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Studies on the Two New Zealand Bats

by

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II. Wing folding and terrestrialism in *Mystacina tuberculata* Gray.

III. Hair structure of New Zealand bats.

IV. A review of field observations on New Zealand bats.

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*Now at University of New England, Armidale, N.S.W. Publication of this paper has been assisted by a grant from the Victoria University Publications Fund.

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I. Subspecies of *Mystacina tuberculata* Gray (Chiroptera: Mystacinidae) in New Zealand

By P. D. Dwyer,
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Abstract

Mystacina tuberculata Gray is represented in New Zealand by two subspecies. Differences between these in overall size and in relative proportions of extremities of the body are discussed.

Introduction

Mystacina tuberculata Gray is a small bat with a close, compact layer of fur which is generally frosted in appearance. The elongate head tapers conspicuously forwards to prominent nostrils. The simple ears have a long, narrow tragus. The thin flight membranes are exceptionally tough and the reduced propatagium, medial portions of the plagiopatagium, and the basal part of the uropatagium are conspicuously thickened. With the exception of the slender metacarpals and phalanges of the chiropatagium limb elements are robust; the feet being very large and turned outwards. The short tail penetrates the uropatagium dorsally.

This species is represented in New Zealand as two distinct forms which are here described as subspecies. One ranges throughout the North Island and is present in at least northern areas of the South Island. but the other is at present only recognised from Stewart Island and a few neighbouring islets. A specimen from Okarito, Westland, was in too poor condition to enable subspecific determination.

Historical

In 1843 Gray (in Dieffenbach, 1843a) prepared a faunal list for New Zealand. He referred, p. 181, to a bat, *Vespertilio tuberculatus* G. Forster of the family Vespertilionidae, which he described as "Yellowish brown; ears small, rounded. Inhab. Dusky Bay, N.Z." In an appendix on page 296 of the same journal he stated that having received two specimens of the New Zealand bat he found it belonged to a new genus and accordingly described it as *Mystacina tuberculata*. He maintained this synonymy in the Catalogue of Mammalia in the British Museum (Gray, 1843b) and included the bat in the group Noctilionina.

Had Gray been able to examine Forster's *Vespertilio tuberculatus* he would have realised that his animal was distinct. It remained, however, for Tomes (1857) to show that there were, in fact, two New Zealand bats. Tomes included Gray's bat in the family Noctilionina describing it as *Mystacina tuberculata* Gray. Later Tomes (1863) referred *Mystacina* to the family Phyllostomidae but Gray (1866) again considered it with the Noctilionidae (equals Noctilionina of Tomes, 1857). Hutton (1872) indicated the confusion apparent in having equivalent trivial names for the two New Zealand bats and proposed that the name *Mystacina velutina* be adopted in reference to the velvet-like nature of the fur of the short-tailed bat.

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Dobson (1875) considered *Mystacina tuberculata* to belong to the family Emballonuridae, but to differ from typical members of that family in possessing a third phalanx in the middle finger, a feature which he described for the American Phyllostomidae. He separated *Mystacina* as a group Mystacinae (subfamily Molossinae) of the above family.

Lydekker (in Flower and Lydekker, 1891) claimed that *Mystacina* Gray was preoccupied by *Mystacina* Boie, 1822* and proposed instead the name *Mystacops tuberculatus* (Gray). His change was generally adopted. Winge (1892) referred *Mystacina* to the Vespertilionidae. Thomas (1905) suggested that since Gray's first reference (in Dieffenbach, 1843a) to New Zealand bats included the first published indication of *Vespertilio tuberculatus* this made Gray the author of that name and at once invalidated Gray's own name for the short-tailed bat. On these grounds he reinstated Hutton's name of 1872 and called the bat *Mystacops velutinus* (Hutton). Miller (1907) did not accept these conclusions. He retained the proposal of Lydekker and considered the bat as the sole representative of a new family, Mystacopidae. Simpson (1945) resurrected the original generic name and attributed authorship to Gray. His family Mystacinidae is equivalent to Miller's Mystacopidae.

Material Examined and Acknowledgments

Eleven specimens of *Mystacina* were available for examination. These are itemized in Table I, in which the abbreviations D.M., A.M., C.M., and V.U.W. are used to indicate Dominion Museum, Auckland Museum, Canterbury Museum and Victoria University of Wellington collections respectively. I would like to thank Dr R. A. Falla, Dr G. Archey and Mr E. G. Turbott for making this material available, and Professor L. R. Richardson for his supervision and guidance throughout the study.

Mystacina tuberculata Gray 1843.

Muzzle conical, obliquely truncated, with conspicuous array of stiffened hairs radiating from posterior margins of glandular eminences. Prominent nostrils opening sublaterally. Ears simple and extending well beyond the fur of the head; tragus long and attenuate. Fur close, grey to black. Coarse overhairs, with long distal thickening, scattered amongst short, wavy underhairs. Scale form entire to repand coronal. Robust forelimb; upper arm slightly less than 3/5 forearm length. Long metacarpals shorter than forearm. Second digit with single rudimentary phalanx Third digit with three bony phalanges. Cartilaginous tip of fifth digit extending beyond margin of chiropatagium. Wings from metacarpal of thumb and from ankles. Propatagium reduced and thickened. Plagiopatagium and uropatagium with numerous ridges on upper surface of proximal portions. Leg short and robust with large feet about $\frac{3}{4}$ shank length. Basal talons present on the claws of toes and thumbs. Short tail perforating uropatagium. Weak calcars.

Mystacina tuberculata tuberculata Gray (Figs. C, E.)

Range: North Island, N.Z., and at least northern areas of the South Island.

A small delicately proportioned bat characterised by the length of the ears, which reach to or beyond the tip of the muzzle, and by the remarkably prominent, though narrow, nostrils. Total length up to about 75 mm, wing span to about 280 mm. Gray's plate (1844, Pl. 22) illustrated an animal clearly of the northern subspecies which has been named accordingly.

Mystacina tuberculata robusta subsp. nov. (Figs. A. B, D.)

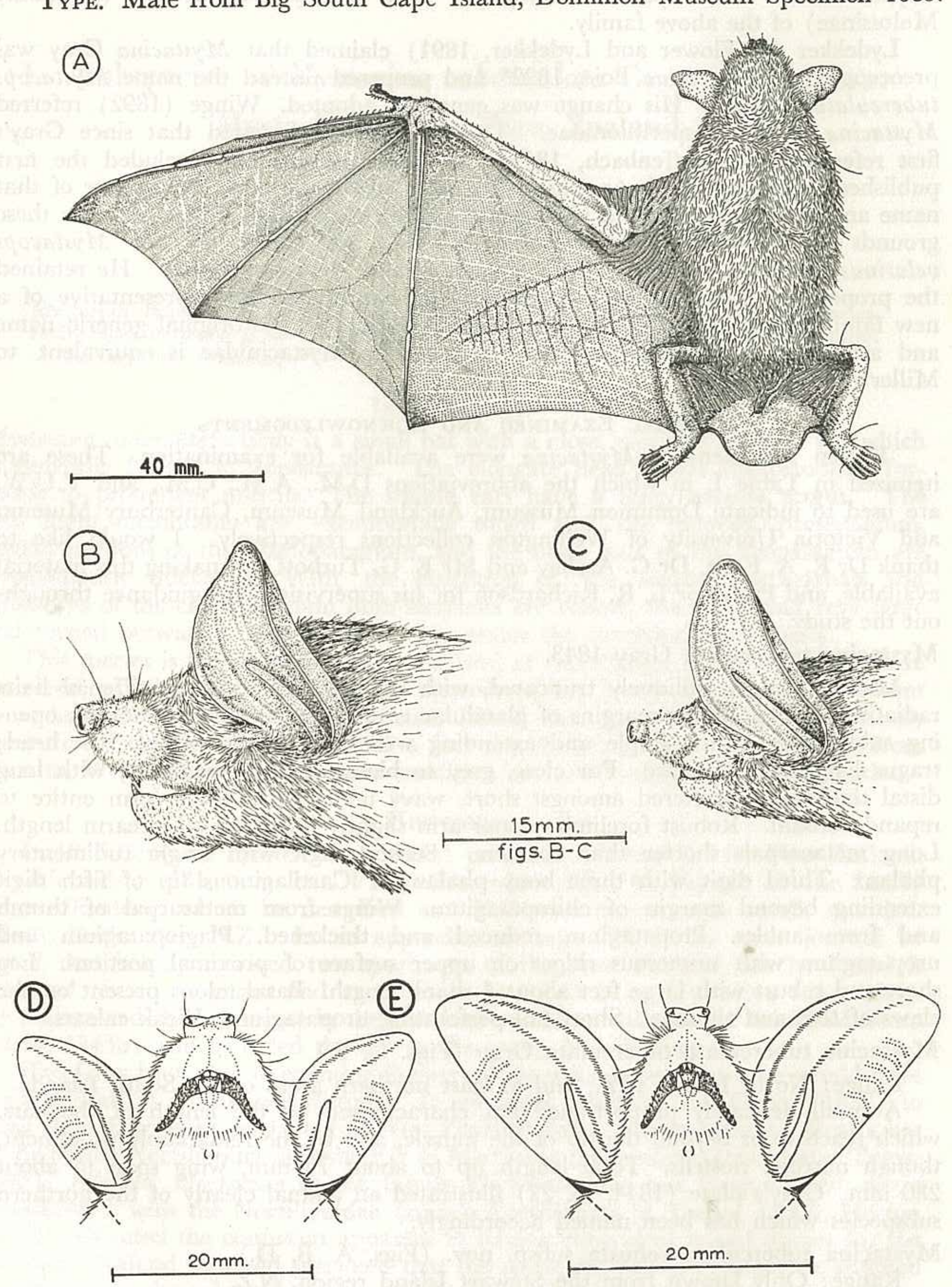
Range: Only known from the Stewart Island region, N.Z.

In contrast to the northern subspecies this animal is larger and extremely robust.

* Neave (1939) gives "*Mystacinus* Boie, 1822, Isis (Oken), 1822, 556—Aves." Hence not a homonym of *Mystacina* Gray.

Total length is up to about 90 mm, wing span to about 310 mm. It has the ears falling short of the muzzle tip, and has the wide nostrils lying relatively closer against the muzzle.

TYPE. Male from Big South Cape Island, Dominion Museum Specimen 1083.



Mystacina tuberculata

Fig. A, *M. t. robusta*, dorsal. Fig. B, Head of *M. t. robusta*, lateral. Fig. C, Head of *M. t. tuberculata*, lateral. Fig. D, Head of *M. t. robusta*, ventral. Fig. E, Head of *M. t. tuberculata*, ventral.

DISCUSSION

Table I shows the relationship of ear length (from junction with head and from meatus), forearm length, digital length (third metacarpal and associated phalanges) to total length for the eleven specimens of *Mystacina* available during this study. Comparable date from the literature has been included and where possible the subspecies has been indicated. "Ear length" of Hutton (1872) and Dobson (1878) has been considered equivalent to "ear length from meatus" in the present table. Carter, Hill, and Tate (1946) give measurements for the head and body, for the tail and for the forearm, but these are approximations of Dobson's (1878) values and have not been included here. Values based on ear measurements for D.M. 352 (female) are considered unreliable as the specimen was a skin in poor condition and these structures were somewhat withered.

With the exception of this last specimen the values for ear or forearm length compared with total length fall into two groups corresponding with the known ranges of the two subspecies. Ear length from junction with head as a percentage of total length is above 20% in *M. t. tuberculata* but below this value in *M. t. robusta*. The values for ear length from meatus are more distinct, above 25% in the northern subspecies, below 23.5% in *M. t. robusta*. For the forearm corresponding values are 62.5% and 60%. The relationship between digital length and total length is not so marked. Values for *M. t. robusta* are generally lower, but Knox's (1872) measurements appear to provide an overlap.

The distinction between the subspecies relates both to overall size and to the relative proportions of exposed parts such as nostrils, ears and limbs. Overall size is greater and the extremities relatively shorter in *M. t. robusta* than in the northern *M. t. tuberculata*. Such differences are in accordance with Bergmann's and Allen's

TABLE I

Ear, forearm and digital lengths as percentages of total length (T.L.)

Specimen	Subsp.	Sex.	T.L. (mm)	Ear from head: T.L.	Ear from meatus: T.L.	Forearm: T.L.	Digit: T.L.
V.U.W.	t.	M.	65.5	21.4	26.7	64.1	108
A.M.	t.	M.	66.0	24.2	30.3	65.2	116
A.M.	t.	F.	63.5	22.0	26.0	63.0	115
D.M. 1321	t.	F.	66.0	22.0	28.8	68.2	120
C.M. 211	t.	F.	67.5	22.2	28.2	63.0	110
D.M. 352	t.	F.	72.5	15.2	19.3	62.8	113
Hutton (1872)	-	-	59.7	-	29.8	-	-
D.M. 879	t.	?	64.5	20.2	25.6	63.0	119
D.M. 1083	r.	M.	81.0	17.3	23.5	59.3	106
D.M. 878	r.	M.	85.0	17.1	20.0	57.7	96
C.M. 209	r.	F.	70.5	19.9	22.7	57.5	104
C.M. 210	r.	F.	78.0	18.0	20.5	57.0	98
Tomes (1857)	-	-	70.7	-	-	59.9	106
Knox (1872)	-	-	71.1	-	-	57.2	111
Tomes (1857)	-	-	72.0	-	-	55.9	103
Tomes (1857)	-	-	76.2	-	-	59.6	100
Dobson (1878)	-	-	81.3	-	21.9	54.6	97

rules (Allee, Emerson *et. al.,* 1949) relating to structural modifications induced by temperature. No evidence of a continuous cline along a temperature gradient is apparent from the few specimens available. It is noted by Allee, Emerson *et. al.,* that hibernation may reduce the effect of temperature upon structure in mammals by avoiding exposure of the animals to winter minimum temperatures. It is of interest, therefore, that there is some evidence that *Mystacina* does not undergo a strict period of hibernation during winter months.

II. Wing Folding and Terrestrialism in *Mystacina tuberculata* Gray (Chiroptera: Mystacinidae)

Mystacina tuberculata Gray is one of the two bat species present in New Zealand, and is the sole representative of the family Mystacinidae. Some attention has been directed to a number of peculiarities in this bat which have been interpreted as adaptations suitable for terrestrialism. These conclusions were first indicated by Dobson (1876) who considered that the basal talons of the claws, the manner in which the wings could be protected from injury when the bat was not flying and the structure of the foot were adaptations for climbing, and he suggested accordingly that "*Mystacina* hunts for its insect food, not only in the air, but also on the branches and leaves of trees, among which its peculiarities of structure most probably enable it to walk about with security and ease."

Dobson stated that in repose the first phalanx of the third digit is folded forwards upon the ventral surface of the metacarpel, the second phalanx is folded backwards on the first and the third forwards on the second. Hutton and Drummond (1904) and Miller (1907) claim that the first phalanx of the third digit is flexed upon the upper surface of the corresponding metacarpal when the wing is folded at rest. I find, however, that the manner in which the wing is folded differs considerably from the descriptions given by previous authors.

The following description is based upon a single female specimen of *M. t. tuberculata* in which the left wing was in the position of repose. The form of the metacarpophalangeal and the phalangeal joints would not permit the wing to fold otherwise. (Figs. A, B, C.)

In folding, the membranous portions of the wings are carried beneath the forearms and against the body and the uropatagium is rolled forwards beneath the tail. Ventrally the reduced propatagium extends beneath the stout forearm as a strong band which takes origin from the metacarpal region of the thumb. On each side this is produced beyond the posterior margin of the forearm so that a distinct concavity is formed between the band and the plagiopatagium. The delicate proximal portions of the wings are concealed within these concavities. The tips of the wings are contained within small lateral pouches present at the sides of the body, just forward of the thighs, and extending along the underside of the thighs. Only the thickened leathery portions of the wings remain exposed. Behind the wrist the ventral and medial aspects of the folded palm are protected externally by a thickened region of the membrane between the second and third metacarpals and by the fifth metacarpal together with a narrow, thickened ridge present immediately lateral to this metacarpal. This ridge extends onto the upper surface of the membrane for almost half the length of the metacarpal.

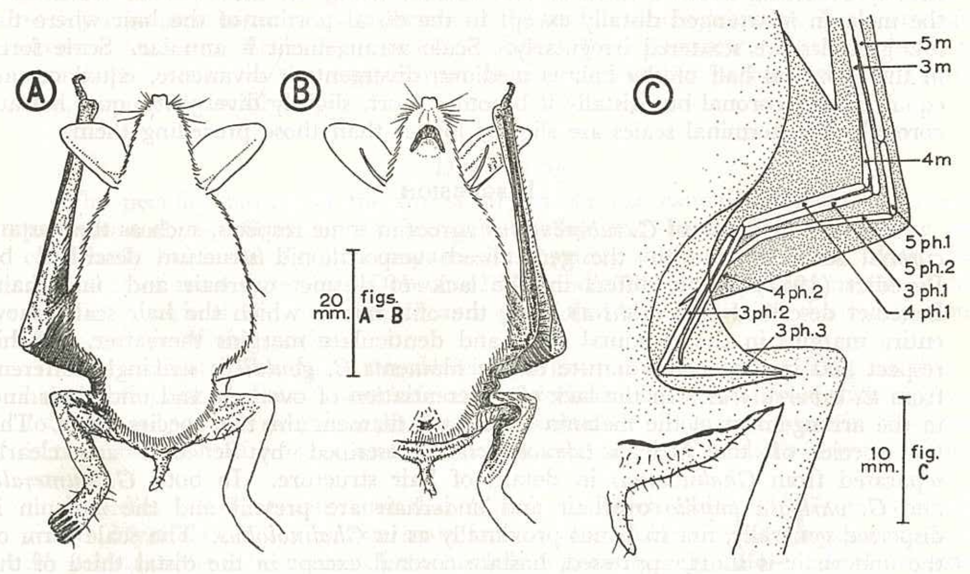
The folding process commences with the proximal phalanx of the third digit being turned inwards beneath the membrane. This carries with it the proximal phalanx of the fourth digit and the second (terminal) phalanx of the fifth digit. The short first phalanx of the fifth digit remains extended along the line of the metacarpal. The second phalanges of the third and fourth digits, and the flexible

distal region of the terminal phalanx of digit five turn backwards and lie close along the side of the body within the pouch formed between the thickened wing membrane and the cutaneous flap extending from the side of the body. This flap continues onto the thigh and conceals the terminal phalanx of the third digit which is directed outwards along this portion of the hind limb.

The distal portion of the uropatagium is rolled forwards beneath the tail so that it lies close against the body at the base of the tail. Only the thickened basal portion remains exposed. The calcar lies along the inner surface of the shank.

DISCUSSION

Mystacina is not, as far as can be ascertained, a crevice dweller, and the extreme protection of the delicate membranes from possible injury correlated with a maximum degree of freedom for the limbs must be interpreted in relation to terrestrial locomotion. Similar protection of wing membranes occurs in the molossid *Cheiromeles torquatus* with the wing tips being folded into pouches, but here the pouches are in the armpits and open backwards (Kitchener, 1954). In the molossids the ability to crawl rapidly is possibly an adaptation related to roosting. *Eumops,* for instance, is unable to take flight from a level surface (Vaughan, 1959). In *Mystacina* freedom of the limbs provided by the reduced propatagium and wing folding process, the robust limbs, the specialized claws, and the wide range of movement of the femur permitted by the form of the acetabulum are terrestrial or arboreal adaptations. The ability to take flight from level ground has been recorded for *Mystacina* and terrestrialism in this bat is not connected with roosting but is rather to be associated with foraging habits. The scanty information available pertaining to the ecology of this species does appear to substantiate Dobson's earlier conclusions.



M. t. tuberculata; Wing Folding

Fig. A, Dorsal; Fig. B, Ventral; Fig. C, Diagram showing the relative positions of the metacarpals and phalanges of the folded wing, left ventral aspect.

Abbreviations: 3m, 4m, 5m, metacarpals of digits 3, 4 and 5; 3 ph. 1, 3 ph. 2, 3 ph. 3, phalanges of digit 3; 4 ph. 1, 4 ph. 2, phalanges of digit 4; 5 ph. 1, 5 ph. 2, phalanges of digit 5.

III. Hair Structure of New Zealand Bats

Abstract

HAIR structure of *Chalinolobus tuberculatus* (Forster) is distinct from that of *C. gouldii* Gray; in some respects it agrees with the generalized vespertilionid structure but differs in the lack of separate overhair and underhair. In *Mystacina tuberculata* Gray, both hair types are present; overall structure is clearly different from that of the Molossidae but corresponds closely to that of the Noctilionidae and Nycteridae.

INTRODUCTION

THE present paper describes the hair structure of the two New Zealand bats *Chalinolobus tuberculatus* (Forster), F. Vespertilionidae, and *Mystacina tuberculata* Gray, F. Mystacinidae, and examines the affinities of these species in the light of this. Hairs from the mid-dorsal region at scapula level were examined and sketched using a camera lucida. The terminology of Benedict (1957) is followed.

Chalinolobus tuberculatus (Forster) (Fig. A.)

DESCRIPTION

In *C. tuberculatus* there is no differentiation of hair as overhair and underhair. The long, fine filaments are of fairly uniform diameter and lack a medulla. Filament length is from 4 to 7 mm with the maximum diameter, 15μ, occurring both above and below the midpoint (diameter 12μ). Distal scales are about 15μ in diameter and the hair ends as an acute projection formed from two or three incompletely developed scales.

Melanin is concentrated in the proximal half of the filament; the maximum density occurring about a third of the distance along the hair. Within each scale the melanin is arranged distally except in the distal portion of the hair where the few granules are scattered irregularly. Scale arrangement is annular. Scale form in the proximal half of the hair is medium, divergent or divaricate, equal or unequal hastate coronal but distally it becomes short, slightly divergent, equal hastate coronal. The terminal scales are slightly longer than those preceding them.

DISCUSSION

The hair structure of *C. tuberculatus* agrees in some respects, such as the hastate coronal scale form, with the generalized vespertilionid structure described by Benedict (1957) but it differs in the lack of distinct overhair and underhair. Benedict described *C. gouldii* as being the only bat in which the hair scales show entire margins in the proximal third and denticulate margins thereafter. In this respect and in the coarser nature of the filaments *C. gouldii* is strikingly different from *C. tuberculatus*. In the lack of differentiation of overhair and underhair and in the arrangement of the melanin within the filament the two species agree. The two species of the African *Glauconycteris* described by Benedict are clearly separated from *Chalinolobus* in details of hair structure. In both *G. humeralis* and *G. varigata papilio* overhair and underhair are present and the melanin is dispersed generally, not in bands proximally as in *Chalinolobus*. The scale form of the underhair is short, appressed, hastate coronal except in the distal third of the filament of *G. varigata papilio* where it becomes lobate.

The two trends away from the typical vespertilionid scale form which occur in these closely related genera are represented more completely in other genera. Thus *Scotophilus* has lobate coronal scales and like *Glauconycteris* has both overhair and underhair and *Mimetellus* has dentate coronal scales and corresponds with *Chalinolobus* in the absence of distinct hair types.

Mystacina tuberculata Gray (Figs. B, C.)

DESCRIPTION

Overhair and underhair are represented in the fur of *Mystacina*. The coarse dark overhairs are scattered amongst the close layer of short and wavy underhairs. They are long and straight and of irregular diameter, having a long, club-like thickening in their distal two-thirds and one or two shorter thickened portions near the base. No medulla occurs in either hair type.

Filament length of overhairs is 7–8 mm. Maximum diameter of the distal club is 30μ, that of the shorter proximal swellings 27μ. Terminal scales have a diameter of 6μ, the base of 11μ and the constrictions between the swellings 13.5μ. The tip is bluntly rounded. Melanin granules are scattered in irregular longitudinal bands through the length of the filament with the greatest concentration about midway along the distal club. This club has a narrow outer zone free of granules. Scale arrangement is annular. Scale length varies considerably along the filament from 7.5μ at the base to 17.5μ in the proximal swellings and thereafter decreases to about 6μ toward the tip. Scale form is appressed to divergent, entire to repand coronal at the base and at the constrictions between the swellings, but is appressed, entire to repand coronal in the swellings and terminally.

In all the overhairs examined a long distal club-like portion was present, but some variation in the presence or absence and in the number of proximal swellings occurred. Usually one or two of these latter were present. In some individuals a number of the overhairs possessed a swollen bulb-like portion at some interval along the length of the distal club.

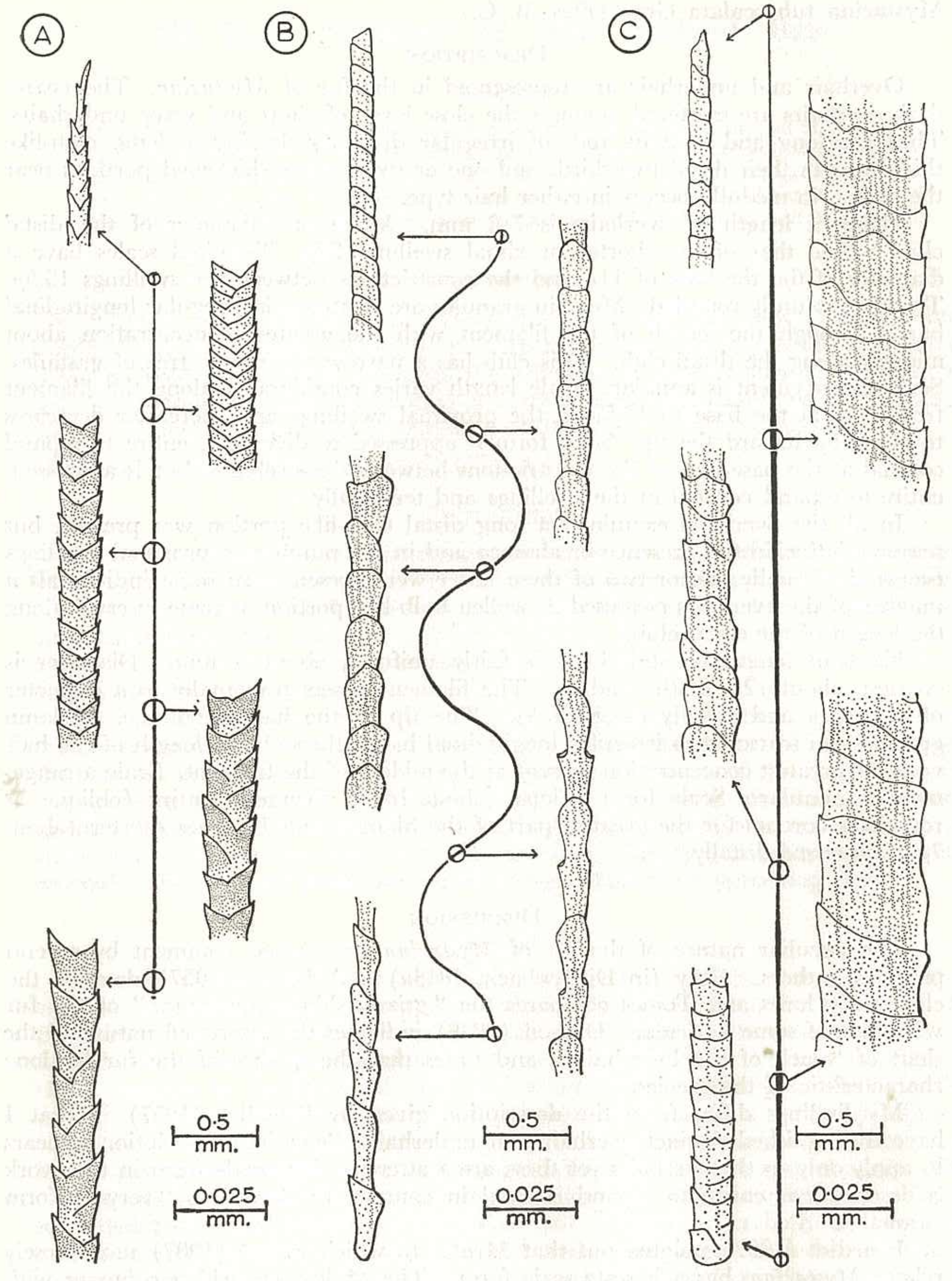
Filament length of underhairs is fairly uniform, about 6 mm. Diameter is greatest, about 12μ, at the middle. The filament tapers proximally to a diameter of about 7μ and distally to about 5μ. The tip of the hair is oblique. Melanin granules are scattered in irregular longitudinal bands through the length of the hair with the greatest concentration present at the middle of the filament. Scale arrangement is annular. Scale form is long (about 18μ), divergent, entire (oblique or rounded) coronal for the greatest part of the filament but becomes shorter (about 7μ), appressed distally.

DISCUSSION

The peculiar nature of the fur of *Mystacina* has caused comment by several previous authors. Gray (in Dieffenbach, 1843a) and Tomes (1857) describe the close body hairs and Tomes compares the " grizzly shiny appearance " of the fur with that of some Soricidae. Dobson (1878) indicates the appressed nature of the shaft of " each of the long hairs " and states that the quality of the fur is alone characteristic of the species.

My findings differ from the description given by Benedict (1957) in that I have distinguished distinct overhair and underhair. Benedict's description appears to apply only to the overhairs yet these are scattered. The scale form in this work is described as entire to repand coronal in contrast to Benedict's " very uniform coronal ".

Benedict (1957) pointed out that *Myotis*, to which Miller (1907) most closely relates *Mystacina*, has a hastate scale form. The Molossidae which compare with *Mystacina* in the robust form of the hind limb are strikingly different in the dentate coronal scale form and the lack of differentiation of overhair and underhair. The Emballonuridae, like the Molossidae, lack distinct hair types and have divaricate, dentate coronal scales. *Mystacina* compares with the Desmodontidae, Natalidae, Noctilionidae and Nycteridae both in the presence of distinct overhair and underhair and also in having a scale form varying only from entire to sinuate coronal. The greater abundance of melanin granules in the central core of the filament of



HAIR STRUCTURE

Fig. A—*Chalinolobus tuberculatus* (Forster). Fig. B—*Mystacina tuberculata* Gray, underhair. Fig. C—*M. tuberculata*, overhair.

The origin of the arrow indicates the section of hair which has been magnified. For each figure the smaller upper scale is that of the complete hair, the lower scale is that of the individual enlarged lengths.

Desmodus corresponds to the presence of an outer granule-free zone in the distal club of *Mystacina*, but the presence of a basal bulb in the former genus clearly distinguishes the two. In the Natalidae the straight overhairs are slightly coarser than the wavy underhairs but the hair types correspond in length and the underhairs have some hastate scales. The Noctilionidae and Nycteridae correspond closely to the form described for *Mystacina*, particularly in the possession of an unusually long, club-like portion in the distal region of the overhair. In general the hairs of noctilionids are somewhat shorter, and those of nycterids somewhat longer than is the case in *Mystacina*.

IV. A Review of Field Observations on New Zealand Bats

Abstract

THE present area of distribution of New Zealand bats is considerably less than it was over a century ago. The decrease is correlated with the restriction of forest during the last century and the failure of either species to survive in open country or to urbanise. The Urewera in the North Island and the Buller River drainage in the South Island appear to support the highest densities of bats in New Zealand. Field observations in relation to behaviour and ecology are reviewed, and probable species differences in hibernation, foraging times, and diet are indicated. Fur mites are reported as parasites of both species.

INTRODUCTION

DURING a recent investigation of the two New Zealand bats, *Mystacina tuberculata* Gray and *Chalinolobus tuberculatus* (Forster), an attempt was made to survey the distribution of these species, and to review the fragmentary knowledge of their ecology and behaviour. A brief account of some of the results of this survey has already been published (Dwyer, 1960) but it is felt that a detailed report of the data obtained may be of worth in providing a basis for future work. The author was unable to make any personal observations on living bats. During the three years ended 1959, numerous trips were made at all seasons to the Tararua and Rimutaka ranges (South Wellington). In addition the following localities were visited: Egmont (April, 1957), Marlborough Sounds (November, 1957), northern Ruahine Range (April, 1958), Kapiti Island (November, 1958) and Waitomo district (June, 1959). At the last named locality some skeletal material of *Mystacina* was obtained.

DISTRIBUTION

Both species of New Zealand bat are endemic. The long-tailed bat, *C. tuberculatus*, is one of six species of the Australasian genus *Chalinolobus* (F. Vespertilionidae); a genus closely related to the southern African *Glauconycteris*. Tate (1946) suggests that the genus is of Australian origin and it appears that *C. tuberculatus* is a comparatively recent immigrant to New Zealand. The short-tailed bat, *Mystacina tuberculata*, is the sole species of the family Mystacinidae. Within New Zealand *Mystacina* is represented as two subspecies. *M. t. tuberculata* is recorded from the North Island and the northern parts of the South Island, while *M. t. robusta* is known only from the Stewart Island region.

There are some unconfirmed records suggesting the existence of other species of bat in New Zealand. Polack (1838) refers to the presence of "Pekapeka, or bats" and "various small batlets, but none of the vampire species". Stock (1876) claims sighting a large bat at Paekakariki (South Wellington) in 1854. The "body was far larger than of a mouse and somewhat smaller than that of an ordinary sized rat; wing spread was certainly not less than 18 inches". He records similar observations by others at Wanganui and at the Clarence River (Marlborough). Baker and Bird (1936) state that the range of *Hipposideros cervinus* (Gould) extends south to New Zealand, but I have been unable to find any evidence for this remark. Tate (1941) has reviewed the genus *Hipposideros* and does not include New Zealand within the range. It is possible that records such as these could be based on chance sightings of occasional wind-borne Australian species.

SOURCES

The information upon which the following account of distribution is based was derived from various sources. Records have been supplied by the Auckland Institute and Museum, Dominion Museum, Canterbury Museum and Southland Museum. Phillipps' file at the Dominion Museum, Internal Affairs Department file No. 46/108 and Animal Ecology Division (D.S.I.R.) file No. 6/24/2 have been valuable references. The reports obtained from the New Zealand Deer Stalkers' Association were summarized in 1959 issues of *Roaring Stag*. Several records have been supplied by the New Zealand Speleological Society.

Distribution records have also been obtained from the following: Buller (1893), Cheeseman (1894), Cockayne (1907), Drummond (1908), Forster (1844), Gray (in Dieffenbach, 1843a), Guthrie-Smith (1921), Hutton and Drummond (1904), Knox (1872), Martin (no date), Myers (1921), Parham (1959), Pascoe (1957), Roach and Turbott (1953), Stead (1937), Thomson (1921), Wilkinson (1952), Wilson (1959), Forest and Bird Journal (May, 1959). Dollimore (1957) has been used extensively to determine the whereabouts of numerous localities.

INTERPRETATION OF DATA

TABLE I

Summary of bat distribution records for New Zealand

District	Colonies or large flights.						Small flights and isolated sightings.						
	Before 1930			After 1930			Before 1930			After 1930			
	M	C	U	M	C	U	M	C	U	M	C	U	TOTAL
N. Auckland	-	2	-	-	-	1	-	2	1	-	-	4	10
Gt. & L. Barrier Is.	1	-	-	-	-	-	2	-	-	-	-	5	8
S. Auckland	-	-	1	-	-	2	4	1	5	3	3	7	26
Rotorua-Taupo	-	-	3	1	-	8	-	-	7	3	2	16	40
Gisborne	-	-	-	-	-	6	-	-	4	-	1	11	22
Taranaki	-	-	-	-	-	1	-	-	2	-	-	2	5
Hawkes Bay	-	-	2	-	-	1	-	-	2	-	-	9	14
N. Wellington	-	-	1	-	-	-	-	-	5	-	5	12	23
S. Wellington	-	1	4	-	-	-	2	-	3	1	-	16	27
Kapiti I.	-	-	-	-	-	-	1	-	1	-	2	5	9
Marlborough	-	1	1	-	-	-	-	-	3	-	-	5	10
Nelson	-	-	4	-	-	1	1	1	9	3	3	30	52
Westland	-	-	1	-	-	-	3	1	6	-	3	10	24
Canterbury	-	-	-	-	-	-	-	4	3	1	1	2	11
Otago	-	-	-	-	-	-	-	1	3	-	-	3	7
Southland	-	-	-	-	-	-	3	1	2	-	1	9	16
Stewart I. etc.	-	-	-	-	-	-	1	-	3	5	-	3	12
Totals:	1	4	17	1	-	20	17	11	59	16	21	149	316

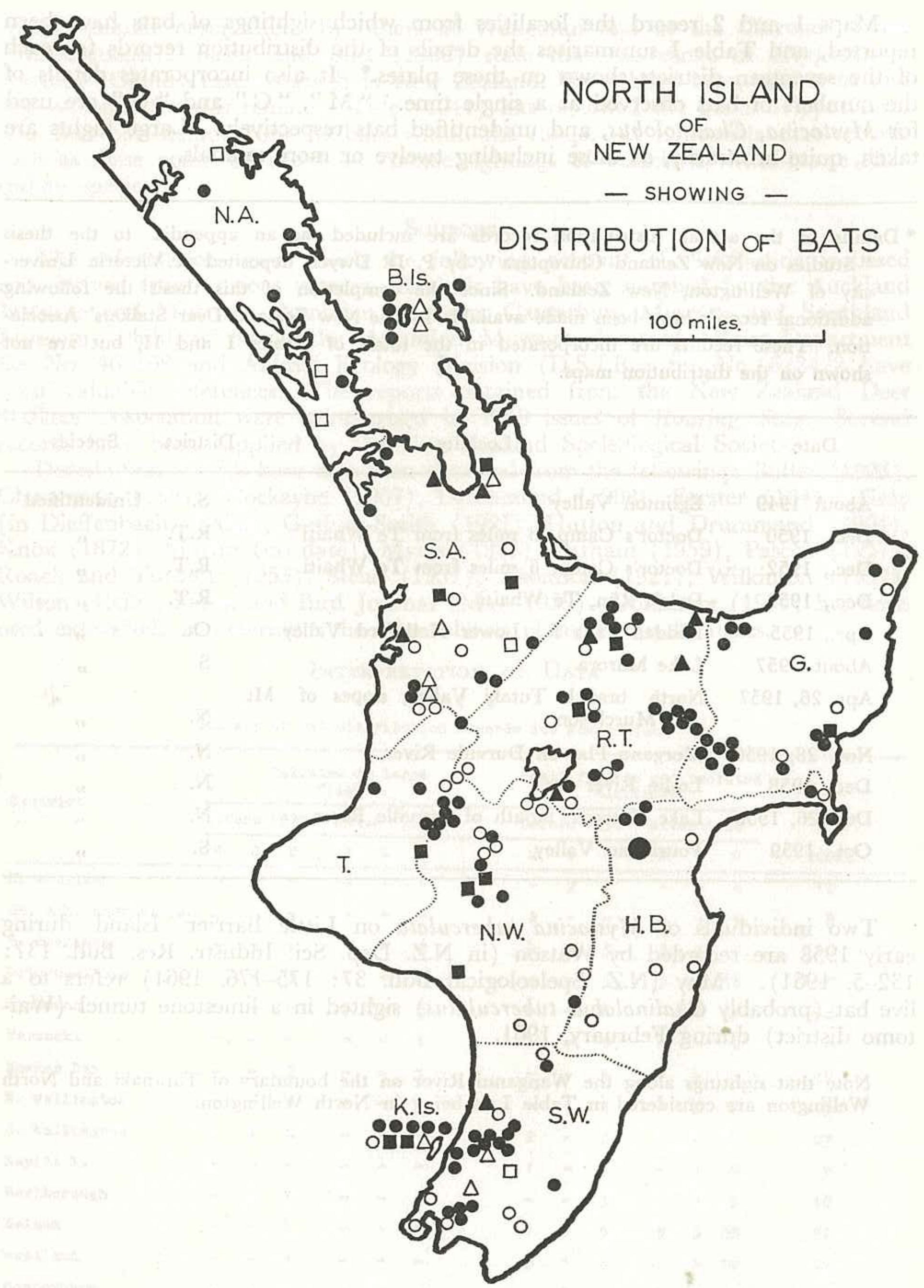
Maps 1 and 2 record the localities from which sightings of bats have been reported, and Table I summarises the details of the distribution records for each of the seventeen districts shown on these plates.* It also incorporates details of the numbers of bats observed at a single time. " M ", " C " and " U " are used for *Mystacina, Chalinolobus,* and unidentified bats respectively. Large flights are taken, quite arbitrarily, as those including twelve or more animals.

* Details of the actual distribution records are included as an appendix to the thesis " Studies on New Zealand Chiroptera ", by P. D. Dwyer, deposited at Victoria University of Wellington, New Zealand. Since the completion of this thesis the following additional records have been made available by the New Zealand Deer Stalkers' Association. These records are incorporated in the totals of Tables I and II, but are not shown on the distribution maps.

Date	Locality	District	Species
About 1949	Eglinton Valley	S.	Unidentified
Dec., 1950	Doctor's Camp, 6 miles from Te Whaiti	R.T.	"
Dec., 1952	Doctor's Camp, 6 miles from Te Whaiti	R.T.	"
Dec., 1952	Dale's Run, Te Whaiti	R.T.	"
Apr., 1955	Hidden Falls R., Lower Hollyford Valley	Ot.	"
About 1957	Lake Marora	S.	"
Apr. 26, 1957	North branch Tutaki Valley, slopes of Mt Murchison	N.	"
Nov. 28, 1958	Morgano Flat on Durville River	N.	"
Dec., 1958	Leslie River area	N.	"
Dec. 26, 1958	Lake Rotoroa, mouth of Durville River	N.	"
Oct., 1959	Pourakino Valley	S.	"

Two individuals of *Mystacina tuberculata* on Little Barrier Island during early 1958 are recorded by Watson (in N.Z. Dep. Sci. Industr. Res. Bull. 137: 132–5, 1961). May (N.Z. Speleological Bull. 37: 175–176, 1961) refers to a live bat (probably *Chalinolobus tuberculatus*) sighted in a limestone tunnel (Waitomo district) during February, 1961.

Note that sightings along the Wanganui River on the boundary of Taranaki and North Wellington are considered in Table I as being in North Wellington.

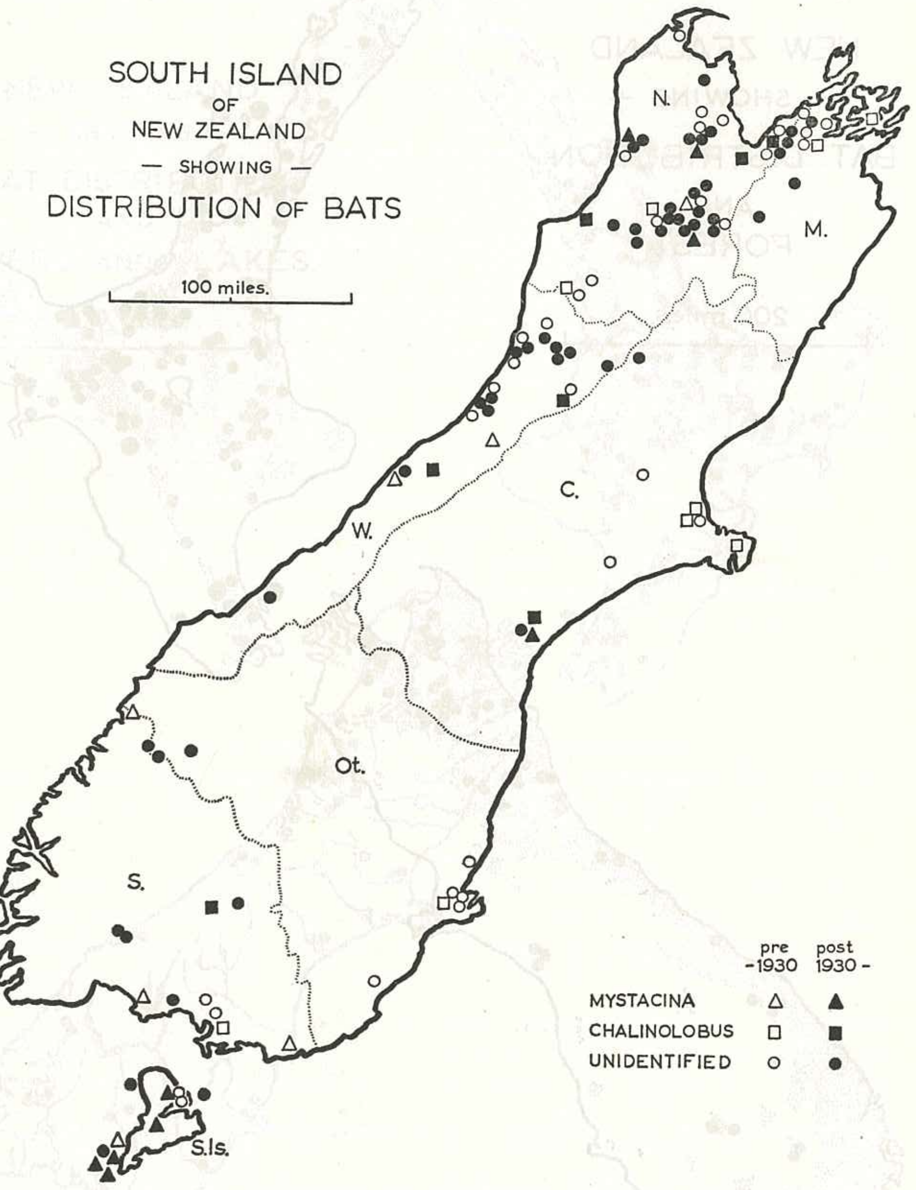


MAP 1

North Island of New Zealand, showing distribution of bats.

Abbreviations: N.A., North Auckland; B.Is., Great Barrier and Little Barrier Islands; S.A., South Auckland; R.T., Rotorua and Taupo districts; G, Gisborne; T, Taranaki; H.B., Hawke's Bay; N.W., North Wellington; S.W., South Wellington; K.Is., Kapiti Island.

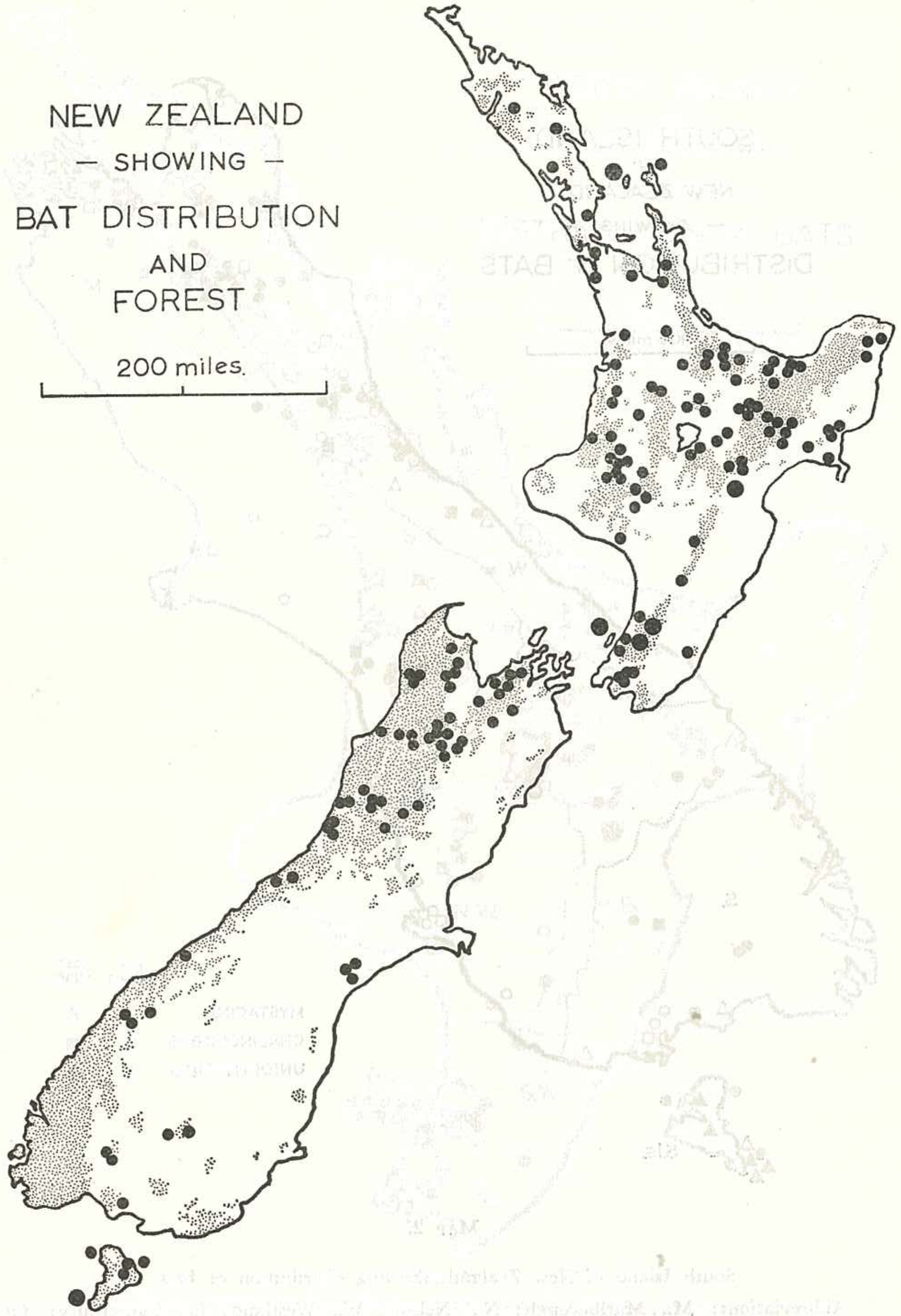
References to symbols as for Map 2. A larger circle indicates a series of records from a single locality.



MAP 2.

South Island of New Zealand, showing distribution of bats.

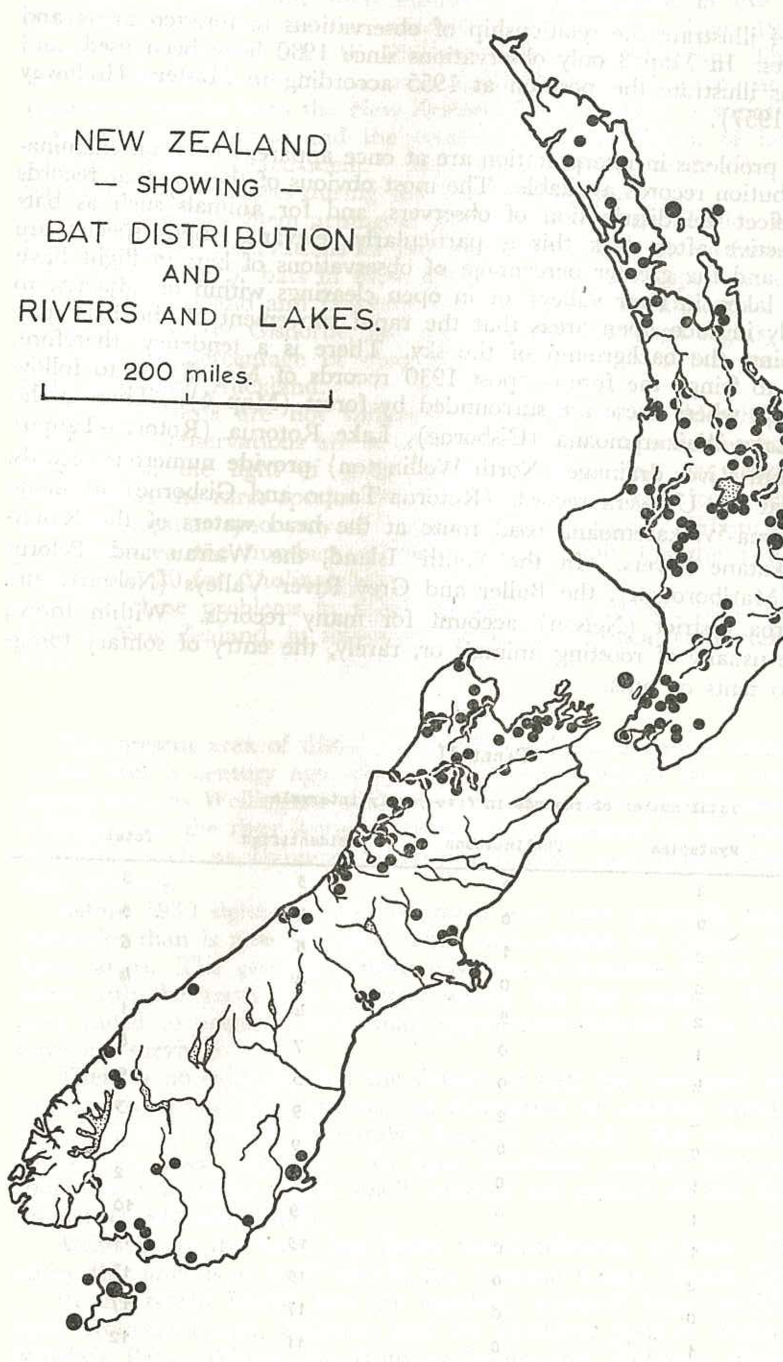
Abbreviations: M., Marlborough; N., Nelson; W., Westland; C., Canterbury; Ot., Otago; S., Southland; S.Is., Stewart Island and subsidiary islets.



Map 3.

New Zealand, showing bat distribution and forest.

Only observations of bats since 1930 are shown. A large circle indicates a series of records from a single locality. Forest areas at 1955 are based on Masters, Holloway and McKelvey (1957).



Map 4.

New Zealand, showing bat distribution and rivers and lakes.

A large circle indicates a series of bat records from a single locality.

Maps 3 and 4 illustrate the relationship of observations to forested areas and to rivers and lakes. In Map 3 only observations since 1930 have been used, and the forested areas illustrate the position at 1955 according to Masters, Holloway and McKelvey (1957).

A number of problems in interpretation are at once apparent from an examination of the distribution records available. The most obvious of these is that records must tend to reflect the distribution of observers, and for animals such as bats which become active after dusk this is particularly relevant. Both species are forest inhabiting and the greater percentage of observations of bats in flight have been made over lakes, in river valleys, or in open clearings within or adjacent to forest. It is only in such open areas that the rapid movement of the bats may be observed against the background of the sky. There is a tendency, therefore, for observations to fringe the forests (post 1930 records of Map 3) or to follow major river valleys where these are surrounded by forest (Map 4). Thus in the North Island, Lake Waikaremoana (Gisborne), Lake Rotorua (Rotorua-Taupo) and the Wanganui River drainage (North Wellington) provide numerous records. It is obvious that the Urewera records (Rotorua-Taupo and Gisborne) lie along the settled Rotorua-Waikaremoana road route at the head waters of the Rangitaiki and Whakatane Rivers. In the South Island, the Wairau and Pelorus River Valleys (Marlborough), the Buller and Grey River Valleys (Nelson), and the Lake Rotoroa district (Nelson) account for many records. Within forest, observations are usually of roosting animals or, rarely, the entry of solitary foraging animals into tents or huts.

TABLE II

Total number of records in five-yearly intervals

	Mystacina	Chalinolobus	Unidentified	Total
1870-74	2	0	3	5
1875-79	0	0	5	5
1880-84	0	1	5	6
1885-89	0	0	4	4
1890-94	2	5	4	11
1895-99	1	0	7	8
1900-04	4	0	5	9
1905-09	2	2	9	13
1910-14	0	0	9	9
1915-19	1	0	1	2
1920-24	1	0	9	10
1925-29	1	0	13	14
1930-34	2	0	15	17
1935-39	0	0	17	17
1940-44	1	0	11	12
1945-49	2	6	47	55
1950-54	2	6	27	35
1955-59	10	8	51	69
Totals	31	28	242	301

Table II groups the total numbers of observations in five yearly intervals.* The sudden increase in the number of observations from 1945-49 is a direct result of a survey by Mr. W. Phillipps, Dominion Museum. The increase during the last five years results, in part, from the present survey as reflected by the numerous records from the New Zealand Deer Stalkers' Association and also from general public interest and the consequent accumulation of information by the Internal Affairs Department. The table certainly cannot be taken to suggest an increase in numbers during the last hundred years.

The second problem arising in interpretation of distribution records is that the total number of observations for different districts may give a false impression of the relative densities of bats in these districts. Thus a comparison of the records for the South Auckland and Gisborne districts (Table I) indicates fewer observations, 22 against 26, for Gisborne, but more colonies or large flights, 6 against 3. In addition the percentage of observations since 1930 is far greater for Gisborne than for South Auckland.

Sight records are not sufficient to enable species identification. Therefore most of the observations are of unidentified bats. Species records have only been accepted in the light of good evidence. *Mystacina* has long been popularly regarded as the rarer species, but I feel this stems from its structural peculiarities and the popular synonymy of "unusual" and "rare". There is no great difference between the numbers of records since 1930 for the two species; 17 for *Mystacina*, 20 for *Chalinolobus*.

With these problems in mind, I have attempted to assess the distribution of bats in New Zealand, in relation to time and physical characters of the environment.

CONCLUSIONS

The present area of distribution of New Zealand bats is considerably less than it was over a century ago. Early records are available from many major urban centres such as Wellington and Dunedin and a well authenticated colony beneath a bridge over the river Avon in Christchurch persisted to the early 1900's. Smaller townships such as Dannevirke (Hawke's Bay) and Ross (Westland) also had their colonies.

Before 1930 sightings were scattered and were generally nearer the coast or townships than is now the case. They were seldom far distant from the extensive forest areas. The general pattern has been a decrease in the distribution correlated with the restriction of forest during the last century. Both species of bat have failed to urbanise, and small populations isolated from the forest generally have not survived.

There is no evidence that the density of bats has decreased within unmodified forest. Rivers and lakes provide an abundance of suitable insect food and clearings near bush provide favourable hunting grounds. Bat colonies have therefore survived in these localities. In open limestone country isolated colonies sometimes occur in caves. Such small colonies are present in the Te Kuiti-Waitomo district (South Auckland).

Altitudinally the bush line limits the distribution of bats. The single record above this limit is at 3,460 feet in the Tararua Range (South Wellington).

In the North Island bats are regularly reported from southern South Auckland, Rotorua-Taupo, Gisborne and the northern parts of North Wellington and Hawke's Bay. Within the Rotorua-Taupo and Gisborne districts the greatest number of sightings are from the Urewera and Lakes Waikaremoana-Rotorua

* The discrepancies in the totals between Tables I and II and between the tables and the maps result from differences in the details supplied by individual records.

districts. A large colony is well established at Aniwaniwa (Waikaremoana) with flights of 40 or more bats being observed over the lake during the summer. Some recent records are derived from the Whakatane-Opotiki district. In North Wellington the upper reaches of the Wanganui River drainage system account for many sightings. The many records from South Wellington have usually been of isolated bats or small flights. It appears that here bats are restricted to a few small scattered colonies in the Rimutaka and Tararua ranges. Little Barrier Island and Kapiti Island have a long history of sightings, but again numbers appear to be relatively few.

In the South Island, north-western Marlborough, Nelson and northern Westland seem to be well populated. The Wairau, Pelorus, Motueka, Karamea, Buller and Grey River drainage systems account for these records. The few recent records for Canterbury come from the Geraldine County. In Southland the few records are perhaps deceptive and the recent nature of these, excepting those coastal, suggests that a general absence of observers in previous years accounts for an apparent absence of bats. Stewart Island and its subsidiary islets still support small but flourishing colonies.

I would suggest that the Urewera in the North Island and the Buller River drainage in the South Island support the highest densities of bats in New Zealand. For only two localities is it possible that one species may occur in the absence of the other. In the North Island only *Chalinolobus* has been recorded from the Wanganui River drainage, and in the Stewart Island region only *Mystacina* has been taken.

GENERAL BIOLOGY

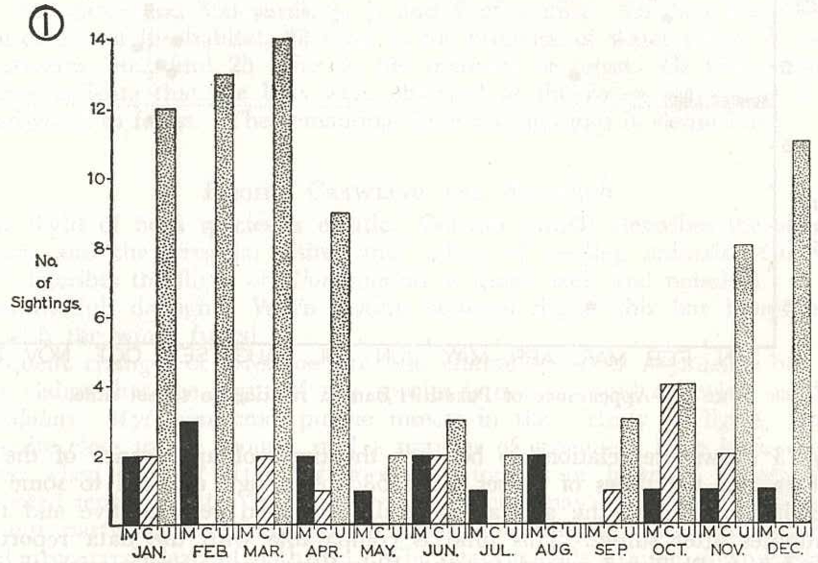
Little has been recorded of the behaviour or general ecology of the New Zealand bats. Chance encounters with colonies, often as a result of felling timber, provide some information relating to habitat and gregarity. Stead (1937) gives a report of observations on *Mystacina* near Stewart Island, and a few brief accounts, such as Roach and Turbott (1953) and Parham (1959), record the behaviour of captive bats. The present survey reviews all past accounts and includes some recent data.

ACTIVITY

Fig. 1 records the activity of bats in terms of the number of observations for each month of the year. The basic pattern, reflected in the value for unidentified bats, is of low numbers during the winter months (May to August) followed by a steady increase in numbers from September to mid-summer and autumn. Though values are low, it is noticeable that records of *Mystacina* are lacking for only two months, March and September, whereas *Chalinolobus* is not recorded during five months, three of these being the winter months, May, July and August. Fig. 2 records the yearly activity of a small colony of unidentified bats at Puketitiri, Hawke's Bay, observed by Miss P. Lewis during the years 1956 to 1959. An almost complete absence is noticeable for the winter, the single observation for the months May to July being of a solitary bat in the early dawn.

Of the numerous observations of unidentified bats, 22 record dusk, 22 evening and 10 summer evenings as the sighting time. A few claim that the bats were seen after dark. Confirmed sightings of *Chalinolobus* state evening as being the period of activity. Roach and Turbott (1953) record this time as the active period for a captive specimen. At Orakei-Korako (Rotorua-Taupo) on the 19th-20th February, 1948, Phillipps (Dominion Museum file) noted the appearance of the first bat from a cave colony at 7.30 p.m., and of the second a little later. No further bats emerged, and both these bats returned at 1.30 a.m.

There are few references to *Mystacina* in flight. Two records of the entry of this species into lighted huts, and Stead's (1937) reference to the activity of this species in the Stewart Island region after 10 p.m., are relevant. During late February, 1959, a captive *Mystacina* in the Rotorua-Taupo district consistently roosted till 8 or 8.30 p.m. in the early stages of its capture.



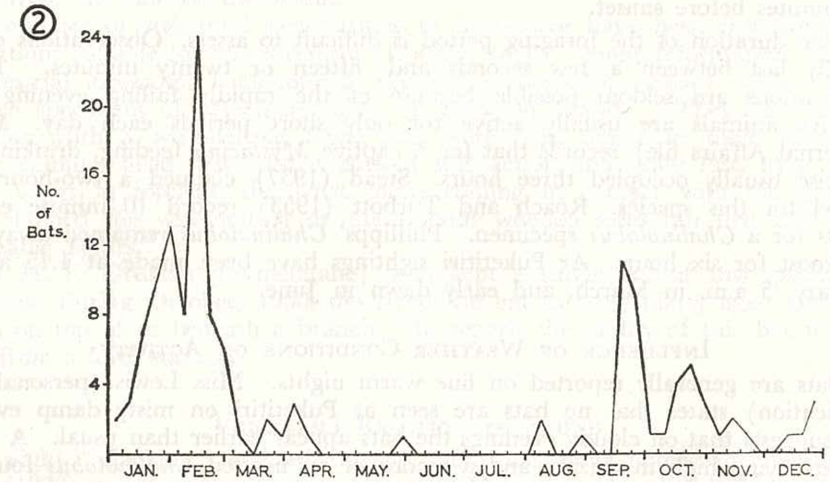


FIG. 1.—Yearly activity of New Zealand bats in terms of the number of sightings recorded every month.

The abbreviations "M", "C", and "U" are used for *Mystacina*, *Chalinolobus* and unidentified bats respectively.

FIG. 2.—Yearly activity of bats at Puketitiri, Hawke's Bay.

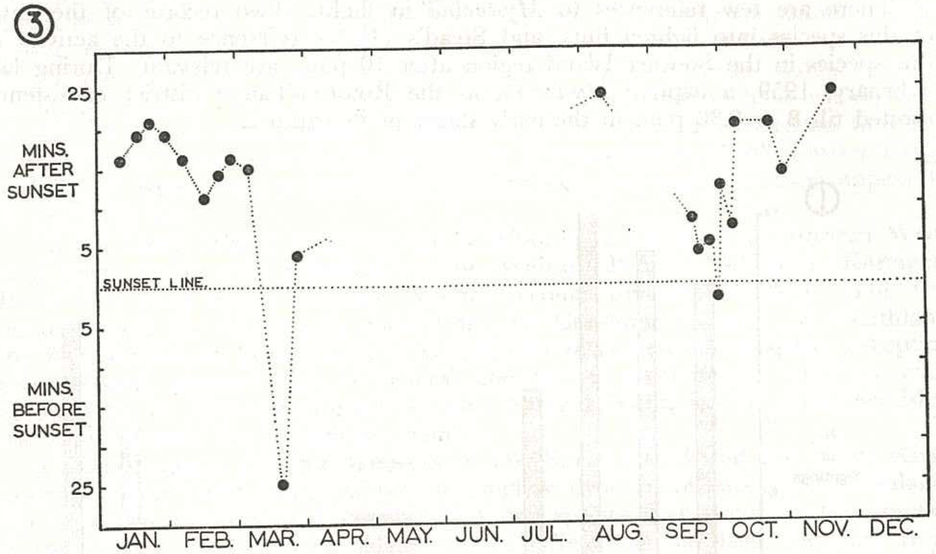


FIG. 3.—Appearance of Puketitiri bats in relation to sunset time.

Fig. 3 shows the relationship between the times of appearance of the Puketitiri bats and the times of sunset for 1958. Although affected to some extent by weather conditions, the animals generally appeared between five and twenty-five minutes after sunset. This time is comparable with the data reported for *Chalinolobus*. Phillipps' record for the 19th February coincides with the Puketitiri times for the corresponding period of the year. A winter sighting of an unidentified bat in the Rotorua-Taupo district during June, 1958, was at about 14 minutes before sunset.

The duration of the foraging period is difficult to assess. Observations of bats usually last between a few seconds and fifteen or twenty minutes. Longer observations are seldom possible because of the rapidly failing evening light. Captive animals are usually active for only short periods each day. McKay (Internal Affairs file) records that for a captive *Mystacina* feeding, drinking, and exercise usually occupied three hours. Stead (1937) claimed a two-hour flight period for this species. Roach and Turbott (1953) record 10 minute evening flights for a *Chalinolobus* specimen. Phillipps' *Chalinolobus* remained away from the roost for six hours. At Puketitiri sightings have been made at 4.45 a.m. in January, 5 a.m. in March, and early dawn in June.

INFLUENCE OF WEATHER CONDITIONS ON ACTIVITY

Bats are generally reported on fine warm nights. Miss Lewis (personal communication) states that no bats are seen at Puketitiri on misty damp evenings and suggests that on cloudy evenings the bats appear earlier than usual. A record of bats flying high in drizzle, and a record of an injured *Chalinolobus* found on the floor of a shed after a rough night, are the only reports of activity in adverse conditions.

RANGE AND FORAGING AREAS

At Puketitiri the bats appear regularly from the same section of forest. Feeding areas are established and are not more than about 800 yards from the point at which the bats appear. Three areas serve as the main feeding grounds. These

are: a paddock about 120 yards from the forest edge; a dam about 220 yards from the forest edge; and a grass paddock about 350 yards from the forest edge. A stream runs along the south-western boundary of the paddocks. Feeding areas nearer the forest are more often frequented and, although some variation occurs from year to year, the sites of these areas generally have close relation to the stream and dam.

A few other evening observations record the following distances from the nearest forest: 150 yards and 350 yards, $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of a mile. Of fifty reports which include details of the habitat, 28 refer to the presence of water either as swamps, lakes, streams, etc., and 25 refer to the presence of forest. Of these latter, all but three indicate that the bats were observed at the forest margin or in open areas adjacent to forest. The remaining three are sightings in dense forest.

FLIGHT, CRAWLING AND ROOSTING

The flight of both species is erratic. Colenso (1890) describes the short zig-zag turns and the irregular rising and falling of feeding animals. Cheeseman (1894) describes the flight of *Chalinolobus* as quick, soft, and noiseless. It is unaffected by full daylight. When resting between flights this bat hangs upside-down with the wings furled.

Frequent changes of direction are also characteristic of *Mystacina* but Stead (1937) claims that the flight of this species is not so rapid or twisty as that of *Chalinolobus*. *Mystacina* may pursue insects in the vicinity of lights, flying at times quite close to the ground, and a number of specimens have been captured in forest when stunned after hitting against torches or lanterns, or after flying into lighted tents or huts. In captivity this species may rest between flights with the wings partially extended. When roosting it suspends itself upside down, using the recurved claws of both feet. The head extends straight downwards. The thigh is directed outwards from the body, at right angles to it, and the shank extends posteriorly and slightly medially. The foot is turned only slightly outwards from the line of the shank.

A number of structural peculiarities in *Mystacina* have been interpreted as adaptations suitable for terrestrialism (Dobson, 1876). Some information relating to terrestrial locomotor behaviour in this bat is available. Stead (1937) refers to seven specimens of *Mystacina* taken on Solomon Island. "They were placed in a box with a wire-netting front, and were most active in their efforts to escape, running head first with a curious stiff action and quite fast, using their folded wings as forelegs, the wrist joints coming in contact with the ground. They climbed the wire-netting or the smooth wooden sides tail first and with remarkable agility."

Mr H. E. Grubner (Whakatane) who kept a single bat of this species for two weeks during October, 1958, described the bat as particularly agile and able to run on top of or beneath a branch. He reports the ability of this bat to take flight from a level surface.

VOICE AND REACTION TO SOUND

A slight "clacking" emitted during flight has been noted for *Mystacina*. Stead (1937) mentions the shrill squeaking of *Mystacina* when handled, and Grubner (personal communication) describes ear twitching as a reaction to light scratching or high pitched sounds. He describes the reaction of this bat to radio static as "panic", and describes a behaviour pattern before flight in which the animal " opened its mouth and turned its head from side to side ". This latter would facilitate echo-orientation. Phillipps (Dominion Museum file) records a high pitched squeak and a low grunt from a colony of *Chalinolobus*.

FOOD AND FEEDING

The numerous evening observations of bats above water suggest that adult instars of insects with aquatic larvae may form a major portion of the diet. Bats hunting the forest margin in the evening probably obtain moths. Moths, mosquitoes, and midges are all recorded as food items by observers, and Colenso (1890) notes that small flies were readily accepted by a captive bat.

Cheeseman (1894) records the capture of insects on the wing by *Chalinolobus*, and Roach and Turbott (1953) fed a bat of this species with mealworms and liver fragments. A praying mantis was readily accepted. The jaw motion in feeding was described as very rapid, food items being quickly reduced to a pulp. The faeces of *Chalinolobus* are small, about 4 to 8 mm long and, though usually tapered at either end, they may be somewhat irregular. Droppings from the surface of a cave pool at Orakei-Korako (Rotorua-Taupo district) consisted almost entirely of lepidopterous and dipterous remnants.

Items accepted as food by captive specimens of *Mystacina* include earwigs, spiders, moths, grasshoppers, crickets, wood grubs, and wire worms. Of these, spiders, moths and crickets were apparently most acceptable. McKay (Internal Affairs file) states that crickets " were quickly killed and, like all other insects that were offered, they were devoured head first with a distinct crunching noise ". Spiders and crickets were readily taken from the floor of the cage.

Stead (1937) records the flesh of a skinned diving petrel being eaten by *Mystacina* and carcasses of mutton birds hung out overnight to dry have been damaged by these bats. The strong transverse tongue ridges (Knox, 1872) would facilitate such feeding habits. The specialization of this bat for terrestrialism and the recorded flesh-eating habits suggest that a scavenging habit could provide a winter food source.

Parham (personal communication) describes drinking habits of *Mystacina*. " The animal was offered half a teaspoonful of water. It would take a drink, then wipe its mouth on the floor of the cage before taking the next. This process was repeated four or five times. During this period it was sitting with the toes of each foot splayed out, and the arms resting on the floor."

HABITAT AND GREGARITY

The number of bats flighting together varies considerably. Table III is prepared from 132 sightings. Nearly all the larger flights have been noted above water. Pairs of bats and solitary bats are frequently seen hunting along the forest margin.

Stead (1937) records the discovery of a small colony of *Mystacina*. The seven bats, including both males and females, were packed closely together. In

TABLE III.—Number of Bats Flighting Together.

No. of Bats Seen	No. of Records	No. of Bats Seen	No. of Records
1	38	7–12	5
2	24	About 14	1
2 or 3	2	20–30	3
3	7	Above 30	3
3 or 4	3	A few or several	22
4	1	Numerous	2
4 or 5	2	Large numbers	4
5	2	Dozens	1
5 or 6	2	Scores	2
6	6	Hundreds	1
6 or 7	5		

the Stewart Island region he found accumulations of droppings, amounting to several bushels, in caves and hollow trees. Solitary specimens of *Mystacina* have been taken from beneath tree bark and, in one recent instance, a bat was present between the folds of a sack hanging from a shed rafter.

Stead's small colony was at the end of a hole in a rata limb. The hole, about 18in long, with the opening about five inches in diameter, was five feet from the ground. Other colonies are recorded from hollow ratas, totaras and puriri trees, as well as from caves. A musty smell is usually associated with long standing colony sites. The colony of thirty or more bats discovered at Matahina during October, 1958, was in a large totara. The cavity occupied was near the base of the tree. It was about three or four feet long and was eight inches in diameter.

Many of the bats from this last colony flew directly to a neighbouring totara when they were disturbed. Stead (1937) records that bats vacated one roosting site for a fortnight and then returned. The capture of several *Mystacina* in Milford Sound in 1871 when the sails of H.M.S. " Clio " were loosed for drying is an additional suggestion that there is a measure of flexibility in the choice of roosting sites.

The body of *Mystacina* is cold to the touch during the roosting hours and if disturbed at this time movements are extremely sluggish. Waking involves stretching and head shaking. The animals are difficult to rouse when cold but become very active and quite warm after handling.

There are several records of large colonies of *Chalinolobus* in trees and caves. A colony numbering several hundreds is mentioned by Buller (1893) and Cheeseman (1894) also refers to several large colonies. One colony of more than thirty bats was present amongst creepers and epiphytes in the upper branches of a large tree. The bats were clinging together in clusters. Cheeseman found that bats liberated in a room settled in groups of four and five. Phillipps (Dominion Museum file) reports a colony from a cave at Orakei-Korako: Air temperature within the cave was about five degrees centigrade higher than that of the entrance. Several " bat holes " in the form of short tunnels were present in the roof. Smaller colonies of this species have been reported, six bats being obtained from a small hollow in a non-native tree. Two records of a pair of bats found beneath tree bark are also known. In one instance the tree was a dead kahikatea. A hibernating bat was discovered in a dead wattle tree at Matarawa (North Wellington). Roach and Turbott (1953) state that waking involves a period of warming up lasting several minutes. The process commences with a yawn or snarl, the jaws opening to nearly ninety degrees.

Colonies of unidentified bats have been found in caves and hollow trees and in the leafy upper portions of tall trees. Totara, rimu, kahikatea, pukatea and rata are all recorded as sites; totara being reported most frequently.* Large accumulations of droppings are sometimes present and colony sites may be characterised by a strong smell. Colenso (1890) records finding clusters of bats in hollow trees during the winter.

PREDATORS

Moreporks have been frequently reported as bat predators. Stead (1937) found a dead *Mystacina* in a morepork's nest. The bat had a small claw puncture in its neck. A pair of moreporks nested for a number of seasons at the entrance to a cave known to support a colony of *Chalinolobus*. Grubner (personal communication) has observed a bat escape an attack from a morepork by flight in a fast upward spiral.

Two records, one for each species, are known of capture by cats. Three

* Specific identification of trees was not available in any instance.

Mystacina were killed by a dog when a tree containing a colony was felled. Stead (1937) considers that in the Stewart Island region black rats may prey on *Mystacina.* Mustelids could similarly cause extensive loss to accessible colonies, but there are no confirmed records of predation by any of these mammals.

PARASITES

Both species of New Zealand bat carry external parasites. Fleas are known from both, but till now records of mites exist only for *Mystacina.* Several observers refer to this bat as being "infested with vermin" and Grubner (personal communication), who reports "a large spidery thing, reddish brown, and about ⅛in or more in size" from a captive bat, states that the animal was able to scratch any portion of its back with the foot.

Most specimens, juvenile and adult, of *Chalinolobus* examined during this study carried fleas (Order Aphaniptera). These occurred in the fur on all portions of the body, being commonest on the ventral surface in the axillary and pubic regions. From four animals (3 females, 1 male) which were thoroughly combed 23 fleas (17 females, 6 males) were obtained. All were *Porribius pacificus* described by Jordan (1947) for New Zealand bats. Only one flea was obtained from the twelve *Mystacina* examined. It was a female *P. pacificus.* Jordan includes five species in the genus *Porribius,* all as parasites of Australasian bats. Host species include *Eptesicus pumilus, Nyctinomus* (= *Tadarida*) *australis,* and *Chalinolobus morio* (Rothschild, 1936). Although the number of specimens from which the fleas were obtained was small the striking difference in infestation between the species could suggest that *P. pacificus* is at present in the process of transferring to *Mystacina.*

Grubner's description of a parasite of *Mystacina* as "spidery" and "about ⅛th inch or more in length" is strikingly suggestive of the family Nycteribidae, Order Diptera. Allen (1939) describes these bat parasites as being spidery in appearance and states that they are a common parasite, especially of Old World bats.

Mites (Order Acarina) were common on *Mystacina,* as many as 15 being obtained from a single specimen. The three species recognised belonging to the family Laelaptidae (Mesostigmata), suborder Sarcoptiformes (perhaps family Acaridae) and the group Parasitoidea (Mesostigmata). The laelaptid mite species was the most common. Only a single specimen of the last was obtained. Mites were present in the fur and none were found on the membranes.

A single specimen of a large mite was obtained from a juvenile *Chalinolobus* from Pelorus Valley (Marlborough). A member of the suborder Trombidiformes, the extremely dense coat of setae on the dorsal surface of this mite suggest that it belongs to the family Trombiculidae. Three genera of this family are recorded (Domrow, 1959) from Australian bats with *Trombicula thomsoni* known from *Chalinolobus gouldii.*

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