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FEEDING BEHAVIOUR AND OTHER NOTES ON 20 SPECIES OF PROCELLARIIFORMES AT SEA

By PETER C. HARPER

ABSTRACT

Between January 1965 and March 1967 4926 observations were made on 20 species of petrel feeding in the Southern Ocean from the research ship USNS *Eltanin*. Most observations were made at night while the ship was stopped on oceanographic research stations. Observations were made possible by bright decklights, following birds with the powerful bridge lights, or under moonlight. Eleven feeding methods were distinguished. Most common were surface seizing (49.1%: used by 14 species), dipping (25.2%: 9 species), and surface plunging (c.6%: 6 species). Seven species foraged entirely at night, and five fed by day only. Food recorded was chiefly crustaceans and squid. The submergence time and prey-handling time for some species are also given.

INTRODUCTION

In the late 1960s and early 1970s the main trend of interest in seabirds was to identify seabirds, rather than to inquire what the birds were doing at sea. Times have changed. The last decade has seen a great interest in seabird diet and feeding methods (e.g. Ainley 1977, Croxall & Prince 1980, Prince 1980 a, b, Brown *et al.* 1981, Clark *et al.* 1981, Imber 1981, Morgan & Ritz 1982, Hunter 1983, Croxall *et al.* 1984, Green 1986).

In a recent review, however, Croxall (1984) emphasised how few observations there are of Procellariiformes feeding, particularly under natural conditions, and especially to support the substantial circumstantial arguments that they do so extensively at night. Moreover, his statement that most petrels "probably catch their prey by 'surface seizing' is a brief but rather accurate summary of what is known on how petrels catch their food.

The purpose of this paper is to provide details of observations deriving from eight *Eltanin* cruises in the Southern Ocean between 1965 and 1967, and in particular:

1. To show that Procellariiformes can feed effectively at night both under natural conditions and on prey attracted to ships by lights;
2. To show that Procellariiformes can catch live squid, sometimes of considerable size;
3. To show the extent to which some species of Procellariiformes forage either by night or by day; and
4. To provide information on topics such as submergence time and prey handling time, rarely recorded for seabirds at sea.

METHODS

Figure 1 shows where *Eltanin* cruised and the dates for each of the eight cruises while I was aboard. During the 363 day, 30 000 nautical mile journey, the Polar Front (Antarctic Convergence) was crossed 15 times. My main preoccupations at the time were to study prions (Harper 1972, 1980) and to gather information for an identification guide to the southern albatrosses and petrels (Harper & Kinsky 1978). My notes on the feeding behaviour of petrels were recorded incidentally.

While *Eltanin* cruised at 9 knots between oceanographic stations, I made bird observations for most of the day from either the bridge or the helicopter deck some 15 m above the waterline. Birds were counted and observed within a 180° field of view in front of and behind the ship, providing a census strip about 0.8 km in width. In calm weather the bow and stern were good points from which to watch birds closely. I used 7x50 binoculars. The ship's position was plotted by satellite navigation. Air and sea surface temperature (SST), sea state, wind speed and direction, and ocean depth were all plotted hourly and were available in the form of data sheets. All times given below are local.

The *Eltanin* frequently stopped for up to 30 h for oceanographic research. During this time, the ship was brilliantly lit up and various forms of plankton, including crustaceans, were attracted to her beacon-like decklights. On calm clear nights squid could be both seen and heard splashing and darting about after their prey. This activity also occurred when the ship was in darkness, and is presumably due to the well-known diurnal vertical migration of zooplankton to the sea's surface at night.

I sometimes had excellent views of squid in the water and occasionally caught one on an unbaited line hung over the side of the ship. My attempts to catch them with a fine-meshed net were mostly unsuccessful. The krill sometimes proved a problem for the ship stopped on station, in that they blocked the three-foot square seawater intakes to the engines. In the Scotia Sea (Cruise 22) a bucketful of Antarctic krill, *Euphausia superba*, was extracted about every 10 hours after dark, with a smaller amount taken during daylight hours. In this way, the presence of crustaceans in the water was confirmed and the species identified. I measured straightened euphausiids from the tip of the rostrum to the caudal end of the telson with vernier calipers.

Seabirds frequently fed at night about the ship. Many came to the decklights and set about feasting in the water; others were spot-lit, while

feeding, with 1500 W bridge signalling lights. The powerful signalling lights (effective operating range of 4 km) had slatted blinkers so that they could be swung in complete darkness over a wide arc and easily opened at will on the unsuspecting birds. They were invaluable not only in confirming that petrels were feeding beyond the range of the decklights, but also in attracting birds on board in times of poor visibility when the birds were easily blinded (Harper 1972).

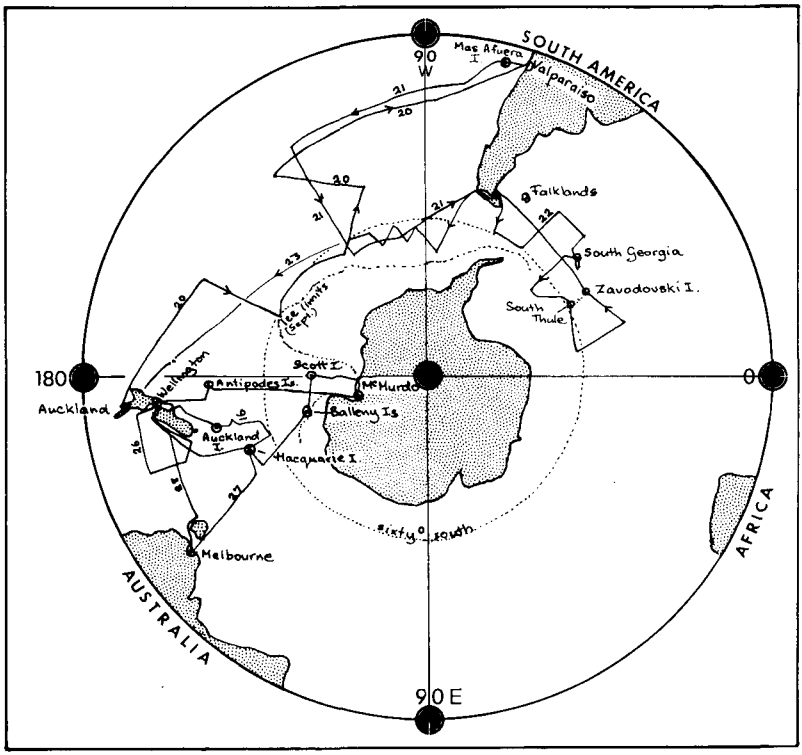

FIGURE 1 — Cruise tracks of Antarctic research ship USNS *Eltanin* 1965-1967

ITINERARY

Cruise 16	28 Jan - 26 Feb 1965	NZ Subantarctic
Cruise 20	14 Sep - 12 Nov 1965	NZ-South Pacific-Chile
Cruise 21	23 Nov - 8 Jan 1966	Eastern Pacific
Cruise 22	19 Jan - 17 Mar 1966	South Atlantic
Cruise 23	31 Mar - 30 May 1966	Chile-South Pacific-NZ
Cruise 26	29 Nov - 20 Dec 1966	Tasman Sea
Cruise 27	31 Dec - 1 Mar 1967	NZ-Ross Sea-Australia
Cruise 28	10 Mar - 28 Mar 1967	Tasman Sea

From the deck about 3 m above the sea, I could observe the feeding petrels, some of which were species rarely seen close to the ship by day (e.g. *Pterodroma* petrels). I could watch them very closely; e.g. I could see them shut their eyes while they fought larger squid. I did not see any birds catching fish, however, although the trawl catches (0-300 m) indicated that fish were certainly present during some of the observations.

What follows is an annotated species list of the petrels I saw feeding from the *Eltanin*, together with a few general behavioural notes made on other occasions. The species listing mainly follows the New Zealand Checklist (Kinsky *et al.* 1970). For each species the foraging techniques, defined below, are in descending frequency of occurrence; 'prey handling time' is defined as the time spent capturing and disposing of prey; these sequences were sometimes timed with a stopwatch. Each observation is of one bird feeding in a particular way. Whenever birds were all foraging in the same way, I have counted them and totalled the number of observations. This procedure took time, and therefore my total counts are conservative. If birds in a large flock were all feeding concurrently, I estimated their numbers. These are noted as n = c.1000.

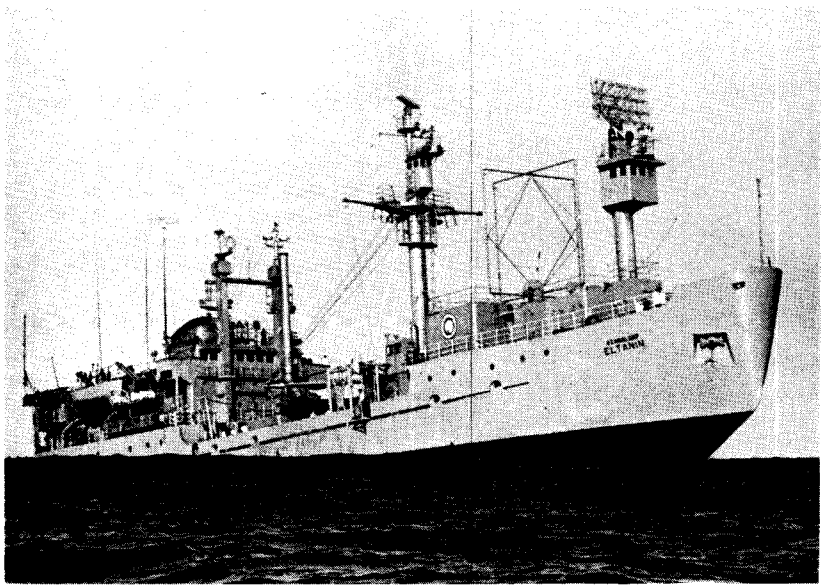

FIGURE 2 — USNS *Eltanin* at sea, riding over a low 3 m swell

DEFINITIONS

The definitions below are derived from a recent review and redefinition of seabird feeding methods (Harper *et al.* 1985).

Surface feeding: A bird remains on the surface while taking food.

Surface seizing: A bird grasps individual prey items with its bill.

Surface filtering: A bird filters out and swallows many food items at a time from the water.
Hydroplaning: A bird filters minute plankton with its breast on the water surface, its head immersed and its wings outstretched, propelling itself through the water with its feet.

Flight feeding: A bird remains airborne, capturing prey at the water's surface; it may momentarily cease flying, but it makes little or no contact with the water.
Dipping: A bird in flight picks prey from on or just below the surface of the sea with little or no use of its feet. Only the bill, head or breast makes momentary contact with the water.
Pattering: A bird uses its feet as well as its wings to maintain a precise height above the water and feeds by picking minute prey items from the surface.

Plunging: A bird in flight plunges into the water, using the momentum of the fall to help it catch prey without pursuit swimming.
Surface plunging: A bird splashes into the water without fully submerging.
Shallow plunging: A bird submerges completely but penetrates little more than its own body length below the water surface.
Deep plunging: A bird submerges completely and penetrates several metres under water, usually preceded by a high near-vertical dive.

Diving: A bird settled on the water surface submerges completely to catch its prey.
Pursuit diving: A bird that is settled on the water dives and pursues its prey underwater by pursuit swimming, using its wings or its feet.
Surface diving: A bird submerges only momentarily, directly on to prey with little or no pursuit swimming.

Pursuit plunging: A bird in flight plunges into the water and then pursues prey underwater by pursuit swimming, using its wings or feet for propulsion.

RESULTS

In all, 4926 observations were made on petrels representing 20 species of seven genera (Table 1). The feeding behaviours, expressed as a percentage of the total observations, are shown in Table 2. Table 3 shows the percentage of records for each species for individuals feeding by day and by night. Specimens of birds collected during the *Eltanin* cruises are in the National Museum, Wellington.

ALBATROSSES AND MOLLYMAWKS

WANDERING ALBATROSS *Diomedea exulans*
ROYAL ALBATROSS *D. epomophora*

Wandering Albatrosses commonly followed the *Eltanin*, and sometimes particular birds which could be individually identified followed us for several days. Adult male and female birds in the South Pacific were seen displaying to each other in the water (facing each other with wings extended and sky pointing with the bill). On one occasion a male and female attacked an immature bird which approached, putting it to flight (18 Dec 65: 49°02′ S

TABLE 1 — Summary of observations made on petrel feeding behaviour during eight voyages of USNS *Eltanin* 1965-1967. For definitions of behaviour, see text.

	DIVING		PLUNGING			SURFACE FEEDING				FLIGHT FEEDING		
SPECIES	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	Surface seize	Ice gleaning	Surface filter	Hydro-plane	Dipping	Pattering	Total obs
Wandering Albatross		3		2		256						261
Black-browed Mollymawk	1		4			227						232
Light-mantled Sooty Albatross			2			21		4				27
Giant Petrels(both species)		8	7			193		19				227
Cape Pigeon	21	33	77			169		44	2	58		404
Snow Petrel						54	19			141		214
Grey-faced Petrel						27				22		49
Kerguelen Petrel										40		40
Mottled Petrel						4				10		14
Juan Fernandez Petrel						1						1
Broad-billed Prion			c200			22		14	251			c.487
Antarctic Prion		21				402		5	96	c.41		c.565
Thin-billed Prion						131				77	98	306
Fairy Prion			4			901				756	48	1709
Grey Petrel					13							13
White-chinned Petrel					2	11						13
Short-tailed Shearwater	26				33							59
Black-bellied Storm Petrel										21		21
Wilson's Storm Petrel										77	207	284
TOTAL OBSERVATIONS	48	65	c.294	2	48	2419	19	86	349	c.1243	353	c.4926

TABLE 2 — Feeding behaviours expressed as a percentage of the total number of observations made from USNS *Eltanin* 1965-1967.

SPECIES	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	Surface seize	Ice gleaning	Surface filter	Hydro-plane	Dipping	Pattering	Total obs
Wandering Albatross		1		1		98						261
Black-browed Mollymawk	1		1			98						232
Light-mantled Sooty Albatross			7			78		15				27
Giant Petrels(both species)		4	3			85		8				227
Cape Pigeon	5	8	19			42		11	1	14		404
Snow Petrel						25	9			66		214
Grey-faced Petrel						55				45		49
Kerguelen Petrel										100		40
Mottled Petrel						29				71		14
Juan Fernandez Petrel						100						1
Broad-billed Prion			c.40			5		3	52			c.487
Antarctic Prion		4				71		1	17			c.565
Thin-billed Prion						43				25	32	306
Fairy Prion			1			53				44	3	1709
Grey Petrel					100							13
White-chinned Petrel					15	85						13
Short-tailed Shearwater	44				56							59
Black-bellied Storm Petrel										100		21
Wilson's Storm Petrel										27	73	284
												c.4926

TABLE 3 — Percentage records for each species for individuals feeding by day and by night

SPECIES	Day feeding %	Night feeding %	Total obs
Wandering Albatross	79 (7)*	21(93)	261 (119)
Black-browed Mollymawk	78(82)	22 (18)	232 (141)
Light-mantled Sooty Albatross	100	0	27
Giant Petrels(both species)	88 (89)	12 (11)	227 (64)
Cape Pigeon	72(67)	28 (33)	404 (246)
Snow Petrel	100	0	214
Grey-faced Petrel	0	100	49
Kerguelen Petrel	0	100	40
Mottled Petrel	0	100	14
Juan Fernandez Petrel	100	0	1
Broad-billed Prion	69	31	c.487
Antarctic Prion	100	0	c.565
Thin-billed Prion	0	100	306
Fairy Prion	99	1	1709
Grey Petrel	100	0	13
White-chinned Petrel	35 (51)	65 (49)	13 (9)
Short-tailed Shearwater	0	100	59
Black-bellied Storm Petrel	100	0	21
Wilson's Storm Petrel	100	0	284
			c.4926 (4347)

* Figure in brackets is % with ship's garbage feeding removed: i.e. natural food

120°05′ W, SST 10.4 °C). These same two birds followed the ship due south for 200 nautical miles (to 52° S, 120° W, SST 8.6 °C) and were seen displaying on the water whenever the *Eltanin* stopped for research.

Southern Royal Albatrosses *(D. e. epomophora)* were observed near the New Zealand east coast and off the coasts of Tierra del Fuego – two on 6 Jan 65: 52°52′ S 75°16′ W, SST 9.2 °C and six on 20 Feb 1966 about 20 nautical miles from Staten Island in waters of 7.8 °C. This species was looked for but not seen south of the Polar Front.

Wanderers will eat any edible ship's garbage. Red and orange items (orange peel, cigarette packets), probably mistaken for similarly coloured pelagic food (Harper 1979), attracted attention and were often retrieved from the water and manipulated in the bill for a few seconds. They were not eaten. The handling time for such items was 3-8 s (n = 51).

Surface seizing: This is the most common foraging behaviour of albatrosses. The birds alighted, sometimes heavily, on the water and swam rapidly towards prey with outstretched neck and sometimes opened wings (n = 256). The bill was sometimes opened, presumably in anticipation of prey. Several birds would briefly quarrel over a large single food item, often croaking and bill clappering at nearby smaller Diomedeidae and petrels. Adult birds generally won conspecific disputes, although on six occasions when 2 or 3 Wanderer adults were outnumbered by 7-11 juvenile birds, the young birds successfully plundered the food first.

Adult Wanderers effectively repelled all Procellariidae for floating food, except when White-chinned Petrels *(Procellaria aequinoctialis)* resorted to dive-bombing small groups of Wanderers, startling them long enough to

snatch their intended food. Adult giant petrels (*Macronectes* spp.) were twice seen to strike Royal Albatrosses with their opened wings for the same result; on both occasions they were unsuccessful. Body size presumably confers a competitive advantage. However, the smaller species, with their greater manoeuvrability, usually arrived at food first.

If food sank, the albatrosses would attempt to retrieve it by partial tipping, like ungainly ducks, with their heads and necks submerged (n = 8).

Surface diving: Albatrosses submerged briefly with only their wing tips above water (n = 3). I have not seen greater albatrosses dive for food sinking below 1 metre.

At night both Wanderers and Royals were much more aggressive and vocal than during the day. A Cape Pigeon *(Daption capense)* which came too close to one immature Wanderer was abruptly seized by the head, lifted from the water and shaken violently before being released. It retired into the night, apparently unharmed.

The greater albatrosses took surface krill and small squid by snatching mouthfuls of the water containing them. They pursued larger squid (seen to be c.30 cm in length) by gliding on outstretched wings just above the water and dropping noisily on them from a height of less than a metre. To maintain height they used their feet to paddle the water – this feeding behaviour required wind speeds above 15-20 kt. On calm nights, when albatrosses had no manoeuvrability in the air, they hunted by stealth, remaining quietly on the water with their wings closed. They grabbed their prey by suddenly snapping at the water. If this proved unsuccessful, they paddled a few metres and tried again.

Squid were efficiently processed. The maxillary pressure of an albatross's bill is sufficient to disable even large squid, some up to c.40 cm in length. On 11 occasions I saw Wanderers drop motionless squid into the water and leave them for several seconds, before retrieving them to eat. They swallowed squid by raising the head and choking slowly. They also chopped and tore the squid into pieces, using either their sharp bill toma or vigorous head shaking. Dark-plumaged immatures appeared to dismember prey more often than adults, suggesting that manipulation of prey may change with experience. Prey-handling time for squid averaged 30.1 s (range 14.5 s to 2.6 min: n = 11). On 10 Dec (Station 13: 40° S 107°22′ W, SST 12.3 °C) at c.2100 h, four *exulans* were seen in the moonlight catching large squid from the surface about 2-5 m from the stern of our darkened stationary ship. One squid hooked on a line was retrieved and photographed (Fig. 3); Dr P. G. Rodhouse (BAS) has recently identified it from the photograph as *Martialia hyadesi*.

Shallow plunging: On 20 Sep 65 at 1100 h (42°59′ S 154°56′ W; wind 14 kt, swell 2 m; SST 9.5 °C, air 9.1 °C), one submature Wanderer was seen to drop from c.3.5 m into the water, completely submerging. It repeated this behaviour 7 min later. Albatrosses are buoyant in the water – this is an unusual way for them to seek food.

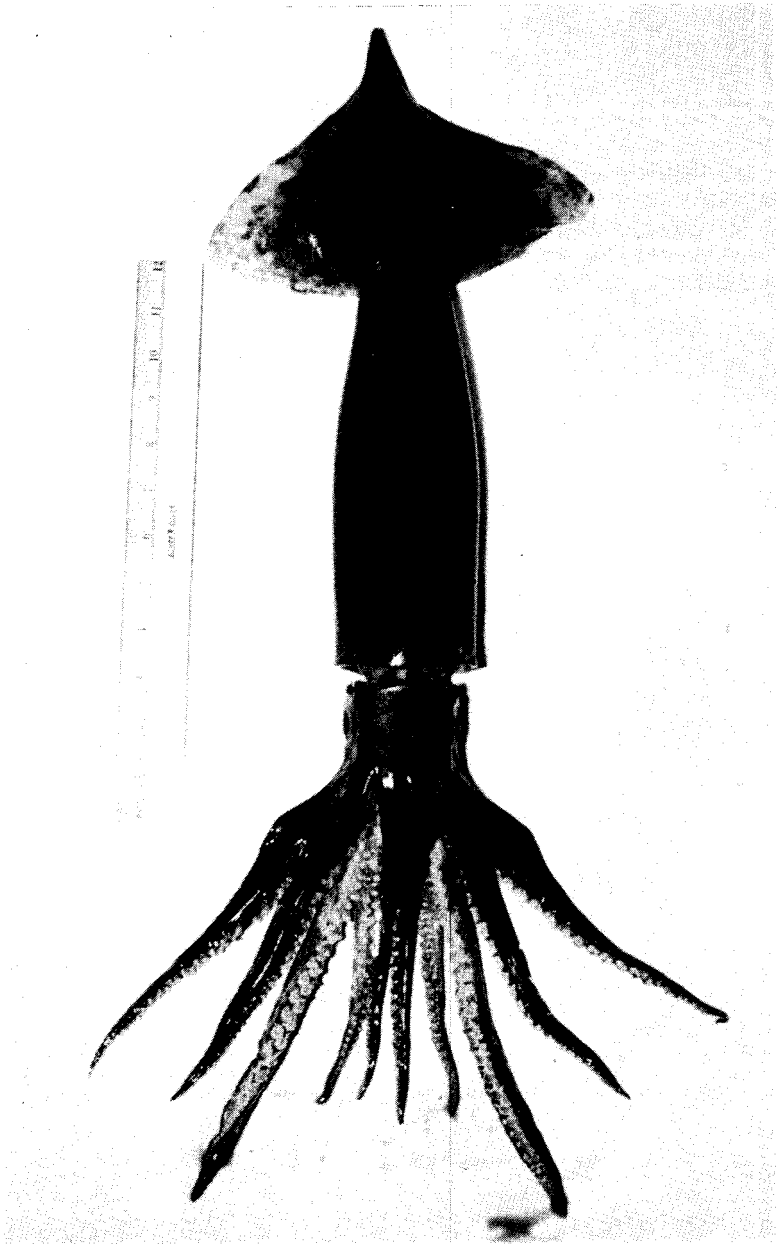

FIGURE 3 — The squid, *Martialia hyadesi*, hooked on a line near foraging Wandering Albatrosses *(Diomedea exulans)* on 10 Dec 1965 (40° S 107°22′ W). See text. An adult Wanderer attempted to retrieve the squid from the line as it was being taken from the water.

BLACK-BROWED MOLLYMAWK *Diomedea melanophrys*
NEW ZEALAND BLACK-BROWED MOLLYMAWK *D. m. impavida*

Black-brows are frequent ship followers, particularly *impavida* in the shelf waters of the New Zealand plateau. The disappearance of dozens of birds from the stern once a ship crosses into deeper waters can sometimes be spectacular. Black-browed Mollymawks are well-known and vocal garbage scavengers and are a good match for giant petrels in contesting food.

Surface seizing: Garbage items, crustaceans, large salps, jellyfish, and salps *Pyrosoma* were taken by surface seizing (n = 227).

Surface plunging: Black-browed Mollymawks surface plunged from heights of 2-5 m after natural prey during daylight hours. They opened the wings immediately after submerging and made no attempt to wing row. The wing tips remained above water. I could not see what food the birds were seeking (n = 4).

Pursuit diving: One immature *impavida* dived from a height of c.6 m into the water directly below the bow of the stopped *Eltanin* and wing-rowed out of sight until it returned to the surface about 20 s later. It had something in its throat which it swallowed before taking to the air (26 Feb 67: 45°30′ S 147°08′ E, wind 12 kt, swell 2 m, SST 13.8 °C). This is the only observation I have of a mollymawk swimming under water.

LIGHT-MANTLED SOOTY ALBATROSS *Phoebetria palpebrata*

Although this small albatross is abundant in the Southern Ocean, I saw it feeding at sea on natural prey on only five occasions, all south of the Polar Front. By day it rarely alighted on the water near the ship.

Immature birds ventured well south of the Antarctic Circle in the Ross Sea near Scott Island during January 1967. My southernmost record is of four immatures on 31 Jan at 71°23′ S 179°06′ W, where the SST was -0.2 °C.

Surface seizing: The albatrosses alighted on the water during the day to search for food among floating garbage in the same way as other Diomedeidae (n = 21). They normally kept out of the way of the other seabirds.

A curious incident occurred on 18 May 1966 (47°34′ S 167°32′ W, SST 10.7 °C). One adult *palpebrata* from an airborne group of 13 alighted near 7 settled *exulans*, which were investigating garbage near the stern of *Eltanin*. On approaching the larger birds, the Sooty was immediately challenged by an adult male and an adult female Wanderer, which clappered their bills and grunted at the newcomer. The Sooty abruptly seized one of its own wings at the carpal flexure and began fiercely savaging it. With its body tilted to one side and slowly beating the air with one foot, the bird battled with itself for 20-30 s, after which it swam away to preen with unusually rapid and jerky movements of its head. After drinking some water, it took to the air.

I have no explanation for this behaviour, except to suggest that the bird was expressing displaced aggression. Prions and the shearwater *Puffinus griseus* in the throes of dying of starvation sometimes fiercely bite their wings just before death.

Surface filtering: Four Sooties were surface filtering among a large concourse of other petrels in a swarm of *E. superba* on 20 Feb 66 (61°44′ S 22°27′ W, SST 1.2 °C – see Harper 1973). They inserted about half their partly opened bills into the water and rapidly sucked water containing euphausiids into their mouths. The euphausiids were retained and swallowed merely by closing the bill.

Surface plunging: On 2 March 1966 (55°24′ S 18°58′ W, 2.3 °C), a flying adult Sooty was twice observed foraging by day like an ungainly tern. While passing the ship, it dropped to the water vertically from a height of c.8 m to seize unknown prey in the water, and immediately took off.

PETRELS, PRIONS, SHEARWATERS, STORM PETRELS

SOUTHERN AND NORTHERN GIANT PETRELS
Macronectes giganteus and *Macronectes halli*

As these two species were not distinguished until 1966 by Bourne & Warham, whose findings were not available to me on the *Eltanin*, I have distinguished my giant petrel sightings below from plumage notes and Ektachrome colour photographs.

Giant petrels, particularly *halli*, are well known as persistent ship followers and scavengers. The increase of their numbers with the rise in wind and sea conditions heralding a cold front was a conspicuous feature of weather conditions during the South Pacific *Eltanin* cruises, and several species of larger petrels clearly gained a wind-assisted passage from one side of the Pacific to the other. This was particularly true of immature giant petrels leaving their nests in the New Zealand region and migrating eastwards across the Pacific in May 1966. They rarely paused by the *Eltanin*, which was punching slowly westward into oncoming gales. During the brief intervals that the wind dropped, the young giant petrels vanished, riding before the wind. The passage of cold front systems and their effect on the distribution and feeding ecology of Procellariiformes clearly require study.

Giant petrels were noisy and belligerent at sea, using their conspicuous aggressive displays to fend off their own kind and smaller petrels gathered about food in the water (see Harper & Kinsky 1978: Fig. 9B). They snapped at smaller seabirds which approached too closely and occasionally beat them with their outstretched wings. One *Daption* was disabled in this way, killed and eaten by an adult male *M. giganteus* on 10 Mar 66 (55°45′ S 42°52′ W).

Wandering Albatrosses and some of the mollymawks presented more of a problem to the giant petrels, however. Giant petrels attempted to win the race for food before these more ponderous competitors arrived; they would abandon food only when directly threatened by the albatrosses.

Giant petrels are day and night feeders. They will attempt to eat almost anything floating on the water; they choked on and regurgitated cigarette packets, paper, orange peel, and floating feathers. When the number of sexes and age groups were about equal, larger adult males would repel females and younger birds from garbage thrown overboard. I have also seen this behaviour among birds congregated about the stern of the Wellington to

Picton rail ferries before their morning departure from Wellington terminal in the 1960s and early 1970s. Young birds were successful in obtaining food only when they outnumbered the adults.

My observations showed that first-year giant petrels moult their flight feathers in December and were in new feather by early April (data from 27 locations in South Pacific and South Atlantic 1965; 1966).

Surface seizing: This is the usual foraging method during the day (n = 193).

At night giant petrels are skilled at catching squid up to 30 cm long (n = 19). A bird grabs the squid with its bill, sometimes impaling it with the maxillary unguis. Having secured the squid, it shakes its head roughly to kill the animal, sometimes moving backwards in the water while doing so. Usually it holds its wings partly open, sometimes draped into the water. It swallows the squid whole or chops it into large chunks and eats it in quick gulps. Two adult *halli* on the water were seen during the day fighting over a large dead squid about 0.8 m in length near Magellan Straits (6 Jan 66: 52°52′ S 75°16′ W, SST 9.2 °C).

Surface filtering: Giant petrels seemed to filter water for small planktonic organisms by gulping a quantity of water and allowing the excess water to flow from the base of the bill at the gape (n = 19).

Surface diving: Giant petrels surface dived to beyond 1 metre, rarely to 2 metres, to wing-row in pursuit of sinking slices of bread and unidentified natural prey (n = 8). In a group of seven giant petrels seen near a fishing boat off Stewart Island in Sep 1976, I observed four *M halli* diving after food while the three *M. giganteus* remained resting on the surface. The possibility that the two species differ in foraging behaviour at sea deserves further study: the food and feeding ecology of the two species at South Georgia, based on food collected from nestlings, has been studied by Hunter (1983).

Surface plunging: Birds flying 2-4 m above the sea by day flopped into the water with only the wing-tips remaining above the surface (n = 7). Giant petrels are very buoyant in the water and can submerge only with difficulty. I do not know what such birds were trying to catch.

CAPE PIGEON *Daption capense*

This noisy and gregarious species forages mostly from the sea's surface. It is a skilled glider, and because of its light body weight and soft plumage, it is buoyant in water. It is attracted to ships both by night and by day and remains near them even during severe gales, when other Procellariidae disappear. I saw Cape Pigeons roosting on icebergs in the Scotia Sea on four occasions. They also sleep on the water by day. For example, I saw a flock of 40 moulting birds asleep on the water in the company of 12 Antarctic Fulmars on 23 Feb 1966 at Station 34 (63°02′ S 14°36′ W, wind 20 kt, sea 1.6 m, SST 0.3 °C). Other Cape Pigeons were sleeping with their bills tucked under their scapulars on small adjacent icebergs.

Surface seizing (n = 169) and **surface filtering** (n = 44): Cape Pigeons investigated all ship garbage and surface seized red and orange objects in the same manner as the Diomedeidae (see Harper & Kinsky 1978: p39).

They also fed on small organisms stunned or disabled by propeller wash or by the discharge of the airgun echo-sounding devices used on the early *Eltanin* cruises.

When foraging for natural prey, Cape Pigeons surface seized with pigeon-like, rapid up-and-down movements of the head, the bill and sometimes the head being inserted into the water. Birds observed closely were **surface filtering**, taking rapid mouthfuls of water into the beak and expanding the small interramal pouch of naked skin. Excess water is forced through the sides of the closed bill by the tongue and collapsing of the pouch. The technique is similar to that of the larger-billed *Pachyptila*, except that the Cape Pigeon's bill is not fringed with highly modified lamellae. It is, however, tight fitting and contains a series of fine serrations.

Cape Pigeon's often used their feet while feeding, paddling with one foot and then the other; sometimes they swam in small circles, using their feet to create water movement to bring small water-borne food to the surface.

Surface plunging (n = 77): This is commonly used to catch prey (mostly squid) on the surface at night. The bird flies swiftly, low over the water, with rapid wingbeats and prolonged glides. When it sees prey, it quickly darts or lunges sideways, often plunging into the water with its wings held out or high over its back for stability. Neighbouring birds are immediately attracted to a catch and noisy squabbles usually result. If a Cape Pigeon is slow in disposing of its catch, giant petrels and larger albatrosses move in to usurp it. I saw this on six occasions when a Cape Pigeon had tried unsuccessfully to fly off with its prey. One of several birds catching squid disabled one, which I was able to retrieve from the water with a net. It was a 109 g *Gonatus antarcticus* (South Atlantic, 10 Mar 66: 55°55′ S 42°34′ W, SST 3.2 °C).

Dipping(n = 58): Dipping is used by Cape Pigeons to take euphausiids from the water. One of a 12 bird flock feeding in this way I managed to attract aboard the *Eltanin* with a 1500 watt signalling light. Its proventriculus was packed with 58 g of *Euphausia triacantha* (11 Oct 65: Station 15: 60°11′ S 122°32′ W, wind 23 kt, swell 2 m, SST 0.6 °C). The bird was an adult female with a bare brood patch and a body weight of 475 g. Another bird attracted to the ship during a snow-storm at 0300 h on 16 Feb 66 (Station 29: 60°02′S 29°59′W, SST 1.0 °C) regurgitated c.22 g of small *E. superba* before being released. The mean length of 30 specimens was 11.1 mm (range 7.2-17.4 mm).

Surface diving (n = 33) and **pursuit diving** (n = 21): Before surface diving Cape Pigeons paddled on the surface with partly opened wings and their heads submerged, presumably scanning for prey below. Crustaceans and small salps were caught in this way.

Such prey was normally eaten at the surface and on five occasions was identified as small squid 50-100 mm in length. One bird surfaced with a large euphausiid, probably *E. superba*. The bird dropped it while regaining the air and a passing Antarctic Prion *(P. desolata)* dipped to retrieve it.

Eighteen night dives averaged 19.1 s (range 7-27 s). Those birds closely observed surfaced under their own buoyancy.

Hydroplaning (n = 2): Two Cape Pigeons close to the ship were seen to scurry forwards on the sea's surface on outstretched wings with their bills briefly immersed in the water and their heads moving rapidly from side to side. I saw nothing large in the water; their prey may have been small translucent copepods which were caught in a plankton net.

SNOW PETREL *Pagodroma nivea*

This Antarctic bird was commonly encountered in high latitudes in water temperatures of about 0 °C, where its favourite haunts are open leads in the ice and around 'bergy bits'.

Snow Petrels foraged at any time of day south of the Antarctic Circle, although possibly less so during the early morning hours (0100-0330 h: n = 14; see also Ainley *et al.* 1984). The lee of large icebergs offered the birds shelter from strong winds and there they foraged undisturbed, sometimes in flocks of several hundred. After feeding, Snow Petrels washed themselves by dipping their heads underwater and funnelling the water over their flattened backs and open wings.

Snow Petrels sat on icebergs, sometimes in hundreds, and remained invisible unless they took to the air. Often a swift and erratic flier, the birds frequently used skimming low dives interspersed with very rapid wingbeats. In this way they could make headway into the teeth of a gale, weaving very quickly from side to side and dipping low to the water to seek respite from the wind. A flock of Antarctic Petrels observed at the same time was flying gull-like strongly and directly into the wind. The birds made no headway, however, and gradually disappeared from view downwind.

In the Pacific, Snow Petrels are normally absent over open ice-free water. I recorded only one, blown north by a southerly gale into waters of SST 5.0 °C at 59° S 120° W on 25 Dec 1965 at 0300 h, in a subsiding S wind of 25 kt.

Dipping: Dipping is commonly used by Snow Petrels to catch euphausiids (n = 141). The euphausiids were large, probably *E. superba*. Sometimes the birds hovered kestrel-like above the water before swooping quickly to the surface. Ainley *et al.* (1984) saw Snow Petrels dipping for prey in the Ross Sea (90% of 35 observations).

Surface seizing (n = 54): Snow Petrels alighted with wings held high over their backs and paddled into the wind with their bills quickly dipping into the water, taking small euphausiids. The capture rate was 15-21 per min (n = 3). Those *E. superba* taken from the *Eltanin's* seawater intakes at the same time as the timed observations were 22-31 mm in length (average 25.2 mm: n = 100).

On 13 Jan 1967, while on Station 5 (70°54′ S 171°50′ E, SST -0.4 °C), 24 nautical miles from Cape Adare, I observed a flock of 30 Antarctic Petrels *(Thalassoica antarctica)* in company with 3 Snow Petrels sitting in the water. Two of the Snow Petrels were clearly much smaller than the other one and were resting very deeply in the water with their tails barely above the surface. One of the smaller birds craned its neck sideways and caught a large euphausiid, which it promptly ate.

Ice gleaning (n = 19): While aboard USCGC icebreakers *Glacier* and *Polar Sea* at the ice edge of the Ross Sea in 1982, I noticed that Snow Petrels took advantage of upturned ice pushed aside by the ships, apparently to retrieve injured or stranded plankton caught in the ice interstices.

GREY-FACED PETREL *Pterodroma macroptera gouldi*

Although a common winter breeder in northern New Zealand, this subspecies is not often seen at sea because it is solitary and swift-winged, it ranges widely in subtropical waters, and it avoids ships. The only remarkable exception to this was one adult female which collided with *Eltanin* in broad daylight (1400 h) on 3 Dec 1966 in the Tasman Sea (40°22′ S 166°24′ E, swell 3 m, wind 25 kt, SST 14.9 °C). Its body weight was 512 g and its stomach was empty (NM 12357). The furthest east I saw one was on 19 Sep 1965, some 2200 km due east of Wellington (42°01′ S 159°27′ W, SST 10.1 °C). They appear to remain in waters warmer than 10 °C on both sides of the New Zealand mainland.

This subspecies fed only at night from the surface of the sea, its main prey being squid and crustaceans.

Surface seizing (n = 27): To catch squid, birds alighted swiftly with wings spread and head stretched forwards. They attacked large squid by lunging, biting, and pulling at them, sometimes impaling them with the bill unguis. One bird, struggling with a large squid, dipped its open wings into the water to act as a brake and hinder its prey from escaping. Three squid killed and eaten seemed about 200 mm in length; the prey-handling times were 14 s, 71 s, and 3.1 min.

Dipping: Grey-faced Petrels dipped and hovered to pick crustaceans from the water. Having secured their prey, the birds briefly rose into the air while eating them (n = 22). I have two sightings of *macroptera* dipping for squid; in both, the birds had to alight to subdue their prey. One squid c.450 mm long escaped from a bird only 2.5 m from me; it immediately resumed feeding, catching two euphausiids in quick succession.

KERGUELEN PETREL *Pterodroma brevirostris*

This widely distributed gadfly petrel, with its distinctive gliding flight high above the sea, was seen on 23 occasions in the Polar Pacific and South Atlantic oceans (full details in Harper *et al.* 1972). During the day the birds remained some distance from the *Eltanin*, except when single birds occasionally investigated us by gliding in over the lee side of the ship.

Dipping (n = 40): Seven birds were seen foraging about our ship shortly after 2300 h on Station 38 (2 Mar 1966 at 55°10′ S 19°02′ W, wind 26 kt, air 0.2 °C, swell 2 m, SST 2.4 °C). The birds wheeled bat-like about the ship, only inches above the water. On sighting something in the water, they would rise slightly in the air, and pause on rapidly beating wings to snatch prey at the sea's surface with their bill. They were probably taking *E. superba*, which were caught in plankton tows at the time. One bird travelling downwind and thus lacking any wind assistance surface-plunged into the water to secure unidentified prey. There was too much wind and surface noise to detect whether squid were present.

MOTTLED PETREL *Pterodroma inexpectata*

The Mottled Petrel has an especially widespread distribution and is the only gadfly petrel to occur in Antarctic and Pacific Arctic waters as far south and north as the ice edge. Although I have seen them associating with mixed flocks of procellariids, including its congener the Soft-plumaged Petrel *(P. mollis)*, which were gorging themselves on krill during the day, I have not once seen Mottled Petrels join in the feast. They appeared and disappeared in their silent, solitary way.

The ice edge seems to interest them, for they will fly regularly along it, sometimes circling particular pieces of brash ice. I have not seen them alight on the water even during the long Antarctic day.

Surface seizing and **dipping:** I have two records of Mottled Petrels catching squid at night.

28 Dec 1965 (Station 20: 61°13′ S 120°09′ W, wind 18kt, swell 2 m, SST 3.5 °C): Shortly after midnight, while *Eltanin* was "steaming on the wire", a single *inexpectata* appeared briefly in the decklights dipping for food (n = 10) very close to the port side where I was standing. It retrieved a squid but then disappeared.

12 Feb 1967 (Station 40: 58°06′ S 154°28′ E, wind 10 kt, swell 2 m, SST 4.5 °C): At 2210 h, one bird, seen alighting and catching prey by surface seizing (n = 4), was caught in a net at the side of the ship but escaped capture by struggling out of the net as it was being hoisted on board. The bird regurgitated the fresh remains of a squid *Moroteuthis ingens*, which was c.12 cm in mantle length.

Ainley *et al.* (1984) saw Mottled Petrels catching squid by pursuit plunging and surface seizing (n = 3) north of the Ross Sea between 2200 h and 0200 h and collected three birds at 68°41′ S 171°49′ W on 27 Dec 1979. These birds contained beaks of the squids *Gonatus antarcticus* (n = 3) and *Galiteuthis glacialis* (n = 5) together with an otolith from the fish *Pleuragramma antarcticum*.

JUAN FERNANDEZ PETREL *Pterodroma externa*

This large subtropical species was recorded daily from when the *Eltanin* left Mas Afuera Island on 25 Nov 1965 (Cruise 21) to well out into the South Pacific at 120° W and south until 19 Dec 65 at 50° S 120° W, SST 9.5 °C. At this latitude the birds were in the company of flocks of 10 White-headed Petrels and single White-chinned and Grey Petrels.

One bird from a mixed flock of 40 Juan Fernandez Petrels and Sooty Shearwaters was seen to alight briefly to feed on unknown prey at 1300 h on 11 Dec 65 (39°55′ S 109°35′ W, SST 14.6 °C). Occasional *externa* were seen flying about the *Eltanin* at night, but I did not see them feeding.

PRIONS (genus *Pachyptila*)

This widespread and abundant group of petrels was intensively studied during the *Eltanin* voyages and I have already discussed the identification, distribution, taxonomy, feeding habits and food of the prions (Harper 1972, 1976, 1978, 1980; Harper & Kinsky 1978; Harper & Rowlett 1983).

Prions are surface feeders and, in keeping with their differing bill structures, feed in different ways. In the Pacific they normally associate with ships only if the vessels are stopped in the water. Once, however, a group of 16 Antarctic Prions followed us, weaving like bats in the wake of the USCGC *Glacier*, which was steaming at 5 kt on 5 Feb 1982 (59°50′ S 173°28′ E) south-east of Macquarie Island. They remained with the ship for 20 min and were photographed at close range before they disappeared from view.

BROAD-BILLED PRION *Pachyptila vittata*

This gregarious species was seen in mixed flocks with Fairy Prions and Fulmar Prions from 10 to 29 March 1967 when the *Eltanin* made a transect crossing, at 43° S, of the Tasman Sea from Tasmania to near Westland (Cruise 28). It feeds by hydroplaning and surface seizing.

Hydroplaning (n = 251): The Broad-billed Prion filters minute plankton from water sucked into its partly opened bill by rapidly lowering the large fleshy tongue and expanding the distensible interramal pouch. It then shuts its beak and forces the water through the palatal lamellae, which retain any food. In large swarms of copepods, flocks of *vittata* alighted to pirouette in the water while they fed, birds sometimes twisting sideways to pick off copepods adhering to their plumage.

Surface seizing: Although its bill is a superbly adapted filter, *vittata* also catches larger prey such as euphausiids and squid. Euphausiids were collected individually (n = 22) or if very small (<8 mm, as in plankton tows) by surface filtering like *Daption* (n = 14).

Surface plunging: On 16 Mar 1967 at Station 10 (43° S 156° E, wind 10 kt, SST 15.2 °C) at 2100 h, I watched a flock of c.200 Broad-billed Prions catching small squid up to 50 mm in length by surface plunging only a few metres from the side of the ship. One bird briefly wing-rowed under water in pursuit of prey for 4-5 s before returning to the surface with a squid held in the bill. The edges of the maxilla are sharp in *vittata* – excellent for clamping squid.

ANTARCTIC PRION *Pachyptila desolata*

In the South Atlantic this species commonly feeds by day during the summer months on krill *(E. superba)*. In 565 observations of feeding behaviour I have seen the Antarctic Prion catch only krill, and I have not recorded it feeding at night. Prince (1980) found that 90 samples of food brought to chicks on Bird I., South Georgia, consisted by weight of 97% crustaceans (59% Euphausiacea, 37% Copepoda, the remainder Amphipoda and Mysidacea) with 3% fish and squid. The paucity of squid in this diet also suggests that this species forages mostly by day in the Scotia Sea Region during the chick-rearing period.

In the Scotia Sea during Cruise 22, pieces of floating kelp were seen to attract the attention of Antarctic Prions, which alighted to peck at them, perhaps because barnacles were present or because small planktonic organisms had briefly adhered to the kelp's worn rough surface.

Surface seizing: The Antarctic Prion surface seizes individual adult krill

(South Atlantic Cruise 22: n = 402); on six occasions I saw birds take to the air with large euphausiids held crosswise in their bills. Three birds attracted aboard *Eltanin* during a night snow-storm on 16 Feb 66 (Station 29: 60°02′ S 29°59′ W, SST 1.0 °C) regurgitated *E. superba* with a mean length of 12.2 mm (range 7.9-19.7 mm; n = 171).

Hydroplaning and **surface filtering:** Antarctic Prions took smaller unidentified prey (small euphausiids or copepods?) by hydroplaning (n = 96). Their surface filtering is exactly the same as that described for *Daption* (South Atlantic Cruise 22 Feb 66: n = 79; also near Macquarie I. Feb 67; n = 5).

Surface diving: Birds sitting on the water surface dived to avoid the oncoming *Eltanin*; they also surface dived to gather unidentified prey from below the surface (n = 21).

Dipping: I have two daylight observations, on 11 Feb 66, 285 nautical miles WNW of the South Orkney Is, of small groups of *desolata* dipping for euphausiids (n = c.41).

THIN-BILLED PRION *Pachyptila belcheri*

Full details on the *Eltanin* records of this species, including their feeding habits, have been published (Harper 1972). The main prey for birds in the Pacific area seems to be the amphipod *Themisto gaudichaudii*; other prey items include the myctophid fish *Electrona* and small squid. Strange (1980) also reported that euphausiids are an important food for chicks at the Falkland Islands. Food is obtained at night by **surface seizing** (n = 131), **dipping** (n = 77) and **pattering** (n = 98).

FAIRY PRION *Pachyptila turtur*

Fairy Prions are common in the offshore waters of New Zealand and frequent in the Tasman Sea (Harper 1976). I have 1709 observations of them foraging at sea; 1698 (99.35%) of these were made by day. Foraging behaviour includes **surface seizing** (n = 901), **dipping** (n = 756), **pattering** (n = 48), and **surface plunging** (n = 4). On 63 occasions, where plankton tows were done concurrently with the observations, the food was probably the euphausiid *Nyctiphanes australis*.

GREY PETREL *Procellaria cinerea*

This winter-breeding species was a key indicator of subantarctic waters in the Pacific. I saw many but rarely in groups of more than three or four. Birds in the mid-Pacific in September and October 1965 were all in fresh plumage and were probably non-breeders; those seen closer to the South American coasts two months later, in December, were all in worn feathering and were probably post-breeding adults.

Deep plunging: The only time I saw Grey Petrels feeding was at 1200 h on 22 Sep (44°51′ S 145°20′ W, SST 8.62 °C) while we were stopped on Station 1. A group of male and female killer whales *(Orcinus orca)* drifted by the ship accompanied by 13 Grey Petrels. The sea was calm and the birds were diving into the water near the whales from about 3 m. I could not see what the birds were feeding on, but trawls at the same time yielded small crustaceans and fish.

WHITE-CHINNED PETREL *Procellaria aequinoctialis*

Widespread and abundant in subantarctic waters, this species is a bold and courageous competitor for food. Groups of up to six birds unhesitatingly plunged into a group of albatrosses with the intention of driving them off their food. This species also competed with the much bigger *M. giganteus* for squid by grabbing prey from the larger bird's beak. This twice resulted in the squid being torn in two and both birds retiring with their meal. A shrill chattering is occasionally given by birds at sea. White-chinned Petrels are opportunistic foragers using a combination of techniques to catch their prey.

Surface seizing: Birds took offal from fishing boats by alighting in the wake and surface seizing, or took crustaceans and squid from the sea's surface at night in the same way (n = 11). One bird was observed from only 2 m distance while it gathered at least 24 euphausiids in just under a minute.

Deep plunging: While in the South Atlantic on 1 Feb 1966 (52°36′ S 52°16′ W, swell 1 m, wind 15 kt, SST 8.2 °C) I saw a large group of c.150 Peron's dolphin *(Lissodelphis peronii)* erupt from the water near the *Eltanin*, possibly startled by our presence. Two White-chinned Petrels deep-plunged into the water vacated by the dolphins, but I could not see what the birds were catching and I did not see them resurface – the ship was under way at the time.

SHORT-TAILED SHEARWATER *Puffinus tenuirostris*

This species was observed only near the east Australian coast and in large numbers only near Macquarie Island during Cruise 27 in Feb 1967. It feeds chiefly by pursuit diving and has a relatively heavy body mass to counteract natural buoyancy. An immature male with an empty gizzard was collected in daylight on 12 Feb at Station 40 at 58° S 154° E. On Station 40 a small flock was observed foraging under the decklights for 21 minutes.

Pursuit diving (n = 26) and **deep plunging** (n = 33): At least 14 birds were foraging by pursuit diving and deep plunging after squid which I could see in the brilliantly lit water around our vessel. Those birds which were on the sea's surface immersed their heads and scanned for prey while paddling slowly forwards. On seeing prey, a bird would immediately paddle powerfully forwards, pushing the front part of its body high off the water before plunging below and wing-rowing quickly out of sight.

Following one bird's dive was difficult because many birds were diving and they often reappeared at the surface up to 15 m from where they entered it. Six dives followed to completion were timed at 6-15 s (mean 8.8 s). On each of these I saw the bird assist its passage back to the surface with rapid strokes of its wings. This was in marked contrast to the more buoyant species such as *Daption*, which return to the surface solely by natural buoyancy. Fluttering Shearwaters *(Puffinus gavia)* catch small fish in Wellington Harbour in exactly the same way as described here for *tenuirostris*.

BLACK-BELLIED STORM PETREL *Fregetta tropica*

Although this storm petrel was often seen during the *Eltanin* voyages, I saw foraging only once. During the Tasman Sea Cruise on 11 Dec 1966

(1720 h) at 45° S 160° E a bird was seen, about 7 m from our stationary ship, **dipping** (n = 21) in a 20 kt wind and sea 3 m. The prey appeared to be small crustaceans.

WILSON'S STORM PETREL *Oceanites oceanicus*

This very common species was often seen foraging near the stern while the ship was on station. The prey was usually too small to be identified. Two feeding behaviours predominated: **pattering** (n = 207) and **dipping** (n = 77). Nine specimens were collected, mostly from the Feb 1966 Scotia Sea Cruise 22; two of these obtained from Station 29 (17 Feb 66 at 0200 h: 60° S 33°05′ W; SST 1.0 °C, swell 1 m, wind 13 kt) and offshore from South Thule Island, South Sandwich group, on 18 Feb 1966 (59°28′ S 27°16′ W) contained small *E. superba* with a length of 6.1 mm (range 5.1-9.7: n = 60). The remaining specimens had gizzards containing only 3-9 small pumice gastroliths.

COMMENTS AND CONCLUSIONS

1. The long-held belief that petrels feed at night is confirmed for Wandering Albatrosses, Giant Petrels, Cape Pigeons, Grey-faced Petrels, Kerguelen Petrels, Mottled Petrels, Thin-billed and Fairy Prions, White-chinned Petrels, and Short-tailed Shearwaters. These species represent seven distinct genera with differing evolutionary and feeding strategies. Thus, although nocturnal feeding is probably widespread among the Procellariiformes as a whole, more information is needed to confirm this.

2. The presence of nocturnally feeding petrels was confirmed by observing them directly under the decklights, by spot-lighting them near the darkened ship with the bridge signalling lights, and by observing them under moonlight. A modern image intensifier could greatly aid future work on the nocturnal habits of petrels at sea.

3. The six species observed feeding exclusively by day were Light-mantled Sooty Albatross (n = 27), Juan Fernandez Petrel (n = 1), Antarctic Prion (n = c.565), Grey Petrel (n = 13), Black-bellied Storm Petrel (n = 21), and Wilson's Storm Petrel (n = 284). The Snow Petrel was seen feeding only during the Antarctic day (n = 214).

4. Five species scavenged the galley refuse for food during the day. If these observations are removed from the Wandering Albatross data, 93% of the remaining 141 feeding observations were at night. This suggests that, although albatrosses are conspicuous scavengers by day, most of their food is live prey (squid and crustacea) captured at night from the sea's surface.

Prince & Francis (1984), using activity recorders attached to 13 South Georgian Grey-headed Mollymawks *(Diomedea chrysostoma)*, have shown that on 284 bird-days the birds foraged at sea during February 1982, they spent an average of 74% of the time flying and 15% of the day and 50% of the night on the sea. Because about half the mollymawk's diet is squid, they concluded that "The extensive nocturnal activity on the water strongly supports suggestions that the species feeds mainly at night".

5. Weimerskirch *et al.* (1986), in assuming that surface-seizing seabirds such as albatrosses are "unlikely" to catch fast-moving prey such as squid, postulated that most of squid prey taken by albatrosses were dead and floating on the surface where albatrosses might scavenge for them. They continued, "This assumption is supported by the fact that some of the cephalopod species found in the chick samples are thought to occur only in deep water and would consequently only be available for albatrosses after their death". Clarke *et al.* (1981) have discussed the possibility that deep water squid might be obtained by seabirds through sperm whales vomiting their stomach contents when approached by humans or to empty them of cephalopod beaks which apparently do not pass further down the gut. Hence, "it is not rare for whalers or marine biologists to observe freshly vomited cephalopods floating on the sea surface even without a sperm whale being actually chased."

While marine birds undoubtedly scavenge dead squid, my observations suggest that live squid are present at the sea's surface much more commonly than is realised. They appear to be a normal predatory component of the vertical planktonic migration to the surface after dark, although large seasonal fluctuations in their numbers probably occur. Some intermediate-sized mesopelagic and deep water species of squid which follow krill swarms to the surface could conceivably become available to avian predators directly, rather than indirectly by dying and floating to the surface as suggested by Weimerskirch *et al.* (1986) or being transported there by sperm whales (Clarke *et al.* 1981). Because albatross bill morphology and behaviour clearly make them skilled at catching live squid, I believe that most of their squid prey is taken actively. Very large squid could only be scavenged from the sea's surface, however.

Because squid appear to be relatively easy for birds to disable (i.e. they bleed freely once their body wall is punctured), it seems highly likely that some cephalopods might be injured by a nocturnal avian predator, escape, and die later from their injury. A flock of birds catching squid might disable a large number at the surface. Such animals would presumably have to remain on the sea's surface because, at the very least, of water pressure at depth; hence, after sunrise they would become easy pickings for passing birds. I am suggesting that squid die through injury at the surface rather than die at depth and drift to the surface as suggested by Weimerskirch *et al.* (1986). Clearly much more information on all these matters is needed.

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SHORT NOTE

Welcome Swallows breeding near Te Anau

In October 1985 Welcome Swallows *(Hirundo tahitica neoxena)* attempted to breed for the first time in the Te Anau district. Welcome Swallows built three nests under a wooden bridge on Stony Creek c. 11 km east of Te Anau. However no eggs were laid (R. B. Lavers, R. G. Thomas, pers. comm.). For a few weeks in spring 1986 three Welcome Swallows were flying around the bridge but the birds did not nest (R. G. Thomas, pers. comm.).

On 30 November 1986 I found Welcome Swallows nesting under a concrete bridge 5 km south of Te Anau on the Te Anau-Manapouri main road. Two nests were empty but the third held three small downy nestlings. They were seen again on 4 December, 10 December and 11 December, when two adults were feeding them. On 12 December at 1740 hours the chicks were gone but at 2130 hours (dusk) they were roosting in the nest with their parents. The three juveniles were perched on the power line by the bridge on 16 December.

A second nest held three nestlings with their first feathers on 17 January 1987. These chicks were fully feathered and overlapped their nest by 22 January and 24 January. The nests were empty on 29 January and have remained so on several later visits up to May 1987. Only two adults were present throughout both nesting periods.

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