INSTITUTE OF ECOLOGY-POLISH ACADEMY OF SCIENCES

EKOLOGIA POLSKA

Vol. XX Warszawa 1972 No. 7

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PRODUCTION OF WORKERS IN AN ANT NEST*

(Ekol. Pol. 20:65–71). Different methods for labelling ants with radioisotopes have been tried. Based on a series of labellings with ^{24}Na it was possible to follow the fluctuation in the population of workers. The Lincoln index was used. To measure the production of workers a series of ^{32}P labellings were made. The production of ants was calculated from a consideration of the population density, the percentage of ants labelled, and the percentage of labelled ants which should be expected assuming that no death occurred after the labelling. The methods were tested on a population of *Lasius alienus* (Först). In this population the density fluctuated from 9,700 to 18,000 during the summer and the production was estimated to be 34,000 workers.

1. INTRODUCTION

The estimation of the production of workers in an ant nest gives rise to many practical problems.

Generally, an estimate of production is carried out by digging up the whole nest and by subsequent counting of broods in different age classes. This method was used by Golley and Gentry (1964) and Pętal (1967) in production estimates. However, this method is very time-consuming and destructive, and the natural conditions in the nest are inevitably disturbed.

*Proceedings of the IBP (PT Section) Meeting on Methods of Productivity Investigations on Social Insects and their Role in the Ecosystems. Institute of Ecology, PAS. Warsaw, June 22–28, 1970. Editors: M. V. Brian, J. Pętal.

This paper presents a method which solves some of these practical problems, viz. a capture-recapture method based on the simple Lincoln index.

2. METHODS FOR THE STUDY OF POPULATION DENSITY AND PRODUCTION

2.1. Labelling

Marking of ants by means of radioisotopes has been carried out by Odum and Pontin (1961) and Brian, Hibble and Stradling (1965) who used ^{32}P.

For the labelling of ants in the present experiment the radioisotopes, ^{32}P and ^{24}Na, were used. Pilot experiments were carried out in the laboratory in order to find the most suitable labelling-method for the field experiments.

Brian, Hibble and Stradling (1965) labelled *Tetramorium caespitum* Mayr. by offering food containing the isotope in the laboratory. The disadvantage of this method is that to prevent the transfer of isotope from labelled to non-labelled ants it is necessary to keep the ants on non-labelled food for 2–3 days after the labelling. This method, therefore, takes about five days. However, in the present work, where sampling was carried out every week, it was impossible to keep the ants away from the nest for such a long time.

Odum and Pontin (1961) labelled *Lasius flavus* (F.) by dipping the ants in an isotope solution and immediately replacing them in the nest. In laboratory experiments I found that a considerable amount of radioisotope transfer took place when newly-labelled wet ants were placed together with unlabelled individuals. If the labelled ants were kept for about 4–6 hours in a "drying cage" with filter paper, and ventilated by an air-flow before they were allowed to mix with the non-labelled, the contamination was reduced to a very low level. By this means it was possible to label a sufficient number of ants in a short time, viz. 6–8 hours. Thus this method was used in the field experiments.

After recapture the ants were tested for radioactivity by a GM-counter with automatic sample-changer. The ants were anaesthetised with CO_2 and placed in small counting dishes covered with opaque Scotch tape. In this way the mortality among the ants was reduced, and at least 98% could be released into the nest after the counting.

2.2. Population density

To estimate the population density of workers in a nest of *Lasius alienus* (Först) the Lincoln index was used. The ants were labelled with ^{24}Na (half-life – 15 hours), so that independent labellings could be made every week. In this

experiment the use of more complicated and time-consuming methods was impossible, because of the short time between the sampling occasions. The procedure of handling the ants, and the time of the day when the different steps were taken, was the same on each occasion. In this way the measurements were standardized, and the results made reproductible.

The samples were taken from three different places in the nest:

1. foraging ants on the soil surface,
2. under a stone with brood-chambers,
3. under a stone where the ants were attracted to food baits.

The proportion of labelled ants in the sample from the different places was equal. Therefore for this species, the Lincoln index could be used to calculate the population density (Ayre 1962).

The population density was calculated by means of the formula:

$$x = \frac{a \times n}{r}$$

where: x – population density, a – number of labelled ants, n – number of ants in the second sample, r – number of labelled ants in the second sample.

2.3. Methods for the estimation of production

In the late spring, before the first workers hatched, a sample of workers was labelled with ^{32}P and, after recapture, the percentage of labelled ants in the population was determined. After a period of one week, the percentage of labelled ants was checked. The population density was found from the ^{24}Na labelling experiments. The expected percentage of ^{32}P labelled ants was then calculated on the assumption that there had been no mortality in the meanwhile. From these figures, the number of ants which had left the population could then be calculated. Thus the production of workers during each period is the increase in the population plus the number which had left the population. By means of one ^{32}P labelling it was possible to follow the production during six weeks.

The calculations were made as follows:

– X_0 = the population density at the time $t = t_0$,
– N_0 = percentage of labelled ants at the time $t = t_0$,
– X_1 = the population density at the time $t = t_1$,
– N_1 = percentage of labelled ants at the time $t = t_1$,
– M_1 = expected percentage of labelled ants at the time $t = t_1$ given that there has been no mortality,

$$M_1 = \frac{N_0 \times X_0}{X_1}$$

– Y_1 = the number of ants which left the population during the period from t_0 to t_1,

$$Y_1 = \frac{(N_1 - M_1) \times X_1}{N_0}$$

The production of workers was then calculated as the number of ants which left the population (Y), plus the increase in the population density.

As the number of ants which hatch and die in the period between two samples is not taken into consideration, the actual production must be higher than the calculated value.

3. EXAMPLE OF PRODUCTION IN A NEST OF *LASIUS ALIENUS*

During the year 1967 this method for estimating production of workers was used in a nest of *Lasius alienus*. The nest, which covered an area of 3.9 m², was situated in a sandy heath locality, dominated by *Corynephorus canescens* (L.) Beauv.

The experiment was started in early June and ran for about a year.

The population density of workers fluctuated between 9,700 and 18,000 individuals during the summer (Fig. 1).

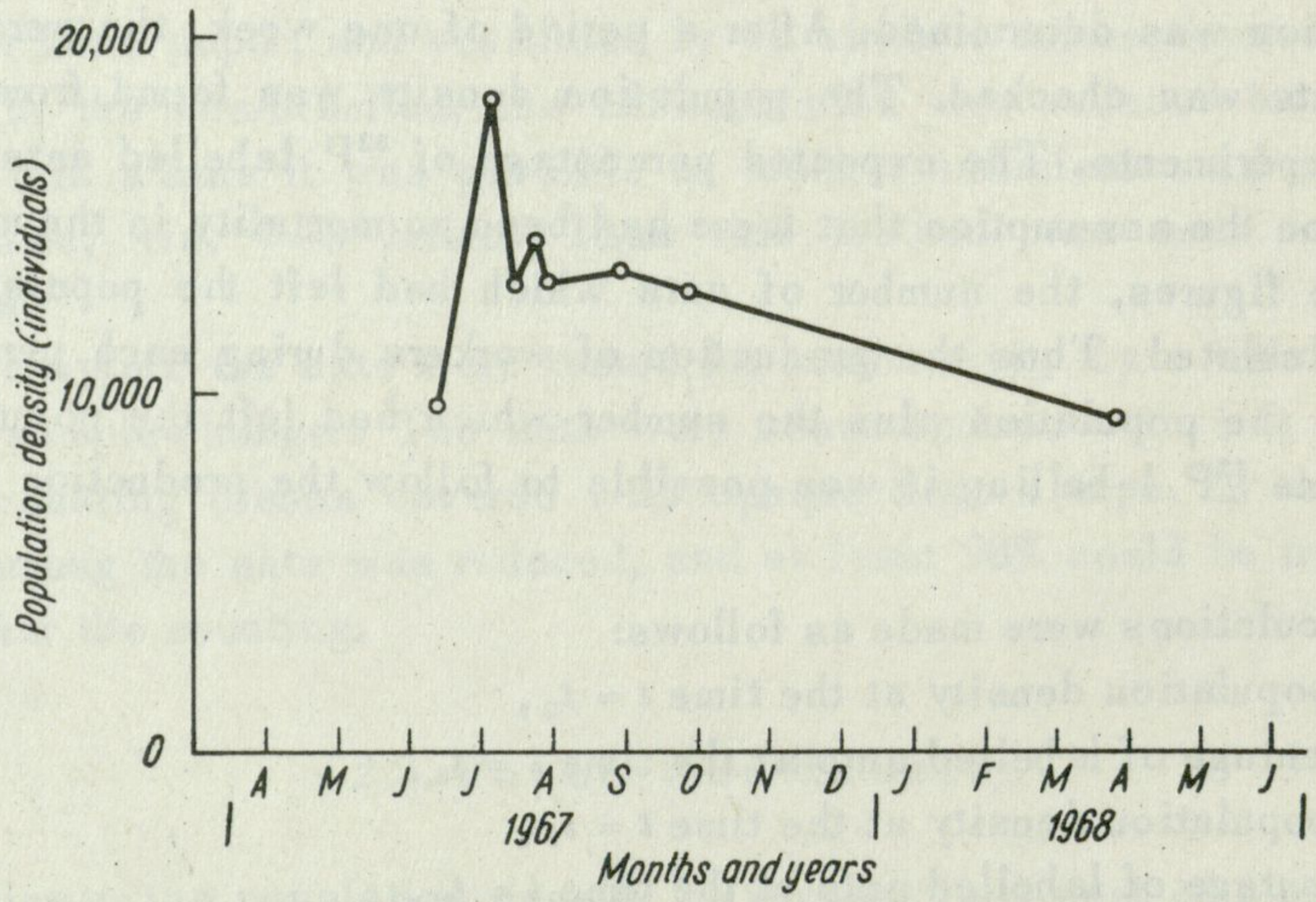

Fig. 1. The fluctuation in the population of workers in a nest of *Lasius alienus*

During the summer three ^{32}P labellings were made in order to assess the production of workers. In the periods between the last samples in one labelling and the first in the next, the production cannot be estimated. Assuming that the production in this period is the same as in the periods before and after, the total production can be calculated by extrapolation (Fig. 2).

The total production of workers in the nest was estimated to be 34,000 individuals over a period of three and a half months.

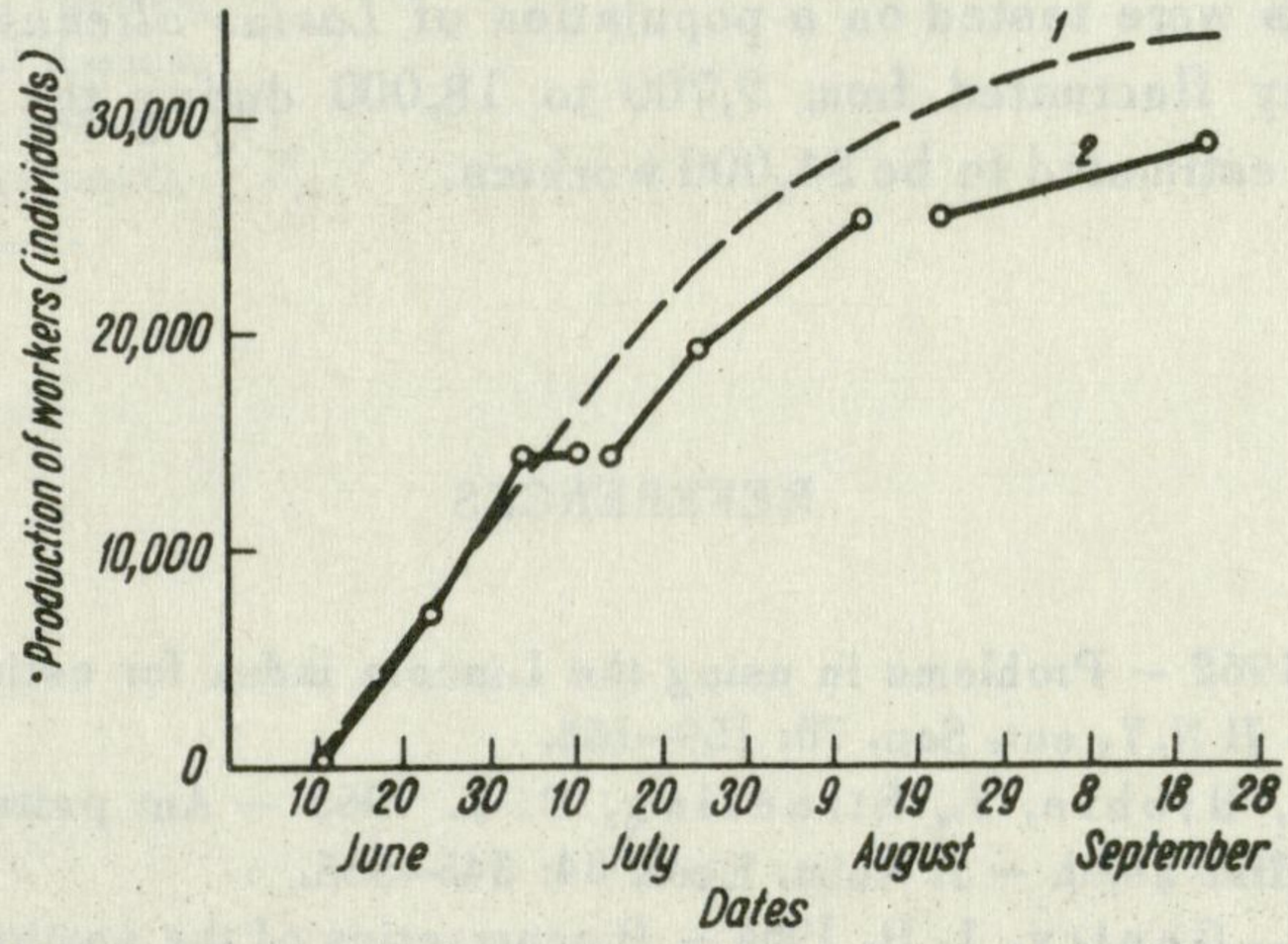

Fig. 2. The estimated production of workers in a nest of *Lasius alienus*
1 – extrapolated production, *2* – measured production

4. CONCLUSION

This method, used for the estimation of production in a population of animals with a continuous input of newly hatched individuals, is fraught with many practical problems in field experiments, e.g., sampling techniques, testing for radioactivity and handling the animals in the laboratory. The example of *Lasius alienus* presented here should be regarded as a preliminary investigation on this species.

It should also be very valuable if the method could be checked in other habitats which would greatly contribute to the solution of the technical problems involved and to the standardization of the method.

5. SUMMARY

Different methods for labelling ants with radioisotopes have been tried. In the present experiment the method of dipping ants in a solution of radioisotopes, and drying of the individuals thus marked in a special drying-cage, proved to be preferable.

Based on a series of labellings with ^{24}Na it was possible to follow the fluctuation in the population of workers. The Lincoln index was used.

To measure the production of workers a series of ^{32}P labellings were made. The percentage of the ^{32}P labelled ants was measured each week during a period of up to six weeks for each ^{32}P labelling. The production of ants was cálculated from a consideration of the population density, the percentage of ants labelled, and the percentage of labelled ants which should be expected assuming that no death occurred after the labelling.

The methods were tested on a population of *Lasius alienus*. In this population the density fluctuated from 9,700 to 18,000 during the summer and the production was estimated to be 34,000 workers.

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PRODUKCJA ROBOTNIC W GNIEŹDZIĘ MRÓWEK

Streszczenie

Dokonano prób zastosowania izotopów promieniotwórczych pierwiastków do znakowania mrówek. W przedstawionym eksperymencie zastosowano metodę zanurzania mrówek w roztworze z promieniotwórczymi izotopami i osuszania znakowanych w ten sposób osobników w specjalnym urządzeniu oraz wypuszczania ich do macierzystego gniazda.

W oparciu o serię znakowań za pomocą ^{24}Na zbadano zmiany w populacji robotnic. Do obliczeń zastosowano wskaźnik Lincolna.

Dla zbadania liczby produkowanych robotnic dokonano serii znakowań przy użyciu ^{32}P. Wysokość produkcji obliczano na podstawie zagęszczenia populacji, procentowego

udziału znakowanych mrówek w pobranej próbie oraz spodziewanego udziału procentowego znakowanych mrówek, przy założeniu niewystępowania śmiertelności osobników po znakowaniu.

Metody te zostały zastosowane do zbadania populacji *Lasius alienus* (Först). W populacji tej liczebność osobników uległa w okresie lata zmianie od 9700 do 18 000; produkcję oszacowano na 34 000 robotnic.

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