DETERMINATION OF AGE OF POLYNESIAN RATS (*RATTUS EXULANS*)

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INTRODUCTION

The weight of an eye lens increases along an asymptotic curve throughout the normal life span of many mammals (Lord, 1959; Friend, 1967a). In rats (laboratory *R. norvegicus*) this increase in lens weight has been found to be largely independent of the nutritional status of the animals. Rats maintained under several controlled diet conditions failed to produce differences in lens weight despite nearly two-fold differences in body weight (Friend, 1967b) although the diets of their mothers during pregnancy and lactation may affect lens weight (Friend and Severingaus, 1967, working on white-tailed deer).

As part of a broad study of *Rattus* species inhabiting coconut and cocoa plantations in Fiji an ageing technique applicable to the most abundant species, *R. exulans*, was evaluated with the aim of investigating the age structure of field populations.

METHODS

To obtain a series of lenses from rats of known age, *R. exulans* were raised and maintained in metal cages at Koronivia Research Station, Nausori, Fiji from November 1970 until November 1972. Approximately half the known age animals were derived from pregnant females live trapped in cocoa or coconut plantations, the remainder were derived from pairs mated and maintained in captivity. All rats were fed on a diet of unhusked rice and a high protein poultry pellet. Water was ad lib. Forty six sets of known age lenses were obtained from the cage population. Most rats were killed in November 1972 although a few were sacrificed at earlier dates to obtain animals of specific ages.

Following the method of Lord (1959) eyes were removed and placed, in their pairs, in a 10 percent buffered formalin. After 20-30 days lenses were removed from the eyes and dried in a laboratory oven at 80°C for 48 hours. After drying, lenses were cooled in a dessicator and then weighed in pairs to the nearest 0.1 mg. Weighings were carried out in an air conditioned laboratory maintained at 20°C. A drying time of 48 hours was found to be sufficient to give constant readings on repeated weighings.

Friend (1967c) reported that after four weeks fixation in 10 percent formalin there was a significant increase in the lens weight of laboratory rats. To investigate this aspect fixing times of 20 and 120 days were compared by assigning one lens, from rats trapped in plantations, to each treatment. This trial was carried out after establishing with another set of lenses, that there was no significant difference between the weight of right and left lenses weighing between 10.0 and 14.0 mg (right $\bar{\chi} = 12.07 \pm 0.18$ mg; left $\bar{\chi} = 12.04 \pm 0.20$ mg, $N = 46$). There was no significant difference between the weight of lenses fixed for 20 days ($\bar{\chi} = 12.68 \pm 0.26$ mg, $N = 30$) and 120 days ($\bar{\chi} = 12.66 \pm 0.26$ mg, $N = 30$), therefore fixing time was not considered a source of variation.

The lenses used to investigate the age structure of plantation populations of *R. exulans* were collected by trapping for four nights, at monthly intervals, on grids covering 0.8 ha. Break-back traps were used on the grids, being set late in the day and checked before 0900 hours each morning. All rats collected were stored in a refrigerator until dissected later in the day. Early collection and maintenance at low temperatures was essential, for Rongstad (1966) found that cotton tail rabbit lenses deteriorated beyond use in less than 12 hours at temperatures typical of the Fijian hot season (25°C to 35°C). The eye lenses from all rats collected in the field were processed in the same manner as those obtained from cage reared animals.

To establish the relationship between lens weight and age, a line was fitted to the plotted lens weights by Connolly, Dudzinski and Longhurst's (1969) method of calculating a linear regression equation from $\log_{10}$ of the lens weight, and the reciprocal of the age plus a constant. For *R. exulans* the value (constant) 59 was found, by computer iteration, to give the best fit ($r = 0.9819$). The calculation of the regression is considerably simplified by this conversion to a reciprocal and confidence limits can be more easily determined (Dudzinski and Mykytowycz, 1961).

TABLE 1. *Eye lens weights of 46 known age* R. exulans *raised in cages at Koronivia Research Station.*

Sex	Wt. of lens pair (mg)	Age (days)	Sex	Wt. of lens pair (mg)	Age (days)
M	9.6	7	F	25.4	335
F	10.6	11	F	25.8	253
F	12.6	20	F	26.0	382
F	14.5	30	M	26.5	370
M	15.5	32	M	26.7	391
M	16.6	52	F	26.7	294
F	17.0	56	F	27.0	358
F	17.7	92	F	27.0	283
M	19.7	92	F	27.1	332
F	20.0	113	M	27.3	263
M	20.3	87	M	28.2	331
F	20.4	92	F	28.4	411
F	20.8	87	M	28.6	391
F	21.1	134	M	28.8	256
M	21.5	113	M	28.9	475
F	21.8	134	F	29.2	350
F	22.4	115	F	29.3	391
M	23.7	134	F	29.4	343
M	23.7	190	M	30.4	353
F	23.9	246	M	30.6	484
F	23.9	246	M	30.8	419
F	24.0	190	F	31.4	427
F	25.3	249	F	31.4	475

RESULTS AND DISCUSSION

Lens weights and ages of 46 known age *R. exulans* are shown in Table 1. All weights are the total for both lenses and data for male and female have been combined for all calculations because there was no significant sexual differences in lens weights (mean male = 11.36 ± 0.38 mg/lens, N = 33; female = 11.46 ± 0.44 mg/lens, N = 33). This result agrees with the findings of Martinet (1966) for *Microtus arvalis* and Ostbye and Semb-Johansson (1970) for the Norwegian lemming *(Lemmus lemmus).*

From Figure 1, with regression line and 95% confidence limits transformed from the linear equation $y = 4.266 - 2.774\ x$, and it is obvious that the precision of age estimates, based upon lens weight, decreases rapidly with increasing age. For example the 95 percent limits of an estimate for an animal with a lens weight of 20 mg ranges from 67-132 days, while at 24 mg the range is 116-270 days.

Estimates of age are mainly used to distinguish age classes, particularly annual classes. These can be used as a basis for life tables, provided basic features of the population dynamics are met, or to analyse such features as age related changes in physiology and parasitology.

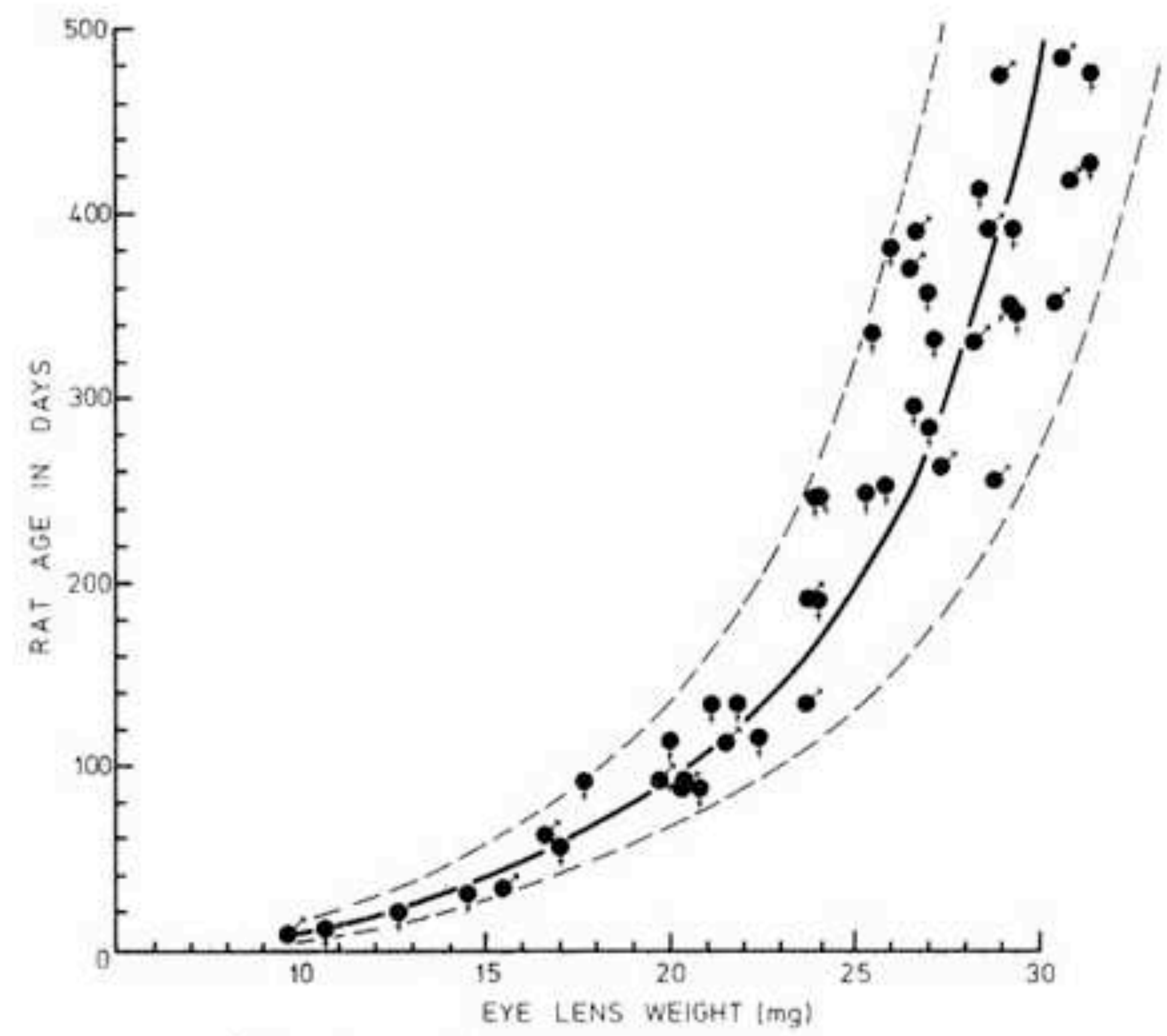

FIGURE 1. *Eye lens weight-age relationship for 46 known age* R. exulans. *The regression line and confidence limits are transformed from the equation* $Y = 4{,}2659 - 2.7735X$. *Broken line denotes 95% confidence limits.*

The relatively short life span of a small mammal such as *R. exulans* means that, to be useful, age classes would have to be on a monthly rather than yearly basis. However, frequency distributions of eye lens weights constructed from monthly samples (Figure 2) indicate that the majority of animals in most months had lens weights of 20 mg or greater (i.e., were over two months old) and therefore in age classes with confidence limits that are excessive for most purposes. Such frequency distributions for *R. exulans* can only indicate very general population trends. For example periods of marked population recruitment may be apparent (i.e., June to July 1970) as could be periods of little recruitment (January 1971).

If only a single sample can be drawn from an *R. exulans* population, such general indicators of population trends may be of value.

The distribution of eye lens weight also indicates the age at which *R. exulans* enter the trappable portion of the population. A very small proportion of the total number of animals sampled had a lens weight of less than 15 mg (i.e., a mean age of less

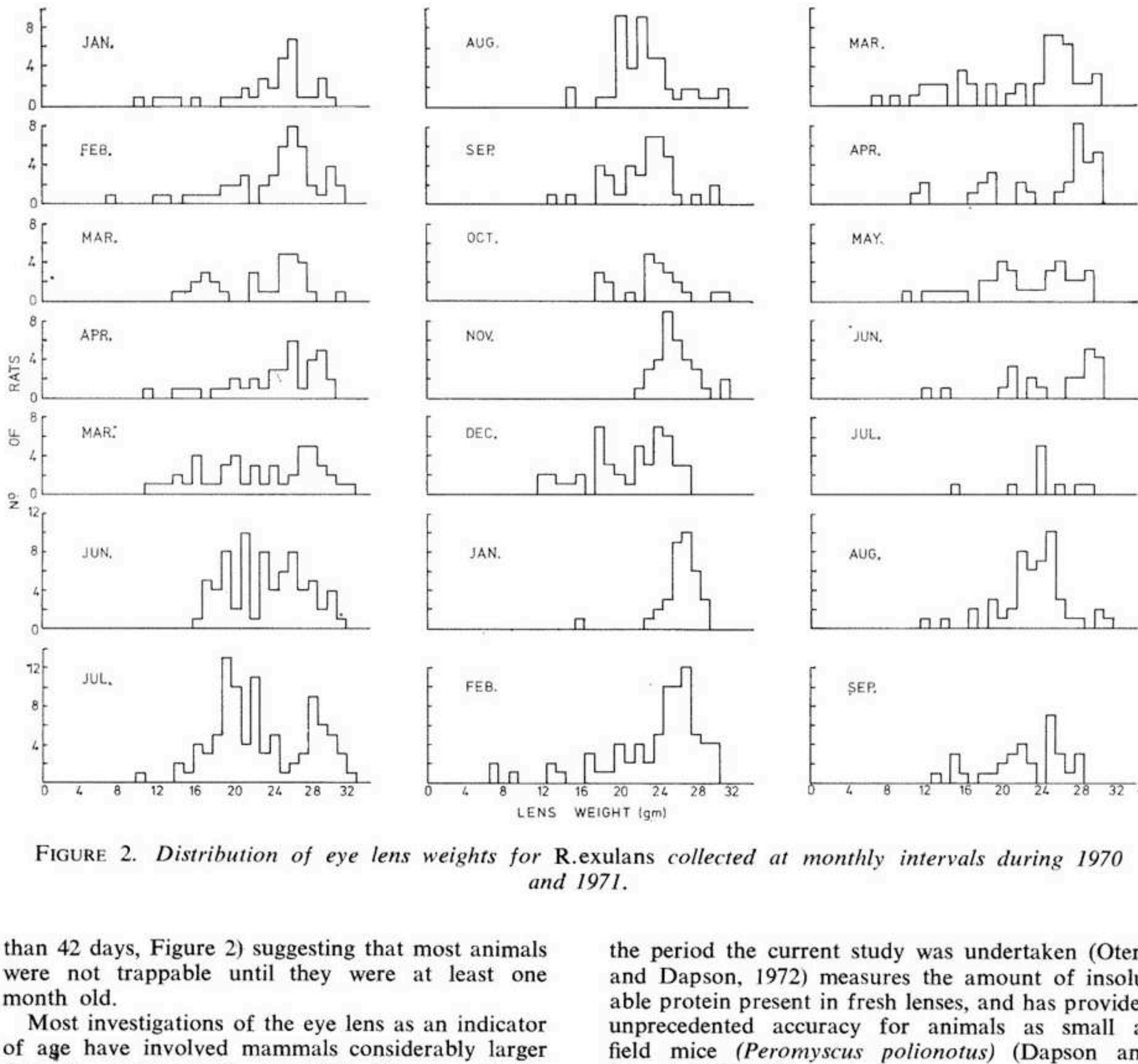

FIGURE 2. *Distribution of eye lens weights for* R.exulans *collected at monthly intervals during 1970 and 1971.*

than 42 days, Figure 2) suggesting that most animals were not trappable until they were at least one month old.

Most investigations of the eye lens as an indicator of age have involved mammals considerably larger than *R. exulans,* such as rabbits (Myers and Gilbert, 1968) and Seals (Bauer *et. al.,* 1964). Experimental errors must be proportionally greater when dealing with small lenses, thereby reducing the precision of the technique. Berry and Trusglove (1968) found that eye lens was not a useful indicator of age in the house mouse as variability was extremely high over most of the age range. However, Ostbye and Semb-Johansson (1970) and Martinet (1966) considered that lens weight was a useful criterion of age for young *Lemmus lemmus* and *Microtus arvalis* respectively, despite considerable variability.

A more sophisticated technique, developed during the period the current study was undertaken (Otero and Dapson, 1972) measures the amount of insoluable protein present in fresh lenses, and has provided unprecedented accuracy for animals as small as field mice *(Peromyscus polionotus)* (Dapson and Irland, 1972). Ninety-five percent confidence limits at 100 days were 96-107 days; at 300 days, 293-319 days and at 700 days, 680-751 days.

On the other hand Birney *et. al.,* (1975), working with the cotton rat, found that lens weight and insoluble lens protein were approximately equal as age indicators for the first 130 days, after which insoluble protein became the best criterion. Unfortunately the technique requires fresh lens plus a considerable amount of sophisticated equipment.

The results presented in this paper suggest that eye lens weight is a useful indicator of *R. exulans* age up to three to four months. Beyond this age the lack of precision clearly limits the technique's usefulness.

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