Contributed Papers

SESSION 1: Chairman: Mr. C. M. Smith

A Preliminary Account of a Regular Fluctuation in California Quail in Central Otago

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Over the last eleven years California quail *(Lophortyx californicus)* in Central Otago have exhibited a very regular annual fluctuation in winter age-ratios as calculated from records of the sex and age of birds shot during the open season. Sexing and aging are simple but accurate operations—the former depending upon a strong sexual dimorphism, the latter upon the possession of mottled primary coverts by birds of the year. The sample obtained by the diary scheme is broken down by the sportsmen co-operators into four classes:—adult males and females and immature males and females. The annual age-ratios are calculated as the total number of immature birds per hundred adult females, and the result of the eleven-year study is shown in Fig. 1.

If results from *individual* diaries are compared, using only those from co-operators known to be reliable who have kept records for at least five years, the seven curves obtained all fluctuate in parallel since 1955. This amount of agreement is all the more impressive as each shooter's sample is taken from different parts of Central Otago.

There is another method of sampling the population: Each year since 1954 trapping has been carried out—mainly in March. The mean number obtained in each sample is 448 (range 307-765). Age-ratios calculated from these are compared with those from the shooting diaries in Table 1. The correlation coefficient $r = +0.940$ which is significant at the 1% level with 4 d.f. The ratio from trapping is higher than that from shooting presumably because more young survive at the earlier time. The difference between the two is less when, as will presently be seen, the population is low. This may be because of the operation of a density-dependent mechanism.

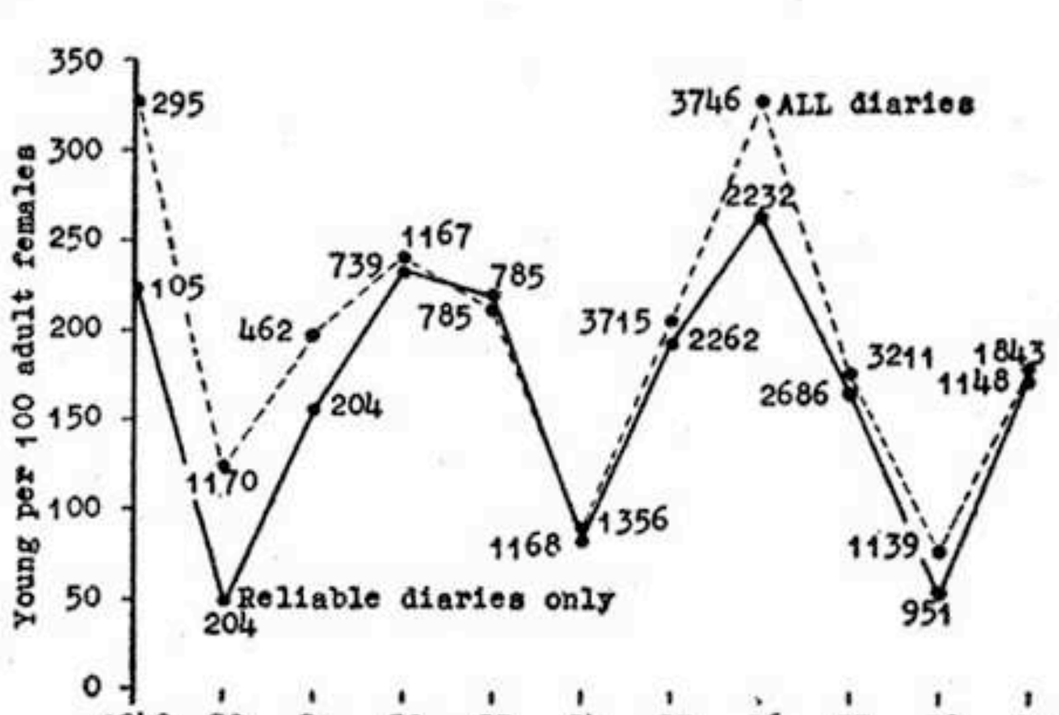

FIGURE 1.—*Fluctuations in age-ratio from 1944 to 1959.*

	1954	*1955*	*1956*	*1957*	*1958*	*1959*
Trapping	114	350	387	300	60	200
Shooting	85	195	266	166	53	175

TABLE 1.—*Comparison of the age-ratios (number of immature birds per 100 adult females) for birds trapped and shot in each season.*

The age-ratio cycle does not necessarily imply a parallel cycle in numbers, for increased juvenile mortality could be offset by decreased adult mortality. In Table 2, however, the reliable shooting age-ratios are compared with figures obtained from an annual late-winter census of an isolated population within the study area, and with sportsmen's opinions on general abundance, and positive correlations significant at about the 1% level are obtained in each instance. The implication is that the population as a whole is fluctuating cyclically too.

One other correlation which is interesting is that between the winter age-ratio and hunting success expressed as the mean number of birds shot per gun per day. For calculating this I have used the diaries only of those reliable sportsmen who have kept continuous records since 1954—some were not in the scheme previously. The two fluctuations are of similar pattern (the mean number of birds shot/gun/day since 1954 being 6.6, 7.7, 8.5, 7.0, 3.2 and 3.8 respectively) but the value of *r*, 0.696, is not significant with 4 d.f. However, the amount of agreement is valuable additional evidence for the reality of the cycle.

	1949	*1950*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*r*
Age-ratio	224	49	85	195	266	166	53	175	+0.802 (6 d.f.)
Cairnmuir	150	125	163	203	252	165	115	167	+0.927 (4 d.f.)
% diaries			0	50	66	49	5	60	

TABLE 2.—*Comparisons between the age-ratio as based on shooting data, the number of birds in the Cairnmuir census area and the percentage of diaries reporting abundance or an increase over the previous year. No census data exist for 1951-1953.*

Analysis of sex-ratios from reliable shooting diaries from year to year shows a random fluctuation not significantly different from unity among the *immatures* but a regular fluctuation in the *adults* that shows a positive correlation coefficient of 0.603 with the age-ratio from shooting, significant at the 5% level with 9 d.f. (see Table 3).

There seems to be a connection between the winter age-ratio and (i) the rate at which young die after hatching (measured by plotting brood-size against approximate age) and (ii) the rate at which surviving young grow (measured by plotting body weights of captured birds against age as found from progress of the moult of the primary wing feathers—Williams 1959). The former is increased and the latter decreased in "low" years, the converse applying in "peak" years. As data on these topics are at present available for only three years, further confirmation is being sought.

	1949	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*
Age-ratio	224	49	156	234	217	85	195	266	166	53	175
% females	36.2	39.8	37.2	40.6	40.0	34.9	37.8	42.9	35.7	31.3	36.1

TABLE 3.—*Comparison between the age-ratio and the percentage of females in adult birds; both based on data from diaries.*

As the percentages of females—immature and adult together—for 1948 and 1949 were 49 and 41 respectively, a higher population in the earlier year is suggested and this is in conformity with comments on the 1949 diaries. (Overall sex-ratios have had to be used for these two years because no age data are available for 1948.) Hence a cycle with periodicity of four years has occurred in Central Otago over the last twelve years with high populations and high proportions of young in 1948, 1952 and 1956 and "lows" in both two years later. As females of breeding age are involved in the same cycle, the killing factor, whatever it may be, exerts its major influence on the population through them and their young.

If one calculates the percentage change of the age-ratio in any year over that of the year immediately before, a four-year cycle appears which shows one year of maximum increase immediately after the "low" followed by three years in which the proportion of young in the population progressively falls. This result is obtained whether one

uses diary returns or the age-ratios calculated from pre-season trapping.

Finally, there is evidence that fluctuations synchronous with those in Central Otago occur in other parts of the South Island—even in such districts as Canterbury and Nelson where climate and habitat are different from each other and from Central Otago. Fluctuations occurring in the central North Island are *not* in phase with those in the South Island.

The whole study is being continued and widened in scope, and possible connections with climatic factors (c.f. Williams 1954), predators, parasites, and physiological and other natural phenomena are being sought. Three important facts have to be accounted for:

(i) The decline in reproductive success and numbers always extends over at least two years,

(ii) In Central Otago, at least, the fall in the proportion of young becomes more marked as population density decreases over the last two years of the cycle,

(iii) The cycle probably extends synchronously throughout the South Island and so includes different habitats and climates. It does not extend to the central North Island.

REFERENCES

WILLIAMS, G. R., 1954: Population fluctuations in some northern hemisphere game birds (Tetraonidae). *J. Anim. Ecol.* 23: 1-37.

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The Seasonal Change of Bird Populations in a Modified South Island Habitat

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Since September, 1958, a study of bird populations has been made in Dunedin in order to determine the pattern of ecological distribution and the population structure of native and introduced species of birds in a modified South Island habitat.

Acknowledgement is made to the Botanic Gardens authority in Dunedin for making accessible to me the upper part of the Gardens in which this work was undertaken, and to the staff of the Botany Department of Otago University for help with the identification of the plants.

The following is the result of the reconnaissance work by which the assessment of an avian habitat of modified conditions was made. The study area was 12 acres in size and consisted of regenerating woodland mixed with a few introduced trees and patches of flower gardens and lawn. This area was visited 97 times during a period of 12 months for estimating the size of the population, recording the nesting and feeding activities of every species, and ringing nestlings and adults of the key species. The early morning counts of the total population were made weekly in the area and they showed the highest number of 229 in spring and the lowest of 43 in winter with a total of 63 pairs in the breeding season and an average of 73.2 individuals in winter. The house sparrow was excluded from the above counts.

Higher counts obtained in spring and autumn were mainly due to the inclusion of flocking white-eyes which were attracted to the flowers and/or fruits of *Edwardsia microphylla, Fuchsia excorticata, Carpodatus serratus, Griselinia littoralis, Plagianthus betu-*