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Concentrated animal food

ARCH PROGRAMME NO. 54
EXPOSURE TESTING (STUDY OF MATERIAL DETERIORATION)

sponsored by
ADVANCED RESEARCH PROJECTS AGENCY (ARPA), U.S. DEPARTMENT OF DEFENSE

conducted by
APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND
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MILITARY RESEARCH AND DEVELOPMENT CENTER (MRDC)

PRESERVED FOOD SERIES

REPORT NO. 3
CONCENTRATED ANIMAL FOOD

27

BY
KAEW NUALCHAWEE
WILLIAM G. PREWETT
PAKORN PAKARNSEREE
ENVIRONMENTAL AND ECOLOGICAL RESEARCH INSTITUTE

ASRCT, BANGKOK 1974
not for publication

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CONCENTRATED ANIMAL FOOD

By Kaew Nualchawee,* William G. Prewett,*
and Pakorn Pakarnseree*

SUMMARY

The concentrated animal food samples were supplied by the Military Research and Development Center (MRDC), to test for weight changes, visible changes, microbiological changes, and composition changes by means of chemical analysis.

It was found that the majority of animal food samples showed increase in weight, especially those exposed in the depots in the cleared site and in the jungle site. The majority of laminated paper/plastic containers remained in good condition until the time of the third withdrawal. Foodstuff inside the containers showed mold growth, and insect infestation to varying degrees. The least mold infestation was found in the control room. Results from microbiological study showed an increasing quantity of microorganisms in the animal food. Results from counting may not be very accurate, but the mold growth on the animal food pellets was enough to be an indication that the animal food had deteriorated beyond the acceptable standard. Results of chemical analysis indicated small degrees of variation from the results of the previous withdrawals. The free fatty acid test showed some change from the results of the previous withdrawals, especially in the case of replicate number X of formula 1 in the depot in the cleared site which increased about 47%.

MATERIALS AND METHODS OF EXPOSURE

The concentrated animal food samples received for use as test specimens comprise five formulae, each contained in both sealed plastic bags, and sewn laminated paper/plastic bags. Only those contained in laminated paper/plastic bags of formulae 1 and 5 were subjected to tests. Details of composition of the formulae are as follows:

* Environmental and Ecological Research Institute, ASRCT.

Composition of food	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5
Paddy rice, ground	+	+	+	+	+
Corn, ground	+	+	+	+	-
Rice bran	+	+	+	+	+
Soybean meal	+	+	+	+	-
Peanut meal	-	-	+	-	-
Fish meal	-	+	-	-	-
Dicalcium phosphate	+	+	+	+	-
Limestone	+	+	+	+	-
Salt	+	+	+	+	+
Mollasses	+	+	+	+	-
Fat	-	-	-	+	-
Premix	+	+	+	+	-
Ground bone	-	-	-	-	+

+ = present in composition

- = absent in composition

Premix consists of vitamins B₂, B₆, B₁₂, A, D₃, and antibiotic.

The reader is referred to previous reports on "Concentrated Animal Food", for further details on containers, environmental conditions for exposure, and withdrawal programme.

METHODS OF TESTS AND RESULTS

The concentrated animal food samples withdrawn from the exposure testing site were tested for:

weight changes,
visual changes,
microorganisms, and
chemical deterioration.

Results can be presented as follows:

TABLE 1. WEIGHT CHANGES

Code number	Description	Original	Final	Weight change (g)
		weight (g) 28 May 72	weight (g) 15 Sept.72	
9-1-1-O-bC ₁	Formula 1, laminated paper/plastic bag, control room, third withdrawal, replicate number 1	1113.8	1122.7	+8.9
9-1-1-O-bC ₂	Formula 1, laminated paper/plastic bag, control room, third withdrawal, replicate number 2	1109.9	1118.2	+8.3
9-1-1-O-bC ₃	Formula 1, laminated paper/plastic bag, control room, third withdrawal, replicate number 3	1108.6	1119.1	+10.5
9-1-1-O-bC ₄	Formula 1, laminated paper/plastic bag, control room, third withdrawal, replicate number 4	1103.1	1113.9	+10.8
9-1-1-O-bC _X	Formula 1, laminated paper/plastic bag, control room, third withdrawal, replicate number X	1117.6	1128.9	+11.3
9-1-1-I-bC ₁	Formula 1, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 1	1115.5	1145.0	+29.5
9-1-1-I-bC ₂	Formula 1, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 2	1099.9	1115.7	+15.8
9-1-1-I-bC ₃	Formula 1, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 3	1123.4	1140.4	+17.0
9-1-1-I-bC ₄	Formula 1, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 4	1109.4	1105.3	-4.1
9-1-1-I-bC _X	Formula 1, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number X	1138.3	1165.3	+27.0
9-1-1-II-bC ₁	Formula 1, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 1	1069.3	1084.4	+15.1
9-1-1-II-bC ₂	Formula 1, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 2	1124.7	1144.9	+20.2
9-1-1-II-bC ₃	Formula 1, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 3	1129.7	1153.5	+23.8
9-1-1-II-bC ₄	Formula 1, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 4	1089.1	1109.0	+19.9
9-1-1-II-bC _X	Formula 1, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number X	1025.6	1048.4	+22.8

TABLE 1. continued

Code number	Description	Original weight (g) May 72	Final weight Sept. 72	Weight change (g)
9-1-2-0-bC ₁	Formula 1, plastic bag, control room, third withdrawal, replicate number 1	1151.3	1154.3	+3.0
9-1-2-0-bC ₂	Formula 1, plastic bag, control room, third withdrawal, replicate number 2	1090.5	1097.4	+6.9
9-1-2-0-bC ₃	Formula 1, plastic bag, control room, third withdrawal, replicate number 3	1078.4	1086.3	+7.9
9-1-2-0-bC ₄	Formula 1, plastic bag, control room, third withdrawal, replicate number 4	1130.9	1133.3	+2.4
9-1-2-0-bC _X	Formula 1, plastic bag, control room, third withdrawal, replicate number X	1097.4	1104.6	+6.2
9-1-2-I-bC ₁	Formula 1, plastic bag, depot, cleared site, third withdrawal, replicate number 1	1131.5	1138.9	+7.4
9-1-2-I-bC ₂	Formula 1, plastic bag, depot, cleared site, third withdrawal, replicate number 2	1097.9	1102.3	+4.4
9-1-2-I-bC ₃	Formula 1, plastic bag, depot, cleared site, third withdrawal, replicate number 3	1122.8	1126.9	+4.1
9-1-2-I-bC ₄	Formula 1, plastic bag, depot, cleared site, third withdrawal, replicate number 4	1083.3	1081.5	-1.8
9-1-2-I-bC _X	Formula 1, plastic bag, depot, cleared site, third withdrawal, replicate number X	1072.0	1065.5	-6.5
9-1-2-II-bC ₁	Formula 1, plastic bag, depot, jungle site, third withdrawal, replicate number 1	1108.0	1094.5	-13.5
9-1-2-II-bC ₂	Formula 1, plastic bag, depot, jungle site, third withdrawal, replicate number 2	1026.9	1032.5	+5.6
9-1-2-II-bC ₃	Formula 1, plastic bag, depot, jungle site, third withdrawal, replicate number 3	1107.0	1111.8	+4.8
9-1-2-II-bC ₄	Formula 1, plastic bag, depot, jungle site, third withdrawal, replicate number 4	1070.1	1051.0	-19.1
9-1-2-II-bC _X	Formula 1, plastic bag, depot, jungle site, third withdrawal, replicate number X	1111.9	1116.2	+4.3

TABLE 1. continued

Code number	Description	Original weight (g) May 72	Final weight (g) Sept. 72	Weight change (g)
9-5-1-0-bC ₁	Formula 5, laminated paper/plastic bag, control room, third withdrawal, replicate number 1	1100.5	1098.3	-2.2
9-5-1-0-bC ₂	Formula 5, laminated paper/plastic bag, control room, third withdrawal, replicate number 2	1081.2	1078.6	-2.6
9-5-1-0-bC ₃	Formula 5, laminated paper/plastic bag, control room, third withdrawal, replicate number 3	1109.7	1108.2	-1.5
9-5-1-0-bC ₄	Formula 5, laminated paper/plastic bag, control room, third withdrawal, replicate number 4	1094.9	1092.5	-2.4
9-5-1-0-bC _X	Formula 5, laminated paper/plastic bag, control room, third withdrawal, replicate number X	1064.1	1063.9	-0.2
9-5-1-I-bC ₁	Formula 5, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 1	1100.1	1108.9	+8.8
9-5-1-I-bC ₂	Formula 5, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 2	1105.3	1112.8	+7.5
9-5-1-I-bC ₃	Formula 5, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 3	1107.4	1120.4	+13.0
9-5-1-I-bC ₄	Formula 5, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number 4	1141.9	1152.0	+10.1
9-5-1-I-bC _X	Formula 5, laminated paper/plastic bag, depot, cleared site, third withdrawal, replicate number X	1187.4	1193.6	+6.2
9-5-1-II-bC ₁	Formula 5, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 1	1129.2	1142.2	+13.0
9-5-1-II-bC ₂	Formula 5, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 2	1080.8	1092.1	+11.3
9-5-1-II-bC ₃	Formula 5, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 3	1015.8	1021.0	+5.2
9-5-1-II-bC ₄	Formula 5, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number 4	1130.0	1138.9	+8.9
9-5-1-II-bC _X	Formula 5, laminated paper/plastic bag, depot, jungle site, third withdrawal, replicate number X	978.6	984.8	+6.2

TABLE 1. continued

Code number	Description	Original weight (g) May 72	Final weight (g) Sept. 72	Weight change (g)
9-5-2-0-bC ₁	Formula 5, plastic bag, control room, third withdrawal, replicate number 1	1115.9	1119.2	+3.3
9-5-2-0-bC ₂	Formula 5, plastic bag, control room, third withdrawal, replicate number 2	1094.5	1094.1	-0.4
9-5-2-0-bC ₃	Formula 5, plastic bag, control room, third withdrawal, replicate number 3	1107.3	1108.5	+1.2
9-5-2-0-bC ₄	Formula 5, plastic bag, control room, third withdrawal, replicate number 4	1096.5	1095.7	-0.8
9-5-2-0-bC _X	Formula 5, plastic bag, control room, third withdrawal, replicate number X	1093.8	1092.4	-1.4
9-5-2-I-bC ₁	Formula 5, plastic bag, depot, cleared site, third withdrawal, replicate number 1	1111.8	1119.4	+7.6
9-5-2-I-bC ₂	Formula 5, plastic bag, depot, cleared site, third withdrawal, replicate number 2	1041.7	1051.3	+9.6
9-5-2-I-bC ₃	Formula 5, plastic bag, depot, cleared site, third withdrawal, replicate number 3	1099.5	1109.5	+10.0
9-5-2-I-bC ₄	Formula 5, plastic bag, depot, cleared site, third withdrawal, replicate number 4	1099.5	1110.1	+10.6
9-5-2-I-bC _X	Formula 5, plastic bag, depot, cleared site, third withdrawal, replicate number X	1084.5	1098.0	+13.5
9-5-2-II-bC ₁	Formula 5, plastic bag, depot, jungle site, third withdrawal, replicate number 1	1115.7	1130.0	+14.3
9-5-2-II-bC ₂	Formula 5, plastic bag, depot, jungle site, third withdrawal, replicate number 2	1095.4	1105.9	+10.4
9-5-2-II-bC ₃	Formula 5, plastic bag, depot, jungle site, third withdrawal, replicate number 3	1104.9	1116.1	+11.2
9-5-2-II-bC ₄	Formula 5, plastic bag, depot, jungle site, third withdrawal, replicate number 4	1095.5	1107.2	+11.7
9-5-2-II-bC _X	Formula 5, plastic bag, depot, jungle site, third withdrawal, replicate number X	1082.7	1085.6	+2.9

Before and during the exposure period until the withdrawal date, visual changes in food containers and foodstuff were observed. The results of observation are presented in Table 2.

TABLE 2. VISUAL OBSERVATION

Code number	Description	Visual change
9-1-1-0-bC _X	Formula 1, laminated paper/plastic bag, control room, withdrawal number 3, replicate number X	Container in good condition, pellets looked normal, insect infestation
9-1-1-I-bC _X	Formula 1, laminated paper/plastic bag, in depot, cleared site, replicate number X	Container in good condition, pellets looked less compact, insect infestation
9-1-1-II-bC _X	Formula 1, laminated paper/plastic bag, in depot, jungle site, replicate number X	Container in good condition, pellets looked less compact, insect infestation
9-5-1-0-bC _X	Formula 5, laminated paper/plastic bag, third withdrawal, replicate number X, control room	Container in good condition, pellets looked less compact, insect infestation
9-5-1-I-bC _X	Formula 5, laminated paper/plastic bag, in depot, cleared site, third withdrawal, replicate number X	Container in good condition, pellets looked less compact, insect infestation
9-5-1-II-bC _X	Formula 5, in depot, jungle site, third withdrawal, replicate number X	Container in good condition, pellets looked less compact, insect infestation

Only few selected food samples were tested for microorganisms. The test made were aerobic count, mold count, anaerobic tests, and coliform tests. The results are presented in Table 3, which follows in the next page.

TABLE 3. MICROBIOLOGICAL DATA

Code number	Description	Aerobic count	Mold count	Anaerobic test	Coliform test
9-1-1-0-bC _X	Formula 1, laminated paper/plastic bag, control room, third withdrawal, replicate number X	2.3×10^4	1×10^3	-	-
9-1-1-I-bC _X	Formula 1, laminated paper/plastic bag, in depot, cleared site, third withdrawal, replicate number X	1.3×10^4	10×10^4	+	-
9-1-1-II-bC _X	Formula 1, laminated paper/plastic bag, in depot, jungle site, third withdrawal, replicate number X	3.0×10^4	20×10^4	-	-
9-5-1-0-bC _X	Formula 5, laminated paper/plastic bag, control room, third withdrawal, replicate number X	8.0×10^4	1.0×10^4	-	-
9-5-1-I-bC _X	Formula 5, laminated paper/plastic bag, in depot, cleared site, third withdrawal, replicate number X	8.0×10^4	80×10^4	-	-
9-5-1-II-bC _X	Formula 5, laminated paper/plastic bag, in depot, jungle site, third withdrawal, replicate number X	10×10^4	90×10^4	-	-

Chemical analysis was carried out on the animal food samples to determine food composition. The results may be compared with those for the previous withdrawals to determine rate of deterioration. Table 4 shows the results of the analysis.

TABLE 4. CHEMICAL ANALYSIS

	Formula 1			Formula 5		
	Control room	Depot cleared	Depot jungle	Control room	Depot cleared	Depot jungle
H ₂ O, %	10.59	12.65	13.62	10.73	11.83	12.41
Ca, %	1.42	1.36	1.41	4.66	4.72	4.71
P, %	0.73	0.68	0.70	1.14	1.09	1.20
Free fatty acid, %	3.81	8.46	3.81	5.78	5.36	4.51
Fat, %	4.15	1.04	1.03	4.81	2.59	2.12
Ash, %	9.90	9.67	9.75	15.88	15.70	15.37
Fibre, %	6.00	5.96	6.04	6.69	6.09	6.76
Protein, %	15.17	14.46	15.27	9.67	9.98	9.90
CHO, %	54.19	56.22	54.29	52.24	53.81	53.44
Net energy (kcal/kg)	3100	2900	2900	2900	2800	2700

METEOROLOGICAL DATA

Meteorological data are presented graphically for the period 12 August 1972 - 12 September 1972. The reader is referred to Report No. 2 on "Concentrated Animal Food" for data in the period 12 May - 12 August 1972. Quantities reported are:

1. Cleared site out of doors:
 - 1.1 Daily rainfall, in mm.
 - 1.2 Daily sunshine duration, in hours.
 - 1.3 Daily maximum and minimum relative humidity, in per cent.
 - 1.4 Daily maximum and minimum temperature, in degrees Fahrenheit.
2. Cleared site in the depot:
 - 2.1 Daily maximum and minimum relative humidity in per cent.
 - 2.2 Daily maximum and minimum temperature in degrees Fahrenheit.
3. Jungle site out of doors:
 - 3.1 Daily rainfall, in mm.
 - 3.2 Daily maximum and minimum relative humidity, in per cent.
 - 3.3 Daily maximum and minimum temperature, in degrees Fahrenheit.
4. Jungle site in the depot:
 - 4.1 Daily maximum and minimum relative humidity, in per cent.
 - 4.2 Daily maximum and minimum temperature, in degrees Fahrenheit.

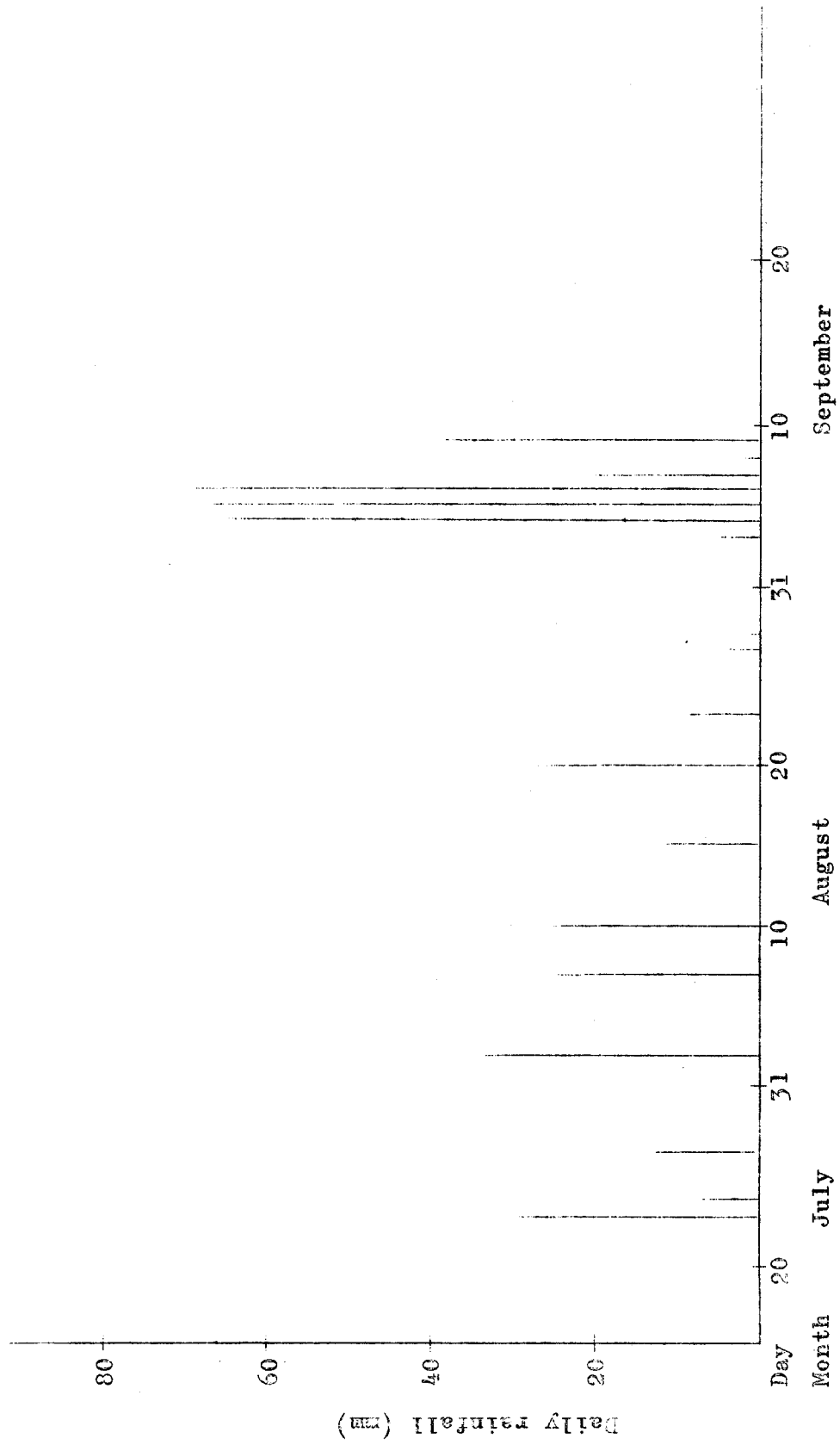


Figure 1. Graph showing daily rainfall, recorded at the cleared site out of doors during the period 15 July - 12 September 1972.

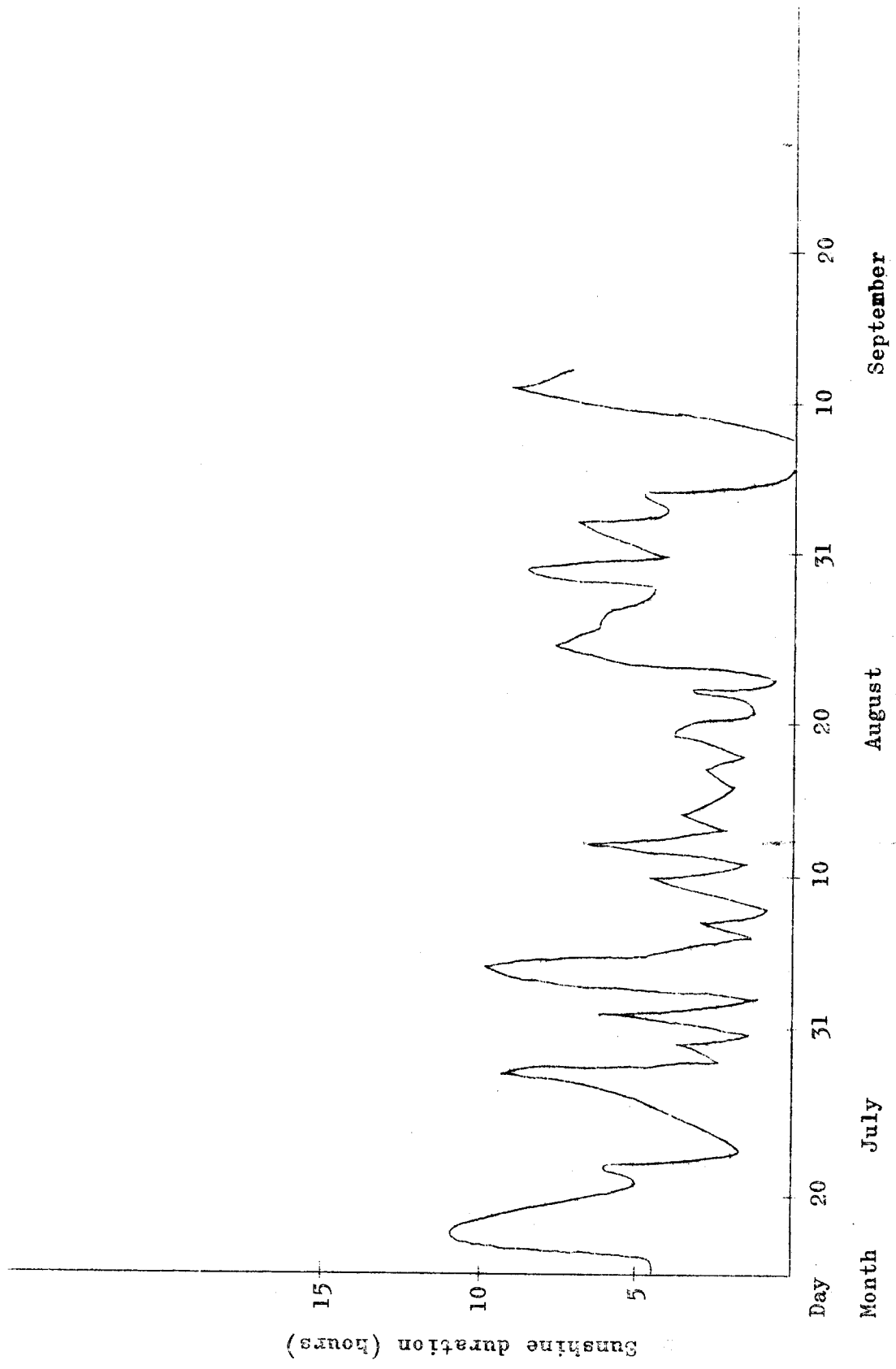


Figure 2. Graph showing daily sunshine duration, recorded at the cleared site during the period 15 July - 12 September 1972.

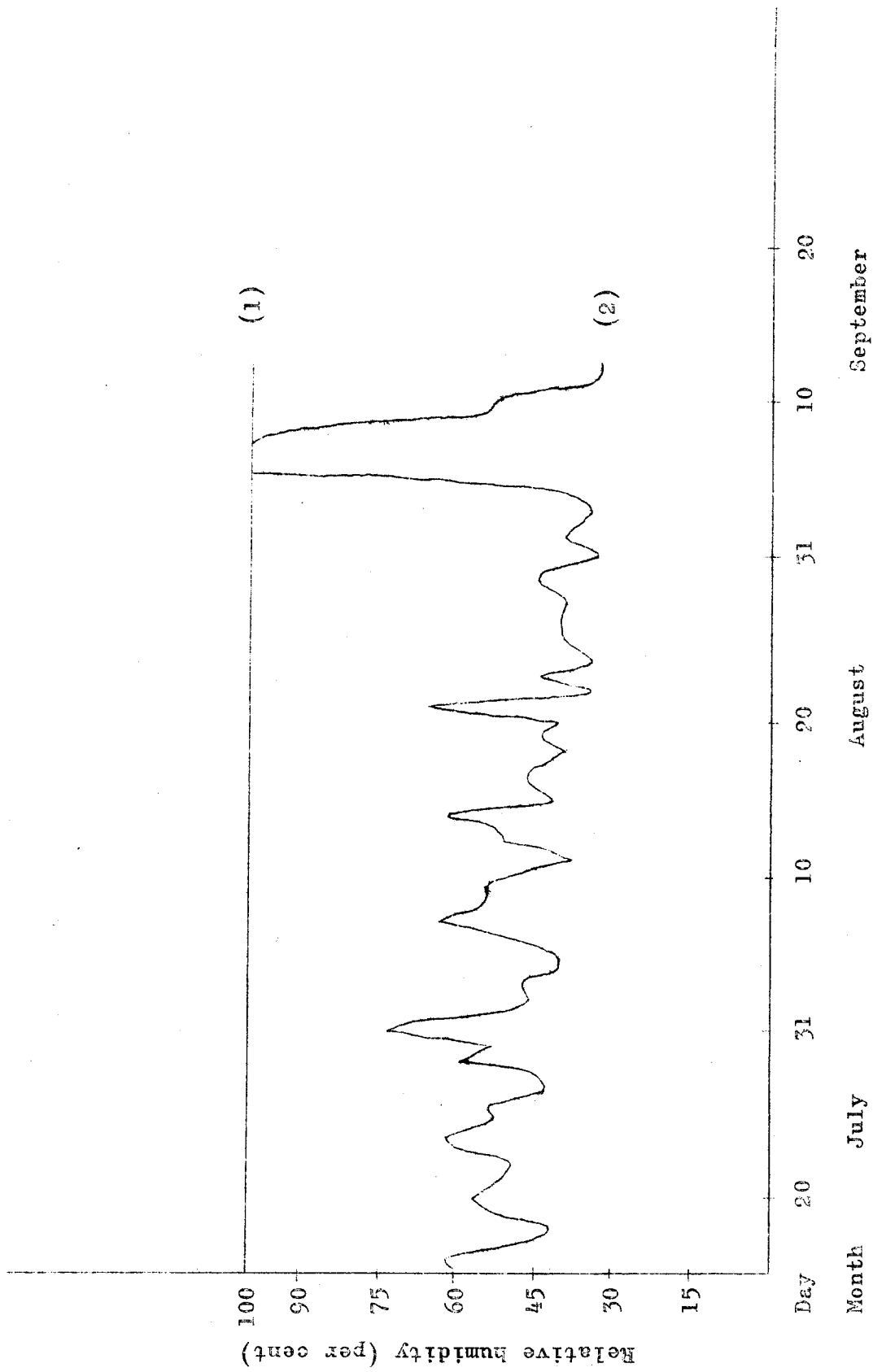


Figure 3. Graph showing daily relative humidity at the cleared site out of doors during the period 15 July - 12 September 1972.

1. Maximum relative humidity.
2. Minimum relative humidity.

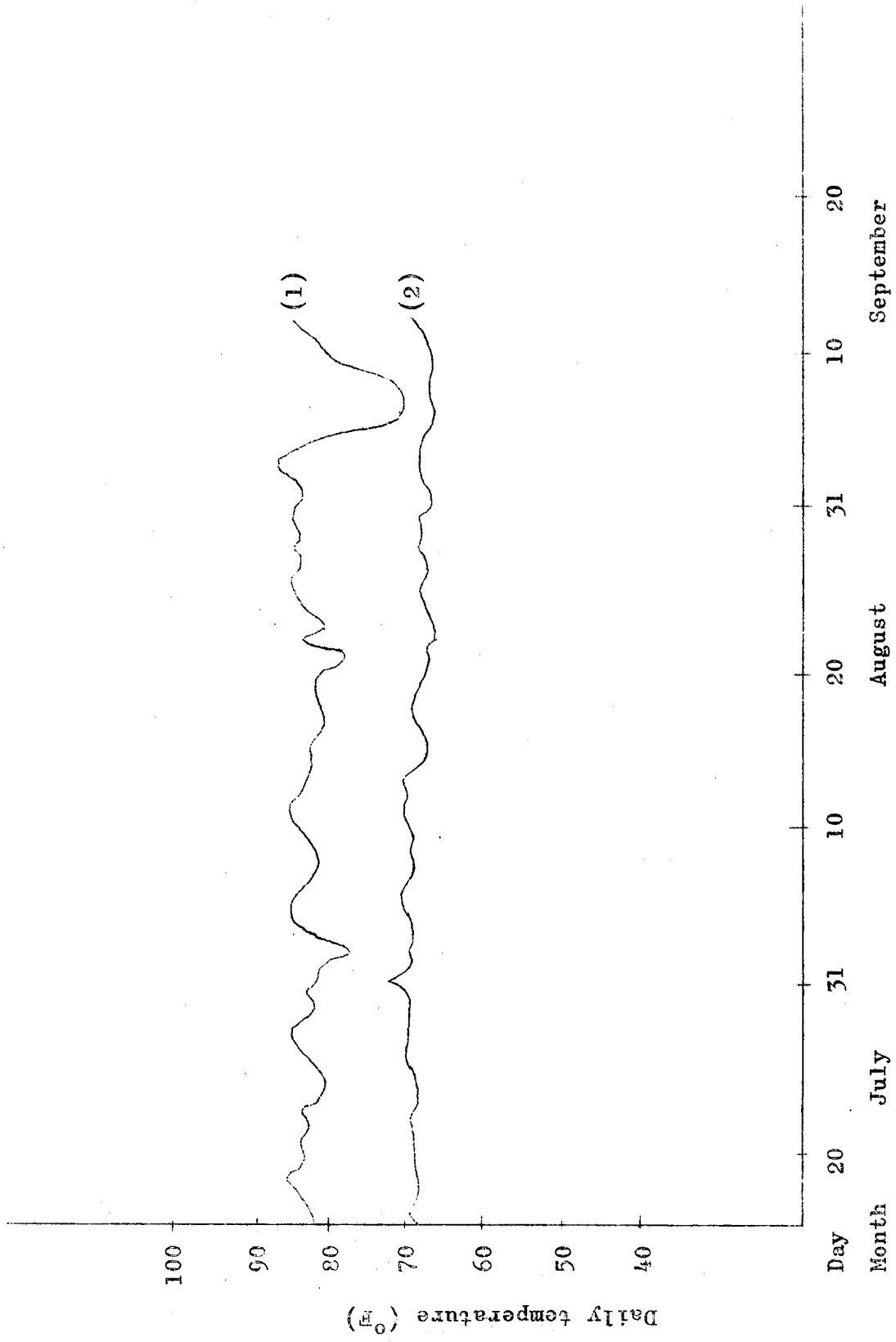


Figure 4. Graph showing daily temperature at the cleared site out of doors during the period 15 July - 12 September 1972.

- 1. Maximum temperature.
- 2. Minimum temperature.

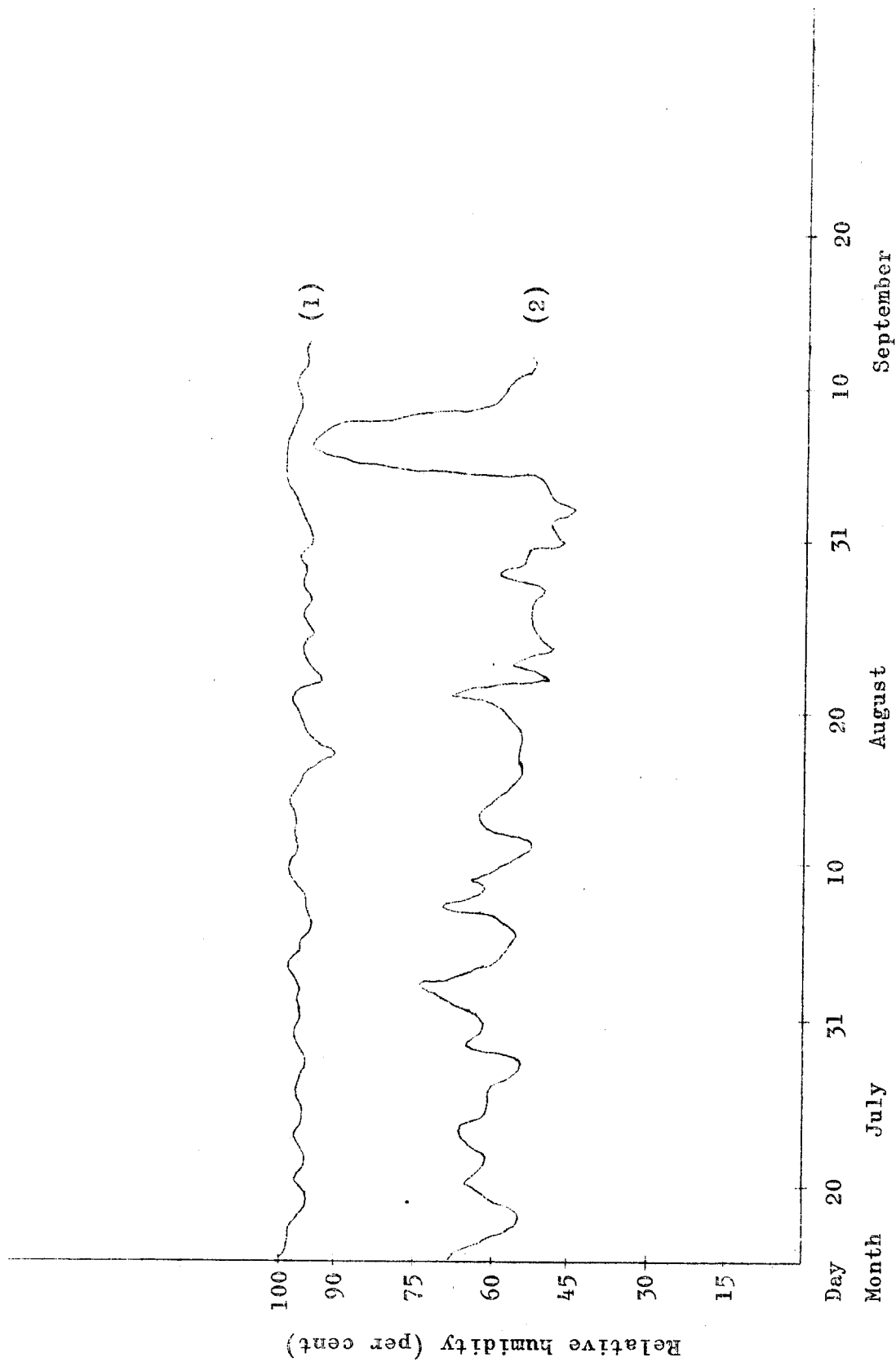


Figure 5. Graph showing relative humidity at the cleared site in the depot during the period 15 July - 12 September 1972.

- 1. Maximum relative humidity.
- 2. Minimum relative humidity.

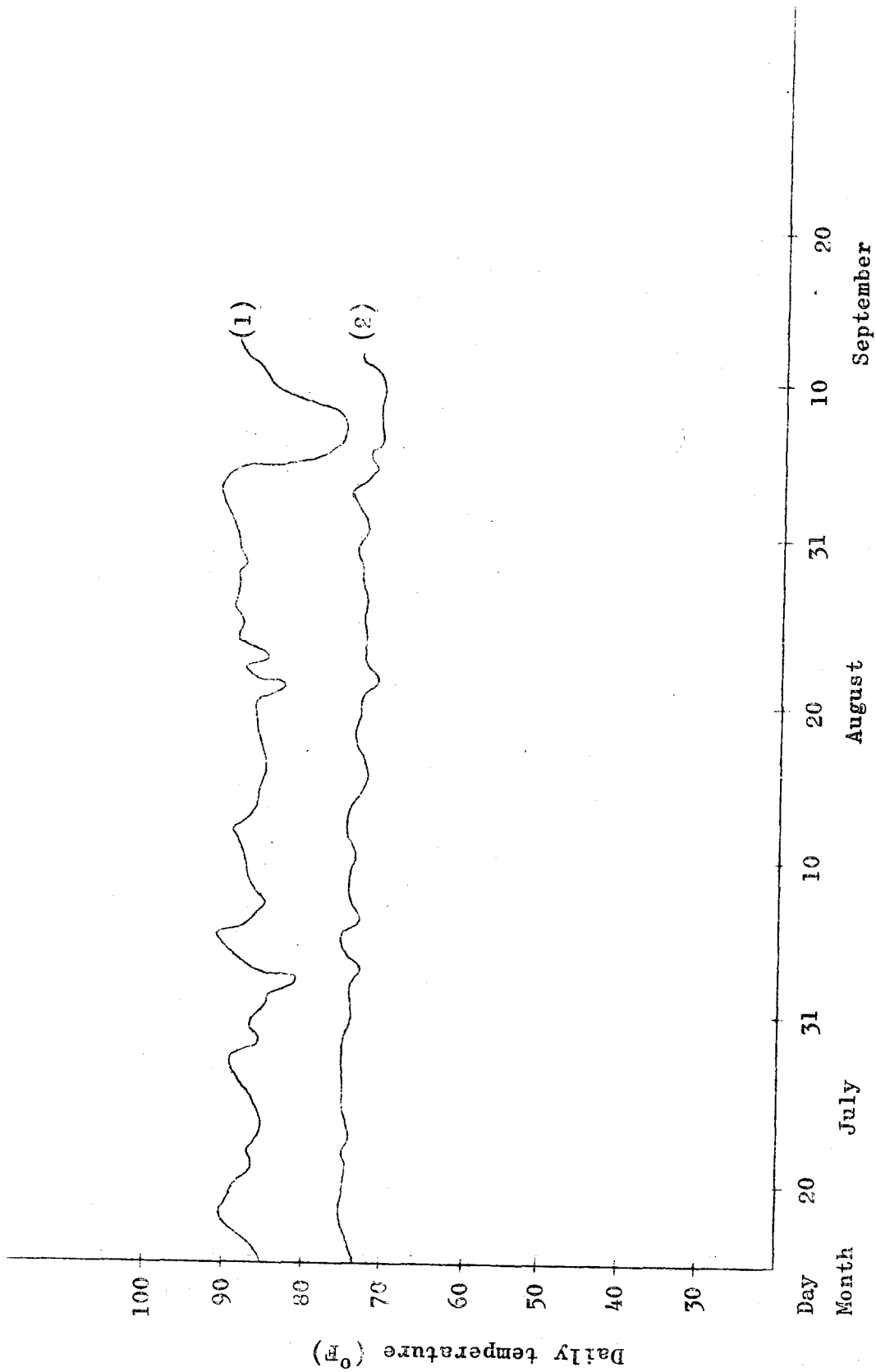


Figure 6. Graph showing daily temperature at the cleared site in the depot during the period 15 July - 12 September 1972.

1. Maximum temperature.
2. Minimum temperature.

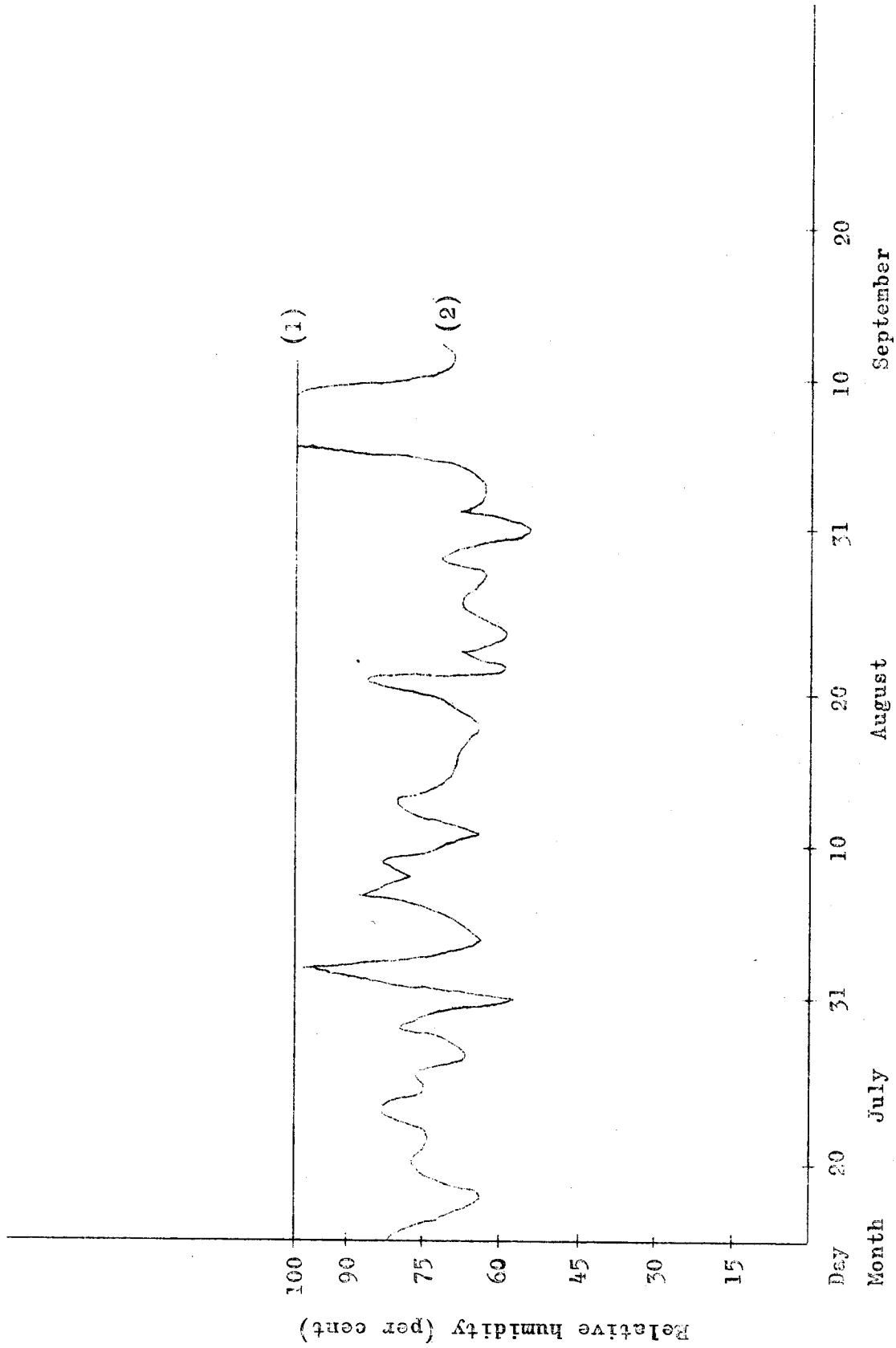


Figure 8. Graph showing daily relative humidity at the jungle site out of doors during the period 15 July - 12 September 1972.

1. Maximum relative humidity.
2. Minimum relative humidity.

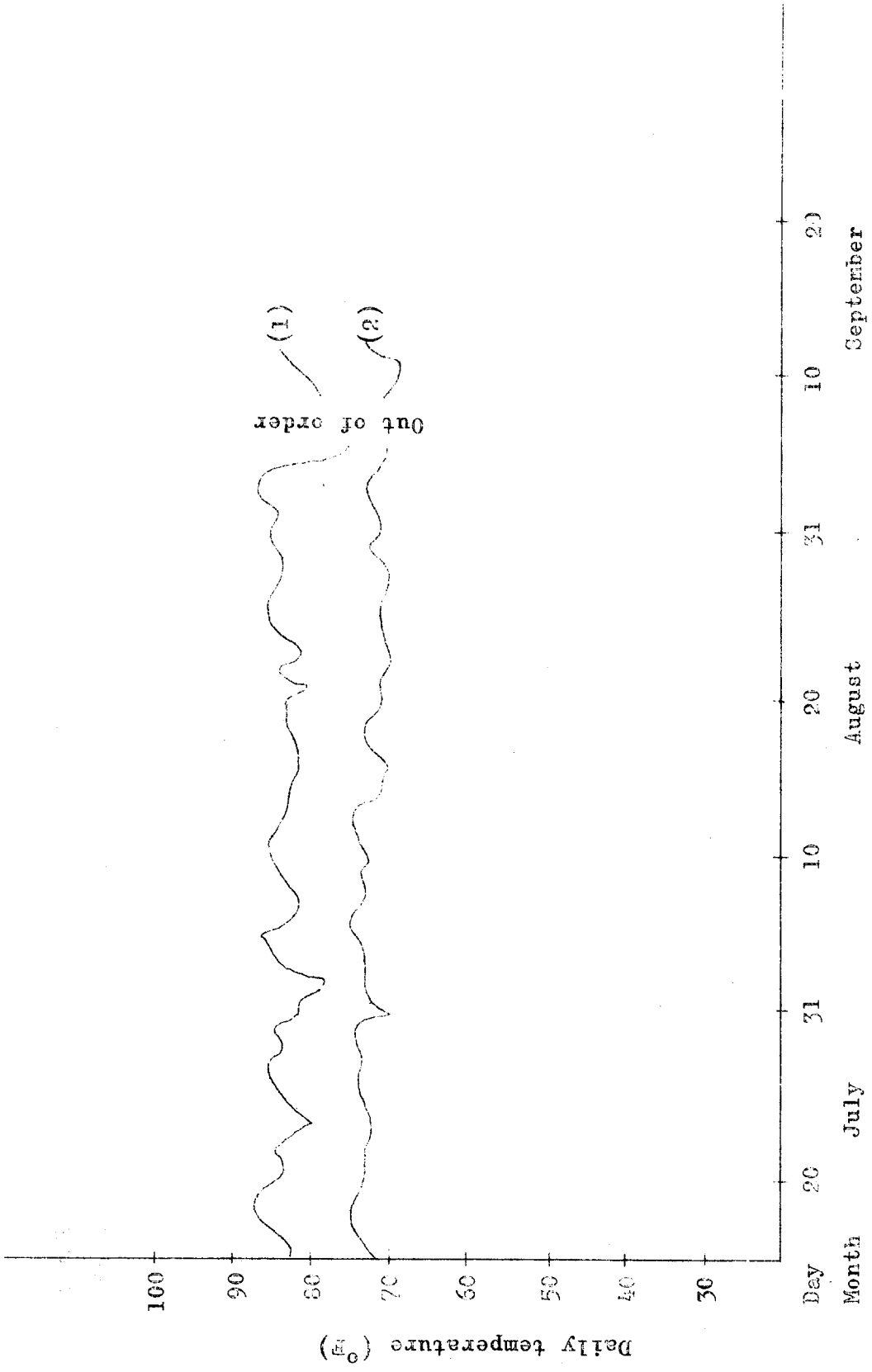


Figure 9. Graph showing daily temperature at the jungle site out of doors during the period 15 July - 12 September 1972.

- 1. Maximum temperature.
- 2. Minimum temperature.

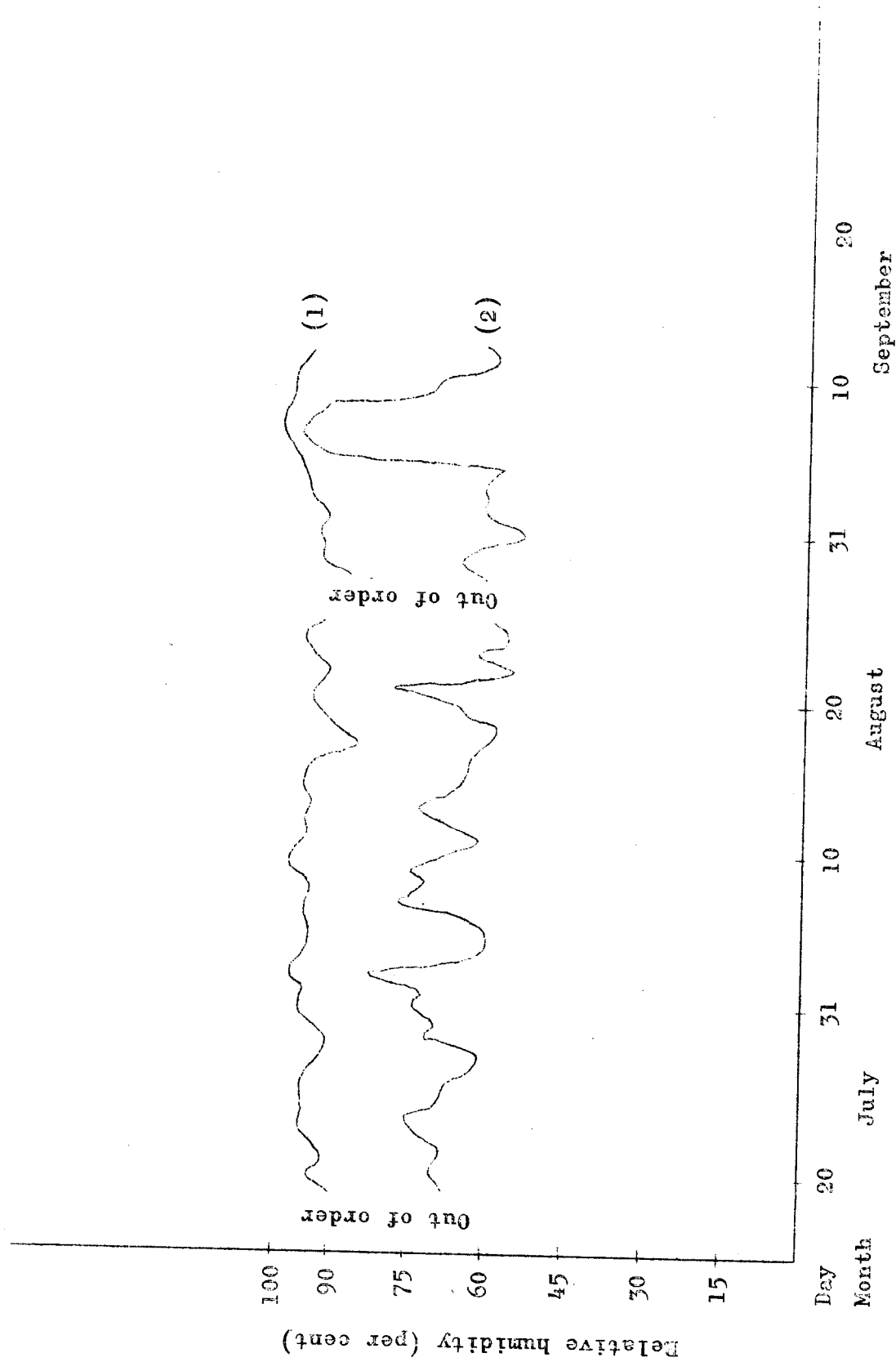


Figure 10. Graph showing daily relative humidity at the jungle site in the depot during the period 15 July - 12 September 1972.

1. Maximum relative humidity.
2. Minimum relative humidity.

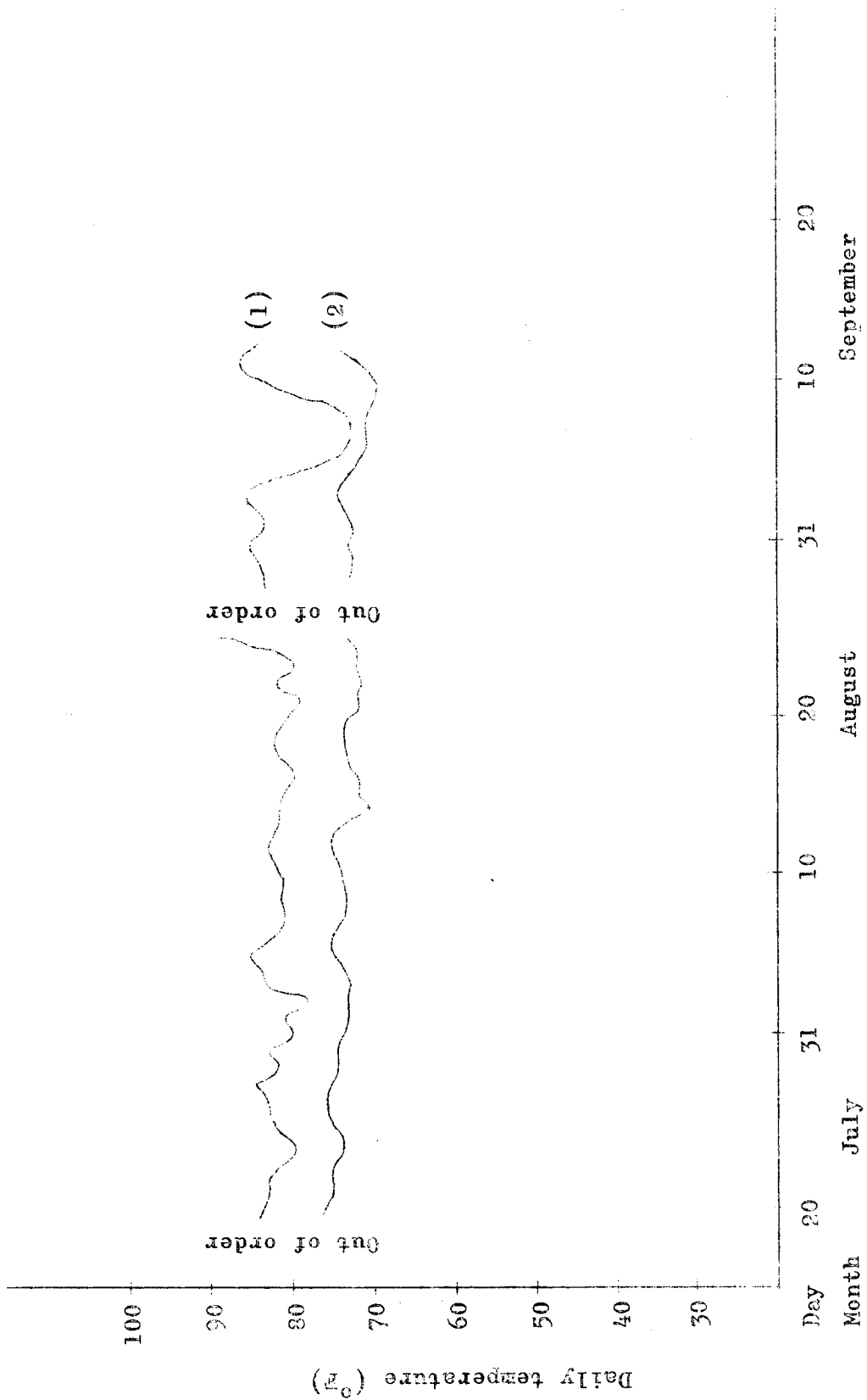


Figure 11. Graph showing daily temperature at the jungle site in the depot during the period 15 July - 12 September 1972.

- 1. Maximum temperature.
- 2. Minimum temperature.

DISCUSSION OF RESULTS

Discussion of weight changes

Changes in weight since the samples were initially weighed are mostly of the same order as they were at the previous withdrawal, except in cases of spillage or removal by vermin. So, it appears that, in general, the weight of the samples has changed little since the last withdrawal and a moisture equilibrium has been reached. The results of moisture determination (under "Chemical analysis") support this conclusion.

Discussion of visual observation

The observations reported give a picture of progressive deterioration. The insect populations are all higher than at previous withdrawals. The pellets of samples have continue to disintegrate. Every sample had become visibly moldy and, because there was no variation in this respect, this aspect has escaped comment in the log book and tables. Samples for analysis at each withdrawal were chosen at the time when the samples were first received and named; this was done to avoid bias in selecting exposed samples for analysis. The containers of samples destined for analysis at this withdrawal were all sound when withdrawn. However, mice had opened some of the containers withdrawn but not described here.

Discussion of microbiological tests

The populations of varieties of microorganisms, for which tests were made, do not appear to have changed substantially since the last withdrawal. Anaerobic bacteria are still infrequent and not a single positive coliform bacteria test result has been obtained. The mold count of 10^3 to 10^6 colonies per gramme probably represent "saturation" measurement, i.e. the conspicuous mold in one gramme of sample does, on dispersion in water and dilution, fall into between 10^3 and 10^6 viable fragments.

Discussion of results of chemical analysis

Calcium, phosphorus and "ash" (involatile constituents) have not changed perceptibly. This is as expected as the total weights of the samples have changed by only a few per cent.

Contents of fibre and free fatty acids have also changed little if at all. The constancy of the latter constituent might either represent an equilibrium between production and consumption or it might indicate that free fatty acid is neither being produced nor destroyed.

Fat has dropped substantially in samples stored in the depots but not in those stored in the control room. This loss is presumably due to biological consumption.

There is little apparent change in the protein content reported. However, the reported figures are expressions of the results of total nitrogen determination, not of protein per se. A large part of the original protein may have been reconstituted within the bodies of bacteria, mold and insects. Also, some of the nitrogen represented by the reported figures may be present in non-proteinoid forms such as ammonium, ion, and urea. The level of carbohydrate has not changed appreciably. The same holds for estimated net energy.

Discussion of meteorological observations

The period from the middle of August until the middle of September (between the previous withdrawal and the one with which this report is concerned) falls within the wet season at Sakaerat. This year, rainfall was somewhat below average during this period and the same probably holds for the humidity. It may be expected that the unusual dryness made this period loss severe, in its deteriorative effects on the samples, than it would have been in most years.

CONCLUSION

The following is based mostly on visual observation made by microbiologist at ASRCT. We would not recommend that material stored until the third withdrawal in the jungle and cleared site depots be fed to mules. However, at that time, the material stored in the air-conditioned room was probably still safe.

Chemical analysis indicated that the nutritional value (in terms of carbohydrate, protein, fat, and net energy) was probably still nearly as high as when the food was received. It was not known how much the vitamin contents may have been reduced or augmented by the organisms present.

Whether the food was or was not safe for consumption, the writers feel there is a possibility that mules would have refused all of the material of this withdrawal. Feeding trials would have been useful in this respect.

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