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GROWTH OF THE PEDIGREE LARGE WHITE PIG POPULATION IN AUSTRALIA

By C. P. McPHEE, B.V.Sc.*

SUMMARY

From one pedigree herd in 1911, the Large White breed has expanded by an increase in the number and sizes of pedigree herds to 571 males and 965 females registered in 169 herds in 1960. Growth was characterized by rapid expansion between 1925 and 1947 followed by a long period of stability. At no time was expansion so rapid as to seriously depress selection intensities. Marked annual fluctuations in registration numbers could have caused random changes in gene frequency.

Of all pedigree herds, 54.6 per cent. registered pigs of both sexes, 31.9 per cent. females alone and 13.5 per cent. males alone. Herds in which both sexes were registered were larger than those in which only one sex was registered. The majority of pedigree males and females were produced in herds registering fewer than 10 females annually.

In each of 5 sample years, imported sires and dams contributed an average of 3.4 and 1.3 per cent. respectively of the genes of the registered animals. Since the early 1930s the frequency of importations has been markedly reduced.

The breed originated in Victoria and by 1941 had expanded to all States of Australia with herds distributed mainly around the major cities.

It is concluded that the large size, diverse origin, slow rate of growth and recent isolation of the breed in Australia give it a potential for genetic improvement. However, a high proportion of herds are unable to run effective breeding programmes due to their small size and dependence on other herds for breeding animals.

I. INTRODUCTION

Large populations respond well to selection based on modern statistical techniques. Hence the improvement of livestock breeds is best done through the co-ordination of the efforts of individual breeders into a type of directed evolution. Recent interest in the genetic improvement of Australian pig breeds is shown by the

* Husbandry Officer, Animal Research Institute, Yeerongpilly.
(Queensland Department of Primary Industries.)

establishment of a pig testing station in Queensland in 1960. Before the best means can be devised for improving these breeds it is necessary to obtain a detailed knowledge of the biology of existing populations. This paper is the first of a series reporting results of a study of the characteristics of the pedigree Large White pig population in Australia. The origin of the breed through importation and its expansion in terms of numbers of pedigree herds, pigs registered in them and geographical distribution are presented in this paper.

II. MATERIALS AND METHODS

Source of data.—Data used in the study were sampled from registrations in the annual volumes of the Australian Stud Pig Herd Book between 1911 and 1960. Initially, these provided the name, age, sex, registration number and four generation ancestors of each pig. Over the years, some changes were made in the mode of registration. From 1927 onwards, registered animals were recorded with parental pedigrees alone and sizes of litters in which they were born. In 1931 Large Whites were separated from the rest of the Yorkshires and provided with a series of registration numbers of their own. Changes in the annual female registrations have been taken as indicative of changes in the size of the pedigree pig population (Donald and El Itriby 1945). Prior to 1925, age of registration was unrestricted and a higher proportion of all female pigs was registered. This results in population size being over-estimated prior to 1925 in comparison with the population subsequent to 1925. Also, a sudden increase or reduction in annual registration was not necessarily followed immediately by a similar change in population size.

Numerical growth.—Time changes in the pedigree population were investigated by averaging over 5-year periods the number of animals contributed by each breed to the total annual registrations. Breeds were classified separately except for those breeds registering fewer than 50 animals per year, which were grouped into a "Minor breeds" classification. The numerical growth of the Large White breed was then studied by observing annual changes in the numbers of males, females and herds registered between 1911 and 1960.

Nature of herd registration.—The numbers of herds and registered males and females were tabulated for each of seven years characterizing different stages in the growth of the breed, viz. 1921, 1933, 1938, 1941, 1946, 1952 and 1960. Herds were classed as registering either males only, females only, or both males and females in the sample years. Time changes and differences between herds were judged on the number of animals and sexes of animals registered annually and the female : male registration ratios.

Influence of importations on the breed.—The influence of imported animals on the breed was estimated by examining the origins of parents producing animals registered in 11 annual herd books sampled at 5-year intervals between 1911 and

1960. The percentage of parents originating from outside Australia equals the percentage of imported genes in the animals of the sample year.

Geographical distribution.—Changes in the geographical distribution of the breed were investigated, using the addresses of herds registering at 10-year intervals.

III. RESULTS

(a) Numerical Growth

Figure 1 shows the contribution of breeds to the total expansion of the pedigree pig population in Australia between 1911 and 1960. Growth of the pedigree population appeared exponential between the periods 1910-1915 and 1950-1955 but declined in 1955-1960. Berkshires have been the most popular breed throughout. Their percentage contribution ranged from 67.0 in 1915-1920 to 33.5 in 1930-1935.

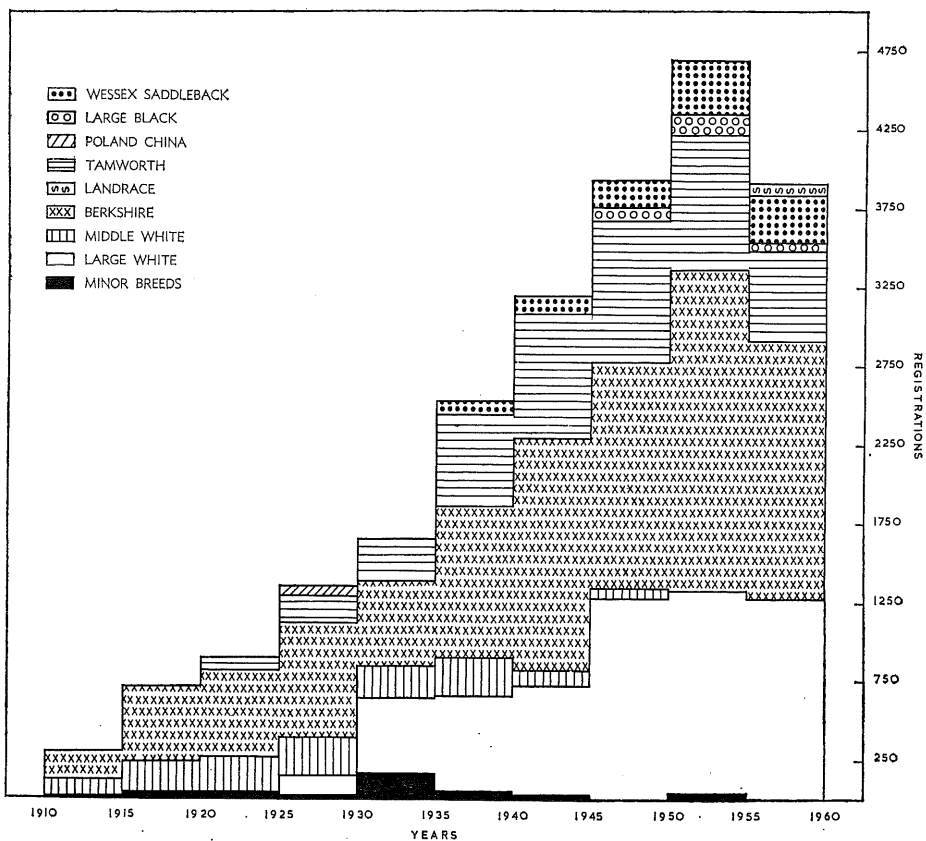


Fig. 1.—Contribution of breeds to the total pedigree pig population in Australia between 1910 and 1960. Annual registrations are averaged over 5-year periods. Minor breeds register fewer than 50 animals per year.

In Australia, the first pedigree Large Whites were bred at Dookie Agricultural College in Victoria. A boar and a sow were registered with 168 Middle Whites in Volume 1 of the Berkshire and Yorkshire Herd Book of Australasia in 1911. Large Whites moved out of the "Minor breeds" classification in 1925-1930, when they contributed 8.6 per cent. of all pigs registered. They held their position as the second most popular breed from 1930 to 1935 with 29.3 per cent., until 1955-1960, when they registered 32.4 per cent. Large Whites appear to have gradually replaced Middle Whites. This has been brought about mainly by the establishment of new herds rather than the replacement of Middle Whites by Large Whites in existing herds.

Annual numbers of Large White pedigree herds and males and females registered in them between 1910 and 1960 are shown in Figure 2.

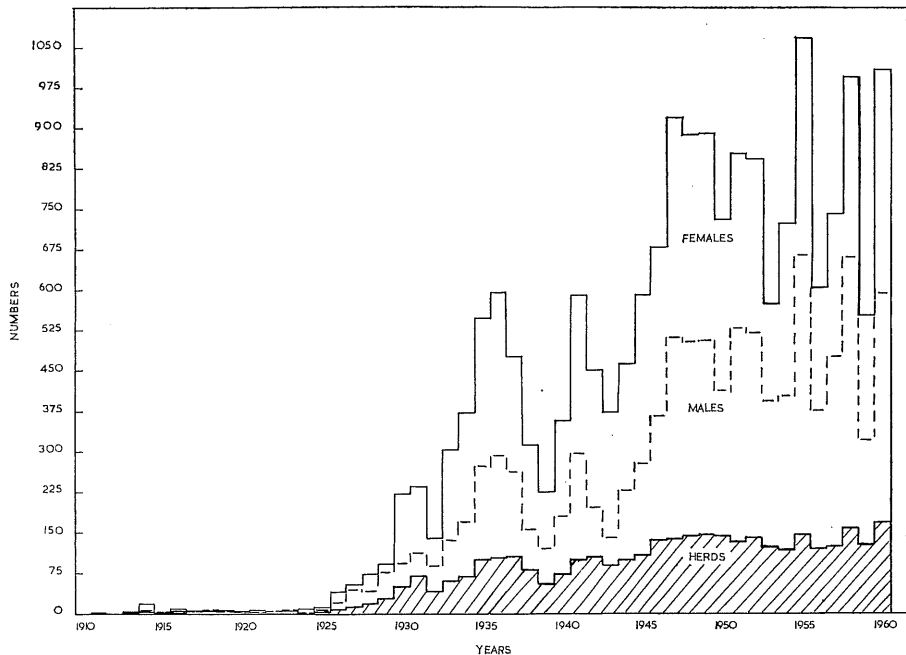


Fig. 2.—Annual herd numbers, and males and females registered as Large Whites, between 1910 and 1960.

The numerical growth of the breed as indicated by female registrations is characterized by early stability to 1925, rapid expansion from 1925 to 1936, a period of general decline between 1937 and 1944 with a temporary rise in 1941, and rapid growth to 1947 followed by a long period of relative stability which included some years with notably high or low registration. Herd numbers increased at a much slower rate than either male or female registrations. They fluctuated in accordance with, but to a much less marked degree than, numbers of registered

animals. The average number of females registered per herd per year rose from 4.6 in the period 1911-1936 to 5.4 in 1937-1960, while male registrations rose at a slightly faster rate from 2.3 to 3.2 over the same period.

(b) Nature of Herd Registration

The distribution of pedigree Large White pigs and herds in seven sample years is shown in Table 1. In the majority of herds (54.6 per cent.) both males and females were registered. In these herds, unusually high percentages of all females (82.5) and all males (92.9) were registered. The percentage of herds in which only females were registered was 31.9 and in which only males were registered was 13.5. Only 17.5 per cent. of all females and 7.1 per cent. of all males were registered in these herds. Pedigree herds producing registered pigs of both sexes registered an average of 8.0 females and 4.8 males a year, while those producing pedigree females alone registered 2.9 females, and males alone 1.5 males. In general, the distribution of herds and animals registered in them has not changed systematically over the years. During the years of reduced breed numbers, however, the majority of herds registered only males or females. These herds comprised 64.5 per cent. of all herds in 1938 and 52.9 per cent. of all herds in 1960. Conversely, a sharp wartime rise in breed numbers in 1941, was accompanied by a sharp rise in the proportion of herds in which both sexes were registered. This rose from 37.5 per cent. of all herds in 1938 to 63.7 per cent. in 1941. The average number of animals registered annually per herd has increased with time. From 1933 to 1960 it rose from 1.0 to 1.6 for herds registering males, from 2.4 to 3.0 for herds registering females, and from 4.3 to 5.1 males and from 8.2 to 9.3 females for herds registering males and females.

TABLE 1

PERCENTAGE DISTRIBUTION IN SEVEN SAMPLE YEARS OF PEDIGREE LARGE WHITE PIGS AND HERDS CLASSIFIED ON SEX OF REGISTRATION

Sample Year	Nature of Herd Registration								Total Annual Number		
	Females Only		Males Only		Females and Males				Herds	Females	Males
	Herds (%)	Females (%)	Herds (%)	Males (%)	Herds (%)	Females (%)	Males (%)	Male/Female			
1921	33.3	33.3	0	0	66.6	66.6	100.0	1.33	3	6	3
1933	33.3	15.8	15.0	6.2	51.7	84.1	93.7	1.89	60	303	144
1938	40.0	22.6	22.5	14.3	37.5	77.4	85.7	1.84	80	314	154
1941	23.5	14.2	12.7	7.3	63.7	85.8	92.6	1.84	102	591	298
1946	32.6	18.4	8.9	4.9	58.5	81.6	95.1	1.59	135	680	367
1952	30.7	17.0	7.9	3.5	61.4	83.0	96.5	1.42	140	847	513
1960	33.6	18.7	19.3	11.8	47.1	81.2	88.2	1.84	169	965	571
All years pooled ..	31.9	17.5	13.5	7.1	54.6	82.5	92.9	1.66	..	..	..

The distribution of male and female registrations according to herd size in the sample years 1933, 1938, 1941, 1946, 1952 and 1960 is presented in Figure 3. Annual female registrations are used here as a criterion of herd size.

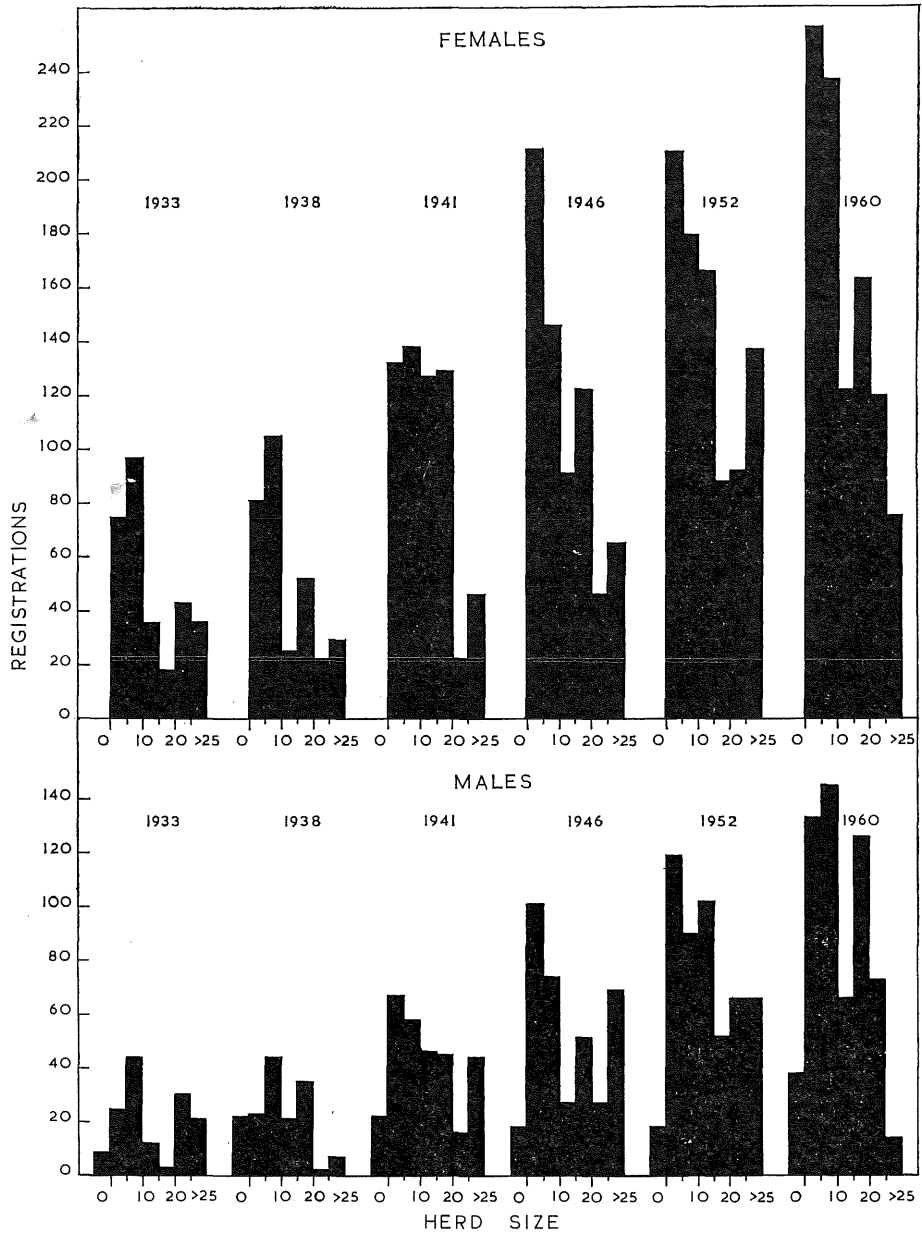


Fig. 3.—Distribution according to herd size of male and female Large White registrations in six sample years. Herd size is measured by annual female registration.

Between 1933 and 1960 the number of females registered in herds of all sizes at least doubled. Percentage increases range from 208 in herds registering more than 25 females to 905 in herds registering between 16 and 20 females. In the period of rapid breed growth between 1938 and 1941 there was a sharp rise in the proportion of herds in which from 11 to 20 females were registered annually. Until 1941, herds in which from 6 to 10 females were registered annually produced most pedigree females. After 1941, however, most females came from herds registering between 1 and 5 females. The distribution of annual male registration follows closely that of the females. A small proportion of males (6.1 per cent.) were from herds registering no females in the sample years. Female : male registration ratios decreased as herd size increased. They were 2.1 : 1 for the 1-5 female herds and 1.8 : 1 for the herds registering more than 25 females annually.

(c) Influence of Importations on the Breed

The contribution of imported parents to the Large White breed is shown in Table 2. They contributed directly 4.7 per cent. of the genes of the 7,048 animals sampled. Direct contribution was high until 1931, after which it declined. Animals imported from the United Kingdom supplying 61.3 per cent. of the total, Canada 6.8 per cent. The first United States sire was registered in the 1911 herd book, New Zealand in 1931 and Canadian in 1946. Imported sires contributed 3.4 per cent. and dams 1.3 per cent. of the genes of the sampled animals. The preponderance of sire genes arose both because more sires than dams were imported and because each sire produced 5.8 registered offspring whereas each dam produced only 2.4 registered offspring. Imported parents had as many registered daughters as sons.

TABLE 2
SOURCE AND FREQUENCY OF IMPORTATIONS INTO THE PEDIGREE LARGE WHITE BREED

Year	1911	1916	1921	1926	1931	1936	1941	1946	1951	1956	1960
Total registrations	2	9	9	59	347	889	888	1,047	1,382	980	1,536
Imported sires ..	1	2	0	14	119	131	62	45	100	0	4
Imported dams ..	0	3	0	0	46	30	38	36	31	0	0
U.K. origin ..	1	5	0	14	48	137	77	4	120	0	0
N.Z. origin ..	0	0	0	0	117	24	23	39	4	0	4
Canada origin ..	0	0	0	0	0	0	0	38	7	0	0
Total imported parents ..	1	5	0	14	165	161	100	81	131	0	4
Genetic contribution (%) ..	25.0	27.7	0	11.9	23.8	9.0	5.6	3.9	4.7	0	0.1

(d) Geographical Distribution

Figure 4 shows the distribution of the pedigree Large White herds in Australia in 1960. Since the average registration of all pigs per herd in 1960 was 10.0, herds

are indicated according to whether they registered more or fewer pigs than average. The spread of the Large White breed in Australia can be summarized as follows. From its origin in 1911 as one herd in eastern Victoria, the breed spread to Sydney by 1921 and thence to southern and western Victoria, southern Queensland and Adelaide by 1931. By 1941 herds had become established on the southern coast of New South Wales, in northern Queensland, in Tasmania, and in Western Australia. In the 1951 and 1960 sampling years, populations were increased in areas already established by 1941 but no further areas were colonized.

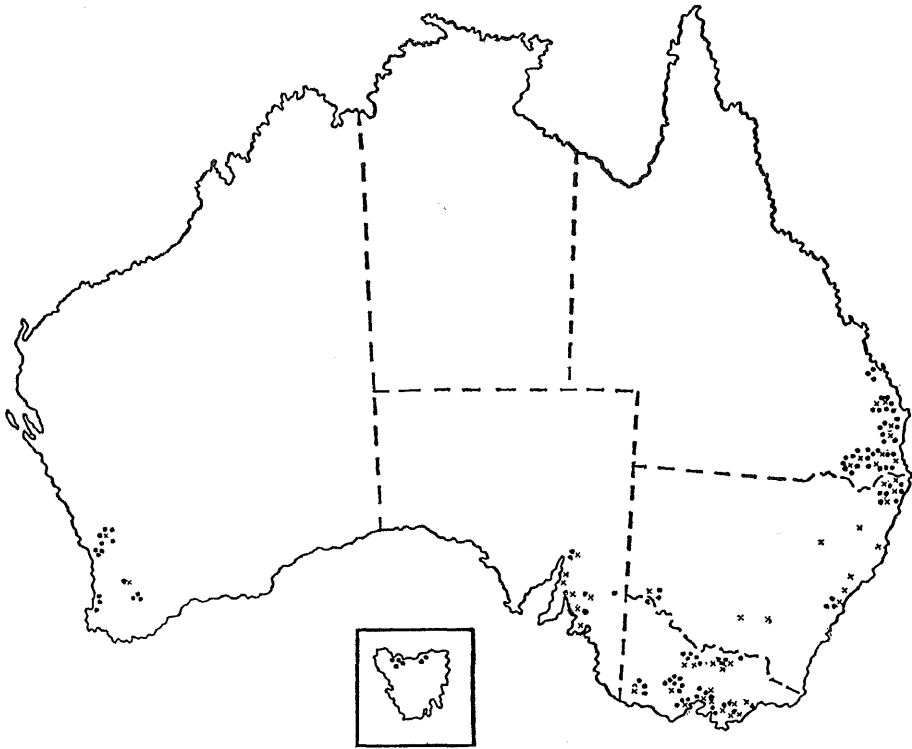


Fig. 4.—Geographical distribution of pedigree Large White herds in Australia in 1960. Herds registering more than 10 animals annually are indicated by crosses and those registering fewer than 10 by closed circles.

Table 3 presents the percentage distribution, the sizes of herds and the number of herds registering in the States of Australia for five sample years and shows that the highest proportion of studs each year is in Victoria. The most rapid expansion appears to have taken place in Queensland, where the number of pedigree herds rose from none in 1921 to 27·4 per cent. of all herds in 1960. Tasmania has had the lowest percentage of pedigree herds throughout. Herd sizes have increased for all States over the period but appear largest for those States which have had Large White herds the longest.

TABLE 3

PERCENTAGE DISTRIBUTION BY STATES OF PEDIGREE LARGE WHITE HERDS AT 10-YEAR INTERVALS

State	Sample Year					Average Herd Size
	1921	1931	1941	1951	1960	
Victoria	66.6 (1.5)	85.7 (5.6)	50.1 (10.4)	32.5 (9.5)	34.4 (9.5)	9.2
New South Wales ..	33.3 (5.0)	4.8 (2.7)	10.1 (8.3)	19.7 (9.2)	15.3 (13.5)	10.19
South Australia ..	..	6.3 (8.2)	18.0 (8.9)	12.8 (13.4)	8.3 (10.6)	10.73
Queensland .. ..	..	3.2 (2.0)	13.5 (6.7)	26.5 (8.3)	27.4 (7.8)	7.71
Western Australia ..	..	..	5.6 (3.2)	6.0 (7.0)	10.2 (4.2)	4.71
Tasmania .. ..	..	..	2.2 (2.5)	2.6 (8.7)	4.5 (2.8)	4.3
Total herds ..	4	70	102	132	169	..

Figures in parentheses are the average annual registrations of herds

IV. DISCUSSION

Although the numerical growth of the Large White breed in Australia is characterized by wide fluctuations, it exhibits all stages of the S-shaped growth curve shown to be common to natural populations by Pearl (1939) and to other livestock breeds by Donald (1945), Robertson and Asker (1951), Wiener and Yao (1952) and Barker (1957). Since reduced numbers in the Large White breed were largely compensated for by increases in the other breeds, fluctuations have evidently been due to variations in the popularity of the numerous other pig breeds. The gradual depression of growth of the pedigree Large White population over the last 10 years probably results from the completion of regional expansion and competition from the increasingly popular Landrace breed. The periodic marked reductions in breed numbers may well have caused changes in breed characteristics and the loss of economically useful genes through the random drift of gene frequencies.

During the period of most rapid expansion of the Large White breed, 1935 to 1947, when it increased almost threefold, its fecundity should have been adequate for expansion and replacement to be accompanied by some selection. Over the same period, in the much less prolific Friesian cattle, Robertson and Asker (1951) showed that a fourfold increase was well below the maximum possible in view of the breed's potential fecundity, thus allowing selection during periods of expansion. Nevertheless, selection intensity in the Large White breed would be reduced during these periods of expansion unless compensatory gains were made in litter size and frequency. Such gains are unlikely in view of the low heritability of these characters (Lush and Molln 1937).

In many breeds expansion also militates against selection by a reduction in herd size. In British Red Polls studied by Donald (1945) and Friesians studied by Wiener and Yao (1952), rapid expansion was accompanied by a proliferation

of small herds and a colonization of new areas. As a consequence, herd size and female : male registration ratios were reduced. In contrast, expansion in the Australian Large Whites was accompanied by both an increase in number of herds and an increase in herd size. This is probably due to a slower rate of expansion than that reported by Donald (1945) and Wiener and Yao (1952), and the higher fecundity of pigs compared with cattle. This increase in herd size should have enabled increased intensity of male selection. On the contrary, however, female : male registration ratios decreased slightly with time and were lower for large herds than small herds. The ratio of 1·8 : 1 estimated for the whole breed is far below the necessary mating ratio and reflects a high dependence of commercial herds on pedigree herds for sires.

As found in the Large White breed in Britain by Donald and Auerbach (1942), a large proportion of the breed in Australia is comprised of herds in which small size and registration practices prevented any significant contribution to breed improvement. In 45 per cent. of the herds only one sex was registered. These herds would be unable to conduct their own closed breeding programmes since they must frequently introduce parents to produce pedigree offspring.

Since its introduction to Victoria, with a climate resembling in some respects that of its native England, the breed has successfully colonized a wide range of environments in Australia. The mode of expansion of the breed has been one of colonization of new areas followed by consolidation through increasing herd numbers and sizes. This expansion strongly resembles that of the Jersey cattle breed studied by Barker (1957) and emphasizes the dependence of the pig industry on the dairy industry and its association with the concentration of human population in Australia. Dispersion has been so wide that the development of ecotypes within the breed seems necessary.

Throughout the life of the breed there have been frequent infusions of new blood from overseas. This has ensured that the breed in Australia represents an adequate sample of all worthwhile genetic material in the breed at large. Recent reduction of importations enforced by quarantine regulations should be advantageous in helping the breed adapt itself to specific economic and climatic environments here in Australia.

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