.	7.2
6)	7,	7,	7,	7,	7.	7.0

12.00AM Air temp. 6°C
70% cloud, slight breeze.

1)	15,	11,	12,	12,	14.	12.8
2)	8,	8,	8,	8,	8.	8.0
3)	10,	9,	9,	9,	9.	9.2
4)	7,	7,	7,	7,	8.	7.2
5)	10,	9,	9,	10,	11.	9.8
6)	7,	7,	7,	7,	7.	7.0

3.00PM Air temp. 12°C
90% cloud (hazey), still.

1)	15,	15,	12,	12*	13.	13.4
2)	10,	10,	8,	8,	10.	9.2
3)	11,	11,	9,	10,	10.	10.2
4)	8,	8,	7,	8,	8.	7.8
5)	10,	10,	11,	10,	9.	10.0
6)	7,	7,	8,	8,	8.	7.6

6.00PM Air temp. 8°C
100% cloud, dull, still.

1)	9,	9,	9,	9,	9.	9.0
2)	9,	10,	10,	10,	10.	9.8
3)	9,	9,	9,	9,	9.	9.0
4)	8,	8,	9,	8,	8.	8.2
5)	8,	8,	8,	8,	7.	7.8
6)	8,	8,	8,	7,	7.	7.6

* Many worker ants underneath the slate but no brood seen.

DATE 10/4/89
12.00AM Air temp. 10°C
80% cloud, steady breeze.
1) 13, 12, 13, 13, 13, 13, 13, 14, 13, 14. 13.1
2) 10, 9, 9, 9, 10, 9, 9, 9, 9, 9. 9.2
3) 13, 11, 10, 11, 12, 12, 12, 12, 10, 10. 11.3
4) 9, 8, 9, 9, 8, 9, 10, 9, 8, 8. 8.7
5) 10, 10, 11, 11, 10, 12, 11, 11, 11, 10. 10.7
6) 8, 8, 8, 8, 8, 8, 8, 7, 8, 8. 7.9

5.00PM Air temp. 11°C
30% cloud, steady breeze.
1) 16, 16, 18, 15, 14, 16, 13, 11, 13, 11. 14.3
2) 11, 11, 11, 11, 12, 13, 11, 10, 11, 10. 11.1
3) 12, 11, 13, 12, 10, 12, 9, 10, 12, 10. 11.1
4) 10, 10, 10, 10, 9, 10, 8, 9, 10, 9. 9.5
5) 10, 12, 11, 11, 11, 13, 10, 9, 10, 10. 10.7
6) 9, 9, 9, 8, 9, 10, 9, 8, 9, 8. 8.8

DATE 19/4/89
9.00AM Air temp. 4°C
20% cloud, still.
1) 3, 2, 3, 3, 3. 2.8
2) 7, 7, 7, 6, 6. 6.6
3) 3, 2, 3, 4, 4. 3.2
4) 6, 5, 6, 6, 5. 5.6
5) 2, 3, 0, 3, 3. 2.2
6) 7, 7, 7, 7, 7. 7.0

12.00AM Air temp. 10°C
5% cloud, still.
1) 25, 25, 24, 25, 26. 25.0
2) 8, 9, 8, 9, 9. 8.6
3) 10, 10, 9, 9, 13. 10.2
4) 7, 7, 6, 6, 8. 6.8
5) 14, 14, 12, 14, 11. 13.0
6) 8, 8, 9, 8, 7. 8.0

3.00PM Air temp. 11°C
90% cloud, still.
1) 17, 15, 16, 17, 19. 16.8
2) 12, 12, 11, 11, 13. 11.8
3) 15, 12, 11, 12, 14. 12.8
4) 9, 9, 8, 9, 9. 8.8
5) 12, 11, 13, 12, 13. 12.2
6) 9, 8, 9, 8, 8. 8.4

6.00PM Air temp. 9°C
100% cloud, still.
1) 13, 12, 13, 14, 11. 12.6
2) 13, 12, 13, 13, 14. 13.0
3) 12, 12, 14, 12, 13. 12.6
4) 9, 8, 11, 10, 11. 9.8
5) 9, 12, 10, 10, 11. 10.4
6) 8, 10, 9, 8, 9. 8.8

DATE 10/5/89

9.00AM Air temp. 10°C
100% cloud, v. light breeze.
1) 12, 12, 13, 13, 13. 12.6
2) 13, 12, 12, 12, 12. 12.2
3) 14, 13, 14, 13, 14. 13.6
4) 12, 12, 11, 12, 11. 11.6
5) 13, 13, 13, 12, 13. 12.8
6) 11, 11, 11, 11, 11. 11.0

12.00AM Air temp. 16°C
95% cloud, still, hazey sun.
1) 23, 22, 28, 21, 18. 20.4
2) 14, 15, 14, 13, 14. 14.0
3) 17, 18, 14, 16, 17. 16.4
4) 13, 12, 12, 12, 14. 12.6
5) 19, 18, 14, 15, 16. 16.4
6) 11, 12, 11, 11, 12. 11.4

3.00PM Air temp. 15°C
100% cloud, still, humid.
1) 21, 21, 20, 20, 21. 20.6
2) 15, 15, 14, 15, 15. 14.8
3) 19, 17, 19, 18, 19. 18.4
4) 15, 13, 16, 14, 15. 14.6
5) 19, 16, 18, 16, 16. 17.0
6) 12, 12, 12, 12, 12. 12.0

6.00PM Air temp. 12°C
100% cloud, almost still.
1) 16, 16, 17, 16, 16. 16.2
2) 16, 15, 15, 14, 15. 15.0
3) 17, 15, 16, 15, 16. 15.8
4) 16, 13, 15, 14, 16. 14.8
5) 14, 14, 14, 14, 13. 13.8
6) 12, 12, 11, 13, 11. 11.8

DATE 24/5/89

9.00AM Air temp. 21°C
80% cloud, (high, hazey), still.
1) 21, 19, 19, 21, 20. 20.0
2) 18, 19, 17, 18, 17. 17.8
3) 19, 20, 20, 20, 20. 19.8
4) 18, 18, 17, 17, 17. 17.4
5) 16, 18, 17, 17, 19. 17.4
6) 15, 15, 15, 14, 15. 14.8

12.00AM Air temp. 27°C
0% cloud, still, hazey.
1) 40, 41, 38, 40, 42. 40.2
2) 19, 22, 20, 21, 21. 20.6
3) 29, 26, 24, 25, 24. 25.6
4) 19, 19, 19, 18, 20. 19.0
5) 25, 24, 24, 23, 25. 24.2
6) 16, 16, 16, 15, 16. 15.8

3.00PM Air temp. 22°C
100% cloud, still, humid.
1) 30, 28* 30, 28, 30. 29.2
2) 25, 25, 26, 25, 25. 25.2
3) 25, 24, 25, 26, 25. 25.0
4) 20, 20, 18, 23, 19. 20.0
5) 22, 22, 21, 24, 22. 22.2
6) 17, 19, 17, 18, 16. 17.4
* Nothing up.

6.00PM Air temp. 19°C
100% cloud, almost still.
1) 23, 23, 24, 23, 22. 23.0
2) 22, 21, 22, 22, 21. 21.6
3) 24, 24, 23, 24, 23. 23.6
4) 21, 21, 19, 21, 21. 20.6
5) 19, 19, 20, 19, 20. 19.4
6) 16, 16, 17, 17, 17. 16.6

DATE 7/6/89

9.00AM Air temp. 9°C
100% cloud, still.
1) 11, 12, 12, 12, 12. 11.8
2) 10, 10, 10, 10, 10. 10.0
3) 11, 11, 11, 11, 11. 11.0
4) 10, 10, 10, 10, 9. 9.8
5) 12, 12, 11, 11, 11. 11.4
6) 10, 10, 10, 10, 10. 10.0

12.00AM Air temp. 13°C
90% cloud, still.
1) 19, 19, 19, 19, 18. 18.8
2) 11, 11, 12, 11, 11. 11.2
3) 15, 14, 13, 12, 14. 13.6
4) 11, 10, 10, 11, 11. 10.6
5) 15, 15, 14, 16, 16. 15.2
6) 11, 10, 11, 11, 11. 10.8

3.00PM Air temp. 14°C
90% cloud, still, drizzle.
1) 20, 24, 24, 22, 23. 22.6
2) 12, 16, 14, 13, 14. 13.8
3) 20, 19, 20, 18, 18. 19.0
4) 13, 12, 14, 13, 13. 13.0
5) 15, 17, 18, 15, 17. 16.4
6) 11, 12, 12, 11, 12. 11.6

6.00PM Air temp. 15°C
10% cloud, almost still.
1) 19, 20, 20, 20, 19. 19.6
2) 15, 15, 16, 15, 16. 15.4
3) 16, 20, 17, 19, 21. 18.6
4) 12, 15, 14, 17, 17. 15.0
5) 16, 16, 16, 15, 16. 15.8
6) 13, 12, 12, 12, 12. 12.8

DATE 23/6/89

9.00AM Air temp. 14°C
No cloud, light breeze.
1) 15, 16, 16, 15* 16. 15.6
2) 15, 16, 16, 15, 15. 15.4
3) 14, 16, 16, 16, 16. 15.6
4) 15, 16, 16, 16, 16. 15.8
5) 15, 16, 16, 16, 16. 15.8
6) 16, 16, 14, 15, 17. 15.6
* No ants up.

12.00AM Air temp. 21°C
No cloud, light breeze.
1) 28, 41, 36, 47, 39. 38.2
2) 18, 20, 21, 22, 21. 20.4
3) 25, 23, 25, 25, 23. 24.2
4) 17, 17, 20, 18, 18. 18.0
5) 22, 26, 20, 26, 23. 23.4
6) 17, 18, 16, 15, 17. 16.6

3.00PM Air temp. 25°C
15% cloud, light breeze.
1) 55, 50, 37, 47, 44. 46.6
2) 30, 28, 25, 26, 27. 27.2
3) 31, 29, 28, 28, 31. 29.4
4) 23, 23, 21, 22, 23. 22.4
5) 27, 26, 21, 25, 24. 24.6
6) 17, 20, 18, 19, 18. 18.4

6.00PM Air temp. 21°C
No cloud, light breeze.
1) 28, 24, 27, 25, 26. 26.0
2) 29, 26, 28, 23, 27. 26.6
3) 28, 24, 26, 22, 26. 25.2
4) 25, 21, 22, 20, 23. 22.2
5) 20, 19, 22, 19, 20. 20.0
6) 18, 21, 19, 18, 19. 19.0

DATE 23/6/90
9.00PM Air temp. 14°C
No cloud, almost still, sunset.
1) 17, 15, 17, 17, 18. 16.8
2) 23, 22, 21, 23, 23. 22.4
3) 20, 18, 20, 22, 21. 20.2
4) 20, 21, 18, 22, 22. 20.6
5) 17, 16, 16, 18, 17. 16.8
6) 17, 16, 17, 16, 17. 16.6

DATE 19/7/89
9.00AM Air temp. 20°C
5% cloud, still.
1) 15, 15, 15, 19, 15* 15.8
2) 15, 15, 15, 16, 15. 15.2
3) 15, 15, 16, 16, 15. 15.4
4) 16, 16, 16, 15, 16. 15.8
5) 16, 16, 15, 16, 15. 15.6
6) 15, 15, 15, 15, 15. 15.0
* ~30 workers only up.

12.00AM Air temp. 23°C
40% cloud, light breeze.
1) 38, 33, 41, 38, 38. 37.6
2) 20, 18, 21, 21, 20. 20.0
3) 27, 22, 25, 25, 26. 25.0
4) 20, 17, 19, 19, 18. 18.6
5) 22, 21, 24, 24, 25. 23.2
6) 17, 16, 19, 19, 17. 17.6

3.00PM Air temp. 24°C
5% cloud, light breeze.
1) 39, 49, 43, 40, 38. 41.8
2) 23, 25, 24, 25, 28. 25.0
3) 24, 26, 26, 25, 28. 25.8
4) 20, 22, 23, 20, 21. 21.2
5) 25, 29, 24, 22, 24. 24.8
6) 19, 19, 18, 17, 17. 18.0

6.00PM Air temp. 22°C
No cloud, almost still.
1) 31, 34, 31, 32, 22* 30.0
2) 24, 27, 25, 28, 23. 25.4
3) 35, 27, 24, 34, 21. 28.2
4) 22, 23, 21, 25, 19. 22.0
5) 24, 32, 24, 23, 20. 24.6
6) 21, 19, 19, 20, 19. 19.6
* 3 males and a few workers only up. Mound in shade.

DATE 3/8/89

9.00AM Air temp. 18°C
20% cloud, still.
1) 17, 16, 16, 16, 16. 16.2
2) 16, 16, 16, 16, 17. 16.2
3) 16, 16, 16, 16, 16. 16.0
4) 16, 15, 15, 16, 15. 15.4
5) 15, 15, 15, 15, 15. 15.0
6) 15, 15, 15, 15, 15. 15.0

12.00AM Air temp. 23°C
80% cloud, light breeze.
1) 38, 37, 33, 32, 34. 34.8
2) 20, 20, 22, 18, 20. 20.0
3) 24, 21, 28, 22, 25. 24.0
4) 17, 18, 18, 18, 17. 17.6
5) 24, 22, 22, 20, 20. 21.6
6) 17, 16, 18, 18, 17. 17.2

3.00PM Air temp. 22°C
65% cloud, v. light breeze.
1) 31, 29, 30, 34, 36. 32.0
2) 20, 22, 22, 23, 22. 21.8
3) 28, 25, 27, 27, 26. 26.6
4) 21, 20, 23, 21, 22. 21.4
5) 22, 23, 25, 25, 25. 24.0
6) 17, 18, 19, 21, 19. 18.8

6.00PM Air temp. 22°C
100% cloud, still.
1) 26, 25, 26, 26, 26. 25.8
2) 23, 23, 21, 21, 22. 22.0
3) 25, 23, 24, 25, 25. 24.4
4) 22, 19, 21, 22, 21. 21.0
5) 21, 21, 20, 21, 21. 20.8
6) 18, 18, 16, 19, 18. 17.8

DATE 23/8/89

9.00AM Air temp. 10°C
0% cloud, still.
1) 11, 10, 10, 9, 9. 9.8
2) 11, 11, 12, 11, 10. 11.0
3) 8, 11, 12, 10, 11. 10.4
4) 12, 13, 13, 12, 13. 12.6
5) 12, 12, 12, 11, 12. 11.8
6) 13, 13, 12, 13, 13. 12.8

12.00AM Air temp. 20°C
0% cloud, almost still.
1) 29, 32, 33, 37, 33. 32.8
2) 14, 16, 15, 16, 17. 15.6
3) 19, 15, 16, 18, 16. 16.8
4) 13, 14, 15, 14, 15. 14.2
5) 15, 18, 20, 15, 17. 17.0
6) 14, 15, 15, 14, 14. 14.4

3.00PM Air temp. 24°C
0% cloud, light breeze.
1) 40, 40, 36, 39, 48. 40.6
2) 25, 22, 23, 24, 26. 24.0
3) 19, 22, 23, 23, 28. 23.0
4) 17, 18, 18, 17, 19. 17.8
5) 21, 18, 22, 20, 24. 21.0
6) 17, 16, 17, 16, 18. 16.8

6.00PM Air temp. 20°C
0% cloud, almost still.
1) 24, 21, 23, 27, 25. 24.0
2) 23, 20, 23, 24, 25. 23.0
3) 22, 17, 21, 22, 22. 20.8
4) 18, 16, 20, 18, 18. 18.0
5) 18, 17, 19, 19, 19. 18.4
6) 17, 16, 17, 16, 16. 16.4

DATE 27/9/89

9.00AM Air temp. 14°C
85% cloud, almost still.

1)	14,	15,	14,	15,	15.	14.6
2)	15,	15,	14,	14,	14.	14.4
3)	14,	15,	14,	14,	14.	14.2
4)	14,	15,	14,	14,	14.	14.2
5)	14,	15,	14,	14,	14.	14.2
6)	14,	14,	14,	14,	14.	14.0

12.00AM Air temp. 19°C
30% cloud, light breeze.

1)	28,	28,	29,	22,	26.	26.6
2)	16,	16,	16,	16,	17.	16.2
3)	17,	17,	17,	16,	16.	16.6
4)	16,	15,	15,	15,	14.	15.0
5)	16,	17,	17,	17,	15.	16.4
6)	15,	15,	15,	15,	14.	14.8

3.00PM Air temp. 17°C
100% cloud, breezy.

1)	20,	19,	20,	19,	20.	19.6
2)	18,	18,	18,	18,	18.	18.0
3)	19,	18,	18,	19,	17.	18.2
4)	16,	16,	16,	17,	16.	16.2
5)	16,	15,	17,	17,	16.	16.2
6)	15,	15,	15,	15,	15.	15.0

6.00PM Air temp. 14°C
100% cloud, light breeze.

1)	16,	16,	16,	15,	15.	15.6
2)	18,	17,	17,	17,	17.	17.2
3)	17,	16,	16,	15,	16.	16.0
4)	16,	16,	15,	15,	15.	15.4
5)	16,	15,	15,	15,	15.	15.2
6)	16,	15,	15,	15,	15.	15.2

DATE 30/11/89

9.00AM Air Temp. 0°C
0% cloud, still.

1)	0,	-1,	-1,	-1,	-2.	-1.0
2)	1,	0,	-1,	0,	-1.	-0.2
3)	-1,	-2,	-1,	0,	0.	-0.8
4)	0,	1,	0,	1,	0.	0.4
5)	1,	0,	0,	1,	0.	0.4
6)	4,	3,	3,	3,	4.	3.4

12.00AM Air temp. 0°C
5% cloud, still.

1)	0,	0,	0,	0,	0.	0.0
2)	0,	0,	1,	0,	-1.	0.0
3)	0,	0,	0,	0,	0.	0.0
4)	1,	1,	0,	0,	0.	0.4
5)	1,	1,	0,	0,	0.	0.4
6)	4,	3,	2,	3,	2.	2.8

3.00PM Air temp. 2°C
0% cloud, still.

1)	0,	0,	0,	0,	0.	0.0
2)	0,	0,	0,	0,	0.	0.0
3)	0,	0,	0,	0,	0.	0.0
4)	1,	1,	0,	0,	0.	0.4
5)	0,	0,	1,	0,	0.	0.2
6)	3,	4,	2,	3,	2.	2.8

6.00PM Air temp. 1°C
0% cloud, almost still.

1)	0,	0,	0,	0,	0.	0.0
2)	0,	0,	0,	0,	0.	0.0
3)	0,	0,	0,	0,	0.	0.0
4)	1,	0,	0,	0,	0.	0.2
5)	1,	0,	0,	0,	1.	0.4
6)	4,	3,	3,	3,	4.	3.4

DATE 18/1/90

9.00AM Air temp. $1^{o}C$
0% cloud, still.

1)	0,	0,	0,	0,	0.	0.0
2)	2,	3,	2,	2,	2.	2.2
3)	0,	0,	0,	0,	0.	0.0
4)	3,	3,	3,	3,	3.	3.0
5)	0,	0,	0,	0,	0.	0.0
6)	5,	5,	5,	5,	5.	5.0

12.00AM Air temp. $3^{o}C$
0% cloud, still.

1)	0,	0,	0,	1,	1.	0.4
2)	2,	2,	2,	2,	2.	2.0
3)	1,	0,	0,	0,	0.	0.2
4)	4,	3,	3,	2,	3.	3.0
5)	2,	0,	2,	0,	1.	1.0
6)	5,	5,	5,	5,	5.	5.0

3.00PM Air temp. $5^{o}C$
50% cloud, still.

1)	1,	0,	1,	1,	1.	0.8
2)	2,	2,	2,	2,	2.	2.0
3)	0,	0,	0,	1,	0.	0.2
4)	3,	2,	3,	2,	3.	2.6
5)	1,	1,	1,	2,	1.	1.2
6)	5,	5,	5,	5,	5.	5.0

6.00PM Air temp. $4^{o}C$
3% cloud, still.

1)	1,	1,	1,	1,	1.	1.0
2)	2,	2,	2,	2,	2.	2.0
3)	1,	3,	0,	0,	0.	0.8
4)	2,	5,	3,	2,	2.	2.8
5)	2,	1,	2,	2,	3.	2.0
6)	5,	5,	5,	5,	5.	5.0

DATE 16/3/89

9.00AM Air Temp. $3^{o}C$
100% cloud, steady rain,
slight breeze.

1)	4,	4,	4,	4,	4*	4
2)	5,	5,	5,	5,	5.	5
3)	4,	4,	4,	4,	4.	4
4)	5,	5,	5,	5,	5.	5
5)	4,	4,	4,	4,	4.	4
6)	5,	5,	5,	5,	5.	5

* 2 ants under slate only.

12.00AM Air temp. $3^{o}C$
100% cloud, steady rain,
slight breeze.

1)	4,	5,	5,	5,	4.	4.6
2)	5,	5,	5,	5,	5.	5
3)	5,	4,	5,	5,	5.	4.8
4)	5,	5,	5,	5,	5.	5
5)	5,	5,	5,	5,	5.	5
6)	5,	5,	5,	5,	5.	5

3.00PM Air temp. $3^{o}C$
100% cloud, steady light
rain, breezy.

1)	4,	4	4,	4,	4.	4
2)	5,	5,	5,	5,	5.	5
3)	4,	4,	4,	4,	4.	4
4)	5,	5,	5,	5,	5.	5
5)	4,	4,	4,	4,	4.	4
6)	5,	5,	5,	5,	5.	5

6.00PM Air temp. $3^{o}C$
100% cloud, steady light
rain, breezy.

1)	3,	3,	3,	3,	3.	3
2)	5,	5,	5,	5,	5.	5
3)	3,	3,	3,	3,	3.	3
4)	4,	4,	5,	4,	5.	4.4
5)	4,	4,	4,	4,	3.	3.8
6)	5,	5,	5,	5,	5.	5

DATE 20/4/89

9.00AM Air Temp. $6^{o}C$
100% cloud, breezy.

1)	7,	7,	8,	7*	7.	7.2
2)	7,	7,	7,	7,	7.	7.0
3)	7,	7,	7,	6,	7.	6.8
4)	7,	7,	6,	6,	7.	6.6
5)	7,	7,	7,	7,	7.	7.0
6)	7,	7,	7,	7,	7.	7.0

* 30-40 workers under slate only.

12.00AM Air temp. $4^{o}C$
100% cloud, steady rain, breezy.

1)	6,	6,	6,	7,	7.	6.4
2)	7,	7,	7,	7,	7.	7.0
3)	7,	7,	7,	6,	7.	6.8
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	7,	6,	6.	6.6
6)	7,	7,	7,	7,	7.	7.0

3.00PM Air temp. $7^{o}C$
50% cloud, sunshine and
showers, breezy.

1)	12,	10	13,	13*	14.	12.4
2)	8,	8,	9,	8,	8.	8.2
3)	9,	9,	9,	10,	8.	9.0
4)	7,	7,	7,	8,	7.	7.2
5)	9,	9,	11,	10,	10.	9.8
6)	8,	8,	8,	8,	8.	8.0

* Lots of workers and brood
(male and gyne), lots of black
aphid eggs also.

6.00PM Air temp. $8^{o}C$
35% cloud, sunshine and
showers, windy.

1)	12,	11,	11,	12,	13*	11.8
2)	10,	10,	11,	11,	11.	10.6
3)	9,	9,	8,	9,	9.	8.8
4)	8,	8,	8,	8,	8.	8.0
5)	9,	9,	8,	9,	9.	8.8
6)	8,	8,	8,	8,	8.	8.0

* Lots of workers up with gyne
larvae.

DATE 3/5/89

9.00AM Air Temp. 14°C
0% cloud, light breeze, misty.
1) 18, 16, 17, 19, 19. 17.8
2) 11, 11, 10, 11, 11. 10.8
3) 17, 15, 16, 15, 17. 16.0
4) 11, 12, 10, 11, 11. 11.0
5) 13, 13, 13, 15, 14. 13.6
6) 9, 10, 9, 10, 10. 9.6

12.00AM Air temp. 17°C
0% cloud, light breeze, hazey.
1) 27, 27, 25, 24, 26. 25.8
2) 13, 14, 13, 13, 13. 13.2
3) 20, 21, 23, 24, 20. 21.6
4) 14, 16, 14, 13, 14. 14.2
5) 21, 21, 20, 20, 21. 20.6
6) 11, 11, 11, 11, 12. 11.2

3.00PM Air temp. 22°C
30% cloud, v. light breeze,
hazey.
1) 29, 29 29, 26, 27. 28.4
2) 18, 18, 17, 17, 15. 17.0
3) 22, 25, 22, 24, 23. 23.2
4) 16, 16, 16, 16, 15. 15.8
5) 21, 22, 23, 24, 23. 22.6
6) 12, 13, 14, 14, 14. 13.4

6.00PM Air temp. 22°C
30% cloud, breezy,
hazey, humid.
1) 24, 22, 24, 23, 22. 23.0
2) 18, 19, 20, 19, 21. 19.4
3) 21, 21, 22, 21, 22. 21.4
4) 17, 17, 18, 16, 17. 17.0
5) 19, 21, 21, 20, 20. 20.2
6) 14, 15, 15, 15, 14. 14.6

DATE 25/5/89

9.00AM Air temp. 11°C
100% cloud, windy, misty.
1) 13, 13, 13, 13, 13. 13.0
2) 14, 14, 14, 14, 14. 14.0
3) 13, 13, 13, 13, 14. 13.2
4) 14, 14, 14, 15, 14. 14.2
5) 14, 14, 13, 14, 14. 13.8
6) 15, 14, 14, 15, 15. 14.4

12.00AM Air temp. 13°C
100% cloud, windy, misty.
1) 15, 15, 16, 16, 16* 15.6
2) 14, 14, 15, 15, 15. 14.6
3) 15, 16, 16, 16, 16. 15.8
4) 15, 15, 15, 15, 15. 15.0
5) 15, 16, 15, 16, 16. 15.6
6) 14, 15, 15, 15, 15. 14.8
* A few workers only up.

3.00PM Air temp. 15°C
100% cloud, windy.
1) 18, 18, 17, 17, 18. 17.6
2) 16, 15, 15, 15, 15. 15.8
3) 18, 18, 17, 17, 17. 17.4
4) 16, 16, 15, 15, 15. 15.4
5) 17, 17, 17, 17, 17. 17.0
6) 15, 15, 15, 15, 15. 15.0

6.00PM Air temp. 11°C
100% cloud, windy.
1) 13, 14, 14, 15* 14. 14.0
2) 15, 15, 15, 16, 15. 15.2
3) 15, 15, 14, 15, 15. 14.8
4) 16, 15, 15, 15, 16. 15.4
5) 15, 15, 15, 14, 15. 14.8
6) 15, 15, 15, 15, 15. 15.0
* 200 workers only up.

DATE 9/6/89

9.00AM Air temp. 13°C
95% cloud, almost still.
1) 16, 15, 14, 15, 15. 15.0
2) 12, 12, 12, 12, 12. 12.0
3) 13, 15, 12, 14, 14. 13.6
4) 11, 11, 11, 11, 11. 11.0
5) 13, 14, 14, 14, 14. 13.8
6) 12, 11, 12, 12, 12. 11.8

12.00AM Air temp. 17°C
50% cloud, light breeze.
1) 22, 22, 21, 22, 20* 21.4
2) 15, 14, 15, 15, 15. 14.8
3) 16, 16, 16, 17, 15. 16.0
4) 13, 13, 13, 13, 14. 13.2
5) 19, 19, 17, 16, 16. 17.4
6) 13, 13, 13, 13, 13. 13.0
* 300 gyne pupae + many small male/worker pupae.

3.00PM Air temp. 16°C
75% cloud, light breeze.

1) 23, 25, 24, 22, 22. 23.2
2) 17, 19, 19, 18, 19. 18.4
3) 18, 19, 20, 20, 19. 19.2
4) 15, 15, 15, 16, 15. 15.2
5) 18, 19, 19, 19, 18. 18.6
6) 15, 15, 15, 15, 14. 14.8

6.00PM Air temp. 17°C
100% high hazey cloud, almost still.
1) 21, 21, 19, 20, 19. 20.0
2) 18, 18, 19, 19, 18. 18.4
3) 19, 21, 21, 20, 21. 20.4
4) 18, 18, 17, 17, 17. 18.6
5) 19, 17, 17, 20, 18. 18.2
6) 15, 15, 15, 16, 16. 15.4

DATE 4/7/89

9.00AM Air temp. 18°C
0% cloud, light breeze.
1) 20, 23, 22, 19, 19* 20.6
2) 16, 16, 16, 15, 16. 15.8
3) 21, 21, 20, 24, 21. 21.4
4) 17, 16, 16, 17, 16. 16.4
5) 18, 19, 21, 19, 18. 19.0
6) 15, 15, 15, 15, 15. 15.0
* Few small pupae + 3 gynes.

12.00AM Air temp. 22°C
5% cloud, breezy.
1) 30* 32, 28, 28, 30. 29.6
2) 19, 20, 18, 19, 19. 19.8
3) 23, 25, 21, 22, 24. 23.0
4) 17, 18, 18, 17, 18. 17.6
5) 25, 25, 23, 22, 22. 23.4
6) 17, 17, 17, 17, 17. 17.0
* 2 workers only

3.00PM Air temp. 23°C
30% cloud, windy.
1) 34, 30, 32, 31, 31. 31.6
2) 25, 25, 24, 22, 24. 24.0
3) 28, 26, 25, 24, 24. 25.4
4) 20, 20, 19, 20, 21. 20.0
5) 24, 24, 23, 24, 24. 23.8
6) 19, 19, 18, 19, 18. 18.6

6.00PM Air temp. 21°C
35% cloud, wind.
1) 26, 28, 23, 24, 24. 25.0
2) 25, 25, 22, 24, 23. 23.8
3) 23, 24, 22, 24, 22. 23.0
4) 21, 21, 22, 21, 19. 20.8
5) 22, 22, 21, 21, 21. 21.4
6) 19, 19, 19, 19, 19. 19.0

DATE 15/8/89
9.00AM Air temp. 18^{o}C
50% cloud, breezy.
1) 18, 20, 20, 18* 19. 19.0
2) 17, 17, 17, 16, 17. 16.8
3) 16, 16, 16, 16, 17. 16.2
4) 16, 16, 16, 16, 16. 16.0
5) 17, 17, 17, 17, 17. 17.0
6) 16, 16, 16, 16, 16. 16.0
* 300 workers only.

12.00AM Air temp. 20^{o}C
75% cloud, windy.
1) 24, 27, 26, 25, 29. 26.2
2) 19, 20, 19, 18, 19. 19.0
3) 18, 18, 19, 18, 20. 18.6
4) 17, 17, 17, 16, 17. 16.8
5) 21, 21, 22, 21, 23. 21.6
6) 17, 17, 17, 18, 17. 17.2

3.00PM Air temp. 21^{o}C
50% cloud, breezy.
1) 29, 30, 29, 28, 25. 28.2
2) 22, 22, 23, 23, 22. 22.4
3) 20, 22, 22, 20, 20. 20.8
4) 17, 18, 19, 18, 18. 18.0
5) 22, 21, 21, 21, 21. 21.2
6) 18, 18, 18, 17, 18. 17.8

6.00PM Air temp. 18^{o}C
60% cloud, breezy.
1) 20, 21, 22, 23, 22. 21.6
2) 20, 22, 23, 23, 22. 22.0
3) 17, 20, 18, 19, 19. 18.6
4) 16, 18, 17, 18, 19. 17.6
5) 19, 19, 19, 20, 20. 19.4
6) 17, 19, 18, 18, 18. 18.6

DATE 24/8/89
9.00AM Air temp. 16^{o}C
high haze, breezy.
1) 17, 17* 16, 15, 15. 16.0
2) 14, 15, 14, 14, 14. 14.2
3) 15, 14, 15, 14, 15. 14.6
4) 15, 13, 14, 13, 14. 13.8
5) 15, 15, 15, 15, 15. 15.0
6) 14, 14, 14, 14, 14. 14.0
* 100 workers only.

12.00AM Air temp. 20^{o}C
50% cloud, windy.
1) 22, 27, 28, 27, 31. 27.0
2) 17, 18, 18, 19, 18. 18.0
3) 18, 17, 20, 20, 19. 18.8
4) 15, 16, 16, 17, 16. 16.0
5) 22, 21, 19, 20, 23. 21.0
6) 16, 16, 16, 16, 18. 16.4

3.00PM Air temp. 23^{o}C
hazey, windy.
1) 31, 34, 29, 28, 29. 30.2
2) 22, 22, 22, 21, 19. 21.2
3) 22, 22, 22, 21, 21. 21.6
4) 18, 18, 17, 17, 18. 17.6
5) 21, 22, 23, 22, 22. 22.0
6) 18, 17, 19, 19, 19. 18.4

6.00PM Air temp. 21^{o}C
10% cloud, windy.
1) 25, 24, 23, 23, 24. 23.8
2) 22, 22, 22, 23, 21. 22.0
3) 19, 18, 17, 17, 17. 17.6
4) 19, 18, 17, 17, 17. 17.6
5) 19, 18, 18, 19, 19. 18.6
6) 17, 16, 16, 17, 18. 16.8

DATE 28/9/89

9.00AM Air temp. 10°C
60% cloud, almost still.
1) 11, 12, 12, 11, 12. 11.6
2) 12, 12, 11, 11, 11. 11.4
3) 12, 11, 11, 11, 11. 11.2
4) 12, 11, 11, 12, 12. 11.6
5) 12, 12, 12, 12, 12. 12.0
6) 13, 13, 13, 13, 13. 13.0

12.00AM Air temp. 13°C
100% cloud, light breeze.
1) 16, 17, 17* 15, 16. 16.2
2) 13, 13, 13, 13, 13. 13.0
3) 15, 15, 15, 15, 15. 14.0
4) 13, 13, 13, 13, 13. 13.0
5) 15, 15, 15, 15, 15. 15.0
6) 13, 14, 13, 13, 13. 13.2
* 200 workers only.

3.00PM Air temp. 15°C
90% cloud, light breeze.
1) 19* 19, 18, 18, 17. 18.2
2) 15, 15, 14, 15, 15. 14.8
3) 17, 16, 16, 15, 14. 15.6
4) 14, 14, 14, 14, 13. 13.8
5) 16, 16, 16, 15, 15. 15.6
6) 14, 14, 15, 14, 14. 14.2
* Several thousand workers only.

6.00PM Air temp. 13°C
100% thin cloud, almost still.
1) 13, 14, 15, 15, 15. 14.4
2) 14, 15, 15, 15, 16. 15.0
3) 14, 14, 15, 14, 15. 14.4
4) 14, 14, 14, 14, 15. 14.2
5) 13, 14, 14, 14, 15. 14.0
6) 14, 15, 14, 15, 15. 14.6

DATE 20/11/89

9.00AM Air temp. 8°C
100% cloud, misty, still.
1) 7, 7, 7, 7, 7* 7.0
2) 7, 7, 7, 7, 7. 7.0
3) 7, 7, 7, 7, 7. 7.0
4) 7, 7, 7, 7, 7. 7.0
5) 7, 7, 7, 7, 7. 7.0
6) 7, 7, 7, 7, 7. 7.0
* 1 worker up only.

12.00AM Air temp. 9°C
97% cloud, windy.
1) 9, 9, 8, 9, 9. 8.8
2) 7, 7, 7, 7, 7. 7.0
3) 8, 8, 8, 8, 8. 8.0
4) 7, 7, 7, 7, 7. 7.0
5) 8, 8, 8, 8, 8. 8.0
6) 8, 7, 7, 7, 7. 7.2

3.00PM Air temp. 10°C
50% cloud, hazey, still.
1) 10, 9* 9, 9, 9. 9.2
2) 8, 8, 8, 8, 8. 8.0
3) 9, 9, 9, 9, 9. 9.0
4) 8, 7, 8, 8, 9. 8.0
5) 9, 8, 9, 9, 9. 8.8
6) 8, 8, 8, 8, 8. 8.0
* Nothing up.

6.00PM Air temp. 8°C
100% high thin cloud, light breeze.
1) 8, 8, 8, 8, 8. 8.0
2) 8, 8, 8, 8, 8. 8.0
3) 8, 8, 8, 8, 8. 8.0
4) 8, 8, 8, 8, 8. 8.0
5) 8, 8, 8, 8, 7. 7.8
6) 8, 8, 8, 8, 8. 8.0

DATE 12/1/90

9.00AM Air temp. $7^{o}C$
100% cloud, breezy.

1)	5,	5,	5,	5,	5.	5.0
2)	6,	5,	5,	6,	6.	5.6
3)	5,	5,	5,	5,	5.	5.0
4)	5,	5,	5,	6,	6.	5.6
5)	5,	5,	5,	5,	5.	5.0
6)	6,	6,	6,	6,	6.	6.0

12.00AM Air temp. $7^{o}C$
100% cloud, light breeze.

1)	7,	7,	6,	7,	7.	6.8
2)	6,	6,	6,	6,	6.	6.0
3)	6,	7,	7,	6,	6.	6.4
4)	6,	6,	6,	6,	6.	6.0
5)	7,	7,	7,	7,	7.	7.0
6)	6,	6,	6,	6,	6.	6.0

3.00PM Air temp. $7^{o}C$
100% cloud, light breeze.

1)	7,	7,	7*	7,	7.	7.0
2)	6,	6,	6,	6,	6.	6.0
3)	7,	7,	7,	7,	7.	7.0
4)	6,	6,	6,	6,	6.	6.0
5)	7,	7,	7,	7,	7.	7.0
6)	6,	6,	6,	6,	6.	6.0

* 5 workers up only.

6.00PM Air temp. $8^{o}C$
100% cloud, still.

1)	7,	7,	7*	7,	7.	7.0
2)	7,	7,	7,	7,	7.	7.0
3)	7,	7,	7,	7,	7.	7.0
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	7,	7,	7.	7.0
6)	7,	7,	7,	7,	7.	7.0

* nothing up.

DATE 16/3/89

9.00AM Air Temp. 3°C
100% cloud, steady rain,
slight breeze.

1)	4,	4,	4,	4,	4.	4.0
2)	5,	5,	5,	5,	5.	5.0
3)	4,	4,	4,	4,	4.	4.0
4)	5,	5,	5,	5,	5.	5.0
5)	5,	4,	4,	4,	4.	4.2
6)	5,	5,	5,	5,	5.	5.0

12.00AM Air temp. 3°C
100% cloud, steady rain,
slight breeze.

1)	5,	4,	4,	4,	4.	4.2
2)	5,	5,	5,	5,	5.	5.0
3)	5,	4,	4,	4,	5.	4.4
4)	5,	5,	5,	4,	5.	4.8
5)	4,	4,	4,	4,	4.	4.0
6)	5,	5,	5,	5,	5.	5.0

3.00PM Air temp. 3°C
100% cloud, steady light
rain, breezy.

1)	4,	5,	4,	4,	4.	4.2
2)	5,	5,	5,	5,	5.	5.0
3)	5,	5,	4,	4,	4.	4.4
4)	5,	5,	5,	5,	5.	5.0
5)	4,	4,	4,	4,	4.	4.0
6)	5,	5,	5,	5,	5.	5.0

6.00PM Air temp. 2°C
100% cloud, steady light
rain, breeze.

1)	3,	3,	3,	3,	4.	3.2
2)	5,	5,	5,	5,	5.	5.0
3)	3,	3,	3,	3,	3.	3.0
4)	5,	4,	4,	4,	4.	4.2
5)	3,	3,	3,	3,	4.	3.2
6)	5,	5,	5,	5,	5.	5.0

DATE 20/4/89

9.00AM Air Temp. 6°C
100% cloud, light breeze.

1)	8,	8,	8,	7,	8.	7.8
2)	7,	7,	7,	7,	7.	7.0
3)	7,	7,	7,	7,	7.	7.0
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	7,	7,	7.	7.0
6)	7,	7,	7,	7,	7.	7.0

12.00AM Air temp. 4°C
100% cloud, steady rain,
breezy.

1)	6,	6,	6*	7,	6.	6.2
2)	7,	7,	7,	7,	7.	7.0
3)	6,	6,	7,	6,	7.	6.4
4)	7,	7,	7,	7,	7.	7.0
5)	6,	7,	6,	6,	6.	6.2
6)	7,	7,	7,	7,	7.	7.0

* Some workers and gyne and male larvae.

3.00PM Air temp. 9°C
70% cloud, heavy showers,
breezy.

1)	18,	13	14,	12*	12.	13.8
2)	8,	8,	8,	9,	8.	8.2
3)	9,	9,	8,	10,	8.	8.8
4)	7,	7,	7,	8,	7.	7.2
5)	11,	9,	10,	9,	9.	9.6
6)	8,	8,	8,	8,	8.	8.0

* Lots of workers and gyne brood up.

6.00PM Air temp. 8°C
35% cloud, windy. light
Sunshine and showers.

1)	11,	11,	13,	13,	11.	11.8
2)	11,	10,	12,	11,	9.	10.6
3)	9,	8,	8,	8,	9.	8.4
4)	8,	7,	8,	7,	8.	7.6
5)	9,	8,	9,	8,	9.	8.6
6)	9,	8,	8,	8,	8.	8.2

DATE 3/5/89

9.00AM Air Temp. 13°C
0% cloud, light breeze, misty.
1) 16, 19, 15, 16, 15. 16.2
2) 10, 11, 11, 11, 10. 10.6
3) 15, 17, 13, 14, 14. 14.6
4) 10, 11, 11, 11, 11. 10.8
5) 14, 12, 12, 13, 12. 12.6
6) 10, 9, 10, 10, 10. 9.8

12.00AM Air temp. 19°C
0% cloud, light breeze, hazey.
1) 29, 25, 24, 24, 28. 26.0
2) 13, 12, 12, 12, 12. 12.8
3) 21, 20, 19, 19, 17. 19.2
4) 14, 13, 13, 12, 12. 12.8
5) 18, 21, 16, 19, 18. 18.4
6) 11, 11, 11, 11, 11. 11.0

3.00PM Air temp. 19°C
30% cloud, v. light breeze, hazey.
1) 31, 29 32, 28, 26. 29.2
2) 16, 15, 17, 16, 15. 15.8
3) 23, 22, 24, 21, 20. 22.0
4) 17, 16, 17, 14, 15. 15.8
5) 22, 23, 20, 22, 21. 21.6
6) 13, 14, 13, 13, 13. 13.2

6.00PM Air temp. 21°C
30% cloud, light breeze, hazey, humid.
1) 23, 23, 23, 23, 23. 23.0
2) 18, 18, 18, 16, 17. 17.4
3) 20, 20, 20, 21, 19. 20.0
4) 15, 15, 17, 16, 16. 15.8
5) 18, 17, 18, 19, 19. 18.2
6) 14, 12, 14, 12, 13. 13.0

DATE 25/5/89

9.00AM Air Temp. 11°C
100% cloud, windy, misty.
1) 12, 14, 13* 13, 13. 13.0
2) 14, 15, 14, 14, 14. 14.2
3) 14, 14, 14, 15, 14. 14.2
4) 14, 14, 14, 15, 15. 14.4
5) 14, 14, 14, 14, 14. 14.0
6) 14, 14, 15, 14, 15. 14.4
* A few workers up only.

12.00AM Air temp. 13°C
100% cloud, windy, misty.
1) 17, 17, 15, 16, 15* 16.0
2) 15, 15, 14, 15, 14. 14.6
3) 15, 15, 14, 16, 15. 15.0
4) 15, 15, 15, 15, 15. 15.0
5) 15, 15, 14, 15, 14. 14.6
6) 15, 15, 15, 15, 15. 15.0
* A few workers and small pupae.

3.00PM Air temp. 15°C
100% cloud, windy.
1) 18, 18, 18, 19, 19* 18.4
2) 16, 16, 15, 16, 16. 15.8
3) 17, 16, 15, 18, 18. 16.8
4) 15, 15, 15, 16, 16. 15.4
5) 17, 17, 17, 17, 18. 17.2
6) 15, 15, 15, 15, 15. 15.0
* c. 100 gyne pupae and others up.

6.00PM Air temp. 11°C
100% cloud, windy.
1) 14, 15, 15, 15, 14. 14.6
2) 16, 15, 16, 16, 15. 15.6
3) 15, 15, 14, 15, 15. 14.8
4) 15, 16, 15, 15, 15. 15.2
5) 15, 15, 15, 15, 15. 15.0
6) 15, 15, 15, 15, 15. 15.0

DATE 9/6/89

9.00AM Air temp. 12°C
95% cloud, very light breeze.
1) 15, 14, 16, 16, 17. 15.6
2) 14, 12, 12, 12, 13. 12.6
3) 14, 14, 14, 15, 15. 14.4
4) 12, 12, 12, 12, 12. 12.0
5) 14, 14, 14, 14, 14. 14.0
6) 12, 12, 12, 12, 12. 12.0

12.00AM Air temp. 16°C
45% cloud, breezy.
1) 23, 22, 24, 23, 25. 23.4
2) 15, 15, 15, 15, 15. 15.0
3) 22, 16, 18, 20, 19. 18.8
4) 16, 14, 13, 14, 15. 14.4
5) 18, 17, 18, 18, 19. 18.0
6) 13, 13, 13, 14, 14. 13.4

3.00PM Air temp. 15°C
50% cloud, light breeze.
1) 21, 23, 24, 22, 20. 22.0
2) 18, 18, 20, 18, 16. 18.0
3) 20, 19, 21, 19, 19. 19.6
4) 16, 16, 17, 16, 16. 16.2
5) 20, 19, 17, 18, 19. 18.6
6) 15, 15, 15, 15, 15. 15.0

6.00PM Air temp. 17°C
100% high hazey cloud, light breeze.
1) 28, 22, 21, 21, 20. 22.4
2) 18, 17, 17, 17, 17. 17.2
3) 20, 19, 19, 18, 18. 18.8
4) 16, 16, 16, 16, 16. 16.0
5) 18, 18, 17, 18, 18. 17.8
6) 15, 16, 15, 15, 16. 15.4

DATE 4/7/89

9.00AM Air temp. 18°C
0% cloud, light breeze.
1) 23, 23, 22, 23, 20. 22.2
2) 16, 16, 16, 16, 17. 16.2
3) 21, 21, 19, 19, 19. 19.8
4) 16, 17, 16, 16, 17. 16.4
5) 19, 22, 20, 18, 20. 19.8
6) 16, 16, 15, 16, 16. 15.8

12.00AM Air temp. 22°C
10% cloud, breezy.
1) 34, 34, 29, 29, 29. 31.0
2) 22, 22, 21, 19, 19. 20.6
3) 23, 23, 21, 24, 20. 22.2
4) 19, 18, 18, 19, 17. 18.2
5) 23, 23, 21, 25, 23. 23.0
6) 17, 17, 18, 17, 17. 17.2

3.00PM Air temp. 24°C
30% cloud, windy.
1) 38, 32, 33, 33, 34. 34.0
2) 24, 22, 23, 23, 25. 23.4
3) 27, 21, 22, 23, 25. 23.6
4) 22, 19, 19, 20, 20. 20.0
5) 23, 23, 23, 23, 22. 22.8
6) 19, 19, 19, 19, 19. 19.0

6.00PM Air temp. 22°C
20% cloud, windy.
1) 24, 29, 27, 22, 29. 26.2
2) 22, 26, 23, 21, 26. 23.6
3) 21, 22, 21, 20, 24. 21.6
4) 19, 19, 19, 19, 20. 19.2
5) 21, 23, 21, 23, 21. 21.8
6) 19, 19, 19, 20, 19. 19.2

DATE 15/8/89
9.00AM Air temp. 18^{o}C
30% cloud, breezy.
1) 21, 17, 21* 19, 21. 19.8
2) 17, 16, 17, 16, 17. 16.6
3) 18, 17, 18, 16, 16. 17.0
4) 16, 16, 16, 16, 16. 16.0
5) 18, 19, 17, 17, 18. 17.8
6) 16, 16, 16, 16, 16. 16.0
* 500 workers and 1 gyne up.

12.00AM Air temp. 22^{o}C
15% cloud, windy.
1) 26, 21* 27, 29, 23. 25.2
2) 20, 17, 19, 19, 18. 18.6
3) 20, 20, 18, 19, 20. 19.4
4) 17, 18, 17, 17, 18. 17.4
5) 20, 21, 23, 19, 24. 21.4
6) 18, 18, 18, 17, 18. 17.8
* Mound shaded by Brachypodium

3.00PM Air temp. 21^{o}C
45% cloud, breezy.
1) 28, 29, 28, 27* 25. 27.4
2) 23, 22, 21, 23, 21. 22.0
3) 20, 20, 20, 21, 19. 20.0
4) 18, 18, 18, 18, 17. 17.8
5) 22, 22, 21, 21, 20. 21.2
6) 19, 19, 19, 18, 18. 18.6
*300 workers up.

6.00PM Air temp. 20^{o}C
30% cloud, breezy.
1) 21, 23, 21, 21* 22. 21.6
2) 20, 22, 21, 22, 22. 21.4
3) 19, 19, 19, 19, 18. 18.8
4) 18, 18, 18, 19, 17. 18.0
5) 19, 20, 19, 20, 19. 19.4
6) 19, 21, 19, 18, 18. 19.0
500 workers and 1 gyne up
(same mound as at 9.00AM).

DATE 24/8/89
9.00AM Air temp. 15^{o}C
high haze, breezy.
1) 18, 18, 18, 19, 18. 18.2
2) 15, 15, 15, 15, 15. 15.0
3) 15, 16, 17, 15, 15. 15.6
4) 15, 15, 15, 15, 15. 15.0
5) 16, 16, 16, 16, 16. 16.0
6) 15, 15, 15, 15, 15. 15.0

12.00AM Air temp. 20^{o}C
50% cloud, light breeze.
1) 31, 24, 28, 29, 30* 28.4
2) 20, 18, 18, 20, 19. 19.0
3) 20, 21, 19, 20, 22. 20.4
4) 16, 16, 16, 17, 17. 16.4
5) 22, 20, 22, 21, 22. 21.4
6) 16, 16, 17, 17, 17. 16.6
* 10 workers only up.

3.00PM Air temp. 24^{o}C
hazey, breezy.
1) 36, 32, 38* 32, 33. 34.2
2) 26, 24, 26, 23, 24. 24.6
3) 23, 23, 22, 24, 22. 22.8
4) 18, 18, 18, 19, 18. 18.2
5) 24, 22, 23, 23, 23. 23.0
6) 19, 18, 19, 18, 19. 18.6
* Nothing up.

6.00PM Air temp. 20^{o}C
10% cloud, breezy.
1) 25, 24, 24, 24, 22. 23.8
2) 24, 23, 22, 23, 21. 22.6
3) 20, 20, 19, 21, 20. 20.0
4) 19, 18, 18, 18, 19. 18.4
5) 20, 19, 19, 20, 19. 19.4
6) 18, 18, 19, 19, 18. 18.4

DATE 28/9/89
9.00AM Air temp. 9°C
80% cloud, light breeze.
1) 11, 11, 12, 12, 12. 11.6
2) 11, 12, 12, 12, 12. 11.8
3) 11, 12, 12, 11, 12. 11.6
4) 12, 12, 12, 12, 12. 12.0
5) 12, 12, 12, 12, 12. 12.0
6) 13, 13, 13, 13, 13. 13.0

12.00AM Air temp. 13°C
100% cloud, light breeze.
1) 17, 16, 17, 17, 18. 17.0
2) 14, 13, 13, 13, 14. 13.4
3) 15, 14, 14, 14, 16. 14.6
4) 13, 13, 13, 13, 14. 13.2
5) 15, 16, 15, 16, 16. 15.6
6) 14, 13, 14, 13, 14. 13.6

3.00PM Air temp. 14°C
70% cloud, breezy.
1) 18, 17, 16, 17, 18. 17.2
2) 15, 15, 14, 16, 16. 15.2
3) 15, 15, 13, 16, 16. 15.0
4) 14, 14, 13, 15, 15. 14.2
5) 15, 16, 16, 14, 16. 15.4
6) 14, 15, 15, 15, 15. 14.8

6.00PM Air temp. 13°C
100% thin cloud, almost still.
1) 14, 15, 14, 14* 14. 14.2
2) 16, 15, 15, 16, 15. 15.4
3) 14, 14, 14, 14, 14. 14.0
4) 14, 14, 14, 15, 14. 14.2
5) 14, 14, 14, 14, 14. 14.0
6) 15, 15, 15, 15, 14. 14.8
* 400 workers up only.

DATE 20/11/89
9.00AM Air temp. 8°C
100% cloud, misty, still.
1) 7, 7, 7, 7, 7. 7.0
2) 7, 7, 7, 7, 7. 7.0
3) 7, 7, 7, 7, 6. 6.8
4) 7, 7, 7, 7, 7. 7.0
5) 7, 7, 7, 7, 7. 7.0
6) 7, 7, 7, 7, 7. 7.0

12.00AM Air temp. 9°C
97% cloud, breezy.
1) 10, 9, 8, 9, 9. 9.0
2) 8, 7, 7, 7, 7. 7.2
3) 8, 8, 9, 8, 8. 8.2
4) 8, 8, 7, 7, 8. 7.6
5) 9, 8, 8, 9, 8. 8.6
6) 7, 8, 7, 7, 7. 7.2

3.00PM Air temp. 10°C
50% cloud, hazey, still.
1) 10, 10, 9, 9, 9. 9.4
2) 8, 8, 8, 8, 8. 8.0
3) 9, 9, 9, 9, 9. 9.0
4) 8, 8, 8, 8, 8. 8.0
5) 9, 9, 9, 9, 9. 9.0
6) 8, 8, 8, 8, 8. 8.0

6.00PM Air temp. 8°C
100% high thin cloud, light breeze.
1) 8, 8, 8, 8, 7. 7.8
2) 8, 8, 8, 8, 8. 8.0
3) 8, 8, 8, 7, 8. 7.8
4) 8, 8, 8, 8, 8. 8.0
5) 8, 8, 8, 8, 7. 7.8
6) 8, 8, 8, 8, 8. 8.0
* 400 workers up only.

DATE 12/1/90

9.00AM Air temp. 6°C
100% cloud, light breeze.

1)	6,	5,	5,	6,	6.	5.6
2)	5,	6,	6,	5,	6.	5.6
3)	5,	5,	5,	5,	5.	5.0
4)	6,	6,	6,	6,	6.	6.0
5)	5,	6,	5,	5,	5.	5.2
6)	6,	6,	6,	6,	6.	6.0

12.00AM Air temp. 7°C
100% cloud, v. light breeze.

1)	7,	7,	7,	7,	7.	7.0
2)	6,	6,	6,	6,	6.	6.0
3)	7,	7,	6,	7,	7.	6.8
4)	6,	6,	6,	6,	6.	6.0
5)	7,	7,	7,	7,	7.	7.0
6)	6,	6,	6,	6,	6.	6.0

3.00PM Air temp. 7°C
100% cloud, v. light breeze.

1)	7,	7,	7,	7,	7.	7.0
2)	6,	6,	6,	6,	6.	6.0
3)	7,	7,	7,	7,	7.	7.0
4)	6,	6,	6,	6,	6.	6.0
5)	7,	7,	7,	7,	7.	7.0
6)	6,	6,	6,	6,	6.	6.0

6.00PM Air temp. 7°C
100% cloud, still.

1)	7,	7,	7,	7,	7.	7.0
2)	7,	7,	7,	7,	7.	7.0
3)	7,	7,	7,	7,	7.	7.0
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	7,	7,	7.	7.0
6)	7,	7,	7,	7,	7.	7.0

DATE 1/3/89 QUADRAT MD 7B

9.00AM Air temp. 5^{o}C
100% cloud, showers.

1)	4,	4,	4,	4,	4.	4.0
2)	4,	4,	4,	4,	4.	4.0
3)	4,	4,	4,	4,	4.	4.0
4)	4,	4,	4,	4,	4.	4.0
5)	4,	4,	4,	4,	4.	4.0
6)	4,	4,	4,	4,	4.	4.0

12.00AM Air temp. 9^{o}C
90% cloud, windy.

1)	8,	8,	9,	10,	9.	8.8
2)	4,	5,	5,	5,	5.	4.8
3)	7,	7,	7,	6,	6.	6.6
4)	5,	5,	5,	5,	5.	5.0
5)	6,	7,	6,	7,	6.	6.4
6)	5,	5,	5,	5,	5.	5.0

3.00PM Air temp. 8^{o}C
90% cloud, very windy

1)	9,	8,	7,	8,	8.	8.0
2)	6,	5,	5,	6,	5.	5.4
3)	6,	6,	6,	6,	6.	6.0
4)	6,	5,	5,	5,	5.	5.2
5)	6,	6,	6,	6,	6.	6.0
6)	5,	5,	5,	5,	5.	5.0

6.00PM Air temp. 6^{o}C
70% cloud, very windy

1)	6,	6,	6,	6,	5.	5.8
2)	5,	6,	6,	6,	5.	5.6
3)	5,	5,	5,	5,	5.	5.0
4)	5,	5,	5,	5,	5.	5.0
5)	5,	5,	5,	5,	5.	5.0
6)	5,	5,	5,	5,	5.	5.0

DATE 29/3/89 QUADRAT MD 7B

9.00AM Air temp. 9^{o}C
100% cloud, light breeze.

1)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
2)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
3)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
4)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
5)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0

12.00PM Air temp. 9^{o}C
100% cloud, still.

1)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
2)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
3)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
4)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
5)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0

3.00PM Air temp. $10^{o}C$
100% cloud, still, misty.
1) 11, 10, 10, 11, 10, 11, 10, 11, 10, 11. 10.5
2) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
3) 11, 11, 11, 11, 11, 11, 11, 11, 11, 10. 10.9
4) 9, 10 11, 10, 10, 10, 10, 11, 10, 10. 10.0
5) 10, 10, 10, 10, 10, 10, 10, 10, 10, 10. 10.0
6) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0

DATE 12/4/89 QUADRAT MD 7B

9.00AM Air temp. $10^{o}C$
95% cloud, still.
1) 8, 8, 8, 8, 8* 8.0
2) 6, 6, 5, 6, 5. 5.6
3) 7, 7, 6, 6, 6. 6.6
4) 5, 5, 6, 5, 5. 5.2
5) 7, 7, 7, 7, 7. 7.0
6) 7, 6, 6, 6, 6. 6.2
* 2 or 3 workers only up.

12.00AM Air temp. $11^{o}C$
80% cloud, v. light breeze.
1) 16, 15, 15, 14, 13* 14.6
2) 7, 7, 7, 7, 7. 7.0
3) 14, 12, 13, 13, 13. 13.0
4) 7, 7, 7, 7, 7. 7.0
5) 11, 11, 10, 12, 11. 11.0
6) 8, 7, 7, 7, 7. 7.2
* Lots of workers with gyne brood.

3.00PM Air temp. $10^{o}C$
95% cloud, heavy showers.
1) 13, 12, 12, 13* 14. 12.8
2) 9, 9, 9, 9, 10. 9.2
3) 13, 13, 13, 12, 12. 12.6
4) 8, 8, 9, 8, 8. 8.2
5) 12, 11, 11, 10, 11. 11.0
6) 8, 8, 8, 8, 8. 8.0
* Under slate 11oC, 30-40 workers only.

6.00PM Air temp. $9^{o}C$
40% cloud, light breeze.
1) 9, 9, 9, 9. 9.0
2) 9, 9, 10, 9. 9.3
3) 9, 11, 10. 10.0
4) 9, 9, 9. 9.0
5) 9, 9, 9. 9.0
6) 8, 9, 8. 8.3
Readings restricted due to thermometer failure.

DATE 26/4/89 QUADRAT MD 7B

9.00AM Air temp. 6°C
0% cloud, light breeze.
1) 12, 17, 12, 13, 20. 14.8
2) 5, 5, 6, 6, 5. 5.4
3)a 1, 4, 1, 1, 2, 1.8
4) 3, 4, 4, 3, 3. 3.4
5) 6, 6, 5, 7, 7. 6.2
6) 5, 6, 5, 6, 6. 5.6
a- mound surface frozen

12.00AM Air temp. 10°C
60% cloud, breezy.
1) 21, 17, 19, 16, 15. 17.6
2) 8, 8, 7, 8, 7. 7.6
3) 11, 9, 11, 9, 9. 9.8
4) 10, 5, 7, 5, 5. 7.0
5) 11, 10, 11, 12, 9. 10.6
6) 6, 7, 6, 7, 7. 6.6

3.00PM Air temp. 12°C
70% cloud, breezy.
1) 15, 15, 15, 15, 19. 15.8
2) 9, 10, 12, 10, 13. 10.8
3) 12, 13, 13, 12, 15. 13.0
4) 8, 8, 8, 7, 11. 8.4
5) 11, 12, 11, 11, 13. 11.6
6) 8, 8, 8, 8, 9. 8.2

6.00PM Air temp. 8°C
80% cloud, windy.
1) 8, 9, 10, 9, 9. 9.0
2) 9, 11, 11, 10, 11. 10.4
3) 10, 10, 10, 9, 10. 9.8
4) 9, 9, 9, 9, 10. 9.2
5) 9, 9, 9, 9, 9. 9.0
6) 8, 8, 8, 8, 8. 8.0

DATE 18/5/89 QUADRAT MD 7B

9.00AM Air temp. 19°C
Some mist, light breeze.
1) 25, 28, 26, 23, 24. 25.2
2) 14, 15, 16, 14, 15. 14.8
3) 21, 25, 20, 24, 22, 22.6
4) 14, 16, 15, 15, 14. 14.8
5) 19, 20, 19, 21, 20. 19.8
6) 14, 13, 13, 13, 14. 13.4

12.00AM Air temp. 23°C
30% cloud, light breeze.
1) 35, 41, 37, 38, 36. 37.4
2) 18, 20, 21, 19, 21. 19.8
3) 31, 30, 31, 24, 34. 30.0
4) 20, 17, 18, 18, 22. 19.0
5) 26, 25, 26, 26, 28. 26.2
6) 16, 15, 15, 14, 16. 15.2

3.00PM Air temp. 26°C
40% cloud, light breeze.
1) 32, 29, 32, 30, 31. 30.8
2) 24, 25, 20, 22, 22. 22.6
3) 34, 32, 33, 33, 31. 32.6
4) 21, 20, 19, 22, 20. 20.4
5) 25, 28, 27, 26, 28. 26.8
6) 18, 18, 18, 18, 18. 18.0

6.00PM Air temp. 20°C
20% cloud, light breeze.
1) 22, 23, 22, 22, 22. 22.2
2) 22, 23, 21, 21, 20. 21.4
3) 22, 24, 24, 23, 24. 23.4
4) 20, 22, 21, 20, 20. 20.6
5) 22, 21, 22, 21, 21. 21.4
6) 18, 19, 18, 18, 20. 18.6

DATE 1/6/89 QUADRAT MD 7B

9.00AM Air temp. 12°C	3.00AM Air temp. 15°C
100% cloud, light breeze.	60% cloud, light breeze.
1) 18, 16, 17, 17, 17. 17.0	1) 23, 23, 22, 22, 29. 23.8
2) 13, 12, 12, 12, 13. 12.4	2) 14, 15, 16, 14, 15. 14.8
3) 16, 16, 15, 15, 16. 15.8	3) 22, 21, 17, 20, 22. 20.4
4) 13, 13, 13, 12, 13. 12.8	4) 15, 14, 16, 15, 15. 15.0
5) 14, 14, 15, 15, 15. 14.6	5) 21, 17, 20, 23, 21. 20.4
6) 12, 12, 13, 13, 12. 12.4	6) 14, 14, 14, 14, 14. 14.0

No readings at 12.00 or 6.00 due to inclement weather conditions.

DATE 8/6/89 QUADRAT MD 7B

9.00AM Air temp. 12°C	12.00AM Air temp. 15°C
80% high thin cloud, light breeze.	100% cloud, light breeze.
1) 14* 16, 13, 16, 16. 15.0	1) 22, 17, 19, 17, 17. 18.4
2) 11, 11, 10, 11, 11. 10.8	2) 16, 13, 14, 14, 13. 14.0
3) 12, 13, 13, 15, 15, 13.2	3) 19, 16, 19, 17, 17. 17.6
4) 10, 10, 10, 11, 11. 10.4	4) 13, 13, 14, 14, 13. 13.4
5) 13, 13, 13, 12, 15. 13.2	5) 15, 15, 14, 16, 15. 15.0
6) 11, 11, 11, 11, 11. 11.0	6) 13, 12, 12, 12, 12. 12.2
* 1 worker only up.	

3.00PM Air temp. 12°C	6.00PM Air temp. 13°C
100% cloud, breezy.	95% cloud, light breeze.
1) 17, 16, 17, 18* 20. 17.6	1) 16, 15, 17, 17* 15. 16.0
2) 14, 14, 15, 14, 16. 14.6	2) 15, 14, 16, 16, 14. 15.0
3) 18, 16, 17, 18, 19. 17.6	3) 16, 17, 18, 17, 17. 17.0
4) 15, 14, 14, 14, 15. 14.4	4) 15, 15, 16, 15, 16. 15.4
5) 15, 16, 16, 15, 15. 15.4	5) 16, 16, 15, 16, 16. 15.8
6) 13, 14, 13, 13, 13. 13.2	6) 14, 14, 14, 14, 14. 14.0
* 300 gyne pupae, 300 small pupae.	* 100 workers only.

DATE 22/6/89 QUADRAT MD 7B

9.00AM Air temp. 18°C
10% breezy.
1) 28, 35, 28, 36, 43. 34.0
2) 17, 19, 17, 19, 19. 18.2
3) 28, 27, 20, 24, 31. 26.0
4) 17, 17, 16, 17, 18. 17.0
5) 21, 22, 21, 25, 24. 22.6
6) 16, 16, 16, 16, 16. 16.0

12.00AM Air temp. 21°C
10% cloud, light breeze.
1) 44, 47, 34+ 35, 42. 40.4
2) 23, 23, 22, 20, 24. 22.4
3) 35, 34, 30, 30, 29. 31.6
4) 20, 20, 19, 20, 20. 19.2
5) 29, 29, 27, 26, 24. 27.0
6) 18, 18, 18, 18, 17. 17.8
+ overgrown mound.

3.00PM Air temp. 23°C
0% cloud, light breeze.
1) 42, 36, 40, 31, 34. 36.6
2) 27, 27, 28, 25, 24. 26.2
3) 33, 31, 31, 39, 34. 33.6
4) 24, 22, 23, 24, 26. 23.8
5) 30, 29, 27, 29, 29. 28.8
6) 20, 20, 19, 20, 19. 19.6

6.00PM Air temp. 22°C
0% cloud, light breeze.
1) 28, 28, 26, 29, 30. 28.2
2) 25, 25, 23, 25, 25. 24.6
3) 34, 29, 26, 31, 28. 29.6
4) 25, 23, 21, 26, 23. 23.6
5) 25, 24, 24, 24, 26. 24.6
6) 19, 20, 21, 20, 21. 20.2

DATE 12/7/89 QUADRAT MD 7B

9.00AM Air temp. 23°C
10% cloud, light breeze.
1) 32, 32, 35, 35, 34. 33.6
2) 18, 21, 20, 19, 21. 19.8
3) 25, 22, 27, 26, 23, 24.6
4) 19, 19, 19, 19, 18. 18.8
5) 23, 22, 24, 23, 22. 22.8
6) 18, 18, 18, 18, 18. 18.0

12.00AM Air temp. 24°C
80% cloud, breezy.
1) 35, 32, 32, 33, 36. 33.6
2) 25, 25, 26, 22, 24. 24.6
3) 30, 28, 30, 31, 29. 29.6
4) 23, 23, 24, 22, 22. 22.8
5) 28, 26, 25, 25, 25. 25.8
6) 19, 20, 19, 22, 19. 19.8

3.00PM Air temp. 24°C
70% cloud, breezy.
1) 31, 29, 28, 29, 26. 28.6
2) 24, 25, 23, 25, 22. 23.8
3) 27, 29, 27, 27, 26. 27.2
4) 22, 24, 23, 24, 23. 23.2
5) 23, 24, 25, 24, 25. 24.2
6) 19, 19, 20, 20, 20. 19.6

6.00PM Air temp. 22°C
30% cloud, breezy.
1) 25, 25, 25, 25, 24. 24.8
2) 24, 25, 24, 23, 24. 24.0
3) 25, 26, 25, 25, 26. 25.4
4) 23, 23, 23, 23, 23. 23.0
5) 23, 22, 23, 22, 22. 22.4
6) 20, 20, 21, 19, 18. 19.6

DATE 2/8/89 QUADRAT MD 7B

9.00AM Air temp. 16°C
100% cloud, almost still.
1) 18* 17, 18, 18, 18. 17.8
2) 15, 14, 14, 15, 14. 14.4
3) 15, 16, 17, 18, 17. 16.6
4) 14, 14, 14, 14, 14. 14.0
5) 15, 15, 15, 16, 16. 15.4
6) 14, 15, 15, 15, 15. 14.8
* 10 workers only.

12.00AM Air temp. 21°C
50% cloud, breezy.
1) 32, 27, 30, 38, 32. 31.8
2) 20, 19, 18, 20, 18. 19.0
3) 21, 23, 23, 26, 25. 23.6
4) 17, 17, 17, 19, 18. 17.6
5) 19, 20, 23, 23, 20. 21.0
6) 16, 17, 17, 17, 16. 16.6

3.00PM Air temp. 22°C
40% cloud, breezy.
1) 41, 36, 33, 26, 31. 33.4
2) 26, 25, 21, 21, 22. 23.0
3) 30, 28, 25, 25, 30. 27.6
4) 21, 22, 21, 21, 21. 21.2
5) 21, 26, 26, 29, 26. 25.6
6) 17, 19, 20, 21, 19. 19.2

6.00PM Air temp. 20°C
95% cloud, breezy.
1) 24, 23, 23, 23, 24. 23.4
2) 22, 25, 22, 23, 25. 23.4
3) 22, 24, 23, 23, 22. 22.8
4) 21, 22, 20, 22, 20. 21.0
5) 21, 21, 22, 21, 20. 21.0
6) 18, 18, 20, 19, 18. 18.6

DATE 22/8/89 QUADRAT MD 7B

9.00AM Air temp. 14°C
90% cloud, light breeze.
1) 15, 14, 15, 17* 16. 15.4
2) 14, 13, 14, 14, 14. 13.8
3) 14, 15, 15, 13, 15. 14.4
4) 12, 13, 14, 14, 14. 13.4
5) 13, 14, 14, 15, 15. 14.2
6) 13, 14, 15, 15, 15. 14.4
* 20 workers only.

12.00AM Air temp. 18°C
80% cloud, breezy.
1) 21, 20, 24, 21, 21. 21.4
2) 16, 16, 17, 16, 16. 16.2
3) 21, 18, 21, 18, 18. 19.2
4) 15, 16, 17, 15, 16. 15.8
5) 17, 20, 18, 20, 19. 18.8
6) 14, 15, 15, 16, 16. 15.6

3.00PM Air temp. 20°C
40% cloud, light breeze.
1) 29, 26, 27, 33, 22* 27.4
2) 19, 18, 19, 23, 18. 19.6
3) 21, 22, 26, 25, 26. 24.0
4) 17, 18, 19, 20, 20. 18.8
5) 19, 21, 22, 23, 22. 21.4
6) 16, 17, 17, 18, 18. 17.2
* South side shaded by tall grass.

6.00PM Air temp. 19°C
30% cloud, windy..
1) 23, 22, 22, 22, 21. 22.0
2) 20, 21, 20, 23, 22. 21.2
3) 21, 22, 21, 22, 22. 21.6
4) 21, 21, 20, 19, 21. 20.4
5) 21, 21, 20, 19, 20. 20.2
6) 20, 19, 18, 18, 17. 18.4

QUADRAT NUMBER 16, MD 7B

DATE 26/9/89 QUADRAT MD 7B

9.00AM Air temp. 14°C
100% cloud, almost still.
1) 14, 14, 14, 13, 14. 13.8
2) 12, 12, 13, 12, 12. 12.2
3) 12, 12, 13, 12, 12. 12.2
4) 12, 12, 12, 12, 12. 12.0
5) 13, 13, 13, 13, 13. 13.0
6) 13, 13, 13, 13, 13. 13.0

12.00AM Air temp. 17°C
100% cloud, light breeze.
1) 19* 19, 17, 20, 19. 18.8
2) 14, 14, 14, 14, 14. 14.0
3) 15, 17, 18, 19, 17. 17.2
4) 14, 14, 14, 14, 14. 14.0
5) 15, 15, 16, 15, 15. 15.2
6) 14, 14, 14, 14, 14. 14.0
* 50 workers only.

3.00PM Air temp. 18°C
100% cloud, light breeze.
1) 20* 18, 20, 17, 19. 18.8
2) 16, 15, 16, 15, 16. 15.6
3) 17, 19, 17, 18, 17. 17.6
4) 15, 15, 15, 16, 16. 15.4
5) 17, 17, 17, 17, 16. 16.8
6) 15, 15, 15, 15, 15. 15.0
* 50 workers only up.

6.00PM Air temp. 17°C
100% cloud, light breeze.
1) 17, 16, 17* 17, 17. 16.8
2) 16, 16, 17, 17, 17. 16.6
3) 17, 17, 17, 17, 17. 17.0
4) 16, 16, 16, 16, 17. 16.2
5) 16, 17, 16, 17, 17. 16.6
6) 15, 15, 15, 15, 15. 15.0
* 20 workers only up.

DATE 29/11/89 QUADRAT MD 7B

9.00AM Air temp. 1°C
0% cloud, light breeze.
1) 0, 1, 1, 1, 1. 0.8
2) 2, 2, 2, 2, 2. 2.0
3) 1, 1, 1, 1, 1. 1.0
4) 2, 1, 2, 2, 1. 1.6
5) 1, 0, 1, 1, 2. 1.0
6) 4, 2, 3, 4, 4. 3.4

12.00AM Air temp. 5°C
0% cloud, breezy.
1) 5, 5, 8, 4, 5. 5.4
2) 3, 3, 3, 2, 2. 2.4
3) 1, 1, 3, 1, 1. 1.4
4) 1, 1, 4, 2, 2. 2.0
5) 3, 3, 3, 3, 3. 3.0
6) 4, 4, 4, 4, 4. 4.0

3.00PM Air temp. 7°C
0% cloud, light breeze.
1) 7, 5, 7* 6, 9. 6.8
2) 5, 4, 5, 3, 5. 4.4
3) 4, 3, 3, 2, 4. 3.2
4) 2, 3, 2, 2, 4. 2.6
5) 4, 4, 3, 3, 4. 3.6
6) 4, 4, 4, 4, 5. 4.8
* Nothing up.

6.00PM Air temp. 2°C
0% cloud, v. light breeze.
1) 3, 3, 2, 3, 3. 2.8
2) 4, 2, 3, 4, 3. 3.2
3) 2, 1, 1, 2, 1. 1.4
4) 2, 2, 2, 2, 1. 1.8
5) 2, 2, 2, 2, 2. 2.0
6) 4, 5, 4, 4, 3. 4.0

DATE 17/1/90 QUADRAT MD 7B

9.00AM Air temp. 6°C
50% cloud, light breeze.

1)	5,	5,	6,	5,	5.	5.2
2)	7,	7,	7,	7,	7.	7.0
3)	6,	5,	5,	6,	5.	5.6
4)	7,	7,	7,	7,	7.	7.0
5)	6,	6,	6,	6,	6.	6.0
6)	8,	8,	7,	7,	7.	7.4

12.00AM Air temp. 9°C
0% cloud, light breeze.

1)	11*	7,	9,	7,	7.	8.2
2)	7,	7,	7,	7,	7.	7.0
3)	7,	6,	6,	6,	7.	6.4
4)	7,	7,	7,	7,	7.	7.0
5)	7,	6,	7,	7,	7.	6.8
6)	7,	7,	7,	7,	7.	7.0

* Nothing up.

3.00PM Air temp. 9°C
20% cloud, v. windy.

1)	9,	7,	8,	9*	7.	8.0
2)	8,	7,	8,	8,	7.	7.6
3)	7,	7,	7,	7,	7.	7.0
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	7,	7,	7.	7.0
6)	7,	7,	7,	7,	7.	7.0

* 3 workers only.

6.00PM Air temp. 6°C
1% cloud, breezy.

1)	6,	6,	6,	5,	6.	5.8
2)	8,	7,	7,	8,	8.	7.6
3)	6,	6,	6,	5,	6.	5.2
4)	7,	7,	7,	7,	7.	7.0
5)	6,	6,	6,	5,	6.	5.8
6)	7,	7,	7,	7,	7.	7.0

DATE 1/3/89

9.00AM Air temp. 6^{o}C
100% cloud, showers.

1)	4,	4,	5,	4,	4.	4.2
2)	4,	4,	4,	4,	4.	4.0
3)	4,	4,	4,	4,	4.	4.0
4)	4,	4,	4,	4,	4.	4.0
5)	4,	4,	4,	4,	4.	4.0
6)	4,	4,	4,	4,	4.	4.0

12.00AM Air temp. 9^{o}C
90% cloud, windy.

1)	8,	6,	8,	6,	7.	7.0
2)	5,	5,	5,	5,	5.	5.0
3)	6,	7,	6,	5,	6.	6.0
4)	5,	5,	5,	4,	5.	4.8
5)	6,	6,	6,	7,	6.	6.2
6)	5,	5,	5,	5,	5.	5.0

3.00PM Air temp. 8^{o}C
90% cloud, very windy

1)	7,	7,	7,	7,	7.	7.0
2)	5,	5,	5,	5,	5.	5.0
3)	6,	6,	5,	6,	6.	5.8
4)	5,	5,	5,	5,	5.	5.0
5)	6,	6,	6,	6,	7.	6.2
6)	5,	5,	5,	5,	5.	5.0

6.00PM Air temp. 6^{o}C
70% cloud, very windy

1)	6,	6,	5,	5,	6.	5.6
2)	5,	6,	5,	5,	5.	5.2
3)	5,	5,	5,	5,	5.	5.0
4)	5,	5,	5,	5,	5.	5.0
5)	5,	5,	5,	5,	5.	5.0
6)	5,	5,	5,	5,	5.	5.0

DATE 29/3/89

9.00AM Air temp. 9^{o}C
100% cloud, light breeze.

1)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
2)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
3)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
4)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
5)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0

12.00PM Air temp. 9^{o}C
100% cloud, still.

1)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
2)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
3)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
4)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
5)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0

3.00PM Air temp. 11°C
100% cloud, still, misty.

1)	11,	11,	11,	11,	11,	12,	12,	11,	11,	11.	11.2
2)	10,	9,	9,	9,	9,	9,	10,	9,	10,	10.	9.4
3)	12,	11,	12,	12,	12,	12,	12,	11,	12,	12.	11.8
4)	10,	10,	9,	10,	9,	10,	10,	10,	10,	10.	9.8
5)	11,	11,	11,	11,	11,	11,	11,	11,	11,	11.	11.0
6)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0

DATE 12/4/89

9.00AM Air temp. 9°C
80% cloud, v. light breeze.

1)	10,	8,	9,	9,	8.	8.8
2)	6,	6,	6,	7,	7.	6.4
3)	9,	7,	8,	8,	9.	8.2
4)	6,	6,	6,	6,	6.	6
5)	8,	7,	8,	7,	7.	7.4
6)	7,	7,	7,	7,	7.	7

12.00AM Air temp. 7°C
100% cloud, still.

1)	10,	10*	10,	10,	10.	10
2)	8,	9,	8,	8,	9.	8.4
3)	10,	9,	11,	10,	11.	10.2
4)	8,	8,	8,	8,	8.	8
5)	9,	9,	9,	9,	9.	9
6)	8,	8,	8,	8,	8.	8

* Workers and gyne brood up.
Just had heavy hail shower.

3.00PM Air temp. 10°C
99% cloud, light breeze.

1)	12,	12,	11,	11,	12.	11.6
2)	10,	9,	9,	9,	10.	9.4
3)	11,	11,	11,	11,	11.	11
4)	8,	9,	9,	8,	9.	8.6
5)	10,	10,	11,	11,	10.	10.4
6)	8,	8,	9,	9,	9.	8.6

6.00PM No readings taken due to thermometer failure.

DATE 26/4/89
9.00AM Air temp. $5^{\circ}C$
0% cloud, light breeze.
1) 12, 8, 11, 9, 10. 10.0
2) 5, 5, 5, 5, 5. 5.0
3) 4, 4, 3, 2, 3, 3.2
4) 5, 4, 4, 4, 4. 4.2
5) 7, 5, 6, 5, 7. 6.0
6) 5, 5, 6, 6, 6. 5.6

12.00AM Air temp. $10^{\circ}C$
50% cloud, breezy.
1) 21, 23, 19, 15, 17. 19.0
2) 9, 8, 7, 7, 7. 7.6
3) 10, 8, 8, 11, 8. 8.6
4) 4, 5, 5, 6, 5. 5.0
5) 13, 11, 11, 10, 10. 10.8
6) 6, 6, 6, 6, 8. 6.4

3.00PM Air temp. $10^{\circ}C$
80% cloud, breezy.
1) 15, 17, 14, 14, 14. 14.8
2) 9, 11, 9, 10, 10. 9.8
3) 12, 12, 16, 11, 12. 12.6
4) 7, 7, 10, 7, 8. 7.8
5) 11, 11, 12, 10, 10. 10.8
6) 7, 8, 9, 8, 7. 7.8

6.00PM Air temp. $10^{\circ}C$
60% cloud, breezy.
1) 13, 12, 13, 9, 12. 11.8
2) 11, 10, 11, 9, 10. 10.2
3) 12, 12, 13, 11, 13. 12.2
4) 9, 8, 8, 9, 9. 8.6
5) 11, 11, 10, 10, 10. 10.6
6) 9, 9, 9, 8, 8. 8.6

DATE 18/5/89
9.00AM Air temp. $16^{\circ}C$
Misty, light breeze.
1) 20, 19, 20, 18, 20. 19.4
2) 15, 14, 15, 14, 14. 14.4
3) 19, 18, 18, 18, 19, 18.4
4) 15, 14, 14, 14, 14. 14.2
5) 17, 18, 17, 18, 18. 17.6
6) 13, 13, 14, 14, 14. 13.6

12.00AM Air temp. $25^{\circ}C$
40% cloud, light breeze.
1) 32, 31, 33, 35, 35. 33.2
2) 18, 18, 18, 19, 18. 18.2
3) 26, 26, 28, 26, 28. 26.8
4) 17, 17, 18, 17, 18. 17.4
5) 26, 24, 28, 25, 28. 26.2
6) 16, 15, 15, 15, 15. 15.2

3.00PM Air temp. $23^{\circ}C$
30% cloud, light breeze.
1) 30, 39, 31, 35, 39. 34.8
2) 21, 22, 21, 21, 23. 21.6
3) 24, 24, 28, 25, 26. 25.4
4) 19, 20, 21, 19, 21. 20.0
5) 28, 30, 28, 27, 29. 28.4
6) 19, 19, 19, 19, 22. 19.6

6.00PM Air temp. $22^{\circ}C$
20% cloud, light breeze.
1) 24, 24, 24, 25, 22. 23.8
2) 22, 22, 23, 23, 20. 22.0
3) 26, 27, 25, 25, 24. 25.4
4) 22, 21, 21, 21, 21. 21.2
5) 24, 24, 24, 22, 22. 23.2
6) 20, 19, 20, 18, 18. 19.0

DATE 1/6/89
9.00AM Air temp. 10°C
100% cloud, light breeze.
1) 15, 14, 14, 16, 16. 15.0
2) 13, 12, 12, 13, 13. 12.6
3) 14, 14, 13, 15, 15, 14.2
4) 13, 12, 12, 12, 13. 12.6
5) 13, 14, 13, 13, 14. 13.6
6) 13, 13, 13, 13, 13. 13.0

12.00AM Air temp. 12°C
100% cloud, light breeze and rain.
1) 15, 18, 21, 19, 17. 18.0
2) 14, 15, 15, 15, 14. 14.6
3) 16, 18, 21, 19, 18. 18.4
4) 14, 15, 15, 14, 14. 14.6
5) 15, 17, 16, 16, 17. 16.2
6) 14, 15, 14, 14, 14. 14.2

DATE 8/6/89
9.00AM Air temp. 13°C
80% high hazey cloud,
light breeze.
1) 16, 19, 17, 18, 18. 17.6
2) 12, 13, 12, 12, 13. 12.4
3) 14, 14, 14, 13, 15, 14.0
4) 12, 11, 12, 12, 12. 11.8
5) 16, 14, 14, 13, 14. 14.2
6) 12, 12, 12, 12, 12. 12.0

12.00AM Air temp. 12°C
100% cloud, breezy, drizzle/rain
starting.
1) 15, 16, 16, 14, 16. 15.4
2) 14, 14, 14, 14, 14. 14.0
3) 16, 16, 16, 15, 16. 15.8
4) 12, 14, 14, 13, 15. 13.6
5) 15, 15, 15, 15, 15. 15.0
6) 13, 14, 13, 14, 14. 13.6

3.00PM Air temp. 11°C
100% cloud, breezy.
1) 16* 17, 17, 17, 17. 16.8
2) 14, 15, 16, 15, 14. 14.8
3) 15, 15, 18, 17, 14. 15.8
4) 14, 15, 15, 15, 13. 14.4
5) 15, 16, 16, 16, 15. 15.6
6) 14, 15, 14, 14, 14. 14.2
* ~200 small pupae only.

6.00PM Air temp. 13°C
100% cloud, light breeze.
1) 16* 15, 17, 16, 16. 16.0
2) 15, 16, 16, 16, 16. 15.8
3) 15, 16, 16, 17, 14. 15.6
4) 15, 16, 15, 15, 14. 15.0
5) 15, 16, 16, 15, 15. 15.4
6) 14, 15, 14, 15, 15. 14.6
* ~600 gyne pupae and 1,000
small pupae.

DATE 22/6/89

9.00AM Air temp. 15°C
10% cloud, hazey, breezy.
1) 25, 24, 27, 25, 24. 25.0
2) 18, 16, 17, 17, 17. 17.0
3) 20, 20, 22, 20, 21, 20.6
4) 17, 16, 16, 17, 17. 16.6
5) 19, 20, 20, 19, 21. 19.8
6) 17, 17, 17, 17, 17. 17.0

12.00AM Air temp. 18°C
20% cloud, light breeze.
1) 34, 29, 37, 32, 40. 34.4
2) 20, 18, 22, 18, 21. 19.8
3) 21, 20, 24, 22, 27. 22.8
4) 17, 17, 18, 17, 19. 17.6
5) 25, 23, 25, 23, 27. 24.4
6) 19, 18, 18, 18, 22. 19.0

3.00PM Air temp. 24°C
0% cloud, hazey, light breeze.
1) 36, 43, 36, 38, 41. 38.8
2) 24, 24, 22, 22, 22. 22.8
3) 28, 28, 29, 30, 30. 29.0
4) 21, 21, 21, 22, 21. 21.2
5) 31, 26, 31, 26, 30. 28.8
6) 22, 20, 20, 20, 21. 20.6

6.00PM Air temp. 22°C
10% cloud, hazey. light breeze.
1) 31, 28, 27, 36, 27. 29.8
2) 24, 25, 23, 26, 25. 24.6
3) 27, 26, 25, 27, 26. 26.2
4) 23, 22, 21, 22, 21. 21.8
5) 25, 25, 25, 26, 25. 25.2
6) 21, 21, 21, 22, 21. 21.2

DATE 12/7/89

9.00AM Air temp. 19°C
20% cloud, light breeze.
1) 26, 22, 27, 26, 24. 25.0
2) 20, 19, 19, 19, 19. 19.2
3) 20, 20, 19, 19, 20, 19.6
4) 18, 18, 17, 18, 18. 17.8
5) 21, 22, 20, 20, 21. 20.8
6) 18, 18, 18, 18, 18. 18.0

12.00AM Air temp. 22°C
90% cloud, light breeze.
1) 31, 29, 27, 29, 27. 28.6
2) 25, 22, 20, 22, 21. 22.0
3) 24, 23, 26, 24, 26. 24.6
4) 20, 18, 21, 20, 21. 20.0
5) 24, 25, 24, 23, 25. 24.2
6) 19, 20, 19, 19, 19. 19.2

3.00PM Air temp. 23°C
80% cloud, breezy.
1) 27, 27, 29, 29, 30. 28.4
2) 22, 22, 25, 24, 24. 23.4
3) 25, 26, 25, 26, 25. 25.4
4) 22, 22, 21, 21, 22. 21.6
5) 24, 24, 26, 25, 26. 25.0
6) 20, 20, 20, 21, 21. 20.4

6.00PM Air temp. 23°C
40% cloud, breezy.
1) 24, 29, 28, 25, 27. 26.6
2) 24, 24, 24, 24, 24. 24.0
3) 26, 26, 26, 24, 25. 25.4
4) 23, 23, 22, 22, 23. 22.6
5) 25, 24, 24, 24, 24. 24.2
6) 23, 20, 20, 20, 21. 20.8

DATE 2/8/89

9.00AM Air temp. 17^{o}C
100% cloud, v. light breeze.
1) 18* 18, 17, 18, 18. 17.8
2) 15, 15, 15, 15, 16. 15.2
3) 16, 16, 15, 16, 17, 16.0
4) 15, 15, 14, 14, 15. 14.6
5) 18, 17, 17, 17, 17. 17.2
6) 15, 15, 15, 15, 16. 15.2
* ~100 workers and 6 males up.

12.00AM Air temp. 20^{o}C
45% cloud, light breeze.
1) 28, 28, 25, 26, 32. 27.8
2) 20, 19, 20, 18, 18. 19.0
3) 20, 23, 24, 20, 26. 22.6
4) 16, 18, 18, 16, 18. 17.2
5) 24, 26, 23, 25, 21. 24.0
6) 18, 18, 17, 18, 17. 17.6

3.00PM Air temp. 24^{o}C
40% cloud, breezy.
1) 37, 33, 31, 31, 28. 32.0
2) 25, 24, 24, 23, 22. 23.6
3) 25, 27, 24, 22, 22. 24.0
4) 22, 21, 21, 19, 18. 20.2
5) 25, 26, 26, 26, 25. 25.6
6) 20, 19, 20, 19, 20. 19.6

6.00PM Air temp. 20^{o}C
80% cloud, breezy.
1) 24, 22, 24* 26, 25. 24.2
2) 21, 22, 24, 25, 24. 23.2
3) 20, 25, 24, 24, 22. 23.0
4) 18, 22, 23, 21, 19. 20.6
5) 23, 23, 24, 20, 22. 22.4
6) 21, 21, 20, 18, 20. 20.0
* 2 workers up.

DATE 22/8/89

9.00AM Air temp. 16^{o}C
95% cloud, light breeze.
1) 17, 18, 19, 18, 17. 17.8
2) 16, 15, 16, 16, 16. 15.8
3) 16, 15, 18, 17, 16, 16.4
4) 16, 15, 16, 16, 15. 15.6
5) 16, 16, 16, 16, 16. 16.0
6) 16, 16, 16, 16, 16. 16.0

12.00AM Air temp. 18^{o}C
99% cloud, light breeze.
1) 21, 20* 23, 21, 21. 21.2
2) 17, 17, 18, 17, 17. 17.2
3) 19, 18, 19, 17, 17. 18.0
4) 17, 16, 17, 16, 16. 16.4
5) 20, 20, 17, 18, 19. 18.8
6) 16, 17, 16, 16, 17. 16.4
*400 workers + 10 small pupae up.

3.00PM Air temp. 21^{o}C
25% cloud, breezy.
1) 25, 25, 24, 25, 26. 25.0
2) 20, 21, 19, 19, 19. 19.6
3) 21, 20, 23, 20, 20. 20.8
4) 18, 18, 19, 18, 17. 18.0
5) 22, 20, 23, 21, 21. 21.4
6) 18, 18, 18, 18, 18. 18.0

6.00PM Air temp. 19^{o}C
60% hazey cloud breezy.
1) 21, 21, 20, 21, 23. 21.2
2) 21, 21, 20, 19, 22. 20.6
3) 20, 20, 19, 19, 20. 19.6
4) 19, 19, 18, 18, 19. 18.6
5) 20, 19, 20, 20, 20. 19.8
6) 19, 18, 19, 19, 19. 18.8

DATE 26/9/89

9.00AM Air temp. 15°C
100% cloud, v. light breeze.
1) 16, 15, 15, 14, 15. 15.0
2) 14, 13, 14, 13, 13. 13.4
3) 15, 14, 14, 14, 14, 14.2
4) 14, 13, 14, 13, 14. 13.6
5) 15, 14, 15, 14, 14. 14.4
6) 14, 14, 14, 14, 14. 14.0

12.00AM Air temp. 16°C
100% cloud, v. light breeze.
1) 19, 19, 18, 19, 19. 18.8
2) 15, 15, 15, 15, 15. 15.0
3) 17, 17, 17, 17, 18. 17.2
4) 14, 15, 15, 15, 15. 14.8
5) 16, 17, 16, 16, 16. 16.2
6) 15, 15, 15, 15, 14. 14.8

3.00PM Air temp. 17°C
100% cloud, light breeze.
1) 19, 19, 19, 20, 19. 19.2
2) 16, 16, 16, 17, 15. 16.0
3) 18, 17, 17, 17, 16. 17.0
4) 16, 15, 16, 15, 15. 15.4
5) 17, 17, 17, 17, 17. 17.0
6) 16, 16, 16, 15, 16. 15.8

6.00PM Air temp. 16°C
100% cloud, light breeze.
1) 16* 17, 16, 18, 16. 16.6
2) 17, 17, 16, 17, 18. 17.0
3) 17, 17, 17, 17, 16. 16.8
4) 16, 15, 16, 16, 15. 15.6
5) 16, 16, 16, 16, 16. 16.0
6) 16, 15, 15, 15, 16. 15.4
* 150 workers only up.

DATE 29/11/89

9.00AM Air temp. 1°C
0% cloud, light breeze.
1) 1* 1, 2, 1, 2. 1.4
2) 2, 1, 3, 3, 3. 2.4
3) 1, 1, 1, 2, 1. 1.2
4) 2, 3, 2, 3, 1. 2.2
5) 2, 2, 2, 2, 1. 1.8
6) 4, 4, 4, 4, 4. 4.0
* Nothing up.

12.00AM Air temp. 5°C
0% cloud, breezy.
1) 5, 4, 4, 5, 5. 4.6
2) 3, 3, 3, 4, 4. 3.4
3) 2, 2, 2, 1, 1. 1.6
4) 3, 3, 3, 2, 3. 2.8
5) 3, 3, 3, 3, 3. 3.0
6) 3, 4, 4, 4, 4. 3.8

3.00PM Air temp. 6°C
0% cloud, light breeze.
1) 7, 7* 7, 9, 6. 7.2
2) 5, 4, 5, 6, 5. 5.0
3) 2, 4, 2, 4, 2. 2.4
4) 2, 3, 3, 4, 2. 2.8
5) 3, 4, 4, 4, 3. 3.6
6) 4, 4, 5, 4, 4. 4.2
* 3 workers up only.

6.00PM Air temp. 2°C
0% cloud, v. light breeze.
1) 2, 3, 3, 2, 2. 2.4
2) 5, 4, 4, 5, 4. 4.4
3) 2, 2, 2, 2, 1. 1.8
4) 2, 2, 3, 1, 2. 2.0
5) 2, 3, 2, 1, 2. 2.0
6) 4, 4, 4, 4, 4. 4.0

DATE 17/1/90

9.00AM Air temp. 6^{o}C
10% cloud, light breeze.

1)	5,	5*	5,	5,	5.	5.0
2)	7,	7,	7,	7,	7.	7.0
3)	6,	5,	6,	6,	6.	5.8
4)	7,	7,	7,	7,	7.	7.0
5)	6,	6,	6,	6,	6.	6.0
6)	7,	7,	7,	7,	7.	7.0

* Nothing up.

12.00AM Air temp. 9^{o}C
0% cloud, light breeze.

1)	9,	8,	8,	10,	7.	8.4
2)	7,	7,	7,	7,	7.	7.0
3)	6,	6,	6,	6,	6.	6.0
4)	7,	7,	7,	7,	7.	7.0
5)	7,	6,	7,	6,	6.	6.4
6)	7,	7,	7,	7,	7.	7.0

3.00PM Air temp. 8^{o}C
10% cloud, v. windy.

1)	9,	9,	8,	11,	7*	8.8
2)	8,	8,	8,	8,	7.	7.8
3)	7,	7,	7,	7,	7.	7.0
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	7,	7,	7.	7.0
6)	7,	7,	7,	7,	7.	7.0

* 30 workers up.

6.00PM Air temp. 5^{o}C
0% cloud, light breeze.

1)	4,	5,	5,	5,	4.	4.6
2)	7,	7,	7,	8,	7.	7.2
3)	5,	5,	4,	5,	5.	4.8
4)	7,	7,	7,	7,	7.	7.0
5)	5,	5,	5,	5,	5.	5.0
6)	7,	7,	7,	7,	7.	7.0

DATE 1/3/89
9.00AM Air temp. 6^{O}C
100% cloud, showers.
1) 4, 5, 4, 4, 4. 4.2
2) 4, 4, 4, 4, 4. 4.0
3) 4, 4, 4, 4, 4. 4.0
4) 4, 4, 4, 4, 4. 4.0
5) 4, 4, 4, 4, 4. 4.0
6) 5, 5, 4, 4, 5. 4.6

12.00AM Air temp. 9^{O}C
90% cloud, windy.
1) 8, 7, 6, 7, 6. 6.8
2) 5, 5, 5, 5, 5. 5.0
3) 6, 6, 5, 5, 5. 5.4
4) 5, 5, 5, 5, 5. 5.0
5) 6, 6, 6, 6, 6. 6.0
6) 5, 5, 5, 5, 5. 5.0

3.00PM Air temp. 8^{O}C
90% cloud, very windy
1) 6, 8, 7, 7, 6. 6.8
2) 5, 5, 5, 5, 5. 5.0
3) 6, 5, 6, 6, 6. 5.8
4) 5, 5, 5, 5, 5. 5.0
5) 6, 6, 6, 6, 7. 6.8
6) 5, 5, 5, 5, 5. 5.0

6.00PM Air temp. 6^{O}C
70% cloud, very windy
1) 6, 5, 5, 5, 5. 5.2
2) 6, 5, 5, 5, 5. 5.2
3) 5, 5, 5, 5, 5. 5.0
4) 5, 5, 5, 5, 5. 5.0
5) 5, 5, 5, 5, 5. 5.0
6) 5, 5, 5, 5, 5. 5.0

DATE 29/3/89
9.00AM Air temp. 9^{O}C
100% cloud, light breeze.
1) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
2) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0
3) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
4) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0
5) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
6) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0

12.00PM Air temp. 9^{O}C
100% cloud, still.
1) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
2) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0
3) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
4) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0
5) 9, 9, 9, 9, 9, 9, 9, 9, 9, 9. 9.0
6) 8, 8, 8, 8, 8, 8, 8, 8, 8, 8. 8.0

3.00PM Air temp. 11°C
100% cloud, still, misty.

1)	10,	11,	11,	10,	12,	12,	11,	11,	11,	11.	11.0
2)	10,	9,	9,	9,	9,	9,	9,	9,	9,	10.	9.2
3)	11,	11,	11,	11,	11,	11,	11,	11,	11,	11.	11.0
4)	10,	9,	10,	10,	10,	10,	10,	10,	10,	10.	9.9
5)	11,	10,	10,	11,	10,	11,	10,	10,	10,	10.	10.3
6)	9,	9,	9,	9,	9,	9,	9,	9,	9,	8.	8.9

DATE 12/4/89

9.00AM Air temp. 8°C
95% cloud, still.

1)	8,	8,	8,	7,	10.	8.2
2)	6,	8,	6,	6,	8.	6.8
3)	7,	8,	8,	8,	8.	7.8
4)	7,	7,	7,	6,	5.	6.4
5)	8,	7,	7,	8,	7.	7.4
6)	7,	7,	7,	7,	7.	7

12.00AM Air temp. 8°C
100% cloud, still.

1)	12,	11,	9,	10,	11.	10.6
2)	9,	8,	8,	8,	8.	8.2
3)	9,	11,	10,	9,	10.	9.8
4)	8,	8,	8,	8,	8.	8
5)	9,	10,	9,	9,	9.	9.2
6)	8,	8,	8,	8,	8.	8

Just had heavy hail storm.

3.00PM Air temp. 10°C
99% cloud, v. light breeze.

1)	11,	12,	12,	12,	12.	11.8
2)	8,	9,	9,	9,	9.	8.8
3)	12,	12,	11,	11,	12.	11.6
4)	9,	9,	9,	8,	8.	8.6
5)	11,	11,	10,	11,	11.	10.8
6)	9,	9,	8,	8,	9.	8.6

6.00PM No readings taken due to thermometer failure.

DATE 26/4/89

9.00AM Air temp. 6°C
0% cloud, light breeze.
1) 15, 20, 14, 5a 16. 13.8
2) 5, 6, 6, 6, 5. 5.6
3) 5, 5, 5, 6, 5. 5.2
4) 5, 5, 5, 5, 4. 4.8
5) 6, 8, 7, 7, 7. 7.0
6) 6, 6, 6, 6, 6. 6.0
a - mound overgrown

12.00AM Air temp. 9°C
60% cloud, breezy.
1) 22, 21, 19, 17, 19. 19.6
2) 7, 10, 9, 9, 10. 9.0
3) 14, 10, 9, 10, 9. 10.2
4) 7, 6, 7, 6, 7. 6.6
5) 11, 11, 10, 13, 11. 11.2
6) 6, 6, 7, 8, 7. 6.8

3.00PM Air temp. 8°C
80% cloud, breezy.
1) 12, 14, 12, 11, 14. 12.6
2) 9, 10, 9, 10, 11. 9.8
3) 11, 11, 12, 13, 11. 11.6
4) 8, 8, 9, 9, 7. 8.2
5) 11, 10, 11, 10, 9. 10.2
6) 8, 8, 8, 8, 8. 8.0

6.00PM Air temp. 7°C
60% cloud, breezy.
1) 11, 9, 10, 10, 9. 9.8
2) 10, 10, 9, 10, 10. 9.8
3) 11, 10, 11, 11, 10. 10.6
4) 9, 8, 9, 9, 8. 8.6
5) 9, 10, 10, 9, 9. 9.4
6) 8, 9, 9, 8, 9. 8.6

DATE 18/5/89

9.00AM Air temp. 17°C
Misty, light breeze.
1) 24, 21, 23, 24, 23. 23.0
2) 14, 15, 14, 14, 14. 14.2
3) 21, 19, 20, 20, 21. 20.2
4) 14, 14, 15, 14, 14. 14.2
5) 18, 17, 17, 19, 20. 18.2
6) 13, 13, 13, 13, 13. 13.0

12.00AM Air temp. 23°C
30% cloud, light breeze.
1) 35, 35, 33, 37, 35. 35.0
2) 19, 19, 17, 18, 18. 18.2
3) 24, 26, 30, 24, 27. 26.2
4) 17, 19, 19, 16, 19. 18.0
5) 29, 27, 27, 27, 29. 27.8
6) 17, 16, 16, 16, 16. 16.2

3.00PM Air temp. 26°C
40% cloud, light breeze.
1) 35, 33, 33, 35, 33. 33.8
2) 20, 20, 19, 22, 21. 20.4
3) 26, 26, 25, 28, 27. 26.4
4) 19, 20, 19, 20, 19. 19.4
5) 29, 27, 26, 27, 30. 27.8
6) 19, 17, 18, 18, 20. 18.4

6.00PM Air temp. 20°C
20% cloud, light breeze.
1) 23, 22, 24, 24, 21. 22.8
2) 21, 21, 22, 22, 19. 21.0
3) 24, 23, 24, 22, 23. 23.2
4) 18, 19, 20, 19, 19. 19.0
5) 22, 21, 22, 21, 21. 21.4
6) 18, 17, 19, 17, 17. 17.6

DATE 1/6/89

9.00AM Air temp. 12°C
100% cloud, light breeze,
rain earlier.
1) 14, 15, 14, 15, 16. 14.8
2) 12, 12, 11, 12, 12. 11.8
3) 16, 15, 14, 16, 15, 15.2
4) 13, 13, 12, 13, 12. 12.6
5) 15, 14, 14, 15, 14. 14.4
6) 12, 13, 13, 13, 13. 12.8

3.00AM Air temp. 12°C
80% cloud, light breeze.
1) 17, 17, 18, 18, 21. 18.2
2) 14, 14, 14, 14, 16. 14.4
3) 17, 17, 19, 18, 21. 18.4
4) 15, 14, 14, 15, 15. 14.6
5) 16, 16, 17, 21, 19. 17.8
6) 14, 14, 14, 14, 15. 14.2

DATE 8/6/89

9.00AM Air temp. 12°C
75% cloud, light breeze.
1) 16, 14, 14, 17, 17. 15.6
2) 11, 12, 11, 13, 12. 11.8
3) 12, 13, 12, 15, 14. 13.2
4) 10, 12, 12, 12, 12. 11.6
5) 13, 14, 15, 15, 15. 14.4
6) 11, 12, 12, 12, 12. 11.8

12.00AM Air temp. 12°C
100% cloud, light breeze.
1) 15, 15, 17, 16, 17. 16.0
2) 13, 13, 14, 14, 14. 13.6
3) 13, 15, 13, 14, 15. 14.0
4) 12, 13, 12, 13, 13. 12.6
5) 15, 14, 15, 15, 15. 14.8
6) 13, 13, 13, 13, 13. 13.0

3.00PM Air temp. 11°C
100% cloud, breezy.
1) 13, 15, 15* 15, 17. 15.0
2) 13, 14, 14, 14, 15. 14.0
3) 15, 14, 14, 14, 14. 14.2
4) 13, 13, 13, 13, 13. 13.0
5) 15, 15, 15, 14, 15. 14.8
6) 13, 13, 13, 13, 13. 13.0
* 40 gyne pupae + lots small pupae.

6.00PM Air temp. 13°C
100% cloud, light breeze.
1) 16, 15, 14, 15, 16. 15.2
2) 15, 15, 14, 14, 15. 14.6
3) 15, 15, 14, 15, 15. 14.8
4) 14, 14, 13, 14, 14. 13.8
5) 14, 15, 15, 14, 15. 14.6
6) 14, 14, 14, 13, 14. 13.8

DATE 22/6/89

9.00AM Air temp. 16°C
10% cloud, breezy.
1) 24, 27, 24, 29, 28. 26.4
2) 17, 17, 17, 17, 17. 17.0
3) 17, 20, 17, 19, 18, 18.2
4) 16, 16, 16, 16, 16. 16.0
5) 21, 23, 20, 20, 21. 21.0
6) 16, 16, 16, 16, 16. 16.0

12.00AM Air temp. 18°C
10% cloud, breezy.
1) 31, 29, 30, 32, 36. 31.6
2) 20, 20, 18, 19, 19. 19.2
3) 21, 19, 20, 19, 21. 19.8
4) 17, 16, 17, 16, 18. 16.8
5) 22, 25, 26, 24, 26. 24.6
6) 18, 18, 18, 18, 18. 18.0

3.00PM Air temp. 21°C
0% cloud, light breeze.
1) 32, 35, 40, 33, 35. 35.0
2) 22, 22, 23, 24, 23. 22.8
3) 24, 26, 25, 27, 22. 24.8
4) 20, 19, 19, 21, 18. 19.4
5) 29, 27, 25, 27, 27. 27.0
6) 21, 20, 19, 19, 20. 19.8

6.00PM Air temp. 22°C
10% cloud, light breeze.
1) 27, 26, 24, 25, 25. 25.4
2) 23, 24, 21, 23, 21. 22.4
3) 24, 26, 22, 22, 21. 23.4
4) 19, 21, 19, 19, 18. 19.2
5) 24, 24, 23, 23, 22. 23.2
6) 22, 20, 19, 20, 19. 20.0

DATE 12/7/89

9.00AM Air temp. 20°C
10% cloud, light breeze.
1) 34, 29, 24, 35, 34. 31.2
2) 19, 19, 18, 20, 19. 19.0
3) 20, 21, 21, 20, 20. 20.4
4) 17, 18, 17, 18, 18. 17.6
5) 22, 22, 21, 22, 23. 22.0
6) 18, 17, 18, 17, 18. 17.6

12.00AM Air temp. 24°C
80% cloud, breezy.
1) 30, 29, 29, 29, 28. 29.0
2) 22, 23, 21, 21, 21. 21.6
3) 24, 24, 24, 21, 22. 23.0
4) 20, 21, 20, 19, 20. 20.0
5) 25, 24, 24, 25, 26. 24.8
6) 19, 19, 19, 19, 20. 19.2

3.00PM Air temp. 24°C
70% cloud, breezy.
1) 28, 28, 29, 27, 29. 28.0
2) 24, 22, 22, 22, 24. 22.8
3) 23, 24, 25, 22, 27. 24.2
4) 20, 20, 21, 21, 21. 20.6
5) 24, 24, 24, 24, 25. 24.2
6) 20, 20, 19, 20, 20. 19.8

6.00PM Air temp. 22°C
40% cloud, breezy.
1) 25, 26, 25, 26, 24. 25.2
2) 23, 25, 22, 24, 22. 23.2
3) 25, 24, 25, 27, 25. 25.2
4) 23, 21, 21, 22, 22. 21.8
5) 24, 23, 25, 24, 25. 24.2
6) 21, 19, 21, 20, 22. 20.6

DATE 2/8/89

9.00AM Air temp. 17^{o}C
100% cloud, almost still.
1) 18, 19, 17, 17, 19. 18.0
2) 15, 16, 15, 15, 16. 15.4
3) 16, 17, 17, 16, 17. 16.6
4) 15, 15, 15, 15, 15. 15.0
5) 17, 17, 18, 16, 17. 17.0
6) 16, 16, 15, 16, 16. 15.8

12.00AM Air temp. 19^{o}C
50% cloud, light breeze.
1) 27* 28, 26, 30, 30. 28.2
2) 19, 18, 18, 20, 21. 19.2
3) 21, 19, 20, 21, 22. 20.6
4) 17, 16, 17, 17, 18. 17.0
5) 24, 23, 23, 22, 25. 23.4
6) 17, 17, 17, 17, 17. 17.0
* ~100 workers up only.

3.00PM Air temp. 24^{o}C
40% cloud, light breeze.
1) 36, 32, 33, 32, 36. 33.8
2) 23, 23, 22, 24, 23. 23.0
3) 24, 24, 21, 23, 23. 23.0
4) 19, 19, 18, 18, 18. 18.4
5) 27, 26, 24, 26, 25. 25.6
6) 19, 20, 19, 19, 19. 19.2

6.00PM Air temp. 19^{o}C
90% cloud, breezy.
1) 24, 25* 23, 23, 25. 24.0
2) 22, 24, 21, 21, 21. 21.8
3) 23, 22, 20, 21, 21. 21.4
4) 21, 21, 18, 19, 19. 19.6
5) 23, 22, 21, 23, 21. 22.0
6) 20, 21, 19, 19, 20. 19.8
* 20 gynes and ~200 workers up.

DATE 22/8/89

9.00AM Air temp. 16^{o}C
90% cloud, light breeze.
1) 16, 17, 16* 16, 17. 16.4
2) 15, 16, 15, 16, 16. 15.6
3) 16, 16, 15, 16, 16. 15.8
4) 15, 16, 16, 15, 16. 15.6
5) 16, 16, 16, 16, 16. 16.0
6) 15, 16, 16, 16, 16. 15.8
* 20 workers only up.

12.00AM Air temp. 19^{o}C
99% cloud, light breeze.
1) 23, 19, 25* 24, 23. 22.8
2) 15, 16, 18, 18, 17. 16.8
3) 17, 17, 17, 19, 18. 17.6
4) 14, 15, 15, 16, 16. 15.2
5) 18, 20, 20, 19, 20. 19.4
6) 16, 16, 17, 16, 16. 16.2
* 30 workers up only.

3.00PM Air temp. 20^{o}C
75% cloud, light breeze.
1) 27, 24, 25, 26* 26. 25.6
2) 21, 20, 20, 21, 19. 20.2
3) 22, 20, 22, 21, 23. 21.6
4) 18, 18, 18, 18, 19. 18.2
5) 22, 22, 20, 22, 22. 21.6
6) 18, 18, 18, 18, 18. 18.0
* 5 workers only up.

6.00PM Air temp. 18^{o}C
60% cloud, breezy.
1) 21, 19, 21, 21* 21. 20.6
2) 20, 19, 21, 21, 19. 20.0
3) 18, 18, 19, 20, 20. 19.0
4) 20, 18, 18, 19, 19. 18.8
5) 20, 19, 19, 20, 20. 19.6
6) 19, 18, 18, 19, 20. 18.8
* 30 workers only up.

DATE 26/9/89

9.00AM Air temp. 14°C
100% cloud, v. light breeze.
1) 14, 15, 14, 15* 15. 14.6
2) 14, 14, 14, 14, 14. 14.0
3) 14, 14, 14, 14, 14. 14.0
4) 14, 14, 14, 14, 14. 14.0
5) 14, 14, 14, 15, 15. 14.4
6) 14, 14, 14, 14, 14. 14.0
* 20 workers only up.

12.00AM Air temp. 17°C
100% cloud, light breeze.
1) 18, 18, 17* 17, 18. 17.6
2) 15, 15, 15, 15, 16. 15.2
3) 16, 16, 16, 16, 17. 16.2
4) 15, 14, 14, 14, 15. 14.4
5) 17, 16, 16, 17, 17. 16.6
6) 15, 15, 15, 14, 15. 14.8

3.00PM Air temp. 17°C
100% cloud, light breeze.
1) 19, 19, 19, 18, 18. 18.6
2) 16, 16, 16, 16, 16. 16.0
3) 17, 17, 17, 16, 17. 16.8
4) 15, 15, 16, 15, 15. 15.2
5) 17, 17, 17, 17, 17. 17.0
6) 15, 16, 16, 15, 15. 15.4

6.00PM Air temp. 16°C
100% cloud, light breeze.
1) 17, 16, 17, 17, 16. 16.6
2) 16, 16, 16, 17, 17. 16.4
3) 16, 16, 16, 16, 17. 16.2
4) 16, 16, 16, 16, 16. 16.0
5) 17, 16, 16, 16, 16. 16.2
6) 16, 16, 16, 16, 16. 16.0

DATE 29/11/89

9.00AM Air temp. 1°C
0% cloud, light breeze.
1) 0, 1, 1, 1, 1. 0.8
2) 3, 3, 2, 2, 3. 2.6
3) 2, 2, 1, 1, 2. 1.6
4) 3, 3, 2, 1, 3. 2.4
5) 1, 2, 1, 1, 1. 1.2
6) 4, 4, 4, 4, 4. 4.0

12.00AM Air temp. 5°C
0% cloud, breezy.
1) 7, 6, 4, 5, 5. 5.4
2) 3, 3, 3, 3, 3. 3.0
3) 1, 2, 3, 2, 2. 2.0
4) 3, 3, 3, 3, 3. 3.0
5) 3, 3, 3, 3, 3. 3.0
6) 4, 4, 4, 4, 5. 4.2

3.00PM Air temp. 7°C
0% cloud, light breeze.
1) 8, 9, 8, 6, 6. 7.4
2) 5, 5, 5, 4, 5. 4.8
3) 3, 3, 4, 4, 3. 3.4
4) 3, 3, 3, 4, 3. 3.2
5) 4, 4, 4, 4, 4. 4.0
6) 4, 4, 4, 4, 4. 4.0

6.00PM Air temp. 2°C
0% cloud, v. light breeze.
1) 2, 4, 4, 3, 3. 3.2
2) 4, 5, 4, 5, 4. 4.4
3) 2, 3, 3, 3, 1. 2.4
4) 3, 3, 3, 3, 2. 2.8
5) 3, 3, 3, 3, 2. 2.8
6) 5, 5, 5, 5, 4. 4.8

DATE 17/1/90

9.00AM Air temp. 6°C
30% cloud, light breeze.

1)	5,	6,	5*	6,	6.	5.6
2)	7,	7,	7,	7,	7.	7.0
3)	6,	6,	6,	6,	6.	6.0
4)	7,	7,	7,	7,	7.	7.0
5)	6,	6,	6,	6,	6.	6.0
6)	7,	7,	7,	7,	7.	7.0

* Nothing up.

12.00AM Air temp. 9°C
0% cloud, light breeze.

1)	8,	9,	9,	8,	10.	8.8
2)	7,	7,	7,	7,	7.	7.0
3)	7,	6,	6,	6,	7.	6.4
4)	7,	7,	7,	7,	7.	7.0
5)	6,	6,	6,	6,	7.	6.2
6)	7,	7,	7,	7,	7.	7.0

3.00PM Air temp. 8°C
10% cloud, windy.

1)	9,	8,	8,	8*	8.	8.2
2)	8,	7,	7,	8,	8.	7.6
3)	7,	7,	7,	7,	7.	7.0
4)	7,	7,	7,	7,	7.	7.0
5)	7,	7,	7,	7,	7.	7.0
6)	7,	7,	7,	7,	7.	7.0

* Nothing up.

6.00PM Air temp. 6°C
0% cloud, light breeze.

1)	5,	5,	5,	6,	6*	5.6
2)	7,	7,	8,	8,	8.	7.6
3)	5,	5,	5,	4,	5.	4.8
4)	7,	7,	7,	7,	7.	7.0
5)	6,	5,	5,	5,	5.	5.8
6)	7,	7,	7,	7,	7.	7.0

* Nothing up.

DATE 1/3/89 QUADRAT MD 3B

9.00AM Air temp. $3^{o}C$
100% cloud, showers.

1)	4,	4,	4,	4,	4.	4.0
2)	4,	4,	4,	4,	4.	4.0
3)	4,	4,	4,	4,	4.	4.0
4)	4,	4,	4,	4,	4.	4.0
5)	4,	4,	4,	4,	4.	4.0
6)	4,	4,	4,	4,	4.	4.0

12.00AM Air temp. $6^{o}C$
90% cloud, windy.

1)	8,	7,	7,	6,	7.	6.8
2)	5,	5,	4,	4,	5.	4.6
3)	6,	6,	5,	5,	5.	5.4
4)	5,	5,	5,	5,	5.	5.0
5)	6,	6,	6,	6,	6.	6.0
6)	5,	5,	5,	5,	5.	5.0

3.00PM Air temp. $9^{o}C$
90% cloud, very windy

1)	7,	6,	6,	7,	6.	6.4
2)	5,	5,	5,	5,	5.	5.0
3)	5,	5,	5,	5,	5.	5.0
4)	4,	5,	5,	5,	4.	4.4
5)	6,	6,	5,	6,	5.	5.6
6)	5,	5,	5,	4,	5.	4.8

6.00PM Air temp. $6^{o}C$
70% cloud, very windy

1)	5,	5,	5,	5,	5.	5.0
2)	5,	5,	5,	5,	5.	5.0
3)	4,	5,	5,	5,	4.	4.6
4)	4,	4,	5,	5,	4.	4.4
5)	5,	4,	5,	5,	5.	4.8
6)	5,	5,	5,	5,	5.	5.0

DATE 29/3/89 QUADRAT MD 3B

9.00AM Air temp. $8^{o}C$
100% cloud, still.

1)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
2)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
3)	9,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.1
4)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
5)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0

12.00PM Air temp. $8^{o}C$
100% cloud, still, misty.

1)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
2)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
3)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
4)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
5)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0
6)	8,	8,	8,	8,	8,	8,	8,	8,	8,	8.	8.0

3.00AM Air temp. 8°C
100% cloud, still, misty.

1)	10,	11,	10,	11,	11,	11,	11,	11,	11,	11.	10.8
2)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0
3)	11,	11,	11,	11,	11,	11,	11,	11,	11,	11.	11.0
4)	9,	10,	9,	9,	9,	9,	9,	9,	9,	9.	9.1
5)	11,	11,	11,	11,	11,	11,	11,	11,	11,	11.	11.0
6)	9,	9,	9,	9,	9,	9,	9,	9,	9,	9.	9.0

DATE 12/4/89 QUADRAT MD 3B

9.00AM Air temp. 9°C
80% cloud, v. light breeze.

1)	9,	8,	9,	8,	8.	8.4
2)	6,	6,	6,	6,	6.	6.0
3)	9,	9,	8,	8,	7.	8.2
4)	6,	6,	6,	6,	6.	6.0
5)	8,	7,	7,	8,	8.	7.6
6)	6,	6,	6,	6,	6.	6.0

12.00AM Air temp. 8°C
100% cloud, v. light rain.

1)	10,	9,	10,	9,	10.	9.6
2)	8,	8,	8,	8,	7.	7.8
3)	9,	9,	9,	9,	9.	9.0
4)	8,	8,	8,	8,	8.	8.0
5)	9,	9,	9,	9,	9.	9.0
6)	7,	8,	8,	8,	8.	7.8

Just had heavy hail storm.

3.00PM Air temp. 10°C
99% cloud, v. light breeze.

1)	11,	12,	12,	12,	12.	11.8
2)	8,	9,	9,	9,	9.	8.8
3)	12,	12,	11,	11,	12.	11.6
4)	9,	9,	9,	8,	8.	8.6
5)	11,	11,	10,	11,	11.	10.8
6)	9,	9,	8,	8,	9.	8.6

6.00PM No readings taken due to thermometer failure.

DATE 26/4/89 QUADRAT MD 3B

9.00AM Air Temp. 7°C
0% cloud, light breeze.
1) 5, 9, 7, 7, 6. 6.8
2) 5, 5, 5, 5, 5. 5.0
3)a 1, 0, 1, 1, 1, 0.8
4) 3, 2, 3, 3, 3. 2.8
5) 3, 4, 3, 4, 3. 3.4
6) 5, 4, 4, 5, 5. 4.6
a- mound surface frozen

12.00AM Air temp. 8°C
30% cloud, light breeze.
1) 20, 20, 16, 11, 13. 16.0
2) 6, 6, 6, 5, 6. 5.8
3) 6, 7, 9, 7, 5. 6.8
4) 4, 4, 5, 4, 3. 4.0
5) 9, 9, 8, 9, 7. 8.4
6) 5, 5, 5, 6, 5. 5.2

3.00PM Air temp. 11°C
70% cloud, still.
1) 15, 15, 14, 13, 15. 14.4
2) 8, 9, 10, 9, 10. 9.2
3) 12, 11, 11, 11, 10. 11.0
4) 7, 6, 6, 6, 6. 6.8
5) 13, 11, 12, 11, 10. 11.4
6) 8, 7, 7, 8, 8. 7.6

6.00PM Air temp. 11°C
60% cloud, breezy.
1) 12, 12, 13, 12, 12. 12.2
2) 10, 11, 9, 10, 10. 10.0
3) 11, 12, 12, 12, 12. 11.8
4) 8, 8, 8, 9, 8. 8.2
5) 11, 10, 11, 11, 11. 10.8
6) 8, 8, 8, 8, 8. 8.0

DATE 18/5/89 QUADRAT MD 3B

9.00AM Air Temp. 15°C
Hazey, light breeze.
1) 18, 18, 19, 19, 20. 18.8
2) 14, 14, 14, 14, 14. 14.0
3) 18, 18, 19, 17, 19, 18.2
4) 14, 14, 14, 14, 14. 14.0
5) 16, 17, 18, 17, 18. 17.2
6) 14, 14, 14, 14, 13. 13.8

12.00AM Air temp. 21°C
40% cloud, light breeze.
1) 34, 29, 32, 30, 32. 31.4
2) 17, 17, 19, 18, 17. 17.6
3) 26, 27, 27, 26, 26. 26.4
4) 16, 17, 16, 19, 17. 17.0
5) 24, 25, 26, 25, 24. 24.8
6) 15, 16, 15, 15, 15. 15.2

3.00PM Air temp. 23°C
30% cloud, light breeze.
1) 32, 35, 37, 38, 37. 35.8
2) 20, 22, 20, 20, 22. 20.8
3) 28, 28, 29, 31, 25. 28.2
4) 19, 19, 21, 20, 20. 19.8
5) 29, 29, 32, 30, 28. 29.6
6) 19, 19, 17, 18, 18. 18.2

6.00PM Air temp. 23°C
20% cloud, light breeze.
1) 25, 25, 25, 24, 23. 24.0
2) 23, 23, 22, 22, 21. 22.2
3) 27, 28, 27, 26, 27. 27.0
4) 20, 22, 21, 21, 21. 21.0
5) 24, 25, 24, 24, 25. 24.4
6) 19, 20, 20, 18, 17. 18.8

DATE 1/6/89 QUADRAT MD 3B

9.00AM Air temp. 12^{o}C
100% cloud, light breeze,
rain earlier.
1) 15, 17, 16, 17, 15. 16.0
2) 12, 12, 12, 12, 12. 12.0
3) 12, 14, 14, 13, 13, 13.2
4) 11, 11, 11, 11, 12. 11.2
5) 14, 14, 13, 14, 13. 13.6
6) 12, 12, 12, 12, 12. 12.0

12.00AM Air temp. 13^{o}C
100% cloud, light breeze,
showers.
1) 18, 18, 18, 21, 20. 19.0
2) 13, 13, 13, 14, 14. 13.4
3) 16, 17, 18, 17, 18. 17.2
4) 12, 12, 13, 13, 13. 12.6
5) 15, 16, 16, 17, 17. 16.2
6) 12, 13, 13, 13, 13. 12.2

No further readings taken due to inclement weather conditions.

DATE 8/6/89 QUADRAT MD 3B

9.00AM Air Temp. 13^{o}C
100% cloud, light breeze.
1) 18, 17, 17, 16, 17. 17.0
2) 12, 13, 12, 12, 13. 12.4
3) 14, 14, 14, 13, 15, 14.0
4) 12, 11, 12, 12, 12. 11.8
5) 16, 14, 14, 13, 14. 14.2
6) 12, 12, 12, 12, 12. 12.0

12.00AM Air temp. 17^{o}C
100% cloud, rain, windy.
1) 15, 15, 16, 14, 15. 15.0
2) 13, 14, 14, 13, 13. 13.4
3) 14, 16, 13, 13, 13. 13.8
4) 13, 14, 12, 13, 12. 12.8
5) 14, 14, 13, 14, 13. 13.6
6) 13, 13, 13, 13, 12. 12.8

3.00PM Air temp. 12^{o}C
30% cloud, breeze, light rain.
1) 15, 17, 16, 16, 17. 16.2
2) 13, 15, 14, 13, 14. 13.8
3) 13, 15, 15, 14, 13. 14.0
4) 12, 14, 13, 13, 15. 13.4
5) 14, 16, 15, 15, 15. 15.0
6) 13, 14, 14, 14, 13. 13.6

6.00PM Air temp. 11^{o}C
95% cloud, breezy.
1) 13, 15, 15, 14, 15. 14.4
2) 15, 15, 15, 14, 14. 14.6
3) 15, 16, 15, 16, 14. 15.2
4) 14, 14, 14, 15, 14. 14.2
5) 14, 14, 14, 14, 15. 14.2
6) 13, 14, 14, 14, 14. 13.8

DATE 22/6/89 QUADRAT MD 3B

9.00AM Air Temp. 14^{o}C
10% cloud, breezy.
1) 29, 23, 24, 26, 24. 25.2
2) 19, 18, 16, 17, 17. 17.4
3) 19, 18, 17, 18, 17, 17.8
4) 16, 15, 15, 15, 15. 15.2
5) 19, 17, 17, 19, 18. 18.0
6) 17, 16, 16, 17, 16. 16.4

12.00AM Air temp. 18^{o}C
20% cloud, breezy.
1) 32, 31, 34, 34, 34. 33.0
2) 19, 19, 20, 20, 20. 19.6
3) 22, 22, 20, 20, 21. 21.0
4) 17, 17, 16, 16, 17. 16.6
5) 22, 22, 22, 24, 25. 23.0
6) 17, 17, 17, 18, 18. 17.4

3.00PM Air temp. 21^{o}C
0% cloud, light breeze.
1) 33, 32, 34, 32, 43. 34.8
2) 22, 19, 21, 22, 26. 22.0
3) 25, 25, 27, 26, 26. 25.8
4) 19, 19, 19, 18, 19. 18.8
5) 28, 27, 30, 25, 28. 27.6
6) 19, 19, 21, 20, 20. 19.8

6.00PM Air temp. 21^{o}C
10% cloud, light breeze.
1) 31, 30, 30, 30, 27. 29.6
2) 23, 24, 23, 26, 23. 23.8
3) 27, 27, 26, 27, 27. 26.8
4) 19, 20, 21, 21, 21. 20.4
5) 25, 26, 26, 25, 27. 25.8
6) 21, 21, 21, 21, 21. 21.0

DATE 12/7/89 QUADRAT MD 3B

9.00AM Air temp. 19^{o}C
60% cloud, light breeze.
1) 23, 24, 25, 25, 26. 24.6
2) 19, 19, 19, 19, 19. 19.0
3) 19, 20, 19, 19, 19, 19.2
4) 17, 17, 17, 17, 17. 17.0
5) 20, 19, 20, 20, 22. 20.2
6) 17, 17, 18, 17, 17. 17.2

12.00AM Air temp. 23^{o}C
90% cloud, light breeze.
1) 33, 30, 30, 29, 25. 29.4
2) 22, 22, 23, 20, 21. 21.6
3) 23, 24, 23, 22, 22. 22.8
4) 19, 20, 19, 19, 19. 19.2
5) 24, 25, 23, 23, 25. 24.0
6) 20, 19, 18, 18, 19. 18.8

3.00PM Air temp. 23^{o}C
80% cloud, breezy.
1) 33, 30, 30, 30, 29. 30.4
2) 26, 23, 23, 23, 24. 23.8
3) 25, 24, 25, 24, 24. 24.4
4) 20, 20, 20, 20, 20. 20.0
5) 25, 26, 24, 23, 24. 24.4
6) 20, 20, 19, 20, 20. 19.8

6.00PM Air temp. 23^{o}C
30% cloud, breezy.
1) 31, 29, 27, 28, 29. 28.8
2) 24, 24, 23, 23, 24. 23.6
3) 27, 25, 26, 24, 27. 25.8
4) 22, 21, 22, 21, 22. 21.6
5) 27, 25, 25, 25, 25. 25.4
6) 21, 21, 21, 20, 21. 20.8

DATE 2/8/89 QUADRAT MD 3B

9.00AM Air temp. $17^{o}C$
100% cloud, almost still.
1) 22, 18, 19, 20, 19. 19.4
2) 16, 15, 15, 16, 15. 15.4
3) 17, 17, 17, 18, 18. 17.4
4) 15, 15, 14, 14, 15. 14.6
5) 18, 19, 18, 18, 18. 18.2
6) 16, 16, 15, 15, 15. 15.4

12.00AM Air temp. $20^{o}C$
40% cloud, light breeze.
1) 32, 33, 34, 32, 32. 32.6
2) 19, 18, 19, 19, 18. 18.6
3) 22, 22, 22, 24, 19. 21.8
4) 17, 17, 18, 18, 16. 17.2
5) 23, 22, 23, 26, 26. 24.0
6) 17, 17, 18, 17, 18. 17.4

3.00PM Air temp. $22^{o}C$
35% cloud, breezy.
1) 31, 27, 30, 34, 35. 31.4
2) 24, 21, 22, 23, 22. 22.4
3) 24, 22, 24, 23, 25. 23.6
4) 19, 19, 19, 19, 20. 19.2
5) 27, 25, 26, 26, 25. 25.8
6) 20, 20, 20, 20, 19. 19.8

6.00PM Air temp. $21^{o}C$
70% cloud, breezy.
1) 27, 24, 26, 26, 26. 25.8
2) 21, 21, 24, 23, 23. 22.4
3) 21, 21, 23, 23, 21. 21.8
4) 19, 18, 20, 19, 18. 18.8
5) 23, 22, 23, 22, 23. 22.6
6) 20, 19, 20, 20, 20. 19.8

DATE 22/8/89 QUADRAT MD 3B

9.00AM Air temp. $16^{o}C$
98% cloud, breezy.
1) 19, 19, 17, 16, 19. 18.0
2) 17, 16, 16, 16, 16. 16.2
3) 16, 16, 16, 16, 15. 15.8
4) 15, 15, 16, 15, 15. 15.2
5) 16, 17, 16, 16, 16. 16.2
6) 16, 16, 16, 16, 16. 16.0

12.00AM Air temp. $19^{o}C$
99% cloud, breezy.
1) 21, 22, 22, 23, 22. 22.0
2) 17, 17, 17, 17, 17. 17.0
3) 17, 19, 17, 18, 17. 17.6
4) 16, 16, 16, 16, 16. 16.0
5) 19, 19, 20, 20, 18. 19.2
6) 16, 17, 16, 16, 16. 16.2

3.00PM Air temp. $20^{o}C$
15% cloud, light breeze.
1) 27, 25, 25, 24, 29. 26.0
2) 20, 20, 20, 20, 21. 20.2
3) 20, 21, 20, 21, 21. 20.6
4) 18, 18, 18, 17, 17. 17.6
5) 22, 22, 21, 22, 22. 21.8
6) 17, 17, 18, 18, 17. 17.4

6.00PM Air temp. $19^{o}C$
50% cloud, hazey, windy.
1) 22, 21, 22, 22, 20. 21.4
2) 21, 20, 21, 20, 20. 20.4
3) 19, 20, 20, 19, 19. 19.4
4) 18, 18, 19, 18, 18. 18.2
5) 19, 20, 19, 20, 19. 19.4
6) 18, 18, 18, 19, 18. 18.2

DATE 26/9/89 QUADRAT MD 3B

9.00AM Air temp. 14°C
100% cloud, light breeze.
1) 15, 14, 15, 15, 15. 14.8
2) 14, 14, 14, 14, 14. 14.0
3) 15, 14, 14, 14, 14. 14.2
4) 13, 14, 13, 14, 14. 13.6
5) 14, 14, 14, 15, 14. 14.2
6) 14, 14, 14, 14, 14. 14.0

12.00AM Air temp. 16°C
100% cloud, light breeze.
1) 18, 18, 20, 19, 18. 18.6
2) 15, 15, 16, 15, 15. 15.2
3) 16, 16, 16, 16, 17. 16.2
4) 14, 14, 14, 14, 14. 14.0
5) 16, 17, 17, 17, 18. 17.0
6) 15, 15, 14, 14, 14. 14.4

3.00PM Air temp. 17°C
100% cloud, light breeze.
1) 19, 19, 20, 18, 20. 19.2
2) 16, 16, 17, 16, 16. 16.2
3) 17, 17, 17, 18, 17. 17.2
4) 15, 16, 15, 16, 16. 15.6
5) 18, 17, 18, 18, 17. 17.6
6) 15, 15, 15, 16, 15. 15.2

6.00PM Air temp. 16°C
100% cloud, breezy.
1) 16, 16, 17, 16, 16. 16.2
2) 16, 17, 17, 16, 16. 16.4
3) 16, 16, 16, 16, 16. 16.0
4) 15, 16, 15, 16, 15. 15.4
5) 16, 16, 16, 16, 16. 16.0
6) 15, 15, 15, 16, 16. 15.4

DATE 29/11/89 QUADRAT MD 3B

9.00AM Air temp. 1°C
0% cloud, light breeze.
1) 1, 1, 1, 1, 1. 1.0
2) 2, 2, 2, 2, 2. 2.0
3) 1, 1, 1, 1, 1. 1.0
4) 2, 1, 2, 2, 2. 1.8
5) 1, 1, 1, 1, 1. 1.0
6) 3, 3, 3, 3, 3. 3.0

12.00AM Air temp. 5°C
0% cloud, breezy.
1) 4, 3, 3, 4, 4. 3.6
2) 2, 3, 3, 3, 3. 2.8
3) 1, 1, 1, 1, 1. 1.0
4) 2, 2, 2, 2, 2. 2.0
5) 1, 2, 2, 2, 1. 1.6
6) 3, 4, 4, 3, 3. 3.4

3.00PM Air temp. 5°C
0% cloud, light breeze.
1) 4, 4, 6, 4, 4. 4.4
2) 3, 2, 4, 3, 3. 3.0
3) 3, 2, 2, 1, 2. 2.0
4) 2, 2, 2, 2, 2. 2.0
5) 2, 2, 2, 2, 2. 2.0
6) 3, 3, 3, 3, 3. 3.0

6.00PM Air temp. 2°C
0% cloud, almost still.
1) 1, 1, 1, 2, 1. 1.8
2) 2, 3, 3, 4, 2. 2.8
3) 1, 1, 1, 1, 1. 1.0
4) 2, 1, 2, 1, 2. 1.6
5) 1, 1, 1, 1, 0. 0.8
6) 3, 3, 3, 3, 3. 3.0

DATE 17/1/90 QUADRAT MD 3B

9.00AM Air temp. 6°C
20% cloud, breezy.

1)	5,	5,	5,	5,	5.	5.0
2)	7,	7,	7,	7,	7.	7.0
3)	5,	6,	6,	5,	6.	5.6
4)	7,	7,	7,	7,	7.	7.0
5)	5,	6,	5,	5,	6.	5.6
6)	7,	7,	7,	7,	7.	7.0

12.00AM Air temp. 8°C
0% cloud, breezy.

1)	9,	10,	11,	7,	8.	9.0
2)	7,	7,	7,	7,	7.	7.0
3)	6,	6,	6,	6,	6.	6.0
4)	7,	7,	7,	7,	7.	7.0
5)	6,	6,	6,	6,	6.	6.0
6)	7,	7,	7,	7,	7.	7.0

3.00PM Air temp. 7°C
3% cloud, v. windy.

1)	8,	9,	8,	7,	8.	8.0
2)	7,	8,	8,	7,	8.	7.6
3)	6,	7,	6,	6,	6.	6.2
4)	7,	7,	7,	7,	6.	6.8
5)	6,	6,	6,	6,	6.	6.0
6)	7,	7,	7,	7,	6.	6.8

6.00PM Air temp. 5°C
0% cloud, light breeze.

1)	3,	4,	4,	3,	4.	3.6
2)	7,	7,	7,	7,	7.	7.0
3)	5,	4,	5,	4,	5.	4.6
4)	6,	6,	6,	6,	6.	6.0
5)	5,	5,	4,	4,	4.	4.4
6)	7,	7,	7,	7,	7.	7.0

APPENDIX NINE

Flora of the quadrats.

This appendix is in two parts. In the first part the full list of plants recorded in each sample area is given. In the second part the results of the assessment of cover-abundance in a limited set of the sample areas are given.

Part 1, the list of plants.

In the following tables the flora of the quadrats is summarised. All plants found within the quadrats are included. On the scale adopted; 1 = rare

2 = scattered

3 = common

Other symbols used are as follows.

J = growing on *Juniperus communis*

S = growing on one of the sample slates positioned in the quadrat area.

Plants recorded from outside the quadrat area.

\+ = found in the area of the sample quadrat and considered representative of the sample area flora.

d = found in disturbed ground in the area of the sample quadrat, but not representative of the typical flora.

w = found in an unrepresentative wooded area in AR 15.

B = growing on birch tree (*Betula pendula*)

E = growing on elder (*Sambucus nigra*)

H = growing on hawthorn (*Crataegus monogyna*).

With many of the mosses it was difficult to assess their abundance. When this was not known the symbol u is used, indicating that while they were found within the quadrat it was not possible to assign a number to them.

In the Tables;

1 = OWH SS 4	10 = AR 11
2 = OWH SS 5	11 = AR 12
3 = OWH SS 7	12 = AR 15
4 = OWH SS 8	13 = AR 16
5 = OWH SS 9	14 = AR 5
6 = OWH SS11	15 = AR NWS
7 = OWH SS12	16 = MD 7B
8 = OWH NFS	17 = MD 4A
9 = OWH C10	18 = MD 4B
	19 = MD 3B

SPECIES	1	2	3	4	5	6	7	8	9
Acer pseudoplatanus	-	-	-	-	-	-	-	1	+
Achillea millefolium	-	-	-	3	3	-	2	3	1
Agrimonia eupatoria	-	-	+	-	-	-	-	1	1
Anacamptis pyramidalis	1	-	-	1	-	-	-	-	-
Anthyllis vulneraria	3	2	1	3	3	3	3	-	-
Arenaria serpyllifolia	-	-	-	-	1	-	-	-	-
Asperula cynanchica	3	2	2	2	3	3	3	3	-
Bellis perennis	2	-	-	-	-	-	-	-	-
Betula pendula	-	-	-	-	-	-	-	-	-
Blackstonia perfoliata	-	-	-	+	3	1	3	-	-
Campanula rotundifolia	2.5	1	2	2	2	2	2	2	-
Carlina vulgaris	2	3	2	1	-	1	1	1	-
Centaurea nigra	1	+	-	1	-	+	+	-	-
Cerastium arvense	2	+	-	2	2	2	-	-	-
Cirsium acaule	3	3	3	3	3	3	3	1	-
Cirsium vulgare	-	-	-	-	-	-	-	2	1
Clematis vitalba	-	-	-	-	-	-	-	+	-
Clinopodium vulgare	-	-	2	3	1	-	-	2	+
Coeloglossum viride	-	-	-	-	-	-	-	+	-
Cornus sanguinea	1	-	2	2	-	+	3	2	1
Crataegus monogyna	1	1	2	2	+	-	2	2	1
Crepis capillaris	1	-	-	-	-	-	-	1	2
Cruciata laevipes	-	-	-	1	-	-	-	2	3
Dactylorhiza fuchsii	-	-	-	1	-	-	-	3	+
Euphrasia officinalis	3	-	-	-	2	-	1	1	+
Fraxinus excelsior	-	-	-	-	-	-	-	1	1
Galium mollugo	1	-	-	2	-	-	3	2	3
Galium verum	-	-	1	2	-	-	-	3	3
Gentianella amarella	3	-	-	-	-	-	1	1	-
Gymnadenia conopsea	1	-	-	2	2	3	2.5	-	-
Heracleum sphondylium	-	-	-	d	-	-	-	-	-
Hieracium pilosella	3	3	-	-	3	3	3	2	1
Hippocrepis commosa	3	3	2	-	3	2	3	-	-
Juniperus communis	1	+	-	1	3	1	2	-	-
Leontodon hispidus	3	3	3	3	3	3	3	3	1
Leucanthemum vulgare	2.5	2	+	2	3	2	3	-	-
Ligustrum vulgare	1	+	-	1	1	-	-	-	-
Linum catharticum	3	3	3	3	3	3	3	2	-
Lotus corniculatus	3	3	3	3	3	2	3	2	+
Mercurialis perennis	-	-	-	-	-	-	-	2	2
Ononis repens	+	-	3	3	3	1	2	-	-
Origanum vulgare	1	-	-	-	1	-	-	-	+
Pastinaca sativa	-	-	-	1	-	-	-	2	-
Phyteuma orbiculare	2	1	2	3	2.5	2	2	-	-
Pimpinella saxifraga	2	1	1	2.5	3	1	2.5	-	-
Pinus sylvestris	+	-	-	-	-	-	-	-	-
Plantago lanceolata	2	3	2	3	3	3	3	3	2
Plantago media	2.5	3	3	3	3	3	3	-	+
Platanthera chloranthera	-	-	-	-	+	-	-	-	-
Polygala vulgaris	3	2	-	-	3	2	2.5	2	-
Primula veris	2	2	2	2	2	2	3	-	-
Prunella vulgaris	1	-	-	-	1	-	+	1	+
Quercus robur	-	-	-	-	-	-	-	1	-

Ranunculus acris	1	-	-	-	-	-	-	2	1
Ranunculus bulbosus	3	-	-	-	-	2	2	1	-
Reseda lutea	-	-	d	-	1	-	-	-	-
Rhamnus cartharticus	-	-	2	-	1	-	-	-	2
Rhinanthus minor	-	-	-	-	-	-	-	1	-
Rosa canina	1	-	2	2	1	1	2.5	-	-
Rubus fruticosus	+	-	-	2	2	+	1	1	+
Rumex acetosa	-	-	-	-	-	-	-	-	1
Sambucus nigra	-	-	-	-	-	-	-	-	1
Sanguisorba minor	3	3	3	3	3	3	3	3	1
Scabiosa columbaria	3	2	+	3	2	2	3	2	-
Senecio jacobaea	1	2	-	1	1	1	1	2	1
Sonchus oleraceous	-	-	-	-	1	-	-	-	-
Sorbus aria	-	+	-	-	-	-	-	+	-
Spiranthes spiralis	+	1	-	-	1	2	1	-	-
Taraxacum officinalis	-	+	2	1	-	-	1	1	+
Taxus baccata	-	-	-	-	-	-	-	-	+
Thymus serpyllum	3	3	3	2	3	3	3	-	-
Tragopogon pratensis	-	-	+	d	-	-	1	-	-
Trifolium pratense	1	-	-	d	-	1	-	-	-
Urtica dioica	-	-	-	-	-	-	-	-	1
Veronica chamaedrys	-	-	-	2	2	-	-	2	3
Veronica officinalis	-	-	-	-	-	-	-	-	1
Veronica serpyllifolia	-	-	-	-	-	-	-	1	1
Viburnum lantana	-	+	-	1	-	-	-	-	-
Viola hirta	3	2	-	3	3	2	-	3	-
Agrostis stolonifera	2	-	-	-	-	-	-	2	1
Anthoxanthemum odoratum	-	-	-	+	-	-	1	1	1
Arrhenatherum elatius	-	-	+	2	-	-	1	2	3
Avenula pubescens	3	3	3	3	3	3	3	3	2
Brachypodium pinnatum	2	2	2	3	2.5	2	2	3	2
Briza media	3	3	3	3	3	2	3	3	-
Bromus erectus	-	-	-	2	-	-	-	-	-
Carex caryophyllea	3	2	2	3	3	3	2	3	1
Carex flacca	3	3	3	3	3	3	3	3	1
Dactylis glomerata	2	-	3	3	2	1	2.5	2	3
Festuca rubra/ovina	3	3	3	3	3	3	3	3	3
Holcus lanatus	2	-	3	3	3	2	3	2	3
Koeleria macrantha	3	-	-	2	3	1	3	2	1
Luzula campestris	-	-	-	-	-	-	-	1	-
Phleum pratense	-	-	1	-	-	-	-	-	-
Poa trivialis	-	-	-	1	-	-	1	-	3
Trisetum flavescens	2	-	3	2.5	3	1	1	1	2
Barbula recurvirostra	-	-	-	-	-	-	-	-	-
Barbula unguiculata	-	-	-	u	-	-	-	-	-
Bracythecium rutabulum	-	-	-	-	-	-	-	-	-
Bryum caespiticium	-	-	-	u	-	-	-	-	-
Bryum capillare	-	u	u	-	u	-	-	-	-
Bryum ?bicolor	-	-	u	-	-	-	-	-	-
Calliergon cuspidatum	-	-	-	-	-	-	-	u	-
Ctenidium molluscum	u	u	-	-	-	u	u	-	-
Dicranum bonjeani	-	-	-	-	u	2	-	2	-
Dicranum scoparium	-	-	-	-	-	-	-	-	1

Eurhyncium swartzii	-	-	u	-	-	-	-	-	-
Fissidens cristatus	u	2	u	-	-	-	-	u	-
Fissidens taraxifolius	2	-	-	-	3	u	2	u	-
Homalothecium lutescens	u	u	u	-	u	u	-	-	-
Hypnum cupressiforme	-	u	-	-	-	-	u	-	-
Phascum cuspidatum	-	-	u	-	-	-	-	-	-
Pseudoscleropodium purum	2	3	2	3	3	3	3	3	3
Rhyncostegium confertum	-	-	-	-	-	-	u	-	-
Rhytidiadelphus squarrosus	-	-	-	-	-	-	-	2	3
Rhytidiadelphus triquetus	-	-	-	-	-	-	-	u	-
Tortula subulata	-	-	-	-	-	-	u	-	-
Wiessia microstoma	2	u	u	u	2	2	2	-	-
Caloplaca citrina	S	-	-	-	-	S	-	-	-
Candellariella aurella	S	-	-	-	-	S	-	-	-
Hypogymnia physodes	J	+	-	-	-	J	-	-	E
Lecanora conizeoides	J	+	-	-	J	J	J	-	-
Lecanora dispersa	S	-	-	-	-	S	-	-	-
Physica sp.	-	-	-	J	-	-	-	-	-
Verrucaria sphinctrina	1	-	-	-	-	1	-	-	-
Xanthoria parietina	S	+	-	-	-	S	-	-	-

SPECIES	10	11	12	13	14	15	16	17	18	19
Acer pseudoplatanus	-	+	d	d	-	-	-	-	-	-
Achillea millefolium	3	3	3	3	-	-	-	2	-	-
Agrimonia eupatoria	d	+	d	-	d	-	2	1	+	-
Anacamptis pyramidalis	-	-	+	-	-	-	-	-	-	-
Anthyllis vulneraria	-	-	-	-	-	-	-	-	-	2
Arenaria serpyllifolia	-	-	-	-	-	1	-	-	-	-
Asperula cynanchica	3	3	3	-	2	2	1	-	2	3
Betula pendula	-	+	1	+	-	-	-	-	-	-
Blackstonia perfoliata	-	+	+	+	2	-	-	-	-	-
Campanula glomerata	2	3	2	-	-	-	-	-	-	-
Campanula rotundifolia	2	2	1	2	-	3	-	3	2	2
Campanula trachelium	-	-	w	-	-	-	-	-	-	-
Carduus nutans	-	-	1.5	-	-	-	-	-	-	-
Carlina vulgaris	2	3	-	-	-	2	-	-	1.5	2
Cephalanthera damasonium	-	-	w	-	-	-	-	-	-	-
Centaurea nigra	+	+	2	2	-	-	-	2	-	-
Centaurea scabiosa	-	-	d	-	d	+	1	1	-	-
Centaurium erythraea	-	-	-	-	1	-	-	-	-	-
Cerastium arvense	-	1	2	2	2	1	2	3	-	1
Cirsium acaule	3	3	2	-	3	3	3	2	2.5	3
Cirsium arvense	+	1	d	d	-	1	-	-	2	-
Cirsium vulgare	+	2	1	2	-	-	-	-	-	-
Chamaenerion angustifolium	-	-	d	-	-	-	-	-	-	-
Clinopodium vulgare	2	3	2	1	1	3	1	3	2	-
Coeloglossum viride	-	-	1	-	-	-	-	-	-	1
Cornus sanguinea	+	2	2	-	-	-	1	1	+	1
Corylus avellana	-	-	w	-	-	-	-	-	-	-
Crataegus monogyna	3	3	2	2	3	1.5	1	3	1.5	1
Crepis capillaris	3	1	d	2	-	1	-	-	2.5	1
Dactylorhiza fuchsii	-	+	2	1	+	-	-	-	-	-
Echium vulgare	-	-	-	-	1	-	-	-	-	-
Euphrasia officinalis	2	2	2	2	1	-	-	-	-	2
Fagus sylvatica	-	-	w	-	-	-	-	-	-	-
Filipendula vulgaris	-	-	-	-	-	-	2	-	-	-
Fraxinus excelsior	-	1	2	+	-	-	-	-	-	-
Galium mollugo	1	-	d	3	2	-	-	1	2	-
Galium verum	3	3	3	3	2	2	3	3	2	2
Gentianella amarella	2	2	1	2	3	3	1	2	-	1
Hedera helix	-	-	w	-	-	-	-	-	-	-
Helianthemum nummularium	3	3	3	3	-	2	-	-	-	-
Heracleum sphondylium	-	-	d	-	-	-	-	-	-	-
Hieracium pilosella	2	3	-	-	2	-	-	-	3	3
Hippocrepis commosa	-	-	-	-	-	1	-	-	-	+
Hypericum perforatum	+	2	2	1	+	-	-	1	-	-
Iberis amara	+	-	-	-	-	-	-	-	-	-
Juniperus communis	-	-	-	+	-	-	-	-	-	-
Knautia arvensis	-	-	-	-	1	-	-	-	-	-
Lathyrus pratensis	-	-	d	-	-	-	-	-	-	-
Leontodon hispidus	3	+	3	3	3	3	3	3	3	3
Leucanthemum vulgare	-	-	-	-	2	-	1	1	-	-
Ligustrum vulgare	1	1	1	-	-	-	-	1	1	-
Linum catharticum	3	3	2	3	3	3	2	3	3	3
Lotus corniculatus	3	3	3	2	3	3	2	2	3	3

Luzula campestris	-	-	-	-	-	-	-	-	-	2
Medicago lupulina	2	2	2	-	2	1	1	2	-	1
Melilotus alba	-	-	d	-	-	-	-	-	-	-
Mentha arvensis	-	-	d	-	-	-	-	-	-	-
Myosotis arvensis	-	-	-	-	-	+	-	-	-	-
Odontites verna	d	d	-	-	-	-	d	-	-	-
Ononis repens	-	-	1	-	3	-	-	-	-	-
Origanum vulgare	-	2	2	3	-	-	-	1	-	-
Pastinaca sativa	1	+	+	1	1	-	-	2	+	-
Picris hieracioides	1	+	3	2	3	1.5	-	-	-	-
Pimpinella saxifraga	2	2	2	3	2	1	2.5	3	-	1
Plantago lanceolata	3	3	3	3	3	3	3	3	2	3
Plantago media	-	2.5	2	-	-	-	2	-	-	2
Polygala vulgaris	-	3	3	2	-	3	2	3	-	2
Potentilla anserina	d	d	d	d	-	-	-	-	-	-
Primula veris	-	-	-	-	+	-	2	-	-	-
Prunella vulgaris	2	2	2	3	-	2.5	1	2	2	2
Ranunculus acris	3	+	-	-	-	-	-	2	-	-
Ranunculus bulbosus	2	3	2	2	1	2	3	3	-	-
Reseda lutea	-	2.5	1	-	-	-	-	-	-	-
Rhamnus carthartica	-	-	-	+	-	-	1	-	-	+
Rhinanthus minor	-	+	3	2	-	-	1	-	-	-
Rosa canina	1	1	1	2	1	1	-	-	-	1
Rubus fruticosus	2	3	2	2	+	+	-	-	1	-
Rumex acetosa	-	-	d	-	d	-	-	-	-	-
Sanguisorba minor	3	3	3	3	3	3	3	2	3	3
Scabiosa columbaria	3	2	3	3	2	+	3	3	1	1
Senecio integrifolius	-	-	-	-	-	-	-	-	-	+
Senecio jacobaea	-	2.5	1	1	2	-	2	3	2.5	2
Sherardia arvensis	-	-	-	-	+	-	-	-	-	-
Silene vulgaris	-	-	d	-	-	-	-	-	-	-
Solanum nigrum	-	d	-	-	-	-	-	-	-	-
Sonchus oleraceous	-	-	d	d	-	-	-	-	-	-
Sorbus aria	-	-	1	-	-	-	-	-	-	-
Tamus communis	-	-	1	-	-	-	-	-	-	-
Taraxacum officinalis	-	-	-	-	-	-	-	2	2	1
Thymus serpyllum	3	3	3	3	3	3	2	3	3	3
Tragopogon pratensis	-	-	d	-	-	-	1	1	-	-
Trifolium dubium	-	-	-	-	1	-	-	-	-	-
Trifolium pratense	2	2	+	+	1	-	3	3	+	1
Trifolium repens	-	1	2	2	-	-	2	-	-	-
Urtica dioica	d	d	d	-	-	-	-	-	-	-
Valeriana officinalis	-	-	1	1	-	-	-	-	-	-
Verbascum nigrum	d	-	-	1	-	-	-	-	-	-
Veronica chamaedrys	3	2	3	-	-	-	-	-	-	2
Veronica serpyllifolia	-	2	-	-	-	-	-	-	-	-
Viburnum lantana	2	3	2.5	1	-	-	-	+	-	-
Vicia cracca	-	-	-	-	-	-	1	2	-	-
Viola hirta	-	2	3	3	-	+	-	1	2	3
Agrostis stolonifera	3	2	1	2	3	3	1	3	-	1
Anthoxanthemum odoratum	-	-	-	+	-	-	+	-	-	-
Arrhenatherum elatius	+	1	3	3	2	-	-	-	-	-
Avenula pubescens	-	2	3	2	-	3	3	3	3	2
Brachypodium pinnatum	3	3	3	3	3	1	-	+	1.5	2

Briza media	3	-	3	1	3	3	2	2	1.5	1
Bromus erectus	-	-	-	-	-	3	3	3	3	3
Bromus ramosus	-	-	w	-	-	-	-	-	-	-
Carex caryophyllea	-	3	2	3	3	3	2	2	?	3
Carex flacca	-	3	3	3	3	3	3	2	2	3
Cynosurus cristatus	-	-	-	-	1	-	-	+	-	-
Dactylis glomerata	+	d	3	2	2	2	1	3	2	1
Elymus repens	-	-	-	-	d	-	-	-	-	-
Festuca rubra/ovina	3	3	3	3	3	3	3	3	3	3
Holcus lanatus	3	3	3	2.5	3	3	1	2	2	2
Koeleria macrantha	-	3	1	-	-	-	1	2	-	2
Phleum pratense	2	2	d	-	-	1	1	2	-	-
Poa annua	+	-	-	-	-	2	-	1	-	-
Poa pratensis	1	+	1	1	-	-	-	-	-	-
Poa trivialis	2	1	-	-	-	-	-	2	-	-
Trisetum flavescens	-	2	1	2	2	3	-	1	-	-
Triticum aestivum	-	-	-	-	-	-	1	-	-	-
Barbula recurvirostra	-	-	-	-	-	u	-	-	u	-
Bracythecium rutabulum	-	-	-	-	u	-	-	u	-	-
Bryum capillare	2	-	-	-	-	-	-	-	u	-
Calliergon cuspidatum	-	-	-	-	-	-	u	u	u	u
Dicranum bonjeani	-	-	-	-	-	u	-	-	-	2
Fissidens cristatus	1	2	2	2	-	-	u	-	2	2
Fissidens taraxifolius	-	-	-	-	-	u	-	-	-	-
Homalothecium lutescens	-	-	-	-	u	u	-	-	u	u
Hypnum cupressiforme	-	2	2	1.5	2	-	-	-	u	-
Pseudoscleropodium purum	3	2	2	3	2	2	3	3	u	2
Rhytidiadelphus squarrosus	-	-	2	2	-	-	-	-	u	u
Rhytidiadelphus triquetus	-	-	u	-	-	-	-	-	-	-
Tortula muralis	-	u	-	-	-	-	-	-	-	-
Wiessia microstoma	1	-	-	-	-	u	-	-	u	u
Lophocolea bidentata	-	-	-	-	1	-	-	-	-	-
Caloplaca citrina	-	-	S	S	-	-	-	-	-	-
Candellariella aurella	-	-	S	S	-	-	-	-	S	-
Lecanora chlarotera	-	-	-	-	-	-	-	-	H	-
Lecanora conizeoides	-	B	B	J+	-	-	-	-	H	-
Lecanora dispersa	-	-	S	S	-	S	S	S	S	-
Xanthoria parietina	-	-	S	-	-	-	-	+	-	-

Part 2, the cover-abundance records.

Cover abundance was assessed using the Domin scale. This is as follows.

Domin number	Cover
1	plants rare, one or two individuals only.
2	scattered individuals
3	frequent, but cover <4%.
4	4% to 10%
5	10% to 25%
6	25% to 33%
7	33% to 50%
8	50% to 75%
9	75% to 90%
10	90% to 100%

The Domin numbers of each species for the four individual quadrats is given, followed by the mean of these, which was the number used in the calculation of the similarity indices.

Records of the sample quadrats: Domin scale cover.

	OWH C10 1	2	3	4	Mean	OWH NFS 1	2	3	4	Mean
Agrimonia eupatoria	1				0.25					
Achillea millefolium						1	3	1	3	2.00
Crepis capillaris						3	3	1	3	2.50
Cruciata laevipes	3		1	3	1.75					
Dactylorhiza fuchsii						3	3	1	1	2.00
Fraxinus excelsior								1		0.25
Galium mollugo	1	1	1	3	1.50					
Galium verum		3			0.75	3	1	4	3	2.75
Hieracium pilosella		3			0.75	3	3			1.50
Leontodon hispidus						5	3	3	3	3.50
Linum catharticum						4			1	1.25
Lotus corniculatus						4	1			1.25
Mercurialis perennis				4	1.00					
Plantago lanceolata	1		1		0.50	3	5	3	1	3.00
Polygala vulgaris								4		1.00
Quercus robur							1			0.25
Ranunculus acris			1		0.25		1	3	1	1.25
Ranunculus bulbosus								5		1.25
Rumex acetosa	3		3		1.50					
Sanguisorba minor			1		0.25	5	8	3	5	5.25
Taraxacum officinalis									1	0.25
Urtica dioica		3			0.75					
Veronica chamaedrys	5	5	6	4	5.00	3		3		1.50
Viola hirta						3	3	3		2.25
Anthoxanthemum odoratum			3		0.75				3	0.75
Arrhenatherum elatius	8		5	7	5.00					
Avenula pubescens						4	5	3	3	3.75
Brachypodium pinnatum						3	3	1	3	2.50
Briza media						4	1	3	3	2.75
Carex caryophyllea						9	6	4	4	5.75
Carex flacca						5	5	1	4	3.75
Dactylis glomerata		6	9	5	5.00		1			0.25
Festuca rubra/ovina	10	8	5	8	7.75	5	4	9	7	6.25
Holcus lanatus	1	7	5	1	3.50	1		3	3	1.75
Koeleria macrantha							3	3		1.50
Poa trivialis	6	6	7	5	6.00					
Dicranum scoparium				1	0.25					
Pseudoscleropodium purum		3		4	1.75	3	3	1	1	2.00
Rhytidiadelphus squarrosus	7	4	1	3	3.75			3	1	1.00

	OWH SS11					OWH SS 4				
	1	2	3	4	Mean	1	2	3	4	Mean
Anthyllis vulneraria	1	3	5	1	2.50	3		1	3	1.75
Asperula cynanchica									1	0.25
Blackstonia perfoliata		3			0.75					
Campanula rotundifolia	1	1	1	1	1.00		1	1	1	0.75
Carlina vulgaris						1	1	1	1	1.00
Cirsium acaule	5	4	4	4	4.25	5	5	4	3	4.25
Euphrasia officinalis						3	1	3	3	2.50
Galium verum			1		0.25					
Gentianella amarella							3	3	3	2.25
Gymnadenia conopsea	3	1	3	1	2.00				1	0.25
Hieracium pilosella	4	3	4	3	3.50	3	1	3	3	2.50
Hippocrepis commosa				4	1.00	5	4	5	4	4.50
Leontodon hispidus	3	3	4	3	3.25	3	3	3	3	3.00
Leucanthemum vulgare								1	1	0.50
Linum catharticum	3	3	3	3	3.00	3	4	4	3	3.50
Lotus corniculatus			1	1	0.50					
Onionis spinosa				5	1.25					
Plantago lanceolata	3	3		1	1.75	4	3	3	3	3.25
Plantago media	3	3	1		1.75			3		0.75
Polygala vulgaris		1	1	1	0.75	1	1	1	1	1.00
Ranunculus bulbosus	1			1	0.50	1		3	1	1.25
Sanguisorba minor	3	3	3	4	3.25	4	4	3	3	3.50
Thymus serpyllum	3	1	1	1	1.50	3	3	3	3	3.00
Viola hirta	1	3	3	3	2.50					
Avenula pubescens		4	4	5	3.25	4	4	3	4	3.75
Brachypodium pinnatum		3			0.75				1	0.25
Briza media	3	1		1	1.25	3	3	3	3	3.00
Carex caryophyllea	3	3	1	3	2.50			1		0.25
Carex flacca	4	4	4	3	3.75	3	1	3	3	2.50
Festuca rubra/ovina	8	8	8	8	8.00	9	9	8	8	8.50
Holcus lanatus		1			0.25					
Koeleria macrantha							1	1	3	1.25
Pseudoscleropodium purum	3	1	1	1	1.50					
Verrucaria spinctrina	1				0.25					

	AR 15					AR 16				
	1	2	3	4	Mean	1	2	3	4	Mean
Achillea millefolium	3	3	4	1	2.75	3	3		1	1.75
Campanula rotundifolia			1	1	0.50					
Cirsium acaule		1			0.25					
Cirsium vulgare			1		0.25			1		0.25
Crataegus monogyna	1		1		0.50					
Dactylorhiza fuchsii		1	1	1	0.75					
Euphrasia officinalis	1		1	1	0.75	1	1	1	1	1.00
Fraxinus excelsior		1			0.25					
Galium mollugo						1	3	3	3	2.50
Galium verum	5	5	4	1	3.75	3		4		1.75
Helianthemum nummularium		3	1	1	1.25					
Leontodon hispidus	5	3	5	5	4.50	5	3	4	3	3.75
Linum catharticum		1	1	1	0.75		1	1		0.50
Lotus corniculatus	5	4	3	3	3.75	1			3	1.00
Onionis spinosa		3			0.75					
Origanum vulgare	3			3	1.50	7	5	3	4	4.75
Pimpinella saxifraga						1	3	3	3	2.50
Plantago lanceolata	4	3	3	4	3.50	4	3	3	5	3.75
Plantago media	1				0.25					
Polygala vulgaris	3	1	3	3	2.50	3	3	1		1.75
Ranunculus bulbosus			1		0.25	3		1		1.00
Rhinanthus minor	3	1	1	1	1.50		1		1	0.50
Sanguisorba minor		5	3	4	3.00	3			1	1.00
Scabiosa columbaria						1	3		3	1.75
Thymus serpyllum			1		0.25					
Trifolium repens	3			3	1.50		1			0.25
Viburnum lantana		1	1		0.50					
Viola hirta	4	4	3	3	3.50	1		1		0.50
Avenula pubescens		4	1	3	2.00		4	3		1.75
Brachypodium pinnatum	1	3	3	3	2.50	3	3	4	5	3.75
Briza media		3	3	4	2.50					
Carex caryophyllea	3		3		1.50	3	1	3	3	2.50
Carex flacca	5	4	4	3	4.00	3	3	3	4	3.25
Dactylis glomerata	3	4	3	4	3.50	5	5	4	4	4.50
Festuca rubra/ovina	9	9	9	8	8.75	8	8	8	7	7.75
Holcus lanatus	4	1		1	1.50	5	3	5	5	4.50
Poa pratensis									1	0.25
Trisetum flavescens						3				0.75
Fissidens cristatus	1				0.25					
Pseudoscleropodium purum	1	1	1		0.75	5	6	5	4	5.00
Rhytidiadelphus squarrosus	1	3			1.00	3	1	3		1.75

	MD 7B					MD 4A				
	1	2	3	4	Mean	1	2	3	4	Mean
Achillea millefolium						3			1	1.00
Agrimonia eupatoria				1	0.25					
Campanula rotundifolia						1				0.25
Carlina vulgaris						3	1		1	1.25
Cerastium fontanum						1				0.25
Cirsium acaule	3	3	3		2.25					
Filipendula vulgaris	3	5	1		2.25					
Galium verum	7	4	7	4	5.50					
Hypericum perforatum						1				0.25
Leontodon hispidus	5	4	4	4	4.25	3	3	4	3	3.25
Linum catharticum	3		4		1.75	1	3	4	3	2.75
Medicago lupulina						3		1		1.00
Origanum vulgare						4			1	1.25
Plantago lanceolata	3	4	5	1	3.25	4	4	5	5	4.50
Polygala vulgaris						3				0.75
Ranunculus bulbosus	3	3	3	3	3.00	3			1	1.00
Sanguisorba minor	8	6	4	4	5.50					
Senecio jacobaea						3	3	1	1	2.00
Thymus serpyllum						1				0.25
Tragopogon pratensis						1				0.25
Trifolium pratense						3	5	3	3	3.50
Trifolium repens	3	3			1.50					
Vicia cracca	3			3	1.50					
Avenula pubescens	5	4	5	5	4.75	4		1		1.25
Briza media	1	3	1	1	1.50	4		5		2.25
Bromus erectus	8	8	8	9	8.25	10	9	8	9	9.00
Carex caryophyllea		3		3	1.50	3		1	1	1.25
Carex flacca	4	4	1	1	2.50					
Festuca rubra/ovina	8	5	8	6	6.75					
Holcus lanatus						3	5	4	5	4.25
Koeleria macrantha		1			0.25					
Pseudoscleropodium purum	3	5	1	5	3.50	8		4	8	5.00

	MD 3B				
	1	2	3	4	Mean
Anthyllis vulneraria	1	5			1.50
Asperula cynanchica	3	1	3	1	2.00
Campanula rotundifolia	1		1		0.50
Cirsium acaule	5	4	4	3	4.00
Crataegus monogyna		1			0.25
Euphrasia officinalis	3			1	1.00
Hieracium pilosella	1	4	1	4	2.50
Leontodon hispidus	4	5	5	5	4.75
Linum catharticum	3	3	4	5	3.75
Lotus corniculatus	5	4	4	5	4.50
Plantago lanceolata	4	3	1	4	3.00
Plantago media	1				0.25
Polygala vulgaris	1				0.25
Prunella vulgaris	1			1	0.50
Rosa canina	1				0.25
Sanguisorba minor	3	4	5	4	4.00
Senecio jacobaea		1		3	1.00
Thymus serpyllum	3	4	3	5	3.75
Viola hirta	1	4	1		1.50
Briza media				1	0.25
Bromus erectus	5	4	7	5	5.25
Carex caryophyllea	3	1	3	1	2.00
Carex flacca	4	3	3	4	3.50
Dactylis glomerata			1		0.25
Festuca rubra/ovina	5	4	5	4	4.50
Koeleria macrantha		3	3		1.50
Dicranum bonjeani	1	3			1.00
Fissidens cristatus			1		0.25
Pseudoscleropodium purum	5	3	5	3	4.00

APPENDIX TEN

Rabbit droppings raw data.

All data collected is summarised in the following section. The method of recording is explained in section 6.8.2. When the presence of sheep prevented rabbit droppings being counted this is indicated.

All counts in the 25 x 25 cm. quadrats are given, together with the mean. Counts were taken in two locations on each occasion;

Mound: sample quadrat positioned on top of an ant mound.

Soil: sample quadrat positioned on the ground between the ant mounds.

QUADRAT 1, OWH SS 4

Date 2/3/89
Mound: 6, 0, 17, 0, 0, 0, 4, 0, 0, 2. Mean 2.9
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 1, 0. Mean 0.1
Date 15/3/89
Mound: 4, 6, 1, 0, 9, 0, 0, 0, 0, 0. Mean 2.0
Soil: 0, 0, 0, 1, 1, 0, 0, 0, 0, 0. Mean 0.2
Date 10/4/89 No data collected due to sheep interference.
Date 20/4/89
Mound: 0, 35, 5, 0, 0, 13, 3, 1, 0, 0. Mean 5.7
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 10/5/89
Mound: 8, 4, 2, 5, 0, 0, 0, 3, 0, 0. Mean 2.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 24/5/89
Mound: 22, 1, 0, 2, 52, 7, 2, 80, 6, 3. Mean 17.5
Soil: 1, 0, 0, 0, 0, 0, 0, 0, 0, 1. Mean 0.2
Date 7/6/89
Mound: 19, 7, 0, 1, 3, 9, 47, 60, 9, 11. Mean 16.6
Soil: 0, 0, 0, 0, 1, 0, 0, 2, 4, 0. Mean 0.7
Date 23/6/89
Mound: 4, 2, 30, 3, 9, 57, 39, 75, 12, 24. Mean 25.5
Soil: 2, 1, 0, 0, 0, 1, 0, 0, 1, 0. Mean 0.4
Date 19/7/89
Mound: 32, 15, 31, 0, 0, 2, 6, 4, 4, 43. Mean 13.7
Soil: 1, 1, 0, 0, 0, 0, 1, 0, 1, 0. Mean 0.4
Date 3/8/89
Mound: 9, 2, 21, 0, 58, 23, 33, 1, 1, 0. Mean 14.8
Soil: 0, 1, 0, 1, 0, 0, 1, 1, 1, 0. Mean 0.5
Date 23/8/89
Mound: 1, 0, 47, 15, 5, 40, 13, 1, 17, 3. Mean 14.2
Soil: 1, 1, 2, 0, 0, 0, 2, 1, 1, 0. Mean 0.8
Date 27/9/89
Mound: 20, 1, 21, 60, 42, 23, 66, 50, 79, 39. Mean 40.1
Soil: 1, 0, 1, 2, 6, 6, 0, 2, 2, 2. Mean 2.2
Date 30/11/89 No data collected due to sheep interference.
Date 18/1/90
Mound: 0, 1, 6, 2, 17, 1, 3, 3, 17, 2. Mean 5.2
Soil: 0, 0, 0, 0, 1, 1, 0, 0, 2, 0. Mean 0.4

QUADRAT 2, OWH SS 5

Date 15/3/89
Mound: 0, 1, 0, 1, 0, 0, 11, 0, 3, 0. Mean 1.6
Soil: 0, 0, 0, 0, 1, 0, 0, 0, 1, 0. Mean 0.2
Green woodpecker droppings seen on mounds.
Date 20/4/89
Mound: 0, 1, 0, 0, 2, 0, 0, 0, 0, 0. Mean 0.3
Soil: 0, 0, 0, 0, 0, 0, 2, 0, 0, 0. Mean 0.2
Date 10/5/89
Mound: 25, 6, 2, 1, 0, 2, 0, 1, 0, 5. Mean 4.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 23/6/89
No data collected due to sheep interference.
Date 19/7/89
No data collected due to sheep interference.
Date 3/8/89
Mound: 31, 2, 1, 0, 17, 35, 3, 12, 0, 5. Mean 10.6
Soil: 1, 0, 0, 0, 0, 0, 0, 2, 0, 0. Mean 0.3
Date 23/8/89
Mound: 19, 24, 43, 18, 27, 22, 16, 5, 5, 70. Mean 24.9
Soil: 0, 0, 7, 5, 1, 0, 2, 0, 0, 0. Mean 1.5
Date 27/9/89
Mound: 51, 68, 12, 5, 5, 41, 21, 27, 46, 31. Mean 30.7
Soil: 0, 4, 0, 0, 0, 0, 2, 2, 1, 1. Mean 1.0
Date 30/11/89 No data collected due to sheep interference.
Date 18/1/90
Mound: 27, 1, 6, 7, 20, 8, 10, 5, 6, 9. Mean 9.7
Soil: 1, 0, 3, 0, 1, 0, 0, 1, 0, 0. Mean 0.6

QUADRAT 3, OWH SS 7

Date 15/3/89
Mound: 0, 2, 0, 0, 0, 3, 0, 4, 7, 13. Mean 2.9
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 2, 0. Mean 0.2
Date 19/4/89
Mound: 1, 5, 0, 5, 2, 0, 11, 0, 2, 3. Mean 3.2
Soil: 0, 0, 0, 0, 0, 1, 0, 12, 0, 0. Mean 1.3
Date 23/6/89
Mound: 9, 6, 6, 12, 16, 1, 5, 17, 3, 13. Mean 8.8
Soil: 0, 0, 0, 0, 0, 1, 0, 0, 1, 0. Mean 0.2
Date 3/8/89
Mound: 6, 28, 44, 13, 12, 7, 20, 16, 50, 34. Mean 23.0
Soil: 3, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.3
Date 23/8/89
Mound: 61, 21, 23, 13, 56, 55, 16, 60, 24, 9. Mean 33.8
Soil: 2, 0, 0, 0, 1, 25, 0, 1, 2, 5. Mean 3.6
Date 27/9/89
Mound: 22, 11, 73, 66, 50, 44, 21, 23, 28, 76. Mean 42.4
Soil: 1, 0, 1, 0, 6, 3, 0, 0, 1, 1. Mean 1.3
Date 30/11/89
Mound: 10, 2, 33, 11, 47, 55, 22, 11, 66, 49. Mean 30.0
Soil: 1, 3, 0, 0, 4, 2, 0, 0, 0, 1. Mean 1.1
Date 18/1/90
Mound: 1, 6, 39, 40, 9, 30, 27, 3, 3, 2. Mean 16.0
Soil: 0, 1, 0, 0, 0, 1, 1, 2, 3, 2. Mean 0.7

QUADRAT 4, OWH SS 8

```
Date 10/5/89
Mound: 14,  0,  0,  0,  0,  0,  0,  0,  0,  0. Mean  1.4
 Soil:  0,  0,  0,  0,  0,  0,  0,  0,  0,  0. Mean  0
Date 23/6/89
Mound:  0,  1, 10,  7,  0, 17,  2,  4,  0,  1. Mean  4.2
 Soil:  0,  0,  0,  0,  0,  0,  0,  0,  0,  0. Mean  0
Date 19/7/89
Mound:  6,  1,  2,  0,  2,  3,  1,  1, 41, 11. Mean  6.8
 Soil:  0,  0,  1,  0,  0,  0,  0,  0,  0,  0. Mean  0.1
Date  3/8/89
Mound: 23, 23, 15,  1,  1,  0,  1,  0,  2,  0. Mean  6.6
 Soil:  0,  0,  0,  0,  0,  0,  0,  0,  0,  0. Mean  0
Date 23/8/89
Mound:  0,  4,  0, 16, 20, 13, 28,  8, 37, 57. Mean 18.3
 Soil:  0,  0,  0,  0,  0,  0,  0,  0,  0,  0. Mean  0
Date 27/9/89
Mound:  3, 28,  9, 13, 33, 44,  6, 46, 38, 55. Mean 27.5
 Soil:  0,  0,  0,  0,  0,  1,  0,  0,  1,  0. Mean  0.2
Date 30/11/89
Mound: 38, 30, 11, 33, 15, 53, 40, 75,  9, 30. Mean 33.4
 Soil:  0,  0,  0,  0,  0,  0,  0,  0,  0,  0. Mean  0
Date 18/1/90
Mound: 20, 12, 44,130, 48, 60, 30, 56, 16,  4. Mean 41.0
 Soil:  0,  0,  0,  0,  0,  1,  0,  0,  0,  0. Mean  0.1
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QUADRAT 5, OWH SS 9

Date 15/3/89
Mound: 0, 42, 3, 1, 7, 4, 1, 0, 2, 1. Mean 6.1
Soil: 0, 0, 1, 0, 0, 1, 0, 0, 0, 0. Mean 0.2
Date 10/5/89
Mound: 0, 9, 3, 5, 25, 2, 5, 9, 3, 41. Mean 10.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 23/6/89
Mound: 7, 44, 16, 1, 11, 3, 34, 7, 5, 1. Mean 13.9
Soil: 0, 0, 0, 0, 0, 0, 1, 0, 0, 1. Mean 0.2
Date 19/7/89
Mound: 30, 13, 11, 13, 12, 3, 12, 6, 6, 60. Mean 16.6
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 3/8/89
Mound: 50, 7, 12, 35, 21, 5, 31, 0, 21, 0. Mean 18.2
Soil: 1, 0, 0, 0, 0, 0, 0, 2, 0, 0. Mean 0.3
Date 23/8/89
Mound: 10, 27, 22, 66, 26, 26, 26, 23, 44, 6. Mean 27.6
Soil: 3, 0, 0, 2, 2, 2, 0, 1, 0, 0. Mean 1.0
Date 27/9/89
No data collected due to sheep interference.
Date 30/11/89
No data collected due to sheep interference.
Date 18/1/90
No data collected due to sheep interference.

QUADRAT 6, OWH SS11

Date 2/3/89
Mound: 62, 1, 0, 0, 1, 3, 0, 39, 2, 0. Mean 10.8
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 15/3/89 No data collected due to sheep interference.
Date 10/4/89
Mound: 8, 1, 0, 5, 0, 0, 13, 1, 4, 13. Mean 4.5
Soil: 1, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.1
Date 19/4/89 No data collected due to sheep interference.
Date 10/5/89
Mound: 7, 19, 11, 14, 1, 8, 2, 49, 10, 11. Mean 13.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 24/5/89
Mound: 2, 38, 12, 45, 4, 75, 8, 1, 1, 4. Mean 18.8
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 7/6/89
Mound: 60, 35, 0, 12,130, 55, 30, 40, 40, 0. Mean 40.2
Soil: 0, 0, 0, 0, 0, 1, 0, 0, 0, 0. Mean 0.1
Date 23/6/89
Mound: 46, 19, 31, 22, 1, 0, 37, 30, 26, 26. Mean 23.8
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 19/7/89
Mound: 12, 14, 17, 1, 3, 13, 23,135, 28, 55. Mean 30.1
Soil: 0, 0, 1, 2, 0, 0, 0, 0, 0, 0. Mean 0.3
Date 3/8/89
Mound: 19, 33, 47, 25, 27, 7, 16, 29, 53, 22. Mean 27.8
Soil: 2, 0, 2, 0, 2, 2, 6, 0, 4, 1. Mean 1.9
Date 23/8/89
Mound: 4, 0, 30, 31, 41, 16, 42, 32, 51, 31. Mean 27.8
Soil: 1, 0, 1, 3, 2, 1, 2, 0, 5, 0. Mean 1.5
Date 27/9/89
Mound: 28, 48, 3, 68, 51, 51, 31, 38,130, 75. Mean 52.3
Soil: 2, 0, 0, 2, 1, 0, 0, 0, 4, 3. Mean 1.2
Date 30/11/89
Mound: 5, 0, 18, 11, 4, 25, 39, 0, 5, 56. Mean 15.3
Soil: 0, 1, 0, 9, 0, 1, 0, 0, 0, 1. Mean 1.2
Date 18/1/90
Mound: 46, 5, 42, 34, 0, 1, 15, 36, 35, 7. Mean 22.1
Soil: 0, 0, 1, 0, 0, 2, 1, 2, 1, 0. Mean 0.7

QUADRAT 7, OWH SS12

Date 15/3/89
Mound: 0, 0, 5, 1, 6, 16, 0, 1, 13, 0. Mean 4.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 10/5/89
Mound: 0, 4, 2, 0, 9, 10, 1, 0, 20, 0. Mean 4.6
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 23/6/89
Mound: 8, 17, 42, 22, 6, 40, 0, 5, 21, 28. Mean 18.9
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 19/7/89
Mound: 57, 85, 51, 17, 13, 15, 6, 26, 5, 70. Mean 34.5
Soil: 1, 0, 0, 0, 0, 1, 0, 0, 0, 1. Mean 0.3
Date 3/8/89
Mound: 24, 26, 53, 70, 2, 29, 22, 5, 90, 0. Mean 32.1
Soil: 0, 3, 0, 0, 0, 0, 0, 0, 0, 1. Mean 0.4
Date 23/8/89
Mound:125,100, 35, 70, 22,100, 14, 9, 68, 8. Mean 55.1
Soil: 0, 5, 0, 5, 0, 0, 0, 0, 0, 0. Mean 1.0
Date 27/9/89
Mound: 20, 16, 66, 6, 17, 53, 54, 16, 39,103. Mean 39.0
Soil: 0, 0, 0, 0, 0, 1, 0, 1, 0, 0. Mean 0.2
Date 30/11/89
Mound: 17, 4, 50, 70, 3, 4, 50, 7, 10, 62. Mean 27.7
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 18/1/90
Mound: 1, 6, 39, 40, 9, 30, 27, 3, 3, 2. Mean 16.0
Soil: 0, 1, 0, 0, 0, 1, 1, 2, 3, 2. Mean 0.7

QUADRAT 8, OWH NFS

Date 2/3/89 No data collected due to sheep interference.
Date 15/3/89 No data collected due to sheep interference.

Date 10/4/89												
Mound:	8,	5,	7,	6,	0,	1,	0,	2,	2,	1.	Mean	3.2
Soil:	0,	0,	0,	0,	0,	0,	0,	0,	0,	1.	Mean	0.1
Date 19/4/89												
Mound:	0,	1,	0,	0,	0,	2,	1,	3,	0,	0.	Mean	0.7
Soil:	0,	0,	0,	0,	0,	0,	0,	0,	0,	0.	Mean	0
Date 10/5/89												
Mound:	0,	0,	1,	0,	1,	0,	6,	0,	0,	40.	Mean	4.8
Soil:	0,	0,	0,	0,	0,	0,	0,	0,	0,	0.	Mean	0
Date 24/5/89												
Mound:	11,	1,	0,	13,	3,	10,	0,	1,	14,	13.	Mean	6.6
Soil:	0,	0,	0,	0,	0,	0,	0,	0,	0,	0.	Mean	0
Date 7/6/89												
Mound:	14,	7,	8,	19,	21,	40,	38,	4,	16,	5.	Mean	17.2
Soil:	1.	0,	0,	1,	0,	0,	0,	0,	0,	0.	Mean	0.1
Date 23/6/89												
Mound:	27,	86,	31,	4,	36,	1,	1,	20,	59,	13.	Mean	27.8
Soil:	0,	0,	0,	0,	0,	0,	1,	0,	0,	2.	Mean	0.3
Date 19/7/89												
Mound:	90,	11,	67,	22,	38,	6,	21,	17,	4,	12.	Mean	28.8
Soil:	0,	1,	0,	0,	0,	0,	0,	2,	0,	2.	Mean	0.5
Date 3/8/89												
Mound:	61,	21,	26,	79,	67,	23,	17,	43,	21,	19.	Mean	37.7
Soil:	0,	0,	0,	0,	0,	0,	0,	0,	1,	0.	Mean	0.1
Date 23/8/89												
Mound:	40,	59,	4,	0,	65,	60,	4,	47,	50,	4.	Mean	33.3
Soil:	0,	1,	0,	1,	0,	2,	0,	0,	0,	0.	Mean	0.4
Date 27/9/89												
Mound:	35,	79,	17,	63,	78,	65,	0,	50,	43,	67.	Mean	49.7
Soil:	0,	0,	1,	0,	1,	2,	2,	0,	0,	0.	Mean	0.6
Date 30/11/89												
Mound:	52,	75,	15,	3,	26,	41,	24,	54,	36,	23.	Mean	34.9
Soil:	1,	1,	0,	0,	0,	0,	3,	0,	0,	0.	Mean	0.5
Date 18/1/90												
Mound:	22,	56,	55,	54,	64,	37,	63,	22,	32,	24.	Mean	42.9
Soil:	2,	1,	0,	2,	0,	0,	0,	1,	0,	4.	Mean	1.0

QUADRAT 9, OWH C10

Date 2/3/89
Mound: 0, 11, 14, 4, 24, 10, 4, 16, 2, 0. Mean 8.5
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
A few patches of fewmets observed. Occasional green woodpecker droppings seen on mounds.
Date 15/3/89
Mound: 25, 4, 11, 12, 18, 4, 1, 0, 1, 0. Mean 7.6
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Patches of fewmets seen.
Date 10/4/89
Mound: 2, 20, 1, 16, 2, 8, 24, 3, 10, 0. Mean 8.6
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 19/4/89
Mound: 2, 0, 15, 0, 2, 1, 19, 41, 7, 25. Mean 10.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 10/5/89
Mound: 0, 0, 0, 2, 0, 8, 9, 0, 50, 0. Mean 6.9
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 24/5/89
Mound: 0, 0, 15, 6, 4, 4, 0, 4, 14, 4. Mean 5.1
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 7/6/89
Mound: 0, 4, 1, 5, 0, 2, 0, 0, 0, 0. Mean 1.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 23/6/89
Mound: 2, 6, 1, 1, 14, 0, 0, 4, 17, 2. Mean 4.7
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 19/7/89
Mound: 19, 15, 35, 6, 8, 5, 6, 12, 11, 2. Mean 11.9
Soil: 0, 0, 0, 1, 0, 0, 0, 0, 11, 0. Mean 1.2
Date 3/8/89
Mound: 9, 29, 1, 12, 4, 5, 2, 6, 11, 10. Mean 8.9
Soil: 0, 0, 1, 0, 0, 0, 0, 0, 1, 1. Mean 0.3
Date 23/8/89
Mound: 9, 9, 10, 5, 2, 24, 5, 4, 15, 30. Mean 11.3
Soil: 2, 0, 0, 0, 0, 0, 0, 0, 1, 0. Mean 0.3
Date 27/9/89
Mound: 16, 25, 57, 14, 4, 36, 43, 38, 2, 37. Mean 27.2
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 30/11/89
Mound: 7, 5, 33, 9, 14, 11, 11, 4, 4, 7. Mean 10.5
Soil: 1, 0, 0, 0, 0, 0, 1, 0, 0, 0. Mean 0.2
Date 18/1/90
Mound: 22, 8, 13, 37, 10, 6, 54, 34, 15, 4. Mean 20.3
Soil: 0, 0, 0, 0, 0, 0, 0, 2, 3, 2. Mean 0.7

QUADRAT 10, AR 11

Date 13/4/89
Mound: 57, 0, 32, 18, 2, 3, 14, 7, 0, 1. Mean 13.4
Soil: 0, 0, 2, 0, 1, 3, 2, 2, 0, 3. Mean 1.5
Green woodpecker seen and heard.
Lots of rabbit scraping and digging.
Date 25/5/89
Mound: 22, 1, 30, 2, 23, 1, 12, 80, 2, 11. Mean 19.4
Soil: 1, 0, 0, 0, 3, 0, 1, 0, 1, 1. Mean 0.7
Date 4/7/89
Mound: 11, 1, 8, 9, 86, 18, 3, 1, 7, 19. Mean 16.3
Soil: 6, 1, 1, 1, 3, 1, 3, 0, 7, 2. Mean 2.5
Date 20/7/89
Mound: 4, 27, 43, 3, 1, 7, 8, 7, 5, 0. Mean 10.5
Soil: 0, 0, 6, 3, 3, 2, 2, 0, 0, 2. Mean 1.8
Date 15/8/89
Mound: 12, 4, 10, 2, 13, 28, 20, 46, 46, 19. Mean 20.0
Soil: 4, 0, 1, 6, 5, 1, 2, 4, 1, 7. Mean 3.1
Date 24/8/89
Mound: 30, 1, 45, 68, 62, 37, 40, 18, 27, 31. Mean 35.9
Soil: 0, 1, 0, 6, 2, 9, 3, 11, 1, 18. Mean 5.1
Date 28/9/89
Mound: 13, 3, 3, 10, 5, 8, 4, 30, 10, 12. Mean 9.8
Soil: 0, 29, 13, 8, 9, 4, 3, 0, 1, 1. Mean 6.8
Date 20/11/89
Mound: 7, 1, 6, 1, 9, 28, 29, 37, 1, 15. Mean 13.4
Soil: 0, 1, 4, 1, 0, 0, 4, 4, 0, 1. Mean 1.5
Date 12/1/90
Mound: 23, 16, 2, 2, 11, 5, 10, 2, 7, 1. Mean 7.9
Soil: 37, 1, 3, 0, 0, 0, 1, 0, 0, 0. Mean 4.2

QUADRAT 11, AR 12

Date 13/4/89
Mound: 50, 23, 3, 0, 1, 2, 0, 1, 4, 2. Mean 8.6
Soil: 0, 1, 0, 1, 0, 1, 0, 1, 0, 1. Mean 0.5
Date 25/5/89
Mound: 4,140, 1, 7, 75, 5, 1, 7, 4, 1. Mean 24.5
Soil: 0, 1, 0, 3, 3, 6, 8, 0, 0, 1. Mean 2.2
Date 4/7/89
Mound: 61, 62, 8, 11, 20, 2,115, 37, 12, 8. Mean 33.6
Soil: 1, 1, 3, 0, 25, 1, 2, 0, 0, 0. Mean 3.3
Date 20/7/89
Mound: 70,135, 27, 36, 60, 38, 48, 9, 0, 67. Mean 49.0
Soil: 3, 4, 1, 3, 5, 7, 3, 2, 6, 0. Mean 3.4
Date 15/8/89
Mound: 1, 75, 33, 0, 4, 24, 17, 30, 40, 2. Mean 22.6
Soil: 1, 17, 1, 0, 0, 0, 4, 6, 1, 9. Mean 3.9
Date 24/8/89
Mound: 13, 41, 19, 10, 5, 80, 12, 84, 17, 44. Mean 32.5
Soil: 1, 6, 3, 7, 5, 1, 9, 1, 2, 2. Mean 3.7
Date 28/9/89
Mound: 67, 85, 18, 40, 12, 25,110, 20, 18, 59. Mean 45.4
Soil: 4, 10, 0, 12, 2, 5, 3, 1, 4, 1. Mean 4.2
Date 20/11/89
Mound: 12, 2, 47, 2, 12, 14, 15, 67, 9, 31. Mean 21.1
Soil: 1, 1, 0, 3, 2, 0, 5, 4, 1, 0. Mean 1.8
Date 12/1/90
Mound: 6, 11, 6, 36, 8, 4, 5, 6, 3, 15. Mean 10.0
Soil: 4, 4, 1, 3, 1, 0, 0, 0, 1, 9. Mean 2.3

QUADRAT 12, AR 15

Date 16/3/89
Mound: 80, 5, 46, 0, 44, 32, 2, 0, 25, 42. Mean 26.9
Soil: 2, 0, 0, 0, 10, 3, 1, 0, 0, 0. Mean 1.6
Date 13/4/89 No data collected due to sheep inteference.
Date 3/5/89
Mound: 3, 1, 1, 0, 13. Mean 3.6
Soil: 0, 0, 1, 0, 0. Mean 0.2
Date 25/5/89
Mound: 3, 2, 10, 3, 1, 0, 3, 2, 4, 1. Mean 2.7
Soil: 2, 2, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.4
Date 9/6/89
Mound: 1, 1, 9, 0, 0, 11, 13, 0, 39, 0. Mean 7.4
Soil: 0, 0, 1, 1, 0, 2, 0, 0, 1, 1. Mean 0.6
Date 4/7/89
Mound: 14, 23, 3, 22, 5, 21, 9, 0, 1, 1. Mean 9.9
Soil: 7, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.7
Date 20/7/89
Mound: 5, 14, 2, 11, 13, 8, 4, 8, 33, 23. Mean 12.1
Soil: 0, 0, 0, 4, 0, 0, 1, 0, 0, 0. Mean 0.5
Date 15/8/89
Mound: 22, 9, 19, 5, 7, 18, 7, 1, 26, 37. Mean 16.1
Soil: 0, 0, 4, 0, 0, 1, 0, 0, 0, 0. Mean 0.5
Date 24/8/89
Mound: 7, 2, 26, 19, 19, 5, 78, 2, 16, 51. Mean 22.5
Soil: 0, 0, 2, 0, 1, 8, 0, 1, 0, 0. Mean 1.2
Date 28/9/89
Mound: 28, 13, 14, 7, 20, 1, 6, 11, 8, 14. Mean 12.2
Soil: 0, 0, 0, 0, 0, 2, 2, 2, 0, 0. Mean 0.6
Date 20/11/89
Mound: 20, 33, 2, 45, 4, 29, 17, 68, 9, 6. Mean 23.3
Soil: 0, 0, 0, 0, 3, 0, 0, 0, 0, 2. Mean 0.5
Date 12/1/90
Mound: 30, 5, 5, 11, 38, 1, 3, 8, 20, 14. Mean 13.5
Soil: 0, 0, 2, 0, 0, 0, 0, 0, 0, 0. Mean 0.2

QUADRAT 13, AR 16

Date 16/3/89
Mound: 17, 16, 7, 4, 10, 1, 1, 3, 0, 0. Mean 5.9
Soil: 0, 1, 0, 0, 0, 0, 0, 0, 0, 2. Mean 0.3
Date 13/4/89 No data collected due to sheep interference.
Date 3/5/89
Mound: 31, 20, 9, 0, 77. Mean 27.4
Soil: 0, 0, 0, 0, 0. Mean 0
Date 25/5/89
Mound: 0, 19, 24, 4, 7, 51, 25, 1, 37, 80. Mean 24.8
Soil: 3, 0, 2, 2, 1, 1, 0, 0, 4, 0. Mean 1.3
Date 9/6/89
Mound: 0, 45, 26, 18, 0, 40, 18, 63, 7, 16. Mean 23.4
Soil: 0, 0, 1, 0, 0, 0, 1, 0, 0, 0. Mean 0.2
Date 4/7/89
Mound: 0, 36, 60, 7, 58, 44, 80, 0, 10, 7. Mean 24.5
Soil: 0, 0, 0, 0, 4, 0, 2, 0, 0, 4. Mean 1.0
Date 20/7/89
Mound: 62, 3, 68, 35, 30, 2, 23, 28, 0, 47. Mean 29.8
Soil: 0, 2, 0, 2, 0, 0, 0, 0, 1, 0. Mean 0.5
Date 15/8/89
Mound: 39, 17, 95, 25, 66, 32, 0, 75, 0,107. Mean 45.6
Soil: 1, 0, 0, 1, 0, 0, 2, 3, 0, 1. Mean 0.8
Date 24/8/89
Mound: 55, 25, 2, 82, 47, 37, 45, 60, 11, 66. Mean 43.0
Soil: 0, 0, 0, 0, 0, 4, 0, 2, 0, 0. Mean 0.6
Date 28/9/89
Mound: 27, 19, 93, 16, 30,100, 30, 14,103, 80. Mean 51.2
Soil: 0, 0, 0, 0, 0, 4, 0, 0, 0, 0. Mean 0.4
Date 20/11/89
Mound: 1, 72,130,110, 56, 26, 8, 16, 50, 80. Mean 54.9
Soil: 0, 0, 0, 2, 0, 1, 0, 0, 0, 0. Mean 0.3
Date 12/1/90
Mound: 36, 32, 80, 15, 62, 36, 42, 10, 60, 5. Mean 37.8
Soil: 0, 0, 0, 0, 0, 0, 5, 0, 0, 1. Mean 0.6

QUADRAT 14, AR 5

Date 13/4/89											
Mound:	3,	2,	27,	3,	0,	1,	1,	0,	1,	0.	Mean 3.8
Soil:	0,	0,	0,	1,	2,	0,	0,	0,	0,	0.	Mean 0.3
Date 25/5/89											
Mound:	18,	80,	3,	25,	75,	1,	0,	35,	7,	2.	Mean 24.6
Soil:	0,	0,	0,	0,	0,	0,	2,	0,	0,	0.	Mean 0.2
Date 4/7/89											
Mound:	96,	80,	43,	48,	76,	7,	7,	43,	12,	43.	Mean 45.5
Soil:	1,	0,	0,	3,	0,	0,	1,	3,	1,	0.	Mean 0.9
Date 12/7/89											
Mound:	51,	11,	60,	103,	70,	110,	36,	79,	18,	22.	Mean 56.0
Soil:	0,	1,	1,	0,	0,	0,	0,	0,	0,	1.	Mean 0.3
Date 15/8/89											
Mound:	26,	34,	125,	82,	34,	130,	8,	3,	3,	76.	Mean 52.1
Soil:	0,	1,	0,	0,	0,	0,	0,	0,	1,	2.	Mean 0.4
Date 24/8/89											
Mound:	59,	19,	105,	67,	11,	72,	63,	19,	80,	135.	Mean 63.0
Soil:	2,	8,	8,	3,	0,	6,	1,	0,	1,	3.	Mean 3.2
Date 28/9/89											
Mound:	65,	10,	110,	51,	66,	12,	27,	2,	80,	73.	Mean 49.6
Soil:	0,	1,	0,	0,	1,	0,	2,	0,	0,	0.	Mean 0.4
Date 20/11/89											
Mound:	100,	130,	63,	35,	110,	15,	28,	100,	125,	11.	Mean 71.7
Soil:	0,	1,	1,	3,	7,	1,	0,	2,	8,	19.	Mean 4.2
Date 12/1/90											
Mound:	33,	90,	40,	4,	39,	9,	47,	33,	70,	50.	Mean 41.4
Soil:	1,	2,	2,	0,	0,	2,	0,	0,	0,	4.	Mean 1.1

QUADRAT 15, AR NWS

Date 13/4/89
Mound: 36, 2, 27, 26, 4, 2, 11, 6, 35, 1. Mean 15.0
Soil: 0, 0, 1, 0, 0, 0, 0, 0, 0, 0. Mean 0.1
Lots of rabbit digging and scraping evident.
Date 24/5/89
Mound: 10, 11, 18, 50, 10, 5, 4, 0, 11, 16. Mean 13.5
Soil: 0, 1, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.1
Date 4/7/89
Mound: 35, 49, 26, 18,112, 50, 59, 11, 7, 28. Mean 39.5
Soil: 0, 3, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.3
Date 20/7/89
Mound: 8,110, 2, 11, 35, 8, 58, 45, 11, 32. Mean 32.0
Soil: 0, 0, 0, 0, 0, 1, 0, 0, 0, 0. Mean 0.1
Date 15/8/89
Mound: 9, 36, 28, 28, 72, 14, 50,135, 5, 23. Mean 40.0
Soil: 1, 1, 7, 1, 0, 0, 0, 0, 0, 0. Mean 1.0
Date 24/8/89
Mound: 38, 22, 60,120, 31, 5, 20, 15, 50, 1. Mean 36.2
Soil: 0, 0, 1, 0, 0, 1, 0, 0, 0, 1. Mean 0.3
Date 28/9/89
Mound: 7, 63, 23,122, 24, 65, 47, 21, 35, 6. Mean 41.3
Soil: 0, 0, 0, 0, 1, 0, 0, 0, 0, 0. Mean 0.1
Date 20/11/89
Mound: 59, 72, 26, 67, 61, 41, 11, 18, 50, 1. Mean 40.6
Soil: 0, 0, 2, 0, 0, 0, 0, 1, 0, 0. Mean 0.3
Date 12/1/90
Mound: 0, 0,100, 0, 29, 24, 40, 36, 0, 38. Mean 16.7
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0

QUADRAT 16, MD 7B

Date 1/3/89
Mound: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 29/3/89
Mound: 1, 0, 0, 0, 0, 0, 1, 0, 0, 0. Mean 0.2
Soil: 0, 0, 0, 0, 0, 0, 0, 1, 0, 0. Mean 0.1
Date 12/4/89 No data collected due to sheep interference.
Date 26/4/89
Mound: 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0. Mean 0
Date 18/5/89
Mound: 1, 0, 1, 0, 0. Mean 0.4
Soil: 0, 0, 0, 0, 0. Mean 0
Date 1/6/89
Mound: 1, 0, 0, 0, 0. Mean 0.2
Soil: 0, 0, 0, 0, 0. Mean 0
Date 8/6/89
Mound: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 22/6/89
Mound: 0, 0, 0, 0, 0, 0, 1, 0, 0, 0. Mean 0.1
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 12/7/89
Mound: 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0. Mean 0
Date 2/8/89
Mound: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 22/8/89
Mound: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 26/9/89
Mound: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 29/11/89
Mound: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 17/1/90
Mound: 0, 0, 0, 0, 0, 3, 0, 0, 0, 0. Mean 0.3
Soil: 0, 0, 0, 0, 0, 0, 1, 1, 0, 0. Mean 0.2

QUADRAT 17, MD 4A

Date 1/3/89
Mound: 0, 6, 0, 0, 6, 0, 6, 6, 0, 0. Mean 2.4
Soil: 0, 2, 1, 4, 1, 0, 0, 0, 0, 0. Mean 0.8
Date 29/3/89
Mound: 4, 0, 2, 3, 0, 3, 0, 2, 2, 0. Mean 1.6
Soil: 0, 0, 0, 0, 0, 0, 0, 2, 1, 0. Mean 0.3
Date 12/4/89
Mound: 11, 0, 0, 0, 2, 0, 0, 2, 11, 14. Mean 4.0
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 26/4/89
Mound: 8, 0, 8, 0, 3. Mean 3.8
Soil: 0, 0, 0, 0, 0. Mean 0
Date 18/5/89
Mound: 0, 2, 6, 8, 12. Mean 5.6
Soil: 0, 0, 0, 0, 0. Mean 0.2
Date 1/6/89
Mound: 8, 2, 10, 8, 4. Mean 6.4
Soil: 0, 0, 0, 0, 0. Mean 0
Date 8/6/89
Mound: 3, 3, 1, 9, 3, 0, 17, 15, 0, 1. Mean 5.2
Soil: 0, 0, 0, 0, 0, 0, 1, 0, 0, 0. Mean 0.1
Date 22/6/89
Mound: 8, 0, 3, 6, 2, 0, 8, 5, 6, 1. Mean 3.9
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 12/7/89
Mound: 68, 13, 13, 5, 7. Mean 10.6
Soil: 0, 0, 1, 0, 0. Mean 0.1
Date 2/8/89
Mound: 15, 5, 8, 26, 8, 72, 1, 11, 5, 25. Mean 17.6
Soil: 4, 0, 1, 1, 1, 0, 0, 0, 60, 0. Mean 6.7
Date 22/8/89
Mound:128, 92, 1, 11, 68, 25, 95, 97, 24, 47. Mean 58.8
Soil: 1, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.1
Date 26/9/89
Mound: 55, 9,145, 15, 25, 90, 31, 17, 63, 10. Mean 46.0
Soil: 0, 0, 0, 0, 1, 0, 0, 0, 0, 0. Mean 0.1
Date 29/11/89
No data collected due to sheep interference.
Date 17/1/90
No data collected due to sheep interference.

QUADRAT 18, MD 4B

Date 1/3/89
Mound: 2, 7, 4, 0, 3, 0, 4, 1, 2, 0. Mean 2.3
Soil: 0, 0, 1, 0, 0, 0, 0, 0, 0, 0. Mean 0.1
Date 29/3/89
Mound: 4, 0, 2, 2, 0, 0, 0, 1, 0, 0. Mean 0.9
Soil: 3, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.3
Date 12/4/89
Mound: 0, 0, 0, 1, 0, 1, 0, 10, 2, 5. Mean 1.9
Soil: 1, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0.1
Green woodpecker droppings seen on mounds.
Date 26/4/89 No data collected due to sheep interference.
Date 18/5/89
Mound: 0, 2, 0, 0, 0. Mean 0.4
Soil: 0, 0, 0, 0, 0. Mean 0
Date 1/6/89
Mound: 4, 2, 4, 6, 1. Mean 3.4
Soil: 2, 0, 0, 0, 0. Mean 0.4
Date 8/6/89
No data collected due to sheep interference.
Date 22/6/89
No data collected due to sheep interference.
Date 12/7/89
No data collected due to sheep interference.
Date 2/8/89
Mound: 9, 41, 17, 16, 53, 7, 5, 1, 9, 49. Mean 20.7
Soil: 2, 0, 1, 0, 0, 0, 2, 3, 0, 0. Mean 0.8
Date 22/8/89
Mound: 25,170, 22, 65, 7, 13, 30, 4, 47, 32. Mean 41.5
Soil: 0, 8, 0, 10, 0, 1, 0, 17, 3, 6. Mean 4.5
Date 26/9
Mound: 5, 56, 9, 84, 53, 80, 43, 19, 73, 82. Mean 50.4
Soil: 0, 1, 10, 3, 1, 0, 0, 2, 3, 2. Mean 2.2
Date 29/11/89
Mound: 10, 36, 55, 33, 2, 2, 34, 24, 0, 5. Mean 20.5
Soil: 0, 2, 0, 2, 0, 3, 0, 1, 3, 1. Mean 1.2
Date 17/1/90
Mound: 7, 3, 14, 2, 0, 13, 65, 8, 4, 6. Mean 12.2
Soil: 0, 0, 0, 2, 0, 0, 0, 0, 0, 0. Mean 0.2

QUADRAT 19, MD 3B

Date 1/3/89 No data collected due to sheep interference.
Date 29/3/89
Mound: 0, 1, 1, 1, 11, 5, 1, 2, 6, 4. Mean 3.2
Soil: 0, 0, 0, 0, 1, 0, 0, 0, 0, 0. Mean 0.1
Date 12/4/89
Mound: 1, 1, 2, 1, 2, 6, 1, 0, 8, 2. Mean 2.4
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Mean 0
Date 26/4/89
Mound: 14, 5, 9, 7, 2. Mean 7.4
Soil: 0, 0, 0, 0, 0. Mean 0
Date 18/5/89
Mound: 2, 11, 5, 15, 14. Mean 9.4
Soil: 1, 0, 0, 0, 0. Mean 0.2
Date 1/6/89
Mound: 57, 5, 8, 15, 3. Mean 17.6
Soil: 0, 0, 0, 0, 11. Mean 2.2
Date 8/6/89
Mound: 45, 30, 8, 6, 2, 40, 1, 6, 3, 8. Mean 14.9
Soil: 1, 5, 0, 0, 1, 1, 0, 1, 0, 6. Mean 1.5
Date 22/6/89
Mound: 70, 3, 7, 7, 1, 32, 6, 2, 44, 10. Mean 18.2
Soil: 3, 0, 0, 0, 0, 0, 1, 0, 0, 0. Mean 0.4
Date 12/7/89
Mound: 10, 25, 20, 62, 8. Mean 12.5
Soil: 0, 0, 4, 0, 0. Mean 0.4
Date 2/8/89
Mound: 18, 2, 3, 21, 33, 8, 9, 28, 1, 50. Mean 17.3
Soil: 0, 0, 0, 0, 0, 0, 0, 0, 3, 0. Mean 0.3
Date 22/8/89
Mound: 52, 6, 92, 5, 5, 0, 2, 71, 15, 25. Mean 27.3
Soil: 8, 0, 1, 5, 1, 1, 0, 0, 0, 3. Mean 1.9
Date 26/9/89
Mound: 5, 6, 3, 14, 27, 12, 17, 3, 0, 43. Mean 13.0
Soil: 5, 2, 0, 0, 0, 0, 1, 1, 0, 0. Mean 0.9
Date 29/11/89
Mound: 7, 9, 2, 42, 1, 8, 2, 12, 13, 4. Mean 10.0
Soil: 1, 2, 1, 1, 0, 1, 1, 0, 0, 2. Mean 0.9
Date 17/1/90
Mound: 66, 8, 3, 1, 27, 17, 2, 9, 34, 20. Mean 18.7
Soil: 0, 1, 0, 0, 1, 0, 0, 0, 1, 0. Mean 0.3

APPENDIX ELEVEN

The calculation of the 1st to the 5th nearest neighbours from the mound coordinates.

The computer program shown overleaf could be adapted for use with a variety of systems. It was written to work on a BBC system (BBC B or MASTER microcomputers).

The raw data, the coordinates of the mounds, is put into a file using the statistics package, STATCALC. The first part of the program loads this data from the STATCALC file into the matrix X. The program then calculates the distance from the first mound to all of the other mounds in the quadrat and selects the five smallest values, the 1st to the 5th nearest neighbour distances.

These results are then printed out. The program has been written for the computer to be connected to a QUME printer, lines 260 and 270 establish the correct connection to the printer. Line 290 switches the link on. The program prints out the results from the first 50 mounds and then pauses for the next sheet of A4 paper to be placed in the printer.

At the end of the printing out the program gives the total distance to each nearest neighbour and the mean distance. Both figures can be used in nearest neighbour analyses.

The output from this program is that seen in the following Appendix, number TWELVE. The data is presented as it was printed out by the program.

```
 10 Q=0:R=0:S=0:T=0:U=0
 20*FX4,1
 30MODE 7
 40 M$=STRING$(155,""):X$=STRING$(15,""):CHAR%=12
 50 INPUT "WHAT QUADRAT IS THIS"Z$
 60INPUT "WHAT IS NAME OF FILE TO RETREIVE"F$
 70F=OPENUP(F$):INPUT#F,M$,N%,V%
 80 DIM X(N%-1,V%-1):DIM G(N%-1,4)
 90FOR I = 0 TO N%-1
100FOR J = 0 TO 4:G(I,J) = 900:NEXT J:NEXT I
110FOR I=0 TO N%-1:FOR J=0 TO V%-1:INPUT#F,X$:PRINT X$:X(I,J)=VAL(X$)
120PRINT X(I,J):NEXT J:NEXT I:CLOSE#F
130 FOR P=0 TO N%-1
140FOR I = 0 TO N%-1:IF P = I THEN GOTO 210
150D = X(I,0)-X(P,0)
160E = X(I,1)-X(P,1)
170F= D^2+E^2
180 H= SQR(F)
190IF H>G(P,4) OR H=G(P,4) THEN GOTO210
200IF H<G(P,4) THEN GOSUB 550
210 NEXT I
220 NEXT P
230 FOR I=0TON%-1
240 Q=Q+G(I,0):R=R+G(I,1):S=S+G(I,2):T=T+G(I,3):U=U+G(I,4)
250 NEXT I
260*FX5,2
270*FX8,7
280 PRINT "READY": C$ = GET$
290VDU2
300 GOSUB 710
310FOR I=0TON%-1
320@%=10
330 IF I = 50 THEN GOSUB 700
340 IF I = 100 THEN GOSUB 700
350 IF I = 150 OR I = 200 THEN GOSUB 700
360 IF I = 200 OR I = 250 THEN GOSUB 700
370 PRINT I+1;
380  @%=131594
390 PRINT G(I,0),G(I,1),G(I,2),G(I,3),G(I,4)
400 @%=10
410 NEXT I
420 @%=&0002040A
430 PRINT:PRINT
440 C$ = GET$
450 PRINT "     TOTALS AND MEANS"
460PRINT:PRINT"     1ST NEAREST NEIGHBOUR -  "Q,Q/(N%-1)
470PRINT:PRINT"     2ND NEAREST NEIGHBOUR -  "R,R/(N%-1)
480PRINT:PRINT"     3RD NEAREST NEIGHBOUR -  "S,S/(N%-1)
490PRINT:PRINT"     4TH NEAREST NEIGHBOUR -  "T,T/(N%-1)
500PRINT:PRINT"     5TH NEAREST NEIGHBOUR -  "U,U/(N%-1)
```

```
510 @%=10
520 VDU3
530*FX4,0
540 END
550 Z=10
560 FOR L = 0 TO 4
570 IF H<G(P,L) OR H=G(P,L) THEN Z=L
580 IF Z=L GOTO 600
590 NEXT L
600 IF Z = 0 THEN GOTO 610 ELSE GOTO 620
610 G(P,4)=G(P,3):G(P,3)=G(P,2):G(P,2)=G(P,1):G(P,1)=G(P,0):G(P,0)=H:RETURN
620 IF Z=1 THEN GOTO 630 ELSE GOTO 640
630  G(P,4)=G(P,3):G(P,3)=G(P,2):G(P,2)=G(P,1):G(P,1)=H:RETURN
640 IF Z=2 THEN GOTO 650 ELSE GOTO 660
650  G(P,4)=G(P,3):G(P,3)=G(P,2):G(P,2)=H:RETURN
660 IF Z=3 THEN GOTO 670 ELSE GOTO 680
670  G(P,4)=G(P,3):G(P,3)=H:RETURN
680  G(P,4)=H:RETURN
690 END
700 C$ = GET$
710PRINT "      QUADRAT "Z$:PRINT
720 PRINT"      NEAREST NEIGHBOURS":PRINT
730PRINT"      NEST           1          2          3          4          5"
740 RETURN
```

APPENDIX TWELVE

The distances to the first to fifth nearest neighbours of all ant mounds as calculated by the computer program.

This Appendix shows the output from the computer program shown in the previous Appendix. The output is shown exactly as the computer program produces it.

The output is given for each sample quadrat in turn.

Further details on the analysis of the data are given in Chapter Fourteen and Appendix Twelve.

QUADRAT OWH SS4

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.74	3.24	3.25	4.39	4.65
2	1.74	2.45	2.99	3.44	4.22
3	2.10	2.28	2.45	2.66	2.74
4	1.01	1.72	2.66	2.71	2.99
5	0.81	1.01	1.70	2.28	2.65
6	0.81	1.07	1.72	2.02	2.02
7	1.07	1.49	1.70	2.05	2.38
8	0.68	1.51	1.90	2.02	2.38
9	0.68	1.72	2.02	2.02	2.05
10	1.28	1.51	1.88	2.02	2.55
11	1.28	2.77	2.82	3.30	3.30
12	0.70	1.40	1.72	1.88	1.90
13	3.02	3.25	3.36	3.41	3.95
14	1.05	1.21	2.06	3.24	3.41
15	1.00	1.21	1.90	2.03	3.02
16	1.00	1.05	1.05	2.73	3.35
17	1.05	1.90	2.06	2.42	2.65
18	2.03	2.10	2.73	3.04	3.24
19	1.49	2.56	2.75	2.81	2.96
20	0.90	1.16	2.16	2.48	2.62
21	0.70	0.96	1.72	2.16	2.28
22	0.67	0.90	1.84	2.48	2.61
23	0.67	1.16	2.00	2.15	2.55
24	0.96	1.00	1.40	2.58	2.62
25	1.00	1.72	2.00	2.32	2.48
26	2.01	2.11	2.72	2.77	3.43
27	2.11	2.13	2.29	2.83	3.24
28	1.06	1.53	2.01	2.29	2.41
29	0.73	1.06	1.45	2.13	2.77
30	0.73	0.91	1.53	2.83	3.43
31	0.91	1.45	2.41	3.24	4.22
32	1.79	1.94	3.41	3.42	3.75
33	1.79	1.96	2.01	2.17	3.00
34	1.96	2.29	2.42	2.59	2.98
35	1.70	2.59	2.65	2.96	3.39
36	2.06	2.08	2.35	2.45	2.55
37	1.70	1.83	2.34	2.81	3.21
38	0.98	1.14	1.56	1.65	1.84
39	1.14	1.83	1.89	2.07	2.31
40	0.76	0.86	0.98	1.46	1.98
41	0.60	0.86	1.84	1.93	1.97
42	0.60	0.76	1.34	1.41	1.65
43	0.84	1.09	1.34	1.46	1.56
44	0.84	1.20	1.23	1.96	2.09
45	1.09	1.20	1.41	1.59	1.97
46	1.23	1.84	1.86	2.15	2.33
47	1.59	1.96	2.12	2.45	2.75
48	1.91	2.72	3.60	3.90	4.19
49	1.91	3.75	3.85	3.88	3.95
50	1.49	1.94	2.01	2.01	3.51

QUADRAT OWH SS4

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.49	1.60	3.00	3.22	3.42
52	1.60	2.01	2.17	2.29	2.98
53	0.76	2.20	2.45	2.56	3.15
54	0.76	1.44	2.84	3.15	3.27
55	1.44	2.20	2.77	2.77	3.02
56	1.78	3.05	3.50	3.52	3.57
57	2.12	2.39	3.05	3.05	3.28
58	1.15	2.39	2.52	2.78	3.12
59	1.15	1.51	2.77	3.05	3.95
60	1.51	2.50	2.52	3.85	4.56
61	2.64	3.40	4.81	5.81	6.18
62	2.64	3.02	3.22	3.46	4.10
63	2.77	3.40	3.46	3.51	4.13
64	1.78	2.77	2.84	3.21	3.51
65	2.51	3.12	3.47	4.11	4.15
66	2.51	3.00	4.55	5.18	5.43
67	2.50	2.77	2.78	3.00	3.47

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	94.1399	1.4264
2ND NEAREST NEIGHBOUR -	128.1608	1.9418
3RD NEAREST NEIGHBOUR -	159.1810	2.4118
4TH NEAREST NEIGHBOUR -	183.5463	2.7810
5TH NEAREST NEIGHBOUR -	207.3074	3.1410

QUADRAT OWH SS5

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	2.06	4.39	5.37	5.98	6.48
2	2.06	3.52	3.53	4.46	4.87
3	1.29	2.13	3.25	4.46	5.18
4	1.29	2.13	2.61	4.29	4.87
5	2.13	2.13	3.05	4.68	4.73
6	2.61	2.83	3.25	3.52	3.55
7	2.66	3.05	3.33	3.36	3.77
8	0.80	1.43	1.66	1.87	2.07
9	0.80	0.94	1.10	1.51	1.74
10	0.89	0.94	1.43	1.60	1.67
11	0.72	0.89	1.10	1.44	1.61
12	0.72	0.79	1.51	1.60	1.87
13	1.54	1.78	2.39	2.66	2.70
14	1.54	1.61	1.67	2.02	2.28
15	3.06	3.97	4.31	4.39	4.47
16	1.63	2.83	3.27	3.53	3.57
17	1.63	1.63	2.44	3.08	3.55
18	1.63	1.84	2.12	2.61	3.27
19	2.12	2.44	2.52	2.65	2.67
20	1.81	1.83	2.65	3.18	3.36
21	1.61	1.80	1.81	2.05	2.66
22	1.83	2.05	2.07	2.25	2.61
23	1.57	1.66	1.88	2.12	2.25
24	1.32	1.57	2.07	2.58	2.73
25	1.32	1.74	1.87	1.88	2.07
26	0.79	1.13	1.44	2.28	2.28
27	1.13	1.91	2.20	2.57	2.96
28	1.77	2.18	2.20	2.65	3.28
29	2.58	2.65	2.80	3.02	3.99
30	0.41	1.77	2.58	2.65	3.40
31	0.84	2.61	3.92	4.25	4.53
32	0.84	1.84	3.08	3.86	4.46
33	0.73	1.61	2.52	3.17	3.18
34	0.73	1.80	2.45	2.86	3.24
35	2.06	2.45	2.87	3.17	3.49
36	2.01	2.06	2.61	2.66	2.86
37	2.01	2.58	3.01	3.27	3.45
38	3.01	3.48	3.61	3.75	3.82
39	0.41	2.18	2.41	2.80	3.09
40	0.84	0.98	2.41	2.65	3.58
41	0.70	0.84	2.77	3.24	3.48
42	0.70	0.98	2.82	3.09	3.40
43	2.02	3.29	4.17	6.14	6.49
44	2.02	2.62	2.80	4.46	5.03
45	2.80	3.29	4.78	4.97	5.22
46	2.62	3.47	3.88	4.17	4.25
47	2.10	2.90	3.13	3.47	4.07
48	1.77	1.99	2.10	4.90	4.97
49	1.99	2.55	4.07	4.78	5.76
50	1.77	2.55	3.13	3.37	4.62

QUADRAT OWH SS5

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	2.87	2.90	3.40	3.88	3.98
52	1.06	3.40	3.58	3.61	3.75
53	1.06	2.69	2.75	3.12	3.48
54	3.10	3.12	3.37	3.58	3.62
55	0.68	1.22	2.17	2.52	2.75
56	0.68	0.92	2.07	2.25	2.69
57	0.92	1.16	1.22	1.34	2.69
58	0.64	1.16	1.95	2.07	2.17
59	0.64	1.34	1.40	2.25	2.52
60	1.40	1.95	2.33	2.69	2.77
61	2.33	2.38	2.74	2.75	2.85
62	1.38	2.38	3.93	4.05	4.37
63	1.38	2.55	2.85	3.42	3.90
64	2.55	3.43	3.62	3.69	3.88

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	100.0102	1.5875
2ND NEAREST NEIGHBOUR -	138.2063	2.1938
3RD NEAREST NEIGHBOUR -	173.4071	2.7525
4TH NEAREST NEIGHBOUR -	203.2176	3.2257
5TH NEAREST NEIGHBOUR -	224.9330	3.5704

QUADRAT OWH SS7

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	7.38	11.30	13.90	15.48	16.71
2	3.96	9.04	9.13	11.30	14.80
3	3.96	7.38	9.09	10.68	13.53
4	3.76	7.69	9.13	9.45	10.68
5	3.76	5.87	6.42	9.04	9.09
6	3.32	5.87	7.26	7.69	14.52
7	3.32	4.98	6.42	9.45	13.53
8	4.98	7.26	11.39	14.38	17.58

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	34.4561	4.9223
2ND NEAREST NEIGHBOUR -	59.3909	8.4844
3RD NEAREST NEIGHBOUR -	72.7372	10.3910
4TH NEAREST NEIGHBOUR -	87.4680	12.4954
5TH NEAREST NEIGHBOUR -	110.4207	15.7744

QUADRAT OWH SS8

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	2.34	3.63	4.15	4.47	5.23
2	1.45	2.34	4.67	4.69	5.25
3	1.45	3.63	4.02	4.30	4.54
4	3.23	4.30	4.37	4.98	5.32
5	2.24	2.92	3.23	3.29	4.03
6	1.34	3.67	4.55	4.61	5.32
7	1.34	2.74	3.88	4.03	4.34
8	1.26	2.05	2.74	3.65	3.67
9	1.26	2.00	2.49	3.36	3.69
10	1.15	2.49	3.65	4.15	4.90
11	1.15	3.36	4.35	5.18	6.04
12	1.82	2.37	2.44	3.39	3.44
13	1.09	1.11	1.58	1.78	2.37
14	0.70	1.09	1.34	1.67	2.97
15	1.11	1.34	1.92	2.05	2.44
16	1.63	1.82	2.05	2.77	3.38
17	1.63	2.92	3.44	3.66	3.91
18	1.87	2.69	2.92	3.52	3.66
19	2.57	2.69	3.46	3.56	3.61
20	1.87	2.06	2.24	2.79	3.46
21	2.06	2.23	2.56	3.37	3.52
22	2.56	2.79	3.29	3.69	4.34
23	2.00	2.05	2.26	2.59	3.36
24	1.37	1.50	2.07	2.67	2.72
25	1.18	1.50	1.84	2.59	2.67
26	1.18	2.26	2.59	2.67	3.69
27	1.58	1.67	1.96	2.60	3.34
28	0.70	1.78	1.92	1.96	2.33
29	2.11	2.78	2.78	3.15	3.34
30	1.78	2.33	2.77	2.78	2.97
31	1.72	1.78	2.11	2.80	3.44
32	1.72	2.77	2.80	2.98	3.59
33	1.92	2.57	3.37	3.59	3.69
34	1.92	2.23	3.74	4.09	4.52
35	2.48	2.52	2.72	3.60	3.69
36	1.16	1.63	1.87	2.52	2.94
37	1.37	1.63	2.11	2.20	2.48
38	1.16	1.67	2.55	2.59	2.59
39	1.67	1.87	2.07	2.11	2.74
40	1.84	2.07	2.12	2.20	2.59
41	2.07	2.12	3.25	3.73	3.80
42	1.95	2.52	3.15	3.20	4.14
43	1.34	1.87	1.95	2.74	3.24
44	1.34	2.06	2.80	2.80	2.84
45	2.06	2.97	2.98	3.24	3.24
46	1.55	2.93	3.24	3.68	4.16
47	1.55	2.42	2.64	3.26	3.61
48	0.72	1.67	2.59	3.09	4.16
49	0.72	0.96	2.55	3.30	3.73
50	0.96	1.67	3.01	3.11	3.17

QUADRAT OWH SS8

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	2.03	2.75	3.17	3.42	3.97
52	2.03	3.30	4.11	5.19	5.79
53	1.85	2.09	2.25	2.75	2.87
54	1.87	1.87	2.09	2.16	2.52
55	0.89	1.08	1.29	1.85	2.16
56	0.87	0.89	2.00	2.25	2.71
57	0.87	1.08	1.56	1.96	2.87
58	1.29	1.56	1.87	2.00	2.74
59	1.96	2.71	2.72	2.86	3.01
60	1.35	2.72	3.31	3.61	3.68
61	1.35	2.42	2.48	2.93	2.95
62	1.90	2.28	2.48	3.31	3.69
63	0.75	1.90	2.64	2.95	3.10
64	0.75	2.28	2.36	3.11	3.26
65	2.36	2.61	2.75	3.10	3.21
66	2.61	3.30	3.42	4.81	5.50

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	104.9399	1.6145
2ND NEAREST NEIGHBOUR -	148.8785	2.2904
3RD NEAREST NEIGHBOUR -	181.6660	2.7949
4TH NEAREST NEIGHBOUR -	209.1076	3.2170
5TH NEAREST NEIGHBOUR -	236.2662	3.6349

QUADRAT OWH SS9

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.92	2.96	3.56	3.97	4.38
2	1.92	2.67	3.08	3.41	3.67
3	2.03	2.98	3.08	3.41	3.92
4	1.69	1.72	2.62	2.98	3.14
5	1.72	1.84	2.03	3.27	3.61
6	1.84	2.94	3.25	3.30	3.41
7	2.55	2.94	2.96	3.31	3.51
8	1.05	1.49	2.36	2.55	3.30
9	0.79	1.05	2.58	3.39	3.59
10	0.79	1.49	2.06	2.61	3.79
11	1.77	2.00	2.06	2.36	2.58
12	2.60	2.61	2.86	3.39	3.55
13	1.10	2.18	2.31	2.71	2.86
14	2.22	3.56	3.60	3.62	4.12
15	1.68	2.22	2.53	2.96	3.21
16	0.88	1.61	1.68	1.72	1.99
17	0.74	0.88	1.22	1.29	2.24
18	0.98	1.29	1.52	1.69	1.72
19	0.60	0.74	1.52	1.61	1.75
20	0.60	1.22	1.32	1.68	1.74
21	0.94	1.36	1.68	2.10	2.24
22	0.94	1.86	2.62	2.67	3.04
23	1.36	1.50	1.74	1.86	2.03
24	0.81	1.32	1.50	1.75	1.82
25	0.81	1.35	1.64	1.91	2.03
26	1.35	1.63	1.75	1.90	2.27
27	1.15	1.69	1.89	1.96	2.90
28	1.15	1.24	1.61	2.31	2.62
29	0.73	1.24	1.27	1.81	1.96
30	1.27	1.40	1.63	1.75	1.77
31	1.24	1.40	1.80	2.45	2.57
32	1.24	1.34	2.50	2.69	2.72
33	1.34	1.83	2.54	2.57	2.64
34	1.05	1.76	1.77	1.83	3.15
35	0.73	1.05	2.00	2.10	2.30
36	0.73	1.41	1.61	1.76	2.18
37	1.24	1.61	1.86	2.15	2.30
38	1.10	1.24	1.41	2.10	3.03
39	1.05	1.38	2.13	2.51	2.54
40	1.20	1.38	1.53	2.15	2.64
41	1.53	1.86	2.47	2.55	2.91
42	0.73	1.55	1.61	1.63	1.75
43	0.97	1.04	1.42	2.27	2.30
44	1.42	1.82	2.39	2.40	2.98
45	0.56	1.04	1.54	2.12	2.28
46	1.26	1.30	1.54	2.09	2.21
47	0.20	1.19	1.30	1.39	2.28
48	1.19	1.69	1.82	2.30	2.53
49	0.98	1.19	1.90	2.26	2.35
50	1.26	1.37	1.90	1.93	1.96

QUADRAT OWH SS9

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.39	1.70	1.93	2.39	2.48
52	1.16	1.26	1.39	1.50	1.87
53	1.16	1.37	1.64	1.73	1.82
54	1.64	1.70	1.87	2.43	2.83
55	0.81	1.50	1.64	1.73	2.44
56	0.81	1.83	1.91	2.08	2.30
57	1.69	2.16	2.32	2.55	2.74
58	0.55	0.74	1.77	2.22	2.24
59	0.74	1.27	1.55	1.63	1.75
60	0.55	1.27	1.75	1.86	2.16
61	1.75	1.80	2.11	2.22	2.30
62	1.30	1.37	1.61	2.77	2.81
63	1.16	1.61	1.62	2.69	2.74
64	1.67	2.13	2.19	2.30	2.68
65	1.67	1.81	2.39	2.48	2.51
66	1.05	1.20	1.81	2.19	2.28
67	2.28	2.39	2.55	2.64	3.31
68	2.62	3.01	4.30	4.38	4.67
69	1.34	1.39	1.82	2.57	2.98
70	0.20	1.26	1.34	1.39	2.12
71	1.19	1.39	1.82	2.21	2.39
72	1.61	1.81	2.45	2.48	2.60
73	1.00	1.06	1.28	1.61	1.90
74	0.88	0.93	1.00	1.34	1.67
75	0.88	1.17	1.27	1.28	1.51
76	0.93	1.09	1.20	1.51	1.90
77	1.09	1.17	1.34	1.47	1.64
78	1.20	1.46	1.64	2.13	2.56
79	1.46	1.69	1.96	2.47	2.85
80	1.37	1.78	1.96	2.69	2.74
81	1.16	1.30	1.78	2.14	3.14
82	2.01	2.31	3.14	3.27	3.43
83	2.22	2.28	3.01	3.26	3.82
84	1.53	2.28	2.49	4.49	5.24
85	1.62	2.14	2.22	2.48	3.13
86	1.06	1.27	1.57	1.67	1.81
87	2.22	2.62	4.27	4.36	4.71
88	2.22	2.25	3.35	4.72	4.90
89	1.57	2.33	2.48	2.58	2.65
90	2.25	2.33	3.21	3.75	4.27
91	1.51	2.47	2.70	2.79	2.80
92	1.47	1.51	1.66	1.91	2.56
93	1.25	1.66	2.53	2.58	2.79
94	1.25	1.40	2.31	2.90	3.58
95	1.40	2.01	2.58	2.88	4.23
96	2.88	3.65	3.86	4.28	4.89
97	1.60	2.49	3.01	3.65	4.05
98	1.53	1.60	3.26	4.89	5.29
99	0.56	0.97	2.09	2.39	2.54

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	129.4590	1.3210
2ND NEAREST NEIGHBOUR -	168.5952	1.7204
3RD NEAREST NEIGHBOUR -	209.5230	2.1380
4TH NEAREST NEIGHBOUR -	244.4373	2.4943
5TH NEAREST NEIGHBOUR -	276.9508	2.8260

QUADRAT OWH SS11

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	2.06	2.69	5.58	5.92	6.45
2	2.06	2.49	4.29	4.69	4.90
3	2.49	2.69	2.93	3.81	3.86
4	0.87	2.22	2.35	2.93	4.04
5	0.87	1.37	2.47	3.60	3.81
6	1.37	2.22	3.47	3.61	3.74
7	1.21	1.59	5.35	6.12	6.45
8	1.05	1.21	5.06	5.12	5.72
9	1.05	1.59	5.72	5.75	6.17
10	3.18	3.61	4.90	5.61	6.58
11	3.00	3.18	3.25	3.41	4.92
12	2.35	2.43	2.47	3.00	3.47
13	2.42	2.43	3.41	3.60	3.74
14	2.33	2.42	3.06	3.12	3.53
15	1.35	2.33	2.50	2.74	3.49
16	1.43	2.08	2.41	2.50	2.68
17	1.27	1.65	1.98	2.41	2.55
18	1.27	1.36	1.67	1.73	1.84
19	1.13	1.36	1.65	2.12	2.96
20	1.13	1.26	1.67	2.21	2.52
21	1.26	1.31	1.48	1.73	1.95
22	1.76	1.95	2.01	2.21	2.39
23	2.39	3.19	3.80	3.95	4.12
24	3.25	3.61	3.78	4.57	5.21
25	1.35	3.12	3.51	3.61	3.84
26	0.72	2.68	3.49	3.53	4.57
27	0.72	2.08	2.78	3.55	4.21
28	1.43	1.98	2.03	2.45	2.78
29	1.48	1.55	1.84	2.45	2.53
30	1.07	1.31	1.55	2.01	2.52
31	1.07	1.76	2.15	2.60	2.67
32	2.41	3.81	4.74	4.85	4.85
33	1.64	2.41	3.29	3.78	4.40
34	1.64	1.90	2.81	3.75	3.81
35	1.78	1.90	2.43	2.77	2.77
36	1.24	1.78	2.49	2.81	3.34
37	1.24	1.85	2.77	2.77	2.77
38	1.36	1.85	2.49	2.75	3.65
39	1.36	1.83	2.77	3.46	3.71
40	1.75	2.21	3.10	3.94	4.05
41	0.61	1.75	2.79	2.85	4.21
42	0.61	2.21	2.44	3.08	3.74
43	2.67	2.85	2.89	3.08	3.55
44	2.72	3.16	3.64	3.74	4.13
45	0.75	2.81	3.65	4.85	5.51
46	0.75	2.05	2.96	4.76	4.86
47	1.39	2.05	2.72	2.81	3.81
48	2.20	2.72	2.77	3.27	3.34
49	2.12	2.77	3.46	3.46	3.65
50	1.83	2.12	2.75	3.11	3.12

QUADRAT OWH SS11

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.71	1.92	3.11	4.11	4.36
52	1.92	2.28	2.44	2.79	3.10
53	1.71	2.28	2.55	3.05	4.20
54	1.03	2.55	2.58	2.72	3.51
55	1.03	1.64	3.05	3.16	4.44
56	1.64	2.58	3.64	4.62	6.07
57	1.39	2.20	2.43	2.96	3.65

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	90.9173	1.6235
2ND NEAREST NEIGHBOUR -	126.2170	2.2539
3RD NEAREST NEIGHBOUR -	171.3922	3.0606
4TH NEAREST NEIGHBOUR -	195.9543	3.4992
5TH NEAREST NEIGHBOUR -	222.8260	3.9790

QUADRAT OWH SS12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.59	3.56	4.43	4.53	4.59
2	1.59	2.91	2.95	3.00	3.91
3	1.03	1.91	2.81	2.91	2.95
4	1.03	1.50	2.40	3.20	3.42
5	1.50	1.91	3.35	3.84	4.64
6	2.23	2.24	3.23	3.35	3.42
7	2.24	2.54	3.40	3.69	3.88
8	1.44	1.71	2.19	3.40	4.70
9	0.75	0.76	1.44	4.24	4.35
10	0.76	1.09	1.71	3.48	3.70
11	0.75	1.09	2.19	4.08	4.23
12	1.73	2.11	2.23	3.00	3.54
13	1.21	2.00	2.11	2.89	2.91
14	1.21	2.17	2.17	2.23	2.77
15	1.70	2.00	2.17	2.40	2.81
16	1.70	2.40	3.00	3.11	3.20
17	1.18	1.83	2.40	2.41	2.88
18	1.18	2.23	2.46	2.54	3.00
19	1.73	1.90	2.17	2.65	2.89
20	1.66	2.17	2.41	3.15	3.20
21	1.43	1.83	2.01	2.17	2.46
22	0.83	1.63	2.01	2.71	2.90
23	0.83	1.55	1.94	2.83	3.48
24	1.55	1.63	2.10	2.45	2.76
25	1.94	2.10	2.70	2.71	3.70
26	1.79	1.84	2.70	4.23	4.55
27	1.79	1.80	4.38	4.45	5.14
28	1.80	1.84	4.36	5.58	5.83
29	0.84	1.90	2.21	2.77	3.00
30	0.84	2.51	2.62	2.65	2.99
31	1.43	1.66	1.89	1.98	2.83
32	0.51	1.73	1.89	2.90	3.05
33	0.51	1.79	1.98	2.45	3.11
34	1.35	1.60	1.67	2.03	2.37
35	1.15	1.46	1.60	1.88	2.08
36	1.15	2.13	2.21	2.37	2.51
37	0.84	0.99	1.46	1.67	2.29
38	0.77	0.84	1.67	2.03	2.28
39	0.77	0.99	1.35	1.96	2.08
40	1.63	1.88	2.13	2.19	2.40
41	0.79	1.63	2.57	2.83	2.92
42	0.79	2.08	2.19	2.29	2.42
43	1.49	2.02	3.15	3.24	3.34
44	0.86	1.49	1.80	3.05	3.14
45	0.86	1.15	2.02	2.34	2.47
46	1.15	1.51	1.80	1.83	2.38
47	1.73	1.79	2.37	2.75	2.99
48	1.58	2.37	2.40	2.47	2.47
49	1.32	2.00	2.13	2.40	2.82
50	2.00	2.29	2.56	3.25	3.31

QUADRAT OWH SS12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.19	1.40	2.29	2.82	3.64
52	1.67	1.96	2.21	2.51	2.80
53	1.05	1.57	2.08	2.22	2.76
54	1.05	1.16	1.56	1.85	2.42
55	1.12	1.16	2.05	2.19	2.22
56	2.05	2.11	2.25	2.34	2.38
57	1.04	1.51	2.11	2.47	2.61
58	1.04	1.58	1.83	2.15	2.97
59	1.79	2.15	2.47	2.58	2.64
60	1.32	2.47	2.53	2.58	2.61
61	0.76	1.19	2.13	2.56	2.61
62	0.76	1.40	2.86	3.14	3.25
63	2.21	2.60	3.40	3.63	3.86
64	2.56	2.60	3.83	4.05	4.11
65	1.56	1.57	2.01	2.19	2.56
66	1.12	1.85	2.01	2.06	2.74
67	2.06	2.25	2.44	2.80	3.58
68	1.79	2.53	3.80	3.81	3.83
69	3.70	3.76	3.80	5.16	5.50
70	1.27	3.70	3.80	4.48	5.08
71	1.27	3.76	5.08	5.75	6.35

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	96.8691	1.3838
2ND NEAREST NEIGHBOUR -	136.3652	1.9481
3RD NEAREST NEIGHBOUR -	175.6450	2.5092
4TH NEAREST NEIGHBOUR -	207.9220	2.9703
5TH NEAREST NEIGHBOUR -	231.5722	3.3082

QUADRAT OWH NFS

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.33	2.81	2.98	3.42	4.36
2	1.33	2.09	2.10	3.04	3.43
3	2.98	3.12	3.27	3.66	5.45
4	2.09	2.61	2.75	2.76	2.81
5	2.75	2.92	3.27	4.46	4.72
6	2.70	2.92	3.45	3.60	3.77
7	2.51	2.95	3.21	3.52	3.81
8	1.18	1.38	2.51	2.84	3.63
9	0.87	1.18	1.97	3.21	3.25
10	0.87	1.38	2.77	3.38	3.81
11	1.75	2.86	2.95	3.05	3.25
12	1.75	1.97	2.77	2.84	2.93
13	1.88	2.16	2.27	3.38	3.48
14	2.72	3.30	3.48	4.46	5.29
15	0.62	1.88	2.72	3.80	4.85
16	0.62	2.16	3.30	3.76	5.00
17	2.68	3.84	4.05	4.24	4.39
18	0.94	2.02	2.10	2.76	2.93
19	0.94	1.78	2.08	3.04	3.39
20	1.78	1.90	1.92	2.02	2.61
21	1.92	2.07	2.08	2.45	2.63
22	1.83	1.90	2.07	2.65	2.70
23	1.10	1.79	1.83	3.05	3.07
24	1.71	1.79	1.89	2.45	2.65
25	1.10	1.89	2.86	2.93	2.99
26	2.14	2.27	2.55	2.93	2.99
27	2.27	3.02	3.04	3.19	3.56
28	2.17	2.46	2.68	3.18	3.30
29	3.30	3.30	4.05	4.07	4.34
30	1.04	1.87	2.11	2.17	2.47
31	0.87	1.04	1.30	2.46	2.62
32	0.69	0.87	1.87	2.14	2.57
33	0.69	1.30	1.84	2.05	2.11
34	1.15	2.23	2.47	2.62	2.63
35	1.15	2.05	2.40	2.71	2.80
36	1.71	2.40	2.82	3.28	3.29
37	1.41	2.27	2.30	2.39	3.20
38	0.98	1.41	1.46	2.14	2.76
39	1.46	1.51	1.62	2.12	2.14
40	0.98	1.51	1.90	2.21	2.39
41	1.72	2.55	2.69	2.73	2.74
42	1.43	1.53	1.70	1.72	2.12
43	0.80	1.18	1.62	1.70	1.78
44	0.80	1.26	1.43	1.57	1.92
45	0.85	1.21	1.59	1.78	1.90
46	0.85	1.85	1.93	2.21	2.44
47	0.75	1.18	1.21	1.57	1.85
48	0.75	1.59	1.76	1.89	1.91
49	1.81	1.91	2.44	2.60	2.77
50	1.43	1.76	1.81	2.44	2.81

QUADRAT OWH NFS

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	2.70	2.82	3.09	3.30	4.07
52	1.38	2.57	2.63	2.70	3.40
53	1.38	1.84	2.14	2.80	3.00
54	1.27	2.91	3.57	3.75	4.28
55	1.50	2.55	2.91	3.21	3.81
56	1.50	2.73	3.75	3.82	4.37
57	1.85	2.41	3.20	3.21	3.48
58	1.53	1.74	1.92	2.41	2.62
59	1.26	1.74	1.99	2.23	2.26
60	2.10	2.36	2.71	3.92	4.11
61	1.43	2.47	2.77	3.24	3.25
62	2.34	3.09	4.24	4.83	5.76
63	2.34	3.97	4.43	6.72	6.98
64	2.82	3.46	3.97	4.24	4.54
65	1.27	2.31	3.35	3.81	4.37
66	2.11	2.31	3.57	4.73	4.77
67	2.11	2.68	3.20	3.35	4.01
68	1.85	2.36	2.68	2.95	3.32
69	1.79	2.10	2.95	4.01	4.80
70	1.79	2.71	4.48	5.80	6.30

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	111.5258	1.6163
2ND NEAREST NEIGHBOUR -	153.3394	2.2223
3RD NEAREST NEIGHBOUR -	182.8175	2.6495
4TH NEAREST NEIGHBOUR -	215.6383	3.1252
5TH NEAREST NEIGHBOUR -	240.1244	3.4801

QUADRAT OWH C10

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	3.51	3.77	4.44	5.08	5.45
2	0.93	2.17	2.52	2.52	2.76
3	0.93	1.84	1.95	2.16	2.39
4	1.31	1.98	2.17	2.25	2.39
5	0.95	1.21	1.31	1.90	2.58
6	0.95	1.08	1.52	1.63	2.10
7	1.21	1.52	1.78	1.95	1.95
8	1.08	1.16	1.62	1.78	1.90
9	0.85	1.16	1.63	1.67	1.76
10	0.85	1.96	2.10	2.16	2.50
11	0.89	1.67	2.09	2.16	2.58
12	0.89	1.62	1.76	2.01	2.50
13	1.64	2.20	2.58	2.59	2.89
14	2.18	2.20	2.42	3.16	3.42
15	1.39	1.64	1.68	1.80	2.18
16	1.14	1.59	1.68	1.72	2.59
17	1.14	1.39	1.91	2.24	2.40
18	1.08	1.80	1.91	2.42	2.53
19	1.08	1.60	2.41	2.74	2.80
20	0.81	1.26	1.60	1.71	1.89
21	0.64	0.81	0.90	1.14	1.73
22	0.64	0.81	1.09	1.26	1.32
23	0.59	0.81	0.90	1.45	1.71
24	0.59	1.14	1.32	1.89	2.03
25	0.84	1.09	1.45	1.73	2.03
26	0.84	1.93	2.19	2.31	2.56
27	2.04	2.16	2.18	2.27	2.48
28	1.15	1.46	1.80	2.18	2.35
29	1.15	1.31	1.52	2.04	2.21
30	1.31	1.39	1.49	1.51	2.07
31	1.18	1.51	1.84	2.21	2.27
32	1.18	1.26	1.95	2.07	2.51
33	1.26	1.47	2.01	2.37	2.53
34	1.09	1.42	1.49	1.52	2.25
35	1.09	1.39	1.84	2.04	2.21
36	1.81	1.84	2.02	2.25	2.46
37	1.21	1.47	1.77	2.25	2.54
38	0.87	1.21	1.80	2.02	2.59
39	0.87	1.13	1.77	2.02	2.11
40	1.13	1.74	1.80	2.18	2.34
41	1.56	1.74	1.92	2.02	2.11
42	1.56	1.62	1.74	1.77	1.82
43	1.07	1.24	1.40	1.62	2.03
44	0.35	1.40	1.82	1.98	2.06
45	1.41	1.59	1.74	1.92	2.58
46	1.41	1.72	1.96	2.18	2.24
47	1.53	1.65	2.18	2.25	2.33
48	0.77	0.91	1.53	1.66	2.18
49	0.77	0.84	0.99	1.74	2.18
50	0.84	0.91	1.65	1.77	2.31

QUADRAT OWH C10

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	0.80	0.99	1.66	1.68	1.77
52	0.80	1.23	1.40	1.74	2.43
53	1.43	1.96	2.03	2.25	2.40
54	1.40	1.43	1.59	1.68	2.11
55	1.23	1.59	1.67	2.02	2.80
56	0.94	1.46	2.43	2.70	3.04
57	0.94	1.80	2.38	2.40	2.48
58	2.19	2.64	2.70	3.13	3.52
59	1.09	2.02	2.46	2.47	2.50
60	1.09	1.42	1.81	2.04	2.40
61	1.40	1.47	2.02	2.51	2.84
62	1.40	1.74	2.53	2.71	2.82
63	1.47	1.63	2.43	2.53	2.73
64	1.71	1.98	2.30	2.50	2.75
65	1.40	1.71	1.71	2.20	2.28
66	1.40	1.42	1.49	1.93	2.25
67	0.35	1.07	1.73	1.77	1.97
68	1.11	1.24	1.71	1.73	2.06
69	1.33	1.71	1.91	1.93	1.97
70	1.11	1.33	1.67	2.20	2.30
71	0.43	1.15	2.20	2.67	2.68
72	0.43	1.38	2.34	2.46	2.66
73	1.15	1.38	1.67	2.11	2.71
74	2.47	2.51	2.68	2.92	3.06
75	1.77	2.19	2.53	2.62	2.71
76	1.05	1.77	2.33	3.28	3.52
77	1.05	2.62	2.78	3.28	3.92
78	2.33	2.47	2.53	2.86	3.15
79	1.74	2.26	2.28	2.51	2.55
80	1.41	1.63	2.19	2.55	2.68
81	0.95	1.72	2.26	2.47	2.48
82	0.95	1.45	2.28	2.76	2.77
83	0.83	1.41	2.25	2.28	2.35
84	0.83	1.42	1.71	1.93	2.19
85	1.48	1.65	2.25	2.31	2.35
86	1.47	1.49	1.93	2.14	2.16
87	1.12	1.47	1.77	1.79	1.88
88	1.12	1.35	1.65	1.80	1.88
89	1.39	1.67	1.91	2.16	2.21
90	1.38	1.48	1.79	2.02	2.14
91	1.26	1.39	1.48	2.16	2.45
92	1.26	1.42	2.00	2.16	2.21
93	1.27	1.37	1.38	1.74	2.39
94	0.59	1.42	2.45	2.47	2.69
95	0.59	2.00	2.38	2.51	2.92
96	1.76	1.79	2.78	3.28	3.52
97	1.67	1.76	3.82	3.84	4.55
98	1.67	1.79	2.15	2.26	4.11
99	0.72	2.15	2.96	3.15	3.52
100	0.72	2.26	3.09	3.84	3.85

QUADRAT OWH C10

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
101	1.68	1.99	2.48	2.95	2.96
102	1.45	1.68	1.72	1.73	1.99
103	1.68	1.73	1.88	2.53	3.18
104	0.86	1.60	1.68	1.88	2.24
105	0.86	1.04	1.44	2.25	2.53
106	1.04	1.48	1.60	1.80	1.80
107	1.44	1.80	2.24	2.37	2.55
108	1.03	1.35	1.88	1.93	2.37
109	1.03	1.37	1.77	1.86	1.88
110	0.80	2.30	2.43	2.46	2.55
111	0.80	1.54	2.15	2.20	2.21
112	0.85	1.27	1.54	1.84	1.86
113	0.85	0.99	1.62	1.74	2.15
114	0.99	1.81	1.84	2.12	2.30
115	1.01	1.23	1.62	1.81	2.03
116	0.87	1.01	1.36	1.87	2.30
117	0.87	1.23	2.06	2.72	2.84
118	1.10	1.87	2.12	2.40	2.72
119	1.10	1.36	2.06	2.26	2.79

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	139.3648	1.1811
2ND NEAREST NEIGHBOUR -	188.1267	1.5943
3RD NEAREST NEIGHBOUR -	234.0774	1.9837
4TH NEAREST NEIGHBOUR -	264.4500	2.2411
5TH NEAREST NEIGHBOUR -	296.6779	2.5142

QUADRAT AR 11

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.10	3.08	3.61	4.03	4.25
2	1.10	2.27	3.01	3.10	3.30
3	0.69	2.00	2.41	2.47	2.98
4	0.69	1.96	2.19	2.72	2.89
5	1.03	1.90	1.96	2.10	2.18
6	1.03	1.50	1.79	2.10	2.17
7	0.77	1.79	2.10	3.41	3.80
8	0.77	1.50	2.18	3.28	3.46
9	1.81	2.52	2.73	2.78	3.23
10	0.85	1.43	1.59	1.76	1.81
11	0.75	0.81	0.85	1.22	2.52
12	1.22	1.33	1.76	1.81	2.73
13	0.59	0.75	1.33	1.59	3.25
14	0.59	0.81	1.43	1.81	3.23
15	1.17	1.45	1.50	1.78	2.50
16	1.15	1.17	1.36	1.86	2.16
17	1.15	1.45	1.72	2.90	2.95
18	1.07	1.50	2.41	2.95	3.16
19	1.07	1.78	2.16	2.26	3.06
20	1.86	1.94	2.26	2.69	2.96
21	1.65	2.27	2.46	3.08	3.28
22	1.13	1.65	2.84	2.94	3.29
23	1.13	1.84	2.15	2.46	2.75
24	0.64	0.79	1.65	2.15	2.41
25	0.79	1.10	1.32	1.84	2.84
26	0.64	1.10	1.32	2.00	2.19
27	1.32	1.32	1.65	1.86	1.90
28	1.52	1.77	2.19	2.38	2.73
29	1.52	1.62	1.65	1.95	2.49
30	1.62	1.71	2.19	2.94	3.04
31	1.86	2.10	2.22	2.67	2.91
32	1.53	2.06	2.11	2.22	2.58
33	1.53	1.68	2.78	2.86	2.93
34	1.13	1.50	1.68	1.73	1.75
35	1.26	1.68	1.73	2.06	2.45
36	1.50	1.91	2.90	2.97	3.09
37	1.25	1.50	2.70	3.12	3.85
38	1.79	2.70	2.97	3.06	3.12
39	1.36	1.72	1.79	1.94	2.50
40	0.89	2.04	2.14	2.95	3.29
41	0.89	1.66	2.31	2.34	2.84
42	1.10	1.40	1.65	1.66	2.04
43	1.40	1.71	2.14	2.34	2.41
44	0.57	0.63	1.17	1.65	1.88
45	0.57	1.10	1.11	1.74	2.25
46	0.63	0.89	1.11	1.30	1.62
47	1.89	2.00	2.07	2.13	2.25
48	1.03	1.43	1.90	2.51	3.11
49	1.30	2.13	2.15	2.49	2.56
50	1.30	1.67	2.08	2.47	2.57

QUADRAT AR 11

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.67	2.02	2.15	2.64	2.72
52	1.27	1.35	1.50	1.88	2.02
53	1.15	1.20	1.65	1.88	2.08
54	0.97	1.20	1.75	1.77	1.95
55	0.97	1.13	1.15	1.27	2.40
56	1.26	1.26	1.68	1.96	2.12
57	1.26	1.35	1.95	2.40	2.45
58	1.25	1.91	2.61	3.11	3.20
59	1.65	1.96	2.56	2.57	2.61
60	1.65	2.08	2.66	3.25	3.26
61	1.76	2.08	2.60	2.76	2.93
62	2.13	2.55	3.19	3.25	3.27
63	1.27	1.57	2.13	2.45	3.47
64	1.27	1.48	2.97	3.27	3.97
65	1.48	1.57	2.55	3.98	4.03
66	1.31	1.62	1.75	2.04	2.08
67	0.80	1.05	1.30	1.31	1.43
68	0.80	1.20	1.40	1.53	1.86
69	0.88	1.43	1.53	1.75	2.09
70	0.88	1.40	1.65	1.75	2.10
71	0.89	1.05	1.17	1.20	1.74
72	1.09	2.07	2.15	2.32	2.57
73	1.09	2.06	2.07	2.47	2.63
74	1.32	1.81	2.07	2.30	2.32
75	1.99	2.06	2.06	2.24	2.30
76	1.73	1.99	2.24	2.30	2.33
77	1.66	1.84	1.99	2.15	2.74
78	0.97	1.73	1.81	1.84	2.53
79	0.97	1.66	1.71	1.95	2.67
80	1.95	2.47	2.66	2.76	2.84
81	1.10	1.58	1.71	1.81	2.04
82	1.01	1.10	1.84	2.02	2.05
83	1.01	1.19	1.40	1.58	2.22
84	1.19	1.76	1.78	2.04	2.05
85	0.70	1.30	1.84	2.30	2.42
86	1.40	1.40	1.88	2.02	2.13
87	0.82	1.48	1.70	1.78	1.88
88	0.82	1.03	1.46	2.23	2.60
89	1.03	1.48	2.45	2.46	2.97
90	1.40	1.46	1.67	1.70	2.23
91	0.67	1.63	1.65	2.09	2.18
92	0.67	1.02	1.83	1.84	2.10
93	0.89	1.02	1.19	1.63	2.93
94	0.73	1.19	1.83	2.18	3.82
95	0.73	0.89	1.84	2.37	3.43
96	1.35	1.63	1.74	2.00	2.26
97	0.90	1.32	1.35	1.70	2.18
98	0.90	1.41	1.81	1.85	1.98
99	0.84	0.85	1.63	2.16	2.18
100	0.65	0.84	1.41	1.70	1.74

QUADRAT AR 11

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
101	0.65	0.85	1.70	1.98	2.26
102	1.52	1.70	2.09	2.55	2.69
103	1.52	1.64	1.85	2.11	2.19
104	1.64	1.99	2.04	2.06	2.54
105	0.86	2.11	2.33	2.54	2.80
106	0.86	1.79	2.52	2.96	3.08
107	0.75	1.30	1.79	2.33	2.33
108	0.70	0.75	2.46	2.52	2.55
109	1.42	2.83	3.21	3.32	3.42
110	1.42	1.76	2.20	2.51	2.61
111	0.68	1.03	1.76	2.10	2.23
112	0.68	1.43	1.67	1.72	2.20
113	1.72	1.90	2.10	2.72	3.42

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	129.7819	1.1588
2ND NEAREST NEIGHBOUR -	178.4607	1.5934
3RD NEAREST NEIGHBOUR -	222.9409	1.9905
4TH NEAREST NEIGHBOUR -	257.7125	2.3010
5TH NEAREST NEIGHBOUR -	295.9611	2.6425

QUADRAT AR12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	0.90	1.80	2.08	2.25	2.31
2	0.90	0.93	1.19	1.37	1.41
3	0.48	0.57	0.58	0.74	0.93
4	0.26	0.27	0.48	0.60	0.95
5	0.26	0.38	0.74	0.77	0.96
6	0.39	0.58	0.58	0.60	0.77
7	0.58	0.68	0.87	0.95	0.96
8	0.73	0.87	1.01	1.34	1.35
9	0.73	1.13	1.19	1.20	1.27
10	0.51	1.19	1.26	1.32	1.53
11	0.51	1.38	1.56	1.68	1.70
12	0.97	1.13	1.26	1.28	1.32
13	1.38	1.38	1.52	1.59	1.64
14	0.98	1.38	1.65	1.93	2.05
15	0.98	0.98	1.28	1.52	1.61
16	1.15	1.32	1.56	1.65	2.02
17	0.52	1.03	1.32	1.71	2.05
18	0.52	0.82	1.26	1.56	1.65
19	0.82	1.03	1.37	1.78	2.02
20	0.48	1.26	1.43	1.48	1.56
21	0.48	0.96	1.44	1.54	1.65
22	1.37	1.44	1.56	1.68	1.78
23	0.96	1.01	1.43	1.78	1.89
24	0.27	0.38	0.39	0.57	0.68
25	1.30	1.99	2.04	2.10	2.26
26	1.30	1.50	1.95	2.25	2.31
27	0.55	0.84	1.50	1.50	2.34
28	0.55	0.85	1.53	1.95	2.44
29	0.69	0.84	0.85	1.62	1.98
30	0.69	0.93	1.40	1.50	1.53
31	0.89	0.93	1.62	1.64	1.72
32	0.75	0.89	0.97	1.32	1.40
33	0.74	0.75	0.81	1.64	1.68
34	0.47	0.74	0.94	0.97	1.72
35	0.47	0.81	1.15	1.32	2.14
36	0.68	1.56	1.57	1.71	1.85
37	0.68	0.90	1.25	1.29	1.74
38	0.54	0.90	1.00	1.10	1.38
39	0.62	0.66	1.00	1.21	1.29
40	0.56	0.66	0.74	0.77	1.02
41	0.77	0.81	1.00	1.00	1.13
42	0.55	0.74	1.00	1.00	1.21
43	0.55	0.81	0.93	0.96	1.02
44	0.40	0.93	0.97	1.13	1.25
45	0.40	0.97	1.10	1.20	1.30
46	0.69	0.96	0.97	1.19	1.32
47	0.53	0.69	0.78	1.02	1.09
48	0.84	0.98	1.10	1.25	1.32
49	0.83	0.84	1.29	1.29	1.46
50	0.83	0.92	1.09	1.09	1.11

QUADRAT AR12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	0.77	0.88	0.92	1.29	1.45
52	0.88	1.11	1.15	1.59	1.65
53	0.77	1.00	1.01	1.11	1.40
54	0.44	0.55	0.99	1.00	1.09
55	0.29	0.73	0.91	1.09	1.53
56	0.29	0.71	0.95	0.99	1.30
57	0.73	0.95	1.48	1.54	1.64
58	1.01	1.86	1.87	2.04	2.13
59	0.74	0.96	0.99	1.43	1.72
60	0.79	0.96	1.20	1.35	1.40
61	0.79	0.99	1.66	1.72	1.99
62	0.83	0.88	1.13	1.32	1.35
63	0.88	0.99	1.20	1.21	1.68
64	0.51	0.81	0.83	1.21	1.46
65	0.51	0.63	1.15	1.24	1.32
66	0.63	0.71	0.81	1.14	1.22
67	0.72	1.23	1.24	1.59	1.62
68	0.72	0.78	1.60	1.74	1.83
69	0.94	1.15	1.62	1.68	1.69
70	1.12	1.51	2.09	2.16	2.25
71	1.12	1.42	1.56	1.72	1.74
72	0.54	0.56	0.62	1.00	1.25
73	0.56	0.97	1.39	1.41	1.48
74	0.56	0.70	0.85	1.40	1.52
75	0.70	0.77	0.83	0.97	1.21
76	1.00	1.16	1.25	1.35	1.42
77	0.77	0.93	0.97	1.03	1.16
78	0.05	0.37	0.40	0.93	1.14
79	0.03	0.36	0.40	1.33	1.35
80	0.70	1.03	1.03	1.06	1.13
81	0.39	0.65	0.70	0.78	1.32
82	0.39	0.52	0.53	1.06	1.09
83	0.52	0.65	0.81	1.02	1.03
84	0.81	1.08	1.19	1.29	1.45
85	0.78	1.08	1.20	1.30	1.33
86	0.55	0.78	0.92	1.01	1.13
87	0.87	1.12	1.13	1.20	1.22
88	0.44	0.71	0.91	0.92	1.01
89	0.73	0.83	0.90	1.01	1.06
90	0.48	0.73	0.75	0.84	0.87
91	0.38	0.48	0.90	0.94	1.09
92	0.71	1.06	1.06	1.09	1.38
93	1.06	1.53	1.76	1.86	1.95
94	0.91	1.16	1.53	1.87	1.88
95	0.91	0.99	1.02	1.37	1.76
96	0.69	0.74	1.02	1.25	1.35
97	0.56	0.69	1.17	1.33	1.37
98	0.56	0.70	0.89	1.25	1.39
99	0.44	1.13	1.18	1.27	1.33
100	0.44	0.78	1.22	1.32	1.36

QUADRAT AR12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
101	0.89	0.95	0.99	1.01	1.32
102	0.59	0.71	0.77	1.14	1.31
103	0.59	0.71	1.03	1.06	1.15
104	0.78	1.03	1.18	1.23	1.34
105	0.71	0.85	1.06	1.18	1.71
106	0.77	0.85	1.11	1.36	1.58
107	0.78	1.01	1.11	1.18	1.31
108	0.38	0.71	0.75	0.83	1.32
109	0.62	1.21	1.59	2.09	2.17
110	0.62	1.09	1.51	2.13	2.29
111	1.09	1.21	1.38	1.52	1.59
112	0.72	0.83	0.85	1.10	1.39
113	0.72	0.84	1.21	1.30	1.33
114	0.05	0.34	0.36	0.97	1.13
115	0.03	0.34	0.37	1.31	1.33
116	0.75	1.20	1.40	1.48	1.55
117	0.65	0.75	0.91	1.19	1.38
118	0.65	0.92	1.11	1.30	1.30
119	0.74	0.75	0.91	1.11	1.20
120	0.74	0.92	1.13	1.19	1.37
121	0.84	0.94	1.23	1.31	1.32
122	1.30	1.31	1.43	1.54	1.56
123	1.16	1.60	1.69	1.92	2.00
124	0.70	0.95	1.17	1.56	1.65
125	0.59	0.99	1.08	1.40	1.56
126	1.21	1.60	1.71	1.71	2.21
127	0.58	1.59	1.72	1.85	1.90
128	0.74	1.38	1.53	1.57	1.65
129	0.74	0.84	1.10	1.59	1.69
130	0.88	1.45	1.59	1.69	1.79
131	0.75	1.15	1.37	1.48	1.53
132	1.00	1.13	1.15	1.20	1.50
133	0.58	1.35	1.42	1.48	1.50
134	0.58	0.94	1.02	1.49	1.52
135	1.02	1.08	1.14	1.31	1.31
136	0.87	0.94	1.01	1.14	1.30
137	1.01	1.08	1.30	1.66	1.68
138	1.47	1.49	1.56	1.69	1.81
139	0.91	1.18	1.56	1.64	1.65
140	0.91	0.99	1.03	1.11	1.62
141	0.59	0.77	1.03	1.18	1.44
142	0.77	1.08	1.11	1.45	1.72
143	0.78	1.21	1.80	2.16	2.41
144	0.78	1.21	1.71	2.42	2.90
145	0.58	1.41	1.78	1.90	2.07
146	1.05	1.16	1.78	2.04	2.16
147	0.69	1.05	1.45	1.53	1.76
148	0.69	1.16	1.59	1.72	2.22
149	0.88	1.72	1.78	1.83	1.92
150	0.14	1.30	1.63	1.77	1.78

QUADRAT AR12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
151	0.14	1.43	1.50	1.68	1.76
152	1.00	1.10	1.35	1.50	1.63
153	0.97	1.08	1.10	1.38	1.51
154	0.73	1.30	1.37	1.43	1.48
155	0.73	0.81	0.87	1.52	1.68
156	0.81	1.15	1.43	1.44	1.49
157	0.63	0.67	1.15	1.62	1.81
158	0.66	0.67	0.95	1.47	1.81
159	0.63	0.66	1.42	1.49	2.12
160	0.95	1.33	1.42	1.49	1.62
161	0.66	1.12	1.23	1.33	1.51
162	0.96	0.99	1.12	1.45	1.47
163	0.66	0.67	0.96	0.98	1.25
164	0.69	1.20	1.53	1.66	1.83
165	0.69	0.77	0.86	1.20	1.27
166	1.21	1.80	1.99	2.25	2.33
167	0.89	1.41	1.67	1.90	2.22
168	1.11	1.67	1.71	2.25	2.94
169	0.89	1.11	1.37	2.07	2.16
170	1.37	1.62	1.71	1.99	2.01
171	1.23	1.34	1.49	1.49	1.66
172	0.73	0.90	1.23	1.53	1.96
173	0.79	0.90	1.16	1.25	1.49
174	0.73	1.25	1.30	1.43	1.74
175	0.54	0.96	1.08	1.60	1.74
176	0.54	1.21	1.39	1.60	1.68
177	0.82	0.96	0.97	1.16	1.21
178	0.82	1.37	1.38	1.47	1.78
179	1.34	1.90	2.41	2.42	2.45
180	1.09	1.17	1.63	1.78	1.85
181	1.09	1.14	1.21	1.43	1.68
182	0.80	0.88	1.14	1.17	1.25
183	0.67	0.67	0.80	1.03	1.16
184	0.67	0.70	0.77	0.98	1.20
185	0.70	0.74	0.86	1.03	1.05
186	0.57	0.62	0.74	0.98	1.20
187	0.62	0.72	1.00	1.17	1.33
188	0.42	0.57	0.72	1.18	1.27
189	0.42	0.98	1.00	1.49	1.57
190	1.55	1.79	1.94	1.99	2.25
191	1.21	1.35	1.35	1.55	1.62
192	0.70	1.21	1.34	1.78	2.01
193	0.70	1.22	1.35	1.44	1.64
194	1.05	1.21	1.22	1.57	1.62
195	0.79	0.81	1.21	1.49	1.50
196	0.81	0.81	1.16	1.57	1.75
197	0.81	0.99	1.50	1.54	1.71
198	0.76	1.44	1.68	1.70	1.71
199	0.76	1.02	1.65	2.03	2.07
200	1.16	1.39	1.44	1.47	1.60

QUADRAT AR12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
201	1.02	1.56	1.70	1.88	1.93
202	1.34	1.86	1.88	1.93	2.26
203	0.87	1.18	1.68	1.86	1.90
204	0.65	0.87	1.95	2.26	2.39
205	0.65	1.18	1.88	1.95	2.47
206	0.57	0.63	0.93	1.11	1.21
207	0.45	0.57	0.90	1.50	1.75
208	0.45	0.45	0.63	1.18	1.58
209	0.45	0.90	0.93	0.96	1.17
210	0.88	0.96	1.05	1.11	1.16
211	1.05	1.29	1.49	1.70	1.81
212	0.51	1.05	1.72	1.92	1.97
213	0.51	1.29	2.01	2.22	2.23
214	0.82	1.79	1.99	2.13	2.16
215	0.44	0.96	1.35	1.54	1.70
216	0.44	0.52	1.31	1.31	1.64
217	0.52	0.95	0.96	1.14	1.29
218	0.97	1.08	1.12	1.14	1.31
219	0.95	1.05	1.05	1.31	1.44
220	1.03	1.05	1.16	1.29	1.50
221	0.98	1.16	1.30	1.37	1.44
222	0.90	0.99	1.06	1.35	1.37
223	0.59	0.69	0.90	0.98	1.30
224	0.59	0.73	1.06	1.25	1.30
225	0.73	0.98	1.32	1.48	1.50
226	0.53	0.69	0.96	1.19	1.25
227	0.43	0.53	0.85	0.92	0.98
228	1.27	1.37	1.56	1.69	1.71
229	0.71	1.53	1.60	1.89	1.95
230	1.68	1.93	2.23	2.24	2.40
231	1.31	1.40	1.93	2.01	2.03
232	0.82	1.28	1.32	1.85	1.98
233	1.16	1.45	1.71	1.76	1.98
234	0.55	0.77	0.87	1.16	1.32
235	0.55	0.58	1.03	1.08	1.28
236	0.58	0.85	0.87	1.03	1.45
237	0.58	0.58	0.77	0.83	1.12
238	0.97	1.03	1.17	1.17	1.19
239	0.83	0.85	1.19	1.30	1.30
240	0.00	0.63	0.66	1.17	1.24
241	0.00	0.63	0.66	1.17	1.24
242	0.63	0.63	0.96	1.00	1.21
243	0.66	0.66	0.69	0.96	1.29
244	0.69	0.90	1.21	1.24	1.24
245	0.90	1.00	1.29	1.46	1.46
246	1.30	1.30	1.51	1.55	1.69
247	0.52	0.85	0.91	1.32	1.42
248	0.43	0.52	0.96	0.96	1.03
249	0.57	0.91	0.99	1.02	1.03
250	0.99	1.23	1.30	1.35	1.45

QUADRAT AR12

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
251	0.48	0.92	0.93	0.96	1.19
252	0.48	1.04	1.27	1.38	1.40
253	0.46	0.57	0.69	0.92	1.02
254	0.60	0.69	0.86	0.93	0.99
255	0.46	0.46	0.60	0.87	1.02
256	0.46	0.86	0.90	0.92	1.18
257	0.87	0.90	0.99	1.02	1.47
258	0.47	0.84	1.30	1.40	1.48
259	0.47	1.22	1.37	1.45	1.53
260	0.84	1.18	1.22	1.63	1.80
261	0.71	0.89	1.67	1.86	1.87
262	0.89	1.29	1.60	1.88	1.94
263	1.65	1.75	1.87	1.88	1.99
264	0.82	1.29	1.33	1.43	1.65
265	0.63	0.82	1.00	2.02	2.05
266	0.63	0.93	1.43	1.75	1.99
267	1.06	1.68	1.75	1.79	1.99
268	0.93	1.00	1.06	1.33	1.58
269	0.64	1.35	1.99	2.11	2.15
270	0.64	1.22	1.58	1.75	1.79
271	0.65	1.22	1.35	1.67	2.03
272	0.65	1.12	1.40	1.86	1.99
273	1.12	1.31	1.67	2.86	2.89

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	200.6113	0.7375
2ND NEAREST NEIGHBOUR -	275.8785	1.0143
3RD NEAREST NEIGHBOUR -	334.8467	1.2311
4TH NEAREST NEIGHBOUR -	389.8708	1.4333
5TH NEAREST NEIGHBOUR -	432.4116	1.5897

QUADRAT AR 15

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	2.70	3.21	3.43	4.14	4.19
2	0.75	2.39	3.21	3.21	3.29
3	0.75	2.68	2.70	2.91	2.94
4	0.99	2.26	2.39	2.73	2.77
5	0.99	1.63	1.87	2.62	3.29
6	1.03	1.47	1.87	2.06	2.12
7	1.03	1.63	1.79	2.20	2.26
8	1.79	2.00	2.12	2.77	2.80
9	1.38	2.34	2.67	2.76	2.77
10	1.17	1.33	1.38	1.70	2.74
11	0.56	0.56	1.17	1.82	2.17
12	0.56	0.89	1.31	1.70	2.28
13	0.56	0.89	1.33	1.63	2.20
14	1.61	1.63	2.17	2.28	2.74
15	1.61	3.24	3.45	3.78	3.87
16	1.27	3.01	3.61	4.00	4.21
17	1.27	1.93	2.40	3.24	3.26
18	0.86	1.93	2.38	2.68	2.81
19	0.86	1.57	2.12	2.33	2.40
20	1.74	2.00	2.10	2.12	2.62
21	1.31	1.57	2.06	2.21	2.35
22	1.47	1.55	1.57	2.00	2.20
23	1.30	1.55	2.01	2.35	2.40
24	1.30	1.65	1.91	2.21	2.33
25	1.07	1.14	1.91	2.01	2.17
26	1.14	1.31	1.56	1.82	2.00
27	1.05	1.56	2.00	2.17	2.35
28	1.05	2.07	2.10	2.41	2.70
29	2.10	3.03	3.45	3.45	3.54
30	1.66	1.95	2.02	2.12	2.42
31	1.00	1.05	1.66	1.79	1.94
32	1.05	1.19	1.44	1.57	2.10
33	1.00	1.05	1.10	1.19	1.77
34	1.04	1.05	1.48	1.70	1.72
35	0.83	1.10	1.31	1.44	1.70
36	0.83	1.41	1.74	1.93	1.94
37	0.60	1.31	1.41	1.48	1.77
38	0.60	1.42	1.72	1.91	1.94
39	1.31	2.23	2.76	2.80	2.80
40	2.23	2.55	2.82	2.82	2.84
41	1.07	1.65	2.00	2.35	2.40
42	1.45	1.73	2.00	2.48	2.70
43	1.15	1.35	1.45	2.10	2.69
44	0.96	1.14	2.02	2.65	3.59
45	1.14	1.31	1.88	2.84	3.05
46	0.96	1.31	1.95	1.99	3.06
47	1.04	1.81	2.08	2.12	2.32
48	1.42	2.02	2.24	2.46	2.82
49	1.08	2.44	2.48	2.76	2.83
50	1.08	1.38	2.09	2.61	2.76

QUADRAT AR 15

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.15	1.18	1.65	1.73	2.59
52	1.35	1.36	1.65	1.76	2.21
53	1.18	1.50	1.76	2.10	2.10
54	1.36	1.49	2.10	2.67	2.69
55	1.07	1.52	1.88	1.99	2.65
56	1.36	2.36	2.66	3.15	3.15
57	1.36	2.32	2.46	2.61	2.67
58	1.25	2.23	2.24	2.61	2.62
59	1.25	1.42	1.63	2.23	2.42
60	1.50	1.55	1.63	1.76	2.23
61	0.67	1.30	1.44	1.68	1.76
62	0.67	0.78	1.55	1.78	2.09
63	0.78	1.38	1.44	1.50	2.44
64	1.33	1.34	2.47	2.56	2.93
65	1.49	1.50	2.21	2.55	2.59
66	0.95	1.07	1.75	2.40	2.84
67	0.95	1.46	1.49	1.52	2.47
68	1.23	1.49	1.75	2.15	2.76
69	2.21	2.23	2.27	2.66	2.93
70	1.46	2.15	2.40	2.44	2.73
71	1.26	1.92	1.98	2.02	2.21
72	0.86	1.25	1.26	1.41	2.07
73	1.01	1.42	1.68	2.07	2.27
74	1.01	1.71	2.02	2.12	2.15
75	1.30	1.71	1.78	2.07	2.27
76	0.45	1.13	1.34	2.97	3.04
77	0.45	1.33	1.37	2.55	2.84
78	1.13	1.37	2.47	2.63	2.79
79	1.23	1.95	2.33	2.44	2.47
80	0.75	1.40	1.43	1.83	2.01
81	0.70	0.75	1.11	1.60	2.07
82	0.70	0.72	1.25	1.43	1.58
83	0.72	1.11	1.27	1.83	1.92
84	1.27	1.44	1.85	2.05	2.21
85	0.72	0.81	1.54	1.95	2.07
86	0.32	0.72	1.11	1.41	1.92
87	0.32	0.81	0.81	1.25	1.98
88	0.81	0.86	1.11	1.54	2.02
89	1.10	1.11	1.51	1.83	2.41
90	0.81	1.06	1.10	2.27	2.42
91	0.40	1.06	1.40	1.50	1.51
92	0.40	0.81	1.11	1.66	1.90
93	1.10	1.30	1.50	1.90	1.96
94	1.30	1.40	1.79	1.95	2.07
95	0.87	1.30	1.36	1.49	2.01
96	1.00	1.25	1.49	1.60	1.92
97	1.00	1.30	1.37	1.58	1.61
98	0.86	1.37	1.44	1.95	2.01
99	0.86	1.29	1.30	2.00	2.11
100	0.71	1.25	1.83	2.51	2.58

QUADRAT AR 15

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
101	0.71	1.52	1.87	2.02	2.52
102	1.25	1.34	1.52	1.93	1.97
103	0.66	1.81	1.96	1.96	1.97
104	0.66	1.30	1.40	1.54	1.66
105	1.10	1.25	1.54	2.03	2.44
106	1.25	2.01	2.03	2.19	2.31
107	2.56	2.57	2.71	2.79	3.31
108	1.78	3.05	3.29	3.45	3.65
109	1.36	1.63	1.78	1.94	2.02
110	0.52	1.28	1.49	1.63	2.70
111	0.52	1.76	1.94	2.01	2.84
112	0.87	1.28	1.76	1.79	1.99
113	1.49	1.61	1.61	1.69	2.14
114	0.62	1.69	2.12	2.69	2.71
115	0.62	1.54	1.61	2.11	2.23
116	1.26	1.29	1.54	1.96	2.12
117	1.10	1.26	2.00	2.02	2.36
118	1.10	1.87	1.92	1.96	2.58
119	1.10	1.92	2.05	2.46	2.54
120	1.10	1.23	1.44	2.27	2.82
121	0.68	1.23	1.34	2.05	2.25
122	0.68	1.44	1.59	1.93	2.45
123	1.59	2.25	2.69	2.82	2.86
124	0.92	1.48	2.03	2.71	3.15
125	0.92	1.50	2.01	2.69	3.25
126	1.48	1.50	3.38	3.91	4.03

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	136.6876	1.0935
2ND NEAREST NEIGHBOUR -	197.6422	1.5811
3RD NEAREST NEIGHBOUR -	237.6730	1.9014
4TH NEAREST NEIGHBOUR -	278.2994	2.2264
5TH NEAREST NEIGHBOUR -	313.1233	2.5050

QUADRAT AR 16

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.49	1.98	2.23	2.56	2.65
2	1.81	2.11	2.23	3.55	3.57
3	1.49	1.52	1.75	1.75	1.92
4	1.75	1.81	2.10	2.82	2.93
5	2.82	2.95	3.35	4.01	4.06
6	2.15	2.16	2.54	2.61	2.97
7	1.30	1.59	2.49	2.53	2.54
8	1.59	1.77	2.45	3.64	4.10
9	1.14	1.63	2.12	2.56	2.60
10	0.81	1.14	1.52	1.98	2.21
11	0.81	1.60	1.63	1.75	1.79
12	1.14	1.60	1.92	2.05	2.10
13	1.14	1.36	1.86	2.06	2.21
14	0.91	2.51	2.95	3.24	3.60
15	0.91	1.60	2.58	3.35	3.41
16	1.60	1.86	2.15	2.51	2.58
17	1.86	1.88	1.96	2.05	2.58
18	1.44	1.96	2.14	2.16	2.41
19	1.25	1.30	2.14	2.40	2.45
20	1.25	1.44	2.53	2.60	2.80
21	1.77	2.40	2.49	2.76	3.15
22	0.85	1.44	1.57	1.87	2.09
23	0.85	0.85	0.87	2.10	2.21
24	0.85	1.36	1.42	1.57	1.79
25	0.87	1.42	1.44	2.37	2.56
26	1.86	2.20	2.41	2.58	2.75
27	0.90	1.88	2.11	2.88	3.41
28	0.90	2.55	2.66	2.78	3.45
29	1.66	2.05	2.11	2.41	2.55
30	1.66	2.26	2.60	2.93	3.00
31	2.11	2.76	2.80	3.03	3.23
32	1.56	1.87	2.54	2.56	3.10
33	1.56	2.40	3.10	3.11	3.33
34	1.03	2.35	2.37	2.75	3.20
35	1.03	2.40	2.41	3.02	3.45
36	1.70	1.94	2.55	2.55	2.88
37	1.94	2.26	2.77	2.92	2.99
38	2.11	3.76	4.80	4.88	5.09
39	2.35	2.40	2.60	2.93	3.70
40	1.70	2.92	3.24	3.48	3.50
41	1.10	1.48	3.33	3.57	4.05
42	1.10	1.84	3.01	3.40	3.66
43	1.48	1.84	2.21	2.40	3.10
44	1.06	2.11	2.21	2.93	3.34
45	1.06	1.32	2.60	3.10	3.38
46	1.95	2.44	2.83	3.03	3.24
47	0.89	1.95	2.26	2.66	2.78
48	0.89	1.97	2.06	2.77	2.83
49	1.97	2.01	2.78	3.62	3.78
50	1.32	2.11	2.44	3.51	3.66

QUADRAT AR 16

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.84	2.44	3.86	4.25	4.39
52	1.82	1.84	2.66	3.03	3.06
53	1.82	2.01	2.06	2.26	3.65
54	2.73	3.01	4.05	4.13	4.65
55	2.44	2.57	3.31	3.38	3.86
56	1.84	2.57	3.48	4.25	4.39
57	1.84	3.58	3.65	3.79	3.86
58	2.68	3.70	3.85	3.86	4.16
59	2.73	5.00	5.73	5.74	5.87
60	3.31	3.48	4.21	5.00	5.32
61	4.21	4.39	4.55	4.74	5.32
62	1.92	3.79	3.85	4.55	5.19
63	1.92	2.68	4.56	5.39	6.45

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	101.8380	1.6425
2ND NEAREST NEIGHBOUR -	139.3531	2.2476
3RD NEAREST NEIGHBOUR -	169.0537	2.7267
4TH NEAREST NEIGHBOUR -	193.0300	3.1134
5TH NEAREST NEIGHBOUR -	210.8945	3.4015

QUADRAT AR 5

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.65	2.97	3.30	3.83	3.92
2	1.65	2.30	3.28	3.50	3.64
3	1.01	1.62	2.39	2.70	2.97
4	1.01	1.60	1.77	2.16	2.19
5	0.82	1.77	1.94	2.09	2.14
6	0.82	1.16	1.51	2.16	2.81
7	1.16	1.27	1.94	2.70	2.72
8	1.27	1.51	1.52	1.73	2.24
9	1.13	1.52	2.64	2.70	2.74
10	0.91	1.92	2.13	2.74	2.79
11	0.91	1.24	1.26	2.42	2.45
12	1.24	1.28	1.41	1.56	1.92
13	1.26	1.27	1.56	2.13	2.42
14	1.27	2.10	2.26	2.42	2.44
15	0.78	1.32	1.99	2.09	2.19
16	0.78	1.60	1.62	2.07	2.14
17	1.32	1.35	1.75	2.07	2.90
18	1.35	1.99	2.22	2.41	2.72
19	0.93	1.89	2.22	2.93	3.01
20	0.93	1.53	2.64	2.84	3.04
21	1.13	1.53	1.73	1.89	2.81
22	1.25	1.41	2.45	2.79	2.84
23	1.25	1.28	2.03	2.26	2.42
24	2.30	2.66	3.37	3.73	3.89
25	1.75	2.66	2.80	2.83	3.44
26	0.85	2.24	3.17	3.19	3.50
27	1.40	1.60	2.84	3.38	3.51
28	0.95	1.40	2.55	2.65	2.71
29	1.17	1.25	1.32	2.10	2.31
30	1.17	1.26	1.98	2.04	2.20
31	0.58	1.30	1.98	2.31	2.54
32	0.58	1.68	2.03	2.44	2.53
33	1.30	1.68	2.20	2.46	3.04
34	0.88	1.04	1.32	1.38	2.04
35	1.04	1.25	1.26	1.88	1.98
36	0.95	1.60	2.47	2.84	2.93
37	2.46	3.68	3.74	4.14	4.60
38	1.24	2.56	2.75	3.31	3.32
39	1.24	1.49	2.99	3.92	3.97
40	1.01	3.31	3.37	3.68	4.44
41	1.01	2.74	2.75	3.73	3.97
42	2.74	2.83	3.19	3.68	3.87
43	0.85	2.02	2.38	2.83	3.31
44	1.56	2.23	2.38	2.54	2.68
45	1.44	1.56	1.66	2.68	3.14
46	1.38	2.02	2.23	2.24	3.14
47	1.38	2.27	2.54	2.68	3.31
48	2.27	3.14	3.45	3.54	3.64
49	0.88	0.98	1.88	2.10	2.55
50	0.98	1.38	1.98	2.01	2.70

QUADRAT AR 5

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	2.01	2.20	2.38	2.57	2.81
52	1.90	2.38	2.46	3.76	4.36
53	1.49	2.19	2.56	2.58	3.46
54	1.37	2.19	2.65	2.99	3.16
55	1.37	2.66	3.46	3.84	3.85
56	2.66	2.80	3.09	3.16	3.36
57	1.44	1.57	2.37	2.68	2.80
58	1.57	1.66	2.13	3.14	3.19
59	2.13	2.15	2.37	2.50	3.46
60	1.40	1.57	2.40	2.50	3.19
61	1.12	1.40	1.97	2.23	2.58
62	1.12	1.86	1.95	2.05	2.40
63	2.05	2.11	2.31	2.46	2.77
64	1.90	2.11	3.66	3.66	4.11
65	2.58	2.65	3.24	3.84	3.91
66	2.81	3.24	3.68	4.61	5.60
67	1.56	2.28	2.81	4.34	4.86
68	0.93	1.56	3.36	3.68	3.91
69	0.93	2.28	3.09	4.41	4.59
70	3.18	4.22	4.33	4.36	4.50
71	1.57	2.15	2.58	3.18	3.70
72	0.64	1.11	1.95	1.97	2.25
73	0.64	0.83	1.86	2.23	2.31
74	0.83	1.11	1.65	2.68	2.77
75	1.65	2.25	2.36	4.16	4.17

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	102.0718	1.3793
2ND NEAREST NEIGHBOUR -	143.7854	1.9430
3RD NEAREST NEIGHBOUR -	180.7743	2.4429
4TH NEAREST NEIGHBOUR -	212.1236	2.8665
5TH NEAREST NEIGHBOUR -	234.7990	3.1730

QUADRAT AR NWS

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	0.80	1.30	1.44	2.11	2.22
2	0.80	0.83	1.14	2.88	2.93
3	0.75	0.83	1.44	2.56	2.77
4	0.75	1.14	1.30	2.02	2.27
5	1.79	2.02	2.27	2.27	2.48
6	0.53	0.65	1.18	1.79	2.35
7	0.55	0.65	0.97	1.82	2.02
8	0.55	1.18	1.38	1.41	2.48
9	1.41	1.82	2.46	2.77	3.07
10	1.39	2.05	2.42	2.57	2.62
11	0.66	1.18	1.39	1.49	1.70
12	0.98	1.26	1.80	1.84	1.94
13	1.26	2.21	2.70	2.93	3.10
14	0.56	1.23	1.44	2.04	2.22
15	0.56	0.95	1.51	1.90	2.00
16	0.95	1.44	1.46	1.48	1.86
17	1.48	1.54	2.00	2.02	2.53
18	1.54	2.02	2.15	2.20	2.32
19	0.53	0.97	1.38	2.02	2.27
20	0.61	0.86	1.87	2.12	2.82
21	0.53	0.61	1.74	1.77	2.70
22	0.53	0.86	1.21	1.28	2.19
23	0.73	1.17	1.21	1.74	1.87
24	0.85	1.91	1.92	2.35	2.35
25	0.85	1.08	1.52	1.59	2.07
26	0.44	1.08	1.15	1.45	1.51
27	1.43	1.51	1.59	1.65	1.92
28	0.44	0.84	1.01	1.52	1.65
29	0.84	0.95	1.15	1.43	1.66
30	0.47	1.16	1.20	1.25	1.46
31	0.60	0.66	1.16	1.28	1.53
32	0.60	0.95	0.99	1.18	1.25
33	0.95	0.98	1.28	1.47	1.49
34	1.47	1.77	1.96	2.03	2.57
35	0.99	1.44	1.46	1.52	1.53
36	0.47	0.74	1.44	1.54	1.58
37	1.23	1.40	1.51	1.86	3.30
38	1.40	1.46	1.90	2.04	2.14
39	0.66	0.75	1.40	1.49	1.62
40	0.72	1.15	1.62	1.80	2.04
41	0.73	0.96	1.28	1.63	1.77
42	0.96	1.17	1.48	2.19	2.62
43	0.95	1.01	1.45	1.77	1.88
44	0.74	1.20	1.53	1.88	2.03
45	0.70	1.40	1.40	1.55	1.57
46	0.70	0.75	0.89	1.64	1.88
47	0.66	0.85	0.89	1.15	1.55
48	0.72	0.85	1.11	1.49	1.64
49	1.11	1.40	1.55	1.80	1.88
50	1.48	1.63	2.29	2.76	3.13

QUADRAT AR NWS

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.00	1.45	2.65	2.75	3.18
52	0.77	1.00	2.28	2.70	2.75
53	0.89	1.73	1.92	2.28	2.57
54	1.05	1.19	1.47	1.63	1.76
55	0.85	1.40	1.63	1.90	2.10
56	0.85	1.19	1.55	1.91	2.05
57	1.40	2.05	2.20	2.31	2.32
58	2.09	2.32	2.93	3.43	3.60
59	0.77	1.45	1.76	2.07	2.20
60	1.16	1.29	1.42	1.47	1.57
61	0.60	1.20	1.29	1.67	1.74
62	1.27	1.71	2.20	2.30	2.97
63	0.60	1.27	1.30	1.74	2.03
64	0.60	1.27	1.55	1.62	1.71
65	1.30	1.55	1.80	1.84	2.30
66	0.40	1.27	1.68	1.74	1.80
67	0.40	1.48	1.62	1.84	2.03
68	1.48	1.68	2.91	3.30	3.42
69	0.75	0.95	1.25	1.57	1.79
70	0.75	0.84	1.20	1.67	1.68
71	0.84	0.85	0.87	0.95	1.17
72	0.85	0.95	0.95	1.18	1.20
73	0.60	0.85	1.13	1.42	1.48
74	0.54	0.85	0.86	1.00	1.13
75	0.54	0.59	0.83	0.87	1.00
76	0.37	0.86	0.97	1.07	1.20
77	0.37	0.89	1.00	1.00	1.29
78	0.51	0.67	0.97	1.29	1.42
79	0.51	0.62	1.07	1.20	1.42
80	0.62	0.67	1.55	1.63	1.85
81	1.07	1.31	1.55	1.55	1.81
82	2.55	2.93	3.01	3.13	3.63
83	1.83	3.30	3.39	3.73	3.83
84	1.25	1.52	1.76	1.79	2.02
85	0.58	0.80	1.15	1.25	1.66
86	0.58	0.59	0.68	1.13	1.17
87	0.68	0.80	0.83	0.89	1.20
88	1.31	1.65	1.83	1.93	2.37
89	0.48	1.53	1.65	1.77	2.55
90	0.48	1.41	1.47	1.83	2.49
91	1.47	1.53	1.82	2.70	2.93
92	1.98	2.49	3.16	3.33	3.57
93	1.83	3.99	4.13	4.31	4.66
94	0.47	0.73	1.79	2.14	2.40
95	0.47	0.76	1.93	1.95	2.22
96	0.73	0.76	1.47	1.76	2.11
97	0.73	0.84	1.12	1.47	1.57
98	0.44	0.56	0.73	1.38	1.64
99	0.56	0.84	0.92	1.81	1.92
100	1.23	1.26	1.93	1.98	2.37

QUADRAT AR NWS

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
101	1.26	1.41	1.77	1.93	2.48
102	1.82	2.42	2.49	2.85	2.91
103	0.96	1.36	1.42	1.49	1.77
104	0.64	1.36	1.57	1.71	1.97
105	0.64	0.93	1.10	1.42	1.70
106	1.19	1.57	1.57	1.64	1.95
107	1.02	1.19	1.38	1.83	1.92
108	0.44	0.92	1.02	1.12	1.57
109	1.23	1.58	1.73	1.81	1.81
110	0.55	1.73	1.93	2.81	3.20
111	0.55	1.98	2.10	2.62	2.95
112	0.56	1.49	1.58	1.93	2.16
113	0.56	0.96	1.37	1.67	1.70
114	0.36	1.10	1.37	1.58	1.71
115	0.36	0.93	1.57	1.67	1.72
116	0.66	0.81	1.72	1.99	2.32
117	0.67	0.81	2.07	2.23	2.85
118	0.66	0.67	2.35	2.58	2.98
119	0.89	1.05	1.16	1.90	1.91

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	103.8884	0.8804
2ND NEAREST NEIGHBOUR -	149.7889	1.2694
3RD NEAREST NEIGHBOUR -	190.4072	1.6136
4TH NEAREST NEIGHBOUR -	224.2779	1.9007
5TH NEAREST NEIGHBOUR -	254.7736	2.1591

QUADRAT MD 7B

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	1.35	2.66	3.26	3.66	4.85
2	1.35	2.93	2.97	3.29	4.39
3	2.84	3.29	3.45	3.66	5.20
4	1.50	2.84	4.05	4.24	4.42
5	1.50	2.97	3.01	3.26	3.27
6	3.10	3.45	5.65	5.92	6.06
7	1.02	3.00	3.10	3.39	3.54
8	1.02	2.45	3.15	3.43	3.45
9	1.26	2.66	2.70	2.93	3.41
10	1.26	1.61	2.55	2.97	3.26
11	2.11	2.97	3.37	3.62	3.64
12	1.53	1.98	2.11	2.19	2.55
13	0.56	0.68	1.53	1.95	2.13
14	0.30	0.56	1.98	2.19	2.19
15	0.30	0.68	1.92	1.98	2.19
16	0.72	1.66	1.95	1.98	2.19
17	0.72	1.92	2.13	2.19	2.38
18	0.60	0.86	3.00	3.01	3.11
19	0.60	0.71	2.42	2.75	2.77
20	0.71	0.86	2.36	2.51	2.53
21	1.10	2.55	2.67	3.16	3.41
22	1.10	1.61	2.70	2.81	3.44
23	1.70	3.19	3.36	3.56	3.64
24	1.70	2.50	2.73	2.81	3.00
25	0.22	1.46	3.04	3.24	3.29
26	0.86	0.90	0.92	2.11	2.14
27	0.90	1.14	1.66	1.82	2.21
28	0.86	1.14	1.29	1.39	1.40
29	0.92	1.29	1.57	1.62	1.82
30	1.19	1.25	1.40	1.94	2.01
31	1.25	1.75	2.14	2.65	2.75
32	1.41	1.81	1.82	1.90	1.93
33	0.57	0.60	1.41	2.36	2.51
34	0.57	0.85	1.90	2.36	2.77
35	0.60	0.85	1.82	2.26	2.94
36	1.75	1.98	2.67	3.16	3.44
37	0.67	1.75	2.02	2.44	3.00
38	0.67	1.52	1.98	2.60	2.90
39	0.73	2.44	2.50	2.90	3.23
40	1.46	1.62	2.44	2.72	2.75
41	0.22	1.62	3.01	3.03	3.45
42	0.53	1.31	1.57	1.79	1.86
43	0.53	0.78	1.62	1.68	1.94
44	0.78	1.19	1.31	1.39	1.80
45	1.60	1.75	1.80	2.01	2.21
46	0.85	1.93	2.15	2.21	2.56
47	0.85	1.81	2.26	2.36	2.63
48	1.52	1.59	1.92	1.99	2.02
49	0.73	2.72	2.73	3.17	3.19
50	1.80	2.44	2.86	2.90	3.01

QUADRAT MD 7B

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.40	1.79	1.80	2.26	2.98
52	1.40	1.78	1.86	2.05	2.29
53	1.60	1.78	2.15	2.36	2.69
54	0.66	1.59	1.99	2.17	2.51
55	0.66	1.52	1.70	1.86	1.99
56	1.70	1.75	1.75	1.92	1.99
57	2.09	2.33	2.75	2.86	4.01
58	1.70	2.10	2.29	2.36	2.77
59	1.51	1.70	1.70	1.97	2.19
60	0.76	1.51	1.90	2.10	2.69
61	0.76	1.89	2.19	2.34	2.56
62	2.34	2.67	2.98	3.09	3.26
63	0.40	1.52	1.60	1.75	2.10
64	0.40	1.58	1.75	1.86	1.92
65	0.14	1.22	1.97	2.02	2.33
66	1.70	2.09	3.36	3.39	3.58
67	1.70	2.04	2.33	3.20	3.82
68	1.46	2.04	2.31	3.01	3.58
69	1.60	2.31	2.84	2.95	3.02
70	1.45	1.60	2.23	2.24	2.48
71	1.45	1.57	1.70	2.35	2.48
72	1.89	1.90	1.97	1.97	2.48
73	1.24	1.97	2.42	3.00	3.04
74	1.06	1.36	2.62	2.64	3.00
75	0.88	1.06	1.58	1.60	2.39
76	0.88	1.36	1.65	1.92	2.10
77	1.16	1.22	1.60	1.65	2.39
78	0.14	1.16	1.89	2.10	2.37
79	1.60	1.89	2.02	3.21	3.83
80	1.46	2.10	3.05	3.20	3.91
81	1.91	2.10	2.83	2.95	3.01
82	1.62	1.91	2.24	2.35	3.34
83	1.57	1.62	2.08	2.48	3.04
84	1.06	1.59	2.08	2.42	3.36
85	1.06	1.86	3.00	3.11	4.24
86	1.24	1.59	1.86	3.05	3.15

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	99.6700	1.1726
2ND NEAREST NEIGHBOUR -	153.1779	1.8021
3RD NEAREST NEIGHBOUR -	197.9711	2.3291
4TH NEAREST NEIGHBOUR -	221.2773	2.6033
5TH NEAREST NEIGHBOUR -	249.6766	2.9374

QUADRAT MD 4A

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	2.15	3.59	3.64	4.52	4.57
2	0.93	1.01	2.06	2.35	3.06
3	0.93	1.57	1.99	2.15	2.86
4	1.99	2.06	2.77	3.07	3.88
5	2.15	2.30	2.34	2.67	2.77
6	2.67	2.87	3.29	3.88	3.95
7	2.75	3.83	4.14	4.23	4.36
8	1.01	1.57	1.78	2.60	3.07
9	1.78	2.15	2.35	3.21	3.46
10	5.62	6.04	7.47	7.62	7.74
11	2.60	3.17	3.23	3.46	3.49
12	2.07	2.30	2.34	2.79	2.80
13	0.82	1.43	2.07	2.16	2.29
14	0.82	1.79	2.34	2.34	2.75
15	1.12	1.50	2.16	2.30	2.75
16	1.12	1.43	1.52	1.79	2.00
17	1.50	1.52	2.18	2.75	2.95
18	2.00	2.18	2.34	2.70	2.97
19	1.61	2.77	3.02	3.17	3.41
20	1.84	2.39	2.66	2.66	2.83
21	1.50	1.83	1.84	2.71	2.86
22	1.50	2.29	2.30	2.34	2.66
23	2.36	3.42	3.93	4.12	4.65
24	2.34	2.36	2.51	2.71	3.45
25	1.56	1.61	1.84	2.51	2.65
26	0.58	1.84	2.24	2.34	2.75
27	0.58	1.56	2.48	2.52	2.70
28	1.55	2.50	2.52	2.65	2.77
29	1.55	2.39	2.80	2.96	3.74
30	1.00	1.83	1.87	2.66	3.22
31	1.00	2.26	2.36	2.71	3.03
32	1.87	2.26	3.12	3.23	3.62
33	1.72	1.83	2.25	3.11	3.36
34	1.56	1.72	2.24	2.36	2.70
35	2.04	2.48	2.50	2.71	2.75
36	1.22	1.74	2.36	3.22	3.23
37	1.18	2.08	2.25	3.27	3.42
38	1.56	1.59	1.83	2.30	2.80
39	1.40	1.59	2.36	2.65	2.71
40	1.59	2.04	2.10	2.65	3.09
41	1.56	2.89	2.96	3.04	3.26
42	1.56	1.99	2.30	2.51	2.94
43	1.80	1.99	2.22	2.27	2.42
44	1.22	1.56	2.22	2.42	3.25
45	1.56	1.74	2.57	3.04	3.55
46	0.94	1.18	2.71	3.11	3.56
47	0.94	2.07	2.08	3.69	3.69
48	2.07	2.44	2.71	2.80	2.84
49	1.40	1.77	2.30	2.44	3.09
50	1.11	2.09	2.10	2.33	2.90

QUADRAT MD 4A

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.11	1.59	2.51	2.53	2.89
52	1.35	1.59	2.27	2.30	2.37
53	1.35	1.80	2.51	2.55	2.83
54	0.94	1.33	2.42	2.42	2.57
55	0.88	0.94	3.04	3.18	3.25
56	0.88	1.33	2.30	2.86	3.24
57	1.77	2.84	2.90	3.13	3.78
58	0.75	2.00	2.33	3.01	3.02
59	0.75	1.70	2.09	2.37	2.53
60	1.59	1.70	2.00	2.51	3.65
61	2.30	2.55	3.18	3.35	3.62

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	94.9862	1.5831
2ND NEAREST NEIGHBOUR -	127.8010	2.1300
3RD NEAREST NEIGHBOUR -	155.1190	2.5853
4TH NEAREST NEIGHBOUR -	176.0034	2.9334
5TH NEAREST NEIGHBOUR -	195.3424	3.2557

QUADRAT MD 4B

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	2.24	3.78	4.04	4.17	4.96
2	1.59	2.11	2.24	2.72	2.89
3	0.96	1.30	1.36	1.59	3.50
4	0.96	1.35	1.98	2.11	2.54
5	1.01	1.30	1.35	2.89	3.16
6	1.01	1.36	1.98	2.72	3.27
7	2.05	2.09	2.23	2.47	2.62
8	1.77	2.23	2.84	3.05	3.74
9	1.77	2.55	2.91	3.91	3.94
10	0.52	2.55	3.07	3.18	3.79
11	0.52	2.64	2.91	3.37	3.73
12	2.41	2.52	2.69	3.18	3.37
13	0.35	2.52	3.01	4.14	4.67
14	0.35	2.69	3.35	4.50	5.02
15	1.47	1.98	2.41	3.01	3.35
16	2.17	2.64	3.67	4.16	4.17
17	2.54	2.55	2.64	2.86	3.34
18	1.02	2.12	2.47	2.50	2.94
19	1.02	1.49	1.92	2.05	2.05
20	0.56	1.12	1.49	2.09	2.50
21	0.56	0.70	1.92	1.94	2.62
22	0.70	1.12	1.70	2.05	3.01
23	1.70	1.94	2.50	2.64	3.07
24	0.53	1.47	2.96	3.88	4.14
25	0.53	1.98	2.43	4.37	4.63
26	2.12	2.55	2.76	3.05	3.24
27	2.17	2.70	2.86	3.31	3.38
28	0.85	2.61	2.64	2.70	3.01
29	0.85	2.43	2.52	3.24	3.31
30	2.31	2.74	2.76	3.24	3.33
31	1.92	1.93	2.31	3.79	3.85
32	1.12	1.46	2.58	3.34	3.56
33	1.12	1.72	1.74	4.24	4.37
34	2.43	2.96	3.15	4.24	4.41
35	2.64	3.32	3.38	3.40	3.44
36	1.07	1.94	2.43	2.61	2.98
37	1.07	2.05	2.52	2.84	3.01
38	1.92	2.07	2.42	2.74	2.84
39	1.93	2.42	2.47	2.63	3.56
40	1.46	1.74	2.05	3.15	3.47
41	1.72	2.05	2.58	3.15	4.36
42	1.92	2.41	2.49	3.20	3.50
43	1.94	2.41	2.84	3.25	3.32
44	1.66	2.05	2.07	2.33	2.98
45	1.26	1.66	3.02	3.26	3.34
46	1.56	1.68	2.47	2.78	2.84
47	1.68	2.29	2.63	2.69	2.92
48	0.60	1.28	1.92	2.73	3.25
49	1.26	2.12	2.33	3.27	3.58
50	1.30	1.56	2.00	2.29	3.25

QUADRAT MD 4B

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.30	1.88	2.64	2.78	2.92
52	2.64	2.69	3.25	3.47	3.50
53	2.77	3.50	4.16	4.36	5.39
54	0.60	0.73	2.19	2.49	2.99
55	0.73	1.28	1.46	2.27	3.20
56	2.12	3.26	3.35	3.79	3.83
57	1.88	2.00	2.33	2.42	3.37
58	2.77	5.01	5.57	6.21	6.39
59	1.02	1.46	2.19	2.73	2.86
60	1.02	1.97	2.27	2.99	3.35
61	1.97	2.66	2.86	4.23	4.30
62	2.66	4.02	4.17	4.26	5.03
63	0.97	2.33	3.14	3.45	4.17
64	0.97	2.17	2.42	2.96	3.43
65	1.92	2.17	2.28	3.01	3.14
66	1.48	1.92	3.86	4.59	4.77
67	1.48	2.28	3.43	4.19	5.26

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	98.4909	1.4923
2ND NEAREST NEIGHBOUR -	145.5809	2.2058
3RD NEAREST NEIGHBOUR -	176.5886	2.6756
4TH NEAREST NEIGHBOUR -	213.2124	3.2305
5TH NEAREST NEIGHBOUR -	240.0261	3.6368

QUADRAT MD 3B

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	2.88	4.12	4.35	4.93	5.25
2	2.27	3.08	3.21	3.85	4.12
3	1.28	1.71	2.27	2.30	2.95
4	1.71	2.10	2.11	2.18	2.59
5	1.07	2.11	2.30	2.70	3.15
6	1.07	1.65	2.82	2.91	3.28
7	1.65	2.48	2.49	2.70	2.78
8	1.18	2.11	2.16	2.59	2.78
9	0.94	1.18	1.22	2.49	2.58
10	0.94	1.14	1.66	1.75	2.01
11	1.14	1.22	1.40	1.82	2.11
12	0.63	1.34	1.66	1.75	1.82
13	0.63	0.72	1.34	1.66	1.80
14	0.72	1.09	1.34	1.76	2.01
15	0.73	1.09	1.34	1.66	2.14
16	0.73	1.47	1.76	1.80	1.89
17	1.47	1.98	2.07	2.12	2.14
18	1.60	1.92	2.07	2.35	2.99
19	1.60	2.28	3.22	3.52	3.53
20	2.28	2.35	3.43	4.40	4.72
21	2.88	3.05	4.57	4.80	5.74
22	1.87	2.16	3.05	3.25	3.39
23	1.28	2.16	2.18	2.30	2.91
24	2.10	2.14	2.30	2.40	2.95
25	1.40	1.85	2.04	2.42	2.46
26	0.61	1.30	1.84	1.89	2.29
27	1.30	1.58	1.92	2.12	2.84
28	1.87	1.98	2.40	2.91	3.06
29	1.63	1.98	2.14	3.17	3.30
30	1.33	2.68	3.30	3.43	3.59
31	0.78	1.46	2.01	2.18	2.44
32	0.78	1.62	1.85	2.04	2.29
33	0.72	1.46	1.62	1.89	1.89
34	0.72	1.84	2.15	2.16	2.18
35	1.63	1.70	2.46	2.86	3.06
36	2.04	2.46	2.50	2.58	2.68
37	1.33	2.04	2.80	3.74	3.85
38	1.13	1.58	2.51	2.89	3.03
39	0.52	1.13	2.41	2.44	2.64
40	0.52	1.58	1.89	2.01	2.15
41	1.20	2.12	2.16	2.83	2.94
42	1.20	1.26	1.87	2.53	2.92
43	1.26	2.12	2.32	2.45	3.90
44	0.70	2.54	2.63	3.11	3.41
45	0.70	2.42	2.80	2.86	3.25
46	1.70	2.12	2.42	2.58	3.11
47	2.30	2.49	2.50	2.80	2.89
48	1.12	1.84	2.12	2.83	2.92
49	1.06	1.65	1.67	1.87	2.12
50	1.06	2.02	2.34	2.45	2.53

QUADRAT MD 3B

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.90	2.63	2.69	3.25	5.58
52	1.68	2.12	2.92	2.94	3.26
53	1.68	1.80	2.49	3.29	3.52
54	2.29	2.30	2.51	3.29	3.46
55	0.72	1.12	1.65	2.34	3.12
56	0.72	1.67	1.84	2.02	3.42
57	2.69	3.13	5.14	5.64	6.00
58	1.90	2.54	2.80	3.13	4.61
59	1.80	2.38	2.94	3.28	3.55
60	1.34	2.23	2.29	2.64	2.78
61	0.97	1.34	1.36	2.60	3.14
62	1.12	1.36	2.48	2.64	3.46
63	3.36	3.46	3.80	3.99	4.41
64	0.61	1.58	1.98	2.04	2.10
65	2.00	3.27	3.29	4.75	5.07
66	2.00	2.46	3.28	3.74	4.14
67	1.23	2.38	2.48	2.58	2.87
68	1.23	1.78	2.39	2.48	2.60
69	0.97	1.12	2.17	2.23	2.39
70	3.27	5.07	5.09	6.00	6.33
71	1.89	2.46	2.81	3.29	4.25
72	1.07	1.89	2.63	3.28	3.49
73	1.07	1.63	2.48	2.48	2.81
74	1.63	1.78	2.00	2.58	2.63
75	2.00	2.47	2.69	3.35	3.48
76	1.76	1.99	2.17	2.48	2.69
77	1.30	1.76	2.47	3.93	4.01
78	1.30	1.99	3.36	3.70	3.81

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	110.7800	1.4387
2ND NEAREST NEIGHBOUR -	157.1572	2.0410
3RD NEAREST NEIGHBOUR -	191.2268	2.4835
4TH NEAREST NEIGHBOUR -	220.9958	2.8701
5TH NEAREST NEIGHBOUR -	248.3447	3.2253

QUADRAT ST. C

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
1	3.31	3.47	4.66	4.88	5.92
2	2.16	2.33	3.28	3.31	3.40
3	1.76	2.16	2.34	3.05	3.76
4	1.05	1.76	2.61	3.42	3.66
5	1.05	1.70	2.34	2.56	2.99
6	1.33	1.70	2.61	2.80	3.04
7	0.90	2.51	2.56	2.80	3.15
8	0.90	2.66	2.91	2.97	3.35
9	1.92	2.80	3.40	3.79	3.87
10	1.92	2.02	3.63	4.33	4.37
11	2.02	2.70	3.79	4.68	5.60
12	2.60	2.67	3.47	3.47	4.31
13	2.11	2.23	2.33	2.60	3.11
14	1.33	2.11	2.41	2.99	3.18
15	1.11	1.78	2.66	2.74	2.75
16	1.11	1.66	2.52	2.80	3.59
17	2.33	2.52	2.66	2.74	3.54
18	2.70	2.74	3.45	3.63	4.42
19	1.68	2.23	2.67	3.13	3.53
20	1.68	2.58	3.18	3.35	3.57
21	2.41	2.58	2.99	3.13	3.39
22	1.90	2.51	2.69	2.78	2.91
23	1.90	2.02	2.14	2.27	2.78
24	1.74	1.90	2.09	2.49	2.55
25	0.86	1.74	2.14	2.60	2.69
26	0.86	1.90	2.27	2.49	2.74
27	1.66	1.78	2.60	2.66	2.95
28	2.33	3.27	3.37	3.45	4.02
29	2.80	3.35	3.78	3.79	4.83
30	2.41	2.80	2.95	3.18	3.29
31	1.80	2.01	3.14	3.29	3.31
32	1.81	2.01	2.36	2.68	2.80
33	1.81	2.02	2.37	2.52	3.10
34	1.29	1.83	2.09	2.52	2.87
35	1.29	1.73	3.25	3.25	3.33
36	1.73	1.74	1.83	2.19	2.37
37	0.90	2.55	2.63	2.95	3.15
38	0.90	1.85	3.23	3.27	3.45
39	1.85	2.62	2.63	3.37	4.21
40	2.26	2.57	2.62	4.46	4.51
41	1.11	1.40	2.41	3.14	3.32
42	0.94	1.40	1.93	2.38	3.07
43	0.94	1.11	2.03	2.54	2.95
44	1.49	1.93	2.30	2.51	2.54
45	1.95	2.03	2.30	2.38	3.14
46	1.80	2.12	2.28	2.68	2.87
47	1.43	2.28	2.66	3.01	3.75
48	1.43	2.67	2.90	2.92	3.26
49	1.32	1.74	2.12	2.36	3.01
50	1.32	2.19	2.66	2.67	2.81

QUADRAT ST. C

NEAREST NEIGHBOURS

NEST	1	2	3	4	5
51	1.27	2.40	2.73	2.81	2.92
52	2.21	2.53	2.73	3.03	3.35
53	1.20	2.21	2.57	2.86	3.57
54	1.20	2.26	2.60	3.35	3.95
55	1.49	2.40	2.94	3.07	3.45
56	0.83	2.40	3.31	3.63	4.97
57	0.83	2.94	4.03	4.46	5.79
58	1.95	2.51	3.45	3.63	3.75
59	2.22	2.95	3.03	3.26	4.07
60	1.14	1.27	2.68	2.90	2.95
61	1.14	1.71	2.22	2.40	2.91
62	1.71	2.38	2.46	2.68	2.95
63	0.92	1.86	2.46	2.53	2.76
64	0.92	1.42	1.99	2.95	3.03
65	1.42	1.86	2.38	2.91	3.74
66	1.99	2.60	2.76	2.86	2.91

TOTALS AND MEANS

1ST NEAREST NEIGHBOUR -	105.6170	1.6249
2ND NEAREST NEIGHBOUR -	145.6724	2.2411
3RD NEAREST NEIGHBOUR -	180.5793	2.7781
4TH NEAREST NEIGHBOUR -	201.3016	3.0969
5TH NEAREST NEIGHBOUR -	228.1540	3.5101

APPENDIX THIRTEEN

Further details of the ordinations of the sample areas.

In this Appendix some of the details of the first ordination of 19 sample areas in Chapter Thirteen, and the second ordination of 9 sample areas in Chapter Eighteen, are given.

Table LXXV.

The matrix of similarity index values for the first ordination.

	2	3	4	5	6	7	8	9	10	11	12	13	14
1	71.6	64.0	71.3	75.4	81.9	76.5	62.2	42.9	61.0	66.1	61.9	62.5	60.4
2	-	70.9	59.6	68.8	78.9	70.2	73.5	51.7	50.0	51.5	47.6	50.5	51.8
3		-	66.7	65.3	67.4	64.6	48.5	39.0	48.5	51.0	50.9	58.3	50.0
4			-	70.8	69.2	73.7	61.0	47.4	52.6	61.5	64.0	59.5	57.1
5				-	83.5	74.3	54.7	37.5	50.5	60.3	66.7	54.5	55.8
6					-	80.8	38.9	34.5	46.8	54.2	53.1	49.5	61.1
7						-	61.0	45.4	53.8	59.8	62.6	55.9	61.0
8							-	65.3	59.3	66.1	68.2	67.8	53.2
9								-	39.1	50.0	44.4	46.8	40.9
10									-	71.0	67.3	63.4	58.9
11										-	79.7	71.9	57.4
12											-	90.0	58.6
13												-	62.7
14													-

	15	16	17	18	19
1	65.4	62.3	66.1	62.0	73.4
2	55.4	54.1	46.2	68.4	65.9
3	65.9	57.8	50.0	64.3	64.5
4	54.4	53.3	64.9	62.6	64.8
5	60.8	53.8	54.5	59.2	65.4
6	64.5	58.1	53.5	50.5	69.4
7	56.3	53.3	57.7	56.6	63.0
8	56.1	56.9	68.6	64.1	69.6
9	37.2	40.9	46.8	43.9	46.2
10	64.5	52.6	54.4	56.6	63.3
11	60.4	61.1	71.2	58.8	68.5
12	57.9	60.3	66.1	54.5	65.5
13	62.0	56.9	64.8	60.4	61.0
14	61.7	58.3	60.8	55.6	60.6
15	-	61.7	62.0	59.2	70.1
16		-	76.5	55.6	68.7
17			-	58.3	61.0
18				-	73.1
19					-

See overleaf for explanation of numbers 1 - 19.

Table LXXVI.

The matrix of dissimilarity index values for the first ordination.

	2	3	4	5	6	7	8	9	10	11	12	13	14
1	28.4	36.0	28.7	24.6	18.1	23.5	37.8	57.1	39.0	33.9	38.1	37.5	39.6
2	-	29.1	40.4	31.2	21.1	29.8	26.5	48.3	50.0	48.5	52.4	49.5	48.2
3		-	33.3	34.7	32.6	35.4	51.5	61.0	51.5	49.0	49.1	41.7	50.0
4			-	29.2	30.8	26.3	39.0	52.6	47.4	38.5	36.0	40.5	42.9
5				-	16.5	25.7	45.3	62.5	49.5	29.7	33.3	45.5	44.2
6					-	19.2	41.1	65.5	53.2	45.8	46.9	50.5	38.9
7						-	39.0	54.6	46.2	40.2	37.4	44.1	39.0
8							-	34.7	40.7	33.9	31.8	32.2	46.8
9								-	60.9	50.0	55.6	53.2	59.1
10									-	29.0	32.7	36.6	41.1
11										-	20.3	28.1	42.6
12											-	10.0	41.4
13												-	37.3
14													-

	15	16	17	18	19
1	34.6	37.7	33.9	38.0	26.6
2	44.6	45.9	53.8	31.6	34.1
3	34.1	42.2	50.0	35.7	35.5
4	45.6	46.7	35.1	37.4	35.2
5	39.2	46.2	45.5	40.8	34.6
6	35.5	41.9	46.5	49.5	30.6
7	43.7	46.7	42.3	43.4	37.0
8	33.9	33.1	31.4	35.9	30.4
9	63.8	59.1	53.2	56.1	53.8
10	35.5	47.4	46.6	43.4	36.7
11	39.6	38.9	28.8	41.2	31.5
12	42.1	39.7	33.9	45.5	34.5
13	38.0	43.1	35.2	39.6	39.0
14	38.3	41.7	39.2	44.4	39.4
15	-	38.3	38.0	40.8	29.9
16		-	23.5	44.4	31.3
17			-	41.7	39.0
18				-	26.9
19					-

1 = OWH SS 4, 2 = OWH SS 5, 3 = OWH SS 7, 4 = OWH SS 8, 5 = OWH SS 9, 6 = OWH SS 11, 7 = OWH SS 12, 8 = OWH NFS, 9 = OWH C10, 10 = AR 11, 11 = AR 12, 12 = AR 15, 13 = AR 16, 14 = AR 5, 15 = AR NWS, 16 = MD 7B, 17 = MD 4A, 18 = MD 4B, 19 = MD 3B.

Table LXXVII.

Matrix of the number of species each pair of samples has in common in the first ordination.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	34	32	41	43	43	44	37	21	32	39	39	35	32	34	33	37	31	40
2	-	28	28	32	33	33	36	20	21	25	25	23	22	23	23	21	27	29
3		-	33	32	30	32	25	16	24	26	28	23	24	29	26	24	27	30
4			-	40	36	42	36	23	30	36	40	33	30	28	28	36	31	35
5				-	43	42	32	18	26	35	38	30	29	31	28	30	29	35
6					-	42	21	15	22	29	30	25	29	30	27	27	25	34
7						-	36	22	28	35	36	31	32	29	28	32	28	34
8							-	33	32	40	44	39	29	30	31	36	33	39
9								-	17	25	24	22	18	16	18	22	18	21
10									-	38	36	32	28	30	25	28	28	31
11										-	51	41	31	32	33	37	30	38
12											-	50	34	33	35	37	30	39
13												-	32	31	29	35	29	32
14													-	29	28	31	25	30
15														-	29	31	29	34
16															-	39	25	34
17																-	28	32
18																	-	34
19																		-

1 = OWH SS 4, 2 = OWH SS 5, 3 = OWH SS 7, 4 = OWH SS 8, 5 = OWH SS 9, 6 = OWH SS 11, 7 = OWH SS 12, 8 = OWH NFS, 9 = OWH C10, 10 = AR 11, 11 = AR 12, 12 = AR 15, 13 = AR 16, 14 = AR 5, 15 = AR NWS, 16 = MD 7B, 17 = MD 4A, 18 = MD 4B, 19 = MD 3B.

Table LXXVIII.

The matrix of similarity index values for the second ordination.

	8	6	1	16	17	19	12	13
9	27.9	21.5	14.9	19.0	12.2	14.6	27.8	39.0
8	-	57.1	50.7	55.6	33.6	47.7	60.2	55.4
6		-	69.8	51.0	29.0	60.0	53.6	43.6
1			-	50.4	30.2	57.8	46.2	37.2
16				-	46.9	54.2	50.2	43.6
17					-	38.8	32.0	41.4
19						-	46.5	39.1
12							-	63.8

Table LXXIX.

The matrix of dissimilarity index values for the second ordination.

	8	6	1	16	17	19	12	13
9	72.1	78.5	85.1	81.0	87.8	85.4	72.2	61.0
8	-	42.9	49.3	44.4	66.4	52.3	39.8	44.6
6		-	30.2	49.0	71.0	40.0	46.4	56.4
1			-	49.6	69.8	42.2	53.8	62.5
16				-	53.1	45.8	49.8	56.4
17					-	61.2	68.0	58.6
19						-	53.5	60.9
12							-	36.2

1 = OWH SS 4, 6 = OWH SS 11, 8 = OWH NFS, 9 = OWH C10, 12 = AR 15,

13 = AR 16, 16 = MD 7B, 17 = MD 4A, 19 = MD 3B.

APPENDIX FOURTEEN

Miscellaneous tables from the spatial analysis of the ant mounds.

In this Appendix some of the less exciting data from the analysis of the spatial distribution of the ant mounds is given. All the tables in the Appendix have been referred to in Chapter Fourteen, where the detailed explanation of what they mean is given.

Table LXXX.

The expected mean distances to the first to fifth nearest neighbours, as calculated from the unmodified formula of Thompson (1956).

QUADRAT	1st	2nd	3rd	4th	5th
OWH SS 4	1.22	1.83	2.29	2.67	3.01
SS 5	1.25	1.88	2.34	2.73	3.07
SS 7	3.53	5.30	6.63	7.73	8.70
SS 8	1.23	1.84	2.30	2.69	3.03
SS 9	1.01	1.51	1.88	2.20	2.47
SS11	1.32	1.98	2.48	2.90	3.26
SS12	1.19	1.78	2.23	2.60	2.92
NFS	1.20	1.79	2.24	2.61	2.94
C10	0.92	1.38	1.71	2.01	2.26
AR 11	0.94	1.41	1.76	2.06	2.32
12	0.61	0.91	1.13	1.32	1.49
15	0.89	1.34	1.67	1.95	2.19
16	1.26	1.89	2.36	2.76	3.10
5	1.15	1.73	2.16	2.53	2.84
NWS	0.92	1.38	1.72	2.01	2.26
MD 7B	1.08	1.62	2.02	2.36	2.65
4A	1.28	1.92	2.40	2.80	3.15
4B	1.22	1.83	2.29	2.67	3.01
3B	1.13	1.70	2.12	2.48	2.79
ST. C	1.23	1.85	2.31	2.69	3.03

These are the expected distances to nearest neighbour used in all calculations using the unmodified normal approximation significance test analysis of Clark and Evans (1954) and Thompson (1956).

Table LXXXI.

The standard errors of the expected mean distances to the 1st to 5th nearest neighbours, calculated using the formula of Thompson (1956).

QUADRAT	1	2	3	4	5
OWH SS 4	0.078	0.081	0.082	0.083	0.084
SS 5	0.082	0.085	0.086	0.087	0.088
SS 7	0.653	0.068	0.069	0.069	0.071
SS 8	0.079	0.083	0.084	0.084	0.085
SS 9	0.053	0.055	0.056	0.056	0.057
SS11	0.092	0.096	0.097	0.097	0.099
SS12	0.074	0.077	0.078	0.078	0.080
NFS	0.075	0.078	0.079	0.079	0.081
C10	0.044	0.046	0.046	0.047	0.047
AR 11	0.046	0.048	0.049	0.049	0.050
12	0.019	0.020	0.020	0.020	0.021
15	0.042	0.043	0.044	0.044	0.045
16	0.083	0.086	0.088	0.088	0.090
5	0.070	0.073	0.074	0.074	0.075
NWS	0.044	0.046	0.046	0.047	0.047
MD 7B	0.061	0.063	0.064	0.065	0.066
4A	0.086	0.089	0.090	0.091	0.093
4B	0.078	0.081	0.082	0.083	0.084
3B	0.067	0.070	0.071	0.071	0.072
ST. C	0.079	0.083	0.084	0.084	0.086

These are the standard errors of the expected means that were given in the previous table.

Table LXXXII.

The Index of Dispersion in each quadrat, for the 1st to 5th nearest neighbour distances, calculated from the coordinates of the mounds.

QUADRAT	1	2	3	4	5
OWH SS 4	1.17	1.06	1.05	1.04	1.04
SS 5	1.27	1.17	1.17	1.18	1.16
SS 7	1.39	1.56	1.57	1.62	1.81
SS 8	1.31	1.24	1.21	1.19	1.20
SS 9	1.31	1.14	1.13	1.13	1.14
SS11	1.23	1.13	1.23	1.21	1.22
SS12	1.17	1.09	1.13	1.14	1.13
NFS	1.35	1.24	1.18	1.20	1.18
C10	1.29	1.16	1.15	1.12	1.11
AR 11	1.23	1.13	1.13	1.12	1.14
12	1.22	1.12	1.08	1.08	1.06
15	1.23	1.18	1.14	1.14	1.14
16	1.30	1.19	1.15	1.13	1.10
5	1.19	1.12	1.13	1.14	0.12
NWS	0.96	0.92	0.94	0.95	1.04
MD 7B	1.09	1.11	1.15	1.10	1.11
4A	1.24	1.11	1.08	1.05	1.03
4B	1.22	1.20	1.17	1.21	1.21
3B	1.27	1.20	1.17	1.16	1.16
ST. C	1.32	1.21	1.20	1.15	1.16

The value of R, the Index of Dispersion, is given. R is the observed mean distance to nearest neighbour divided by the expected mean distance to nearest neighbour. A value of R>1 indicates overdispersion, R<1 indicates aggregation and R = 1, indicates a random distribution. Without significance testing the index cannot be interpreted meaningfully.

Table LXXXIII.

The sum of the squared nearest neighbour distances for the 1st to 5th nearest neighbours, as calculated from the mound coordinates, in each quadrat.

QUADRAT	1st	2nd	3rd	4th	5th
OWH SS 4	158.26	283.54	418.95	548.31	692.62
SS 5	190.72	343.60	520.38	715.60	867.26
SS 7	161.10	469.42	707.37	1007.59	1580.48
SS 8	186.25	368.73	541.28	708.92	897.17
SS 9	197.17	321.96	490.63	665.85	847.64
SS11	169.18	301.11	570.29	734.00	942.71
SS12	152.67	289.56	476.29	663.17	813.75
NFS	207.52	367.74	520.27	727.01	906.22
C10	187.22	320.11	490.72	622.63	779.24
AR 11	165.28	306.66	469.09	623.78	811.67
12	168.79	308.32	448.26	596.07	726.70
15	169.99	345.46	487.17	655.49	813.65
16	192.00	346.75	503.61	642.49	765.66
5	162.43	309.02	469.39	642.53	779.44
NWS	111.74	224.71	344.38	465.45	595.54
MD 7B	143.74	309.92	498.12	612.13	780.24
4A	181.52	304.59	434.08	547.07	662.93
4B	174.88	353.13	500.14	721.25	901.15
3B	188.85	354.19	514.91	686.47	865.36
ST. C	189.85	337.53	513.65	635.94	825.47

These values are used in the calculation of the Chi squared statistic for the significance test described by Thompson (1956). Further details are given in Chapter Fourteen.

Table LXXXIV.

The critical values of the Chi squared statistics for the 1st to the 5th nearest neighbours in each quadrat, as calculated from the formula of Pearson and Hartley (1966).

QUADRAT	1st	2nd	3rd	4th	5th
OWH SS 4	162.01	307.18	449.75	590.97	731.33
SS 5	155.40	294.32	430.69	565.75	699.96
SS 7	26.29	46.19	65.17	83.67	101.87
SS 8	159.81	302.90	443.40	582.56	720.88
SS 9	231.83	443.40	651.81	858.58	1064.31
SS11	139.92	264.22	386.13	506.79	626.65
SS12	170.81	324.31	475.12	624.55	773.10
NFS	168.61	320.03	468.78	616.16	762.66
C10	274.99	527.86	777.27	1024.89	1271.37
AR 11	262.07	502.57	739.69	975.06	1209.32
12	601.47	1169.99	1733.27	2293.84	2852.67
15	290.03	557.34	821.07	1082.98	1343.69
16	153.20	290.03	424.33	557.34	689.50
5	179.58	341.40	500.46	658.09	814.82
NWS	274.99	527.86	777.27	1024.89	1271.37
MD 7B	203.60	388.25	569.95	750.13	929.34
4A	148.78	281.44	411.61	540.50	668.57
4B	162.01	307.18	449.75	590.97	731.33
3B	186.14	354.19	519.43	683.22	846.08
ST. C	159.81	302.90	443.40	582.56	720.88

These are the critical 5% significance level values of Chi squared used in all of the Chi squared tests. Most tables of Chi squared statistics do not show high enough values of n for the purposes of nearest neighbour analysis.