

Papers and Proceedings of the Royal Society of Tasmania, Volume 107

THE BIOLOGY BEHIND THE MUTTON-BIRD INDUSTRY

The Royal Society of Tasmania Medal Lecture 1970

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(with one table and two text figures)

INTRODUCTION

It is particularly gratifying to me to receive this honour from our President in these circumstances as it was before this Society that distinguished former members made important announcements on the subject on which I am addressing you tonight. Bishop H.H. Montgomery (father of the Field Marshal) spoke to your forebears at the end of the last century on his most interesting and still valuable personal investigations on the habits of the Short-tailed Shearwater or Tasmanian Mutton-bird (*Puffinus tenuirostris*). His were amongst the most important foundation papers on the natural history of a bird species which formed the basis of a picturesque local industry enduring since pioneering days, and whose economics and biology have captured the popular imagination beyond the borders of our State. He was followed at intervals by other members of the Society on the same theme. They included Colonel J.E.C. Lord, so long Commissioner of Police and chairman of the Fauna Board (Animals and Birds Protection Board) from its inception in 1929 until his retirement in 1940; Mr. Clive E. Lord, Director of the Tasmanian Museum and distinguished officer of this Society, who made notable publications on sea-birds in Tasmania, and Dr. Joseph Pearson, who was associated with the beginnings of my own work on the mutton-bird. As a follower in their footsteps, and one who derived great stimulus from them, I pay tribute to the work they did.

This is also Captain Cook year, when we are celebrating the bi-centenary of that navigator's explorations and discoveries along the east coast of Australia, so that it is appropriate to mention the fact that our bird is associated with the scientific activities of his expeditions. Though he encountered the species in our area (Beagle-hole 1962, 2, 47), it was only during the Third Expedition, and then not in Australian seas at all, but among the ice floes between Alaska and Siberia, that a specimen was collected and examined, and a painting made of it by the expedition artist, William Ellis. This picture, the first ever made of the bird, is preserved in a folio of drawings at the British Museum (Natural History) but remained unpublished until I reproduced it (Serventy 1958a).

The basic facts about the biology of the mutton-bird are now generally available to laymen and biologists (cf. Serventy 1958a, 1958b, 1962, 1963, 1967, 1969; Marshall and Serventy 1956; Serventy, Serventy and Warham 1971). The species is found only in south-eastern Australia and mainly in the Tasmania area; it exists in numbers so incredibly vast that it qualifies for the claim of being Australia's most numerous bird; has a most exact breeding time-table; has a long period of adolescence and does not begin to breed until it is 5 to 7 years old; it performs a remarkable trans-equatorial migration into the North Pacific after it rears its single chick; and it homes back to a particular nesting location each year, which may often be only a few yards from where it itself was hatched.

BACKGROUND OF THE INDUSTRY

Both biology and a peculiar combination of local circumstances permitted a successful industry to become established on the bird, but it was its biology mainly that enabled the industry to endure without the birds becoming exterminated or

seriously diminished in the process - as has happened in so many cases where wild creatures are commercially exploited. Successive generations have seen this happen in Tasmania - from the elephant and fur seals in the early days to whales and scallops in our own times. Our mutton-bird industry was first established in the Furneaux Group, on the small islands around Flinders Island. The physical conditions there are almost ideal. The breeding (or "rookery") islands are usually in fairly calm waters and it is possible to unload gear and embark casks of processed birds on to small boats with very little trouble or hazard. In addition there is a long-established community of sea-faring folk on the islands, with a traditional inheritance from the first colonising sealers, who were able to exploit the birds efficiently. Though many of the operatives in the industry are now Cape Barren Islanders, the coloured people partly descended from the sealers, it is important to remember that the industry is a white man's industry, for neither the Australian aborigines nor the Tasmanian aborigines at the time of white settlement appear to have used the bird as food to any degree. In any case they did not practise the industry as it is traditionally carried on - by preservation of the fledgling birds in brine. But this method was in use for centuries in Great Britain on the Manx shearwater (*Puffinus puffinus*). Until the English Civil War in the 17th century the Earls of Derby received an annual rent of 500 salted shearwaters harvested on the Calf of Man.

The key biological fact that ensured the stability of the Flinders Island industry was the annual constancy and extreme shortness of the egg-laying season. This made possible exact planning of the industry. The operatives know that the fledglings will be available for harvesting at exactly the same time each year, despite any vagaries of the season, and because the egg-laying season is so short all of the fledglings will be approximately the same size. Therefore, when the time comes to harvest the fledglings they know that each time they put their hand in a burrow they will pull out a marketable bird and there will be no need for culling or putting it back because it may be too small. This amazing breeding time-table was soon discovered by the early sealers and the information was published in a scientific paper by R.H. Davies, brother of Archdeacon R.R. Davies, and an amateur naturalist, in a contribution to a journal which was the forerunner to the proceedings of this Society (Davies 1846). The facts were repeated in Australian natural history publications, and though emphasised by Montgomery (1892, 1898), never made any deep impact overseas, where they may have been suspected as unreliable folklore. Even in our own day this exact timing was disbelieved, as incredible, by eminent scientists, so that a precise study of the phenomenon was early one of the objectives at the Fisher Island field station. We extended the investigations to South Australian and New South Wales nesting stations, and, with the help of Dr. E.R. Guiler and his students at the University of Tasmania, to the South Arm rookeries. Over the whole breeding range of the species, which occupies a band extending over  $10\frac{1}{2}$  degrees of latitude and  $16\frac{1}{2}$  degrees of longitude, i.e. approximately about 1,000 miles from west to east and 500 miles north to south, covering a wide range of marine and climatic conditions, the same mean egg-laying date prevails, namely November 25-26 (Serventy 1963). This was the same mean date as published by Davies in 1846! The extreme span of egg-laying, which begins about November 20-21, extends over only about 13 days, but 85% of all eggs are laid within 3 days on each side of the mean date. And this, I repeat, is unvarying from year to year and appears to have been the case since records were first made by the early sealers. The breeding cycle is obviously in step with the calendar year and the birds are somehow determined in their behaviour by the solar cycle. One consequence of this remarkable timing, and telescoping, of the egg-laying into a brief, precise time period is that almost every bird is doing the same thing as its neighbours and the composition and functioning of the island population at any particular time can be known exactly (see Fig. 1, Serventy, 1967, 174). All these dates are regular and the sequence of events follows remorselessly the same pattern, almost to the day, each year. Of all the harvesters or hunters of natural products perhaps the commercial mutton-birder alone knows exactly the day-by-day status of his "crop".

Having now taken note of the structure of a mutton-bird colony, its formidable constancy and how, thereby, it lends itself admirably to economic exploitation, we may

ask how it manages to survive unscathed from over-exploitation in view of its vulnerability in various ways? A pair of birds lay only one egg each season, and they take at least 5 years to reach sexual maturity and to become productive. Furthermore it would seem, when watching the operatives at work, extremely easy for a mutton-bird to pull out virtually every fledgling in a rookery.

Before going more particularly into this problem I wish to make a generalisation based on bird population studies overseas, and perhaps I can most pithily express this by quoting the words of a notable American ornithologist, Dean Amadon, who went into this question of low reproductive rates in birds. He said (Amadon 1964): "The evolutionary trend among birds has been towards producing relatively few young, but bestowing upon them protracted parental care. The climax of this trend is found in certain large, long-lived species, characterised by clutches of one or two eggs, a protracted period of brooding of egg and young, and late development of sexual maturity. The need for annual recruitment in these birds is very low."

#### SURVIVAL DATA

Our mutton-bird is a very nice example of this. It lays only one egg - in fact so deeply established is this single egg clutch in the whole petrel order, that the birds are now physiologically incapable of laying a second egg in the same season (Marshall and Serventy 1956, 505; 1957). The species has a long period of immaturity, which is coupled with a long period of productive adulthood. We have now demonstrated that the mean expectation of life in our mutton-bird, after it attains sexual maturity, is about 15 years. So if it began to breed at 6 years the mean age would be about 21 years. Many individuals would live much longer than this; some birds ringed as mature adults in the 1947-48 breeding season at Fisher Island were still breeding there in the 1971-72 season. Farner (1962, p. 184) has computed that "it is probable that annual survival rate among breeding birds in a stable colony could exceed 95% per year." To ensure survival of a stable population only two of the many eggs laid by a breeding female need to survive to become mature adults. In the case of the Tasmanian mutton-bird we have to be sure that not only does this minimum survive, to ensure a stable population, but enough also to compensate for the very intense commercial industry which exists on some islands.

How intensive is this industry? From the start of our work we have attempted to make some assessment of it by what is known as the Lincoln Index (or Petersen Index) technique. Just before the commercial season opens Fauna Board officers band at random over the commercial rookeries a random sample of fledglings - up to 600 or so on the bigger islands. Subsequently commercial operators will take a proportion of these marked individuals among their total catch. The bands are handed over to the Board's officers supervising the industry and a small fee is paid for each band. From the number of such bands recovered, in conjunction with the number originally put out, and the statistics of total catch, it is possible to calculate approximately how many young birds comprised the "standing crop". The results were rather surprising. Many birders imagined they took almost every bird in their rookeries, or very close to it. Our Lincoln Index work showed that on well-birded islands the figure taken was rarely more than 70%, usually nearer 50% and much lower, of course, on lightly birded islands.

The situation is illustrated in figures 1 and 2 summarising the catch figures, intensity of catching effort and results on the "crop" of young birds on two important islands in the Furneaux Group with very different exploitation histories. Babel Island, of 1,100 acres, is practically all mutton-bird rookery, but production has fallen over the years due to the gradual abandonment of the island for social and transport reasons - it is the most inaccessible of the Flinders Island group of bird islands. The number of sheds has fallen from 26 in 1939 to only one in 1961, when the Lincoln Index sampling was discontinued. The drop in intensity of catching is reflected in the Lincoln Index figures, which declined from 54% in 1952 to 6.6% in 1961 - they are represented by the "percentage of young taken" curve in figure 1. Great Dog Island, 820 acres, and largely mutton-bird rookery, presents a different picture: that of a

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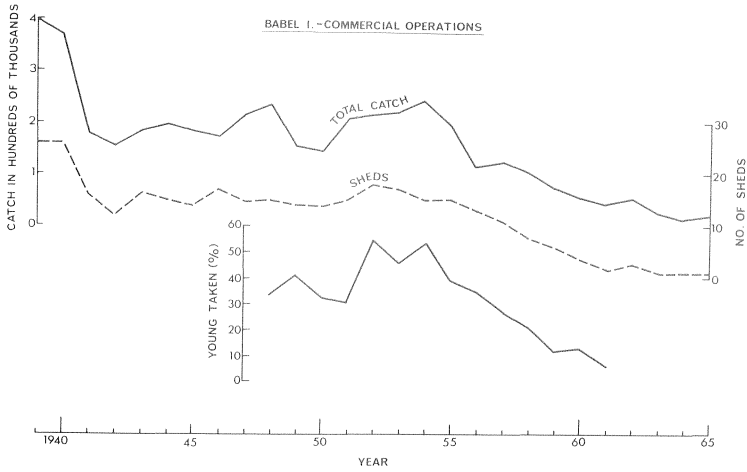


FIG. 1. - Commercial operations, Babel Island.

more stable situation. For many years there was a regular set-up of 12 operating sheds, but through social reasons the number of these has recently dropped. A fairly constant total production is indicated, correlated with the effort put into the catching of young birds. The regular catching rate was interrupted twice during the record in the graph - by flooding of the rookeries, in 1950 (commercial season wholly abandoned) and in 1956 (severely restricted). The Lincoln Index (represented by the curve of "percentage young taken") shows a harvesting intensity oscillating between 50 and 70%, but now falling because of a reduction in catching effort. In both islands, Babel and Great Dog, more and more young birds are escaping because of a decline in catching intensity in the industry.

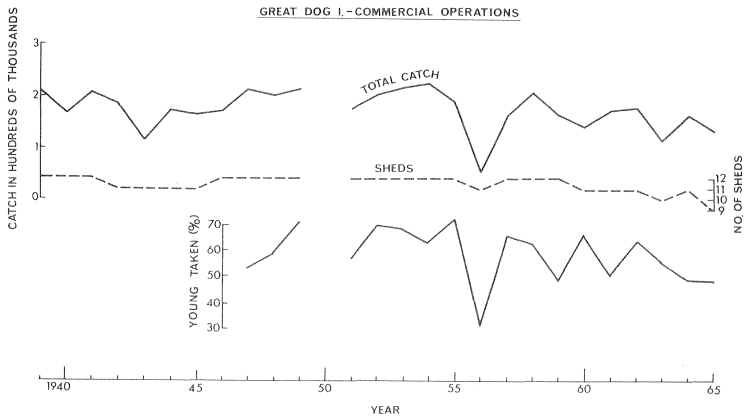


FIG. 2. - Commercial operations, Great Dog Island.

Is this escapement figure a safe one? How many of the young birds which do escape the birders survive to productive adulthood?

We know from general bird studies that the first year of life of any bird is a very vulnerable one and that very large numbers perish. In the shorter-lived passerine birds the mortality in the first year is enormous. David Lack, analysing European data, has concluded that between 80 and 93% of all eggs laid fail to produce adults.

Our work at Fisher Island has produced some nice data on the survival of young mutton-birds after they leave the island on their first exodus migration at the end of April. Because of the strong homing tendency of young birds to return to their hatching place we have taken advantage of the habit by instituting an intense search for these birds whilst they are on the surface at night in the months of January and February. It is then that the third and fourth year adolescent birds make a land-fall on their natal rookeries preliminary to establishing their breeding sites in later years. The results show quite a startling survival pattern compared with that shown for other birds.

TABLE 1  
SURVIVAL OF FISHER ISLAND PROGENY

<u>Natal Year</u>	<u>Escapement Number</u>	<u>Return to Date</u>	<u>Percent Return</u>
1950	20	9	45
1951	63	19	30
1952	22	13	59
1953	35	14	40
1954	81	29	36
1955	26	13	50
1956	30	7	23
1957	71	33	46
1958	58	15	26
1959	65	23	35
1960	51	24	47
1961	61	28	46
1962	56	35	63
1963	34	20	59
1964	63	33	52
1965	46	23	50
1966	42	23	55

Table 1 shows the number of mutton-birds returned to Fisher Island after 3-5 years compared with the escapement number of fledglings. The mean number of returned (i.e. surviving) birds is 44%. This must be a minimum value. Obviously there are returning birds which have eluded re-capture, and it is likely that the lower percentage returns in the earlier years are partly due to our less perfect sampling techniques compared with our present procedures. It is not unreasonable to claim that the average survival of young birds, and their return to the breeding islands, is not less than 50% and possibly higher. In some years (as in the year class of 1962) the survival was proved to be appreciably higher, namely 63%.

The nature of the work on Fisher Island precluded the acquisition of reliable data on the survival from egg-laying to successful fledgling. Observations on adjoining islands indicated a success of at least 60% with a reasonable estimation of 70% or more. This accords with a more detailed study by Norman (1970, p. 221) on Big Green Island, off the west coast of Flinders Island. He found that fledgling success (the successful departure of a chick from the nest), expressed as a percentage of the eggs laid, ranged from 64.0 to 77.3%, the mean fledgling rate being 70.5%.

A fuller treatment of the implications of these sets of survival data is being made in another paper. However calculations from the figures just given will show

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that sufficient young birds survive to carry on the species with the degree of commercial exploitation (at 50% escapement) carried on in the Furneaux Group. And very considerably more young are produced than are necessary for the maintenance of stable populations in the many unexploited islands (of which some 160 are listed by Serventy *et al.* 1971). Sources of loss of young birds not considered in the previous paragraphs include flooding of rookeries by occasional heavy rains and localised outbreaks of "limey-bird" disease (Mykytowycz 1963; Munday 1966; Munday *et al.* 1971). However, on the whole, there appears to be a surplus of birds being produced and a situation of over-population appears to exist. This is also suggested by the frequent occurrence of eggs laid on the surface ("gluts"), particularly on the unexploited islands. These eggs are laid by birds unable to be accommodated in burrows and have been shown to be produced largely by very young adults (Serventy 1967, p. 183).

These indications of saturated rookeries imply that the potential exists for new colonies to become established if conditions are suitable and uninhabited islands (i.e. in respect to this particular species) are available. This is in fact what now appears to be happening.

### THE POPULATION EXPLOSION

Briefly, a population explosion is going on among the local mutton-birds. It apparently first became evident in the 1920's but was not appreciated at the time. The first ornithologist to become aware of the phenomenon was Sharland (1956) who stated that the mutton-bird had increased substantially in numbers in Tasmanian waters "during the past 12 to 15 years", and new breeding colonies had been established and old ones expanded. I had also been keeping similar records and placed the start of the increase rather earlier than Mr. Sharland did.

One of the most decisive pieces of evidence of the population increase comes from King Island. When Mr. J.H. Hemsley, Curator of Fauna, of the Fauna Board, and I visited the island in March 1967 we learnt by questioning the old inhabitants that the 10 or 11 mutton-bird colonies on the main island of King, which were known to the Fauna Board, were comparatively new colonisations. When our informants were boys the birds nested only on two small islets off the north-west coast of King Island - New Year and Christmas Islands. This is confirmed by Campbell (1888), in his report of the excursion of the Field Naturalists' Club of Victoria in the previous year. Various points on the mainland of King began to be colonised in the 1920's and there are now some 17 separate nesting stations around the entire coastline of that island and some are still expanding (M. McGarvie, pers. comm.). Mr. McGarvie showed us the colony at Martha Lavinia, of about 7-8 acres, where five years previously Dr. M.E. Gillham had placed a peg at its southeast boundary. The boundary had now advanced 100 yards beyond Dr. Gillham's peg!

Apparently the first new colony to be made known on Tasmania itself was on the mainland at Woolnorth Point in the north-west. Inspector T.A. Canning, of the Tasmanian Police, informed me in March 1947 that it had been known for about 10 years. At the South Arm, a promontory south-east of Hobart, there are three colonies on promontories jutting into Storm Bay, which appear to have been derived from the large breeding station at Betsy Island, adjacent. One of these, at Fort Direction, was first discovered during World War II when flying birds were seen in the beam of searchlights. The other two colonies, at Goat Bluff and Watson's Bluff (C. Contrariety) had been known since the early 1920's - I have been unable to discover their earlier history. In October 1954 mutton-birds were found burrowing on a farmer's property at Wilson's Point, two miles west of the entrance to Port Sorell, Devonport, on the north coast. They were discovered during rabbit trapping operations on the farm and were unknown to local people previously. Breeding was proved later in the season. (Duncan Macdonald, pers. comm.)

Dr. E.R. Guiler informs me that all the rookeries in south-east Tasmania have expanded in recent years, even the ones at C. Queen Elizabeth which is the principal

one being exploited for fledglings. He has also given me particulars of several places along the west coast, between Macquarie Harbour and Cape Grim. However as this isolated coast was so rarely inspected in the past it is not possible to state if these stations are new colonisations or not. It will be noted that all of the newly-known nesting places are on mainland promontories, all within the area of known nesting distribution. Presumably all the suitable islands around Tasmania are long-established nesting stations; at least no new nesting colony on a Tasmanian island has been proved.

The most dramatic evidence on the expansion of the breeding range of the mutton-bird is along the east coast of Australia, as these are in an area beyond the previously known nesting limits. All are on islands, and these are already occupied by a closely similar species of shearwater, the wedge-tailed shearwater (*Puffinus pacificus*). Moreover they are islands which had been fairly closely studied in the past by ornithologists interested in marine birds.

The first find (Davies 1959) was made in December 1958 on the Tollgates, twin islets off Batemans Bay, 125 miles north of Gabo Island, hitherto regarded as the northern limit of the breeding distribution of the Tasmanian mutton-bird. Then in rapid succession nesting of the mutton-bird was reported on four other New South Wales islands. In December 1959 breeding was discovered at Broughton Island, some 250 miles north of the Tollgates (Hindwood and D'Ombraïn 1960). The birds were nesting both on the main island and Little Broughton Island, adjacent. This is the furthest north that the Tasmanian mutton-bird has been found nesting in New South Wales, representing a northward extension of breeding range of about 375 miles. In January 1960 the mutton-bird was found nesting on the Five Islands, off Wollongong (Lane 1961), though in the autumn of 1955 several juveniles with down still adherent to the feathers had been seen on nearby mainland beaches, but their significance was not then appreciated. In February 1960 nesting was found on Montague Island on the south coast of New South Wales (Robinson 1962); this is the southernmost breeding limit of the wedge-tailed shearwater. In December 1961 the Tasmanian mutton-bird was found to be breeding at Brush Island, near Ulladulla. In January 1969 small numbers were found nesting on Wasp Island, off South Durras, near Bateman's Bay.

Though many of these islands had not been closely examined in recent years, some, such as the Five Islands, had had close but intermittent attention. Most of them had, however, been inspected between about 1910 and 1916 by A.F. Basset Hull and S.E. Rohu, specifically for nesting petrels (see Hindwood and D'Ombraïn 1960, p. 151, for discussion). Rohu told me (in November 1942) that when Gregory Mathews was gathering materials for his "Birds of Australia" he commissioned Rohu to collect for him 20 specimens of each of the sea-birds in New South Wales waters. In connection with this assignment he visited all the local islands in 1914, including the Tollgates but excluding one of the Solitaires. It is clear that there could have been no large-scale nesting of the Tasmanian mutton-bird at that time, though individuals were then evidently prospecting the islands. Hull collected an adult Tasmanian mutton-bird in a burrow at Cabbage Tree Island off Port Stephens, in December 1910, but it was not nesting and no nesting has since been reported on this island, which has been closely studied for its unique colony of the Gould petrel (*Pterodroma leucoptera*). In December 1915, on Brush Island, he found several dead Tasmanian mutton-birds and a fresh egg on the surface, which from its dimensions could only have been, as Hull suggested, laid by this species. However, despite a thorough search he found no other sign of nesting (Hull 1916). As has just been stated, breeding on Brush Island was not confirmed until December 1961.

Ornithologists are continuing field studies of these islands, including investigations as to possible competition between *P. tenuirostris* and *P. pacificus*. In the Australian region the three common large shearwaters, *tenuirostris*, *pacificus* and *carneipes*, are allopatric - prior to the invasion of the first-named. This phenomenon of the encroachment of *P. tenuirostris* into the southern portion of the breeding area of *P. pacificus* in the Tasman Sea is made more interesting in that *P. griseus* (apparently from New Zealand) is also establishing bridgeheads in the same area. These

colonies, all very small at present, were discovered a few years prior to those of *P. tenuirostris*.

Suggestions have been made that the cause of the population increase in the Tasmanian mutton-bird may be a consequence of the lessening hunting pressure in the commercial mutton-birding industry. This can be dismissed as highly unlikely. There can be no doubt that the cause of this expansion must do with some change in conditions in the sea. The marine environment is improving for the mutton-bird and more and more individuals are able to survive. In this connection an explanation has been offered that the increase in bird numbers may be correlated with the decline in whaling, additional food supplies becoming available to the birds. This also seems unlikely as the baleen whales on their transit migrations do not feed very much in temperate waters (Chittleborough 1965). Whatever the explanation marine organisms other than mutton-birds ought to be affected. It is of interest that the phenomenon does not extend to the mutton-bird populations west of Bass Strait. The species nests in South Australian waters as far west as the islands off Ceduna, but no comparable increase in numbers has been reported in that region.

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