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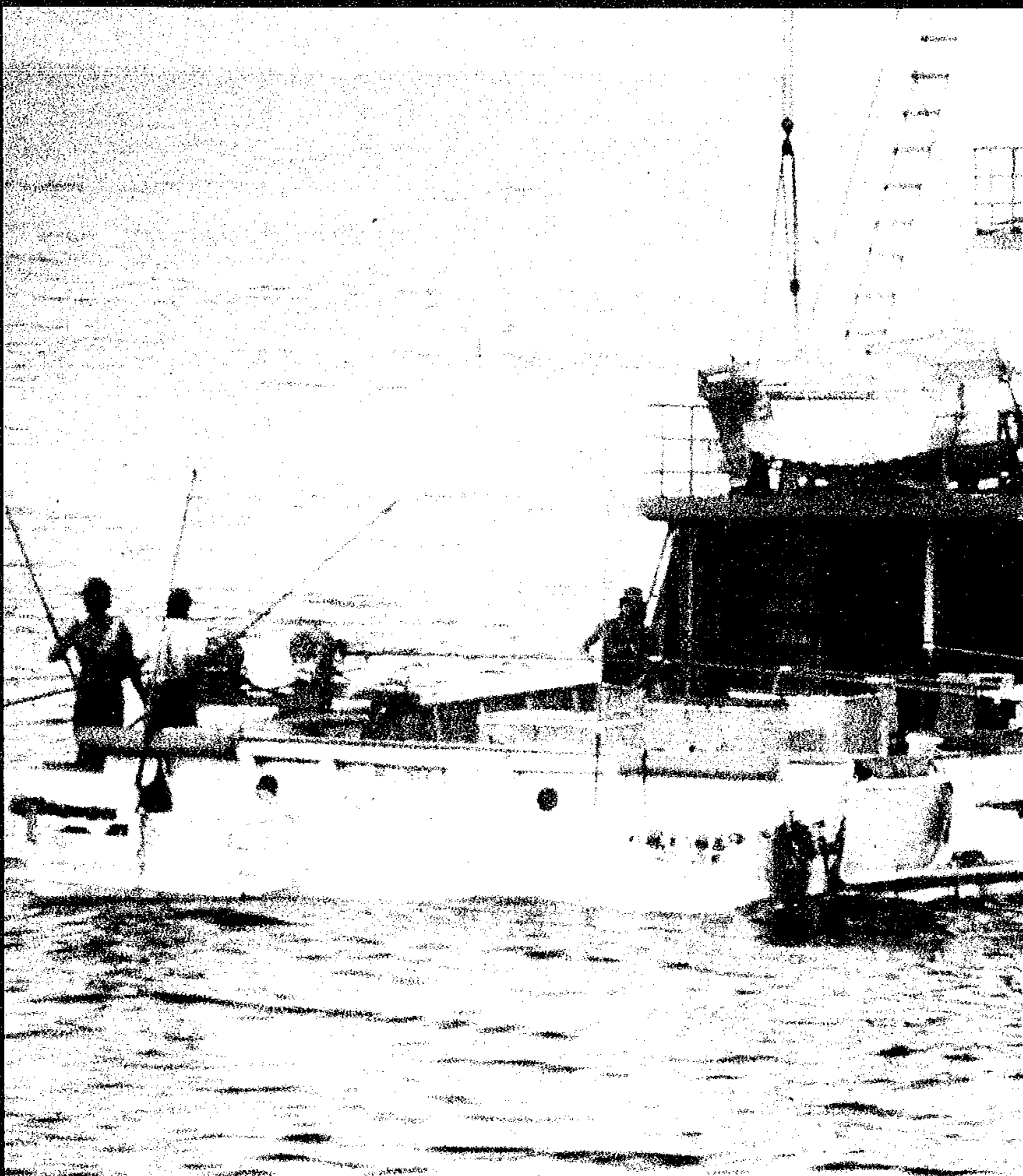

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Handling practices on inshore fishing vessels: effect on the quality of finfish products[1]

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Introduction

The primary motive of the fishing industry, as with any other commercial activity, is to make a profit. Whilst governments may perceive other goals for the industry, such as generating foreign exchange, occupying a strategic geographical area, creating jobs and producing food, the individuals and companies engaged in seafood harvesting and processing do so primarily to create wealth for themselves and their shareholders.

To maximize profits, as much saleable product must be extracted from the raw material as is commensurate with the cost of such extraction and the product must then be sold for the highest possible price. At any fish market a visitor will see sellers who are trying to present their fish as attractively as possible and buyers who are trying to gauge the profit they can get from the fish.

Ironically, at a time of increasing research interest in the exploration and exploitation of Australia's finfish resources, the industry faces increasing costs for fuel, gear and wages. The decline in the value of the dollar, however, has meant that returns from exports of expensive invertebrate species such as lobsters, abalone and prawns have increased. There is therefore little incentive to catch finfish for the domestic market and so much of the raw material for processing into finfish products in Australia is supplied from overseas, and expansion of the local fishing industry has been limited.

In the United States, consumer surveys identified a potential market for high quality fillets, and the US Department of Commerce, through the National Marine Fisheries Service, set up a quality assurance program that sought to guarantee that consumers get good quality fish when they buy a product carrying a US Government seal (Gorga and Ronsivalli 1982). There is a similar demand for fresh finfish in Australia. The best fresh fish are sold at the metropolitan markets, whilst the poorer quality fish are usually bought by processors. To maximize returns, Tasmania ships some fish to Melbourne for market sale, some is sold to retailers and some is sold as lobster bait.

In an attempt to increase consumer confidence in the local product, the Tasmanian Fisheries Development Authority (TFDA) invited the author in 1982 to set up a quality assurance program for finfish. The observations made in this paper reflect my experiences in that endeavour (Thrower 1984), as well as my experience of purse seining off Albany, Western Australia at a later date.

The initial step in formulating a quality assurance scheme was to make detailed observations of existing handling practices at sea and ashore. Very few fishermen in Tasmania fish exclusively for finfish; they do so chiefly in the off-season for lobsters or scallops. Their vessels are not usually designed for finfishing, and their methods range through Danish seining, trawling, mesh netting, purse seining, to long lining and drop lining. A typical example of each of these methods is described in an attempt to identify the factors that affect product quality.

Fishing methods

Danish seining

A 17 m wooden vessel with a conventional displacement hull makes one to two day trips with a crew of two. The boat has a forward wheelhouse with a large, uncluttered work deck aft. The deck surface is caulked, unpainted planks. Removable boards can be fitted to form a deck pound of about one tonne capacity on the starboard side. Target species are flathead and school whiting.

Below decks is a spacious ice bunker, which holds about two tonnes of ice, and an ice room which holds five tonnes of bulk iced fish. The walls of the room are the uninsulated wooden planking of the hull. The room is about two metres at its highest point. Neither the deck nor the bulkhead is insulated although the air temperature in the engine room behind the bulkhead often reached over 35 °C.

[1] Based on a paper presented at the CSIRO-DSIR Workshop on Seafood Technology, Nelson, New Zealand, April 1986.

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The trip described is in late spring when the air temperatures are 12°–15 °C (day) and 5°–8 °C (night). Two long ropes are laid out along the seabed in a diamond pattern, with the boat at one apex of the long diagonal axis and the net at the other end of the diagonal. The boat steams slowly away from the diamond whilst slowly hauling in the ropes. This has the effect of drawing in the diamond, with the ropes skipping across the bottom and herding the fish into the path of the net.

The fish expend a considerable amount of energy swimming away from the oncoming ropes. The net moves quite slowly so that crushing is avoided during fishing. Some crushing occurs however when the net is hauled aboard. The shots last sixty to ninety minutes. Fish landed in the pound are alive and flapping, but have generally passed into rigor before sorting and grading are complete. The time on deck varies from twenty minutes to two hours, depending on the size of the haul. If a haul is quite small, the fish are sometimes left on deck until the next haul is landed on the boat. Sometimes the fish spill out of the pound and are contaminated by grease around the winch area.

The fish are sorted by species and size and placed in cane baskets. These are then tipped into the hold, leaving the fish in layers fifteen to twenty cm deep separated by layers of ice ten cm deep. Only the top and bottom fish in each layer are in contact with ice. The temperature of the fish in contact with the ice is 3°–4 °C and that of fish in the middle of the layer is 6°–8 °C. Before long a sharp, metallic smell pervades the hold. Fishing ceases about 10 pm. By morning, a foam caused by flocculated exudate from the fish indicates that drainage through the bilges is not effective.

There is a good standard of cleanliness on the vessel. The deck is scrubbed with a broom and washed with water from the deckhose after each shot. Baskets are washed with the deckhose. The hold, washed with detergent and sanitized with a quaternary ammonium-based disinfectant after each trip, has a fresh smell with no trace of 'off' odour. The net is spread out along the wharf after every trip and freed of dead fish and other debris.

After two days at sea the vessel returns to port, arriving at about 1 am. The catch (either whiting or flathead) is unloaded into bulk (one tonne) bins the next morning at about 8 am. This is a rather labour-intensive operation. Crushed ice is mixed in with the fish to keep the temperature down.

By the time the unloading has been completed there is evidence of autolysis (seen as 'bellyburn' and anal breakdown) and some

TABLE 1
Temperature history of fish caught by several fishing methods

	Danish seine	Purse seine	Drop line 1	Drop line 2	Long line	Gill net	Mesh net
In water							
Time (hours)	1	0.5	nr	nr	nr	12	24
Temperature °C	14	18	—	—	—	12	11
"Icetime" (hours)	6	3.8	—	—	—	60	108
Before stowage							
Time (hours)	2	0.25	0.5	10	2	4	1
Temperature °C	15	18	8	20	14	20	8
"Icetime" (hours)	12.9	1.9	1.6	81	12	32.4	3.2
Storage on board							
Time (hours)	48	1.25	48	5	60	96	2
Temperature °C	8	18	4	18	3	2	7
"Icetime" (hours)	134	9.5	91	38	102	134	5.6
Road transport							
Time (hours)	1	0.1	3	2	3	0.5	1
Temperature °C	8	18	5	18	7	8	10
"Icetime" (hours)	3.2	0.76	6.6	15.2	8.4	1.6	4.0
Time (days)	2.2	0.09	2.14	0.71	2.71	4.69	1.1
"Icetime" total (days)	6.5	0.7	4.1	5.6	5.1	9.5	5.0
Loss of chilled shelf life (days)	4.3	0.61	1.96	4.89	2.39	4.81	3.8

nr — not relevant, since the fish are free swimming in the water.
"Icetime" is the equivalent time on ice. (Bremner *et al.* 1978).

'sweating' (which shows as excessive sliminess, dulled skin and a pungent, metallic smell).

Fish from this vessel finds ready acceptance on export and domestic markets. Buyers express satisfaction with the fish and many believe that bulk-stored fish is better than binned fish (because inadequate drainage in the bottom of the bins results in some fish being left lying in stagnant melt water). However, the bulk bins used in transport cause crushing of the fish which results in considerable damage and increased autolysis.

Although the operation is very efficient, there are some areas for improvement, especially in the method of icing and the quantity of ice used in stowage of the catch. Replacement of cane sorting baskets with plastic bins would reduce the chance of contamination, but the owner argues that plastic bins slide around the deck. Insulating the hold and installing shelves would reduce ice wastage and give better temperature control.

Purse seining

The vessel used is 7 m long, of wooden construction with a fibreglass deck surface. It carries a crew of three. Top speed is ten knots. The wheelhouse is located well forward, giving a large, uncluttered workspace. Pilchards are the target species, for use by the petfood canning industry. The catch is held in 30 kg high-density polyethylene bins on deck. The fish are not chilled. The vessel is fishing inshore grounds, so on this winter trip, fish are held on board for 2 hours; in summer, when more distant grounds are fished, fish can be on board up to 35 hours before landing.

The boat leaves port at 7 am and reaches the grounds by 8 am. The fish are located by observing the behaviour of birds and scanning the area with an echo-sounder. A deckhand in a dinghy is dropped into the centre of the school to 'chum' the fish to the surface by casting pollard onto the water. A purse seine net is laid by the mother ship to encircle the fish and a small 'pot hauler' winch on the forward side of the working deck draws in the purse line to trap the fish. The net is then drawn in by a power block mounted on a gantry on the stern. The whole shot, from laying the net to bringing the cod-end to the leeward side of the vessel, takes thirty minutes. The fish are then brailed from the cod-end into rows of fish bins laid out on the deck. Brailing one and a half tonnes of fish takes about fifteen minutes.

When landed on deck, the pilchards are alive and very active. Their appearance is excellent with shining irridescent colours. As the fish thrash violently about they lose some scales. Within fifteen minutes of landing they stiffen in rigor. The vessel returns to port and the fish are unloaded from the boat within 75 minutes after brailing began. Most of the bloom has been lost and the fish have passed through rigor. There is no sign of autolysis, but inspection of the gut contents reveals that these fish are not 'feedy' at this time of year, so autolysis would not be expected.

By the time the fish have been delivered to the factory they have been out of the water for about two hours. The bins in which they are delivered have inadequate drain holes, so the fish in the bin are covered in a thick slime exuded from their guts and gills.

The catch is processed into canned petfood by freezing, dicing and retorting. The raw material from the winter fishery is satisfactory, but fish caught in summer, when fish are 'feedy', trips are longer, and ambient temperatures higher, tend to have suffered from autolytic spoilage and oxidation. In these circumstances, some form of on-board refrigeration is necessary.

Drop lining — 1

A 14 m drop-liner fishing for trevella operates two to three day trips on the continental slope. This is a small, planing-hull, fibreglass vessel with a crew of three. The season is late winter. The boat leaves port early in the morning to operate seven drop lines with one hundred hooks on each line. The lines are dropped on suitable bottom just after dawn and are pulled up after three or four hours. There is a heavy swell and twenty knot winds. The air temperature is 5 °C when fishing begins and warms to 9 °C during the day. The boat rolls and pitches, and the deck is constantly swept by waves during fishing. Two men attend the line while another uses a gaff to retrieve fish lost as the line comes up. The fish are dead when they land on deck due to the decrease in pressure as they are pulled up. The swim bladder often protrudes through the mouth. The muscles are very firm but the fish are not in rigor. The bodies undergo occasional spasms.

The line is rebaited and shot, which takes twenty to thirty minutes. The fish on deck are then gutted, washed with a deck hose, and packed in bins in ice. Some of the fish are too big for the bins and hang over the ends. The bins are stowed below decks in an insulated hold. After two days, the boat returns to port. By now there is little ice left on the fish and fish temperatures are around 8 °C. The fish are in rigor when unloaded from the boat and the skin has a glistening, fresh appearance. The bins are re-iced and loaded onto a truck for a three-hour trip to the customer.

Hygiene on this boat is good at every step. The working deck is made of impervious fibreglass, there is an efficient deck hose and waves are constantly washing across the deck. The ice room, a fibreglass-lined tank, is regularly hosed clean. The slight smell when the empty room is first opened is probably due to the tank being well sealed.

This trip highlights the problem of handling fish on small boats in heavy seas. The cramped working conditions are such that it is difficult to keep things in place. Bins are constantly sliding about the deck and fish are thrown out of the bins and become bruised. Clean gutting and effective icing are difficult tasks on a pitching deck and icing is not always fully effective. Despite this, the catch is handled efficiently.

Drop lining — 2

A 17 m drop-liner operates day trips on the continental slope. This light, planing-hull vessel has a crew of three. The season is mid-summer, air temperatures are 20–25 °C (day) and 12–15 °C (night), winds ten to fifteen knots, swells moderate. The vessel leaves port late at night; and fishing begins at 7 am. Lines are in the water about two hours, fishing operations are similar to the previous case although working conditions are a bit calmer and the working deck is much more spacious. The temperature of fish on catching is 12–13 °C. Air temperature is 15 °C initially. Fish are left lying on the deck while the line is cleared. Catch rate is high (30–50% strike rate), the fish vary in size but average three kg. There is considerable bumping of fish as they slide around the deck. After catching, fish are dropped into a tank of seawater (20 °C) and left while the line is rebaited and shot, then they are pulled out singly and gutted, leaving the gills in the fish. Once each fish is gutted, it is returned to the tank, so there is soon a mixture of gutted and ungutted fish in bloody sea water.

Fishing continues through the day and the air temperature rises to 25 °C. In all 300 fish weighing 900 kg have been taken by the time the boat returns to port. The trip has taken 20 hours; 5 to get to the grounds, 10 for fishing, and 5 hours to return. As the boat begins the return journey, ice is added to the tank, lowering the seawater temperature from 20 °C to 15 °C. On arrival at the dock the temperature of the fish is 18 °C.

Unloading, which takes 40 minutes, begins about 10 pm. The fish are loaded into bulk bins in an enclosed truck with no ice. The truck does not leave for about 90 minutes. The fish are delivered directly to retail premises within 60 minutes of leaving the wharf.

When brought on board, the fish are dead but pre-rigor. During the day, they pass into and through rigor rapidly, due to the high temperature. On landing the fish have a limp, washed out, dull appearance.

This case highlights the need for effective chilling. Storing the fish in seawater may reduce physical damage, but it also warms up the fish. The tank should have contained an ice/seawater slurry rather than warm seawater. The mixture of gutted and ungutted fish leads to contamination, especially since the gills, which harbour large numbers of bacteria, have not been removed. The delay in shore transport also shows lack of care.

Hygiene standards on this boat are fairly good, the deck hose works effectively and the deck and handling areas are scrubbed regularly. The tank used to hold fish is drained and hosed out as soon as the catch is unloaded. No attempt is made to use detergents and sanitizers to reduce bacterial loads.

By failing to chill the fish the crew has considerably reduced the chilled storage life of the fish. The fillets show obvious bruising and autolysis. Fillets of fish from this boat held overnight in a domestic refrigerator and eaten the next day had lost the characteristic fresh-fish taste.

Long lining

A 12 m shark long-liner operates three-day trips with a crew of two. Season is late autumn; temperatures are 14–15 °C (day), 5–6 °C (night). Winds are twenty knots, swells are moderate. The vessel is a round-bilge, wooden ex-crayboat, with a wheelhouse aft. She moves with a rolling action, smoother than the jerky motion of the hard chine planing vessels.

The first shot is made at about 8 am and the line is down for eight hours. When the line is pulled in, most of the sharks are alive, but some are dead and already going into rigor. The sharks are quickly cut at the neck, snout and tail as they are landed, then put live into a seawater tank on deck to bleed. After the line is cleared and re-set, the sharks are removed from the tank, headed and gutted and packed in ice in the ice room. The core temperature of the fish falls to 5 °C in six hours. A regular pattern of catching and stowing fish is soon established.

After three days the vessel returns to port. The ice is depleted. By the time the boat docks, most of the shark carcasses have been removed from the tank and stacked on deck, where they begin to warm up. The fish temperatures are about 6–8 °C when the catch is unloaded. No attempt is made to keep the fish cold in transit. The truck trip to the customer may take two to three hours.

Standards of hygiene are quite good on this boat. The bare wooden deck planking is kept well scrubbed. The ice room is a converted cray tank lined with 50 mm polyurethane insulation and fibreglass. Handling is good. The cooling rate achieved, which is good for such large fish, is the result of thorough icing. This results in the marked depletion of ice on the fish. The fish should be re-iced to maintain the chill temperatures. The unloading and road transport of the catch allows the fish to warm up considerably, which undoes some of the good work done on the boat. The fish should have been kept in the ice room as long as possible, and should have been iced during road transport. This case clearly shows the need for quality control through the distribution chain.

Mesh netting

A 15 m shark gill-net vessel operates trips of from four to ten days in summer with a crew of three. Winds are fifteen knots, swell slight, temperatures 20 °C (day) to 10 °C (night). The vessel leaves port about 11 am, the first shot, made about 5 pm, is not retrieved until 4 am. About half of the fish that come aboard are dead; some are in rigor. The main species are gummy and elephant sharks, with a few school and tiger sharks. To make it easier to remove the sharks from the net, their heads are sometimes cut off and thrown into a corner of the deck to be kept for cray bait.

Once the haul is completed, the sharks are bled by cutting the tail and laying the fish on a piece of carpet on top of a hatch cover whilst the next shot is made. The sharks are then headed, gutted, and put into a tank of seawater. Bleeding is not effective if the fish is dead because the heart is not beating to provide pressure to drive the blood from the tissues. Valdimarsson *et al.* (1985) found that when cod were bled in air, removal of blood could be best effected by severing the dorsal and ventral aortas and leaving the remainder of the vascular system intact.

After one or two hours in the tank the carcasses are washed and carefully laid in cold sea water in a refrigerated seawater (RSW) tank with just enough water to cover the fish. A wooden partition running vertically fore and aft prevents the fish from moving as the vessel rolls.

On arrival in port, the fish are quickly unloaded onto an open truck (with a dog in the back!) and taken to the customer. The quality by now is mixed. Recently caught fish are still in rigor whilst some of the earlier catch are limp (post-rigor) and smell of ammonia. The vessel is a purpose-built multi-chine boat with good layout and ample working space. The crew is very proficient at catching fish. Standards of hygiene are good, and the deck and working surfaces are scrubbed clean after every shot. The carpet on which the fish lie whilst bleeding prevents movement (bruising) but undoubtedly causes contamination, some of which may be removed by the subsequent washing. The shark heads piled on the deck soon putrefy and attract flies. They should be bagged and chilled or otherwise discarded.

The gutting, bleeding and washing are very thorough, as is necessary to prevent ammoniation. Nonetheless, some ammonia was detected in the earliest-caught fish. It is caused by the enzyme urease breaking down urea in the flesh, and is a result of the catching method, which leaves dead fish in the net for several hours, and inefficient bleeding which leaves residual blood containing urease in the flesh. As urea is not broken down in the flesh of shark held at chill temperatures (Ehira, 1983; Bilinski *et al.* 1983), ammoniation is an indication of storage at high tempertures. Despite this the chilling rates achieved are good, as would be expected from an RSW system which uses galvanized refrigeration coils around the sides of the tank for chilling the water. As the tank is not full of water, there is a considerable build-up of ice on the coils at the surface of the water. The seawater in the tank is therefore really a concentrated brine solution and its temperature could fall well below 0 °C.

Inshore mesh netting

The vessel is a 5 m open, aluminium work boat powered by an outboard motor. It is operated by the proprietor of a retail fish shop two days a week to get supplies of fresh fish. Fishing trips last about five hours but, as will be seen, the net is in the water for up to twenty hours. The season is mid-winter, air temperature is 5 º-12 °C, water temperature is 11 °C.

The boat leaves port at first light, about 7 am, and reaches the fishing grounds in two to three hours. The fishing location is chosen from experience and no fish-finding equipment is used. The net is shot over the stern and recovered by means of a roller mounted along the gunwale. The haul is about fifty kg of fish of mixed species. The condition of the fish varies; some are still flapping, some are in rigor and some have passed through rigor. As the net comes in the fish are shaken into the bottom of the boat, where they are subject to contamination from bilge water and crushing by the fisherman's boots. The net is shot immediately, and then the fish are stowed in plastic bins. No ice is used on this vessel.

The nets are retrieved either that night or the following morning, depending on weather and the other commitments of the fisherman.

On the return trip, the fish are headed and gutted and stacked in plastic bins. They are off-loaded onto a four-wheel-drive, enclosed vehicle for the one hour trip to the shop. At the shop, the bins are loaded into a chill room.

This is obviously a very poor operation. The duration of each shot is variable. The handling of fish on the boat is bad, and considerable crushing and bruising are evident. At no time are the fish exposed to an efficient chilling system; even the chill room at the shop is designed only to maintain chill temperature, not to chill fish. The whole system is very amateurish, yet this fish may be offered to the public for a period up to five days. This operation overall is typical of the small-scale fishermen who supply fish to retail outlets, especially in rural areas, and may account for the reluctance of many people to buy local fish.

Discussion

The quality of fish offered to the public is affected by the condition of the fish when caught, method of capture, post-catch handling, temperature history, methods of processing, duration of storage and packaging. Most scientific work concentrates on factors that can be easily quantified, such as temperatures, time and pH, and is usually done in laboratories or on research vessels. When fish from commercial sources is used, it is frequently bought from markets and its previous history is not known.

Much of the quality loss seen in fish is caused by physical damage. Careful observations of handling practices at sea can assist in improving hull design, deck layouts, refrigeration facilities and handling practices to eliminate many of the causes of such abuse. Table 1 provides a comparison of the temperature history of the fish on the vessels described earlier. As fishing is a continuous operation, the times and temperatures chosen are estimated from the observations made. On time/temperature grounds alone, the purse seiner should have had far superior fish to the other vessels (Bremner *et al.* 1978). Such a judgement however, ignores the differences between the species caught and the handling practices used. There is a considerable body of knowledge, often fallacious, which influences the way inw hich fishermen handle various species; for example, some fishermen in Tasmania believe that ammoniation in shark is a sign that the animal is 'on heat' and 'kneeing' (bending) shark in rigor is thought by some to give it a tender texture. Fortunately, most of their knowledge is far more accurate and useful.

Conclusion

The foregoing descriptions give some idea of the types of observations that can be made in the field. The scope of this work can be extended to cover transport, processing, warehousing and retailing. Such work helps in identifying critical points in quality loss of seafoods and highlights areas where more research is needed. More emphasis should be placed on conducting research in collaboration with industry, using commercial vessels and processing plants that handle larger commercial quantities of raw material than is available on research boats. The benefits of such an approach are many: costs can be reduced because sampling a commercial batch is cheaper than buying large quantities of raw material; scaling up the results of such trials to commercial needs is easier; industry benefits from exposure to the scientific method and scientists benefit from more direct exposure to industry problems. The overall result will be more relevant tactical research and more rapid technology transfer.

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Australian consumer acceptance of novel foods

By Anthony Worsley[1] and David Crawford

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Seven hundred and thirteen randomly selected respondents reported on their consumption of 28 novel foods and ethnic meals in the three months prior to the survey.

Women, persons in younger age groups, and those in higher status occupations reported greater consumption of both novel foods and ethnic meals. The findings are discussed in relation to the adoption of innovations and the shift which has occurred during recent years, to a consumer society.

Introduction

Australian food consumption habits have changed radically since World War II. Our food supply now is generally thought to be composed of more ethnic and exotic foods than previously (Wood 1977). However, apart from casual observations at food outlets, and the unpublished activities of market research companies, there has been surprisingly little investigation of Australians' consumption of these "novel" or "exotic" foods. Thus it was desirable as part of a larger random population survey to include a list of "novel" foods and meals in order to examine the Australian population's usage of them.

It was also possible to examine the differing patterns of adoption of these foods across socio-demographic groups. For example, one might expect older people to be more conservative and hence to resist these dietary innovations more than younger people. Since most women still have major responsibility for food acquisition and preparation (Worsley unpublished) they might be expected to be exposed more to newer foods and so to adopt them more readily than men. Finally, studies of the social dispersion of innovations suggest that opinion leaders and persons of high social standing tend to be among the first to adopt new habits (Rogers and Shoemaker 1971). If this hypothesis applies to food we might expect more persons in high status occupations to use more of these foods.

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This brief exploratory study then, had two major aims:

1. to describe the usage of novel foods and meals among a random sample of adult Australians;
2. to examine the variations in usage across socio-demographic groups.

Method

A study of "diet and lifestyle" was conducted between October and November 1984, on a random sample, drawn from the South Australian Electoral Rolls, of the adult population of metropolitan Adelaide. Survey booklets were mailed to 1000 individuals and up to three reminders were sent at approximately fortnightly intervals thereafter. This methodology has been described in more detail elsewhere (Dillman 1978, Worsley 1984, Worsley and Crawford 1984). Sections in the survey dealt with dietary perceptions, lifestyle habits and personal values.

Respondents were asked: "which of these foods have you eaten in the *past three months*?"

Twenty-eight foods and meals were listed. The respondents were asked to circle the numbers beside those foods and meals they had eaten (Table 1).

Details of the respondents' sex, age, education, occupation, height and weight were also sought. Occupations were coded according to Daniel's revision of Congalton's seven point social status scale (Daniel 1984, Congalton 1969). Respondents in categories 1, 2 and 3 (e.g. doctors, lawyers, teachers) were grouped into a single high status category, those in categories 4 and 5 (e.g. clerks, skilled workers) into a middle status group, and the remainder (e.g. labourers) into a low status group. Women

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TABLE 1

Percentages of respondents in the Age, Social Status and Sex categories who consumed novel foods and ethnic meals in the three months prior to the survey

	Age Groups (years)							Social Status Groups				Sex	
	Total	<31	31-40	41-50	51-60	>60		High	Middle	Low		Men	Women
No. of respondents	707	190	147	103	125	142		148	319	218		327	379
Food													
Avocado	28	26	33	33	26	21	ns	55	18	25	****	22	33
Kiwi fruit	32	42	35	28	29	20	***	43	32	24	***	25	38
Paw paw	8	7	4	7	14	10	ns	12	6	11	ns	8	9
Grapefruit	36	22	27	47	47	49	****	42	27	46	****	32	40
Prawns	56	64	64	61	52	35	****	72	59	39	****	57	55
Oysters	20	25	25	21	19	9	***	34	20	11	****	24	17
Squid/calamari	31	47	35	32	23	11	****	43	35	17	****	15	28
Mushrooms	58	72	74	80	73	58	***	79	73	61	****	59	56
Eggplant	11	14	14	14	5	8	*	20	9	9	***	9	7
Capsicum	66	75	69	80	62	45	****	78	69	56	****	62	70
Yoghurt	45	52	50	53	35	31	****	52	46	38	**	37	51
Muesli	40	47	40	34	43	33	ns	47	39	35	ns	36	44
Wholegrain bread	76	80	78	79	67	75	ns	85	73	73	**	71	80
Bean sprouts	36	45	43	42	26	20	****	57	34	24	****	33	39
Phoenician bread	18	26	29	15	9	8	****	30	19	10	****	17	19
Dried fruits	61	61	66	65	59	55	ns	71	57	58	**	51	70
Mung beans	6	4	11	6	5	4	*	11	5	4	**	4	7
Kibbled wheat	13	15	10	11	12	13	ns	19	10	12	**	11	14
Chick peas	10	13	12	7	8	9	ns	12	8	11	ns	9	11
Lentils	19	22	23	16	12	18	ns	24	17	18	ns	17	20
Haricot beans	11	6	10	17	15	12	*	19	8	11	***	11	12
Soya beans	12	15	12	7	9	13	ns	12	12	11	ns	10	13
Lebanese meal	8	15	12	2	2	2	****	14	7	5	***	8	8
Asian meal	37	50	42	40	34	18	****	59	37	24	****	40	35
Indian meal	11	17	12	13	9	4	**	24	10	4	****	12	11
Italian meal	40	56	54	44	32	9	****	58	45	22	****	35	45
Greek meal	13	22	16	13	5	6	****	20	14	6	****	14	12
Vegetarian meal	31	32	35	36	30	23	ns	38	30	27	ns	25	36

Statistically significant differences between these categories are signified thus:
* = $p<0.05$; ** = $p<0.01$; *** = $p<0.001$; **** = $p<0.0001$

who described themselves as "housewives" were allocated their spouses'/partners' social status rankings.

Heights and weights were converted into body mass indices (weight (kg)/height (m)^2). These were divided into two categories according to health related criteria suggested by Bray (1978). The categories were: average weight (men: Body Mass Index (BMI) = 19.50 to 25.49, women: BMI = 18.50 to 24.49) and overweight (men: BMI $\geq$ 25.50; women: BMI $\geq$ 24.50). Underweight subjects were not included in subsequent analyses because of their small numbers.

Results

Seven hundred and thirteen people returned completed booklets. After allowance was made for confirmed non-deliveries (n = 85) the response rate was 78%. Examination of the sex, age and social status distributions of the sample showed them to be similar to those of the general population of metropolitan Adelaide (Australian Bureau of Statistics, 1983).

Table 1 lists the main findings from a series of contingency table analyses. These were of the form: sex/age social status groups by response categories, and age groups/social status groups by sex by response categories.

Overall consumption

Wholegrain bread, dried fruits, capsicum, mushrooms and prawns were among the most popular foods, each being consumed by over half the respondents. Yoghurt, muesli,

TABLE 2

Mean numbers of ethnic meals and novel foods consumed during the three months prior to the survey in the age, social status, sex and body mass status groups

Age groups (years)	<31 (186)	1-40 (143)	41-50 (97)	51-60 (119)	>60 (121)
No. ethnic meals	1.90	1.72	1.52	1.08	0.64***
No. novel foods	7.78	7.71	7.73	6.36	5.83***
Social Status Groups	High (144)		Middle (308)		Low (190)
No. ethnic meals	2.15		1.42		0.91***
No. novel foods	9.17		6.79		6.22***
Sex	Men (298)	Women (344)			
No. ethnic meals	1.34	1.52			**
No. novel foods	6.60	7.64			***
Body Mass Index (Bray's Categories) (1978)	Normal (402)	Overweight (226)			
No. ethnic meals	1.52	1.22			**
No. novel foods	7.53	6.58			**

* = $p<0.05$; ** = $p<0.01$; *** = $p<0.001$.

grapefruit, kiwi fruit, bean sprouts, avocado and squid/calamari were next in popularity, being eaten by between one-quarter and one-third of the sample. Asian, Italian and vegetarian meals were the most popular of the meals we listed. Inspection of the overall consumption column of Table 1 also shows that all of the foods and meals were consumed by substantial proportions of the sample.

Sex differences

Analyses of variance of the sum of novel foods consumed, and the sum of ethnic meals eaten, showed that women ate significantly more novel foods and ethnic meals than men (Table 2).

These sex differences were most pronounced with respect to avocado, kiwi fruit, squid/calamari, capsicum, yoghurt, wholegrain bread, dried fruits and Italian and vegetarian meals. Only oysters and Asian meals were more popular among men than women.

Age group differences

Analyses of variance of age group differences (Table 2) showed clearly that there was a decline in the mean number of ethnic meals consumed from the youngest to the oldest age groups, the drop being most marked among the 51-60 year olds and the over sixties. Similar decreases were observed in the numbers of exotic foods consumed. There were no statistically significant age group by sex interactions.

Consumption of individual foods and meals followed these general age related patterns, however:

- consumption of grapefruit *increased* with advancing age;
- no significant age group differences were associated with the consumption of avocado, paw paw, muesli, wholegrain bread, dried fruits, kibbled wheat, chick peas, lentils, soya beans or vegetarian meals, i.e. with respect to relatively popular or unpopular foods and meals.

Social status group differences

Consumption of ethnic meals and exotic foods was significantly greater among high status respondents than among middle or low status people (Table 2). No statistically significant social status group by sex interactions were found. Again the only exception to these generalizations was the consumption of grapefruit. Fewer middle status people ate this fruit than either low or high status respondents (Table 1). Significant differences were not observed with respect to either relatively popular or unpopular foods and meals.

Body mass

Overweight respondents of both sexes ate significantly fewer ethnic meals and exotic foods than average weight respondents (Table 2).

Discussion

These findings support the view that Australians' food consumption today differs from that of forty years ago. Asian and Southern European meals are commonplace, as is the consumption of foods from traditional Anglo-celtic cuisines. In this, Australia is similar to the USA, UK, West Europe and Japan — all of which have increased the variety of available food products.

Aggressive marketing campaigns, as with kiwi fruit and avocadoes, have probably contributed to these changes, as has the influx of migrants from Southern Europe and Asia. It should be noted that the reported consumption of each of the ethnic meals was several times greater than the proportion of members of ethnic minorities in the sample. Concerns about health may also have played a part in the popularity of products such as wholegrain bread, yoghurt and bean sprouts.

The greater preference of women for "novel" foods has not been widely reported previously. A recent Australian study of people over sixty-five, however, has shown that women generally have more heterogeneous deits than men (Horwarth 1987). The reasons for this sex difference are not clear. Women's greater preferences for wholegrain bread, yoghurt, fruit and vegetarian meals seem likely to be related to their generally greater concern with nutrition and health (Worsley 1987, unpublished manuscript). However, the greater popularity of other foods such as squid/calamari, and Italian meals may reflect women's greater exposure to the market place with its promotion of novel products. It may also be possible that some of these newer foods are perceived as women's foods rather as meat used to be seen and promoted as "men's food" (Lannon 1981). Differences in taste perceptions between the sexes may provide yet another explanation (Cowart 1981).

The age group differences clearly show that it is the younger groups which have adopted many of these dietary innovations. Again this agrees with the study referred to above. Age seems directly related to dietary conservatism (Horwarth 1987). The lone exception of grapefruit probably reflects older persons' generally higher intakes of citrus and other "conventional" fruit.

This raises the question of whether these age differences are cohort or ageing effects. A cross sectional study such as this cannot definitely indicate which is the more likely possibility. However, the fact that younger people select novel foods which were not generally available twenty or thirty years ago coupled with the observation that the older age groups reported lower consumption of these foods in both this and Horwarth's study does suggest that these differences are at least partly cohort effects rather than the effects only of ageing processes such as declining olfactory discrimination. Horwarth (1987) showed that older age groups had higher consumption of foods which were more common during their youth than today e.g. stewed fruit.

However, the usage of several foods such as wholegrain bread, muesli, lentils, chick peas, did not vary significantly across the age groups. These were foods which were either highly popular or rather unpopular. They seem to be foods which either have a wide following because of their generally agreed health benefits e.g. wholegrain bread, or appeal only to small groups involved in ethnic or alternative lifestyles.

At first sight the social group differences appear to confirm the generalization that innovations are taken up first by members of high status occupations. However, social status, education and age tend to be confounded to some degree. Younger people tend to be better educated and in higher status occupations than those in the oldest age groups. Thus the greater preferences of the high status groups for certain foods may, in part, reflect the fact that more members of these groups, and the tertiary educated group, were under 21 years of age.

Australian market research evidence (Benjamin, Gates, personal communications) suggests that these age and social group differences may be associated with the different lifestyles and values of these groups. For example there are strong demands, such as child care and full time work outside the home, made on the time available for young women with families to prepare food. Although "comprehensive" evening meals are still expected by family members, these women are less able to spend time to prepare them. Hence they rely more on convenience foods and labour saving techniques such as microwave cooking. In general young people appear to be more consumer orientated than members of older genrations (Worsley, 1987).

There is an established experimental literature on the differences between obese and non-obese persons' eating behaviours (Stunkard 1980). The present finding that obese people ate fewer ethnic and novel or exotic foods is in keeping with those studies which have shown the obese to be more restrained in their usual dietary patterns (Brownell and Stunkard 1980, Herman and Polivy 1980). Is this restraint part of attempts to reduce energy intake or does it reflect a more fundamental fear of exoticness or luxury in food?

The main conclusions to be drawn from these findings are that:

1. present day diets contain more exotic foods and meals than those of earlier generations;
2. women and younger people consume more of these foods and meals than men and older people.

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Controlled atmosphere storage of bananas in bunches at ambient temperatures

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Introduction

Bananas are produced in quantity throughout the year in Australia with major production areas situated along the east coast, in particular northern New South Wales and northern Queensland. Production and prices fluctuate considerably. Seasonal shortages may result from the effects of strong winds or cold winters while periods of overproduction occur, particularly in the summer months. When high levels of production occur in New South Wales and Queensland at the same time, the cost of production plus the cost of transporting the fruit to market may be more than the wholesale price. New South Wales growers have had an industry-financed scheme that withdraws some of the excess production from the market during these periods of overproduction. Considerable quantities of fruit may be withdrawn from the market for several weeks. After the 'glut' has passed the wholesale price of bananas often rises considerably. Thus it may be profitable to store bananas in Australia, if a low-cost controlled atmosphere system was available. In developing countries in the tropics, bananas are a staple food. This is true for lowland areas of Papua New Guinea where bananas can be in short supply during the dry season. Low-cost storage systems therefore may be of value also in countries such as Papua New Guinea.

This paper reports the results of initial experiments on the storage of bananas in bunches held in a plastic room under controlled atmosphere conditions. The studies were carried out at the Division of Food Research, North Ryde. The project was sponsored by the Australian Centre for International Agricultural Research (ACIAR).

Materials and Methods

A plastic room (Fig. 1) was constructed for the controlled atmosphere storage of bananas using a support frame, made from PVC tubing which was covered with polyethylene film (thickness 200μm). The joins in the film were heat-sealed to ensure gas tightness. A wooden box 1.6 m long x 0.6 m wide x 0.6 m deep, was fitted with 24 staggered shelves and attached to the plastic room. A layer (15 mm) of potassium permanganate on aluminium oxide (Purafil) was placed on the shelves (total wt. 19.2 kg) to

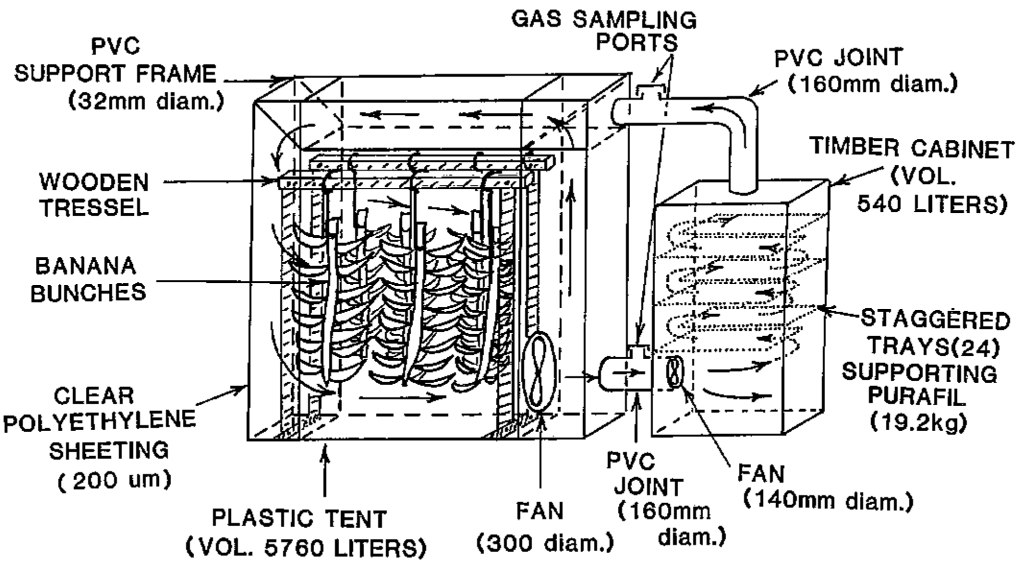

Fig. 1. Plastic tent and ethylene scrubbing box used for the controlled atmosphere storage of bananas.

absorb ethylene from the storage atmosphere. A fan circulated the atmosphere between the room and the box containing the Purafil. To obtain the controlled atmosphere inside the plastic tent (~ 2% O_2 and ~ <5% CO_2), gas cylinders containing high purity nitrogen (CIG Australia) were used to flush the tent to low oxygen levels. Carbon dioxide was introduced into the tent as required to maintain the desired concentration.

Two experiments were conducted using ten banana bunches of the cultivar 'Williams'. Bunches were selected for uniformity of size and maturity at plantations in the Coffs Harbour district of New South Wales. During transport by road to the CSIRO Division of Food Research laboratory at North Ryde each bunch was supported on a 'U'-shaped block of polystyrene (length 1.2 m x 0.4 m wide x 0.16 m deep) to minimize mechanical damage.

On arrival at the laboratory the bunches were sprayed with Benomyl (0.1%) (marketed by Du Pont as Benlate) to reduce fungal wastage. Seven bunches were placed inside the plastic, gas-tight room held under cover at ambient temperature. To prevent mechanical damage during storage, the bunches were supported vertically off the floor by a nylon rope attached to wooden trestles while the other three bunches were similarly suspended outside the plastic room as controls.

Before storage three fruit were taken from each bunch, placed individually in glass jars and ventilated with ethylene free air at 20 °C. Respiration (carbon dioxide production) was

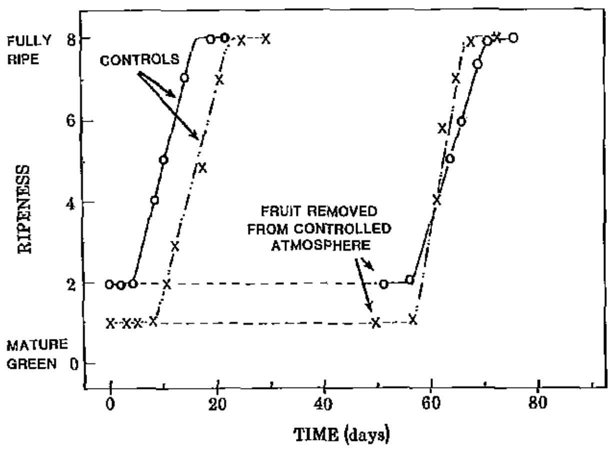

Fig. 2. *Storage of banana bunches in a controlled atmosphere compared to storage in air at the same temperatures.*

Expt.1 Expt.2
(O-O) (X---X) Controls – fruit held in air at ambient temperature.
(O-O) (X---X) Stored in a controlled atmosphere (≈ 5% CO_2, 3% O_2 and 0.01 µl/l C_2H_4) at ambient temperature, then allowed to ripen in ethylene-free air at 20°C.

measured by sampling (1 mL) the atmosphere within the jar and injecting it into a gas chromatograph (GOW MAC - Series 550) having a thermal conductivity detector. The time to the onset of ripening (green life) was determined by scoring individual fruit for colour using the standard colour index (Anon. 1971) where 1 = mature green and 8 = fully ripe (Fig. 2).

During storage, carbon dioxide and oxygen concentrations in the controlled atmosphere plastic room were measured as above. Ethylene concentrations were measured using a gas chromatograph fitted with a flame ionization detector (McGlasson, 1969). Temperatures were monitored using a maximum and minimum thermometer. After storage was completed, the bunches were dehanded and the fruit washed with water and treated with Benomyl (0.01%). Five fruit from each bunch were placed in jars and ventilated with ethylene free air at 20 °C to determine green life. The remaining fruit were packed as hands in cartons and ripened at 20 °C with ethylene (20µl/L).

Results and discussion

The respiration measurements indicated that the fruit in both experiments were preclimacteric at the beginning of storage. The minimum and maximum ambient temperatures for both experiments are shown in Fig. 3. The concentrations of carbon dioxide, oxygen and ethylene inside the storage tent were also monitored (Fig. 4). The control bunches were allowed to ripen naturally and showed signs that ripening had commenced after 4 days (Expt. 1) and after 8 days (Expt. 2). The fruit was fully ripe (colour index = 8) after 14 and 20 days respectively from the commencement of each experiment (Fig. 2).

In both experiments, fruit held in the controlled atmosphere remained green and firm. After about 1 month's storage there was some white mycelial growth forming on the flower ends of the fruit and there was some evidence of a rot progressively extending down the bunch stalk from the cut end. However after 6 weeks when storage was terminated the bunch stalk rot had not reached the first hand. The fruit were still hard and green on each bunch after storage except for 3 or 4 ripening fruits in the top hands of 2 bunches in experiment 1, and 3 bunches in experiment 2 which were showing signs of ripening at the end of each experiment. After the fruit were dehanded and washed, the fine mycelial growth disappeared and there was no evidence of fungal infection.

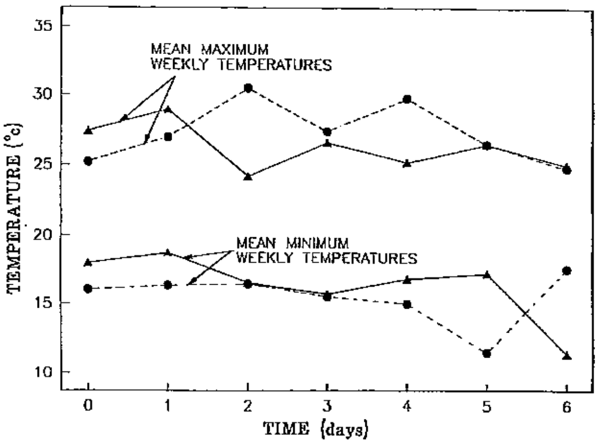

Fig. 3. Mean minimum and maximum weekly storage temperatures inside the plastic tent.
Expt. 1 • Expt. 2 ▲

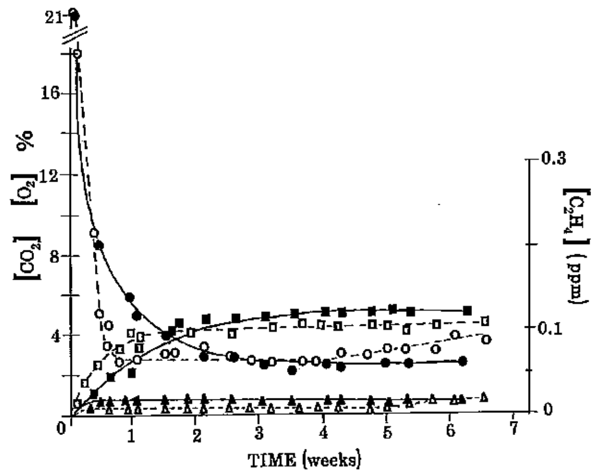

Fig. 4. Ethylene, carbon dioxide and oxygen concentrations inside plastic tent.

	Expt. 1	Expt. 2.
Ethylene	▲—▲	△---△
Carbon dioxide	■—■	□----□
Oxygen	●—●	○---○

Samples of fruit that was then placed in jars at 20 °C and ventilated with ethylene free air, began to ripen (score 3 for colour) after a further 11-12 days (Fig. 2). Thus there was an adequate shelf life remaining after controlled storage for 6 weeks. The remainder of the fruit was packed as hands in fibreboard boxes and ripened at 20 °C with ethylene (20μl/L). This fruit ripened normally in 4-5 days and appeared similar to normal commercial fruit ripened a few days after harvest. Eating quality was determined by a small laboratory panel who found the bananas acceptable.

Conclusion

This study shows that preclimateric bananas can be stored for considerably longer periods under controlled atmosphere conditions in a low cost plastic tent, at a range of ambient temperatures. A five fold increase in storage life (Fig. 2) was obtained for controlled atmosphere stored fruit, compared to bananas stored in air at the same temperature. The successful use of a low cost plastic room for controlled atmosphere conditions means that banana storage periods can be extended during seasons of overproduction, for a moderate capital outlay. Finally, the stored fruit exhibited an adequate post-storage life of 11 to 12 days during which they ripened normally.

Acknowledgement

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People prefer coloured flavours

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A cartoon on the second author's noticeboard depicts a man standing in front of a drink vending machine. Affixed to the machine is the sign: "3 Flavours — pink, yellow, green".

Facetious though it may be, such confusion between colour and flavour is not entirely fanciful: colour has long been recognized to influence the identification and acceptability of foodstuffs (e.g. see Amerine, Pangborn, and Roessler, 1965, p.220; DuBose, Cardello and Maller, 1980; Stone and Pangborn, 1968). This note reports another instance of the effect of colour on acceptability.

Method

A survey was carried out in an icecream parlour in Dee Why, a beachside suburb of Sydney, over a period of four weeks in late summer. The parlour was open 12 hours a day, seven days a week.

In the window of the freezer cabinet were displayed 12 flavours of icecream, side by side, six coloured and six uncoloured (see Table 1). Each contained appropriate flavouring material (Fritzsche Dodge & Olcott Pty Ltd). Ten of the flavours served as "background" and were held constant throughout the study, while presentation of the other two followed a crossover design: uncoloured passionfruit and coloured butterscotch were presented in week one, coloured passionfruit and uncoloured butterscotch in week two; uncoloured rockmelon (cantaloupe) and coloured peppermint chip in week three, coloured rockmelon and uncoloured peppermint chip in week four.

The four flavours surveyed are routinely sold with or without color, so presentation in either form would not arouse any unusual consumer reaction; however, note that coloured and uncoloured icecream of the same flavour was not presented simultaneously. All flavours were clearly labelled but no reference was made to colour (e.g. both uncoloured and coloured passionfruit were labelled "passionfruit"). For each of the surveyed flavours, the time taken for purchase of 12 litres (approximately 108 scoops) was noted.

TABLE 1
Icecream flavours displayed during the survey

Flavour	Colour*
Surveyed	
Passionfruit	orange/yellow (Beta carotene)
Passionfruit	white
Rockmelon	orange/yellow (Beta carotene)
Rockmelon	white
Butterscotch	brown (caramel)
Butterscotch	white
Peppermint chip	green (chlorophyll)
Peppermint chip	white
Background	
Vanilla	white
Chocolate	brown
Vanilla chocolate chip	white
Orange chocolate chip	orange
Peach mango	white
Boysenberry	purple
Honeycomb	white
Caramel toffee	brown
Rum raisin	white
Coffee walnut	brown

*Refers to the predominant colour only; some flavours (e.g. vanilla chocolate chip) contained particles of a different colour.

TABLE 2
Time taken (hr) for purchase of 12 l of icecream

Flavour	Uncoloured	Coloured
Passionfruit	44	15
Rockmelon	40	16
Butterscotch	27	9
Peppermint chip	36	9

Results

Table 2 gives the time for purchase of the four icecream flavours when presented uncoloured or coloured. In every case the coloured flavours out-sold their uncoloured counterparts by approximately 3:1. For example, the *coloured*

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passionfruit icecream was sold in 15 hr whereas the same quantity of *uncoloured* passionfruit took 44 hr to sell.

Colour aside, there were differences in consumption among flavours, with passionfruit and rockmelon less popular than butterscotch and peppermint chip. Nevertheless, the consumption of coloured passionfruit and coloured rockmelon clearly exceeded that of uncoloured butterscotch and uncoloured peppermint chip, suggesting that colour plays a more important role than labelled flavour in determining the consumer purchase of icecream.

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Normal Q-Q plots

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Introduction

Availability of computer graphics software and hardware has made preparing even quite complex plots an easy task. Plots are often more informative and easier to follow than tables. In this note normal Q-Q (quantile-quantile) plots useful for statistical analysis are discussed. These plots are useful for examining normality and as a graphical complement to *t*-tests. They are also useful in the design and evaluation of certain food quality control procedures.

Normality

The assumption that certain measurements are distributed as normal or Gaussian variables is fundamental to many of the commonly used statistical methods. For example, when a "*t*-test" is done to compare two samples this assumption is implied. The mean and standard deviation are, in fact, just the small sample estimates of the two parameters of the normal distribution. This suggests that the normality assumption should be checked before using the mean and/or standard deviation to summarize a set of numbers.

A commonly used plot for examining the normality of a set of measurements is a histogram. For example, a histogram of the following 50 measurements of % protein content (fat-free) basis from a random sample of acceptable canned hams is shown in Figure 1:

18.6	15.8	18.3	18.2	17.2	20.1	17.8	17.9	17.5
17.2	17.4	18.3	17.8	18.0	18.9	17.2	18.5	16.5
17.9	19.1	17.1	15.6	19.8	18.3	19.0	17.2	17.3
18.3	18.1	18.7	19.4	16.7	16.9	17.6	16.6	17.0
18.3	18.2	18.0	17.5	19.7	18.4	18.5	18.3	17.9
18.6	17.5	17.4	18.1	19.0				

Figure 1 also shows a superimposed fitted normal curve. Such histograms are easily made with most computer graphics packages while modifications to produce the fitted curve are also not difficult. From Figure 1 we might conclude "by eye" that the data are normally distributed.

However, a difficulty with the use of a histogram is that, particularly for small data sets, different choices of number and size of classes can result in quite different plots. Thus it is usually not advisable to make conclusions

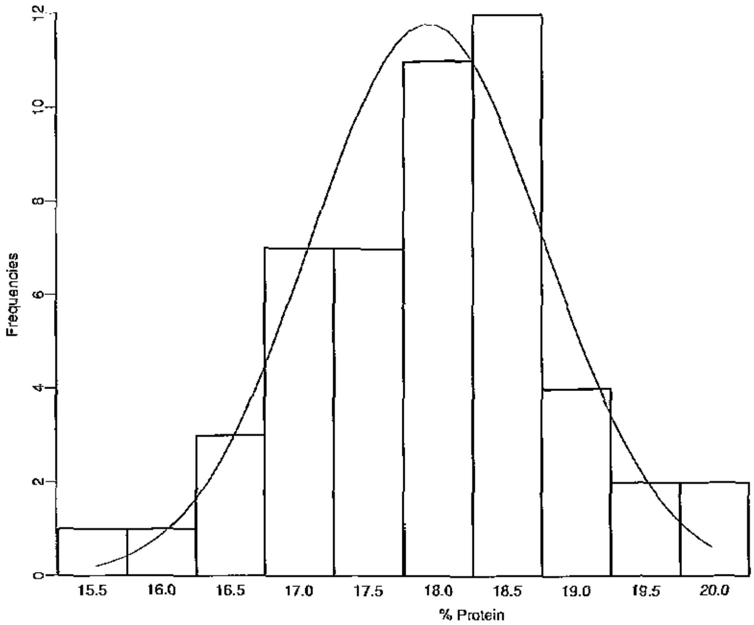

Fig. 1. *Histogram and Normal Curve.*

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based on histograms of small data sets. For this reason another common plot for checking the normality assumption is to plot the data, ordered from smallest to largest, against "expected values" for a normal distribution. These "expected values" are easily calculated for any sample size and a good method is given in the Appendix. Figure 2 shows such a plot, called a normal probability plot, or a normal quantile-quantile (Q-Q) plot, for the canned ham data. The ordered data points are called quantiles and other names for the normal "expected value" are normal score and normal quantile. Hence the name normal quantile-quantile or normal Q-Q plot. The plot provides a description of the data and it can be seen immediately that the median is about 18.0 (the protein value corresponding to the zero value normal score) and the range about (20.5–15.5) = 5.0.

The linearity of the plot confirms the data can be considered to be normally distributed. If the plot is linear then its slope (about unity in this case) estimates the sample standard deviation while the median is then the same as the mean. Normal Q-Q plots are also useful for (i) highlighting "outliers" or badly recorded values or (ii) indicating if working with transformed data might be better. Given that % protein of acceptable canned hams is normally distributed it is sensible to summarize such data by the mean and standard deviation. Other implications are, for example, that a variables sampling inspection scheme suitable for import/export regulations or quality control of canned ham can be designed using the usual normal theory. A formal statistical test of significance for normality is a good complement to the normal Q-Q plot and the interested reader is referred to Best and Rayner (1985).

Students' t

A Students' t-test is a well-known statistical method for comparing the means of two sets of numbers. However, for such a test to be valid, three assumptions about the two sets of numbers must be satisfied. These are (i) independence of the numbers (ii) normality and (iii) homogeneity of standard deviation. Assumption (i) can usually be assured by correct experimental technique while assumptions (ii) and (iii) can be examined using the normal Q-Q plot we are discussing. Consider the following two sets of data which are determinations of the concentration of a chemical using a standard (S) and a quick (Q) method:

S:	23	24	25	26				
Q:	23	18	22	28	17	25	19	16

Normal Q-Q plots for each set of data can be superimposed and given in the one figure (see Figure 3).

The "by eye" lines through the S points and through the Q points would have different slopes. This indicates different standard deviations and violation of assumption (iii) above. The linearity of the plots of the S and Q data suggests that assumption (ii) is plausible. The overall higher values for S rather than Q which is evident in Figure 3 indicate the mean of S may be significantly greater than the mean of Q. In this case where standard deviations

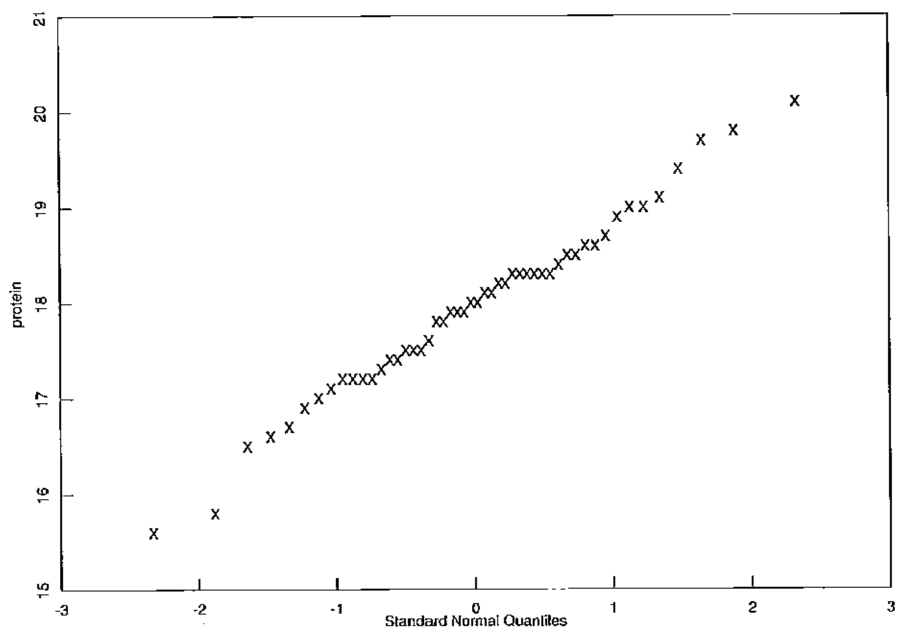

Fig. 2. Normal Q-Q plot of % protein data.

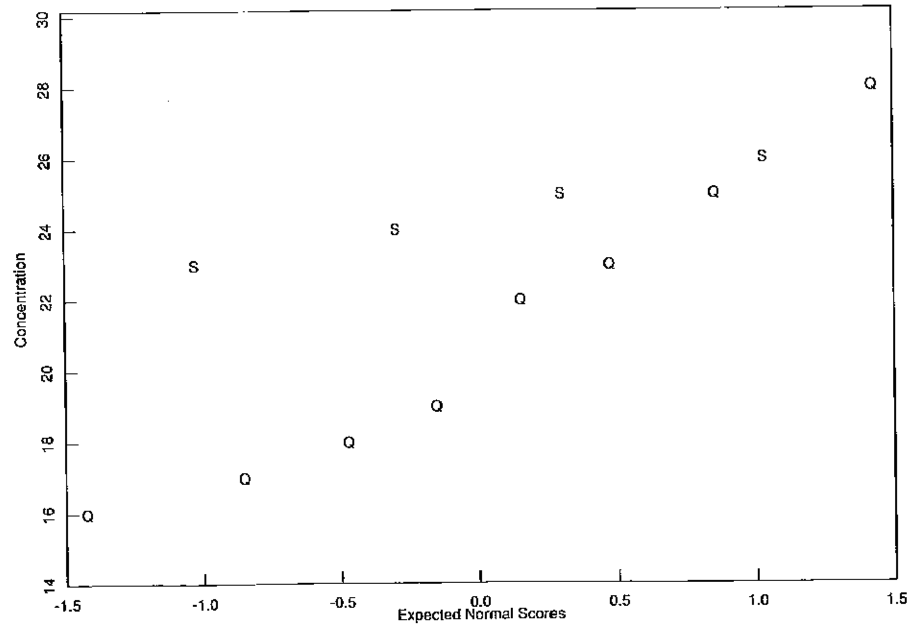

Fig. 3. Normal Q-Q plot for chemical data.

differ, a more appropriate *t*-test is a Welch *t*-test which is provided, along with Students' *t*-test, on many computer packages. For these data the usual Student *t*-test is less significant than the Welch *t*-test. For more discussion of Welch's *t*-test see Best and Rayner (1987). Figure 3 in itself, however, gives a good comparison of the two data sets.

References

Best, D.J. and Rayner, J.C.W. (1985) Lancaster's test of normality. *Journal of Statistical Inference and Planning,* **12,** 395-400.

Best, D.J. and Rayner, J.C.W. (1987) Welch's approximate solution for the Behrens-Fisher problem. *Technometrics,* **29,** 205-10.

Appendix

Suppose a sample of size n is drawn from a normal population with zero mean and unit standard deviation. Further, suppose that the sample is ordered from smallest, x_1, to largest x_n say. The mean or expected values of the ith largest value, $E(X_i)$, say, is given to a good approximation by $4.91(z_i^{0.14} - (1 - z_i)^{0.14})$ where $z_i = (i - 3/8)/(n + 1/4)$ and $i = 1, 2,\ldots,n$. The $E(X_i)$ are called "standard normal quantiles" or "expected normal scores" or "normal order statistics". The first two of these are often abbreviated to "normal quantiles" and "normal scores".

News from the Division

Retirements

Alan R. Johnson

Dr Alan Johnson has retired from CSIRO as a Chief Research Scientist after 26 years in the Division. He has been the Officer-in-Charge of the Food Research Laboratory and Assistant Chief of the Division of Food Research since 1978, and Acting Chief of the Division on many occasions.

Alan Johnson was born in Yorkshire and obtained his PhD in Biochemistry from the University of Leeds in 1953. His non-scholastic activities at the University included cross country running and work with Leeds University Union, of which he was president in 1949, and the British National Union of Students. He developed an interest in Bridge which continued throughout his career, and he especially enjoyed playing in the regular lunchtime Bridge sessions at the Laboratory.

In 1953 Alan came to Australia to take up a position as Lecturer in Biochemistry at the University of Adelaide. Later he became Project Leader of the Commonwealth Antioxidant Research Project at this University, while maintaining his connection with the Biochemistry Department.

In 1961, after a year at the DSIR Fats Research Laboratory in New Zealand, Alan came to Sydney to join CSIRO as a Senior Research Scientist in the Animal Products Section of the Division of Food Research. He became Section Leader of that Section in 1964, and of the Biochemistry Section which replaced it, and in 1978, after a short period in an acting capacity, became Officer-in-Charge of the Food Research Laboratory and Assistant Chief of the Division.

Alan Johnson's involvement with antioxidants in Adelaide and with fats and oils in New Zealand led him to specialize in the biochemistry of fats and oils at CSIRO. His initial research in lipids at FRL centred on the effects of cyclopropene fatty acids on egg yolk lipids. This work was funded by a PL480 Grant from the USDA. The small team of researchers assembled by Alan Johnson during this period became established within the Division as "the lipid group", and work on food lipids and lipid-related problems has continued to the present day. Among the larger studies undertaken were ones on the fatty liver and kidney syndrome in broiler chickens, on polyunsaturated foodstuffs prepared by the protected lipid process (in which Alan Johnson was overall co-ordinator of studies undertaken within the Division and responsible for the interfacing of CSIRO with its commercial partner), and on the Sudden Infant Death Syndrome. In 1969 Alan Johnson and his colleagues organised a summer school on "Biochemistry and Methodology of Lipids", and he then edited (with J.B. Davenport) a text with the same title. Alan's scientific papers cover many facets of lipid research, and in the course of his career he made several overseas trips to enlarge his experience in this field. In 1969 he was invited to spend a year as Visiting Scientist at the Unilever Research Laboratory at Bedford in the UK, and in 1975 he spent a year as Visiting Scientist at the Department of Nutrition and Food Science, Queen Elizabeth College, London. Shorter trips were made in connection with the PL480 grant and with the studies on polyunsaturated ruminant foodstuffs, and in his capacity as Australian delegate to Codex meetings and to meetings of the IUPAC Commission on Oils and Fats. In this last capacity Alan has involved the FRL lipid group in a number of collaborative studies of lipid analytical techniques, which enable comparisons to be made between this laboratory and similar groups around the world.

Alan Johnson's wide-ranging experience has involved him in membership of numerous Committees and Advisory panels. He has acted as CSIRO representative on the CEMAA Poultry Research Advisory Committee and the Australian Chicken Meat Research Committee and Advisory Panel since 1970. More recently, in his own right, he was appointed to the Chicken Meat Research Council. He has been on organising Committees for Australian and World Poultry Science and Production conferences. Other international duties included representation at the meetings of the IUPAC Commission of Oils and Fats, the Codex group on Oils and Fats, the International Dairy Federation, and the International Conference on the Biochemistry of Lipids.

At one time Alan was chairman of the steering committee which set up the Australian Nutrition Foundation in 1978, and has been a member since 1979, and Chairman since 1982, of the NH and MRC Working Party on Food Composition data. This Working Party was involved in revising and updating the Tables of Composition of Australian Foods, and the first set of revised Tables should be available later this year. He has been a member of the NH and MRC Working Party on Standards for Special Dietary Foods since 1980, and of the Nutrition Committee of the Australian Academy of Science, also since 1980. He was Chairman of the Sydney Group of the Nutrition Society of Australia when the Society's Annual Conference was held in Sydney in 1981. He is a member of a number of scientific societies, and a Fellow of the Australian Institute of Food Science and Technology.

In his capacity as Officer-in-Charge of the Food Research Laboratory, Alan Johnson was responsible for a variety of innovations. At his suggestion, each officer retiring from the Laboratory is now presented with a bound volume containing all of his or her published work, and a similar copy is placed in the Library. Alan was a keen advocate of the participation of all staff in consultations with management as part of the process of making management decisions. Alan was an enthusiastic proponent of regular "counselling" of all members of staff to ensure that their views and aspirations would be received by management. Furthermore he instituted a system of regular meetings of a Laboratory Advisory Committee, comprising representatives of all groups within the Laboratory, as a means of communication from management to staff and *vice versa,* in matters concerning the operation of the Laboratory. Similarly he held regular meetings of the Group Leaders to discuss financial and research matters.

Alan Johnson and his wife Jeanne propose to return to England to live closer to their daughter, son-in-law and granddaughter. Alan is not planning to become mentally idle and has already accepted some offers to act as a UK representative of Australian firms and organisations, and would welcome discussion of similar offers.

We have greatly appreciated Alan's contribution to the scientific work of the Division, and his untiring efforts in the management of the Food Research Laboratory during nearly ten years of financially difficult times. We shall miss Alan and Jeanne from our occasional social events after they leave Australia, but we will not forget them, and we wish them well for the future.

George Fisher

George Fisher retired in December 1986 after 16 years service with the Division of Food Research. George was appointed in 1970 as Technical Secretary of the Division of Food Preservation but was best known outside the Division for his work as Consumer Liaison Officer with the Food Research Laboratory, a role he adopted progressively from 1974.

After early training in physics George was for many years active in the field of non-destructive testing. Prior to joining the Division he had been assistant secretary at what was then the Australian Institute of Nuclear Science and Engineering, Lucas Heights, N.S.W. George retained a special interest in nuclear energy and its peaceful uses throughout his career. He was also a keen student of national science policy, where it existed, and in 1979 he completed a Master's course in "Science and Society" at the University of NSW.

As Technical Secretary George was for several years Secretary of the Standing Committee on Agriculture's Horticulture Post Harvest Committee which coordinates research in CSIRO and State Departments of Agriculture. He was also Secretary of the Editorial Committee of CSIRO Food Research Quarterly for his 16-year period with the Division.

George has a wide interest in social and political questions and enjoyed his role of looking after and settling the many visiting workers to the Division. His attention to details of housing and transport for visitors to this country, often with a limited command of English, made him many friends.

George was responsible for the printing and distribution of the 14 consumer leaflets produced over several years by the Division and prepared one of the most popular of these leaflets, 'How to Handle Chicken — Fresh or Frozen' himself. He was also responsible for having the leaflet 'Handling Food in the Home' translated into 14 different languages to reach the widest possible audience. Despite his strong aversion to public speaking George effectively maintained links with a number of organizations whose interests in food and public information were closely allied to those of the Division. At the time of his retirement George was National Secretary of the Australian Nutrition Foundation and served on two advisory committees of the Australian Consumers Association. It is ironic that in 1986 two of George's abiding professional interests, sound scientific information for the public and irradiation of foods should become uneasy partners in the media.

Toward the end of his time with the Division, George became fond of saying 'You'll miss me when I'm gone'. He was of course quite right. George intends to spend his retirement writing about food irradiation for the general public, growing avocadoes in Queensland, minding his wife's cats and drinking the big Australian red wines he has been carefully maturing. His friends from the Division and elsewhere wish him well in all these endeavours.

John H. Last

John Hunter Last joined the Division of Food Preservation and Transport in 1950 as a Junior Laboratory Assistant and 36 years later retired from the Division of Food Research as an Experimental Scientist Grade III. John graduated from Sydney Technical College in 1956 with an Associate Diploma in Applied Chemistry, and by the time of his retirement was author or co-author of more than 20 scientific papers.

As a Technical Assistant, John worked with S.M. Sykes and J.H. Scheltema in the Freezing of Fruit and Vegetable Section of the Division. By 1956 his all round skills in the handling and processing of crops had developed to the stage where he was virtually in charge of the experimental programme of this Section. It was during these first six years in the Division that John gained the extensive knowledge of harvesting, food processing and packaging, which in later years was to be used to advantage in the field of food flavours.

With the reorganisation of the Division in 1959, John was joined by Jack Shipton and G. Walker in what was to become the Quick Frozen Foods Section. John, now an Experimental Officer, Grade I, was the only serving member of the original team working on the freezing of food, and his experience and general knowledge in this field was of critical importance to the new section during its formative years. Over the next five years John and Jack worked closely with the infant Australian frozen food industry, developing and evaluating new processes in the production and transportation of frozen foods. They also introduced the local industry to a range of frozen vegetables not then processed in this country. In 1963, with the frozen food industry well established, John and Jack commenced work on the causes of off-flavours in frozen peas. This led in 1966 to the amalgamation of the Quick Frozen Foods Section with K.E. Murray's gas chromatography-mass spectrometry team to form the Flavour Chemistry Section, and John's investigation was transformed into a team project involving six scientists.

Over the next seven years John directed his energies to developing techniques for the isolation of volatile components from foods, and their examination by gas chromatography. With Frank Whitfield, John commenced sniffing the effluent from gas chromatography columns in an effort to establish which volatile components were dominant in the flavour of foods. It was during this period that John and Frank discovered the importance of the three 2-methoxy-3-alkylpyrazines in the flavour of green peas and that of the edulans in passionfruit juice. However, it took many years of team effort to identify these compounds fully.

In 1973 the Division needed to develop an expertise in the application of extrusion technology to the production of textured protein foods. John and Jack Shipton were given the difficult task of acquiring practical information for another infant industry. Armed only with a pilot-scale extruder which suffered from many serious defects in design and performance, they accepted the challenge. John identified the major faults in the machine and, using skills learnt in the 1950s, modified its design to improve its performance dramatically. Using this equipment he then succeeded in developing several new textured protein foods from novel seed sources. In 1978, Jack's ill-health caused him to transfer to Administration, the textured protein project was terminated and the Shipton-Last partnership which had endured 19 years ended.

John returned to the Flavour Chemistry Section, now under the leadership of Frank Whitfield, and so began a most profitable eight years in which he was co-author of some 12 research papers. Using all the skills he had learnt during the previous 28 years with the Division, he became an invaluable member of the team. His ability to perceive the key aroma components in foods had been recognised in his previous association with the Section. Now with a new freedom to concentrate fully on the odours eluted from his gas chromatograph he demonstrated he was the owner of the most sensitive and discriminating nose in the laboratory, a title previously claimed by one or two pretenders. With a greater emphasis during these years on the causes of off-flavours in the food industry, John's knowledge of factory conditions complemented the Section's scientific expertise. The successful solution of many major industrial problems, such as the occurrence of faecal off-flavours in french fries and musty taints in dried fruits, were due in no small way to John's many skills and his ability to work as part of a team.

John, always a perfectionist at heart, believed emphatically that there was only one way to carry out an experiment — the right way. In 1986, and faced with another Divisional reorganisation, John carefully weighed the pros and cons of early retirement and decided that the tennis court was more attractive than the laboratory bench. It is to be hoped that John's only disappointment on retirement was the failure, during these 36 years, of Ipswich to win the British football championship.

F.B. Whitfield

Jack Middlehurst

Jack Middlehurst retired from the CSIRO Division of Food Research, Food Research Laboratory as a Senior Principal Research Scientist in December 1986 after 36 years with CSIRO. Prior to 1963 Jack had been with the Division of Physics.

Jack Middlehurst played a key role in the research management of the Laboratory, initially as Leader of the Physics Section, and over the last 10 years as Group Leader with the Food Structure Group. On occasions he served as Acting Officer-in-Charge of the Laboratory. In these roles he demonstrated a notable capacity to lead research into both basic and applied problems in the food industry.

Jack Middlehurst's published work covers a remarkable breadth of activities ranging through the development of scientific equipment, the concept of a new form of water — polywater — practical aspects of heat and mass transfer, and computer simulations. Unfortunately the exciting concept of polywater, whilst being accepted by the editors of the most prestigious scientific journals, proved to be invalid.

His research has had a considerable impact on the container industry, particularly in providing recommendations to overcome the effects of condensation in transporting canned foods from one temperature zone to another. His knowledge and research into heat and mass transfer resulted in joint publications with Keith Richardson and led to the introduction of a new Australian standard for frozen food retail cabinets.

Towards the end of his research career, he collaborated with Bruce Cornell and Norman Parker on theories of membrane formation and modelling studies of the structure of membranes.

Jack Middlehurst has an analytical mind which he used to advantage in his considerable expertise in computing and electronics. He was the principal advisor to the Laboratory in these areas. Since his retirement he has set up a company, Aguila Holdings, to act as a programming consultant. It is pleasing to note that his knowledge in this area will still be accessible.