

environment. All records in New Zealand to date have been from gardens and houses, it having never been found in unsettled areas.

The third suborder, Lamiatore, includes the majority of the New Zealand opilionids. A remarkable feature found in the New Zealand fauna is the preponderance of one family, the Triaenonychidae, considered the least specialised family of the suborder. The tarsal claws of legs 3 and 4 are single, but in the adult possess two lateral branches. In the South African genera *Roeweria* and *Speleomontia*, and the New Zealand *Sorensenella*, the lateral branches are well developed, but the median prong is greatly reduced. By complete reduction of the median prong the double claw found in the more specialised families Phalangodidae and Assamiidae was possibly developed. Except for one possibly erroneous record, neither of these families has been found in New Zealand.

The general distribution of the triaenonychids is of interest. They are practically limited to the southern areas of the world. Of the 67 genera known, the distribution is as follows: North America 1, South America 2, South Africa 24, Madagascar 6, New Caledonia 2, Australia 19, and New Zealand 12, the only occurrence in the Northern Hemisphere being the one genus from North America. From the present figures the family would appear to have attained its greatest development in South Africa. However, only in New Zealand are representatives of all three sub-orders found and when the fauna is completely worked it seems probable that the greatest development of this family will be seen to be in Australia and New Zealand.

Of the twelve genera at present recorded from New Zealand, nine are endemic. While a number of New Zealand species are placed in the typically South African genus *Adaeum*, the main affinities are undoubtedly with Australia and the Sub-Antarctic Islands. The distribution of the subfamily Triaenobuninae includes only New Zealand and Australia, and while no genera of this subfamily are found common to both areas, the widespread New Zealand genus *Pristobunus* is closely related to *Dipristes* of Victoria and possibly to *Peckhamius* of Tasmania.

In the suborder Triaenonychinae, the dominant New Zealand genus *Nuncia* of which thirteen endemic species are recorded, occurs also on the Auckland and Crozet Islands, on which two islands they represent the entire known opilionid fauna, and a further species is known from New South Wales, Australia. The closely related genus *Nunciella* is also found in both Australia and New Zealand, but its greatest development is in Australia. It is once again evident that the relationship shown is with the eastern portion of Australia.

To summarise: All of the native New Zealand species of opiliones are endemic. Only one species has been introduced by man. The New Zealand opilionid fauna is characterised by the occurrence of a comparatively large number of those forms which are to be considered primitive. Some, for example those of the Cyphophthalmi, show affinities with South Africa, while others, for example *Zeopsopilio*, show close affinity with South America and to a lesser degree with South Africa. The presence of these primitive forms, taken into consideration with the absence of the most highly specialised families, would seem to point to the isolation of New Zealand in the remote past before the development of the more advanced forms. The persistence of these animals would be assisted by the presence of extensive forest areas, the leaf mould of which presents an ideal environment.

The more advanced opiliones found in New Zealand of the families Phalangiidae and Triaenonychidae show a very strong relationship with those found on Tasmania and the East Coast of Australia, a relationship which could be considered as evidence for a comparatively recent interchange of forms between these two areas.

PROBLEMS RELATING TO THE BIRDS OF NEW ZEALAND'S OFFSHORE ISLANDS

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THIS short paper is an elaboration of part of my account of the birds of Little Barrier Island, which is to appear in the July, 1947, issue of *New Zealand Bird Notes*. There I have referred to certain ecological conditions affecting the birds of island forests, and emphasised that these birds are not typical of forests on the mainland before European settlement. The problem is essentially ecological,

for it refers to differences in populations rather than in species or subspecies. This paper, however, in order to provide a balanced discussion of insular tendencies, refers also to more general problems of speciation.

Island Species and Subspecies.

Non-adaptive differentiation: Insular differentiation, resulting in distinct forms (generally subspecies) has long been familiar to the taxonomist. Until recently no satisfactory explanation had been found for the obviously non-adaptive nature of many island characters. Sewall Wright (1940) and others have now shown that any new character which may arise has a relatively greater chance of survival in the small isolated population of an island. An example of such characters is provided by the grey wing patch and rump of the Chatham Island pigeon (*Hemiphaga novaeseelandiae chathamensis*), which although apparently of no adaptive significance, form the taxonomic basis upon which this subspecies is separated.

As Mayr (1942) has pointed out, another genetic basis for non-adaptive differences in isolated populations is provided where the entire population has apparently been derived from a single pair.

As a result chiefly of the "Sewall Wright effect," non-adaptive distinctions tend to accumulate on a small island. The degree of differentiation has been shown to depend upon the size of the island; and must ultimately be governed within broad limits by environmental and population factors. Again, isolation, especially on the nearer offshore islands, must be interrupted in many species by interchange with the mainland.

Adaptive differentiation: The development of characters directly adapted to local conditions is probably at the same time as effective as on the mainland; and as Huxley (1942) points out, may even be carried to a further pitch in isolated populations. An interesting paper by Marshall and Harrison (1941), although directed primarily towards proving the non-adaptive nature of many taxonomic characters, provides a record of apparently adaptive tendencies common to many species on Espiritu Santo, New Hebrides, but absent on the Australian continent. These tendencies are towards "sedentary habit, lack of sociability, decrease in voice, stronger nests, smaller clutches, and food specialization."

Island Populations.

Turning to the characteristics of island populations as distinct from species, I shall refer in detail to birds of the offshore islands: Little Barrier Island, Hen Island, and the Poor Knights group.

Influence of area upon presence or absence of species: Area alone would appear to play an important part in determining the species represented on islands of similar vegetation. There is for every species a minimum effective population. The accumulation of deleterious characters, or of those too uniform to provide for adaptation to environmental change, may result in the elimination of species present in small populations (Huxley, 1942; Mayr, 1942). It is thus possible that the pigeon (*Hemiphaga novaeseelandiae*), with a diet including large quantities of seasonal fruits, could not on the 480 acres of the Poor Knights establish the minimum number of breeding pairs. The effect is accentuated by the nature of the vegetation, which is a coastal scrub, with some coastal forest, not rich in berry-bearing trees. In my census on Hen Island (1940) I recorded a density of 30 breeding pairs of pigeons in 75 acres, in an area of coastal forest including taraire (*Belschmiedia tarairi*) and other large-fruited trees.

To take another example, the absence of the tui (*Prosthemadera novaeseelandiae*) from the Poor Knights list contrasts very decidedly with the abundance of the bell bird (*Anthornis melanura*), a species with apparently similar food habits. Area may here again be significant, in this case probably associated with behaviour in relation to territory. The combined effect of area and vegetation probably answers Buddle's difficulty (1941) in accounting for the absence of tui and other species on the Poor Knights.

It would follow from these considerations that the forest populations of the larger islands should include the greater number of species; and should as the result of both area and more varied environmental conditions reflect more closely those of mainland forests. This is supported by the following comparison of the representation of thirteen species on three islands or groups.

Little Barrier Island (Area 7,000 acres)	Hen Island (1,175 acres)	Poor Knights (480 acres)
1. Red-fronted parakeet (<i>Cyanoramphus novaezelandiae</i>)	1. Red-fronted parakeet	1. Red-fronted parakeet
2. Bell bird (<i>Anthornis melanura</i>)	2. Bell bird	2. Bell bird
3. Kaka (<i>Nestor meridionalis</i>)	3. Kaka	3. ———
4. Grey warbler (<i>Pseudogerygone igata</i>)	4. Grey warbler	4. ———
5. Pied tit (<i>Petroica macrocephala toitoi</i>)	5. Pied tit	5. ———
6. Fantail (<i>Rhipidura fuliginosa</i>)	6. Fantail	6. ———
7. Tui (<i>Prosthemadera novae-seelandiae</i>)	7. Tui	7. ———
8. Saddleback (<i>Creadion carunculatus</i>) [formerly]	8. Saddleback	8. ———
9. Rifleman (<i>Acanthisitta chloris</i>)	9. ———	9. ———
10. Robin (<i>Miro australis</i>)	10. ———	10. ———
11. Whitehead (<i>Mohoua ochrocephala albicilla</i>)	11. ———	11. ———
12. Kiwi (<i>Apteryx australis</i>) [introduced]	12. ———	12. ———
13. ———	13. ———	13. <i>Porzana plumbea</i>

In view of the successful introduction of the kiwi to Little Barrier, it would be particularly interesting to test its power of survival on Hen Island.

Comparison of total population densities: Direct comparison of density, irrespective of the species involved, gives a general indication of the effect of local conditions on bird populations. Unfortunately, comparison between insular and unmodified mainland forests is no longer possible, but fruitful comparative work is possible based upon a series of offshore islands. By comparison of unit areas it would be possible to gauge the extent to which the few species represented on a small island can concentrate in place of absent species.

My census on Hen Island (1940) represents the only basis for such work in New Zealand so far. The total population density in this case, based upon a count of breeding pairs on an area of 75 acres, was 728 birds per 100 acres.

An unpublished census which I carried out with the help of Mr. P. C. Bull on the Poor Knights in 1940 indicated a lower total density than on the Hen. This may be correlated with the more varied food supply and range of nesting sites on the Hen; and with limitations of increase in the numbers of various species, even in the absence of possible competitors.

To give comparable results, such censuses should be carried out at all times of the year, and if possible on several islands at the same time.

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