NOTES AND COMMENTS

THE INFLUENCE OF ADVANCING AGE ON CHIASMA FREQUENCY IN *PHYMATEUS CINCTUS* FAB. (ACRIDIDAE)

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1. INTRODUCTION

THE influence of age on recombination is well known in animals (Bridges, 1915, 1927, 1929; Plough, 1917; Stern, 1926; Fisher, 1949; Wallace, 1957; Bodmer, 1961; Hayman and Parsons, 1961). The results from these investigators show a decrease, in recombination with advancing age. In particular, Bridges (1929) recorded in *Drosophila*, an initial decrease, followed by further increases and decreases giving a W-shaped curve of variation (Bodmer, 1961).

In contrast not much is known about the influence of age on chiasma frequency. The only available results suggest significant differences with advancing age (Oyidi, 1966) but the exact relationship is not known. Hence this investigation was conducted to test the influence of advancing age on chiasma frequency in the males of *Phymateus cinctus* Fab. (Acrididae) so as to determine in particular the shape of the graph. The species is particularly suitable for this study because the adults live long. Furthermore, the chromosomes which number only nine autosomes and a single X-chromosome are very large and acrocentric.

2. EXPERIMENTAL DETAIL

Two large adjacent populations of *P. cinctus* Fab. were studied in Zaria (North Central State) between October 1966 and January 1967. The first few adults appeared in the field on 6th October. The adult population increased rapidly after a week and by 3rd November the field population was almost all adults.

The first attempts to take samples on 13th, 20th and 27th October were not successful because the testes of the insects were still very young and small. The first successful sample was taken in the first population on 12th November. After this date, two samples were taken, one from each of the two populations on 19th and 26th November, 3rd, 10th, 17th, 24th and 31st December at weekly intervals. Further samples could not be taken in the second population after 31st December because male insects had become very rare in the population. However, it was possible to take three more samples in the first population on 7th, 14th and 21st January 1967.

In all cases each of the sample contained 12 individuals caught in the afternoon. The testes were fixed in 1:3 acetic alcohol immediately after sampling, before being stored in 70 per cent. alcohol. The stain used was acetocarmine and chiasma analysis was carried out from temporary squash preparations, under an oil immersion lens. Total chiasmata were counted

per cell and five cells scored per individual. The standard errors of the sample means were determined and the sample means were then plotted.

3. RESULTS

The results of the chiasmata counts from the two populations (table 1) show high chiasma frequency in the youngest individuals. An initial

TABLE 1

The results of the chiasma analysis to show the sample means and their standard errors

Age in weeks	Population I		Population II	
	Sample means	Standard errors	Sample means	Standard errors
4	14.50	± 0.33	—	—
5	13.72	± 0.33	14.07	± 0.26
6	13.28	± 0.33	13.15	± 0.26
7	13.43	± 0.33	12.95	± 0.27
8	13.50	± 0.33	13.17	± 0.26
9	12.95	± 0.33	13.32	± 0.28
10	12.98	± 0.35	13.02	± 0.26
11	13.22	± 0.35	13.55	± 0.27
12	13.80	± 0.33	—	—
13	12.93	± 0.33	—	—
14	13.53	± 0.33	—	—

decrease with advancing age is followed by further increases and decreases giving a W-shaped graph within the first twelve weeks of life of the insects (figs. 1 and 2), but the increases are consistently lower than the values found for the youngest individuals. It is further seen that except for the eleven-week-old sample in population II, the differences in chiasma frequency between the youngest individuals and the other age-groups are more than twice the standard errors. Similarly the differences between the samples for five and nine, ten and thirteen weeks, nine and twelve weeks, and twelve and thirteen weeks in population I, and that between the samples for seven and eleven weeks in population II are probably due to real changes. Hence there is significant variation in chiasma frequency with advancing age in *P. cinctus*.

4. DISCUSSION

The results from this investigation suggest significant decreases and increases in chiasma frequency with advancing age to give a W-shaped graph of variation within the first twelve weeks of life of the insects. They are similar to those of Oyidi (1966), which gave an initial decrease followed by an increase before the early death of the animals put an end to the experiment.

Bodmer (1961), reviewing the work of Rees and Naylor (1960), had attempted to explain the influence of age on chiasma frequency by suggesting that chiasma formation and chromosome pairing in the female may be intimately affected by developmental differences such as might occur in the ovum. He further suggested that this effect may be related to the influence

of maternal age on nucleolar organiser as had previously been suggested by Polar *et al.* (1960).

It can be seen from figs. 1 and 2 that the shape of the graph may depend on the age of the animals and the duration of the experiment. It may also

FIG. 1.—*Phymateus cinctus*, Fab. The influence of advancing age on chiasma frequency: population 1.

FIG. 2.—*Phymateus cinctus*, Fab. The influence of advancing age on chiasma frequency: population II.

depend on the age difference between the samples. Thus the graph of a similar experiment which is restricted to the first eight to nine weeks or the last nine to twelve weeks of life of the insects will very likely be U-shaped if

the sampling is at shorter intervals. This observation appears consistent with the results of Fisher (1949), Owen (1953) and Wallace (1957), which gave a U-shaped curve of variation (Bodmer, 1961). The results of these investigators may therefore have greater significance than had been judged by Bodmer (1961). The observed variation in chiasma frequency with age is consistent with the influence of age on recombination as demonstrated in particular by Bridges (1929). This close similarity is strong evidence in support of the view that a reasonable positive correlation exists between chiasma frequency and recombination frequency (Darlington, 1931, 1932; Mather, 1938; Sturtevant, 1951; Brown and Zohary, 1955; Stebbins, 1958; Bodmer and Parsons, 1962). Hence the rate at which new variability is released through recombination could be controlled by controlling chiasma frequency (Darlington, 1932).

5. SUMMARY

1. The influence of age on chiasma frequency has been investigated in the natural populations of *P. cinctus*, Fab.
2. The results show an initial decrease in chiasma frequency with advancing age, followed by further increases and decreases, given a W-shaped graph of variation, within the first twelve weeks of life of the insects.

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PHENETICS OF NATURAL POPULATIONS

IV. THE POPULATION ASYMMETRY PARAMETER IN THE BUTTERFLY COENONYMPHA TULLIA

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1. INTRODUCTION

RECENTLY Soulé (1967) described a property of insular lizard populations that supports the idea that the average level of developmental stability differs significantly from one population to another. The level of stability was estimated by comparing populations with respect to their relative expression of minor departures from perfect bilateral symmetry—"fluctuating asymmetry"—assuming that every population had an estimable level of asymmetry for a given set of characters, i.e. a population asymmetry parameter (PAP). The operations used to arrive at the PAP estimates and to assess the reality of the phenomenon are as follows:

1. Choose a number of (preferably) uncorrelated bilateral characters in which differences between the sides can be accurately scored or measured (e.g. scale or bristle counts or appendage measurements).

2. Score a sample of individuals from a number of populations for the characters.

3. The absolute difference (d) between right and left sides is determined for each character on each specimen. From the asymmetry distributions the mean asymmetry ($\bar{d}$) is calculated for each character in each population; $\bar{d}$ is an estimate of the PAP.

4. Check for the existence of directional asymmetry and antisymmetry (see Van Valen, 1963), and scale effects that might result from differences in the means of the characters among the populations, and make the appropriate corrections (see Soulé, 1967, for details and references).

5. For each character rank the populations according to the $\bar{d}$ values and determine the Kendall coefficient of concordance, W , in order to verify the hypothesis that the different characters "agree" on the relative levels of fluctuating asymmetry in the populations. Significance* of W means that

* Due to an error the actual value of W was omitted from the earlier paper; it is 0.49; $P < 0.01$.