STUDIES OF SHOT-HOLE BORER OF TEA V.—BORER POPULATION.

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The work of an economic entomologist is largely concerned with insect populations though the fact is often camouflaged. Usually, his object is either to reduce a population to a minimum or maintain it at a maximum, depending on whether the insect is a pest or of value, like silkworms. When the insects are visible, marked changes in their numbers become obvious without counting, and should numbers be required enumeration is relatively simple. Borer beetles are rarely seen and consequently little is known about fluctuations in their numbers. Gallery entrances are fairly obvious and it might be assumed that their number bears a direct relationship to the beetle population, but it is now known that bushes will contain numerous galleries when the beetle population is very small.

Methods.—The first attempt to estimate the borer population in experimental plots was made by Jepson (1922) in order to assess the effect of manures. For obvious reasons the counting of all beetles in his plots was a well-nigh impossible task, so a method of sampling had to be resorted to. He therefore, selected at random a number of bushes in each plot and counted the gallery entrances, and by opening some of the galleries he ascertained the number of insects within them. An estimate of the total population could be obtained by multiplying the number of galleries by their mean content. As the bushes were examined *in situ* and relatively few branches were removed to ascertain the mean gallery content, the damage caused to the tea was small. The counting of gallery entrances in the field, however, involved considerable labour and discomfort and the error resulting was undoubtedly large.

King (Gadd 1942) improved on this method by pruning sample bushes and counting the galleries and beetles in the prunings. In this way the error is undoubtedly decreased but the temporary damage to the tea is tremendous, as by the end of an experiment the area contains bushes at different ages from pruning, and a few years must elapse before the area can become uniform again. Obviously such treatment cannot be superimposed on a long term manurial experiment without causing considerable inconveniences.. This method was used with advantage to determine the relative effects of light and hard plucking on the beetle population.

In order to avoid these disadvantages a third method has been tried. Instead of taking a given number of bushes as a sample, only such branches as are broken during plucking and other cultural operations or by natural means such as by the wind are used. The method allows of a thorough examination of the material without causing any extra damage to the bushes, but at the same time it introduces other disadvantages, the most obvious of which is the variation in the size of the sample from time to time. The largest samples are collected at times when damage is greatest.

The number of broken branches in the sample affords a measure of the damage done, and, if as is usually the case, damage is proportional to the size of the population causing it, then the variation in the numbers of broken branches will indicate the fluctu ations of the beetle population. If that assumption is true, it will be obvious that the counting of broken branches will be the simplest method of determining the fluctuations in beetle numbers. But the damage to a borer infested bush depends not only upon the number of galleries or beetles but upon the treatment the bush is subjected to. For instance if a stick is drawn over its surface more branches break than if the bush is not so roughly treated. Sufficient branches break during normal plucking operations to make unnecessary the use of other methods to cause breakages. But when other works are undertaken or strong winds are prevalent extra breakages, which cannot be estimated accurately, will occur Also a breakage depends upon the existence of a gallery. That gallery may be empty or it may be occupied by a family of beetles. So it would appear that the number of breakages would depend more upon the number of galleries than upon the actual number of beetles in the bush at the time. It becomes evident therefore, that any assumption of damage being proportional to population needs verification before acceptance.

The problem.—During the 3-year cycle (1940-43) in an area of tea in the Passara district records were collected weekly of the damage occurring as represented by broken branches. The records showed that the damage followed a definite pattern. At the beginning of the cycle broken branches were few but towards the end of the first year and more markedly in the second year they became more numerous until a peak was reached near the end of the year. Early in the third year damage decreased and finally became relatively stable at a low level. Our problem is to determine whether the beetle population followed a similar course

Records of broken branches were collected from the same area during the cycle 1943-46 with the object (1) of determining whether a similar course of events would occur and (2) of ascertaining whether the beetle population fluctuated in a similar manner. The experimental area is 3.2 acres in extent and is laid out primarily as a long term manurial experiment, on which the pruning of bushes at intervals for estimations of beetle population could not be allowed ; so the best had to be made of broken branches for that purpose At three-week intervals the broken branches were dissected and records made of the galleries and insects within them (Table 3).

Before attempting to interpret the results certain sources of error must be mentioned. When broken branches are collected after plucking some are apt to be overlooked. At the next collection such branches are obvious because of their dried leaves. Each collection, therefore, consisted of dried and fresh branches, the dried ones really belonging to the previous week's records At first no great importance was attached to this source of error until it was ascertained that the galleries in the dried branches invariably contained fewer insects than the fresh ones. Evidence was obtained that during drying many adults left the galleries and many larvae died. From February 21st, 1945, onwards, the fresh and dried branches were separated and although the total was entered in the records as broken branches, only freshly broken branches were used for the determination of insect numbers. The values given before that date for total occupants and mean contents per occupied gallery are probably somewhat under-estimated

Fractures always occur at a gallery and such broken galleries are referred to as "Galleries at the break" to distinguish them from "Galleries in the branch" which are not so damaged. There is of course a risk that some insects are lost from galleries at the break and these were therefore not used at any time for the estimation of beetle contents. They are, however, included in the estimate of "Galleries per branch."

Beetle Counts.—The simplest and most direct way of estimating the size of a population is by counting heads The number of beetles in all stages of development found in the broken branches on each occasion is given in Table 3 under the heading "Gallery contents." The number increased until May 16th and then declined. But on May 16th there were more branches to be examined than at other times so the larger number of beetles counted then may be due solely to the larger sample from which the beetles were taken. A much better estimate of a beetle population was made by King when determining the effect of hard plucking on the beetle population. His data have already been published (Gadd 1942) and a part of them is produced here as Table I for easy reference. It will be seen from that table that the population steadily increased from 14 per bush in the 19th month from pruning to 87 per bush in the 23rd month. No further records were taken till the end of the third year when only 7 or less per bush were found These figures clearly indicate a steady increase during the second year and a marked decrease in the third year though the time of the change cannot be ascertained.

Gallery Counts.—The same data also show that the number of galleries per bush increased from 3 to 25 between the 19th and 23rd months from pruning and that at the end of the 3rd year they numbered about 100.

A borer-infested tea bush is rather like a town of which the beetle galleries are the houses. The citizens of that town live mainly indoors and are rarely seen in the streets. They also have other curious characteristics. When the young females become adult they leave home and build new houses in which to raise their families; the result is that the town increases in size but the empty houses become more numerous also. To an observer the town would appear large if the houses are numerous; but to get any idea of the condition of the population he must note the number of new houses being erected. If they are many, the population is thriving; but if they are very few the town is dead. When once a house is made it remains as part of the town and so the town never diminishes in size even if the population becomes extinct. The size of the town therefore represents the summation of its history; the new houses only represent current times.

Applying these principles to the above figures it becomes evident from the increasing number of galleries in the second year that the population is thriving; and that conclusion is verified by the increase in the population at that time. At the end of the third year although galleries are numerous the population cannot be large because new houses are very scarce and difficult to find. Those observations indicate that the population is either extinct or very small in number. That conclusion is again confirmed by the actual count of the inhabitants.

Turning now to the 1943-46 data in Table 3 the number of galleries per broken branch is given at each examination; the galleries at the break are included in these estimates. The number varies from rather more than one to less than three but there is no indication of a steady increase from a low to a high value as would be expected. Beetles were undoubtedly living in the infested bushes during the whole period and new galleries were undoubtedly being made. It becomes evident, therefore that the method of sampling is entirely unsuitable and will not allow the fluctuations in the beetle population of the area being determined either from the number of galleries or the number of beetles in broken branches.

Before abandoning the data as being of no value it is necessary to ascertain whether the records do not give the information required in other ways

Natural Balance.—The rate at which a population can increase will depend upon (1) the length of the life cycle of the insect, (2) the number of young each female can produce, and (3) the sex ratio These data give the *Reproductive potential* which may be defined as the number of female descendents produced by one pair of insects in a given period under conditions ideal for breeding and survival. For instance Tea tortrix (*Homona coffearia*) at St. Coombs produces 5 generations in a year, the female can lay 500 eggs of which about half are males. Each generation could, therefore, be 250 times greater than the preceding one. At that rate the offspring of a pair of moths would number thousands of millions at the end of one year.

Obviously the reproductive potential tells nothing of the real rate of growth of an insect population under natural conditions It merely tells what can happen when circumstances are favourable, but it affords an explanation of why certain insects with a high potential suddenly become very numerous at times. The reproductive potential is a measure of an inherent character or force always tending to increase the population numbers. Counteracting that tendency are a number of destructive factors such as unfavourable temperature, humidity, parasites, disease, shortage of food, etc., which together form the controlling factors of the environment. The resultant of these two pressures, the reproductive potential on one side tending to increase numbers, and the controlling factors on the other tending to reduce them, is a balance sometimes known as the *Natural balance.* In an unchanging environment the population would remain numerically unchanged and the beam of the balance would remain stationary. But although the reproductive potential is constant, the environment is always changing. The weather may become less favourable, the destruction of the host plants by the insects themselves may result in famine; over-crowding may cause disease epidemics; all result in a decreasing population. The beam of the balance is, therefore, rarely stationary, it swings up and down as the environment changes The movement is so continuous that the term balance seems a misnomer.

No accurate estimate can yet be given of the reproductive potential of shot-hole borer, except to say that it is very small when compared with that of Tea tortrix (given above) and most other insects. Its life cycle occupies 6 or 7 weeks which allows of 7 or 8 generations per year, and the male to female ratio is usually 1:4 or 5 though at times it may be narrower than that. But little is known about the number of eggs a female is capable of laying under most favourable conditions. This cannot be ascertained merely by opening galleries and counting their contents. When a gallery is opened it is impossible to tell whether the parent has laid her full compliment of eggs, or whether some individuals have died or have left the gallery on completion of their development.

Gallery Contents.—A very large number of galleries were opened during the 1943-46 plucking cycle to ascertain their contents. In Table 2 is given a summary of examinations made weekly during the period May 16th to August 1st 1945 when the bushes were nearing the end of the second year from pruning and damage in the plots was at its maximum.

2,766 galleries contained beetles and rather more than half of them contained one only, the parent female. Some of those which contained the parent only were no doubt less than 10 days old and would not, therefore, be expected to contain eggs or young, but it is very unlikely that fifty per cent of the galleries were less than 10 days old. We know that the eldest of a family is not likely to emerge till the gallery is 45 days old and the youngest some time later depending upon the number of eggs laid and the intervals between oviposition. If we assume that the occupied galleries varied in age from 1 to 50 days we should not expect much more than 1/5th or 20 per cent. of them to be less than 10 days old and, consequently, without young. Those figures lend support to the view expressed in an earlier section that many females fail to produce a family, possibly because they are not fertilised.

The galleries contained, in all, 9,714 insects which gives a mean content of occupied galleries of 3.5 individuals of which 2.5 are young. If, however, we exclude from the calculation those galleries which contain an adult female only, the average family size becomes 6.1 of which 5.1 are young. The term 'average family size' has been used here in contradistinction to 'mean contents' which is determined from all occupied galleries no matter whether they contain young or not.

It may be seen from Table 2 that the size of individual families varies very considerably though the majority includes five young or less. Two galleries contained more than 30 young; that demonstrates the ability of some females to lay at least 30 eggs The average size of a family as determined in this way depends on several factors of which one is the average age of the galleries. As the gallery ages after 10 days the number of inmates increases until the young begin to emerge, after which the number decreases. For this reason and others it has not been found possible to determine the average age of a sample of galleries from its contents

Family size also appears to be dependent to some extent on the location of the gallery. As a general rule the largest families were found in galleries made in the pith and at points where a branch forked. As the gallery is an important part of the beetle's environment, any changes in that environment will be reflected in population numbers, possibly in family size and mean content.

That hypothesis can be tested. We have already seen that during the twelve week period May 16th to August 1st, 1945 the mean content of the occupied galleries was 3.5. That period can be divided into two equal parts and the mean content of occupied galleries determined separately. During the six week period May 16th to June 20th. 1569 occupied galleries were opened and the inmates ascertained to number 6286 giving a mean content of 4. During the second six week period terminating on August 1st the corresponding figures were 1197 galleries, 2428 inmates and a mean content of 2.9. It would appear, therefore, that a change detrimental to the beetle had occurred as shown by the fall in mean content of occupied galleries from 4.0 to 2.9 and that in consequence a future decrease in the amount of damage to the plots may be expected. After August 1st the number of broken branches in the plots did decrease as may be seen from the records shown in Table 3. King's data in Table 1 also show smaller mean contents of occupied galleries in 1941 than in 1940.

In Table 3 the mean contents of occupied galleries as determined at each examination are given, but there is no evidence there of any obvious change in family size. It seems doubtful, therefore, that any great reliance can be placed on mean contents of occupied galleries as a means of measuring the fluctuations of the borer population or of forecasting the degree of future attacks. The large variation in the number of young in individual galleries makes a large sample essential for an accurate estimation of their mean contents, and it is probable that the great variation of the means shown in Table 3 is due largely to the samples not being sufficiently large. If heads have to be counted a method of sampling like King's, using whole bushes as units, must be resorted to, so that absolute figures can be used. Other methods, however, remain to be tested.

Net Reproduction Rate.—If a community is to replace itself every potential mother must, on the average, produce at least one daughter. Unless this happens no reduction of mortality can save the community from eventual extinction. Moreover, if the community is to survive that daughter must reach maturity and in her turn produce, on the average, at least one daughter. Viewed in this way it is evident that survival depends upon the female of the species, not merely on the number born but on the number that survives and carries on the functions of reproduction. So long as every mother of one generation is merely replaced by another in the following generation the population will tend to remain constant, when the net reproductive rate is said to be 1. If this rate has a higher value the population will increase. For instance, for the net reproduction rate to be 2 there must be two mothers for every one of the preceding generation and each must, on the average, have two daughters who in turn will have similar families. Each generation then will be twice the size of the preceding one.

The net reproductive rate is one of the most important statistics concerning any population as it affords a measure of the rate of increase in the population. It will be noted that it concerns mothers only and is quite independent of birth or death rates; it is the resultant of inherent reproductive capacity of the insects and the opposing forces of the environment; thus, it is a measure of Natural balance. A true balance occurs only when the net reproduction rate is 1 as then the population neither increases nor decreases from generation to generation.

Percentage of occupied galleries.—As each gallery is made by a potential mother borer the number of galleries within a bush provides a record of all mothers, past and present, that have used the bush for breeding since it was last pruned. The occupied galleries each contain a mother or potential mother, so an estimate of the number of mothers in the current generation can be obtained. Let us assume that 50 per cent. of all the galleries are occupied. That means that the existing population of mothers is equal in number to all the mothers in past generations that have used the material examined for breeding purposes. Obviously the population has been steadily increasing. In order to ascertain what effect the net reproduction rate will have on the percentage of galleries occupied let us suppose that the rate is 2 and that it will be so maintained during the next few generations. We can represent the percentage of occupied galleries by the fraction ½ the numerator being occupied galleries (or mothers) and the denominator all galleries. In the next generation the one mother will be replaced by 2, and 2 new galleries will be made. The fraction then becomes 2/4 or still 50 per cent This process can be repeated any number of times without altering the percentage. Now suppose that the net reproduction rate increases to 4 while the percentage of occupied galleries is still 50. The fraction representing the present generation is still ½ but those representing future generations in succession become

4/6 (67%), 16/22 (73%), 64/86 (74%)

The percentage is gradually approximating 75 per cent,* at which it will become stable. An increasing percentage therefore indicates an increasing rate of reproduction and a decreasing percentage can be interpreted as indicating a diminishing rate until that rate is 1. When the rate remains at 1 and the beetle population in consequence remains stable, the percentage of occupied galleries will continue to fall slowly until after many generations it would become so small as to approximate 0. A net reproduction rate of less than 1 would result in a more rapid decrease in the percentage of occupied galleries.

The percentages of occupied galleries determined at intervals during the cycle 1943-1946 are given in Table 3. Until November 22nd, 1944 (near the beginning of the second year) the percentage fluctuated between 60 and 70 indicating a net reproduction rate of about 3. During this time an appreciable population was being built up from relatively few beetles until the damage in the plots began to be measurable. Between November 22nd, 1944 and August 1st, 1945 (near the end of the second year) the percentage fluctuated between 40 and 50 representing a net reproduction rate between 1.6 and 2.0 which indicates that the beetle population was continuing to increase though less rapidly than previously. In consequence of the growing population broken branches increased in number till more than 700 were being collected weekly. After August 1st, the percentage of occupied galleries fell rapidly until by December 19th, only 5 per cent. of the galleries were occupied. This can only mean that the net reproduction rate had fallen below a value of 1 and in consequence the beetle population was dying out. This conclusion is supported by the fact that the damage decreased until between 100-125 broken branches only were collected from May 15th 1946 onwards.

The data in Table 1 tell the same though less complete story. During the first part of that experiment until the bushes were 23 months from pruning the percentage of occupied galleries, though decreasing, was never below 50 which clearly indicates a growing population. During the second part of the experiment, at the end of the third year, the percentage was never above 2. Although that value of itself does not indicate a net reproduction value of less than 1 and a fall in population numbers, the fact that the population was 7 or less per bush during that period is clear proof of the decrease in population.

There is clear evidence, therefore, that the beetle populations in both experiments were affected similarly. The 1943-46 experiment, however, shows more clearly that the net reproduction rate after the first few months decreased steadily throughout the cycle until by the beginning of the third year it had fallen below a value of 1, and the population in consequence was almost extinguished.

Percentage Healed Galleries.—Some time after the galleries are empty the entrances become obliterated by the growth of new tissues which completely block the aperture. Such galleries are known as healed galleries. The number found at any examination can be expressed as a percentage in the same way that the percentage of occupied galleries can be determined. The question arises whether fluctuations in the net reproductive rate is also reflected in the

* A simple formula for determinating the value at which occupied gallery percentages will stabilise for a given net reproduction rate is :-

Percentage of occupied galleries $= \frac{100\,(r - 1)}{r}$ where r is the net reproduction rate.

percentage of healed galleries. The counting of healed galleries in prunings or broken branches in the laboratory is far less laborious than the counting of occupied galleries because the necessity for dissecting galleries to ascertain their contents is eliminated.

The healing of galleries was discussed in part 2 of these studies (Gadd 1947) and it was there shown that estimates of the time taken for galleries to heal varied from 3 to 5 months. For our purpose here it will be necessary to convert that period into terms of beetle generations ; so the period from the beginning of boring to the healing of the gallery becomes equal to 2 to 3 beetle generations.

Let us assume a net reproduction rate of 2, a period of healing equal to 3 generations. If the net reproduction rate has been maintained at 2, 50 per cent of galleries will be occupied. We can represent the occupied galleries in successive generations. as before, by the fractions.

1/2 ; 2/4 ; 4/8 ; 8/16 ; 16/32, etc.

In the first generation there are two galleries for every one occupied by beetles. Three generations later those two galleries will be healed, but the total galleries will number 16 of which 8 are occupied. If we now write the fraction with healed galleries instead of occupied galleries as the numerator it becomes 2/16 and the percentage of healed galleries is, therefore, 12.5. Similarly the 4 galleries of the second generation will be healed 3 generations later when there are 32 galleries in all and the fraction representing healed galleries becomes 4/32 or 12.5 per cent as before. So long as the net reproduction rate remains at 2 the percentage of healed galleries is stable at 12.5 per cent. If we change the net reproduction rate from 2 to 3 we can write the successive fractions for occupied galleries as

1/2 ; 3/5 ; 9/14 ; 27/41 ; 81/122 ; 243/365, etc.

and for healed galleries at the fourth and successive generations as

2/41 (4.9%); 5/122 (4.1%);
14/365 (3.8%), etc.

stabilising around 3.7%.* An increase of the net reproduction rate, therefore. results ultimately in a decrease in the percentage of healed galleries.

Similarly. increasing percentages of healed galleries indicate a decreasing rate of reproduction until the net reproductive rate becomes 1 and then, although the population remains constant in number, the percentage of healed galleries will increase slowly. A diminishing population can only be detected by a more rapid increase in the percentage of healed galleries.

The story given by the percentages of healed galleries in Table 3 is much the same as that told by the occupied galleries. Until the end of November 1944 the percentage of healed galleries remained low ; by March 1945 it had risen to about 30 per cent. where it remained till the beginning of October 1945 ; later it rose rapidly and fluctuated at about 80. The story is that of a decreasing net reproductive rate and although there is no definite means of determining exactly when it fell below a value of 1 the increase in the percentage of healed galleries from the end of October 1945 suggest that it occurred 2 or 3 months earlier.

Conclusions.—The story disclosed by this study of the borer beetle population is one of a decreasing rate of

* A formula for determining the value at which healed gallery percentages will stabilise is :-
Percentage of healed galleries $= \frac{100}{rt}$ where r = the net reproduction rate and t the time of healing expressed in terms of beetle generations.

reproduction. At the beginning of the cycle conditions are at their best for the beetles and the population increases at a rapid rate. Initially the beetles are few and some time is taken to build up an appreciable population. About the end of the first year conditions begin to become less satisfactory and the net rate of reproduction decreases gradually. Nevertheless, the population continues to grow for a time and then is only able to maintain itself at a level. At this period the maximum amount of damage will be done in the plots as the population is at its maximum. Conditions continue to grow worse as from the 23rd month onwards there is a rapid decrease of occupied galleries and similar rapid increase of healed galleries about 3 months later. The decline of the population is as rapid as its growth if not more so and by the end of the third year the population may be almost extinct.

There can now be no doubt that the increase of damage in the second year and its decrease in the third is due entirely to the growth and decline of the beetle population.

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TABLE I.
Beetle Population in Plucked Bushes.
(King's data from T.Q.XV. P.34, Table I)

Date		Month from pruning	No. of bushes	Type of Gallery						Galls per bush.	Gallery Contents	
				Healed		Empty No.	Occupied		Total No.		Per bush	For occupied gallery
				No.	%		No.	%				
1940												
July	24	19	30	9	9	21	65	68	95	3	14	6·5
Aug.	15	20	30	17	11	44	99	62	160	5	20	6·0
Sept.	5	21	30	19	10	44	118	65	181	6	23	6·0
Sept.	24	21	30	38	11	42	253	76	333	11	46	5·5
Oct.	16	22	30	65	12	157	340	60	562	19	80	7·1
Nov.	6	23	30	69	13	184	285	53	538	18	62	6·5
Nov.	29	23	30	116	16	255	377	50	748	25	87	7·0
1941												
Oct.	9	34	12	894	74	293	19	1·6	1206	100	5	3·4
Oct.	23	34	9	501	72	193	3	0·4	697	77	1	1·7
Nov.	5	35	12	871	78	229	19	1·7	1119	93	5	3·4
Nov.	19	35	12	869	85	145	8	0·8	1022	85	2	2·9
Dec.	3	36	11	971	88	111	22	2·0	1104	100	7	3·9

TABLE II.
Frequency Table of gallery contents during the period May 16th—August 1st, 1945.

	Contents	Frequency	Percent	Contents	Frequency	Percent
	1	1408	50·9	17–21	33	1·2
	2–6	907	32·8	22–26	4	0·14
	7–11	304	11·0	27–31	3	0·11
	12–16	105	3·8	32–36	2	0·07
Total	—	—	—	—	2766	100·02

TABLE III.

Data collected from broken branches during the cycle 1943-1946.

DATE	Month from pruning	No. of broken branches	Galleries per branch	Galleries in Branch: Occupied No.	Galleries in Branch: Occupied %	Galleries in Branch: Healed No.	Galleries in Branch: Healed %	TOTAL	Gallery contents: Total	Gallery contents: Per occupied gallery.
1944.										
June 7	9	108	1·17	[illegible]	76	2	11	18	69	4·9
28		93	1·30	16	57	6	21	28	39	2·4
July 19	10	225	1·44	42	62	5	7	68	104	2·5
Aug. 9	11	314	1·26	58	71	6	7	82	205	3·5
30		314	1·50	67	71	3	3	95	259	3·9
Sept. 20	12	245	1·39	66	69	9	9	96	247	3·7
Oct. 11	13	355	1·45	106	67	13	8	159	441	4·2
Nov. 1	14	277	1·49	79	59	12	9	135	228	2·9
22		338	1·65	138	63	19	9	220	681	4·9
Dec. 13	15	344	2·26	113	54	22	11	209	613	5·4
1945.										
Jany. 3	16	469	1·83	194	50	72	19	388	1075	5·5
24		439	1·75	147	45	58	18	326	632	4·2
Feb. 21	17	559	1·70	127*	48*	73*	27*	267*	492*	3·9*
Mar. 14	18	451	2·20	176	34	178	34	523	773	4·4
Apl. 4	19	602	1·93	208	42	148	30	491	1395	6·7
25		508	2·30	249	41	229	38	607	1448	5·8
May. 16	20	1125	1·78	361	55	171	26	660	1465	4·1
June. 6	21	716	1·79	189	44	136	32	428	758	4·0
27		711	1·71	176	53	81	24	331	529	3·0
July. 18	22	821	1·77	182	39	136	29	465	404	2·2
Aug. 1	23	806	1·86	228	42	151	28	543	792	3·5
22		779	1·88	188	34	172	31	561	767	4·1
Sept. 12	24	660	2·69	151	31	161	33	482	569	3·8
Oct. 3	25	505	1·89	72	20	128	35	361	233	3·2
24		495	1·91	42	11	242	62	388	133	3·2
Nov. 14	26	451	2·04	46	10	272	58	467	233	5·0
Dec. 5	27	480	2·24	44	8	386	70	555	204	4·6
19		392	2·32	25	5	388	77	505	143	5·7
1946.										
Jany. 9	28	364	2·19	31	8	288	72	400	112	3·6
30		337	2·70	42	7	455	83	572	[illegible]	[illegible]
Feby. 20	29	316	1·53	27	5	435	79	549	136	5·0
Mar. 13	30	290	2·76	32	6	374	78	503	139	4·4
Apl. 3	31	239	2·80	25	6	315	73	430	80	3·2
24		135	2·78	22	9	189	79	238	86	3·9
May. 15	32	97	2·16	13	12	96	86	112	101	7·8
June. 5	33	125	1·92	20	18	71	66	107	51	2·6
26		127	1·85	25	29	51	69	87	122	4·9
July. 17	34	109	1·83	31	26	42	48	87	117	3·8
Aug. 7	35	126	1·81	19	23	56	69	81	104	5·5
28		118	2·00	30	26	70	61	115	112	3·7

*From February 21st, 1945, onwards, determined from fresh branches only. See text.