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## BIOLOGICAL RESEARCH AT MACQUARIE ISLAND

This issue completes a two-part series devoted to the biology of Macquarie Island, Tasmania's most southerly landmass. The previous issue (Tasmanian Naturalist No. 78) featured articles on the history of biological research at Macquarie Island, and on its botany, lakes, seashores and fish. The present issue deals exclusively with various aspects of animal life on the island. A map of Macquarie Island, showing place names used in this series, appeared on p. 2 of the previous issue.

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# MORPHOLOGY OF THE ROYAL PENGUIN *EUDYPTES SCHLEGELI* AT MACQUARIE ISLAND

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## Introduction

The Royal Penguin *Eudyptes schlegeli* is endemic to Macquarie Island, where it numbers approximately 2 million individuals in 48 rookeries scattered around the island (Horne 1983, N.P.W.S. 1978). General accounts of the species can be found in Falla (1937) and Warham (1975), with aspects of the breeding cycle presented by Warham (1971) and behaviour by Smith (1974).

The absence of valid morphological data on *E. schlegeli* has prevented the clarification of its taxonomic status and relationship to the other species in the genus and particularly the Macaroni Penguin *E. chrysolophus* (Warham 1975, 1980) which is found on most other subantarctic islands. The two are very similar in appearance and superficially differ only in facial colouring; *E. chrysolophus* has a black face and *E. schlegeli* a white face. As a result, some authors recognise *E. schlegeli* to be a sub-species to *E. chrysolophus* (Shaughnessy 1975) and others have recognised it as a species (Falla 1937).

The overlap in the few comparable measurements obtained for sexed individuals of both forms and the highly variable facial colouring in *E. schlegeli* first described by Falla (1937) and later examined by Shaughnessy (1975) has cast doubts on attempts to identify individuals found on Australian and New Zealand coasts. A "dark-faced Royal Penguin" was figured by Warham and Keeley (1969) whose identification was questioned and confirmed in the following articles: Warham (1971, 1972) and Falla *et al.* (1970, 1971).

In 1978 the RAOU accepted *E. schlegeli* as a species (RAOU 1978), reversing an earlier opinion of Condon (1975) that it was a sub-species. The decision was based on the fact that *E. schlegeli* is allopatric to *E. chrysolophus* (R. Schodde, pers. comm.). Warham (1980) takes this as further highlighting the need for the collection of comparable morphological data from *E. schlegeli* and *E. chrysolophus*.

It is the aim of this paper to describe some of the morphology of the two sexes of *E. schlegeli* by examining the data collected by the author at Macquarie Island in 1980. No attempt will be made to clarify the taxonomy *per se*, this is to be found in Woehler (in prep.).

## Methods

Body measurements were collected from 123 Royal Penguins from both east and west coast rookeries on Macquarie Island.

Eleven measurements were made on each bird and from these a further six derived parameters were calculated. Only breeding adults were measured, eliminating allometric variation from the analysis. The measurements made were done according to standard, published methods (Warham 1975), enabling valid comparisons to be made.

## Results and Discussion

A summary of the body measurements obtained is presented in Table 1. For each measurement presented in Table 1, the male values are higher than

TABLE 1. Body measurements of Royal Penguins at Macquarie Island.

	Male (M)		Female (F)		M/F
	n	mean	n	mean	
Bill Length mm	60	68.91	63	61.30	1.12
Bill Width mm	60	16.70	63	15.43	1.08
Bill Depth mm	60	30.48	63	26.65	1.14
Bill Shape Index	60	3521.40	63	2526.50	1.39
Flipper Length mm	60	214.70	63	205.10	1.05
Flipper Width mm	60	64.95	63	63.10	1.03
Body Weight kg	43	5.90	42	3.97	1.49

those of the females. The other species in the genus *Eudyptes* also show this sexual dimorphism, particularly in the bill where the males have larger bills (Warham 1975).

The sexual dimorphism exhibited by body weight is subject to many factors and so becomes extremely variable, both seasonally and individually. To compound the variability, the data were collected in the breeding season, a time of great metabolic stress and demand, introducing greater individual variation to the analysis. It is during the breeding season that demands are put on the female metabolism regarding egg production and this decreases the comparative value of the body weight data between the sexes.

Bill depth shows the greatest dimorphism of the body measurements obtained, with a M/F ratio of 1.14, the largest other than body weight. Bill length (M/F = 1.12) in association with bill depth would provide enough discrimination in order to identify the sex of an individual Royal Penguin.

Bill width (M/F = 1.08) and flipper measurements of length (M/F = 1.05) and width (M/F = 1.03) provide poorer discriminatory powers and could not be used with any certainty.

The derived measure Bill Shape Index also shows sexual dimorphism. It is calculated by bill length\*depth\*width/10 and the large magnitude of the male to female ratio (M/F = 1.39) reflects the sexual dimorphism present in each of the three components.

Overlap exists in some of the measurements obtained, however. For example, bill width and flipper width both show a high degree of overlap in the data collected for each sex, with a result that their discrimination is poor. Other measurements, notably bill length and depth show minimal overlap and provide excellent discriminators in sexing individuals.

### Conclusions

Morphology of the bill and flipper has been presented and bill morphology has been shown to demonstrate the greatest sexual dimorphism of the body measurements collected from the Royal Penguin at Macquarie island. Other measurements collected showed little or no dimorphism and provide no discriminatory action in determining the sex of an individual.

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## KING PENGUINS

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Four species of penguins breed at Macquarie Island; Gentoo, Rockhopper, Royal and King. King Penguins were confined to two colonies but after being exploited for oil in the 1800's only one remained at Lusitania Bay, and that much reduced. By 1930 only 3,400 birds existed and these produced less than 1,000 chicks annually. Since then the population has grown remarkably and numbers of birds in the colony have increased geometrically. By 1980 the island supported approximately 218,000 King Penguins and all available breeding space at Lusitania Bay was taken. New small breeding groups appeared on the east coast and the population was fully recovered from exploitation in a period of about 80 years. The growth of the population was monitored by counting chicks directly or in photographs of the whole colony. It is now the third largest population of King Penguins. It is interesting to note that no vagrant King Penguins were found in Tasmania between about 1900 and 1969. After 1969 they became regular vagrants and one appears here on average every year.

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## SOME NOTES ON THE FOODS OF THE DOMINICAN GULL AT MACQUARIE ISLAND

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*Larus dominicanus* is circumpolar in its distribution in the Southern Hemisphere. Within this range it is known by a variety of common names, Kelp Gull (the name adopted by the R.A.O.U.), Southern Black-backed Gull and Dominican Gull. Because the Pacific Gull is also black backed and Kelp Gull could refer to any one of a number of gull species both south and north of the equator I prefer the name Dominican Gull, as it is derived from the scientific designation and in this regard removes the possibility of confusion with other species.

At Macquarie Island, 900 miles south east of Tasmania, the Dominican is the only gull species present. Two close relatives, the Antarctic Tern and the Southern Skua, are also present. In its quest for food the Dominican is an opportunist, being both a seafood gourmet and a scavenger. As a seafood gourmet, this gull has virtually no competitors on Macquarie Island. In this marine environment tide and weather conditions are very important in limiting when and where food resources are available. As a scavenger, the Dominican Gull comes into direct competition with Giant Petrels and the Southern Skua. In this roll the Dominican is relegated to the third row to scavenge behind these species. During the winter months when the Skuas are absent, the Dominican is able to move 'up' to become the secondary scavenger.

Since 1948, the Australian National Antarctic Expedition has maintained a station on Macquarie Island. Biological research has been one of the important elements of their program. Though I was primarily responsible for the continuation of the long term research into the breeding biology of the Royal Penguin, Wandering Albatross and Southern Elephant Seal, during the quieter times I also conducted some research into the seasonal feeding habits of the Dominican Gull. In the course of this work some birds were collected but the majority of information came from personal observations, previous records and from the analysis of regurgitations. Regurgitations are pellets of undigested materials 'coughed up' by the gulls on their resting areas. By carefully collecting fresh undisturbed specimens, comparable seasonal diets could be determined. Some interesting results came to light. Briefly comparing late winter with the late spring, the results are given in Table 1.

In the course of these studies it became apparent that the Dominican Gull utilised many different food sources, in many different ways, under varied environmental conditions. For example, during periods of mid day low tides during calm water conditions, the number of gulls feeding inshore was in direct proportion to the lowness of the tide. A short while later, during a period of high tides and high seas, Dominicans were picking kelp fly larvae and adults from the surface of the sea and beach. These had been washed from the rotting kelp at the high tide line.

From the results gathered during the course of this study three major influences were identified as being important to the diet of the Dominican Gull. These were:

1. the breeding chronologies of the larger bird and mammal species, notably the Royal Penguin and the Southern Elephant Seal.
2. the presence or absence of the Southern Skua, the species which dominates the Dominican around penguin rookeries, seal harems and carcasses.
3. physical factors and conditions such as day length (summer to winter), weather conditions and tidal cycles.

In its overall diet the Dominican Gull at Macquarie Island appears to have a preference for marine organisms, notably molluscs. None the less the Dominican is a very versatile feeder.

TABLE 1. Occurrence of food items in 144 samples of regurgitated pellets from Dominican Gulls in late winter and late spring.

Food Item	Number of Samples	Winter 30	Spring 114
<b>Marine Life</b>			
Snails		12.5	17.3
Limpets		10.4	14.4
Chitons		8.8	10.6
Squid		1.7	4.8
Isopods		6.4	3.9
Fish		2.7	7.7
	Total Marine	42.5%	58.7%
<b>Terrestrial</b>			
Penguin		21.9	5.7
Elephant Seal		2.3	18.3
Kelp Flies		7.4	1.0
Goose Neck Barnacles (Beach washed)		10.8	1.0
	Total Terrestrial	42.4%	26.0%
<b>Plant Material</b>			
		3.7	5.7
<b>Inert (Sand, pebbles &amp; pumice)</b>			
		11.4	9.6
	Totals	100.0%	100.0%

## BIOLOGY OF THE HOUSE MOUSE (*MUS MUSCULUS*) ON MACQUARIE ISLAND

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During the early years of sealing and whaling activity in the southern ocean many of the sub-antarctic islands that lie in this region were extensively exploited for their seal stocks. This ultimately led to a dramatic change in the unique flora, fauna and ecology of many of these islands, including Macquarie Island (Jenkins *et al.* 1982). Closely following the island's discovery in 1810 there was intense sealing activity until 1834 and spasmodically thereafter until 1919. As sealing gangs arrived camps were established around the island with men and supplies ferried ashore from the sealing vessels. This period also saw the arrival of a variety of alien animals mainly of domestic stock. These included such ecological gems as the cat (*Felis catus*) which had become feral by 1820 (Debenham 1945) and the rabbit (*Oryctolagus cuniculus*) introduced around 1880 (Cumpston 1968). There were also inadvertent introductions to Macquarie of two of the three rodent species that now inhabit many of the sub-antarctic islands. These were the Black Rat (*Rattus rattus*) and the House Mouse (*Mus musculus*).

The House Mouse has a long history of successful adaptation and colonization. As a commensal with man or as a wild living species it is now present in many parts of the world. The environmental conditions acceptable to this small mammal range from the sub-antarctic islands to arid deserts,

from coastal temperate regions to 4000m above sea level in the Andes (Berry 1981), and as far north as the Faeroes (Evans and Vevers 1938). Mice have been found 600 metres underground in coal mines (Elton 1936, Clegg 1965) and in frozen meat lockers operating at  $-10^{\circ}\text{C}$  (Laurie 1946) and as low as  $-28^{\circ}\text{C}$ . Much of the near-global distribution of this species has been directly attributed to man and his travels. This was certainly the case with the sub-antarctic populations.

The earliest date of introduction of mice to Macquarie cannot be determined with accuracy. Although the first mention of them was not made until 1890 (Cumpston 1968) it may have been much earlier. Mice could have reached shore by shipwreck, the first recorded wreck being that of the Campbell Macquarie in 1812, or in the provisions which were shipped ashore to serve the needs of the sealing gangs. In either case there were probably multiple introductions with mice arriving on different parts of the coast.

## Distribution

Law and Burstall (1956) reported that mice (and rats) were widely distributed around the coastal areas and appeared to have no difficulty in obtaining a livelihood. Berry and Peters (1975) trapped mice at a number of sites around the island: in the vicinity of the ANARE station, and near field huts at Bauer Bay, Green Gorge and Caroline Cove. Traps were placed in buildings and a variety of nearby habitats up to 70m above sea level. Mice were caught in all areas and habitats except Lusitania Bay (where traps were set for only two nights). Signs of mice were also noted at several huts on the plateau at about 300m above sea level.

Recent field studies have confirmed the widespread occurrence of mice around the island. However the population is divided into discrete units by the rugged topography of the island, and as yet little is known of the population density within these units.

## Habitat

The favoured habitat of mice, based on the extensive live-trapping program during 1980/81 and 1982 (T.P.), is the tall tussock grassland formation dominated by *Poa foliosa* and the broad-leaved *Stilbocarpa polaris*. Both species may occur in pure stands within this formation. Greater numbers of mice were trapped in mixed stands, particularly those with patches of *Agrostis magellanica*, *Festuca contracta*, *Luzula crinita* and other associated vascular species such as *Cardamine corymbosa*, *Epilobium* spp., *Neopaxia* (Montia), and *Poa annua*. Short-tussock grassland, dominated by *Agrostis*, *Festuca*, *Luzula*, *Deschampsia chapmanii* and *Uncinia* spp., with numerous bryophytes and other vascular species is also strongly favoured as a habitat.

## Food and Feeding

Although data are at present sparse on the feeding habits of the Macquarie mice, evidence from the present study suggests that their diet consists mainly of seeds and other plant material, supplemented by invertebrates. The seeds from Macquarie cabbage *Stilbocarpa polaris* appear to be a favoured food of the animals throughout the year. The mice gain access to the seeds by climbing up the long stalks and leaves, feeding either

directly from the umbel bearing the fresh fruit or stripping the fruit which drops and is gathered in the broad leaves of the plant. As the fruits ripen and are shed well into the winter the umbel droops to the ground. The leaves become a natural food store during this period making seed gathering even easier for the mice. The empty fruit cases are discarded amongst the leaves and are easily recognised. Caches of flower heads from *Poa foliosa* were also found during the summer in runs made by the mice. Annelids (earthworms), spiders and moth larvae were present in soil and litter samples throughout the winter. The latter two were also reported in mouse stomachs collected from Macquarie by Jenkin *et al.* (1982). Invertebrates, particularly larval insects, are known to be eaten by feral house mice elsewhere (Whitaker 1966, Berry 1968).

## Reproduction

Reproduction in feral house mouse populations can be seasonal or non-seasonal. For those living in temperate latitudes this may depend largely upon environmental conditions (Bronson 1979). Nevertheless, the earlier work by Berry and Peters (1975) on Macquarie suggested that the mice were non-seasonal in their reproductive patterns and were breeding throughout the year. These conclusions were based on the capture of one pregnant animal carrying two embryos, and an age structure for the population, estimated by tooth wear using criteria established by Lidicker (1966) for mice on Brooks Island, San Francisco Bay. This appeared to show that many births at Macquarie occurred in June. The present study based on the quantitative and systematic collection of data strongly indicates that on Macquarie Island the reproduction of the house mouse is seasonal.

House mice (and rats) are polyoestrous rodents which ovulate spontaneously every four days during their normal oestrous cycle. The cycle is divided into four periods; prooestrous, oestrous, metoestrous and dioestrous. During this time pronounced changes occur in the vaginal epithelium which becomes thickened, the uteri distend with maximum distension occurring at oestrous, follicles approach the surface of the ovaries, ovulation occurs and ova are liberated. Following ovulation the ruptured follicle changes dramatically and develops into a true endocrine gland, the corpus luteum.

However, this sequence of events is interrupted in winter in the Macquarie mice. From mid-June until early September I observed vaginal mucinification (absence of certain cells in the vaginal epithelium), inhibition of normal oestrous cycles and the incidence of vaginal closure, a similar pattern found by Whitten (1959) in grouped mice, demonstrating that females were anoestrous during these winter months. Out of 29 females trapped during this period, none showed any sign of reproductive activity. These findings were supported by gross changes in the uterine and ovarian structures. The most significant of these was the complete absence of corpora lutea in some animals and their atrophic condition in others.

## Parasites and Predation

The Macquarie mice and rats are parasitized by fleas *Nosopsyllus faciatus*, Bosc. This is a common species found on both rodent species elsewhere and has been recorded on Brown rats *Rattus norvegicus* at the same latitude on South Georgia, South Atlantic Ocean (Pye and Bonner 1980) and as far north as Nome, Alaska (Schiller 1956). Endoparasites in the form of



nematodes have been recovered from the caecum contents of the mice, but as yet have not been identified.

The main predator of both rodent species is the feral cat. However, of the food items found in gut contents of cats by Jones (1977) less than 10% was made up of mice and only 2% were rats. Predation by the Great Skua (*Stereorarius skua lonnbergi*) has been reported (Gillham 1967), and the introduced Weka (*Gallirallus australis scotti*) may also prey on mice.

House mice and Black rats have become an established part of the wildlife of Macquarie Island. Their distribution together with the topography and dense vegetation of the island make attempts to reduce these introduced rodent species ineffective. The mice appear to have made very little impact on the ecology of the island. However the presence of rats gives cause for greater concern. It is surprising to note that since their introduction sometime last century, they have been little studied. Furthermore it is well known that feral rats on other isolated islands have severely damaged ground-nesting bird populations. This may or may not be the case on Macquarie Island (Brothers in press, Johnstone in press). Management proposals should be accompanied by studies of abundance, patterns of distribution and diet. Further introductions of rodent species should be avoided.

### Acknowledgements

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## THE CURRENT STATUS OF SEAL POPULATIONS AT MACQUARIE ISLAND

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For more than 150 years Macquarie Island has been recognized as the home of many Elephant Seals (*Mirounga leonina*), Leopard Seals (*Hydrurga leptonyx*) and Fur Seals (*Arctocephalus spp.*). Following discovery of the island in 1810, seals were indiscriminately slaughtered for their oil and skins. Records of seal numbers and breeding patterns were poorly kept, and even today little is known of the population dynamics of seal species on Macquarie Island. A brief review of the overall situation follows.

### Elephant Seals

Numbers of Elephant Seals killed for oil extraction on the island are unavailable. Initially both Elephant Seals and Fur Seals were harvested. The more valuable Fur Seals were exterminated by the 1820's. Although Elephant Seals were seriously depleted by the 1830's, harvesting of them for oil continued intermittently until 1920. In the latter years of that industry, penguins were also taken for oil (Cumpston 1968). The Elephant Seal populations had recovered by the 1950's when Carrick and Ingham (1960) suggested that an estimated 110,000 of these animals were present on Macquarie Island. Records of its breeding status were kept for the northern isthmus of the island in 1969 and 1970 (Jones 1981), and more than 5000 female seals were present in this area each year in the breeding months of September-October. Males were present in lesser numbers, approximately 850 being recorded on the isthmus of which only 250 were

classified as breeders. Today, possibly fewer Elephant Seals are seen on the isthmus, an estimation of 3000 in the October 1982 breeding season being made by the relevant ANARE expedition, but many hundreds of others are present around the remainder of the island. Very large colonies of these seals are frequently noted at Bauer Bay, Sandy Bay and Hurd Point, but this seal is ubiquitous on the island whenever a sliver of beach is available. Again breeding occurs around the entire coastline of the island. It would not be expected however that anywhere near 110,000 Elephant Seals are to be found on the entire island today, and a serious census is long overdue and will hopefully be tackled in the near future.

The population of these seals begins to build up in September, rapidly reaches a peak in mid-October when pupping occurs, which is immediately followed by mating, and then progressively declines throughout November and December. These seals are present on the island throughout the entire year, but their number is extremely small during the winter months, limited to less than 500.

Past attempts at accurate census taking have included (a) flipper tagging (unsuccessful due to rapid erosion of cartilage by tags with subsequent loss); (b) dye and paint marking (limited short term value until erosion and moulting occur); and (c) hot-iron branding (very successful over the long-term but an extremely cumbersome method of marking seals, not very portable, and rather time consuming). Ages of Elephant Seals recorded on Macquarie Island have ranged up to 17 years for males but figures are not available for females (Jones 1981).

#### Leopard Seals

Studies of the Leopard Seal population on Macquarie Island have been undertaken with varying degrees of enthusiasm since 1949. The Leopard Seal visits Macquarie Island during the winter and spring months, its arrival being noted about June and its departure around December (Ledingham 1979). There is an observed tendency for the population to peak on the island every 4 or 5 years, the number of seals being sighted frequently exceeding 200 at this time, the highest recording being 283 in 1959. Between these peaks, annual sightings have been less than 10. No significant difference of sex distribution has been verified in past observations (Rounsevell and Eberhard 1980).

Tagging of these seals has been done in the past by the same methods as those used on Elephant Seals. Return visits to the island have been recorded in the past but it is difficult to know with what frequency animals return. Branding and dye methods are no longer used, and plastic tags inserted into tail flippers are often observed hanging out of large erosions a few weeks after insertion.

Eight seals (plastic-tagged) were observed to return to the island after a 12 month period in a study between 1976 - 79, and one tagged seal was found in Tasmania in 1977. Another tagged seal from Macquarie Island was also reported on Campbell Island in 1977. To date, no pupping or mating of Leopard Seals has been confirmed at Macquarie Island, and this aspect of their behaviour still remains enigmatic.

#### Fur Seals

From the time of the discovery of Macquarie Island in 1810, the Fur Seal population was exploited for its yield of pelts. At least 62,000 skins were taken in 1810 and 1811, and at least a total of 120,000 by the end of 1812 (Cumpston 1968). 180,000 skins were taken by 1813 (Csordas and Ingham 1965). In 1820, a Russian expedition visited Macquarie Island and could not find any Fur Seals at all. In 1911 - 13, an Australasian expedition on the island reported no Fur Seals, but were told by sealers that occasional individuals were caught and killed (Csordas 1958). By 1948, a small colony of Fur Seals was reported as established on North Head and since then a slow but progressive build up of Fur Seals has occurred. By 1950, 174 Fur Seals were established on North Head but none elsewhere on the island. No breeding was noted at this time. In 1954, a small colony was found at Hurd Point, and in 1955 another small colony was observed at Handspike Point. Throughout these observations, it was always reported that the

developing colonies were *Arctocephalus forsteri*, the New Zealand Fur Seal. Identification of the original species of Fur Seal which was slaughtered has never been established but it is usually considered not to have been *Arctocephalus forsteri* (e.g. Falla 1965).

In 1982, 1245 Fur Seals were counted in a census around the entire island (Fletcher, unpublished data). In 1955, the first recording of a pup being born on Macquarie Island in 134 years was made at North Head (Csordas and Ingham 1965). Since then, a very slow but steady increase has been observed in the number of Fur Seal pups born on the island, and by the summer of 1982/83, twenty pups were counted. These pups were present only at North Head.

A study of the breeding colonies in 1981/82 revealed some interesting findings:

- (a) four large bulls were present in these colonies and were distinguished from all other seals by characteristic colours and markings. They were tentatively classified as Subantarctic Fur Seals *A. tropicalis*, a finding which has since been confirmed (results to be presented in detail for publication elsewhere);
- (b) the pups were born in two specific sites on North Head, and examination of old records revealed that all previous births on the island has been limited to these specific localities. No recordings of births has been made at any other colonies around the island; and
- (c) the females in the harems were smaller in size and different in colour from all males (both *A. tropicalis* and *A. forsteri*), and outnumbered the males by four-to-one approximately. Initially, it was thought that all these females were *A. tropicalis*, but a few of them have now been identified as Antarctic Fur Seals *A. gazella*. The specific identity of the remainder is yet unconfirmed.

Because of these findings, it was speculated that of the 1245 Fur Seals counted on the entire island, only two groups of breeders were present, which comprised *A. tropicalis* males, and *A. tropicalis* and/or *A. gazella* females, and their breeding areas are presently limited to two constant locations. Their numbers in 1981/82 were four males, fifteen females, and fifteen pups. This implies that the remaining Fur Seals (*A. forsteri*) on the island are a non-breeding population. In 1982/83, another whole-of-island survey was undertaken, and once again the only breeding colonies on the island were found at the two specified sites on North Head. In this latter survey, five *A. tropicalis* bulls were counted, two *A. tropicalis* subadult males, thirty cows (either *A. tropicalis* or *A. gazella*), and twenty pups.

Study of the weaning habits of these pups has yielded the possibility of two populations, one with behaviour and weaning patterns comparable with *A. tropicalis* pups elsewhere, and the other with patterns similar to *A. gazella*. Further studies are currently being undertaken in an attempt to solve this problem, and to identify the species of pups being born on Macquarie Island. It is interesting to read historic records of sealing on both Macquarie and Antipodes Islands whereby the species being killed were referred to as the "upland seal". This "seal" was said to have a "superior fur", and on one occasion speculation (Falla 1965) suggested that the species was not *A. forsteri* but *A. gazella*, based on the sighting of an *A. tropicalis* by Csordas (1962).

Regardless of our lack of knowledge of the biological history of the Fur Seal population on Macquarie Island, it is satisfying to see colonies nowadays reestablished with positive, though slow, growth. Future observations should be maintained on all seal populations on the island as we have yet much to learn about these animals, their habits and their future.

### Hooker's Sea Lion

Few records have been kept on Hooker's Sea Lions (*Phocarcos hookeri*) at Macquarie Island in the past but the occasional sighting is made. These seals are invariably wounded or exhausted when seen on the island, and their presence is usually maintained at their haul-out location for a few days. At least 5 distinct animals were counted in 1982, 3 males and 2 females, all being seen at North Head. Several reports of Hooker's Sea Lions were

made by expeditioners, but because of the animal's aggressiveness it was difficult to tag or mark them for future identification. Four of the animals remained in one location for a minimum of 3 days, and one female remained at one site for 2 weeks. At present, it is not possible to quote trends of population movement for these Sea Lions.

### Crabeater Seals

Crabeater Seals (*Lobodon carcinophagus*) rarely beach at Macquarie Island and little is known of their movements in that area. Only one was sighted in 1982 and was reported to be "sick" in appearance. It did not stay at its beaching-site for more than 24 hours. Although few sightings of these animals are made, it is worthwhile maintaining a watch for them on the island and keeping an update in the log books. Tagging of Crabeater Seals should also be encouraged.

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## LEOPARD SEALS

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Fur Seals and Elephant Seals breed on Macquarie Island and Crabeater Seals, Weddell Seals, Leopard Seals and Hooker's Sea Lions are regular visitors or vagrants. Leopard Seals, *Hydrurga leptonyx*, breed in Antarctic pack ice and spend most of their lives there occasionally visiting the shores of southern continents. They feed principally on Crabeater Seal pups and krill. Little is known of their biology since there are few places where it is convenient to study them, Macquarie Island, South Georgia and Heard Island being among those few. In 1976 a tagging programme was initiated on Macquarie Island to follow the movement of Leopard Seals passing the island from June to December. Overwintering ANARE expeditions have tagged and measured Leopard Seals for the Tasmanian NPWS over the past nine years. It appears that mainly 1-3 year old seals move out of the Antarctic pack-ice past Macquarie Island to reach temperate waters. Many of these animals are thin and must perish in our seas never to return to pack-ice. The interesting thing about this is that the numbers involved followed a 4 to 5 year cycle in the

period from 1949 to 1979. This cycle of abundance appears to have diminished because no distinct peak in numbers was obtained in 1982 as predicted. Adult Leopard Seals may live for up to 26 years but spend most of their lives in pack-ice zone around the Antarctic. Counting them and determining what regulates their abundance is proving to be a challenge.

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## THE RABBIT ON MACQUARIE ISLAND

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The rabbit *Oryctolagus cuniculus*, originated in the Mediterranean region and was introduced to islands of the Southern Ocean as a source of fresh meat for crews of sealing vessels. Rabbits have survived on the French subantarctic islands of Iles Kerguelen, Archipel Crozet, Ile Saint-Paul and New Zealand's Auckland Islands. They were introduced to Macquarie Island in 1878 from New Zealand and said to be domestic stock of French origin. They multiplied quickly and have now colonised most suitable habitat.

Rabbit research and control began in December 1965 when Greg Johnston of the Tasmanian Department of Agriculture spent the summer studying rabbits (Johnston 1966). Poisoning with 1080 was attempted but found to be impracticable on a large scale. In conjunction with the CSIRO it was decided to release in December 1968 the European rabbit flea *Spilopsyllus cuniculi* as a vector of myxomatosis since there were no other suitable mobile insects (Sobey *et al.* 1973). For the next 10 years the rabbit flea was released throughout Macquarie Island and in November 1978 myxoma virus was first introduced.

During the summers of 1969, 1970 and 1971 Bob Gould of the Department of Agriculture released 32,600 fleas. Altogether 242,000 were released up to 1980 (Skira *et al.* 1983). In 1972 the National Parks and Wildlife Service was asked to contribute to the programme and I spent the 1972 summer releasing fleas. Detailed studies on rabbits only commenced from 1974 when I wintered in 1974, Geoff Copson in 1975, 1978 and 1980 and Nigel Brothers in 1976 and 1979. Summer work only was done in 1981 by Service Trainee rangers.

The detailed life of the rabbit on Macquarie Island is now well known (Copson *et al.* 1981, Skira 1978, 1980). Briefly the most important facts are that it mainly occurs only on one third of the island, its distribution corresponding to the extent of the herbfield plant formation. It breeds from August to mid-March, although in some years breeding may begin one month earlier. Average litter size is almost 6 and in some years many young survive the crucial first few months. Once they reach the age of one year, survival is high and longevity may be 3 or more years. Overall recruitment of young into the population is mainly controlled by the effects of wet burrows with help from predation by feral cats, skuas and wekas.

The effect by rabbits on native fauna and flora has been severe (Taylor 1979). The introduction of rabbits led to increases in feral cats and wekas which led to the extinction of the endemic parakeet *Cyanoramphus novaezelandiae erythrotis* and banded rail *Rallus philippensis macquariensis* by the 1890's, and intensive predation on burrowing petrels. The blue petrel *Halobaena caerulea*, and common diving petrel *Pelecanoides urinatrix*, once formerly abundant occur only on isolated stacks while the winter breeding grey petrel *Procellaria cinerea* is extinct. In the 5 years between 1974 and 1978 the

numbers of rabbits jumped from 50,000 to 150,000 because of several dry summers. The grazing pressure exerted by rabbits contributes to erosion and can alter the composition of particular plant communities and threaten the survival of some species.

Cats predate heavily on rabbits and a campaign to reduce rabbits should also help to reduce cats and wekas and make their eradication from the island a reality. Eradication of rabbits is probably impossible owing to logistics, rough terrain and scattered distribution of rabbits. However control through myxomatosis and other methods is practicable.

The introduction of myxomatosis in November 1978 greatly reduced rabbit numbers in many areas (Brothers *et al.* 1982). In one particular area the number of rabbits crashed from a peak of 78 rabbits/ha in March 1978 to zero after being ravaged by myxomatosis. The last count was 5 in October 1982. In many areas the regrowth of tussocks and of herbfield species like the impressive Macquarie Island cabbage *Stilbocarpa polaris* and *Pleurophyllum hookeri* has been remarkable and illustrates the effectiveness of rabbit removal.

However success over the whole island has not been achieved primarily because of irregular distribution of rabbit fleas, their slow rate of spread and the occurrence of rabbits in isolated and sedentary pockets. It took years to introduce and establish fleas and their limited distribution after 15 years indicates that other control methods should be tried in conjunction with myxomatosis. These alternate methods which mainly involve poisons and fumigators are realistic options only on a small scale. Direct and secondary poisoning of native fauna such as skuas are factors to consider in their use.

Geoff Copson is spending his fourth winter on Macquarie Island in 1984 and will try to answer such questions as immunity to myxomatosis in rabbits, the status of rabbit fleas and level of plant recovery. He is also attempting to reduce cat and weka numbers by every means. Returning Macquarie Island to its former natural state before man interfered is the ideal aim of the National Parks and Wildlife Service.

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# THE FERAL CAT ON MACQUARIE ISLAND

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## Introduction

Domestic cats must have been taken to Macquarie Island soon after its discovery in 1810; feral cats were reported on the Island by 1820 (Debenham 1945). No records are available on the activities of these cats for the next 70 years, but the role of the feral cat as a predator of burrow-nesting petrels was then recognised by visitors to Macquarie Island such as Hamilton (1894), Burton (1900) and Mawson (1916) (the latter two in Cumpston 1968).

During 1974 I studied the diet of feral cats on Macquarie Island by a combination of scat and gut analysis, in an effort to determine their present ecological impact on the Island's fauna.

## Results and Discussion

The percentage frequencies of the major food items found in 756 cat scats are presented in Table 1.

TABLE 1. Occurrence of major food items in 756 cat scats.

Food Item	Number of Scats	Percentage Frequency
Rabbit	619	81.9
Prion	220	29.1
White-headed Petrel	120	15.9
Mouse	33	4.4
Penguin	25	3.3
Rat	20	2.6
Weka	15	2.0

These results clearly indicate that rabbits, Antarctic Prions and White-headed Petrels were the major dietary items; other foods were less frequently eaten. The analysis of the gut contents of an additional 41 adult cats confirmed this finding but also indicated a seasonal change of diet during winter when less common food items such as wekas were eaten, and scavenging on dead elephant seals and penguins took place. Also, by the measurement of bone fragments it was found that 58% of the rabbits eaten weighed 200 - 300g, 23% weighed 300 - 600g, 8% weighed 600 - 1300g, and 11% weighed more than 1300g.

Cats were sighted and scats collected from all parts of the Island but densities were highest in areas of greatest prey abundance. It was estimated that in 1974 there were between 250 - 500 adult cats present and those cats collected were similar in size (mean weight of males 4518g; mean weight of females 2844g) to common domestic cats.

The ecological impact that these cats are now having on the fauna of Macquarie Island is difficult to assess, due to the other major ecological changes which have also taken place. However their depredations may still be affecting the less common species of petrels present.

Since most burrow-nesting petrels are absent from the Island during winter and the young rabbits have grown larger, the total amount of food available to the cats at this time is at a minimum. This winter food stress acts as a yearly limit to the cat population size and also causes the change in diet mentioned earlier. Thus if a major reduction in the rabbit population could be achieved, then this would cause a corresponding reduction in the cat population. The remaining cats would then become major predators of young rabbits in the following spring and summer and suppress the rate of increase of



the rabbit population. However if rabbits were eliminated from Macquarie Island, feral cats would become rare.

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## THE KELPFLIES (DIPTERA: COELOPIDAE) OF MACQUARIE ISLAND

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### Introduction

Kelpflies are small to medium-sized and characteristically rather flattened, pubescent flies which are adapted to live and breed on beaches. They generally reproduce in decaying piles of seaweed, especially brown kelps, which have been stranded by storms or high tides. Some species however, also breed in other organic matter.

Coelopids are amongst the most abundant insects on beaches where they occur and this is true of Macquarie Island also. Hence it is not surprising that two species of kelpflies were included in the first recorded collection of insects made on the island in 1894 by M.A. Hamilton.

In distribution the family is largely amphipolar (perhaps reflecting the distribution of brown kelps), occurring in temperate and subarctic regions of both hemispheres. Two species are known from Tasmania, the abundant *Chaetocoelopa sydneyensis* (Schiner) which occurs widely on the coastline of south-eastern Australia, and an undescribed species from Marrawah (D. McAlpine, pers. comm.).

This article summarises much of the previous information on the kelpflies of Macquarie Island and records some ecological observations made during a field study by the junior author in October-November 1983 and a subsequent study of captive flies undertaken in environmental cabinets in Hobart.

### Identification

The kelpflies of Macquarie Island can be distinguished from other flies occurring there by a combination of the following characters: Length 2.8 - 7.5 mm, greyish brown to black in colour, rather dorsoventrally flattened and bristly if fully winged, otherwise of rather humped appearance and densely pilose if with greatly reduced wings; front of head concave in profile, postvertical bristles convergent; terminal segment of tarsi triangular and wider than the preceding segments.

The following key, adapted from Hardy (1962), will identify adult flies of the 3 species:

1. Wings reduced to tiny non-functional lobes; small flies between 2.5 and 3 mm long . . . . . *Apetaenus watsoni* Hardy 1962
- Wings fully developed and functional; medium-sized flies 4-7 mm long . . . . .

2. Lower anterior margin of face with a small black spot on each side; metasternum bare . . . . .  
*Coelopa (Coelopella) curvipes* Hutton 1902  
 Face without a black spot as above; metasternum hairy . . . . .  
*Coelopa (Fucomyia) nigrifrons* Lamb 1909

*C. curvipes* also occurs in the Auckland and Chatham Islands as well as New Zealand whereas the other 2 species are apparently restricted to Macquarie Island. Remarkably, the only other *Apetaenus* known (*A. litoralis* Eaton 1875) is also incapable of flight and lives on remote Kerguelen Island in the South Atlantic Ocean. Such a disjunct distribution however is known for some other insect groups which occur on widely separated subantarctic islands and raises the possibility of faunal interchange or dispersal from a common origin. Gressitt (1962) speculated that much of the Macquarie insect fauna was recruited from sources to the west (e.g. southern South America) from where it came to the island through the agency of air and sea currents and birds.

#### Kelp as an Environment for Kelpflies

The Macquarie climate, though windy, is relatively mild and uniform the year round with mean temperatures near sealevel ranging from 3.0 to 6.3°C. Humidity is high, usually around 90%. The intertidal zone is dominated by the growth of the kelp *Durvillea antarctica* which is often detached from its holdfasts by frequent storms and cast higher upon the beaches. Consequently, this food resource is somewhat patchy in space and time, and is vulnerable to being swamped and washed back to sea.

Decaying kelp is a crucial resource for at least two of the three Macquarie coelopids and the sequential stages of its decomposition affect its exploitation. Newly cast fronds of kelp are firm and dark green in colour (Stage 1) but rapidly begin to break down. After a few days they become yellowish brown in colour with a sticky exterior and the internal texture becomes glutinous as it decomposes to a putrid semiliquid soup (Stage 2). Subsequently the kelp becomes semi-amorphous and coats or permeates the underlying substrate (Stage 3) before the decomposed liquid dries to a dark brown membrane which envelopes the substrate (Stage 4).

The majority of beaches are pebbly to rocky and large sections of the coastline consist of wave-cut rock platform. Kelp cast upon the beaches beyond the high tide mark is less prone to removal by wave action and is a favoured environment for larval development.

#### Biology

On relatively calm days adults fly along the littoral zone usually 1 to 2 metres above the ground. In the vicinity of stranded kelp their flight activity consists of apparently random short hops followed by walking a distance of several centimetres, stopping frequently to palpate and probably imbibe liquid from the surface with their extended tongue. Crevices amongst the kelp and substrate are actively explored as well as adjacent habitats such as amongst *Colobanthus* and *Cotula* plants.

The factors eliciting oviposition are not well understood but most eggs are laid on the underside of the kelp or on the adjacent substrate. In captivity, *C. nigrifrons* laid batches of small white eggs 16-62 in number in spaces between fragments of kelp. *Apetaenus watsoni* on the other hand laid groups of creamy coloured eggs on the gauze on top of their container in an untidy

group of several hundred but this was probably contributed by a number of females. In northern European *Coelopa* species, Dobson (1976) noted that masses of eggs are laid in parts of the kelp which are slightly warmer due to decay which is further promoted by larval feeding. Additional females are attracted and the weed is rapidly decomposed. The heat of decomposition promotes rapid growth of larvae, and together with the even climate and continuous supply of cast kelp, probably means that breeding occurs all year round - an uncommon phenomenon in insects living at high latitudes.

On Macquarie Island flies are attracted to kelp within a few hours of it being stranded (Stage 1), and are frequent visitors to such kelp until it reaches Stage 2. However, significantly less flies are attracted to late Stage 2 and Stage 3 kelp with established larval populations. This may be due to the risk of entrapment in the soupy texture of the kelp which also lacks crevices for oviposition in the latter stages of decay.

Aggregation of adults into compact clusters of flies often numbering thousands of individuals is a common feature of coelopid populations. This phenomenon has been noted by the senior author and H. Burton in *Chaetocoelopa sydneyensis* near Eddystone Point in N.E. Tasmania in January when thousands of adults clustered on coastal shrubs and offshore rocks. Watson (1967) recorded that clusters of Macquarie Island *Coelopa* adults often sheltered behind rocks and *Poa* tussocks during stormy weather and that *Apetaenus* adults congregate under rocks in penguin rookeries.

A remarkable feature of many kelpfly populations worldwide is the great range of variation in the size of individuals. This phenomenon may be a response to overcrowding of a fluctuating food resource and may limit density-dependent mortality in that large populations of maggots which threaten to exhaust their food supply may transform early into smaller adults rather than suffer high mortality (Dobson 1976). This size variation is commonly correlated with variability in a range of anatomical features which has led to taxonomic confusion in the past. A large size range is well exhibited by the Macquarie *Coelopa* species but to a much lesser extent by *Apetaenus*.

An adaption of *Coelopa* species to their littoral environment is their waterproof exterior. If swamped by seawater - a common hazard - adult flies soon float to the surface from which they can readily take flight.

Larvae of all 3 species are present all year round on Macquarie Island (Watson 1967) and breeding is probably continuous. Those of *Coelopa* can be found feeding gregariously in kelp at early Stage 2 and large populations of mature larvae are found in and under Stage 3 kelp. Weed which was stranded on drier substrates well above high tide mark, often close to *Poa* tussocks, hosted especially large number of larvae. It is possible that coelopid larvae require bacterial infection of the kelp in order to survive, either feeding on the micro-organisms directly or else on some products which they release (Dobson 1976). *Coelopa* larvae can also be found under the carcasses of dead animals such as sea elephants (Watson 1967).

Pupae of *Coelopa* species were found lying under and amongst stones and dried kelp at Stage 4 and a few were also found amongst fringing plants such as *Cotula*.

All stages of the life history of *Apetaenus watsoni* are commonly found under and amongst faecal covered boulders in the vicinity of penguin rookeries, such as the Royal Penguin rookery at Nuggets Point. However,

the fly is widely distributed over a range of habitats and Watson (1967) recorded larvae in crevices and amongst algae growing in coastal rocks.

#### **Predators and Other Mortality Factors**

Watson (1967) observed that predacious staphylinid beetles were widespread around the coast and active in seal carcasses and kelp throughout the year. In an environmental cabinet maintained at 5°C, adult beetles of *Omaliomimus albipenne* (Kiesenwetter) moved actively amongst rotting kelp and we observed them to eat eggs and first instar larvae of *Coelopa*. Although unconfirmed, other possible predators could be *O. venator* (Brown), any of the three native spiders and a diapiiid wasp parasite.

Introduced New Zealand wekas (*Gallirallus australis scotti*) include kelpflies in their wide range of dietary items (N. Brothers, pers. comm.) and it is likely that introduced starlings do also. There are no records as yet of pathogenic micro-organisms in any Macquarie Island kelpflies. Environmental factors may also detrimentally affect populations of kelpflies. Especially important is swamping of breeding sites by high tides and removal of the foodplant.

#### **Interaction Between The Species**

Both *Coelopa* species commonly occur in mixed populations both as adults and larvae, although in varying proportions. At present, details of interactions between them are poorly known. There is some evidence that the species differ in their preference of the type of substrate on which the kelp is stranded. Substrates dominated by pebbles or gravel generally less than 2 cm in diameter were colonised most often by *C. curvipes* whereas rocky substrates with particles generally exceeding 10 cm in diameter supported a larger proportion of *C. nigrifrons*. It was observed that where a mixed substrate occurred beneath the same pile of kelp, there was often vertical zonation of larvae in that *nigrifrons* dominated at depth amongst coarse stones whereas *curvipes* largely occupied the finer gravel above. Some horizontal differentiation was also noted on a similar pattern as also reported by Watson (1967), who additionally noted a preponderance of *curvipes* in seal carcasses. It remains unclear whether the basis for this phenomenon lies with site selection by ovipositing females, or active migration or differential mortality of the larvae.

In contrast, *Apetaenus watsoni* does not appear to interact to a large extent with the *Coelopa* species and is probably much less dependent on kelp for its survival.

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**THE BREEDING BIOLOGY OF THE  
LIGHT-MANTLED SOOTY ALBATROSS  
*PHOEBETRIA PALPEBRATA*  
ON MACQUARIE ISLAND**

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The Light-mantled Sooty Albatross is a bird of the Antarctic and sub-Antarctic regions. It has a circumpolar distribution and breeds on Macquarie Island and eight of the other sub-Antarctic Islands which are found either side of the Antarctic convergence. At sea it is most common between this oceanic front and the pack-ice of the Antarctic. Occasionally it is observed to the north in the Tasman Sea.

The breeding population of the Light-mantled Sooty Albatross on Macquarie Island is 500-700 pairs (Kerry and Colback 1972). Their nests are scattered along the steep hillsides and cliffs of the entire 85km of coastline. Mostly the nests are in ones or twos and are difficult to find among the tussocks and even harder to reach.

Observations on the species commenced in 1951 when birds were given bands made from narrow aluminium strips stamped "Inform ANARE Australia" (Howard 1954). A bird was found in 1970 and another in 1976 still wearing these bands! In 1954 bands supplied by the newly formed Australian Bird-banding Scheme were used (Kerry and Colback 1972). From then until 1969 114 adults and 71 chicks were banded and since then to the present a further 347 adults and 724 chicks.

A detailed study was commenced in 1970 initially to describe as fully as possible the biology and more recently the population dynamics of the species. The methods and some of the results are briefly summarized below.

The field work for this program was initiated by one of us (Kerry) during 1970 and the summer of 1971/72 and then by a number of ANARE expeditioners both from the Antarctic Division and the Tasmanian National Parks and Wildlife Service.

The main study is carried out at the north end of the Island within a 2km radius of the ANARE station. Usually 40-60 pairs breed there annually. The majority of the nests are found in Gadget Gully, First Gully and along the east face of Wireless Hill. Each year the nests are numbered and the parent birds checked for bands. Chicks are banded in February. A total of 398 nests have been recorded between the breeding seasons 1970/71 and 1983/84. Detailed records are maintained on computer file within the Antarctic Division and the banding records also with the Australian Bird-banding scheme.

During the early years of the study, nests outside the study area were searched but without success for banded birds which had moved outside the study area. Further there was no evidence of an interchange of breeding birds between Wireless Hill and the area to the south of the Isthmus. This suggests that the birds do not disperse very far around the Island and that population studies based on breeding birds at least can be made on the basis of birds marked and recaptured in the study area itself.

A second group of birds were studied from time to time. These are located at Bauer Creek Valley just inland from Bauer Bay. These nests are subjected

to minimum interference and serve as a control to monitor the effects, if any, of the more intensive investigations in the main study area.

The first birds for the season arrive about 1 October. Established breeding pairs arrive seemingly together. Courtship proceeds over a ten day period during which time the mate is selected or old pair bonds reestablished. The courtship displays are elaborate but two elements are observed commonly. These are the advertisement call performed by the male and the paired flight. The advertisement call is a disyllabic call "Pee-aw" call with the first syllable (pee) performed with the head pointing skyward and the second (-aw) with the head tucked to the breast. The paired flight is beautiful to watch. It is an ethereal *pas de deux* with both birds flying in synchrony. Courtship commences with the male on a prominent site or at a nest site calling to the birds flying past. Eventually one or more birds will land and the displays proceed through a sequence of elements which include those described above and also beak thrusting, self and mutual preening and tail fanning (usually by the male). At first the displays are very short and often break off early in the sequence with a member of the pair flying away. The other bird may follow and together they perform the paired flight. The ritual then repeats with the male often landing at a new site. Eventually a nest site is chosen, a rudimentary nest prepared. The hen after mating a number of times over 1-2 days goes to sea leaving the male to guard and continue to build the nest. She returns several days later, lays a single egg and again departs to sea leaving the male to take the first incubation shift. Both birds alternate shifts throughout the incubation, brooding and then feeding the chick.

Laying takes place between 20 October and 5 November. The first chipping of the egg occurs through the period 26 December - 3 January. The chick take 3-5 days to emerge from the egg and is brooded for about 18 days. The fledglings finally leave the nest between mid-May and mid-June after which no further birds are seen for the season. The incubation period is 64-71 days, the hatching to final departure 144-153 days and the total breeding season from the first adult to arrive to the last chick to leave is 253 days.

Once a breeding pair becomes established they will, with minor exceptions, remain together for life. One pair (00141, 00142) recorded together breeding in 1954/55 were still together in 1975/76 when they were last observed. Pairs tend to breed in the same location and even on the same nest. Chicks also seem to return to their hatching area when they eventually breed.

The hen lays a single egg which if broken is not replaced. During the period of 1970/71 to 1980/81 breeding success measured as eggs laid to chicks fledged averaged only 52%. It was found that if the pair failed to rear a chick then approximately 33% of the pairs return to breed the following year. However if they reared a fledgling then they miss a complete breeding season. Even then only 30% of these pairs breed 2 years later and a further 18% the year after that. Thus a pair of birds is capable of fledging a chick at best once every 2 years but on average once every 3-4 years. The reproductive rate of this species on Macquarie Island is probably the lowest for any avian species.

The cause of failure varies but since the 1971/72 season there appears to

be a steady decline in the success rate. It is unlikely to be due to human interference since failure of the control nests is similar. One possibility is a change in the availability of food. It has been suggested also that the predation of chicks by feral cats might have increased. It is possible also that the two causes are linked in that undernourished chicks are less able to defend themselves by spitting proventriculus oil. (I have observed a fully grown cat being repelled in such a manner by a two month old chick.)

The age-specific mortality for the species has not been calculated, however the recoveries of banded birds show the species to be long lived. Of the 66 birds banded as chicks between 1954 and 1964 11 have been observed 15 or more years later. The oldest known age birds were 27 years. So far only two birds banded as chicks have joined the breeding population one a hen aged 8 years and the other of unknown sex aged 6 years. It would seem that breeding at this age is exceptional since chicks have been banded each year since 1970 and only one of these has joined the breeding population.

After the chicks depart the nest they go to sea and remain there for several years. Virtually nothing is known of their movements away from the Island since only two birds banded at Macquarie Island have been recorded elsewhere. These were fledglings, and each was found four months after banding on the North Island of New Zealand. The young birds return to the Island from about 6 years of age onward. These adolescents are usually seen about the breeding areas with an increasing frequency after egg laying has ceased. They are then observed throughout much of the remaining breeding season often participating in courtship displays. Because of the short period of time between the arrival of both members of an established breeding pair it has been suggested that they remain together at sea. There is no direct evidence to support this hypothesis but it is interesting to note that birds have been observed displaying at sea among the pack-ice and that pairs remain together following a successful or an unsuccessful breeding season.

The study of the Light-mantled Sooty Albatross population on Macquarie Island has now spanned 33 years dating from the time banding first took place. It has provided interesting and valuable results. It is hoped that the study will continue for some time yet and that it will continue to provide useful data on this interesting and beautiful species.

The authors wish to thank all those expeditioners who assisted with this study and in particular to acknowledge the work of Roger Barker who died as the result of a fall while working on the project. We thank Howard Burton for computing assistance.

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## IT'S GREAT TO BE ALIVE, ESPECIALLY ON MACQUARIE ISLAND

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I am tired of writing "scientific" articles for ornithological journals. Nowadays these articles must be curt, statistical and non-speculative. They are dehumanised.

Five such articles of mine on the Wandering Albatross (*Diomedea exulans chionopectera*) at Caroline Cove, Macquarie Island are in various stages of publication or preparation. They deal with the morphology and plumage (Tomkins 1984), breeding success and adult mortality, egg fertilisation (Tomkins 1983a), purple bill flushes and "pink ears" (Tomkins 1983b), and the attendance of breeders and non-breeders there. Intriguing and thought-provoking though some of it may be, it is dry. Can I share with you some of the more fun side of Wanderers by describing observations, not data?

Macquarie Island is a flower, and don't let anyone tell you different. Green and brown, shapely, it glistens like a banksia bush in the dew. It is regularly daubed white, as when a bird on high sends its message to the flower below. It is swayed gently by a predictable breeze (cold and strong), and is sometimes shaken unkindly by earth tremors. But you do not run the risk of sunburn. Imagine then, after breasting Sodomy Ridge standing awestruck watching the white specks dancing in the caldera-like amphitheatre below. These are the magnificent Wanderers of Caroline Cove, circumpolar travellers of the Southern Oceans.

But first, a bit of background information. Approximately 11½ months after egg-laying the young birds fledge in rich dark chocolate brown plumage, but then change over many years into Persil white with intricately laced, finely tipped black feathers on their wings. Females don't become as white as males, and their dark plumage remains identifiably brown instead of the males' black. With a wing span of 3 to 3½ metres and body weight of 6 to 8½ kg they are one of the world's biggest sea birds. In spite of this their grace at sea, and majesty on the breeding ground, defies my description. They breed on several remote islands in the South Pacific, South Atlantic and South Indian Oceans. They probably live for 20 to 30 years on average, and at Macquarie Island in 1982 one supercilious male was breeding at 27+ years of age. They usually mate for life, but, compared with populations on other islands, there are an unusually large number of examples of a partner being absent from Macquarie Island for several years and then returning, only to find that in its absence its mate has commenced breeding with a third bird. All partners seemed to accept this "divorce" unperturbed. They lay only one egg per breeding attempt, and because of an extended period of chick care can raise only one chick every two years. This slow reproductive rate, the almost alarmingly high adult mortality rate, all coupled with the very small numbers of breeders at Macquarie Island (7 eggs in 1975 and less each year since then) makes this population very vulnerable to natural or unnatural mortality.

At the end of November males which expected to breed and those which did not have a partner (surely they know this) arrived; then came the females a week or two later. The males which expected to breed went to almost the exact spot as they bred last time, sat there, and went to sleep.



They rarely participated in colony society, content to save their energies until their loved ones arrived. Model solid citizens. Usually the female accepted her mate's choice of nest site, but sometimes matrimonial disharmony raised its voice. One female arrived for the first time that season whilst her mate was temporarily absent. She went to a site on which they had bred about three seasons previously, and there she sat. Hubbie returned, and invited her back to his rough arrangement of trodden tussocks he called home. But no. There she was, and in spite of his appealing to her in voice and caresses of that delicately wielded huge bill, there she stayed. Guess who gave in! Later that summer, at the other end of the island another "pair" experienced similar home-making problems. They each built a big nest within 1 ½ metres of each other, and each refused to visit the other's nest. No wonder they had not laid an egg for the past few years. But back to our typical pair. He stayed at home and slept most of the time. She occasionally visited him, to seek the comforts she can only get in port, otherwise she remained at sea, presumably feeding to build up energy for egg production. Two or three days before that happy event she flew into the colony, and immediately set about converting his wretched hovel into a proper, solid volcano of a nest. Usually she ignored him whilst building, pausing only for the occasional cuddle. Twice I watched different pairs cooperate in a spectacular fashion. The male walked slowly away from the nest, ripping up sods of roots and soil, and throwing them over his shoulder towards the nest. She either sat and stretched from her nest or moved off a little. But either way she picked up the exact piece he had thrown, and moulded it into the nest. This cooperation seemed unlikely to be due to coincidence.

Like all good stories these days, a bit of sex is essential. Copulation between partners of a breeding pair is not hurried, penguin-style. Lots of gentle preening, endless "talking" and the considerate fellow takes his time until m'lady is ready. His ungainly waddle backwards along her back, using her depressed folded wings as guide rails is effective. With the female sitting on the ground the pair seem so rock-steady that they could make contact repeatedly, without dismounting. But no - the male jumped off after each contact. At the moment of cloacal contact both birds remained motionless for up to 19 seconds, and this is a good field guide to successful copulation. They seem to be quite happy, and successful, and this acrobatic performance can be repeated several times in succession. They undertake these "sessions" several times a day, and at any time between first arrival at the colony and the day before egg laying. There is very little description in the literature of egg laying, so it was of particular interest to watch. Unfortunately I saw only two egg-laying, but both were essentially similar. Both laid whilst standing, with feet on the nest rim, and the egg was ejected quickly. Immediately before laying the first bird stood hunched, body leaning forward as if unbalanced, her head slightly forced forward and lower to the ground than was the other birds' usual upright stance. She remained in this strained, motionless position for at least three minutes, and then laid. Need I add that by the time we stumbled madly across the top of tussocks and the bottom of gullies with monstrous tripods and even more awkward movie cameras we were too late to film the egg laying? The second bird began to rotate her body about her pelvis, rhythmically rocking back and forth for several minutes before laying. Her body movements were as if she was

defecating in slow motion, i.e. a backward swing lifting tail and cloaca high. The frequency of her swings increased until she laid. Both birds stood motionless for a few seconds after laying, inspected and touched the egg, then settled on it and commenced to incubate. To this day egg laying on Macquarie Island remains unfiled. Had you been there you would have seen two grown men cry . . . At the moment of laying by the second bird there was no suggestion of the "frozen", strained position noticed with the first bird. Perhaps the first had difficulties in laying and assumed the strained position to assist her labour, whereas the second had a relatively easy laying, and the rocking is normal (I saw a slight rocking at egg laying with Shy Albatross on Albatross Island, Bass Strait.) Both birds are known to have laid a minimum of five eggs and therefore must be considered experienced layers. In 1975/76 all five eggs laid at Caroline Cove were laid in December (19, 23, 25, 26, 26) and the next year four of the seven eggs on the island were laid on 14, 14, 15, December and 5 January, and the other three on approximately 25 December ( $\pm 3$  days). Three obligingly laid by day, but four did not, and the rest were not under frequent observation. Tickell (1968) reports that in South Georgia it was usual for eggs to be laid during the day rather than during the night.

The high failure rate of eggs and chicks allowed only one chick to be followed through to fledging - and the duration of its incubation was 70 to 78 days, which surprised no one in that it is identical to the incubation period of Wanderers in other locations. Incubation shifts of both sexes is short in the beginning, gets longer, then shortens again as hatching approaches. At least that is what we presume happens on Macquarie Island - no one has ever sat and watched the entire cycle. Any volunteers? Within this generalisation some individuals vary their shifts enormously. For example, one male, who was a breeder years ago but who played the field in 1975/76, settled down and incubated his egg for 47 consecutive days the next season. His truant mate did not reappear that season, and he eventually abandoned it: as quick as a flash the everpresent Skuas were onto it. At the top end of the island two eggs cracked. They say "never let a chance go by", so, to see how long, if at all, these birds will incubate an artificial egg, the one and only Smilie Brothers (that human fly from TASPaws) carved two eggs from polystyrene, bolted their middle for weight, and "inserted" them. Both birds accepted, and both partners accepted them at the change of incubation shift. In fact the artificial eggs were incubated beyond the usual incubation period of 78 days by between 60 and 70%, and 23% of the normal incubation periods respectively. Dr. Gavin Johnstone (Antarctic Division) had both cracked eggs tested for organochlorine contamination, and both were very "clean".

Just to show that experiments do not always turn out the way we want, I will risk ridicule and banishment to a desk job and tell of my egg weighing experiment. In the summer of 1976/77 I weighed all 3 surviving eggs at Caroline Cove the day they were laid, and every five days afterwards. Three eggs at the north end were weighed every 10 days when possible. The pattern of egg weight for a healthily developing egg is a *constant, gentle loss* in weight so that at hatching it has lost approximately 15% of its weight when laid. Not so my eggs. *All increased* up to 10% of fresh weight, then most decreased. The two cracked eggs lost weight rapidly after cracking, but

even they increased after laying. Only one egg is known to have hatched, and the egg weight at hatching was approximately 16% less than at laying - but it had increased weight by almost 18% within 38 days of laying. Desperation is the mother of ingenuity, and when this egg was found cracked about eight days before hatching, Slippery Smilie sidled over and patched it up . . . Little Doug hatched healthily, but disappeared a few weeks later. To this day I have no satisfactory explanation for this unique pattern of increase and then decrease in weight. The scales were calibrated regularly, eggs were protected from strong winds, all were dry and relatively clean. This pattern is too unusual to present to the sceptical scientist (including myself!) until duplicate experiments can be done. And considering the very small number of eggs laid in recent seasons this experiment is not likely to be repeated. Thus my data are doomed to a dusty note book on a top shelf.

Incubation shift changeovers occur at any time of the day. (They may take place at night too, but this observer was too busy at night to check them out - I was usually trying to unscramble messages on the island radio session, or fighting sledge biscuits, or being led astray by goodie/grog-bearing visitors from the main station). Like all males the fellows (Wanderers) were most reluctant to give up their family responsibilities. To effect changeover some females had to resort to bullying tactics such as neck and wing biting, and even walking on her partner's back. The behaviour people would tell us that this is a response to territory (= nest and egg) ownership, but sailors of the Southern Oceans know that it is more comfortable to stay on the nest than to battle the elements at sea. However, to illustrate I have no chauvinistic bias I agree that in some circumstances females showed better judgement than males. When approached for egg weighing or other closeup activities incubating males usually put on a brave front and an even braver hooked bill - right onto the nearest unprotected arm, nose or ear. On the other hand the females recognised me as being harmless and let me do almost anything with them with only the occasional tempering snap at me.

Both sexes fed chicks, and I never ceased to be amazed at the gentle precision with which these birds manipulate that 156-181 mm hook-tipped bill. Feeding a two day old chick is a slow and patient process. Although it had greatly improved since 1 day old the chick still had great difficulty coordinating its movements. The chick spent most of its time asleep under its parents brood patch (often with its head pointing out from under the parents tail, peek-a-boo style) or eating. Feeding occurs at any time of the day, and presumably at any time of the night. To feed the chick the parent stood a little above it and put its bill down near the slightly exposed chick. The chick responded immediately by shuffling to face the same direction as its parent, and pointing head and bill up at 45°, waved its head from side to side, and commenced to call continuously. The parent then adopted an ungainly feeding position: its head and neck laid low on the rim of the nest, body pointed up at a sharp angle, and tail depressed (possibly as a counterweight balance). Wings were moved slightly away from the body and raised slightly: they remained folded. This may also assist the parent to maintain balance. The parent then formed a "trap" for the chick's waving head by manoeuvring its own neck, chest and bill into a "V", with its mandibles wide open on one side of the "V". The adult slowly moved this arrangement towards the chick, and fitted its gaping mouth over the chick's head. At this stage the

adult had muscular spasms of the neck and chest region, in readiness for regurgitation of oil. Sooner or later the chick put its head in the correct position - perpendicular to and across the parent's tongue, and feeding commenced. Sometimes the chick's waving head went into the parent's throat. The parent discharged small amounts of oil which ran along its tongue. (If you are bamboozled by all of this, try describing it yourself. Better still, watch the ABC film called "Ocean Wanderers".) Older chicks interrupt this flow whilst adopting the cross bill feeding position, and redirect it into their own throat by quickly moving their lower mandible up and down their parent's tongue. However, with a tiny chick a lot of oil was spilt, and it actually swallowed as infrequently as one in eight discharges. The chick's muscle coordination and the feeding technique improved noticeably daily, and at five days old most attempts at feeding were successful. Unlike other members of this Order, neither adult nor chick Wanderer ever regurgitated food in defence.

Assuming an incubation period of 78 days, the fledgling period (i.e. the time between hatching and fledging) of several chicks was known - 297, 283, 274, 266,  $284 \pm 5$  days, and less than 281 and 269 days. These durations are in close agreement to the average of 278 days on South Georgia. Large chicks from the previous breeding season were usually present at the breeding ground at the commencement of egg-laying, and some observers have suggested their presence interferes with activities of recently arrived breeders and non-breeders. I disagree this is so in this sparsely populated colony at Caroline Cove. Only once in three seasons was interaction seen between these chicks and the newly arrived adults. A large chick approached and supplicated to a non-breeding male who had landed and walked near the chick. The male snapped abruptly at the chick, and both went their own ways. Contrary to early belief, Wanderer chicks are not abandoned by their parents in normal growth. Five chicks fledged an average of nine days after their last observed feed, and in two nests a parent visited the nest site nine and one days after the chick had flown. Interestingly, only one parent was seen to return to the colony after the chick had fledged, either the male or the female. Also, neither parent of the chicks which fledged in 1976/77 was seen at the colony again that season after the chick had fledged. This may be because birds met at a given location at sea offshore from Caroline Cove, and there the news of chick fledging is communicated to those concerned. But more on association at sea later.

Two major components of the diet of Wandering albatross on Macquarie Island were probably squid and fish. Several boluses regurgitated by adults and chicks were collected, and they mostly contained squid beaks, and long strands or "sheets" of skin-like substance. These were dark green in colour, and knobbly on one side, and were much paler in colour and smooth on the other side. These may have been the outer skin of squid. No red "skins" or fibres were ever seen. (Red and green were the predominant colours I saw in boluses and excreta of Waved Albatross in the Galapagos Archipelago.) One female visited her large chick three times in two days. Her first visit was very disrupted by a very frisky non-breeding male, and little or no food was passed. Two days later she returned and fed the chick, which continued to supplicate vigorously until she left. Several hours later she returned again and regurgitated large sections of fish onto the ground. One piece was

salvaged from the indignant hungry chick and the flakes measured 40mm in diameter. Regurgitation of food onto the ground was not seen very often in Wanderers (however it was very common with the Southern Skua on Macquarie Island). Food was usually passed from the parent to the chick several times in each feeding session, and the maximum number of feeds in one session one gluttonous chick received was twelve.

The intensity of supplication depended, among other things, on its age. A chick two to six weeks old called very little, and softly, and was not very active physically. Frequently the parent seemed to instigate feeding, not the chick. In comparison, several weeks before fledging big chicks could identify their flying parents whilst they were several hundreds of metres distant, and commenced a whinnying supplication before the parent had landed. When the parent walked near the nest the chick approached and its call changed to a high pitched squeak. If the parent did not produce food quickly the chick tentatively touched its parent's bill, but soon hit it vigorously with side to side movements of its own bill. Preening by parents of small chicks before and after feeding sessions was common, but infrequent with chicks large enough to fly. Ticks were seen on fleshy parts of the face, legs and feet of large chicks, but the colony did not seem infested by the little beasts.

During their many months of growth chicks occupy their time in a variety of ways, but sleeping must be their most time-consuming activity!!! Nest building, which also serves as nest maintenance, was done by chicks from the age of four weeks onward. Snipping off tussock blades and ripping up grass and roots gave the vicinity of the nest a battle-scarred appearance. One chick was seen to cut and hold aloft a long leaf of Macquarie Island Cabbage (*Stilbocarpa polaris*) - yuk, I tasted awful, I don't know how early sealers and sailors ate it - and dexterously manipulated it with its bill, holding only the outer edge of the leaf. The same chick performed the same trick when offered a woollen mitten. (And if you really want a high, get a young female to nibble between your fingers and around your finger tips. Exciting!) As chicks get older they wander from their nest more frequently. A month or so before fledging it was rarely seen at its natal nest: in fact it may have constructed one or two small nests of its own nearby. I saw this happen with another subspecies of Wanderer on Gough Island *D. e. dab-banena*), too. It would be interesting to know if one sex builds these additional nests more than the other. Other workers (Tickell and Pinder 1972) have found that Wanderer parents can identify and locate their vagrant chicks at the age of 8 to 20 weeks old (probably by sight as well as voice), and will feed only their own chick. By comparison Black-browed Albatross and Grey-headed Albatross parents will feed any chick in the parent's nest. For a few weeks before fledging, chicks strengthen their muscles by practising flying, and this fun spectacle has been well documented by others. Several chicks grabbed and bit the elbow (carpal) joint of their wings whilst practicing, and made short high pitched whinnies (of frustration?). None of the chicks which fledged from Caroline Cove were seen again that season once they had flown. However, in another area, of gently sloping feldmark, a chick made several flights, the longest of which was one kilometer to sea, and then returned to land rather bumpily near its nest. After watching them grow for many months, I had a weird tightness in my throat as these chicks practised, climbed up high on a hill, and then disappeared in their debut flight. It may be the closest I ever get to "fatherhood".

Back to more tangible things, such as moult. Wing primary and secondary feathers and tail were not examined for moult (it is problem enough to accurately measure these not-so-gentle-giants on your own without having to unfold and extend their never-ending glider wings). No such feathers were seen on the ground during my three summers and an intervening winter, and it is unlikely adults moult these whilst at the colony. Several other albatross workers arrived at the same conclusion, and we can't all be wrong . . . On Macquarie Island the occasional body contour feather can be seen at any time of the year near a nest, and it is probable breeding adults undergo a gradual but continuous moult of body contour feathers. Incidental observations on the condition of paint sprayed on the neck and chest region allowed me to look for moult in these regions. No 1977 breeder or known ex-breeder showed any significant moult of painted feathers. One previously unbanded male ("Toorak" - his social habits were similar to that of some fair residents in that suburb in Melbourne Town and perhaps of Lower Sandy Bay) moulted slightly. He was a non-breeder in all three summers, and in the last had a combined plumage score (see Gibson 1967 for an excellent plumage pattern scoring system in which he used intermediate quarter scores to describe patterns on the head, back, wing and tail) of 19.25, which suggests he was, say, at least 15 years old. It is not known if he had ever bred, but in the last two summers he arrived later than was expected for this age group (i.e. breeders and exbreeders). Three of the four birds less than 12 years old (two females and one male) underwent distinct body moult whilst at the colony. The fourth bird, an eight year old male, showed no sign of moult, and was very active in courtship activities. It is possible he had reached full physiological maturity. This bird was one year older but considerably darker than a seven year old bird I thought was a male, who changed from a dark to a reasonably light plumage colour in only 33 days. Several authors agree that the change from the all dark juvenile plumage to the all white stage is a slow, gradual process, but when the long term study on plumage pattern in Wandering Albatross on Macquarie Island is completed by the Antarctic Division it may show the most dramatic change, from the juvenile to a "typical female" score of, say 11.00, and to a "typical male" score of, say, 17.50 occurs quite quickly - in two or three years - but changes after that are indeed slight and occur over many years. Breeding is not delayed until the plumage transformation is finished. Wise birds.

I believe birds from the same colony have a mechanism which allows them to communicate with each other at sea. The simultaneous arrival at the colony of non-breeders, simultaneous departure and arrivals of breeders, "disappearances" or presumed death in the same year of both members of higher-than-expected numbers of Macquarie Island breeding pairs, offshore congregations often seen from Caroline Cove (all subjects of papers being published in other journals) and the non reappearance of one parent of fledged chicks (this article) leads me to suspect individuals keep company with specific individuals away from the colony, at sea, far more than is currently believed. Richdale (1950, p. 52), in his memorable account of Royal Albatross in New Zealand says the same. Gibson's recapture off Bellambi, NSW of the same birds on the same day years apart also supported this idea, but a bit of fancy statistical analysis knocked that example for six!

Another "coincidence" which deserves comment is this: an examination of almost any sea bird log kept whilst a ship is in the range of Wanderers will show that very infrequently is only *one* Wanderer seen. Usually there are two or more in any general area. This species is not a "mass migrator" as are some others, e.g. shearwaters, so one does not expect to see groups of Wanderers, except at feeding grounds. No one has yet published the incidence of old birds flying with young birds, or old with old birds. This might throw some light on whether or not fledglings travel the world alone, or in the company of an adult, or with a parent. It may well assist in the comprehension of how young birds locate winter and summer feeding grounds. These age categories would have to be based on plumage characters; but in view of a paper being prepared by New Zealand workers on the variability of plumage between subspecies of Wanderers, this category allocation could be very misleading. Valuable observations from coastal and seaward stations (e.g. Barton 1979 and Cox 1976) could give plumage pattern details rather than the observer's interpretation of age. All these "coincidences of association" above may be simply due to chance. Information gained about association at sea of specific birds (i.e. by radio telemetry or satellite tracking) may increase our knowledge of the mechanisms controlling the formation and maintenance of pair bonds between breeders. What happens at sea is one of the darkest spheres of our knowledge of sea birds. My idea of association at sea by specific individuals is unacceptable to most workers. I ask though, that future research into the unknown be tackled with an open mind, and not discard theories simply because there is no proof, nor simply because it is beyond the scope of Man's surprisingly narrow perspective. A proverb I recently coined says "Big hypotheses come from small figments . . .".

The best is yet to come. What you did depends on who you were, i.e. breeder or non-breeder. We already know what social sticks-in-the-mud breeders were. How and why did the non-breeders (who were also colour banded and colour painted) differ? If you agree with me that the ultimate objective of their sometimes frantic antics during summer was to select and then secure a mate, then let's look in general terms how they did it. The male claimed a bit of earth as theirs, and threw together a rough nest on which they slept, rested and attracted females - I called this their "display nest". Females do not have such a nest. Females flew over the colony checking out the males, who displayed their wares to them. If interested she landed (i.e. "visits"), and they engaged in "courtship displays". Males often visited other males, especially when a female was there. If any inter-male aggression followed then the owner of the nest area almost always won.

Although some preliminary sequences of courtship displays by birds sitting on the sea have been seen, most occurred on land, at their natal colony. Courtship displays are a series of manoeuvres which culminate in an almighty shrieking of first one then the other bird. The noise cannot be put on paper, and the courtship displays are both intricate and rapid, so I recommend that you contact the Antarctic Division or TASPAAWS and view "Ocean Wanderers", one of the four magnificent programmes on Macquarie Island in the ABC-TV series "Edge of the Cold", filmed by David Parer. Some experts tell us the function of the courtship display is to break down male barriers of aggression, and to assist the birds to synchronise their hormonal and physiological condition so that they will both be at the same

stage of readiness when they commence breeding.

Aggression is an obvious part of a male's personality. Take for example Gilbert (a male whose sexual exploits were second only to a certain expeditioner, after whom the bird was named . . .). I watched him for three consecutive summers and he metamorphosed from a knock-them-down-and-bite-them (literally!!) type to a gentle, mild-mannered fellow, living in sin for the third summer with a charming lady - they bred the following summer, so perhaps their cohabitation was vindicated? The behaviour of the females changed too, as Randy-Mandy showed. She was a pretty active young thing, but summers later she ended up a model breeder.

The aspect of non-breeders behaviour which most interested me was the apparent presence of a hierarchy - a pecking order, in both males, and females. In intra-sex aggressive encounters on neutral ground the same males, often older, usually won, as did older females. In multi-bird courtship displays very young males and females were often forced to sit on the side lines and watch their elders, and this was probably because they were not proficient at their display steps. But they were aggressively excluded. Slightly older males fought their elders to get part of the action. In the air, as a group of up to 7 birds circled the amphitheatre in "line formation" gestures and calls which I interpreted as being aggressive or threatening, were common. It seemed that these gestures were made by younger birds following an older bird, and by any male following an older female. If such a hierarchy exists, it is reasonable to assume that it has advantages to the Wanderers. It may be that aggressive males rather than old males win a female as a life partner - this is one of the subjects of my next article.

Macquarie Island is magic, Wandering Albatross are enthralling. But so are most animals in the wild. Most have idiosyncracies, and if you take the time and have the patience to learn about them then the rewards are enormous. I enthusiastically recommend to all field naturalists, beginners or old hands, the gentle practice of sitting and watching, and loving life.

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